FRENIC 5000VG7S USER'S MANUAL

High-performance, Vector Control Inverter

FRENIC 5000VG7S Series

MEH407

Introduction

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

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

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

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

Introduction

Safety Instructions

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

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

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

Instructions on use

⚠WARNING

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

There is a risk of accident.

Instructions on installation

⚠CAUTION

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

There is a risk of fire.

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

Electric shock or injury may result.

⚠CAUTION

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

Instructions on wiring

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

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

Introduction

Instructions on operation

⚠WARNING

- Be sure to install the surface cover before turning on the power (closed). Do not remove the cover while power to the inverter is turned on.

Electric shock may occur.

- Do not operate switches with wet hands, **as electric shock may result.**
- When the retry function is selected, the inverter may restart automatically after tripping. (Design the machine to ensure personal safety in the event of restart)

Accident may result.

- When the torque limiting function is selected, operating conditions may differ from preset conditions (acceleration/deceleration time or speed). In this case, personal safety must be assured.

Accident may result.

- As the STOP key is effective only when a function setting has been established, install an emergency switch independently, and when an operation via the external signal terminal is selected, the STOP key on the keypad panel will be disabled.

Accident may result.

- As operations start suddenly if alarm is reset with a running signal input, confirm that no running signal is input before resetting alarm.

Accident may result.

- When an alarm is activated, the motor coasts. If the motor needs to be stopped in such a case, install a brake to the machine with the motor.

Accident may result.

- If AUTO RESTART is selected in the restart mode after momentary power failure (function code F14), the inverter restarts automatically starting the motor rotation when the power is recovered.

Accident may result.

- When the tuning (function code H01) is started, the motor, machine or equipment starts and stops repeatedly. Ensure safety before performing tuning.

Accident may result.

- If the user set the function codes wrongly or without completely understanding this user’s manual, the motor may rotate with a torque or at a speed not permitted for the machine.

Accident or injury may result.

- Do not touch inverter terminals when energized even if inverter has stopped.

Electric shock may result.

⚠CAUTION

- Do not start or stop the inverter using the main circuit power.

Failure may result.

- Do not touch the heat sink or braking resistor because they become very hot.

Burns may result.

- As the inverter can set high speed operation easily, carefully check the performance of motor or machine before changing speed settings.

Injury may result.

- Do not use the inverter braking function for mechanical holding.

Injury may result.

- During pre-excitation, the speed adjuster does not function and the motor may be rotated by load disturbance. When using pre-excitation, therefore, also use the mechanical brake.

Injury may result.

- If improper data is set at the function code related with speed adjuster as in the case of setting high gain abruptly, the motor may hunt.

Injury may result.

Instructions on maintenance, inspection, and replacement

⚠WARNING

- Wait a minimum of five minutes (15kW or less) or ten minutes (18.5kW or more) after power has been turned off (open) before starting inspection. (Also confirm that the charge lamp is off and that DC voltage between terminals P(+) and N(–) does not exceed 25V.)

Electric shock may result.

- Only authorized personnel should perform maintenance, inspection, and replacement operations. (Take off metal jewelry, such as watches and rings. Use insulated tools.)

Electric shock or injury may result.

Instructions on disposal

⚠CAUTION

- Treat as industrial waste when disposing it.

Injury may result.

Other instructions

⚠WARNING

- Never modify the product.

Electric shock or injury may result.

Conformity to Low Voltage Directive in Europe

⚠CAUTION

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

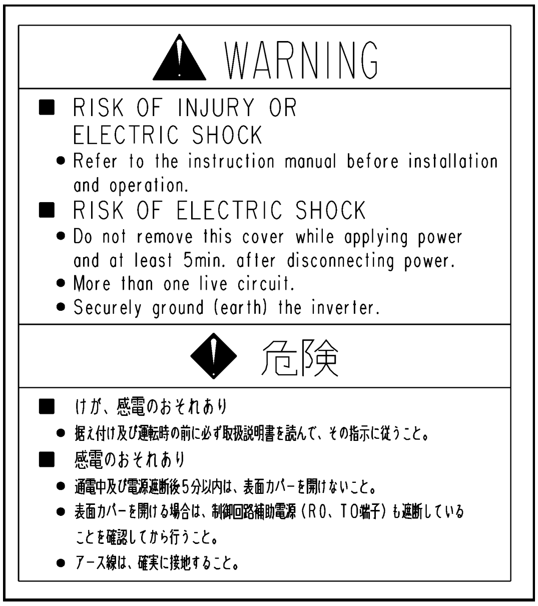
General Instructions

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

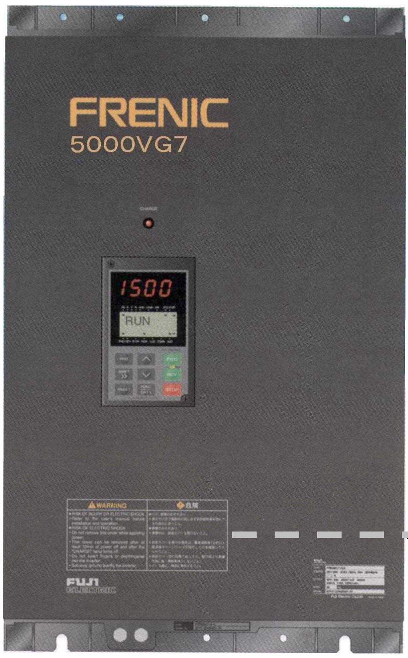
Introduction

Warning label positions

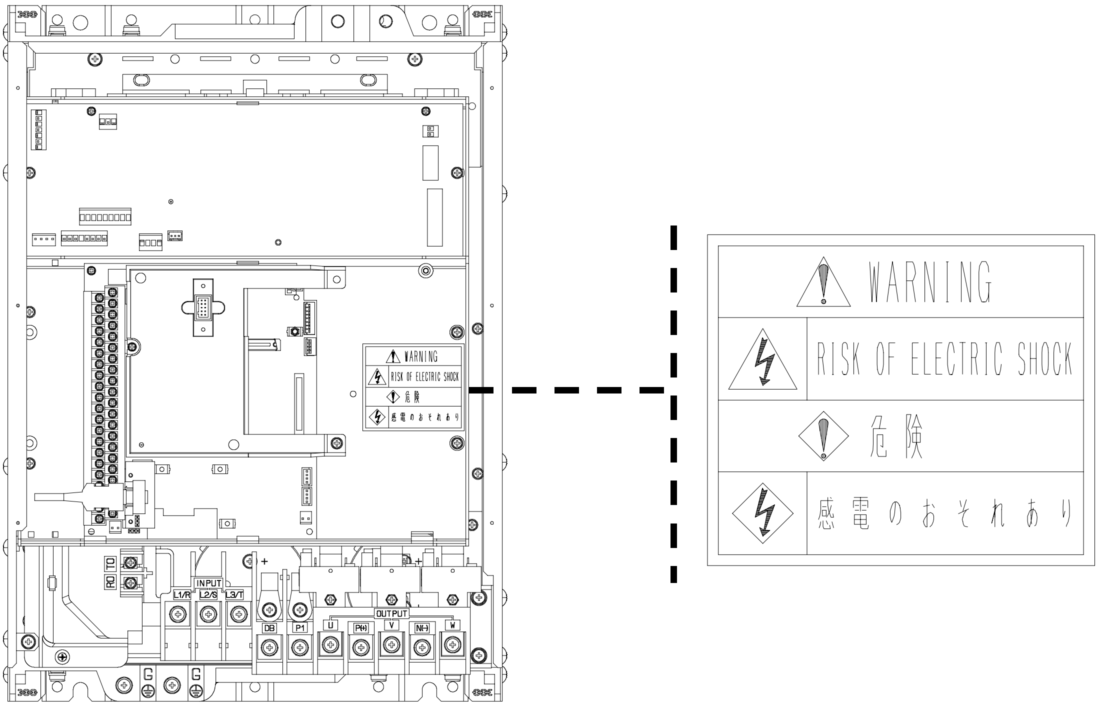
Inverter with a small capacity (15kW or lower)



Inverter with a middle capacity (18.5kW or higher)



Inside the inverter



CONTENTS

THE INVERTER

Ⅰ. Vector Control Inverter System FRENIC5000VG7S

1. Vector Control Inverter System FRENIC5000VG7S

1.1 Outline

1.1.1 The Industry's Best Control Capability

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

1.1.2 System Integration

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

1.1.3 A Wealth of Integrated Functions

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

1.1.4 A Wide Range of Capacities and Applications

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

1.1.5 Global Products

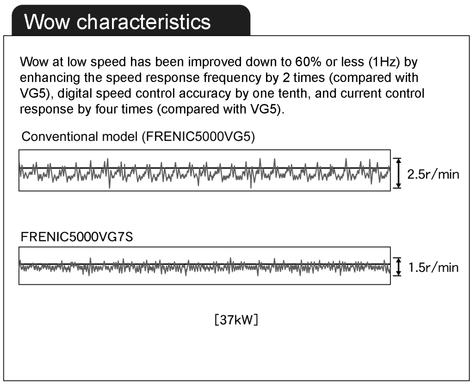
- A standard product that conforms to UL/cUL and CE marking, allowing unification of devices and machines made at home and abroad.
- The KEYPAD panel is set for 7 languages as standard to make exporting simple.
- Various options to connect to all types of the field bus are available

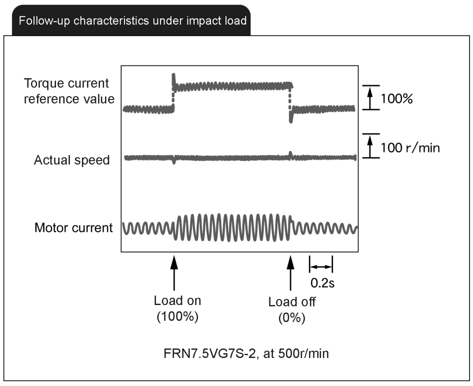
1.2 Features

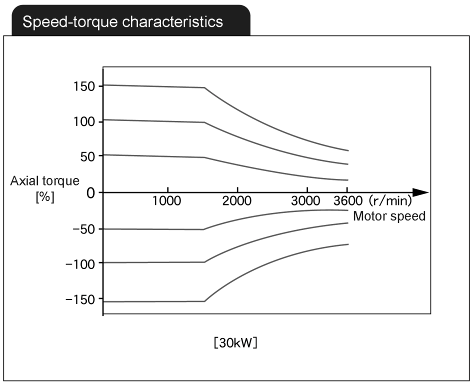
High-performance vector control inverter capable of controlling motor speed and torque at will.

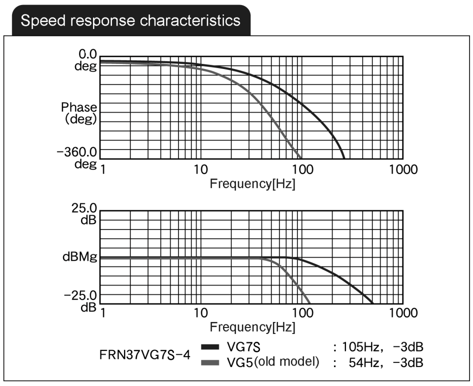
1.2.1 The Industry's Best Control Capability

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









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

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

1.2.3 A Wide Range of Capacity/flexible Applications

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

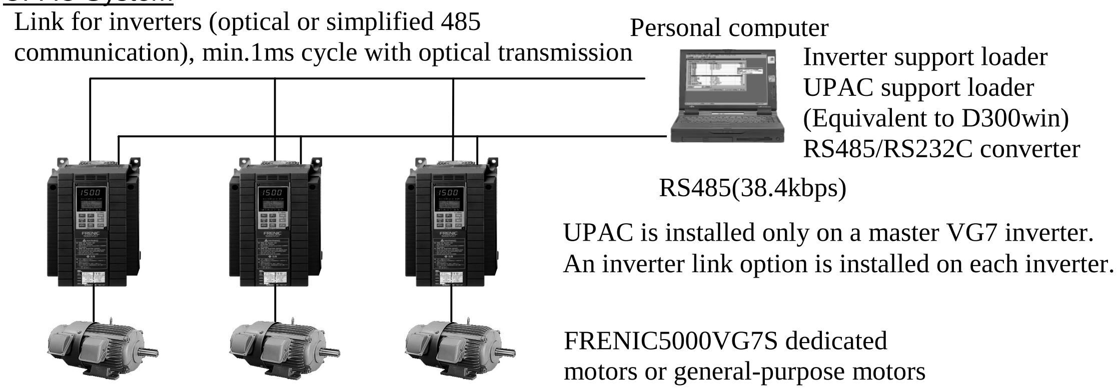
Specification type	Overload	Main application	Carrier frequency
CT	150%	Constant torque applications	High frequency
VT(*)	110%	Variable torque applications	Low frequency
HT	200% / 170%	Vertical transfer applications	High frequency

(*) One class smaller model applicable.

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

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

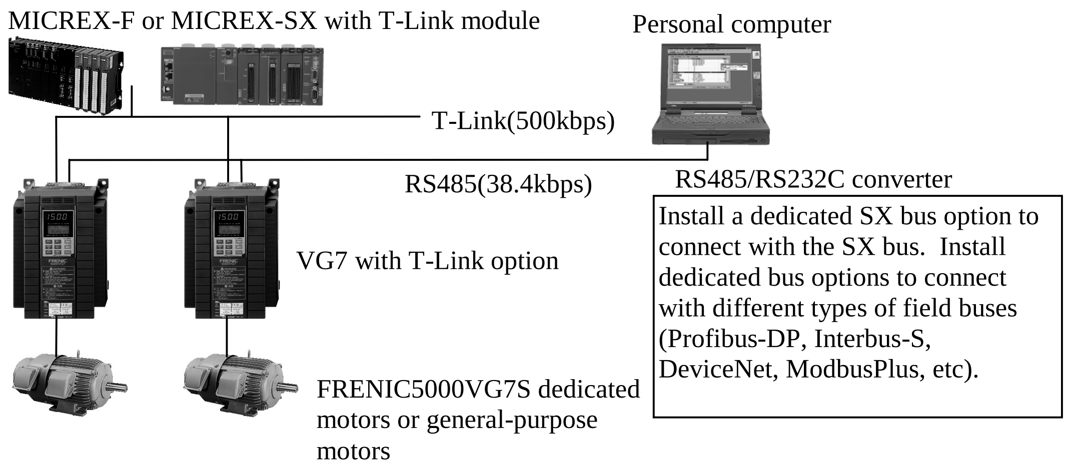
UPAC System



1.2.5 Enhanced Network Readiness

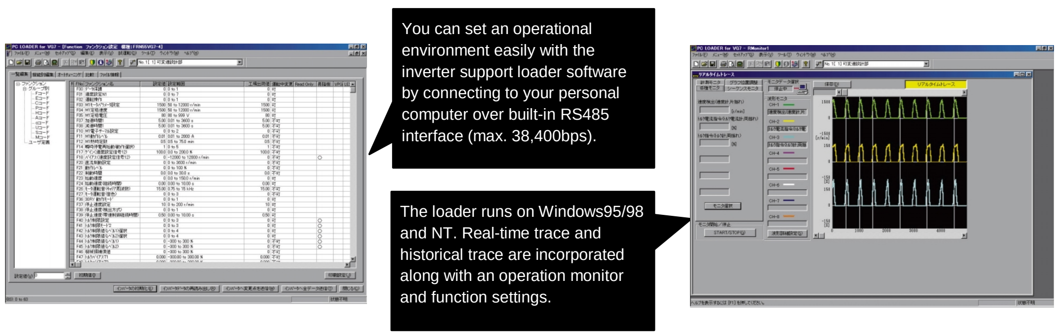
- The RS485 communication function is provided as standard, and the T-Link and SX bus (available soon) functions are provided as options.
- Different field bus types (Profibus-DP, DeviceNet, Interbus-S, ModbusPlus, and CAN Open) can also be used (available soon).

T-Link System



1.2.6 Inverter Support Loader Provided

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



1.2.7 Enhanced Built-in Functions

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

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

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

1.2.8 Upgraded Maintenance/protective Functions

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

1.2.9 Interactive KEYPAD Panel for Simple Operation

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

1.2.10 Conformity to World Standards

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

Europe	North America/Canada
EC Directive (CE marking)	UL and cUL standards

1.3 Control Systems

1.3.1 Features and Applications of Different Control Systems

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

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

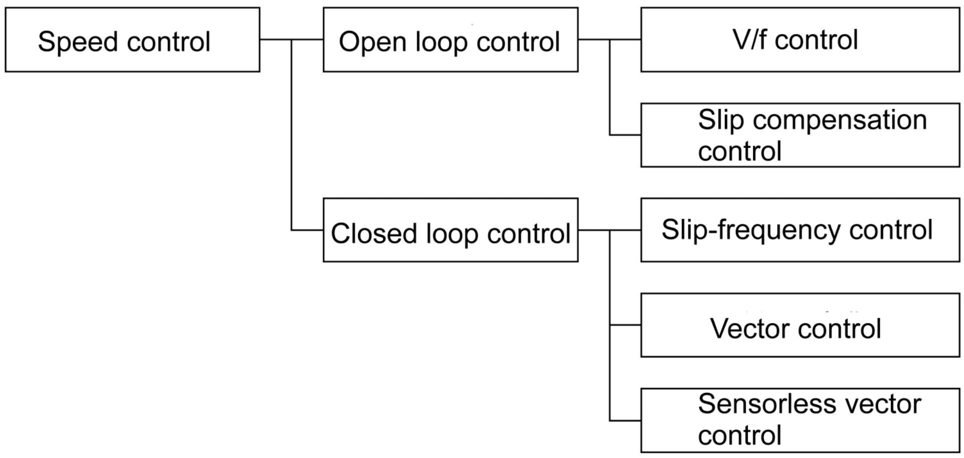


Figure 1-3-1 Speed Control Systems

1.3.1.1 Open Loop Speed Control System

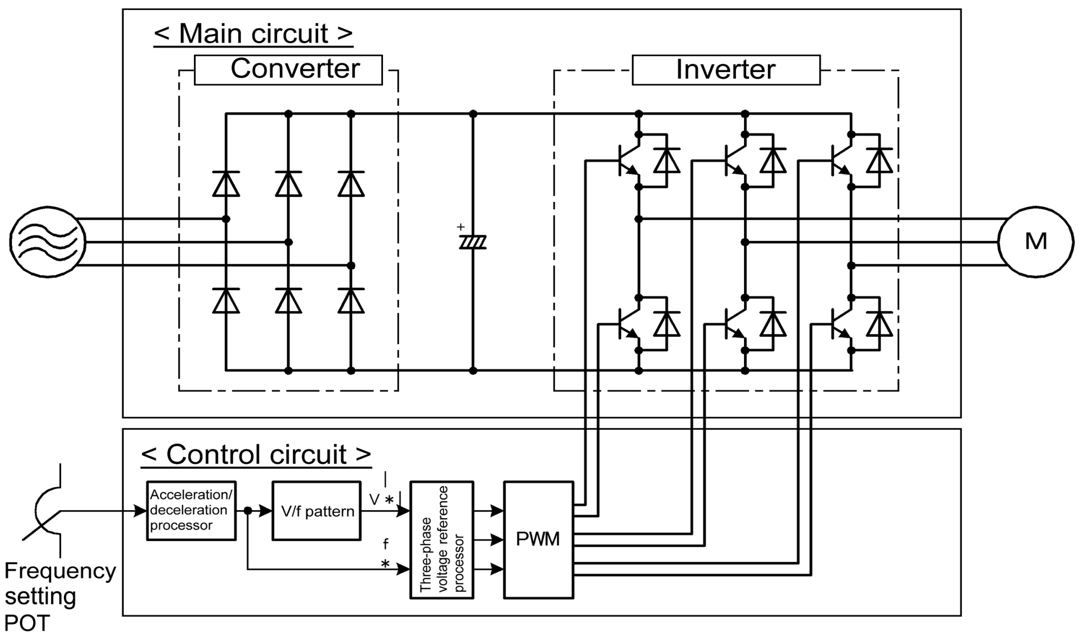


Figure 1-3-2 Basic Configuration of Open Loop Speed Control System

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

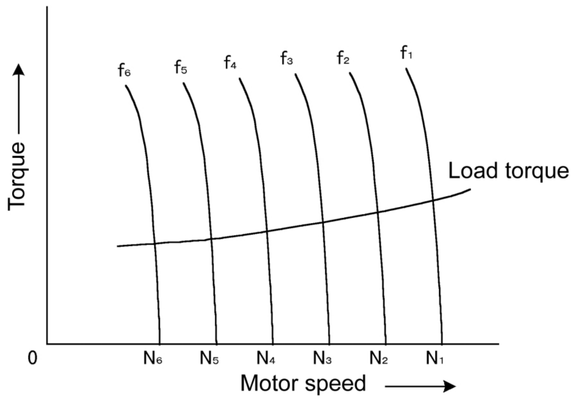


Figure 1-3-3 Motor Speed vs Torque

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

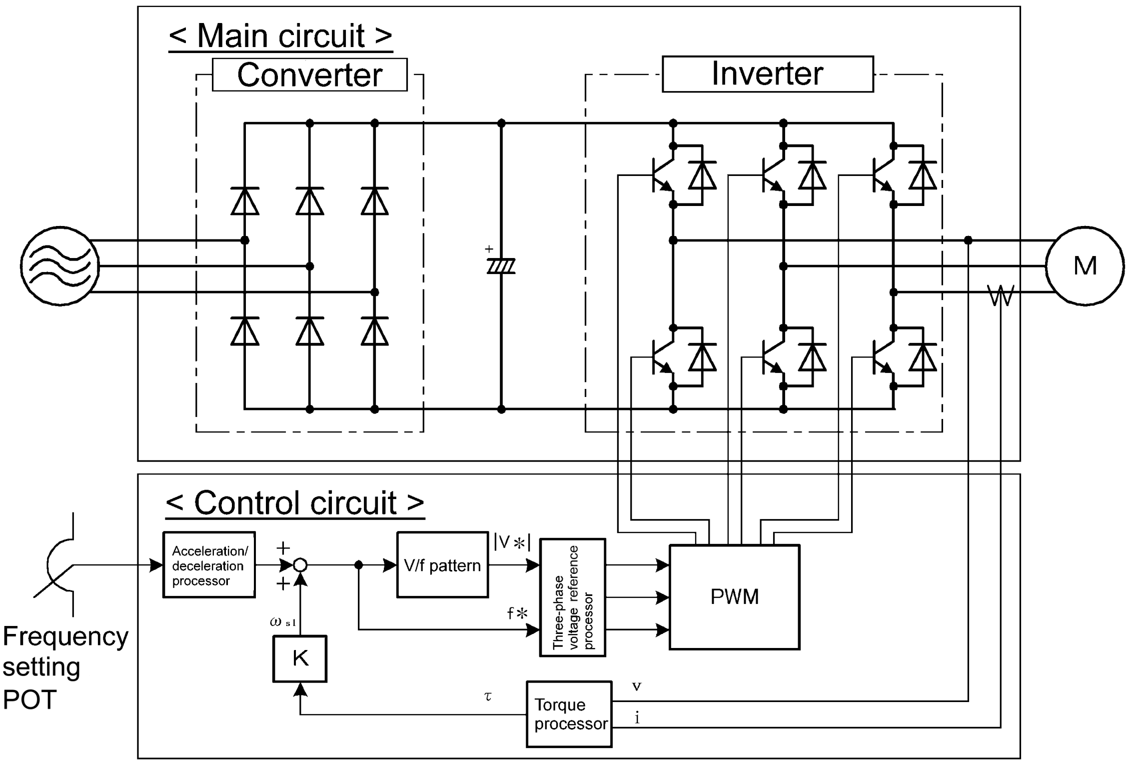


Figure 1-3-4 Slip Compensation Speed Control System

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

1.3.1.2 Closed Loop Speed Control Systems

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

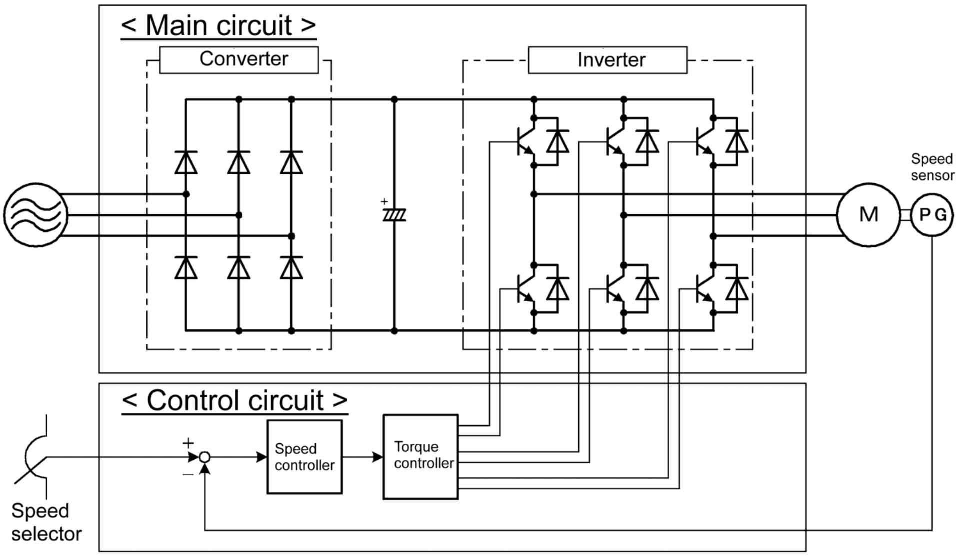


Figure 1-3-5 Basic Configuration of Closed Loop Speed Control System

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

(1) Slip-frequency Control System

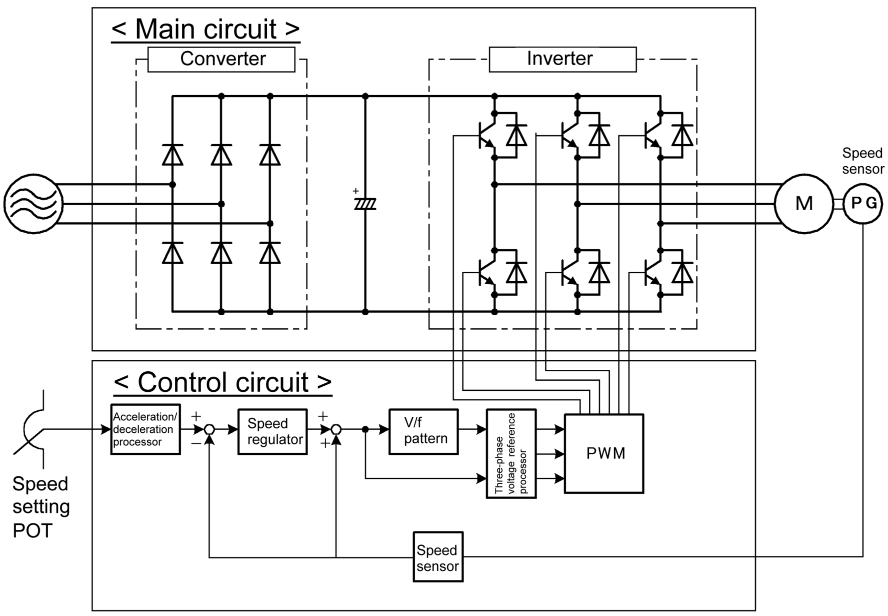


Figure 1-3-6 Configuration of Slip-frequency Control System

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

(2) Vector Control system

The vector control system ensures a quick response from an AC motor. This system controls the primary current of the AC motor as divided into magnetic flux and torque components to provide a control performance equivalent to that as would be obtained with DC motors.

Compared with the V/f control system, the vector control system has the following features and is suitable for applications requiring a quick response and high precision.

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

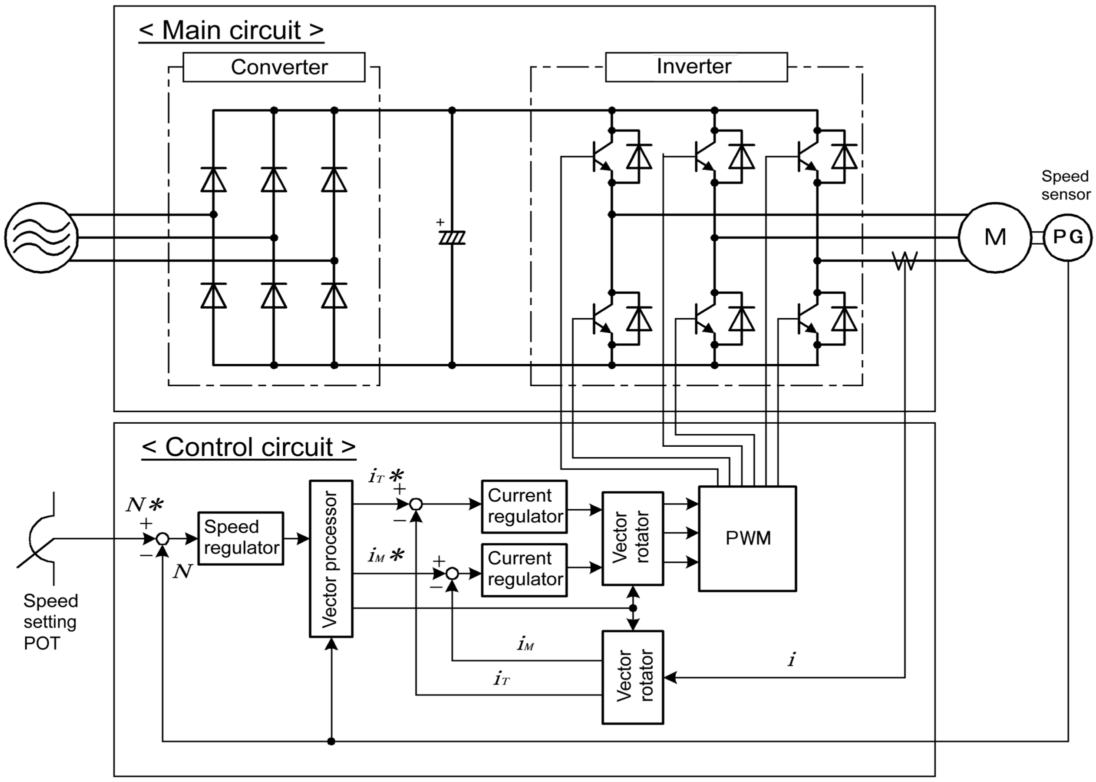


Figure 1-3-7 Example of Configuration of Vector Control System

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

(3) Sensorless Vector Control System

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

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

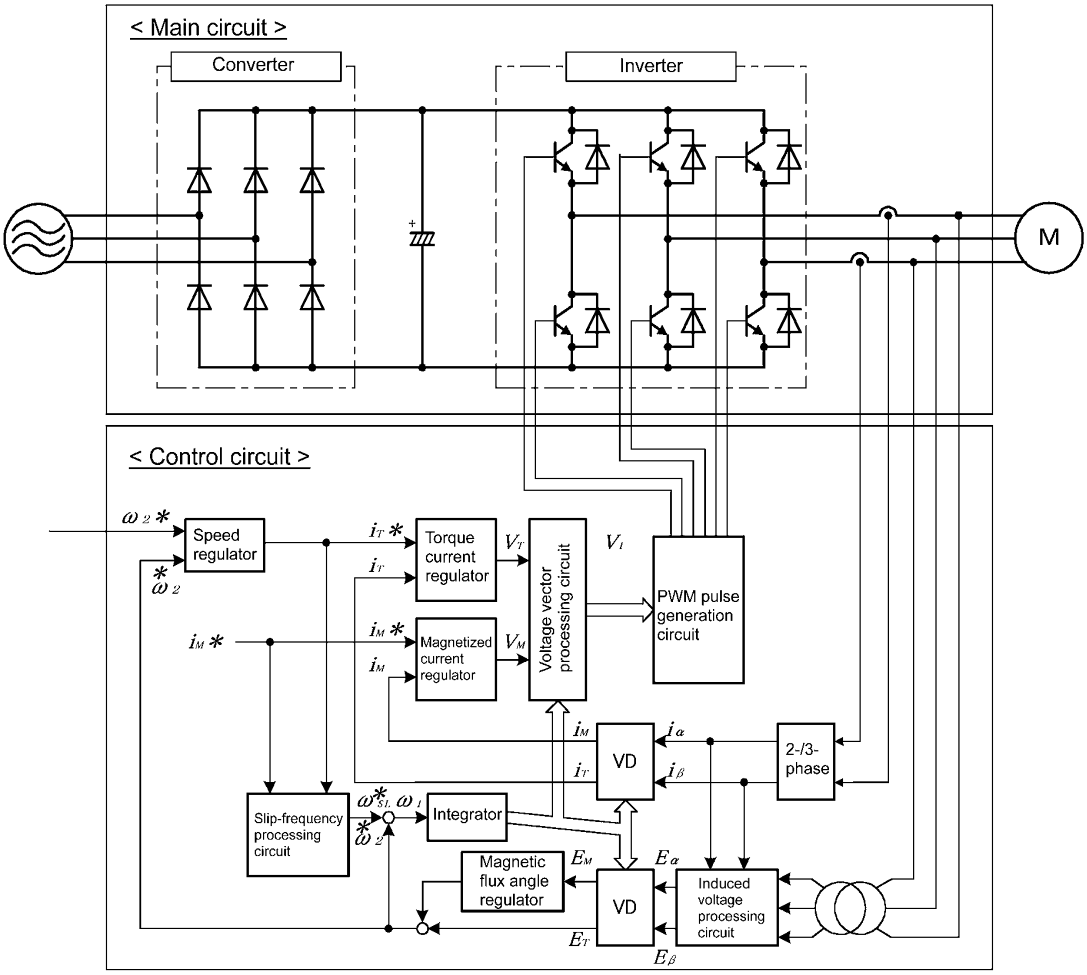


Figure 1-3-8 Example of Construction of Sensorless Vector Control System

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

- MEMO -

THE INVERTER

Ⅱ

Ⅱ. Specifications

2. Specifications

2.1 Standard Specifications

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

● Three-phase 200V series

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

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

● Three-phase 400V series

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

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

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

● Three-phase 200V series

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

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

● Three-phase 400V series

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

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

2. Specifications

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

● Three-phase 200V series

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

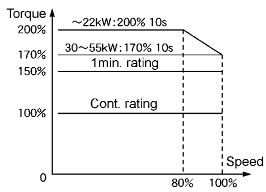
*1) Inverter output capacity [kVA] at 220V.
*2) Select the inverter capacity such that the square average current in cycle operation is 80% or less of the rated current of an inverter.
*3) Order individually for 220 to 230V/50Hz.
*4) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same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

● Three-phase 400V series

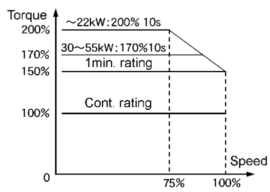
Type FRN☐VG7S-4		3.7	5.5	7.5	11	15	18.5	22	30	37	45	55
Nominal applied motor [kW]		3.7	5.5	7.5	11	15	18.5	22	30	37	45	55
Rated capacity [kVA] (*1)		6.8	10	14	18	24	29	34	44	57	69	85
Rated current (*2)	(Continuous)	9.0	13.5	18.5	24.5	32.0	39.0	45.0	58.0	75.0	91.0	112
	(1min.)	13.5	20.0	27.5	36.5	48.0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

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

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



< Driving torque characteristics >



< Braking torque characteristics >

2.2 Common Specifications

2.2.1 CT Use, VT Use and HT Use

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

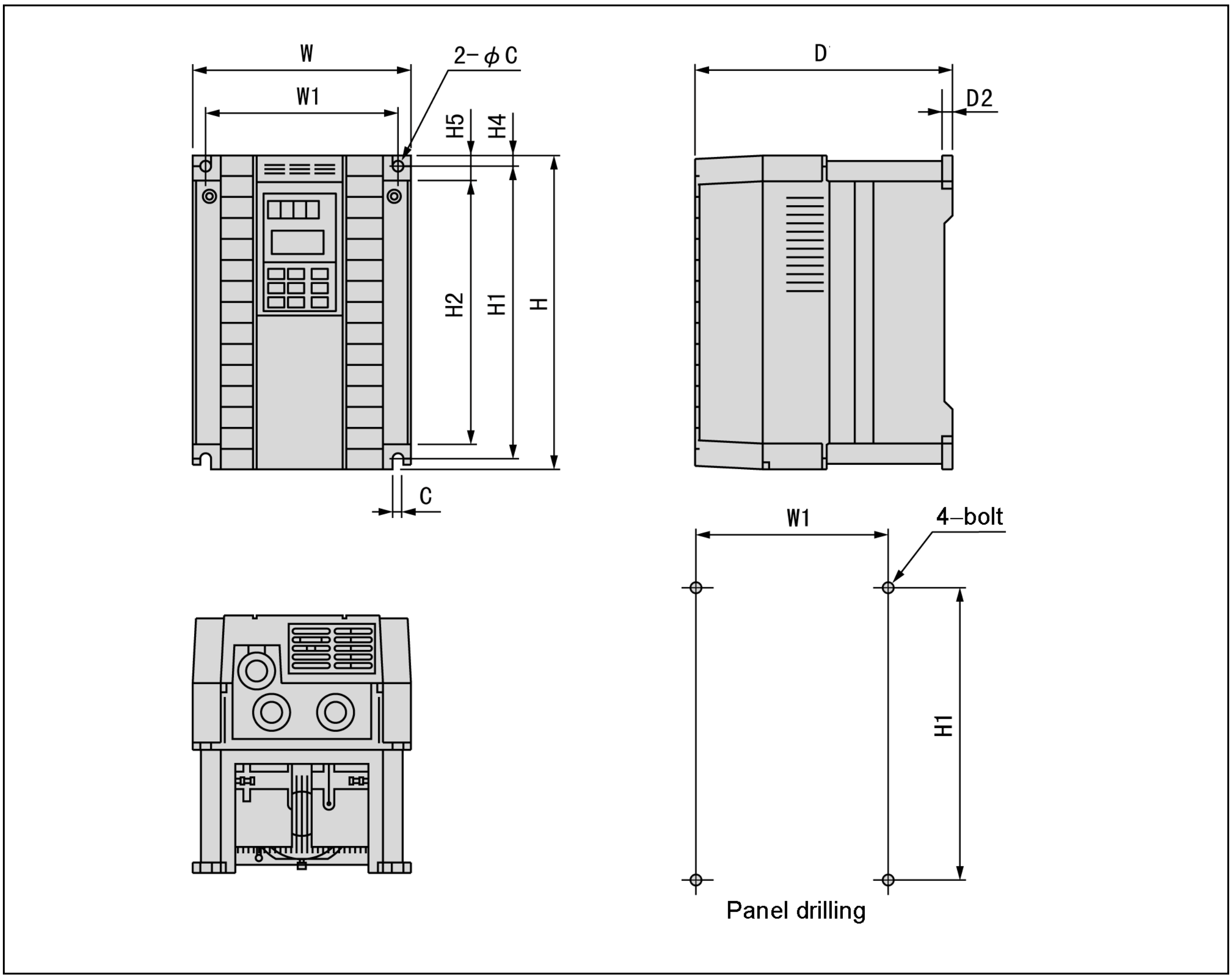
2. Specifications

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

- MEMO -

2.2.2 External Dimensions

● Internal mounting type



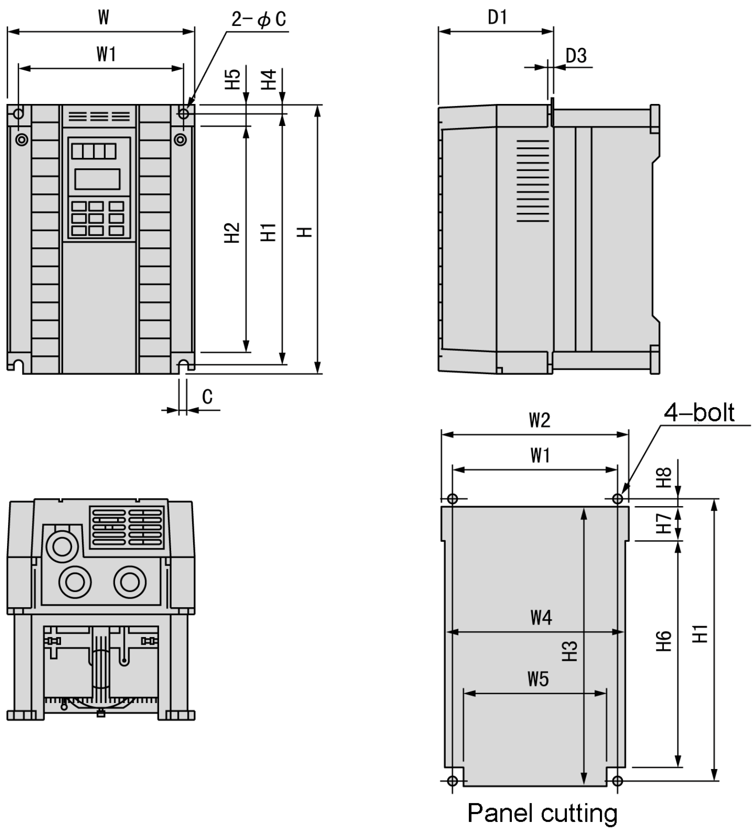
● 200V series

Inverter type	Dimensions [mm]																		Mtg. bolt	Approx. mass [kg]
	W	W1	W2	W3	W4	W5	H	H1	H2	H3	H4	H5	H6	H7	H8	D	D2	C		
FRN0.75VG7S–2	205	181	–	–	–	–	300	278	255	–	11	21	–	–	–	245	10	10	M8	7
FRN1.5VG7S–2																				
FRN2.2VG7S–2																				
FRN3.7VG7S–2																				8
FRN5.5VG7S–2																				
FRN7.5VG7S–2																				
FRN11VG7S–2	250	226	–		–	–	380	358	335	–			–							12.5
FRN15VG7S–2																				

● 400V series

Inverter type	Dimensions [mm]																		Mtg. bolt	Approx. mass [kg]
	W	W1	W2	W3	W4	W5	H	H1	H2	H3	H4	H5	H6	H7	H8	D	D2	C		
FRN3.7VG7S–4	205	181	–	–	–	–	300	278	255	–	11	21	–	–	–	245	10	10	M8	8
FRN5.5VG7S–4																				
FRN7.5VG7S–4																				
FRN11VG7S–4	250	226	–		–	–	380	358	335	–			–							12.5
FRN15VG7S–4																				

● External cooling type



● 200V series

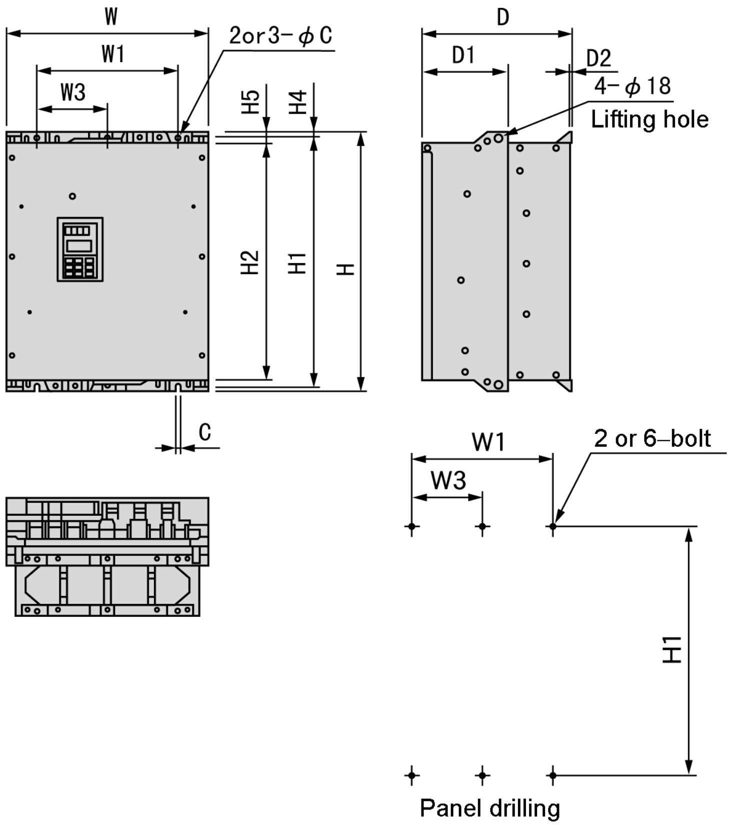
<table>
<tr><th rowspan="2">Inverter type</th><th colspan="18">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W2</th><th>W3</th><th>W4</th><th>W5</th><th>H</th><th>H1</th><th>H2</th><th>H3</th><th>H4</th><th>H5</th><th>H6</th><th>H7</th><th>H8</th><th>D1</th><th>D3</th><th>C</th></tr>
<tr><td>FRN0.75VG7S-2</td><td rowspan="6">205</td><td rowspan="6">181</td><td rowspan="6">207</td><td rowspan="8">–</td><td rowspan="6">197</td><td rowspan="6">159</td><td rowspan="6">300</td><td rowspan="6">278</td><td rowspan="6">255</td><td rowspan="6">314</td><td rowspan="8">11</td><td rowspan="8">21</td><td rowspan="6">253.5</td><td rowspan="8">39</td><td rowspan="8">8</td><td rowspan="8">127</td><td rowspan="8">7</td><td rowspan="8">10</td><td rowspan="8">M8</td><td rowspan="3">7</td></tr>
<tr><td>FRN1.5VG7S-2</td></tr>
<tr><td>FRN2.2VG7S-2</td></tr>
<tr><td>FRN3.7VG7S-2</td><td rowspan="3">8</td></tr>
<tr><td>FRN5.5VG7S-2</td></tr>
<tr><td>FRN7.5VG7S-2</td></tr>
<tr><td>FRN11VG7S-2</td><td rowspan="2">250</td><td rowspan="2">226</td><td rowspan="2">252</td><td rowspan="2">242</td><td rowspan="2">202</td><td rowspan="2">380</td><td rowspan="2">358</td><td rowspan="2">335</td><td rowspan="2">394</td><td rowspan="2">333.5</td><td rowspan="2">12.5</td></tr>
<tr><td>FRN15VG7S-2</td></tr>
</table>

● 400V series

<table>
<tr><th rowspan="2">Inverter type</th><th colspan="18">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W2</th><th>W3</th><th>W4</th><th>W5</th><th>H</th><th>H1</th><th>H2</th><th>H3</th><th>H4</th><th>H5</th><th>H6</th><th>H7</th><th>H8</th><th>D1</th><th>D3</th><th>C</th></tr>
<tr><td>FRN3.7VG7S-4</td><td rowspan="3">205</td><td rowspan="3">181</td><td rowspan="3">207</td><td rowspan="5">–</td><td rowspan="3">197</td><td rowspan="3">159</td><td rowspan="3">300</td><td rowspan="3">278</td><td rowspan="3">255</td><td rowspan="3">314</td><td rowspan="5">11</td><td rowspan="5">21</td><td rowspan="3">253.5</td><td rowspan="5">39</td><td rowspan="5">8</td><td rowspan="5">127</td><td rowspan="5">7</td><td rowspan="5">10</td><td rowspan="5">M8</td><td rowspan="3">8</td></tr>
<tr><td>FRN5.5VG7S-4</td></tr>
<tr><td>FRN7.5VG7S-4</td></tr>
<tr><td>FRN11VG7S-4</td><td rowspan="2">250</td><td rowspan="2">226</td><td rowspan="2">252</td><td rowspan="2">242</td><td rowspan="2">202</td><td rowspan="2">380</td><td rowspan="2">358</td><td rowspan="2">335</td><td rowspan="2">394</td><td rowspan="2">333.5</td><td rowspan="2">12.5</td></tr>
<tr><td>FRN15VG7S-4</td></tr>
</table>

2. Specifications

● Internal mounting type



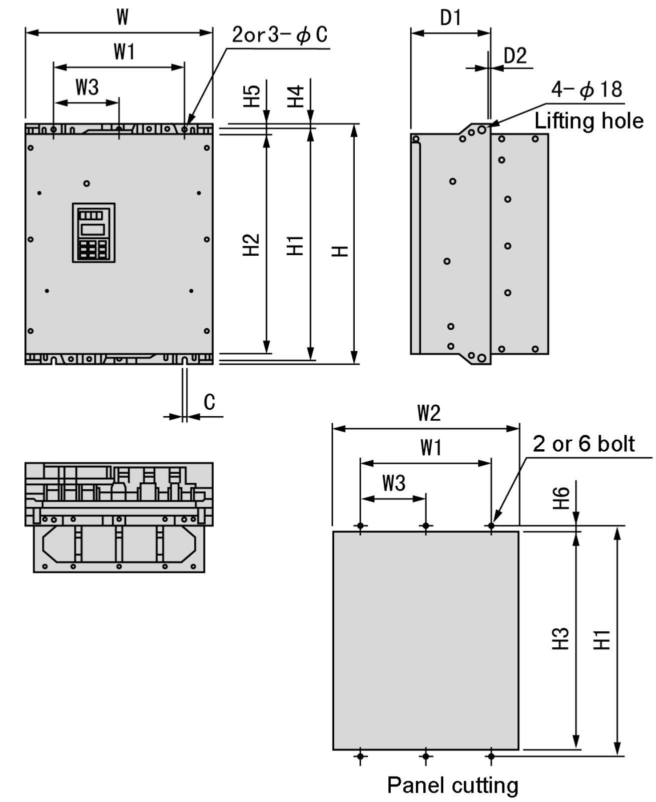
● 200V series

<table>
<tr><th rowspan="2">Inverter type</th><th colspan="12">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W3</th><th>H</th><th>H1</th><th>H2</th><th>H4</th><th>H5</th><th>D</th><th>D1</th><th>D2</th><th>C</th></tr>
<tr><td>FRN18.5VG7S-2</td><td rowspan="3">340</td><td rowspan="3">240</td><td rowspan="7">–</td><td rowspan="2">480</td><td rowspan="2">460</td><td rowspan="2">430</td><td rowspan="6">12</td><td rowspan="6">25</td><td rowspan="3">255</td><td rowspan="6">145</td><td rowspan="8">4</td><td rowspan="6">10</td><td rowspan="6">M8</td><td rowspan="2">25</td></tr>
<tr><td>FRN22VG7S-2</td></tr>
<tr><td>FRN30VG7S-2</td><td>550</td><td>530</td><td>500</td><td>30</td></tr>
<tr><td>FRN37VG7S-2</td><td rowspan="3">375</td><td rowspan="3">275</td><td>615</td><td>595</td><td>565</td><td rowspan="3">270</td><td>37</td></tr>
<tr><td>FRN45VG7S-2</td><td rowspan="2">740</td><td rowspan="2">720</td><td rowspan="2">690</td><td>46</td></tr>
<tr><td>FRN55VG7S-2</td><td>48</td></tr>
<tr><td>FRN75VG7S-2</td><td>530</td><td>430</td><td>750</td><td>720</td><td>685</td><td rowspan="2">15.5</td><td rowspan="2">32.5</td><td>285</td><td>145</td><td rowspan="2">15</td><td rowspan="2">M12</td><td>70</td></tr>
<tr><td>FRN90VG7S-2</td><td>680</td><td>580</td><td>265</td><td>880</td><td>850</td><td>815</td><td>360</td><td>220</td><td>115</td></tr>
</table>

● 400V series

<table>
<tr><th rowspan="2">Inverter type</th><th colspan="12">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W3</th><th>H</th><th>H1</th><th>H2</th><th>H4</th><th>H5</th><th>D</th><th>D1</th><th>D2</th><th>C</th></tr>
<tr><td>FRN18.5VG7S-4</td><td rowspan="3">340</td><td rowspan="3">240</td><td rowspan="11">–</td><td rowspan="2">480</td><td rowspan="2">460</td><td rowspan="2">430</td><td rowspan="7">12</td><td rowspan="7">25</td><td rowspan="3">255</td><td rowspan="7">145</td><td rowspan="13">4</td><td rowspan="7">10</td><td rowspan="7">M8</td><td rowspan="2">25</td></tr>
<tr><td>FRN22VG7S-4</td></tr>
<tr><td>FRN30VG7S-4</td><td rowspan="2">550</td><td rowspan="2">530</td><td rowspan="2">500</td><td>30</td></tr>
<tr><td>FRN37VG7S-4</td><td rowspan="4">375</td><td rowspan="4">275</td><td rowspan="4">270</td><td>35</td></tr>
<tr><td>FRN45VG7S-4</td><td rowspan="2">675</td><td rowspan="2">655</td><td rowspan="2">625</td><td>40</td></tr>
<tr><td>FRN55VG7S-4</td><td>41</td></tr>
<tr><td>FRN75VG7S-4</td><td>740</td><td>720</td><td>690</td><td>50</td></tr>
<tr><td>FRN90VG7S-4</td><td rowspan="4">530</td><td rowspan="4">430</td><td rowspan="2">740</td><td rowspan="2">710</td><td rowspan="2">675</td><td rowspan="6">15.5</td><td rowspan="6">32.5</td><td rowspan="2">315</td><td rowspan="2">175</td><td rowspan="6">15</td><td rowspan="6">M12</td><td rowspan="2">72</td></tr>
<tr><td>FRN110VG7S-4</td></tr>
<tr><td>FRN132VG7S-4</td><td rowspan="4">1000</td><td rowspan="4">970</td><td rowspan="4">935</td><td rowspan="4">360</td><td rowspan="4">220</td><td rowspan="2">100</td></tr>
<tr><td>FRN160VG7S-4</td></tr>
<tr><td>FRN200VG7S-4</td><td rowspan="2">680</td><td rowspan="2">580</td><td rowspan="2">290</td><td rowspan="2">140</td></tr>
<tr><td>FRN220VG7S-4</td></tr>
</table>

● External cooling type



● 200V series

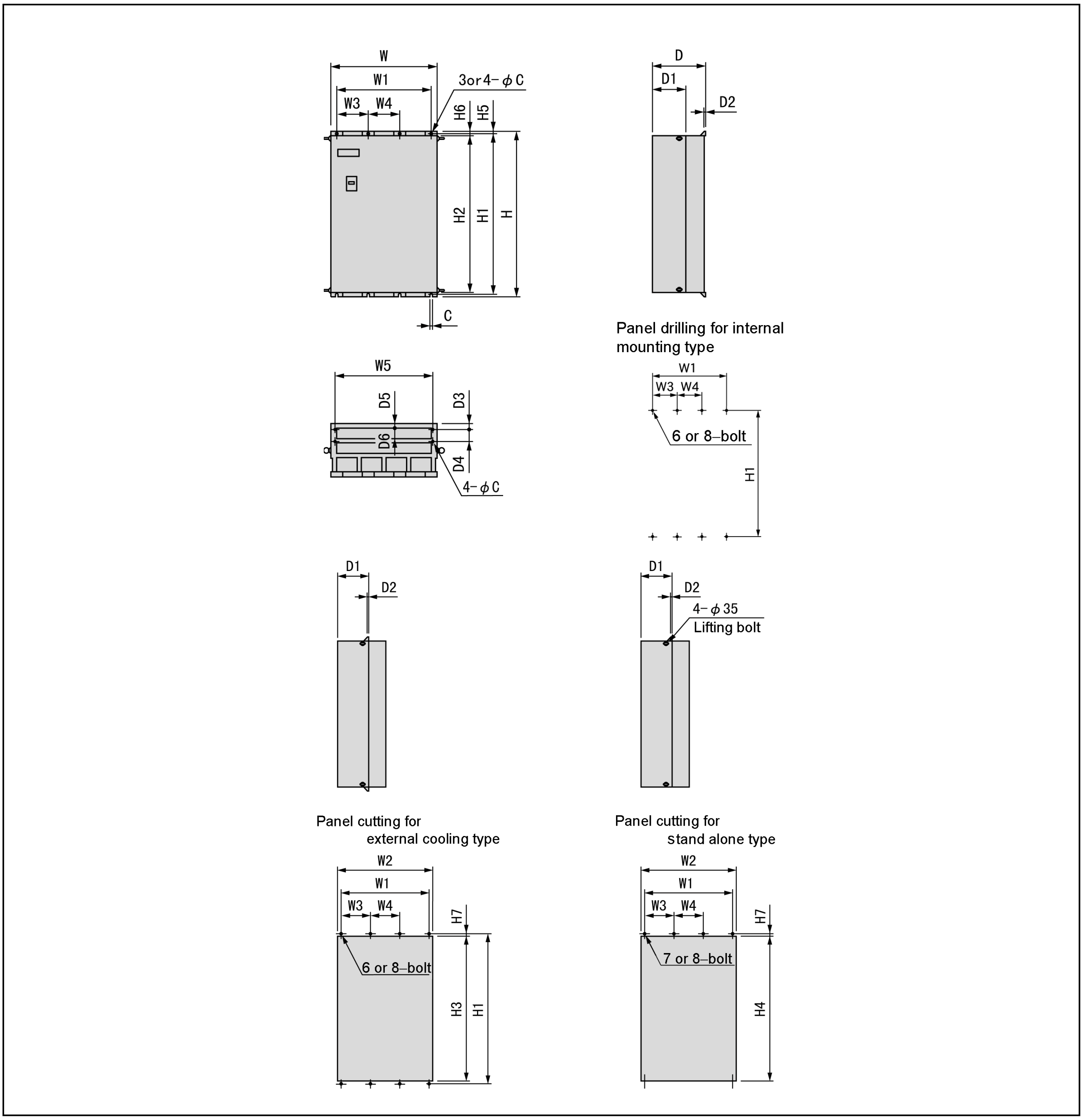
<table>
<tr><th rowspan="2">Inverter type</th><th colspan="14">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W2</th><th>W3</th><th>H</th><th>H1</th><th>H2</th><th>H3</th><th>H4</th><th>H5</th><th>H6</th><th>D1</th><th>D2</th><th>C</th></tr>
<tr><td>FRN18.5VG7S-2</td><td rowspan="3">340</td><td rowspan="3">240</td><td rowspan="3">326</td><td rowspan="7">–</td><td rowspan="2">480</td><td rowspan="2">460</td><td rowspan="2">430</td><td rowspan="2">442</td><td rowspan="6">12</td><td rowspan="6">25</td><td rowspan="6">9</td><td rowspan="6">145</td><td rowspan="8">4</td><td rowspan="6">10</td><td rowspan="6">M8</td><td rowspan="2">25</td></tr>
<tr><td>FRN22VG7S-2</td></tr>
<tr><td>FRN30VG7S-2</td><td>550</td><td>530</td><td>500</td><td>512</td><td>30</td></tr>
<tr><td>FRN37VG7S-2</td><td rowspan="3">375</td><td rowspan="3">275</td><td rowspan="3">361</td><td>615</td><td>595</td><td>565</td><td>577</td><td>37</td></tr>
<tr><td>FRN45VG7S-2</td><td rowspan="2">740</td><td rowspan="2">720</td><td rowspan="2">690</td><td rowspan="2">702</td><td>46</td></tr>
<tr><td>FRN55VG7S-2</td><td>48</td></tr>
<tr><td>FRN75VG7S-2</td><td>530</td><td>430</td><td>510</td><td>750</td><td>720</td><td>685</td><td>695</td><td rowspan="2">15.5</td><td rowspan="2">32.5</td><td rowspan="2">12.5</td><td>145</td><td rowspan="2">15</td><td rowspan="2">M12</td><td>70</td></tr>
<tr><td>FRN90VG7S-2</td><td>680</td><td>580</td><td>660</td><td>265</td><td>880</td><td>850</td><td>815</td><td>825</td><td>220</td><td>115</td></tr>
</table>

● 400V series

<table>
<tr><th rowspan="2">Inverter type</th><th colspan="14">Dimensions [mm]</th><th rowspan="2">Mtg. bolt</th><th rowspan="2">Approx. mass [kg]</th></tr>
<tr><th>W</th><th>W1</th><th>W2</th><th>W3</th><th>H</th><th>H1</th><th>H2</th><th>H3</th><th>H4</th><th>H5</th><th>H6</th><th>D1</th><th>D2</th><th>C</th></tr>
<tr><td>FRN18.5VG7S-4</td><td rowspan="3">340</td><td rowspan="3">240</td><td rowspan="3">326</td><td rowspan="11">–</td><td rowspan="2">480</td><td rowspan="2">460</td><td rowspan="2">430</td><td rowspan="2">442</td><td rowspan="7">12</td><td rowspan="7">25</td><td rowspan="7">9</td><td rowspan="7">145</td><td rowspan="13">4</td><td rowspan="7">10</td><td rowspan="7">M8</td><td rowspan="2">25</td></tr>
<tr><td>FRN22VG7S-4</td></tr>
<tr><td>FRN30VG7S-4</td><td rowspan="2">550</td><td rowspan="2">530</td><td rowspan="2">500</td><td rowspan="2">512</td><td>30</td></tr>
<tr><td>FRN37VG7S-4</td><td rowspan="4">375</td><td rowspan="4">275</td><td rowspan="4">361</td><td>35</td></tr>
<tr><td>FRN45VG7S-4</td><td rowspan="2">675</td><td rowspan="2">655</td><td rowspan="2">625</td><td rowspan="2">637</td><td>40</td></tr>
<tr><td>FRN55VG7S-4</td><td>41</td></tr>
<tr><td>FRN75VG7S-4</td><td>740</td><td>720</td><td>690</td><td>702</td><td>50</td></tr>
<tr><td>FRN90VG7S-4</td><td rowspan="4">530</td><td rowspan="4">430</td><td rowspan="4">510</td><td rowspan="2">740</td><td rowspan="2">710</td><td rowspan="2">675</td><td rowspan="2">685</td><td rowspan="6">15.5</td><td rowspan="6">32.5</td><td rowspan="6">12.5</td><td rowspan="2">175</td><td rowspan="6">15</td><td rowspan="6">M12</td><td rowspan="2">72</td></tr>
<tr><td>FRN110VG7S-4</td></tr>
<tr><td>FRN132VG7S-4</td><td rowspan="4">1000</td><td rowspan="4">970</td><td rowspan="4">935</td><td rowspan="4">945</td><td rowspan="4">220</td><td rowspan="2">100</td></tr>
<tr><td>FRN160VG7S-4</td></tr>
<tr><td>FRN200VG7S-4</td><td rowspan="2">680</td><td rowspan="2">580</td><td rowspan="2">660</td><td rowspan="2">290</td><td rowspan="2">140</td></tr>
<tr><td>FRN220VG7S-4</td></tr>
</table>

2. Specifications

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



● 400V series

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

2.2.3 Dedicated Motor Specifications

● Three-phase 200V series standard specifications

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

● Three-phase 400V series standard specifications

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

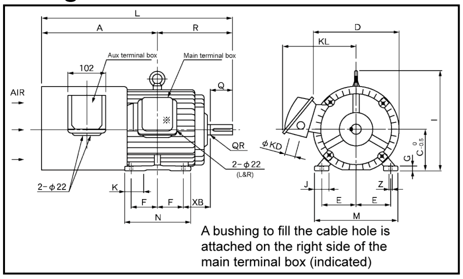
● Common specifications

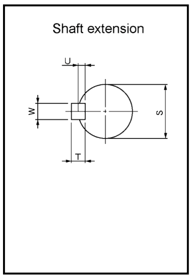
Item	Specifications
Insulation class/Number of poles	Class F/4P
Terminal design	Main terminal box (lug type): 3 or 6 main circuit terminals, 3 NTC thermistor terminals (1 is reserved) Auxiliary terminal box (terminal block): Pulse generator (PGP, PGM, PA, PB, SS), cooling fan (FU, FV or FU, FV, FW)
Mounting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

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

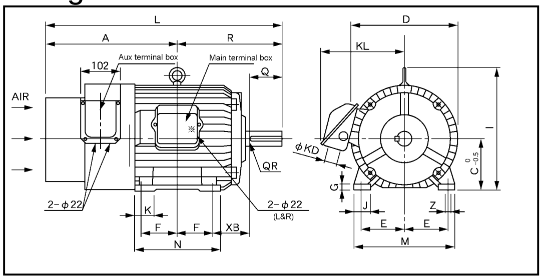
2. Specifications

● Fig. A

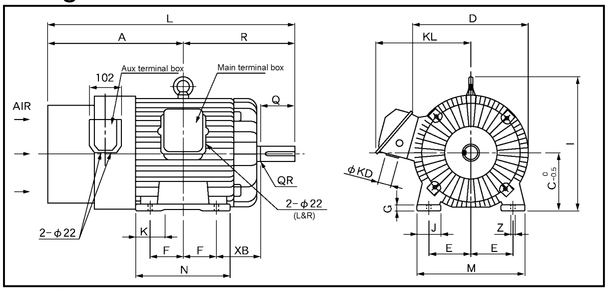




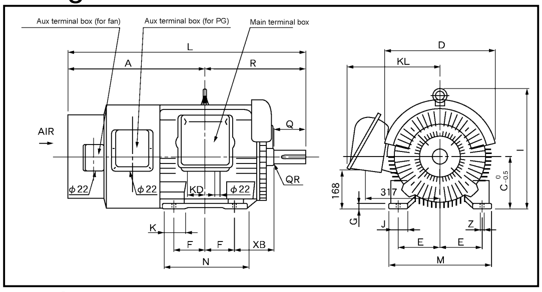
● Fig. B



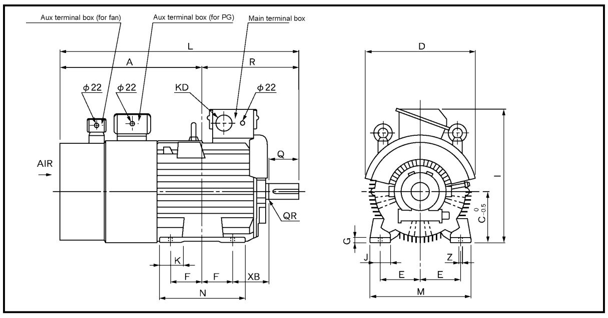
● Fig. C



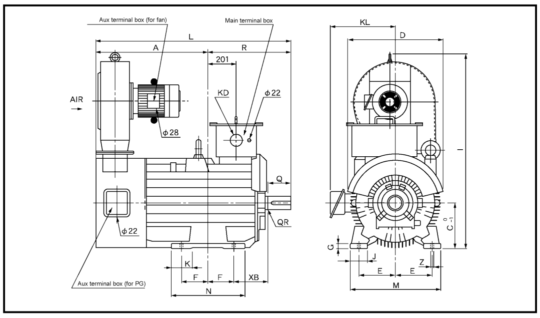
● Fig. D



● Fig. E



● Fig. F



● Common dimensions to 200V and 400V series

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

2.2.4 Protective Functions

Function	Description	LED monitor	Related function code
DB resistor overheating	When the built-in braking resistor overheats, the inverter stops discharging and running. Function codes E35 to 37 corresponding to the resistor (built-in/external) must be set.	dbH	E35-37
DC fuse blown	When a fuse at the main DC circuit blows due to a short-circuit in the IGBT circuit, the inverter stops operation.	dCF	
Ground fault	Activated by a ground fault in the inverter output circuit. Connect a separate earth-leakage protective relay or an earth-leakage circuit breaker for accident prevention such as human damage and fire.	EF	
Excessive position deviation	Activated when the position deviation between the reference and the detected values exceeds the function code o18 "Excessive deviation value" in synchronized operation. The option code "o" becomes valid and is displayed on the KEYPAD panel after installing options.	dO	o18
Memory error	Activated when a fault such as "write error" occurs in the memory.	Er1	
KEYPAD panel communication error	Activated if a communication error is detected between the inverter control circuit and the KEYPAD panel when the start/stop command from the KEYPAD is valid (function code F02=0). Note: KEYPAD panel communication error does not indicate the alarm display and issue the alarm relay output when the inverter is operated by external signal input or the link function. The inverter continues operating.	Er2	F02
CPU error	Activated when a CPU error occurs due to noise.	Er3	
Network error	Activated if a communication error occurs due to noise when the inverter is operated through T- Link, SX bus or field bus.	Er4	o30,31
RS485 communication error	Activated if: The function code H32 is set to 0 to 2, or a disconnection continues for more than the specified period of 0.1 to 60.0 with the function code H38.	Er5	H32,H33 H38
Operation procedure error	Activated if multiple network options (T-Link, SX bus, and field bus) are installed. Though you can install multiple SI, DI and PG options, this error is issued if the two SW settings are identical.	Er6	
Output wiring error	Activated when the measured data are out of the motor characteristic data range during executing tuning or the wires are not connected in the inverter output circuit.	Er7	H01,H71
A/D converter error	Activated when an error occurs in the A/D converter circuit.	Er8	
Speed disagreement	Activated when the deviation between the speed reference (speed setting) and the motor speed (detected speed, predicted speed) becomes excessive.	Er9	
UPAC error	Activated on a hardware fault in the UPAC option or a communication error between the inverter control circuit and the UPAC option.	ErA	
Inter-inverter communication error	Activated if a communication error occurs in inter-inverter communication over the optical option or simplified RS485.	Erb	
Input phase loss	The inverter is protected from being damaged due to input phase loss.	Lin	
Undervoltage	Activated if the DC link circuit voltage decreases to the undervoltage level due to a reduction in the supply voltage. The alarm output is not issued when the DC link circuit voltage decreases and the "function code F14" is set to "3 to 5". • Undervoltage detection level: 200V series: 186V dc, 400V series: 371V dc.Activated when the power supply *phase is unbalunced.	LU	F14
NTC thermistor disconnection	Activated if the thermistor circuit is disconnected when the application of NTC thermistors to corresponding motors (M1, 2, 3) is specified with the function codes P30, A31 and A47.	nrb	P30,A31,A47
Overcurrent	Activated if the momentary value of the inverter output current exceeds the overcurrent detection level due to a short-circuit or ground fault.	OC	
Overheating at heat sink	Activated if the temperature of the heat sink to cool the rectifier diodes and the IGBTs increases due to colling fan stoppage.	OH1	
External alarm	The inverter stops on receiving the external alarm signal (THR). It is activated by a terminal signal when the control circuit terminals (THR assignment) are connected to alarm terminals of external devices such as a braking unit or a braking resistor.	OH2	E01-E14
Inverter internal overheat	Activated if the ambient temperature of the control PC board increases due to poor ventilation of the inverter.	OH3	
Motor overheat	Activated if the detected temperature of the built-in NTC thermistor for motor temperature detection exceeds the data of the "function code E30 Motor overheat protection".	OH4	E30,E31
Motor 1 overload	Activated when the motor 1 current (inverter output current) exceeds the operation level set by "function code F11".	OL1	F11
Motor 2 overload	Activated when the motor 2 current (inverter output current) exceeds the operation level set by "function code A33".	OL2	A33
Motor 3 overload	Activated when the motor 3 current (inverter output current) exceeds the operation level set by "function code A49".	OL3	A49
Inverter unit overload	Activated if the output current exceeds the overload characteristic of the inverse time characteristic.	OLU	
Overspeed	Activated if the motor speed (detected speed value/predicted speed value) exceeds 120% of the specified value by the function code "maximum speed".	OS	F03,A06,A40
Overvoltage	Activated if the DC link circuit voltage exceeds the overvoltage level due to an increase of supply voltage or regenerative braking current from the motor. However, the inverter cannot be protected from excessive voltage (high voltage, for example) supplied by mistake. • Overvoltage detection level 200V series: 400V dc, 400V series: 800V dc	OU	
PG error	Activated when the pulse generator terminal PA/PB circuits are disconnected. It is not activated when the sensorless control or the V/f control is selected.	Pg	
Charging circuit error	Activated if the bypass circuit of the DC link circuit is not formed (the magnetic contactor for the charging circuit bypass is not closed) two minutes after power is supplied.	PbF	

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

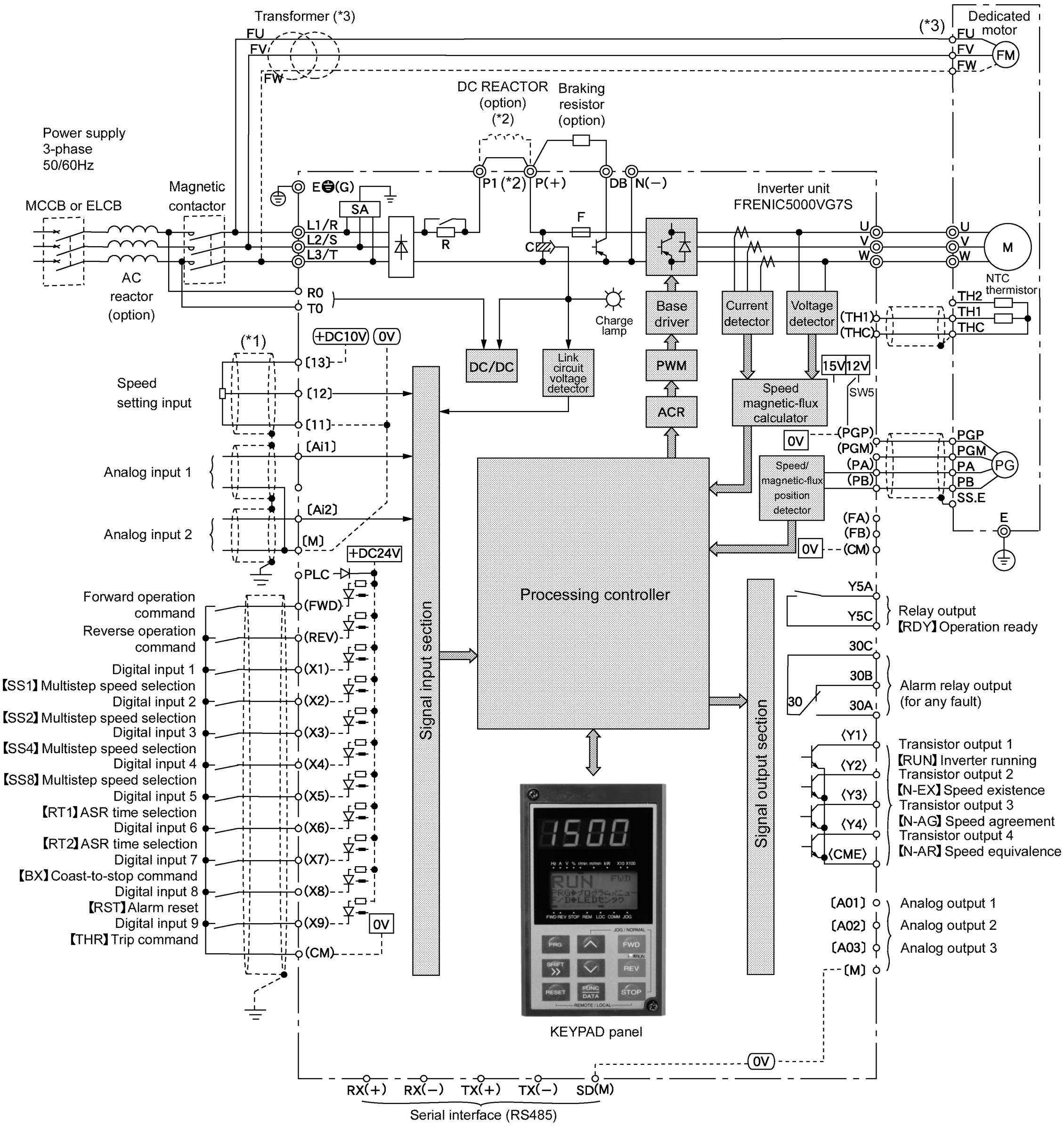
Note 2: Fault history data is stored for the last ten trips.

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

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

2.3 Basic Wiring Diagram and Terminal Functions

2.3.1 Basic Wiring Diagram



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

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

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

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

2.3.2 Terminal Functions

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

2. Specifications

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

2.3.3 Terminal Arrangement

2.3.3.1 Terminal Arrangement

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

Fig. 1

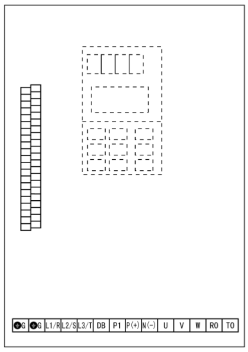


Fig. 2

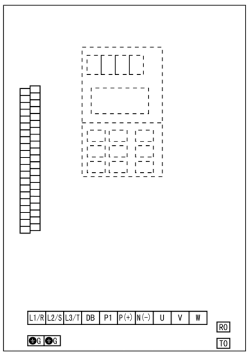


Fig. 3

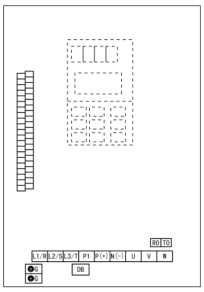


Fig. 4

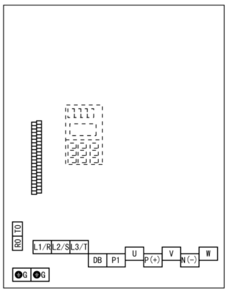


Fig. 5

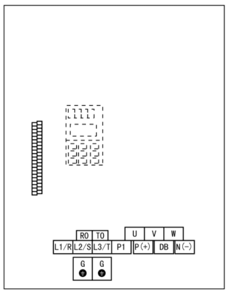


Fig. 6

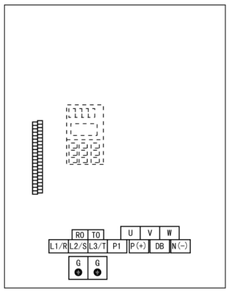


Fig. 7

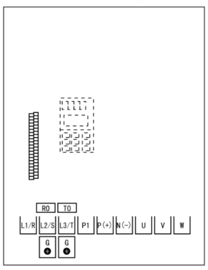


Fig. 8

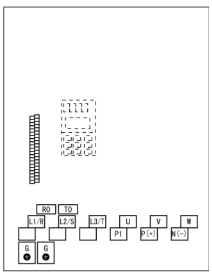


Fig. 9

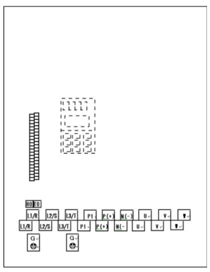
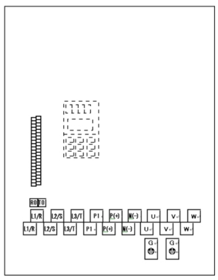


Fig. 10



See the next page for details of terminal arrangement.

2.3.3.2 Terminal Arrangement Chart

● Main circuit terminals

Three-phase 200V series

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

Fig. 1

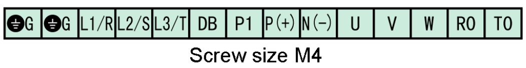


Fig. 2

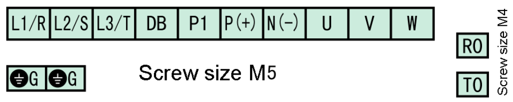


Fig. 3

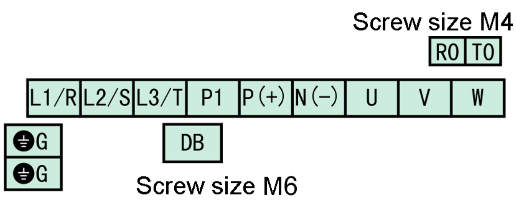


Fig. 4

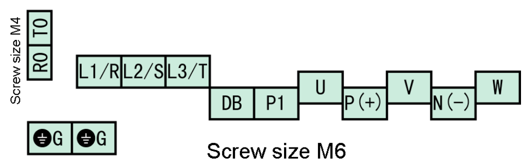


Fig. 5

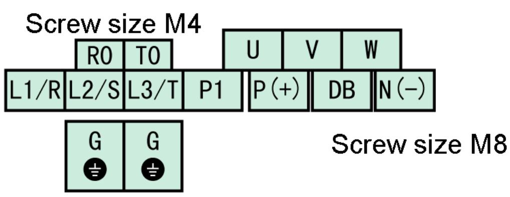


Fig. 6

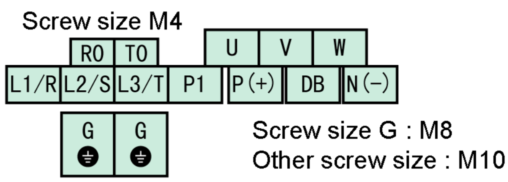


Fig. 7

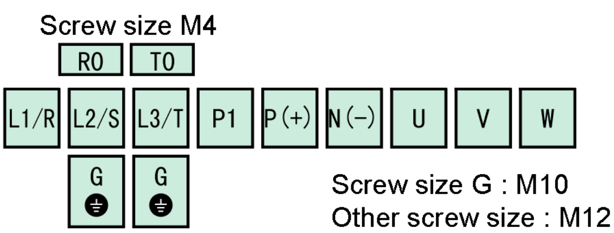
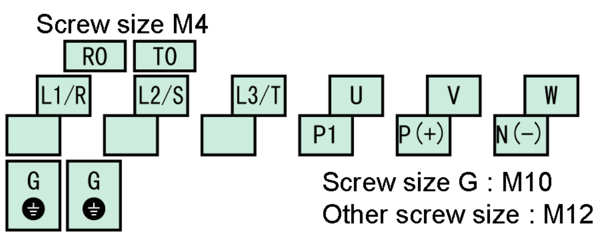


Fig. 8



Three-phase 400V series

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

Fig. 1

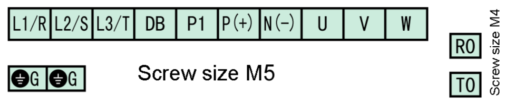


Fig. 2

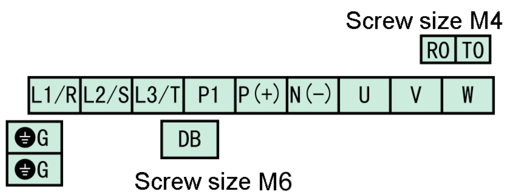


Fig. 3

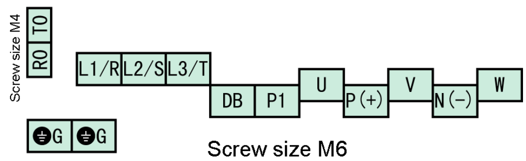


Fig. 4

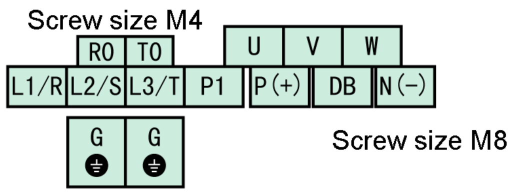


Fig. 5

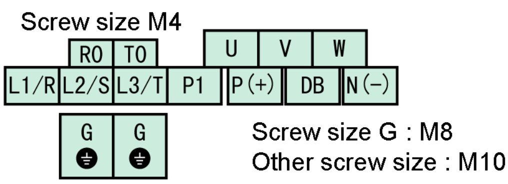


Fig. 6

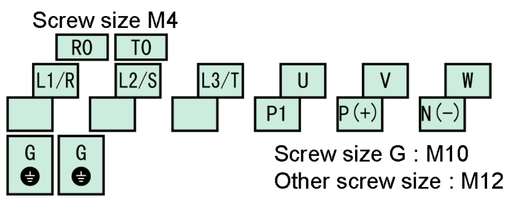


Fig. 7

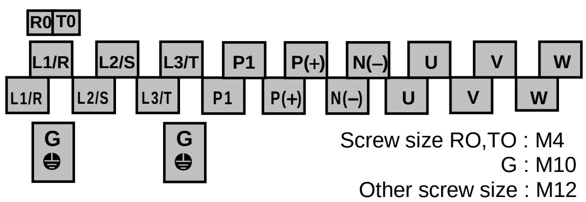
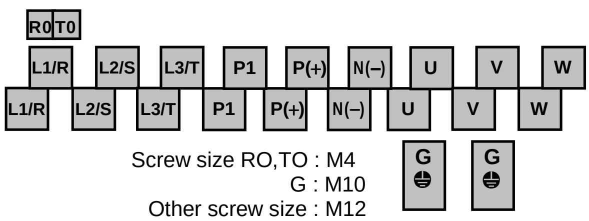
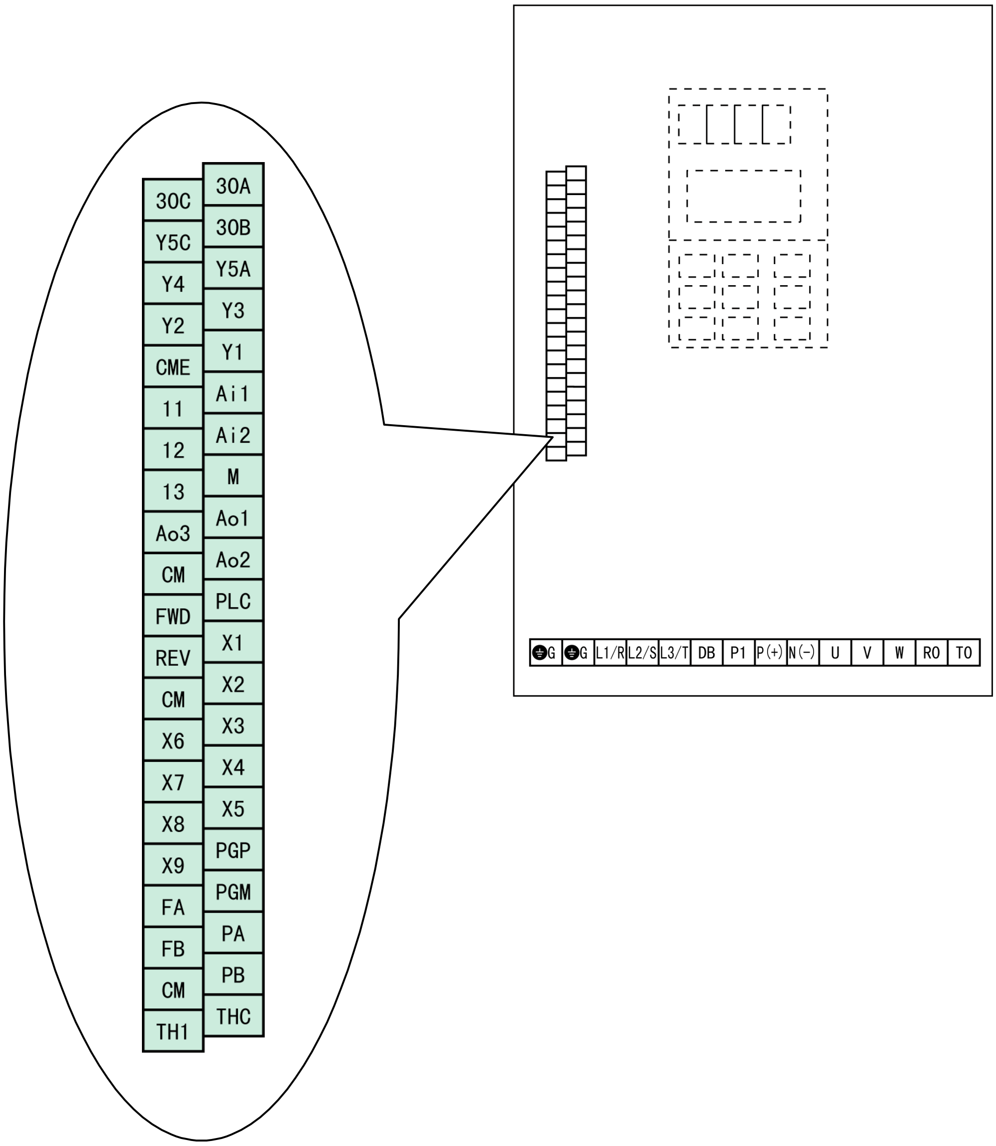


Fig. 8



● Control circuit terminals



2.3.3.3 Terminal Size

● Main circuit terminals

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

● Control circuit terminals

M3 : Common to all types.

- MEMO -

Ⅲ. Preparatory Operations and Test Run

3. Preparatory Operations and Test Run

3.1 Before Use

3.1.1 Inspection After Receipt

Unpackage the product and perform the following checks.
If the product is found to have a fault, please contact the dealer from which you purchased the product or the nearest sales office of Fuji Electric.

(1) Read the nameplate to check that the product is the same thing as ordered.

TYPE: Inverter type

FRN 30 VG7S - 4

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

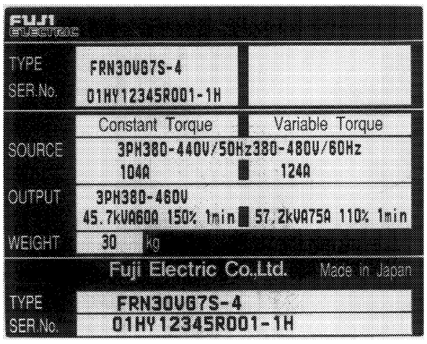


Figure 3-1-1 Nameplate

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

0 1 HY12345R001 - 1H

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

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

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

3.1.2 External View of the Product

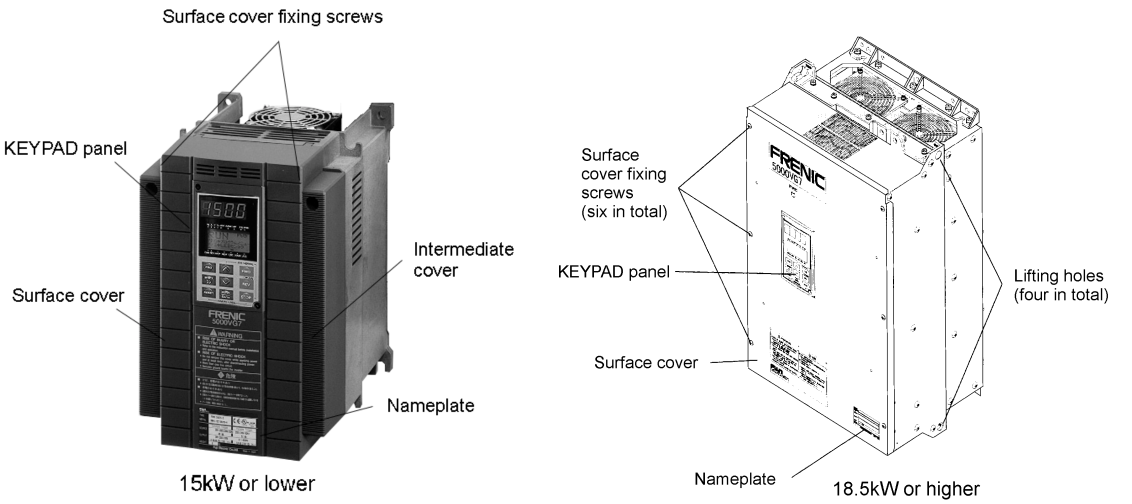


Figure 3-1-2 External View of the Product

3.1.3 Handling of the Product

(1) Removal of Surface Cover

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

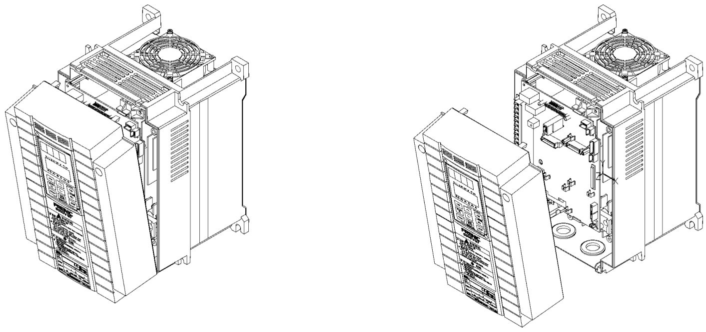


Figure 3-1-3 Removal of Surface Cover (15 kW or lower)

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

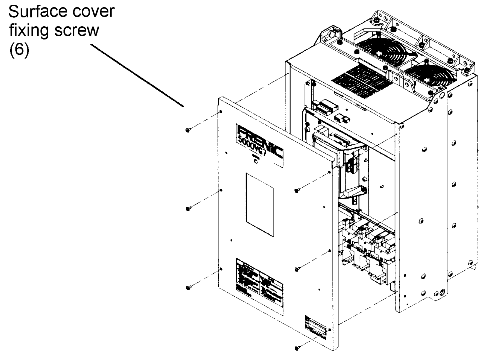


Figure 3-1-4 Removal of Surface Cover (18.5 kW or higher)

(2) Removal of KEYPAD Panel

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

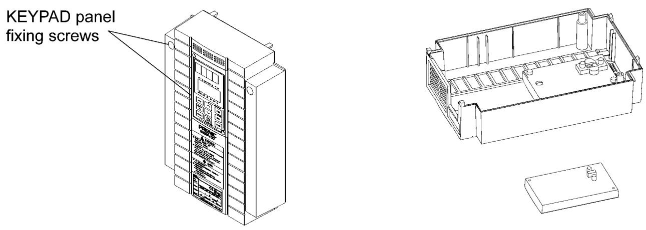


Figure 3-1-5 Removal of KEYPAD Panel (15 kW or lower)

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

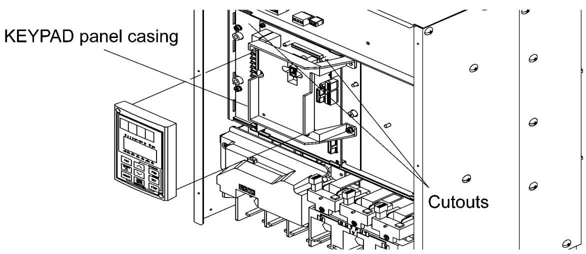


Figure 3-1-6 Removal of KEYPAD Panel (18.5 kW or higher)

Preparatory Operations and Test Run

3. Preparatory Operations and Test Run

3.1.4 Transportation

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

3.1.5 Storage

Temporary Storage

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

Table 3-1-1 Storage Conditions

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

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

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

Extended Storage

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

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

3.2 Installation and Connection

3.2.1 Operating Conditions

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

Table 3-2-1 Operating Conditions

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

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

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

3.2.2 Installation Procedure

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

⚠CAUTION
Failure to do so may lead to injury.

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

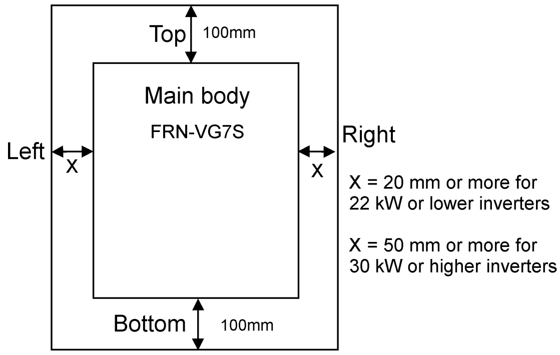


Figure 3-2-1

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

⚠CAUTION
The fins may burn your skin.

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

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

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

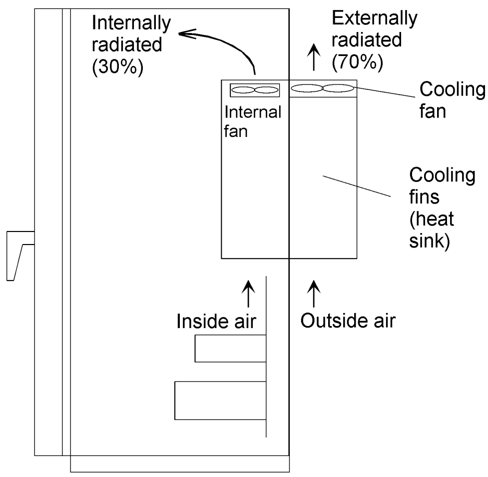


Figure 3-2-2 External Cooling System

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

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

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

Number and Size of Fixing Screws

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

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

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

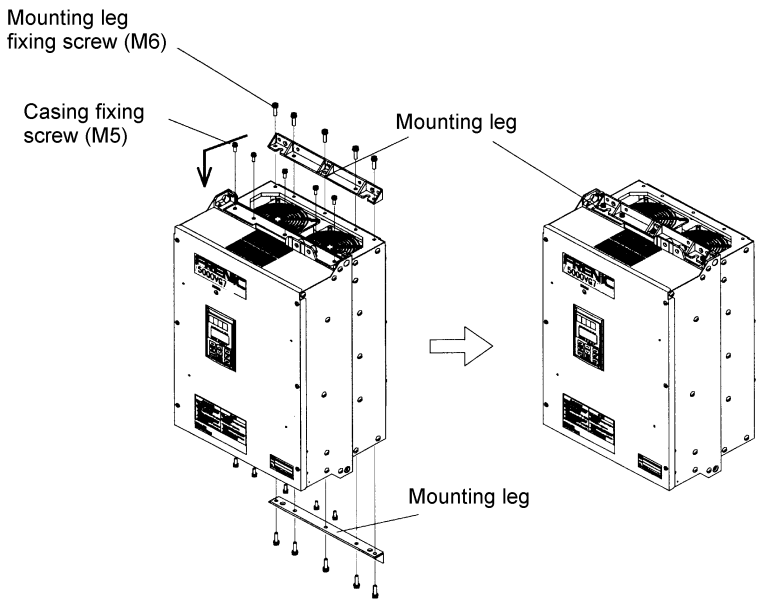


Figure 3-2-3

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

3.3 Electric Connections

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

3.3.1 Basic Connections

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

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

The basic connection diagram is given in Subsection 2.3.1.

3.3.2 Wiring of Main Circuit and Grounding Terminals

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

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

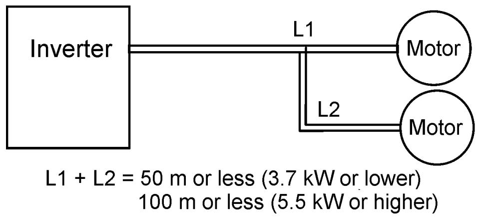
(1) Main circuit power input terminals (L1/R, L2/S, and L3/T)

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

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

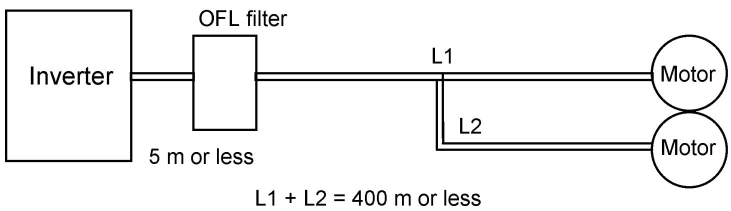
1) Connect three-phase motor leads to the inverter output terminals, U, V, and W with care not to connect a wrong phase.
2) Do not connect a phase advancing capacitor or surge absorber (suppressor) to the inverter output terminals.
3) If the wiring between the inverter and the motor is too long, a high-frequency current will run through the wiring due to floating capacity to trip the inverter because of overcurrent, increase the leakage current, and/or deteriorate the current indication accuracy. Therefore, the motor wiring length should not exceed 50m for 3.7kW or lower inverters or 100m for others, as a guide. Connect the optional output circuit filter (OFL filter) if the wiring is too long.

Without output circuit filter



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

With output circuit filter



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

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

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

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

1) Use a motor with reinforced insulation (all the Fuji Electric's general-purpose motors have reinforced insulation).
2) Connect the optional output circuit filter (OFL filter) to the inverter output terminals.
3) Shorten the wiring between the inverter and the motor as short as possible (to10 to 20m or less).

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

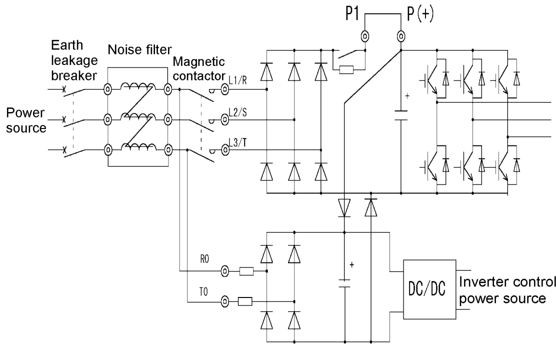


Figure 3-3-1 Wiring of Auxiliary Control Power Input Terminals

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

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

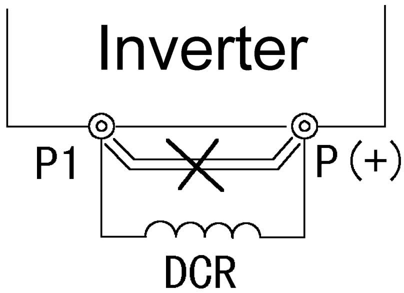


Figure 3-3-2

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

(5) Braking resistor connecting terminals (P(+) and DB)
The optional braking resistor may be externally mounted. It is required when the inverter is operated frequently or under heavy inertia.
1) Connect the braking resistor terminals, P(+) and DB, to the inverter terminals, P(+) and DB.
2) Lay out so that the wiring length will not exceed 5m. The two leads should be twisted or in close contact (parallel).

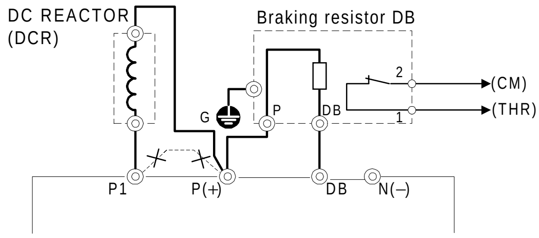


Figure 3-3-3 Connection Diagram
(For 200V, 55kW or Lower and 400V, 110kW or Lower Inverters)

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

(6) DC link circuit terminals (P(+) and N(–))
The 200V series, 75kW or higher and 400V series, 132kW or higher inverters contain no braking resistor drive circuit. When the braking resistor is required, a braking unit should be used.
1) Connect the braking unit terminals, P(+) and N(–), to the inverter terminals, P(+) and N(–). Lay out so that the wiring length will not exceed 5m. The two leads should be twisted or in close contact (parallel).
2) Connect the braking resistor terminals, P (+) and DB, to the braking unit terminals, P (+) and DB. Lay out so that the wiring length will not exceed 10m.
The two leads should be twisted or in close contact (parallel).
When the inverter terminals, P(+) and N(–), are not used, they should be left open. Never short these terminals or directly connect the braking resistor. Doing so may break the inverter.
3) Auxiliary contacts 1 and 2 of the braking unit have polarity. When connecting a power regenerative unit, see the instruction manual for the unit.

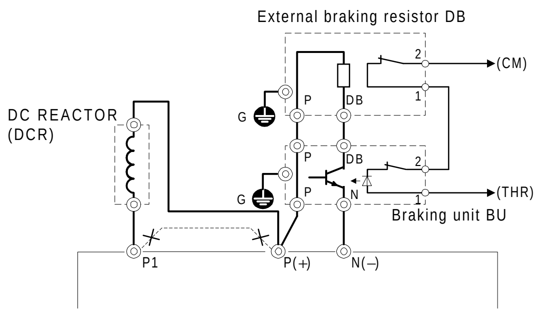


Figure 3-3-4 Connection Diagram
(200V, 75kW or Higher and 400V, 132kW or Higher Inverters)

(7) Inverter grounding terminals (⏚ G)

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

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

Table 3-3-2

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

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

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

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

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

⚠CAUTION

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

Doing so may lead to injury.

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

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

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

For details, see Figure 3-3-7.

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

⚠CAUTION

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

Doing so may fail the inverter.

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

Failure to do so may fail the inverter.

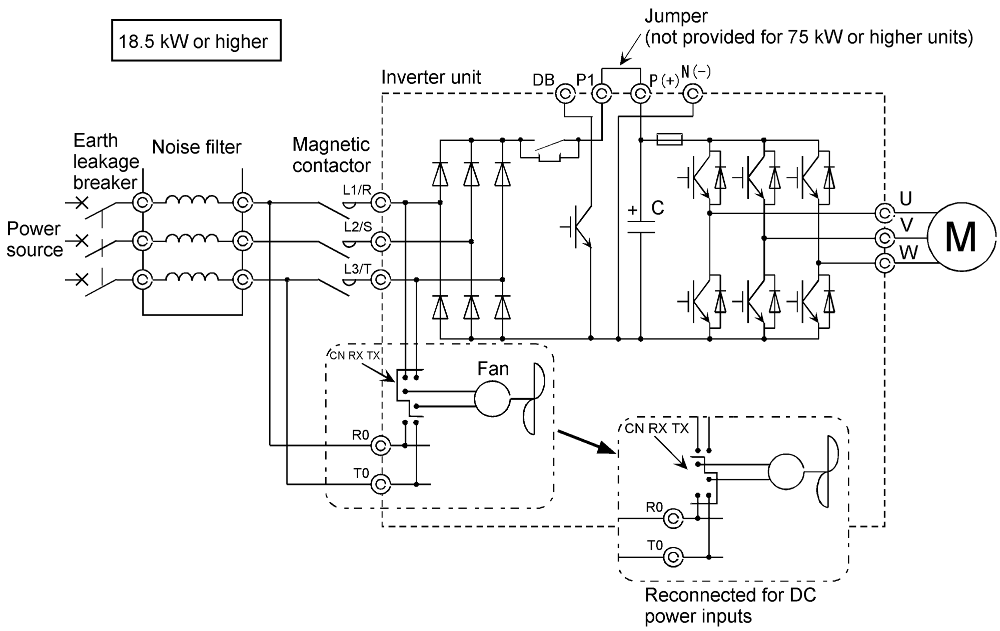


Figure 3-3-5 Reconnection of Fan Power Switching Connector

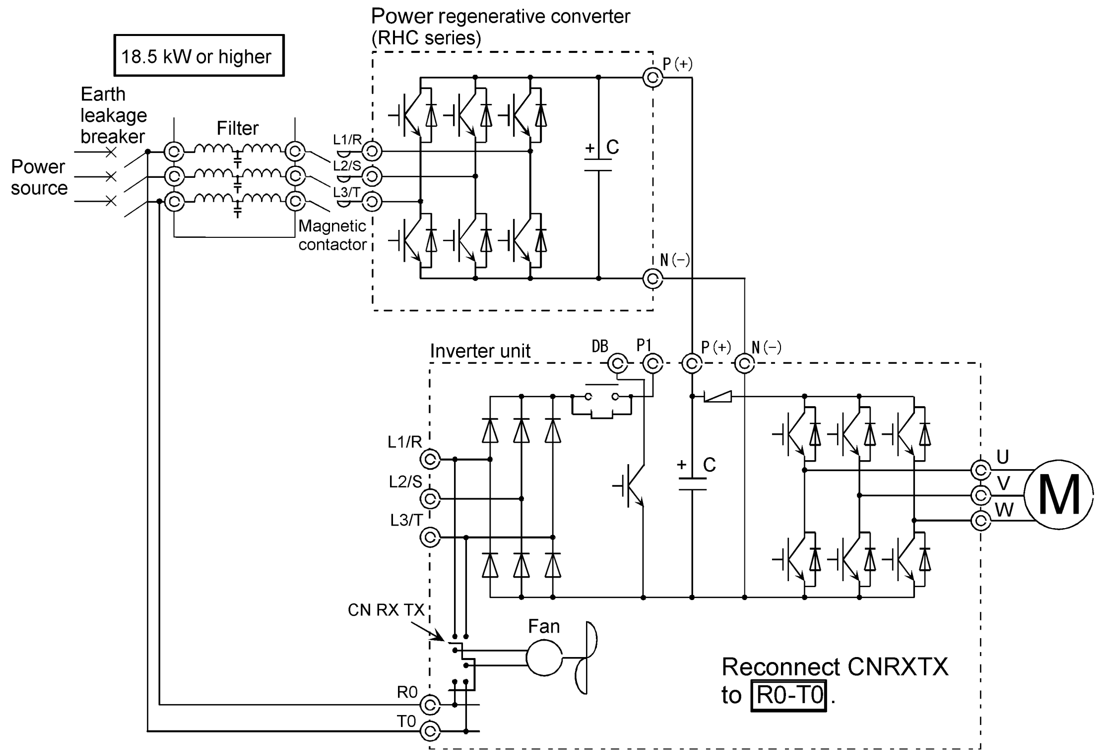


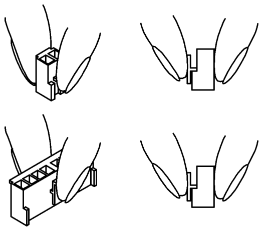
Figure 3-3-6 An Example of Wiring of Inverter Combined with Power Regenerative Converter

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

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

3. Preparatory Operations and Test Run

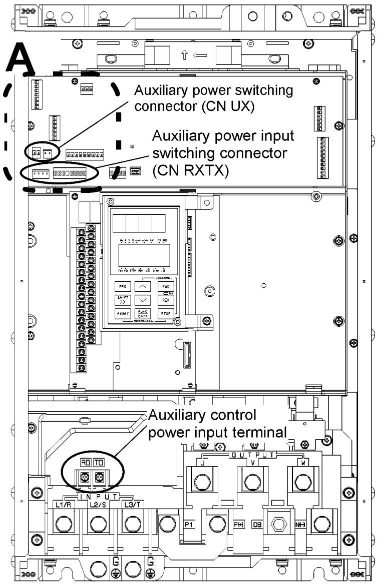
The switching connectors are mounted in the power PC board at the top of the control circuit PC board.



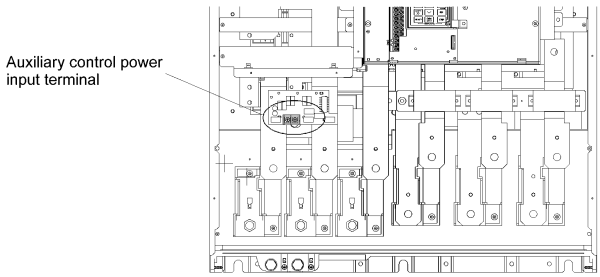
CNUX

CNRXTX

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

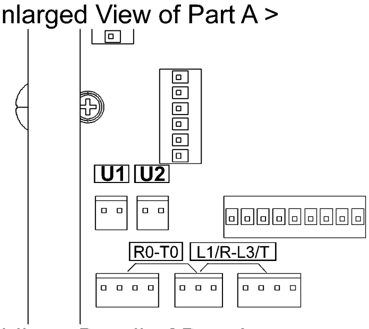


FRN18.5VG7S-2 to FRN55VG7S-2
FRN18.5VG7S-4 to FRN110VG7S-4



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

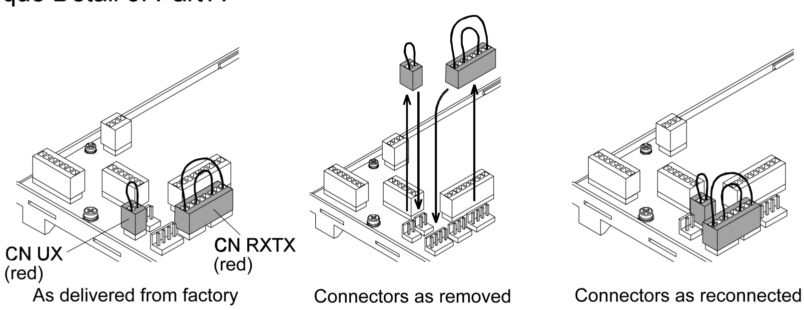
< Enlarged View of Part A >



CN UX is connected to U1

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

< Oblique Detail of Part A >



CNUX : U1

CNRXTX : L1/R-L3/T

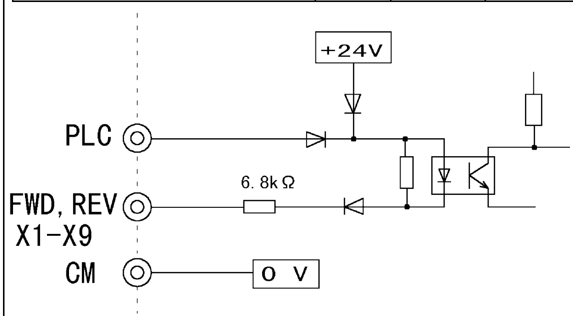
The Figure applies when the inverter is used with DC power inputs at a supply voltage of 380-398 V, 50 Hz or 380-430 V, 60 Hz.

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

3.3.3 Wiring of Control Terminals

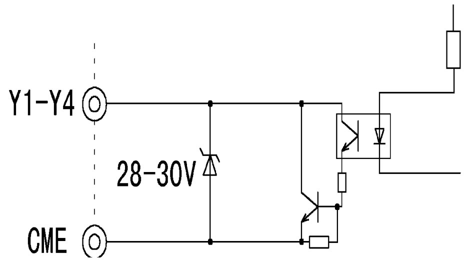
Functions of the control circuit terminals are described in Table 3-3-4. Each control terminal should be wired in different ways, depending on its setting.
Terminal arrangement is given in Section 2.3.3.

Table 3-3-4

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

Transistor output	Y1	Transistor output 1	Outputs signals such as Running, Speed equivalence, Overload early warning, ... and ⊖ as transistor outputs from inverter to specified ports. For details, see 2.3.2 'Functions of Terminals'. <Transistor Output Circuit Specifications>
	Y2	Transistor output 2	
	Y3	Transistor output 3	
	Y4	Transistor output 4	

Item		min.	typ.	max.
Operating voltage	ON level	-	1V	2V
	OFF level	-	24V	27V
On-time max. load current		-	-	50mA
Off-time permissible leak current		-	-	0.1mA



Transistor output	CME	Transistor output common	A common terminal for transistor output terminals. Insulated from terminals CM and 11.
Relay output terminals	30A,30B, 30C	Alarm relay output (for any fault)	Outputs alarm signal as relay contact output (1SPDT) when inverter stops due to alarm. Contact capacity: 250V AC, 0.3 A, cos ∅ = 0.3 (or 48 V DC, 0.5 A when conformed with Low Voltage Directive) You may choose to close contacts under unusual or normal conditions.
	Y5A,Y5C	Relay output	You may select a signal as you may with Y1 to Y4 terminals. Contact capacity is the same as with alarm relay output terminals.
Communication	RX(+), RX(–) TX(+),TX(–)	RS485 communication input/output	Input/output terminals for RS485 communication Up to 31 inverters may be connected through multi-drop connections. Terminating resistor (100 Ω) can be connected via switch (SW3).
	SD(M)	Communication shield cable connection	Connected with shielded wires.
Speed detection	PA,PB	Pulse generator 2-phase signal input	Connected with 2-phase signals from pulse generator
	PGP,PGM	Pulse generator power supply	Supplies power (+15 V DC (switchable to +12 V DC)) to PG.
	FA,FB	Pulse generator output	Output pulse generator signal with frequency divided to 1/n. (n is programmable with function code E29.)
	CM	Pulse generator output common	A common terminal for FA and FB.
Temperature	TH1,THC	NTC/PTC thermistor connection terminals	Monitors motor temperature with NTC and PTC thermistors. For PTC thermistor, motor overheat protection level can be set with function code E32.

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

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

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

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

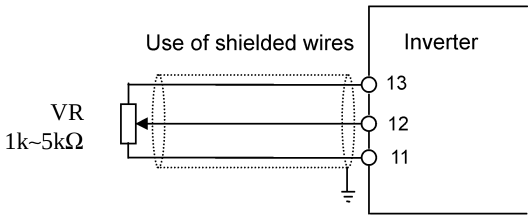


Figure 3-3-8

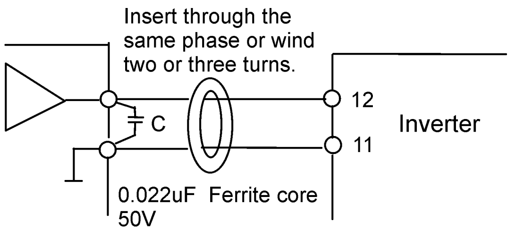


Figure 3-3-9
Protection against Noise (Example)

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

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

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

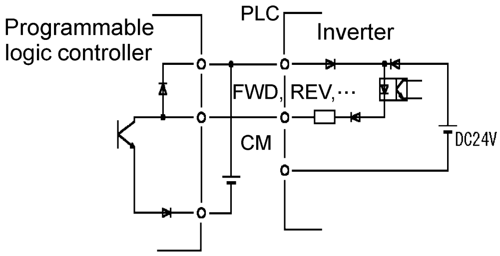


Figure 3-3-10
Protection against Current Leak from External Power Source

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

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

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

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

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

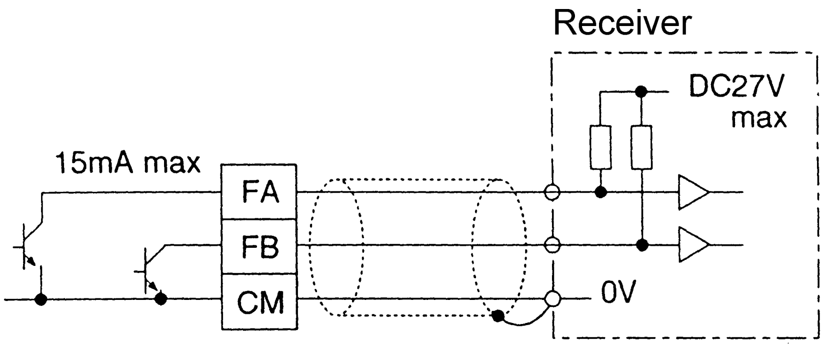


Figure 3-3-11 Wiring of PG Output Terminals

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

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

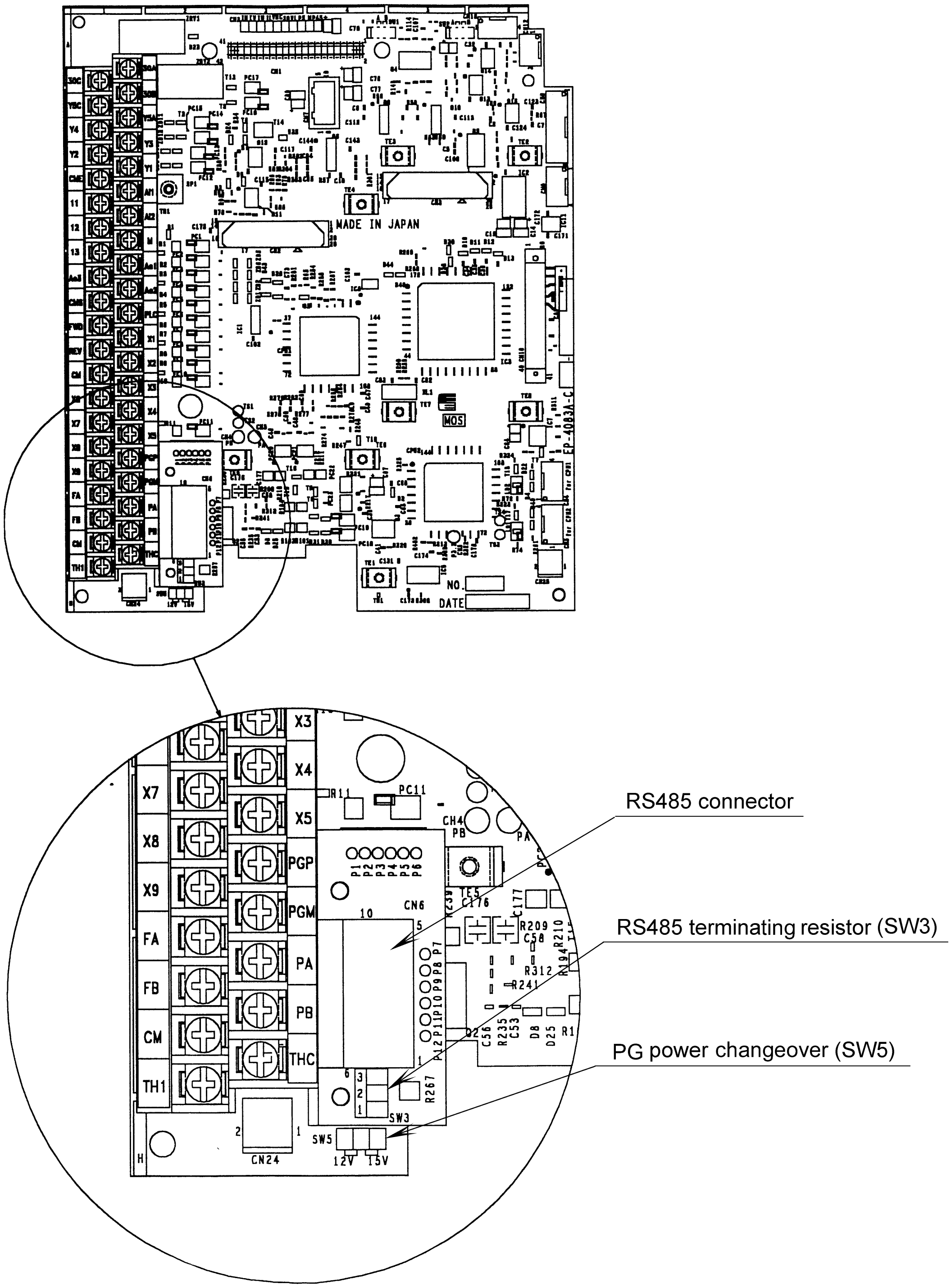


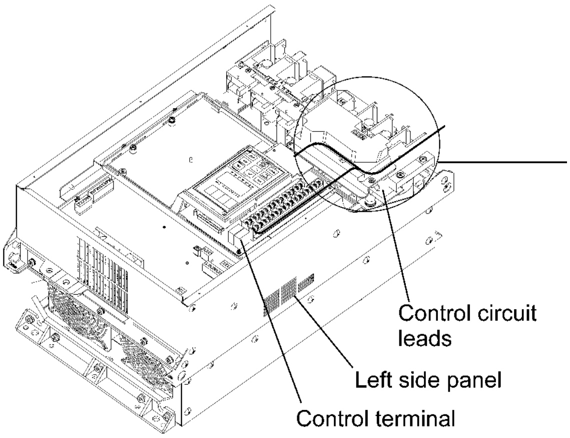
Figure 3-3-12
Layout of switch and connector

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

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

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

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



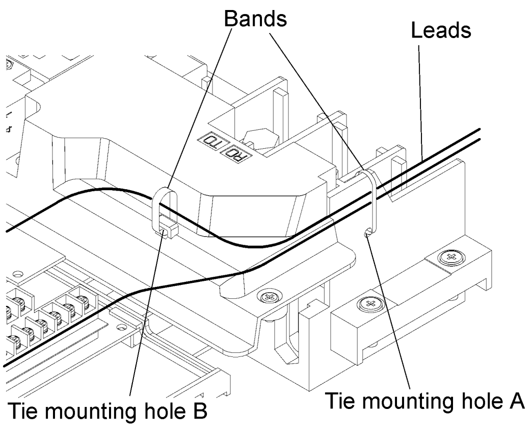


Figure 3-3-13
Routing Inverter (18.5 kW or Higher) Control Circuit Leads

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

2) FRN132VG7S-4 to FRN160VG7S-4

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

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

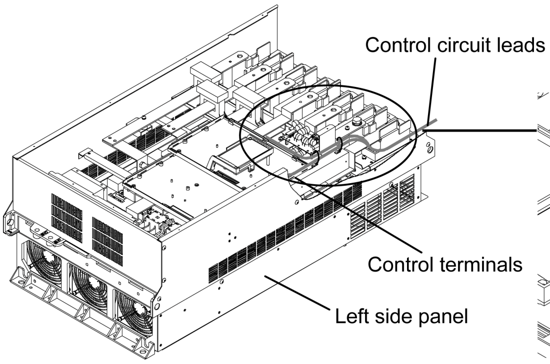


Figure 3-3-15
Routing Inverter Control Circuit Leads

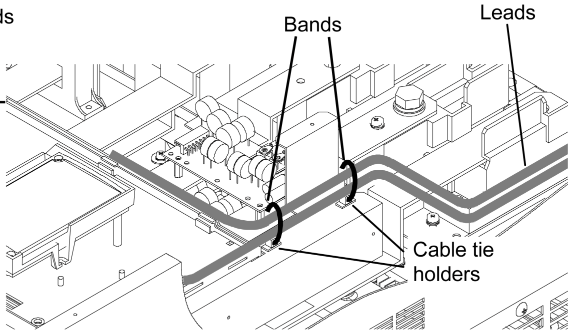


Figure 3-3-16
Securing Inverter Control Circuit Leads

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

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

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

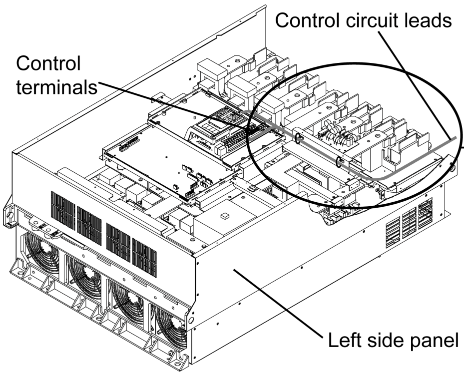


Figure 3-3-17
Routing Inverter Control Circuit Leads

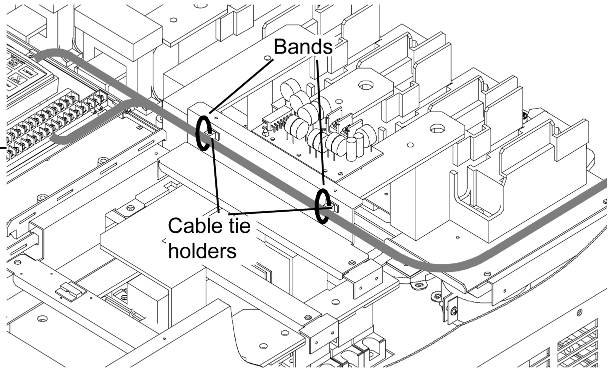


Figure 3-3-18
Securing Inverter Control Circuit Leads

3. Preparatory Operations and Test Run

3.4 Test Run

3.4.1 Preliminary Check and Preparation

Perform the following checks before starting operation.

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

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

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

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

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

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

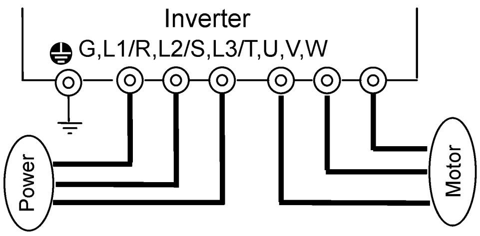


Figure 3-4-1
Inverter Connection Diagram

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

⚠ WARNING
• Never turn the power switch on (closed) before mounting the face cover. Do not remove the cover while the inverter is energized. • Do not handle the inverter with wet hand. **Doing so may lead to electric shock.**

3.4.2 Operating Methods

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

3.4.3 Test Run

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

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

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

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

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

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

Table 3-4-1 General Operating Methods

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

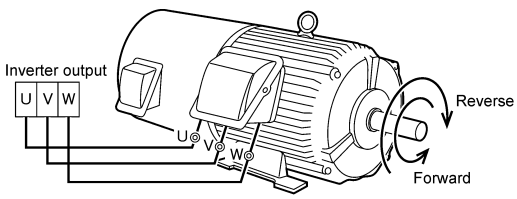


Figure 3-4-3 Motor Rotating Directions

3. Preparatory Operations and Test Run

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

⚠ CAUTION

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

⚠ WARNING

- Setting a function code in a wrong manner or without fully understanding this manual may cause the motor to revolve at an unacceptable torque or speed, possibly resulting in accident or injury.

Accident on injury may result.

THE INVERTER

IV. Control and Operation

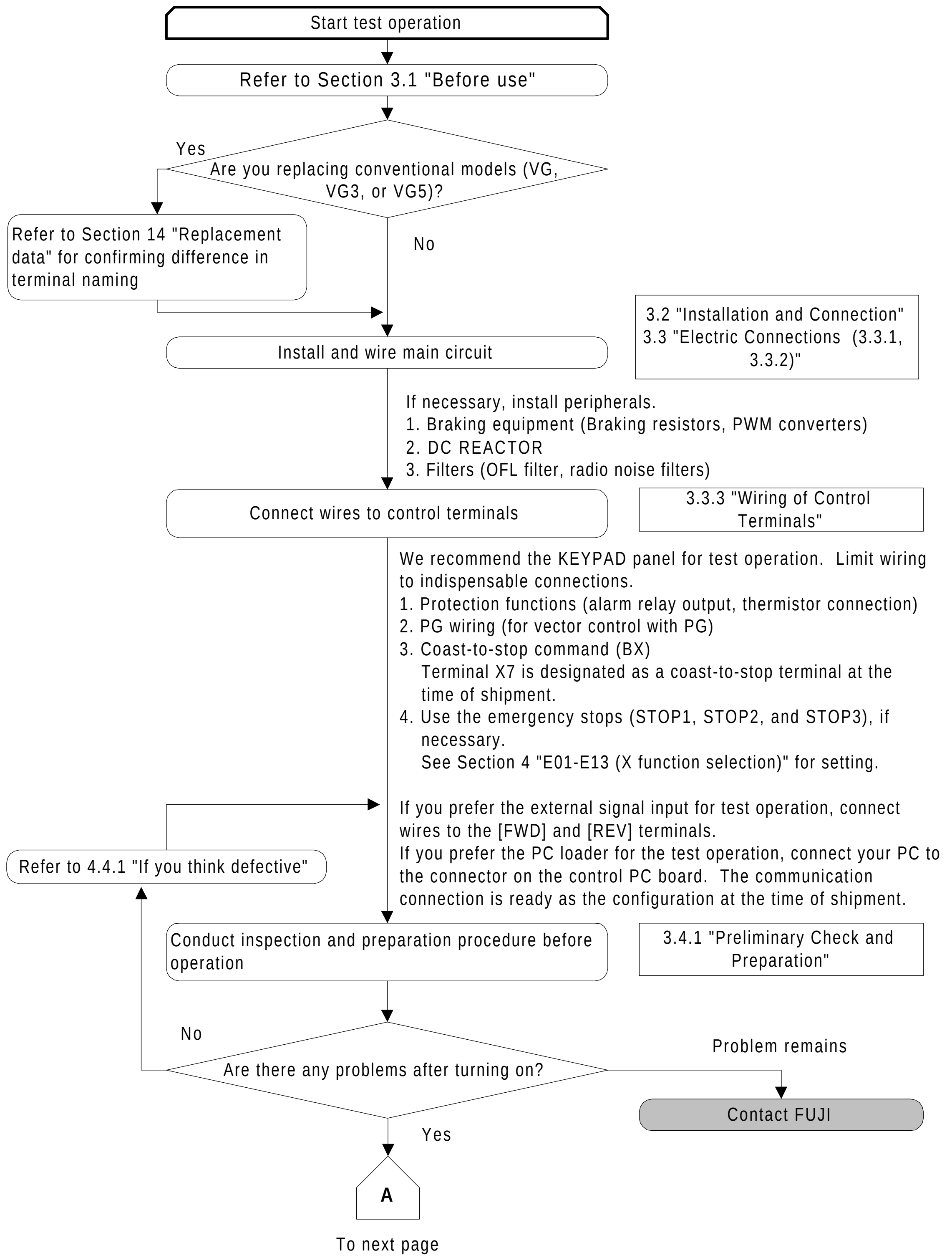
4. Control and Operation

4.1 Read this Section First

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

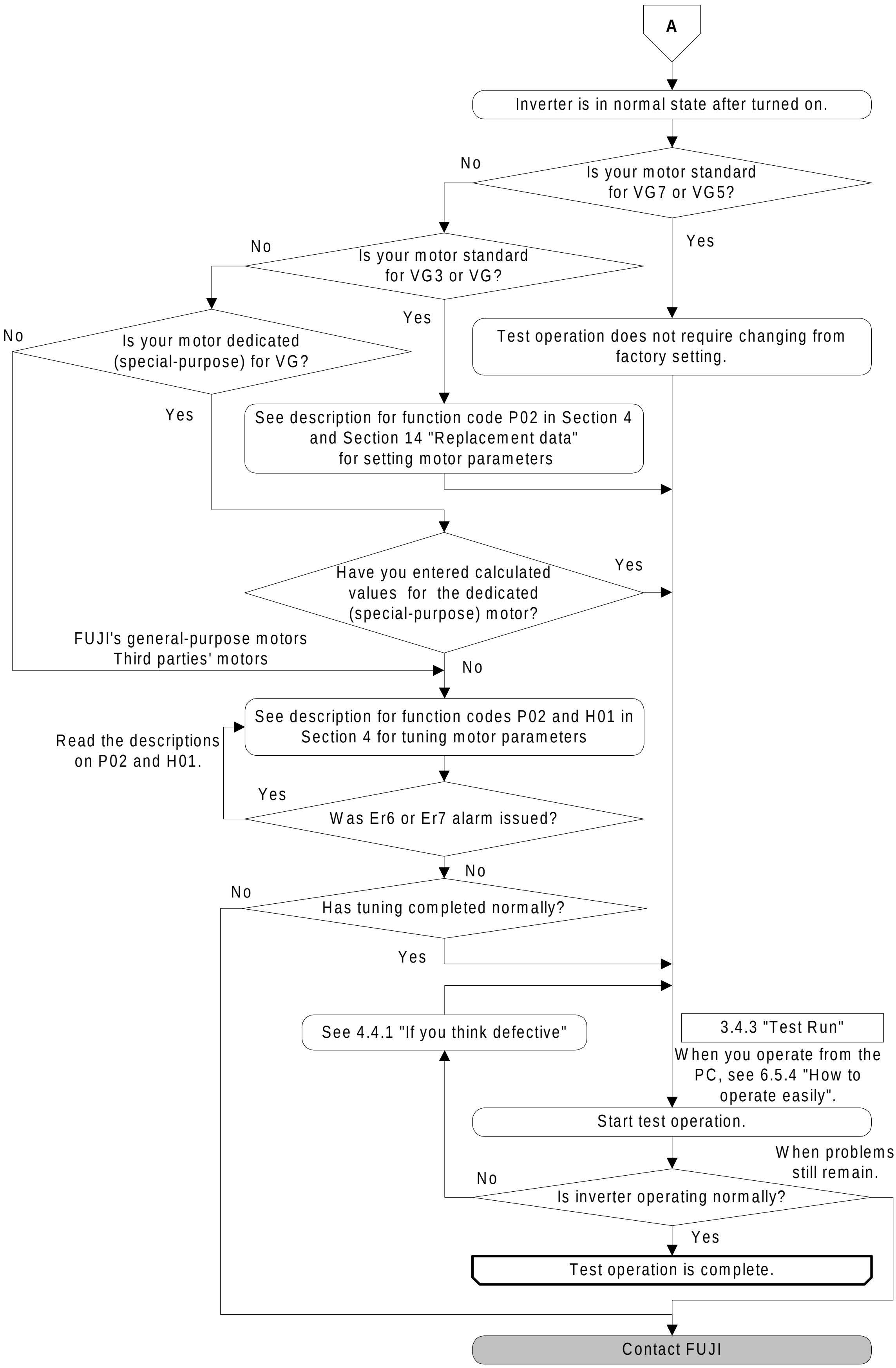
4.1.1 Turning ON the Power

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



4.1.2 Starting Test Operation

Start test operation after the inverter is turned on normally.



4. Control and Operation

4.1.3 Introduction to Setting in Detail

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

Changes made to previous models

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

Overview of the integrated functions

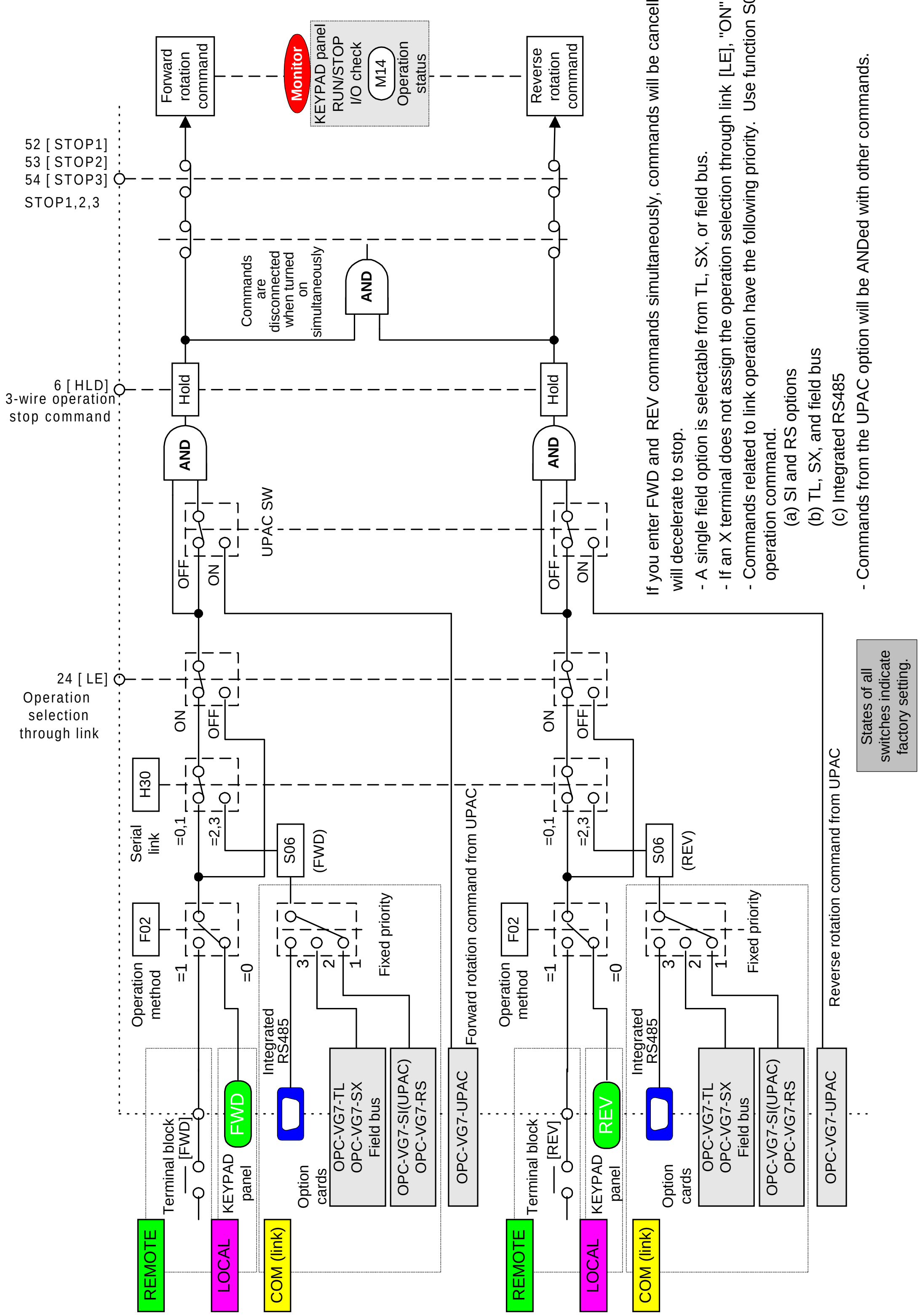
PWM converter connection is provided as standard.	See Section 3.3.2 "Wiring of Main Circuit and Grounding Terminals".
Triple standards (CT, VT, and HT) are selectable.	See "F80" in Section 4.3" Function Code Description".
Various control types (such as vector control) are available.	See "P01" and "A01"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

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

4. Control and Operation

4.2 Control Block Diagrams

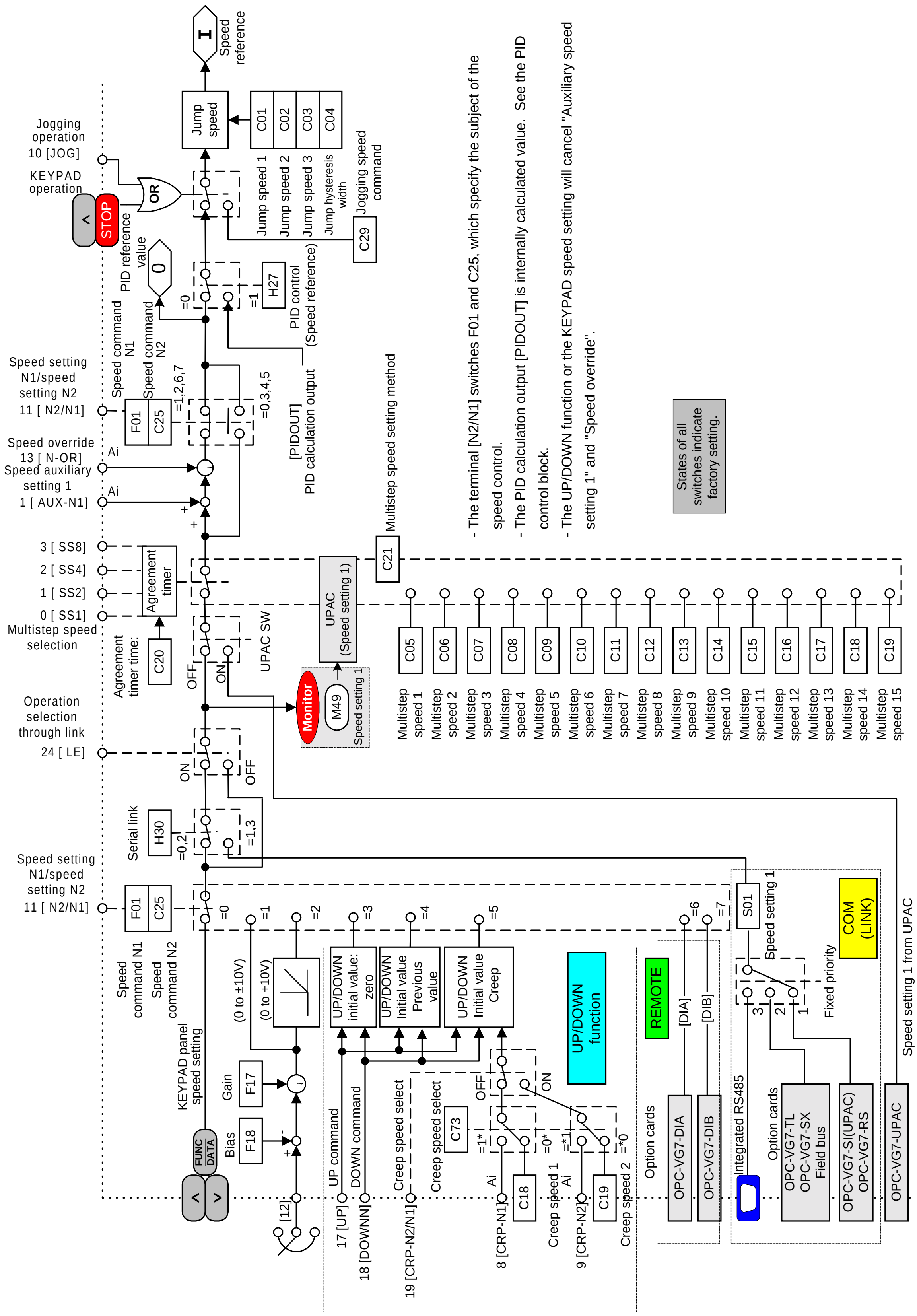
4.2.1 Operation Command



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

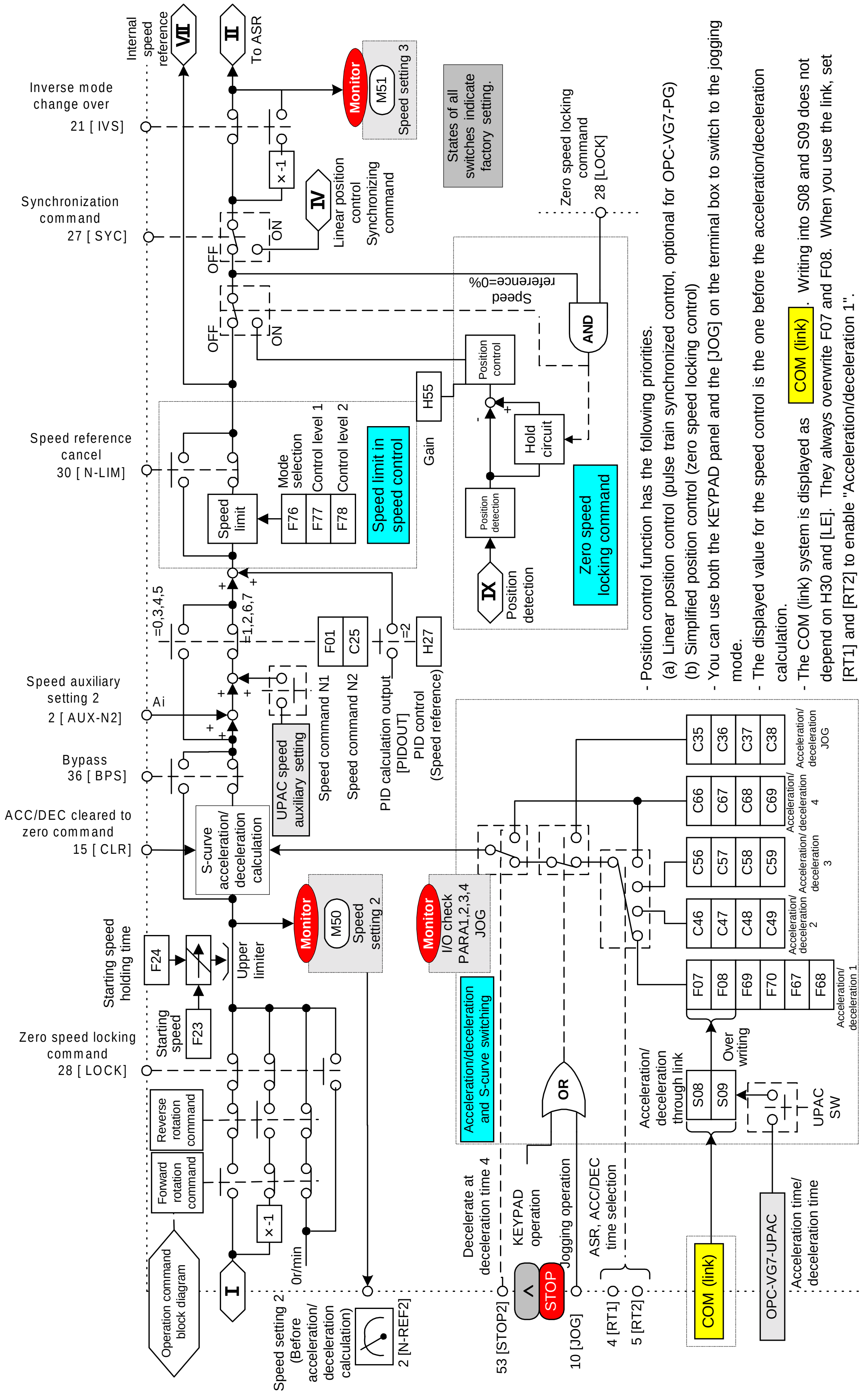
- A single field option is selectable from TL, SX, or field bus.
- If an X terminal does not assign the operation selection through link [LE], "ON" is assumed to it.
- Commands related to link operation have the following priority. Use function S06 for an operation command.
  - (a) SI and RS options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

4.2.2 Speed Command Selection Section



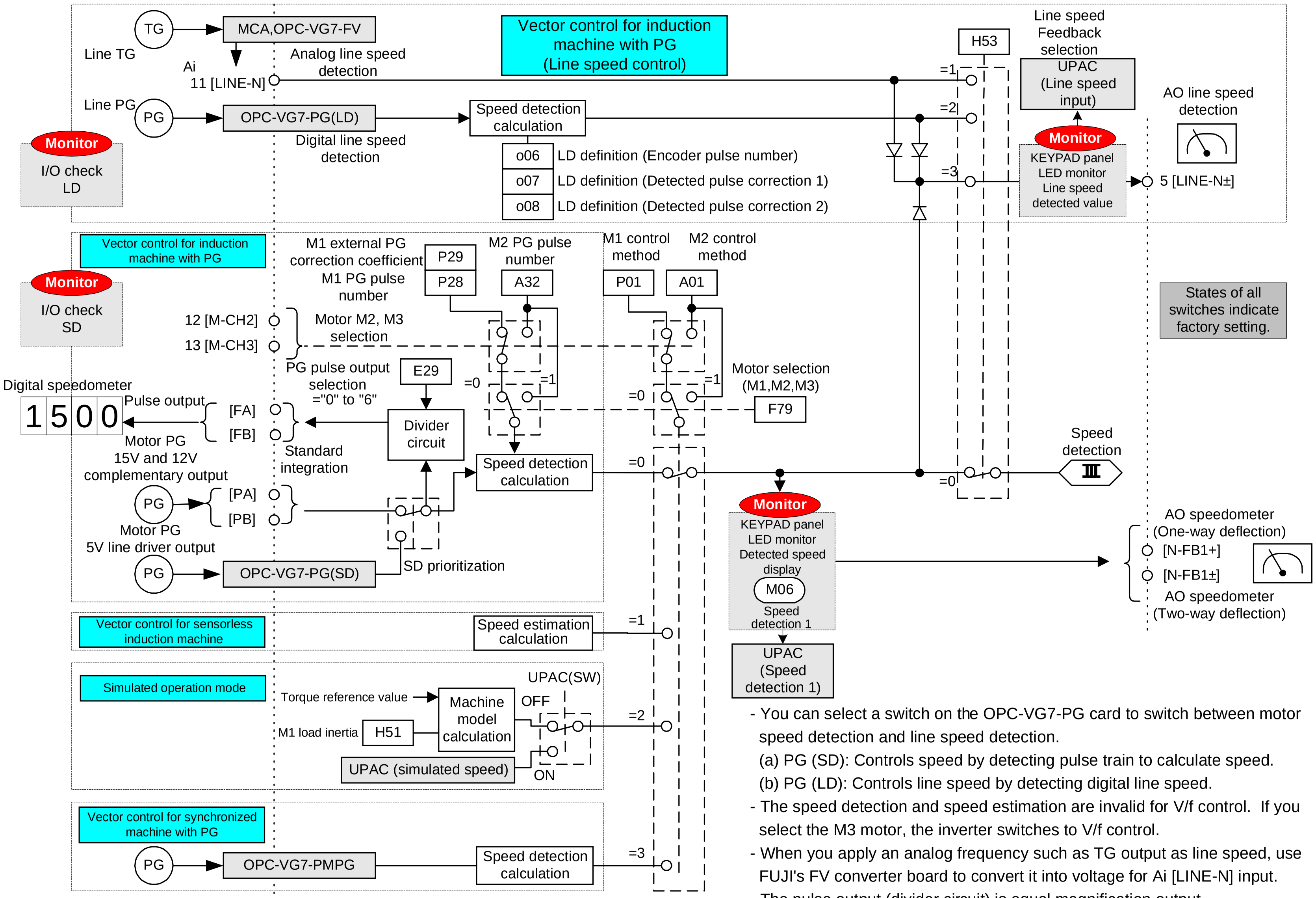
Control and Operation

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



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

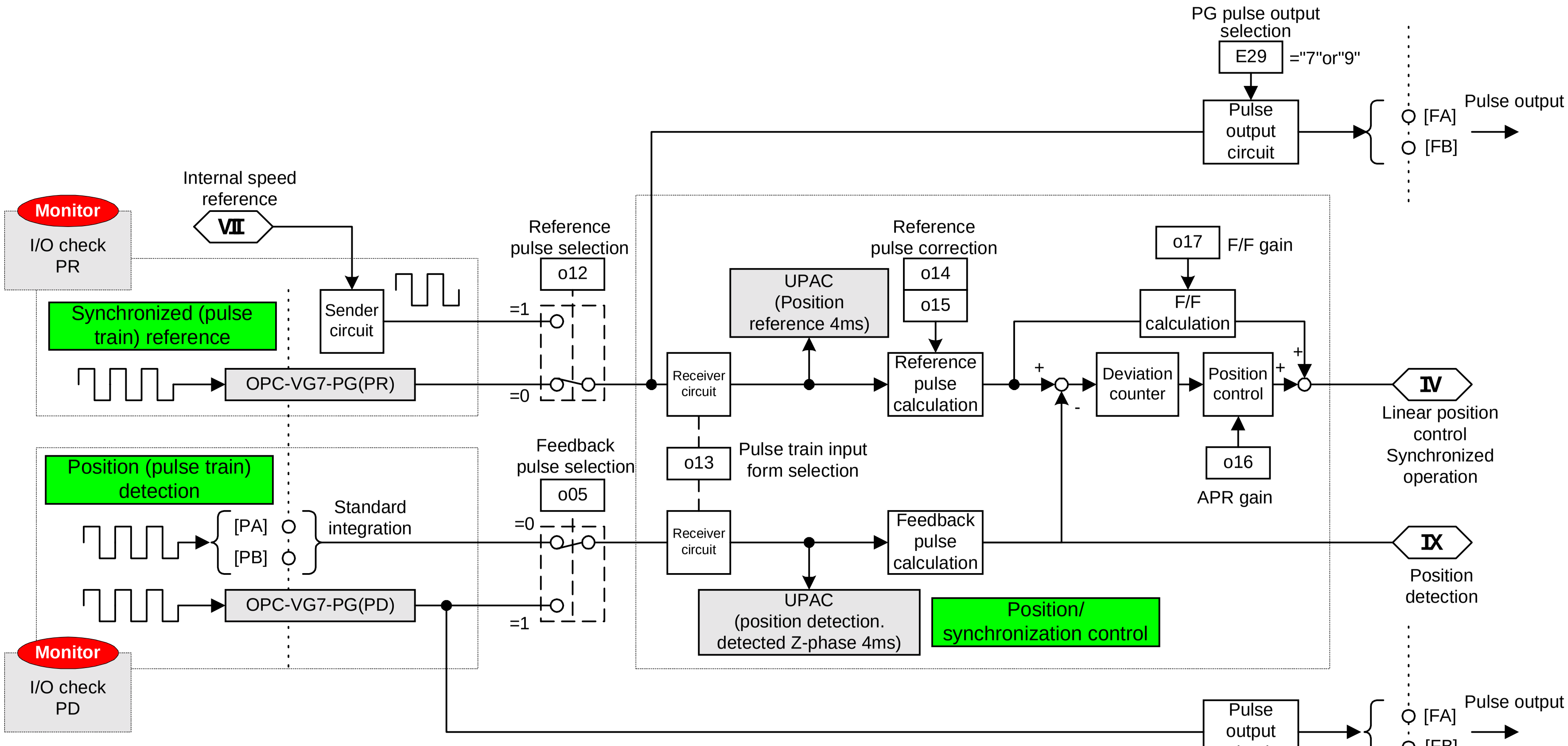
4.2.4 Motor Speed/line Speed Detection



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

4. Control and Operation

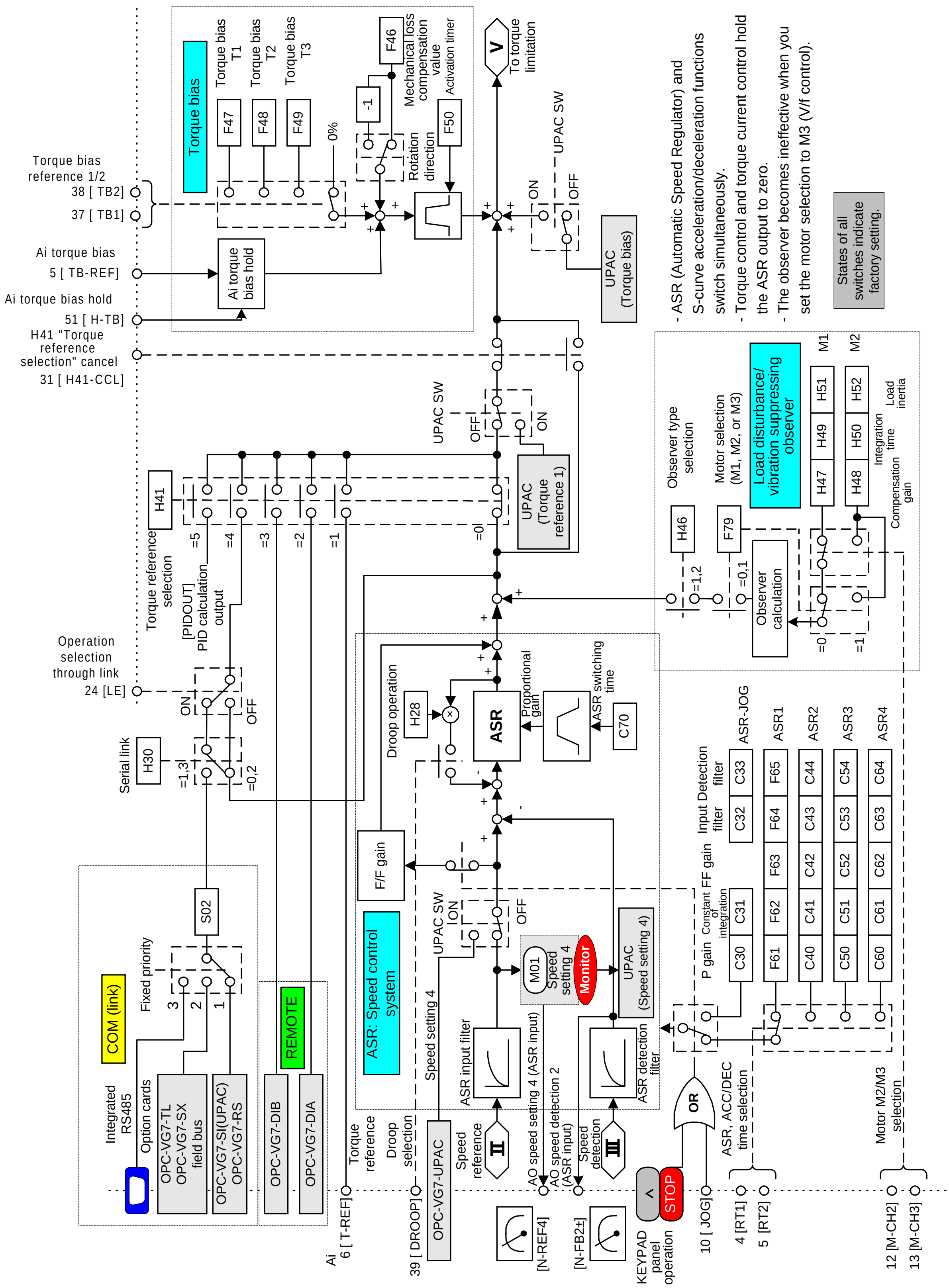
4.2.5 Pulse Train Reference Input Section and Position Detection Section



States of all switches indicate factory setting.

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

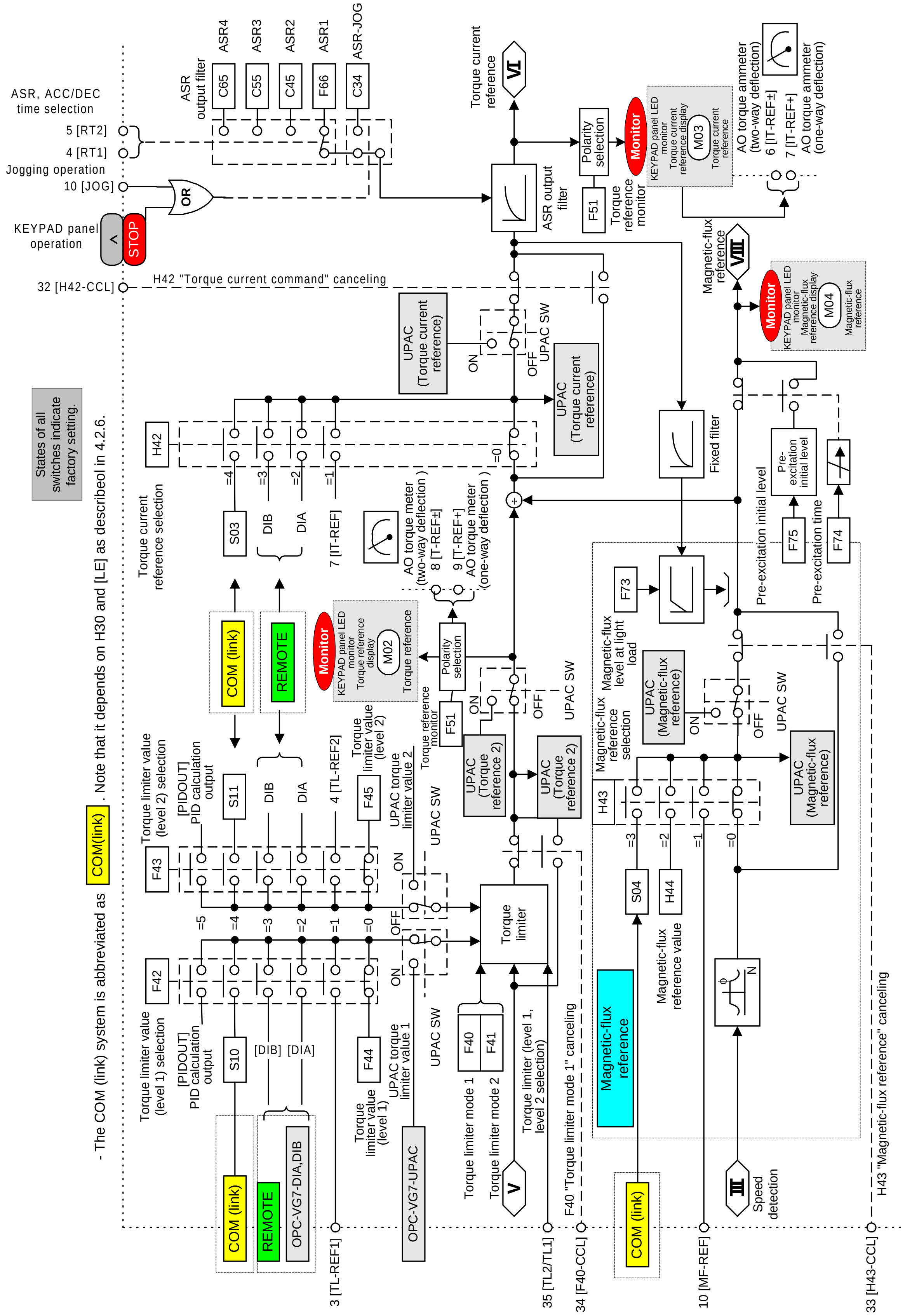
4.2.6 Speed Control and Torque Reference Section



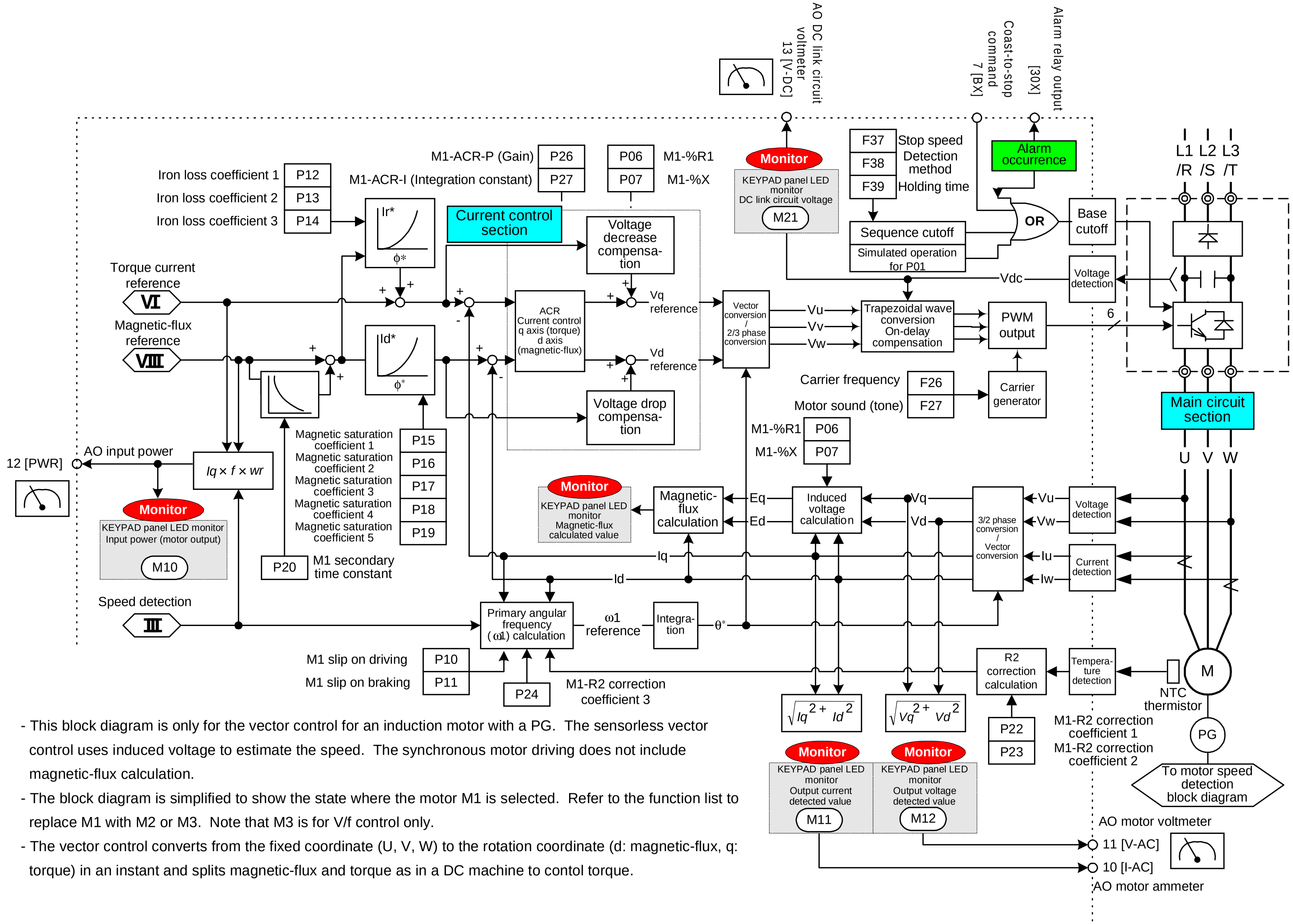
- ASR (Automatic Speed Regulator) and S-curve acceleration/deceleration functions switch simultaneously.
- Torque control and torque current control hold the ASR output to zero.
- The observer becomes ineffective when you set the motor selection to M3 (V/f control).

States of all switches indicate factory setting.

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

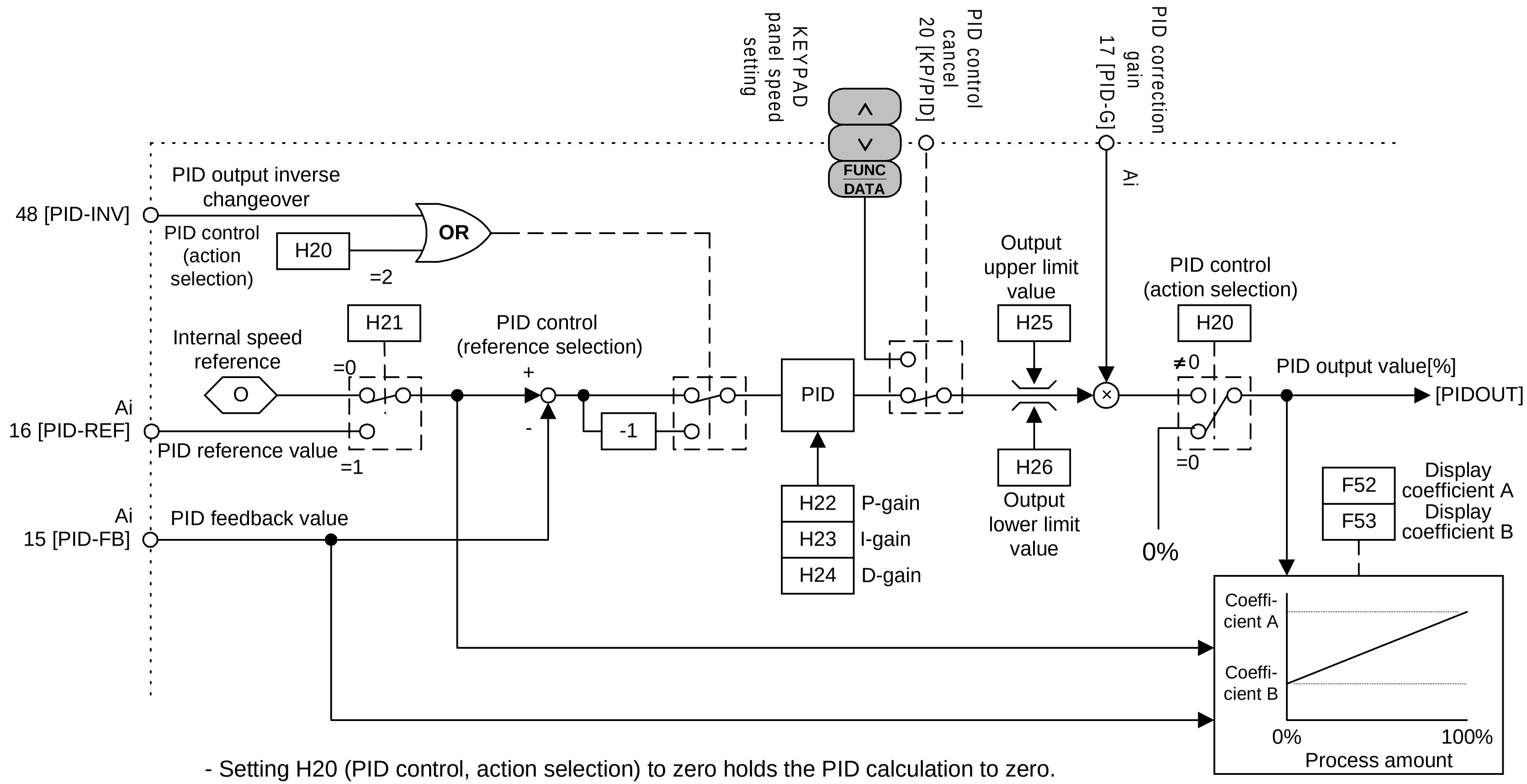


4.2.8 Current Control and Vector Control Section



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

4.2.9 PID Calculation Section



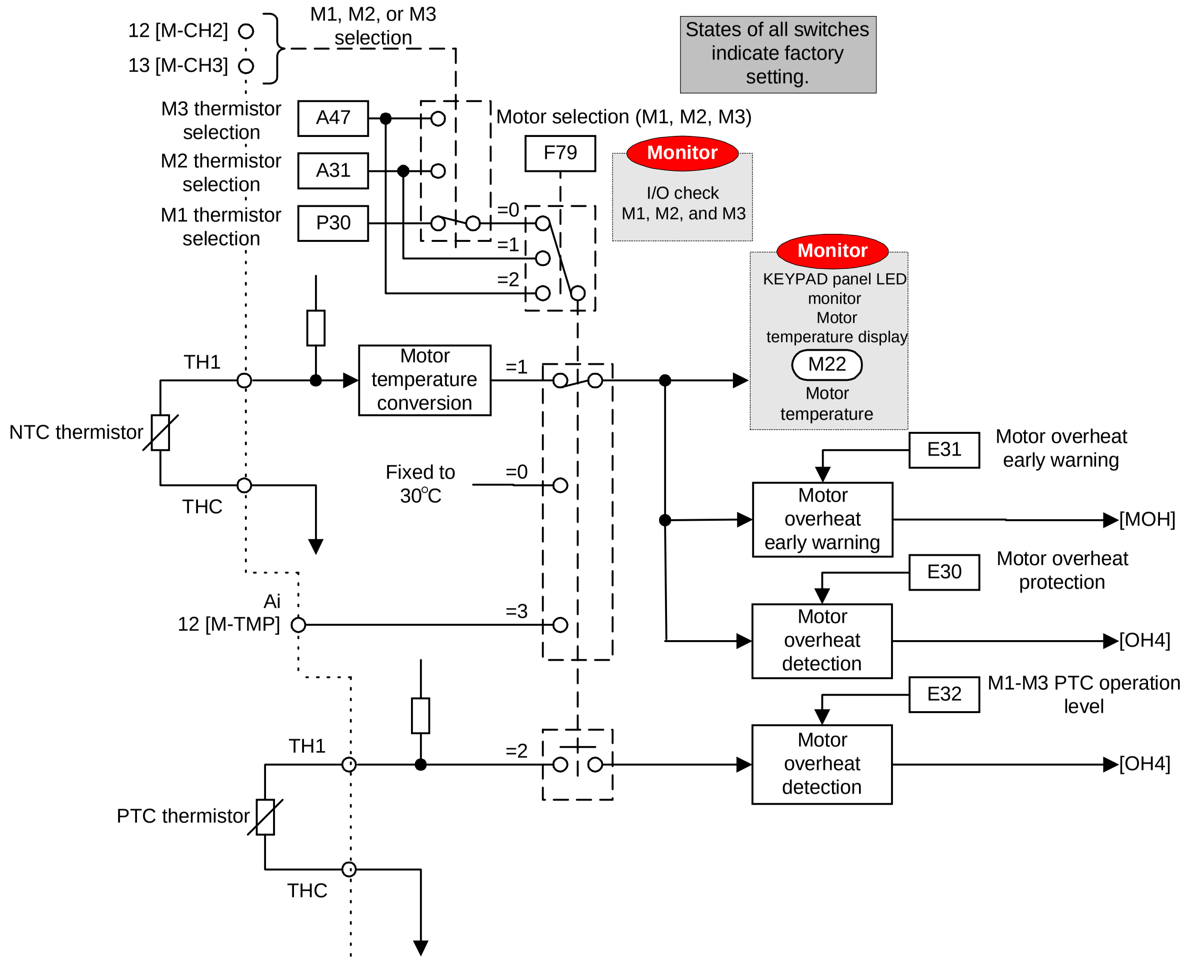
Monitor

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

States of all switches indicate factory setting.

- Setting H20 (PID control, action selection) to zero holds the PID calculation to zero.
- The UP/DOWN setting mode disables PID fuctions.
- [PIDOUT] of PID output is used for individual controls. See corresponding block diagrams for details.
  Speed reference when H27 "PID control (speed reference selection)" is set to 1.
  Auxiliary speed reference when H27 "PID control (speed reference selection)" is set to 2.
  Torque reference when H41 "Torque reference selection" is set to 5.
  Torque limiting when F42 or F43 "Torque limiter value (level 1) or (level 2) selection" is set to 5.

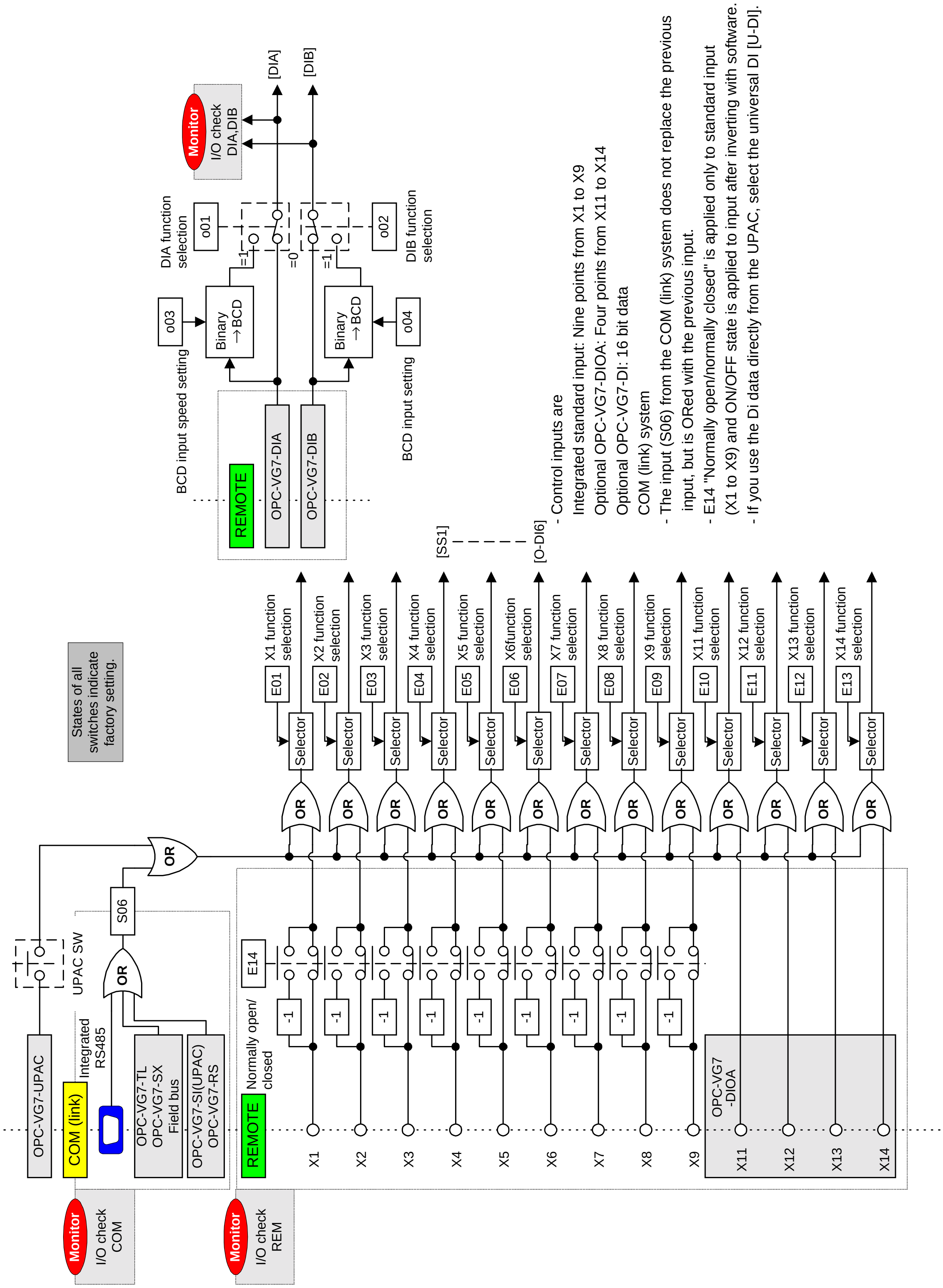
4.2.10 Motor Temperature Detection Section



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

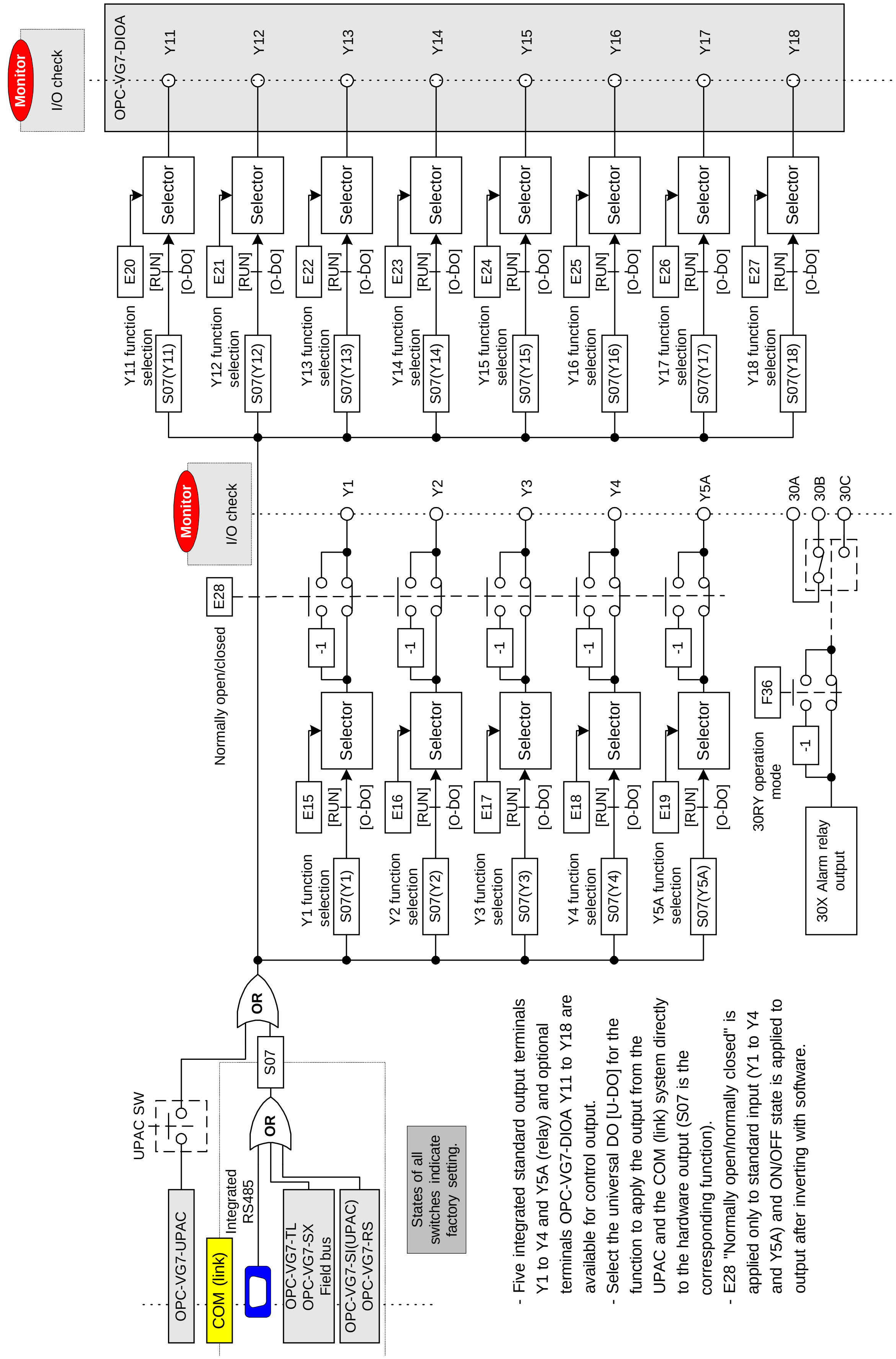
4. Control and Operation

4.2.11 Function Selection Digital Input



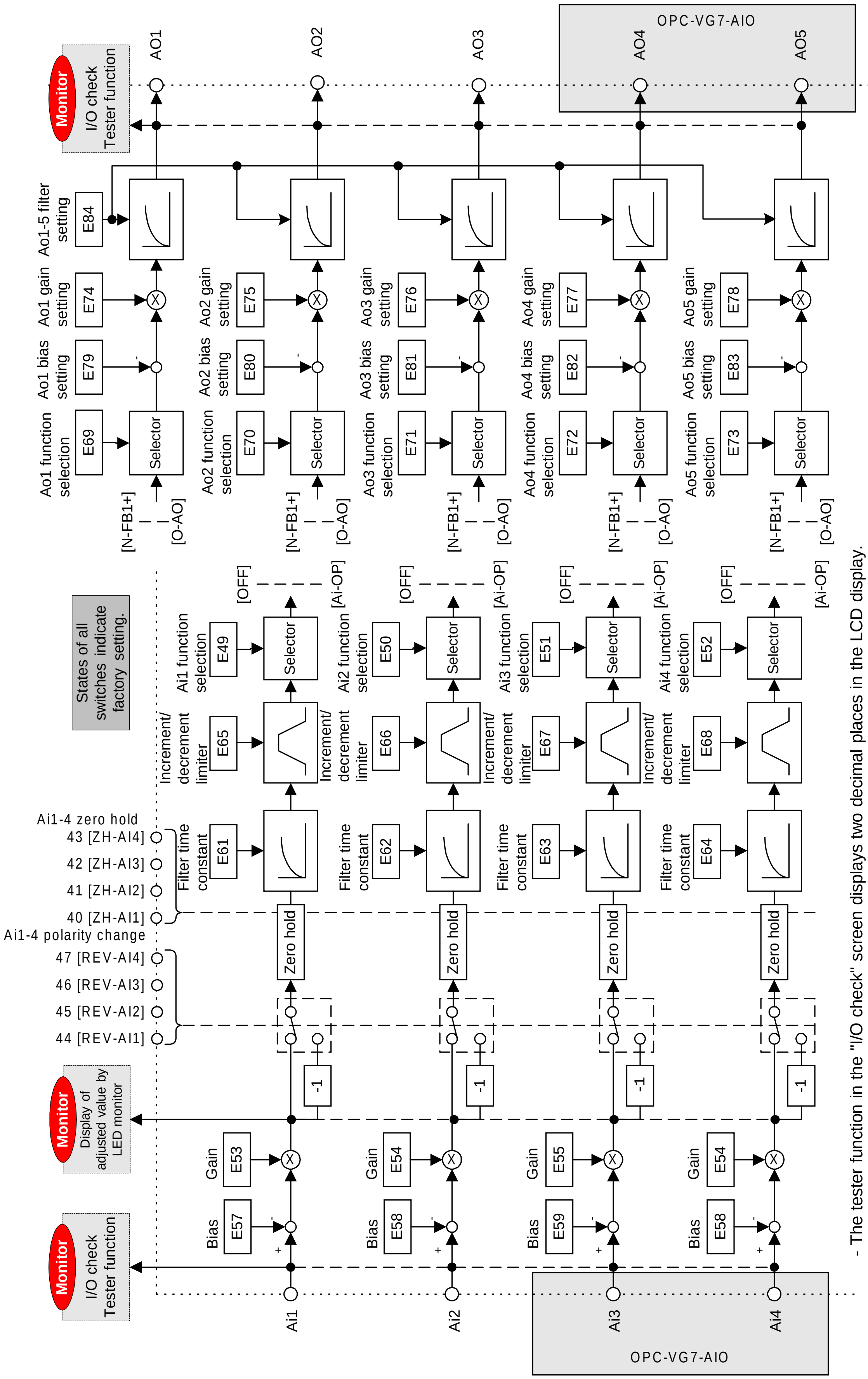
- Control inputs are
  Integrated standard input: Nine points from X1 to X9
  Optional OPC-VG7-DIOA: Four points from X11 to X14
  Optional OPC-VG7-DI: 16 bit data
  COM (link) system
- The input (S06) from the COM (link) system does not replace the previous input, but is ORed with the previous input.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

4.2.12 Function Selection Digital Output/Fault Output



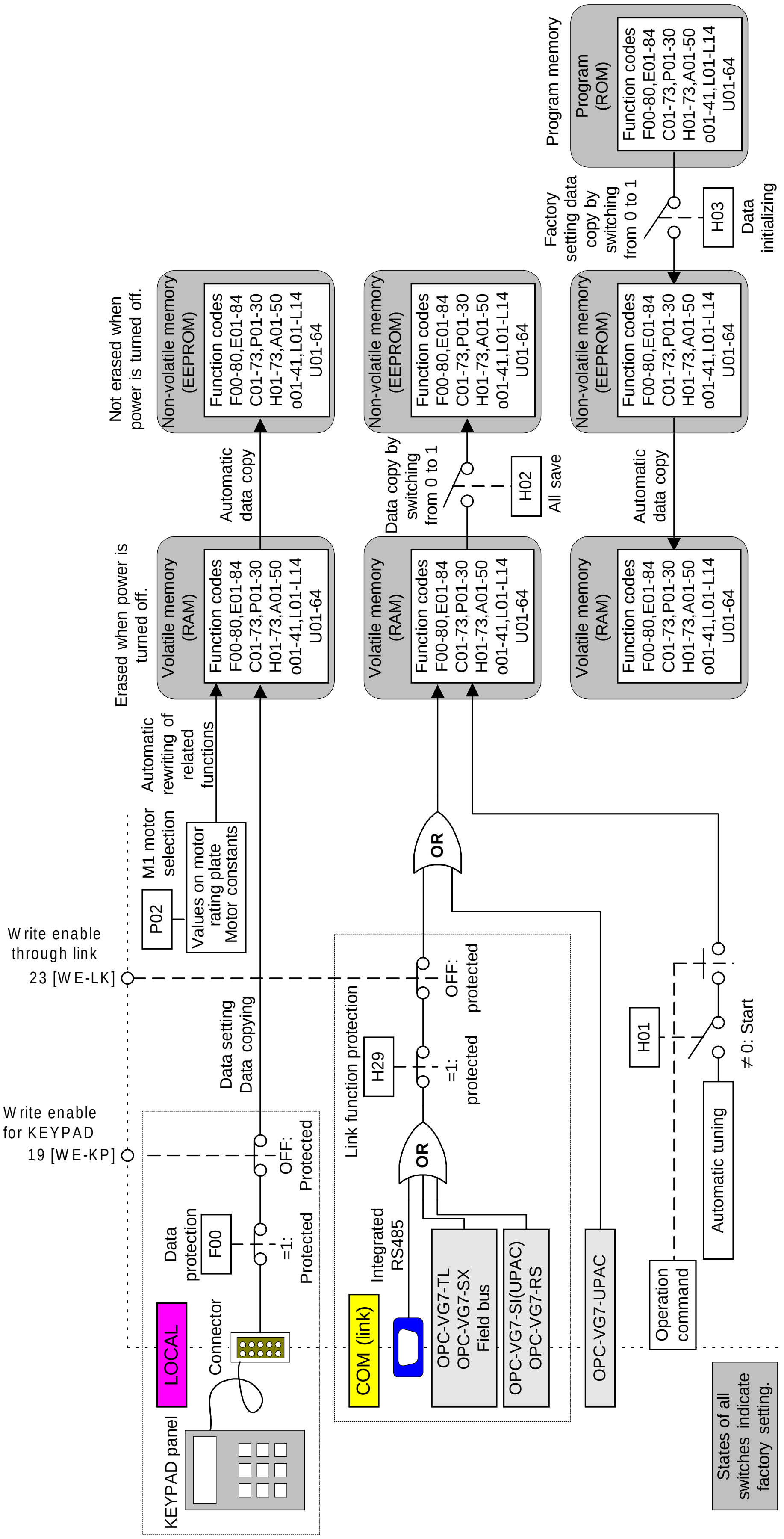
- Five integrated standard output terminals Y1 to Y4 and Y5A (relay) and optional terminals OPC-VG7-DIOA Y11 to Y18 are available for control output.
- Select the universal DO [U-DO] for the function to apply the output from the COM (link) system directly to the hardware output (S07 is the corresponding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

4.2.13 Function Selection Analog Input/Output



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

4.2.14 Enabling to Write to/recording Function Codes



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

4.3 Function Code Description (Arranged by Code)

4.3.1 F Code (Fundamental Functions)

F00 **Data protection**

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

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

F	0	0	D	A	T	A		P	R	T	C	

Set value: 0: You can change data. <0:CHGOK>

1: Data are protected. <1:PROTECT>

[Setting procedure]

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

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

F01 **Speed setting N1**

◆Defines the speed reference setting.

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

F	0	1	S	P	D		C	M	D		1	

Set value: 0: Set by the KEYPAD panel (∧ and ∨ keys) <0: KEYPAD>

1: Set by the voltage input (Terminal [12]: 0 to ±10 V) <1:12INPUT>

2: Set by the voltage input (Terminal [12]: 0 to +10 V) <2:12(ABS)>

3: Set by the UP/DOWN (Initial value=0) <3:U/D(0)>

4: Set by the UP/DOWN (Initial value=previous value) <4:U/D(BEF)>

5: Set by UP/DOWN (Initial value=CRP1, CRP2)
(Set by the [UP] and [DOWN] terminals. Related functions: E01 to E13 "X function selection") <5:U/D(CRP)>

6: DIA card input <6: DIA CARD>

7: DIB card input <7: DIB CARD>

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

1200

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

F02 **Operation method**

◆Sets operation method.

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

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

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

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

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

1500
REM □X2 □X6
■FWD □X3 □X7
□REV □X4 □X8
□X1 □X5 □X9

F03 **M1 max. speed**

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

F 0 3 M 1 - N m a x

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

F04 **M1 rated speed**

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

F 0 4 M 1 - N r

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

F05 **M1 rated voltage**

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

F 0 5 M 1 - V r

Setting range: 80 to 999 [V]

F07	Acceleration time 1
F08	Deceleration time 1

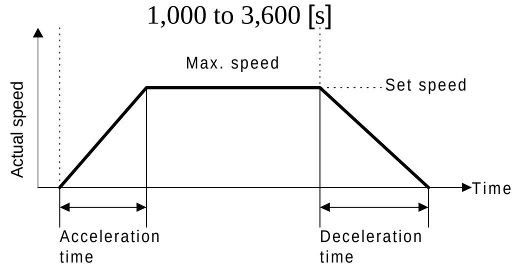
◆Set the acceleration time from zero to the maximum speed and the deceleration time from the maximum speed to zero. The acceleration time and deceleration time are set based on the maximum speed.

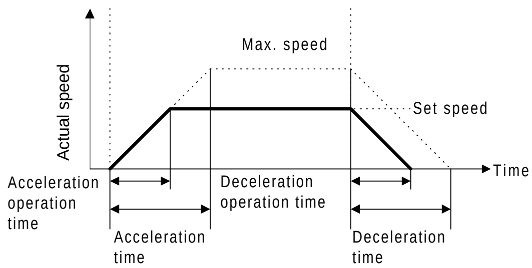
◆The following equation denotes the relationship between the set speed and the acceleration/deceleration times. The acceleration/deceleration times become longer when you specify the S-curve acceleration and deceleration. See F67 function description for more details.

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

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

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





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

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

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

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

- Operation selection

When you use a dedicated motor for the VG5 or the VG7, the motor overheat protection by an NTC thermistor becomes in operation and you do not hove to use an electronic thermal overload relay. Disable this function.

When a motor overheat protection by an NTC thermistor is not available, enable the electronic thermal overload relay and select a motor (self-cooling fan or separate cooling fan).

The protection function (motor overload: oL1) is activated when 150% of the current specified by F11 flows for the time specified by F12.

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

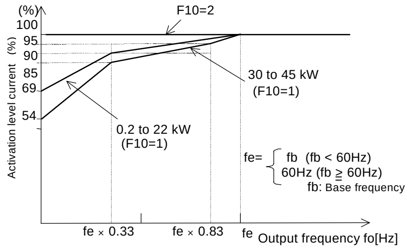
F 1 1 M 1 - E O L - L V L

- Operation level

  Set the activation level in current value for the electronic thermal overload relay.

  Enter a value in the range from 1.0 to 1.1 times of the rated current of a motor.

  Setting range: 0.01 to 99.99 [A]
  100.0 to 999.9 [A]
  1,000 to 2,000 [A]



Activation level current and output frequency

F 1 2 M 1 - E O L - T C

- Thermal time constant

  Set the time for 150% or more of the current at operation level (specified by F11) flows continuously before the electronic thermal overload relay is activated.

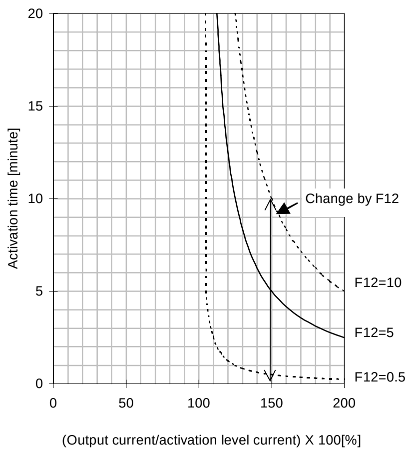
  Setting range: 0.5 to 75.0 [min]

(Example) If you set F12=5 [min],

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

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

Example of current-activation time characteristics



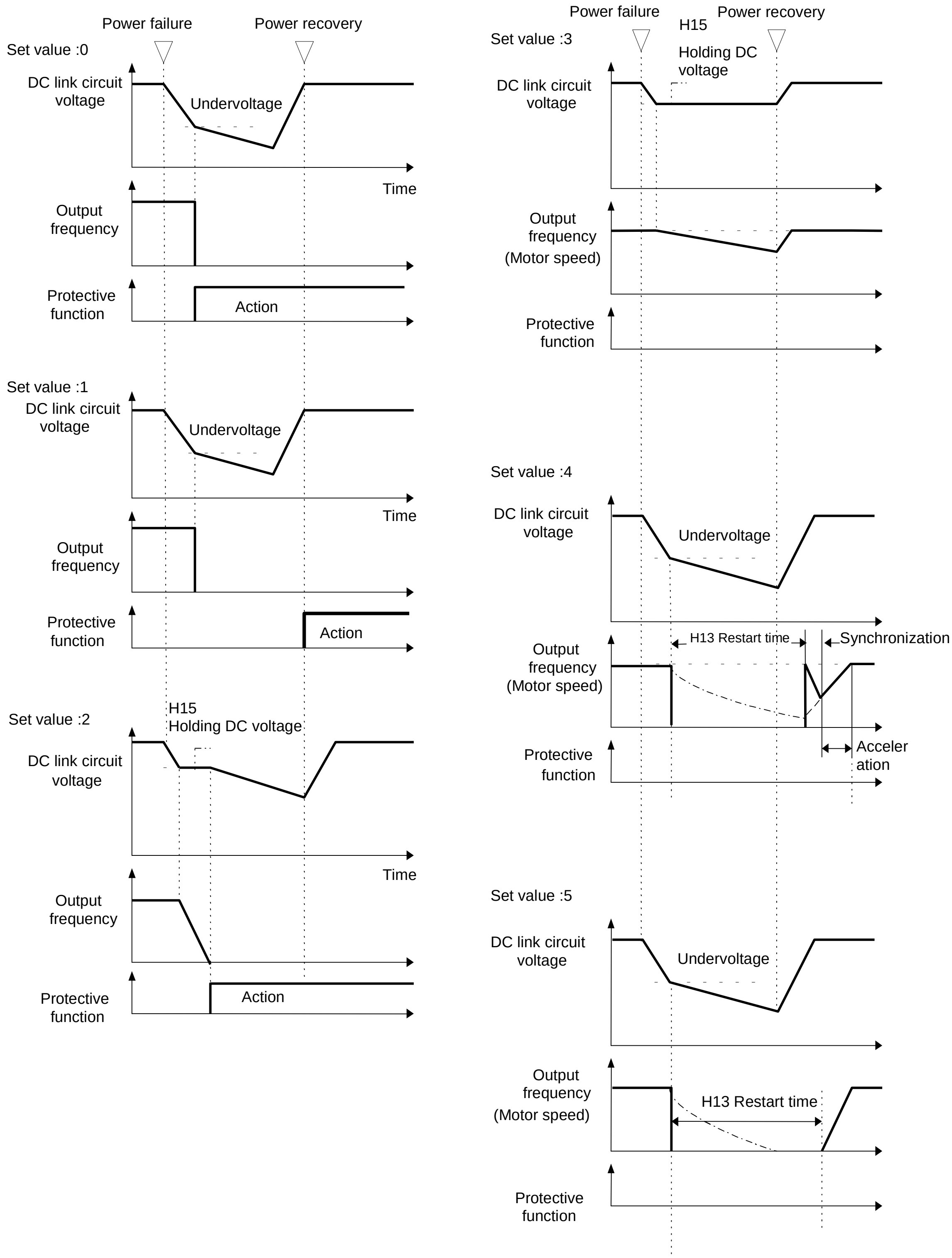
F14 Restart mode after momentary power failure (Select)

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

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

F14 RESTART

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



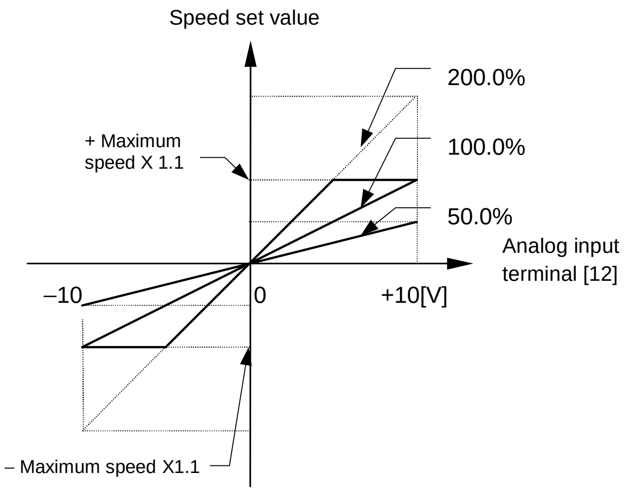
Set value :0
Power failure
Power recovery
DC link circuit voltage
Undervoltage
Time
Output frequency
Protective function
Action
Set value :1
DC link circuit voltage
Undervoltage
Time
Output frequency
Protective function
Action
Set value :2
H15
Holding DC voltage
DC link circuit voltage
Time
Output frequency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

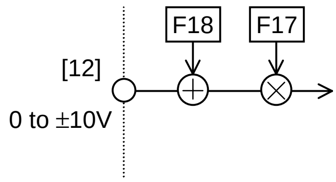
F17 Gain (for speed setting signal 12)

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

F	1	7	G	A	I	N	(	1	2	)		

Setting rage: 0.0 to 200.0 [%]



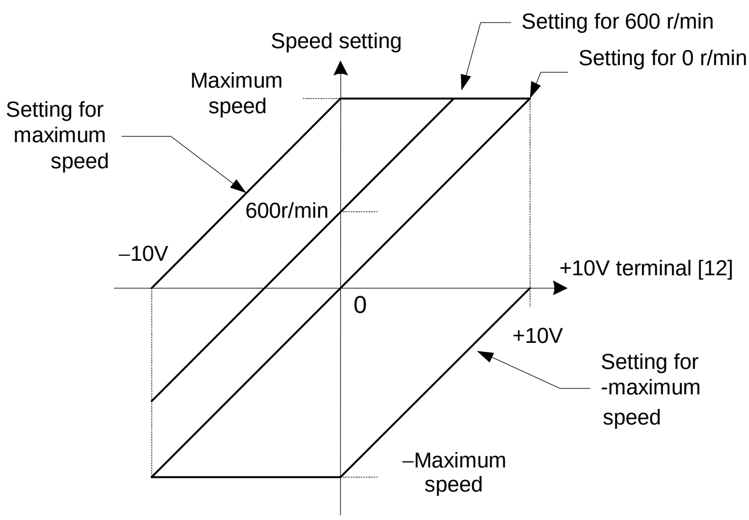


F18 Bias (for speed setting signal 12)

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

F	1	8	B	I	A	S	(	1	2	)		

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



F	2	0	D	C		B	R	K		N		

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

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

F	2	0	D	C		B	R	K		N		

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

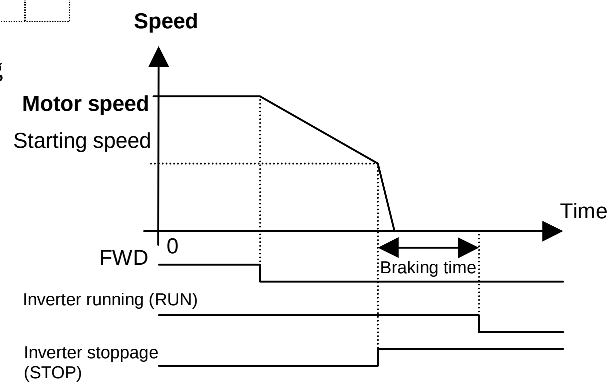
F	2	1	D	C		B	R	K		L	V	L

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

F	2	2	D	C		B	R	K		t		

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

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



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

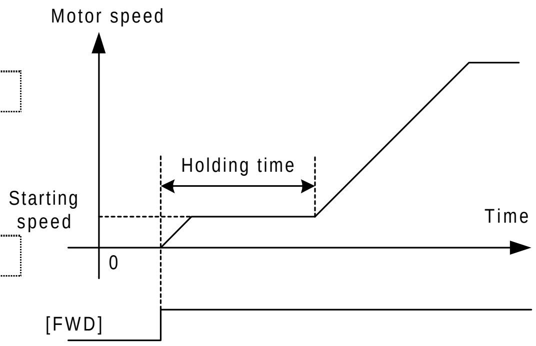
F23 Starting speed
F24 Starting speed (Holding time)

◆You can set a starting speed to assure a starting torque.

Vector control operation:

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

V/f control operation:
You can accelerate a motor after operating the motor at a starting speed for a certain period to establish the magnetic-flux on start.



F23 START N

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

F24 HLD STARTt

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

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

F26 Motor sound (Carrier freq.)

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

F26 MTR SOUND

Setting range: 0.75 to 15 [kHz]

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

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

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

F27 Motor sound (Sound tone)

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

F27 SOUND TONE

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

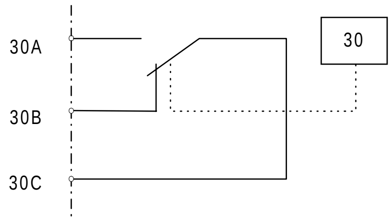
This function changes (modulates) the carrier frequency in the range of set frequency ±α[%] periodically. This does not cause adverse effects such as losses (motor or inverter).

F36 30RY operation mode

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

F	3	6	R	Y		M	O	D	E			

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



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

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

F	3	7	S	T	O	P		N				

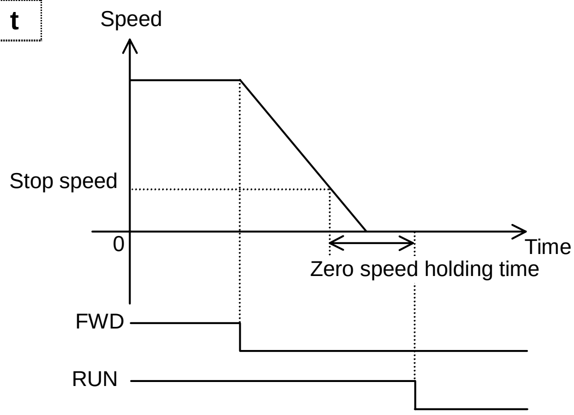
- Stop speed
  Sets the stop speed.
  Setting range: 0.0 to 150.0 [r/min]
  If starting speed < stop speed, or the speed setting value is lower than the stop speed, a motor does not start.

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

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

F	3	9	H	L	D		S	T	O	P		t

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



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

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

F40	Torque limiter mode 1
F41	Torque limiter mode 2

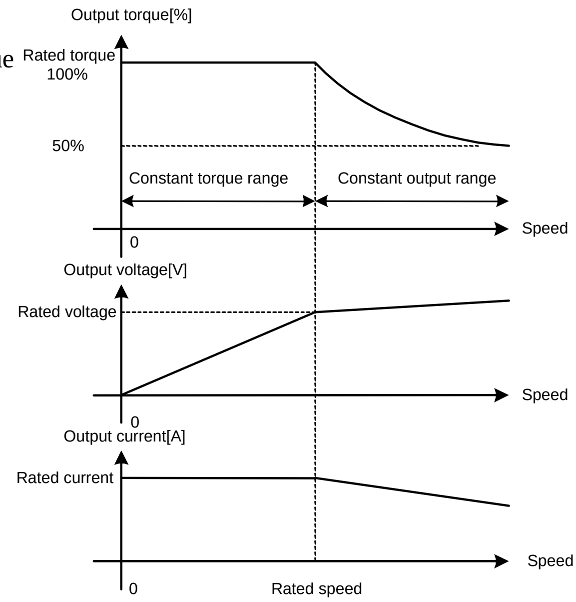
◆Torque limiter mode 1: Selects whether to enable or disable limiters (torque, power, or torque current). Turning on with applying "F40 cancel" [F40-CCL] has the same effect as setting "0" which disabling limiters.

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

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

Background information

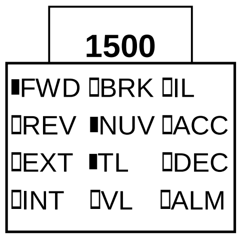
The right graph shows a continuous permissible torque (not short-time rating) for forward rotation driving in the speed control range (0-rated speed-200%). The control generally reduces magnetic-flux above the rated speed to extend the speed control range. The reduced output current in the right graph shows that the control reduces the current corresponding to the amount of the reduced magnetic-flux. This reduces the increase of the induced motor voltage to restrain the increase of the voltage output proportional to the speed.
Under the rated speed, the rated torque is effective. Since the torque is proportional to the product of the exciting current ant the torque current, the current is limited in practice.
Over the rated speed, since the inverter capacity (output: power) resticts the torque, the output torque decreases in inversely proportional to the speed.
The torque limiter condition switches at the rated speed.



Output characteristic
(first quadrant, forward rotation driving)

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

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



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

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

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

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

Description and application of the limiter mode 1

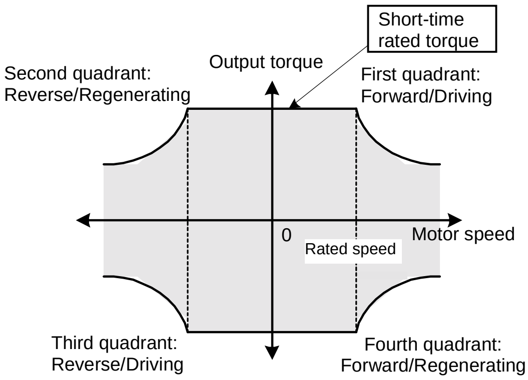
Limiter type	Limiter description	Application
Torque limiter disabled (set value: 0) [F40-CCL]= ON	Limits the torque by the maximum output current (One-minute, ten-second ratings) in the entire speed limiting range. $\tau(\text{Torque\%}) = \frac{\sqrt{\mathrm{Im}ax^2 - \mathrm{Im}^2}}{It} \times 100[\%]$ Maximum driving torque for 30kW, 200V, CT use, and VG7 dedicated motor is 153.1% Imax(Short-time rated current)=174(A) Im(Exciting current:P08)=53.42(A) It(Torque current:P09)=108.18(A) $\tau(\text{Torque\%}) = \frac{\sqrt{174^2 - 53.42^2}}{108.18} \times 100[\%]$ $= 153.1[\%]$	Use for the shortest acceleration/deceleration with the inverter. Note: For driving, 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.
Torque limiter enabled (set value: 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 (one-minute, ten-second rating) may limit the torque in the constant output range depending on the set value for the limiter.	Use for constant torque control involving speed control and torque limiting such as winding or tension control.
Power limiter enabled (set value: 2)	Limits the torque by the power in the entire speed control range. Restrain the output capacity (power: kW) in terms of the percentage of the rated capacity of an inverter assumed as 100%. The maximum output current of the inverter (one-minute, ten-second rating) may limit the torque in the constant torque range depending on the set value for the limiter.	Use for limiting braking torque such as stopping by braking capacity (power). 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).
Torque current limiter enabled (set value: 3)	Limits the torque in the constant torque range and limits the power in the constant output range. Restricts the torque current reference in terms of the percentage of the rated torque current assumed as 100%. Since this control limits the torque current to a constant level, the control reduces the magnetic-flux in the constant output range, resulting in reducing torque accordingly.	Enables a limiter restricting below the short-time rated torque. Use when you limit the output torque for the motor temporarily.

See the following pages for detailed application examples.

(1) Torque limiter disabled

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

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

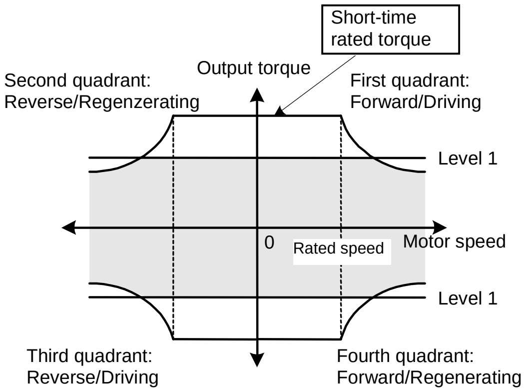


(2) Torque limiter enabled

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

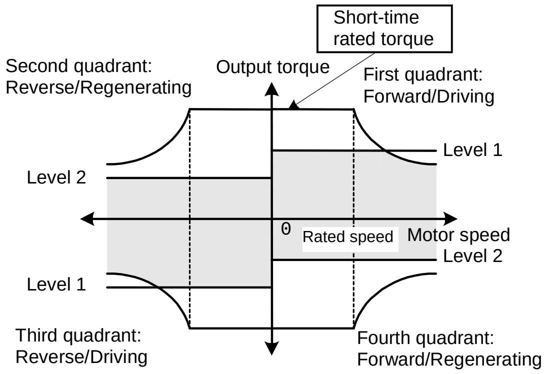
Code	Set value	Description
F40	1	Torque limiter enabled
F41	0	Level 1 for all four quadrants simultaneously

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



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

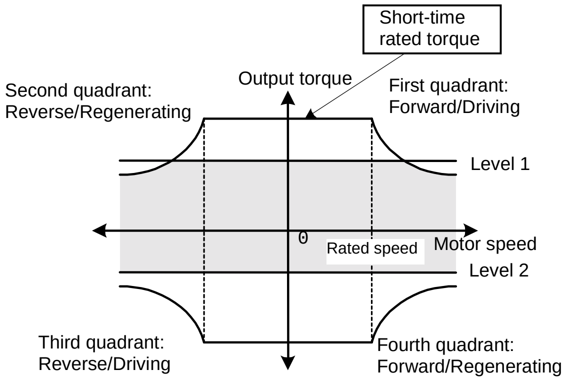
Code	Set value	Description
F40	1	Torque limiter enabled
F41	1	Driving (Level 1), Braking (Level 2)



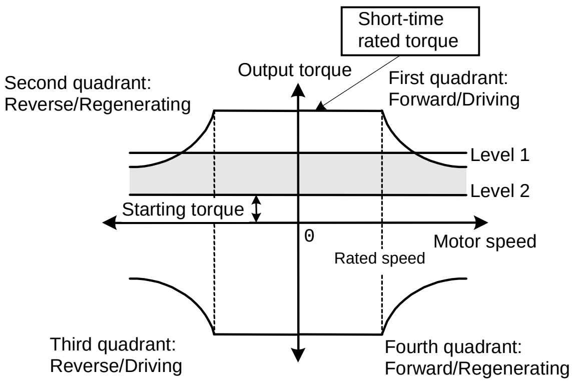
- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.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

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

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



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



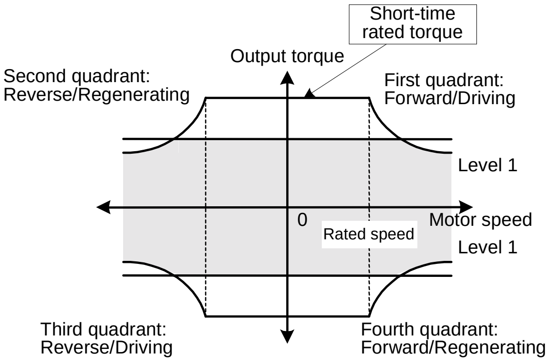
- When you assign plus values both to the Level 1 and the Level 2, the entire valid torque range stays in plus (Level 1 > Level 2).
- When you assign minus values both to the Level 1 and the Level 2, the entire valid torque range stays in minus (|Level 1| < |Level 2|. e.g. Level 1=–10 and Level 2=–100).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

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

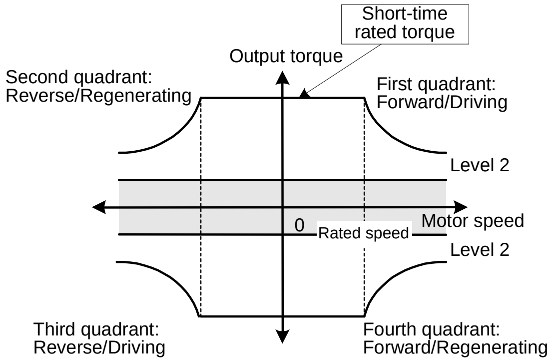
(2)-4.Switching between Level 1 and Level 2 for all four quadrants simultaneously

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

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



[TL2/TL1] = OFF



[TL2/TL1] = ON

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

(3) Power limiter enabled

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

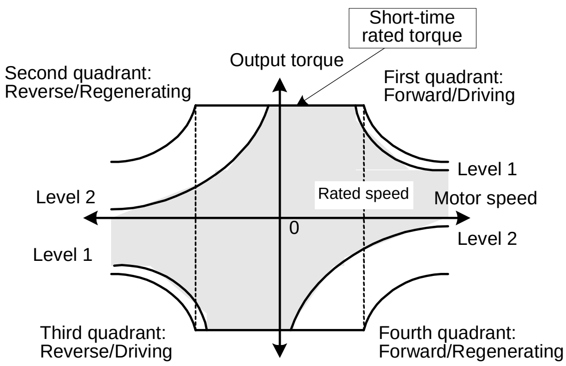
Code	Set value	Description
F40	2	Power limiter enabled
F41	0	Level 1 for all four quadrants simultaneously

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

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

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

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



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

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

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

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

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

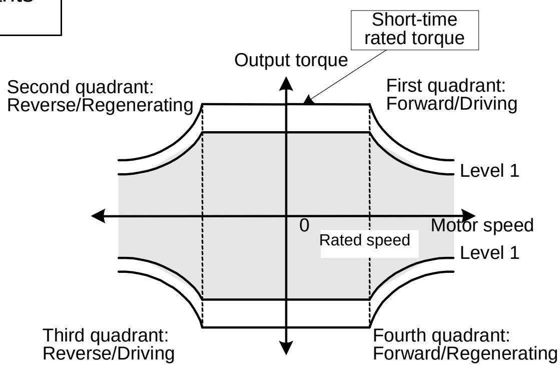
- Though this setting is possible, there is no such an application.

(4) Torque current limiter enabled

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

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

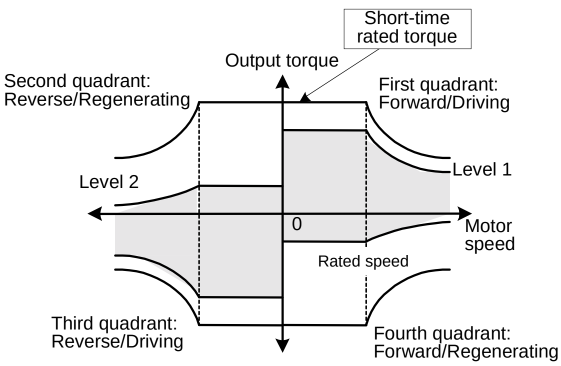
- Unless you set the Level 1 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload or motor overload) occur frequently, you can lower the setting level to avoid this phenomenon.
- Though you can specify the Level 1 both in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



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

Code	Set value	Description
F40	3	Torque current limiter enabled
F41	1	Driving (Level 1), Braking (Level 2)

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



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

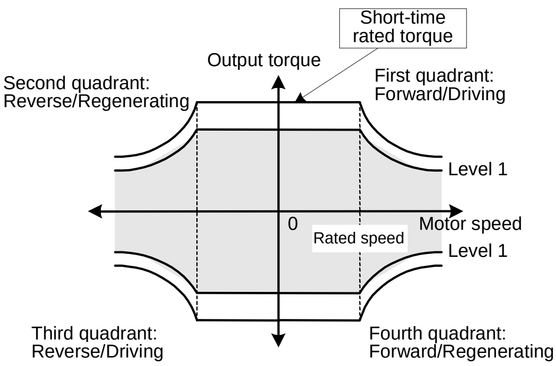
Code	Set value	Description
F40	3	Torque current limiter enabled
F41	2	Upper limit (Level 1), Lower limit (Level 2)

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

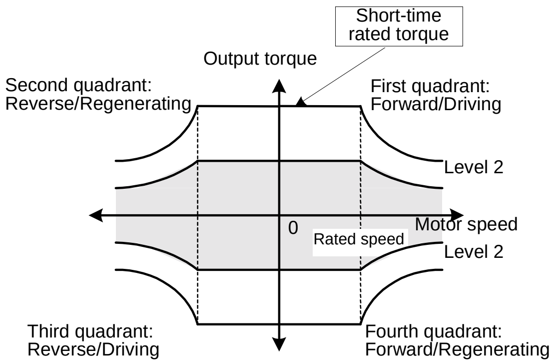
(4)-4.Switching between Level 1 and Level 2 for all four quadrants simultaneously

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

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



[TL2/TL1] = OFF



[TL2/TL1] = ON

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

F42 Torque limiter value selection (Level 1)

F43 Torque limiter value selection (Level 2)

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

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

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

- Level 1
  Selects a mean that sets the Level 1
  Set value: 0: Function code F44
  1: Ai [TL-REF1]
  2: DIA card
  3: DIB card
  4: Link enabled
  5: PID output

- Level 2
  Selects a mean that sets the Level 2
  Set value: 0: Function code F45
  1: Ai [TL-REF2]
  2: DIA card
  3: DIB card
  4: Link enabled
  5: PID output

<Setting example>

(1) Preparation

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

(2) When you use the function code

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

(3) When you use the analog input

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

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

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

(5) When you use the link

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

(6) When you use the PID output

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

F44 **Torque limiter value (Level 1)**

F45 **Torque limiter value (Level 2)**

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

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

Setting range: –300 to 300 [%]

F46 **Mechanical loss compensation value**

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

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

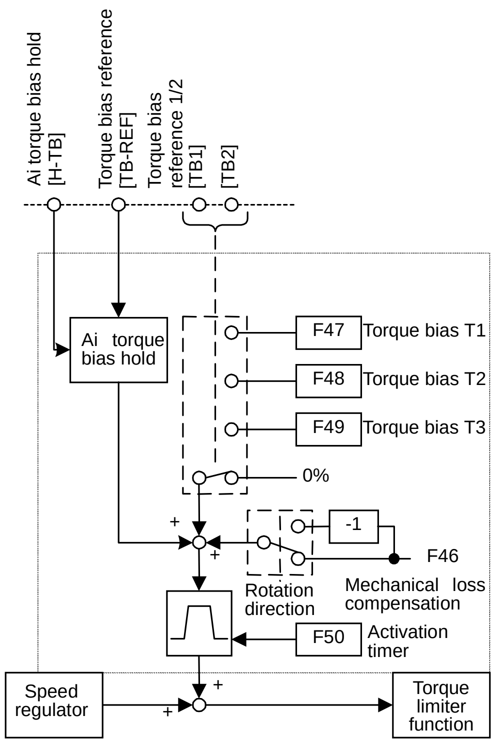
Setting range: –300.00 to 300.00 [%]

F47 **Torque bias 1**

F48 **Torque bias 2**

F49 **Torque bias 3**

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



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

Setting range: –300.00 to 300.00 [%]

F50	Torque bias activation time

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

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

Setting range: 0.00 to 1.00 [s]

F51	Torque reference monitor (Polarity selection)

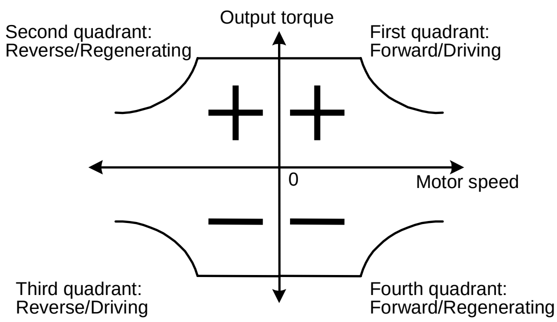
◆Sets the polarity for data display related to torque. (AO monitor, KEYPAD panel LED monitor, KEYPAD panel LCD monitor)

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

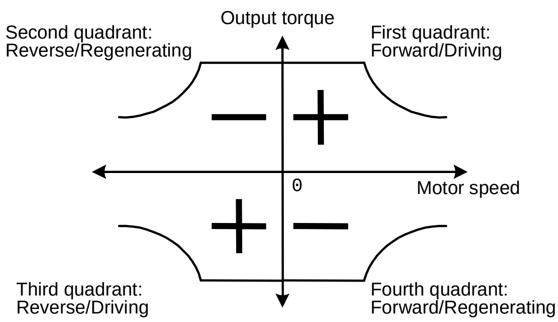
Set value: 0: Torque polarity
1: + for driving, – for braking

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

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



F51=0: Torque polarity



F51=1: + for driving, – for braking

F52 **Display coefficient A**

F53 **Display coefficient B**

◆Use these coefficients as conversion coefficient to determine the display values (process amount) of the load speed/line speed, the reference/feedback of the PID regulator on the KEYPAD panel LED.

Setting range: Display coefficient A: –999.00 to +999.00

Display coefficient B: –999.00 to +999.00

◆Load speed, line speed

Use the Display coefficient A of F52

Displayed value=Motor speed × (0.01 to 200.00)

The effective display range is 0.01 to 200.00 while the setting range is ±999.00. The minimum value 0.01 or the maximum value 200.00 replaces a value out of the display range.

Foe example, you should specify as F52=0.02 when the motor speed is 1500[r/min] and the line speed is 30[m/min].

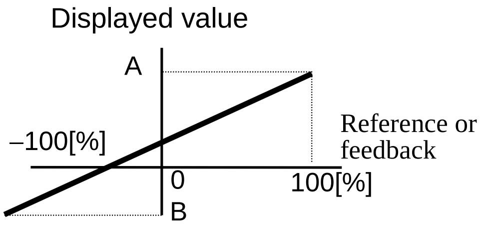
◆Reference and feedback values for the PID regulator

Use F52 Display coefficient A to set the maximum value for display data and use F53 Display coefficient B to set the minimum value for display data.

Displayed value=(Reference or feedback value)

× (Display coefficient A–B)+B

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



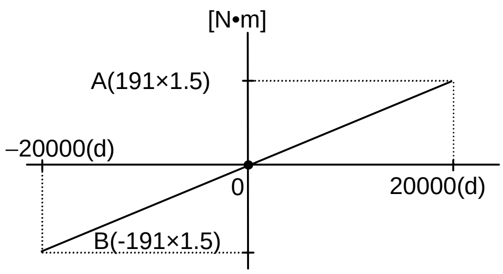
<Display example>

When you want to display the output of the PID calculation (reference value) in [N·m] for a unit with 30 kW and rated torque of 191[N·m], the PID output is 150% torque output at 20,000 [d].

Thus you should set the coefficients as follows to obtain the right graphs.

Coefficient A: F52=286.5 [N·m]

Coefficient B: F53=–286.5 [N·m]



F54 **Display filter**

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

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

Setting range: 0.0 to 5.0 [s]

F55 LED monitor (Display selection)

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

F	5	5	L	E	D		M	N	T	R		

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

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

F56 LED monitor (Display at stopping state)

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

F	5	6	L	E	D		M	N	T	R	2	

Set value: 0: Reference value display
1: Actual value display (detected value)

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

F57 **LCD monitor (Display selection)**

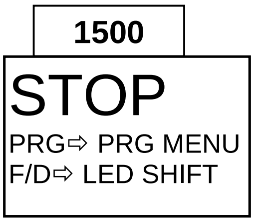
◆Selects the contents of the KEYPAD panel LCD monitor in the operation mode.

F57 LCD MNTR

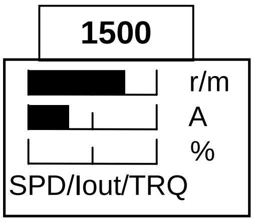
Set value: 0: Operation state, rotation direction, operation guide
1: Bar graphs for motor speed, output current, torque reference values.

Set value: 0

In operation In stopping



Set value: 1



Full scale values for bar graphs

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

Note: The scale is not adjustable.

F58 **LCD monitor (Language selection)**

◆Selects a language displayed on the KEYPAD LCD monitor.

F58 LANGUAGE

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

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

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

F59 **LCD monitor (Contrast adjusting)**

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

F59 CONTRAST

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

F60	Output unit (HP/kW) selection

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

F	6	0	k	W	/	H	P					

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

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

◆Sets the P and I constants of the ASR1.

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

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

- P gain

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

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

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

⚠ CAUTION

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

- Constant of integration

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

⚠ CAUTION

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

F63 **ASR1-FF (Gain)**

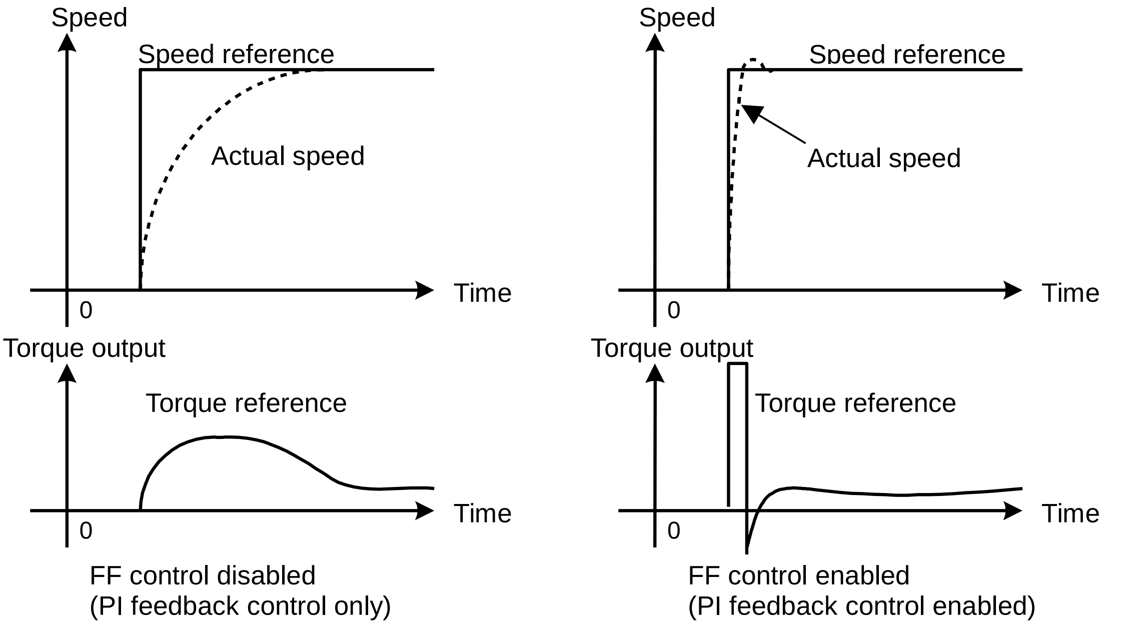
◆Conducts a feedforward control by adding torque determined by the change in the speed reference to the torque reference directly.

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

F	6	3	A	S	R	1	-	F	F			

Setting range: 0.000 to 9.999 [s]

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



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

F64 **ASR1 input filter**

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

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

F	6	4	A	S	R	1	-	I	N			

Setting range: 0.000 to 5.000 [s]

F65 ASR1 detection filter

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

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

F	6	5	A	S	R	1	-	D	E	T		

Setting range: 0.000 to 0.100 [s]

F66 ASR1 output filter

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

F	6	6	A	S	R	1	-	O	U	T		

Setting range: 0.000 to 0.100 [s]

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

(1) Measures to eliminate mechanical resonance

1)Reduce response speed

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

2)Use ASR output filter

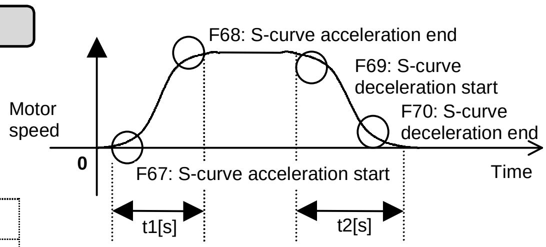
- Though you can reduce the resonance amplitude, excessive filter elements may cause instability.

3)Use oscillation suppressing observer

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

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

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



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

Setting range: 0 to 50 [%]

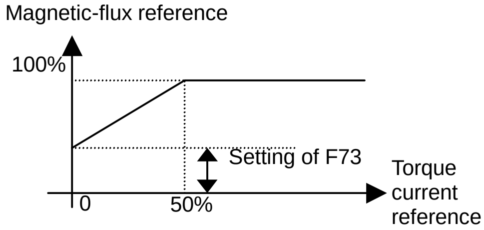
◆Setting the S-curve will extend F07 "Acceleration time 1" and F08 "Deceleration time 1" as described below.

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

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

F73 Magnetic-flux level at light load

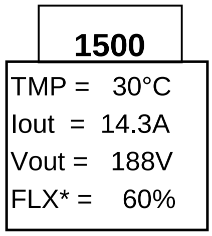
◆You can specify a small value to reduce the electromagnetic noise of a motor at light load. The magnetic-flux reference decreases according to the torque current reference to reduce the electromagnetic noise.



F	7	3	M	I	N	-	F	L	U	X		

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

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



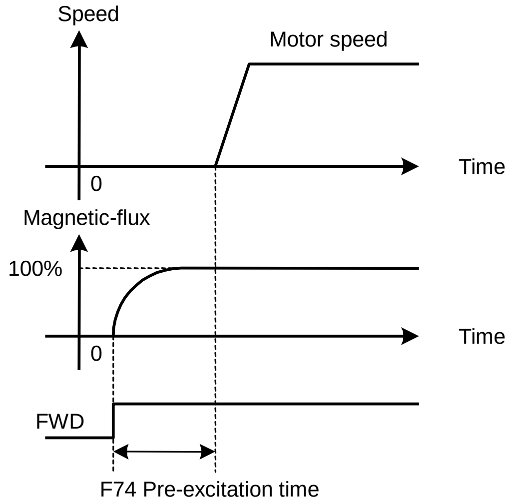
F74 Pre-excitation time

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

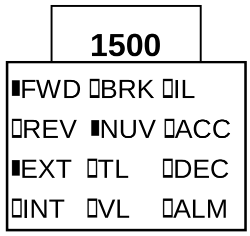
F	7	4	P	R	E		E	X		t		

Setting range: 0.0 to 10.0 [s]

◆Set the pre-excitation time to start a motor after the magnetic-flux is established 100% as shown in the graph.



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



F75 Pre-excitation initial level

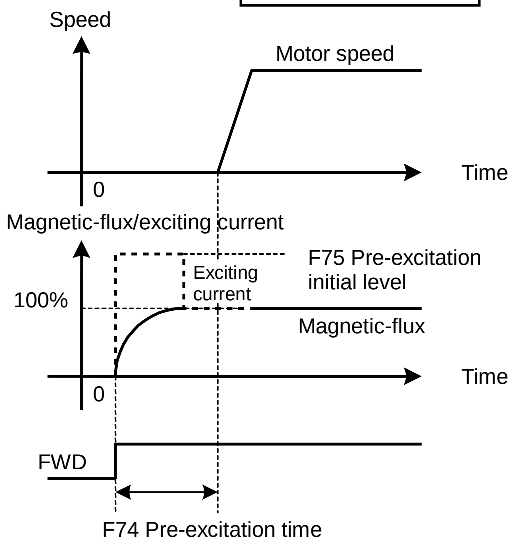
◆Sets the initial level of the pre-excitation.

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

Set value: 100 to 400 [%]

◆When you want to reduce the pre-excitation time (function code F74) to establish the magnetic-flux quickly, set the exciting current high.

◆The transient response to the exciting current reference until the magnetic-flux is established 100% depends on the secondary time constant of a motor (exciting inductance/resistor). This function applies more than 100% of the exciting current to establish the magnetic-flux faster. The initial level ends when the magnetic-flux is established 100%, and the exciting current returns 100%.



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

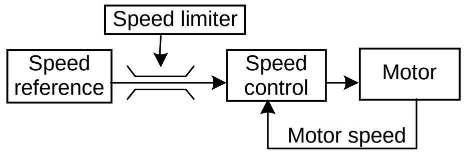
◆The speed control and the torque control (torque control, torque current contol) differs in the usage of these function codes.

Usage for speed control

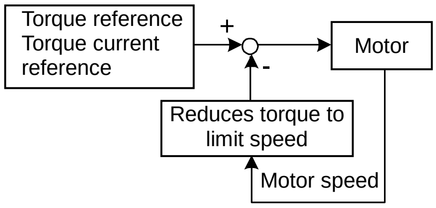
Since the inverter usually (factory setting) controls speed (internal ASR enabled, motor controlled by speed reference), and the speed limitter is applied to the speed reference (See "(1) Speed control")

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

(1) For speed control



(2) For torque control



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

1) Speed control

You can set the speed limit to the speed reference.

F76 N-LIM-MODE

- Method selection

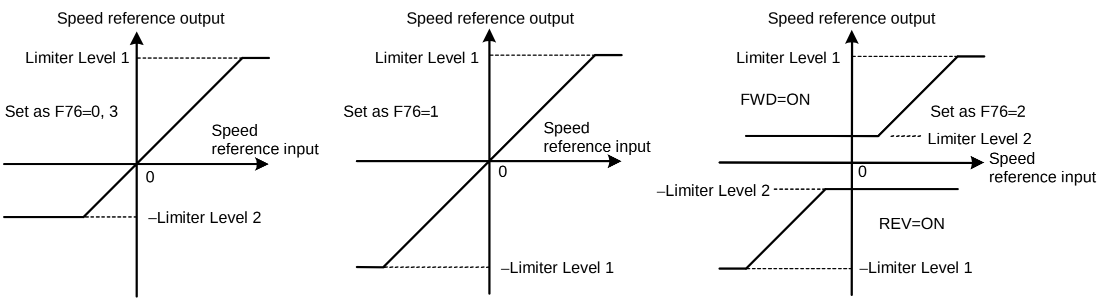
Set value: 0: Forward (Level 1) and reverse (Level 2) are limited individually.
1: Level 1 limits forward and reverse.
2: Upper limit by the Level 1 and the lower limit by the Level 2.
3: Disabled (If set, replaced by 0).

F77 N-LIM-LVL1

F78 N-LIM-LVL2

- Level 1, 2

Setting range: –110.0 to 110.0 [%]



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

<Example of a setting inhibiting reverse rotation>

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

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

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

- Method selection

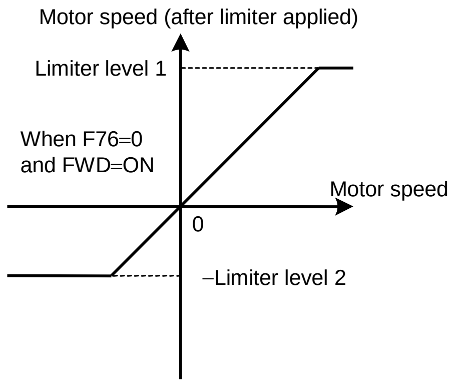
  Set value: 0: Forward and reverse are limited individually. FWD and REV switch the levels.
  1: Level 1 limits forward and reverse.
  2: Upper limit by the Level 1 and the lower limit by the Level 2.
  3: Individual limiters for forward and reverse rotation. [12] input is added as a variable part of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

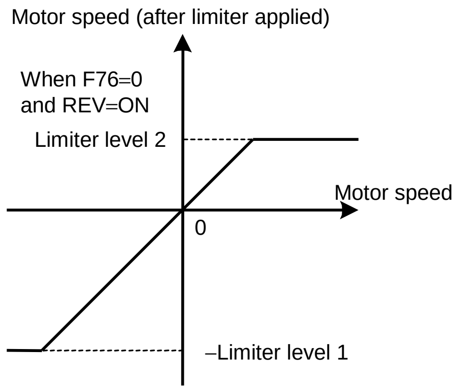
F	7	7	N	-	L	I	M	-	L	V	L	1
F	7	8	N	-	L	I	M	-	L	V	L	2

- Level 1, 2

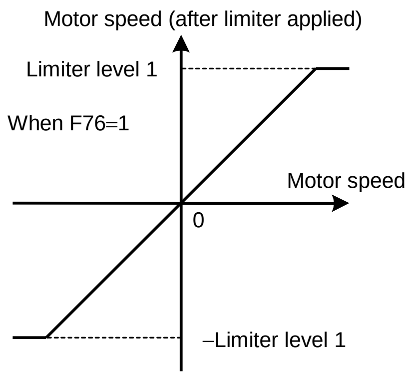
  Setting range: –110.0 to 110.0 [%]

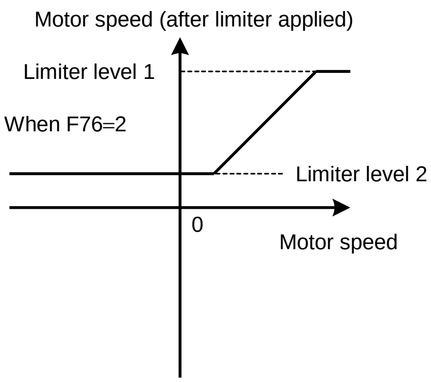
• When F76=0 is specified, the upper and lower limit levels for forward operation and those for reverse operation switch between the Level 1 and the Level 2.



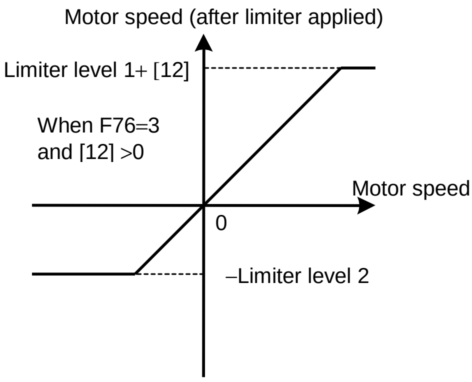


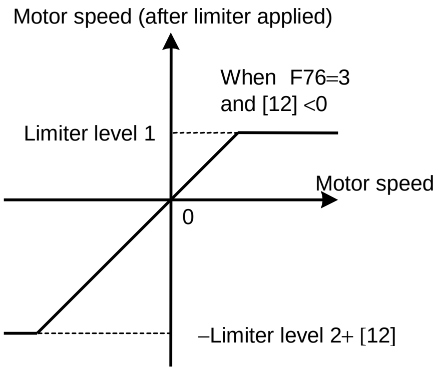
• See the following figures when F76=1 or F76=2 is specified.





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





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

F79 | **Motor selection**

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

F 7 9 M 1 - 3 S E L E C T

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

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

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

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

1500
□PARA 1 □M1
□PARA 2 ■M2
■PARA 3 □M3
□PARA 4 □JOG

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

F80 Current rating switching

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

F 8 0 I r   S E L E C T

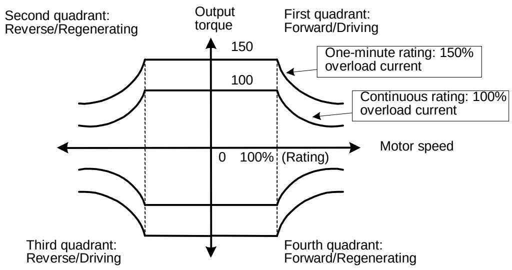
Set value: 0: CT (Constant Torque, overload current 150%)
1: VT (Variable Torque, overload current 110%)
2: HT (High Torque, overload torque 200%/170%)

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

- Torque characteristics for CT use

  Application

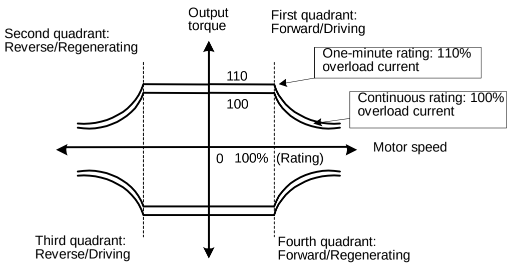
  Use for general constant torque applications including speed control with torque limit for winding machines, wire drawing machines, and test machines and control by direct torque reference.



- Torque characteristics for VT use

  Application

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



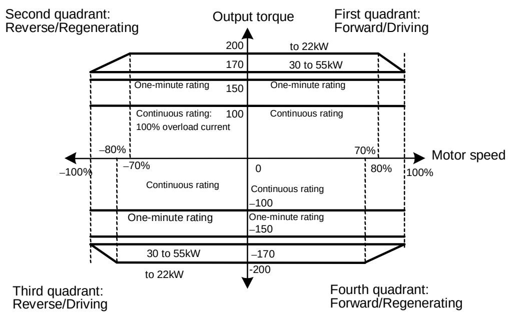
- HT use

  Application

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

  Restrictions

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



Motor operation exceeding the rated speed.

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

4.3.2 E Codes (Extension Terminal Functions)

E01-E13 **X function selection**

◆You can assign arbitrary functions to individual digital input terminals [X1-X14] ([X11-X14] are effective only when optional OPC-VG7-DIOA is installed).

◆Use after you review the 4.2 "Control Block Diagrams" to check the selection of control terminals.

E	0	1	X	1		F	U	N	C			

to

E	1	3	X	1	4		F	U	N	C		

Setting range: 0 to 63

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

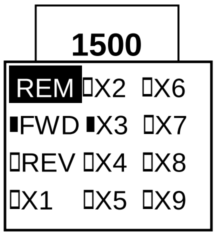
<Using terminal input>

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

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

Setting procedure

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



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

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

Multistep speed selection

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

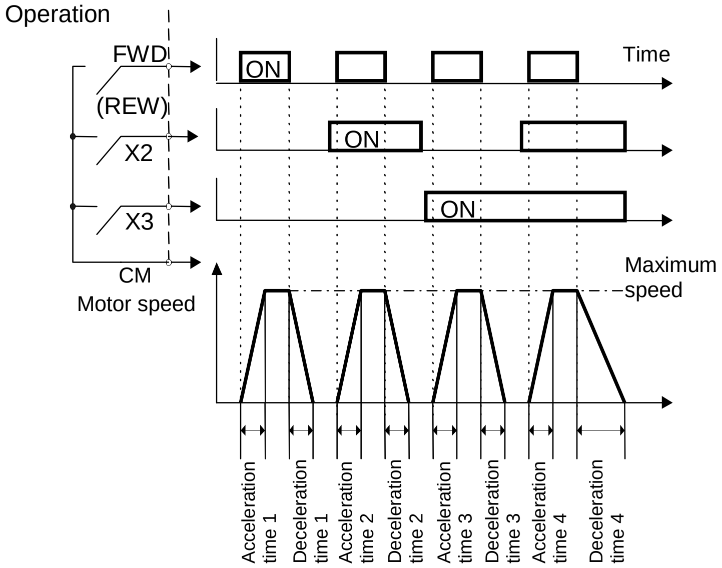
Input signal combination to select specified data				Speed to be selected	
3 [SS8]	2 [SS4]	1 [SS2]	0 [SS1]		
OFF	OFF	OFF	ON	C05 Multistep speed 1	Related function codes C05 to C19 Setting range 0 to 24000r/min or 0.00 to 100.00%
OFF	OFF	ON	OFF	C06 Multistep speed 2	
OFF	OFF	ON	ON	C07 Multistep speed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

ASR, acceleration/deceleration time selection

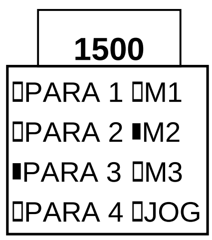
You can switch predetermined acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations specified by function codes through external digital input signals. Assign data 04 to 05 to digital terminals to select acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations.

Input signal combination to select specified data		Acceleration/deceleration times to be selected	
05 [RT2]	04 [RT1]		
OFF	OFF	F07 Acceleration time 1 F08 Deceleration time 1 F61 to F66 ASR1 constants F67 S-curve (Acc start side) F68 S-curve (Acc end side) F69 S-curve (Dec start side) F70 S-curve (Dec end side)	Related function codes F07, F08, 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].

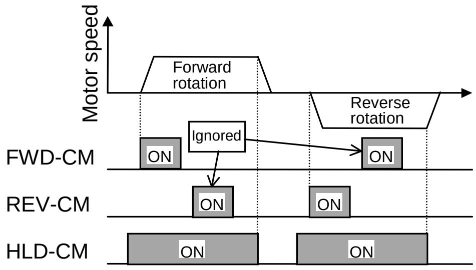


* If you switch the acceleration/deceleration times, the ASR constants and S-curve actions are switched simultaneously. You can see which set is currently selected from (1, 2, 3, 4) on the "I/O check" screen of the KEYPAD panel. When the data set 3 is selected, "■ PARA 3" is indicated on the display.



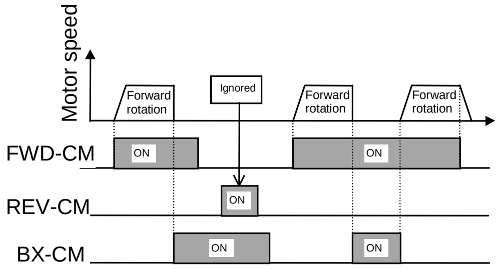
3-wire operation stop command [HLD]

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



Coast-to-stop command [BX]

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



Alarm reset [RST]

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

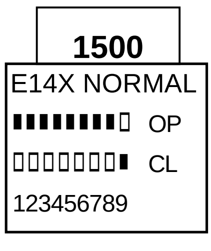
Trip command [THR]

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

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

<Application and notes>

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



4. Control and Operation

Jogging operation [JOG]

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

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

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

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

Motor selection 1,2 [MCH2, CH3]

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

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

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

DC brake command [DCBRK]

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

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

ACC/DEC cleared to zero [CLR]

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

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

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

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

UP command in UP/DOWN setting [UP]

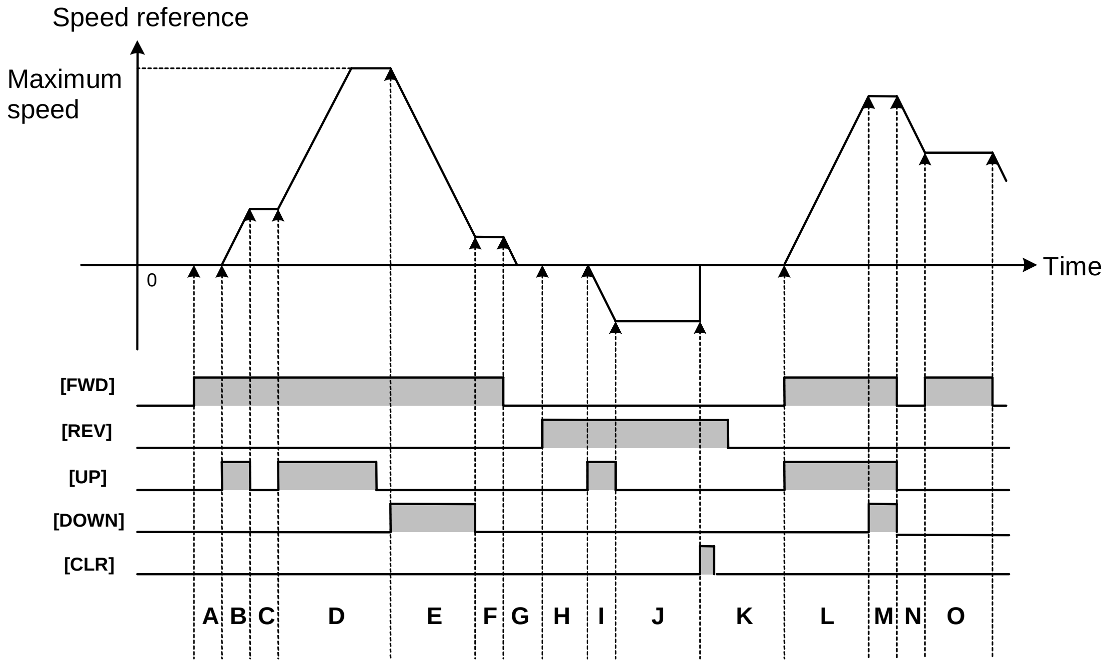
The external digital input signal increase the speed during the signal is ON. The maximum speed restricts the speed. The acceleration follows the specified acceleration time and S-curve acceleration.

DOWN command in UP/DOWN setting [DOWN]

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

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

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

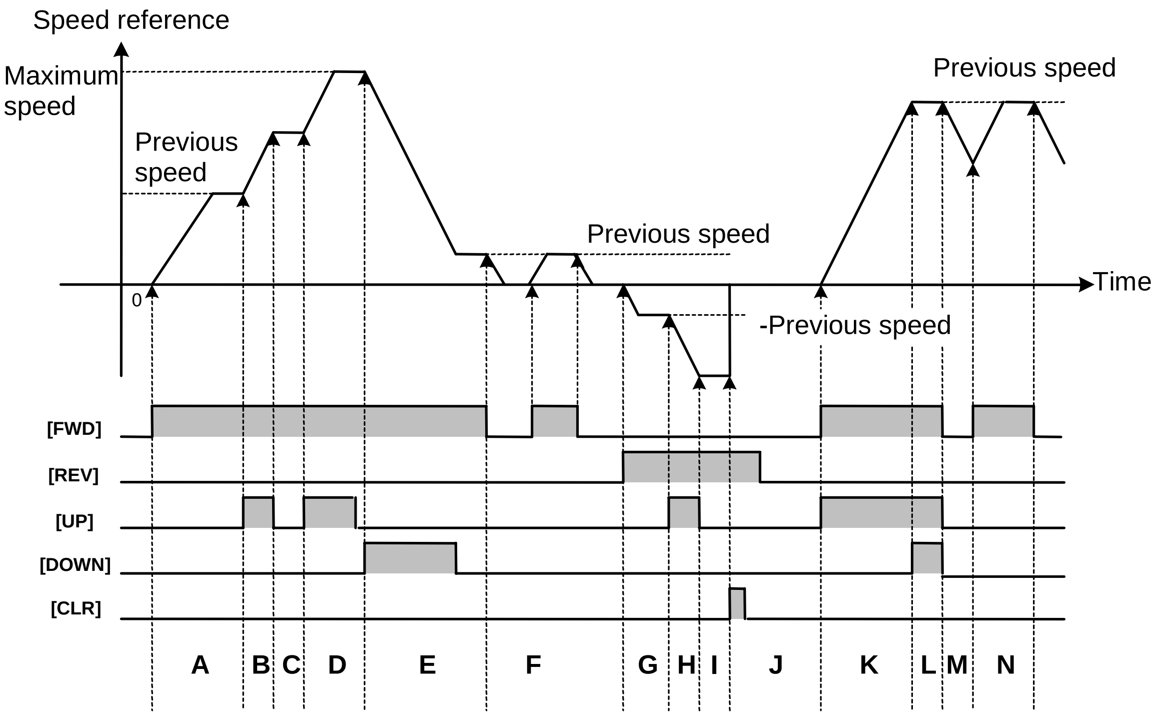


A : Operates at 0r/min speed reference
B : Accelerates in forward direction
C : Fixed to the speed reference when **[UP]** is set to OFF
D : Restricted by the maximum speed after acceleration in forward direction
E : Decelerates in forward direction
F : Fixed to the speed reference when **[DOWN]** is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

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

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

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

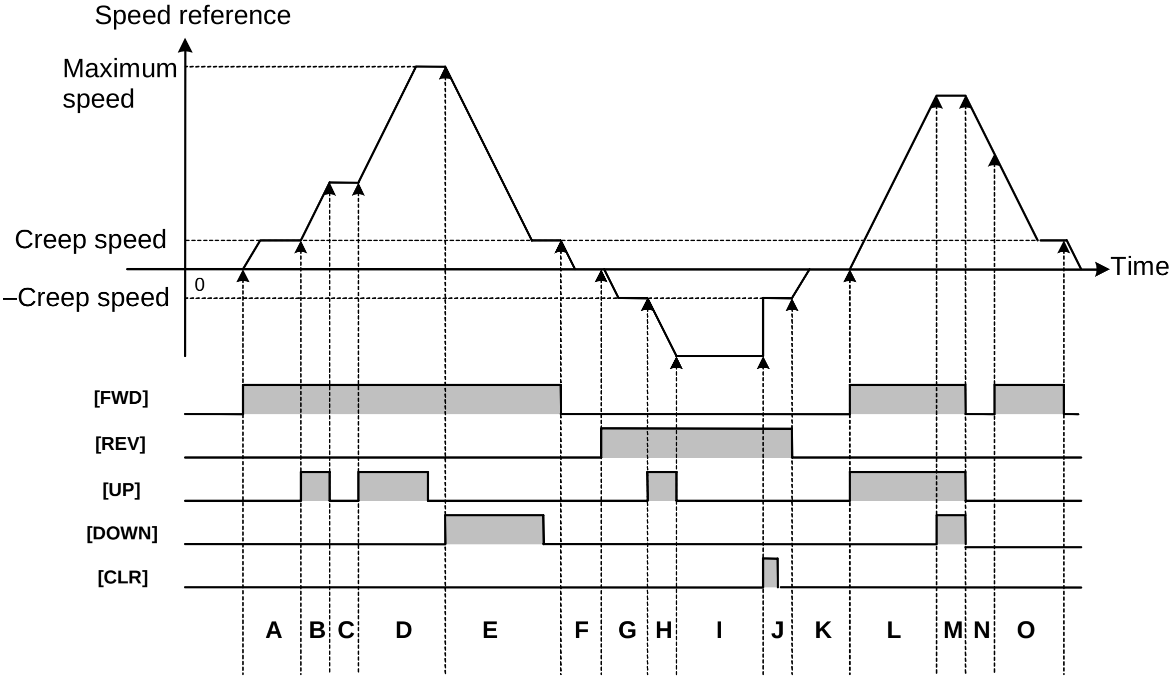


A : Accelerates in forward direction up to "+previous speed reference (speed reference just before the operation command is set to OFF)"
B : Accelerates in forward direction
C : Fixed to the speed reference when **[UP]** is set to OFF
D : Restricted by the maximum speed after acceleration in forward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

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

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

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



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

Write enable for KEYPAD [WE-KP]

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

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

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

PID control cancel [N/PID]

The external digital input signal disables the PID control.

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

Inverse mode changeover [IVS]

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

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

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

Interlock signal [IL]

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

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

4. Control and Operation

Write enable through link [WE-LK]

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

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

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

Operation selection through link [LE]

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

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

Input signal to select specified data	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 references and operation commands come from multiple communication systems.

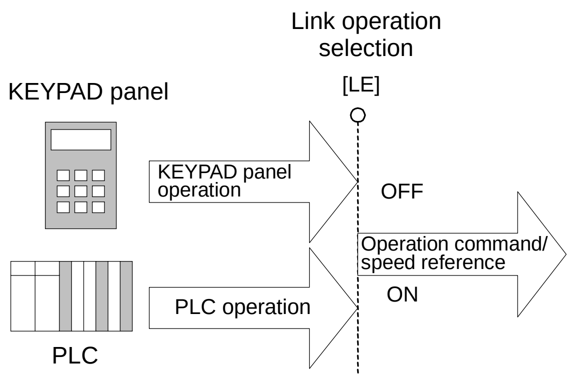
Priority	Operation command (FWD, REV), speed reference	Description of source of commands
1	Field options	One option selected from T-Link, SX, and field bus can be installed at a time.
2	Integrated RS485	Disabled when the option above is installed.

<Application example 1>

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

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

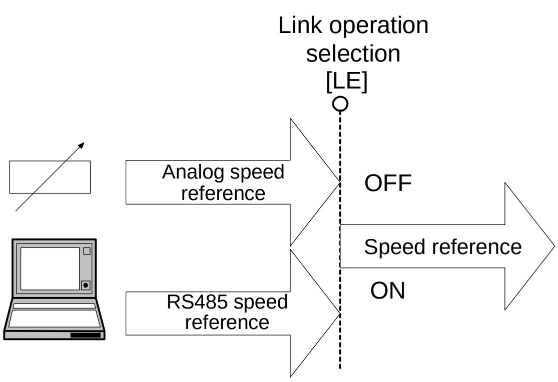
The PLC operation requires option cards (If you use RS485, an integrated function is available). See the descriptions of the option or RS485 for more details.



<table>
<tr><th rowspan="2"></th><th rowspan="2">Set value</th><th rowspan="2">Description</th><th colspan="3">Terminal [LE]</th></tr>
<tr><th>OFF</th><th>ON</th><th>Not assigned (*)</th></tr>
<tr><td rowspan="3">Function code specification</td><td>F01=“0”</td><td>Operation command from KEYPAD panel</td><td rowspan="2">Enabled</td><td colspan="2" rowspan="2">Disabled</td></tr>
<tr><td>F02=“0”</td><td>Speed reference from KEYPAD panel</td></tr>
<tr><td>H30=“3”</td><td>Initial setting enabling both speed reference and operation command through link (PLC)</td><td>Disabled</td><td colspan="2">Enabled</td></tr>
</table>

<Application example 2>

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



<table>
<tr><th rowspan="2"></th><th rowspan="2">Set value</th><th rowspan="2">Description</th><th colspan="3">Terminal [LE]</th></tr>
<tr><th>OFF</th><th>ON</th><th>Not assigned (*)</th></tr>
<tr><td rowspan="3">Function code specification</td><td>F01=“1”</td><td>Operation command from [FWD] and [REV]</td><td colspan="3">Enabled
(External signal is always selected)</td></tr>
<tr><td>F02=“1”</td><td>Speed reference from analog input at terminal [12]</td><td>Enabled</td><td colspan="2">Disabled</td></tr>
<tr><td>H30=“1”</td><td>Initial setting enabling only speed reference from link (RS485)</td><td>Disabled</td><td colspan="2">Enabled</td></tr>
</table>

Universal DI [U-DI]

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

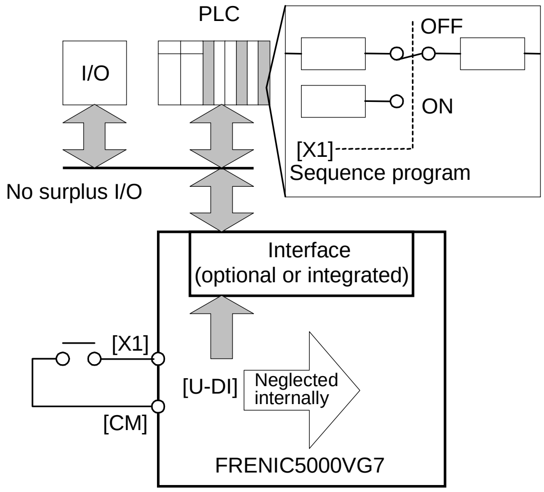
1) Check the ON/OFF state of the input signal through RS485, T-Link, SX, or field bus.
2) Use for an input to software created with the UPAC option without affecting the inverter operation.

<Application example>

You do not have enough numbers of I/O and want to use inverter control terminals to switch the control of a PLC program.

If you choose [X1] as a control terminal:

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



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

Pick up start mode [STM]

The external digital input signal enables/disables the function H09 "Start mode (Rotating motor pick up)"

Assign a data 26 to a desired digital input terminal and the input signal applied to it switches between the enabled state and the disabled state.

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

Synchronization command [SYC]

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

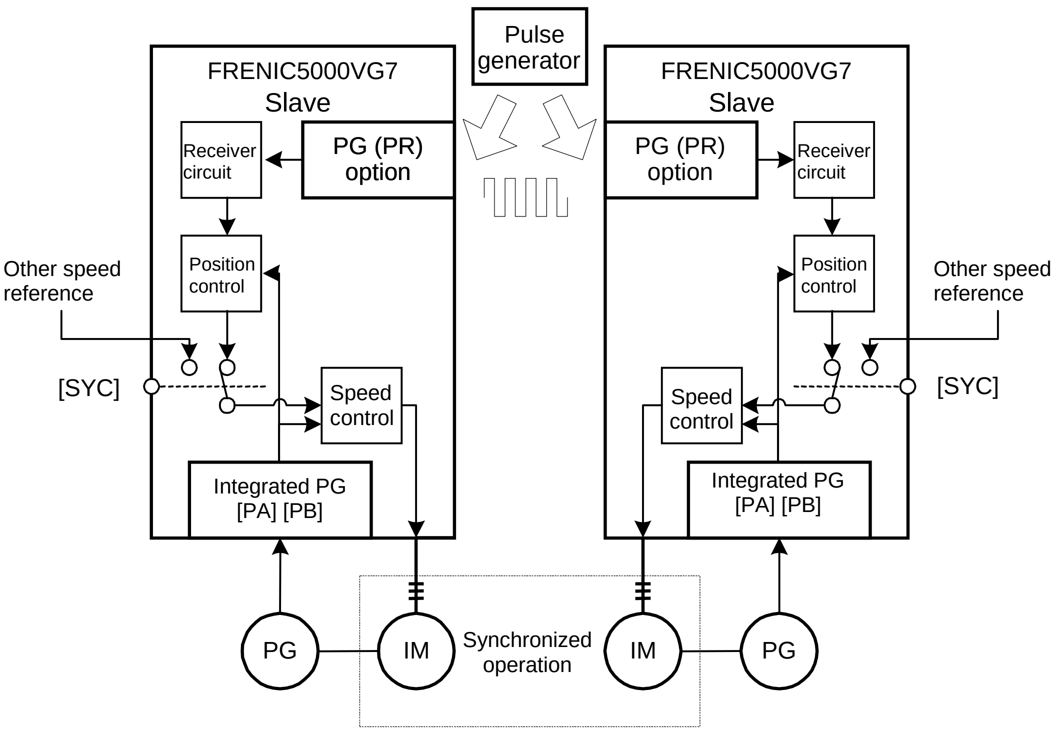
Assign a data 27 to a desired digital input terminal and the state of the input signal applied to it selects the function.

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

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

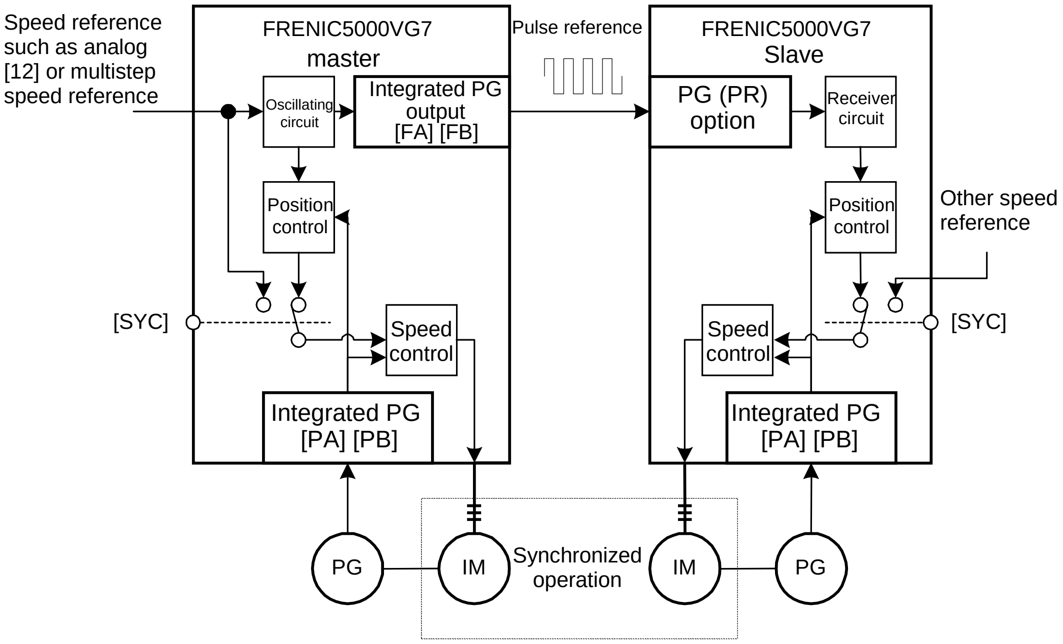
<Application example 1> Synchronized operation by receiving pulse

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



<Application example 2> Synchronized operation by pulse generation

Pulse signal converted (oscillated) from an internal speed reference (such as [12] input or multistep speed reference) is also converted into a speed reference through the position control and the [SYC] enables the resulting speed reference. You can put the converted pulse signal to the output and apply it to the other inverters to synchronize the inverter with other inverters.
The motor speed of the master and the PG pulse number determines the pulse frequency. When you use a PG with 1024P/R at 1500r/min, the frequency is 1500×1024/60=25.6kHz. The pulse compensation is available on the slave side. See the function codes o14 and o15 or the PG (PR) option for more details.



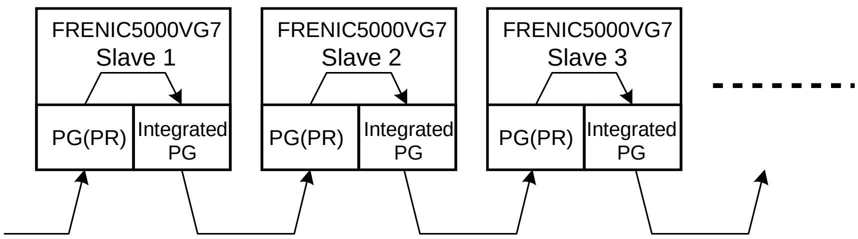
The complete synchronization (± 2 pulses or less) is possible both in the application example 1 and 2 during both transient and steady states.

About differences in methods

Method	Merits	Demerits
<Application example 1> Synchronized operation by receiving pulse	No position deviation	One PG (PR) option necessary 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

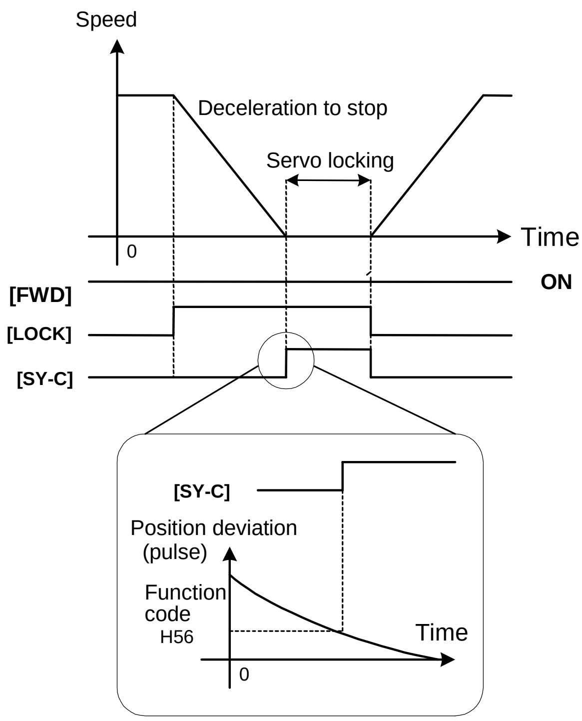
Set E29 "PG pulse output selection" to 9 to directly supply the position reference applied to the PG (PR) option to the [FA] and the [FB] of the integrated PG.



Zero speed locking command [LOCK]

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

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



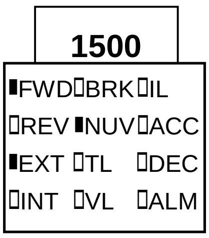
1) The inverter decelerates to stop (following an effective deceleration time setting) from the speed just after the [LOCK] is set to ON.
2) Position control (servo locking state) is applied with respect to the motor position (angle) when the speed reference of the acceleration/deceleration calculation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

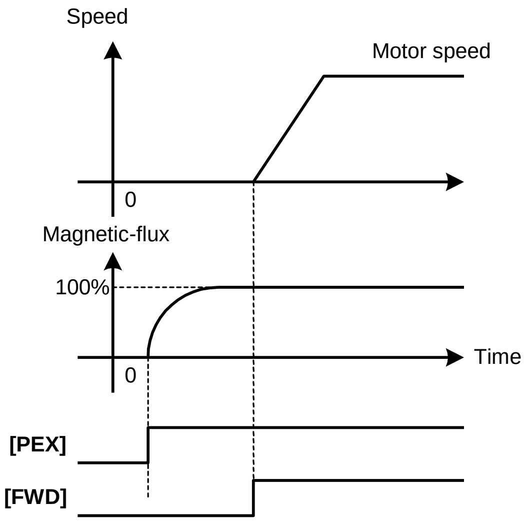
Pre-exciting command [PEX]

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

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

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





Speed reference limiter cancel [N-LIM]

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

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

H41 (torque reference) cancel [H41-CCL]

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

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

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

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

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

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

Application

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

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

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

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

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

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

Input signal to select specified data 34	Function to be selected
OFF	F40 setting enabled
ON	F40 setting disabled (limiter disabled)

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

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

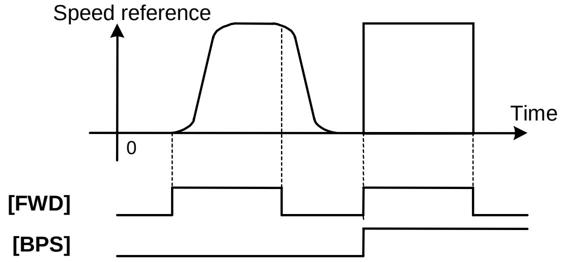
Input signal to select specified data 35	Function to be selected
OFF	F42: Torque limiter value (level 1) selection
ON	F43: Torque limiter value (level 2) selection

Bypass [BPS]

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

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

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



Restrictions

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

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

Torque bias reference 1/2 [TB1, TB2]

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

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

Droop selection [DROOP]

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

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

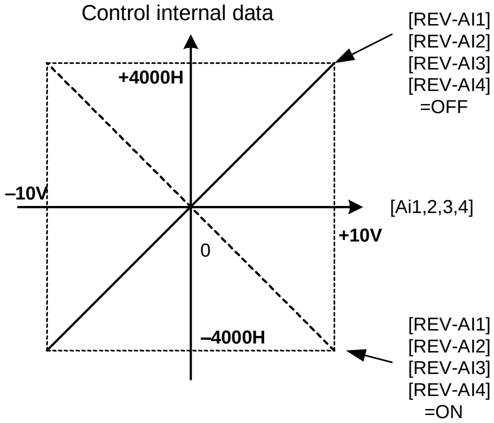
Ai1 zero hold [ZH-AI1]
Ai2 zero hold [ZH-AI2]
Ai3 zero hold [ZH-AI3]
Ai4 zero hold [ZH-AI4]

The external digital input signals fix the individual analog signals Ai1 to 4 to "0: input voltage invalid". Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.

You need optional OPC-VG7-AIO for Ai3 and Ai4.

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

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



The external digital input signals invert the polarity of the input data from Ai1 to 4. Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.

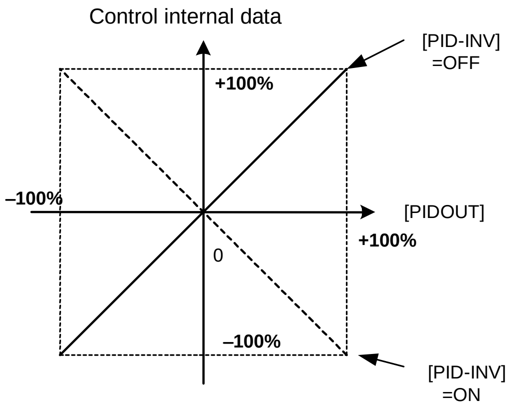
You need optional OPC-VG7-AIO for Ai3 and Ai4.

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

PID output inverse changeover [PID-INV]

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

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



PG alarm cancel [PG-CCL]

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

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

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

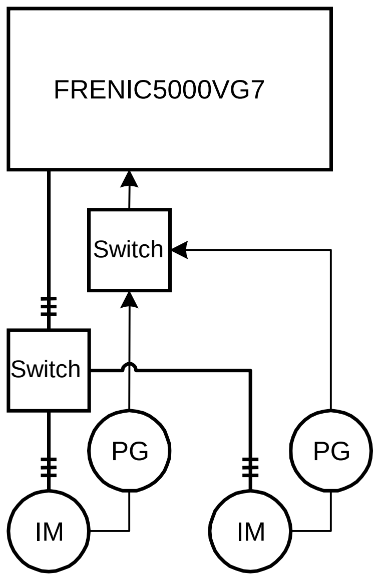
Actions on detecting PG disconnection

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

Application

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

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



Operation with PG disconnected

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

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

<Control mechanism>

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

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

Undervoltage cancel [LU-CCL]

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

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

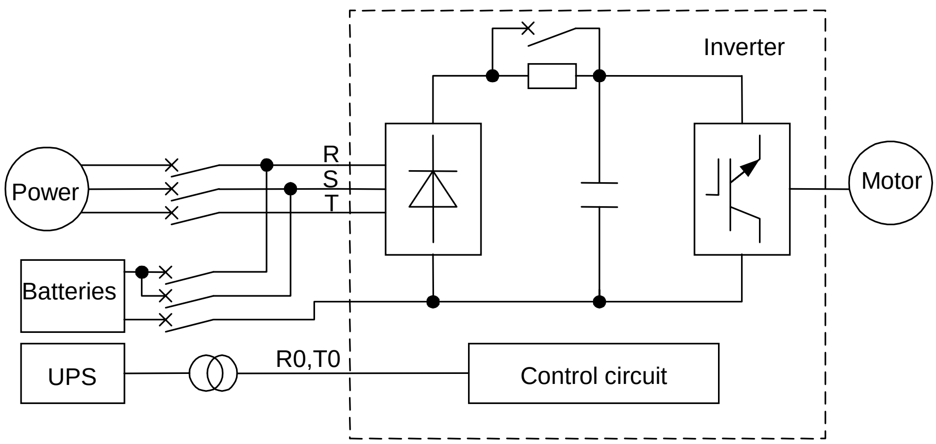
Actions on detecting undervoltage inside the inverter

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

Application

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

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



Ai torque bias hold [H-TB]

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

Input signal to select specified data 51	Function to be selected
OFF	Torque bias hold disabled
ON	Torque bias hold enabled

STOP1 [STOP1]

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

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

STOP2 [STOP2]

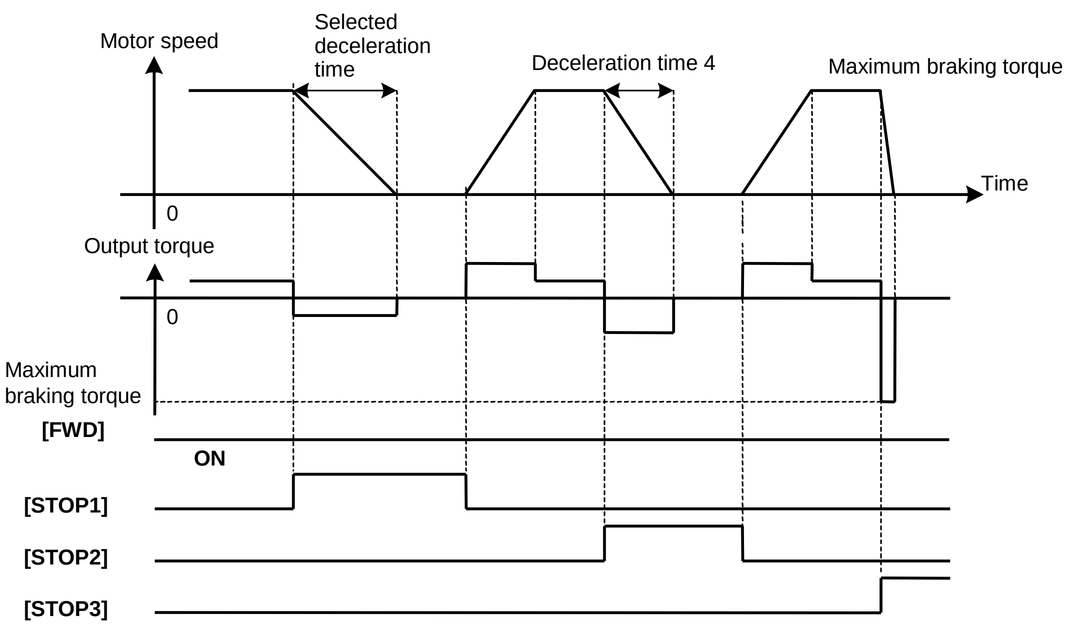
The external digital input signal directs to decelerate to stop with the C67 "Deceleration time 4" and C68 and C69 "S-curve start/end side 4".
Assign a data 53 to a desired digital input terminal and the existence of the input signal activates the operation.

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

STOP3 [STOP3]

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

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



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

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

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

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

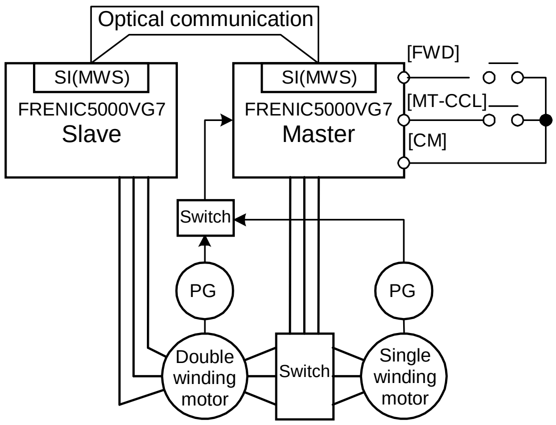
Option Di1 to 6 [O-DI1 to 6]

Not used

Multiwinding motor control cancel [MT-CCL]

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

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

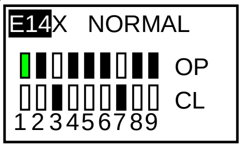


Input signal to select specified data 57	Function to be selected when o33 "Multiwinding system"=1
OFF	Multiwinding motor drive
ON	Single winding motor drive (Multiwinding cancelled)

E14 | X function normally open/normally closed

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

E	1	4	X		N	O	R	M	A	L		



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

E15-E27 | Y function selection

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

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		

Setting range: 0 to 47

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

<Using terminal output>

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

Setting procedure

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

1500

□Y1 □Y5A
□Y2
■Y3
□Y4

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

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

Inverter running [RUN]

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

Speed existence [N-EX]

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

Speed agreement [N-AG]

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

Speed equivalent [N-AR]

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

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

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

Stopping on undervoltage [LU]

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

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

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

Torque limiting [TL]

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

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

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

KEYPAD operation mode [KP]

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

Inverter stopping [STOP]

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

Operation ready output [RDY]

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

Magnetic-flux detection signal [MF-DT]

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

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

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

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

Brake release signal [BRK]

◆Provides the mechanical brake apply/release signal.

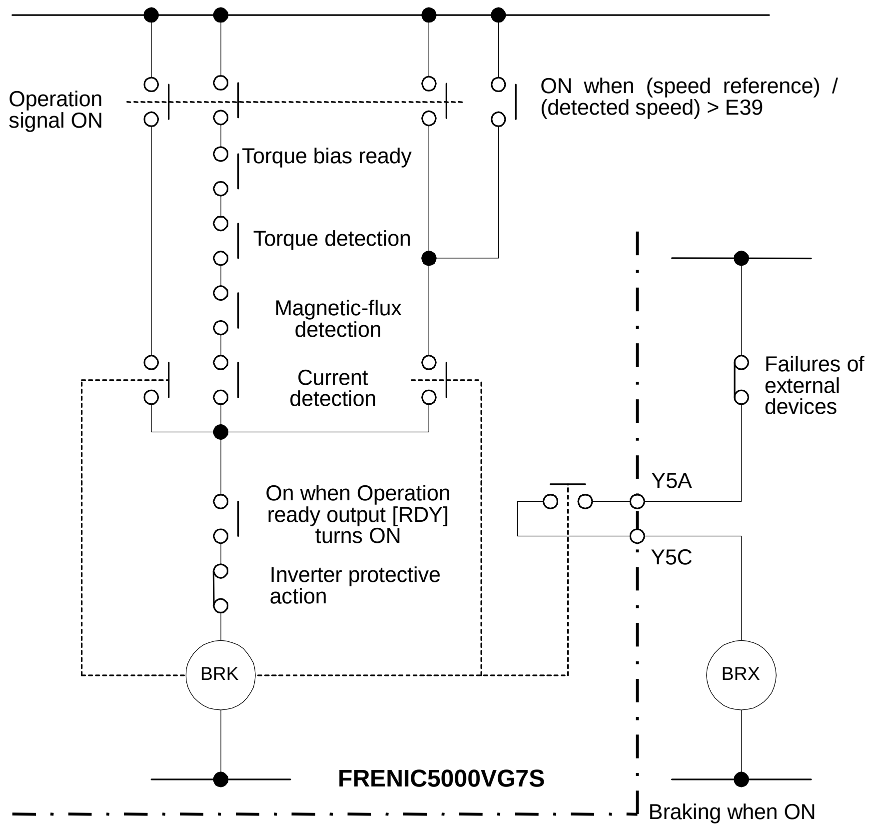
There are the Torque bias, the Torque detection level 1, and the Magnetic-flux detection level as parameters (user defined) for releasing (opening) brake.

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

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

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

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



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

<Setting>

Brake release sequence

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

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

Brake applying sequence

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

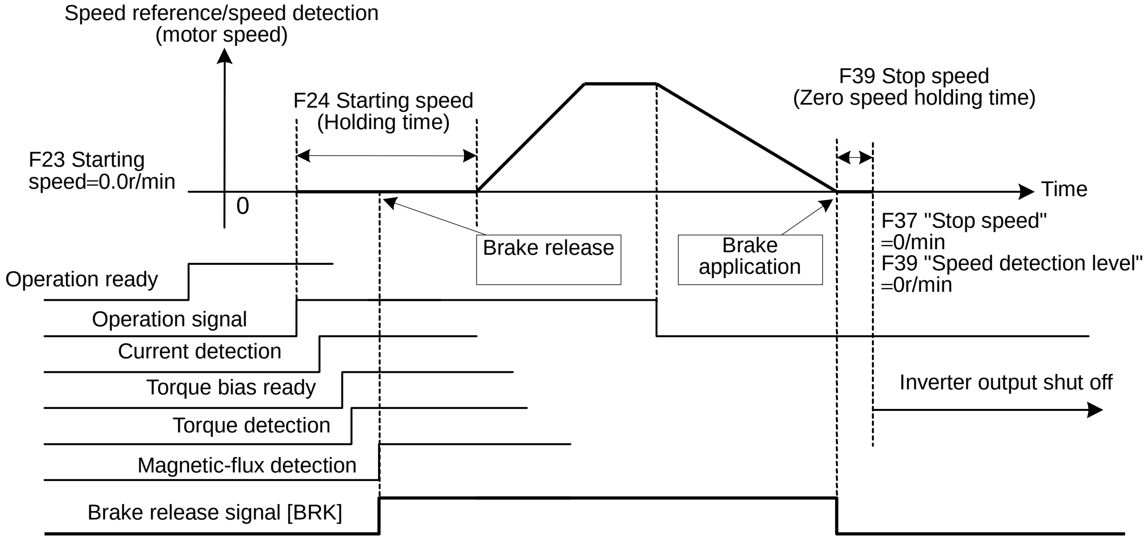
1) The operation command (FWD or REV) is OFF.
2) (Speed reference value/Detected speed value) < Speed detection level 1
   Select the speed reference for sensorless control.
   Use the third digit (0: Speed detection, 1: Speed reference) of the function code E38 "Speed detection method" to select the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

Starting speed/Stop speed

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

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

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



Alarm indication [AL1, 2, 4, 8]

Provides the operation status of the inverter protection function.

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

Fan operation signal [FAN]

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

Auto-resetting [TRY]

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

Universal DO [U-DO]

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

The applications of this signal are:

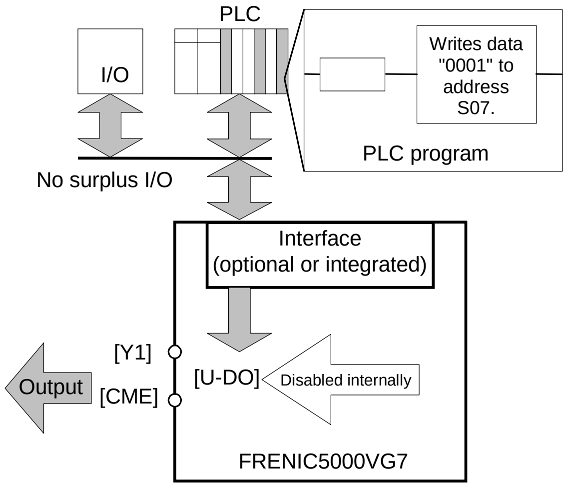
1) To set ON/OFF to the control terminal directly through RS485 or field bus.
2) To put the output which are assigned by the software created by the UPAC option on a DO of the control terminals.

<Application>

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

If you use the control terminal [Y1]:

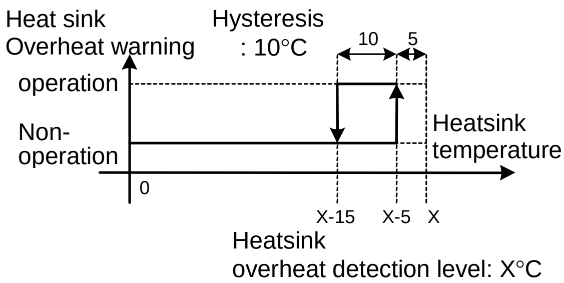
1) Set 25 [U-DO] to the function code E15 "Y1 function selection". Now the inverter does not use the Y1 terminal internally and you can use the terminal for the output of the communication.
2) Use the PLC to write "1" to the corresponding bit (data type: 33) of the function code S07 "Universal DO". You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



Heat sink overheat early warning [INV-OH]

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

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



Synchronization completion signal [SY-C]

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

Lifetime alarm [LIFE]

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

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

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

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

Inverter overload early warning [INV-OL]

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

Motor temperature early warning [M-OH]

Provides the overheat early warning signal at a level specified by the Motor overheat early warning (E31). See the E31 "Motor overheat early warning" for more details.

Motor overload early warning [M-OL]

Provides the overload early warning signal at a level specified by the Inverter overload early warning (E34). See the E34 "Inverter overload early warning" for more details.

DB overload early warning [DB-OL]

Provides the overload early warning signal at a level specified by the DB overload early warning (E36). See the E36 "DB overload early warning" for more details.

Link transmission error [LK-ERR]

Turns ON when a communication error occurs in the transmission through the link (RS485, T-Link, SX, field bus). Turns OFF when the communication returns to normal.

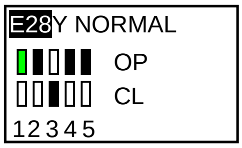
Load adaptive control under limiting [ANL]
Load adaptive control under calculation [ANC]

Analog torque bias hold [TBH]
Turns on when the analog bias hold command is present.

E28 Y function normally open/normally closed

◆Sets Y1 to Y4 and RY to be open or closed by software.

E	2	8	Y		N	O	R	M	A	L		



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

E29 PG pulse output selection

◆Use this function to provide different applications with the PG pulse signal.

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 reference (digital and analog) into pulse to supply. See the <Application example 2> of Synchronization command [SYC] of the function codes E01 to E13 for more details.
Set value 7: Pulse generation mode (A, B: Signals with 90° phase difference)

3) You can put the optional PG input on the pulse output.
Set value : 8: OPC-VG7-PG (PD), pulse train detection input is directly supplied to the pulse output.
9: OPC-VG7-PG (PR), pulse train reference input is directly supplied to the pulse output.
See the <Application example 3> of Synchronization command [SYC] of the function codes E01 to E13 for more details.

E30 Motor overheat protection (Temperature)

◆Sets the temperature at which the Motor overheat alarm is issued. Select the protection level according to the types of motors.

E	3	0	M	-	P	R	T	C	-	T		

Note: This function is available for the motor temperature input from the NTC thermistor or the Ai.
Setting range: 100 to 200 [°C]

E31	Motor overheat early warning (Temperature)

◆Sets the temperature at which the Motor overheat early warning is issued before the overheat protection becomes active. The early warning signal is put on the DO to which [M-OH] is assigned.

E	3	1	M	-	W	A	R	N	-	T		

Note: This function is available for the motor temperature input from the NTC thermistor or the Ai.
Setting range: 50 to 200 [°C]

E32	M1-M3 PTC operation level

◆Activated when the input voltage from a PTC becomes higher than the specified voltage (activation level) if you select to use a thermistor.

E	3	2	M	-	P	R	T	C	-	L	V	L

Setting range: 0.00 to 5.00 [V]
The warning temperature depends on a PTC thermistor and the resistor of the PTC thermistor changes drastically at the warning temperature. The activation (voltage) level is specified by this change of the resistor.

E33	Inverter overload early warning

◆Sets the level at which the overload early warning is issued before the Inverter overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [INV-OL] is assigned.

E	3	3	I	N	V	-	O	L	W	A	R	N

Setting range: 25 to 100 [%]

E34	Motor overload early warning

◆Sets the level at which the overload early warning is issued before the Motor overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [M-OL] is assigned.

E	3	4	M	-	O	L	-	W	A	R	N	

Setting range: 25 to 100 [%]

E35	DB overload protection

◆Sets in %ED with respect to the inverter capacity. When you use a braking resistor with 10%ED, set as 10%. When the set value is zero, the overload protection (dBH) becomes disabled.

E	3	5	D	B	-	O	L	-	P	R	T	C

Setting range: 0 to 100 [%]

E36	DB overload early warning

◆Sets the level at which the overload early warning is issued before the DB overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [DB-OL] is assigned.

E	3	6	D	B	-	O	L	-	W	A	R	N

Setting range: 0 to 100 [%]

E37	DB thermal time constant

◆Sets the thermal time constant of a DB resistor to be used.

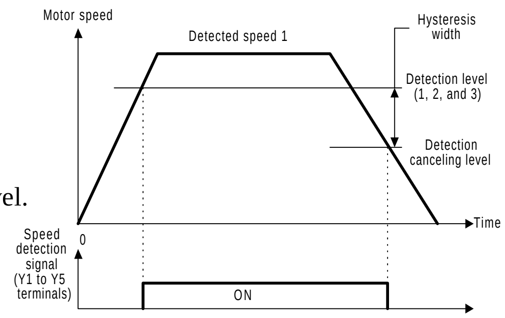
E	3	7	D	B	-	T	H	-	T	C		

Setting range: 0 to 1,000 [s]

E38	Speed detection method
E39	Speed detection level 1
E40	Speed detection level 2
E41	Speed detection level 3

◆Provide signals when the Detected speed 1 [N-FB1±] /Speed reference 4 [N-REF4] exceeds the detection level (1, 2, and 3). The detected signals are present on the DO's to which [N-DT1], [N-DT2], and [N-DT3] are assigned. You can set the detection method (detection, reference) individually.

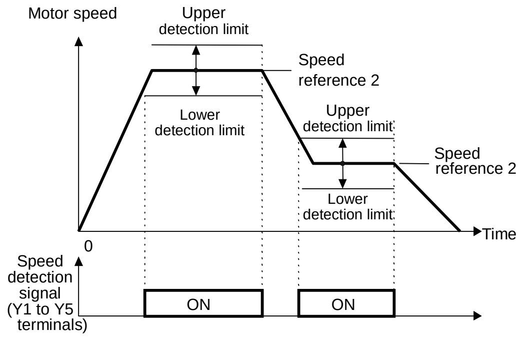
E	3	8	N	D	T		M	E	T	H	O	D
E	3	9	N	D	T	1	-	L	V	L		
E	4	0	N	D	T	2	-	L	V	L		
E	4	1	N	D	T	3	-	L	V	L		



- Detection level
  You can specify three types of speed detection level.
  (Level 1)
  Setting range: 0 to 24,000 [r/min]
  Note: The absolute value of the speed is used.
  (Level 2 and 3)
  Setting range: –24,000 to 24,000 [r/min]
  Note: When the reference value exceeds the maximum speed, the reference value is interpreted as the maximum speed. The hysteresis width is 1% of the maximum speed.
- Detection method
  You can specify the detection method of the speed detection functions individually.
  Setting range: 000 to 111
    First digit=Detection method of E39: 0=Detected speed (estimation), 1=Reference speed
    Second digit=Detection method of E40: 0=Detected speed (estimation), 1=Reference speed
    Third digit=Detection method of E41: 0=Detected speed (estimation), 1=Reference speed
  Detected speed 1 [N-FB1±] is used as the detected speed.
  Speed reference 4 (ASR input) [N-REF4] is used as the speed reference.

E42	Speed equivalence (Detection range)

◆Specifies the level (detection range) to determine whether the Detected speed 2 (ASR input) [N-FB2±] reaches the Speed reference 2 (before the acceleration/deceleration calculation) [N-REF2]. The inverter provides the detection signal when the detected speed is between the Speed reference 2 plus the hysteresis and the Speed reference 2 minus the hysteresis. The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned.



E	4	2	N	A	R	-	H	Y	S	T	R	

Setting range: 1.0 to 20.0 [%]

E43	Speed agreement (Detection range)
E44	Speed agreement (Off delay timer)

◆Set the agreement levels (agreement ranges) of the Speed reference 4 (ASR input) [N-REF4] and the Detected speed 2 [N-FB2±]. The inverter provides the detection signal when the Detected speed 2 is between the Speed reference 4 plus the Detection range and the Speed reference 4 minus the Detection range.

◆The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned. You can also set the off delay timer for the detection signal. If the Detected speed 2 goes out and returns to the detection range in a period specified by the off delay time, the detection signal will not be set to OFF.

E	4	3	N	A	G		H	Y	S	T	R	
E	4	4	N	A	G		D	E	L	A	Y	

Setting range: E43 = 1.0 to 20.0 [%]
E44 = 0.000 to 1.000 [s]

E45	Enable/disable alarm for speed disagreement

◆Specifies whether the Speed disagreement alarm (Er9) is issued or not when the deviation between the Speed reference 4 (ASR input) and the Detected speed 2 remains for a certain period.

E	4	5	N	-	U	E	-	A	L	M		

Setting 0: Disabled
1: Enabled

E46	Torque detection level 1
E47	Torque detection level 2

◆Provides a detection signal when the torque reference exceeds a specified value. You can specify two levels of detection level, level 1 and level 2. 100% means a torque reference of the continuous rating. The detection signals appear on the DO's to which the [T-DT1] and [T-DT2] are assigned.

E	4	6	T	D	T	1	-	L	V	L		
E	4	7	T	D	T	2	-	L	V	L		

Setting range: 0 to 300.0 [%]
Note: The calculated torque value is used for determination in V/f control.

E48	Magnetic-flux detection level

◆Provides a detection signal when the calculated magnetic-flux value exceeds a specified value. The detection signal appears on the DO to which the [M-DT] is assigned.

E	4	8	M	F	D	T	-	L	V	L		

Setting range: 10 to 100 [%]

E49-E52	Ai function selection

◆You can select functions for the analog input Ai1 to Ai4 from the following.

E	4	9	A	i	1		F	U	N	C		
E	5	0	A	i	2		F	U	N	C		
E	5	1	A	i	3		F	U	N	C		
E	5	2	A	i	4		F	U	N	C		

Set value: 0 to 18

Set value	Function	Symbol	Scale
0	Input signal off	[OFF]	–
1	Auxiliary speed setting 1	[AUX-N1]	±10V/±Nmax
2	Auxiliary speed setting 2	[AUX-N2]	±10V/±Nmax
3	Torque limiter (level 1)	[TL-REF1]	±10V/±150 %
4	Torque limiter (level 2)	[TL-REF2]	±10V/±150 %
5	Torque bias reference	[TB-REF]	±10V/±150 %
6	Torque reference	[T-REF]	±10V/±150 %
7	Torque current reference	[IT-REF]	±10V/±150 %
8	Creep speed 1 in UP/DOWN setting	[CRP-N1]	±10V/±Nmax
9	Creep speed 2 in UP/DOWN setting	[CRP-N2]	±10V/±Nmax
10	Magnetic-flux reference	[MF-REF]	+10V/+100 %
11	Detected line speed	[LINE-N]	±10V/±Nmax
12	Motor temperature	[M-TMP]	+10V/200 °C
13	Speed override	[N-OR]	±10V/±50 %
14	Universal Ai	[U-AI]	±10V/±4,000 [h]
15	PID feedback value	[PID-FB]	±10V/±20,000 [d]
16	PID reference value	[PID-REF]	±10V/±20,000 [d]
17	PID correction gain	[PID-G]	±10V/±4,000 [h]
18	Option Ai	[O-AI]	±10V/±7,FFF [h]

<Using analog input>

There are 19 types of analog input functions from 0 to 18 available. You cannot use all of these functions at the same time. You can use total of four terminals, which are two terminals, [Ai1] and [Ai2], as standard and two terminals, [Ai3] and [Ai4], using optional AIO. The maximum number you can use is four unless you switch externally.

When you assign the same function to [Ai1] and [Ai2], the input to [Ai2] will become effective. When you install the AIO option and assign the same function to [Ai1], [Ai2], [Ai3], and [Ai4], the input to [Ai4] will become effective. Note that you should assign [U-AI] to all the analog input terminals at the same time.

Setting procedure

- Select a function you want to use. We select the "Torque bias" as an example.
- Assign the "Torque bias" function to one of the available terminals ([Ai1] to [Ai4]). If you want to assign it to [Ai2], write a data, "5:TB-REF", to the function code E50 "Ai2 function selection".
- Apply a voltage of ±10V/±150% to the analog terminal [Ai2] considering the scale conversion of the torque bias in mind. If you need the torque bias of 15%, you should apply +1.0V.
- See the "I/O check" screen of the KEYPAD panel to confirm that +1.0V is applied to [Ai2]. The right figure shows the screen you must view.

1500

12 = 0.0 V
Ai1 = 0.2 V
Ai2 = 1.0 V

- You can specify the bias, the gain, the filter and the increment/decrement limiter applied to the analog input.

Function	Application
Bias	Sets the offset.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. 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.

Input signal off [OFF]

Select when you want assign no function to an analog input terminal.
Use when you do not use the analog input terminals.

Auxiliary speed setting 1, 2 [AUX-N1, 2]

Assign a data 1 [AUX-N1] and a data 2 [AUX-N2], to desired analog input terminals to designate them as Auxiliary speed setting 1 and Auxiliary speed setting 2 terminals. See the table below and the control diagram for the points where the control inputs are applied. This function adds a speed (±10V corresponds ±maximum speed) to main speed reference values ([12] input and the multistep speed reference). Two points are available to add a speed.

Auxiliary speed setting	Point of application	Restrictions
1 [AUX-N1]	After multistep speed command	Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25.
2 [AUX-N2]	After acceleration/deceleration calculation (acceleration/deceleration calculation applied to input is disabled)	

Torque limiter (level 1, 2) [TL-REF1, 2]

Assign a data 3 [TL-REF1] and a data 2 [TL-REF2] to desired analog input terminals to designate them as Torque limiter (level 1) and Torque limiter (level 2) terminals. See the function codes F40 to 43 for torque limiter.

Torque bias reference [TB-REF]

Assign a data 5 [TB-REF] to a desired analog input terminal to designate it as Torque bias reference terminal. See the function code F47 to 49 for more details.

Torque reference [T-REF]

Assign a data 6 [T-REF] to a desired analog input terminal to designate it as Torque reference terminal. See the control block diagram and the function code H41 "Torque reference selection" for more details.

Torque current reference [IT-REF]

Assign a data 7 [IT-REF] to a desired analog input terminal to designate it as Torque current reference terminal. See the control block diagram and the function code H42 "Torque current reference selection" for more details.

Creep speed 1 and 2 in UP/DOWN setting [CRP-N1, 2]

Assign a data 8 [CRP-N1] and a data 9 [CRP-N2] to desired analog input terminals to designate them as Creep speed 1 and Creep speed 2 terminals. See the UP/DOWN functions of the function codes E01 to 13 for more details.

Magnetic-flux reference [MF-REF]

Assign a data 10 [MF-REF] to a desired analog input terminal to designate it as Magnetic-flux reference terminal. See the control block diagram and the function code H44 "Magnetic-flux reference value" for more details.

Detected line speed [LINE-N]

Assign a data 11 [LINE-N] to a desired analog input terminal to designate it as Detected line speed terminal. See the control block diagram and the function code H53 "Line speed feedback selection" for more details.

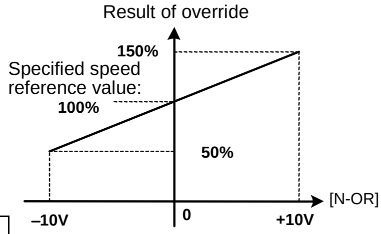
Motor temperature [M-TMP]

Assign a data 12 [M-TMP] to a desired analog input terminal to designate it as Motor temperature terminal. When you use a VG dedicated motor (VG3, VG5, VG7), you can use the NTC thermistor supplied with a motor to detect the motor temperature and to protect the motor from overheat. When you use a motor with a PTC thermistor, you can use it for overheat protection. You can also use an electronic thermal relay for protection against motor overload.
You can use this function to build your own motor overheat protection system detecting the motor temperature directly without using method mentioned above.
You can use the function code E30 "Motor overheat protection" and E31 "Motor overheat early warning" to specify the detection levels.

Speed override [N-OR]

Assign a data 13 [N-OR] to a desired analog input terminal to designate it as Speed override terminal.

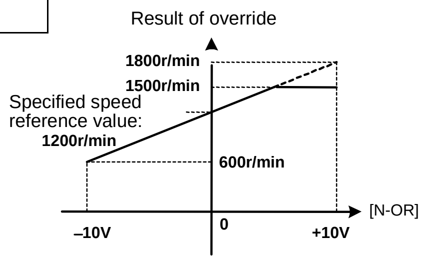
You can supply +10V to override the speed reference with 150% of the reference and supply −10V to override with 50% of the reference. See the control diagram for a point of the control input.



Speed override	Point of application	Restrictions
13 [N-OR]	Just after Auxiliary speed setting 1	Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25. 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: 1,500r/min
Specified speed reference value: 1,200rmin (100%)
Input voltage applied to the terminal [N-OR]: ±10V

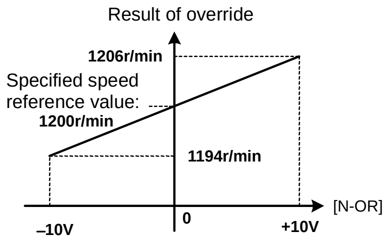


Coarse adjustment

As shown in the right graph, the overridden value is 600r/min for −10V input and is restricted by the maximum speed for +10V input.
Applying voltage enables coarse speed adjustment around the speed reference (1,200r/min).

Fine adjustment

Set the gain of used [Ai] to 0,01 (function code E53 to 56).
As shown in the right graph, the overridden value is 1194r/min for −10V input and is 1206r/min for +10V input.
Applying voltage enables fine speed adjustment around the speed reference (1,200r/min).
Either the reference value of the maximum speed or the precision of the analog input determines the resolution.
In this example, the resolution is determined by the former one: 0.08r/min.



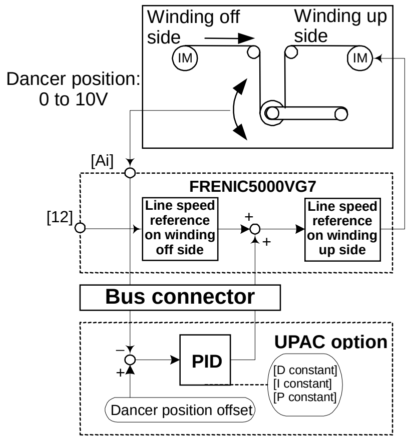
The larger value between the following values determines the resolution. Reference value of the maximum speed: 1,500r/min÷internal data 20,000=0.075r/min≈0.08r/min Precision of the analog input: Unipolar scale (6r/min) is divided into 15 bit. Thus, 6r/min÷32767 (15bit)×100 (scaling)=0.018r/min

Universal Ai [U-AI]

Assign a data 14 [U-AI] to a desired analog input terminal to designate it as Universal Ai terminal. You can use this function to check the existence of the input signal through communication and this function does not affect the inverter operation.

You can use this signal to the following applications.

1) You can read out input signal as an analog data through RS485 or optional field bus.
2) You can use Ai for an input to a software you create with the UPAC option or the PLC without affecting the inverter operation.



<Application example>

The right figure shows a diagram of a winding control utilizing dancer control.

The UPAC option uses PID control for dancer position control. The line speed reference generated by adding the PID output to the line speed reference for the winding off side received from [12] is supplied to the winding up side.

You can use an [Ai] terminal to read the dancer position detected by a potentiometer.

If you assign Universal Ai [U-AI] to the AI input, the output of the potentiometer is directly available to the UPAC. See the description of the UPAC for more details on the UPAC.

You can also use [U-AI] to control in the same manner if you replace the UPAC option and the bus connector with the PLC and the communication line.

PID feedback value [PID-FB]
PID reference value [PID-REF]
PID correction value [PID-G]

Assign a data 15 [PID-FB], a data 16 [PID-REF] and a data 17 [PID-G] to desired analog input terminals to designate them as PID feedback value , PID reference value, and PID correction value terminals, respectively.

These terminals can be used as input terminals for feedback signals, reference signals and correction signals in the process under PID control.

See the function codes H19 to H26 for more details on the PID functions.

Option Ai [O-AI]

Reserved for options and special applications

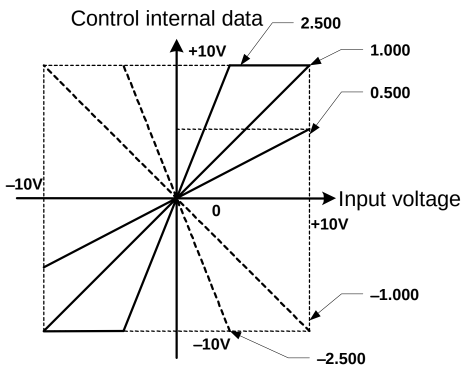
E53-E56 Ai gain setting

◆You can specify a times applied to the analog input (Ai1 to 4 terminals)

E	5	3	G	A	I	N		A	i	1			
E	5	4	G	A	I	N		A	i	2			
E	5	5	G	A	I	N		A	i	3			
E	5	6	G	A	I	N		A	i	4			

Setting range: –10.000 to 10.000 [times]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.



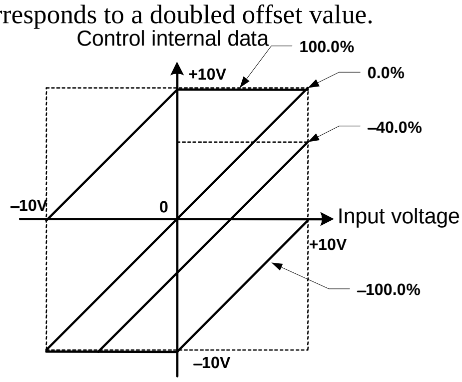
E57-E60 **Ai bias setting**

◆Sets a bias to the analog input [Ai1-4]. A value of 100% corresponds to a doubled offset value.

E	5	7	B	I	A	S		A	i	1		
E	5	8	B	I	A	S		A	i	2		
E	5	9	B	I	A	S		A	i	3		
E	6	0	B	I	A	S		A	i	4		

Setting range: –100.0 to 100.0 [%]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.



E61-E64 **Ai filter setting**

◆You can specify whether to apply a filter to the analog input [Ai1 to 4] terminals, and you can also specify a time constant of the filter individually. The filter used here is a low-pass filter. The time constant means the time until the filter output data reaches 63% of the input data.

Since a large filter time constant decreases the response, consider the response of a mechanical system to determine the time constant. If the input voltage fluctuates due to noise, first try hardware measures, and then use this filter after you failed.

Use the function code (E65 to E68) to increase or decrease a reference value gradually.

E	6	1	F	I	L	T	E	R		A	i	1
E	6	2	F	I	L	T	E	R		A	i	2
E	6	3	F	I	L	T	E	R		A	i	3
E	6	4	F	I	L	T	E	R		A	i	4

Setting range: 0.000 to 0.500 [s]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.

E65-E68 **Increment/decrement limiter (Ai)**

◆Specifies a time to increase a data inside the inverter from 0V to 10V when you change the input from 0 to 10V applied to the analog input [Ai1 to 4] terminals.

<Application example>

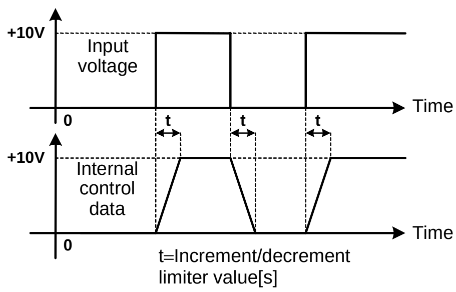
When you use the analog torque reference or the analog torque bias, you may not use a reference that changes stepwise. A step-wise torque reference may tear a paper in a paper rolling machine or present an elastic vibration (damping) when a subject matter has a large elastic modulus.

To avoid this phenomenon, though you should change the reference with an external volume, you can use this Increment/decrement limiter to specify the automatic increase and decrease of an analog reference value.

E	6	5	A	/	D	-	L	-	A	i	1	
E	6	6	A	/	D	-	L	-	A	i	2	
E	6	7	A	/	D	-	L	-	A	i	3	
E	6	8	A	/	D	-	L	-	A	i	4	

Setting range: 0.00 to 60.00 [s]

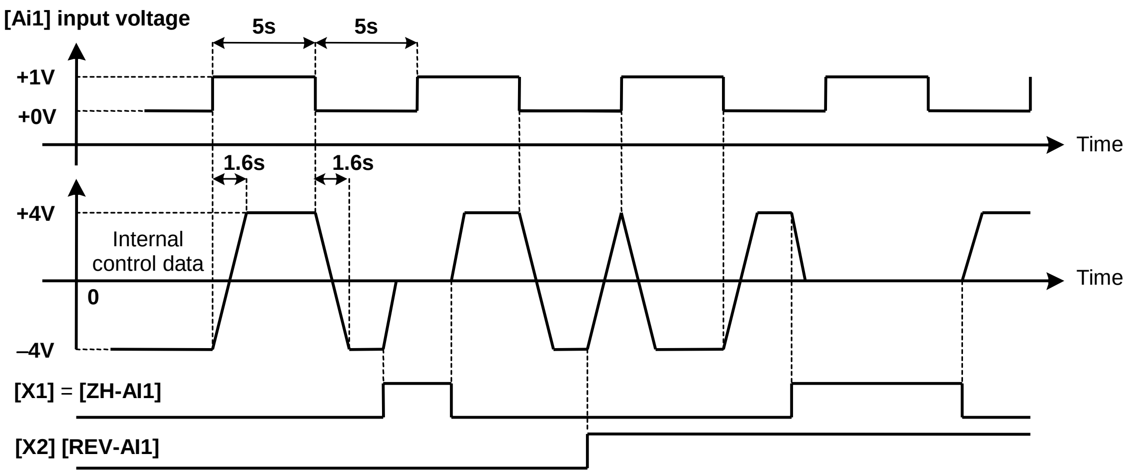
Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.



Appendix

This section shows an example specifying the bias, the gain, and the increment/decrement limiter of [Ai1] and assigning "Ai1 zero hold" to [X1] function and "Ai1 polarity change" to [X2] function. See also the control block diagram for better understanding. The filter function is not included in this example, since you can use this function to eliminate noise, but should not use actively.

Function code	Set value
E01: X1 function selection	40: Ai1 zero hold [ZH-AI1]
E02: X2 function selection	44: Ai1 polarity change [REV-AI1]
E53: Ai1 gain setting	8.000 [magnification]
E57: Ai1 bias setting	–50.0 [%]
E65: Increment/decrement limiter (Ai1)	2.00s



- The increment/decrement limiter set the time for the change of an internal control data by 8V (–4V↔4V) to 2.0s×8/10=1.6s. Note that the increment/decrement limiter is applied not to the change of the input voltage from 0 to 1V, but to the change of the internal data scaled by the gain.
- The change of the internal control data to 0V follows the increment/decrement limiter when the zero hold signal [ZH-AI1]is applied.
- The change of the polarity of the internal control data follows the increment/decrement limiter when the polarity change signal [REV-AI1] is applied.

E69-E73 **AO function selection**

◆You can select signals applied to the analog output and signals for adjusting AO.

E	6	9	A	O	1		F	U	N	C		
E	7	0	A	O	2		F	U	N	C		
E	7	1	A	O	3		F	U	N	C		
E	7	2	A	O	4		F	U	N	C		
E	7	3	A	O	5		F	U	N	C		

Setting range: 0 to 15, 30, 31
16 to 29 are reserved. Do not use them.

Set value	Function	Symbol	Scale
0	Detected speed 1 (Speedometer, one-way deflection)	[N-FB1+]	+Nmax/10V
1	Detected Speed 1 (Speedometer, two-way deflection)	[N-FB1±]	±Nmax/±10V
2	Speed setting 2 (Before acceleration/deceleration calculation)	[N-REF2]	±Nmax/±10V
3	Speed setting 4 (ASR input)	[N-REF4]	±Nmax/±10V
4	Detected speed 2 (ASR input)	[N-FB2±]	±Nmax/±10V
5	Detected line speed	[LINE-N±]	±Nmax/±10V
6	Torque current reference (Torque ammeter, two-way deflection)	[IT-REF±]	±150%/±10V
7	Torque current reference (Torque ammeter, one-way deflection)	[IT-REF+]	+150%/10V
8	Torque reference (Torque meter, two-way deflection)	[T-REF±]	±150%/±10V
9	Torque reference (Torque meter, one-way deflection)	[T-REF+]	+150%/10V
10	Motor current rms value	[I-AC]	200%/10V
11	Motor voltage rms value	[V-AC]	200%/10V
12	Input power	[PWR]	200%/10V
13	DC link circuit voltage	[V-DC]	800V/10V
14	+10V output test	[P10]	Output equivalent to +10V
15	–10V output test	[N10]	Output equivalent to –10V
30	Universal AO	[U-AO]	±4000H/±10V
31	Option AO	[O-AO]	±4000H/±10V

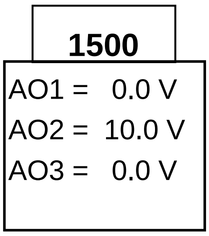
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

<Using analog output>

There are 16 types of analog output functions from 0 to 15 available. You cannot use all of these functions at the same time. You can use total of five terminals, which are three terminals, [AO1], [AO2] and [AO3], as standard and two terminals, [AO4] and [AO5] using optional AIO.

Setting procedure

- Check a device such as a meter including wires. Set data to 14 to check 10V output.
- Select a function you want to use. We select the "Detected Speed 1 (Speedometer, two-way deflection)" as an example.
- Assign the "Detected Speed 1 (Speedometer, two-way deflection)" function to one of the available terminals ([AO1] to [AO5]). If you want to assign it to [AO2], write a data, "1:N-FB1±", to the function code E70 "AO2 function selection".
- See the "I/O check" screen of the KEYPAD panel to confirm that [AO2] supplies +10.0V during operating a motor. The right figure shows the screen you must view.
- Connect a speedometer to the analog terminal [AO2].



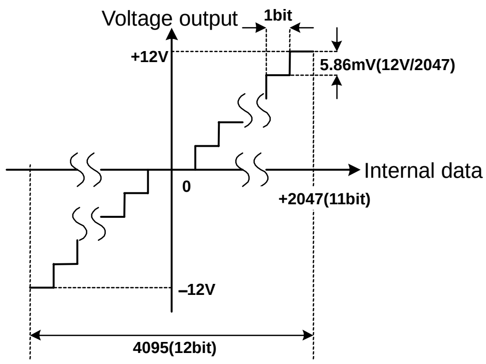
- You can specify the bias, the gain, and the filter applied to the analog output.

Function	Application
Bias	Sets the offset.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. Use a minus value to invert the polarity.
Filter	You do not need to change the factory set data 0.010s (10ms). 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 a 12-bit digital data into an analog data for output. 11 bits (2047) are assigned to +12V, thus the output resolution is 5.86mV. Note that a binary data corresponding to 10V is 1705 (2047×10/12).
When you use about +10V to supply a speed reference corresponding to the maximum speed of 1500r/min, the resolution is 1500/1700=0.88r/min.



Output cycle

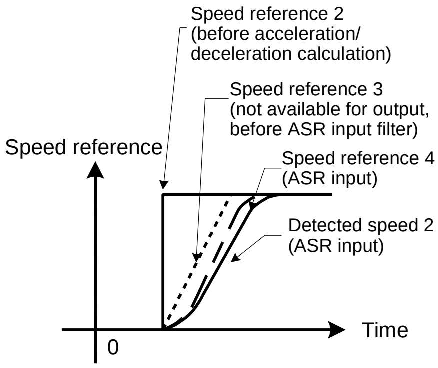
Output is supplied with a sampling cycle of 500µs.

Detected speed 1 (Speedometer, one-way deflection) [N-FB1+]
Detected speed 1 (Speedometer, two-way deflection) [N-FB1±]

Assign a data 0 [N-FB1+] and 1 [N-FB1±] to desired analog output terminals to designate them as speedometer functions.
Use [N-FB1+] for a unipolar meter and use [N-FB1±] for a bipolar meter. This function detects encoded motor speed and supplies a data after the speed detection calculation or the speed estimation calculation.

Speed setting 2 (Before acceleration/deceleration calculation) [N-REF2]
Speed setting 4 (ASR input) [N-REF4]
Detected speed 2 (ASR input) [N-FB2±]

Assign a data 2 [N-REF2], 3 [N-REF4] and 4 [N-FB1+] to desired analog output terminals to output the speed reference and detected speed of each of them. You can use these functions to measure and observe the follow-up and the deviation of the Detected speed 2 (ASR input) against individual speed references externally. Note that the Speed agreement (the comparison between [N-REF2] and [N-FB2±]) and the Speed equivalent ([N-REF4] and [N-FB2±]) of the inverter DO output use these data for output.
The speed reference 3 in the right graph is not available for an AO output.



Detected line speed [LINE-N±]

Assign a data 5 [LINE-N±] to a desired analog output terminal to designate it as line speed detection. The highest data among the analog line speed [LINE-N], the digital line speed, detected speed by PG (LD) and a data from integrated speed detection/estimation is provided to output.

Torque current reference (Torque ammeter, two-way deflection) [IT-REF±]
Torque current reference (Torque ammeter, one-way deflection) [IT-REF+]

Assign a data 6 [IT-REF±] and 7 [IT-REF+] to desired analog output terminals to designate them as torque ammeters.
Use [IT-REF+] for a unipolar meter and use [IT-REF±] for a bipolar meter. You can use the function code F51 "Torque reference monitor (Polarity selection)" to select the output polarity.

Torque reference (Torque meter, two-way deflection) [T-REF±]
Torque reference (Torque meter, one-way deflection) [T-REF+]

Assign a data 8 [T-REF±] and 9 [T-REF+] to desired analog output terminals to designate them as torque meters.
Use [T-REF+] for a unipolar meter and use [T-REF±] for a bipolar meter. You can use the function code F51 "Torque reference monitor (Polarity selection)" to select the output polarity.

Torque meter and torque ammeter

A torque meter and a torque ammeter behave differently in constant output range over the rated speed (100%).
You can use the torque ammeter as a load meter (equivalent to load current).
You can use the torque meter as an output equivalent to actual torque reflecting torque decrement.
Though both of them provide the reference values, you can use them as real torque and torque current since the VG7 controls the current.

Motor current rms value [I-AC]
Motor voltage rms value [V-AC]

Provide effective values of the output current and voltage supplied to the motor.

Input power [PWR]
DC link circuit voltage [V-DC]

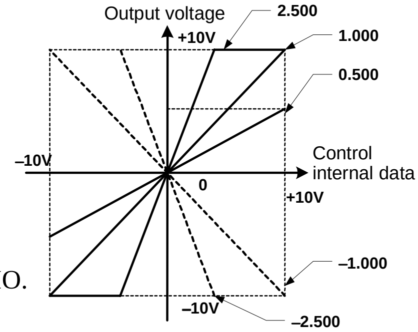
See the control block diagram (4.2.8).

E74-E78	AO gain setting

◆Sets the gain of the analog output A01 to AO5.

E	7	4	G	A	I	N		A	O	1		
E	7	5	G	A	I	N		A	O	2		
E	7	6	G	A	I	N		A	O	3		
E	7	7	G	A	I	N		A	O	4		
E	7	8	G	A	I	N		A	O	5		

Setting range: –100.00 to 100.00 [times]
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

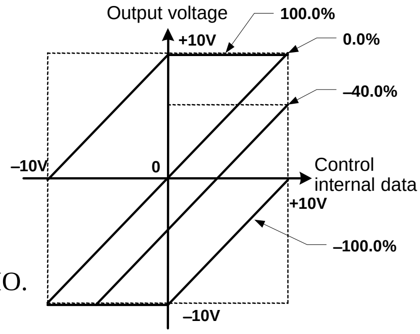


E79-E83	AO bias setting

◆Sets the bias of the analog output A01 to AO6.

E	7	9	B	I	A	S		A	O	1		
E	8	0	B	I	A	S		A	O	2		
E	8	1	B	I	A	S		A	O	3		
E	8	2	B	I	A	S		A	O	4		
E	8	3	B	I	A	S		A	O	5		

Setting range: –100.00 to 100.00 [%]
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

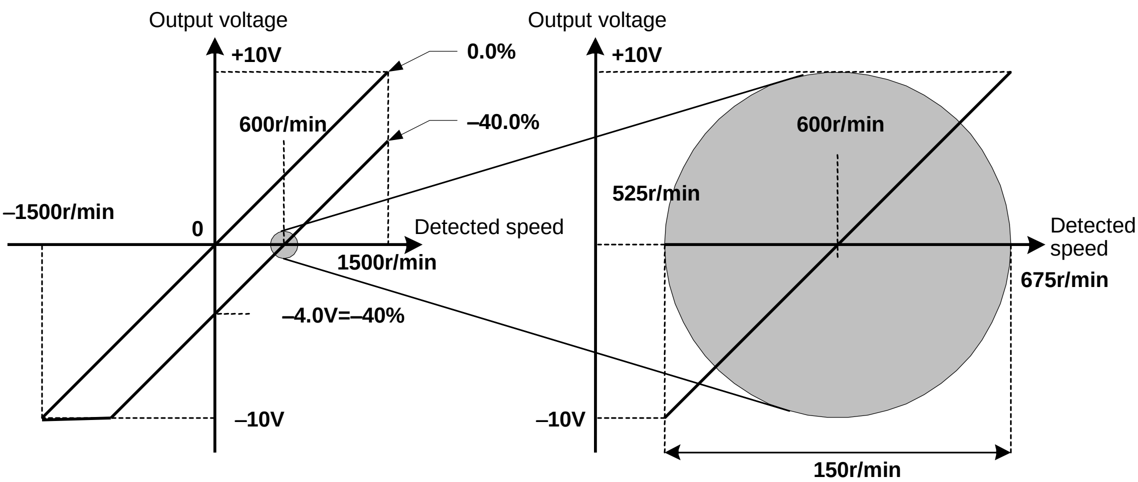


<Application example>

This is an example to use the AO gain and the AO bias functions to magnify the data of the Detected speed 1 around 600r/min to provide full-scale output (in the range from -10 to 0 to 10V). If we use [AO3] as an output analog terminal, the following setting is necessary.

Function code	Set value
E71: AO3 function selection	1: [N-FB1±]
E76: AO3 gain setting	20.0 [magnification]
E81: AO3 bias setting	–40.0 [%]

When we set the bias to shift 0.0% to –40.0%, 0r/min provides –4.0V (–40.0%) output. Therefore 0V corresponds to 600r/min. Then, when we set the gain to 20.0, 1500r/min/10V becomes 75r/min/10V. As a result, –10V output indicates 600–75r/min and +10V output indicates 600+75r/min.



E84 **AO1-5 filter setting**

◆Sets the time constant of the output filters for the analog output AO1 to AO5 simultaneously.

E	8	4	F	I	L	T		A	O	1	-	5

Setting range: 0.000 to 0.500 [s]

Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

4.3.3 C Codes (Control Functions of Frequency)

C01	**Jump speed 1**
C02	**Jump speed 2**
C03	**Jump speed 3**
C04	**Jump hysteresis**

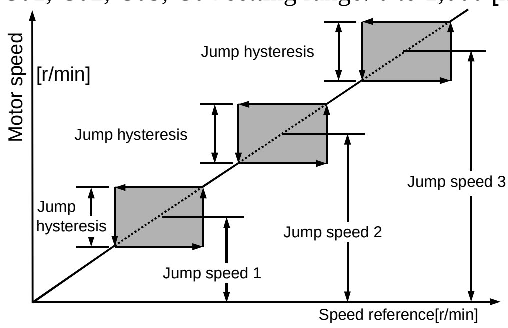
◆Jumps the speed reference to avoid mechanical resonance points of a load. You can set three jump points.

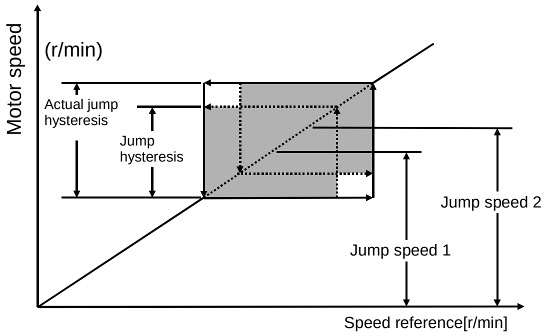
◆When you set the Jump speed 1 to 3 to 0r/min, this function is disabled. The speed reference does not jump during acceleration/deceleration.

◆When specified ranges of jump speed overlap one another, the sum of them is considered as a jump range.

C	0	1	J	U	M	P		N	1			
C	0	2	J	U	M	P		N	2			
C	0	3	J	U	M	P		N	3			
C	0	4	J	U	M	P		H	Y	S	T	R

C01, C02, C03, C04 setting range: 0 to 1,000 [r/min] setting range: 0 to 24,000 [r/min]

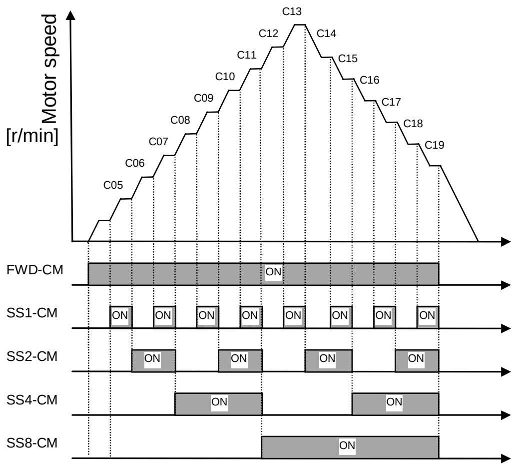




C05-C17	**Multistep speed 1-13**

◆You can set ON or OFF to the terminal function [SS1], [SS2], [SS4], and [SS8] to switch among Multistep speed 1 to 15 (refer to E01 to E13 "X function selection" for setting the terminal function).

◆When a terminal among [SS1], [SS2], [SS4], and [SS8] is not defined, the terminal considered to be OFF. You can select 1r/min or 0.01% for a unit of a setting range according to the setting of C21 "Multistep setting definition". When you choose 0.01% for a unit, 100% is the maximum speed defined by the function code (F03, A06, or A40).



C	0	5	M	U	L	T	I		N	-	1	

to

C	1	7	M	U	L	T	I		N	-	1	3

Setting range: 0 to 24,000 [r/min], 0.00 to 100.00 [%] or 0.0 to 999.9 [m/min]

C18 **Multistep speed 14/Creep speed 1**

C19 **Multistep speed 15/Creep speed 2**

◆C18 and C19 also work as a creep speed function when you use the UP/DOWN function. See E01 to E09 "X function selection" for more details.

C	1	8	N	-	1	4	/	C	R	E	P	1
C	1	9	N	-	1	5	/	C	R	E	P	2

Setting range: 0 to 24,000 [r/min], 0.00 to 100.00 [%] or 0.0 to 999.9 [m/min]

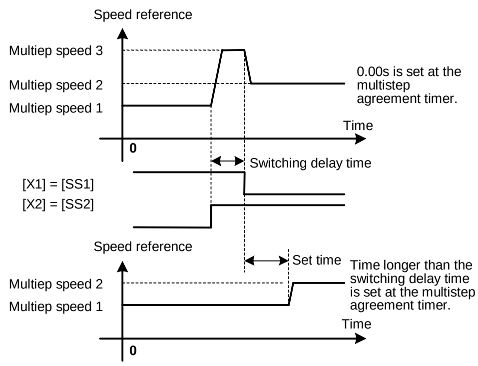
C20 **Multistep speed reference agreement timer**

◆When the terminal function [SS1], [SS2], [SS4], and [SS8]do not change simultaneously, a speed reference out of the specification may be specified. When you use the Multistep speed reference agreement timer, the speed reference changes after [SS1], [SS2], [SS4], and [SS8] maintain the same state for a time specified by the Multistep speed reference agreement timer.
Use this timer to use two or more terminals simultaneously among [SS1], [SS2], [SS4], and [SS8] to switch the speed. If you switch only one terminal, leave the setting to 0.000s.

<Application example>

This section shows an example to use terminals [SS1] and [SS2] to switch the multistep speed. When you want to change from the Multistep speed 1 to the Multistep speed 2, you should switch two terminals simultaneously.

- When you set the timer to 0.00s, the difference in switching timing of [SS1] and [SS2] activates the Multistep speed 3 for the delayed period and presents a operation pattern out of the specification as shown in the upper right graph.
- When you set the time of this function code to a period longer than the switching time, the switching to Multistep speed 2 occurs just when a specified time passes after [SS1] is set to OFF. You can avoid the Multistep speed 3 to be selected.



<Point>

The cycle sampling the terminal signals is about 500μs (0.5ms) in the VG7. You do not have to set this function if your switching period is shorter than the sampling cycle.

C	2	0	M	L	T		N		T	I	M	E

Setting range: 0.000 to 0.100 [s]

C21 **Multistep setting definition**

◆Sets the unit to specify the multistep speed.

C	2	1	M	L	T		U	N	I	T		

Set value: 0: 0 to 24,000 [r/min]
1: 0.00 to 100.00 [%]
2: 0.0 to 999.9 [m/min]

Defines setting methods of C05 to C19.
With selection of "1", the setting range applies to the max speeds (F03, A06, A40) of selected motor .
Refer to F79 for motor selection.

C25 **Speed setting N2**

◆Sets a method to specify the speed reference. When the X terminal function [N2/N1] is set to ON, the speed specified this function will be effective. See the description of F01 "Speed setting N1" for setting method you can select.

C	2	5	S	P	D		C	M	D		2	

C29 Jogging speed

C	2	9	J	O	G		N					

Setting range: 0 to 24,000 [r/min]

◆Sets a speed for inching a motor in addition to the normal operation. You can use this function for positioning a work, for example.

◆You can choose the following two ways for the jogging operation.

- Turn on the X control terminal [JOG] to change to the jogging mode and set the operation command [FWD] or [REV] to ON.
- Set the ∧ and STOP keys on the KEYPAD panel to ON simultaneously to switch to the jogging mode and set the operation command [FWD] or [REV] to ON.

C30-C69 ASR, S-curve acceleration/ deceleration 2, 3, and 4, and JOG function groups

The function code group C30 to C38 becomes effective in the JOG mode.

The terminal input signal [RT1] and [RT2] set the function code group C39 to C69 to either enabled or disabled

See E01 to E13 "X function selection" and the control block diagram for the details of switching.

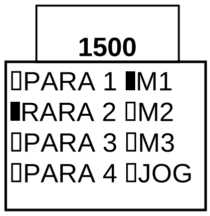
Acceleration/deceleration time: See the description of the function code F07 and F08.

S-curve setting : See the description of the function codes F67 to F70. Note that you can set only the two points, the start and end sides, for the S-curve acceleration/deceleration 2,3, and 4 and the JOG.

ASR setting : See the description of the function codes F61 to F65. Note that you cannot set the F/F gain to the ASR-JOG.

You can view the setting on the "I/O check" screen of the KEYPAD panel.

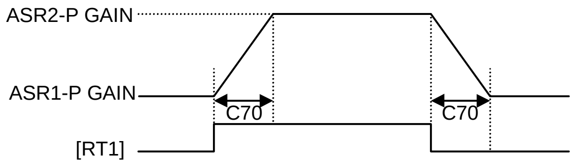
The right figure shows that the ASR2 and the S-curve deceleration (PARA 2) are selected.



C70 ASR switching time

◆This function specifies the duration of the switching, when you use the X control terminals [RT1] and [RT2] to switch the ASRs. This function change the P (gain) gradually in a specified time to reduce the mechanical shocks during the switching.

◆The right figure shows an example to set the [RT1] to OFF, ON, then to ON to switch the gain between the ASR1 and ASR2.



C	7	0	A	S	R		C	H		t		

Setting range: 0.00 to 2.55 [s]

C71 Acceleration/ deceleration time switching speed

C72 ASR switching time

See the description of the L code for more details.

C	7	1	A	C	C	/	D	E	C		C	H
C	7	2	A	S	R		C	H		S	P	D

Setting range: 0.00 to 100.00 [s]

◆100.00% corresponds to the maximum speeds specified by the function codes (F03, A06 and A40).

C73	Creep speed switching (on UP/DOWN control)

◆Specifies whether to use a function or an analog input to set the creep speeds used in the UP/DOWN setting mode.

C	7	3	C	R	P		S	W	I	T	C	H

Setting range: 00 to 11
Description: □ □

First digit: Creep speed 1 (0: function code C18, 1: analog input [CRP-N1])
Second digit: Creep speed 2 (0: function code C19, 1: analog input [CRP-N2])

See the description of the UP/DOWN in the E01 to E13 "X function selection".

4.3.4 P Codes (Motor Parameters)

The P codes are motor parameters that become available when you select the M1 (first motor). See the A codes (second and third motors) when you use the M2 or M3.
You can use the function code F79 and the terminal input signal [M-CH2] and [M-CH3] to select the M1, the M2, or the M3.
See the individual descriptions and make sure that the M1 is selected. You can use the "I/O check" screen of the KEYPAD panel as shown in the right figure.
■ indicates a selection. Check if ■M1 is indicated.
F03 to 05 and F10 to 12 are available in addition to the P codes when you select the M1.

1500
□PARA 1 ■M1
□PARA 2 □M2
□PARA 3 □M3
□PARA 4 □JOG

P01 **M1 control method**

◆You can select a control method to drive the motor 1 from vector control for an induction motor with PG, vector control without PG (sensorless control), and vector control for a synchronous motor with PG. See also the description of the function code P02 for the setting.

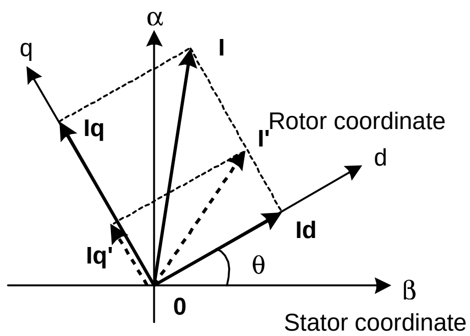
P	0	1	M	1	-	C	T	L	-	M	T	D

Set value: 0: Vector control
1: Sensorless vector control
2: Simulated operation mode
3: Vector control (synchronous motors)

◆About vector control

The right figure shows a rotating coordinate (d-q axes) of a rotor on a coordinate (α-β axes) generated by two-phase conversion from a stator coordinate (U, V, W). θ shows the rotation position and indicates the position of the magnetic-flux (d axis=direction of magnetic flux) observed on the fixed coordinate (α-β axes).

The alternating current (I) flowing through the stator generates a rotating magnetic field. The rotor coordinate (d-q axes) rotates at the frequency of this alternating current. If you observe the current (I) from the rotor coordinate (d-q axes), the current (I) seems stationary. Thus, the alternating current (I) can be considered direct current value on the rotor coordinate (d-q axes). You can decompose the current into the d axis element and the q axis element (I→Iq+Id). The d axis current (Id) is defined as magnetic-flux current (exciting current) denoting a current required to generate a magnetic-flux. The q axis current (Iq) is defined as torque current (load current).



When a load changes to require Iq' (indicated by a dotted arrow in the figure) as the torque current, you should control the current by directing I' (indicated by a dotted arrow in the figure) as a current reference while maintaining the magnetic-flux current (Id). The control that maintains the magnetic-flux (Id=constant) and changes the torque current (Iq) according to the load is referred as **vector control**. Since this control is similar to the control for the direct current motor where the magnetic-flux is maintained constant by the magnet and the rotor current is controlled according to the load, you can use the same control for a alternating current motor as for a direct current motor.

4. Control and Operation

◆About sensorless control

This control utilizes vector control (similar to DC motor control) for a motor without a pulse generator. This control enables torque control, which is not available in V/f control. Use this control when you use existing general-purpose motors or motors to which you cannot install a PG.
Note that the control capability (such as speed control range, speed control response, and speed control accuracy) differs from that of control utilizing PG described in Chapter 2 "Specifications" when you select the control. If you need this capability, select vector control with PG for a motor with a PG.
Tune the motor parameter to control properly. Use the function code H01 to conduct tuning (set value 3 and 4).

<Control mechanism>

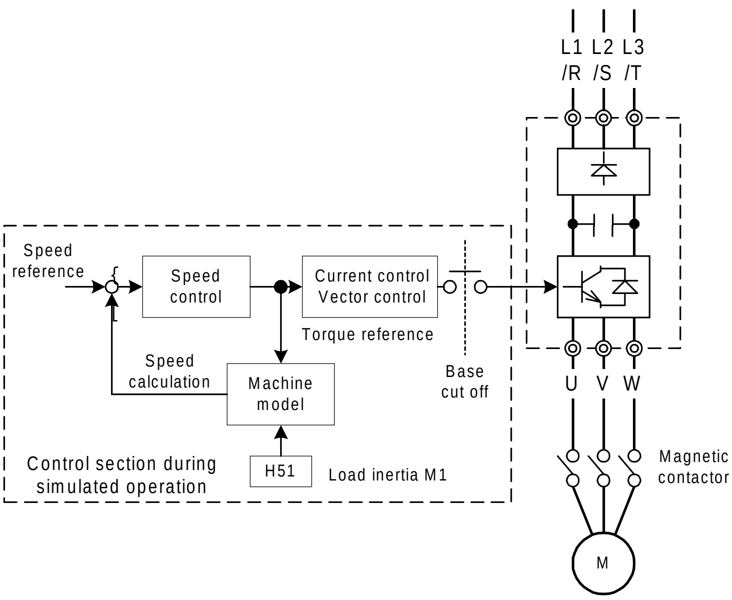
Sensorless control calculates the motor speed and the magnetic pole position. This control detects the output voltage and the output current and uses the motor parameters (R1, Lσ) identified through tuning to calculate the induced voltage. The magnetic flux position is determined since the Ed element obtained by decomposing this induced voltage into the d axis direction is 0. Since the Eq element on the q axis direction corresponds to the induced motor voltage and is proportional to the motor speed, you can obtain the motor speed. This control has the following restrictions compared with vector control with PG.

- Speed control range is limited at low speed due to the inferior accuracy of the induced motor voltage compared with that at high speed.
- Speed control response is low due to the slow convergence of the internal calculation.
- Speed control accuracy is inferior due to the accuracy of the speed calculation based on the induced voltage.

◆About simulated operation

You can select the setting "2" "Simulated operation mode" to operate the inverter internally without connecting a motor in a state similar to the real operation. Use the simulated operation to check your system such as I/O or to test after installation.

When you give a torque reference to a machine model (load inertia: H51), the machine model accelerates to a certain speed. Since speed control is a type of feedback control, the machine model rotates to follow the speed reference in the end. You can use the LED and the LCD monitor on the KEYPAD panel and the monitor code (M code) to monitor this operation. Note that since the inverter does not detect the current and the voltage, the "Detected output current" and the "Detected output voltage" display "0". The individual function codes and the protective function are available as long as they are not restricted. Since the simulated operation cuts off the bases (cuts of the inverter output), the secondary side (U, V, W) does not present voltage. However, disconnect the secondary side or use a magnetic contactor to cut off the secondary side for your safety.



P02	M1 motor selection

◆You need different procedure to use a standard motor for VG7S and VG5 (setting: 0.75-2 to 220-4) (Note 1) or another motor (setting: OTHER)

◆When you use a standard motor for VG7S or VG5, select a combination of "capacity (kW)-voltage (2 or 4)" from the setting list ranging "0.75-2" to "220-4", and optimal values for the standard motor are written into F04, F05, and P03 to P27 automatically. You do not need to change F04, F05, and P03 to P27 and they are write-protected.

◆Select "OTHER" when you use a motor (FUJI's motor, standard motor for VG3 or VG, or others) other than standard motors for VG7S and VG5.

◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used. They are valid only for vector control and sensorless control of an induction motor. When you use a synchronous motor, contact FUJI.

P	0	2	M	1	-	S	E	L	E	C	T	

Function code for motor 1	FUJI motors			Other motors
	Standard motors for VG7S or VG5	Standard motors for VG3 and VG	FUJI motors	
P01 M1 control method	0: Vector control		Select depending on with or without PG With PG : 0, vector control Without PG: 1, sensorless control	
P02 M1 motor selection	Select form "0.75-2" to "220-4"	Select "OTHER"		
F04 M1 rated speed	P02 automatically sets: - Motor ratings nameplate values, and - Optimal motor constants. These data remain after you turn off. You cannot change the data set automatically (write-protected). Do not use H01 "Tuning operation selection".	Set the data described in the Chapter 14 "Replacement data" manually. Do not use H01 "Tuning operation selection".	Set the ratings nameplate data provided on the motor manually.	
F05 M1 rated voltage				
P03 M1 rated capacity				
P04 M1 rated current				
P05 M1 pole number				
P06 M1-%R1			Use H01 "Tuning operation selection" to tune motor parameters. See the function description of H01 for more details.	
P07 M1-%X				
P08 M1 exciting current				
P09 M1 torque current				
P10,11 M1 slip on driving, braking				
P12-14 M1 iron loss coefficient 1-3			Preserve the initial value. Not available for tuning.	
P15-19 M1 magnetic saturation coefficient 1-5				
P20 M1 secondary time constant				
P21 M1 induced voltage coefficient				
P22-24 M1-R2 correction coefficient 1-3				
P25 M1 exciting current correction coefficient				
P26, 27 M1-ACR-P, I (Gain, Constant of integration)			Preserve the initial value.	
P28 M1-PG pulse number	Select PG pulse number. Not effective during sensorless control.			
P30 M1 thermistor selection	1: NTC thermistor		See F10 for details on motor protection.	
F10 M1 electronic thermal overload relay (Select)	0: Disabled (VG standard motor)			
H01 Tuning operation selection	Motor parameters tuning not required. Procedure above sets optimal data automatically. Select "2" for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.		Motor parameters turning required. Tune while wires are installed. See function description of function code H01.	
H02 All save function	Execute "all save" operation after using H01 to tune. This operation writes tuned data to non-volatile memory. Not necessary when you did not tune parameters.			
P02 M1 motor selection	-	Setting to "36:P-OTR" protects function code F04, F05, and P03 to P27 from writing. Set last if necessary.		

Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

P03 **M1 rated capacity**

◆Sets the rated capacity value of the motor 1. Enter the value described on the ratings nameplate. Set a capacity corresponding to a single winding for a multiwinding motor.

P	0	3	M	1	-	C	A	P				

Setting range F60=0: 0.00 to 500.00 [kW]
F60=1: 0.00 to 600.00 [HP]

P04 **M1 rated current**

◆Sets the rated current value of the motor 1. Enter the value described on the ratings nameplate.

P	0	4	M	1	-	I	r					

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

P05 **M1 pole number**

◆Sets the number of poles of the motor 1. Enter the value described on the ratings nameplate.

P	0	5	M	1	-	P	O	L	E	S		

Setting range: 2 to 20 [pole]

P06 **M1-%R1**

P	0	6	M	1	-	%	R	1				

Setting range: 0.00 to 30.00 [%]

$$\%R1 = \left(\frac{(R1[\Omega] + \text{Cable resistance}[\Omega]) \times \text{P04 : Motor rated current[A]}}{\text{F05 : Motor rated voltage[V]}/\sqrt{3}} \right) \times 100[\%]$$

Use a value corresponding to the Y connection for one phase to specify R1 [Ω].
Use a value corresponding to one winding of multiwinding motor.

P07 **M1-%X**

P	0	7	M	1	-	%	X					

Setting range: 0.00 to 30.00 [%]

$$\%X = \left(\frac{(L\sigma[H] + \text{Cable } L[H]) \times \text{P04 : Motor rated current[A]}}{\text{F05 : Motor rated voltage[V]}/\sqrt{3}} \times 2\pi \left(\frac{\text{P05 : Pole numbers} \times \text{P04 : Rated speed[r/min]}}{120} \right) \right) \times 100[\%]$$

Use a value corresponding to the Y connection to specify Lσ[H].
Use a value corresponding to one winding of multiwinding motor.

P08 **M1 exciting current**

◆Sets the effective current value of the motor 1 during no-load operation.

P	0	8	M	1	-	I	M					

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

P09	M1 torque current

◆Sets the current contributing torque.

P	0	9	M	1	-	I	T					

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

$$\text{P09 : Torque current} = \sqrt{(\text{P04 : Rated current})^2 - (\text{P08 : Exciting current})^2}\,[A]$$

P10	M1 slip on driving
P11	M1 slip on braking

◆Sets the slips of the motor at rated speed and under rated load.

P	1	0	M	1	-	S	L	I	P	d		
P	1	1	M	1	-	S	L	I	P	b		

Setting range: 0.001 to 10.000 [Hz]

$$\text{Slip frequency[Hz]} \times \frac{\text{P05 :Pole numbers} \times (\text{Synchronized speed)[r/min]} - \text{F04 :Rated speed[r/min])}}{120}$$

P12	M1 iron loss coefficient 1
P13	M1 iron loss coefficient 2
P14	M1 iron loss coefficient 3

◆Sets coefficients to compensate an amount corresponding the iron loss (hysteresis loss, eddy current loss) of the motor. If you do not need the iron loss compensation, you may set 0.

P	1	2	M	1	-	L	O	S	S	1		
P	1	3	M	1	-	L	O	S	S	2		
P	1	4	M	1	-	L	O	S	S	3		

Setting range: 0.00 to 10.00 [%]

P15	Magnetic saturation coefficient 1
P16	Magnetic saturation coefficient 2
P17	Magnetic saturation coefficient 3
P18	Magnetic saturation coefficient 4
P19	Magnetic saturation coefficient 5

◆The relation between the exciting current (current generating magnetic-flux in a motor) and the magnetic-flux is non-linear. These functions set the coefficients to compensate this relation.

P	1	5	M	1	-	S	A	T	1			
P	1	6	M	1	-	S	A	T	2			
P	1	7	M	1	-	S	A	T	3			
P	1	8	M	1	-	S	A	T	4			
P	1	9	M	1	-	S	A	T	5			

Setting range: 0.0 to 100.0 [%]

P20 M1 secondary time constant

◆The response of the magnetic-flux to the exciting current is a first-order lag. This time constant is defined as secondary time constant and you should set a value determined by the motor parameters as in the following equation. You can compensate the lag to lead.

P	2	0	M	1	-	N	D	-	T	C		

Setting range: 0.001 to 9.999 [s]
Set value: Secondary time constant [s]=Lm [H] / R2 [Ω]
Lm: Exciting inductance, R2: Resistance of secondary winding

P21 M1 induced voltage coefficient

◆The rotating magnetic field generated by the stator (primary winding) sections the rotor vertically to induce voltage on the secondary side in an induction machine. You can add voltage larger than this induced voltage to accelerate a motor. This function sets a coefficient to compensate this induced voltage.

P	2	1	M	1	-	E	M	F	-	C	O	F

Setting range: 0 to 999 [V]
Set value: Effective induced voltage substituted by the voltage between the windings at the rated speed.

P22 M1-R2 correction coefficient 1
P23 M1-R2 correction coefficient 2
P24 M1-R2 correction coefficient 3

◆The resistance of the rotor (secondary resistor) is used to calculate the slip frequency in vector control of slip frequency type. The change in secondary resistance due to the temperature increase caused by the frequent operation or load may degrade the torque control accuracy. The inverter detect the temperature with an NTC thermistor and use R2 correction coefficient 1, 2, and 3 to estimate the rotor temperature to prevent the decrease of the torque control accuracy. Do not change these settings.

P	2	2	M	1	-	R	2	C	O	R	R	1
P	2	3	M	1	-	R	2	C	O	R	R	2
P	2	4	M	1	-	R	2	C	O	R	R	3

P22, P23 setting range: 0.500 to 5.000
P24 setting range: 0.010 to 5.000 (P24)

P25 M1 exciting current correction coefficient

◆Corrects the exciting inductance. Do not change these settings.

P	2	5	M	1	-	I	M		C	O	R	R

Setting range: 0.000 to 5.000

P26	M1-ACR-P (Gain)
P27	**M1-ACR-I (Integration time)**

◆Vector control feeds back the motor output current to control a motor to follow the current reference. These functions specify the gain and the integration time for the current control (ACR). Usually you do not have to change from the factory setting.

◆When a winding has a large inductance, you should set a large P gain to compensate it in general. When a winding has a small inductance, you should set a small P gain to prevent OC (overcurrent) due to the overshoot of the current.

◆You should specify the integration time to reduce the steady-state deviation between the current reference and the actual current to zero. Do not specify too small value otherwise a current hunting occurs.

P	2	6	M	1	-	A	C	R	-	P		
P	2	7	M	1	-	A	C	R	-	I		

P26 setting range: 0.1 to 20.0
P27 setting range: 0.5 to 100.0 [ms]

P28	M1-PG pulse number

◆Set according to the pulse number of the PG for detecting the speed of the motor 1. If you set a wrong value, the inverter cannot determine the speed and the magnetic pole to conduct speed and vector controls accurately.

P	2	8	M	1	-	P	G	-	P	L	U	S

Setting range: 100 to 60,000

P29	M1 external PG correction coefficient

◆You need a correction coefficient to convert the output of a PG built in a machine system into the motor speed to control the speed. Set the coefficient here. Speed control by PG requires parameter setting at both P28 and P29.

P	2	9	P	G	-	C	O	M	P			

Setting range: 0000 to 7FFF

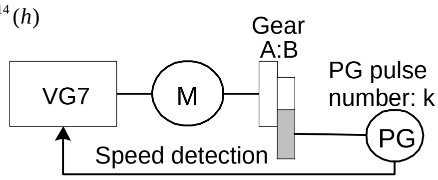
◆When you do not use an external PG, do not change from 4000h. The value of 4000h corresponds to a gear ratio of 1:1, i.e., a PG directly coupled to a motor. When you use a PG directly coupled to a motor, if you set a value other than 4000h, you cannot conduct speed and vector controls accurately.

Setting procedure

Suppose the gear ratio is A:B, specify the function code P28 and P29 as indicated below.

$$\text{Function code P28 (M1 - PG pulse number)} = \text{Integer part of } \left| \text{k(PG pulse number)} \times \frac{B}{A} \right|$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{P28}{k \times B/A} \right] \times 2^{14}(h)$$



<Setting example>

If PG pulse number=1,024 and the gear ratio A:B=13:1, then:

$$\text{Function code P28 (M1 - PG pulse number)} = \text{Integer part of } \left| \text{1024(PG pulse number)} \times \frac{1}{13} \right| = 78$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{P28}{k \times B/A} \right] \times 2^{14}(h) = \left[\frac{78}{1024 \times 1/13} \right] \times 2^{14}(h) = 16224(d) = 3F60(h)$$

P30	M1 thermistor selection

◆Specifies an analog input (0 to 10V) from a thermistor or a temperature sensor for motor protection. Select NTC thermistor for VG standard motors (VG7S, VG5, and VG3). Select PTC thermistor when a PTC thermistor is installed on a motor for overheat protection.

P	3	0	M	1	-	T	H	R				

Setting range: 0: No thermistor
1: NTC thermistor (for VG standard motors)
2: PTC thermistor
3: Ai [M-TMP]

Use E30 "Motor overheat protection (Temperature)" to E32 "M1-M3 PTC operation level" to specify the protection level of the motor.

4.3.5 H Codes (High Performance Functions)

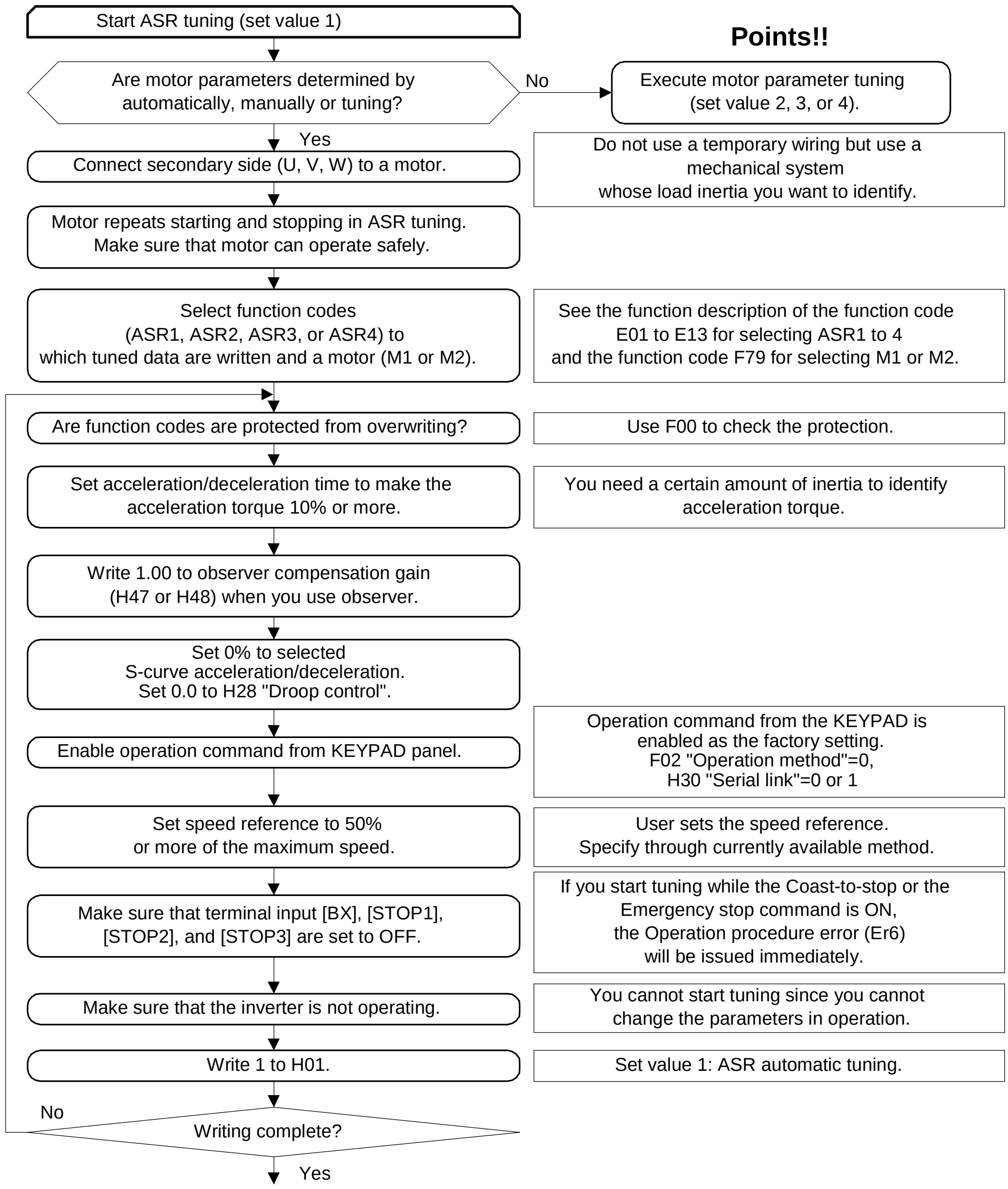
H01 **Tuning operation selection**

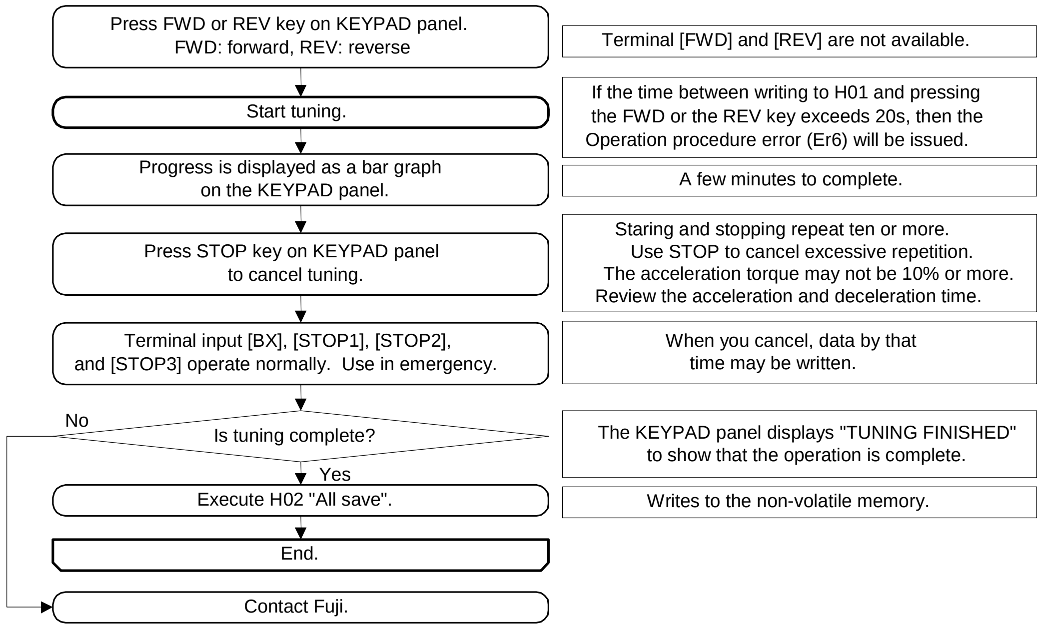
◆Refer to the table below and flowcharts on the following pages to tune correctly.
◆The tuned data are written to the volatile memory (RAM) and are erased when you turn off the power. Make sure to use H02 "All save" to write data into the non-volatile memory after tuning.
◆Execute the ASR automatic tuning specified by the setting "1" after motor parameters are determined (determined by automatically, manually, or tuning).
◆Contact FUJI to tune a synchronous motor.

H01 TUN MODE

<table>
<tr><th>Setting</th><th colspan="2">Tuning description</th><th>Data to be tuned</th><th>Process description</th><th>Application</th></tr>
<tr><td>1</td><td colspan="2">ASR (Speed control system) tuning
(* Execute after motor parameters are fixed)
Not available for V/f control</td><td>Following functions to be selected
ASR-P (Gain)
ASR-I (Constant of integration)
H47, 48: Compensation gain
H49, 50: Integration time
H51, 52: Load inertia</td><td>Measures motor shaft conversion load inertia of a mechanical device (mechanical time constant), calculates optimal gain and constant of integration, and sets them to corresponding function codes</td><td>Execute for a motor integrated into a mechanical system to be tuned for speed control.
Execute especially to obtain the motor shaft conversion mechanical inertia to use observer function of H46 "Observer type selection"</td></tr>
<tr><td>2</td><td rowspan="3">Motor parameter tuning</td><td>R1, Lσ</td><td>When M1 is selected: P06, P07
When M2 is selected: A08, A09
When M3 is selected: A42, A43</td><td>Measures primary resistance (%R1) when the motor is at stopping and leakage reactance (Lσ) when the motor is at rated speed and sets motor parameters (M1, M2, and M3) automatically</td><td>Use when you use a VG standard motor (VG, VG3, VG5, and VG7) and output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.</td></tr>
<tr><td>3</td><td>Motor stopping action</td><td rowspan="2">When M1 is selected: P06 to P25 (P12, P13, and P14 excluded)
When M2 is selected: A08 to A27 (A14, A15, and A16 excluded)
When M3 is selected: A42 to A45</td><td>Measures %R1 and %X when the motor is at stopping as in set value "2". Then, measures and tune exciting current, slip of rated load, magnetic saturation coefficient, induced voltage, secondary time constant, R2 correction coefficient, and exciting current correction coefficient when the motor is at stopping and writes them into corresponding motor parameters (M1, M2, and M3) automatically.</td><td>Execute in advance to drive a non-standard motor or a special-purpose motor whose motor parameters are not available.
Use when a motor you want to drive is integrated into a mechanical system and you cannot disconnect it. Note that the tuning accuracy is a bit inferior to those obtained by the tuning in operation for the set value "4".</td></tr>
<tr><td>4</td><td>Motor rotation action</td><td>Measures %R1 and %X when the motor is at stopping as in set value "2". Then, measures and tune exciting current, slip of rated load, magnetic saturation coefficient, induced voltage, secondary time constant, R2 correction coefficient, and exciting current correction coefficient when the motor is running and writes them into corresponding motor parameters (M1, M2, and M3) automatically.</td><td>Execute in advance to drive a non-standard motor or a special-purpose motor whose motor parameters are not available.
Since you tune parameters while motor is running, make sure that you can drive a motor safely when the motor is disconnected from a mechanical system before you start. The motor operates following the specified acceleration/deceleration times.</td></tr>
</table>

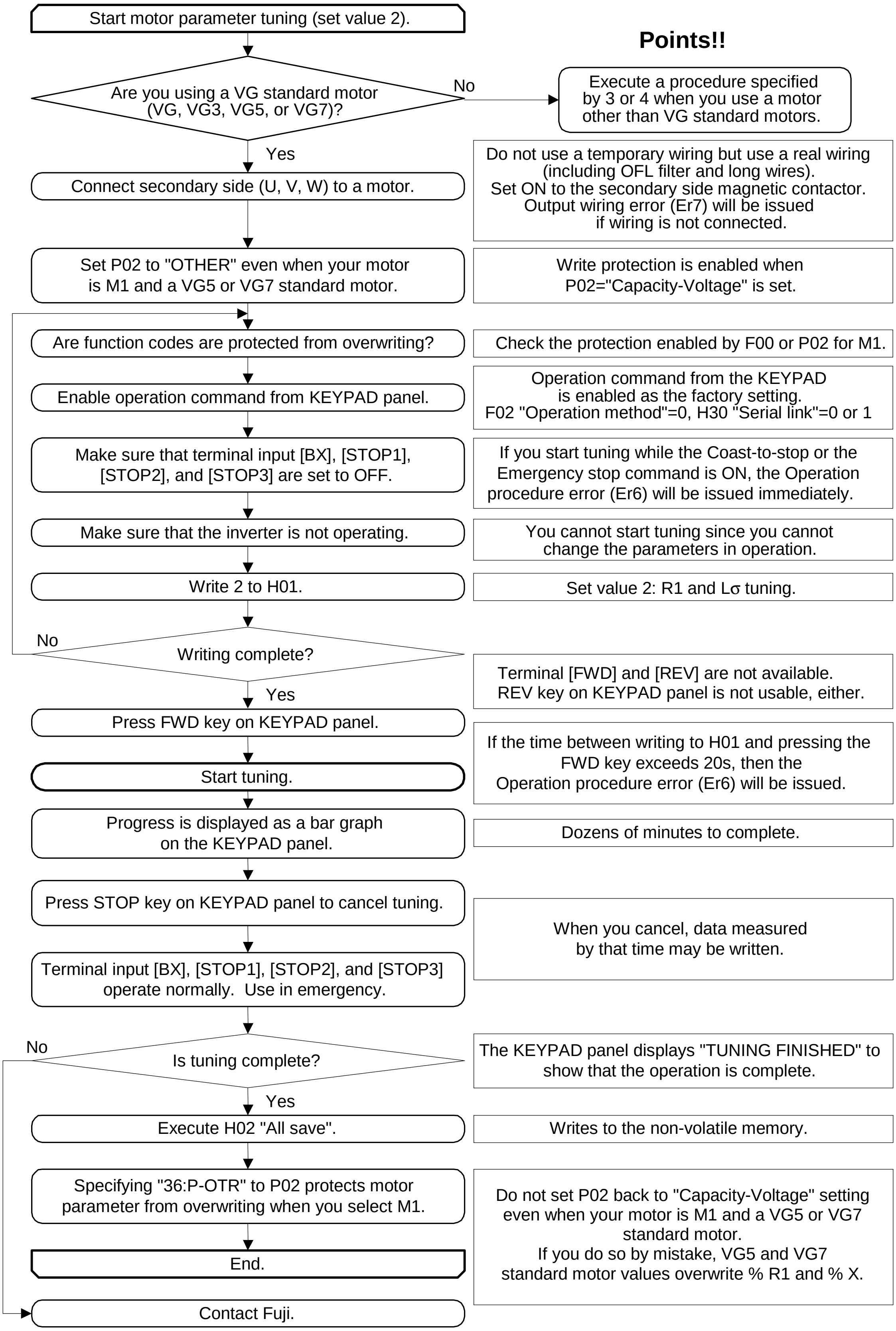
ASR tuning procedure (For set value 1)



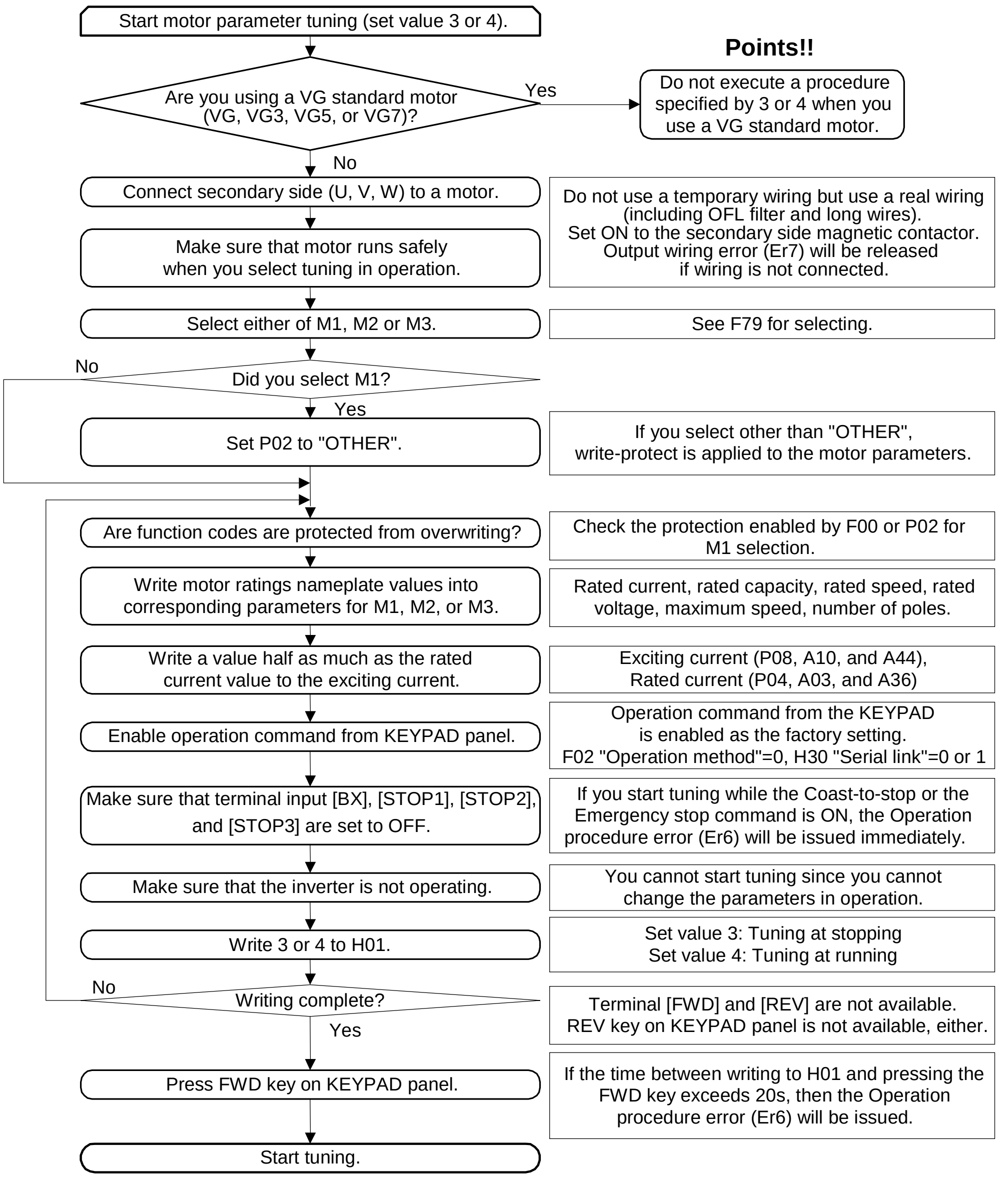

Press FWD or REV key on KEYPAD panel.
FWD: forward, REV: reverse
Terminal [FWD] and [REV] are not available.
Start tuning.
If the time between writing to H01 and pressing the FWD or the REV key exceeds 20s, then the Operation procedure error (Er6) will be issued.
Progress is displayed as a bar graph on the KEYPAD panel.
A few minutes to complete.
Press STOP key on KEYPAD panel to cancel tuning.
Staring and stopping repeat ten or more.
Use STOP to cancel excessive repetition.
The acceleration torque may not be 10% or more.
Review the acceleration and deceleration time.
Terminal input [BX], [STOP1], [STOP2], and [STOP3] operate normally. Use in emergency.
When you cancel, data by that time may be written.
Is tuning complete?
No
Yes
The KEYPAD panel displays "TUNING FINISHED" to show that the operation is complete.
Execute H02 "All save".
Writes to the non-volatile memory.
End.
Contact Fuji.

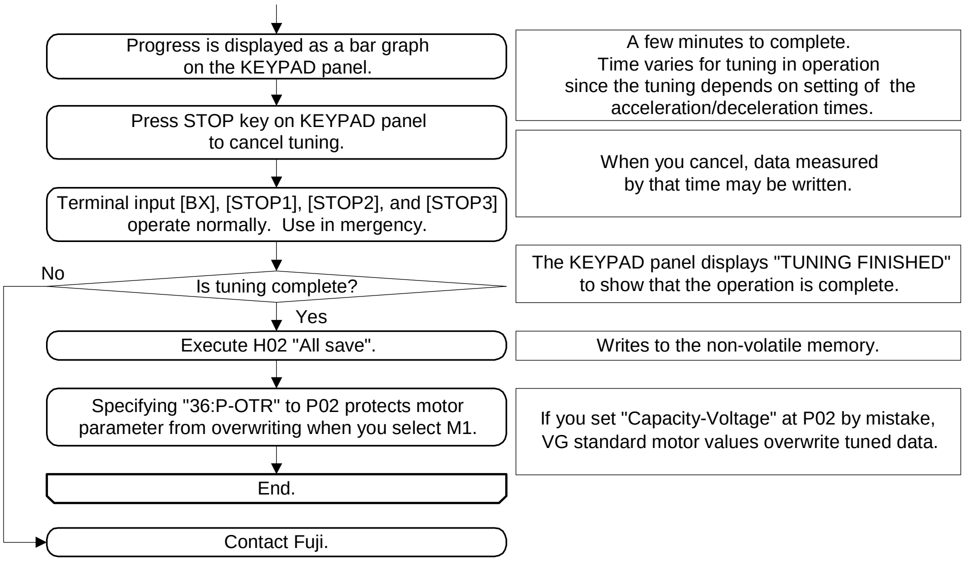
4. Control and Operation

Motor parameters tuning procedure (For set value 2)



Motor parameters tuning procedure (For set value 3, or 4)





⚠ WARNING

- When you set 1 or 4 to the tuning, a motor will run. Make sure that the motor runs safely.

You may be injured.

H02 **All save function**

◆When you execute H01 "Tuning operation" to rewrite the internal data or you rewrite data through the link (RS485 or field bus), the data are written to the volatile memory (RAM) temporarily and the data are erased when you turn off the power. Execute this function when you want to save these data (to write to the non-volatile memory).

◆Set the value 1 and press **STOP** and **∧** keys at the same time to execute. Progress is displayed as a bar graph on the KEYPAD panel and "100%" is indicated when saving is completed.

◆When you use the All save, you may delete previous data.

H	0	2	A	L	L		S	A	V	E		

H03 **Data initializing**

◆Set the value 1 and press **STOP** and **∧** keys at the same time to initialize set values to the factory setting. When the initialization is complete, the set values return to zero automatically. Not all functions execute initialization. See the function code list for more details.

H	0	3	D	A	T	A		I	N	I	T	

H04 **Auto-reset (Number)**

H05 **Auto-reset (Reset interval)**

◆The Auto-reset function cancels the inverter protective function to restart the inverter automatically without alarm and output shut-off after the inverter protective function is activated. These functions set the number of canceling the protective function and the wait time between the activation and the cancellation of the protective function.

H	0	4	A	U	T	O	-	R	E	S	E	T
H	0	5	R	E	S	E	T		I	N	T	

Setting range (number): 0: Auto-reset disabled
1 to 10 [times]
(Wait time) 0.01 to 20.00 [s]

Set H04 "Auto-reset (Number)" to 0 when you do not use the auto-reset function.

◆Inverter protective functions you can reset to restart.

OC: Overcurrent	dBH: Braking resistor overheat
OV: Overvoltage	OL1, 2, 3: Motor 1,2, and 3 overload
OH1: Overheating at heat sink	OLU: Inverter overload
OH3: Inverter internal overheat	

◆When you set 1 to 10 to H04 "Auto-reset (Number)", the auto-reset is activated and inverter start command is automatically directed after a time specified by H05 "Auto-reset (Reset interval)" has passed. If the cause of the alarm does not exist any more, the inverter starts without entering the alarm mode. Otherwise, the protective function is activated again to wait for the time specified by H05 "Auto-reset (Reset interval)". If the cause of the alarm still exists after the inverter restarts specified times by H04 "Auto-reset (Number)", then the inverter enters the alarm mode.

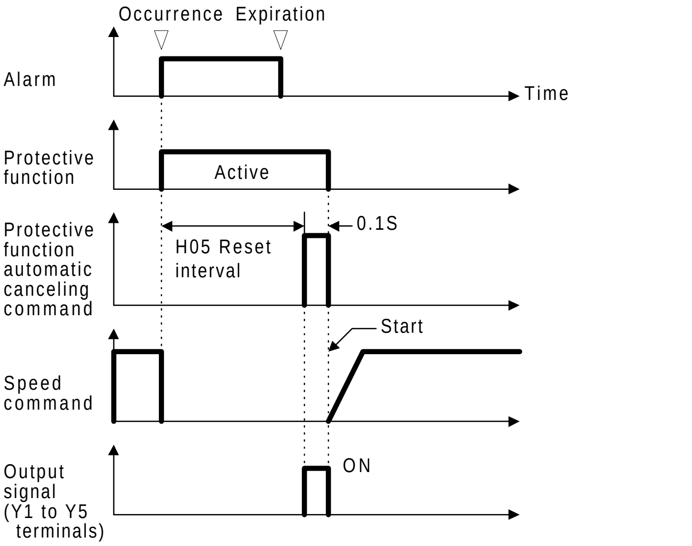
You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the retry operation. Note that if you want to use [Y11] to [Y18], you need the option OPC-VG7-DIOA. You can also use the link to poll M15 to read out the terminal information.

⚠ **WARNING**

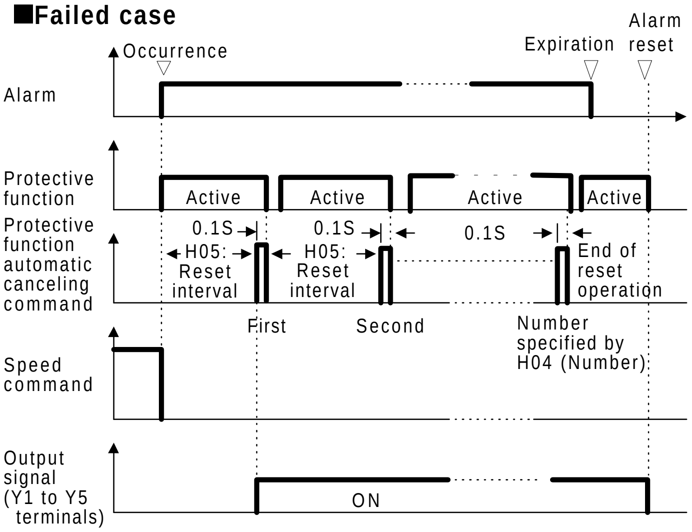
- When you select the restart function, the inverter may restart automatically depending on the cause a trip after the inverter stops due to the trip. You must design your machine such that the machine restarts without causing any danger to persons.

Otherwise the restart may cause accidents.

■**Successful case**



■**Failed case**



H06	Fan stop operation

◆You can select whether to enable automatic ON/OFF operation of the cooling fan by detecting the temperature of the heat sink inside the inverter when the power is supplied to the inverter.
Set value: 0: Fan ON/OFF operation disabled
1: Fan ON/OFF operation enabled

◆You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the cooling fan operation. Note that if you want to use [Y11] to [Y18] , you need the option OPC-VG7-DIOA.

H	0	6	F	A	N		S	T	O	P		

H08 Rev. phase sequence lock

◆You can inhibit the reverse rotation of a mechanical devise that should not do so. This function is not available when you use V/f control.

H	0	8	P	R	T	D	-	I	N	V	T	

Set value: 0: Disabled
1: Enabled

◆Use the function code F76 to F78 "Speed limiter" to inhibit the reverse operation directed by negative [12] input or [REV] input. This function uses torque control to inhibit the reverse operation due to an undershoot in stopping operation.

H09 Start mode (Rotating motor pick up)

◆Restarts a motor smoothly when the motor starts after a momentary power failure or an external force is coasting the motor.
Detects the speed of a motor and supplies the same speed as that of the motor to start. Thus, the motor starts smoothly without presenting any shocks.

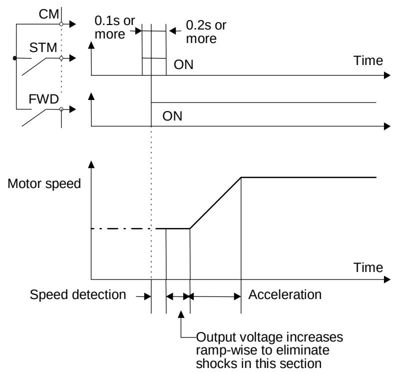
H	0	9	S	T	A	R	T		C	H	A	R

◆Setting range: 0, 1, and 2

Set value	Normal start	Start after momentary power failure
0	Disabled	Disabled
1	Disabled	Enabled
2	Enabled	Enabled

◆Description of the set values
- 1: Enabled when F14 "Restart mode after momentary power failure (Select)" is set to 3, 4, or 5. Also starts the motor at the coasting speed.
- 2: Starts the motor at the detected coasting speed after any start situation including the ON operation command regardless of the occurrence of a momentary power failure.

◆Assign a setting value 26 (Pick up start mode) to either of the terminal from [X1] to [X9] to switch this function externally to apply the function to a normal ON operation command.



H10 Energy-saving operation

◆To reduces the output voltage automatically during constant speed operation with light load to operate at a state where the product of voltage and current (power) is the smallest. This function is not available for V/f control.

H	1	0	A	U	T	O	-	E	N	G	Y	

Set value: 0: Disabled
1: Enabled

H11 Automatic operation OFF function

◆Turns off the operation automatically when the motor speed decreases down under the F37 "Stop speed" while the FWD or REV command is present, or coasts the motor instead of decelerating the motor to stop when the input is set to OFF.

H	1	1	A	U	T	O		O	F	F		

Set value: 0: The motor decelerates to stop when the FWD-CM and the REV-CM are OFF (normal).
1: The motor operation is set to OFF when the speed is F37 under the "Stop speed" while the FWD-CM and the REV-CM are ON.
2: The motor coasts to stop when the FWD-CM and the REV-CM are OFF.

H13 **Auto-restart (Restart time)**

◆Waits for a time specified this function after power recovery and restarts.

H	1	3	R	E	S	T	A	R	T			

Setting range: 0.1 to 5.0 [s]

H14 **Auto-restart (Speed fall rate)**

◆Sets the speed fall rate, i.e. the speed of matching operation, to match the inverter output speed to the motor speed after a momentary power failure and power recovery.

H	1	4	F	A	L	L		R	A	T	E	

Setting range: 1 to 3,600 [r/min/s]

H15 **Auto-restart (Holding DC voltage)**

◆If you select setting 2 (deceleration to a stop on power failure) or 3 (continuous operation) in Restart mode after momentary power failure (F14: Action selection), this function affects them. At both settings, control operation starts when the main circuit DC voltage drops below this setting level.

H	1	5	H	O	L	D		V				

Setting range: 200V: 200 to 300 [V]
400V: 400 to 600 [V]

H16 **Auto-restart (Operation command self-hold setting)**

◆Holds the operation command when the control power supply is maintained in the inverter or until the main circuit DC power supply voltage decreases about to zero (recognized as "momentary power failure") when you specifies 1.

◆Holds the operation command for a time specified by the H17 "Auto-restart (Operation command self-hold time)" when you specifies 0.

H	1	6	S	L	F	H	L	D	-	S	E	L

H17 **Auto-restart (Operation command self-hold time)**

◆When the power to the main power supply and the external control circuit (relay sequence) discontinues on power failure, the operation command given to the inverter becomes OFF in general. This function sets the time to hold the operation command. When the period of a power failure exceeds the self-hold time, the inverter recognizes the power failure here cancels the "restart after momentary power failure" mode and restarts normally on power recovery (you can consider this setting as permissible momentary power failure time).

H	1	7	S	E	L	F	H	O	L	D		

Setting range: 0.0 to 30.0 [s]

H19 **Active drive**

◆Restrains the output torque automatically in vector control for a machine system with a large inertia requiring acceleration for more than 60 seconds and avoid a trip due to overload.

◆Triples the acceleration time automatically in V/f control for a similar machine system mentioned above to avoid trip.

H	1	9	A	C	T	-	D	R	I	V	E	

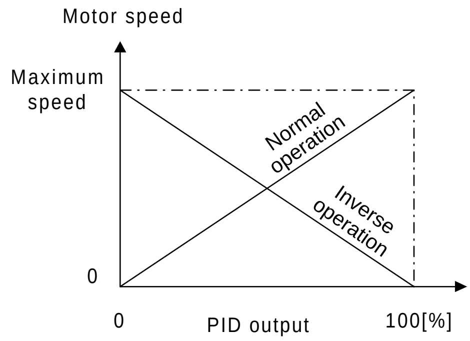
Set value: 0: Disabled
1: Enabled

H20 PID control

◆PID control uses a sensor attached to a subject of control to detect the controlled value (feedback value) and compares it with the reference value (such as speed reference). When there is a deviation between them, the control behaves to decrease the deviation to zero. This is a control to match the feedback value with the reference value.

This control is applied to process control such as dancer control, tension control and extruders.

◆You can select normal or inverse operation for the output of the PID regulator and set increase or decrease to the rotation of a motor receiving the output of the PID regulator.



H	2	0	P	I	D		C	O	M	N	D	

Set value: 0: Disabled
1: Enabled (normal operation)
2: Enabled (inverse operation)

H21 Command selection

◆Select the source of the reference applied to the PID regulator.
Set value: 0: KEYPAD panel or [12] terminal input
1: Analog input Ai [PID-REF]

◆You can assign [PID-FB] to an analog input Ai to specify the feed back value applied to the PID regulator. You cannot specify a feed back value other than this voltage input.

◆You can view the process values of the reference value and the feedback value according to set values of the F52 "Display coefficient A" and F53 "Display coefficient B". See the function description of F52 and F53 for more details.

H	2	1	P	I	D		R	E	F	E	R	

H22 PID control setting (P-gain)

H23 PID control setting (I-gain)

H24 PID control setting (D-gain)

Set the individual constants of PID control.

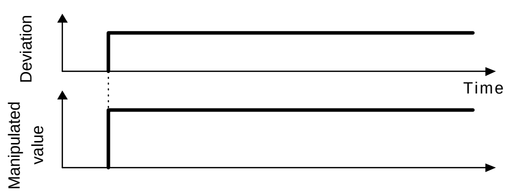
H	2	2	P	-	G	A	I	N				
H	2	3	I	-	G	A	I	N				
H	2	4	D	-	G	A	I	N				

H22 setting range: 0.000 to 10.000 [times]
H23 setting range: 0.00 to 100.00 [s]
H24 setting range: 0.000 to 10.000 [s]

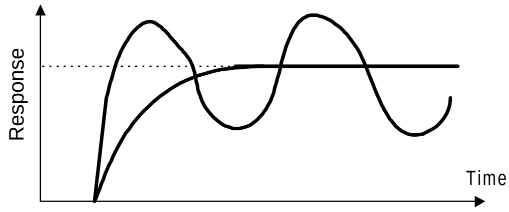
◆You do not use P: Gain, I: Integral time, or D: Differential time individually, but use them by combining them as P control, PI control, PD control, and PID control in general.

◆P control action

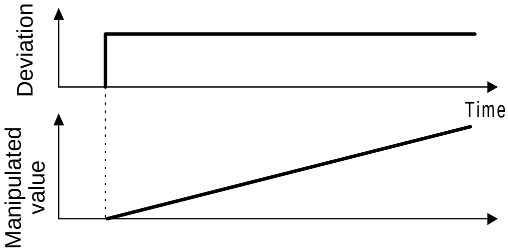
This action is referred to as P control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) and deviation has a linear relation. Thus P control action provides a manipulated value proportional to the deviation. Note that you cannot use only P control action to decrease the deviation to zero.



P: gain is a parameter to define a degree of the response to a deviation. When you set a large gain, you will have a quick response. Too large gain presents an oscillation. Too small gain slows down the response.

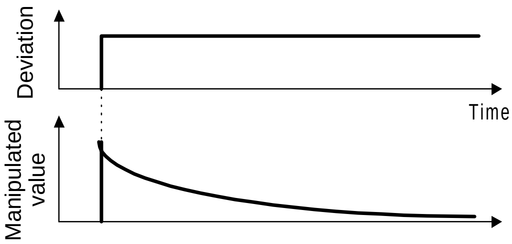


◆I control action
This action is referred to as I control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) changes at a speed in proportion to deviation. Thus, I control action provides an integrated deviation as a manipulated value. I control action behaves to conform the controlled value (feedback value) to the reference value (such as speed reference). However I control cannot responds to a deviation changing quickly.



You can use I: integral time as a parameter to determine the effect of I control action. If you set a large integral time, you will have a slow response. A large integral time also decreases the repulsive force. A small integral time quickens response. However, too small integral time will cause an oscillation.

◆D control action
This action is referred to as D control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) is proportional to differential of deviation. Thus D control action provides a differential of deviation as a manipulated value to respond a quick change.



You can use D: differential time as a parameter to determine the effect of D control action. A large differential time attenuates an oscillation caused by P control action quickly when a deviation occurs. Too large differential time may induce even a larger oscillation. A small differential time decreases attenuation action applied to a deviation.

◆PI control action
When you use only P control action, the deviation still remains. PI control, P control action combined with I control action, is used in general to eliminate this residual deviation. PI control always behaves to eliminate a deviation due to a change of reference or a continual disturbance. However if you increase I control action, the control cannot respond a fast deviation.
You can use only P control action for a load including an integral element.

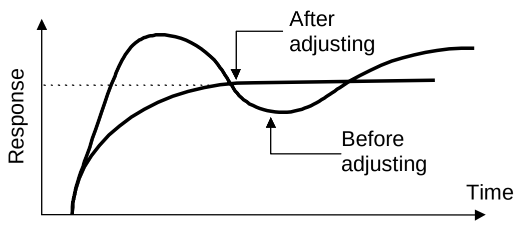
◆PD control action
PD control action generates a larger manipulated value than that of D control action to restrain the increase of the deviation. When the deviation decreases, P control action is restrained.
If a subject of control contains an integral element, sole P control action will present an oscillating response due to the integral element. If this is a case, you can use PD control to attenuate the oscillation caused by sole P control action. You apply this control to a process that does not have self-damping action.

◆PID control action
PID control action combines I control action, which acts to reduce deviation and D control action, which acts to restrain oscillation with P control action. You can obtain a stable response with no deviation.
This control is effective when applied to a load which respond slowly.

◆Adjusting PID setting

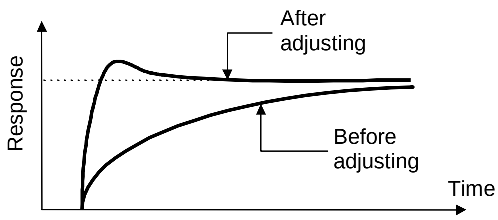
We recommend you to use an oscilloscope to view a response waveform and adjust PID setting. Adjust following the procedure described below.

- Increase H22 "PID control setting (P control action)" (P gain) as long as it does not present an oscillation.
- Decrease H23 "PID control setting (I control action)" (I integral time) as long as it does not present an oscillation.
- Increase H24 "PID control setting (D control action)" (D differential time) as long as it does not present an oscillation.

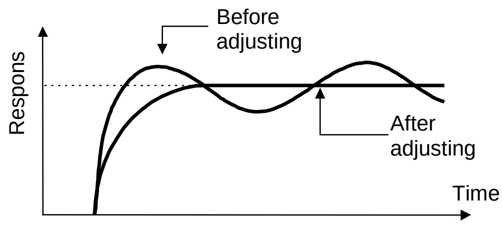


Follow the procedure below to adjust the response waveform.

- To restrict overshoot
  Increase H23 "PID control setting (I control action)" (I integral time). Decrease H24 "PID control setting (D control action)" (D differential time).

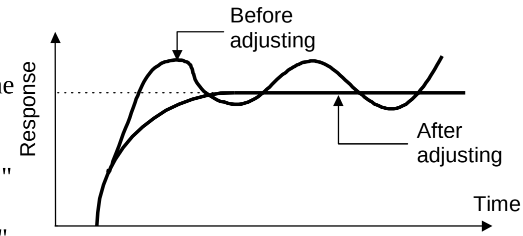


- To stabilize fast (accepting some overshoots.)
  Decrease H23 "PID control setting (I control action)" (I integral time). Increase H24 "PID control setting (D control action)" (D differential time).



- To restrain an oscillation whose cycle is longer than H23 "PID control setting (I control action)" (I integral time).
  Increase H23 "PID control setting (I control action)" (I integral time).

- To restrain a oscillation whose cycle is about the same as the H24 PID control setting (D control action)" (D differential time)
  Decrease H24 "PID control setting (D control action)" (D differential time).
  Decrease H22 "PID control setting (P control action)" (P gain) if you set 0.0 and the oscillation still exists.



H25 **PID control setting (Output upper limit value)**

H26 **PID control setting (Output lower limit value)**

◆Set the upper and lower limiters applied to PID control.

H	2	5	P	I	D		U	P	P	E	R	
H	2	6	P	I	D		L	O	W	E	R	

Setting range: –300 to 300 [%]

H27 **PID control setting (Speed reference selection)**

◆Selects a destination of PID output to be used as a speed reference.

H	2	7	P	I	D		S	P		R	E	F

Setting: 0: Disabled
1: PID
2: Auxiliary speed

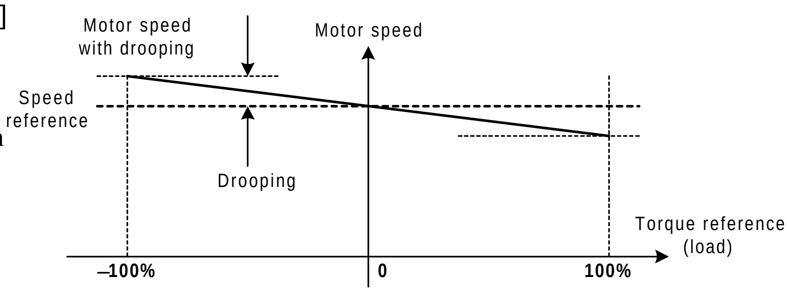
H28 Droop operation

◆When you use multiple motors to drive a single machine, a motor whose speed is higher has to drive a larger load. Droop operation balances load by adding a drooping characteristic to speed. This function is not available for V/f control.

H28 DROOP

Setting range: 0.0 to 25.0 [%]

◆Set a drooping amount at 100% of torque reference. A value set to 100% corresponds to the maximum speed. When the maximum speed is 1,500r/min and the drooping is set to 10%, then the drooping speed is –150.0r/min at 100% of torque reference (load).



H29 Link function protection

◆Protects code data from false writing through different types of communication systems (such as integrated RS485 and field bus).
Set value: 0: Write enabled
1: Write protected

◆You should use H30 "Serial link" to define the write operation to the S area (function codes including operation commands and speed references) separately.

◆When you assign [WE-LINK] to a digital input, you can protect from writing by short-circuiting between [WE-LINK] and [COM].

H29 LINK PROCT

H30 Serial link

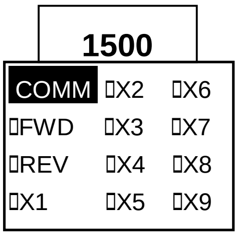
◆Uses different types of communication systems (such as integrated RS485 and field bus) to enable/disable reference data (such as speed reference, position reference, torque reference) and operation commands (FWD and REV). Monitoring (access to M area) is always available. The reference data correspond to S01 to S05 and S08 to S12. The operation commands correspond to the lowest two bits of S06.

◆When you assign [LE] to a digital input, you can connect between [LE] and [CM] to enable the setting by H30 and open to disable operations specified through the link (set to H30=0 regardless of the setting by H30).

H30 LINK FUNC

Set value:

	Monitoring	Reference data	Operation commands (FWD, REV)
0:	Enabled	Disabled	Disabled
1:	Enabled	Enabled	Disabled
2:	Enabled	Disabled	Enabled
3:	Enabled	Enabled	Enabled



You can use the KEYPAD panel to check the operation commands from the link and Di inputs.

H31-H40 RS485 setting

◆Sets different types of specifications for RS485 communication. Specify according to your host device. See "Standerd RS485 interface" for the communication protocol.

- Station address
  Sets the station address of RS485
  Setting range: 0 to 255 (Broad cast: (0: RTU), (99: FUJI)/ address: 1 to 255)

- Action on error occurrence
- Timer operation time
  Specify a procedure when an error occurs and an error handling time.
  Set values
  Procedure: 0: Immediate trip on Er5 (forced stop)
  1: Stop after the timer operation time (H33) initiated by an error, then trip on Er5
  2: Stop after a continued transmission error over the timer operation time (H33), then trip on Er5.
  3: Continued operation
  Timer operation time: 0.01 to 20.00 [s]

- Transmission rate
  Specifies transmission rate.
  Set value: 0: 38,400 [bps]
  1: 19,200 [bps]
  2: 9,600 [bps]
  3: 4,800 [bps]
  4: 2,400 [bps]

- Data length
  Specifies data length.
  Set value: 0: 8 [bit]
  1: 7 [bit]
  (fixed to 8 bit for SX protocol)

- Parity bit
  Specifies parity bit.
  Set value: 0: None
  1: Even parity
  2: Odd parity
  (fixed to even parity for SX protocol)

- Stop bit
  Specifies stop bit.
  Set value: 0: 2 [bit]
  1: 1 [bit]
  (fixed to 1bit for SX protocol)

- Continued communication disconnected time
  Specifies a time to wait to provide a trip signal (Er5) after detecting discontinued access due to disconnection during operation through RS485 in a system where the station is always accessed in a certain period.
  Setting range: 0: Detection disabled
  0.1 to 60.0 [s]

- Interval time
  Specifies a time between the completion of receiving a request from a host device (personal computer or PLC) and the start of responding to the request.
  Setting range: 0.00 to 1.00 [s]

- Protocol selection
  Specifies a communication protocol.
  Set value: 0: FUJI general-purpose inverter protocol
  1: SX bus protocol (loader protocol)
  2: Modbus RTU protocol
  Set 1 to connect to VG7S support loader.
  Set 0 to control FUJI general-purpose inverters and VG7S inverters connected through the common RS485 communication.
  Modbus RTU is a communication protocol defined by Modicon company.

H41 | **Torque reference selection**

◆Selects an element with which you provide the torque reference. See the control block diagram for more details.

H	4	1	T	-	R	E	F		S	E	L	

Setting value: 0: Internal ASR data
1: Ai input [T-REF]
2: DIA card
3: DIB card
4: Link (S02)
5: PID output

◆Use also the speed limiter setting (F76 to F78) when you use the torque reference.

H42 | **Torque current reference selection**

◆Selects an element with which you provide the torque current reference. See the control block diagram for more details.

H	4	2	I	T		R	E	F		S	E	L

Setting value: 0: Internal ASR data
1: Ai input [IT-REF]
2: DIA card
3: DIB card
4: Link (S03)

◆Use also the speed limiter setting (F76 to F78) when you use the torque current reference.

⚠ WARNING
• Make sure to use the speed limiter in cooperation with the torque reference or the torque current reference. You can avoid the motor overrun. **Accidents or physical injuries may occur otherwise.**

H43 | **Magnetic-flux reference selection**

◆Selects an element with which you provide the magnetic-flux reference.

H	4	3	M		R	E	F		S	E	L	

Setting value: 0: Internal calculated value
1: Ai input [MF-REF]
2: Function code H44
3: Link (S04)

H44 | **Magnetic-flux reference value**

◆Specifies magnetic-flux reference value. This function becomes available when you set 2 to H43.

H	4	4	M		R	E	F					

Setting range: 10 to 100 [%]

H46	Observer type selection

◆Specifies an inertia of a mechanical system or uses the ASR tuning to measure the inertia, operates an internal machine model in the inverter, estimates a load torque that becomes a disturbance element or a oscillation element, adds a value to the torque reference to counteract the load torque to increase the speed response against a load disturbance and to damp an oscillation generated by the mechanical resonance quickly. This function selects load disturbance observer or oscillation suppressing observer.

H	4	6	O	B	S		M	O	D	E		

Set value: 0: Disabled
1: Load disturbance observer
2: Oscillation suppressing observer

Note: When a load inertia specified by H51 or H52 has a large error, you cannot obtain an expected performance. Specify an accurate value.

H47,48	Observer setting (M1, M2 compensation gain)
H49,50	Observer setting (M1, M2 integral time)
H51,52	Observer setting (M1,M2 load inertia)

◆Specifies the compensation gain, the integral time, and the load inertia for the observer function.

H	4	7	O	B	S	-	P	1				
H	4	8	O	B	S	-	P	2				
H	4	9	O	B	S	-	I	1				
H	5	0	O	B	S	-	I	2				
H	5	1	M	1	-	I	N	E	R	T	I	A
H	5	2	M	2	-	I	N	E	R	T	I	A

H47, H48 setting range: 0.00 to 1.00 [times]
H49, H50 setting range: 0.005 to 1.000 [s]
H51, H52 setting range: 0.001 to 50.000 [$kg \cdot m^2$]

◆Specify a load inertia of motor shaft conversion in $kg \cdot m^2$. You can also use ASR tuning by H01 "Tuning operation selection" to measure the inertia.

H53	Line speed feedback selection

◆You can select an element for the speed feedback.

H	5	3	N	-	F	B		S	E	L		

Set value: 0: Line speed disabled (integrated PG enabled)
1: Analog line speed detection [LINE-N]
2: Digital line speed detection (optional OPC-VG7-PG (LD))
3: High selector (select the higher speed between the motor speed or line speed)

◆About High selector

When you conduct a line speed control, and a line PG fails and presents a speed feedback of 0r/min, the inverter provides a reference corresponding the maximum torque (torque limiter value if you use it) to accelerate the motor to the maximum speed to follow up the speed reference. To change the feedback input from the line PG to a motor PG to prevent overrun when the line PG is disconnected is referred as "High selector". Make sure to use this High selector when you do not have a protective mean to detect the PG disconnection for line speed control.

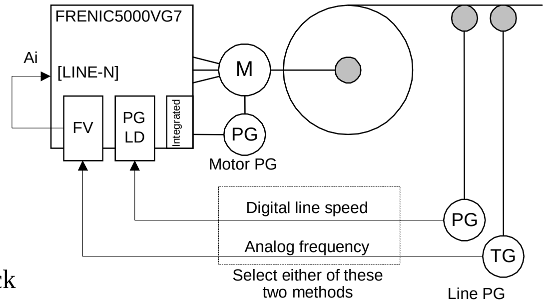
Note: When you use a motor PG and the optional OPC-VG7-PG (LD), a protective function of "PG disconnection alarm" becomes available.

<Application example of line speed control>

The right figure illustrates an example of line speed control with PG.

When the line PG output is analog frequency, then use the FUJI FV card (MCA, OPC-VG7-FV) to convert the analog frequency into voltage to supply the voltage output to Ai [LINE-N]. Also specifies H53 as High selector.

When the line PG output is digital pulse, then use FUJI PG card (OPC-VG7-PG(LD)). See also the description of o06, o07, and o08 and the control block diagram.



H55 Zero speed control (Gain)

H56 Zero speed control (Completion range)

◆Specifies the gain of the servo locking command and the range of completion to provide the servo locking completion signal. See the section of [LOCK] of the function code E01 to E13 "X function selection".

H	5	5	Z	E	R	O	-	G	A	I	N	
H	5	6	Z	E	R	O	-	H	I	S	S	

H55 setting range: 0 to 100 [times]
H56 setting range: 0 to 100 [pulse]

H57 Overvoltage suppressing function

◆When the DC link circuit voltage exceeds the overvoltage protection level during braking operation, the overvoltage (OV) trip occurs. This function limits the braking torque to zero before the overvoltage trip during the braking operation. The link circuit voltage decreases after 0 limiting, and the brake torque recovers automatically. This operation repeats to restrain the overvoltage trip.

◆You can use only inverter loss energy to apply brake without braking devices (braking resistor and PWM converter). When you want to use this function, see also "Power limiter" of the function code F40 to F45 "Torque limiter".

H	5	7	O	U		P	R	E	V	E	N	T

Set value 0: Disabled
1: Enabled

H58 Overcurrent suppressing function

◆The overcurrent trip occurs when the motor current changes suddenly to become more than the protection level. The overcurrent suppressing function restrains the inverter from supplying a current more than the protection level when the load changes.

H	5	8	O	C		P	R	E	V	E	N	T

Set value 0: Disabled
1: Enabled

Note: The output torque may decrease under the overcurrent suppressing condition.

H60-H66 **Load adaptive control function**

◆When you use a crane to wind up a heavy baggage, if the acceleration torque lacks compared with the speed reference, the speed of the baggage cannot follow the reference. The deviation between the reference and the actual values may become excessive to activate the speed disagreement alarm (Er9). If you do not limit the torque, the inverter continues to provide the maximum torque and the inverter overload and the motor overload protections may be activated when the overload is frequent. Though you should specify longer acceleration and deceleration times to avoid activating these protective functions, the longer acceleration and deceleration times are inefficient for lighter loads.

◆This function limits the speed reference automatically based on the load of a baggage, acceleration/deceleration torque, and the mechanical loss. You can operate the motor at the speed reference when the load is light and at the limited speed when the load is heavy.

◆Contact FUJI for the details of this function.

H68 **Trip data delete**

◆Deletes the alarm history and the alarm information maintained in the inverter completely. The corresponding functions are the KEYPAD panel alarm information, the alarm history and the source of alarms.

◆Specify 1 and press the **STOP** and the **∧** keys simultaneously to execute the function. The data returns to 0 automatically.

H	6	8	T	R	I	P		D	A	T	A	

Setting range: 0 to 1

H70 **Reserved 1**

◆Selects function codes to be displayed on the KEYPAD panel.

Set value: 0: Standard
1: Elevators
2-9999: Reserved

◆When you select 1: Elevators, you will view the functions required for vertical transfer.

H	7	0	M	A	K	E	R	1				

H71 **Reserved 2**

H72 **Reserved 3**

H73 **Reserved 4**

◆These functions are reserved for makers to adjust the inverter.

H	7	1	M	A	K	E	R	2				
H	7	2	M	A	K	E	R	3				
H	7	3	M	A	K	E	R	4				

4.3.6 A Codes (Alternative Motor Parameters)

The A codes are motor parameters that become available when you select the motor M2 or M3 (second or third motor). See the P codes when you use the M1.

A01 - A34 **Codes for the second motor**

1500
□PARA 1 □M1
□PARA 2 ■M2
□PARA 3 □M3
□PARA 4 □JOG

You can use the function code F79 and the terminal input signal [M-CH2] and [M-CH3] to select the M2.
See the individual descriptions and make sure that the M2 is selected. You can use the "I/O check" screen of the KEYPAD panel as shown in the right figure.
■ indicates "selected". Check if ■ M2 is indicated.

◆The function description is omitted since the A codes are the same as the P codes in terms of function.
◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used.

Function code for motor 2	FUJI motors		Other motors
	Standard motors for VG7S, VG5, VG3 and VG	FUJI motors	
A01 M2 control method	0: Vector control	Select depending on with or without PG. With encoder: 0, vector control Without encoder: 1, sensorless control	
A02 M2 rated capacity	Set the data described in the Chapter 14 "Replacement data" manually. Do not use H01 "Tuning operation selection".	Set the ratings nameplate data provided on the motor manually.	
A03 M2 rated current			
A04 M2 rated voltage			
A05 M2 rated speed			
A06 M2 maximum speed			
A07 M2 pole number		Use H01 "Tuning operation selection" to tune motor parameters. See the function description of H01 for more details.	
A08 M2-%R1			
A09 M2-%X			
A10 M2 exciting current			
A11 M2 torque current			
A12,13 M2 slip on driving, braking			
A14-16 M2 iron loss coefficient 1-3		Preserve the initial value. Not available for tuning.	
A17-21 M2 magnetic saturation coefficient 1-5			
A22 M2 secondary time constant			
A23 M2 induced voltage coefficient			
A24-26 M2-R2 correction coefficient 1-3			
A27 M2 exciting current correction coefficient			
A28, 29 M2-ACR-P, I (Gain, Constant of integration)		Preserve the initial value.	
A30 M2-PG pulse number	Select pulse number of PG to be used. Not effective during sensorless control.		
A31 M2 thermistor selection	1: NTC thermistor	See F10 for details on motor protection.	
A32 M2 electronic thermal overload relay (Select)	0: Disabled (VG standard motor)		
H01 Tuning operation selection	Motor parameter tuning not required. Procedure above sets optimal data automatically. Select 2 for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.	Motor parameter turning required. Tune while wires are installed. See function description of function code H01.	
H02 All save function	Execute "all save" operation after using H01 to tune. This operation writes tuned data to non-volatile memory. Not necessary when you did not tune parameters.		

Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

A35-A50 Codes for the third motor (for V/f control)

◆Motor parameters dedicated for the V/f control.
◆These parameters become available when you use the function F79 "Motor selection" and X functions to select the motor 3.
◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used.

Function code for motor 3	FUJI motors		Other motors
	Standard motors for VG7S, VG5, VG3 and VG	FUJI motors	
A35 M3 rated capacity	Set the data described in the Chapter 14 "Replacement data" manually. Do not use H01 "Tuning operation selection".	Set the ratings nameplate plate data provided on the motor manually.	
A36 M3 rated current			
A37 M3 rated voltage			
A38 M3 maximum output voltage			
A39 M3 rated speed			
A40 M3 maximum speed			
A41 M3 pole number		Use H01 "Tuning operation selection" to tune motor parameters. See the function description of H01 for more details.	
A42 M3-%R1			
A43 M3-%X			
A44 M3 exciting current			
A45 M3 slip compensation value			
A47 M3 thermistor selection	1: NTC thermistor	See F10 for details on motor protection.	
A48 M3 electronic thermal overload relay (Select)	0: Disabled (VG standard motor)		
H01 Tuning operation selection	Motor parameter tuning not required. Procedure above sets optimal data automatically. Select 2 for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.	Motor parameter tuning required. Tune while wires are installed. See function description of function code H01.	
H02 All save function	Execute "all save" operation after using H01 to tune. This operation writes tuned data to non-volatile memory. Not necessary when you did not tune parameters.		

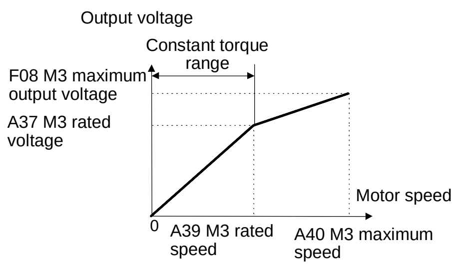
Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

A37 M3 rated voltage
A38 M3 maximum output voltage
A39 M3 rated speed
A40 M3 maximum speed

◆Specifies the maximum speed of the motor 3 that the inverter provides. The maximum output frequency for V/f control is 400Hz. Set the maximum speed determined by the pole number of the motor.

A	3	7	M	3	-	V	r					
A	3	8	M	3	-	V	m	a	x			
A	3	9	M	3	-	N	r					
A	4	0	M	3	-	N	m	a	x			

A37, A38 setting range: 80 to 999 [V]
A39, A40 setting range: 50 to 24,000 [r/min]



You may damage a motor or machines when you set a value higher than the rating of the driven devices. Set according to the devices.

A45 **M3 slip compensation value**

◆A change in the load torque will change the motor slip, resulting in the motor speed change. The slip compensation control adds a frequency proportional to the motor torque to the inverter output frequency and reduces the fluctuation of the motor speed due to torque change.

A	4	5	M	3	-	S	L	I	P	d		

Setting range: –20.000 to 5.000 [Hz]

◆You can use the following equation to obtain the slip compensation value.

$$\text{Slip compensation value} = \text{Base frequency} \times \frac{\text{Slip[r/min]}}{\text{Synchronous speed[r/min]}} \text{ [Hz]}$$

Slip = Synchronous speed - Rated speed

A46 **M3 torque boost**

◆This function is dedicated to V/f control of the motor 3. The following selections are available.

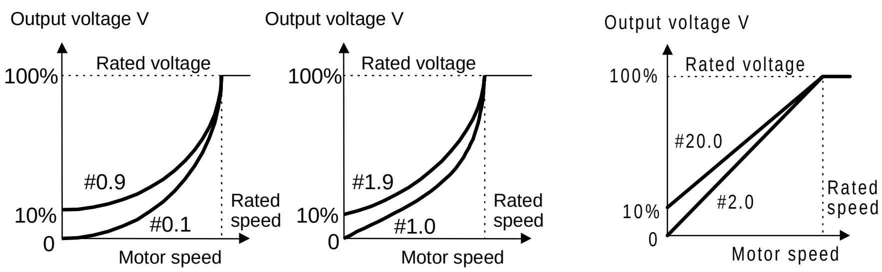
A	4	6	M	3	-	B	O	O	S	T		

- Selection of load characteristic from automatic torque boost, variable torque load, proportional torque load, and constant torque load.
- Compensating insufficient magnetic-flex of a motor due to the voltage decrease in low frequency range and boosting torque at low speed operation (boosting V/f characteristic).

Setting range	Description
0.0	Automatic torque boost characteristic to adjust torque boost value automatically for constant torque load changing linearly
0.1 to 0.9	Variable torque characteristic for fan/pump load
1.0 to 1.9	Linear torque characteristic for a load that has a middle characteristic between variable torque and constant torque characteristics
2.0 to 20.0	Constant torque characteristic changing linearly

◆Torque characteristic

<Variable torque characteristic> <Proportional torque characteristic> <Constant torque characteristic>



Note: Increasing torque boost value will present over-excited state at low speed in all characteristics. Continued operation may cause motor overheat. Review the characteristic of a motor to be driven.

4.3.7 O Codes (Optional Functions)

OPC-VG7-DIA, DIB

Use this option to specify the digital speed reference, torque limiter value, torque reference, and torque current reference. When you install two option cards, you use hardware switches to distinguish them as DIA and DIB. See the control option section for more details.

o01 **DIA function selection**

o02 **DIB function selection**

◆Select the data format for the digital speed reference, torque limiter value, torque reference, and torque current reference.

o	0	1	D	I	A		F	U	N	C		
o	0	2	D	I	B		F	U	N	C		

1) See the function description of the function code F01 "Speed setting N1" to use for the speed reference.
2) See the function description of the function code F42 "Torque limiter value selection" to use for the torque limiter value.
3) See the function description of the function code H41 "Torque reference selection" to use for the torque reference.
4) See the function description of the function code H42 "Torque current reference selection" to use for the torque current reference.

Set value: 0: Binary
1: BCD

o03 **DIA BCD input setting**

o04 **DIB BCD input setting**

◆Specify BCD data for setting the maximum speed of DIA and DIB inputs. Use when you want to enter "machine operation speed" directly to specify input data.

o	0	3	B	C	D		C	M	D		A	
o	0	4	B	C	D		C	M	D		B	

Setting range: 99 to 7,999

OPC-VG7-PG

Use this option for the following applications.
1) Set the switch to PD to use the PG signal of the 5V line driver for pulse calculation to detect position.
2) Set the switch to LD to detect the line speed.
3) Set the switch to PR to use for pulse train synchronized operation and position control (orientation).
4) Set the switch to SD to use the PG signal of the 5V line driver for speed detection of VG7S.

o05 **Feedback pulse selection**

◆Switches the source of the position detection signal between the integrated PG and the optional PG. Use for synchronized operation and the position control for orientation control.

o	0	5	P	L	S		F	E	D		S	L

Set value: 0: Integrated PG (15, 12V complementary output)
1: PG (PD) option (5V line driver output)

o06	Digital line speed detection definition (PG pulse number)
o07	Digital line speed detection definition (Detected pulse correction 1)
o08	Digital line speed detection definition (Detected pulse correction 2)

◆Specify to use the PG (LD) option for line speed control. A PG disconnection activates a protective function (PG alarm).

◆The pulse correction is for speed detection. Speed=(Correction 1/Correction 2)×Input pulse

o	0	6	L	S	-	P	G		D	E	F	
o	0	7	L	S	-	P	G		C	P	1	
o	0	8	L	S	-	P	G		C	P	2	

o06 setting range: 100 to 60,000 [P/R]

o07, o08 setting range: 0 to 9,999

o12	Reference pulse selection

◆Select a pulse output source from the PG (PR) option and internal speed data.

o	1	2	P	L	S		R	E	F		S	L

Set value: 0: PG (PR) option

1: Internal speed reference

◆See the 4.2.5 Block diagram fore more details.

o13	Pulse train input form selection

◆Select the input form of the signal supplied to the PG (PR) option.

o	1	3	P	L	S		S	T	A	T	E	

Set value: 0: 90° phase difference between phase A and phase B.

1: Phase A: Reference pulse, Phase B: Reference code (sign)

2: Phase A: Forward pulse, Phase B: Reverse pulse

o14	Reference pulse correction 1
o15	Reference pulse correction 2

◆Set when you install the PG (PR) option card to conduct synchronized operation. You can change the position reference data entered into the pulse train card to change the speed ratio between the master motor and the slave motor.

o	1	4	P	L	S		C	O	R	R		1
o	1	5	P	L	S		C	O	R	R		2

Setting range: 0 to 9,999

◆Internal data=Input pulse× (Pulse correction 1/Pulse correction 2)

o16	APR gain

◆You can specify a data to improve the position control response in pulse train operation. You can also reduce the steady-state deviation in the steady-state operation. Since too large setting may present a motor hunting, increase gradually from a small value to adjust.

o	1	6	A	P	R	-	P	-	G	A	I	N

Setting range: 0.0 to 999.9 [times]

o17 F/F gain

◆The setting can reduce the steady-state deviation. The setting of 1.0 provides the smallest deviation. You do not have to change from 0.0 in general.

o	1	7	F	/	F		G	A	I	N		

Setting range: 0.0 to 1.5 [times]

o18 Deviation excess range

◆When the difference (deviation) between the internal position reference and the amount of the motor rotation exceeds this setting, the inverter issues the "Excessive position deviation alarm".

o	1	8	D	E	V		O	V	E	R		W

Setting range: 0 to 65,535 [pulse]

o19 Deviation zero range

◆When the current position of the motor comes into this range of a reference position, the inverter provides the "zero deviation" signal. You can use the zero deviation signal to detect that the motor locates almost at the target position. The inverter provides the zero deviation signal on the DO to which you can assign a function.

o	1	9	D	E	V		Z	E	R	O		W

Setting range: 0 to 1,000 [pulse]

OPC-VG7-PMPG

You can use this option to detect the magnetic pole position and the speed and to drive a synchronous motor.

o09 ABS signal input definition

◆Defines the input signal when you install a PG card to drive a synchronous motor.

o	0	9	A	B	S		D	E	F	I	N	T

Set value: 0 to 16

o10 Magnetic pole position offset

◆Specifies an offset value relative to the magnetic pole position detected by the PG.

o	1	0	S	M	-	O	F	F	S	E	T	

Set value: 0000 to 03FF

o11 Salient pole ratio (%Xq/%Xd)

◆Set the difference in reactance due to the difference in magnetic resistance on the q axis and the d axis in terms of the ratio of the q axis value/d axis value.

o	1	1	S	A	L	I	E	N	T		R	T

Setting range: 1.000 to 3.000

OPC-VG7-TL

You can use this option to conduct operate, to refer to and change the function codes, and monitor operation from the MICREX-F and SX series PLC. You cannot install other filed bus options (SX, field bus) at the same time. See the section of the control options for more details.

o30 Action on communication error

◆Specifies an action on error in the T-Link communication.

`o30 MODE ON ER`

Set value: 0: Immediate trip on a communication error

1: Stop after a time specified by o31 "Action time on communication error" initiated by a communication error, then trip

2: Stop after a continued communication error for a time specified by o31 "Action time on communication error", then trip.

3: Continued operation even on a communication error
(Removal of the error cause will recover the operation through communication automatically.)

o31 Action time on communication error

◆Specifies a time for a continued T-Link communication error.

`o31 TIMER TL`

Setting range: 0.01 to 20.00 [s]

o32 Communication format

◆Specifies the number of data transmitted over the T-Link.

`o32 4W/8W SEL`

Setting range: 0: 4 words+4 words

1: 8 words+8 words

OPC-VG7-SI

You can use this option in the following two ways according to the setting of the hardware switch.

1) SI (MWS): Use as multiwinding system

2) SI (UPAC): Use as inter-inverter link option of the UPAC

o33 Multiwinding system

◆Specifies whether to use the SI option as a multiwinding system. When you set this parameter to disabled, then you can use this option for single motor operation. See also the canceling multiwinding motor control of E01 to E13 "X function selection".

`o33 MWS ACTVE`

Set value: 0: Disabled (single motor operation)

1: Multiwinding system

o34 Multiwinding system slave station number

◆Specifies the number of slave stations for the multiwinding system.

`o34 MWS SLAVES`

Setting range: 1 to 5

OPC-VG7-UPAC

You can use this option to create a program and to operate the VG7S with the program. See the description of the UPAC of the control options.

o38 **UPAC start/stop**

◆Specifies to start/stop the UPAC option.

o	3	8	U	P	A	C		A	C	T		

Set value: 0: Stop UPAC
1: Start UPAC
2: Start UPAC (with initialization)

o39 **UPAC memory mode**

◆Specifies to clear/to reserve the individual memory areas when you switch the UPAC from start to stop.

o	3	9	U	P	A	C		M	E	M	O	R

Setting range: 0000 to 001 [F]
bit1: IQ area
bit2: M area
bit3: RM area
bit4: FM area
bit5: SFM area

o40 **UPAC Address**

◆Set the address of the UPAC when you access the UPAC from a personal computer through RS485 communication.

o	4	0	U	P	A	C		A	D	R	E	S

Setting range: 100 to 255

o41 **UPAC system slave station number**

◆Set the number of slave inverters when you link multiple inverters with SI or RS option assigning an inverter with the UPAC as a master.

o	4	1	U	P	A	C		S	T	A	T	N

Setting range: 0 to 11

4.3.8 L Codes

L01	Password data 1
L02	Password data 2

⚠ CAUTION
• Handle the password with care. If you set the password by mistake, you cannot refer to or change the function code. The person who is responsible for specifying the password must manage the password carefully.

◆You can specify an 8-digit password by combining L01 and L02. You can use the password to restrict the change and the reference to the function codes. When you specify a non-zero value to either L01 or L02, the restriction by password will become effective.

L	0	1	P	A	S	S	W	O	R	D	1	
L	0	2	P	A	S	S	W	O	R	D	2	

Setting range: 0 to 9,999

(1) Setting password

When you set non-zero data to L01 or L02 and open the program menu, you will not view "1. Set data" and "2. Check data", but "3. Operation monitor". and the rest. See the figure right below.

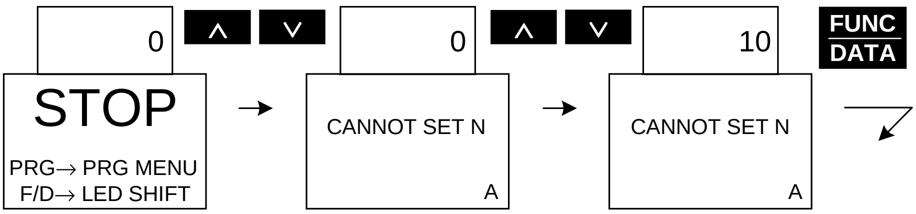
Usual program menu screen
(password is not specified or is disabled)

1. Set data
2. Check data
3. Operation monitor
4. I/O check
5. Maintenance info
6. Measure load factor
7. Alarm info
8. Cause

Program menu screen
when password is enabled

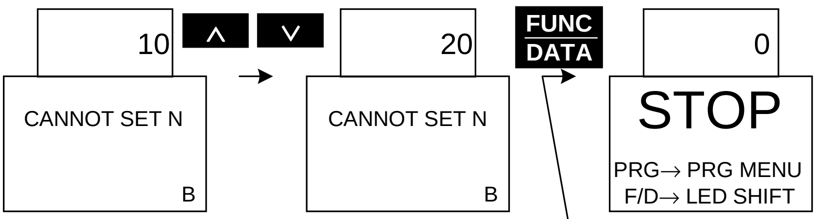
3. Operation monitor
4. I/O check
5. Maintenance info
6. Measure load factor
7. Alarm info
8. Cause

(2) To disable password (ex. password: L01=10, L02=20)



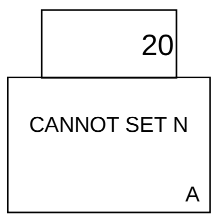
Press ∧ or ∨ key once on the operation mode screen, "A" is displayed at the lower right corner on the LCD monitor.

Set the LED monitor to the password data set to L01 and press FUNC/DATA.



When "B" is displayed at the lower right corner on the LCD monitor, set the LED monitor to the password data set to L02 and press FUNC/DATA.

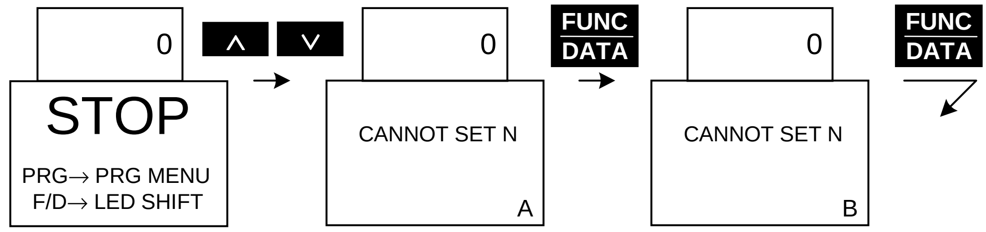
The display will return to the operation monitor screen, if the data entered at "A" conforms to the password data set by L01 and the data entered at "B" conforms to the password data set by L02. You will view the following screen if the data do not conform to the data.



You will see this screen if the data entered at "A" and/or "B" are wrong.

Note: Canceling password described above will become ineffective after you turn off the inverter.

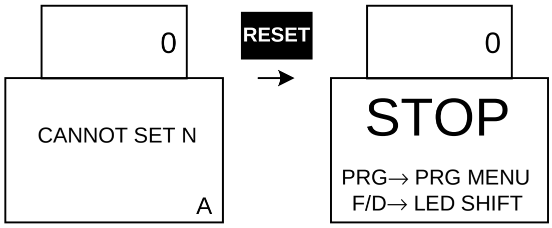
(3) To enable password again after disabled



Press ∧ or ∨ key once on the operation mode screen, "A" is displayed at the lower right corner on the LCD monitor.

Check if "0" appears on the LED monitor and press FUNC/DATA.

Check if "0" appears on the LED monitor and press FUNC/DATA.



Press RESET when "A" is displayed again at the lower right corner on the LCD monitor.

L03 **Elevator rated speed**

◆This function code is necessary to calculate the estimated travel distance on deceleration.

L03 LIFT-MAX

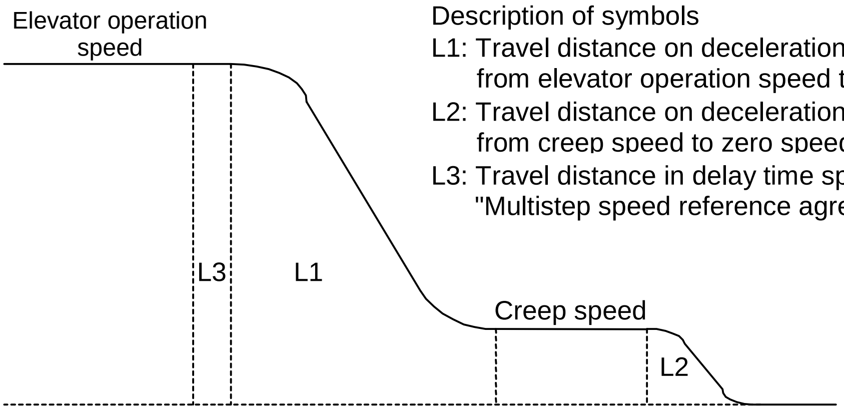
Setting range: 0.0 to 999.9 [m/min]

About the estimated travel distance on deceleration

◆You can display an estimated travel distance from the deceleration start point to the stopping point to check the consistency of the decelerating pattern.

◆The estimated travel distance on deceleration is an addition of travel distance on deceleration from the elevator operation speed to the creep speed and that from the creep speed to the zero speed and does not include the travel distance by the constant operation at the creep speed (L1+L2+L3 in the graph below).

[Operation pattern]



Description of symbols
L1: Travel distance on deceleration from elevator operation speed to creep speed
L2: Travel distance on deceleration from creep speed to zero speed
L3: Travel distance in delay time specified by C20 "Multistep speed reference agreement timer"

◆The estimated travel distance on deceleration appears on the "Option monitor 1, 2" on the LED monitor of the KEYPAD panel.

◆This function is effective when L04=1 or 2.
Option monitor 1: Travel distance from the operation speed 1 after deceleration operation.
Option monitor 2: Travel distance from the operation speed 2 after deceleration operation.

◆Function data codes used for the estimated travel distance on deceleration.

Description	L04=1		L04=2	
	Code	Name	Code	Name
Elevator rated speed	L03	Elevator rated speed	←	←
Operation speed 1	C09	Multistep speed 5	←	←
Operation speed 2	C11	Multistep speed 7	C10	Multistep speed 6
Creep speed	C07	Multistep speed 3	←	←
Deceleration time from operation speed 1	F08	Deceleration time 1	←	←
Deceleration time from operation speed 2	C47	Deceleration time 2	←	←
Deceleration time from creep speed	C36	Deceleration time JOG	←	←
S-curve setting on decelerating from operation speed 1	L10	S-curve 6	←	←
S-curve setting on decelerating from operation speed 2	L12	S-curve 8	←	←
S-curve setting on reaching creep speed	L07	S-curve 3	←	←
S-curve setting on decelerating from creep speed	L08	S-curve 4	←	←
S-curve setting on reaching zero speed	L06	S-curve 2	←	←
Delay time by the speed reference agreement timer	C20	Multistep speed reference agreement timer	←	←

L04 **Preset S-curve**

◆Specifies the application of S-curve setting and the multistep speed.

L	0	4	S	-	C	U	R	V	E			

Setting range: 0 to 2

Setting: 0: **VG7S standard multistep speed and S-curve mode**
15 steps of multistep speed (C05 to C19)
S-curve applied to four sections (F67 to F70)

Setting: 1: **Elevator application compatible with VG3N and VG5N**
7 steps of multistep speed (C05 to C11)
S-curve applied to eight sections (L05 to L12)

Setting: 2: **VG7 original elevator application mode**
7 steps of multistep speed (C05 to C11)
S-curve applied to ten sections (L05 to L14)

L05 - L14 **S-curve set 1 to 10**

L	0	5	S	-	C	R	V		S	E	T	1

to

L	1	4	S	-	C	R	V		S	E	1	0

Setting range: 0 to 50 [%]

(1) Introduction to an operation example in each mode

1) VG7S standard multistep speed and S-curve mode

Since this operation mode uses the standard multistep speed and the S-curve, see the description of the individual function codes.

2) Elevator application compatible with VG3N and VG5N

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

Terminal function			Multistep speed setting		
SS4	SS2	SS1	Code	Name	Description
OFF	OFF	OFF	-	-	External speed setting
OFF	OFF	ON	C05	Multistep speed 1	Zero speed
OFF	ON	OFF	C06	Multistep speed 2	Inching speed
OFF	ON	ON	C07	Multistep speed 3	Creep speed
ON	OFF	OFF	C08	Multistep speed 4	Maintenance operation speed
ON	OFF	ON	C09	Multistep speed 5	Operation speed 1
ON	ON	OFF	C10	Multistep speed 6	Zero speed
ON	ON	ON	C11	Multistep speed 7	Operation speed 2

The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Description	Code	Description
C06	Multistep speed 2	Inching speed	F07	Acceleration time 1	F08	Deceleration time 1
C07	Multistep speed 3	Creep speed	C35	Acceleration time JOG	C36	Deceleration time JOG
C08	Multistep speed 4	Maintenance operation speed	F07	Acceleration time 1	F08	Deceleration time 1
C09	Multistep speed 5	Operation speed 1	F07	Acceleration time 1	F08	Deceleration time 1
C11	Multistep speed 7	Operation speed 2	C46	Acceleration time 2	C47	Deceleration time 2

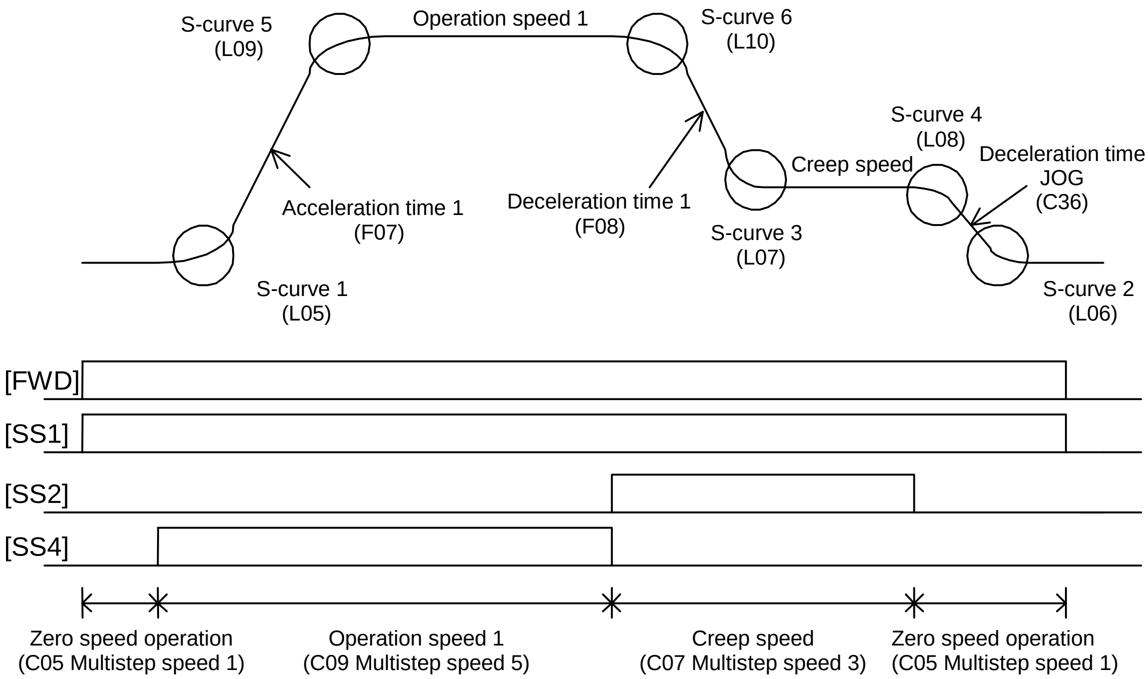
The following table shows how S-curve setting is applied to the multistep speed.

S curve setting		Application
Code	Name	
L05	S-curve 1	Acceleration start side from Zero speed
L06	S-curve 2	Deceleration end side to Zero speed
L07	S-curve 3	Acceleration end side to Creep speed
L08	S-curve 4	Deceleration start side from Creep speed
L09	S-curve 5	Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed
L10	S-curve 6	Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed
L11	S-curve 7	Acceleration end side to Operation speed 2
L12	S-curve 8	Deceleration start side from Operation speed 2

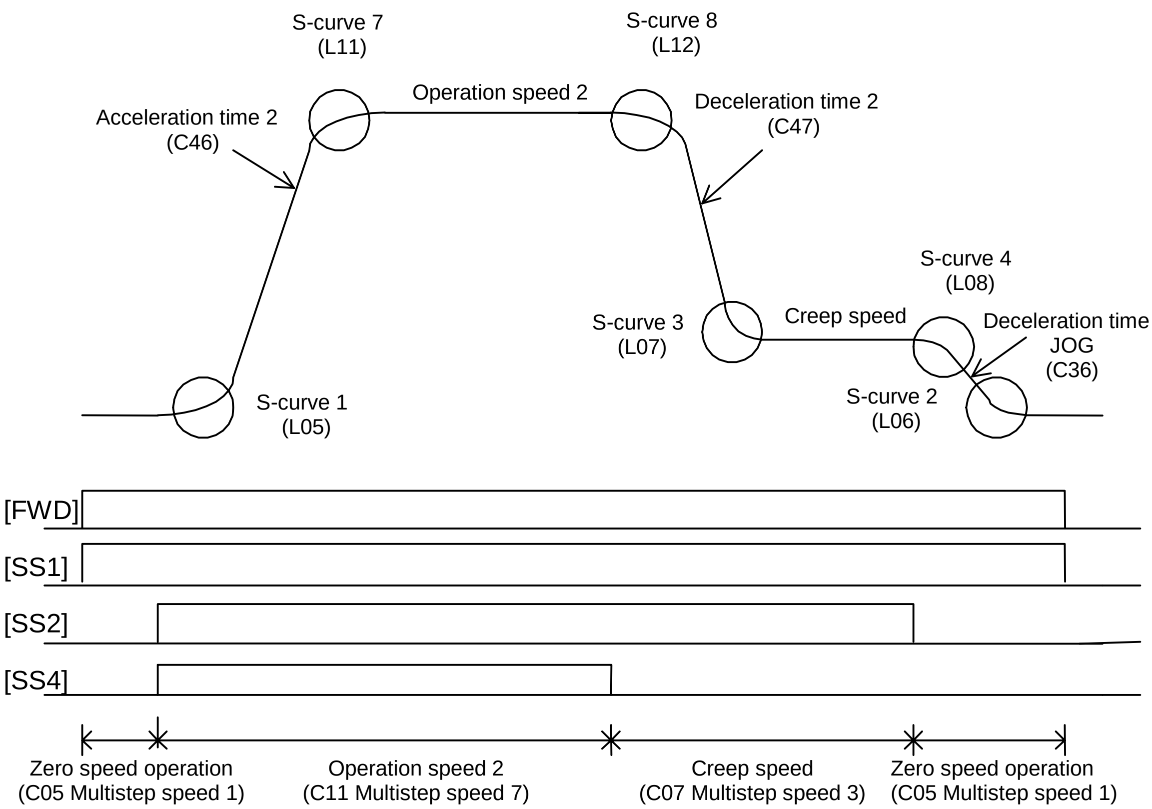
About emergency stop

When the operation command (FWD, REV) is set to OFF, the inverter decelerates linearly neglecting the S-curve setting. The deceleration time follows the C67 "Deceleration time 4".

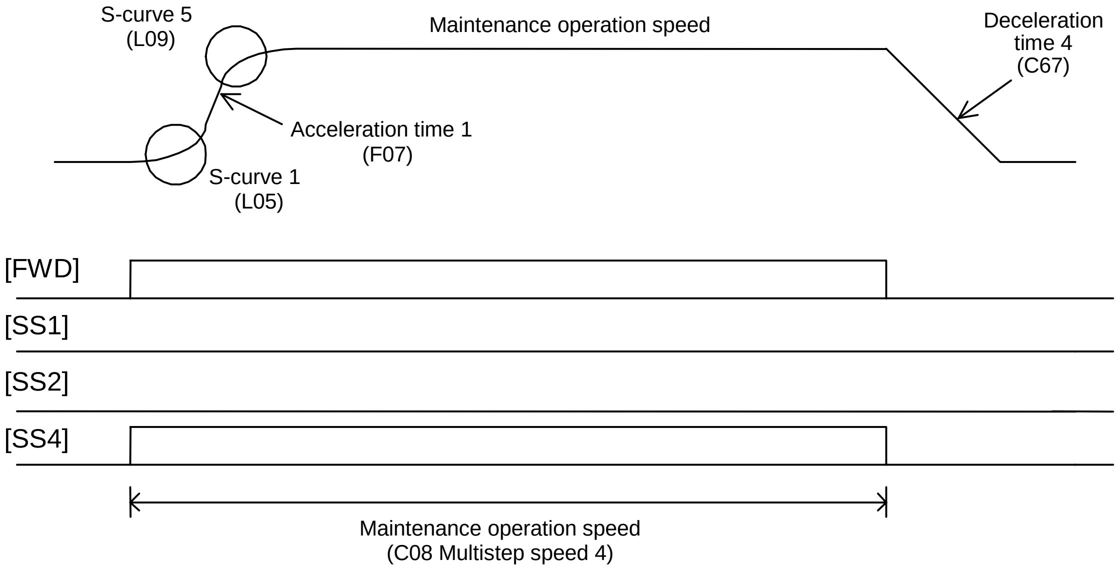
(a) Operation speed 1



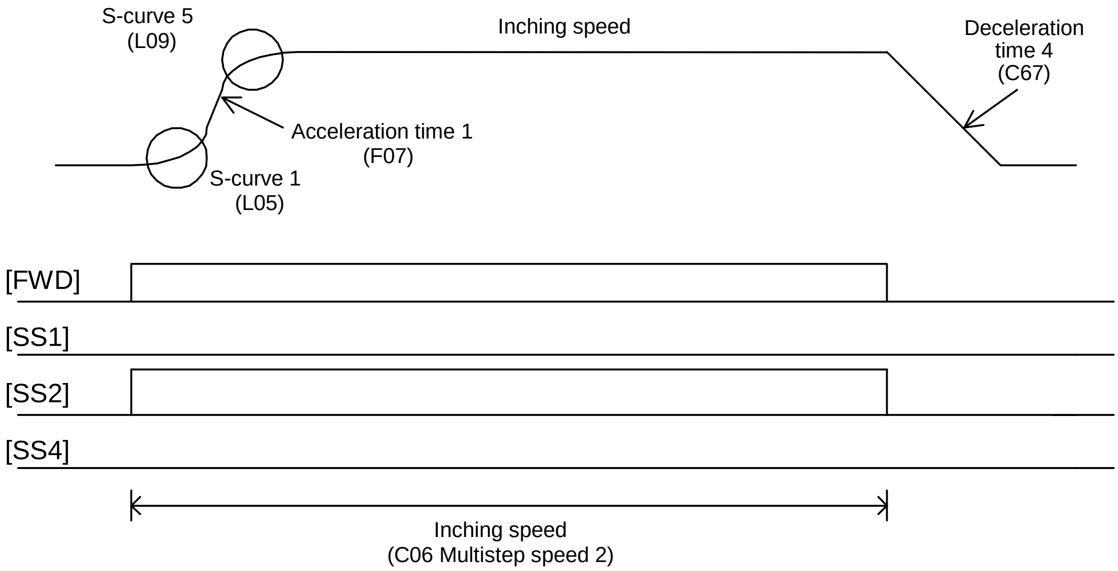
(b) Operation speed 2



(c) Maintenance operation speed



(d) Inching speed



3) VG7 original elevator application mode

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

Terminal function			Multistep speed setting		
SS4	SS2	SS1	Code	Name	Description
OFF	OFF	OFF	-	-	Zero speed
OFF	OFF	ON	C05	Multistep speed 1	Emergency elevator speed
OFF	ON	OFF	C06	Multistep speed 2	Inching speed
OFF	ON	ON	C07	Multistep speed 3	Creep speed
ON	OFF	OFF	C08	Multistep speed 4	Maintenance operation speed
ON	OFF	ON	C09	Multistep speed 5	Operation speed 1
ON	ON	OFF	C10	Multistep speed 6	Operation speed 2
ON	ON	ON	C11	Multistep speed 7	Operation speed 3

The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Description	Code	Description
C05	Multistep speed 1	Emergency elevator speed	C56	Acceleration time 3	C57	Deceleration time 3
C06	Multistep speed 2	Inching speed	F07	Acceleration time 1	F08	Deceleration time 1
C07	Multistep speed 3	Creep speed	C35	Acceleration time JOG	C36	Deceleration time JOG
C08	Multistep speed 4	Maintenance operation speed	F07	Acceleration time 1	F08	Deceleration time 1
C09	Multistep speed 5	Operation speed 1	F07	Acceleration time 1	F08	Deceleration time 1
C10	Multistep speed 6	Operation speed 2	C46	Acceleration time 2	C47	Deceleration time 2
C11	Multistep speed 7	Operation speed 3	C56	Acceleration time 3	C57	Deceleration time 3

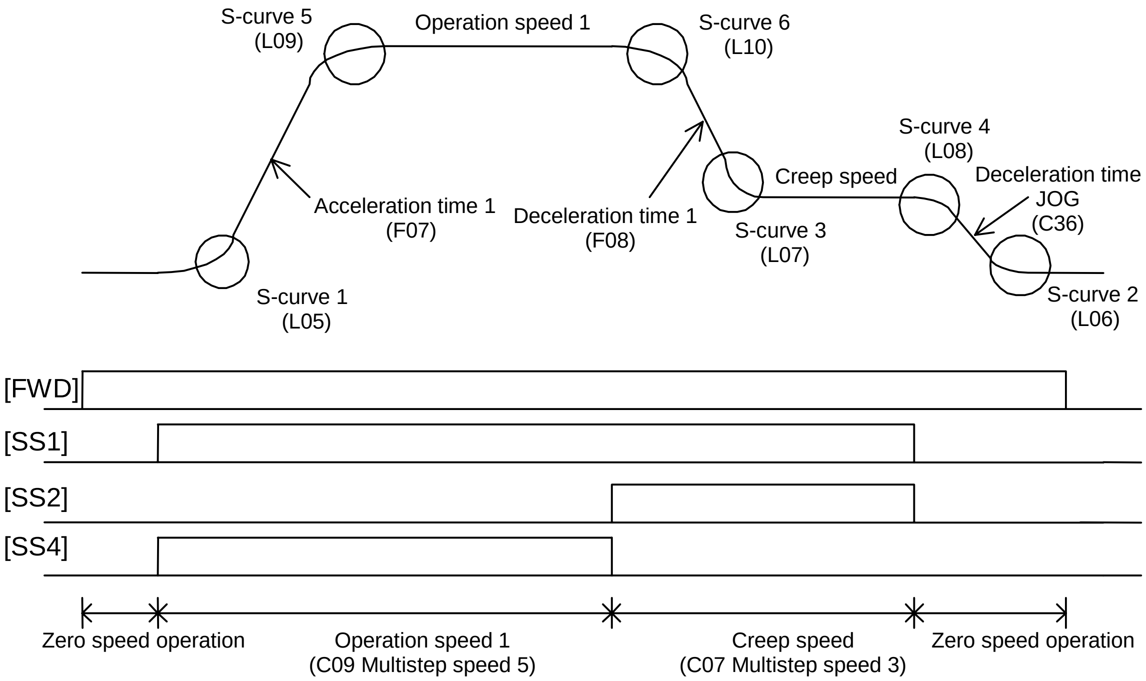
The following table shows how S-curve setting is applied to the multistep speed.

S curve setting		Application
Code	Name	
L05	S-curve 1	Acceleration start side from Zero speed
L06	S-curve 2	Deceleration end side to Zero speed
L07	S-curve 3	Acceleration end side to Creep speed
L08	S-curve 4	Deceleration start side from Creep speed
L09	S-curve 5	Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed
L10	S-curve 6	Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed
L11	S-curve 7	Acceleration end side to Operation speed 2
L12	S-curve 8	Deceleration start side from Operation speed 2
L13	S-curve 9	Acceleration end side to Operation speed 3 or Emergency elevator speed
L14	S-curve 10	Deceleration start side from Operation speed 3 or Emergency elevator speed

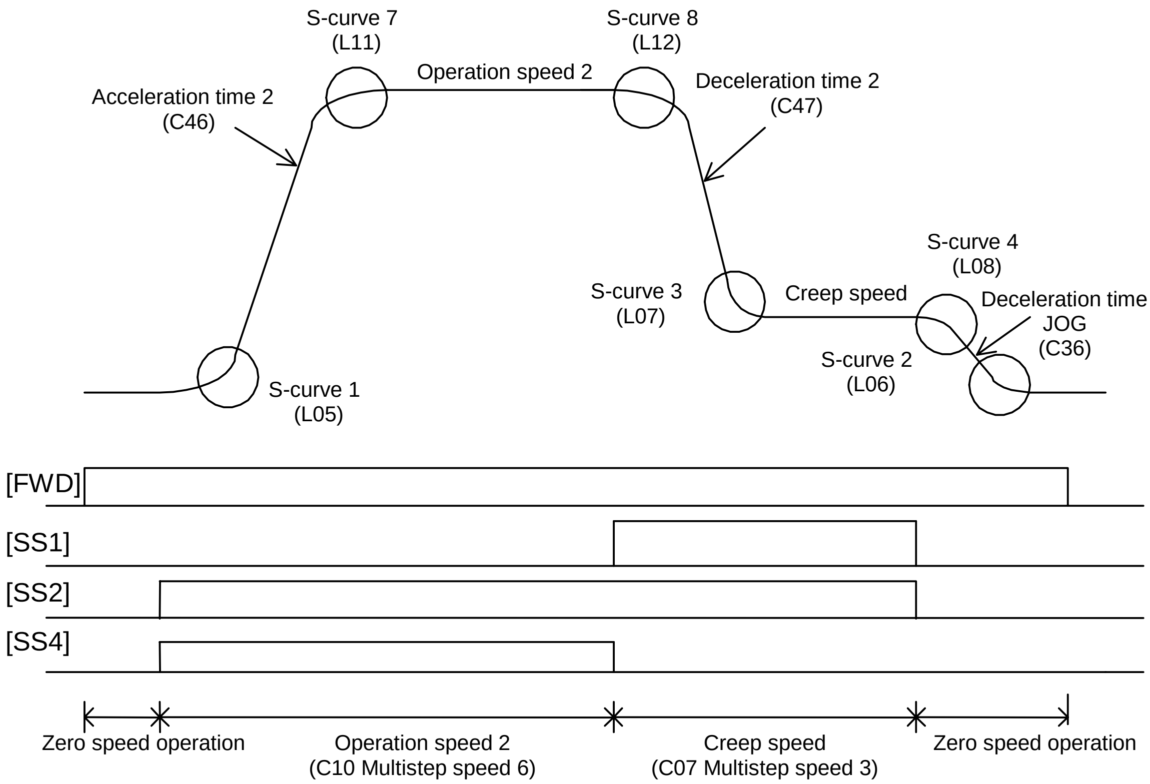
About emergency stop

When the operation command (FWD, REV) is set to OFF, the inverter decelerates linearly neglecting the S-curve setting. The deceleration time follows the C67 "Deceleration time 4".

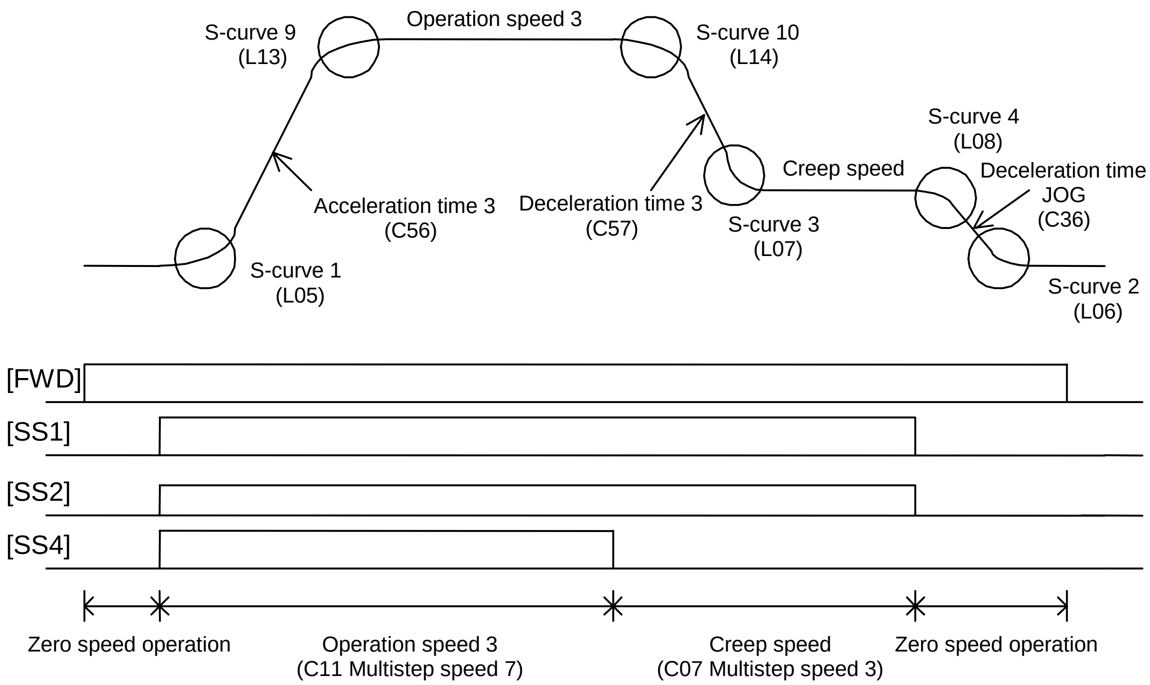
(a) Operation speed 1



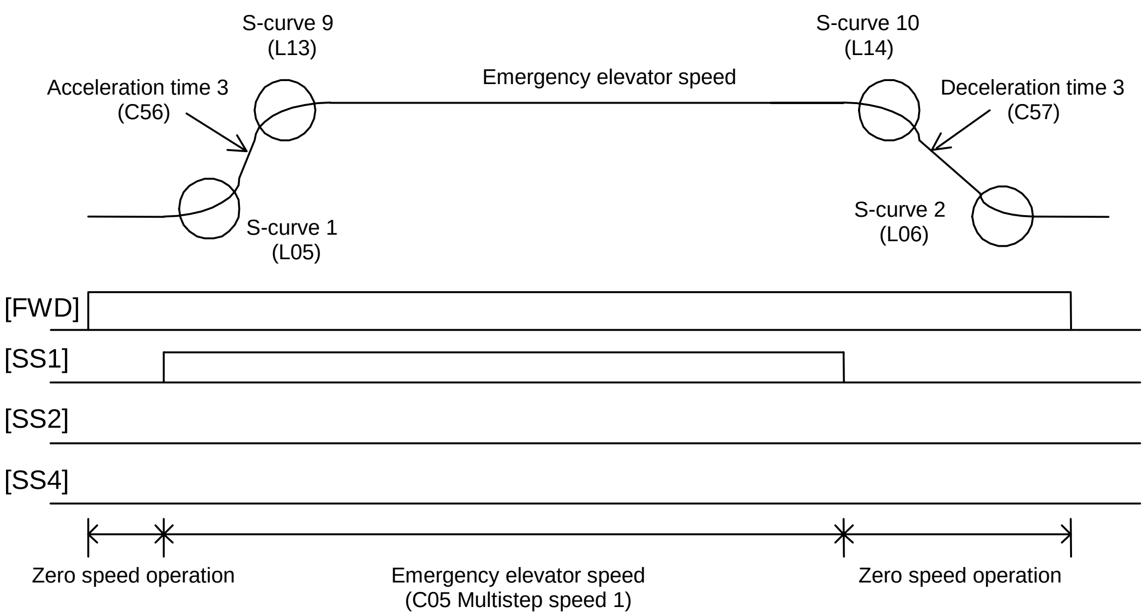
(b) Operation speed 2



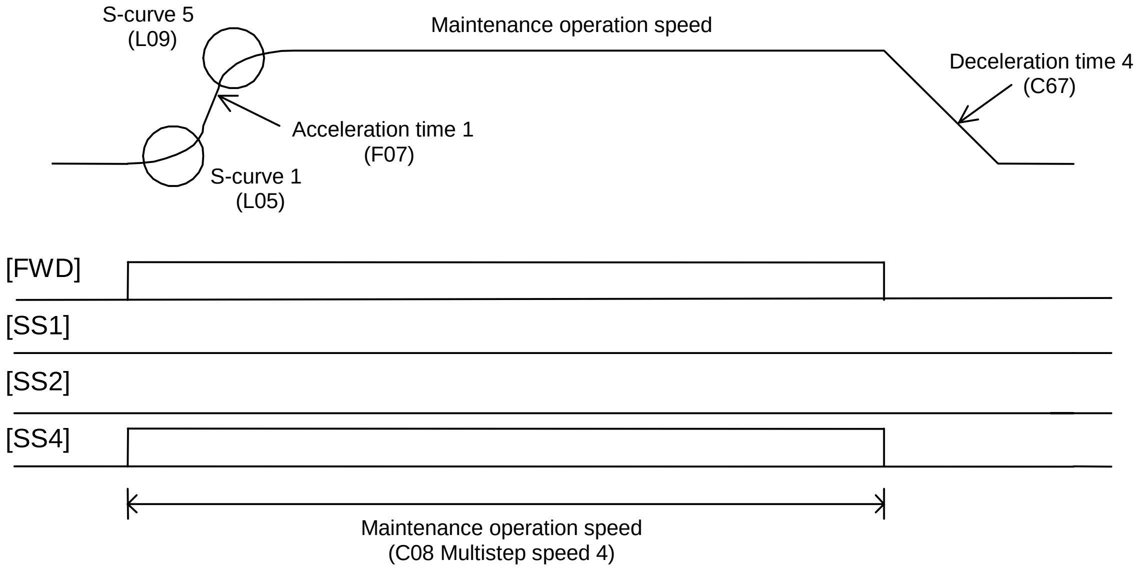
(c) Operation speed 3



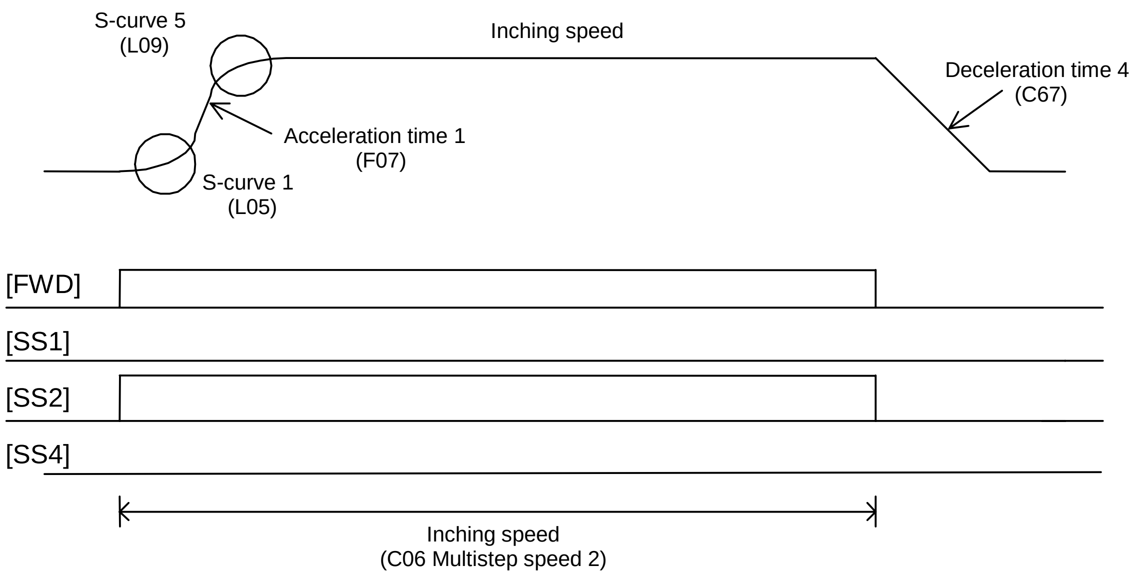
(d) Emergency elevator speed



(e) Maintenance operation speed

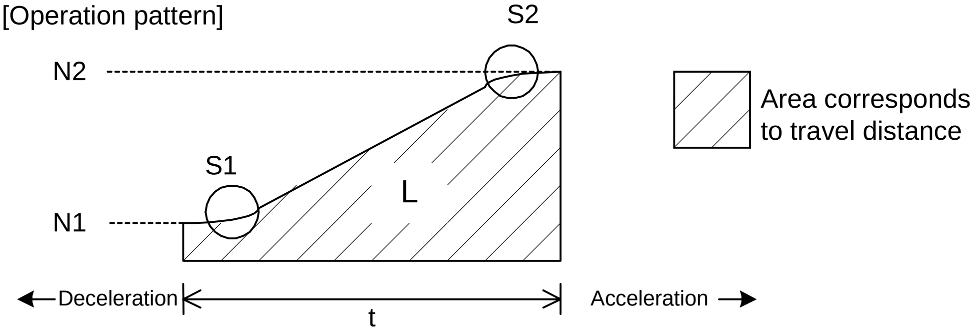


(f) Inching speed



4. Control and Operation

(1) How to calculate acceleration/deceleration times and travel distance



[Description of symbols]
Nmax [r/min]: Maximum motor speed
N1 [r/min] : Speed reference before acceleration (after deceleration)
N2 [r/min] : Speed reference after acceleration (before deceleration)
S1 [%]: S-curve portion at the beginning of acceleration (at the end of deceleration)
S2 [%]: S-curve portion at the end of acceleration (at the beginning of deceleration)
T [s] : Acceleration (deceleration) reference time (time from zero to Nmax (Nmax to 0))
Vmax [m/min]: Elevation speed at the maximum motor speed (Maximum elevation speed)
t [s] : Acceleration (deceleration) time
L [m] : Travel distance

1) When the S curve portion fits in a specified speed range .... $\frac{N2-N1}{Nmax} \geq \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \left(\frac{N2-N1}{Nmax} + \frac{S1+S2}{100}\right) \times T \quad \text{[Equation 1]}$$

Travel distance

$$L = \frac{T \times Vmax}{120} \times \left[\frac{S1^2 - S2^2}{30000} + \frac{S2}{50} \times \frac{N2-N1}{Nmax} + \left(\frac{N2-N1}{Nmax}\right)^2\right] + \frac{t \times Vmax}{60} \times \frac{N1}{Nmax} \quad \text{[Equation 2]}$$

2) When the S curve portion exceeds a specified speed range .... $\frac{N2-N1}{Nmax} < \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \frac{S1+S2}{50}\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}} \times T \quad \text{[Equation 3]}$$

Travel distance

$$L = \left(\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}}\right)^3 \times \frac{T \times Vmax}{90} \times \frac{S1^2 + 2 \times S2^2 + 3 \times S1 \times S2}{10000} \times \frac{t \times Vmax}{60} \times \frac{N1}{Nmax} \quad \text{[Equation 4]}$$

4.4 Function Description (Arranged by Function)

4.4.1 If You Think Defective

⚠ WARNING
• After the inverter protective function was activated and you removed the cause, if you reset the alarm while the operation command has been set to ON, the inverter restarts. Reset the alarm after you confirm the operation command has been set to OFF. **You may be injured.**

If you think defective

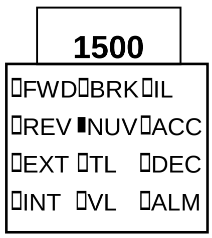
An inverter may not operate as instructed while you think you specified the operation command and the speed reference properly or you may not reset the alarm to restart operation. Also an alarm may occur frequently to obstruct the operation of a facility.
If this is the case, use the KEYPAD panel to identify the cause of the malfunction or the alarm. If you still cannot identify the cause or you suspect an inverter fault or damaged parts, contact the shop you purchased the inverter or the FUJI's sales representative.

4.4.1.1 What You Should Check First

This section describes how to use the KEYPAD panel to investigate causes though the protective function is not activated, but an inverter does not operate as instructed. Then the flowcharts illustrate the procedures.

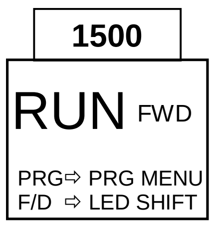
(1) Is the inverter ready for operation?

It takes about one second before an inverter becomes ready for operation after you turn on the main circuit. You can view the "CHARGE" lamp on the front of an inverter with 18.5 kW or more capacity to confirm this state. Also you should use the "I/O check" screen of the KEYPAD panel to check if "■NUV" is displayed as shown in the right figure. This status indicates that the inverter is ready for operation.
If "□NUV" is displayed, the power may not be supplied to the inverter. Check the input power line to the main circuit.
When you do not use a DCR, you should connect a jumper wire between P1 and P(+) terminals. Check if the jumper wire is not disconnected.



(2) Have you instructed an operation command?

Following the procedure described above to confirm that the inverter is ready.
When you direct the operation command (FWD), "RUN" must be displayed as in the right figure.
If the display remains "STOP", the inverter has not received your operation command.
When you enter the operation command from the KEYPAD panel, a green indicator RUN LED turns on.
You can see the indicator on the LCD monitor to check the available source of the operation command (LOC: KEYPAD panel, REM: External signal, and COMM: link).
You should change the function code F02 "Operation method" and H30 "Serial link" to change the source of the operation command.
If you have installed an option, you cannot use RS485 to enter the operation command (the option has higher priority). When you have several options, the priority may be fixed. See the description of applicable options.



When you use the UPAC, you should enter the operation command as well. See the description of the UPAC for more details.

(3) Have you entered the speed reference?

Confirm the speed reference (N*) on the "Operation monitor" when you have directed the speed reference by the KEYPAD panel, external analog input, or through the link (T-Link or RS485) or the UPAC. If the "N*" is blank, the inverter has not received the speed reference.

```
1500
N*=xxxxx r/m
N =xxxxx r/m
f* =   xxx Hz
TRQ=xxx %
```

When you use the analog input [12] to provide the speed reference, you can check the voltage on the "I/O check" screen of the KEYPAD panel.
Since the displayed voltage is the one the inverter recognizes, you can check the [12] input on this screen.
When you use the [12] and the value fluctuates, you can check if the analog reference itself fluctuates.
In the same manner, check the auxiliary speed reference supplied to the analog input Ai1 and Ai2.

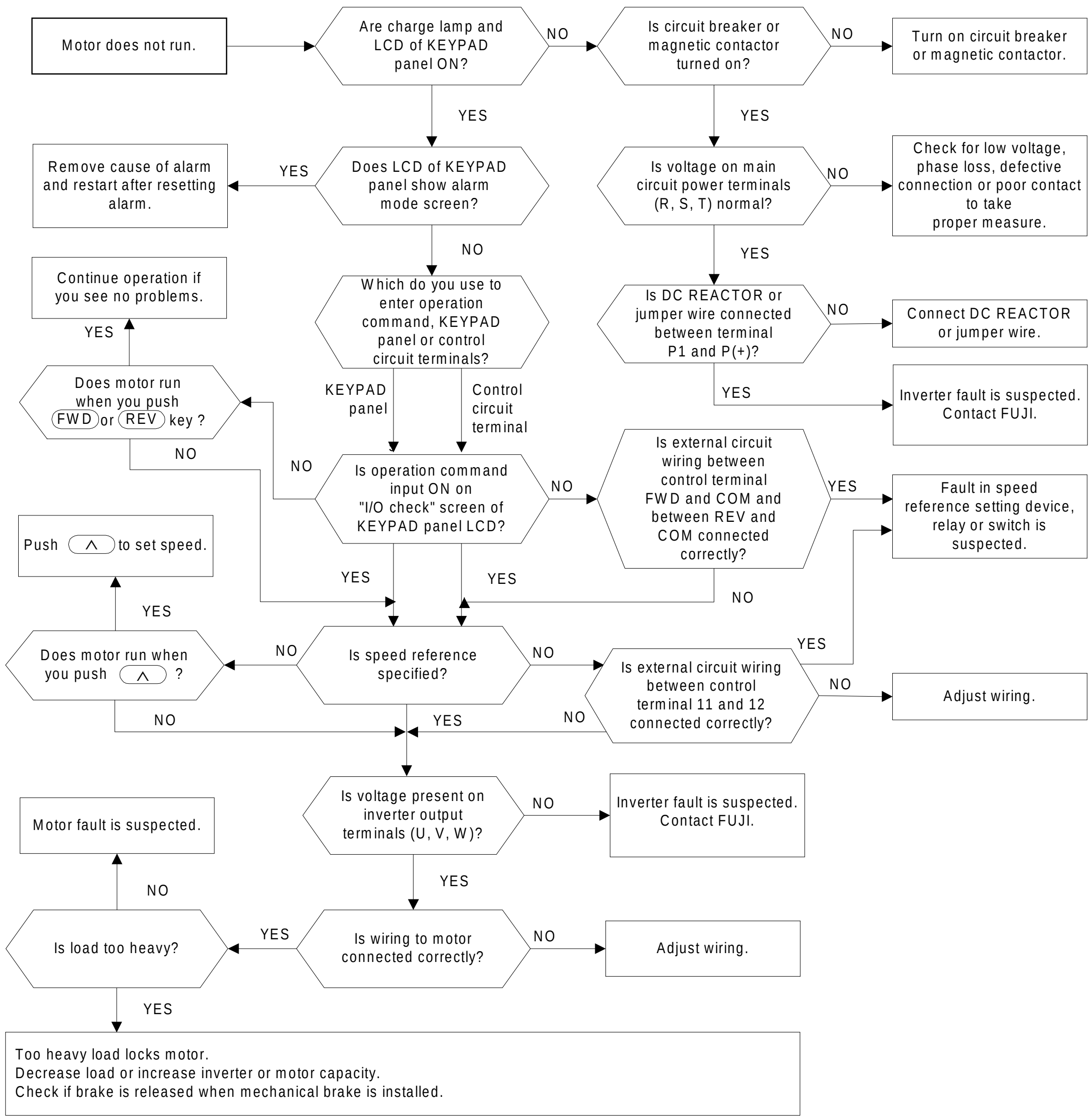
```
1500
12   = ± xx.x V
Ai 1 = ± xx.x V
Ai 2 = ± xx.x V
```

4.4.1.2 Diagnosing Unstable Operation

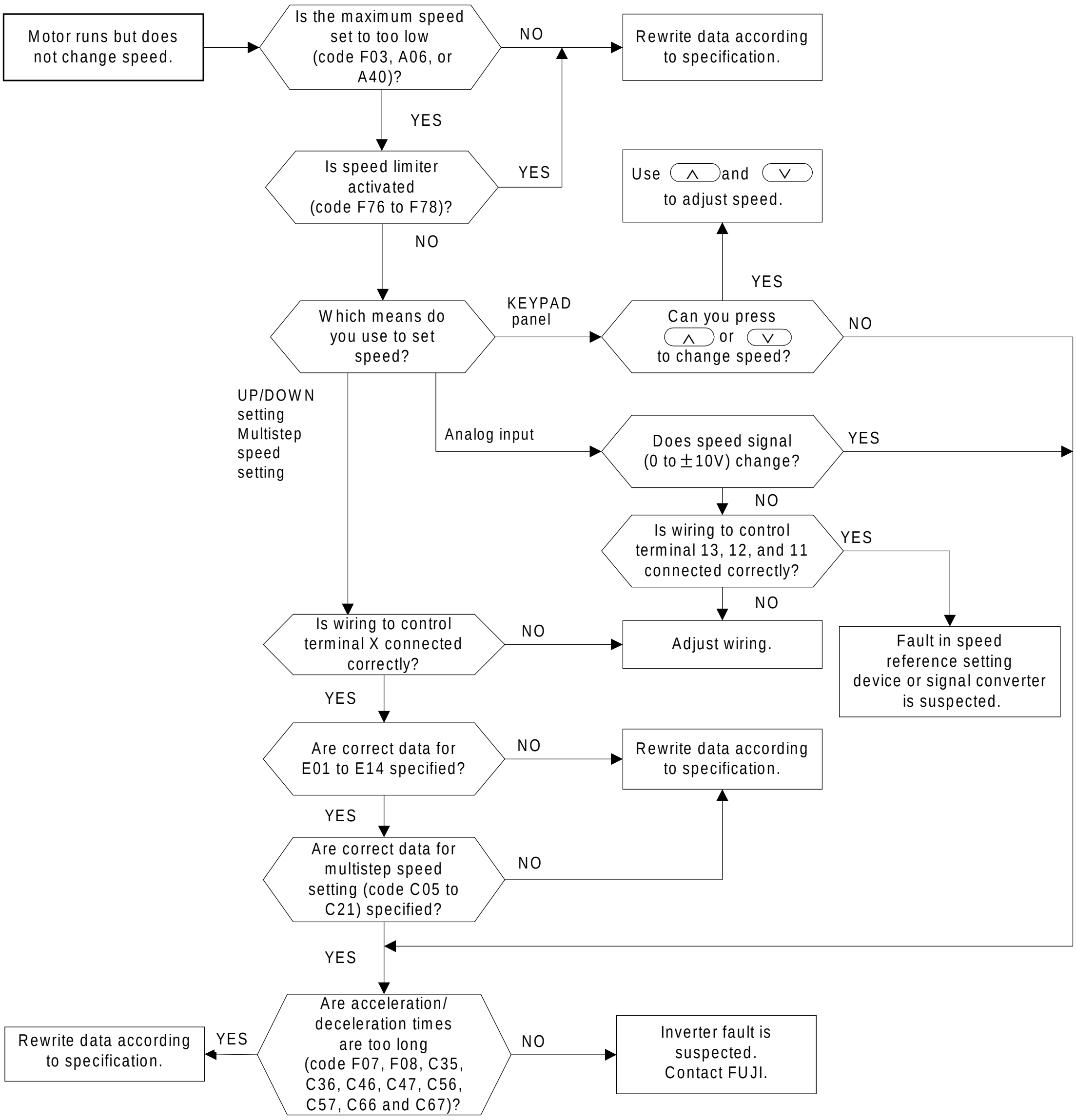
This section shows individual flowcharts for vector control, sensorless vector control and V/f control.

(1) Vector control and sensorless vector control

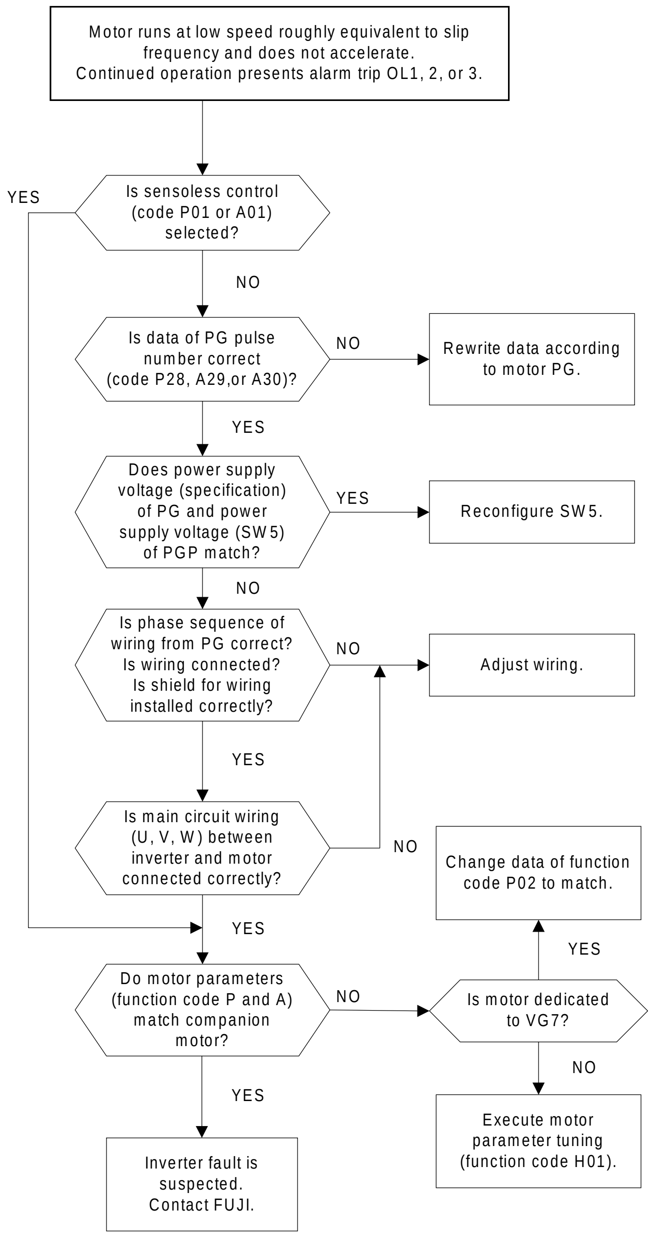
1) Motor does not run.



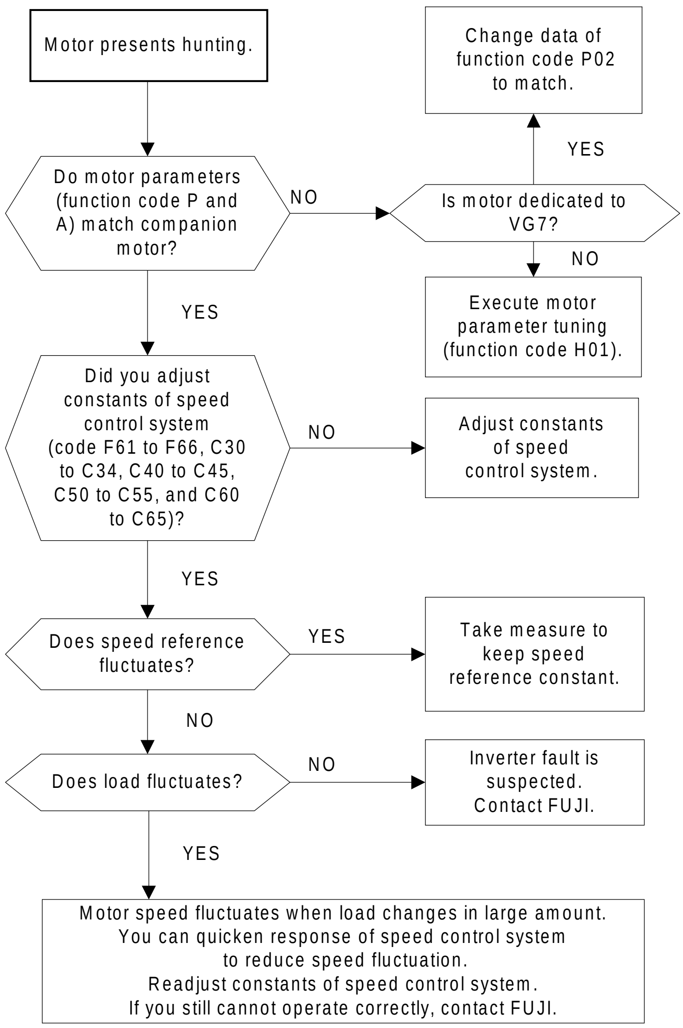
2) Motor runs but does not change speed



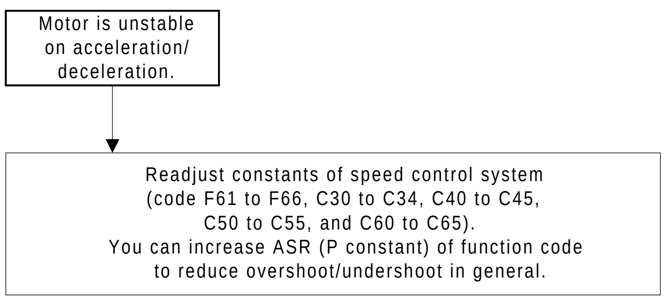
3) Motor runs only at low speed



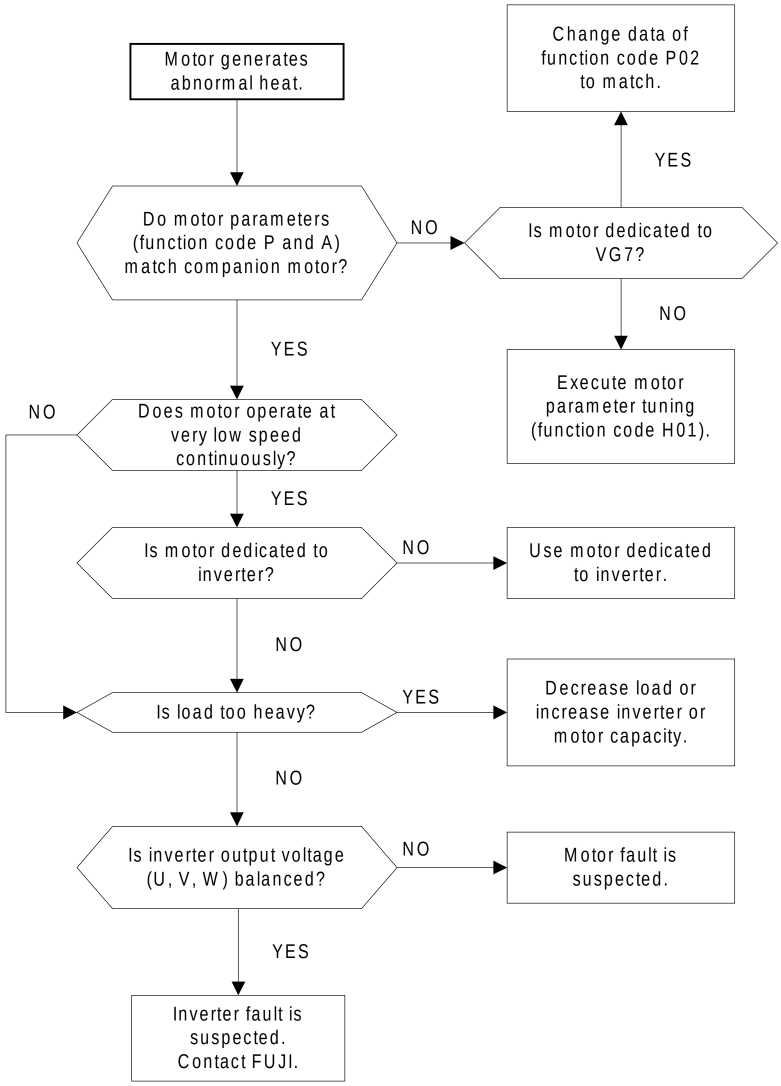
4) Motor presents hunting



5) Motor is unstable on acceleration/deceleration



6) Motor generates abnormal heat

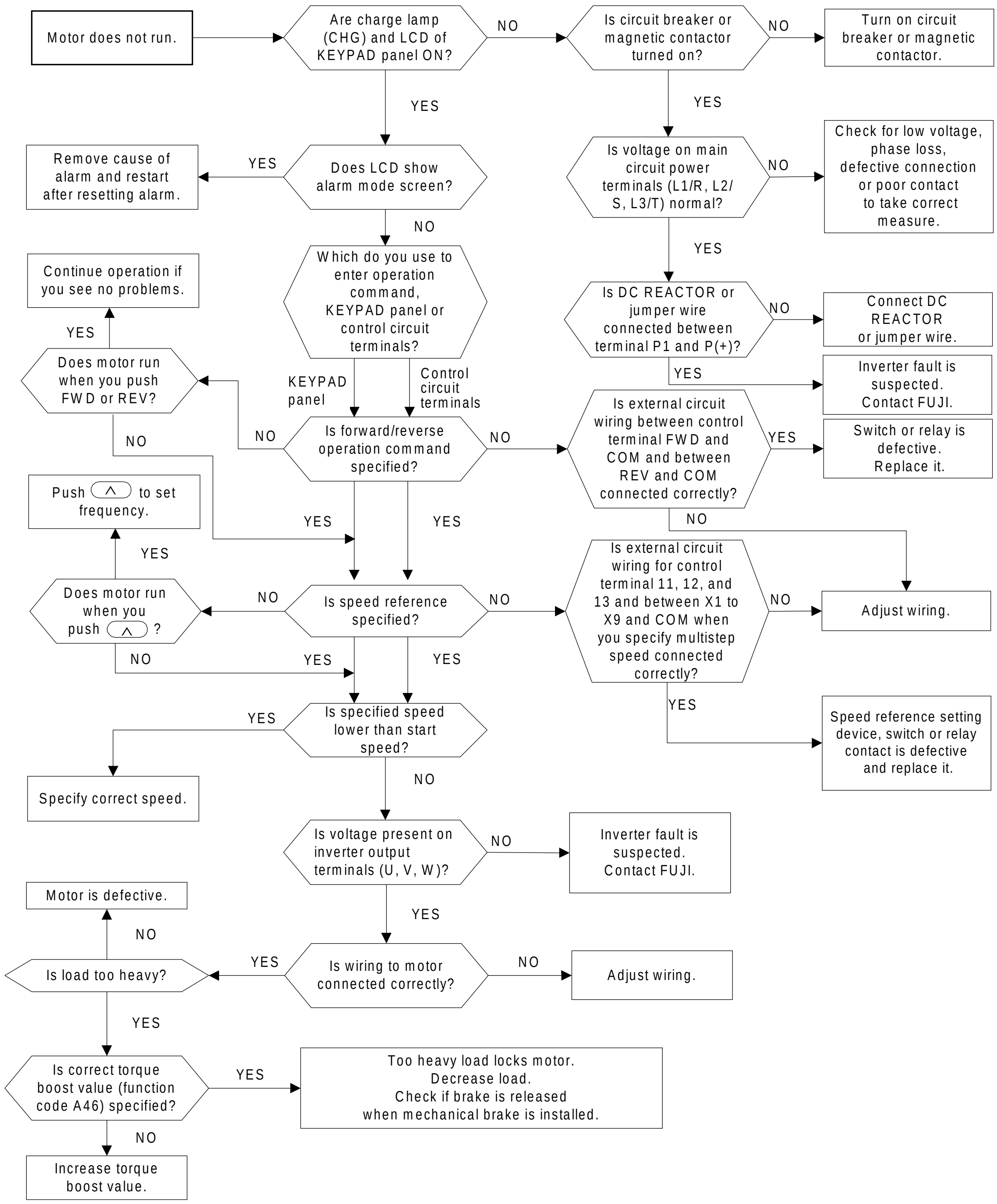


7) Motor runs inversely against direction reference

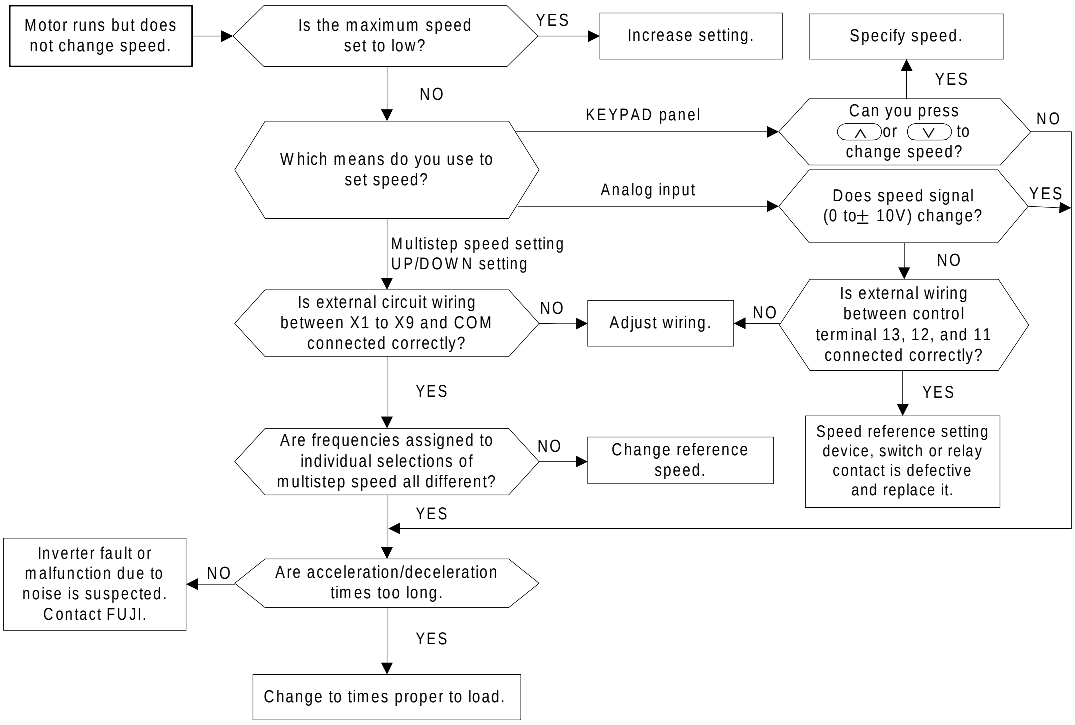
Phase sequence of main circuit wiring (U, V, W) between inverter and motor does not match in sensorless control.
Or, function data for speed reference are incorrect.

(2) V/f control

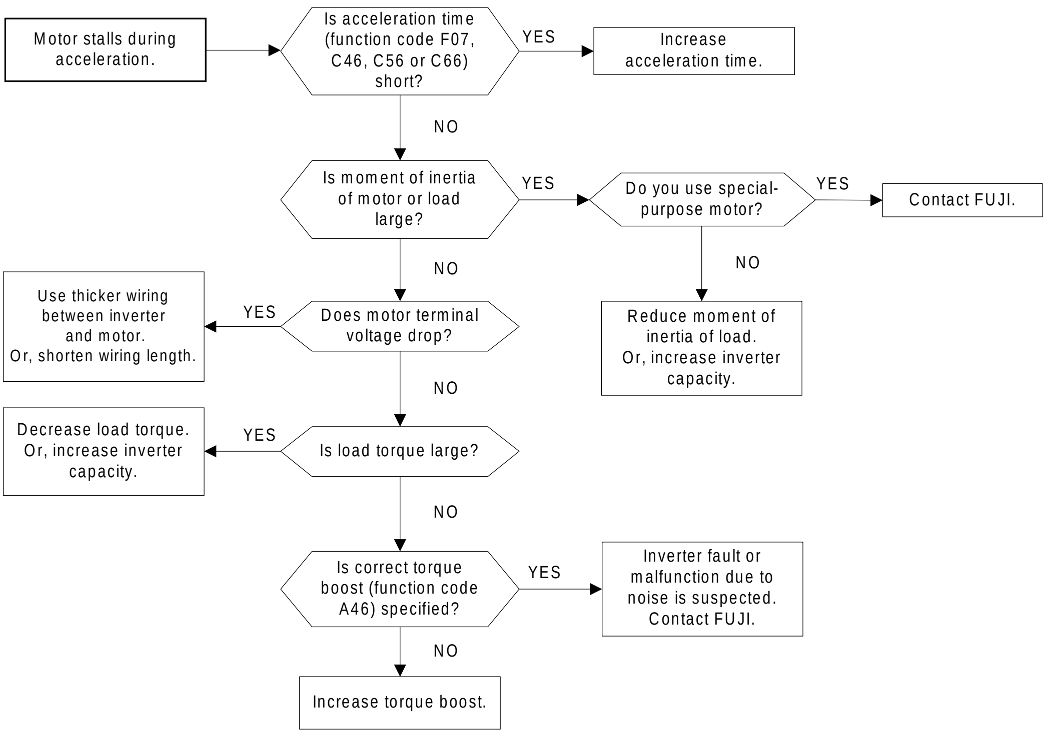
1) Motor does not run.



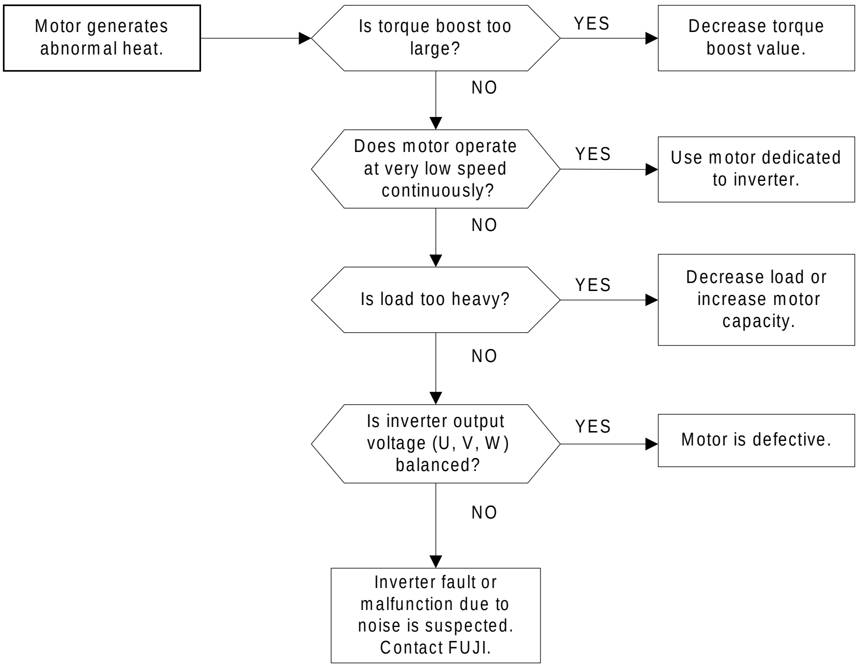
2) Motor runs but does not change speed



3) Motor stalls during acceleration



4) Motor generates abnormal heat



4.4.1.3 List of Inverter Protective Functions

⚠WARNING

- The motor coasts when an alarm is issued. Install a brake on the driven machine side if you need to stop the motor.

An accident may occur.

- When you reset the inverter while applying the operation command, the motor restarts suddenly. Make sure the operation command is turned off before you restart.

Function	Description	Display	Related function code
DB resistor overheating	When the built-in braking resistor overheats, the inverter stops discharging and running. You must set the function codes E35 to 37 corresponding to the resistor (built-in/external).	dbH	E35 - 37
DC fuse blown	When a fuse at the main DC circuit blows due to a short-circuit in the IGBT circuit, the inverter stops operation. This function prevents secondary disaster. A damage to the inverter is suspected and contact FUJI immediately.	dCF	
Ground fault	Activated by a ground fault in the inverter output circuit. If a large current flows due to ground fault, the overcurrent protective function may operate to protect the inverter. Connect a separate earth-leakage protection relay or an earth-leakage circuit breaker for accident prevention such as human damage and fire.	EF	
Excessive position deviation	Activated when the position deviation between the reference and the detected values exceeds the function code o18 "Excessive deviation value" in synchronized operation. The option code "o" becomes valid and is displayed on the KEYPAD panel after installing options.	d 0	o18
Memory error	Activated when a fault such as "write error" occurs in the memory.	Er 1	
KEYPAD panel communication error	Activated if a communication error is detected between the inverter control circuit and the KEYPAD panel when the start/stop command from the KEYPAD is valid (function code F02=0). Note: KEYPAD panel communication errors do not indicate the alarm display and issue the alarm relay output when the inverter is operated by external signal input or the link function. The inverter continues operating.	Er 2	F02
CPU error	Activated when a CPU error occurs due to noise.	Er 3	
Network error	Activated if a communication error occurs due to noise when the inverter is operated through T- Link, SX bus or field bus.	Er 4	o30,31
RS485 communication error	Activated if: - RS485 communication error occurs while the function code H32 is set to 0 to 2. - A disconnection continues for more than the specified period of 0.1 to 60.0 with the function code H38.	Er 5	H32,H33 H38
Operation procedure error	Activated if multiple network options (T- Link, SX bus, and field bus) are installed. Though you can install multiple SI, DI and PG options, this error is issued if the two SW settings are identical.	Er 6	
Output wiring error	Activated when the measured data are out of the motor characteristic data range during executing tuning or the wires are not connected in the inverter output circuit.	Er 7	H01,H71
A/D converter error	Activated when an error occurs in the A/D converter circuit.	Er 8	
Speed disagreement	Activated when the deviation between the speed reference (speed setting) and the motor speed (detected speed, predicted speed) becomes excessive.	Er 9	
UPAC error	Activated on a hardware fault in the UPAC option or a communication error between the inverter control circuit and the UPAC option.	ErA	

Function	Description	Display	Related function code
Inter-inverter communication error	Activated if a communication error occurs in inter-inverter communication over the optical option or simplified RS485.	Erb	
Input phase loss	The inverter is protected from being damaged due to input phase loss.	Lin	
Undervoltage	Activated if the DC link circuit voltage decreases to the undervoltage level due to a reduction in the supply voltage. The alarm output is not issued when the DC link circuit voltage decreases and the function code F14 is set to "3 to 5". ■ Undervoltage detection level: 200V series: 186Vdc, 400V series: 371Vdc.	LU	F14
NTC thermistor disconnection	Activated if the thermistor circuit is disconnected when the application of NTC thermistors to corresponding motors (M1, 2, 3) is specified with the function codes P30, A31 and A47.	nrb	P30,A31, A47
Overcurrent	Activated if the momentary value of the inverter output current exceeds the overcurrent detection level due to a short-circuit or ground fault.	OC	
Overheating at heat sink	Activated if the temperature of the heat sink to cool the rectifier diodes and the IGBTs increases due to cooling fan stoppage.	OH1	
External alarm	The inverter stops on receiving the external alarm signal (THR). It is activated by a terminal signal when the control circuit terminals (THR assignment) are connected to alarm terminals of external devices such as a braking unit or a braking resistor.	OH2	E01 - E04
Inverter internal overheat	Activated if the ambient temperature of the control PC board increases due to poor ventilation of the inverter.	OH3	
Motor overheat	Activated if the temperature detected by the NTC thermistor built in the VG7 dedicated motor exceeds the data of the function code E30 "Motor overheat protection".	OH4	E30,E31
Motor 1 overload	Activated when the motor 1 current (inverter output current) exceeds the operation level set by function code F11.	OL1	F11
Motor 2 overload	Activated when the motor 2 current (inverter output current) exceeds the operation level set by function code A33.	OL2	A33
Motor 3 overload	Activated when the motor 3 current (inverter output current) exceeds the operation level set by function code A49.	OL3	A49
Inverter unit overload	Activated if the output current exceeds the overload characteristic of the inverse time characteristic.	OLU	
Overspeed	Activated if the motor speed (detected speed value/predicted speed value) exceeds 120% of the specified value by the function code "maximum speed".	OS	F03,A06, A40
Overvoltage	Activated if the DC link circuit voltage exceeds the overvoltage level due to an increase of supply voltage or regenerative braking current from the motor. However, the inverter cannot be protected from excessive voltage (high voltage, for example) supplied by mistake. ■ Overvoltage detection level 200V series: 400Vdc, 400V series: 800Vdc	OU	
PG error	Activated when the pulse generator terminal PA/PB circuits are disconnected. It is not activated when the sensorless control or the V/f control is selected.	PG	
Charging circuit error	Activated if the bypass circuit of the DC link circuit is not formed (the magnetic contactor for the charging circuit bypass is not closed) two minutes after power is supplied.	PbF	

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

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

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

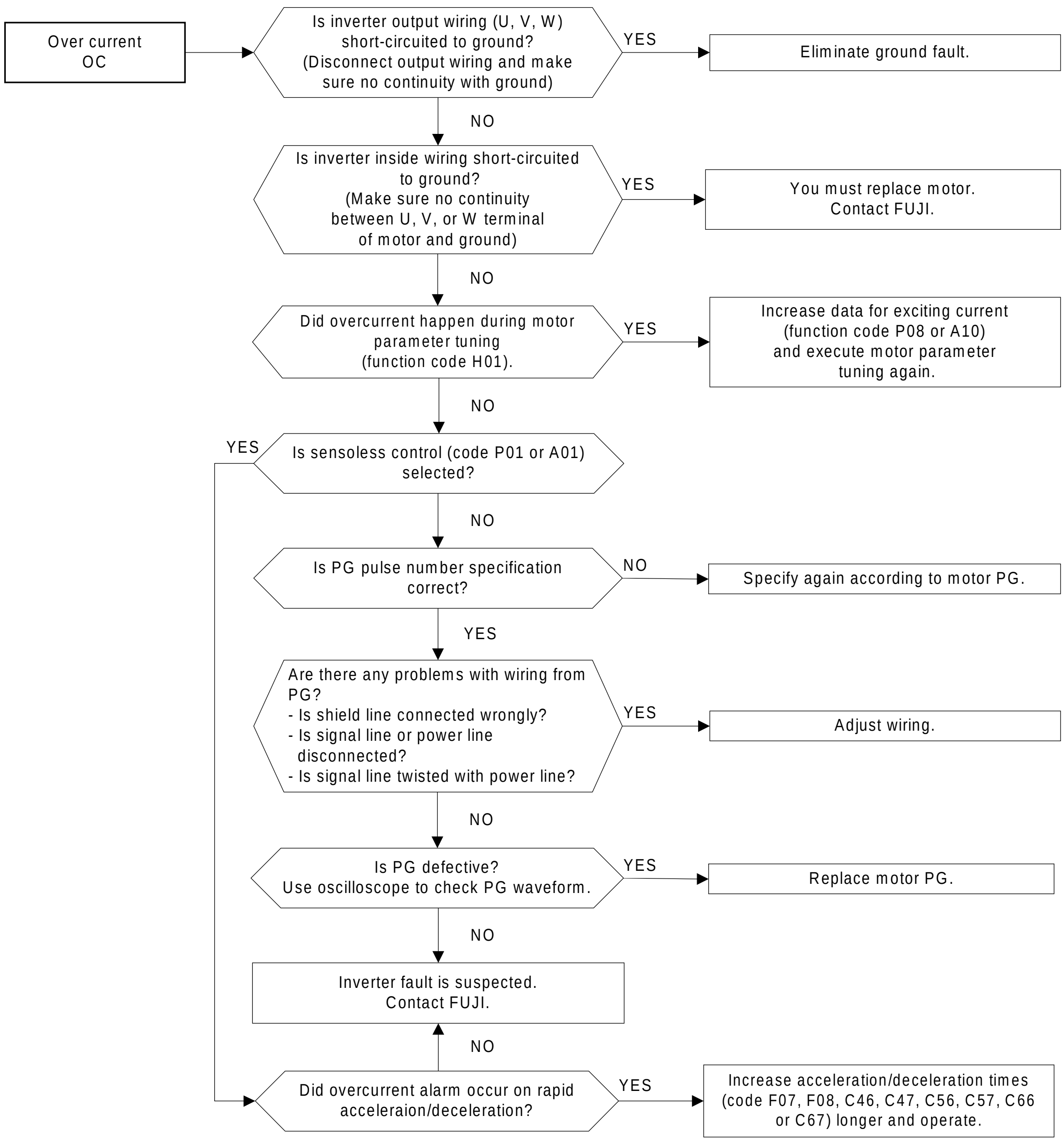
Note 4: In addition to these protective functions, there can be further protective from surge voltage by connecting surge suppressors to the main circuit power terminals (L1/R, L2/S, L3/T) and the auxiliary control power terminals (R0, T0).

4.4.1.4 Diagnosing Activated Protective Function

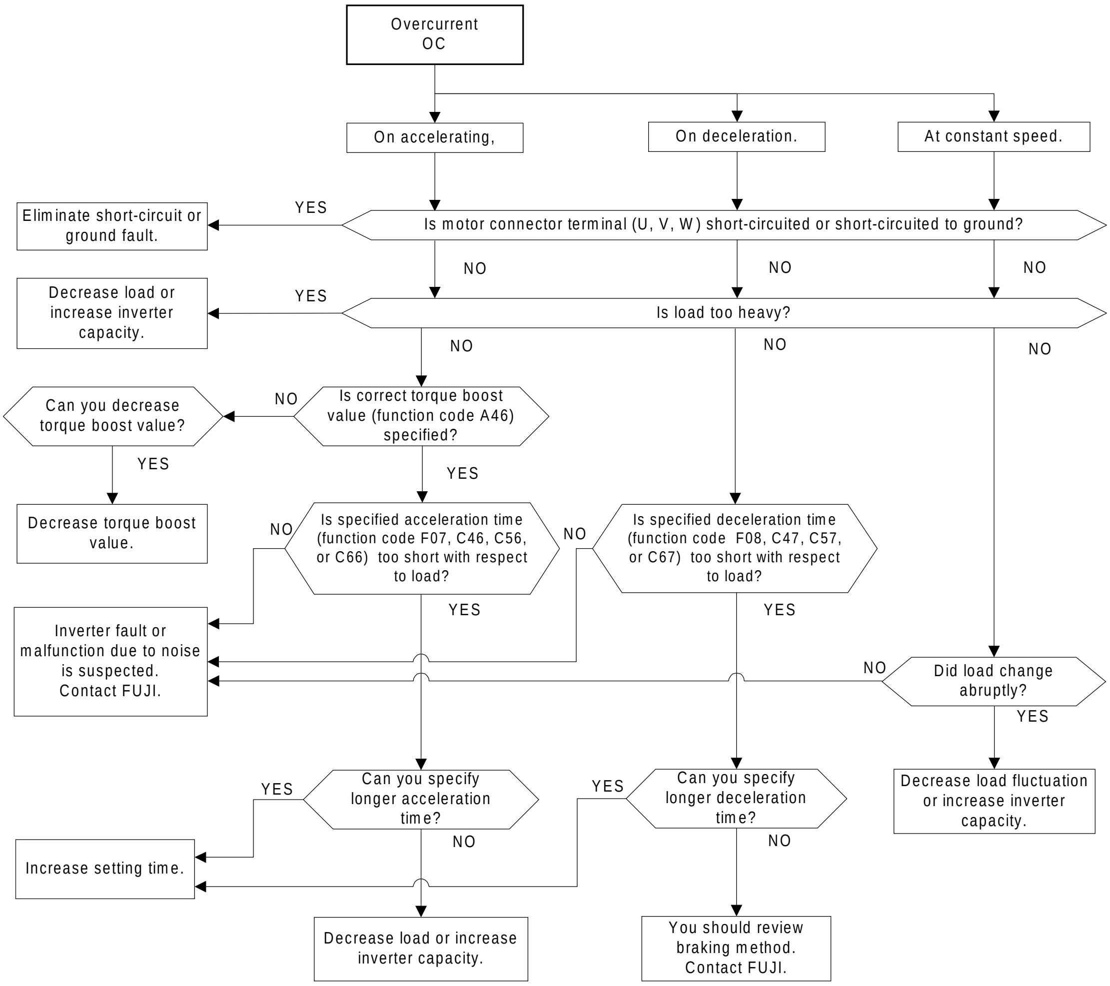
VG7 inverter includes various protective functions to prevent damages to connected machines, accidents, fires or physical injuries of customers.
When the protective function is activated, the inverter immediately trips (discontinues output) and enters into the alarm mode. The alarm mode displays the description of the alarm on the LCD screen of the KEYPAD panel, flashes alarm code (such as OC or OH1) on the LED display and informs the customer of the alarm mode. The trip (discontinued output) shifts the rotating motor into coasting state.
The alarm mode continues until you enter the reset command. Make sure to direct the reset command after you isolate the source of the alarm or replace parts.
When you have eliminated the source of the alarm, the inverter returns to the operation mode on the reset command and is ready to restart.

(1) Overcurrent

1) Vector control and sensorless vector control

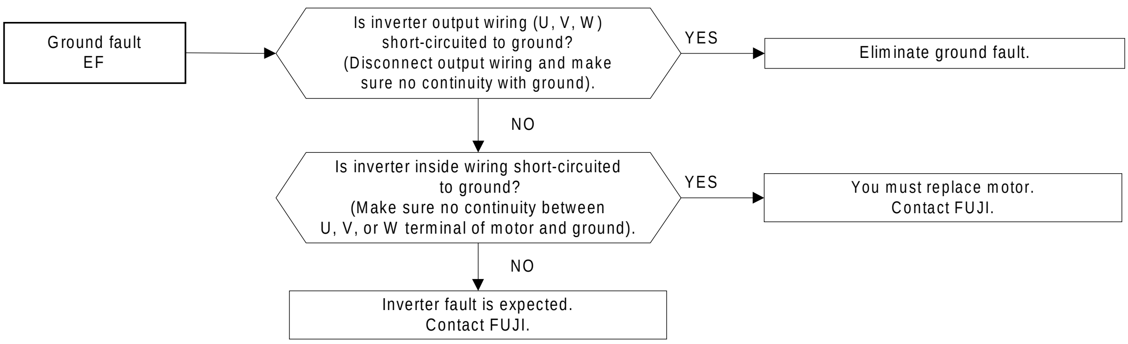


2) V/f control



(2) Ground fault

⚠WARNING
• Eliminate the cause before turn on the power. **You may start fire.**

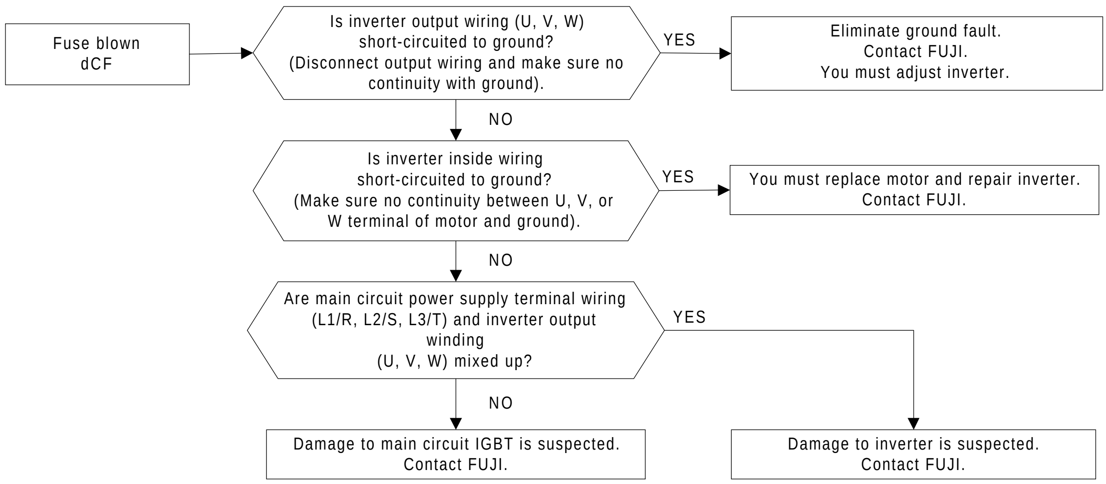


Note: The protective function from ground fault is installed on models of 18.5kW or more.

(3) Fuse blown

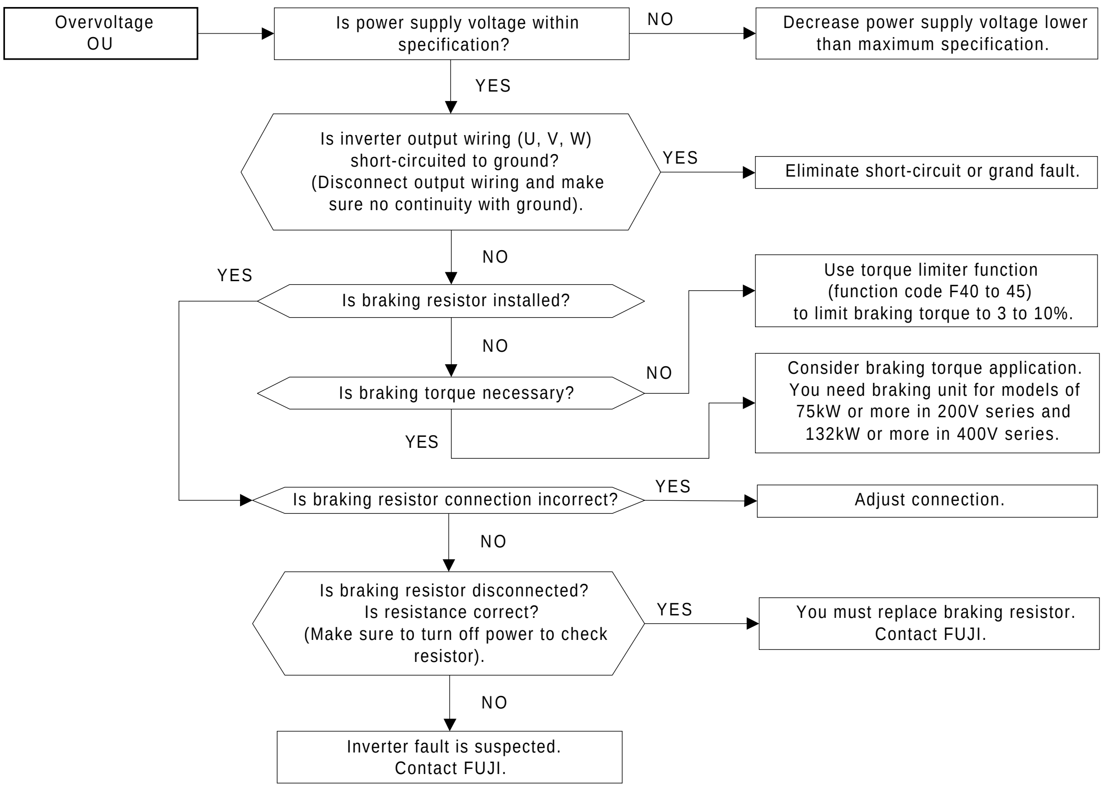
⚠ WARNING
• Replace inverter before turn on the power. **You may start fire.**

The fuse is provided to prevent a secondary disaster such as a fire. You cannot operate inverter with the fuse blown. When this alarm is issued, turn off the power immediately, identify the cause following the description below, and replace the inverter.
When this alarm is issued, do not turn on the power and contact us.

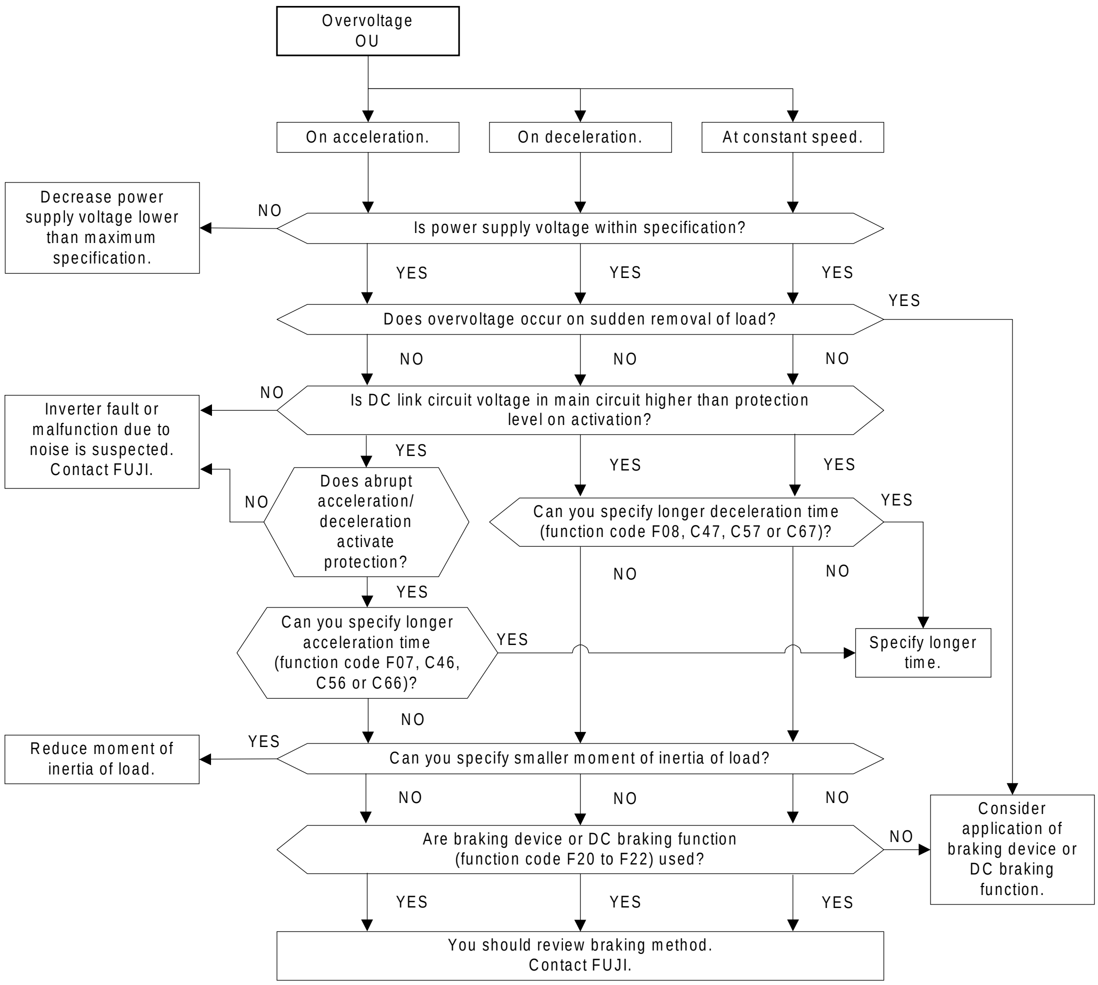


(4) Overvoltage

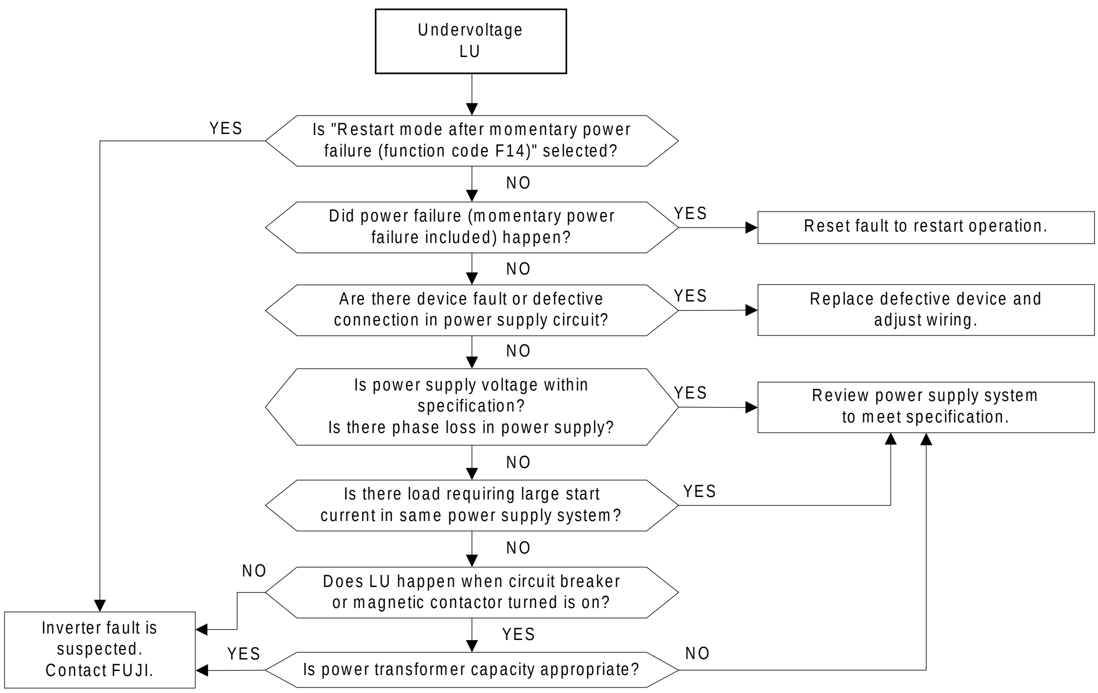
1) Vector control and sensorless vector control



2) V/f control



(5) Undervoltage

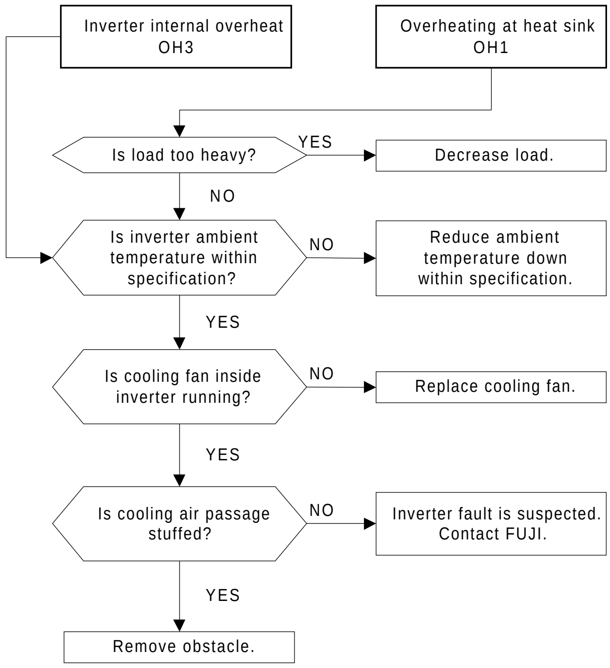


(6) Inverter internal overheat and overheating at heat sink

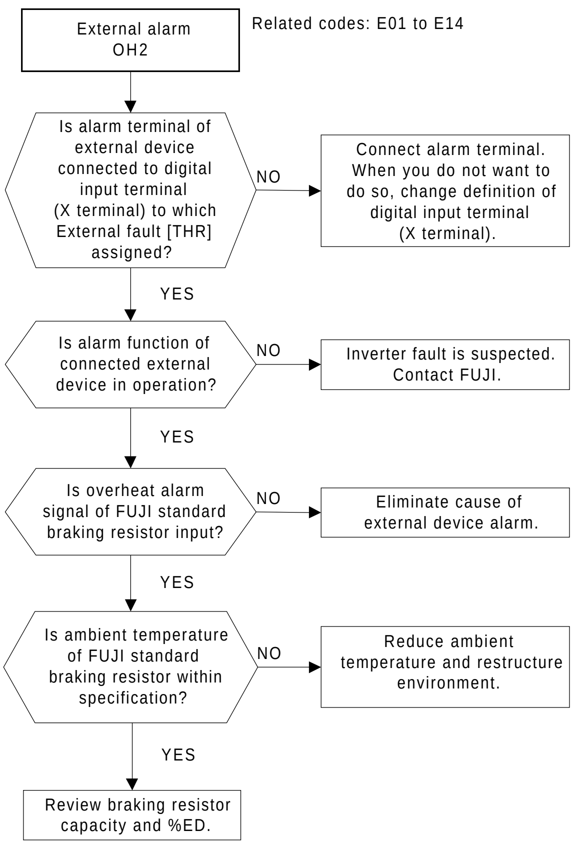
⚠CAUTION

- Heatsink becomes very hot and do not tough it.

You may get burnt.

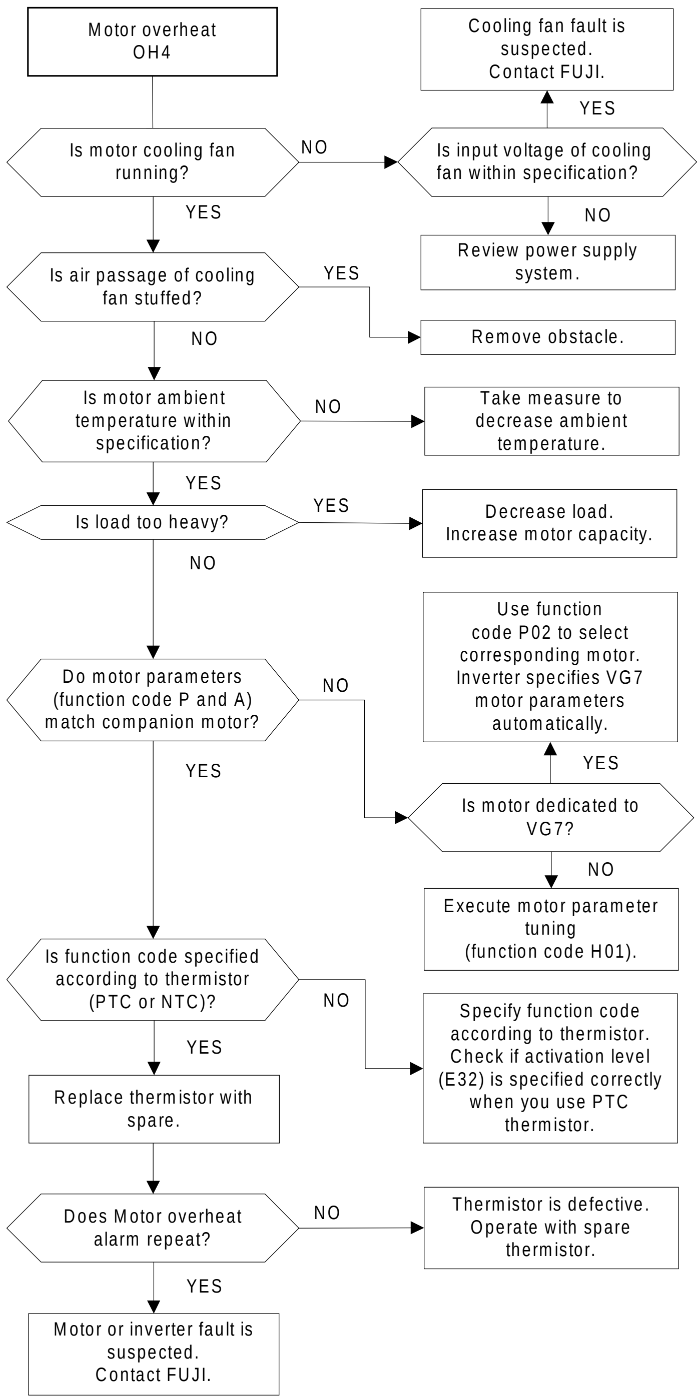


(7) External alarm

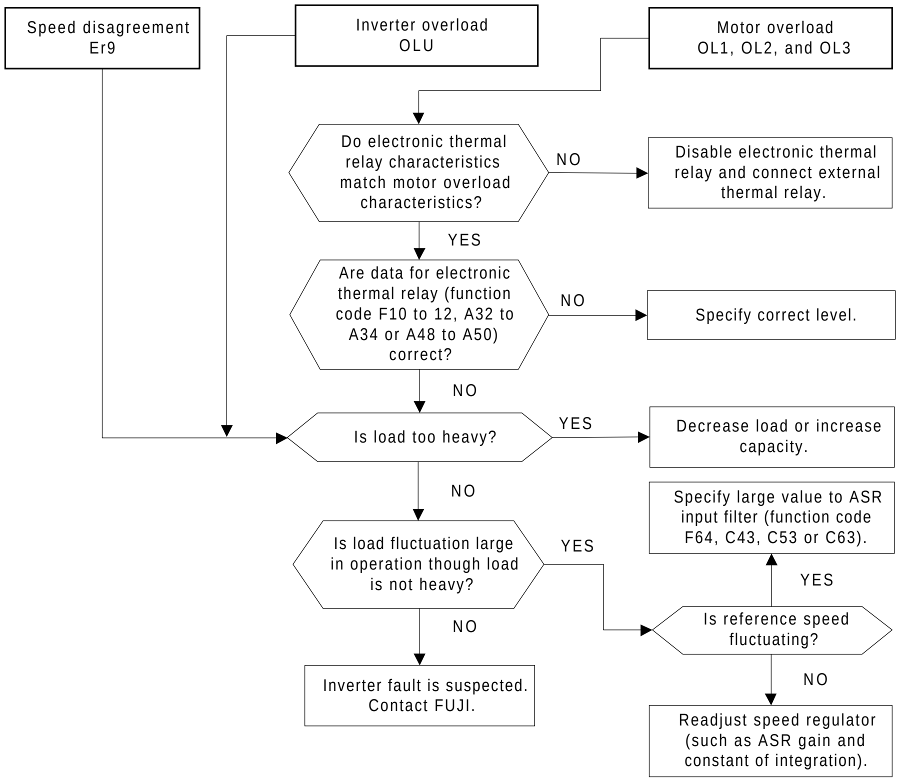


(8) Motor overheat

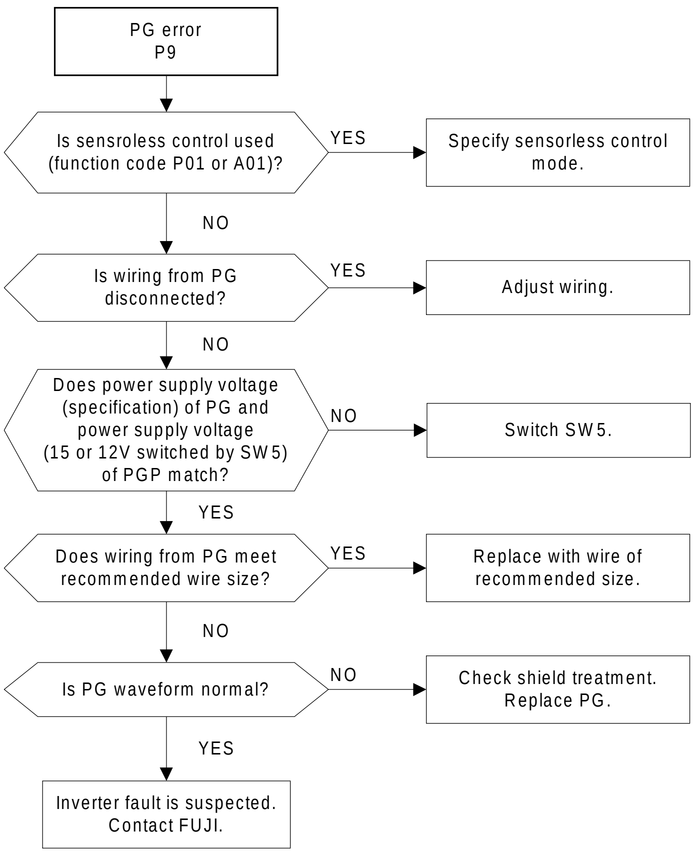
Related codes:
E30, E31, E32, and P30



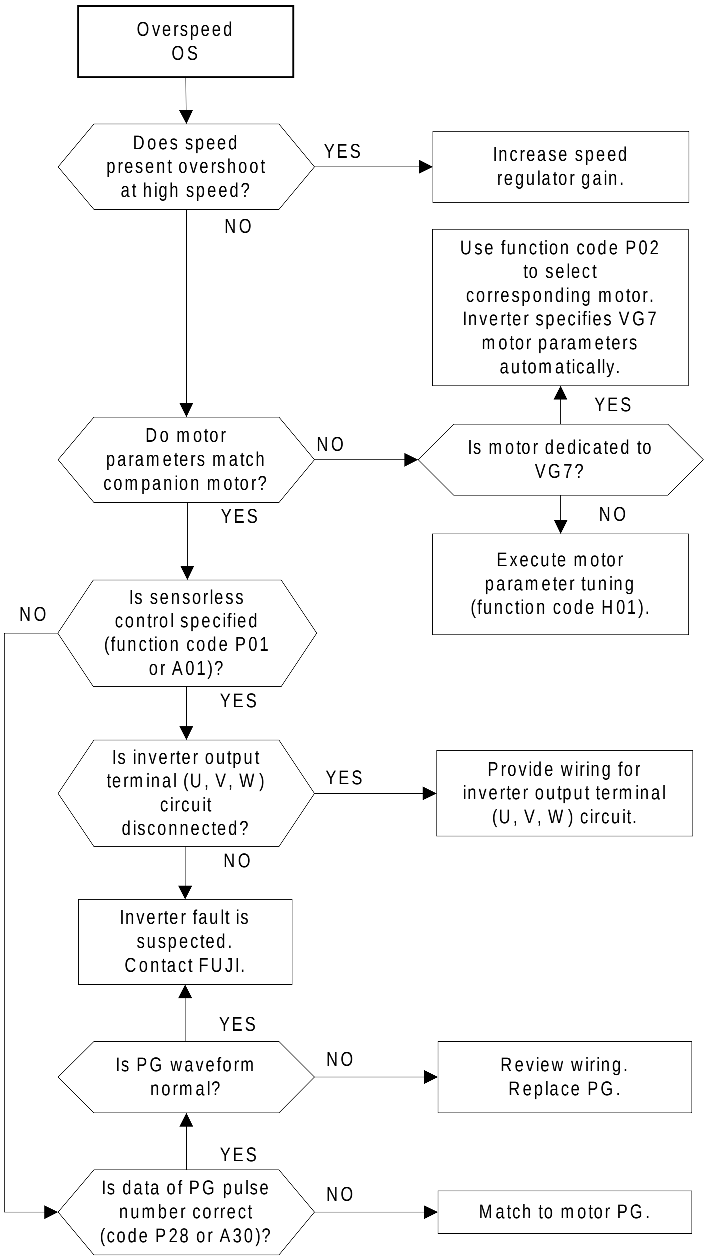
(9) Inverter overload and motor overload



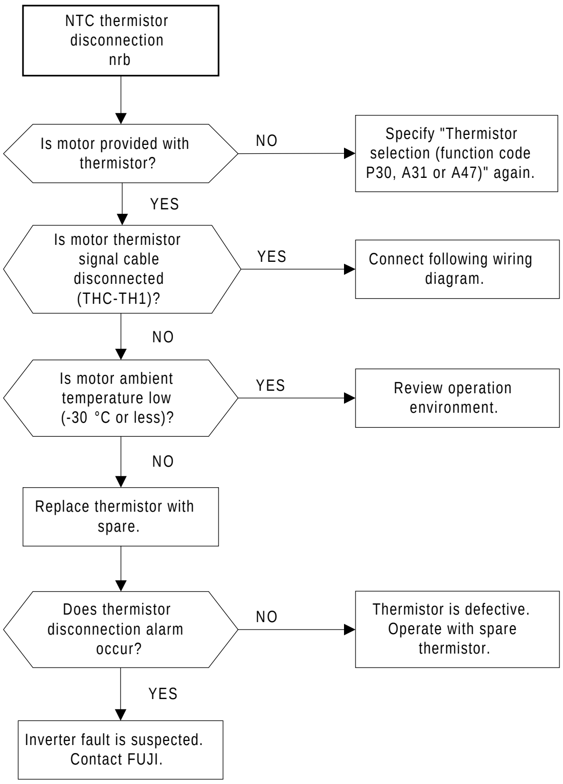
(10) PG error



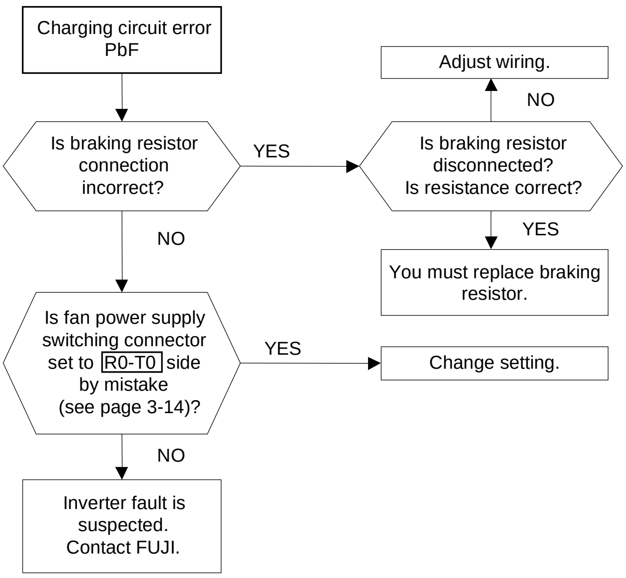
(11) Overspeed



(12) NTC thermistor disconnection



(13) Charging circuit error

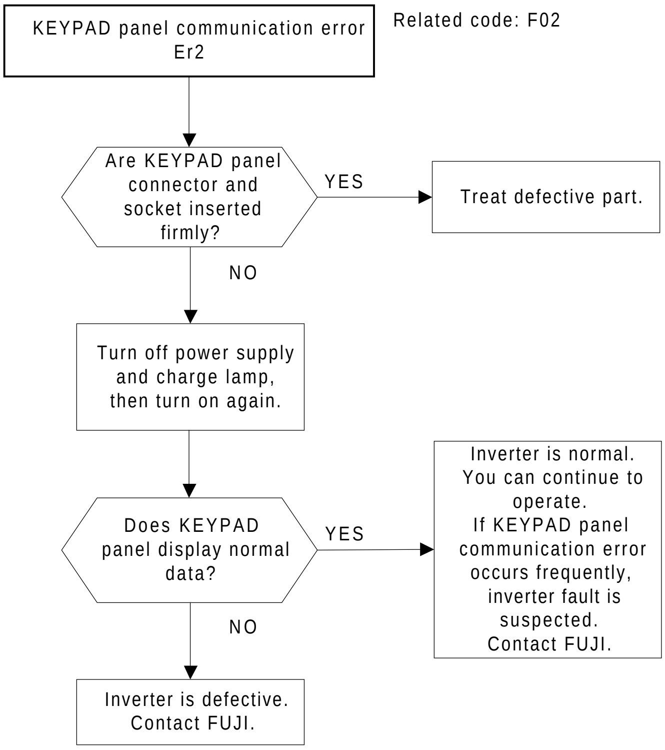


(14) Memory error (Er1)

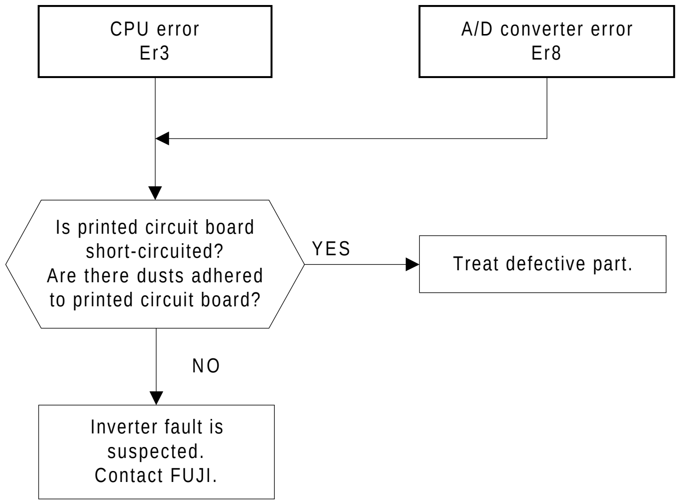
Review the function data before you turn off the power when the memory error occurs. When the data are correct, the error is limited to data in the back up memory. Only if you can use "All save" to save data without reoccurence of Memory error, you can operate the inverter. Check the printed circuit board visually for dusts.

When the function data are abnormal, or memory error occurs frequently while function data are normal, an inverter fault is suspected. Contact FUJI.

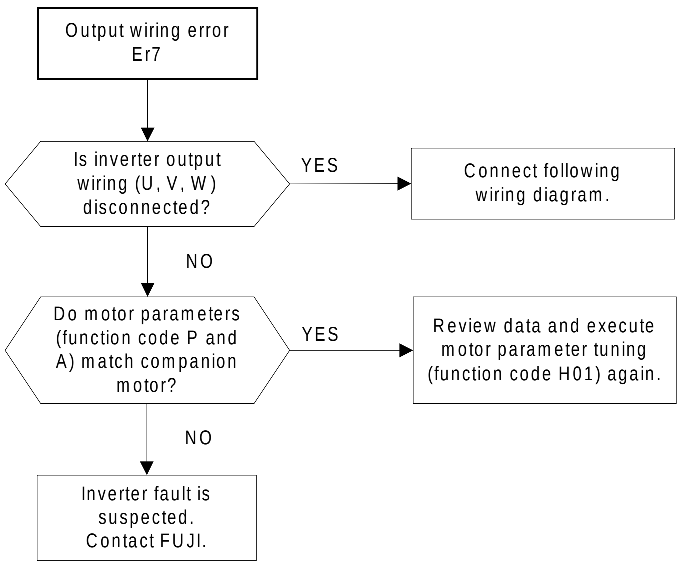
(15) KEYPAD panel communication error



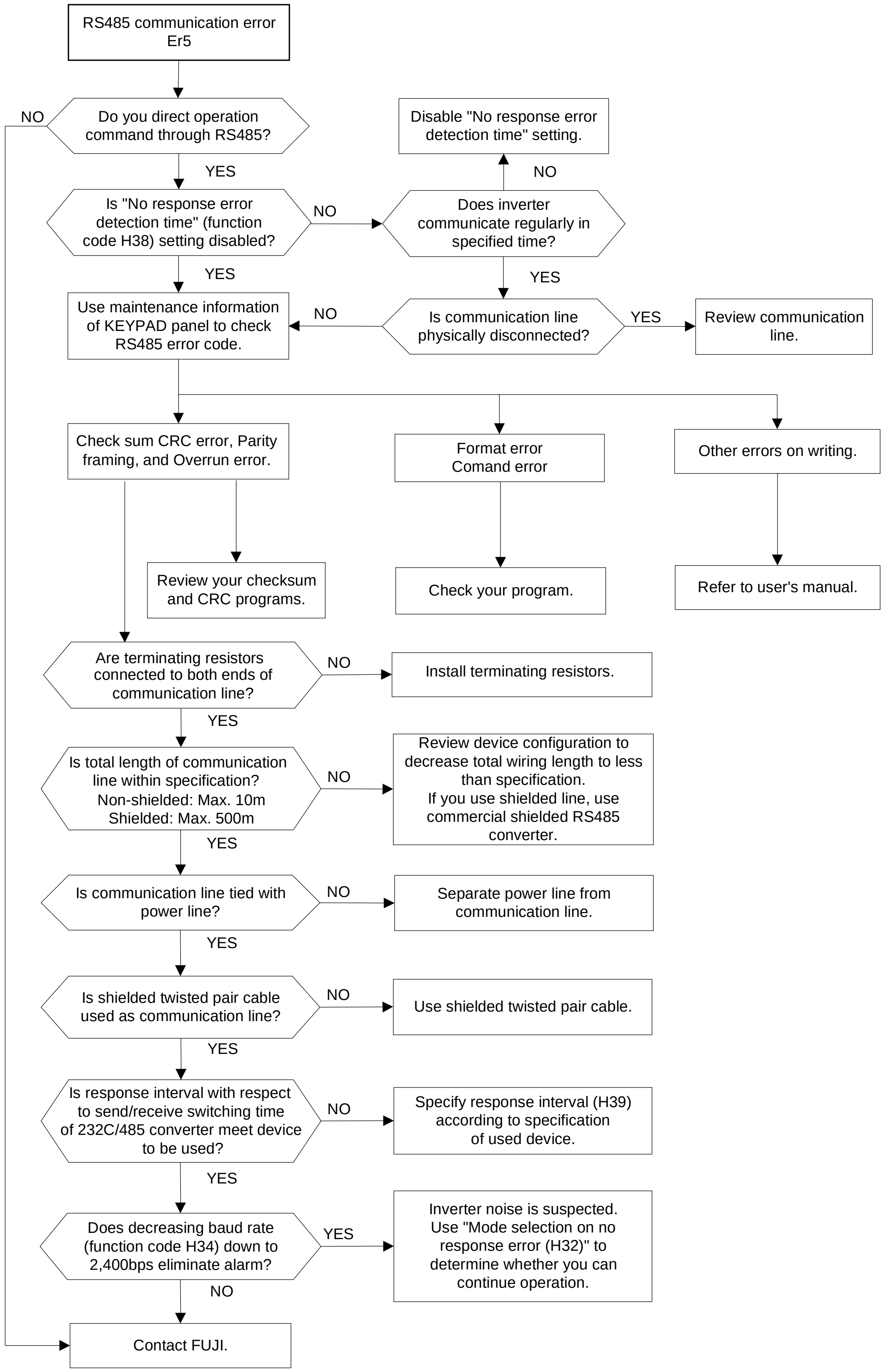
(16) CPU error and A/D converter error



(17) Output wiring error

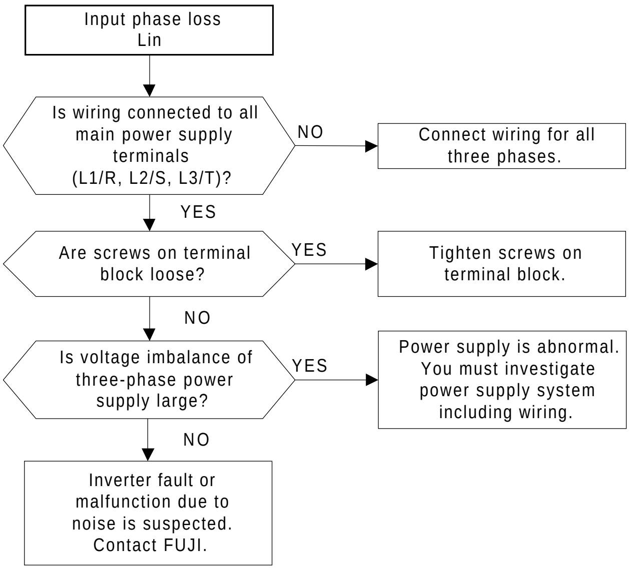


(18) RS485 communication error

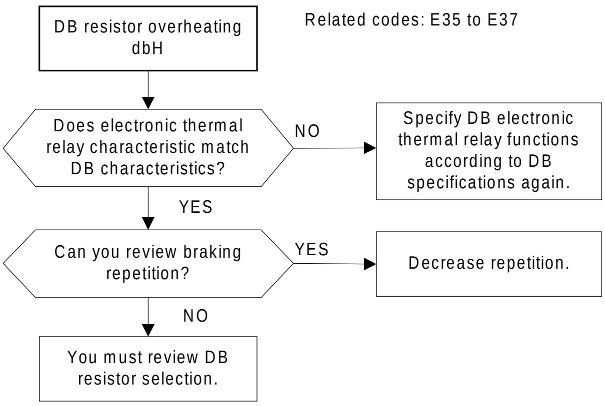


(19) Input phase loss

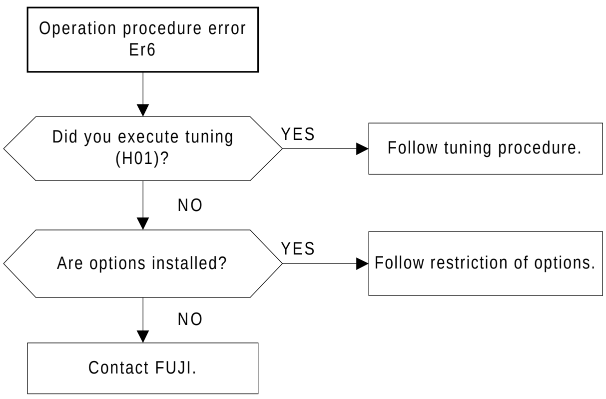
⚠CAUTION
• Turn on the power after you eliminate faults. **You may start fire.**



(20) DB resistor overheating



(21) Operation procedure error



(22) Others

The following alarms are related to options. See User’s Manual for details.

Er4 : Network error. When T-Link, SX bus or field bus option is installed.

ErA : UPAC error. When UPAC option is installed.

Erb : Inter-inverter communication error. When RS or SI option is installed.

- MEMO -

THE INVERTER

Ⅴ. KEYPAD Panel

5. KEYPAD Panel

⚠ WARNING
• If the user set the function codes wrongly or without completely understanding this user's manual, the motor may rotate with a torque or at a speed not permitted for the machine. **Accident or injury may result.** • The STOP key is effective only when its function has been set. Install an emergency stop switch separately. **Accident may result.**

5.1 Appearance of KEYPAD Panel

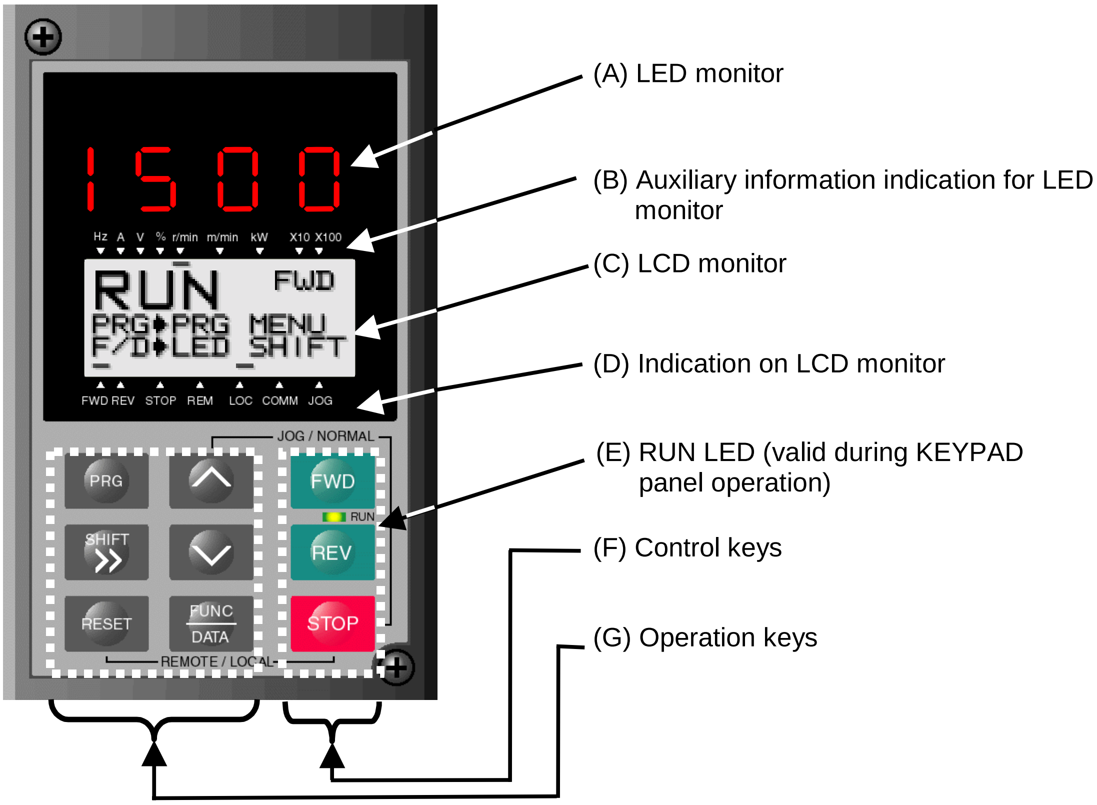


Figure 5-1-1 Appearance of KEYPAD Panel

(A) LED monitor:

Four-digit 7-segment display

Used to display various items of monitored data such as setting frequency, output frequency and alarm code.

(B) Auxiliary information indication for LED monitor:

Selected units or multiple of the monitored data (on the LED monitor) are displayed on the top line of the LCD monitor. The ■ symbol indicates selected units or multiple number. The symbol ▲ indicates there is an upper screen not currently displayed.

(C) LCD monitor:

Used to display such various items of information as operation status and function data. An operation guide message, which can be scrolled, is displayed at the bottom of the LCD monitor.

(D) Indication on LCD monitor:

Displays one of the following operation status with ■.

FWD: Forward operation REV: Reverse operation STOP: Stop

Displays the selected operation method:

REM: External signal LOC: KEYPAD panel COMM: Communication terminal JOG: Jogging mode

The symbol ▼ indicates there is a lower screen not currently displayed.

(E) RUN LED (valid during KEYPAD panel operation):

Indicates that an operation command is being input by pressing the FWD or REV key.

(F) Control keys:

Used for inverter run and stop

FWD : Forward operation command REV : Reverse operation command STOP : Stop command

(G) Operation keys:

Used for screen switching, data change, frequency setting, etc.

The Table 5-1-1 shows the main function of the operation keys.

Table 5-1-1 Functions of Operation Keys

Operation key	Main function
PRG	Used to switch the current screen to the menu screen or switch to the initial screen in the operation/alarm mode.
FUNC DATA	Used to switch the LED monitor or to determine the entered frequency, function code, or data.
∧ , ∨	Used to change data, move the cursor up or down, or scroll the screen.
SHIFT >>	Used to move the cursor horizontally at data change. When this key is pressed with the up or down key, the cursor moves to the next function block.
RESET	Used to cancel current input data and switch the displayed screen. If an alarm occurs, this key is used to reset the trip status (valid only when the alarm mode initial screen is displayed).
STOP + ∧	Used to switch normal operation mode to jogging operation mode or vice versa. The selected mode is displayed on the LCD monitor.
STOP + RESET	Switches operation method (from KEYPAD panel operation to external signal operation or vice versa). When these keys are pressed, function F02 data is also switched from 0 to 1 or from 1 to 0. The selected mode is displayed on the LCD indicator. (REM, LOC)

5. KEYPAD Panel

5.2 Alarm Mode

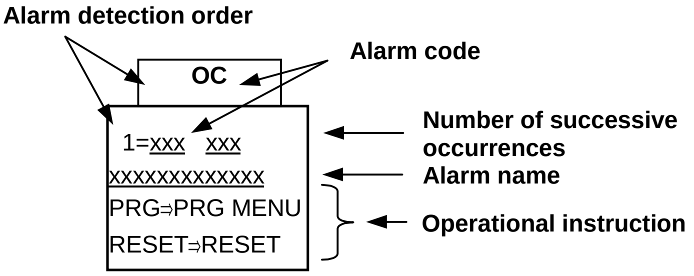


Figure 5-2-1 Alarm Mode Screen

When a single alarm occurs, the alarm mode screen appears where the content of the alarm is indicated.

When multiple alarms occur at the same time, the contents of the alarms can be checked using the ∧ and ∨ keys.

Table 5-2-1 Alarm Detection Order

Operating keys		LED display	LCD display	Content
		5.	5	Alarm No. 5
∧ ↑	∨ ↓	4.	4	Alarm No. 4
		3.	3	Alarm No. 3
		2.	2	Alarm No. 2
		1.	1	Alarm No. 1 (multiple alarms)
		Blank	0	Latest alarm (single alarm/already has been reset)
		Blank	-1	1st latest alarm
		Blank	-2	2nd latest alarm
		Blank	-3	3rd latest alarm
		Blank	-4	4th latest alarm
		Blank	-5	5th latest alarm
		Blank	-6	6th latest alarm
		Blank	-7	7th latest alarm
		Blank	-8	8th latest alarm
		Blank	-9	9th latest alarm
		Blank	-10	10th latest alarm

5.3 KEYPAD Operation System (Hierarchical Structure of LCD Screens)

5.3.1 During Normal Operation

The basic KEYPAD operation system (hierarchical structure of screens) is illustrated below.

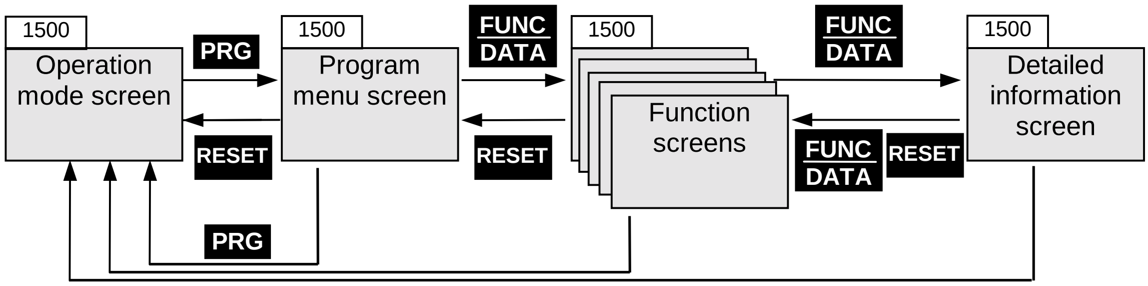


Figure 5-3-1 KEYPAD Operation in Operation Mode

5.3.2 When an Alarm Occurs

When an alarm occurs, the KEYPAD screen system is switched from the normal operation mode to the alarm mode. The alarm mode screen appears where the alarm information is indicated.
The program menu, function, and detailed information screens are similar to those of normal operation.
The program menu screen can be switched to the alarm mode screen using PRG only.

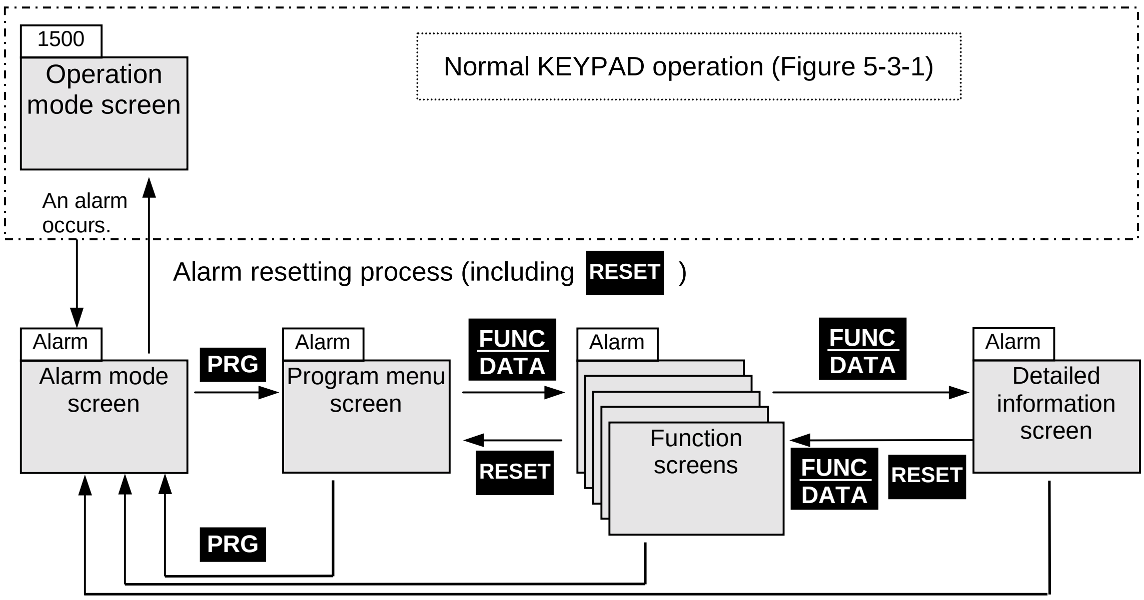


Figure 5-3-2 KEYPAD Operation in Alarm Mode

KEYPAD Panel

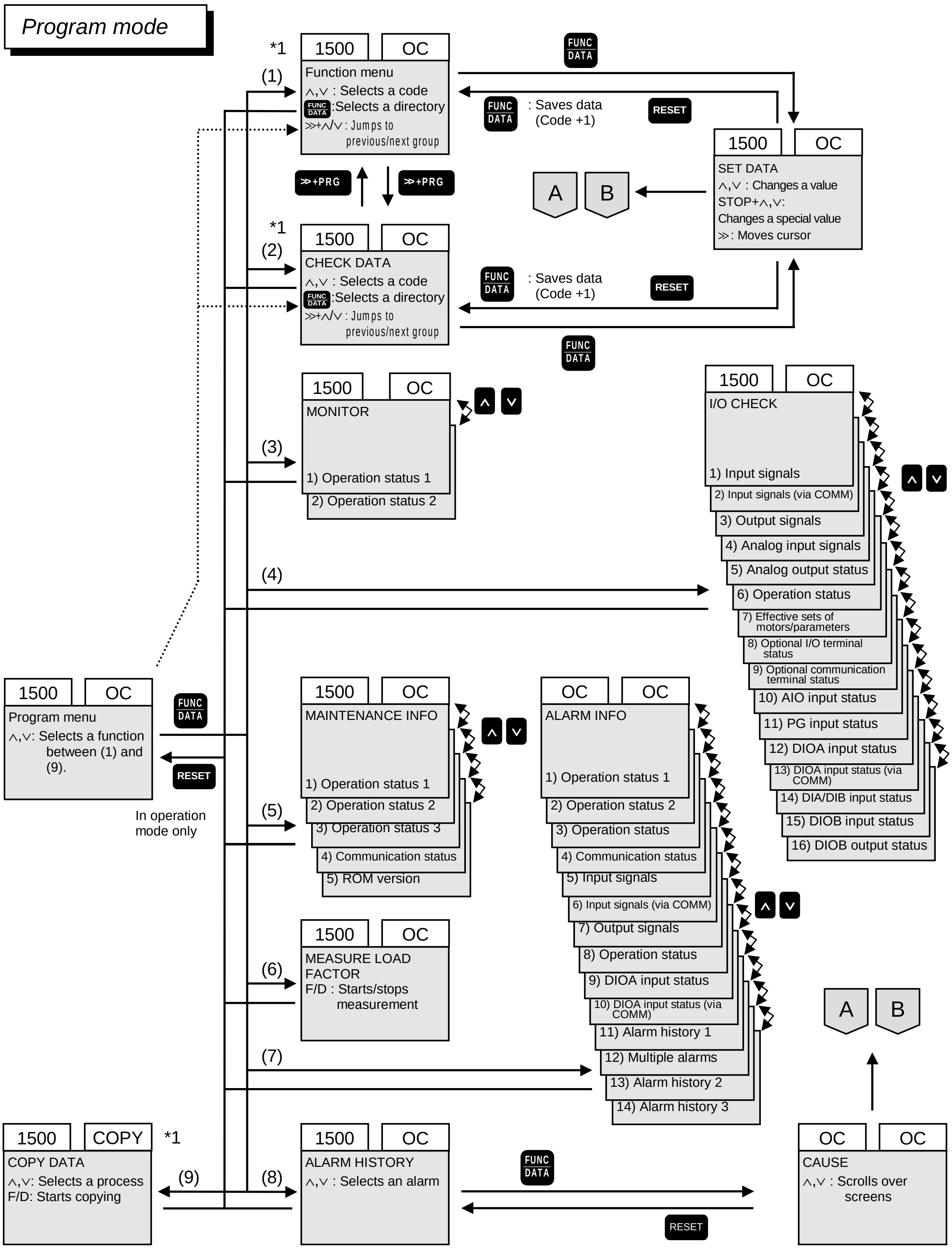
Table 5-3-1 Outline of Indications on Different Screens

<table>
<tr><th>No.</th><th>Screen name</th><th>Description</th></tr>
<tr><td>1</td><td>Operation mode</td><td>You can change motor speed or switch LED monitor when this screen is shown on KEYPAD during normal operation.</td></tr>
<tr><td>2</td><td>Program menu
(Program mode)</td><td>Function menu is shown on this screen for your selection. Select a desired function from menu and press FUNC DATA to call screen for selected function. Menu contains the following options as KEYPAD functions.
<table>
<tr><th>No.</th><th>Menu item</th><th>Outline</th></tr>
<tr><td>1</td><td>Function menu</td><td>If this is selected, a name list of function codes appears. Select a desired code to call data setting screen for that code where its setting can be checked or changed.</td></tr>
<tr><td>2</td><td>CHECK DATA</td><td>If this is selected, a data list of function codes appears. Select a desired code to check its setting. Similar to the SET DATA above, data setting screen can be selected where its setting can be changed.</td></tr>
<tr><td>3</td><td>MONITOR</td><td>This screen is used as operation status monitor to check various data.</td></tr>
<tr><td>4</td><td>I/O CHECK</td><td>This screen is used to check status of inverter and optional analog input/output and digital input/output signals.</td></tr>
<tr><td>5</td><td>MAINTENANCE INFO</td><td>This screen is used to check maintenance information including inverter status, life expectancy, communication errors, and ROM version.</td></tr>
<tr><td>6</td><td>MEASURE LOAD FACTOR</td><td>Maximum and average currents and average braking power can be measured to determine load factor.</td></tr>
<tr><td>7</td><td>ALARM INFO</td><td>This screen is used to check operation status and I/O status at the time of the latest alarm.</td></tr>
<tr><td>8</td><td>ALARM HISTORY</td><td>This screen is used to check the latest alarm, multiple alarms that occurred at the same time, and alarm history. Select an alarm and press FUNC DATA to check cause of that alarm and troubleshooting information.</td></tr>
<tr><td>9</td><td>COPY DATA</td><td>Function code settings for an inverter can be stored and copied to another inverter.</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Function screens</td><td>When a function is selected from program menu, the corresponding function screen appears for execution of that function.</td></tr>
<tr><td>4</td><td>Detailed information screen</td><td>Functions that cannot be executed by function screens (change of function code settings and indication of causes of alarms) are displayed by detailed information screen.</td></tr>
</table>

5.4 KEYPAD Operating Procedures

5.4.1 Transition of Screens

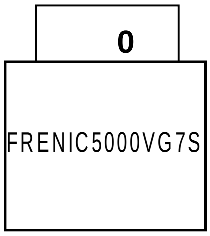
The KEYPAD operation (hierarchical structure of screens) in the program mode is illustrated below.



*1: The functions whose use has been limited by password (function codes L01 and L02) cannot be selected until the password is entered. Unless limited, they can be selected at any time.

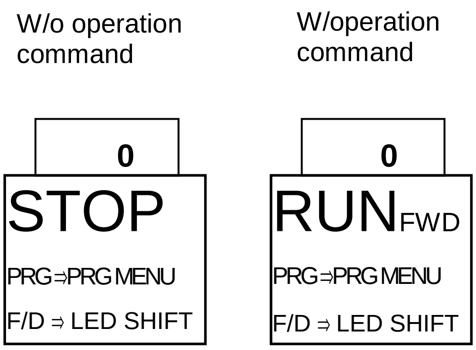
5.4.2 Operation Mode

Initial screen



The screen shown on the left appears for five seconds after power-on. Then, the screen is replaced by the operation mode screen.

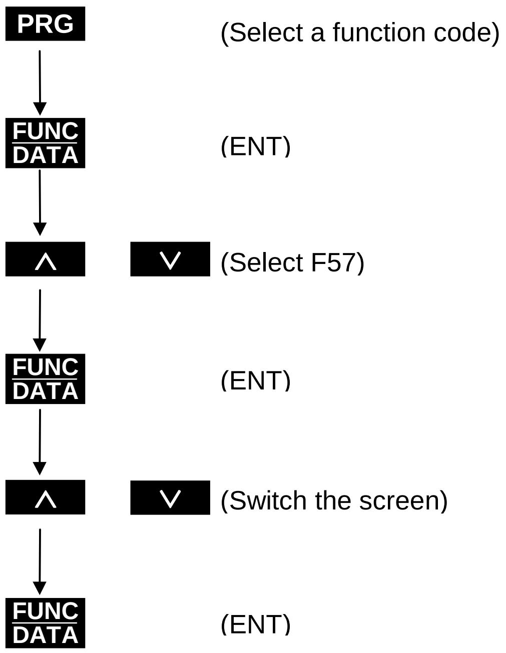
Operation mode screens



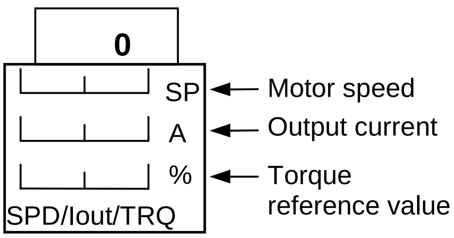
The operation mode screen takes the descriptive form where the inverter operation status and operational instruction are indicated or the graphical form where the operation status is expressed by bar graphs.

The form can be switched with function code F57 (LCD monitor).
(The descriptive form is initially selected.)

To switch to the bar graph screen:



Bar graph screen



Motor speed:
The full scale represents the maximum speed.

Output current:
The full scale represents 200% of the rated inverter output.

Torque reference value:
The full scale represents 200% of the rated motor torque.

5.4.3 Digital Speed Setting Procedure

Digital speed setting screen

```
    1500
<DIG SET SP>
       LOCAL
50~24000
F/D ⇒ STORE
```

Press the ∧ or ∨ key with the operation mode screen to call the digital speed setting screen. (If you do nothing for five minutes, the screen will return to the operation mode.)

Digital speed setting procedure

```
    1500        ← Preset speed
<DIG SET SP>    ← Screen name
       LOCAL    ← Speed setting mode
50~24000        ← Setting range
F/D ⇒ STORE     ← Operation guide
```

Press the ∧ or ∨ key again with the digital speed setting screen to change the digital speed. Keep pressing the ∧ or ∨ key to change the speed in tens, hundreds, or thousands.

```
    1500
<DIG SET SP>
       LOCAL
50~24000
F/D ⇒ STORE
```

Press the SHIFT ≫ key to shift the place where the value is to be changed. (LEDs at the selected place will blink.)

```
    1500
<DIG SET SP>
       LOCAL
50~24000
EXECUTING...
```

Press the FUNC DATA key to store the currently entered speed.

```
    1500
<DIG SET SP>
      REMOTE    ← Current speed setting mode
50~24000
F/D ⇒ STORE
```

If the KEYPAD setting mode has not been selected (Remote or PID screen), the current speed setting mode is indicated on the LCD. If REMOTE is indicated, you can check but cannot change the speed using the ∧ and ∨ keys.

5.4.4 Switching the LED Monitor Indication

Press the FUNC DATA key with the operation mode screen to switch the LED monitor indication. The information given by the monitor changes each time the FUNC DATA key is pressed and the current mode is indicated on the LCD.

Table 5-4-1 Monitor Indication

<table>
<tr><th rowspan="2"></th><th colspan="2">LED monitor</th><th colspan="2">Digital setting mode</th><th rowspan="2">Unit</th><th rowspan="2">Resolution</th></tr>
<tr><th>Running</th><th>Stopping</th><th>Digital speed setting</th><th>PID command</th></tr>
<tr><td>0</td><td>Detected speed 1 *0)</td><td>Setting speed 4 *0)</td><td rowspan="13">Speed reference from KEYPAD</td><td rowspan="29">PID reference from KEYPAD</td><td>r / min</td><td>0-9999: 1-10,000 resolution
10,000-24,000: 10</td></tr>
<tr><td>1</td><td colspan="2">Speed setting 4 *0)</td><td>r / min</td><td>0-9999: 1-10,000 resolution
10,000-24,000: 10</td></tr>
<tr><td>2</td><td colspan="2">Reference output frequency</td><td>Hz</td><td>0.1 to 400.0: 0.1 resolution</td></tr>
<tr><td>3</td><td colspan="2">Reference torque current</td><td>%</td><td>1 %</td></tr>
<tr><td>4</td><td colspan="2">Reference torque</td><td>%</td><td>1 %</td></tr>
<tr><td>5</td><td colspan="2">Calculated torque</td><td>%</td><td>1 %</td></tr>
<tr><td>6</td><td colspan="2">Input power</td><td>F 60= 0;kW
F 60= 1;HP</td><td>0.01 to 99.99 : 0.01
100.0 to 999.9 : 0.1
1000 to : 1</td></tr>
<tr><td>7</td><td colspan="2">Detected output current</td><td>A</td><td>0.01 to 99.99 : 0.01
100.0 to 999.9 : 0.1
1000 to : 1</td></tr>
<tr><td>8</td><td colspan="2">Detected output voltage</td><td>V</td><td>1 V</td></tr>
<tr><td>9</td><td colspan="2">Detected DC link circuit voltage</td><td>V</td><td>1 V</td></tr>
<tr><td>10</td><td colspan="2">Reference flux value</td><td>%</td><td>1 %</td></tr>
<tr><td>11</td><td colspan="2">Calculated flux value</td><td>%</td><td>1 %</td></tr>
<tr><td>12</td><td colspan="2">Motor temperature *1)</td><td>-</td><td>1</td></tr>
<tr><td>13</td><td>Load shaft detected speed</td><td>Load shaft reference speed</td><td>Load speed from KEYPAD</td><td>r / min</td><td>1</td></tr>
<tr><td>14</td><td>Detected line speed</td><td>Reference line speed</td><td rowspan="15">Speed reference from KEYPAD</td><td>m / min</td><td>1</td></tr>
<tr><td>15</td><td colspan="2">Adjusted value of Ai (12)</td><td>%</td><td>0.1 %</td></tr>
<tr><td>16</td><td colspan="2">Adjusted value of Ai (Ai1)</td><td>%</td><td>0.1 %</td></tr>
<tr><td>17</td><td colspan="2">Adjusted value of Ai (Ai2)</td><td>%</td><td>0.1 %</td></tr>
<tr><td>18</td><td colspan="2">Adjusted value of Ai (Ai3) *2)</td><td>%</td><td>0.1 %</td></tr>
<tr><td>19</td><td colspan="2">Adjusted value of Ai (Ai4) *2)</td><td>%</td><td>0.1 %</td></tr>
<tr><td>20</td><td colspan="2">PID reference value *3)</td><td rowspan="3">-</td><td rowspan="3">0.00 to ± 9.99 : 0.01
10.0 to ± 99.9 : 0.1
100 to ± 999 : 1</td></tr>
<tr><td>21</td><td colspan="2">PID feedback value *3)</td></tr>
<tr><td>22</td><td colspan="2">PID output value *3)</td></tr>
<tr><td>23</td><td colspan="2">Optional monitor 1 (HEX) *4)</td><td>HEX</td><td>1</td></tr>
<tr><td>24</td><td colspan="2">Optional monitor 2 (HEX) *4)</td><td>HEX</td><td>1</td></tr>
<tr><td>25</td><td colspan="2">Optional monitor 3 (DEC) *4)</td><td>DEC</td><td>1, × 10</td></tr>
<tr><td>26</td><td colspan="2">Optional monitor 4 (DEC) *4)</td><td>DEC</td><td>1, × 10</td></tr>
<tr><td>27</td><td colspan="2">Optional monitor 5 (DEC) *4)</td><td>DEC</td><td>1, × 10, × 100</td></tr>
<tr><td>28</td><td colspan="2">Optional monitor 6 (DEC) *4)</td><td>DEC</td><td>1, × 10, × 100</td></tr>
</table>

*0): Indicated as an absolute value. *1): If the system is programmed not to indicate the motor speed, "--" appears. *2): Not indicated when optional AIO unit is not connected.
*3): Not indicated when the PID is inactive. *4): Indicated or not indicated, depending on the application.

5.4.5 Menu Screen

⇒1.DATA SET
2.DATA CHECK
3.OPR MNTR
4.I/O CHECK

Press the PRG key with the operation mode screen to call the menu screen.

Move the arrow at the left of the screen to a desired menu using the ∧ or ∨ key. Press the FUNC/DATA key to call the screen for the selected menu.

5.4.6 Function Code Setting Procedure

RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT

↓ PRG

⇒1.DATA SET
2.DATA CHECK
3.OPR MNTR
4.I /O CHECK

↓ FUNC/DATA

F00 DATA PRTC
F01 SPD CMD 1
F02 OPR METHOD
F03 M1- Nmax

Press the PRG key with the operation mode screen to call the menu screen. Move the arrow to “1. SET DATA” using the ∧ or ∨ key. Press the FUNC/DATA key to call the function code setting screen.

Select a desired function code on the function code setting screen using the ∧ or ∨ key.

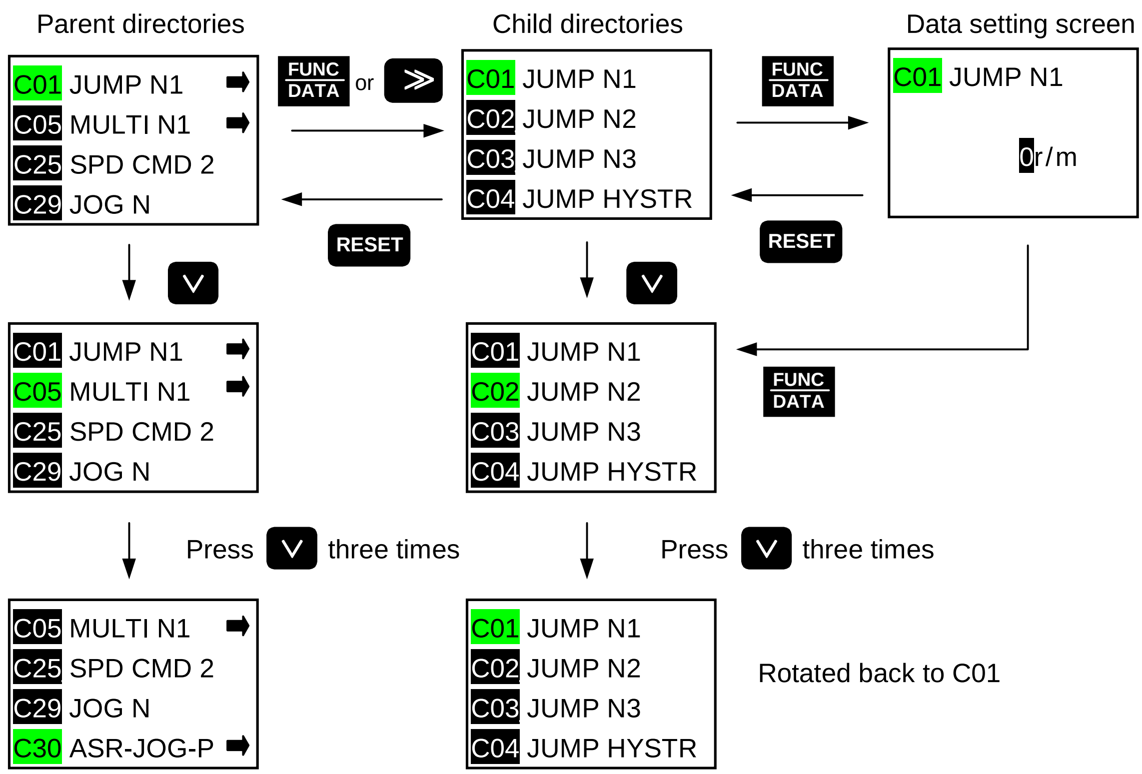
5. KEYPAD Panel

(1) KEYPAD Directory Structure

The directory structure described herein is the same as used for personal computers where a group of function codes are contained in each directory.

For example, function codes C01 to C04 are all related with the mechanical resonance point of the load and considered as the same. Therefore, C02 to C04 are not indicated in the parent directory list. In this case, ➔ appears to the right of C01 to indicate that it has child directories. To open the directory for a function code identified with ➔, move the cursor to that code using the ∧ or ∨ key and press the FUNC DATA key.

An Example of Selecting a Function Code with Child Directories



- ➔ appears to the right of each function code with child directories.
- Press the >> key once (do not keep pressing longer than a second) to call the child directory list for the selected function code.

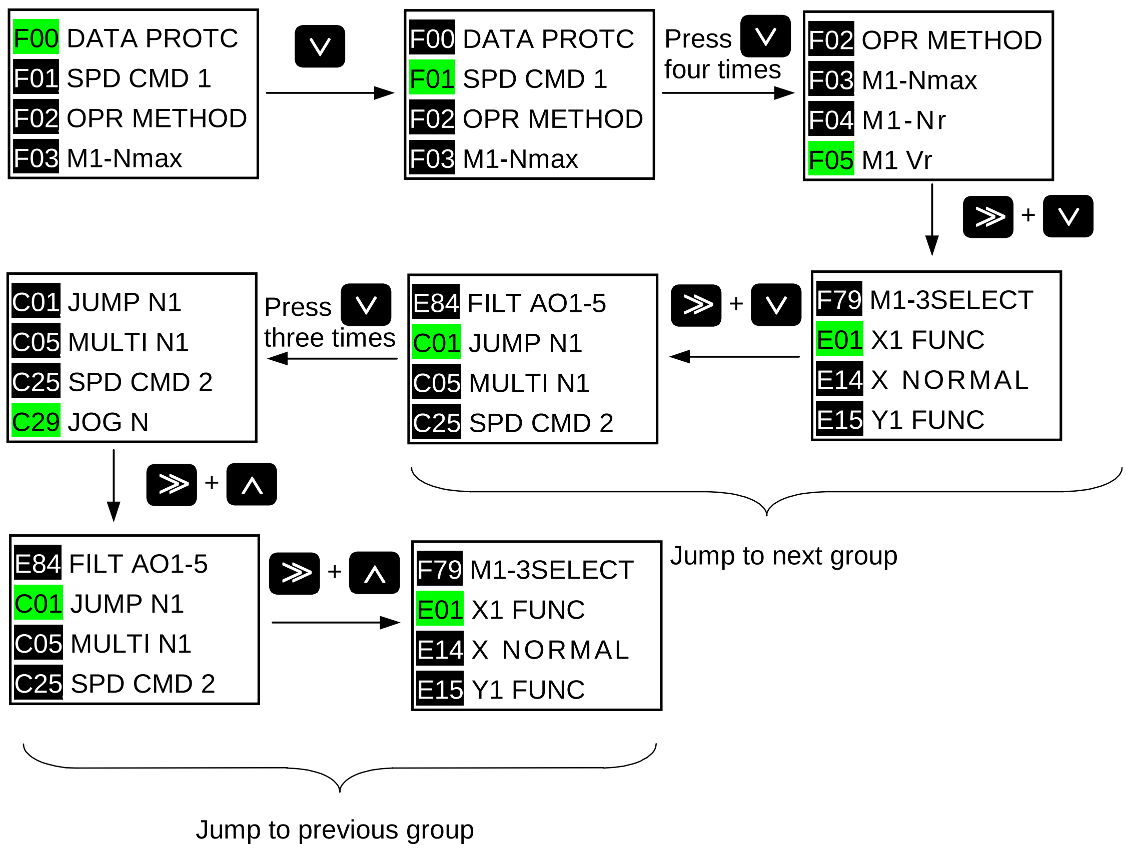
Each function code consists of an alphabet and number. The alphabet represents the function group.

Table 5-4-2 Function Code Groups

Function codes	Functions	Remark
F00 to F80	Fundamental functions	
E01 to E84	Extension terminal functions	
C01 to C73	Control functions of frequency	
P01 to P30	Motor 1 parameters	
H03 to H73	High performance functions	
A01 to A50	Alternative motor parameters	
o01 to o41	Optional functions	Selectable when relevant optional unit is mounted.
L01 to L14	Lifter functions	
U01 to U64	User functions	

(2) Jumping by Group

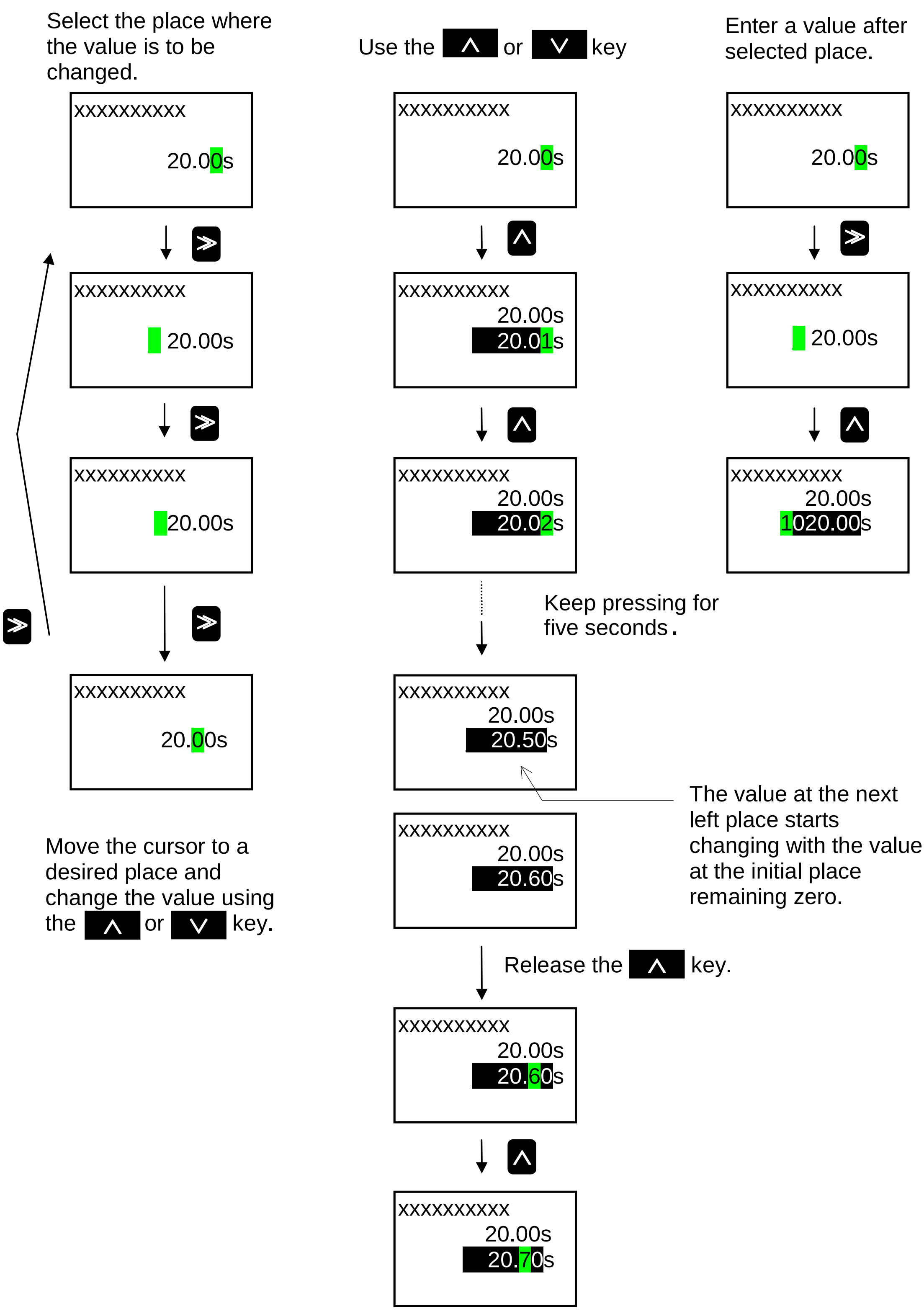
When selecting a function code not shown on the screen, press the ≫ and ∧ or ≫ and ∨ keys to jump to the previous or next group.



(3) Setting Procedures

Ordinary setting procedures

To change a setting, keep pressing the ∧ or ∨ key or select a place using the cursor and directly enter a new value.

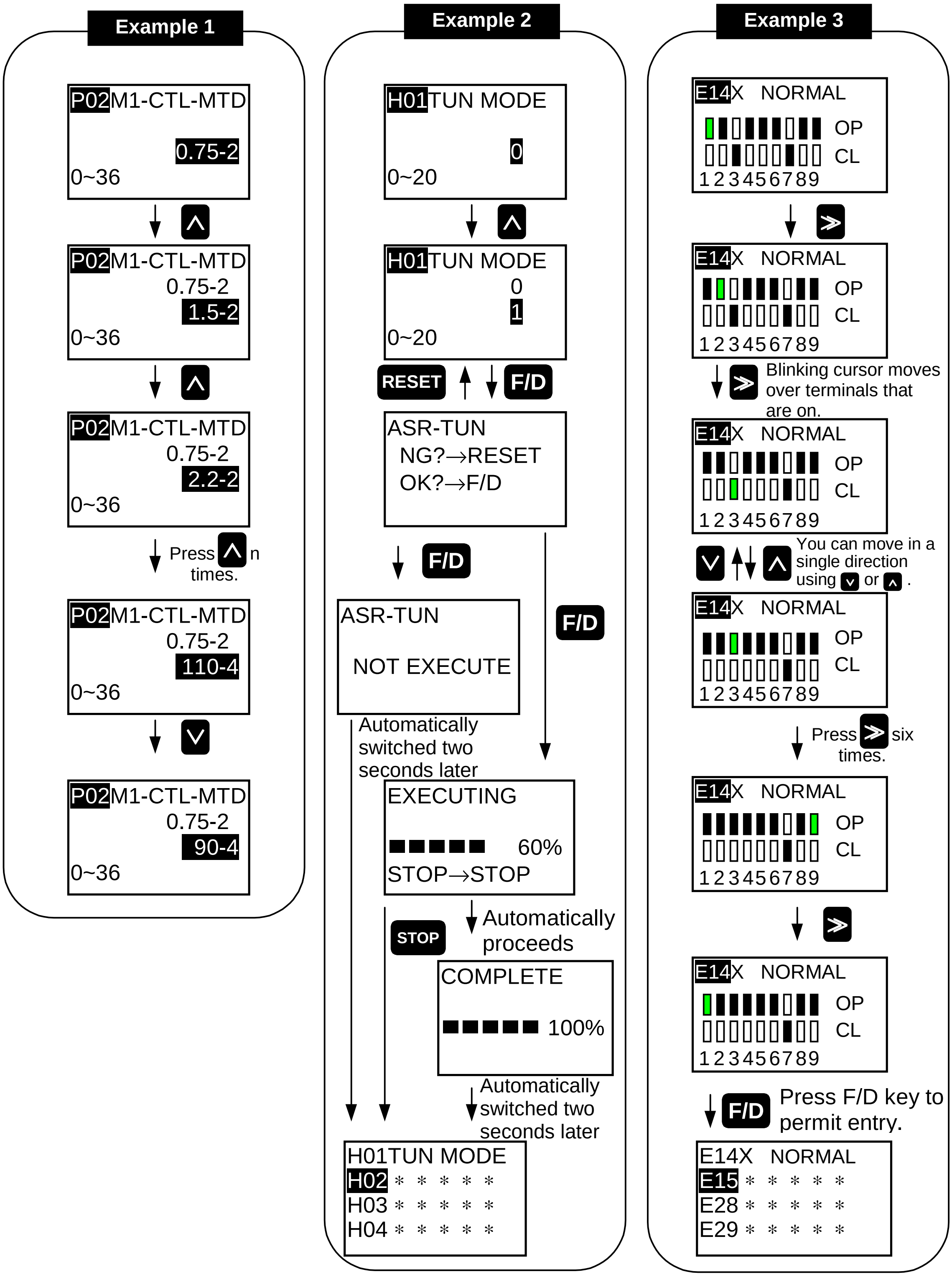


Select a function code. Press FUNC/DATA to call the data setting screen.
Press ∧ or ∨ with the data setting screen to increase or decrease the value in the minimum unit on the LCD.
Keep pressing ∧ or ∨ to increase or decrease the setting in tens, hundreds, or thousands for rapid changing. It is also possible to select a place using ≫ and directly enter a value. Once any setting is changed, the previous value is also indicated for your reference. Press FUNC/DATA to store the new value.
Press RESET to return to the function menu screen without storing the value.
Any function code setting is not reflected on the inverter operation until stored by pressing FUNC/DATA . Some settings cannot be changed when protected or during operation or for another reason. The conditions required for changing them should be satisfied. The reason why the settings cannot be changed is indicated below.

Table 5-4-3 Reasons for Disabling the Change

Indication	Reason	Remedy
NO SIGNAL (WE)	The edit enable command function via general-purpose input terminal has been selected.	Turn on the terminal for function codes set to 19 (edit enable command selected) between E01 and E13.
DATA PRTCTD	Data is protected by function code F00.	Set function code F00 to 0.
INV RUNNING	An attempt was made to change a function code with the inverter running though the change has been disabled during inverter operation.	Stop the inverter.
FWD/REV ON	An attempt was made to change a function code with the FWD/REV command on though the change has been disabled with the FWD/REV command on.	Turn the FWD/REV command off.

Examples of special setting procedures



- Example 1 shows an example of list selection.
  For conventional models, only function codes are listed and the settings should have been changed or stored by referring to the manual. With the list selection capability, codes are listed on the LCD with their contents so that you can change or store the settings while checking the contents. The list selection screens for different function codes are shown in the subsequent pages.
- Example 2 shows an example of transition of screens during tuning process.
- Example 3 shows an example of setting control I/O terminals.
- Some function codes in addition to the above should be programmed in the same manner. Change the settings in reference to the above examples.

(4) List Selection Screens for Function Codes

List selection screens (common to all languages)

1) Data protection
(function code F00)

Code	List
0	0 : CHG OK
1	1 : PROTECT

2) Speed setting N1 and N2
(function codes F01 and C25)

Code	List
0	0 : KEYPAD
1	1 : 12 INPUT
2	2 : 12-ABS
3	3 : U/D-0
4	4 : U/D-BEF
5	5 : U/D-CRP
6	6 : DIA CRD
7	7 : DIB CRD

3) Operation method
(function code F02)

Code	List
0	0 : KEYPAD
1	1 : FWD , REV

4) Electronic thermal relay (select)
(function codes F10, A32, and A48)

Code	List
0	0 : INACTIV
1	1 : ACT-GEN
2	2 : ACT-INV

5) 30RY operation mode
(function code F36)

Code	List
0	0 : EXT-TRP
1	1 : EXT-NOR

6) Torque limiter mode 1
(function code F40)

Code	List
0	0 : INVALID
1	1 : TORQUE
2	2 : POWER
3	3 : TRQ CUR

7) Torque limiter mode 2
(function code F41)

Code	List
0	0 : 4Q LVL1
1	1 : DR/GEN
2	2 : UP/LOW
3	3 : 4Q SEL

8) Torque limiter value (level 1)
(function code F42)

Code	List
0	0 : F44 DAT
1	1 : AI (TL1)
2	2 : DIA CRD
3	3 : DIB CRD
4	4 : PID OUT

9) Torque limiter value (level 2)
(function code F43)

Code	List
0	0 : F45 DAT
1	1 : AI (TL2)
2	2 : DIA CRD
3	3 : DIB CRD
4	4 : PID OUT

11) LED monitor (Display selection)
(function code F55)

Code	List	Code	List
0	00 : SPEED	15	15 : 12 ADJ
1	01 : SPD RF	16	16 : Ai1ADJ
2	02 : FREQ	17	17 : Ai2ADJ
3	03 : TRQ CR	18	18 : Ai3ADJ
4	04 : TRQ RF	19	19 : Ai4ADJ
5	05 : TRQ CL	20	20 : PID RF
6	06 : M PWR	21	21 : PID FB
7	07 : EFT CR	22	22 : PID OU
8	08 : EFT VL	23	23 : OPMON1
9	09 : DC LNK	24	24 : OPMON2
10	10 : M FLXR	25	25 : OPMON3
11	11 : M FLXC	26	26 : OPMON4
12	12 : M TMP	27	27 : OPMON5
13	13 : LD SPD	28	28 : OPMON6
14	14 : LIN SP		

5. KEYPAD Panel

10) Torque reference monitor
(function code F51)

Code	List
0	0 : TRQ POR
1	1 : DRV/GEN

12) LED monitor
(Display at stopping state)
(function code F56)

Code	List
0	0 : REFER
1	1 : DETECT

13) LCD monitor (Display selection)
(function code F57)

Code	List
0	0 : GUIDANC
1	1 : GRAPH D

14) LCD monitor
(Language selection)
(function code F58)

Code	List
0	0 : JAPANES
1	1 : ENGLISH
2	2 : GERMANY
3	3 : FRENCH
4	4 : SPANISH
5	5 : ITALIAN
6	6 : CHINESE

15) Output unit (HP/kW)
selection (function code F60)

Code	List
0	0 : kW DISP
1	1 : HP DISP

16) Motor selection
(function code F79)

Code	List
0	0 : M1 CONT
1	1 : M2 SEL
2	2 : M3 SEL

17) Current rating switching
(function code F80)

Code	List
0	0 : CT
1	1 : VT
2	2 : HT

18) X function selection
(function codes E01 to E13)

Code	List	Code	List	Code	List	Code	List
0	00 : SS1	16	16 : CPN2/1	32	32 : H42CCL	48	48 : PIDINV
1	01 : SS2	17	17 : UP	33	33 : H43CCL	49	49 : PG-CCL
2	02 : SS4	18	18 : DOWN	34	34 : F40CCL	50	50 : LU-CCL
3	03 : SS8	19	19 : WE-KP	35	35 : TL2/1	51	51 : H-TB
4	04 : RT1	20	20 : KP/PID	36	36 : BPS	52	52 : STOP1
5	05 : RT2	21	21 : IVS	37	37 : TB1	53	53 : STOP2
6	06 : HLD	22	22 : IL	38	38 : TB2	54	54 : STOP3
7	07 : BX	23	23 : WE-LK	39	39 : DROOP	55	55 : DIA
8	08 : RST	24	24 : LE	40	40 : ZH-AI1	56	56 : DIB
9	09 : THR	25	25 : U-DI	41	41 : ZH-AI2	57	57 : MT-CCL
10	10 : JOG	26	26 : STM	42	42 : ZH-AI3	58	58 : O-DI1
11	11 : N2/N1	27	27 : SYC	43	43 : ZH-AI4	59	59 : O-DI2
12	12 : M-CH2	28	28 : LOCK	44	44 : REVAI1	60	60 : O-DI3
13	13 : M-CH3	29	29 : EXITE	45	45 : REVAI2	61	61 : O-DI4
14	14 : DCBRK	30	30 : N-LIM	46	46 : REVAI3	62	62 : O-DI5
15	15 : CLR	31	31 : H41CCL	47	47 : REVAI4	63	63 : O-DI6

19) Y function selection
(function codes E15 to E27)

Code	List	Code	List	Code	List
0	00 : RUN	16	16 : SW-M2	32	32 : M-OH
1	01 : N-EX	17	17 : SW-M3	33	33 : M-OL
2	02 : N-AG	18	18 : BRK	34	34 : DB-OL
3	03 : N-AR	19	19 : AL1	35	35 : LK-ERR
4	04 : N-DT1	20	20 : AL2	36	36 : ANL
5	05 : N-DT2	21	21 : AL4	37	37 : ANC
6	06 : N-DT3	22	22 : AL8	38	38 : TBH
7	07 : LU	23	23 : FAN	39	39 : O-DO1
8	08 : B/D	24	24 : TRY	40	40 : O-DO2
9	09 : TL	25	25 : U-DO	41	41 : O-DO3
10	10 : T-DT1	26	26 : INV-OH	42	42 : O-DO4
11	11 : T-DT2	27	27 : SY-C	43	43 : O-DO5
12	12 : KP	28	28 : LIFE	44	44 : O-DO6
13	13 : STOP	29	29 : U-ACC	45	45 : O-DO7
14	14 : RDY	30	30 : U-DEC	46	46 : O-DO8
15	15 : MF-DT	31	31 : INV-OL	47	47 : O-DO9

20) Ai function selection
(function codes E49 to E52)

Code	List	Code	List
0	00:OFF	12	12:M-TMP
1	01:AUX-N1	13	13:N-OR
2	02:AUX-N2	14	14:U-AI
3	03:TLREF1	15	15:PID-FB
4	04:TLREF2	16	16:PID-RF
5	05:TB-REF	17	17:PID-G
6	06:T-REF	18	18:O-AI
7	07:IT-REF		
8	08:CRP-N1		
9	09:CRP-N2		
10	10:MF-REF		
11	11:LINE-N		

21) AO function selection
(function codes E69 to E73)

Code	List	Code	List
0	00:N-FB1+	16	16:TMP-M
1	01:N-FB1±	17	17:TMP-I
2	02:N-REF2	18	18:IM-REF
3	03:N-REF4	19	19:IM
4	04:N-FB2±	20	20:MF-REF
5	05:LIN-N±	21	21:MF
6	06:ITREF±	22	22:T
7	07:ITREF+	23	23:IT
8	08:T-REF±	24	24:I-U
9	09:T-REF+	25	25:I-W
10	10:I-AC	26	26:V-U
11	11:V-AC	27	27:V-W
12	12:PWR	28	28:TBL
13	13:V-DC	29	29:TBG
14	14:P10	30	30:U-AO
15	15:N10	31	31:O-AO

22) Motor control method
(function codes P01 and A01)

Code	List
0	0:PG VECT
1	1:SNSRLES
2	2:EMULAT
3	3:SM VECT

23) Motor
(see the next page)

24) Thermistor selection
(function codes P30, A31, and A47)

Code	List
0	0:UNUSED
1	1:NTC
2	2:PTC
3	3:M-TMP

25) Tuning operation selection
(function code H01)

Code	List
0	0:INACTIV
1	1:ASR-TUN
2	2:R1,L
3	3:AUT-STP
4	4:AUT-ROT

26) Fan stop operation
(function code H06)

Code	List
0	0:INACTIV
1	1:ACTIVE

27) Rev. phase sequence lock
(function code H08)

Code	List
0	0:INACTIV
1	1:ACTIVE

23-1) M1 motor selection
(function code P02) with F60 set to 0 (kW)

Code	List	Code	List
0	00:0.75-2	19	19:7.5-4
1	01:1.5-2	20	20:11-4
2	02:2.2-2	21	21:15-4
3	03:3.7-2	22	22:18.5-4
4	04:5.5-2	23	23:22-4
5	05:7.5-2	24	24:30-4
6	06:11-2	25	25:37-4
7	07:15-2	26	26:45-4Y
8	08:18.5-2	27	27:45-4S
9	09:22-2	28	28:55-4
10	10:30-2	29	29:75-4
11	11:37-2	30	30:90-4
12	12:45-2Y	31	31:110-4
13	13:45-2S	32	32:132-4
14	14:55-2	33	33:160-4
15	15:75-2	34	34:200-4
16	16:90-2	35	35:220-4
17	17:3.7-4	36	36:P-OTR
18	18:5.5-4	37	37:OTHER

23-2) M1 motor selection
(function code P02) with F60 set to 1 (HP)

Code	List	Code	List
0	00: 1-2	19	19: 10-4
1	01: 2-2	20	20: 15-4
2	02: 3-2	21	21: 20-4
3	03: 5-2	22	22: 25-4
4	04:7.5-2	23	23: 30-4
5	05: 10-2	24	24: 40-4
6	06: 15-2	25	25: 50-4
7	07: 20-2	26	26: 60-4Y
8	08: 25-2	27	27: 60-4S
9	09: 30-2	28	28: 75-4
10	10: 40-2	29	29:100-4
11	11: 50-2	30	30:125-4
12	12: 60-2Y	31	31:150-4
13	13: 60-2S	32	32:175-4
14	14: 75-2	33	33:200-4
15	15:100-2	34	34:250-4
16	16:125-2	35	35:300-4
17	17: 5-4	36	36:P-OTR
18	18:7.5-4	37	37:OTHER

28) Energy-saving operation
(function code H10)

Code	List
0	0:INACTIV
1	1:ACTIVE

29) Active drive
(function code H19)

Code	List
0	0:INACTIV
1	1:ACTIVE

30) PID control (operation mode)
(function code H20)

Code	List
0	0:INACTIV
1	1:ACTIVE
2	2:ACT-INV

31) PID control
(Command selection)
(function code H21)

Code	List
0	0:KPAD,12
1	1:PIDS

32) Link function protection
(function code H29)

Code	List
0	0:CHG OK
1	1:PROTECT

33) Serial link
(function code H30)

Code	List
0	0:MONITOR
1	1:REFER
2	2:COMMAND
3	3:REF,COM

34) RS485 (Mode select on no response error)
(function code H32)

Code	List
0	0:EMG STP
1	1:STP LIM
2	2:STP ERR
3	3:DRV CNT

35) RS485 (Baud rate)
(function code H34)

Code	List
0	0 : 38400
1	1 : 19200
2	2 : 9600
3	3 : 4800
4	4 : 2400

36) RS485 (Data length)
(function code H35)

Code	List
0	0 : 8BITS
1	1 : 7BITS

37) RS485 (Parity check)
(function code H36)

Code	List
0	0 : NON
1	1 : EVEN
2	2 : ODD

38) RS485 (Stop bits)
(function code H37)

Code	List
0	0 : 2BITS
1	1 : 1BIT

39) RS485 protocol selection
(function code H40)

Code	List
0	0 : FUJI
1	1 : SX(LDR)
2	2 : RTU

40) Torque reference selection
(function code H41)

Code	List
0	0 : ASR
1	1 : AI-TS
2	2 : DIA CRD
3	3 : DIB CRD
4	4 : COMM
5	5 : PID

41) Torque current reference selection
(function code H42)

Code	List
0	0 : ASR
1	1 : AI-ITCS
2	2 : DIA CRD
3	3 : DIB CRD
4	4 : COMM

42) Magnetic-flux reference selection
(function code H43)

Code	List
0	0 : IN-CALC
1	1 : AI-FLUX
2	2 : H44 DAT
3	3 : COMM

43) Observer type selection
(function code H46)

Code	List
0	0 : INACTIV
1	1 : DISTURB
2	2 : VIBRAT

44) Line speed feedback selection
(function code H53)

Code	List
0	0 : INACTIV
1	1 : AI-LINE
2	2 : DI-PGLD
3	3 : HI SEL

45) Overvoltage suppressing function
(function code H57)

Code	List
1	0 : INACTIV
2	1 : ACTIVE

46) Overcurrent suppressing function
(function code H58)

Code	List
1	0 : INACTIV
2	1 : ACTIVE

47) Load adaptive control function definition 1
(function code H60)

Code	List
0	0 : INACTIV
1	1 : METHOD1
2	2 : METHOD2
3	3 : METHOD3

48) Load adaptive control definition 2 (function code H61)

Code	List
0	0 : FWD-UP
1	1 : FWD-DWN

49) Reserved 2 (function code H71)

Code	List
0	0 : INACTIV
1	1 : ACR-TUN
2	2 : VGAIN-T
3	3 : V OFFST
4	4 : I-UMBLC
5	5 : POLE-TU

50) DIA/DIB function selection (function codes o01 and o02)

Code	List
0	0 : BINARY
1	1 : BCD

52) Action on communication error (function code o30)

Code	List
0	0 : EMG STP
1	1 : STP LIM
2	2 : STP ERR
3	3 : DRV CNT

53) Communication format (function code o32)

Code	List
0	0 : 4W+4W
1	1 : 8W+8W

54) Multiwinding system (function code o33)

Code	List
0	0 : INACTIV
1	1 : ACTIVE

55) UPAC function (function code o38)

Code	List
0	0 : INACTIV
1	1 : ACTIVE
2	2 : ACT-INI

56) Fixed S-shaped pattern (function code L04)

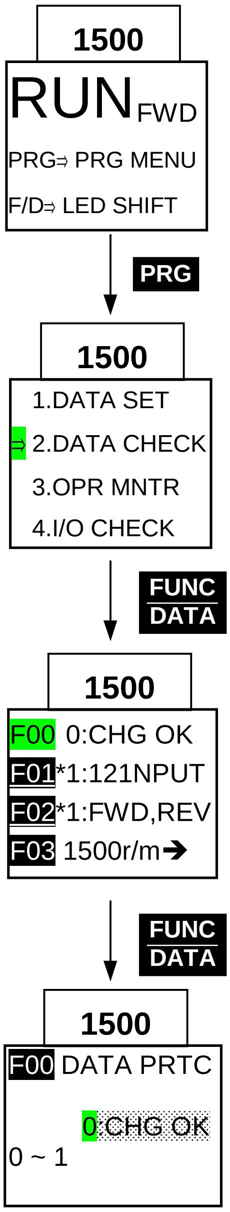
Code	List
0	0 : INACTIV
1	1 : METHOD1
2	2 : METHOD2
3	3 : METHOD3

58) Inverter capacity (function code n01)

Code	List	Code	List	Code	List
0	00 : 0.75-2	11	11 : 37-2	22	22 : 22-4
1	01 : 1.5-2	12	12 : 45-2	23	23 : 30-4
2	02 : 2.2-2	13	13 : 55-2	24	24 : 37-4
3	03 : 3.7-2	14	14 : 75-2	25	25 : 45-4
4	04 : 5.5-2	15	15 : 90-2	26	26 : 55-4
5	05 : 7.5-2	16	16 : 3.7-4	27	27 : 75-4
6	06 : 11-2	17	17 : 5.5-4	28	28 : 90-4
7	07 : 15-2	18	18 : 7.5-4	29	29 : 110-4
8	08 : 18.5-2	19	19 : 11-4	30	30 : 132-4
9	09 : 22-2	20	20 : 15-4	31	31 : 160-4
10	10 : 30-2	21	21 : 18.5-4	32	32 : 200-4

Code	List	Code	List
33	33 : 220-4	44	44 : OTR-6
34	34 : 250-4	45	45 : OTR-7
35	35 : 280-4	46	46 : OTR-8
36	36 : 315-4	47	47 : OTR-9
37	37 : 355-4	48	48 : OTR-10
38	38 : 400-4		
39	39 : OTR-1		
40	40 : OTR-2		
41	41 : OTR-3		
42	42 : OTR-4		
43	43 : OTR-5		

5.4.7 Checking the Function Code Settings



Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "2. CHECK DATA" using the ∧ or ∨ key. Press the FUNC/DATA key to call a list of function codes and their settings to the LCD.

Select the function code which is to be checked using the ∧ or ∨ key with the same procedure as described in 5.4.6 "Function Code Setting Procedure".

Select a function code and change its setting. Press the FUNC/DATA key to store the new value as you do on the function code setting screen.

5.4.8 Operation Status Monitor

Press the **PRG** key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "3. MONITOR" using the **∧** or **∨** key. Press the **FUNC DATA** key to check the current inverter operation status on the LCD.

1500
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT

↓ **PRG**

1500
1.DATA SET
2.DATA CHECK
⇒ 3.OPR MNTR
4.I/O CHECK

↓ **FUNC DATA**

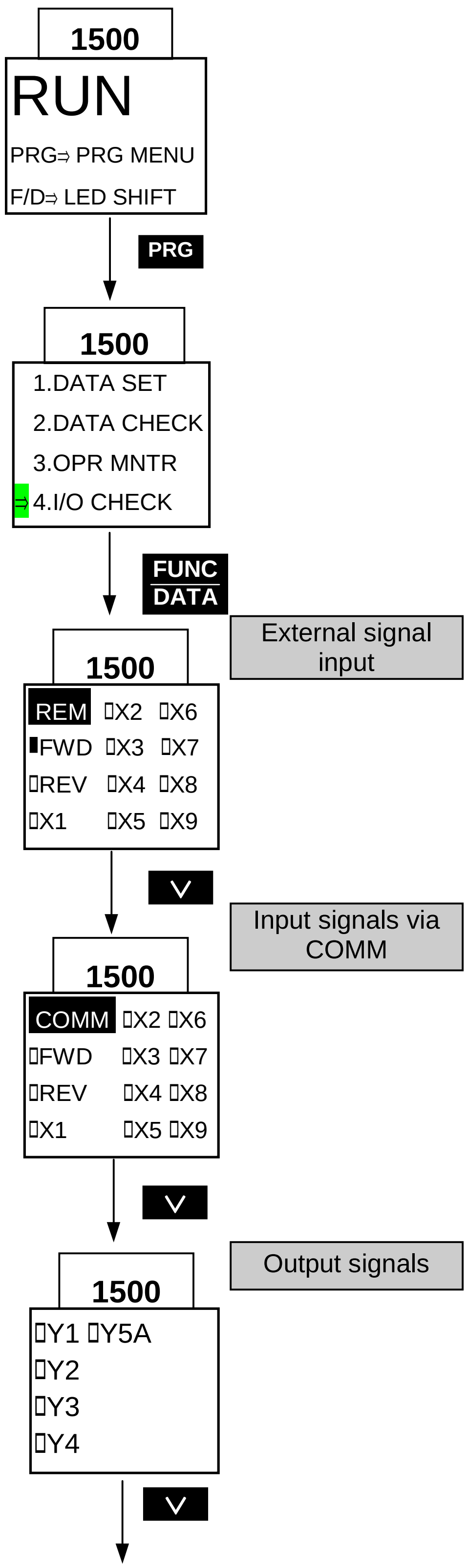
There are two operation status monitor screens. Press the **∧** or **∨** key to call the other screen.

Display	Description
1500	LED monitor (The latest alarm code blinks quickly when an alarm is issued.)
N*= xxxxx. xr/m	Speed setting 4 (rounded to a decimal)
N = xxxxx. xr/m	Detected speed 1 (rounded to a decimal)
f* = xxx. xHz	Reference output frequency
TRQ= xxx%	Reference torque

↓ **∨**

Display	Description
1500	
TMP = ± xxx°C	Motor temperature ("---" appears with NTC thermistor not connected)
Iout=xxxx. xx A	Detected output current
Vout= xxx V	Detected output voltage
FLX*= xxx%	Reference flux value

5.4.9 I/O Check



Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to “4. I/O CHECK” using the ∧ or ∨ key. Press the FUNC/DATA key to check the status of inverter and optional analog input/output and digital input/output units on the LCD.

There are sixteen I/O check screens. Press the ∧ or ∨ key to call the previous or next screen. The I/O status of each optional unit is only indicated when the optional unit is mounted.

This screen is used to check input signals to the terminal block (REM).

□ : Signal off , ■ : Signal on

This screen is used to check input signals via the link (COMM).

□ : Signal off , ■ : Signal on

This screen is used to check the on/off status of the functions assigned to Y1 to Y5A.

□ : Signal off , ■ : Signal on

1500

12 =± xx. xV
Ai1=± xx. xV
Ai2=± xx. xV

Analog input signals (AI)

This screen is used to check analog input voltages to the terminal block (–10.0 to +10.0 V).

[1] Analog input signal (12)
[2] Analog input signal (Ai1)
[3] Analog input signal (Ai2)
[4] Not used

1500

AO1 =± xx. xV
AO2 =± xx. xV
AO3 =± xx. xV

Analog output status (AO)

This screen is used to check the status of the functions assigned to analog output terminals (–10.0 to +10.0 V).

[1] Analog output signal (AO1)
[2] Analog output signal (AO2)
[3] Analog output signal (AO3)
[4] Not used

1500

□FWD□BRK□IL
□REV□NUV□ACC
□EXT □TL □DEC
□INT □VL □ALM

Operation status

This screen is used to check the inverter operation status.
□ : Signal off , ■ : Signal on

FWD: Forward operation
EXT: Pre-exciting
BRK: Braking

TL: Torque limiting
IL: Current limiting
DEC: Decelerating

REV: Reverse operation
INT: Inverter shut off
NUV: DC link circuit voltage established (ready for operation)
VL: Voltage limiting
ACC: Accelerating
ALM: Alarm output (for any fault)

1500

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

Effective sets of motors/parameters

Indicates currently effective sets.
□ : Signal off , ■ : Signal on

PARA 1 (F07, F08, and F61 to F70) JOG (C30 to C38)
PARA 2 (C40 to C49)
PARA 3 (C50 to C59)
PARA 4 (C60 to C69)
M1 (F03 to F05, F10 to F12, and P codes)
M2 (A01 to A34)
M3 (A35 to A50)

1500

□DIA □DIB
□DIOA □DIOB
□AIO □PMPG
□PG-LD□PG-PD

Status of optional I/O units

Indicates the status of optional I/O units.
□ : Signal off , ■ : Signal on

DIA, DIB (OPC-VG7-DIA, DIB)
DIOA, DIOB (OPC-VG7-DIOA, DIOB)
AIO (OPC-VG7-AIO)
PMPG (OPC-VG7-PMPG)
PG-LD, PD (OPC-VG7-PG)

1500

□PG-PR	□PG-SD
□UPAC	□SX
□TL	□FIELD
□SI-UP	□SI-MW

Status of optional I/O communication units

Indicates the status of optional I/O communication units.
□ : Signal off , ■ : Signal on

PG-PR, SD (OPC-VG7-PG)
UPAC (OPC-VG7-UPAC)
SX (OPC-VG7-SX)
TL (OPC-VG7-TL)
FIELD (optional field bus)
SI-UP, MW (OPC-VG7-SI)

∨

* The following information is indicated when the optional AIO unit is mounted.

1500

Ai3 =±xx. x V
Ai4 =±xx. x V
AO4 =±xx. x V
AO5 =±xx. x V

I/O status of optional AIO unit

[1] I/O status 1 of AIO (Ai3) ... “---” appears with AIO not connected.
[2] I/O status 1 of AIO (Ai4) ... “---” appears with AIO not connected.
[3] I/O status 2 of AIO (AO4) ... “---” appears with AIO not connected.
[4] I/O status 2 of AIO (AO5) ... “---” appears with AIO not connected.

∨

1500

SD =± xxxxxp/s
LD =± xxxxxp/s
PR =± xxxxxp/s
PD =± xxxxxp/s

Input status of inverter/optional PG (SD, LD, PR, and PD)

[1] Input status of inverter/PG (SD) signal; Open collector: Phase A/B x4 frequency, SD: line driver phase A/B
[2] Input status of PG (LD) signal ... “---” appears with PG (LD) not connected.
[3] Input status of PG (PR) signal ... “---” appears with PG (PR) not connected.
[4] Input status of PG (PD) signal ... “---” appears with PG (PD) not connected.

∨

* The following information is indicated when the optional DIOA unit is mounted.

1500

R□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit

□ : Signal off , ■ : Signal on

∨

1500

C□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of DIOA (via COMM)

□ : Signal off , ■ : Signal on

∨

* The following information is indicated when the optional DIA/DIB unit is mounted.

1500

□DIA □BCD□BIN
A = XXXXX
□DIB □BCD□BIN
B = XXXXX

Input status of optional DIA/DIB unit

[1 and 3] Function codes o01 and o02 are used to switch the optional unit between DIA and DIB (BCD or binary) and between BCD and binary respectively.

□ : Signal off , ■ : Signal on

[2] Input status of optional DIA unit
[4] Input status of optional DIB unit

∨

* The following information is indicated when the optional DIOB unit is mounted.

1500

X□21□25□29□33
□22□26□30□34
□23□27□31□35
□24□28□32□36

Input status of optional DIOB unit

□ : Signal off , ■ : Signal on

∨

1500

□Y21□Y25□Y29
□Y22□Y26□Y30
□Y23□Y27
□Y24□Y28

Output status of optional DIOB unit

□ : Signal off , ■ : Signal on

5.4.10 Maintenance Information

```
1500
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT
```

↓

Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to “5. MAINTENANCE INFO” using the ∧ or ∨ key. Press the FUNC/DATA key to call the information necessary for maintenance and inspection on the LCD.

```
1500
 1.DATA SET
 2.DATA CHECK
 3.OPR MNTR
 4.I/O CHECK
⇒5.MAINTENANC
```

↓

There are five maintenance information screen. Press the ∧ or ∨ key to call the previous or next screen.

Operation status 1

```
1500
TIME= xxxxxh
EDC =  xxxV
TMPI=  xxx°C
TMPF=  xxx°C
```

[1] Cumulative operation hours
[2] Detected DC link circuit voltage
[3] Maximum inverter inside air temperature (within an hour)
[4] Maximum heat sink temperature (within an hour)

↓ ∨

Operation status 2

```
1500
Imax=xxxx.xxA
CAP =  xxx. x%
```

[1] Maximum effective current (within an hour)
[2] Main capacitor capacity

↓ ∨

1500

TCAP= xxxxxh
(61000h)
TFAN= xxxxxh
(25000h)

Operation status 3

[1] Cumulative operation hours of capacitor on PC board
[2] Estimated remaining life of capacitor on PC board (fixed)
[3] Cooling fan operation hours
[4] Estimated remaining life of cooling fan (fixed)

∨

1500

NRK=xxxxx
NRR=xxxxx xx
NRO=xxxxx xx
NRL=xxxxx xx

Communication status

This screen indicates the number of communication errors that have occurred with each unit and the code representing the cause of the latest error. For details of codes, see the description of each optional unit or RS485.

[1] Number of communication retries for KEYPAD
[2] Number of communication retries and latest error code for RS-485
[3] Number of communication retries and latest error code for T-Link/SX
[4] Number of communication retries and latest error code for optional SI/RS unit

Numbers of communication errors detected by the inverter. "--" appears when no error has occurred.

∨

1500

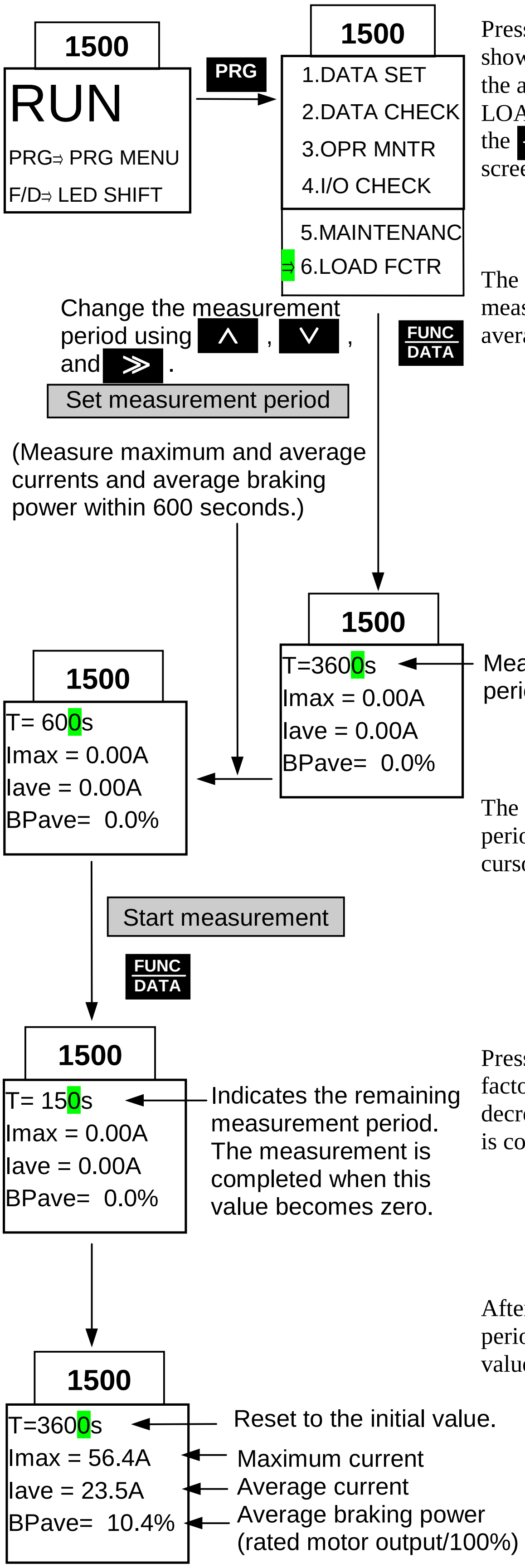
MAIN=H1xxxx
MTR =H2xxxx
KP =K0xxxx

ROM version

The screen indicates the ROM number of the inverter control CPU. Fuji Electric may ask the ROM version in case of a malfunction.

[1] ROM version of main control CPU (MAIN)
[2] ROM version of motor control CPU (MTR)
[3] ROM version of KEYPAD
[4] Not used

5.4.11 Measurement of Load Factor



Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to "6. MEASURE LOAD FACTOR" using the ∧ or ∨ key. Press the FUNC DATA key to call the load factor measurement screen on the LCD.

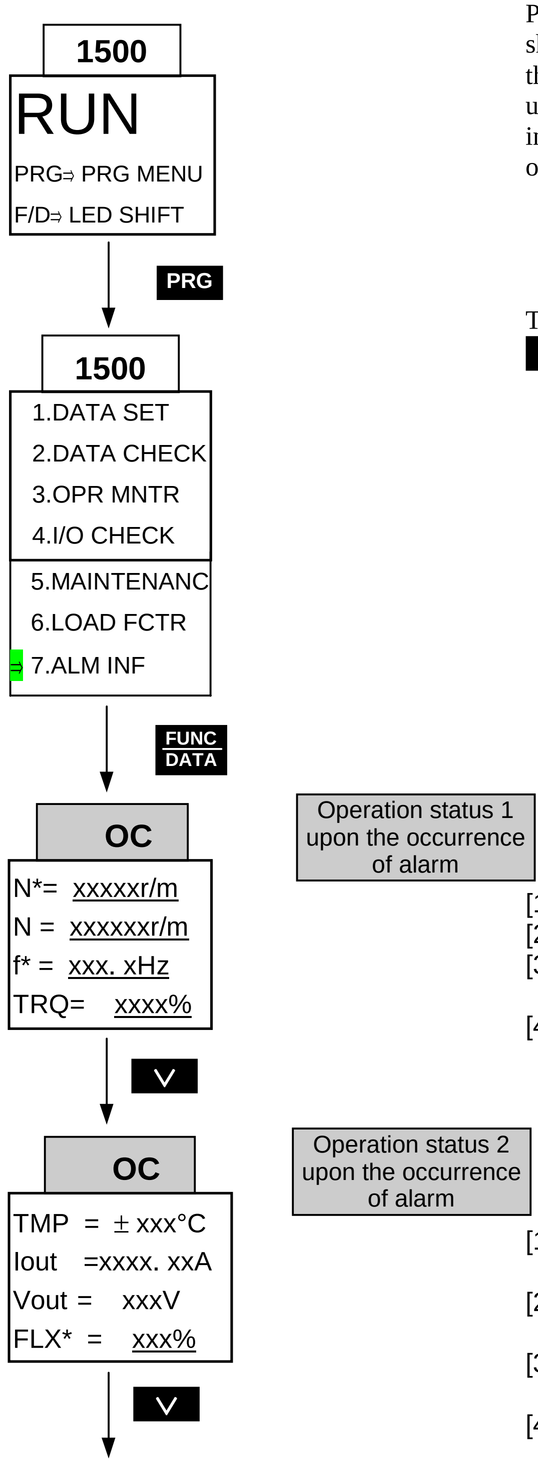
The load factor measurement screen indicates the measured maximum current, average current, and average braking power within a preset period.

The cursor resides at the last digit of the measurement period. You can change the value at the place where the cursor resides. Press the ≫ key to move the cursor.

Press the FUNC DATA key to start the measurement of the load factor. The indicated measurement period is gradually decremented after this key is pressed. The measurement is completed when this value becomes zero.

After the measurement is completed, the measurement period is reset to the initial value and the measured values are indicated.

5.4.12 Alarm Information



Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to “7. ALARM INFO” using the ∧ or ∨ key. Press the FUNC/DATA key to indicate the various operation status upon the occurrence of the last alarm on the LCD.

There are eleven alarm information screens. Press the ∧ or ∨ key to call the previous or next screen.

[1] Speed setting 4 upon the occurrence of alarm
[2] Detected speed 1 upon the occurrence of alarm
[3] Reference output frequency upon the occurrence of alarm
[4] Reference torque upon the occurrence of alarm

[1] Motor temperature upon the occurrence of alarm (“---” appears with NTC not connected)
[2] Detected output current upon the occurrence of alarm
[3] Detected output voltage upon the occurrence of alarm
[4] Reference magnetic-flux upon the occurrence of alarm

OC

TIME =xxxxxh
Mout =xxx. xkW
TMPI= xxxx°C
TMPF= xxxx°C

Operation status upon the occurrence of alarm

[1] Cumulative operation hours upon the occurrence of alarm
[2] Reference motor output (in kW or HP) upon the occurrence of alarm…… kW or HP can be selected with code F60.
[3] Inverter inside air temperature upon the occurrence of alarm
[4] Heat sink temperature upon the occurrence of alarm

Temperatures measured when the alarm was detected

V

OC

NRK=xxxxx
NRR=xxxxx
NRO=xxxxx
NRL=xxxxx

Communication status upon the occurrence of alarm

[1] Number of communication retries for KEYPAD upon the occurrence of alarm
[2] Number of communication retries for RS-485 upon the occurrence of alarm
[3] Number of communication retries for T-Link/SX upon the occurrence of alarm
[4] Number of communication retries for optional SI/RS unit upon the occurrence of alarm

Numbers of communication errors detected by the inverter

V

OC

REM	□X2	□X6
□FWD	□X3	□X7
□REV	□X4	□X8
□X1	□X5	□X9

Input signal status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

V

OC

COMM	□X2	□X6
□FWD	□X3	□X7
□REV	□X4	□X8
□X1	□X5	□X9

Input signal status via COMM upon the occurrence of alarm

□ : Signal off , ■ : Signal on

V

OC

□Y1 □Y5A
□Y2
□Y3
□Y4

Output signal status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

V

OC

□FWD□BRK□IL
□REV □NUV□ACC
□EXT □TL □DEC
□INT □VL □ALM

Operation status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

* The following information is indicated when the optional DIOA unit is mounted.

OC

R□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit (terminal information) upon the occurrence of alarm

□ : Signal off , ■ : Signal on

OC

C□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit (via COMM) upon the occurrence of alarm

□ : Signal off , ■ : Signal on

OC

0/1=xxx xxx
–1=xxx xxx
–2=xxx xxx
–3=xxx xxx

Alarm history 1

Latest alarm

Alarm history (–1 to –3)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

OC

5=xxx
4=xxx
3=xxx
2=xxx

Multiple alarms

Multiple alarms (indicated while pending).

Alarm history 2

OC

–4=xxx xxx
–5=xxx xxx
–6=xxx xxx
–7=xxx xxx

Alarm history (–4 to –7)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

∨

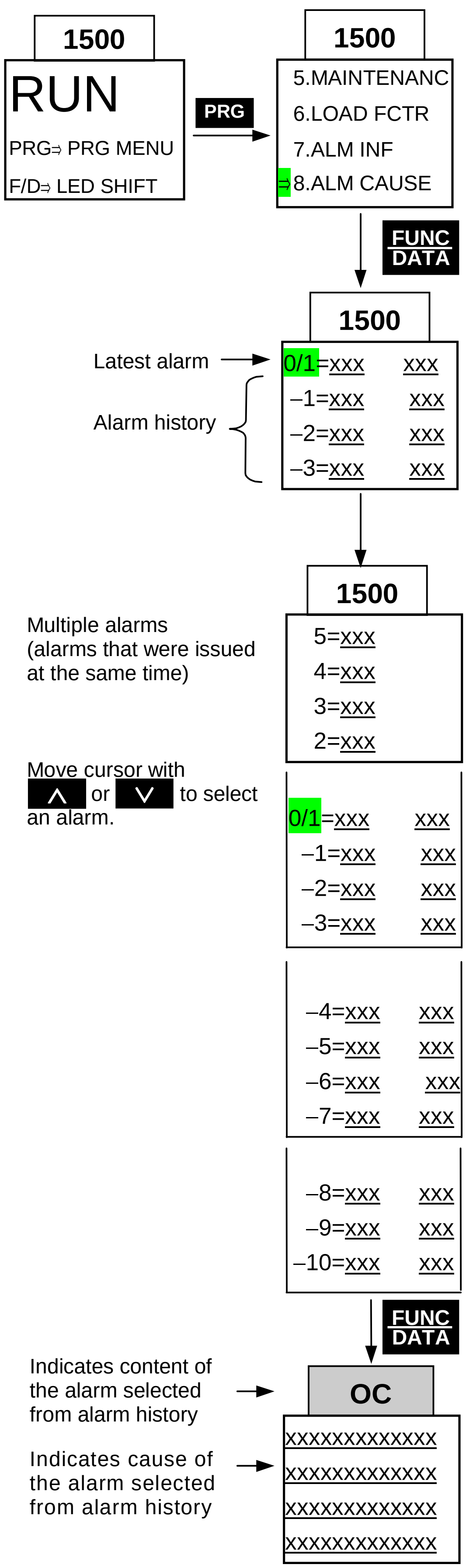
Alarm history 3

OC

–8=xxx xxx
–9=xxx xxx
–10=xxx xxx

Alarm history (–8 to –10)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

5.4.13 Alarm History and Causes

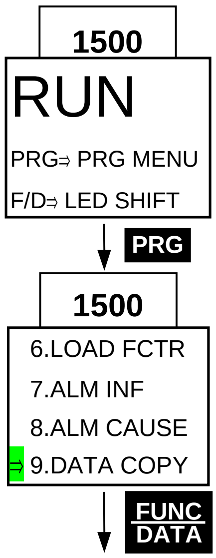


Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to "8. ALARM CAUSES" using the ∧ or ∨ key. Press the FUNC/DATA key to call the alarm history on the LCD.

Press the ∧ or ∨ key to select an alarm the information of which is to be checked. Press the FUNC/DATA key to call the troubleshooting information for the selected alarm.

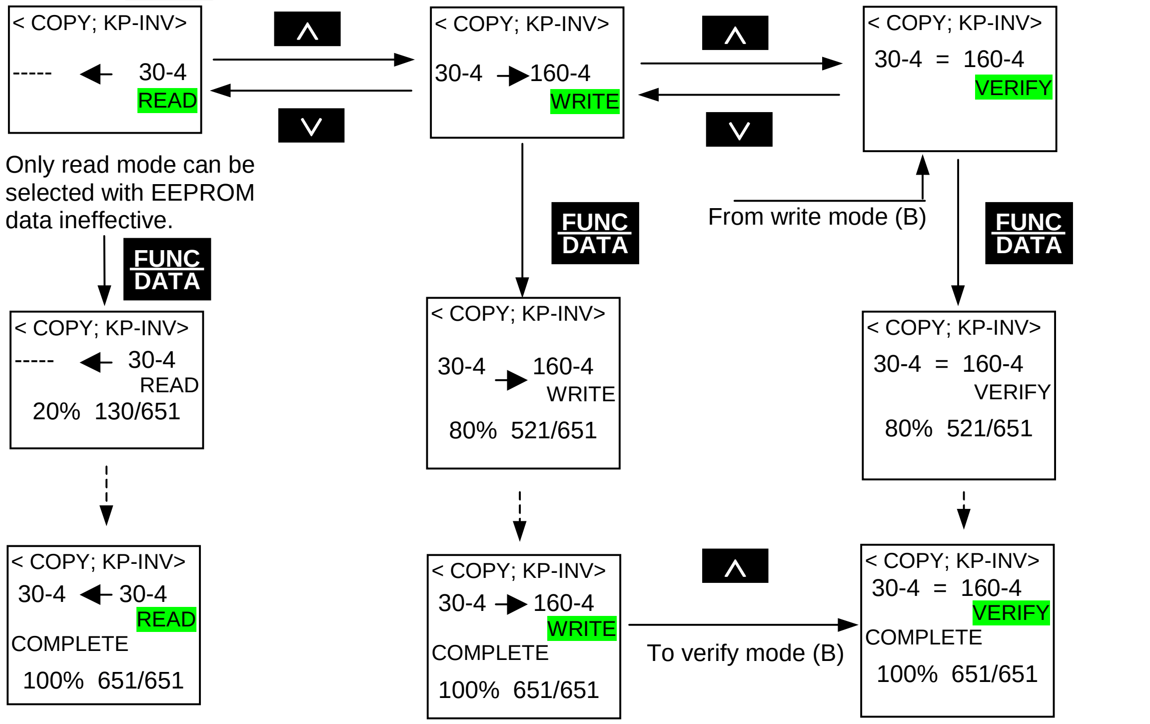
If all the information for the selected alarm is not shown on the screen at a time, scroll over the descriptive information using the ∧ and ∨ keys.

5.4.14 Copying Data



Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to `9. COPY DATA' using the ∧ or ∨ key. Press the FUNC DATA key to call the copy mode screen on the LCD.

You can select the read, write, or verify mode on the copy mode screen using the ∧ or ∨ key.



Copy data with the following procedure.

1) Download the function code settings to the KEYPAD panel.
2) Remove the KEYPAD panel from the inverter.
3) Mount the KEYPAD panel to another inverter.
4) Upload the function code settings to the inverter.

- The verify mode is used to check the consistency between the data stored in the KEYPAD panel and those in the inverter.

Data copy errors

(1) Writing disabled during operation

If an attempt is made to upload data to a running inverter or start the inverter during an uploading process, an error message appears as shown on the right.
Stop the inverter, press **RESET** , and try to upload again.

During operation

```
< COPY; KP-INV>
30-2 → 160-4
         WRITE
INV RUNNING
```

Press RESET or PRG to quit.

(2) Memory error

If an attempt is made to upload without downloading data to the KEYPAD memory (with the memory empty) or upload data to an inverter with a different capacity, model, or voltage class from the inverter from which the data was downloaded, an error message appears as shown on the right.

EEPROM check sum error

```
< COPY; KP-INV>
55-4 → 160-4
         WRITE
MEMORY ERROR
```

Press RESET or PRG to quit.

(3) Verification error

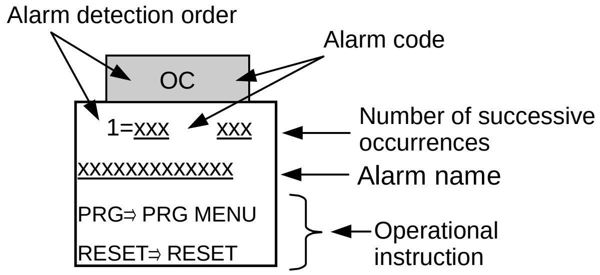
If the data stored in the KEYPAD memory is found by the data check (verification) to be inconsistent from that stored in the inverter, the relevant function code and error code appear. The data check is interrupted.
Press **FUNC/DATA** to resume the data check and check for other inconsistencies or **RESET** to exit the verify mode and proceed to another process.

Error found in write/verify mode

```
< COPY; KP-INV>
55-4 → 160-4
         WRITE
ERR:F25
```

Press F/D to continue or
RESET or PRG to quit

5.4.15 Alarm Mode



When a single alarm is issued, the alarm mode screen appears where the content of the alarm is indicated.

When multiple alarms are issued at the same time, the contents of the alarms can be checked using the ∧ and ∨ keys.

Table 5-4-4 Alarm Detection Order

Operating keys	LED display	LCD display	Content
	5.	5	Alarm No. 5
∧ ∨	4.	4	Alarm No. 4
	3.	3	Alarm No. 3
	2.	2	Alarm No. 2
	1.	1	Alarm No. 1 (multiple alarms)
	Blank	0	Latest alarm (single alarm/already reset)
	Blank	–1	1st latest alarm
	Blank	–2	2nd latest alarm
	Blank	–3	3rd latest alarm
	Blank	–4	4th latest alarm
	Blank	–5	5th latest alarm
	Blank	–6	6th latest alarm
	Blank	–7	7th latest alarm
	Blank	–8	8th latest alarm
	Blank	–9	9th latest alarm
	Blank	–10	10th latest alarm

- The information given by the LCD and LED when multiple alarms are issued at the same time is different from that given when a single alarm is issued.
  - When multiple alarms are issued, the information about alarm No. 1 is given.
  - When a single alarm is issued, the information about the latest alarm is given.
- When multiple alarms are issued, only alarm No. 1 is recorded in the alarm history. No. 2 and subsequent ones are not recorded.
- When a single alarm is issued, the latest alarm is recorded in the alarm history.

- MEMO -

THE INVERTER

VI

Ⅵ. Standard Interface RS485

6. Standard Interface RS485

6.1 Overview

The FRENIC5000VG7S has an integrated RS485 communication system. You can use this communication system to connect the inverter unit serially with a host device (master) such as a personal computer or a PLC and to enable the host device to operate, to stop, or to monitor the inverter or to change the function codes of the inverter.

The following three types of communication protocols are available. Select a protocol according to your application or for your convenience.
You can use the function code H40 "Protocol selection" to select a protocol.

FGI (FUJI General Purpose RS485 Communication)

FGI is a protocol supported by the FUJI G, P, and E series inverters. This protocol is convenient for multidrop connection with these inverters and the VG7S's as slaves.

Loader Command (SX Protocol)

This is a protocol to use the FRENIC5000VG7S support loader, a personal computer software operating on the Microsoft Windows. This protocol uses a number of special commands to make best use of the functions and the performance of the support loader. This protocol is not open to users and you should use them only when you use the support loader.

Modbus RTU

Modicon has specified this protocol to link their PLC's together or their PLC and other slave devices (such as inverters) over network.
Though the standard Modbus Protocol supports RTU transmission mode and ASCII transmission mode, the VG7S supports only the RTU that has higher transmission density.

Though the standard integrated RS485 communication hardware has a full duplex connector connection, the communication protocol is half duplex procedure that repeats request and response. Since the internal hardware of the inverter supports half duplex, a half duplex connection outside of the inverter is available. Note that when you use the UPAC option, since the internal connection between the UPAC and the VG7S is multidrop and the UPAC only supports full duplex communication, the external half duplex communication is not available.

In general, the driver/receiver circuits of RS485 are balance circuits. The "balance" means a positive signal and a negative signal (combination of TX+ and TX- or RX+ and RX-) have equal status. These circuits will have a strong anti-noise characteristic when you combine the circuits with balance cables (twisted pair cables with shield).
Inverters are source of noise. Master instrumentation devices (personal computers and PLC's) and isolated converters (RS485/RS485, RS232C/RS485) may malfunction. If this is the cease, you need the measures against abnormal communication described in this section.

You can select an action if the communication line is disconnected or an error occurs when you direct an operation command via the RS485 communication. When a communication error occurs during operation, the Er5 alarm (RS485 alarm) will be released after an action you select. After the alarm, the inverter will shut off its output and coast to stop.

The RS485 communication utilizing the option OPC-VG7-RS (simplified inter-inverter link) is dedicated for an inter-inverter link with the UPAC as a master or for the POD connection. No part of the description in this section is applicable to that case. See the sections for the control options.

6.2 Common Specifications

6.2.1 Specifications

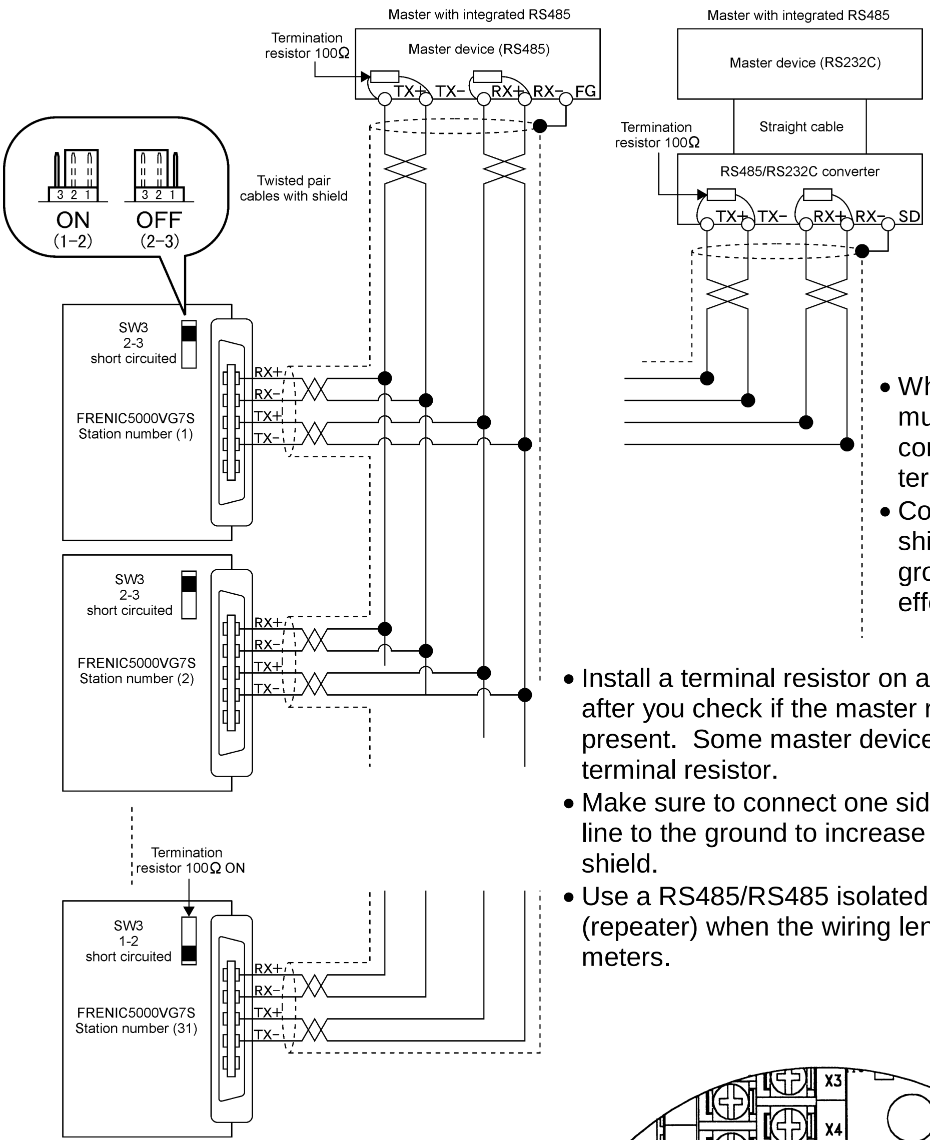
	Item	Specification		
Communications	Slave side specifications			
	Communication protocol	Loader command	Modbus RTU	FUJI general purpose RS485 communication
	Compliant with	Special commands dedicated to support loader (not open to user)	Modicon Modbus RTU	FUJI general purpose RS485 communication
	Applicable to	FRENIC5000VG7S	FUJI general purpose inverter (E9, 11 series UN) FRENIC5000VG7S	FUJI general purpose inverter (11 series) FRENIC5000VG7S
	Protocol selection	Function code H40="1"	Function code H40="2"	Function code H40="0"
	Message type	Command message	RTU (Remote Terminal Unit) mode ASCII mode is not supported Query, Broadcast message	Polling/selecting Broadcast
	Electric specification	EIA RS485		
	Communication rate	2,400, 4,800, 9,600, 19,200, 38,400bps		2,400, 4,800, 9,600, 19,200bps
	Synchronization type	Asynchronous (UART)		
	Transmission type	Half duplex		
	Communication form	Direct connection to inverter, 1:N (1≤N≤31)		
	Character type	HEX		ASCII 7 bits
	Data length	8 bits fixed		H35 data length setting Seven bits or eight bits
	Stop bit	1 bit fixed	2 bits *2) / 1 bit	H37 stop bit setting One bit or two bits
	Parity	Even parity fixed	No parity / Even parity / Odd parity	H36 parity setting No, even, or odd parity
	Error check type	Checksum (one byte BCC)	CRC-16 Generation polynomial: $X^{16}+X^{15}+X^{2}+1$	Checksum (2-byte BCC)
	Station number selection	1 to 255: Station number	0: Broadcast 1 to 247: Station number	99: Broadcast *1) 1 to 31: Station number
	Frame length	Variable length	Variable length	Standard transmission: 16-byte fixed length High-speed transmission: 8-, 12-byte fixed length
	Maximum transmission data (per one message)	Write: 16 words Read: 99 words	Write: 16 words Read: 99 words	1 word
	Disconnection detection time	H38 (Time out) sets disconnection detection time. This function is effective only during RS485 operation.		
	Wiring length	Non-isolated: 10m max Isolated: 500m max • Use a commercial 485/485 isolator (repeater) or a 485/232C isolated converter for isolation. • An inverter may be a source of noise. Use a converter superior in anti-noise capability. Recommended converter: System Sacom KS-485PTI		

*1) The broadcast is available only for S01 to S12. You cannot broadcast other function codes.
*2) The parity selection automatically determines the stop bit in the RTU broadcast.

6.2.2 Basic Wiring Diagram

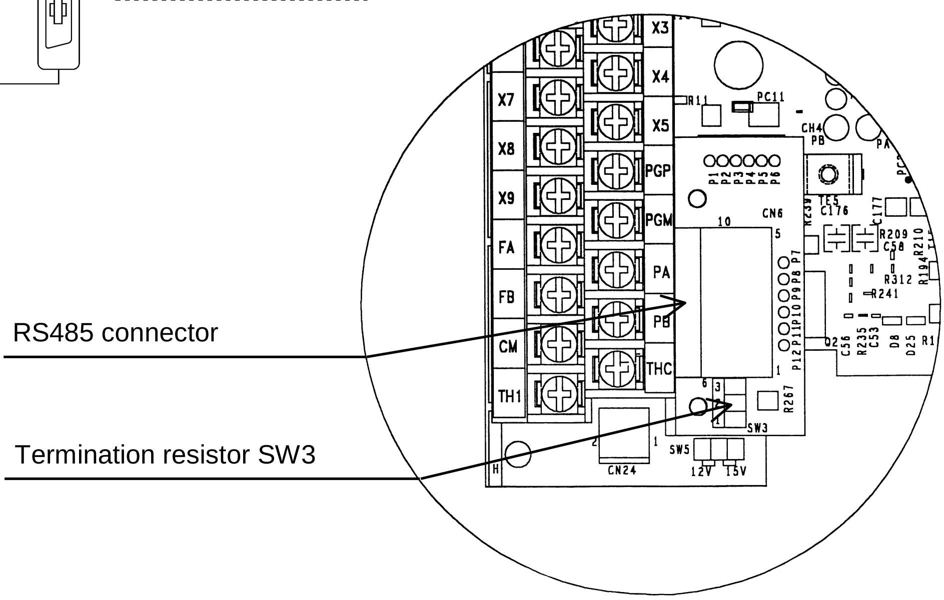
(1) Full Duplex Wiring Diagram

This wiring diagram describes a case when you select a separate transmission signal and a reception signal. The VG7S connector has assignments for full duplex signals (TX+, TX-, RX+, RX-).



- When you connect multiple units, connect them via a terminal box.
- Connecting the shield line to the ground may be effective for noise.

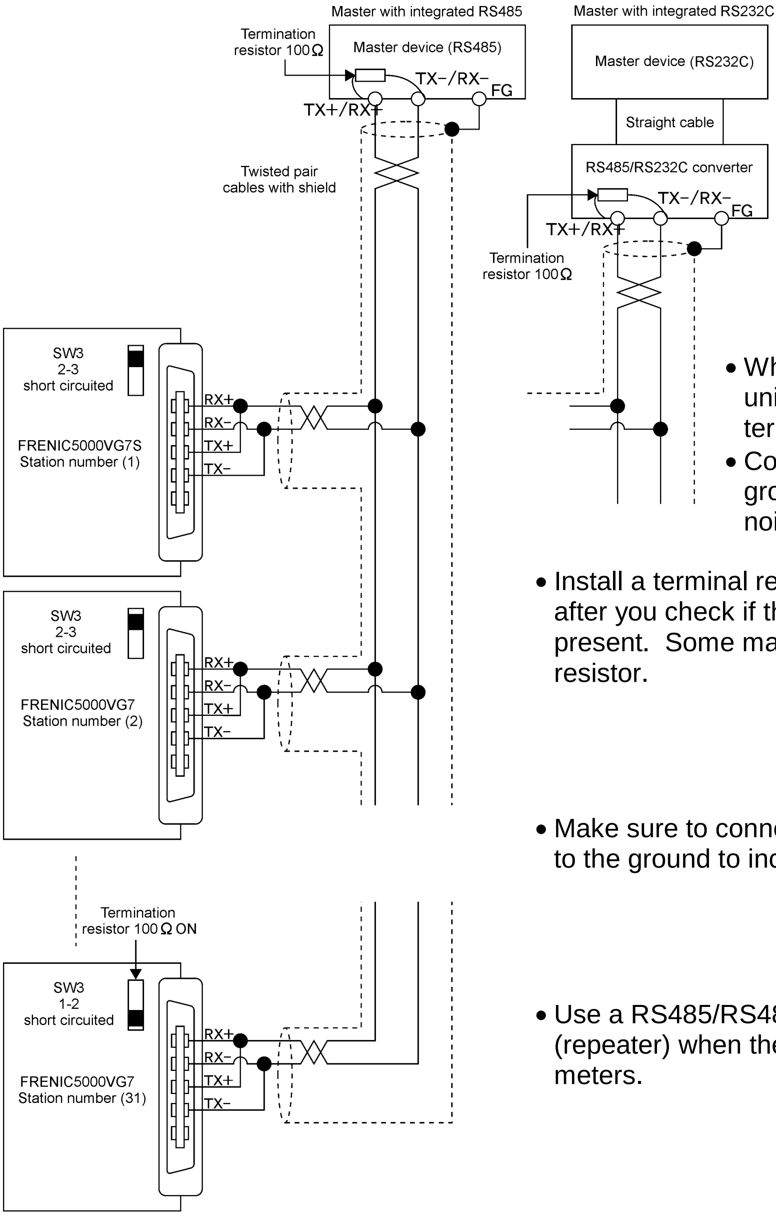
- Install a terminal resistor on a master device after you check if the master resistor is not present. Some master devices have a terminal resistor.
- Make sure to connect one side of the shield line to the ground to increase the effect of the shield.
- Use a RS485/RS485 isolated converter (repeater) when the wiring length exceeds ten meters.



Locations on the control print circuit board

(2) Half Duplex Wiring Diagram

This wiring diagram describes a case when you use common lines serving both for a transmission signal and a reception signal. Since the VG7S connector has assignments for full duplex signals (TX+, TX-, RX+, RX-), you should short-circuit lines from the VG7S connector as described in the diagram.



- When you connect multiple units, connect them via a terminal box.
- Connecting the shield line to the ground may be effective for noise.

- Install a terminal resistor on a master device after you check if the master resistor is not present. Some master devices have a terminal resistor.

- Make sure to connect one side of the shield line to the ground to increase the effect of the shield.

- Use a RS485/RS485 isolated converter (repeater) when the wiring length exceeds ten meters.

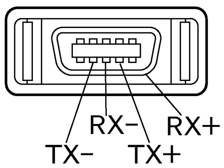
6.2.3 Connection Instructions

⚠WARNING
• Make sure to turn off (open) the power before performing connection work. **You may get electric shock.**

Connectors are used for RS485 connection.

- When you connect a master device to a VG7S one-to-one, we recommend a RS485/RS232C converter with a cable (2m) (Type: NP4H-CNV).
- For one-to-N connection, make sure to combine a connection plug (See (2) below) with a twisted pair cable with shield.

(1) Pin Assignment for PCB Mount Receptacle



Pin Assignment for RS485 Receptacle (Connector) Mounted on the PCB.

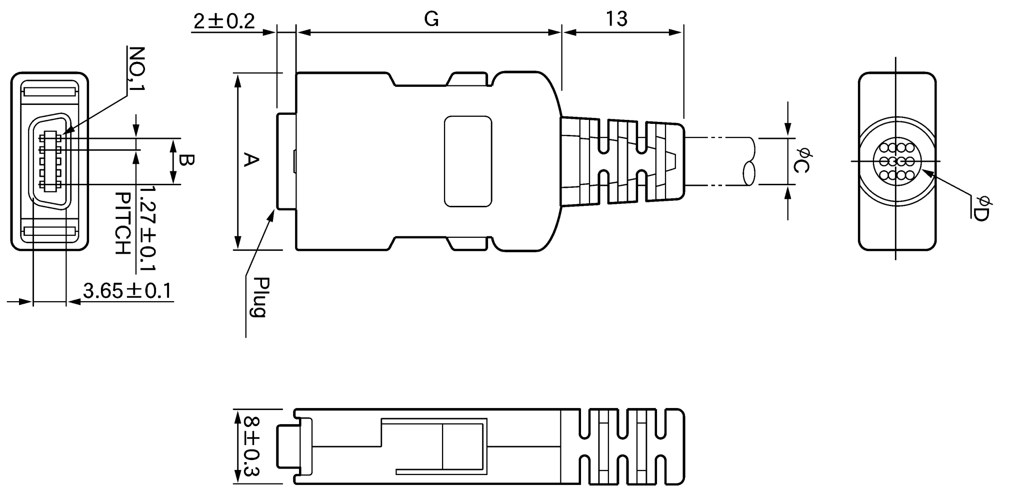
Pin number	Name	Description	Pin Number	Name	Description
1	Do not use		7	TX+	Transmission (+)
2					
3	RX+	Reception (+)	8	RX–	Reception (–)
4	Do not use		9	TX–	Transmission (–)
5					

(2) Recommended Plug Manufacturer

Recommended plug manufacturer for the RS485 receptacle on the print circuit board.

Manufacturer: Japan Aviation Electronics Ind.

Product Name: Pressure contact type plug (with food), 10-core, TX20A-10PH1-D2P1-D1



Dimensions

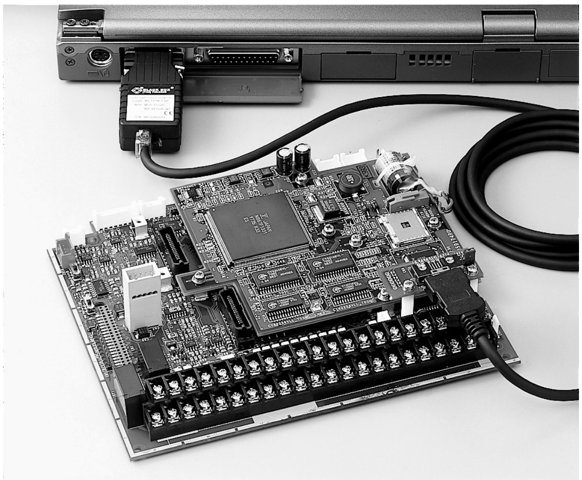
Core number	Product name	A ±0.3	B ±0.15	∅C	∅D ±0.4	G ±0.3
10	TX20A-10PH1-D2P1-D1	19.08	5.08	5	5.3	28

(3) Cable with RS485 Converter

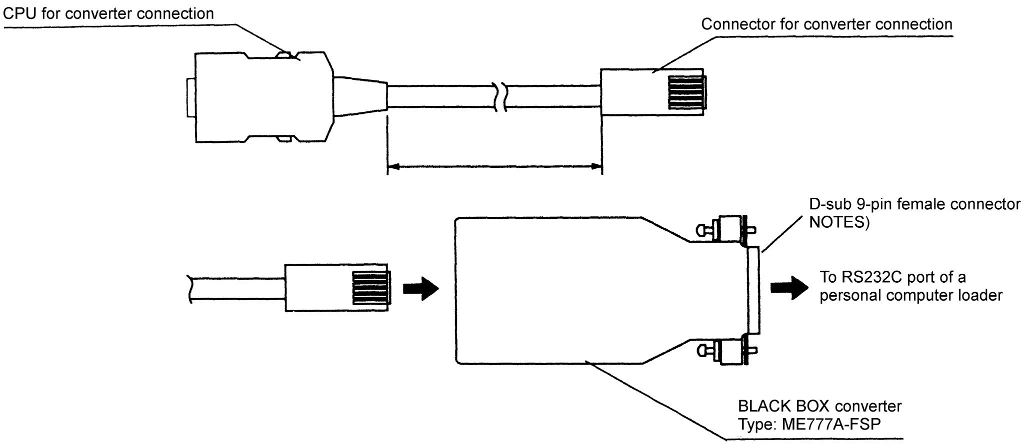
If a master device is a communication apparatus for RS232C, you need a RS485/RS232C converter. You can find wiring diagrams with a converter inserted in 6.2.2 "Basic Wiring Diagram".

1) Wiring Structure

For one-to-one connection, use FUJI general purpose cable (cable with RS485/RS232C converter: NP4H-CNV) to connect to the RS485 connector on the PCB as in the right figure.



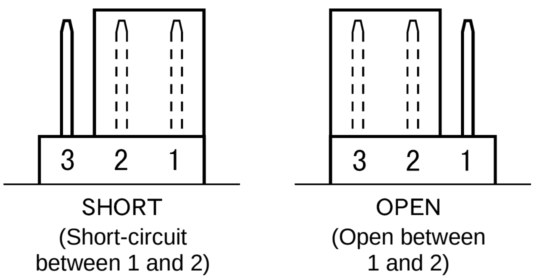
MICREX-SX series SPH D300win connection cable (with a converter)
Type: NP4H-CNV



Note: Connect a commercial converter cable if the RS232C port of your personal computer is not a D-sub 9-pin male connector. Also use a commercial converter cable when the mounting screws interfere with the hooks of the RS232C port.

(4) Termination Resistor

Install 100Ω of termination resistors on the both ends of the system. These termination resistors eliminate the reflection of signals. The VG7S has a termination resistor as standard. Set the short bar to the SW3. Make sure to install on two positions, a master device and a terminal slave device (inverter). Avoid installing at all positions, otherwise the signal capacity will be insufficient.



(5) Isolation

The control print circuit board is not isolated. We recommend an RS485/RS485 isolated converter or an RS232C/RS485 converter with isolation capability to protect the control PCB from noise and to eliminate common mode noise.

6.2.4 Link Function

You can use the function code H30 and the X function "24: Operation selection through link [LE]" together to switch the sources (REM/LOC or COM) of reference data (S area). See also "4.2 Control Block Diagrams" for better understanding.
You can combine the function code H29 and the X function "23: Write enable through link [WE-LK]" to control write to the function codes (F, E, C, P, H, A, o, L, U) through the link. See also "4.2 Control Block Diagrams" for better understanding.

6.2.4.1 Enabling Link Operation

1) Switching to Link

You can assign "24: Operation selection through link [LE]" to an X function input terminal to change the mode as follows.

Signal of "Operation selection through link"	Input to terminal	State
Assigned	-	"Operation through link disabled" mode
Not assigned	ON	
	OFF	"Operation through link enabled" mode

Though you can write reference data and operation commands through the link in the "Operation through link disabled" mode, the data are not reflected. You can set data in the "Operation through link disabled" mode and switch to the "Operation through link enabled" mode to reflect the data.

2) Writing through Link

In the "Operation through link enabled" mode, you can use the function code H30 (Serial link) to switch the source of the operation command and reference data between the link (COM) and the remote/local. The remote and local means REM (terminal box) and LOC (KEYPAD panel) respectively.

H30 setting	Operation through link enabled		Operation through link disabled
	Reference data (S01 to S05, S08 to S12)	Operation command (FWD, REV)	
0	Link disabled (REM/LOC)	Link disabled (REM/LOC)	Link disabled (REM/LOC)
1	Link enabled (COM)	Link disabled (REM/LOC)	
2	Link disabled (REM/LOC)	Link enabled (COM)	
3	Link enabled (COM)	Link enabled (COM)	

This function enables you to construct a flexible system where you can apply an operation command from the terminal box and apply a speed reference from RS485.

6.2.4.2 Enabling Writing through Link

1) Switching to Writing through Link

You can assign "23: Write enable through link [WE-LK]" to an X function input terminal to write in the function codes (F, E, C, P, H, A, o, L, and U).

Signal of "Write enable through link"	Input to terminal	State
Assigned	-	"Write through link enabled" mode (Writing enabled to F to U)
Not assigned	ON	
	OFF	"Write through link disabled" mode (Writing disabled to F to U)

2) Writing through Link

In "Write through link" enabled mode, you can use the function code H29 (Link function protection) to control writing to the function codes (F, E, C, P, H, A, o, L, and U).

H29 setting	"Write through link enabled" mode	"Write through link disabled" mode
0	Codes (F, E, C, P, H, A, o, L, U) write-protected	Codes (F, E, C, P, H, A, o, L, U) write-protected
1	Codes (F, E, C, P, H, A, o, L, U) write-enabled	

6.2.4.3 Prioritized Options for S Area

When you have installed a field option **(T-LINK, field bus, SX, SI (UPAC), or RS485 option)**, writing (operation commands and reference data) to the S area via RS485 communication is disabled and the option has priority. You can always read and write data for the function codes (F, E, C, P, H, A, o, L, U) through RS485.

6.2.5 Referencing to and Changing Data

When you have not installed a field option, you can always write to the S area (operation commands and reference data). Use "485 number" in the Chapter 13 "Function Code List" to read or write data for the other function codes (F, E, C, P, H, A, o, L, U, M) through RS485.
Note the setting range and the restriction on changes during operation, when you read or write these data.

6.2.5.1 Restrictions on Writing to Function Codes

There are following restrictions on writing (selecting) to the function codes (F, E, C, P, H, A, o, L, U).

1) Writing to Volatile Memory
The destination of the writing through RS485 is the volatile memory (RAM: Random Access Memory, stored data are disappeared when you turn off the power) to enable high-speed writing. When you want maintain the data after you turn off the power, use the function code H02 "All save" to store the data into the non-volatile memory. It takes about two seconds to use H02 to write into the non-volatile memory. Note that you cannot write new data while you are saving data.

2) "Writing through RS485 disabled" Mode
You will receive negative acknowledgement after you write to the following function codes.

Code	Name	Reason
P02	M1 motor selection	Changing P02 updates other codes automatically. Though this update will be written into the non-volatile memory, the change of P02 is written only into the volatile memory (disappears when you turn off the power) and the consistency among the codes is not maintained after power cycle.
H31	Station address	Changing will disconnect the communication.
H34 to H37	(UART setting)	These function codes specify RS485 communication hardware setting.
H40	Protocol selection	Changing will disconnect the communication.

3) "Consecutive writing disabled" Mode
You can use the Modbus RTU to write 16 words consecutively. Do not include the following function codes into a group of consecutive words, otherwise you will receive a negative acknowledgement. You can include the following function codes in a single writing in the FUJI general purpose communication or Modbus RTU.

Code	Name	Reason
H01	Tuning operation selection	Internal data are updated simultaneously with the execution of these functions and the consecutive data will overwrite the updated data.
H02	All save	
H03	Data initialization	
H67	Trip data delete	

4) Data Protection
- The function code F00 "Data protection" does not restrict the writing through RS485. F00 protects only the writing from the KEYPAD panel.
- The function code H29 "Link function protection" and the X function [WE-LK] restrict the writing through RS485 (see 6.2.4.2). **Note that you can write to H29**, even in the "Operation through link disabled" mode.

6.2.5.2 Negative Acknowledgement and Error Response

If there is an error in transmission data or you write when the inverter is not ready, you will get a negative acknowledgement or an error response and the writing is not processed. You can use the function code M26 or the "I/O Check" screen of the KEYPAD panel to check the description of the error. See the Type [34] "Communication error code" in the "Function Code List" for more information.
The Modbus RTU protocol uses a special code (Subcode) for the error response. See the section for the Modbus RTU.

6.2.5.3 No Response

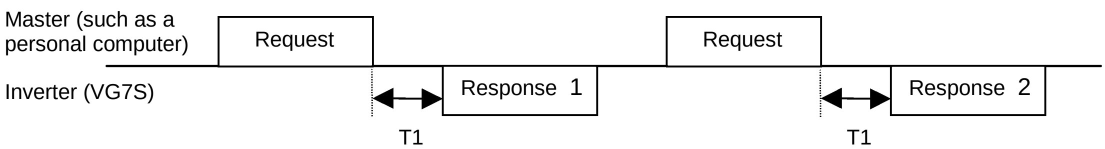
You will receive no response when the inverter hardware detects a parity framing error or the software detects a checksum error or a CRC error after the communication data are physically destructed. You can also use the function code M26 or the "I/O Check" screen of the KEYPAD panel to check the description of the no response.
When the interval between characters from the host exceeds 20ms due to hardware abnormality, the inverter does not respond and resets the communication up to then.

6.2.6 RS485 Function Codes

Function code		Data setting	Note
H31	RS485 setting (Station address)	0 to 255 1 to 255: Address	Specifies a station number when connected to an inverter. No response to broadcast
H32	RS485 setting (Action on error)	0: Forced to stop 1: Stops in specified period after error 2: Stops if transmission error continues for specified period 3: Continues operation	Processes for RAS
H33	RS485 setting (Timer operation time)	0.01 to 20.00s	
H34	RS485 setting (Transmission rate)	0: 38,400bps 1: 19,200bps 2: 9,600bps 3: 4,800bps 4: 2,400bps	Initializes communication
H35	RS485 setting (Data length)	0: 8 bit 1: 7 bit	
H36	RS485 setting (Parity bit)	0: No 2: Even parity 3: Odd parity	
H37	RS485 setting (Stop bit)	0: 2 bits 1: 1 bit	
H38	RS485 continued communication disconnected time	0.00 to 60.0s 0.0; Invalid	
H39	Response interval time	0.00 to 1.00s	
H40	RS485 protocol selection	0: FUJI general purpose communication protocol 1: SX protocol 2: Modbus RTU	Switches protocol

6.2.6.1 Response Interval Time (H32)

This function code sets a time in which the inverter responds after a request from an upper level device such as a personal computer. This function allows a personal computer slow in response to set a response interval and to match the timing of an inverter.



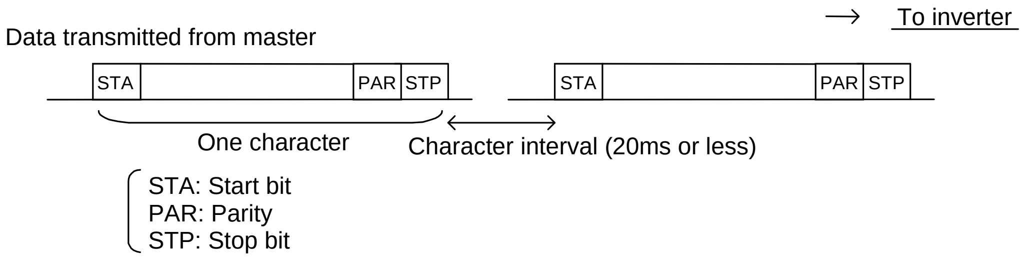
T1 = Response interval + Td (Response delay: 1ms to 5ms)
Use the function code H39 to set in the range from 0.00 to 1.00s

6.2.6.2 Continued Communication Disconnected Time (H38)

During link operation (S06 operation command FWD, REV) thorough RS485, if a communication disconnection from a master (PLC, PC) exceeds this specified period, a RS485 communication error (Er5) will occur. Disable this function (set to 0) when the communication is at a random cycle. When your communication is at a constant cycle, set the H38 to a period longer than that cycle and use the function of detecting disconnection.

6.2.6.3 Character Time Out Processing

A timer measuring a fixed period monitors the reception cycle. If the character interval of transmitted data from the master exceeds the period specified by the timer, a disconnection is assumed. The timer expires in 20ms determined by the character interval of 5ms to 4.6ms (12 to 11 bit/2400) at the lowest baud rate of 2,400bps. The inverter resets the communication if the character interval exceeds this period.



6.2.6.4 Time Out Processing on Master Side

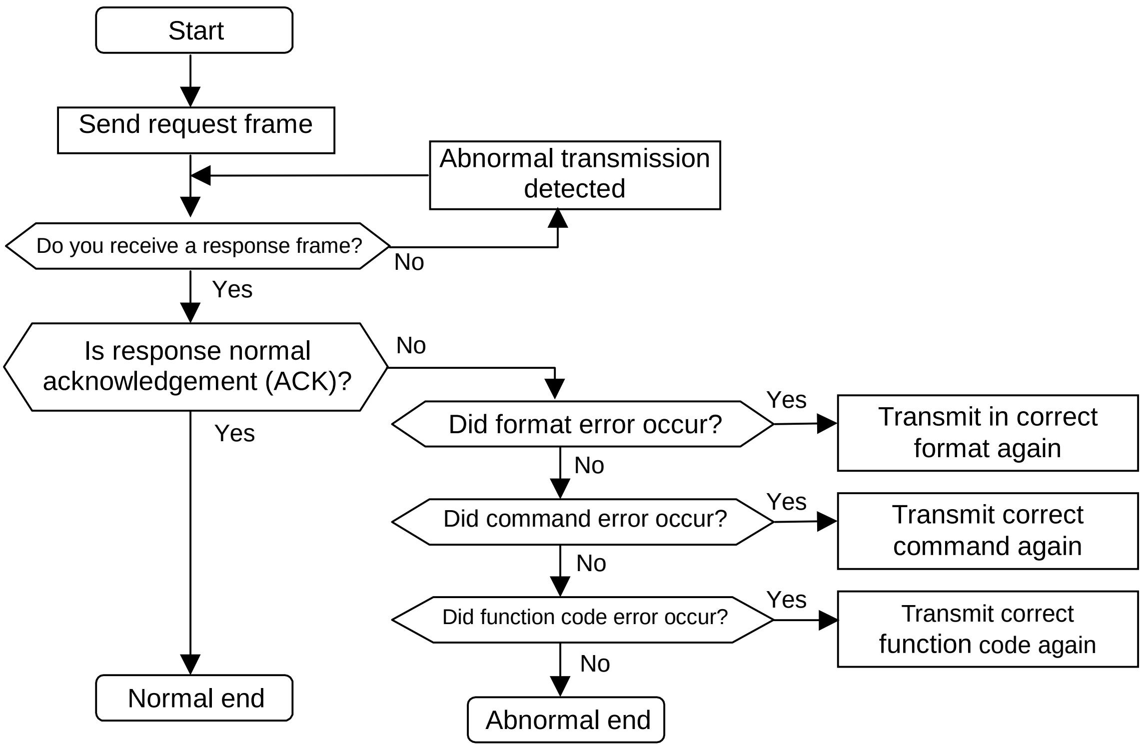
The master (PLC, PC) assumes a time out when a communication from the inverter discontinues for a certain period. The time out period is common to all FUJI inverters (G, C, E, VG) and is specified as 500ms. Set a longer period than this period as a time out period of the master. An inverter responds in a period combining an internal processing period (about 1ms) and a period set by an interval timer (H39 setting). Though you may set a time a little longer than the period set by an interval timer, set 500ms or longer to a master device assuming a connection to other models (G, E, series).

6.2.7 Host Side Procedure

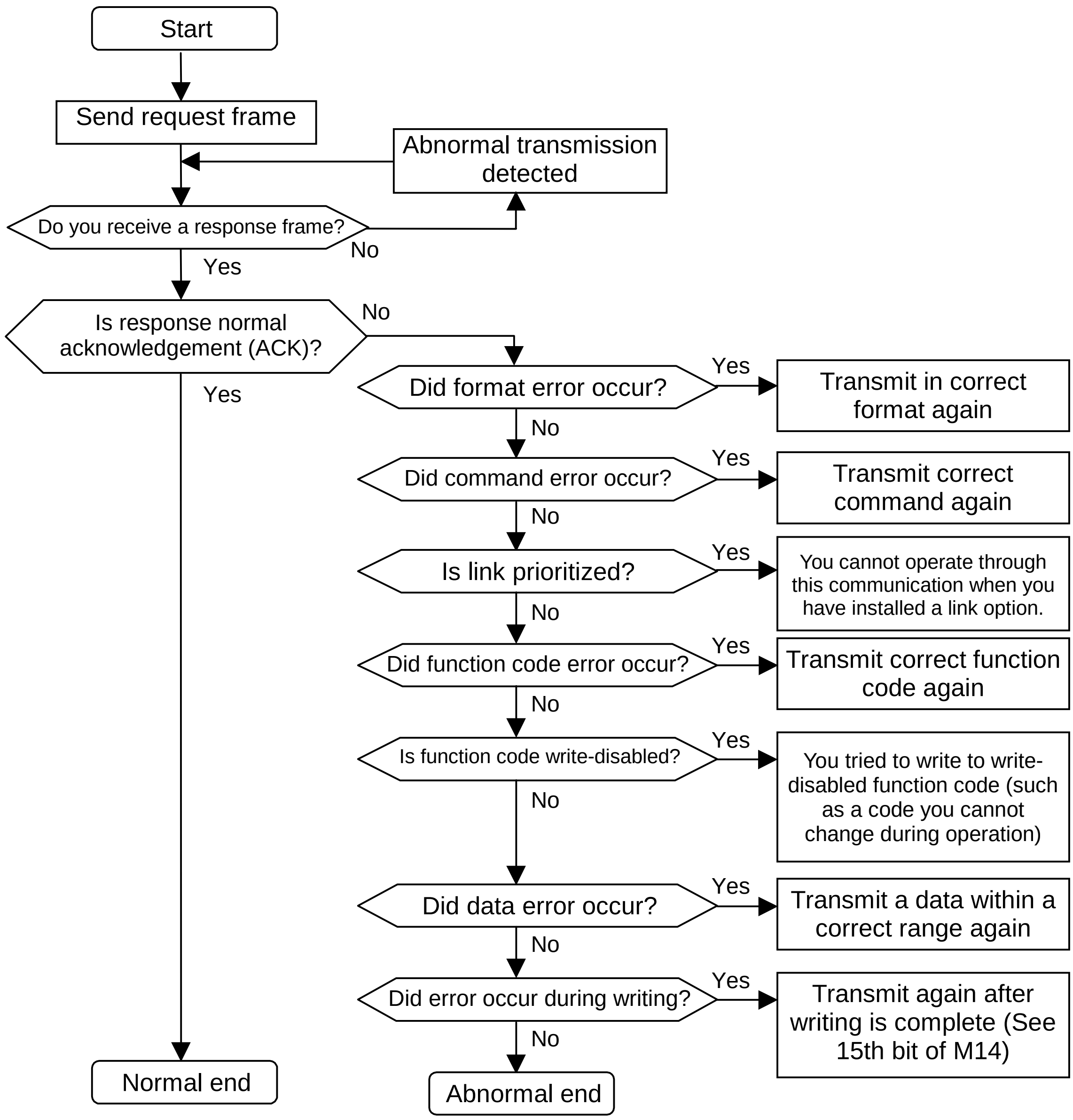
Refer to flowcharts of individual communication procedures for frame communication procedure.
Make sure to transmit the next frame after confirming a response both in reading and writing. When the master does not receives a response from an inverter in a certain period, assume a time out and execute a retry (if you start a retry before the time out, you cannot receive a request frame).

1) Retry Processing
The retry processing sends a data as sent before the no response error in a standard frame or polls to read out the error description (M26) to check if a normal acknowledgement is received (you need to check if a time out occurs again).
If you receive a normal acknowledgement, a transient communication error occurred due to noise or others and you can continue normal communication (there may be abnormality and you need an investigation if you have this phenomenon frequently).
If you have no response again, repeat retry. If the number of retry exceeds a specified value (usually three times), you can suspect a hardware problem or a software problem of a upper level device. If this is the case, you have to terminate the communication as an abnormal end and start investigation.

6.2.7.1 Reading Procedure



6.2.7.2 Writing Procedure



6.2.8 RAS Processing

6.2.8.1 Measures against Abnormal Communication

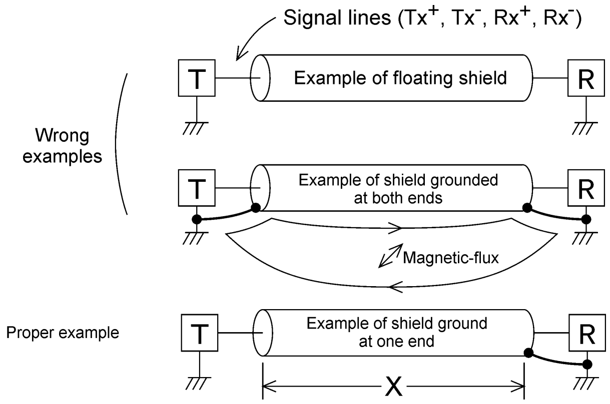
In some environments, the noise generated by the inverter may interfere normal communication or cause malfunctions of instrumentation devices and converters of a master. This section describes the measures against these situations.

(1) Measures at Receiving End of Noise

Isolated converter: Eliminates common mode noise exceeding the specified operation voltage range of a receiver generated in a case such as long distance wiring. Since a converter may malfunction due to noise, use a converter withstanding noise.

Twisted pair cable with shield: The shield is effective against electrostatic induction noise. Make sure to connect only one side of the shield to the ground.
The twisted lines are effective against electromagnetic induction noise. Use a cable with a twist pitch as short as possible. Consider individual shields for transmission and reception for long wiring where cross talk is a problem.

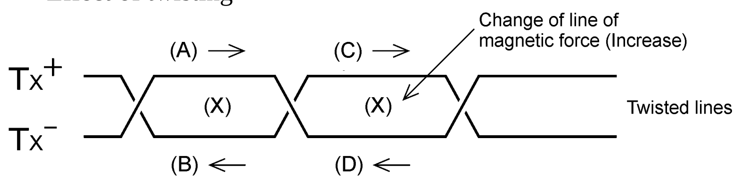
Effect of shield



The shield acts as an antenna to collect noise.

If the shield and ground form a loop and grounded points of the shield are separated in a long distance, an electric potential between the two grounded points may generate current flowing through the loop and induce noise. Also the change of the magnetic-flux inside the loop may induce noise.
You can eliminate the effect of electrostatic induction in the section indicated by X in the figure

Effect of twisting



When there is constant magnetic flux penetrating this page from front face to back face and the magnetic flux changes (increases), electromotive forces in the direction indicated by arrows are generated. The magnitude of electromotive forces from (A) to (D) are the same and the directions are indicated in the figure.
(B) and (C) on the Tx+ line are in the opposite direction each other and counteract each other. Also (A) and (D) counteract each other. Thus, the electromagnetic induction never induce normal mode noise. Note that the noise cannot be eliminated completely due to reasons such as uneven twist pitch. If Tx+ and Tx- are in parallel, normal mode noise will be induced.

Termination resistor: Install resistors equivalent to the cable impedance (100Ω at the both ends to restrain ringing.

Separate wiring installation: Install RS485 communication lines separately from the power lines (input: R, S, T and output: U, V, W) and do not tie them together. Separate installation will restrain induction noise.

Grounding: Do not share the same grounding between the instrumentation devices and the inverter. The grounding line may propagate noise. Use thick lines for grounding.

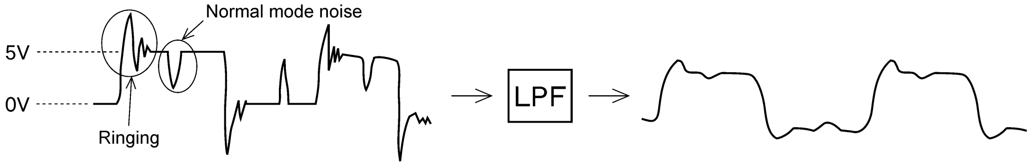
6. Standard Interface RS485

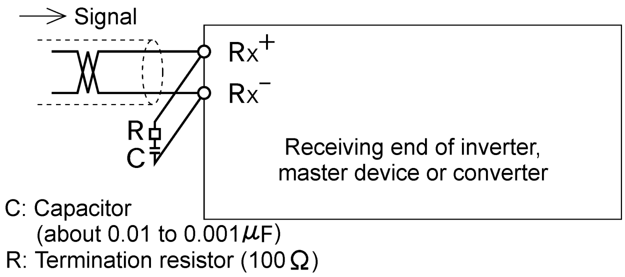
Isolating power supply: The power lines of the instrumentation devices may propagate noise. We recommend an insolated inverter power supply and application of an isolated transformer (TRAFY) for power supply or a noise cut transformer.

Filter: Install capacitors in parallel at input/output terminals to form a LPF (Low Pass Filter) eliminating ringing or high frequency noise.

Effect of Filtering

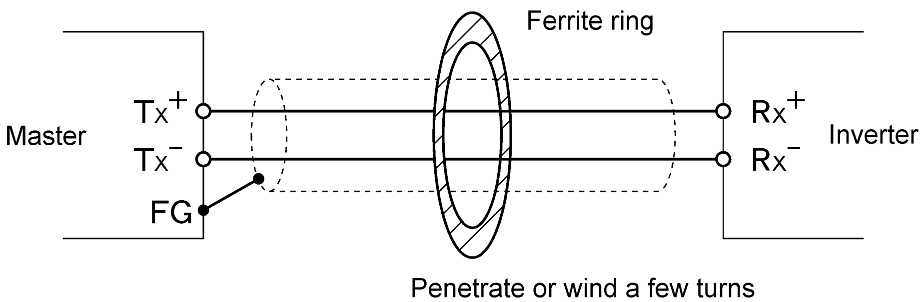
A low pass filter separates ringing due to a reflected signal and normal mode noise from a signal. Since the ringing is generally in higher frequency, the low pass filter can separate the signal.





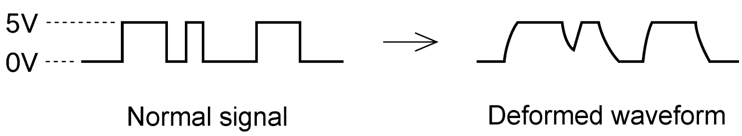
Adding inductance: Insert a choke coil serial to the signal lines or pass the signal lines through a ferrite ring to introduce an inductance into the circuit to create a high impedance against high frequency noise.

Adding inductive element



⚠CAUTION

When you apply a filter or add an inductive element, the signal waveform may be deformed at high-speed transmission. If this is the case, use the function code H34 to reduce the communication rate.



(2) Measures at Source of Noise

Carrier frequency:	You can use the function code F26 "Motor sound (Carrier frequency)" to decrease the carrier frequency to reduce noise. Note that reduced carrier frequency increase noise.
Installation:	You can install power lines through a metal pipe or use a metal control panel to contain noise (radiation/induction).
Isolating power source:	Install an isolated power supply transformer for the inverter power source to eliminate propagating noise (conduction).

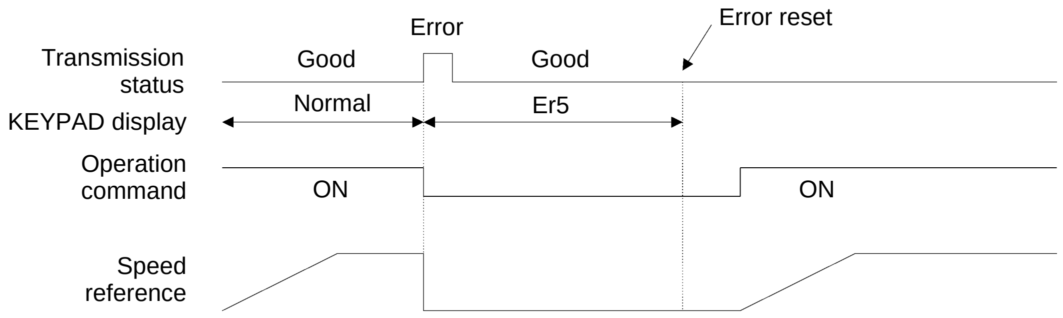
(3) Measures Reducing Noise Level

Consider using ferrite rings (9.6.5) or EMC filters (9.6.2). First implement (1) and (2) and then implement (3) if the noise level does not go down below the permissible level of your facility.

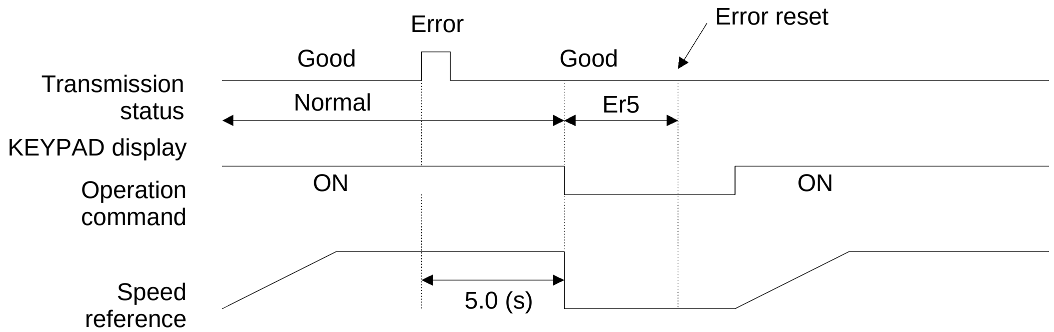
6.2.8.2 Actions on Communication Error

When you are providing operation commands and reference data, you can use a function handling communication error to continue inverter operation without shutting down the inverter. The following section describes examples corresponding to individual settings of the error handling function (the KEYPAD panel displays "Er5") when you direct operation commands from a master.

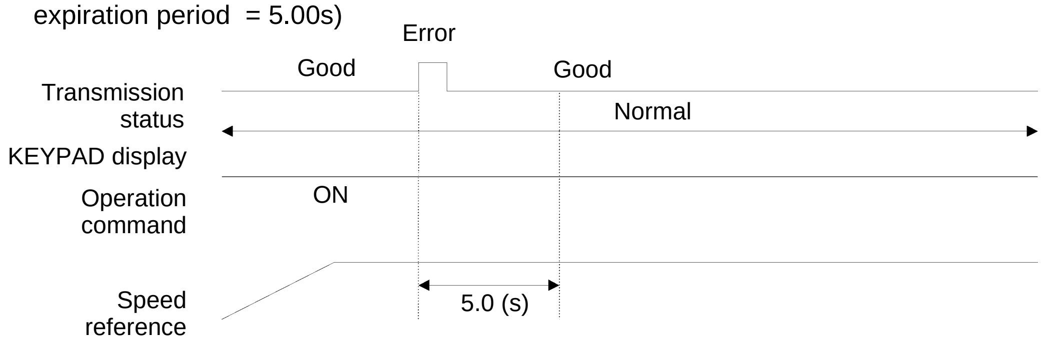
(1) H32 = 0, forced to stop mode (coasts to stop after error)



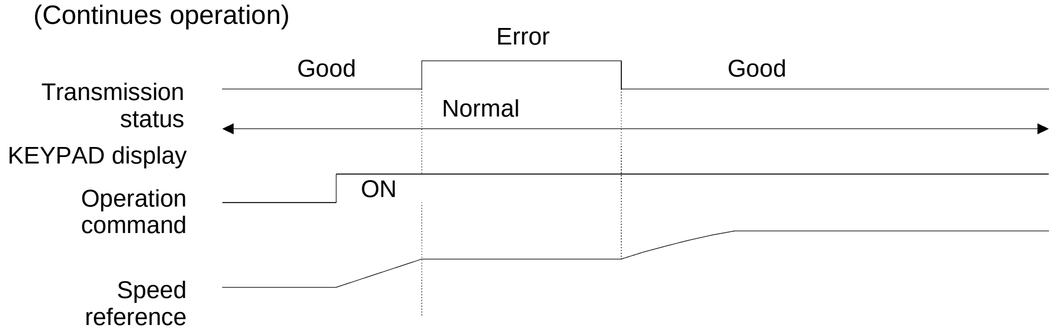
(2) H32 = 1, mode to coast to stop in a specified period by a function code after transmission error (Stops after a period specified by timer, H33: timer expiration period = 5.00s)



(3) H32 = 2, mode to continue operation if a transmission error is restored in a specified period by timer as in (b) (Stops after continued error for a period specified by timer, H33: timer expiration period = 5.00s)



(4) H32 = 3, mode to continue operation during transmission error (Continues operation)



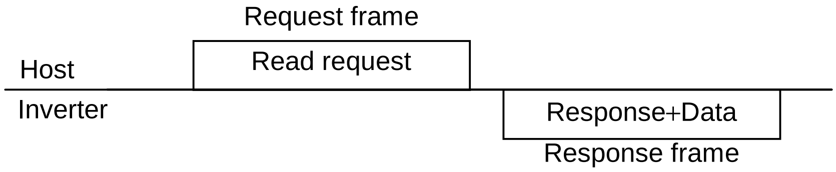
6.3 FUJI General Purpose Communication

6.3.1 Message Format

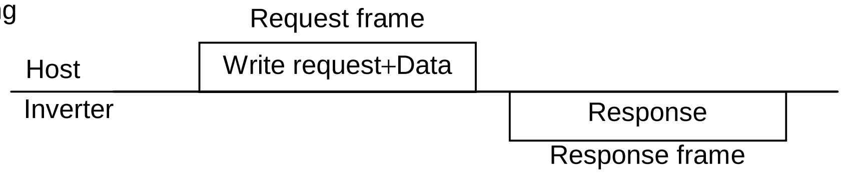
Messages are handled in polling/selecting manner. An inverter is always waiting for selecting (write request) or polling (read request) from a host (personal computer or PLC).

When an inverter is ready and receives a request addressed to its station number from a host, if the inverter receives the frame successfully, the inverter returns a positive acknowledgement, and if the inverter fails to receive the frame, the inverter returns a negative acknowledgement. Note that an inverter returns no response to a broadcast (selecting all stations at once).

1) Polling



2) Selecting



3) Broadcast

Notes on broadcast (selecting all stations at once)
All inverters process a frame with a station number (station address) of 99 as a broadcast. You can use a broadcast to provide an operation command or a reference data to all inverters at once (available for S01 to S06 in standard frame and for W, E, a to f, and m in option frame).

6.3.2 Transmission Frame

There are standard frame, which you can use for all communication functions and option frame, which is fast but limited to transmitting reference data to and monitoring an inverter in the transmission frame.

All characters (including BCC) constituting both the standard frame and the option frame are ASCII codes. The lengths of the standard frames and the option frames are listed in the following table.

Frame type			Frame length
Standard frame	Selecting	Request	16 byte
		Response	16 byte
	Polling	Request	16 byte
		Response	16 byte
Option frame	Selecting	Request	12 byte
		Response	8 byte
	Polling	Request	8 byte
		Response	12 byte

6.3.2.1 Standard Frame

Request Frame (Host ⇒ Inverter)

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station number	ENQ	Com-mand	Type	Function code number	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

Used for BCC (byte 1 to byte 13)

Byte	Field	Value: ASCII	Value: Hexadecimal	Description
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Request command Polling (read) Selecting (write) Fast response selecting (write) *1) Alarm reset
5	Type	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Fundamental functions Extension terminal functions Control functions Motor parameters High performance functions Alternative motor parameters Lift functions User functions Optional functions Serial communication functions Monitoring functions
6	Function code number	'0' to '4'	30_H to 34_H	Function code number (Decimal, tens digit)
7		'0' to '9'	30_H to 39_H	Function code number (Decimal, ones digit)
8	SP	' '	20_H	Not used (fixed to space)
9	Data	'0' to 'F'	30_H to $3F_H$	First data character (hexadecimal: thousands digit)
10		'0' to 'F'	30_H to $3F_H$	Second data character (hexadecimal: hundreds digit)
11		'0' to 'F'	30_H to $3F_H$	Third data character (hexadecimal: tens digit)
12		'0' to 'F'	30_H to $3F_H$	Fourth data character (hexadecimal: ones digit)
13	ETX	ETX	03_H	End of message
14	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
15		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

*1) The VG7S returns response fast to any writings. The standard selecting (W) and the fast response selecting (A) behave in the same manner for the VG7S.

ACK Response Frame (Inverter ⇒ Host)

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station number	ACK	Com-mand	Type	Function code number	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

Used for BCC

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ACK	ACK	06_H	Transmission response Positive acknowledgement: No reception error and no logical error in request
4	Command	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Answer back to request command Polling (read) Selecting (write) Fast response selecting (write) Alarm reset
5	Type	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Fundamental functions Extension terminal functions Control functions Motor parameters High performance functions Alternative motor parameters Lift functions User functions Optional functions Serial communication functions Monitoring functions
6	Function code number	'0' to '4'	30_H to 34_H	Function code number (Decimal, tens digit)
7		'0' to '9'	30_H to 39_H	Function code number (Decimal, ones digit)
8	Special			Not used
9	Data	'0' to 'F'	30_H to $3F_H$	First data character (hexadecimal: thousands digit)
10		'0' to 'F'	30_H to $3F_H$	Second data character (hexadecimal: hundreds digit)
11		'0' to 'F'	30_H to $3F_H$	Third data character (hexadecimal: tens digit)
12		'0' to 'F'	30_H to $3F_H$	Fourth data character (hexadecimal: ones digit)
13	ETX	ETX	03_H	End of message
14	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
15		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

6. Standard Interface RS485

NAK Response Frame (Inverter ⇒ Host)

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station number	NAK	Com-mand	Type	Function code number	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

Used for BCC

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	NAK	NAK	15_H	Transmission response Negative acknowledgement: Logical error in request
4	Command *1)	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Answer back to request command Polling (read) Selecting (write) Fast response selecting (write) Alarm reset
5	Type *1)	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Fundamental functions Extension terminal functions Control functions Motor parameters High performance functions Alternative motor parameters Lift functions User functions Optional functions Serial communication functions Monitoring functions
6	Function code number *1)	'0' to '4'	30_H to 34_H	Function code number (Decimal, tens digit)
7		'0' to '9'	30_H to 39_H	Function code number (Decimal, ones digit)
8	SP	' '	20_H	Not used (fixed to space)
9	Data	' '	20_H	Not used (fixed to space)
10		' '	20_H	Not used (fixed to space)
11		'4', '5'	34_H, 35_H	Communication error code 1 (hexadecimal. tens digit)
12		'0' to 'F'	30_H to $3F_H$	Communication error code 2 (hexadecimal. ones digit)
13	ETX	ETX	03_H	End of message
14	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
15		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

*1) A space (' '=20_H) is set when a transmission format error or a transmission command error.

6.3.2.2 Option Frame

Selecting Request Frame (Host ⇒ Inverter)

0	1 2	3	4	5 8	9	10 11	
SOH	Station number	ENQ	Command	Data	ETX	BCC	
1	2	1	1	4	1	2	(byte)

Used for BCC

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 'a' 'b' 'c' 'd' 'e' 'f' 'm'	 61_H 62_H 63_H 64_H 65_H 66_H $6D_H$	Request command Speed reference 1 (S01) Torque reference (S02) Torque current reference (S03) Magnetic-flux reference (S04) Orientation position reference (S05) Operation method 1 (S06) Reset command: Set "0" to all
5	Data	'0' to 'F'	30_H to $3F_H$	First data character (hexadecimal: thousands digit)
6		'0' to 'F'	30_H to $3F_H$	Second data character (hexadecimal: hundreds digit)
7		'0' to 'F'	30_H to $3F_H$	Third data character (hexadecimal: tens digit)
8		'0' to 'F'	30_H to $3F_H$	Fourth data character (hexadecimal: ones digit)
9	ETX	ETX	03_H	End of message
10	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
11		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

Selecting Response Frame (Inverter ⇒ Host)

0	1 2	3	4	5	6 7	
SOH	Station number	ACK/NAK	Command	ETX	BCC	
1	2	1	1	1	2	(byte)

Used for BCC (bytes 1 to 5)

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ACK/NAK	ACK NAK	06_H 15_H	Transmission response Positive acknowledgement: No reception error and no logical error in request Negative acknowledgement: Logical error in request
4	Command	 'a' 'b' 'c' 'd' 'e' 'f' 'm'	 61_H 62_H 63_H 64_H 65_H 66_H $6D_H$	Request command Speed reference 1 (S01) Torque reference (S02) Torque current reference (S03) Magnetic-flux reference (S04) Orientation position reference (S05) Operation method 1 (S06) Reset command: Set "0" to all
5	ETX	ETX	03_H	End of message
6	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
7		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

Polling Request Frame (Host ⇒ Inverter)

0	1 2	3	4	5	6 7	
SOH	Station number	ENQ	Command	ETX	BCC	
1	2	1	1	1	2	(byte)

Used for BCC (bytes 1 to 5)

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ENQ	ENQ	05_H	Transmission request
4	Command	 'g' 'h' 'i' 'j' 'k'	 67_H 68_H 69_H $6A_H$ $6B_H$	Request command Detected speed value (M06) Calculated torque value (M07) Calculated torque current value (M08) Output frequency (M09) Operation status (M14)
5	ETX	ETX	03_H	End of message
6	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
7		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

Polling Response Frame (Inverter ⇒ Host)

0	1 2	3	4	5 8	9	10 11	
SOH	Station number	ACK/NAK	Command	Data	ETX	BCC	
1	2	1	1	4	1	2	(byte)

Used for BCC

Byte	Field	Value		Description
		ASCII	Hexadecimal	
0	SOH	SOH	01_H	Start of message
1	Station number	'0' to '3', '9'	30_H to 33_H, 39_H	Inverter station address (decimal, tens digit)
2		'0' to '9'	30_H to 39_H	Inverter station address (decimal, ones digit)
3	ACK/NAK	ACK NAK	06_H 15_H	Transmission response Positive acknowledgement: No reception error and no logical error in request Negative acknowledgement: Logical error in request
4	Command	 'g' 'h' 'i' 'j' 'k'	 67_H 68_H 69_H $6A_H$ $6B_H$	Request command Detected speed value (M06) Calculated torque value (M07) Calculated torque current value (M08) Output frequency (M09) Operation status (M14)
5	Data	'0' to 'F'	30_H to $3F_H$	First data character (hexadecimal: thousands digit)
6		'0' to 'F'	30_H to $3F_H$	Second data character (hexadecimal: hundreds digit)
7		'0' to 'F'	30_H to $3F_H$	Third data character (hexadecimal: tens digit)
8		'0' to 'F'	30_H to $3F_H$	Fourth data character (hexadecimal: ones digit)
9	ETX	ETX	03_H	End of message
10	BCC	'0' to 'F'	30_H to $3F_H$	Checksum 1 (hexadecimal, tens digit)
11		'0' to 'F'	30_H to $3F_H$	Checksum 2 (hexadecimal, ones digit)

6.3.2.3 Negative Acknowledgment Frame

When a response frame length depends on the command type, the response follows the length specified by that command type if the command type character is recognized successfully.

Num-ber	Frame/command type	Source of error	Negative acknowledgment frame	Error code (M26)
1	Standard frame Option frame	ENQ is not detected at prescribed position	Standard frame (16-byte length)	Format error [74]
2	Other than prescribed command	Command other than prescribed commands (R, W, A, E, a to k, m) is detected	Standard frame (16-byte length)	Format error [75]
3	Selecting command (a to f, m)	ETX is not detected at prescribed position	Option frame (8-byte length)	Format error [74]
4	Polling command (g to k)	ETX is not detected at prescribed position	Option frame (12-byte length)	Format error [74]

Note: When a negative acknowledgment is returned in a standard frame as in Number 1 or Number 2 in case of format error or command error, the contents of the Command field, the Type field, and the Function code number field are undetermined.

6.3.3 Description of Fields

6.3.3.1 Data Field

Standard frame

8	9	10	11	12
Special additional data	First data character	Second data character	Third data character	Fourth data character

Option frame

5	6	7	8
First data character	Second data character	Third data character	Fourth data character

All data except for special ones are 16 bits in length. These data are hexadecimal (0000_H to $FFFF_H$) and each digit is expressed by an ASCII code in the data field of a communication frame. A negative integer data (signed data) are expressed as a 2's complement.

Note 1: Use upper case for A to F of hexadecimal number.
Note 2: Set zero ('0') to the entire data filed of a polling request frame and send it.
Note 3: The data field of the ACK response frame is undetermined

Example) When you want use the function code S01 "Speed reference 1" to specify 500r/min (where the maximum speed is 1500r/min):

1) Calculate a value to set according to the data format of S01 (±20,000/maximum speed)

Data = 500r/min × ± 20,000/1,500r/min (+ for forward rotation and – for reverse rotation)
= ± 6,666.6
≈ ± 6,667

2) Convert the data into a hexadecimal number (2's complement for a negative data)

Data = 6,667 (Forward rotation)
= $1A0B_H$
Data = –6,667 (Reverse rotation)
= 0 – 6,667 = 65,536 – 6,667 = 58,869
= $E5F5_H$

3) Set the data

Field position	Setting (Forward rotation)		Setting (Reverse rotation)	
First data character	ASCII	'1'	ASCII	'E'
Second data character	ASCII	A'	ASCII	'5'
Third data character	ASCII	'0'	ASCII	'F'
Fourth data character	ASCII	'B'	ASCII	'5'

6.3.3.2 Checksum Field

This data is used to check an error of a communication frame in data transmission. The checksum is the lowest byte of a byte-wise addition of all fields except for the SOH and the checksum fields represented in ASCII code.

Example) When result of addition is 0123_H:

Field position	Setting	
Checksum 1	ASCII	'2'
Checksum 2	ASCII	'3'

6.3.4 Communication Examples

The following section describes typical communication examples (All station numbers are assumed as 12)

6.3.4.1 Standard Frame

(1) Selecting (write) for S01 "Speed reference 1", 300r/min (reference) × 20,000/1,500 (maximum speed) = **4,000d** = $0FA0_H$

Request frame (Host ⇒ Inverter)

SOH	1	2	ENQ	W	S	0	1	SP	0	F	A	0	ETX	7	D

ACK response frame (Inverter ⇒ Host)

SOH	1	2	ACK	W	S	0	1	SP	0	F	A	0	ETX	7	E

NAK response frame (Inverter ⇒ Host) .... Error due to link priority

SOH	1	2	NAK	W	S	0	1	SP	0	0	4	C	ETX	7	D

(2) Polling (read) for M09 "Output frequency"

Request frame (Host ⇒ Inverter)

SOH	1	2	ENQ	R	M	0	9	SP	0	0	0	0	ETX	5	3

ACK response frame (Inverter ⇒ Host) .... 30.00Hz ($0BB8_H$ ⇒ 3,000d ⇒ 30,00)

SOH	1	2	ACK	R	M	0	9	SP	0	B	B	8	ETX	8	0

6.3.4.2 Option Frame

(1) Selecting for Operation Command (Write)

Request frame (Host ⇒ Inverter) .... FWD command

SOH	1	2	ENQ	f	0	0	0	1	ETX	9	2

ACK response frame (Inverter ⇒ Host)

SOH	1	2	ACK	f	ETX	D	2

NAK response frame (Inverter ⇒ Host) .... Refer to M26 "Communication error code" for source of error

SOH	1	2	NAK	f	ETX	E	1

(2) Polling for Torque Reference (Read)

Request frame (Host ⇒ Inverter)

SOH	1	2	ENQ	h	ETX	D	3

ACK response frame (Inverter⇒Host) .... 85.0% (2134_H ⇒ 8,500d ⇒ 85.00)

SOH	1	2	ACK	h	2	1	3	4	ETX	9	E

(3) Selecting for Operation Command as Broadcast (Write)

Request frame (Host ⇒ Inverter) .... REV command

SOH	9	9	ENQ	f	0	0	0	2	ETX	A	2

No response is returned to a broadcast.

● ASCII Code Table

	00_H	10_H	20_H	30_H	40_H	50_H	60_H	70_H
0_H	NUL	DLE	SP	0	@	P	`	p
1_H	SOH	DC1	!	1	A	Q	a	q
2_H	STX	DC2	”	2	B	R	b	r
3_H	ETX	DC3	#	3	C	S	c	s
4_H	EOT	DC4	$	4	D	T	d	t
5_H	ENQ	NAK	%	5	E	U	e	u
6_H	ACK	SYN	&	6	F	V	f	v
7_H	BEL	ETB	’	7	G	W	g	w
8_H	BS	CAN	(	8	H	X	h	x
9_H	HT	EM	)	9	I	Y	i	y
A_H	LF	SUB	*	:	J	Z	j	z
B_H	VT	ESC	+	;	K	[	k	{
C_H	FF	FS	,	<	L	\	l	|
D_H	CR	GS	-	=	M	]	m	}
E_H	SO	RS	.	>	N	^	n	~
F_H	SI	US	/	?	O	_	o	DEL

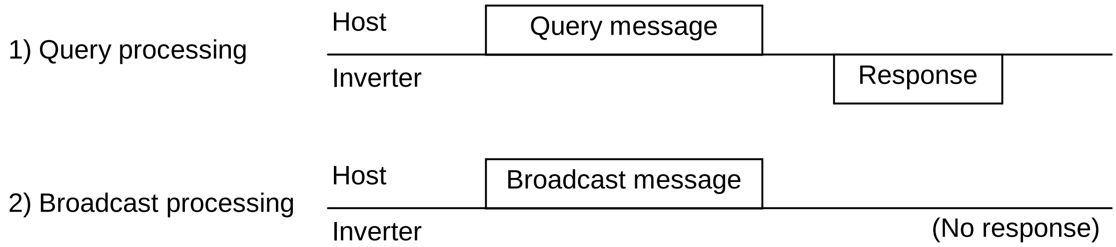
This communication uses the codes indicated by the shading .

6.4 Modbus RTU

This protocol is created outside of Japan.

6.4.1 Message Format

The standard formats for RTU message transmission are described below.



When an inverter is ready and receives a message addressed to itself, if the inverter determines that it received the massage successfully, the inverter processes the request and returns a normal response. If the inverter determines that it did not receive the massage successfully, the inverter returns an error response. The inverter does not return a response to a broadcast.

(1) Query
A host transmits a massage to a single inverter.

(2) Normal Response
After receiving a query, the inverter processes the request and returns a normal response.

(3) Error Response
After receiving a query, the inverter cannot process the request and returns an error response.
The error response includes a reason why the inverter cannot process the message.
The inverter does not return an error response to a CRC error or a physical transmission error.

(4) Broadcast
A master uses address 0 to transmit a message to all slaves. All slaves receiving the broadcast message execute a requested function. The timeout of the master terminates this process.

6.4.2 Transmission Frame

The following section describes the transmission frame. The details depend on the FC (Function Code) and see 6.4.2.1 "Reading FC Data", 6.4.2.2 "Writing Data for Single FC" and 6.4.2.3 "Writing Data for Consecutive FC's".

1byte	1byte	max 203byte	2bytes
Station Address	FC (Function Code)	Information	Error Check

(1) Station Address
The Station Address in one byte in length and you can select from 0 to 247.
The Station Address 0 selects all slave stations and means a broad cast message.

(2) FC (Function Code)

The FC is one byte in length and you can use a value ranging from 0 to 255 to define a function code. The FC's indicated by shading are available. Do not use the FC's that are not available, otherwise you will receive an error response.

FC	Description
0 to 2	Not used
3	Read data for FC, maximum 99
4 to 5	Not used
6	Write data for single FC
7	Not used
8	Maintenance code
9 to 15	Not used
16	Write data for consecutive FC's, maximum 16 data
17 to 127	Not used
128 to 255	Reserved for Exception Response

(3) Information

The Information field contains all information (such as FC, Byte Count, Data Number, and Data). See **6.4.2.1 "Reading FC Data", 6.4.2.2 "Writing Data for Single FC" and 6.4.2.3 "Writing Data for Consecutive FC's"** for more information on the Information field.

(4) Error Check

The Error Check field is two bytes in length and used for a CRC-16 type error check.

The frame length is necessary to obtain a CRC-16 code from the FC and the byte count data since the Information field length is variable.

6.4.2.1 Reading FC Data

(1) Query

1byte	1byte	2bytes	2bytes	2bytes
Station Number	03	Function Code	Number of Data to be Read (Maximum 99)	Error Check

(2) Normal Response

1byte	1byte	1byte	2 to 198bytes	2bytes
Station Number	03	Byte Count	Read Data (Maximum 198)	Error Check

Hi,Lo,Hi,Lo,Hi,Lo,…

(3) How to Set Query
- You cannot use the Broadcast for a Query. The Station Number 0 is not available.
- FC=03
- The FC is two bytes in length and consists of an identification code and a number (Example F40=F+40). The Hi byte corresponds to an identification code ranging F to L and the Lo byte corresponds to a number. The setting range for the Hi is 0 to 10 (F to U) and for the Lo is 0 to 99. For example, you should set "0014h" for F20,

Set data	Identification code	Name	Set data	Identification code	Name
0	F	Fundamental functions	6	o	Optional functions
1	E	Extension terminal functions	7	S	Serial communication functions
2	C	Control functions	8	M	Monitoring functions
3	P	Motor parameters	9	L	Lift functions
4	H	High performance functions	10	U	User functions
5	A	Alternative motor parameters			

- A read out data is two bytes in length. The setting range is 1 to 99 (in word). Set the Number of Data to be Read so as not to exceed the upper offset limit, 99, otherwise you will receive an error response.

(4) Interpreting Normal Response
- The range of the Byte Count is 2 to 198. The Byte Count is twice as large as the Number of Data to be Read (1 to 99) of a Query.
- The Read Data are arranged in the order of the Hi byte and the Lo byte of individual word data and the word data are arranged from the data of the specified function code in a query and its address, then the next data and its address, and so on. If you try to read a nonexistent function code (such as F09), you will receive "0000".

6.4.2.2 Writing Data for Single FC

(1) Query

1byte	1byte	2bytes	2bytes	2bytes
Station Number	06	Function Code	Data to be Written	Error Check
			Hi Lo	

(2) Normal Response

1byte	1byte	2bytes	2bytes	2bytes
Station Number	06	Byte Count	Data to be Written	Error Check
			Hi Lo	

(3) How to set Query

- You can set 0 to the station number for Broadcast. Then all inverters execute the request directed by the broadcast and return no response.
- FC=06
- The Function Code is two bytes in length and consists of an identification code and a number. See the table in 6.4.2.1 for more information on the identification code.
- The Data to be Written field is fixed two bytes in length.

(4) Interpreting Normal Response

- A normal response has the same frame as the query.

6.4.2.3 Writing Data for Consecutive FC's

(1) Query

1byte	1byte	2bytes	2bytes	1byte	2 to 132 bytes	2bytes
Station Number	16	Function Code	Number of Data to be Written	Byte Count	Data to be Written	Error Check
					Hi,Lo,Hi,Lo,···	

(2) Normal Response

1byte	1byte	2byte	2byte	2byte
Station Number	16	Byte Count	Data to be Written	Error Check

(3) How to set Query

- You can set 0 to the station number for Broadcast. Then all inverters execute the request directed by the Broadcast and return no response.
- FC=16
- The Function Code is two bytes in length and consists of an identification code and a number. See the table in 6.4.2.1 for more information on the identification code.
- The Number of Data to be Written field is two bytes in length. The setting range is from 1 to 16. You will receive an error response to a number of 17 or more.
- The Byte Count is one byte in length. The setting range is from 2 to 32. The Byte Count must be set twice as large as the Number of Data to be Written.
- Set the lowest data (data for the function code specified in the Function Code) to the first two bytes and set higher data (the second data, the third data and so on) in the increasing order.

(4) Interpreting Normal Response

- A response returns the same values as those in its query in the Function Code and the Number of Data to be Written fields.

6.4.2.4 Maintenance Code

You can use this function code to check the connection of the communication line (hardware).

(1) Query

1byte	1byte	2bytes	2bytes	2bytes
Station Number	08	Diagnosis Code 00 00	Data	Error Check

(2) Normal Response

1byte	1byte	2bytes	2bytes	2bytes
Station Number	08	Diagnosis Code 00 00	Data	Error Check

(3) How to set Query
- You cannot use the Broadcast for a Query.
- FC=08
- The Diagnosis Code is two bytes in length and you should always specify 0x0000, otherwise you will receive an error response.
- The Data is two bytes in length and you can specify freely.

(4) Interpreting Normal Response
- A normal response is the same as its query.

6.4.2.5 Error Response

An invalid query will not be executed and be responded with an Error Response.

(1) Error Response

1byte	1byte	1byte	2bytes
Station Number	Exception Func	Sub Code	Error Check

(2) Interpreting Error Response

- The error response is the same as a query requesting a Station Number.
- The Exception Func is the sum of the FC in the query and 128.
  For example, when FC=3, then Exception Func=3+128=131 (83_H).
- The Subcode indicates the reason of invalidity as in the following table.

Subcode	Item		Description	M26 code
1	Invalid FC		FC other than 3, 6, 8, and 16 is received.	-
2	Invalid address	Invalid function code	Function code out of range (for example F81) is received.	78
		Invalid data number	Writing 16 words or more is attempted.	
		Abnormal diagnosis code (maintenance code)	Data other than "0" is set to Diagnosis Code.	-
3	Invalid data	Data range error	Data to be written is out of valid range.	80
7	NAK	Link priority	Writing operation command or reference data is attempted while a field option (such as T-KINK or SX) is installed.	76
		Write disabled	1. Write disabled during operation 2. Write disabled (read only or M area) 3. Operation through link disabled 4. Write through RS485 disabled (H31, H34 to H37, H40, P02) 5. F04, F05, P03 to P27 (when M1 motor parameters are protected)	79

6.4.3 Error Check

6.4.3.1 CRC-16

This data is used to check for a error in a communication frame.
The CRC is one of the most effective error check systems. The sender side calculates and adds a CRC data at the end of a frame. The receiver side calculates a CRC data on a received data and compares these two CRC data.

(1) Brief Description of Steps to Calculate CRC Data

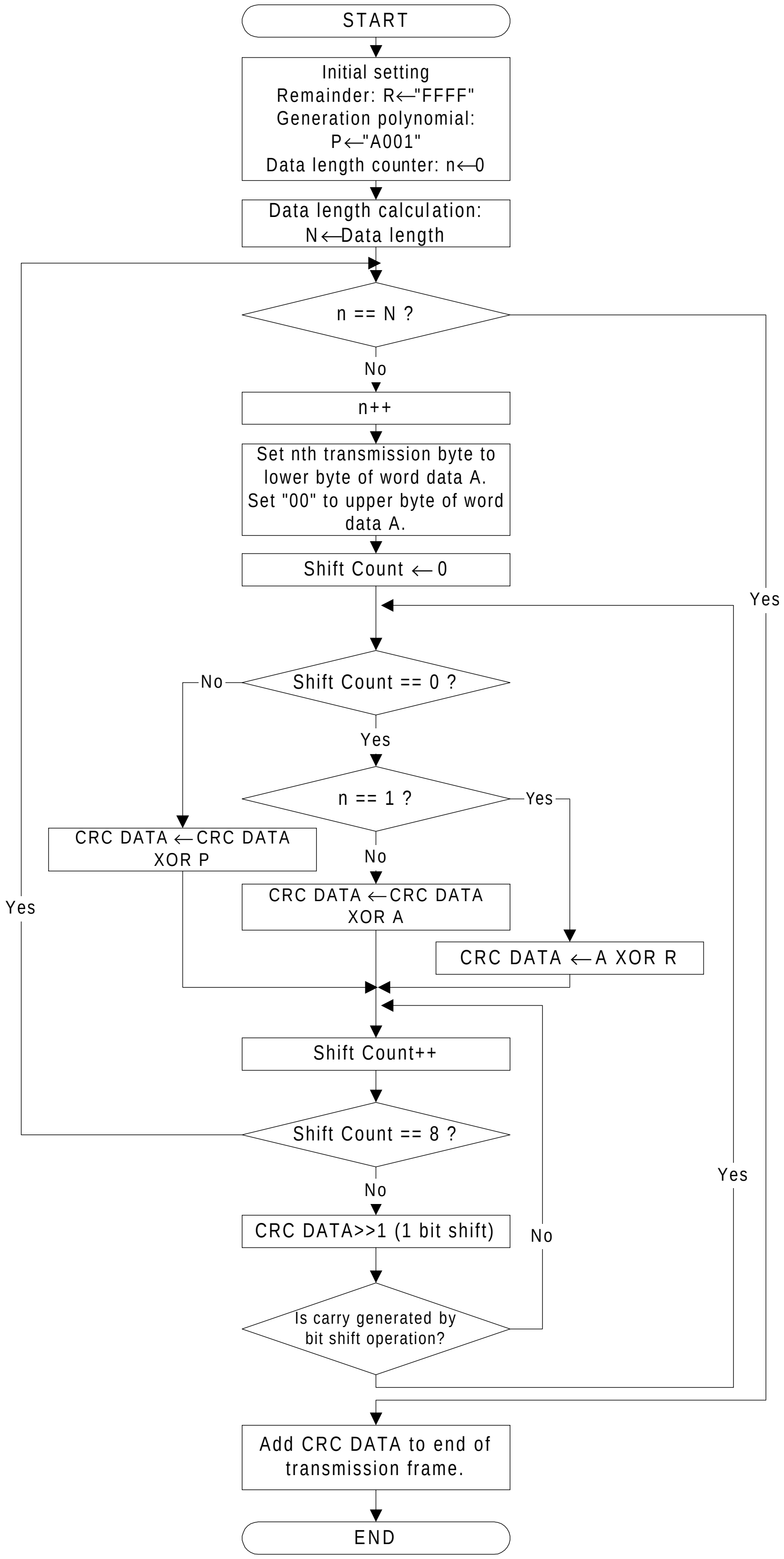
- A data expressed as a polynomial (1100 0000 0010 0001 is expressed as $X^{15}+X^{14}+X^{5}+1$) is divided by a generation polynomial (17 bits, $X^{16}+X^{15}+X^{2}+1$). The CRC data is obtained as a remainder (16 bits) of this division.
- Neglect the quotient, add the remainder at the end of a data, and send a message.
- A receiver side divides this message (with CRC data) by the generation polynomial and assumes that a transmission is executed without error if the remainder is 0.

(2) About CRC-16

The generation polynomial is expressed with powers of X such as $X^{3}+X^{2}+X$ instead of binary code 1101. Though you can choose an arbitrary generation polynomial, there are some defined/proposed standard polynomials to optimize error detection. The RTU protocol uses a generation polynomial of $X^{16}+X^{15}+X^{2}+1$ corresponding to 1 1000 0000 0000 0101 expressed in binary. In this case, a generated CRC is known as CRC-16.

6.4.3.2 CRC Algorithm

The following flowchart describes the calculation algorithm of CRC-16. See also a calculation example in 6.4.3.3.



- The CRC DATA occupies one word memory and is updated through calculation to be finally added to a transmission frame as a check code.
- The reception process is the same as that in the figure above. Note that the CRC data calculated on the transmission side and that on the reception side should be compared.

6.4.3.3 Example of CRC-16 Calculation

The following example is a data sent as a Query for a function code. The Station Number is 1, FC=03, the Function Code is P49 (code for P is 03 and 49 is 31hex), the Number of Data to be Read is 20, G.P. is a generation polynomial (1010 0000 0000 0001).

Station Number	FC	Function Code		Number of Data to be Read	
01	03	03	31	00	14

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
1	Initial data R="FFFF"	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	1st data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	CRC = No.1 Xor No.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
4	Shift >> 2 (until flag=1)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CRC = No.4 Xor G.P.	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
6	Shift >> 2	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7	CRC = No.6 Xor G.P.	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
8	Shift >> 2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
9	CRC = No.8 Xor G.P.	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift >> 2 (completion of 8 shifts)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC = No.10 Xor G.P.	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
12	2nd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13	CRC = No.11 Xor No.12	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
14	Shift >> 1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
15	CRC = No.14 Xor G.P.	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
16	Shift >> 1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
17	CRC = No.16 Xor G.P.	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
18	Shift >> 2	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
19	CRC = No.18 Xor G.P.	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
20	Shift >> 2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1
21	CRC = No.20 Xor G.P.	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift >> 2 (completion of 8 shifts)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
23	3rd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
24	CRC = No.22 Xor No.23	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	
25	Shift >> 1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
26	CRC = No.25 Xor G.P.	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	
27	Shift >> 6	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
28	CRC = No.27 Xor G.P.	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	
29	Shift >> 1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1
30	CRC = No.29 Xor G.P.	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	
31	4th data byte	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	
32	CRC = No.30 Xor No.31	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1	
33	Shift >> 1	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1
34	CRC = No.33 Xor G.P.	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1	
35	Shift >> 1	0	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1
36	CRC = No.35 Xor G.P.	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1	
37	Shift >> 1	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1
38	CRC = No.37 Xor G.P.	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	
39	Shift >> 1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1
40	CRC = No.37 Xor G.P.	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	
41	Shift >> 3	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1
42	CRC = No.41 Xor G.P.	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1	
43	Shift >> 1	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1
44	CRC = No.43 Xor G.P.	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
45	5th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	CRC = No.44 Xor No.45	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
47	Shift >> 5	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1
48	CRC = No.47 Xor G.P.	1	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	
49	Shift >> 3	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	0

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
50	6^{th} data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
51	CRC = No.49 Xor No.50	0	0	0	1	0	1	0	0	1	1	1	0	1	0	0	0	
52	Shift >> 4	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1
53	CRC = No.52 Xor G.P	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	
54	Shift >> 1	0	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1
55	CRC = No.54 Xor G.P	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	0	
56	Shift >> 2	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1
57	CRC = No.56 Xor G.P	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	
58	Shift >> 1	0	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0
	CRC data to be transmitted	4				E				1				4				

The following table shows the data to be transmitted after the calculation above.

Station Number	FC	Function Code		Number of Data to be Read		CRC Check	
01	03	03	31	00	14	14	4E

6.4.3.4 Calculating Frame Length

You should obtain the variable message length to calculate a CRC-16 data. You can use the following table to determine the length of all message types.

FC	Name	Query Broadcast message length except for CRC code	Response message length except for CRC code
3	Reading FC Data	6 bytes	(3+3rd data length) bytes
6	Writing Data for Single FC	6 bytes	6 bytes
8	Maintenance Code	6 bytes	6 bytes
16	Writing Data for Consecutive FC's	(7+7th data length) bytes	6 bytes
125 to 255	Exception Function	Not used	3 bytes

*7th or 3rd bit shows the number of counted bytes of the information.

6.4.4 Communication Examples

The following section describes typical communication examples (all station numbers are assumed to be 5).

6.4.4.1 Reading

(1) Read M06 "Detected speed value".

1) Query (Host ⇒ Inverter)

05	03	08	06	00	01	67	EF

2) Normal Response (Inverter ⇒ Host)

05	03	01	27	10	A3	B8

Detected speed value; $2710_H \Rightarrow 10{,}000d$

$$10{,}000 \times \frac{\text{Maximum speed}}{20{,}000} = 750\ [\text{r/min}]$$

(Maximum speed: 1,500r/min)

(2) Write 400r/min to S01 "Speed reference 1" (Maximum speed: 1,500r/min).

$$400\ [\text{r/min}] \times \frac{20{,}000}{1{,}500} = 5333d = 14D5_H$$

1) Query (Host ⇒ Inverter)

05	06	07	01	14	D5	16	65

2) Normal Response (Inverter ⇒ Host)

05	06	07	01	14	D5	16	65

6.5 How to Use PC Loader (Loader command protocol)

6.5.1 Advantages of PC Loader

Real-time trace

Real-time trace shows the current condition of the inverter more realistically in a graph by the high-speed sampling (10ms).

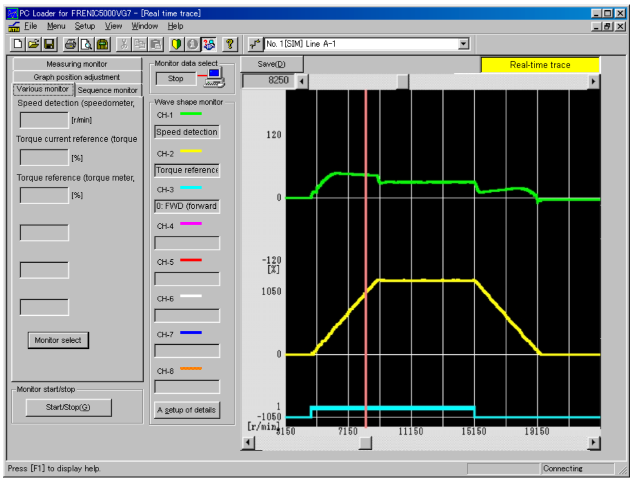


Figure 1 Real-time Trace

Real-time trace realizes the continuous waveform measurement of up to 30,000 points at the minimum intervals of 10ms (continues 5 minutes in case of 10ms sampling). This high-speed sampling discloses the detailed transition of the inverter at an unprecedented speed. Historical trace enables the continuous sampling of 100 points at the minimum intervals of 1ms.

All the required information such as speed detection, speed setting, line speed, torque current reference, motor voltage, motor current can be indicated in a graph with eight points at a time (in case all the data are digital signals). Additionally, the condition of that moment is indicated with digital values in the left columns of the screen. Therefore, you can understand the condition of the inverter at a glance. Furthermore, the time scale and Y scale of the graph can be set freely.

Auto tuning

Inverter will correct the motor in any environment condition. You can start the operation of the inverter immediately in everywhere.

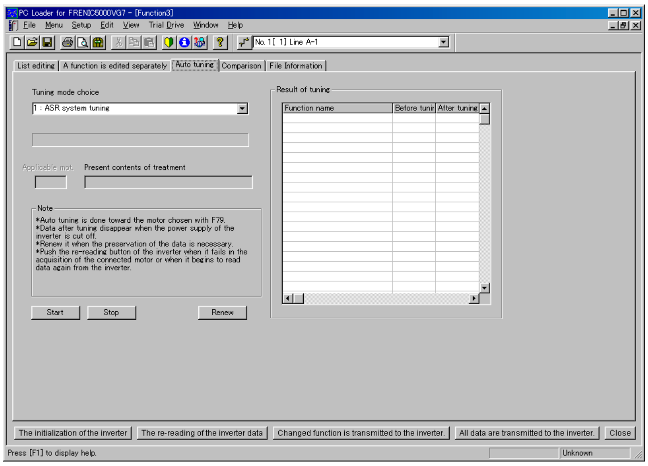


Figure 2 Auto Tuning

The settings of inverter in the motor was formerly very difficult for the people who were not accustomed to do it, because various kinds of the complicated configuration are required to operate the inverter correctly.
In this VG7S, the inverter will do the required settings automatically by itself. Complicated configuration or calculation is no more required.
You can perform the auto tuning through KEYPAD or, if using PC Loader, you can easily check the condition of the tuning or compare the data before and after tuning.
Auto tuning function also reduces the time for the settings. This is really the function for the customers.

6.5.2 Specifications

Item		Specifications	Remarks
System requirements			
	PC	PC/AT compatible machine	Excluding Macintosh
	OS	Microsoft Windows™ 95,98 Microsoft Windows™ NT 4.0	Excluding Microsoft Windows 3.XX.
	Display	SVGA(800×600) or more is recommended	Trace screen corresponds to XGA.
Software			
	Language	Japanese, English	Selectable at the time of installation.
Software to be installed			
	Distribution medium	CD-ROM	
	Uninstallation	Possible	
	Custom set-up	Total installation type	Customization is impossible.
Communication setup			
	Interface	RS485	
	Transmission speed	2400, 4800, 9600, 19200, 38400bps	Changeable at communication setup.
	Synchronization method	Start-stop synchronization (UART)	
	Transmission Method	Full-duplex (physical level) Half-duplex (protocol)	The connection method is full-duplex but the data exchange method repeats request and response alternately
	Communication style	Direct connection to inverter 1:n(1≤n≤31)	Changeable at connection setup.
	SX bus connection	Impossible	
	Network connection	Impossible	
	Data length	8bit	Cannot be changed at communication setup. Set the VG7S function code to be fixed.
	Stop bit	1bit	
	Parity	Even parity	
	Flow control	Supports the selection of RTS or DTR control.	Changeable at communication setup.
	Error check method	Checksum method (1byte BCC)	
	Protocol	Following the SX bus protocol	Not opened.
	Time-out detection interval	Time-out × number of retries	Changeable at communication setup.
	No. of retries	Retry function executed in the case of data error or physical error.	Changeable at communication setup.

6. Standard Interface RS485

Loader standard specifications		
Function code setting specifications		
Edit by list	Refers/Changes the function code F, E, C, P, H, O, L, and U. The L code requires password.	
Edit by function	Individual setting for digital input · output, analog input/output is available.	
Automatic tuning	The condition of the tuning and its result can be compared.	
Comparison	Can compare the inverter data and the data in edit, files and the data in edit. The result can be printed out.	
File information	Inverter system, function codes, the date information when the file is read and comments can be input.	
Print·Save	Function codes can be printed and saved. CSV format is also available, therefore the file can be read by other applications.	
Monitor function		
Multiple monitor	Monitors VG7S connected to RS485 by the periodical scanning, up to max. 31 machines	
I/O monitor	Monitors digital input/output.	
System monitor	Monitors ROM, option, inside control information, maintenance information.	
Error monitor	Indicates currently occurring alarm and alarm history.	
Real-time trace · Historical trace specifications		
	Real-time trace	Historical trace
Sampling interval	10,20,50,100,200,500ms	1,2,5,10,20,50,100ms
No. of samplings	Max. 30,000 points (In case of over 30,000, the data will disappear in order from the old one).	100 points (the number of samplings can be set before and after the trigger).
Filter function	Can set manual or auto filter individually.	
No. of data	Max. 4 for analog, max. 8 for digital. (The number of data is limited when the analog and digital data are used in combination.)	
Analog data	Speed detection 1 (Speedometer, one-way deflection), Speed detection 1 (Speedometer, two-way deflection), Speed setting 2 (Before calculation for acceleration/deceleration), Speed setting 4 (ASR input), Speed detection 2 (ASR input), Line speed detection, Torque current reference (Torque ammeter, two-way deflection), Torque current reference (Torque ammeter, one-way deflection), Torque reference (Torque meter, two-way deflection), Torque reference (Torque meter, one-way deflection), Motor current, Motor voltage, Power consumption, DC link circuit voltage, +10V output test, –10V output test, Motor temperature, Heat sink temperature, excitation current command, excitation current detection, Magnetic-flux command, Magnetic-flux calculation, Torque calculation, Torque current detection, U,W phase motor current, U,W phase motor voltage, Torque bias balance adjustment, Torque bias gain adjustment, Universal AO, Option AO	

	Digital input data	Multistep speed selection, 1,2,4,8,ASR, Acceleration/deceleration selection 1,2, Self-hold selection, Coast-to-stop command, Alarm reset, External alarm, Jogging operation, Speed setting, N2/Speed setting N1, Motor M2 selection, Motor M3 selection, DC control braking command, ACC/DEC zero clear command, UP/DOWN setting, Creep speed switching, UP command, DOWN command, KEYPAD write enable command, PID control cancel, Forward operation/Reverse operation switch over, Interlock (52-2), Write enable through link command, Operation selection through link, Universal DI, Control method selection at the time of motor start, Synchronization command, Zero speed locking command, Pre-exciting command, Speed reference limit cancel, H41 [torque reference] cancel, H42 [torque current reference] cancel, H43 [magnetic-flux reference] cancel 34, F40 [torque limiter mode 1] cancel, Torque limiter (level 1, level 2 selection), Bypass, Torque bias command 1,2, Droop selection, Ai1,2,3,4, Zero hold, Ai1,2,3,4 Polarity change, PID output inverse changeover, PG alarm cancel, Undervoltage cancel, Ai torque bias hold, STOP1,2,3, DIA data latch, DIB data latch, Multi-winding function cancel, Option Di 1,2,3,4,5,6
	Digital output data	Inverter running, Speed detected, Speed agreement, Reaching the preset speed, Speed detection 1,2,3, Stopping on undervoltage, Torque polarity detection (braking/driving), Torque limiting, Torque detection1,2, KEYPAD operation mode, Inverter stopping, Operation ready output, Magnetic-flux detection signal, Motor M2 selection status, Motor M3 selection status, Brake release signal, Alarm indication1,2,3,4, Cooling fan operating, Retry operation mode, Universal DO, Heat sink overheat early warning, Synchronization completion, Lifetime alarm, Under accelerating, Under decelerating, Inverter overload early warning, Motor temperature early warning, Motor overload early warning, DB overload early warning, Transmission error, Load adaptive control under limiting, Load adaptive control under calculation, Analog torque bias hold, Option DO 1,2,3,4,5,6,7,8,9
	Print · Save	Trace data can be printed and saved. CSV format is also available, therefore the file can be read by other applications.
	Trial operation	
	Operation	FWD, REV, STOP command can be used.
	Speed setting	Digital speed setting command can be used.
	Control input	X1 to X9 can be input.
	Monitor	Speed command, actual speed, torque and operational status can be monitored.

6.5.3 How to Install

(1) Setting CD-ROM and auto start
Set the CD-ROM into the CD-ROM drive slot with the face down.
The CD-ROM program automatically starts after a while.

(2) Welcome message

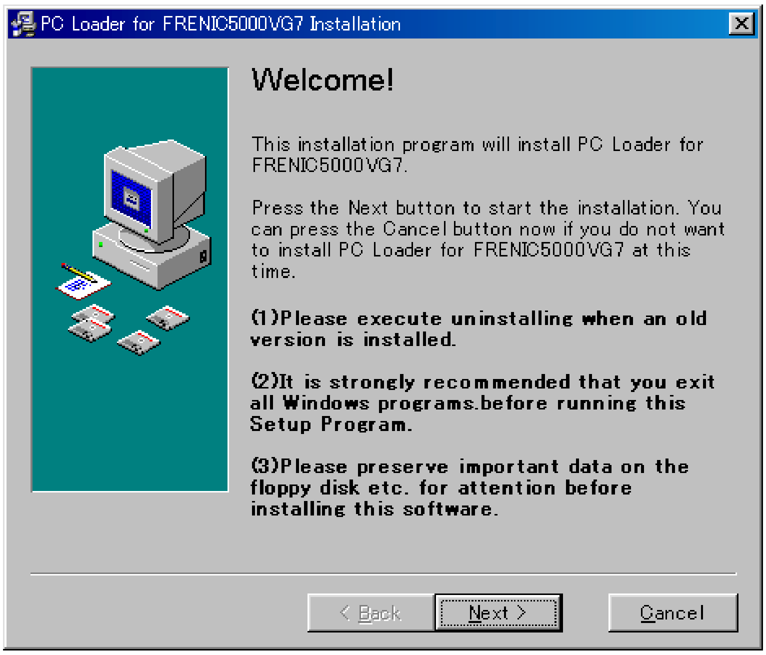


Figure 3 Welcome Message

Before running this installation program, be sure to exit all application programs. (because installation of PC loader requires to restart the computer, which will delete the application data). When the CD-ROM is started, a welcome message (Figure 3) automatically appears.
Read the message carefully and click "Next (N)".

Note 1: When the welcome message in Figure 3 does not appear after setting CD-ROM and waiting for a while, double click "my computer", and double click CD-ROM. Then, double click "AutoRun. exe".

Note 2: This subsection describes the installation method assuming that the PC loader is installed on MS-Windows95. The installation method may differ according to the OS version. If installing on the other OS, replace the description with the operations that corresponds to the OS to be used.

(3) End user software license agreement

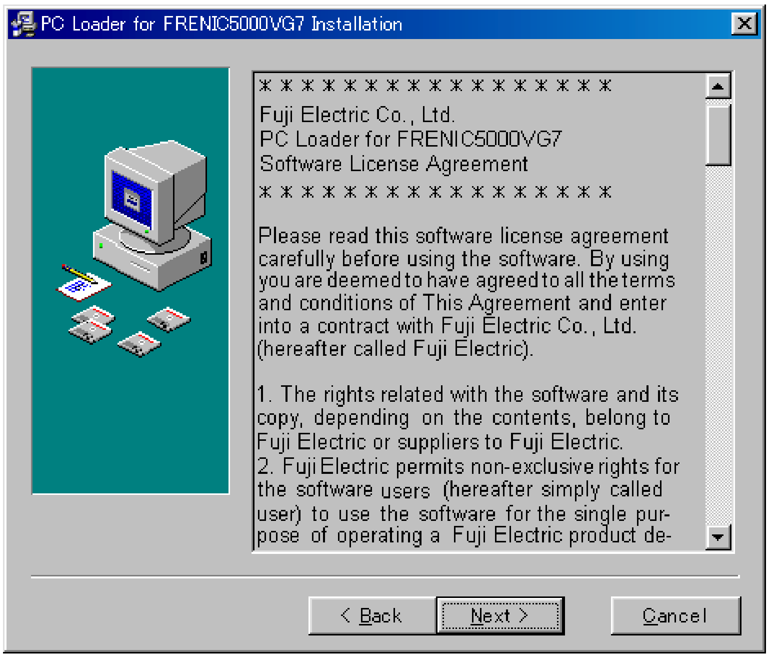


Figure 4 End User Software License Agreement

The end user software license agreement (Figure 4) will appear.

Read this agreement carefully, and if you agree with this, click “Next (N)”.

If not, click “Cancel”.

(4) Input of the user information

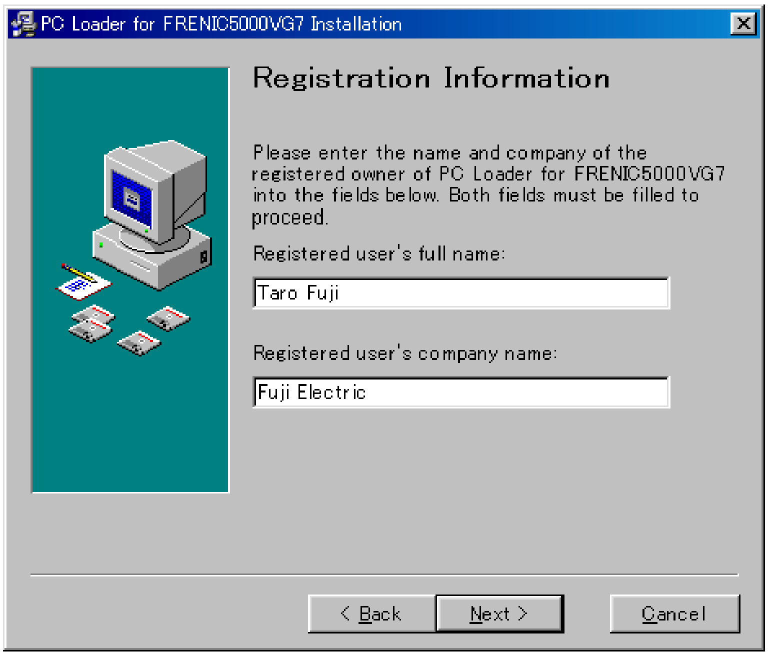


Figure 5 User Information

Always input the user name and the company name. Without these data, you cannot proceed to the next step.

After inputting the user name and the company name, click “Next (N)”.

(5) Locating the directory to be installed

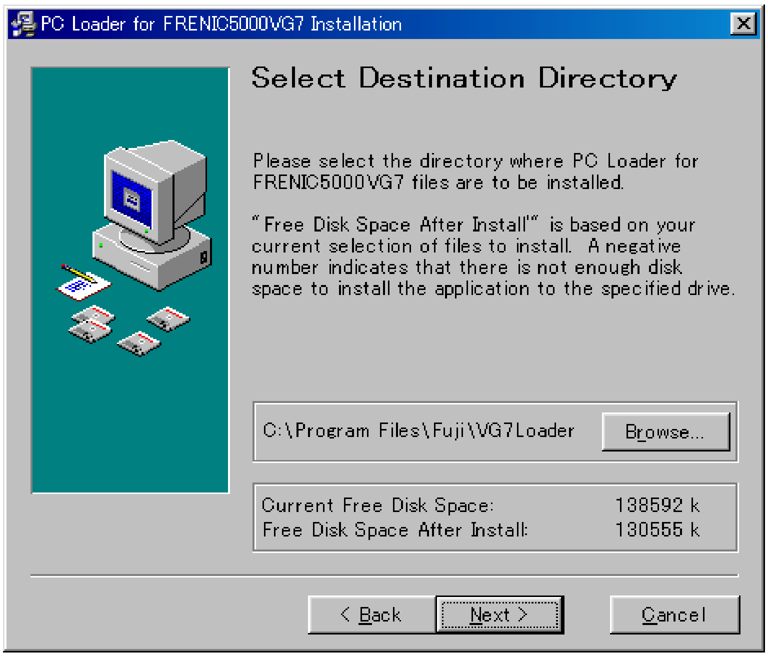


Figure 6 Locating the Directory to be Installed

The default directory where the software is installed is C:\ProgramFiles\Fuji\FRENIC. If there is no problem, install in this directory.

When you change the directory, click "Reference (R)". At the same time, confirm the free area. After confirming the free area and changing the directory, click "Next (N)".

If the old version of the program is installed, the following screen will appear.

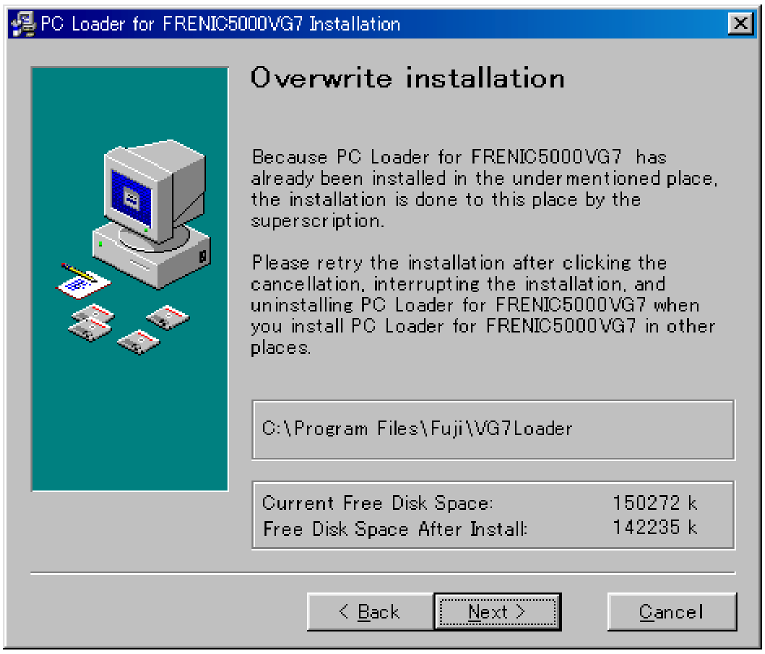


Figure 7 Rewrite Install

In this case, only the "Rewrite install" is available. If you want to change the directory for installation, click "Cancel" to stop installation. Uninstall the old version, and retry installation.

When installing the software by overwriting, click "Next (N)".

(6) Selecting the component to be installed

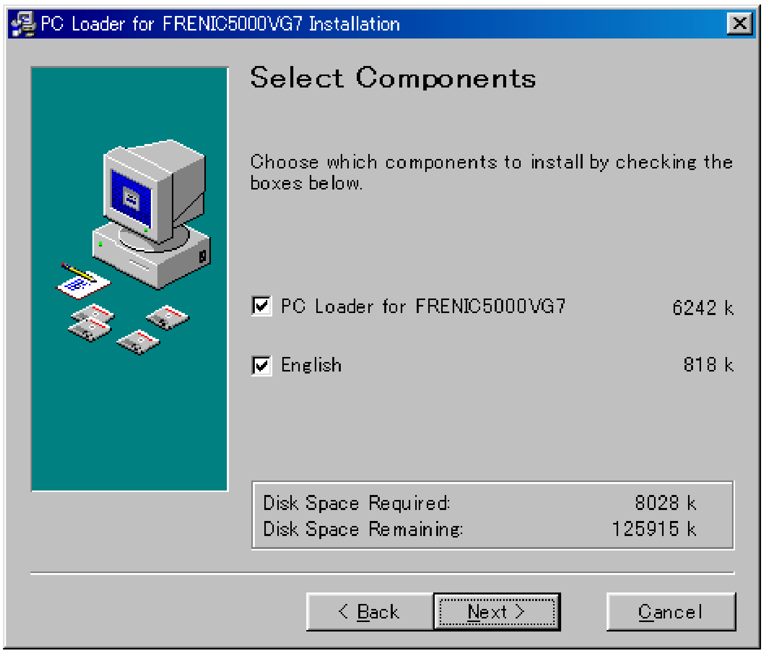


Figure 8 Selecting the Component

You can select the component to be installed. The following components are available:

(1) PC Loader for FRENIC5000VG7
(2) Japanese

Currently, both of these components should be installed. When these components are installed separately, the program cannot run.
Check two columns and click "Next (N)".

(7) Selecting the program manager group

Figure 9 Selecting the Program Manager Group

By default, "Program manager group" is installed in "FRENIC5000VG7".
If there is no problem, proceed without adding any change.
Click "Next (N)" to go to the next step.

(8) Selecting the starting method

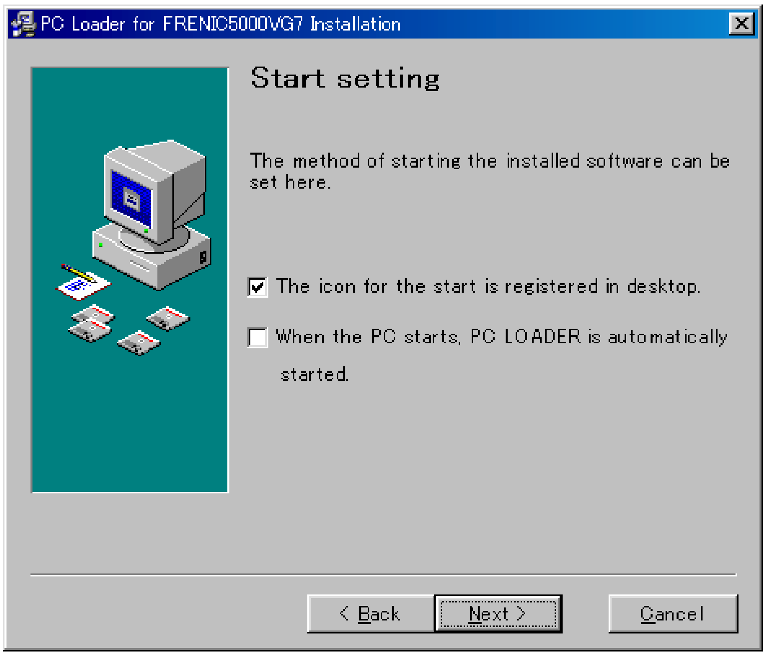


Figure 10 Selecting the Starting Method

(1) If you want to create the startup icon on the desk top, check "Register the startup icon on the desk top".
(2) If you want to start the PC LOADER automatically when starting the Windows, check "Start the PC LOADER automatically at the time of the computer start".
After the checking, click "Next (N)".

(9) Starting the copy to the computer

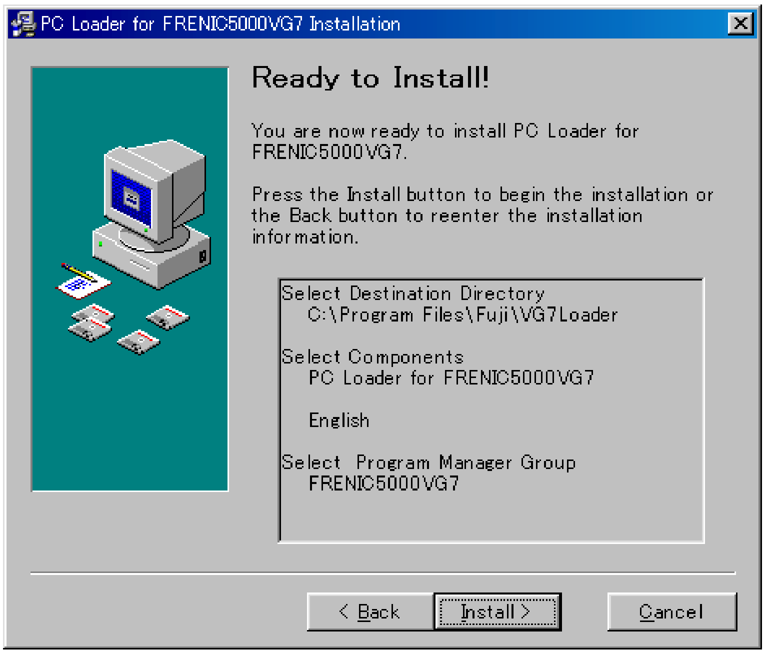
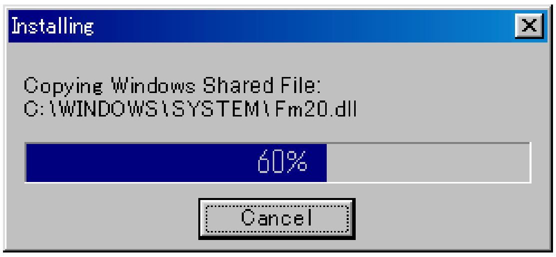


Figure 11 Starting the Copy

Click "Start (S)", and the copy of the program from CD-ROM to the computer will start.
If you want to change the indicated settings, click "Back (B)" and set them again.

When "Start (S)" is clicked, the "Installing" screen will appear as shown in Figure 12.

(10) Indication of “Now copying”



When the “Start (S)” is clicked on the screen in Figure 11, the left dialog box appears, indicating that the PC LOADER is being installed. When the bar in the middle of the screen reaches 100%, the installation is completed.

Figure 12 Dialog Box Showing Progress of Installation

(11) Indication after the completion of the copy

On completion of program copy, the configuration of the PC will start. Wait until the message of “Rewriting the system configuration file. Wait a second” disappears.

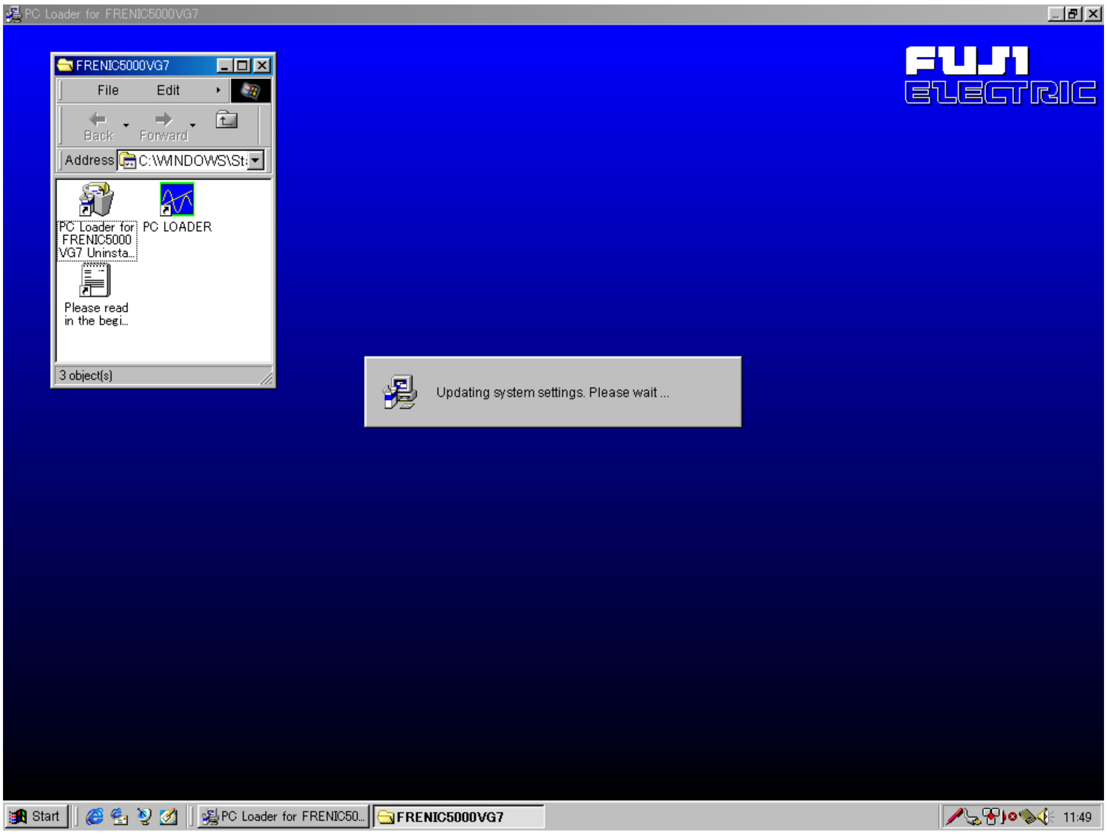


Figure 13 System Configuration is Being Set

(12) Installation completed

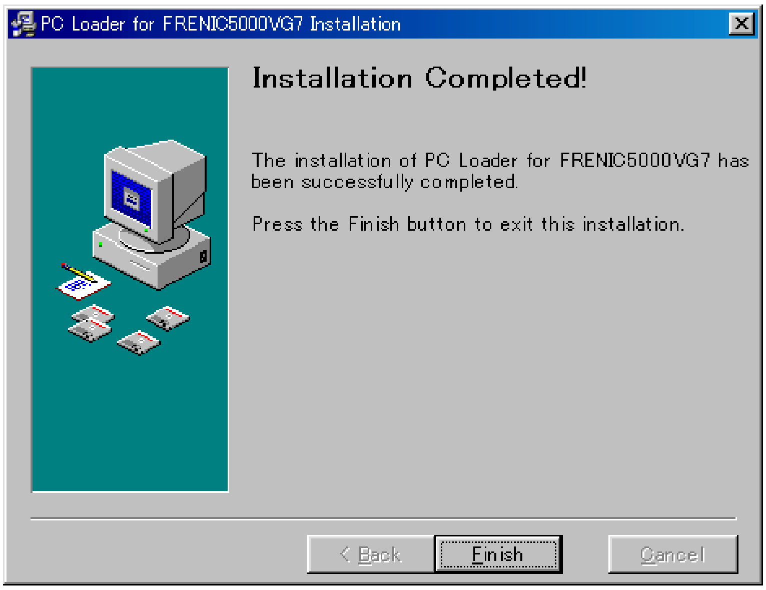


Figure 14 Installation Completed

When the installation is completed, the left screen will appear.
Click "Finish (F)" to complete installation.

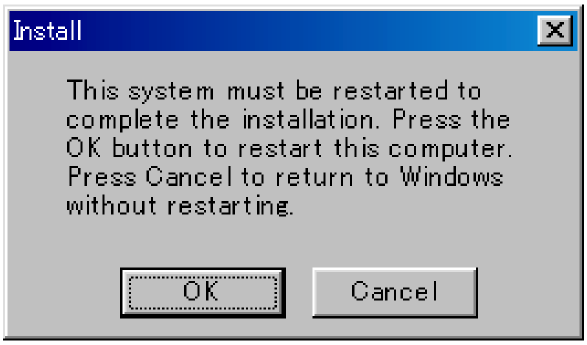


Figure 15 Finish

When clicking the "Finish(F)", the left screen will appear.
The computer should be restarted to start the installed application.
If other applications are not closed, click "Cancel" and exit all the applications.
After that, restart the computer.

6.5.4. Simple Operation Method

6.5.4.1 Start of PC Loader

The way of starting PC loader differs according to the selected starting method.

(1) If “Start the PC LOADER automatically at the time of the computer start” is selected, PC Loader will start automatically when the computer is started.

(2) If “Register the startup icon on the desk top” is selected, click this startup icon to start.

(3) Click PC LOADER in FRENIC5000VG7 folder.

Note: When the folder name is changed, the dialog box in the left figure shows the new folder name.

Figure 16 FRENIC5000VG7 Folder

(4) Select PC Loader in the start menu as shown in Figure 17.

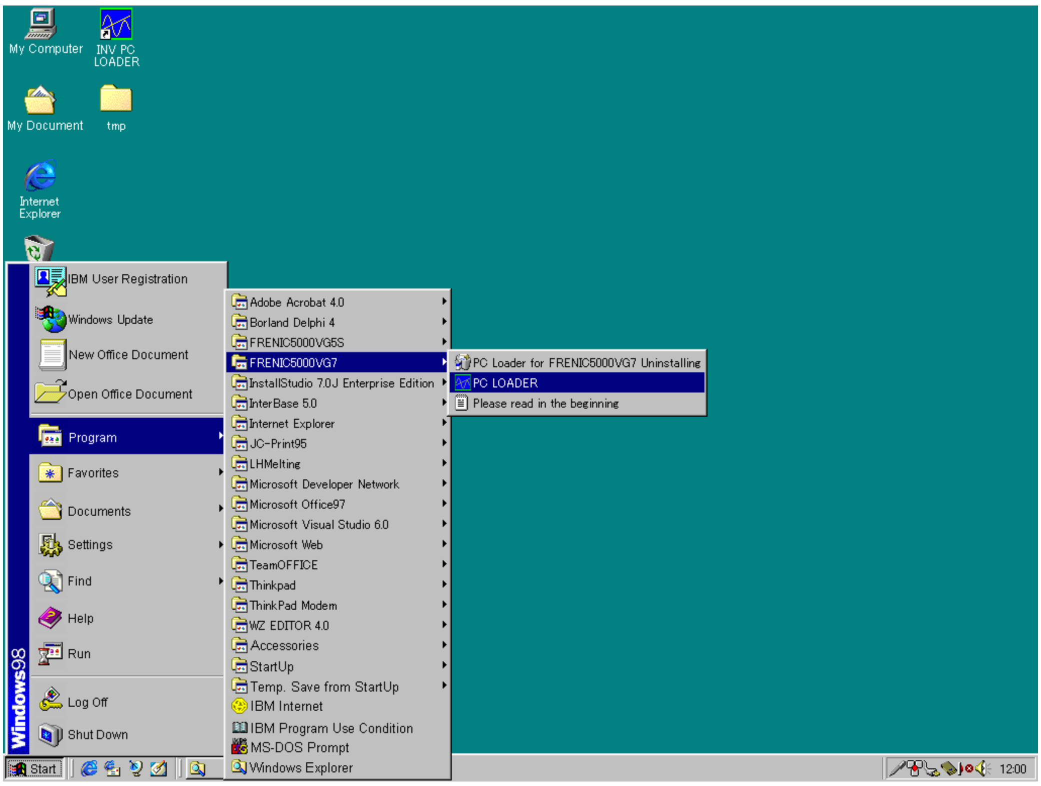


Figure 17 Start from the Start Menu

6.5.4.2 Communication Setup

Set the data for communication between the computer and the inverters.

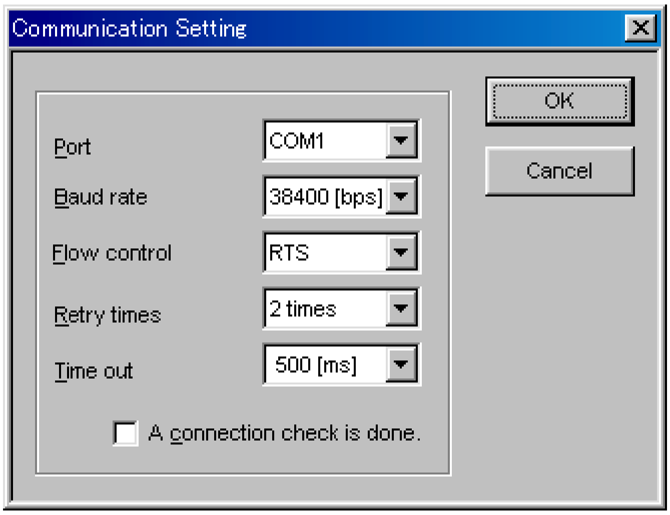


Figure 18 Communication Setup

(1) Selection of port
Select the connection port of the computer (four ports from COM1 to COM4 are available).

(2) Baud rate setting
Set the communication speed.

(3) Flow control
Select the flow control.

(4) Number of retries
Set the number of retries to be done automatically when the communication error occurs. You can select the number of times from zero to ten.

(5) Setting time-out error time
Set the time before timeout error occurs when no reply is returned from the inverter.

(6) To do the connection check or not
Select whether the communication line should be connected or not. If this box is checked, the communication will be made at any time, and the processing of the computer will delay by the time taken for communication. Always check here during the real-time processing.

6.5.4.3 Connection Setup

Next, select the inverters to which PC is connected for communication.

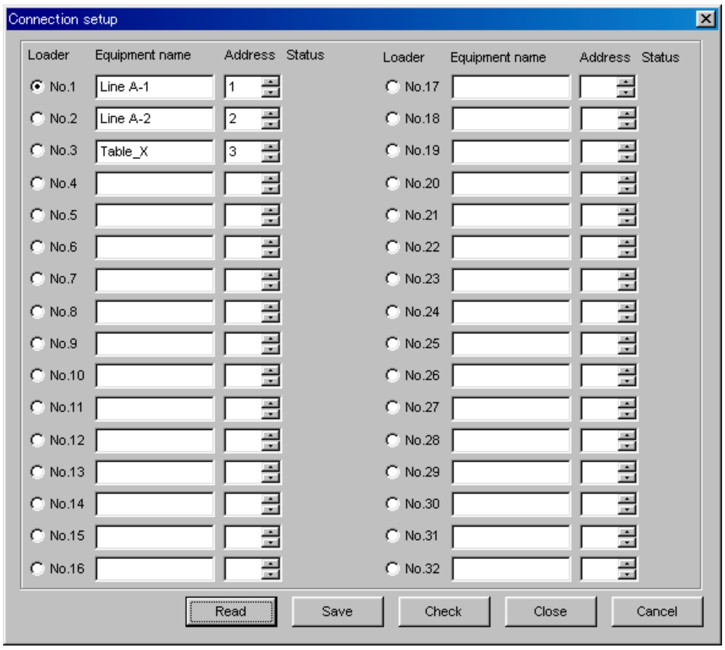


Figure 19 Connection Setup

(1) Loader connection
Select the inverters to be connected with the computer.

(2) Inverter equipment name
Enter the of the inverter name currently used. (You can input freely)

(3) Channel number
Set the inverter number.

(4) Communication status
When "Confirm Communication" is clicked, the ON/OFF status appears in this column.
(Refer to Figure 20.)

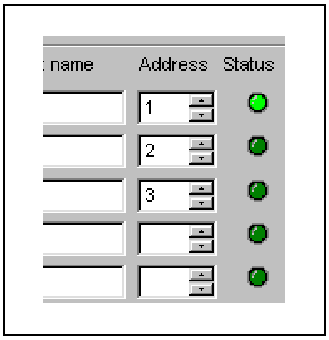


Figure 20 Communication Status

6.5.4.4 Function Code Setup

Edit, compare and initialize the function codes.

(1) Selecting the data to be edited

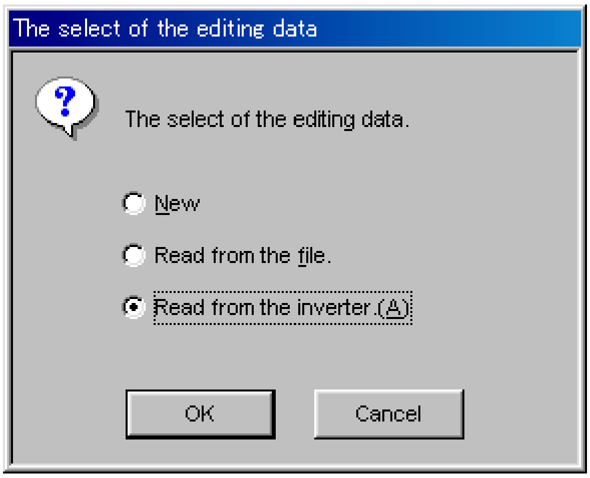


Figure 21 Selecting the Data to be Edited

"Selecting the data to be edited" window will appear when the function code setup mode starts. Select the data to be edited and Click OK, then the new edit screen will start.

- New File (N)
  Select this button mainly when the computer is not connected to the inverter.
  Edit the function codes based on the function codes prepared in the inverter support software.

- Read the file in the computer (F)
  Select this button when editing the function code setup file which has been already saved.

- Load from the inverter (A)
  Select this button when editing the function codes of the currently connected inverter.

⚠CAUTION

If "Load from the inverter" is selected although the computer is not connected to the inverter, "time-out" error will occur and the left dialog box shows an error message.

In this case, click "OK" and reconnect.

(2) Edit by list

Edits the function codes in the list.

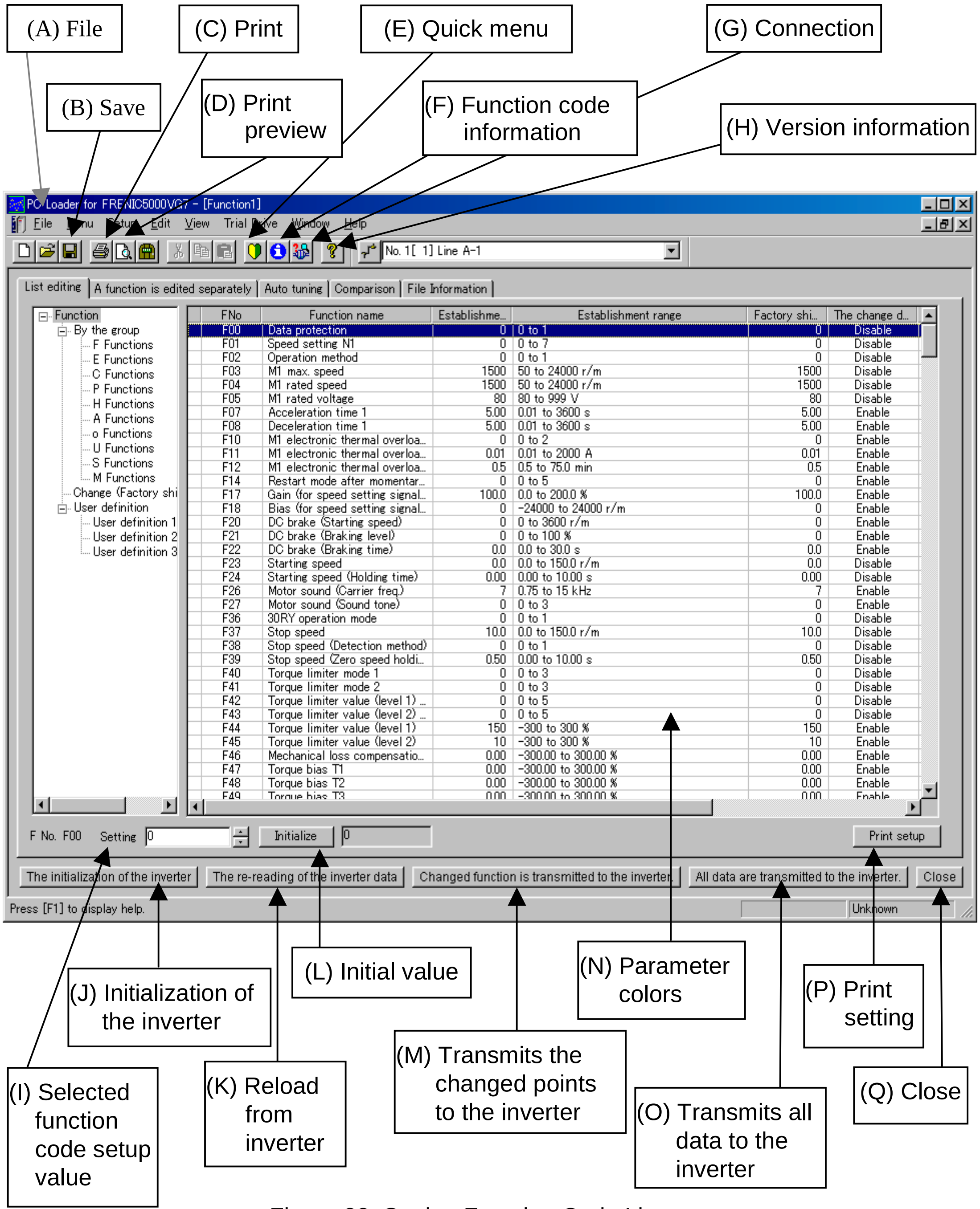


Figure 22 Setting Function Code List

6. Standard Interface RS485

(A) File

Used to open, save, and print the existing function code file.

(B) Save

Used to save the function codes being edited.

If you choose the CSV format (* . CSV) at the time of saving, the file can be opened by Microsoft Excel etc.

*** Refer to “5 Read the file and save”.**

(C) Print

Used to print the parameters being edited.

Prints in the form of a list.

(D) Print preview

Previews the printed image.

(E) Quick menu

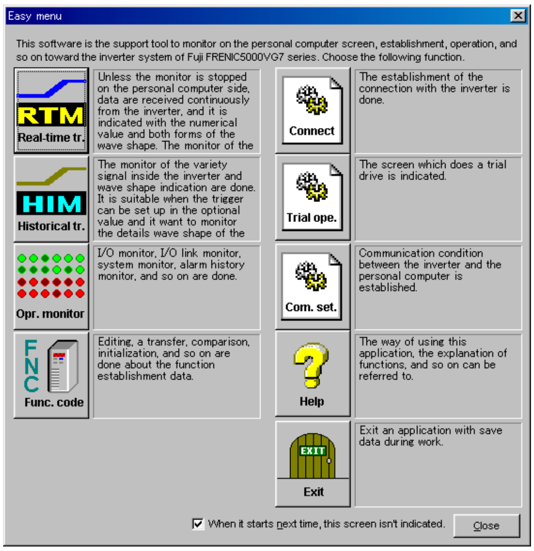


Figure 23 Quick Menu

This screen allows you to jump from the menu screen to each setting screen. This screen covers all the fundamental data setting screens.

(F) Function code information

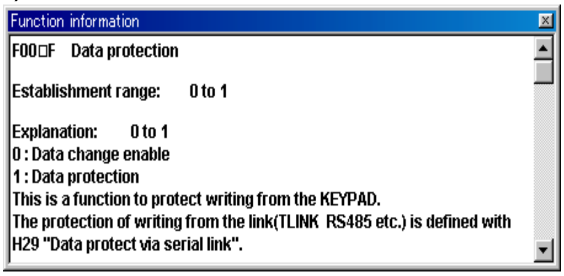


Figure 24 Function Code Information Window

The left window shows the information on the selected function code.

(G) Connection

Used to set the data communication as the persistent connection or not.

(H) Version information

Shows the version of this software.

(I) Selected function code setup value

Indicates the code number and the setup value of the currently selected function code.
You can edit the currently selected function code by either the numerical keys or the spin buttons on the right side of this data input column.

(J) Initialization of the inverter

Changes the function code setup value of the connected inverter to the factory setup value.

(K) Reload from inverter

Loads the function code setup values from the currently connected inverter and inserts it into the file being edited.
Save the file before executing this function to prevent the file being edited from getting lost.
Use this function to reconfirm the function codes transmitted to the inverter.

(L) Initial value

Sets the currently selected function code setup value as an initial value.

(M) Transmits the changed points to the inverter

Writes only the changed function codes to the connected inverter.

(N) Parameter colors

Black: Function codes which are not yet changed.
Blue: 1) Function codes which are already changed.
The color will become black after the change is written in the inverter correctly.
"*" before the function code shows that the current setup value differs from the factory setup value.

(O) Transmits all data to the inverter

Writes all of the function code setup value being edited in the connected inverter.

(P) Print setting

Sets the print condition.

(Q) Close

Quits the function code setup.

After changing the setup value, if the data is not saved, the screen as shown in the left figure will appear.
If you want to save the data, click "cancel" and save the data according to "(B) Save".

Figure 25 Notice that the Data are not Saved

(3) Edit by function

Edits the function codes by classifying the codes by function.

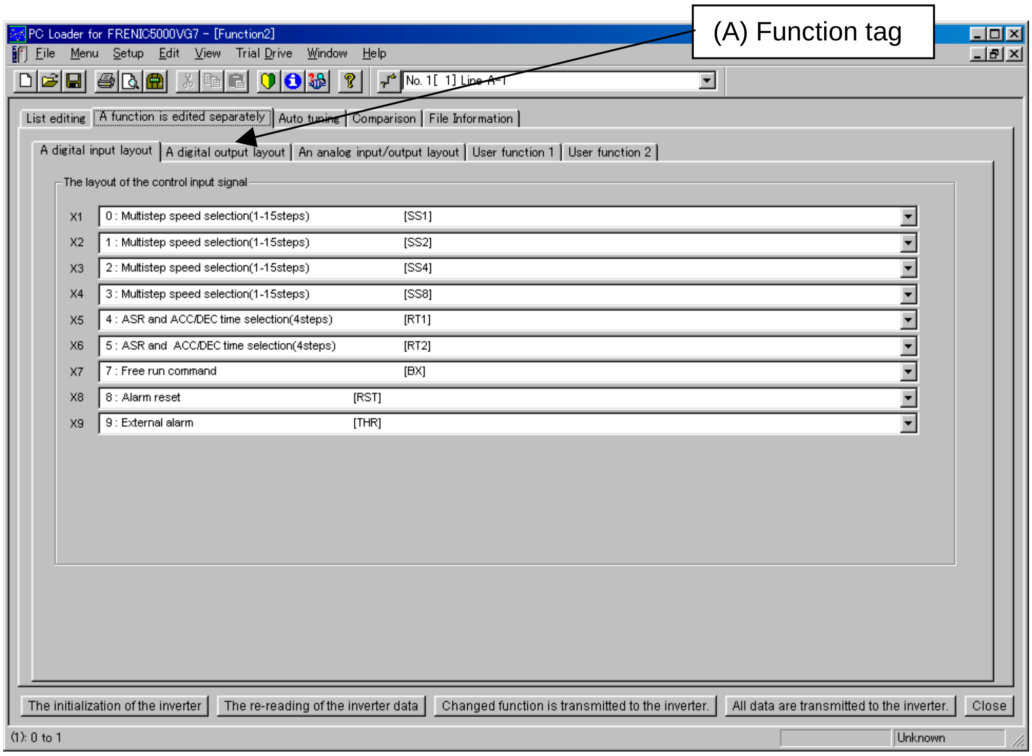


Figure 26 Edit by Function

(A) Function tag

Tags classified by the function.

1) Digital, analog input/output allocation

Selects the tag of the function to be edited.

Refer to (2) Edit by list for the procedure of initialization of the inverter etc.

User function

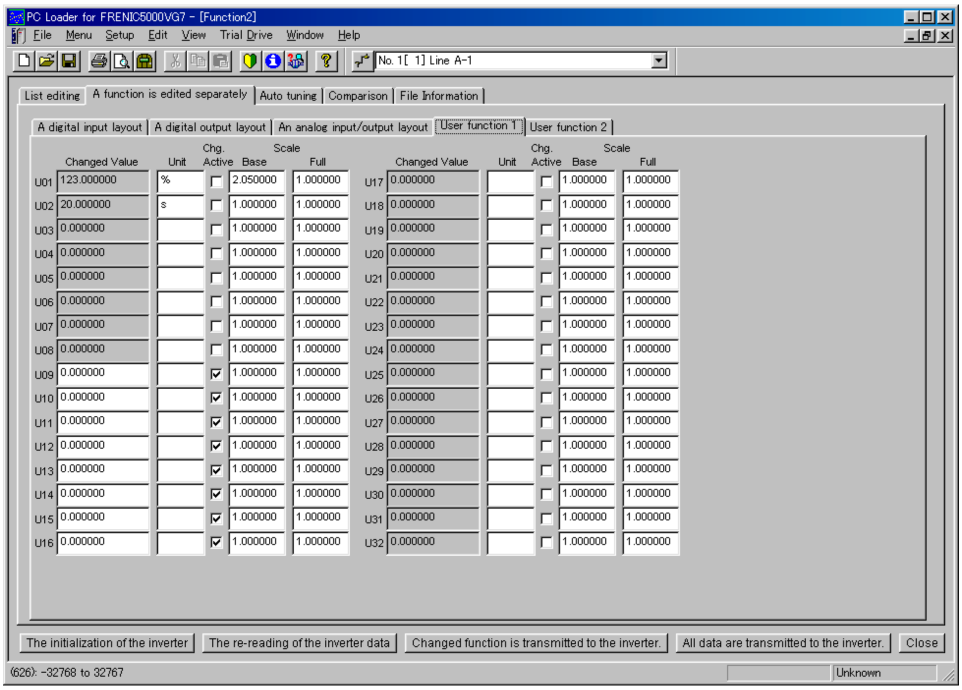


Figure 27 Edit by Function

The above table is used to convert the hexadecimal data used by the computer to the decimal data that you can easily understand. You can complete this table by entering required calculation values.

1) In case of loading the data from the inverter (reload of the inverter data)
   Regardless of the check in the converted value reference box, indicates the result of calculation of "communication data" × "base scale" ÷ "full scale" = "converted value" in the text box of the converted value.

2) In case the converted value reference box is not checked.
   The text box of the converted value is set as "**read only**" (edit is impossible). The color of the text box will also change.
   The indicated converted value will be changed according to the change of base scale and full scale. (Recalculated when the focus moves. The communication data will not be changed).

3) In case the converted value reference box is checked.
   The converted value can be edited in the text box. In this case, the communication data will also be changed (recalculated when the focus moves).
   The communication data will be changed according to the change of base scale and full scale. (Recalculated when the focus moves. The data of the converted value will not be changed).

4) When the U code is edited in the "edit by list" screen, the converted value will be recalculated regardless of the check in the converted value reference box.

(4) Auto tuning

Executes the auto tuning for each constant of the inverter.

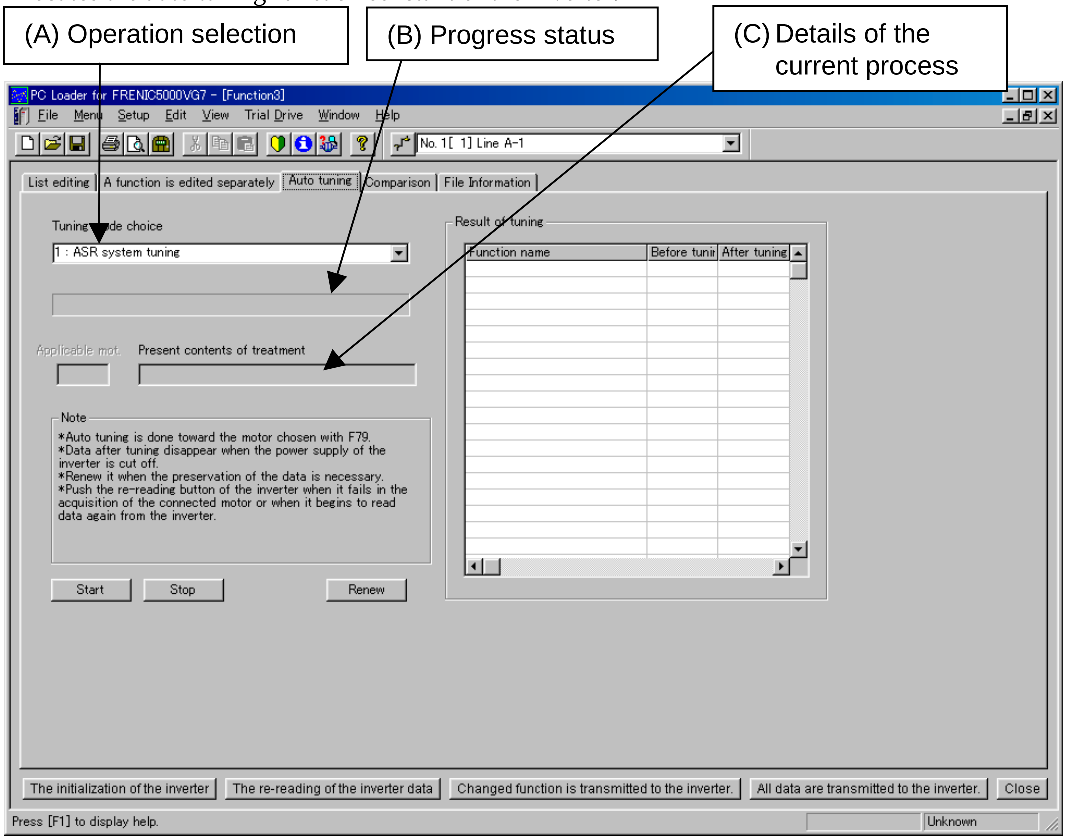
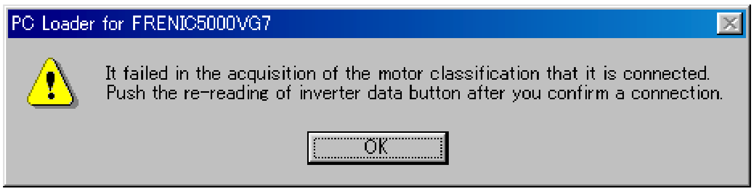


Figure 28 Auto Tuning

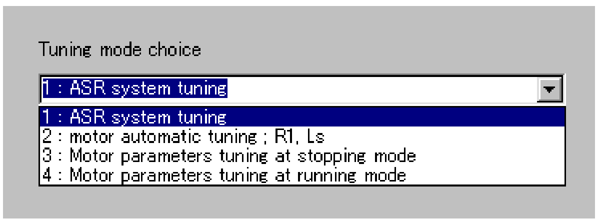
If the PC fails to acquire the motor type (not connected), the in the following message window will appear.



In this case, auto tuning cannot be executed until the inverter data successfully reloaded.

Figure 29 Acquisition Failed

(A) Selecting operation



Select the auto tuning operation from the pull-down menu as shown in the left figure.

Figure 30 Selection of the Operation

(B) Progress status

Indicates the progress status of the auto tuning by a bar (indicated in percent).

(C) Details of the current process

Indicates the details of the actual process during auto tuning.

(5) Comparison

Compares the following combinations.

1) Function codes being edited and data of the connected inverter.
2) Function codes being edited and the saved function code setup file.

3) Compares the function code being edited with the setup value of the function code of the connected inverter.

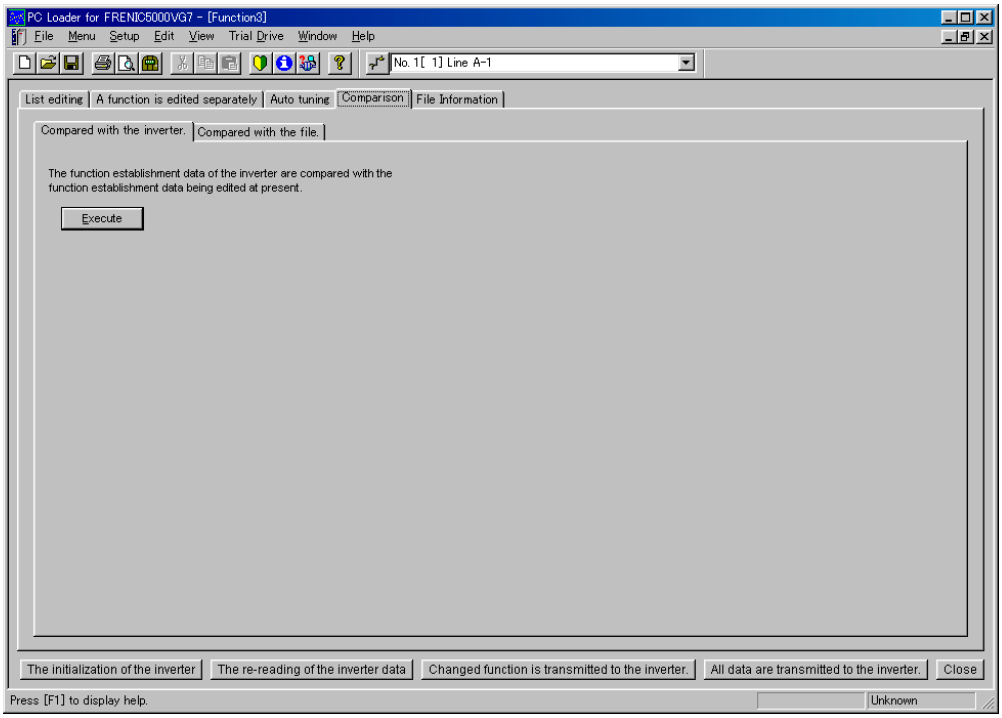


Figure 31 Comparison-inverter

4) Compares the function code being edited and the saved function code file.

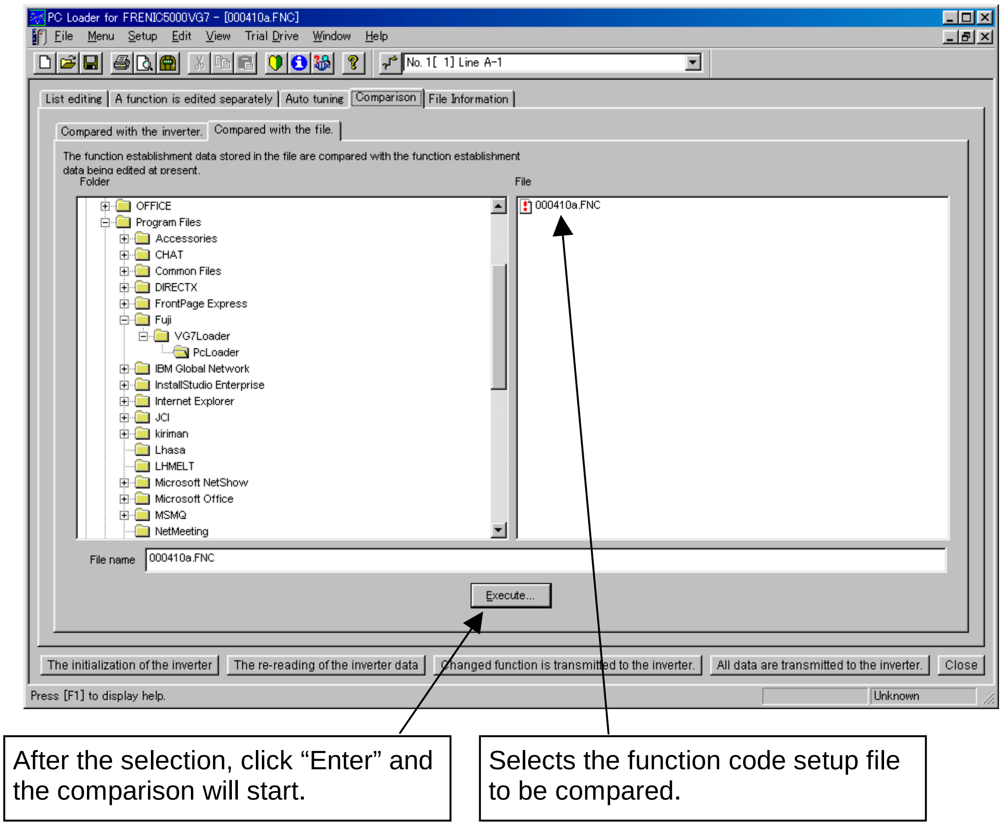
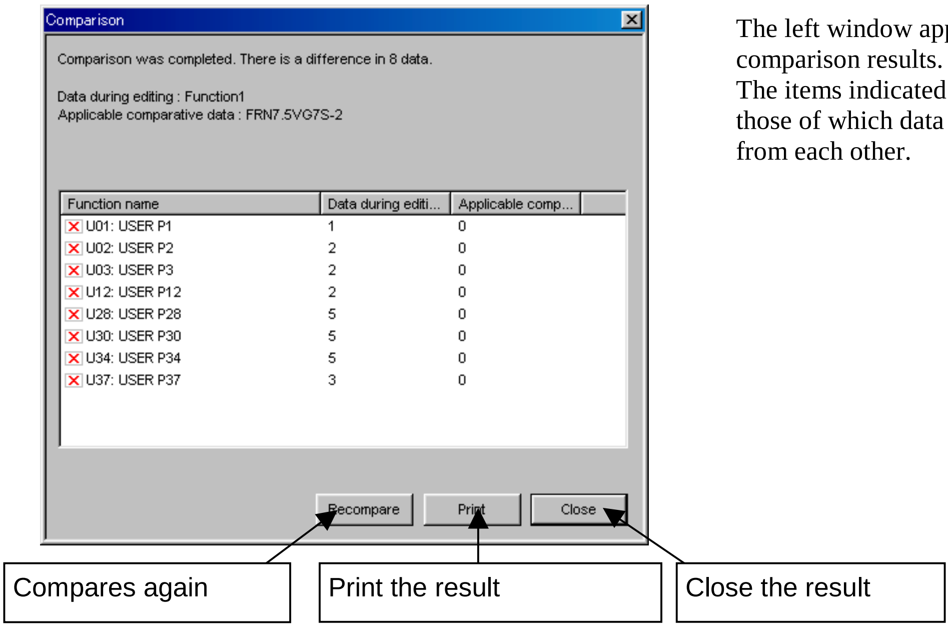


Figure 32 Comparison-file

5) The result of the comparison



The left window appears, showing comparison results.
The items indicated here are only those of which data are different from each other.

Figure 33 The Result of the Comparison

6) Print of the result of the comparison

Print out the comparison result.

Comparison result 2000/ 4/10 20:23:16

Source:Function1

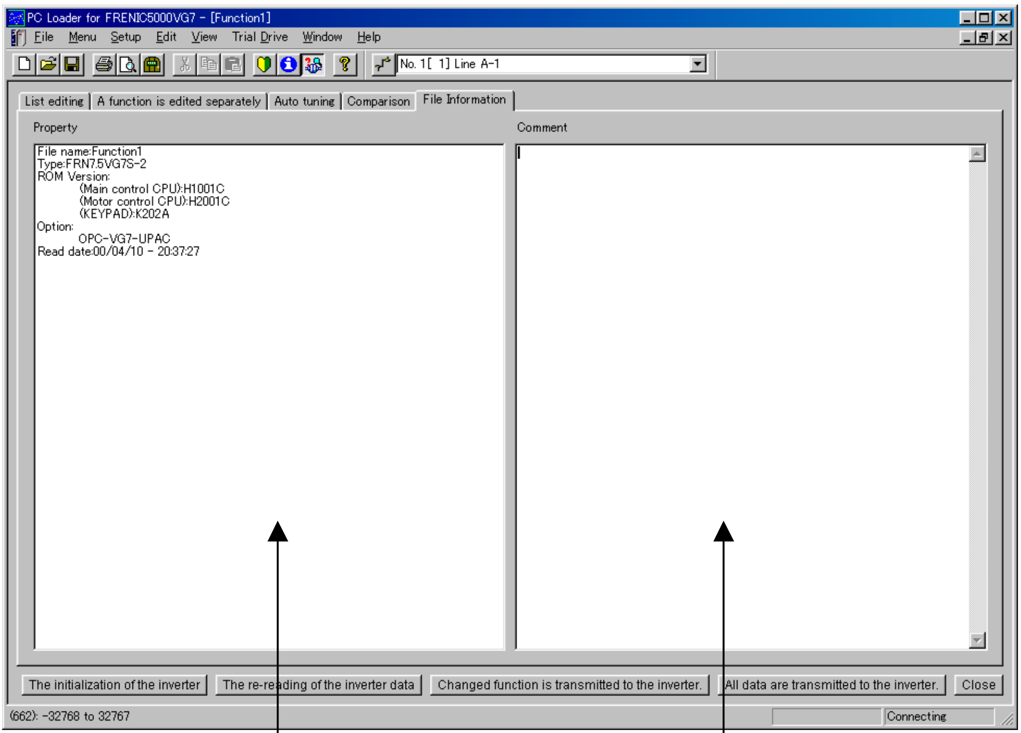
Destination:FRN7.5VG7S-2

Number of differences:8

FNo.	Function code Name	Sorce	Destination
U01	USER P1	1	0
U02	USER P2	2	0
U03	USER P3	2	0
U12	USER P12	2	0
U28	USER P28	5	0
U30	USER P30	5	0
U34	USER P34	5	0
U37	USER P37	3	0

Figure 34 Output Indication

(6) File information



Indicates the property of the function codes being edited.
- File name at the time of save.
- System condition of the loaded inverter.
- Date of load from the inverter.

You can add comments freely to the file being edited.
This comment will be saved automatically at the time of file save.
Up to 500 characters can be accepted.

Figure 35 File Information

6.5.4.5 Operation Monitor

(1) Multiple monitor

Indicates the operational status of the inverter whose terminal number is set by the connection setup.

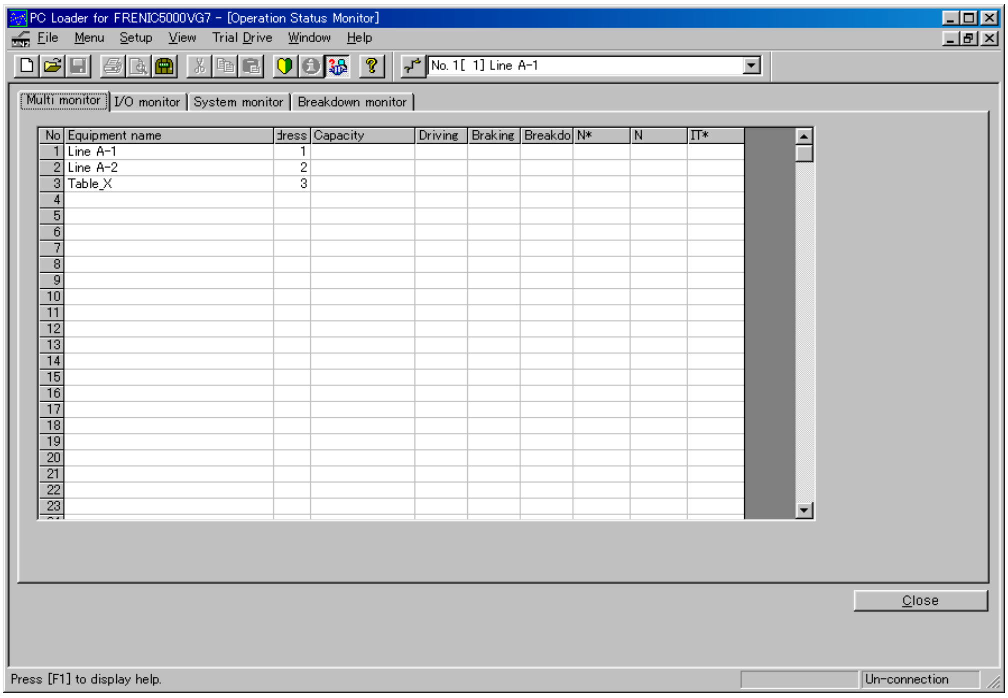


Figure 36 Multiple Monitor

1) Name of the equipment : Indicates the name which was input in the connection setup.
2) Terminal number : Terminal number of the inverter
3) Capacity : The type (capacity) of the inverter
4) In operation : 1=In operation 0=Not in operation
5) In braking : 1=Braking 0=Not braking
6) At fault : 1=Alarming 0=not yet alarming
7) Close : Closes the operation monitor.

Note: If the PC fails to acquire the inverter operational status, the data columns are left blank as shown at No.2 and No. 3 in the above screen.

(2) I/O Monitor

Indicates the ON/OFF of the input/output control signal of the connected inverter.

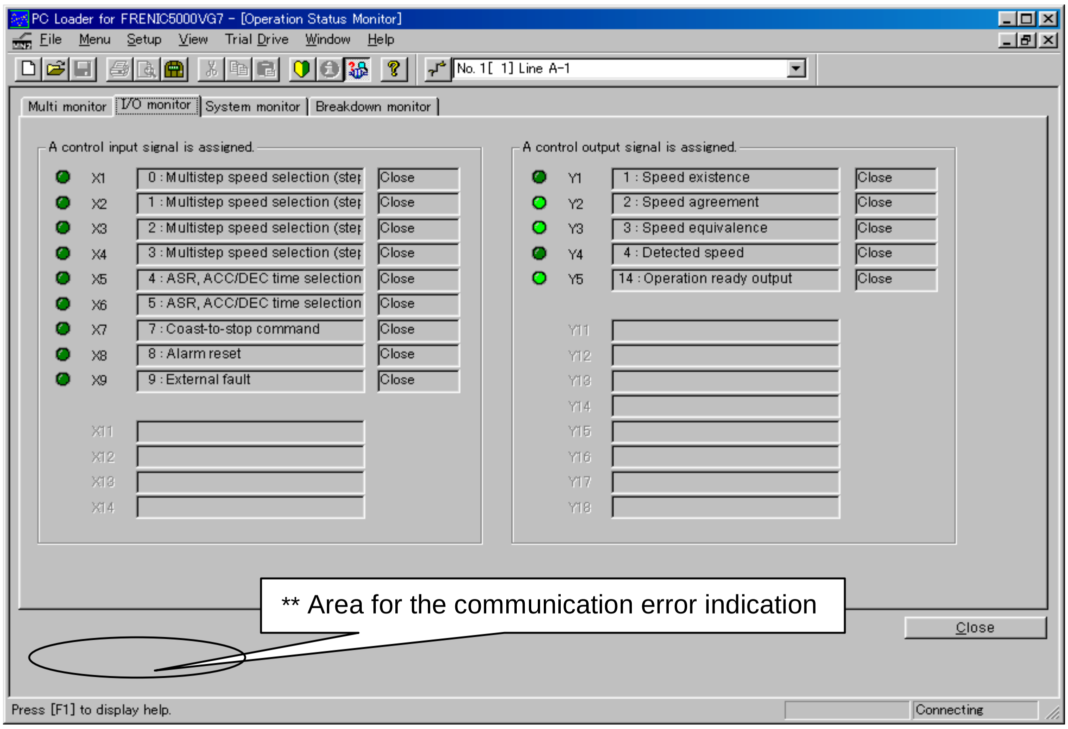


Figure 37 I/O Monitor

1) Status of the input/output control signal

 ON

 OFF

2) Close :Closes the operation monitor.

3) Communication error indication: The message in the following figure will appear if the acquisition of data from the inverter fails.

Figure 38 Communication Error Indication

System monitor and fault monitor will be indicated in the same way.

Note: The input/output control signals which cannot be used due to the option status will be indicated in gray; for example, X11 to X14, Y11 to Y18 in the above figure.

(3) System monitor

Indicates the system condition of the connected inverter and motor.

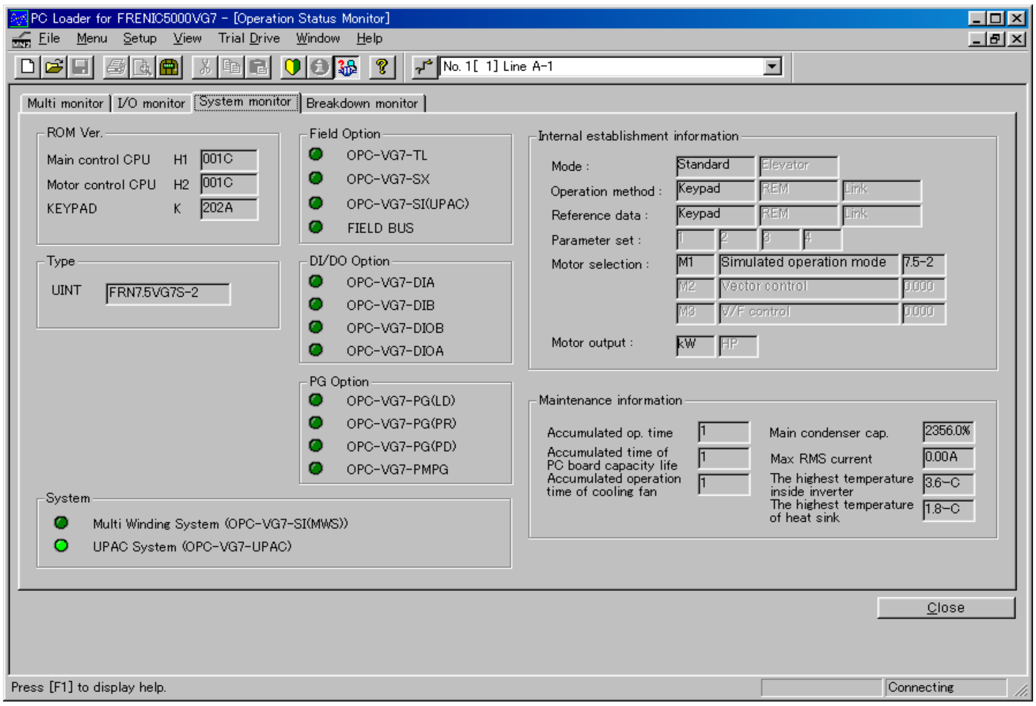


Figure 39 System Monitor

1) Condition of each option

(Green light on) :Loaded

(Green light off) :Not loaded

2) ROM Ver.

Indicates the ROM Ver. (version information of ROM) of two CPUs in the inverter (main control and motor control) and a CPU in KEYPAD panel. In case of the trouble of the inverter, we may sometimes require this ROM Ver. number.

3) Type

Indicates the unit information of the inverter (capacity, voltage).

4) Information of the internal configuration

Mode	:	Standard/Lift (function code H70).
Operation command	:	Effective input device among KEYPAD (LOC), terminal block (REM), and LINK (Link, COMM).
Command data	:	Effective input device among KEYPAD (LOC), terminal block (REMM), and LINK (Link, COMM).
Parameter set	:	Acceleration and deceleration time, switching-over status of ASR setup.
Motor selection	:	Selection of M1, M2, M3, control status, motor capacity

5) Maintenance information

Indicates the data for judging the inverter's life and load information.

6) Close : Closes the operation monitor screen.

(4) Fault Monitor

Indicates the alarms occurring in the connected inverter.

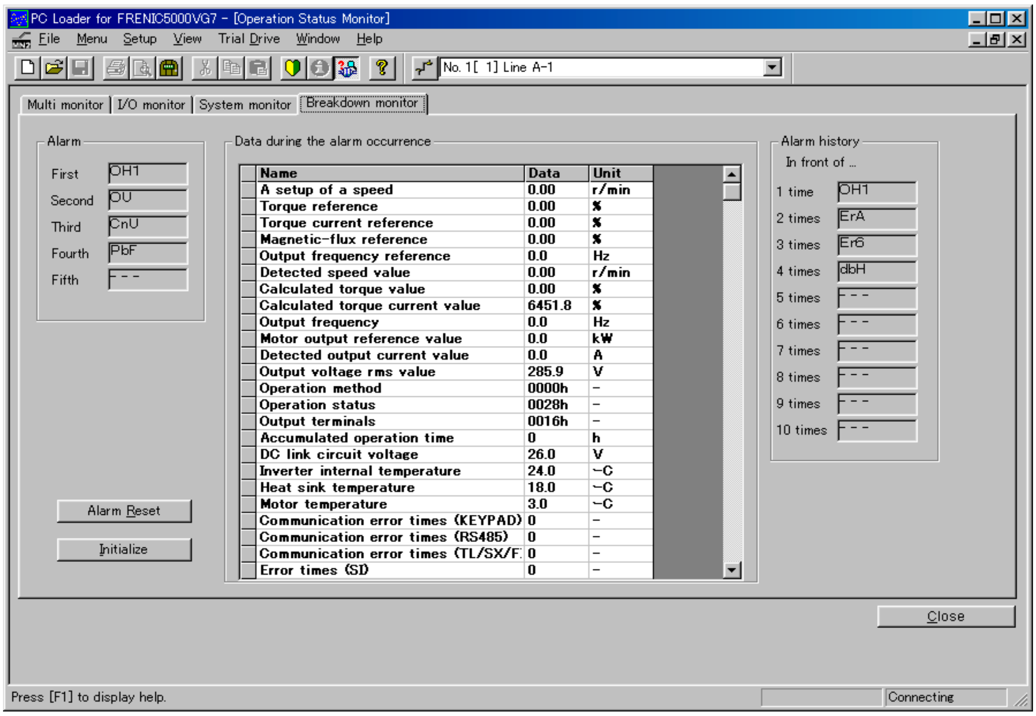


Figure 40 Fault Monitor

1) Alarm reset : Resets the alarm being activated.
2) Initialization of the alarm : Initializes the alarm history.
3) Close : Closes the operation monitor screen.

List of alarm display

Display	Description	Display	Description	Display	Description
- - -	No alarm	Er7	Output wiring error	OH4	Motor overheat
CnU	Converter error	Er8	A/D converter error	OL1	Motor overload (M1)
dbH	DB resistor overheat	Er9	Speed disagreement	OL2	Motor overload (M2)
dCF	Fuse Fusion	ErA	UPAC error	OL3	Motor overload (M3)
dO	Excessive position deviation	Erb	High-speed serial communication error	OLU	Inverter overload
EF	Ground fault	Lin	Input phase loss, Condenser error	OS	Overspeed
Er1	Memory error	LU	Undervoltage	OU	Overvoltage
Er2	KEYPAD communication error	nrb	NTC thermistor Disconnection	PbF	Charging circuit error
Er3	CPU error	OC	Overcurrent	P9	PG breakage
Er4	Network error	OH1	Cooling fin overheat		
Er5	RS-485 Communication error	OH2	External alarm		
Er6	PL error	OH3	Pt board surrounding temperature overheat		

6.5.4.6 Historical Real-time Trace

(1) Historical trace

Historical trace indicates the waveform before and after the trigger at the minimum sampling interval of 1ms. (Quantity of the waveform data: 100 points/ch)

The trigger must be always set because the data does not appear without the trigger.

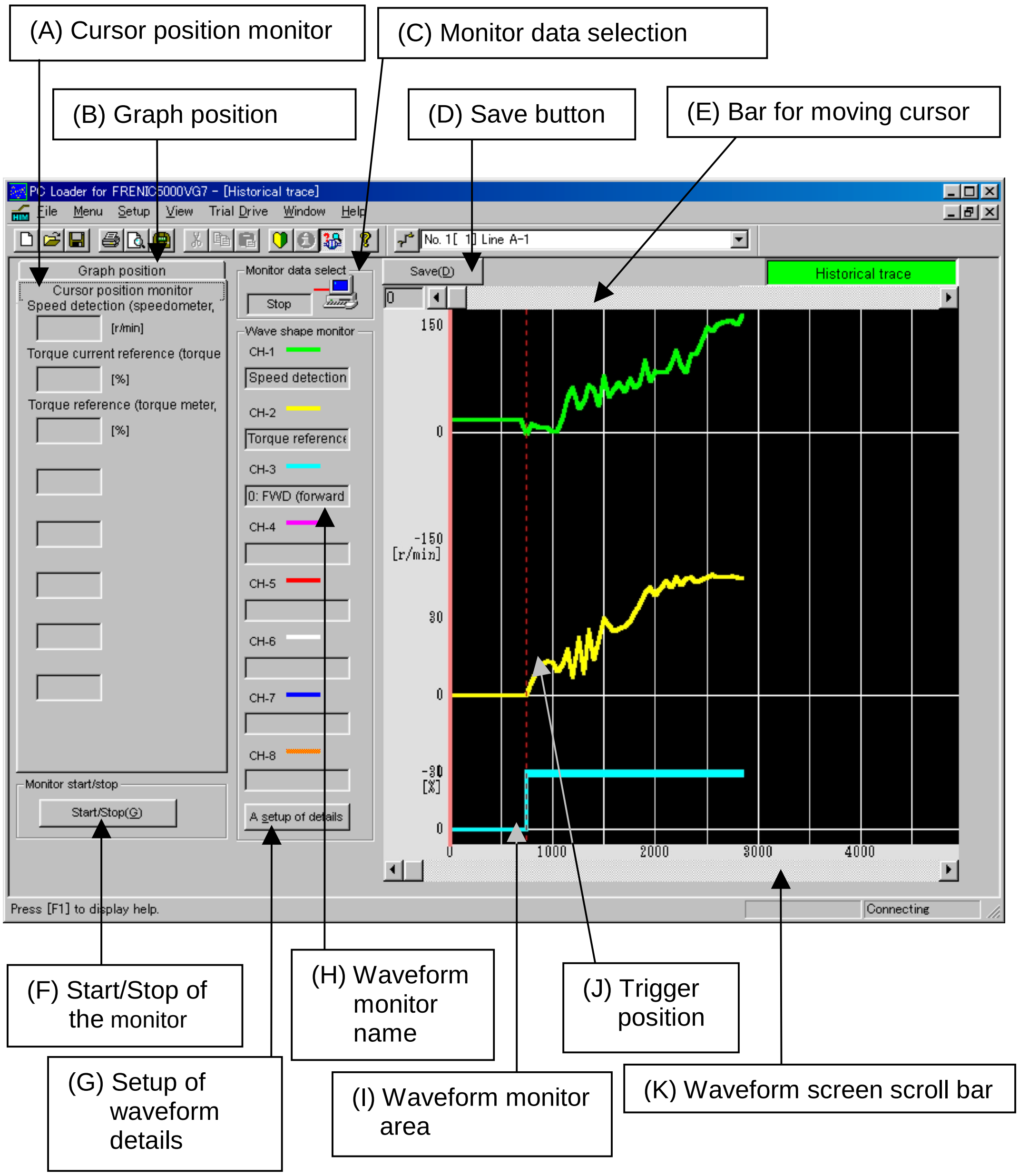
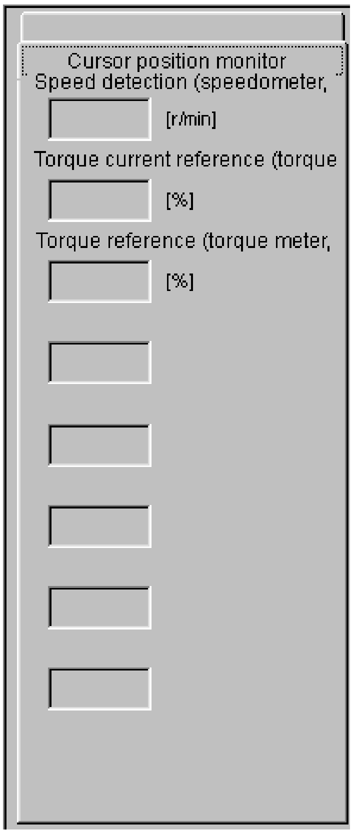


Figure 41 Historical Trace

Note 1: When the historical trace and real-time trace are on the screen, the terminal number cannot be changed.

Note 2: When changing the size of the historical trace screen, the size of the waveform monitor area is also changed.

(A) Cursor position monitor

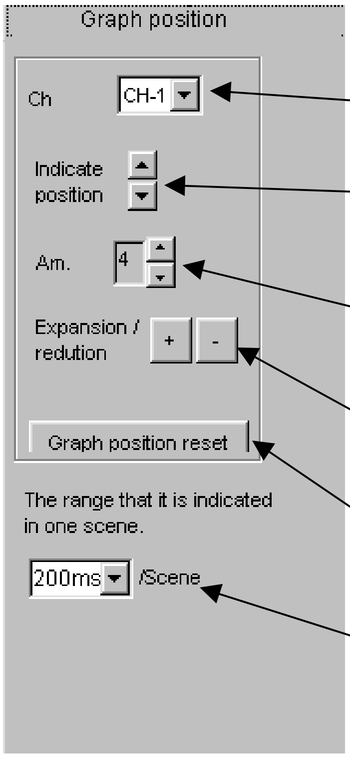


The intersection data of the cursor position in the waveform monitor area and waveform are expressed numerically. Cursor position can be moved by (5) Bar for moving cursor.

Figure 42 Cursor Position Monitor

(B) Graph position adjustment

Set the position where the waveform is indicated in the waveform monitor, amplitude, and time scale of one screen.



Selects the channel where the position is adjusted or the amplitude is changed.

Adjusts the position of the selected waveform.

Changes the amplitude of the selected waveform.

Enlarges/Reduces the selected waveform.

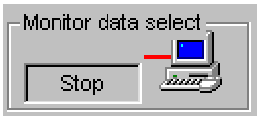
Initializes the position and the amplitude of the selected waveform.

Selects the range to be indicated (time scale of one screen) in one screen.
* When setting this value as sampling time×100, all historical trace waveform can be shown in one screen and easier to view.

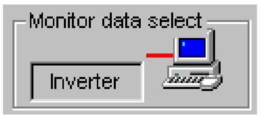
Figure 43 Graph Position Adjustment

(C) Monitor data selection

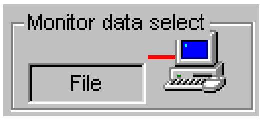
This window shows the status of the currently displayed waveform.



The indicated waveform is after or before the trace.



The indicated waveform is in trace.



The indicated waveform shows the data of the saved file.

Figure 44 Monitor Data Selection

(D) Save

Saves the traced waveform in the file.

(E) Bar for moving cursor

Moves the position of the cursor of the traced waveform.

The intersection value of the cursor position and the waveform is expressed numerically in (1) Cursor position monitor.

(F) Start/Stop of the monitor

Starts/Stops the historical trace.

(G) Setup of waveform details

1) Setup of the channel composition.

Sets the composition of the waveform to be traced.

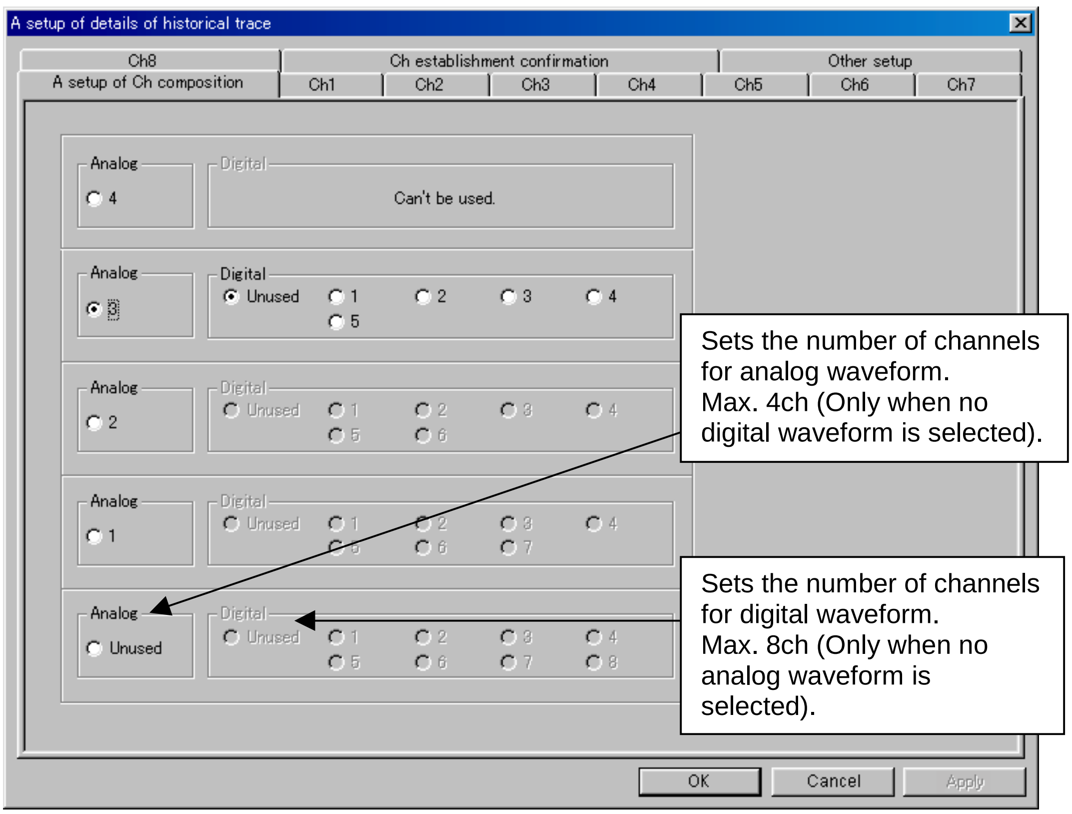


Figure 45 Historical trace - Setup of Waveform Details

2) Setup of analog channel

Selects the analog signal to be traced, and sets the filter and trigger.

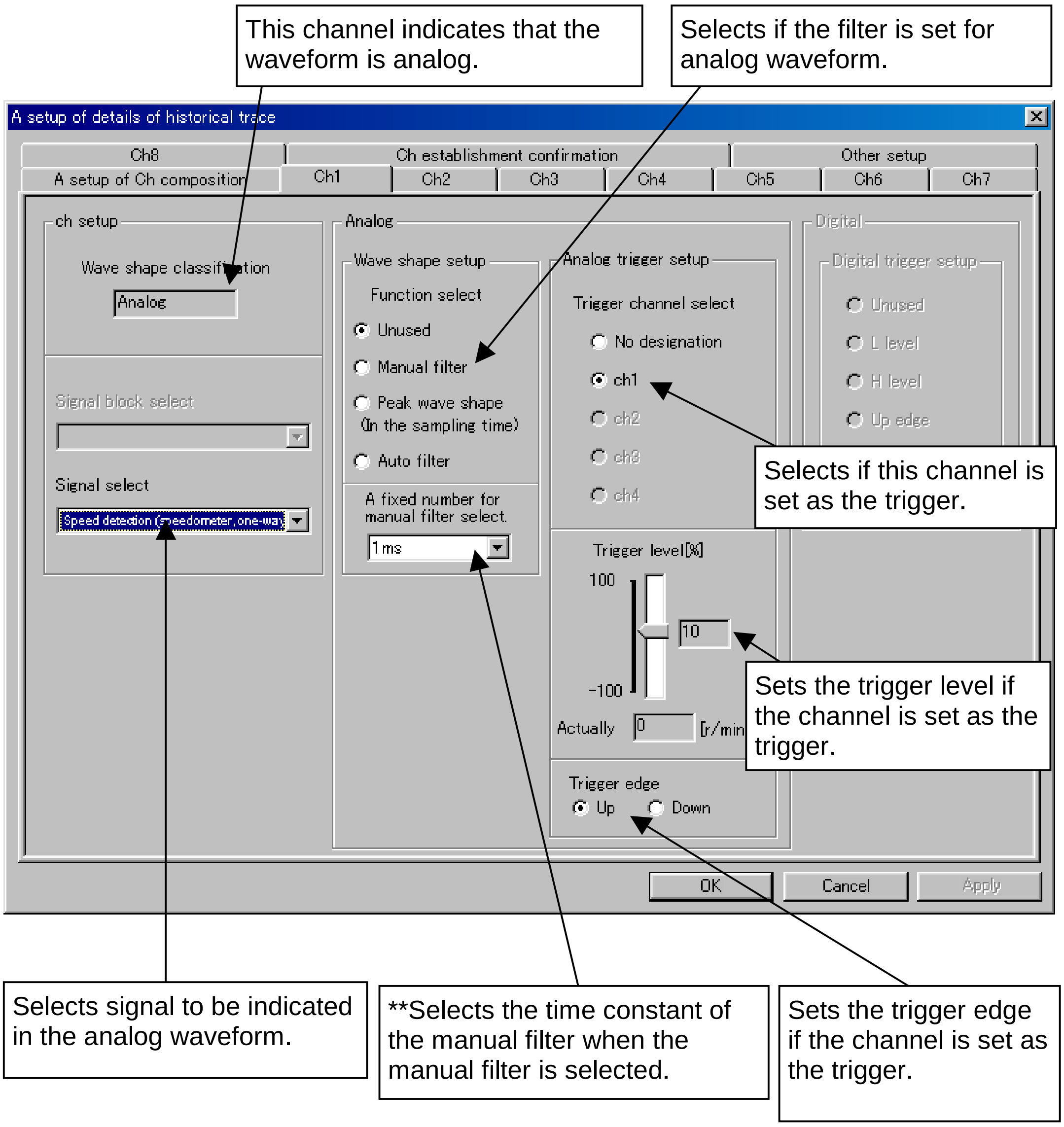


Figure 46 Historical Trace - Analog

6. Standard Interface RS485

3) Setup of digital channel

Selects the digital signal to be traced, and sets the trigger.

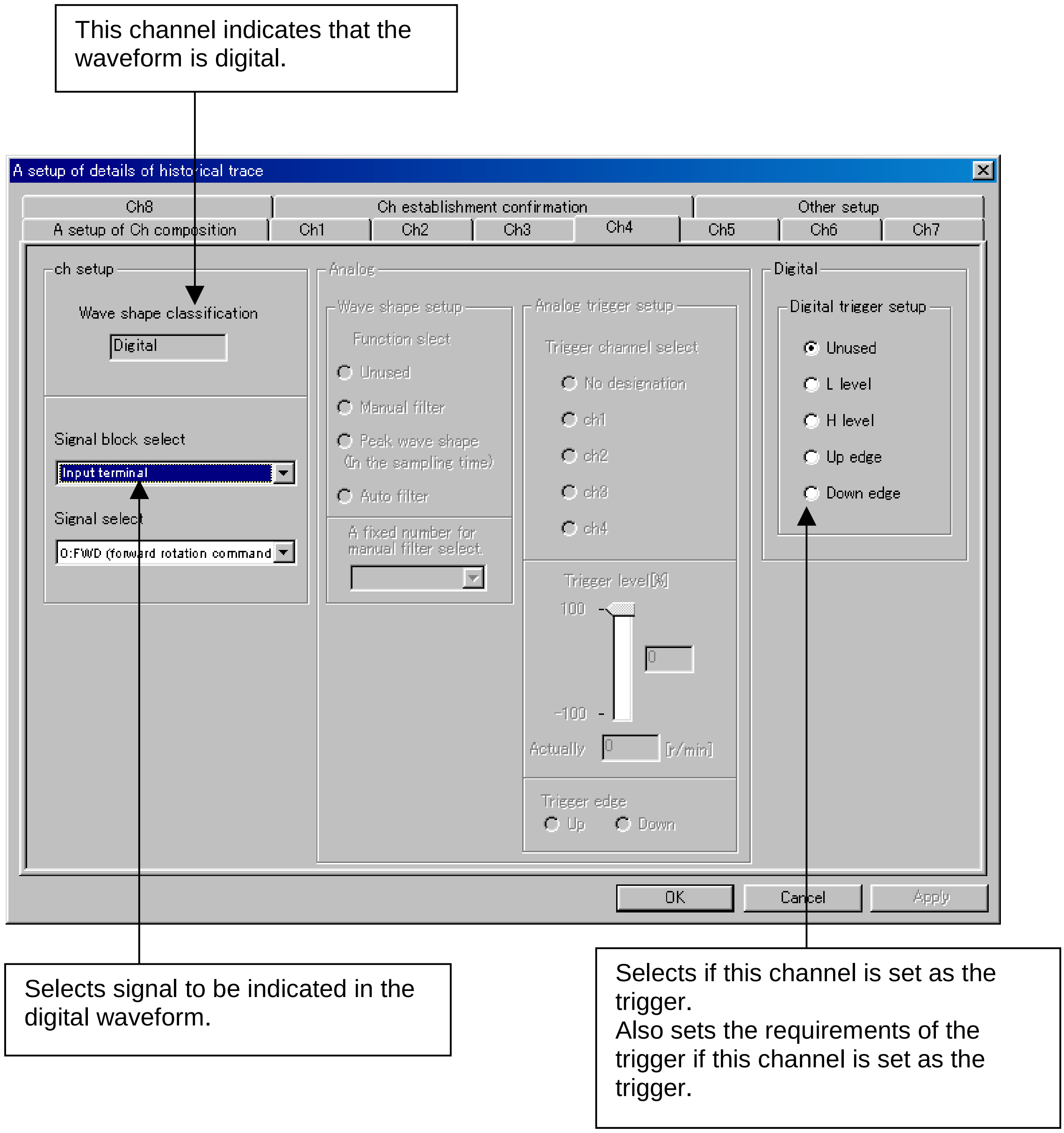


Figure 47 Historical Trace - Digital

4) Review of the channel settings

The settings of each channel to be traced can be reviewed.

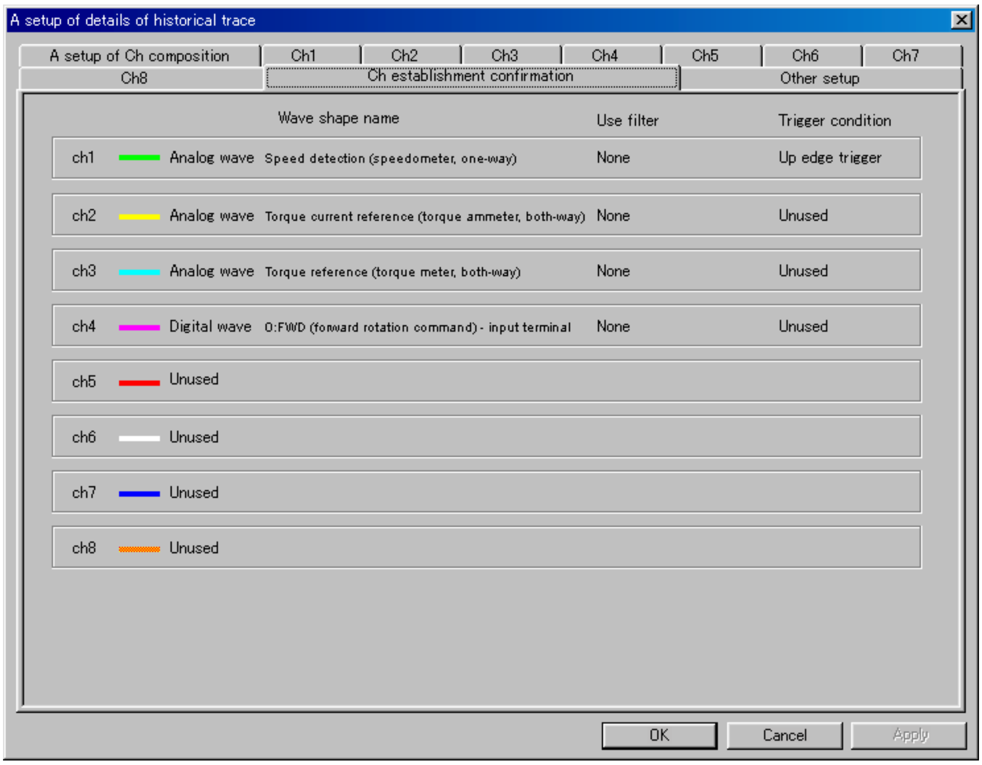


Figure 48 Historical Trace - Review of Channel Setting

5) Other settings

Sets the sampling intervals of the trace and the number of traces from the trigger position.

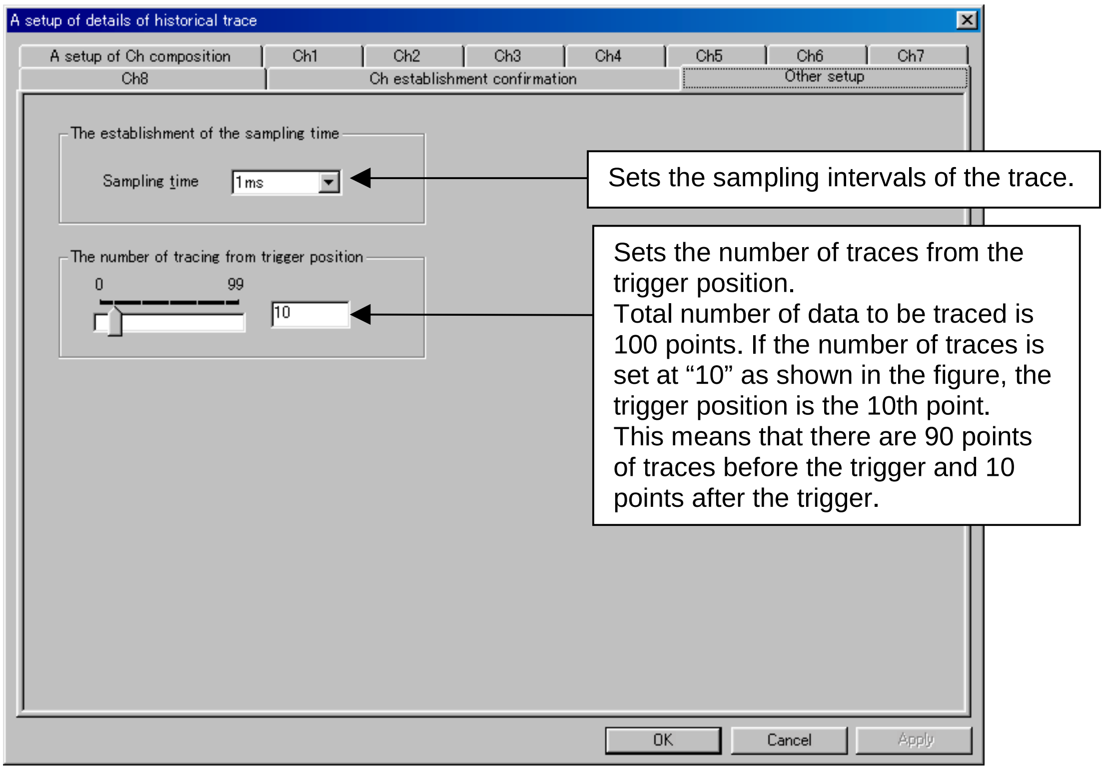


Figure 49 Historical Trace - Other Settings

(H) Waveform monitor name

Indicates the name of the traced waveform of each channel.

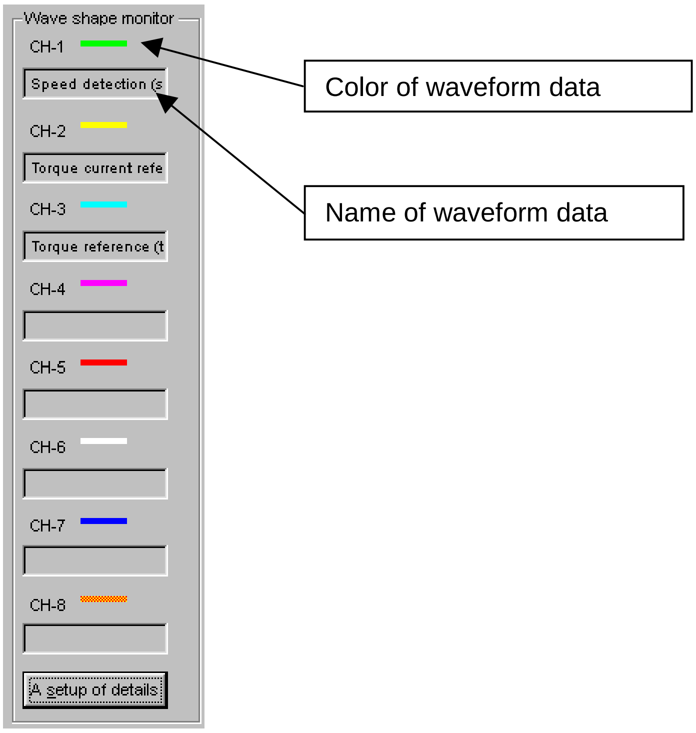


Figure 50 Historical Trace - Waveform Monitor

(I) Waveform monitor area

Shows the traced waveform.

(J) Position of trigger

The total waveform data consists of 100 points. Decide the points from which the data should be acquired.
A dotted line indicates the trigger position.
The number of traces from the trigger position in the left figure is set as “68”.

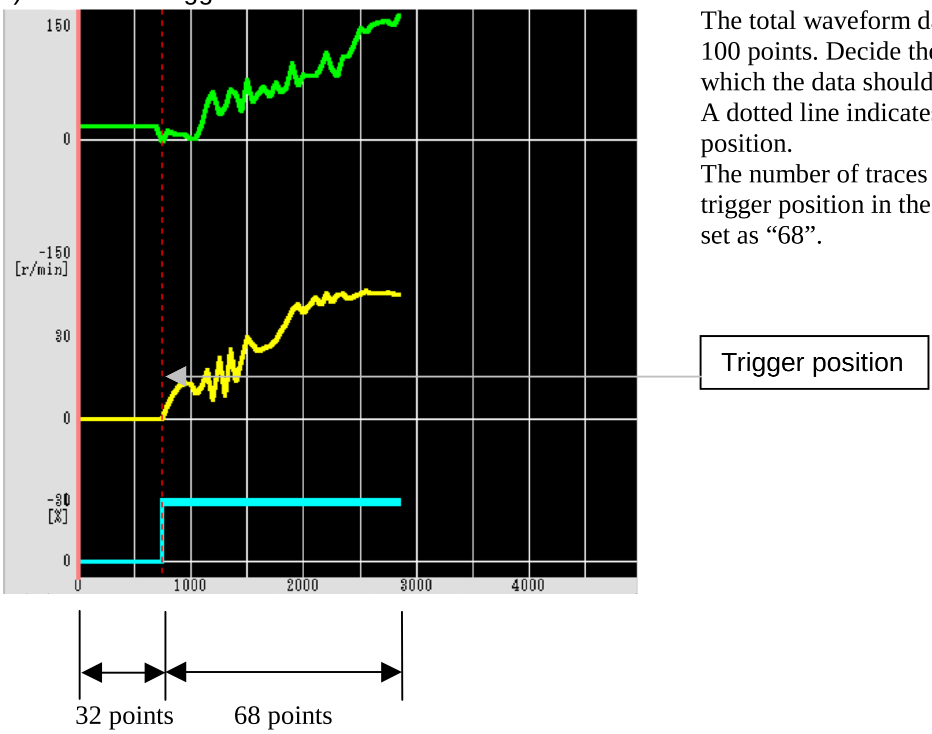


Figure 51 Historical Trace - Position of Trigger

(K) Waveform screen scroll bar

Scrolls the waveform screen.
You can check before and after the currently indicated screen by scrolling.

(L) Print

Printing is executed when selecting “Print” from the menu.
“Print Preview” in the menu shows the image of print

6. Standard Interface RS485

(2) Real-time trace

Real-time trace realizes the continuous waveform measurement at the minimum sampling intervals of 10ms. (Total quantity of waveform data: approx. 30000 points/1ch)

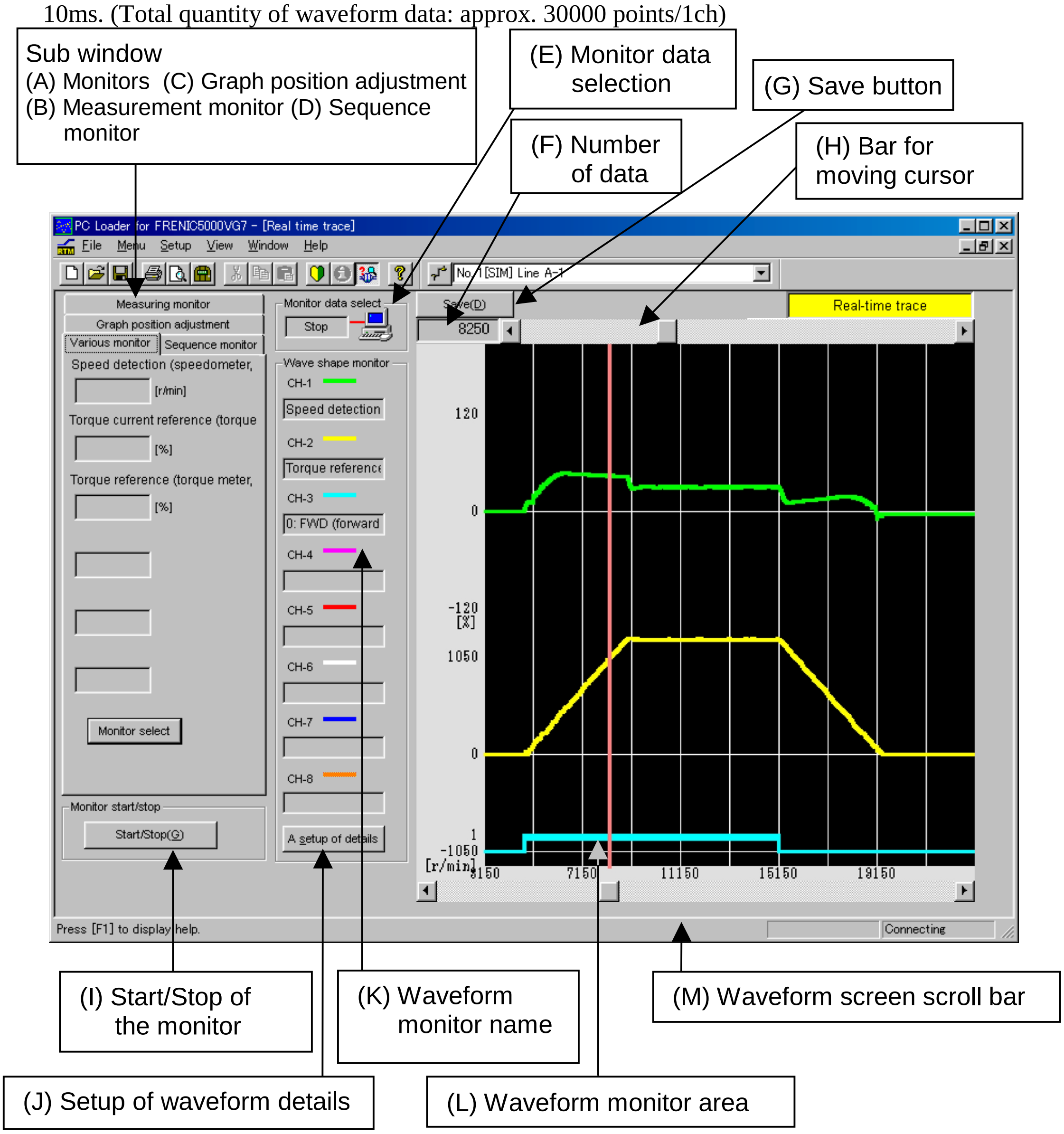


Figure 52 Real-time Trace

Note 1: The real-time trace screen and the trial operation screen cannot be opened at the same time. Choose either one.

Note 2: When the historical trace and real-time trace are on the screen, the terminal number cannot be changed.

Note 3: When the size of the real-time trace screen is changed, the size of waveform monitor area is also changed.

1) Tracing time

The real-time trace data totals approx. 30,000 points. If the sampling interval is set to 10ms, the tracing is possible for five minutes (30,000×10ms=300s=5 min.). If the tracing time exceeds five minutes, the older data will disappear in due order. This means the data taken for the latest five minutes is always kept.

(A) Monitors

The data selected in the “Monitor selection” are expressed numerically, separately from the traced waveform data.

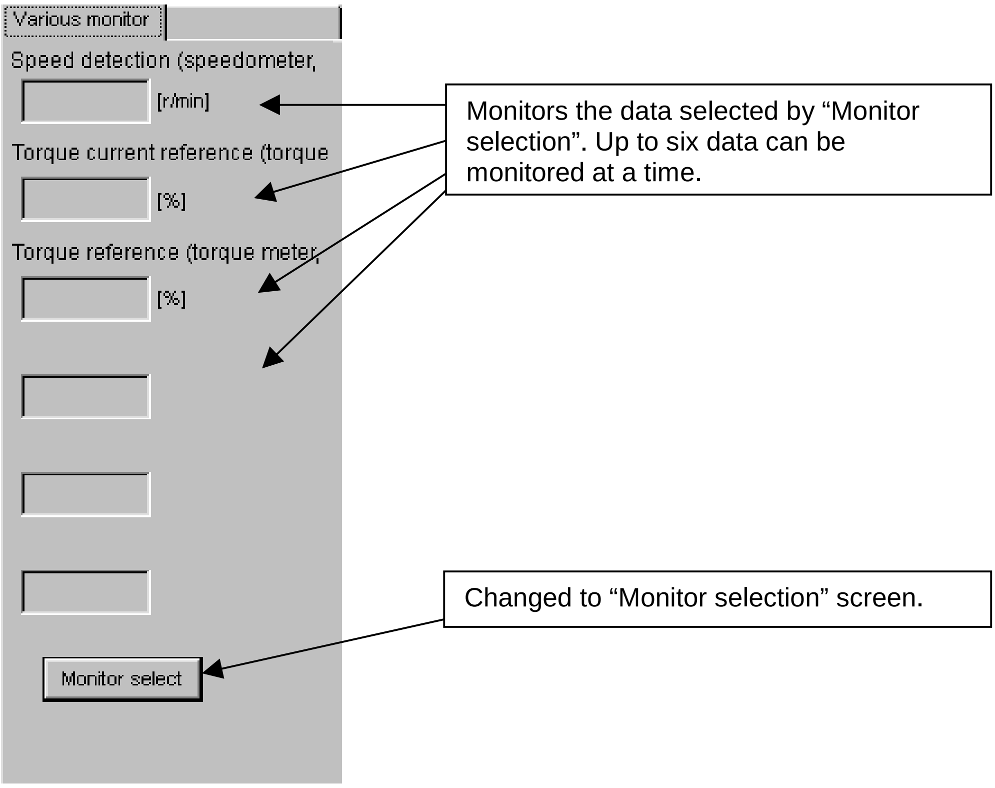


Figure 53 Real-time Trace - Monitors

1) In the “Monitor selection” screen, the data to be indicated in “Monitors” can be selected.

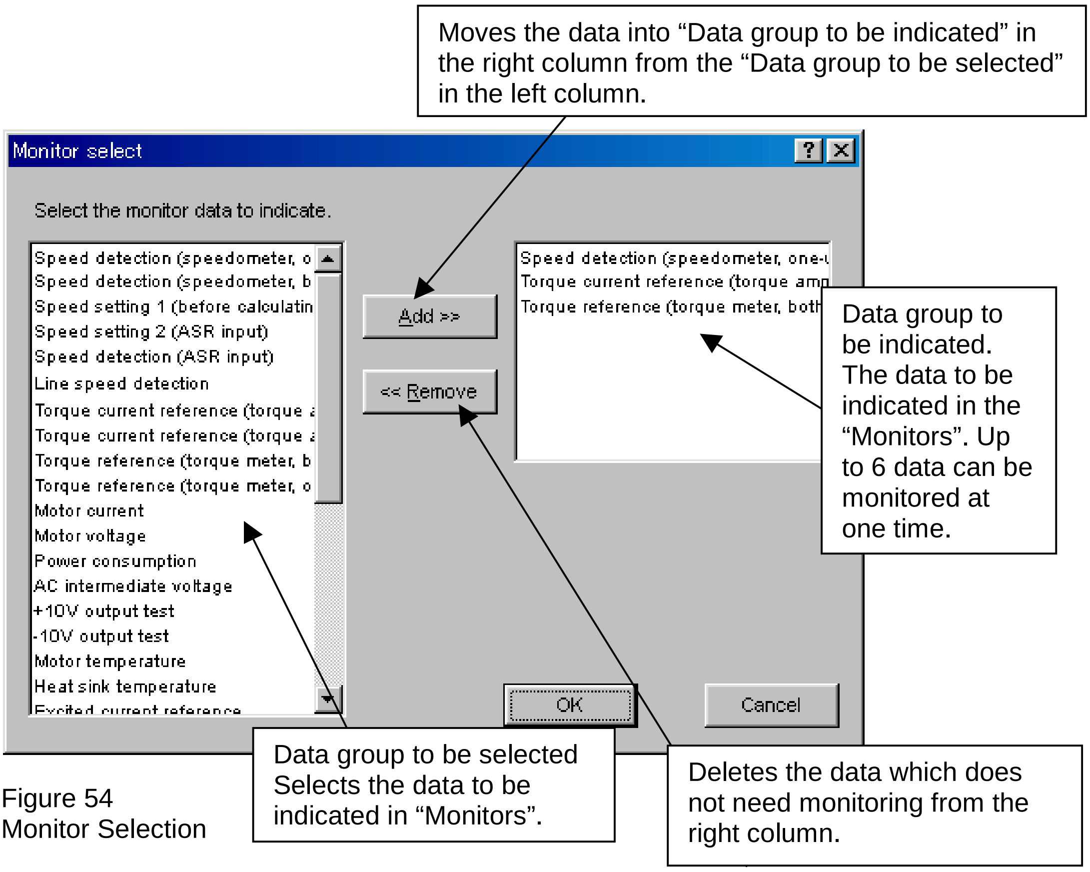
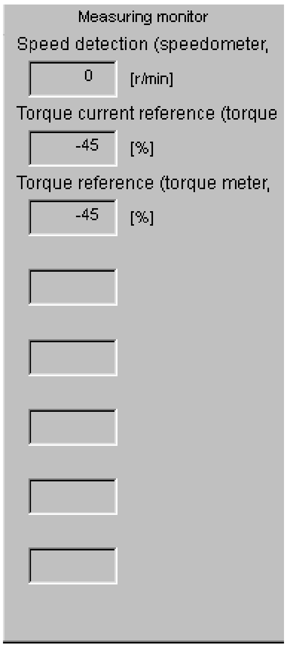


Figure 54
Monitor Selection

(B) Measurement monitor



The intersection value of the cursor position in the waveform monitor area and the waveform are expressed numerically. Cursor position can be changed by (H) Bar for moving cursor.

Figure 55 Measurement Monitor

(C) Graph position adjustment

Set the position where the waveform is indicated in the waveform monitor, amplitude, and time scale of one screen.

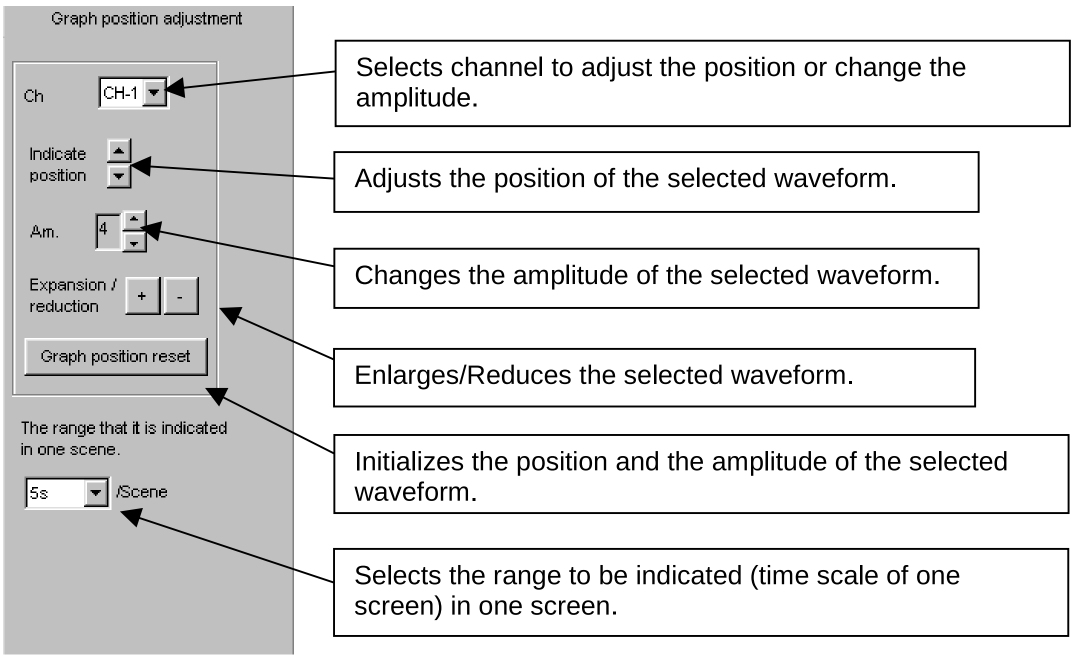


Figure 56 Graph Position Adjustment

(D) Sequence monitor

Indicates the sequence mode of the connected amplifier.

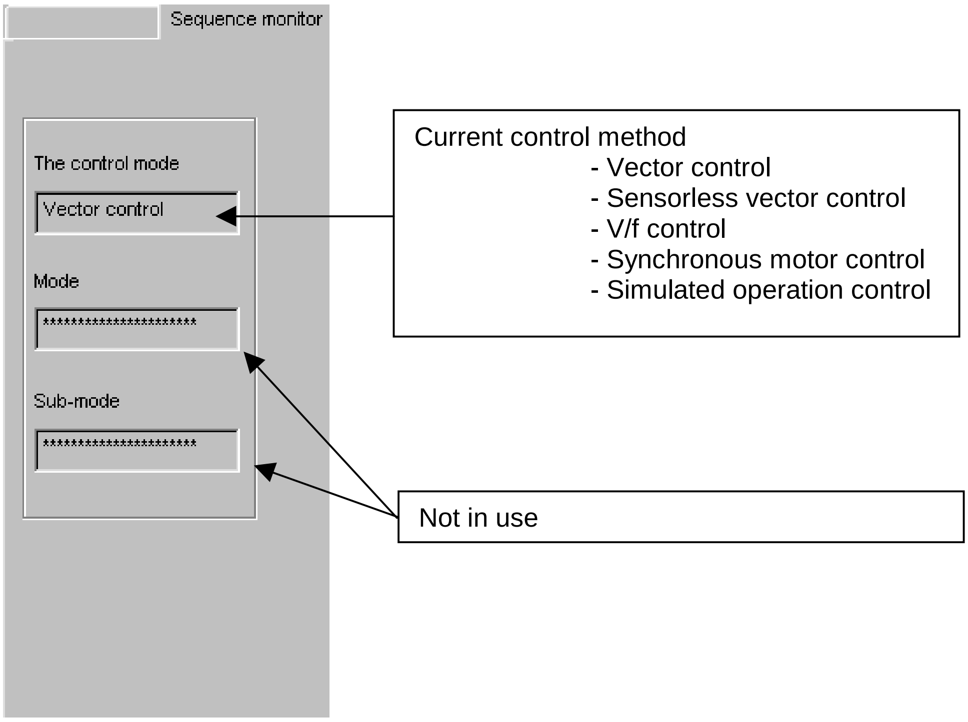
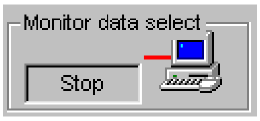


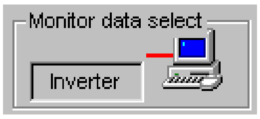
Figure 57 Sequence Monitor

(E) Monitor data selection

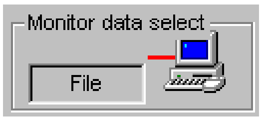
This window shows the status of currently indicated waveform.



The indicated waveform is after or before the trace.



The indicated waveform is in trace.



The indicated waveform shows the data of the saved file.

Figure 58   Monitor Data Selection

(F) Number of data

Indicates the number of traced data per channel.

(G) Save button

Saves the traced waveform in the file.

(H) Bar for moving cursor

Moves the position of the cursor of the traced waveform.

The intersection value of the cursor position and the waveform is indicated numerically in (a) Cursor position monitor.

(I) Start/Stop of the monitor
Starts/Stops the real-time trace.

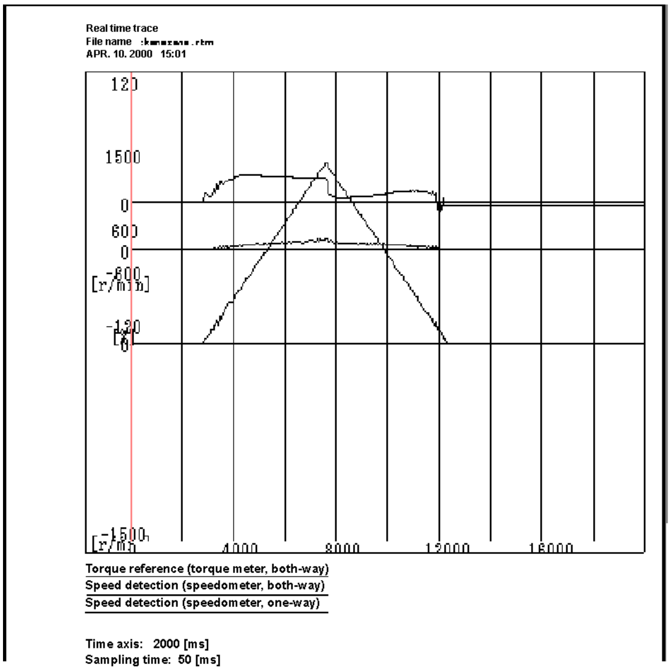
(J) Setup of waveform details
Sets the details of the waveform to be traced.
Refer to “1) Historical trace (g) Setup of waveform details” for the details.

(K) Waveform monitor name
Indicates the name of the traced waveform of each channel.

(L) Waveform monitor area
Shows the traced waveform.

(M) Waveform screen scroll bar
Scrolls the waveform screen.

(N) Print



Printing is executed when.
Printing is executed when selecting “Print” from the menu.
”Print Preview” in the menu show the image of print.

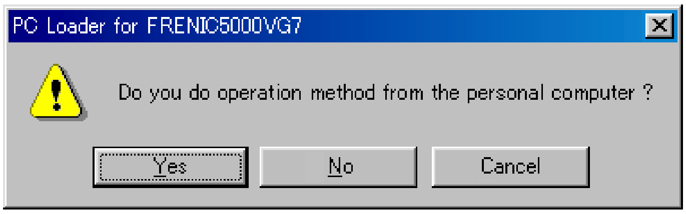
Figure 59 Print

6.5.4.7 Operation Procedure

When the "Trial operation " in the menu bar is clicked, operation procedure for the connected inverter will be executed.

Note: **A motor actually rotates.**

When the test operation is selected, the following message window will appear.



If "Yes" is selected, the operation procedure of the trial operation will become effective.

If "No" is selected, the operation procedure of the trial operation will not be available.

Figure 60 Message Window for Selecting Operation Mode

Note 1: The real-time trace screen and the trial operation screen cannot be opened at the same time. Choose either one.

Note 2: When the tool bar for the trial operation is already shown, the message window for selecting the operation mode will not appear. In this case, the operation procedure will become effective.

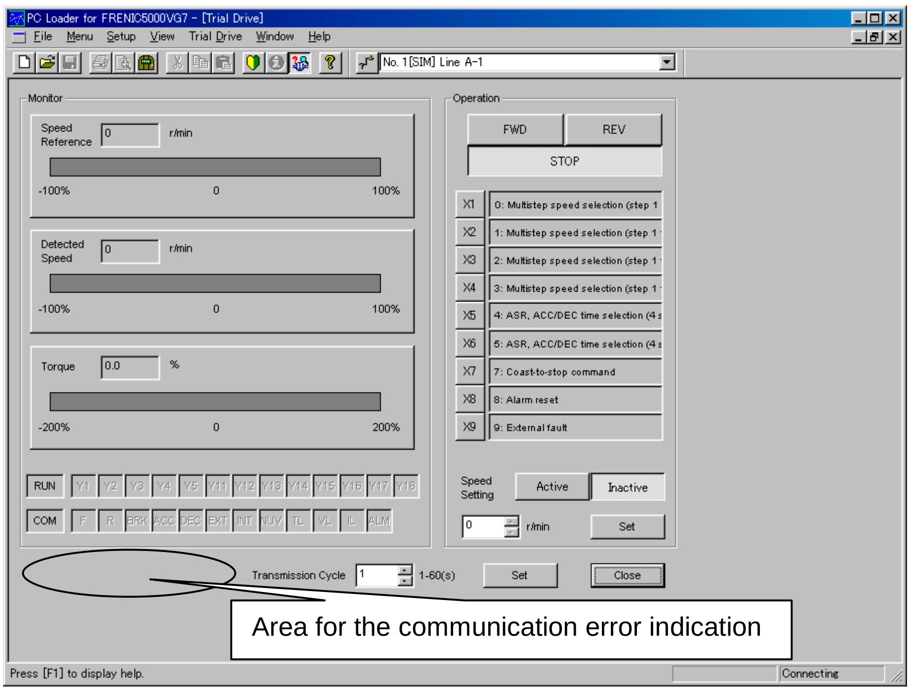


Figure 61 Trial Operation Screen

1) Speed command : Set the data in the range from–max. speed to+max. speed in r/min. Click the "Reload" button to make the newly set value effective.

2) Transmission cycle : Set the data in the range from 1 to 60s. Data is acquired and commands are transmitted to the inverter at the intervals set at the transmission cycle. Click the "Reload" button to make the newly set value effective.

3) Close : Closes the trial operation.

4) Communication error indication: If the PC failed to acquire the inverter data, the following message will appear.

Figure 62 Communication Error Message

5) COM (Operation status) : If the inverter is under the following status, the corresponding symbol is displayed in black with the irrelevant symbols displayed in gray.

F	:	Motor is rotating in forward direction.
R	:	Motor is rotating in reverse direction.
BRK	:	Brake is being applied.
ACC	:	Motor speed is accelerated.
DEC	:	Motor speed is decelerated.
EXT	:	DC injection braking or pre-exciting
INT	:	Inverter is shut-off.
NUV	:	DC link voltage has been established.
TL	:	Torque is being limited.
VL	:	Voltage is being limited.
IL	:	Current is being limited.
ALM	:	Alarm output

THE INVERTER

VII

VII. Control Options

7. Control Options

7.1 T-Link Interface Card

7.1.1 Product Guide

7.1.1.1 Product Overview

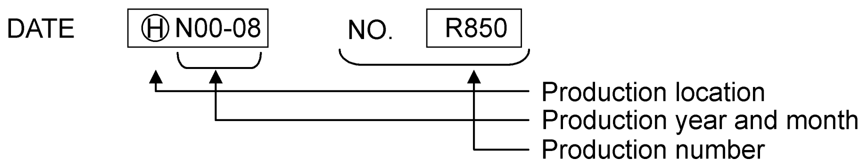
This product is an option for the vector control inverter FRENIC5000VG7S and links the FUJI programmable logic controller MICREX-F series and the inverter through the T-Link. The MICREX-F series PLC allows you to operate the inverter automatically and to monitor the inverter. You can also use the MICREX-F series PLC to change and monitor the setting of function codes required for the operation.

7.1.1.2 Product Guarantee

The period of product guarantee is either twelve months after your purchase or eighteen months after production that comes first.
Note that the following cases will void the product guarantee.

- Improper operations, repairs or modifications
- Operation out of the standard specifications
- Drops or damages during transportation after your purchase
- Earthquakes, fires, winds, floods, lightning, abnormal voltages, and other natural disasters, or secondary disasters.

Production date and production number (displayed on the product)



7.1.1.3 Standard Specifications

Table 1

Item		Specification
Name		T-Link interface card
Type		OPC-VG7-TL
Transmission type		T-Link slave I/O transmission
Number of words to be occupied for transmission		Use the function code o32 to select total of 16 words (MICREX to inverter: eight words, inverter to MICREX: eight words), or total of eight words (MICREX to inverter: four words, inverter to MICREX: four words)
Operation	Operation command	Forward/reverse command, alarm reset command, X1 to X14 commands
	Speed reference	Setting resolution: 0.005%
	Operation status output	Status such as running, braking, torque limiting, alarm relay signal, remote/local
		Data displayed on the KEYPAD panel LED, such as motor speed reference, torque current reference and digital input/output information
Function code		You can refer to or change only functions assigned to the link number in the "Function Code List"
Function codes for this option		o30, o31, o32 (Displayed on the KEYPAD panel when the T-Link card is installed)
Protective function		Er4: Communication error (Where option fails or inverter assumes communication with MICREX-F is disabled)

7.1.2 Connections

7.1.2.1 Terminal Function Description

(1) Terminal Arrangement

Terminal TB11	T1	T2	SD

(2) Terminal Description

Table 2

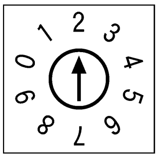
Terminal symbol	Name	Description
T1 T2 SD (Shield)	T-Link cable connection terminals	For T-Link cable connection

Note: All terminals are open on delivery.

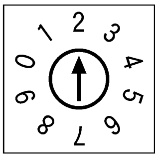
7.1.2.2 Switch Description

(1) Rotary Switches

Use rotary switch RSW1 and RSW2 to specify station number (address).



RSW1
0～9



RSW2
0～9

RSW1: Upper digit (×10)
RSW2: Lower digit (×1)

Note 1: Specify a unique address when you use multiple units.
Note 2: The factory setting is RSW1=0, and RSW2=0 (station number=00).

7. Control Options

7.1.2.3 Basic Wiring Diagram

The figure below shows a basic wiring diagram. Follow the descriptions below when you conduct wiring work.

[Notes for Wiring]

(1) Use the following specified cables for the T-Link.
- Twisted pair cable from Furukawa Electric
  CPEV-SB ϕ0.9×one pair
- Twisted pair cable from Furukawa Electric
  KPEV-SB 0.5mm^2×one pair

Refer to the relevant literature of the MICREX for the specifications of the cables above.

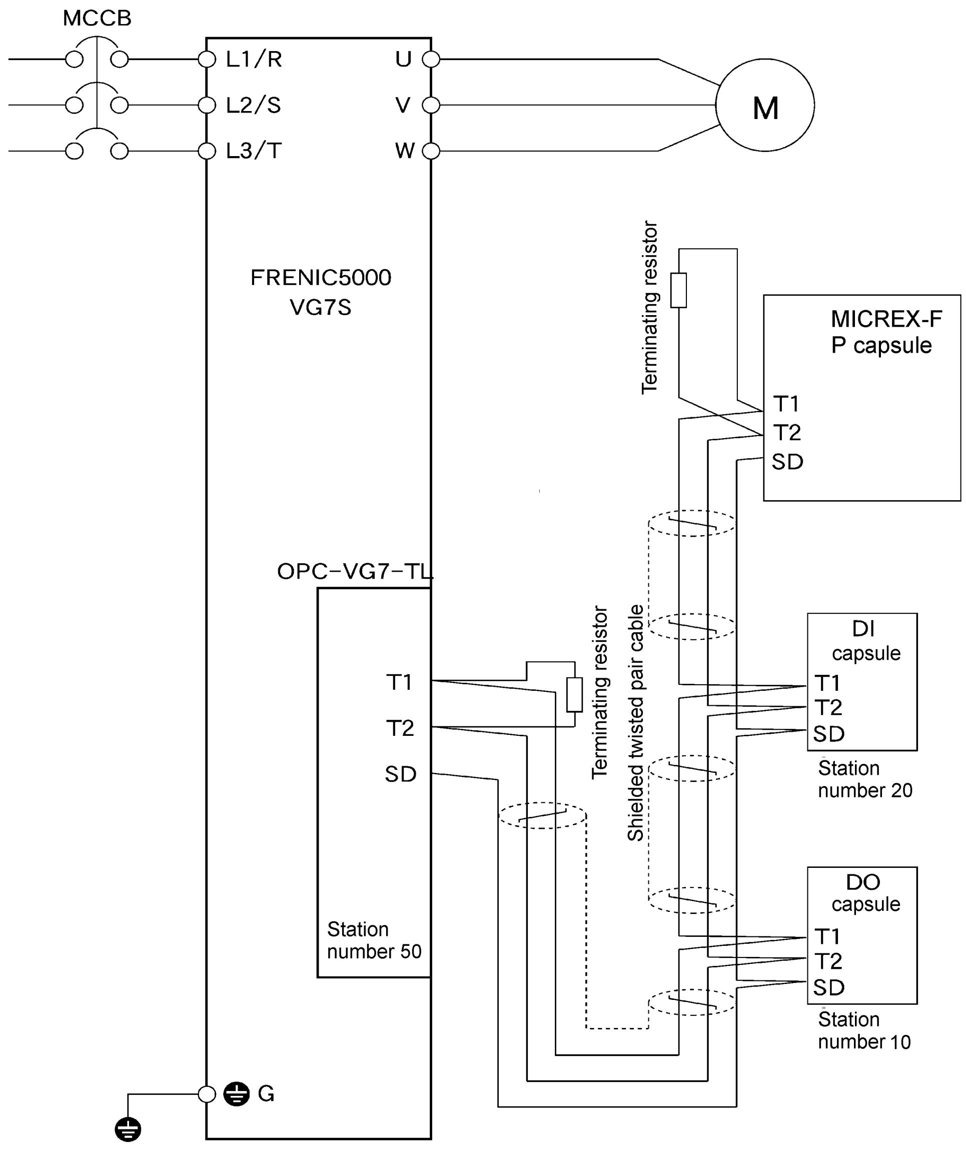
(2) Attach 100Ω terminating resistors provided with the P capsule on the both ends of the T-Link.

(3) Connect the T-Link cable without forming branches as described in the figure (form "daisy chain"). You cannot transmit data properly through a branched Link.

(4) Place cables for the T-Link as far as possible (30cm or more) from the main circuit wiring or other power lines to prevent malfunctions due to noises. Never install the T-Link and the main circuit wiring or other power lines in the same ducts.

[Example of Basic Wiring]

(This figure describes the only optional part. See other sections in this document or the instruction manual for the wiring of the FRENIC5000VG7S main unit.)



7.1.3 Function Codes for this Option

Function code	Function	Data	Description
o30	Action selection on communication error	0	Forced to stop immediately after a communication error occurs (Er4 trip: coast-to-stop)
		1	After a communication error, continues operating for a period specified by the timer (Holding the last operation command directed through communication in the communication error state). Forced to stop after the timer expires (Er4 trip: coast-to-stop). Follows the command directed through communication if the communication recovers during the timer operation. Even then, forced to stop after the timer expires.
		2	After a communication error, continues operating for a period specified by the timer (Holding the last operation command directed through communication in the communication error state). Forced to stop after the timer expires (Er4 trip: coast-to-stop) if the communication has not recovered. Returns to the normal operation if the communication recovers during the timer operation.
		3	An alarm (Er4) is not issued on a communication error. Holding the last operation command directed through communication in the communication error state.
o31	Action time on communication error	00 to 20.0	Timer for the operation period after a communication error. Effective when o10=1, 2
o32	Communication format	0	Format 1 (Standard format, 4W+4W)
		1	Format 2 (8W+8W)

- Use the [RST] terminal and the [RESET] key or a reset signal from MICREX-F or SX to reset Er4 after the cause of a communication error has been removed.
- The following conditions are considered as errors.

1) T-Link configuration error (redundant addresses, disconnection, no power supply to MICREX-F or SX)
2) Checksum error due to noise

- 0 is set to all function codes as a factory setting.
- Refer to the link numbers in the "Function Code List" for function codes available for access.

7.1.3 1 About o32

This function code allows you to select either of the following two communication formats.

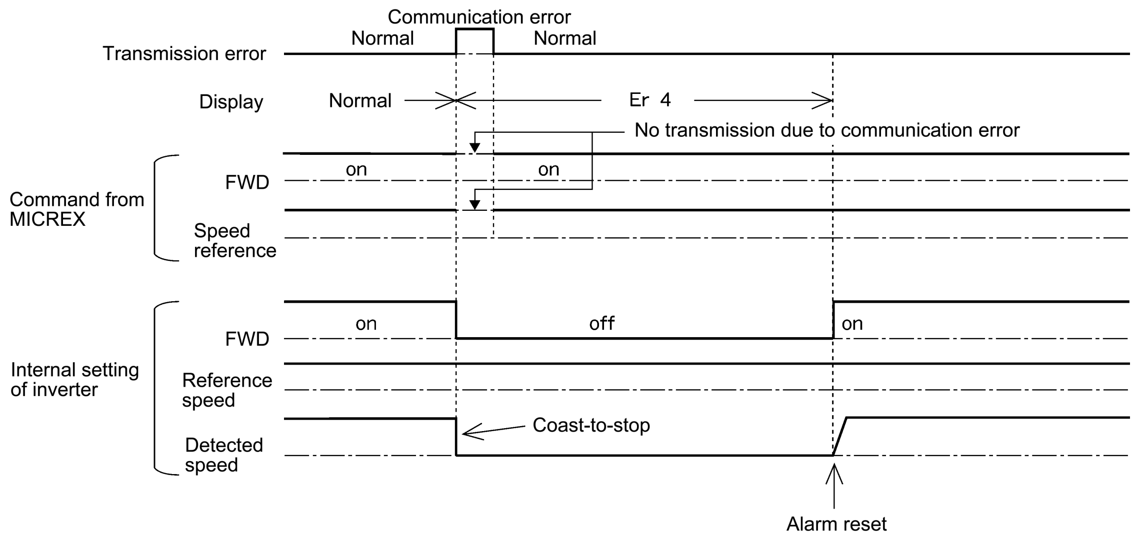
1) o32=0: (Format 1, standard format, 4W+4W are occupied)
2) o32=1: (Format 2, 8W+8W words are occupied)

7.1.3.2 About o30 and o31

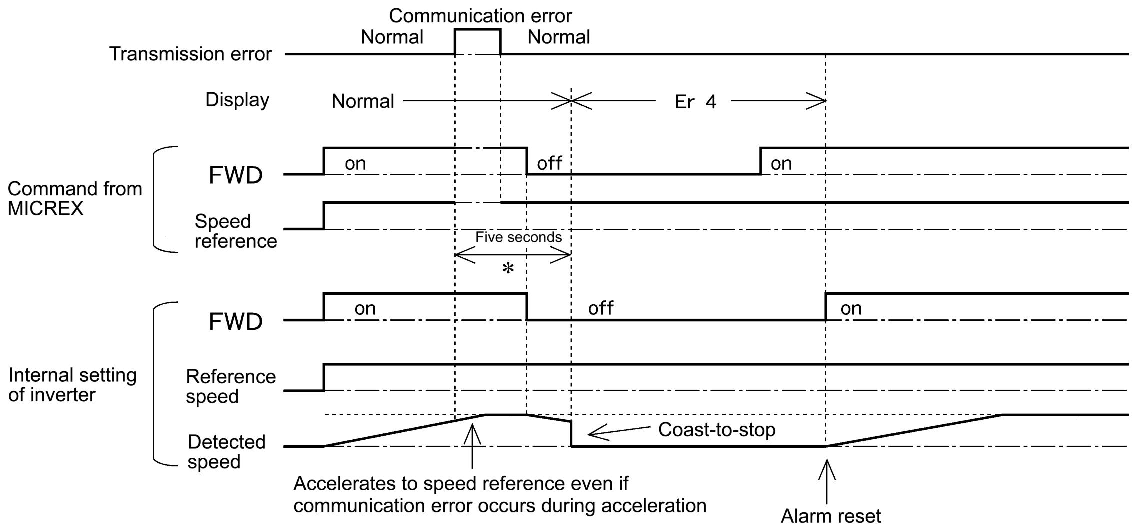
[Operation Description]
The following example shows an operation where MICREX-F or SX directs a FWD command and a communication error occurs during communication.

Note: The inverter holds the last command (operation command, speed reference or both) directed through the communication in this period if the inverter does not receives a new command or a specification after the communication recovers.

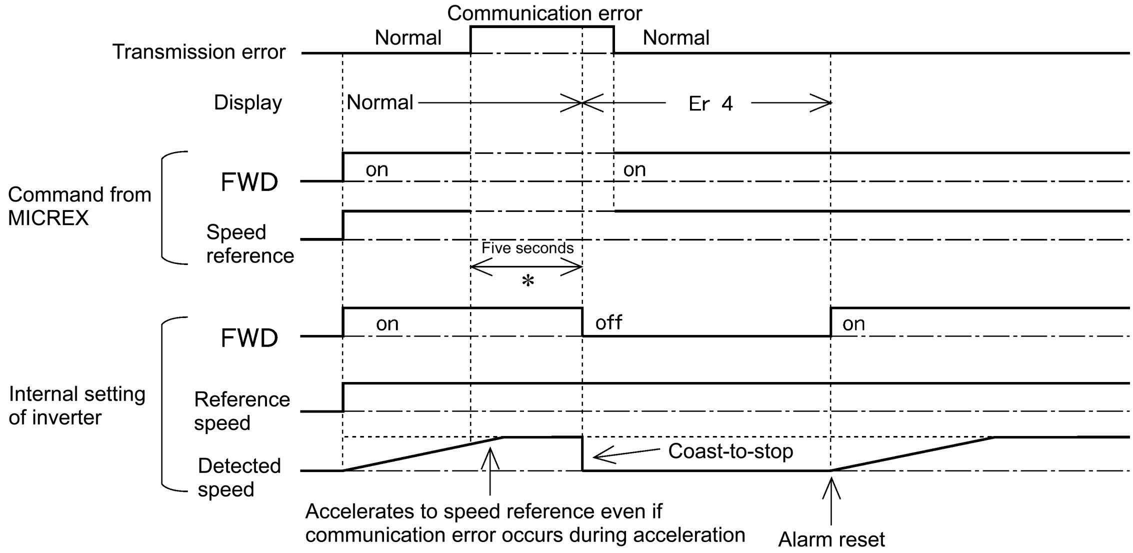
(1) o30=0



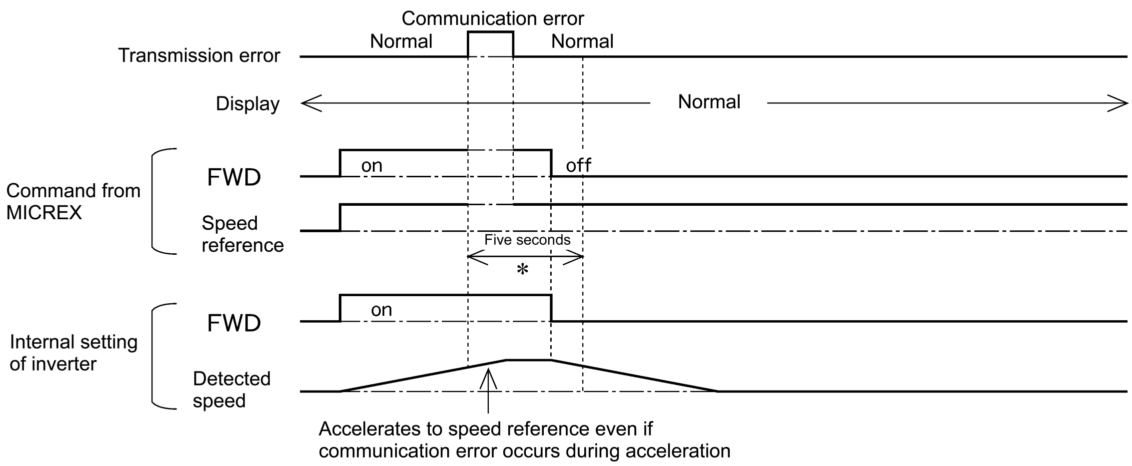
(2) o30=1, o31=5.0 (the mode to stop the inverter for five seconds after a communication error)



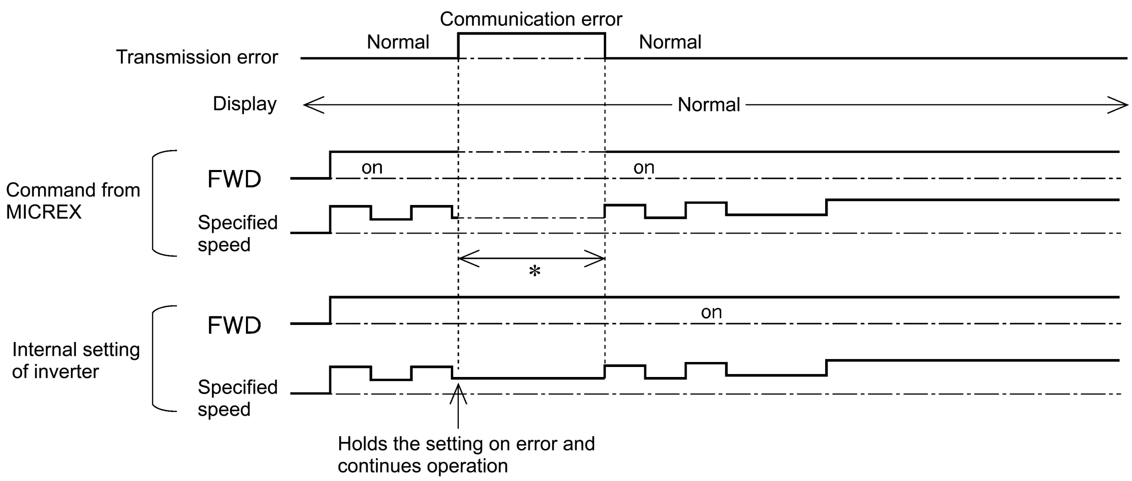
(3) o30=2, o31=5.0 (the communication does not recover from a communication error in five seconds and trips on Er4)



(4) o30=2, o31=5.0 (the communication recovers from a communication error in five seconds)



(5) o30=3

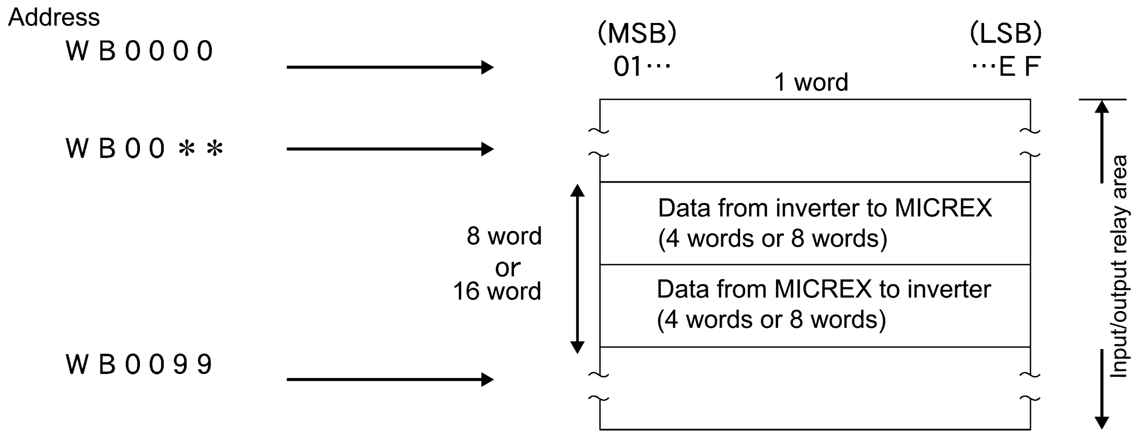


7. Control Options

7.1.4 Used Area and Addresses for Assigning Data

7.1.4.1 Used Area

One inverter uses consecutive eight words or sixteen words in the input/output relay area. You can use the dip switch RSW1 and RSW2 on the option card to set the lowest two digits of the address (WB00**in the figure).



7.1.4.2 Addresses for Assigning Data

(1) Format 1 (standard format 4W+4W)

Upper address	Offset	(MSB) 01··· 7 / 8 ···EF (LSB)	
WB00**	+0	Operation status (M14)	INV ⇓ MICREX
WB00**	+1	Detected speed (M06)	
WB00**	+2	Address for polled function code / Blank (fixed to 0)	
WB00**	+3	Data for polled function code	
WB00**	+4	Operation command, Di, RESET input (S06)	MICREX ⇓ INV
WB00**	+5	Speed reference (S01)	
WB00**	+6	Address for function code to select / Address for function code to poll	
WB00**	+7	Data for function code to select	

(2) Format 2 (8W+8W)

Upper address	Offset	(MSB) 01… 7	8 …EF (LSB)	
WB00**	+0	Address for polled function code (1)	Address for polled function code (2)	INV ⇓ MICREX
WB00**	+1	Address for polled function code (3)	Address for polled function code (4)	
WB00**	+2	Data for polled function code (1)		
WB00**	+3	Data for polled function code (2)		
WB00**	+4	Data for polled function code (3)		
WB00**	+5	Data for polled function code (4)		
WB00**	+6	Detected speed (M4)		
WB00**	+7	Operation status (M06)		
WB00**	+8	Address for function code to select (1)	Address for function code to select (2)	MICREX ⇓ INV
WB00**	+9	Address for function code to select (3)	Address for function code to select (4)	
WB00**	+10	Data for function code to select (1)		
WB00**	+11	Data for function code to select (2)		
WB00**	+12	Data for function code to select (3)		
WB00**	+13	Data for function code to select (4)		
WB00**	+14	Address for function code to poll (1)	Address for function code to poll (2)	
WB00**	+15	Address for function code to poll (3)	Address for function code to poll (4)	

7.1.5 Link Function

You can use the function code H30 and the X function "24: Operation selection through link [LE]" together to switch the sources (REM/LOC or COM) of reference data (S area). See also "4.2 Control Block Diagrams" for better understanding.
You can combine the function code H29 and the X function "23: Write enable through link [WE-LK]" to control write to the function codes (F, E, C, P, H, A, o, L, U) through the link. See also "4.2 Control Block Diagrams" for better understanding.

7.1.5.1 Enabling Link Operation

(1) Switching to Link

You can assign "24: Operation selection through link [LE]" to an X function input terminal to change the mode as follows.

Signal of "Operation selection through link"	Input to terminal	State
Not assigned	-	"Operation through link enabled" mode
Assigned	ON	
	OFF	"Operation through link disabled" mode

Though you can write reference data and operation commands through the link in the "Operation through link disabled" mode, the data are not reflected. You can store data in the "Operation through link disabled" mode and switch to the "Operation through link enabled" mode to reflect the data.

(2) Writing through Link

In the "Operation through link enabled" mode, you can use the function code H30 (Serial link) to switch the source of the operation command and reference data between the link (COM) and the remote/local. The remote and local means REM (terminal block; External signal) and LOC (KEYPAD panel) respectively.

H30 setting	Operation through link enabled		Operation through link disabled
	Reference data (S01 to S05, S08 to S12)	Operation command (FWD, REV)	
0	Link disabled (REM/LOC)	Link disabled (REM/LOC)	Link disabled (REM/LOC)
1	Link enabled (COM)	Link disabled (REM/LOC)	
2	Link disabled (REM/LOC)	Link enabled (COM)	
3	Link enabled (COM)	Link enabled (COM)	

This function enables you to construct a flexible system where you can apply an operation command from the terminal block and apply a speed reference from the RS485.

7.1.5.2 Enabling Writing through Link

(1) Switching to writing through link

You can assign "23: Write enable through link [WE-LK]" to an X function input terminal to write in the function codes (F, E, C, P, H, A, o, L, and U).

Signal of "Write enable through link"	Input to terminal	State
Not assigned	-	"Write through link enabled" mode (Writing enabled to F to U)
Assigned	ON	
	OFF	"Write through link disabled" mode (Writing disabled to F to U)

(2) Writing through link

In "Write through link" enabled mode, you can use the function code H29 (Link function protection) to control to write to the function codes (F, E, C, P, H, A, o, L, and U).

H29 setting	"Write through link enabled" mode	"Write through link disabled" mode
0	Codes (F, E, C, P, H, A, o, L, U) write-protected	Codes (F, E, C, P, H, A, o, L, U) write-protected
1	Codes (F, E, C, P, H, A, o, L, U) write-enabled	

7.1.6 Transmission Format

7.1.6.1 Data Format (Inverter ⇒ MICREX)

(1) Operation Status (1 is set to a bit when ON)

(MSB) 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	(LSB) F
BUSY	ERR	WR	RL	ALM	DEC	ACC	IL	VL	TL	NUV	BRK	INT	EXT	REV	FWD

- The ERR is set to "0" when writing/reading is successful. The ERR is set to "1" when the following writing/reading errors occur. When an error is present and the next writing/reading is successful, the ERR is reset to "0" automatically. If this bit is "1", repeat reading/writing until this bit becomes "0".

	Read/write error
1	Access to unavailable function
2	Write to read-only function
3	Write to function to which you cannot write during operation
4	Write to function to which you cannot write when FWD/REV is ON
5	Write to data out of range

- The BUSY is set to "1" during data is being written (processing). When you write data successively, write next data after this bit turns to "0". If you write data when this bit is "1", written data is neglected.

(2) Motor Speed

(MSB) 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	(LSB) F
Motor speed (decimal)×20,000÷maximum speed⇒16-bit data															

The maximum speed is set by a function code. If you want a data in r/min, use the equation above for inverse operation. If a data is negative (2's complement), you will direct the reverse rotation.

(3) Address and Data for Polled Function Code

Format 1

Address for polled function code	Blank (fixed to 0)
Data for polled function code	

The link number corresponding to the function code polled by the MICREX is stored in the "Address for polled function code". And the data of the function code is stored in the "Data for polled function code". Refer to the "Function Code List" for the link number.

Format 2

Address for polled function code (1)	Address for polled function code (2)
Address for polled function code (3)	Address for polled function code (4)
Data for polled function code (1) to Data for polled function code (4)	

The link numbers corresponding to the function codes polled by the MICREX are stored in the "Address for polled function code (1)" to "Address for polled function code (4)". And the data of these function codes are stored in the "Data for polled function code (1)" to "Data for polled function code (4)".

7.1.6.2 Data Format (MICREX ⇒ Inverter)

(1) Operation Command, Di, RESET Input (1 is set to a bit when ON)

(MSB) 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	(LSB) F
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

When the operation through the link is enabled as described in "7.1.5.1 Enabling Link Operation", FWD and REV are effective. X1 to X14 and RST are always enabled.

(2) Speed Reference

(MSB) 0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	(LSB) F
Speed reference (decimal)×20,000÷maximum speed⇒16-bit data															

The equation above is the same as that for the motor speed. The maximum speed is set by a function code. You should use a 16-bit data calculated by the equation above for specification (Use a 2's complement for a negative value).
When the operation through the link is enabled as described in "7.1.5.1 Enabling Link Operation", reference data (such as speed reference) are effective.

(3) Address for Function Code to Poll or to Select and Data for Function Code to Select

Format 1

(MSB) 0 1 … 7	8 … E (LSB) F
Address for function code to select	Address for function code to poll
Data for function code to select	

Use the "Address for function code to select" (8 bits) and the "Data for function code to select" (16 bits) in the table above to write a function code data. Use the "Address for function code to poll" to specify a link number corresponding to a function code number to poll.

Format 2

(MSB) 0 1 … 7	8 … E (LSB) F
Address for function code to select (1)	Address for function code to select (2)
Address for function code to select (3)	Address for function code to select (4)
Data for function code to select (1)	
⇓	
Data for function code to select (4)	
Address for function code to poll (1)	Address for function code to poll (2)
Address for function code to poll (3)	Address for function code to poll (4)

Write link numbers to the "Address for function code to select (1)" to the "Address for function code to select (4)" (8 bits) corresponding to the function codes to select from the MICREX. You should write data to the "Data for function code to select (1)" to the "Data for function code to select (4)" as well.

Note: When you select, write a link number and its data at the same time.

Use the "Address for function code to poll (1)" to the "Address for function code to poll (4)" to specify a link numbers corresponding to function code numbers to poll.
When the writing through the link is enabled as described in "7.1.5.2 Enabling Writing through Link", selecting is effective. Remember the restrictions on writing such as "Write disabled on operation".

7.1.6.3 Data Transmission Examples

(1) Speed Reference

Directing a speed reference of 785r/min in froward (FWD) direction from MICREX.

(Conditions: function code H30 "Serial link"=3, maximum speed: 1500r/min, T-Link station number: 10, 8+8 words)

Set forward (FWD: ON) to S06 and a speed reference to S01.

WB18	0	6	0	1	Addresses to select function code S06 and S01 (link number 06h and 01h)
19	0	0	0	0	Dummy addresses for function code to select
20	0	0	0	1	Data for function code S06 is "FWD: ON"
21	2	8	E	3	Data for function code S01 is a speed reference, 785/1500×20,000=10,467=28E3[h]
		↓			After acceleration is completed
WB16	2	8	E	3	Monitored motor speed

(2) Torque Reference Monitor

Monitoring torque reference value.

(Conditions: T-Link station number: 24, 8+8 words)

WB38	1	0	0	0	Address to monitor the torque reference (link number: 10h)
39	0	0	0	0	
		↓			After reading is completed
WB24	1	0	0	0	Reading is completed when the polled link number is returned to this area.
25	0	0	0	0	Monitored data of torque reference value
26	1	3	8	8	1388 (h) × 100 (%) ÷ 10,000 = 50 (%)
27	0	0	0	0	
28	0	0	0	0	↓
29	0	0	0	0	Above result indicates that torque reference value is "50% in driving".

(3) Function Code Data Setting

1) Setting 30.5sec to the acceleration time (function code S08)

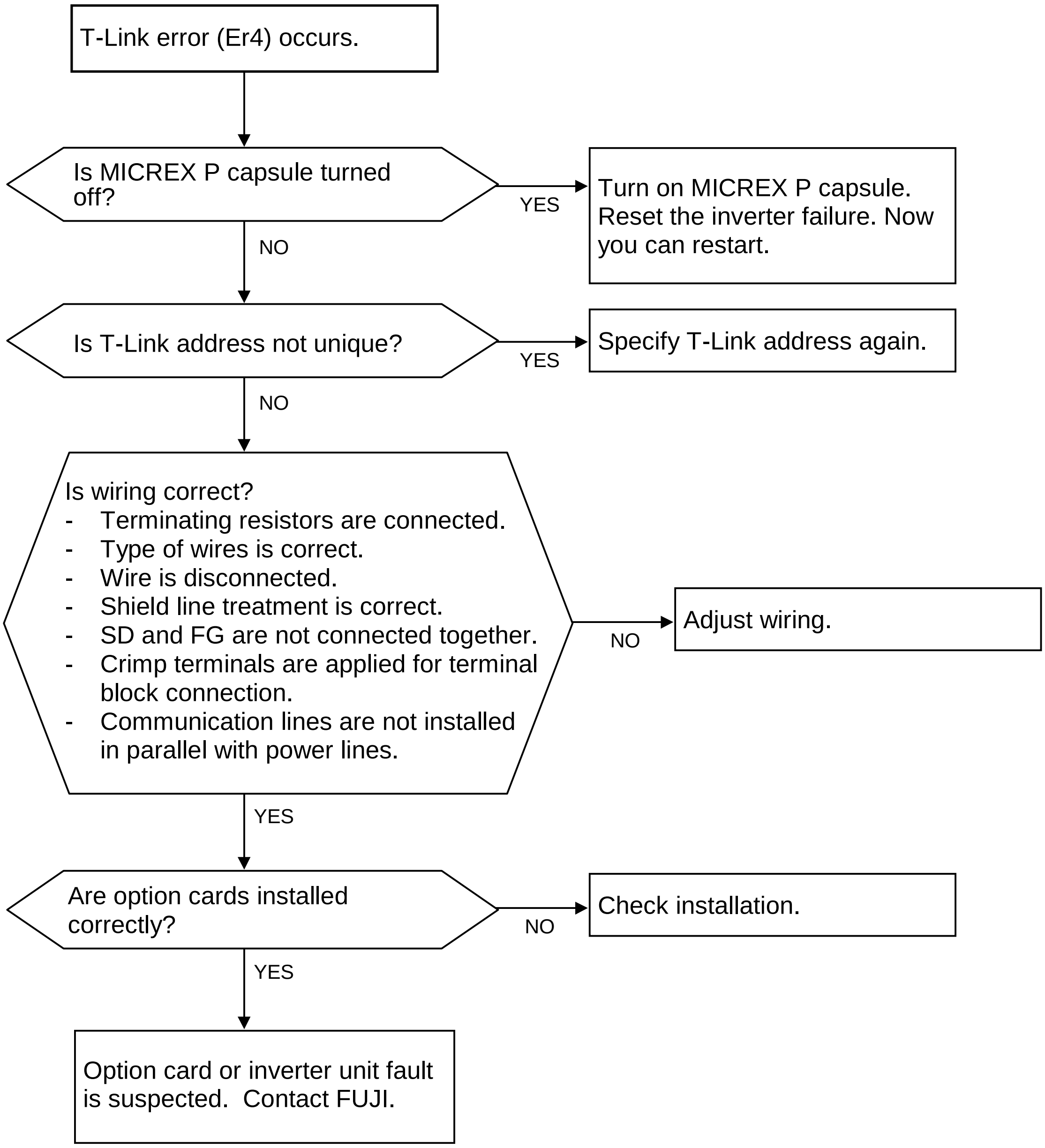
(Conditions: T-Link station number: 58, 4+4 words)

WB62	0	0	0	0	Address to select function code S08 (link number 08h)
63	0	0	0	0	131 (h) = 305, 305 × 0.1s = 30.5s
64	0	8	0	8	
65	0	1	3	1	Address to poll function code S08 for confirmation after setting
		↓			
WB58	*	*	*	*	Address for polled function code
59	*	*	*	*	131 (h) = 305, 305 × 0.1s = 30.5s
60	0	8	0	0	This data indicated that setting is successful.
61	0	1	3	1	

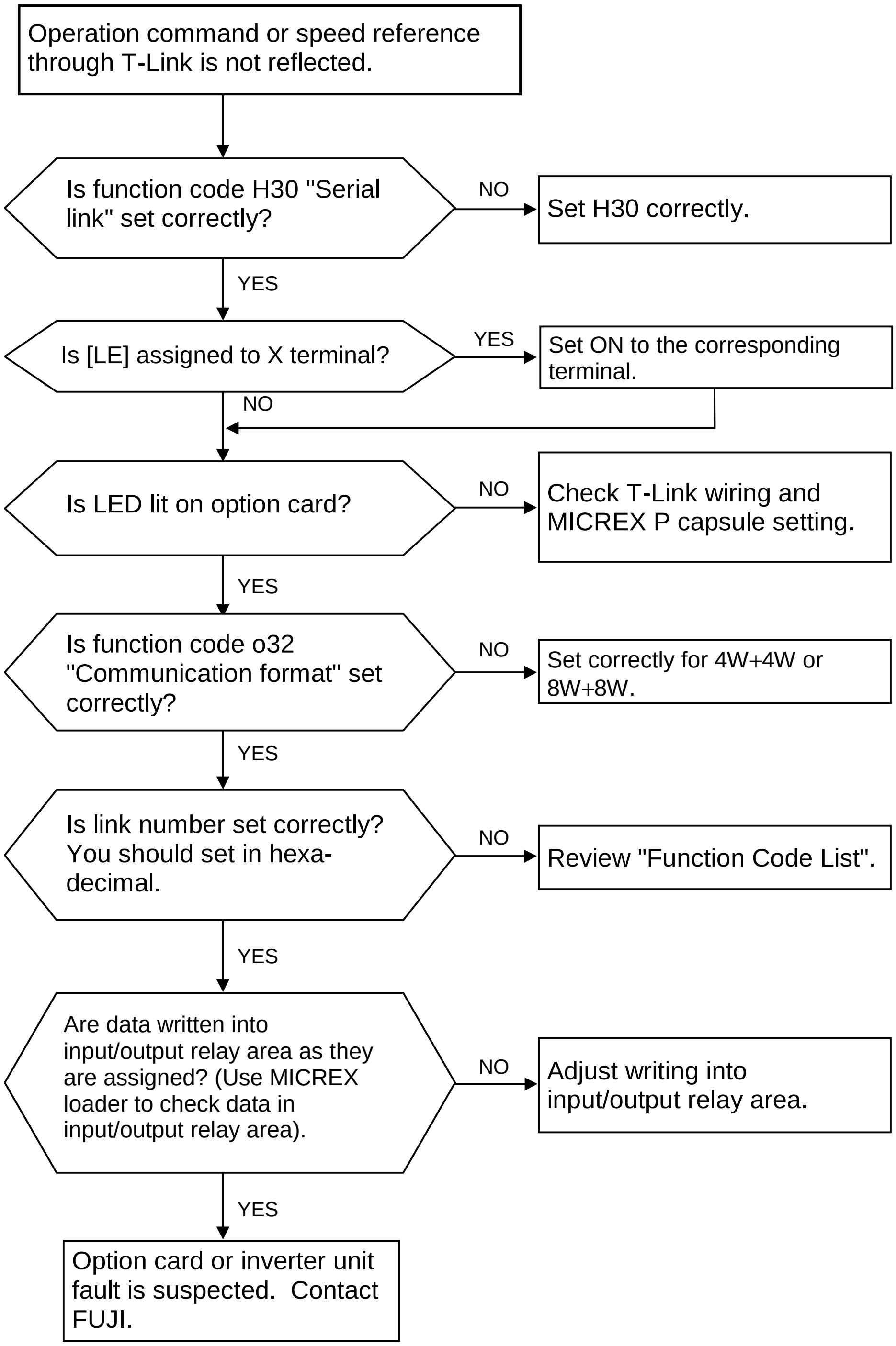
7.1.7 Troubleshooting

(1) T-Link error (Er4)

Refer to the RAS information of the MICREX P capsule to diagnose the cause of a failure when you have a T-Link error. Refer to the instruction manual of the MICREX for the RAS information.



(2) Operation command and speed reference setting



* You can use the "I/O Check" screen of the KEYPAD panel to view the description of the Er4.

Code	T-Link option error type	How to reset
1	CRC check error Flag error	Normal reception resets automatically
2	Transmission cycle time over Frequent CRC error (16 times or more)	Power reset or reset key
3	Overrun or under run	Power reset or reset key

7. Control Options

7.2 DI (DIA, DIB) Extension Card

7.2.1 Product Guide

7.2.1.1 Product Overview

Overview

This option card (OPC-VG7-DI) is an inverter control option card installed on the FRENIC5000VG7S (VG7S hereafter).
You can use this card to specify a speed reference, a torque reference and a torque current reference in 16-bit digital data. You can also use this card to specify torque limiters during speed control.
There is a hardware switch on this card. This switch is set to "DIA" as factory setting and you do not have to change this setting when you use a single card. When you want use two DI cards for a speed reference and a torque reference, set them as "DIA" and "DIB" respectively and install both of them simultaneously.

⚠WARNING
• Turn off the circuit breaker on the power supply side of an inverter when you mount/dismount this option after you have turned on the inverter. You will get electric shock if you touch the live part since the smoothing capacitors are still charged after you turn off. Wait until the charge lamp (CHARGE) is off on the inverter and use a multimeter to check if the DC voltage of the inverter (between P and N terminals) has decreased to a safe level.
You may get electric shock.
• Improper wiring work may cause electric shock and a fire. Leave the wiring work to a specialist.
You may cause fires.
• Improper data specified to function codes may cause dangerous situations. Check your data again after you specify and write data.
You may cause accidents.
• An inverter starts if you reset an alarm while the operation command is set to ON after the protective function of the inverter was activated and you removed the cause of the alarm. Reset the alarm after you check the operation command is set to OFF.
You may cause accidents or be injured.

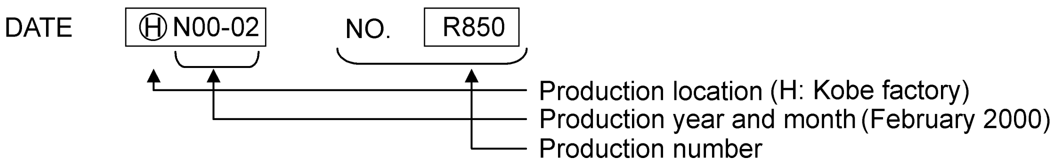
⚠CAUTION
• Avoid using a damaged product or a product with missing parts.
You may be injured.
• You may damage a product when you mount/dismount the product in improper manner.
You may cause accidents.
• After you turn off the main circuit power supply, the control circuit power supply and the auxiliary power supply, if the external control circuit has a separate power supply, the power is still applied to the 30A, 30B, 30C, RYA, and RYC. Turn off the external power supply to avoid electric shock.
You may get electric shock.
• Avoid to apply voltage over permissible levels to individual terminals. The voltage over the permissible level may damage this option.
You may cause accidents.

7.2.1.2 Product Guarantee

The period of product guarantee is either twelve months after your purchase or eighteen months after production that comes first.
Note that the following cases will void the product guarantee.

- Improper operations, repairs or modifications
- Operation out of the standard specifications
- Drops or damages during transportation after your purchase
- Earthquakes, fires, winds, floods, lightning, abnormal voltages, and other natural disasters, or secondary disasters.

Production date and production number (displayed on the product)



7.2.1.3 Standard Product Specifications

Table 7-2-1 Standard Specifications

Item		Specification
Name		Digital input option card
Type		OPC-VG7-DI (switch to DIA or DIB)
Input	Number of contacts	16 points
	Circuit	Isolated by photocouplers, sink type (Continuous current per circuit: 3mA)

Note 1: This product is dedicated for the vector control inverter FRENIC5000VG7S. You cannot apply to other products.
Note 2: Avoid megger test on the terminals of this option.
Note 3: When the protective function is activated, refer to "4.4 If You Think Defective" and remove the cause of abnormality to restart.
Note 4: Items of maintenance and inspection are the same as those of the inverter. Refer to the instruction manual of the inverter.

7.2.2 Connections

⚠WARNING
• Improper wiring work may cause electric shock and a fire. Leave the wiring work to a specialist. Turn off the circuit braker on the power supply side of an inverter to avoid electric shock when you work with connection after you have turned on the inverter. You will get electric shock if you touch the live part since the smoothing capacitors are still charged after you turn off. • Wait until the charge lamp (CHARGE) is off on the inverter and use a mutimeter to check if the DC current of the inverter (between P and N terminals) has decreased to a safe level. **You may get electric shock.**

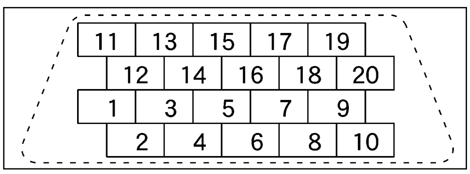
⚠CAUTION
• Avoid to apply voltage over permissible levels to individual terminals. The voltage over the permissible level may damage this option. • After you turn off the main circuit power supply, the control circuit power supply and the auxiliary power supply, if the external control circuit has a separate power supply, the power is still applied to the 30A, 30B, 30C, RYA, and RYC. • Turn off the external power supply to avoid electric shock. **You may get electric shock.**

7.2.2.1 Terminal Function Description

Connect wiring to the plug supplied with the option card and connect the plug to the connector CN2. The pin assignment is described below.

Table 7-2-2 Pin Numbers and Signals of CN2

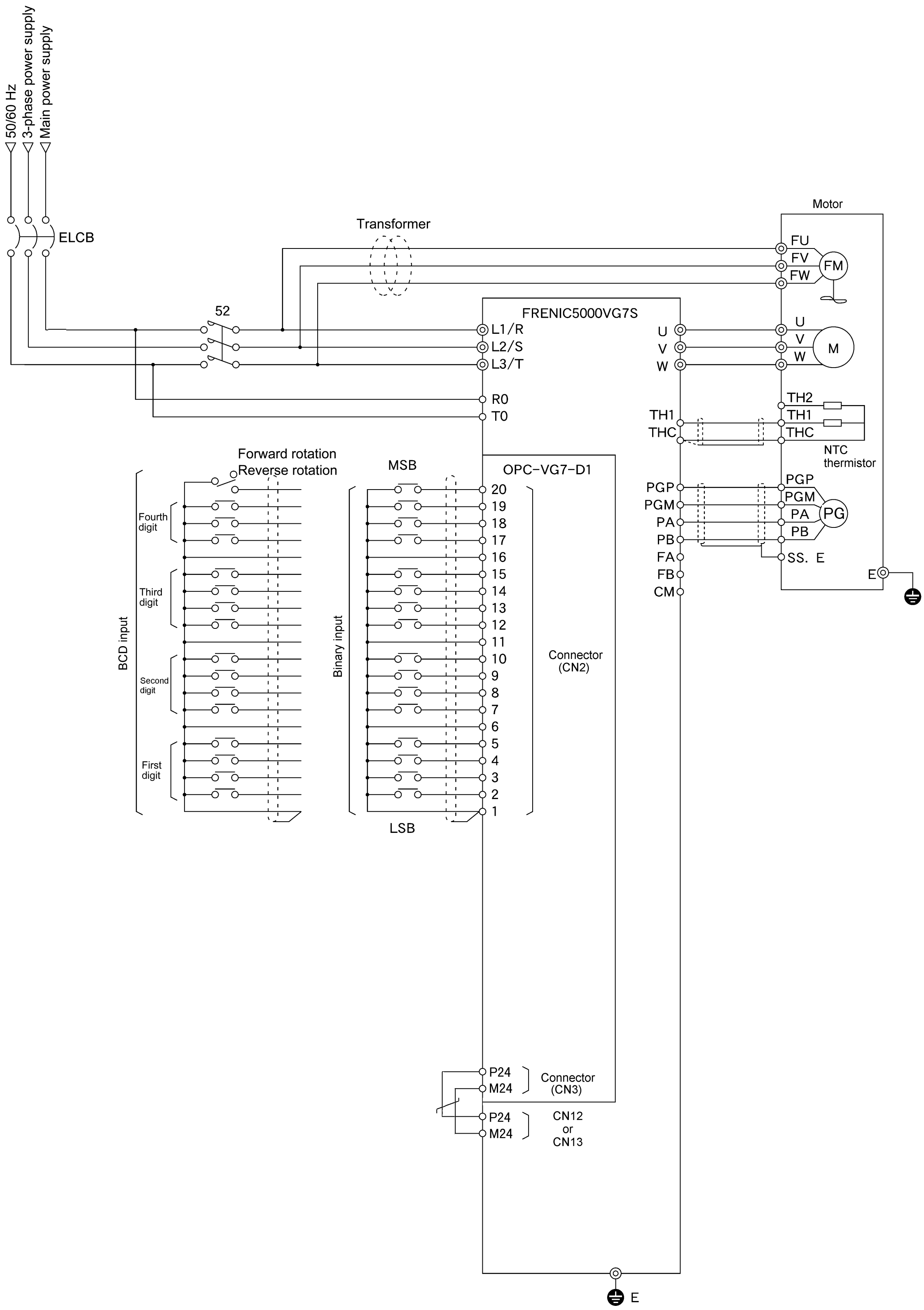
Pin number	Name	Description		Notes
		In binary	In BCD	
1	CM	Common (M24)		• Contact capacity: about 3mA, 24V DC
2	DI0	$2^0 = 1$	1×10^0	
3	DI1	$2^1 = 2$	2×10^0	• "1" when a signal terminal and the common terminal is connected.
4	DI2	$2^2 = 4$	4×10^0	
5	DI3	$2^3 = 8$	8×10^0	
6	CM	Common (M24)		
7	DI4	$2^4 = 16$	1×10^1	• Use function code o01 and o02 to select between binary and BCD
8	DI5	$2^5 = 32$	2×10^1	
9	DI6	$2^6 = 64$	4×10^1	
10	DI7	$2^7 = 128$	8×10^1	
11	CM	Common (M24)		• In BCD, pin 20 is used as sign and input range is −7,999 to 0 to +7,999
12	DI8	$2^8 = 256$	1×10^2	
13	DI9	$2^9 = 512$	2×10^2	
14	DI10	$2^{10} = 1024$	4×10^2	
15	DI11	$2^{11} = 2048$	8×10^2	
16	CM	Common (M24)		
17	DI12	$2^{12} = 4096$	1×10^3	
18	DI13	$2^{13} = 8192$	2×10^3	
19	DI14	$2^{14} = 16384$	4×10^3	
20	DI15	$2^{15} = 32768$	Sign (negative when closed)	



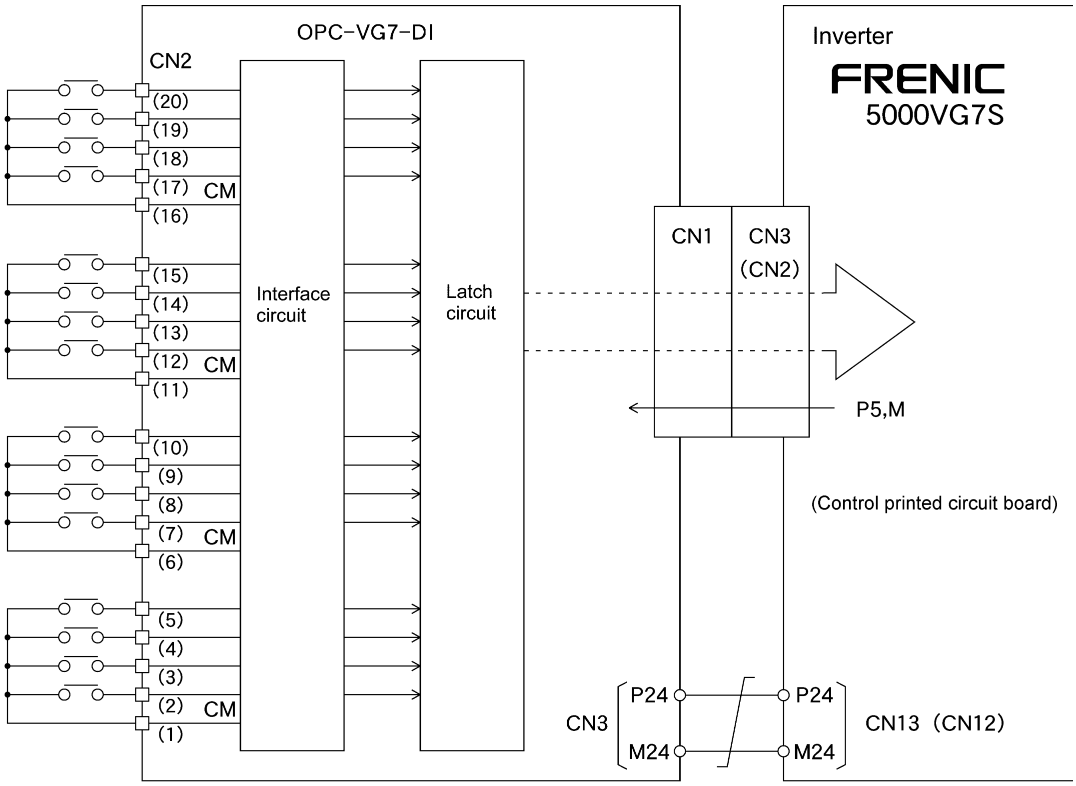
Viewed from the soldering terminal side of the plug

Pin assignment of plug (for CN2)

7.2.2.2 Basic Wiring Diagram

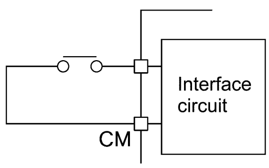


7.2.2.3 Block Diagram

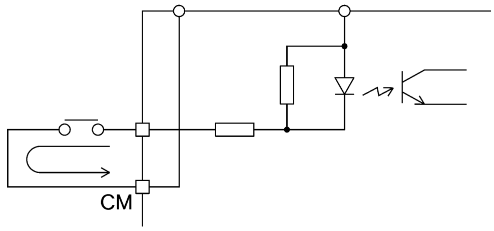


Block diagram

Note: Interface circuit structure is described below.



Block diagram (one circuit)



Permissible contact capacity
24V DC,3mA

Equivalent circuit (one circuit)

7.2.3 Function Codes for this Option

⚠ WARNING

- Improper data specified to function codes may cause dangerous situations. Check your data again after you specify and write data.

You may cause accidents.

- An inverter starts if you reset an alarm while the operation command is set to ON after the protective function of the inverter was activated and you removed the cause of the alarm. Reset the alarm after you check the operation command is set to OFF.

You may cause accidents or be injured.

7.2.3.1 DI Data Latch Function

You can enter a 16-bit parallel data into an inverter to reflect it at 1ms cycle.
You can use the data latch function to hold a data or to restrain the fluctuation of the lower bits of a data obtained by A/D conversion.

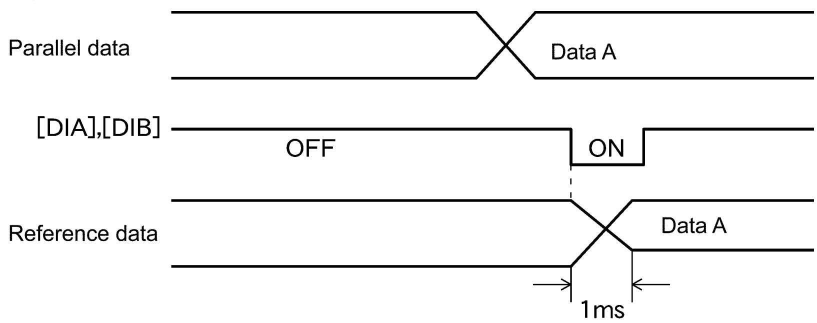
(1) Related Function Codes

Function code	Name	Setting range
E01 to E13	X1 to X14 function selection (X11 to X14 are DIOA option)	0 to 63[d]

1) Assign functions to the control input terminals (X1 to X14).
57 [DIA] DIA data latch: For setting DIA (specified by a hardware switch)
57 [DIB] DIB data latch: For setting DIB (specified by a hardware switch)

[DIA], [DIB]	Terminal signal	Parallel data to DI card
Not assigned	-	Reads always
Assigned	ON	
	OFF	Does not read (Holds the last data before OFF)

Assigned case



7.2.3.2 Selecting Binary or BCD

You can use the option function code o01 "DIA function selection" and o02 "DIB function selection" to select binary or BCD as a parallel input data.

Set data 0: Binary
1: BCD (Binary Coded Decimal)

Examples of Binary Input

Valid range is –32768 to 32767

(MSB)															(LSB)	
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	Intended data
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	20000
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32767
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–32768
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–32767
1	0	1	1	0	0	0	1	1	1	1	0	0	0	0	0	–20000
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	– 2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	– 1

Examples of BCD Input

Valid range is –799.9 to 799.9

(MSB)															(LSB)	
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	Intended data
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.2
0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	462.0
0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	799.9
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	–0.1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	–0.2
1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	–462.0
1	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	–799.9

Digit for 100 (bits 20–17) Digit for 10 (bits 15–12) Digit for 1 (bits 10–7) Digit for 0.1 (bits 5–2)

7.2.3.3 Control Reference Input

(1) Speed Reference Input

When you use the DI input as a speed reference, specify either the function code F01 or C25 that is effective according to the switch set to either DIA or DIB.

You can set the control input [N2/N1] to either ON or OFF to switch between F01 and C25. When you have not assigned the control input, F01 is effective.

1) Binary Input Setting

(a) When you specify 600r/min as a speed reference:

If the maximum speed setting is 1,500r/min,
you enter the following value into the DI card.

$$600 \times \frac{20{,}000}{1{,}500} = 8000\ [d]$$

$$= 1F40\ [H]$$

$$= 0001\ 1111\ 0100\ 0000\ [B]$$

(b) When you specify –1,000r/min as a speed reference:

If the maximum speed setting is 1,500r/min,
you enter the following value into the DI card.

$$-1{,}000 \times \frac{20{,}000}{1{,}500} = -13333\ [d]$$

$$= CBEB\ [H]$$

$$= 1100\ 1011\ 1100\ 1011\ [B]$$

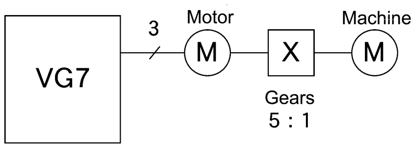
2) BCD Input Setting

You should specify the function code o03 and o04 "BCD input setting" according to the DIA and the DIB setting.

Set data: 99 to 7,999

Use this function to specify "the operation speed of a machine" in BCD.

For example, a machine connected to a motor through gears with ratio of 5:1, the machine runs at 300.0r/min while the motor runs at 1,500r/min.



When you use the BCD input to specify the operation speed of the machine directly, set "300" to the "BCD input setting". This setting drives the motor at 1,500r/min when the input to the DI card is 300.0. When you want to set the speed of the machine to 120.0r/min, enter 120.0 to the DI card.

$$\frac{120.0}{300} \times 1500 = 600\ \text{r/min(Motor speed)}$$

In this example, the motor runs at 600r/min.

3) Specified Resolution for BCD Input

Compare the setting 100 and 500 specified to the o03 or o04 "BCD input setting".

When the maximum motor speed is 1,500r/min,

For setting of 100: $\frac{\text{DI card input}: 0.0 \text{ to } 100.0}{100} \times 1500$ = 0 to 1,500r/min (1.5r/min per step)

For setting of 500: $\frac{\text{DI card input}: 0.0 \text{ to } 500.0}{500} \times 1500$ = 0 to 1,500r/min (0.3r/min per step)

As indicated above, the resolution changes according to the set value.

(2) Torque, Torque Current and Torque Limiter Input

Specify DIA or DIB in the following function codes to use the DI input to specify the torque, the torque current and the torque limiter. Refer to the Control Block Diagram for more details.

H41 "Torque reference selection" H42 "Torque current reference selection" F42, F43 "Torque limiter value selection (Level 1, Level 2)"

In all cases, 10,000 is assumed as 100%.

1) Binary Input Setting (∗BCD input is not available. o01 and o02 setting is not effective in this case)

(a) When you specify a torque reference of 70%:
You enter the following value into the DI card.

$$70 \times \frac{10000}{100} = 7000 \text{ (d)}$$

$$= 1B58 \text{ [H]}$$

$$= 0001\ 1011\ 0101\ 1000 \text{ [B]}$$

(b) When you specify a torque current reference of −25%:
You enter the following value into the DI card.

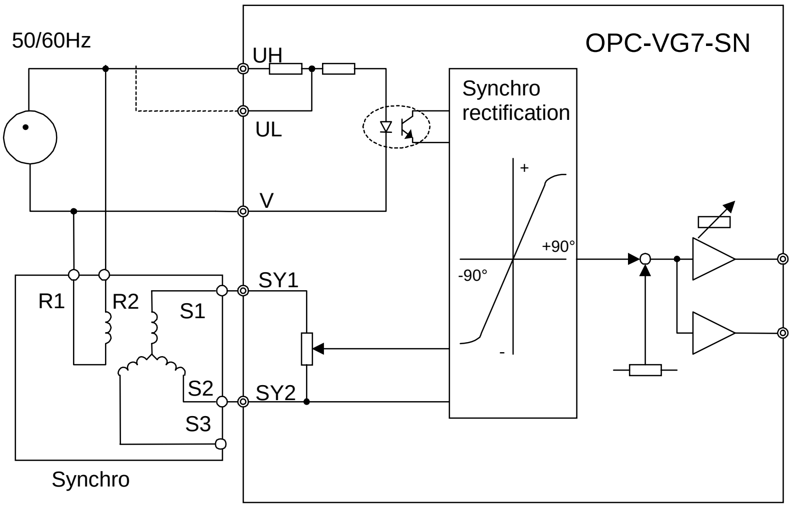
$$-25 \times \frac{10000}{100} = -2{,}500 \text{ [d]}$$

$$= F63C \text{ [H]}$$

$$= 1111\ 0110\ 0011\ 1100 \text{ [B]}$$

7.3 Synchronized Interface Card/Unit

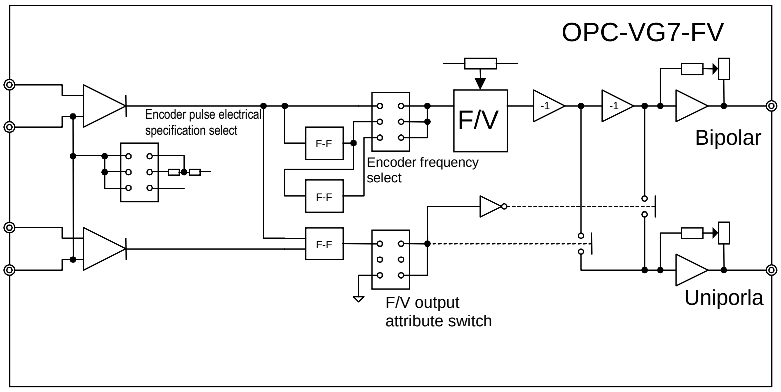
- Integrated type OPC-VG7-SN
- Separate type MCA-VG7-SN



This card/unit converts the AC voltage supplied from a synchrony-transmitter used for dancer control to a control signal in the range of 0 to ±10V.

7.4 F/V Converter

- Integrated type OPC-VG7-FV
- Separate type MCA-VG7-FV



You can use this card/unit to detect line speed.
This card/unit converts the frequency signal from a PG to a voltage signal.

7. Control Options

7.5 AIO Extension Card

● OPC-VG7-AIO

You can use this card when you need additional analog input/output points for a system construction using the UPAC or a control system utilizing the PID control integrated into the inverter.

This card adds 2 channels of Ai and 2 channels of Ao.
Ai specification: ±10V input, 12-bit resolution, conversion cycle 1ms
Ao specification: ±10V output, 12-bit resolution, conversion cycle 1ms

7.6 PG Interface Extension Card

● OPC-VG7-PG

- You can use this card to add a PG signal input of 5V line driver type, voltage output type, or open collector output type.
- You can install up to two of this card. You can set the switch on the printed circuit board to select a setting from the following four types.

1) PG (SD)
For motor speed detection. You can use this setting to drive a motor with a 5V line driver type PG as used in the combination of a FALDIC-IM motor and a VG7S.

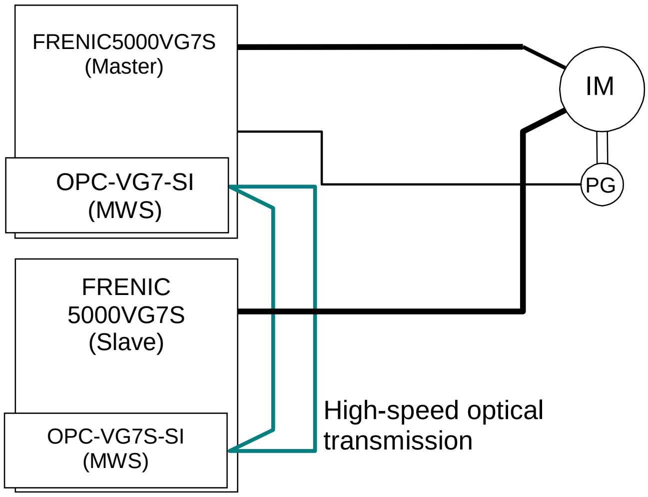
2) PG (LD)
Use to detect line speed directly in digital data.
Related function codes are o06, o07, and o08.

3) PG (PR)
Use to specify the position reference in pulse train control.
You can select from three pulse train types: 90 degrees of phase difference between A- and B-phases, A-phase: reference pulse and B-phase: reference sign, A-phase: forward rotation pulse and B-phase: reverse rotation pulse.

4) PG (PD)
Use to detect the spindle position in pulse train control.
You can use a motor PG to detect the position in pulse train control.
(Related function code: o05)
You can also use this setting to detect the spindle position in orientation control.

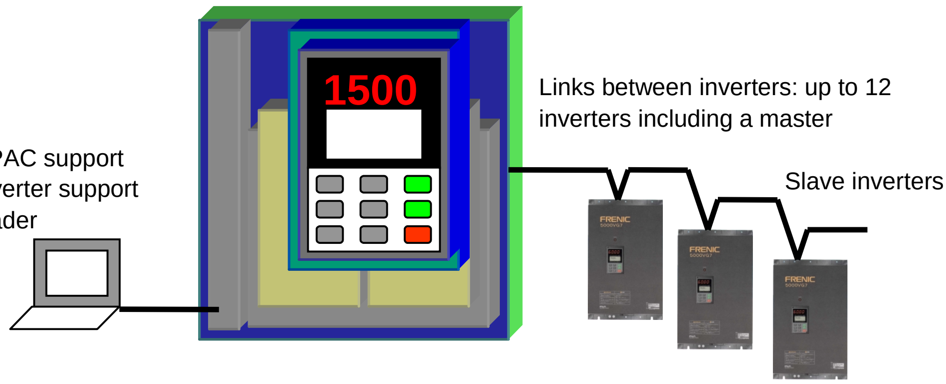
7.7 High-Speed Serial Card

● OPC-VG7-SI (MWS)



Multiplexing windings of a motor and preparing an inverter for each winding (up to four-way multiplexing) can increase the capacity of a drive system.
Though a master inverter conducts normal operation, slave inverters conduct only current control following the current control instruction from the master inverter.

● OPC-VG7-SI (UPAC)



A link system connecting inverters can be constructed by designating one inverter with a UPAC as a master.

50W input/output mode: Up to 5 slave inverters can be linked.
(1 to 3 slaves: 2ms, 4 to 5 slaves: 3ms)
22W input/output mode: Up to 11 slave inverters can be linked.
(1 to 6 slaves: 2ms, 7 to 11 slaves: 3ms)

7. Control Options

7.8 RS485 Extension Card

- OPC-VG7-RS

1) Use to construct a low-cost inter-inverter link utilizing the UPAC system

A link system connecting inverters can be constructed by designating an inverter with a UPAC as a master
50W input/output mode: Up to 5 slave inverters can be linked.
(1 to 3 slaves: 200ms, 4 to 5 slaves: 300ms)
22W input/output mode: Up to 11 slave inverters can be linked.
(1 to 6 slaves: 200ms, 7 to 11 slaves: 300ms)

2) Use when you employ the POD as a remote controller

7.9 PG Card for Synchronous Motor Driving

- OPC-VG7-PMPG

- This PG interface card provides a magnetic pole position signal input.
  U, V, and W signals or multiple-bit Gray code are available as a magnetic pole position signal and this card can accept A- and B-phase signals and an up to 4 bits of magnetic pole position signal.

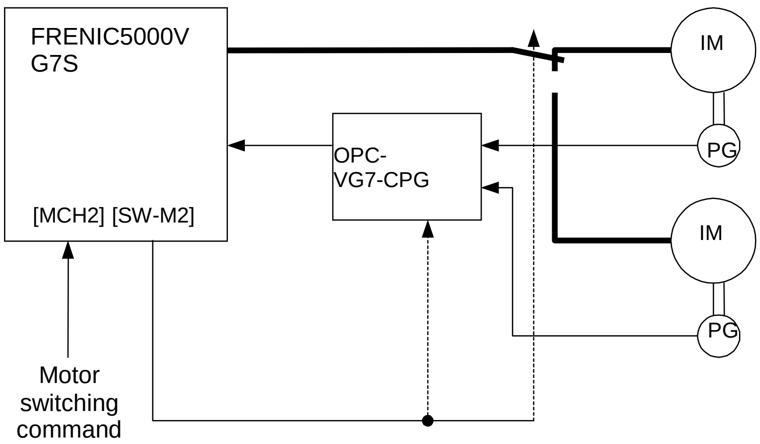
- Applicable PG signal is 5V line driver type.

- Use OPC-VG7-PG card for synchronous motor drive with an A-, B-, and Z-phase pulse generator.

7.10 PG Signal Switch

● MCA-VG7-CPG

- You can use this option for one inverter to switch between two motors to drive.
- This option can switch PG signals and NTC thermistor signals.
- The following example shows a connection when this option is combined with the second motor selection function of the VG7S.



7.11 Field Bus Interface Unit

- Comply with different types of field bus.
- Communication protocol meets each DRIVE Profile (except for MODBU-RTU).

1) For Profibus-DP: OPC-VG7-PDP
   (Drive profile: PROFIDRIVE)
2) For DeviceNet: OPC-VG7-DEV
   (Drive profile: AC Drive)
3) For Interbus-S: OPC-VG7-IBS
   (Drive profile: DRIVECOM Profile 21)
4) For CAN Open: OPC-VG7-COP
   (Drive profile: DRIVES & MOTION CONTROL)
5) For Modbus Plus: OPC-VG7-MBP
   (supports Global database)

- MEMO -

THE INVERTER

VIII

VIII. Peripheral Equipment

8. Peripheral Equipment

8.1 Inverter Input Current

• This section describes selecting peripheral devices and cables.

Table 8.1 Various Current Value Through Inverter

Power supply voltage	Nominal applied motor [kW]	50Hz, 200V (400V)					60Hz, 220V (440V)				
		Input effective value current [A]		DC link circuit current [A]	Braking resistor circuit current [A]		Input effective value current [A]		DC link circuit current [A]	Braking resistor circuit current [A]	
		With DCR	Without reactor		CT/HT	VT	With DCR	Without reactor		CT/HT	VT
Three-phase 200V	0.75	3.1	6.4	3.8	1.4	–	2.7	6.2	3.3	1.4	–
	1.5	5.7	11.1	7.0	1.9	1.4	5.1	10.6	6.2	1.9	1.4
	2.2	8.3	16.1	10	2.3	1.9	7.5	15.5	9.2	2.3	1.9
	3.7	14.0	25.5	17	3.4	2.3	12.5	24.2	15	3.4	2.3
	5.5	19.7	40.8	24	5.1	3.4	16.9	36.2	21	5.1	3.4
	7.5	26.9	52.6	33	6.8	5.1	24.0	46.6	29	6.8	5.1
	11	39.0	76.9	48	10.2	6.8	34.7	67.7	42	10.2	6.8
	15	54.0	98.5	66	13.7	10.2	48	87	59	13.7	10.2
	18.5	66.2	117	81	17.6	13.0	59	104	72	17.6	13.0
	22	78.8	136	96	20.3	16.4	70	123	86	20.3	16.4
	30	109	168	133	30.0	20.3	99	149	121	30.0	20.3
	37	135	204	165	35.1	28.5	122	181	149	35.1	28.5
	45	163	243	200	41.1	33.2	148	217	181	41.1	33.2
	55	199	291	244	50.8	38.9	182	262	223	50.8	38.9
	75	272		333	68.5	50.8	247		303	68.5	50.8
	90	327	–	400	83.0	64.2	296	–	363	83.0	64.2
	110	400		490	–	78.6	364		446	–	78.6
Three-phase 400V	3.7	7.1	14.9	8.7	1.7	–	6.3	14.2	7.7	1.7	–
	5.5	10.0	21.5	12	2.5	1.7	8.3	19.0	10	2.5	1.7
	7.5	13.5	27.9	17	3.4	2.5	12.1	24.6	15	3.4	2.5
	11	19.8	39.1	24	5.1	3.4	17.7	34.5	22	5.1	3.4
	15	26.8	50.3	32	6.8	5.1	24	44	29	6.8	5.1
	18.5	33.2	59.9	40	8.8	6.5	29	53	36	8.8	6.5
	22	39.3	69.3	48	10.2	8.2	35	62	43	10.2	8.2
	30	54	86	66	15.0	10.2	49	76	60	15.0	10.2
	37	67	104	82	17.6	14.3	61	92	75	17.6	14.3
	45	81	124	99	20.5	16.6	74	111	91	20.5	16.6
	55	100	150	122	25.2	19.4	91	134	111	25.2	19.4
	75	134		164	34.6	25.2	122		149	34.6	25.2
	90	160		196	41.6	32.5	146		179	41.6	32.5
	110	196		240	50.8	39.4	178		218	50.8	39.4
	132	232		284	61.7	47.6	211		258	61.7	47.6
	160	282		345	73.9	58.2	256		314	73.9	58.2
	200	352	–	431	92.6	70.7	320	–	392	92.6	70.7
	220	385		472	102	83.2	350		429	102	83.2
	280	491		601	138	98.1	446		546	138	98.1
	315	552		676	147	125	502		615	147	125
	355	624		764	175	133	567		694	175	133
	400	704		962	186	159	640		784	186	159
	500	880		1078	-	178	800		980	–	178

Note 1: The inverter efficiency is calculated using individual value by capacity. The input effective value current is obtained for following conditions:

[22kW or smaller]

Power source capacity : 500kVA Power source impedance : 2.5%

[30kW or larger]

Power source capacity and impedance are calculated using values corresponding to Fuji's recommended capacity.

Note 2: For different power voltages such as 230V or 380V, input current is in inverse proportion to the power voltage.

Note 3: The braking resistor circuit currents are obtained on condition that the standard braking resistor (10% ED) is used. Ask us for the data taken when the resistor of 20%ED, 40%ED, 100%ED, or continuous rating is used.

8.2 Circuit Breakers and Magnetic Contactors

Table 8.2 Circuit Breakers and Magnetic Contactors

Power supply voltage	Nominal applied motor [kW]	Inverter type: CT use, HT use	Inverter type: VT use	MCCB, ELCB Rated current [A]: With DCR	MCCB, ELCB Rated current [A]: Without reactor	MC1 (for input circuit): With DCR	MC1 (for input circuit): Without reactor	MC2 (for output circuit): CT use, HT use	MC2 (for output circuit): VT use
Three-phase 200V	0.75	FRN0.75VG7S-2	–	5	10	SC-05	SC-05	SC-05	–
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2	10	15				SC-05
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2		20				
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2	20	30		SC-5-1		
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	30	50		SC-N1	SC-N1	
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	40	75	SC-5-1	SC-N2		SC-N1
	11	FRN11VG7S-2	FRN7.5VG7S-2	50	100	SC-N1	SC-N2S	SC-N2	
	15	FRN15VG7S-2	FRN11PS11-2	75	125	SC-N2	SC-N3	SC-N2S	SC-N2
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	100	150	SC-N2S	SC-N4		SC-N2S
	22	FRN22VG7S-2	FRN18.5VG7S-2		175		SC-N5	SC-N3	
	30	FRN30VG7S-2	FRN22VG7S-2	150	200	SC-N4	SC-N7	SC-N4	SC-N3
	37	FRN37VG7S-2	FRN30VG7S-2	175	250	SC-N5	SC-N8	SC-N5	SC-N4
	45	FRN45VG7S-2	FRN37VG7S-2	200	300	SC-N7		SC-N7	SC-N5
	55	FRN55VG7S-2	FRN45VG7S-2	250	350	SC-N8	SC-N11	SC-N8	SC-N7
	75	FRN75VG7S-2	FRN55VG7S-2	350	–	SC-N11	–	SC-N11	SC-N8
	90	FRN90VG7S-2	FRN75VG7S-2	400					SC-N11
	110	–	FRN90VG7S-2	500		SC-N12		–	
Three-phase 400V	3.7	FRN3.7VG7S-4	–	10	20	SC-05	SC-05	SC-05	–
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	15	30		SC-4-0		SC-05
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4	20	40		SC-5-1	SC-4-0	
	11	FRN11VG7S-4	FRN7.5VG7S-4	30	50		SC-N1	SC-5-1	SC-4-0
	15	FRN15VG7S-4	FRN11VG7S-4	40	60	SC-5-1		SC-N1	SC-5-1
	18.5	FRN18.5VG7S-4	FRN15VG7S-4		75	SC-N1	SC-N2		SC-N1
	22	FRN22VG7S-4	FRN18.5VG7S-4	50	100		SC-N2S	SC-N2	
	30	FRN30VG7S-4	FRN22VG7S-4	75	125	SC-N2	SC-N3	SC-N2S	SC-N2
	37	FRN37VG7S-4	FRN30VG7S-4	100		SC-N2S	SC-N4	SC-N3	SC-N2S
	45	FRN45VG7S-4	FRN37VG7S-4		150	SC-N3		SC-N4	SC-N3
	55	FRN55VG7S-4	FRN45VG7S-4	125	200		SC-N5	SC-N5	SC-N4
	75	FRN75VG7S-4	FRN55VG7S-4	175	–	SC-N4	–	SC-N7	SC-N5
	90	FRN90VG7S-4	FRN75VG7S-4	200		SC-N7		SC-N8	SC-N7
	110	FRN110VG7S-4	FRN90VG7S-4	250					SC-N8
	132	FRN132VG7S-4	FRN110VG7S-4	300		SC-N8		SC-N11	
	160	FRN160VG7S-4	FRN132VG7S-4	350		SC-N11		SC-N12	SC-N11
	200	FRN200VG7S-4	FRN160VG7S-4	500		SC-N12			SC-N12
	220	FRN220VG7S-4	FRN200VG7S-4	500				SC-N14	
	280	FRN280VG7S-4	FRN220VG7S-4	600		SC-N14			SC-N14
	315	FRN315VG7S-4	FRN280VG7S-4	800					
	355	FRN355VG7S-4	FRN315VG7S-4	800					
	400	FRN400VG7S-4	FRN355VG7S-4	1200				SC-N16	
	500	–	FRN400VG7S-4	1600		SC-N16		–	SC-N16

Note 1: For the MCCB and ELCB types, the rated current values recommended for 50°C or lower panel inside temperature are shown. Select an actual type according to facility short-circuit interrupting capacity.

Note 2: The magnetic contactor is selected on assumption that **the contactor is connected with HIV cable (allowable temperature: 75°C).** When connecting with other cables, reselect a magnetic contactor that matches the terminal size and the cable size.

8. Peripheral Equipment

8.3 Wire Size

8.3.1 Recommended Wire Size

(1) Under the 50°C or lower panel inside temperature

Table 8.3.1(1) Wire Size (50°C)

Power supply voltage	Nominal applied motor [kW]	Inverter type		Recommended wire size [mm²]															
				Input circuit [L1/R, L2/S, L3/T]								Output circuit [U, V, W]							
		CT use, HT use	VT use	With DCR				Without reactor				CT use, HT use				VT use			
				Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG7S-2	–	2.0	2.0	2.0	3.1	2.0	2.0	2.0	6.4	2.0	2.0	2.0	5.0	–			
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2				5.7				11.1				8.0	2.0	2.0	2.0	8.0
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2				8.3	3.5			16.1				11				11
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2				14.0	5.5	3.5		25.5	3.5			18	3.5			18
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	3.5			19.7	14	5.5	3.5	40.8	5.5	3.5		27	5.5	3.5		27
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	5.5	3.5		26.9	22	8.0	5.5	52.6	14	5.5	3.5	37	14	5.5	3.5	37
	11	FRN11VG7S-2	FRN7.5VG7S-2	14	5.5	3.5	39.0	38	14	14	76.9	14	8.0	5.5	49	14	8.0	5.5	49
	15	FRN15VG7S-2	FRN11VG7S-2	22	8.0	5.5	54.0	60	22	14	98.5	22	14	8.0	63	22	14	8.0	63
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	38	14	8.0	66.2	60	38	22	117	38	14	14	74	38	14	14	74
	22	FRN22VG7S-2	FRN18.5VG7S-2	38	14	14	78.8	–	38	38	136	38	22	14	90	38	22	14	90
	30	FRN30VG7S-2	FRN22VG7S-2	60	38	22	109	–	60	38	168	60	38	22	116	60	38	22	116
	37	–	FRN30VG7S-2	–	38	38	135	–	60	60	204	100	38	38	145	100	38	38	145
		FRN37VG7S-2	–	100					100										
	45	FRN45VG7S-2	FRN37VG7S-2	–	60	38	163	–	100	60	243	–	60	38	180	–	60	38	180
	55	FRN55VG7S-2	FRN45VG7S-2	–	100	60	199	–	100	100	291	–	100	60	215	–	100	60	215
	75	FRN75VG7S-2	FRN55VG7S-2	–	150	100	272	–				–	150	100	283	–	150	100	283
	90	FRN90VG7S-2	FRN75VG7S-2	–	150	150	327					–	150	150	346	–	150	150	346
	110	–	FRN90VG7S-2	–	200	150	400					–				–	200	150	415
Three-phase 400V	3.7	FRN3.7VG7S-4	–	2.0	2.0	2.0	7.1	2.0	2.0	2.0	14.9	2.0	2.0	2.0	9.0	–			
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4				10.0	5.5			21.5				13.5	2.0	2.0	2.0	13.5
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4				13.5	5.5	3.5		27.9	3.5			18.5	3.5			18.5
	11	FRN11VG7S-4	FRN7.5VG7S-4	3.5			19.8	14	5.5	3.5	39.1	5.5	3.5		24.5	5.5	3.5		24.5
	15	FRN15VG7S-4	FRN11VG7S-4	5.5	3.5		26.8	14	8.0	5.5	50.3	8.0	3.5	3.5	32	8.0	3.5	3.5	32
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	8.0	5.5	3.5	33.2	22	14	8.0	59.9	14	5.5	3.5	39	14	5.5	3.5	39
	22	FRN22VG7S-4	FRN18.5VG7S-4	14	5.5	3.5	39.3	38	14	8.0	69.3	14	8.0	5.5	45	14	8.0	5.5	45
	30	FRN30VG7S-4	FRN22VG7S-4	22	8.0	5.5	54	38	22	14	86	22	14	8.0	60	22	14	8.0	60
	37	FRN37VG7S-4	FRN30VG7S-4	38	14	8.0	67	60	22	22	104	38	14	14	75	38	14	14	75
	45	FRN45VG7S-4	FRN37VG7S-4	38	22	14	81	60	38	22	124	38	22	14	91	38	22	14	91
	55	FRN55VG7S-4	FRN45VG7S-4	60	22	14	100	–	60	38	150	60	38	22	112	60	38	22	112
	75	–	FRN55VG7S-4	–	38	38	134					100	60	38	150	100	60	38	150
		FRN75VG7S-4	–	100															
	90	FRN90VG7S-4	FRN75VG7S-4	100	60	38	160					–	60	38	176	–	60	38	176
	110	FRN110VG7S-4	FRN90VG7S-4	–	60	60	196					–	100	60	210	–	100	60	210
	132	FRN132VG7S-4	FRN110VG7S-4	–	100	60	232					–	100	100	253	–	100	100	253
	160	FRN160VG7S-4	FRN132VG7S-4	–	150	100	282	–				–	150	100	304	–	150	100	304
	200	FRN200VG7S-4	FRN160VG7S-4	–	150	150	352					–	200	150	377	–	200	150	377
	220	FRN220VG7S-4	FRN200VG7S-4	–	200	150	385					–	200	150	415	–	200	150	415
	280	FRN280VG7S-4	FRN220VG7S-4	–	250	200	491					–	325	200	520	–	325	200	520
	315	FRN315VG7S-4	FRN280VG7S-4	–	325	250	552					–	325	200	585	–	325	200	585
	355	FRN355VG7S-4	FRN315VG7S-4	–	400	250	624					–	400	325	650	–	400	325	650
	400	FRN400VG7S-4	FRN355VG7S-4	–	500	325	704					–	500	325	740	–	500	325	740
	500	–	FRN400VG7S-4	–	–	500	880					–				–	–	500	960

*1): Allowable temperature **60°C** means using **"IV wire"**; **75°C** means **"600V HIV insulation wire"**; and **90°C** means **"600V cross-linking polyethylene insulation wire"**.

- Select an appropriate wire size referring to **Table 8.1** and **Table 8.3.2** if conditions such as ambient temperature or power voltage are different.

Table 8.3.1(1) Wire Size (50°C) (cont'd)

Recommended wire size [mm²]																								
DC link circuit [P1, P(+)]								Braking circuit [P(+), DB, N(–)]								Control circuit			Auxiliary control power supply [R0, T0]			Grounding [⏚G]		
CT use, HT use				VT use				CT use, HT use				VT use												
Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]	Allowable temp. *1)			Current [A]	Allowable temp. *1)			Allowable temp. *1)			Allowable temp. *1)		
60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
			3.8	–							1.4	–												
2.0			7.0	2.0			7.0				1.9				1.4							2.0		
	2.0	2.0	10		2.0	2.0	10				2.3				1.9								2.0	2.0
3.5			17	3.5			17	2.0			3.4				2.3									
5.5			24	5.5			24		2.0		5.1	2.0			3.4							3.5		
8.0	3.5	3.5	33	8.0	3.5	3.5	33			2.0	6.8		2.0		5.1							5.5	3.5	
14	8.0	5.5	48	14	8.0	5.5	48				10.2			2.0	6.8							14	5.5	3.5
22	14	8.0	66	22	14	8.0	66				13.7				10.2							22	8.0	5.5
38	22	14	81	38	22	14	81	35			17.6				13.0	1.25	1.25	1.25	2.0	2.0	2.0	38	14	8.0
60	22	14	96	60	22	14	96				20.3	3.5			16.4							38	14	14
–	38	38	133	–	38	38	133	8.0	3.5		30.0				20.3							60	38	22
–	60	38	165	–	60	38	165	14	5.5	3.5	35.1	8.0	3.5		28.5							– 100	38	38
–	100	60	200	-	100	60	200	14	5.5	3.5	41.1	8.0	5.5	3.5	33.2							–	60	38
–	100	60	244	-	100	60	244	14	8.0	5.5	50.8	14			38.9							–	100	60
–	150	100	333	-	150	100	333	38	14	8.0	68.5	14	8.0	5.5	50.8							–	150	100
–	200	150	400	-	200	150	400	38	22	14	83.0	22	14	8.0	64.2							–	150	150
–				-	250	200	490	–				38	14	14	78.6							–	200	150
2.0			8.7	–							1.7	–												
	2.0	2.0	12	20			12				2.5				1.7							2.0	2.0	
3.5			17	3.5	2.0	2.0	17				3.4				2.5									2.0
5.5			24	5.5			24	2.0			5.1				3.4							3.5		
8.0	3.5	3.5	32	8.0	3.5	3.5	32		2.0		6.8	2.0			5.1							5.5	3.5	
14	5.5	3.5	40	14	5.5	3.5	40			2.0	8.8		2.0		6.5							8.0	5.5	3.5
14	8.0	5.5	48	14	8.0	5.5	48				10.2			2.0	8.2							14	5.5	3.5
22	14	8.0	66	22	14	8.0	66				15.0				10.2							22	8.0	5.5
38	22	14	82	38	22	14	82	3.5			17.6				14.3							38	14	8.0
60	22	14	99	60	22	14	99	3.5			20.5	3.5			16.6	1.25	1.25	1.25	2.0	2.0	2.0	38	22	14
60	38	22	122	60	38	22	122	5.5	3.5		25.2	3.5			19.4							60	22	14
100	60	38	164	100	60	38	164	8.0	5.5	3.5	34.6	5.5	3.5		25.2							– 100	38	38
–	60	60	196	–	60	60	196	14	5.5	3.5	41.6	8.0	3.5	3.5	32.5							100	60	38
–	100	60	240	–	100	60	240	14	8.0	5.5	50.8	14	5.5	3.5	39.4							–	60	60
–	150	100	284	–	150	100	284	22	14	8.0	61.7	14	8.0	5.5	47.6							–	100	60
–	150	150	345	–	150	150	345	38	14	14	73.9	22	14	8.0	58.2							–	150	100
–	250	150	431	–	250	150	431	38	22	14	92.6	38	14	14	70.7							–	150	150
–	250	200	472	–	250	200	472	60	22	22	102	38	22	14	83.2							–	200	150
–	400	250	601	–	400	250	601	100	38	38	138	60	22	14	98.1							–	250	200
–	400	325	676	–	400	325	676	100	38	38	147	60	38	22	125							–	325	250
–	500	400	764	–	500	400	764	150	60	38	175	100	38	38	133							–	400	250
–	–	500	862	–	–	500	862	150	60	38	186	100	60	38	159							–	500	325
–				–	–	–	1078	-				150	60	38	178							–	–	500

8. Peripheral Equipment

(2) Under the 40°C or lower panel inside temperature

Table 8.3.1(2) Wire Size (40°C)

Power supply voltage	Nominal applied motor [kW]	Inverter type		Recommended wire size [mm^2]															
				Input circuit [L1/R, L2/S, L3/T]								Output circuit [U, V, W]							
				With DCR				Without reactor				CT use, HT use				VT use			
		CT use, HT use	VT use	Allowable temp. *1)			Current	Allowable temp. *1)			Current	Allowable temp. *1)			Current	Allowable temp. *1)			Current
				60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]
	0.75	FRN0.75VG7S-2	–				3.1				6.4				5.0	–			
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2				5.7	2.0			11.1	2.0			8.0				8.0
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2	2.0			8.3		2.0	2.0	16.1		2.0		11	2.0			11
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2		2.0	2.0	14.0	3.5			25.5			2.0	18		2.0	2.0	18
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2				19.7	8.0	5.5	3.5	40.8	3.5			27	3.5			27
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	3.5			26.9	14	8.0	5.5	52.6	5.5	3.5		37	5.5	3.5		37
	11	FRN11VG7S-2	FRN7.5VG7S-2	5.5	5.5	3.5	39.0	22	14	8.0	76.9	8.0	5.5	3.5	49	8.0	5.5	3.5	49
Three-	15	FRN15VG7S-2	FRN11VG7S-2	14	8.0	5.5	54.0	38	22	14	98.5	14	8.0	5.5	63	14	8.0	5.5	63
phase	18.5	FRN18.5VG7S-2	FRN15VG7S-2	14	14	8.0	66.2	38	22	22	117	22	14	8.0	74	22	14	8.0	74
200V	22	FRN22VG7S-2	FRN18.5VG7S-2	22	14	14	78.8	60	38	22	136	22	14	14	90	22	14	14	90
	30	FRN30VG7S-2	FRN22VG7S-2	38	22	14	109	60	38	38	168	38	22	22	116	38	22	22	116
	37	–	FRN30VG7S-2	60	38	22	135	60	60	38	204	60	38	22	145	60	38	22	145
		FRN37VG7S-2	–					100											
	45	FRN45VG7S-2	FRN37VG7S-2	60	38	38	163	100	100	60	243	100	60	38	180	100	60	38	180
	55	FRN55VG7S-2	FRN45VG7S-2	100	60	38	199	–	100	100	291	100	60	60	215	100	60	60	215
	75	–	FRN55VG7S-2	–	100	60	272					150	100	100	283	150	100	100	283
		FRN75VG7S-2	–	150				–											
	90	FRN90VG7S-2	FRN75VG7S-2	200	150	100	327					200	150	100	346	200	150	100	346
	110	–	FRN90VG7S-2	250	150	150	400					–				250	150	150	415
	3.7	FRN3.7VG7S-4	–				7.1	2.0			14.9				9.0	–			
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	2.0			10.0		2.0	2.0	21.5	2.0			13.5	2.0			13.5
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4		2.0	2.0	13.5	3.5			27.9		2.0	2.0	18.5		2.0	2.0	18.5
	11	FRN11VG7S-4	FRN7.5VG7S-4				19.8	5.5	5.5	3.5	39.1	3.5			24.5	3.5			24.5
	15	FRN15VG7S-4	FRN11VG7S-4	3.5			26.8	14	5.5	5.5	50.3	3.5	3.5		32	3.5	3.5		32
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	5.5	3.5		33.2	14	8.0	5.5	59.9	5.5	3.5	3.5	39	5.5	3.5	3.5	39
	22	FRN22VG7S-4	FRN18.5VG7S-4	5.5	5.5	3.5	39.3	14	14	8.0	69.3	8.0	5.5	3.5	45	8.0	5.5	3.5	45
	30	FRN30VG7S-4	FRN22VG7S-4	14	8.0	5.5	54	22	14	14	86	14	8.0	5.5	60	14	8.0	5.5	60
	37	FRN37VG7S-4	FRN30VG7S-4	14	14	8.0	67	38	22	14	104	22	14	8.0	75	22	14	8.0	75
Three-	45	FRN45VG7S-4	FRN37VG7S-4	22	14	14	81	38	38	22	124	22	14	14	91	22	14	14	91
phase	55	FRN55VG7S-4	FRN45VG7S-4	38	22	14	100	60	38	38	150	38	22	14	112	38	22	14	112
400V	75	FRN75VG7S-4	FRN55VG7S-4	60	38	22	134					60	38	38	150	60	38	38	150
	90	FRN90VG7S-4	FRN75VG7S-4	60	38	38	160					60	60	38	176	60	60	38	176
	110	FRN110VG7S-4	FRN90VG7S-4	100	60	38	196					100	60	60	210	100	60	60	210
	132	FRN132VG7S-4	FRN110VG7S-4	100	60	60	232					150	100	60	253	150	100	60	253
	160	FRN160VG7S-4	FRN132VG7S-4	150	100	100	282					150	100	100	304	150	100	100	304
	200	FRN200VG7S-4	FRN160VG7S-4	200	150	100	352	–				200	150	100	377	200	150	100	377
	220	FRN220VG7S-4	FRN200VG7S-4	250	150	150	385					250	150	150	415	250	150	150	415
	280	FRN280VG7S-4	FRN220VG7S-4	325	200	150	491					325	250	200	520	325	250	200	520
	315	FRN315VG7S-4	FRN280VG7S-4	400	250	200	552					400	250	200	585	400	250	200	585
	355	FRN355VG7S-4	FRN315VG7S-4	500	325	250	624					500	325	250	650	500	325	250	650
	400	FRN400VG7S-4	FRN355VG7S-4	–	400	250	704					–	400	325	740	–	400	325	740
	500	–	FRN400VG7S-4	–	500	400	880					–				–	–	400	960

* 1) Allowable temperature **60°C** means using **"IV wire"**; **75°C** means **"600V HIV insulation wire"**; and **90°C** means **"600V cross-linking polyethylene insulation wire"**.

- Select an appropriate wire size referring to **Table 8.1** and **Table 8.3.2** if conditions such as ambient temperature or power voltage are different.

Table 8.3.1(2) Wire Size (40°C) (cont'd)

Recommended wire size [mm²]																								
DC link circuit current [P1, P(+)]								Braking circuit [P(+), DB, N(–)]								Control circuit			Auxiliary control power supply [R0, T0]			Grounding [⏚G]		
CT use, HT use				VT use				CT use, HT use				VT use												
Allowable temp. *1)			Current	Allowable temp. *1)			Current	Allowable temp. *1)			Current	Allowable temp. *1)			Current	Allowable temp. *1)			Allowable temp. *1)			Allowable temp. *1)		
60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]	60°C	75°C	90°C	[A]	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
2.0	2.0	2.0	3.8	–				2.0	2.0	2.0	1.4	–				1.25	1.25	1.25	2.0	2.0	2.0	2.0	2.0	2.0
			7.0	2.0	2.0	2.0	7.0				1.9	2.0	2.0	2.0	1.4									
			10				10				2.3				1.9									
			17				17				3.4				2.3									
			24	3.5			24				5.1				3.4									
3.5			33	5.5	3.5		33				6.8				5.1							3.5		
8.0	5.5	3.5	48	8.0	8.0	5.5	48				10.2				6.8							5.5	5.5	3.5
14	8.0	5.5	60	14	14	8.0	66				13.7				10.2							14	8.0	5.5
14	14	8.0	81	22	14	14	81				17.6				13.0							14	14	8.0
22	14	8.0	96	38	22	14	96				20.3				16.4							22	14	14
38	22	22	133	60	38	22	133	3.5	3.5	2.0	30.0				20.3							38	22	14
60	38	22	165	60	38	38	165	5.5	3.5	3.5	35.1	3.5			28.5							60	38	22
100	60	38	200	100	60	38	200	8.0	5.5	3.5	41.1	5.5	3.5		33.2							60	38	38
100	60	60	244	100	100	60	244	14	5.5	5.5	50.8	5.5	3.5	3.5	38.9							100	60	38
–	100	100	333	–	150	100	333	14	14	8.0	68.5	14	5.5	5.5	50.8							– 150	100	60
–	150	100	400	–	150	150	400	22	14	14	83.0	14	8.0	8.0	64.2							200	150	100
–				–	200	150	490	–				22	14	14	78.6							250	150	150
2.0	2.0	2.0	8.7	–				2.0	2.0	2.0	1.7	–				1.25	1.25	1.25	2.0	2.0	2.0	2.0	2.0	2.0
			12	2.0	2.0	2.0	12				2.5	2.0	2.0	2.0	1.7									
			27				17				3.4				2.5									
3.5			24	3.5			24				5.1				3.4									
3.5	3.5		32	5.5	3.5		32				6.8				5.1							3.5		
5.5	5.5	3.5	40	5.5	5.5	3.5	40				8.8				6.5							5.5	3.5	
8.0	5.5	5.5	48	8.0	5.5	5.5	48				10.2				8.2							5.5	5.5	3.5
14	14	8.0	66	14	14	8.0	66				15.0				10.2							14	8.0	5.5
22	14	14	82	22	14	14	82				17.6				14.3							14	14	8.0
22	22	14	99	38	22	14	99				20.5				16.6							22	14	14
38	22	22	122	38	22	22	122	3.5	2.0	2.0	25.2				19.4							38	22	14
60	38	38	164	60	38	38	164	5.5	3.5	3.5	34.6	3.5	2.0	2.0	25.2							60	38	22
60	60	38	196	–	60	38	196	8.0	5.5	3.5	41.6	5.5	3.5	2.0	32.5							60	38	38
100	100	60	240	–	100	60	240	14	5.5	5.5	50.8	5.5	5.5	3.5	39.4							100	60	38
–	100	100	284	–	100	100	284	14	8.0	5.5	61.7	8.0	5.5	5.5	47.6							100	60	60
–	150	100	345	–	150	100	345	22	14	8.0	73.9	14	8.0	5.5	58.2							150	100	100
–	200	150	431	–	200	150	431	22	14	14	92.6	14	14	8.0	70.7							200	150	100
–	200	150	472	–	200	150	472	38	22	14	102	22	14	14	83.2							250	150	150
–	325	200	601	–	325	200	601	60	38	22	138	38	22	14	98.1							325	200	150
–	325	250	676	–	325	250	676	60	38	22	147	38	38	22	125							400	250	200
–	400	325	764	–	400	325	764	60	60	38	175	60	38	22	133							500	325	250
–	500	400	862	–	500	400	862	100	60	38	186	60	38	38	159							–	400	250
–				–	–	500	1078	–				100	60	38	178							–	500	400

8.3.2 Recommended Wire Size Classified by Power Supply Conditions

● IV wire (Maximum allowable temperature : 60°C)

Table 8.3.2(1) Allowable Current of Insulation Wire

Wire size [mm^2]	Allowable current reference value (up to 30°C) Io [A]	Wiring outside duct					Wiring in the duct (Max. 3 wires in one duct)			
		35°C (Iox0.91) [A]	40°C (Iox0.82) [A]	45°C (Iox0.71) [A]	50°C (Iox0.58) [A]	55°C (Iox0.41) [A]	35°C (Iox0.63) [A]	40°C (Iox0.57) [A]	45°C (Iox0.49) [A]	50°C (Iox0.40) [A]
2.0	27	24	22	19	15	11	17	15	13	10
3.5	37	33	30	26	21	15	23	21	18	14
5.5	49	44	40	34	28	20	30	27	24	19
8.0	61	55	50	43	35	25	38	34	29	24
14	88	80	72	62	51	36	55	50	43	35
22	115	104	94	81	66	47	72	65	56	46
38	162	147	132	115	93	66	102	92	79	64
60	217	197	177	154	125	88	136	123	106	86
100	298	271	244	211	172	122	187	169	146	119
150	395	359	323	280	229	161	248	225	193	158
200	469	426	384	332	272	192	295	267	229	187
250	556	505	455	394	322	227	350	316	272	222
325	650	591	533	461	377	266	409	370	318	260
400	745	677	610	528	432	305	469	424	365	298
500	842	766	690	597	488	345	530	479	412	336
2 x 100	497	452	407	352	288	203	313	283	243	198
2 x 150	658	598	539	467	381	269	414	375	322	263
2 x 200	782	711	641	555	453	320	492	445	383	312
2 x 250	927	843	760	658	537	380	584	528	454	370
2 x 325	1083	985	888	768	628	444	682	617	530	433
2 x 400	1242	1130	1018	881	720	509	782	707	608	496
2 x 500	1403	1276	1150	996	813	575	883	799	687	561

● HIV wire (Maximum allowable temperature : 75°C)

Table 8.3.2(2) Allowable Current of Insulation Wire

Wire size [mm^2]	Allowable current reference value (up to 30°C) Iox1.22 [A]	Wiring outside duct					Wiring in the duct (Max. 3 wires in one duct)			
		35°C (Iox1.15) [A]	40°C (Iox1.08) [A]	45°C (Iox1.00) [A]	50°C (Iox0.91) [A]	55°C (Iox0.82) [A]	35°C (Iox0.80) [A]	40°C (Iox0.75) [A]	45°C (Iox0.70) [A]	50°C (Iox0.63) [A]
2.0	32	31	29	27	24	22	21	20	18	17
3.5	45	42	39	37	33	30	29	27	25	23
5.5	59	56	52	49	44	40	39	36	34	30
8.0	74	70	65	61	55	50	48	45	42	38
14	107	101	95	88	80	72	70	66	61	55
22	140	132	124	115	104	94	92	86	80	72
38	197	186	174	162	147	132	129	121	113	102
60	264	249	234	217	197	177	173	162	151	136
100	363	342	321	298	271	244	238	223	208	187
150	481	454	426	395	359	323	316	296	276	248
200	572	539	506	469	426	384	375	351	328	295
250	678	639	600	556	505	455	444	417	389	350
325	793	747	702	650	591	533	520	487	455	409
400	908	856	804	745	677	610	596	558	521	469
500	1027	968	909	842	766	690	673	631	589	530
2 x 100	606	571	536	497	452	407	397	372	347	313
2 x 150	802	756	710	658	598	539	526	493	460	414
2 x 200	954	899	844	782	711	641	625	586	547	492
2 x 250	1130	1066	1001	927	843	760	741	695	648	584
2 x 325	1321	1245	1169	1083	985	888	866	812	758	682
2 x 400	1515	1428	1341	1242	1130	1018	993	931	869	782
2 x 500	1711	1613	1515	1403	1276	1150	1122	1052	982	883

● 600V cross-linking polyethylene insulation wire (Maximum allowable temperature : 90°C)

Table 8.3.2(3) Allowable Current of Insulation Wire

Wire size [mm^2]	Allowable current reference value (up to 30°C) Iox1.41 [A]	Wiring outside duct					Wiring in the duct (Max. 3 wires in one duct)			
		35°C (Iox1.35) [A]	40°C (Iox1.29) [A]	45°C (Iox1.22) [A]	50°C (Iox1.15) [A]	55°C (Iox1.08) [A]	35°C (Iox0.94) [A]	40°C (Iox0.90) [A]	45°C (Iox0.85) [A]	50°C (Iox0.80) [A]
2.0	38	36	34	32	31	29	25	24	22	21
3.5	52	49	47	45	42	39	34	33	31	29
5.5	69	66	63	59	56	52	46	44	41	39
8.0	86	82	78	74	70	65	57	54	51	48
14	124	118	113	107	101	95	82	79	74	70
22	162	155	148	140	132	124	108	103	97	92
38	228	218	208	197	186	174	152	145	137	129
60	305	292	279	264	249	234	203	195	184	173
100	420	402	384	363	342	321	280	268	253	238
150	556	533	509	481	454	426	371	355	335	316
200	661	633	605	572	539	506	440	422	398	375
250	783	750	717	678	639	600	522	500	472	444
325	916	877	838	793	747	702	611	585	552	520
400	1050	1005	961	908	856	804	700	670	633	596
500	1187	1136	1086	1027	968	909	791	757	715	673
2 x 100	700	670	641	606	571	536	467	447	422	397
2 x 150	927	888	848	802	756	710	618	592	559	526
2 x 200	1102	1055	1008	954	899	844	735	703	664	625
2 x 250	1307	1251	1195	1130	1066	1001	871	834	787	741
2 x 325	1527	1462	1397	1321	1245	1169	1018	974	920	866
2 x 400	1751	1676	1602	1515	1428	1341	1167	1117	1055	993
2 x 500	1978	1894	1809	1711	1613	1515	1318	1262	1192	1122

8. Peripheral Equipment

8.4 Braking Unit and Braking Resistor

8.4.1 10%ED

● CT use

Table 8.4.1(1) Braking Unit and Braking Resistor (Standard)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option: Braking unit Type	Option: Braking unit Q'ty	Option: Braking resistor Type	Option: Braking resistor Q'ty	Option: Braking resistor Ohmic value	Maximum braking torque [%]	Maximum braking torque: Torque [N·m] 50Hz	Maximum braking torque: Torque [N·m] 60Hz	Cont. braking (150% torque conversion value): Braking time [s]	Cont. braking (150% torque conversion value): Discharging capability [kWs]	Repetitive braking (100s or less cycle): Duty cycle [%ED]	Repetitive braking (100s or less cycle): Average loss [kW]
	0.75	FRN0.75VG7S-2			DB2.2V-21B	1	30	150	7.16	5.97	10	16.5	10	0.165
	1.5	FRN1.5VG7S-2			DB2.2V-21B	1	30	150	14.3	11.9	10	16.5	10	0.165
	2.2	FRN2.2VG7S-2			DB2.2V-21B	1	30	150	21.0	17.5	10	16.5	10	0.165
	3.7	FRN3.7VG7S-2			DB3.7V-21B	1	24	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG7S-2			DB5.5V-21B	1	16	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG7S-2			DB7.5V-21B	1	12	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG7S-2	–	–	DB11V-21B	1	8.0	150	105	87.5	10	82.5	10	0.825
Three-phase 200V	15	FRN15VG7S-2			DB15V-21B	1	6.0	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG7S-2			DB18.5V-21B	1	4.5	150	177	147	10	139	10	1.39
	22	FRN22VG7S-2			DB22V-21B	1	4.0	150	210	175	10	165	10	1.65
	30	FRN30VG7S-2			DB30V-21B	1	2.5	150	286	239	10	225	10	2.25
	37	FRN37VG7S-2			DB37V-21B	1	2.25	150	353	294	10	278	10	2.78
	45	FRN45VG7S-2			DB45V-21B	1	2.0	150	430	358	10	338	10	3.38
	55	FRN55VG7S-2			DB55V-21C	1	1.6	150	525	438	10	413	10	4.13
	75	FRN75VG7S-2	BU55-2C	2	DB75V-21C	1	1.2	150	716	597	10	563	10	5.63
	90	FRN90VG7S-2	BU90-2C	2	DB90V-21C	1	1.0	150	859	716	10	675	10	6.75
	3.7	FRN3.7VG7S-4			DB3.7V-41B	1	96	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG7S-4			DB5.5V-41B	1	64	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG7S-4			DB7.5V-41B	1	48	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG7S-4			DB11V-41B	1	32	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG7S-4			DB15V-41B	1	24	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG7S-4			DB18.5V-41B	1	18	150	177	147	10	139	10	1.39
	22	FRN22VG7S-4	–	–	DB22V-41B	1	16	150	210	175	10	165	10	1.65
	30	FRN30VG7S-4			DB30V-41B	1	10	150	286	239	10	225	10	2.25
	37	FRN37VG7S-4			DB37V-41B	1	9.0	150	353	294	10	278	10	2.78
	45	FRN45VG7S-4			DB45V-41B	1	8.0	150	430	358	10	338	10	3.38
Three-phase 400V	55	FRN55VG7S-4			DB55V-41C	1	6.5	150	525	438	10	413	10	4.13
	75	FRN75VG7S-4			DB75V-41C	1	4.7	150	716	597	10	563	10	5.63
	90	FRN90VG7S-4			DB90V-41C	1	3.9	150	859	716	10	675	10	6.75
	110	FRN110VG7S-4			DB110V-41C	1	3.2	150	1050	875	10	825	10	8.25
	132	FRN132VG7S-4	BU220-4C	1	DB132V-41C	1	2.6	150	1261	1050	10	990	10	9.90
	160	FRN160VG7S-4	BU220-4C	1	DB160V-41C	1	2.2	150	1528	1273	10	1200	10	12.0
	200	FRN200VG7S-4	BU220-4C	2	DB200V-41C	1	1.75	150	1910	1592	10	1500	10	15.0
	220	FRN220VG7S-4	BU220-4C	2	DB220V-41C	1	1.6	150	2101	1751	10	1650	10	16.5
	280	FRN280VG7S-4	BU220-4C	2	DB160V-41C	2	1.1	150	2674	2228	10	2100	10	21.0
	315	FRN315VG7S-4	BU220-4C	2	DB160V-41C	2	1.1	150	3008	2507	10	2363	10	23.6
	355	FRN355VG7S-4	BU220-4C	3	DB132V-41C	3	0.867	150	3390	2825	10	2663	10	26.6
	400	FRN400VG7S-4	BU220-4C	3	DB132V-41C	3	0.867	150	3820	3183	10	3000	10	30.0

Note 1: Refer to Selection procedure and Notes on Selection.

Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 3: The braking resistor types DB160V-41C to DB220V-41C use two braking resistors when their quantity is described as "1".
(For example, if the quantity of DB160V-41C is "2", four braking resistors are used.)

● VT use

Table 8.4.1(2) Braking Unit and Braking Resistor (Standard)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option					Maximum braking torque [%]	Torque [N·m]		Cont. braking (150% torque conversion value)		Repetitive braking (100s or less cycle)	
			Braking unit		Braking resistor									
			Type	Q'ty	Type	Q'ty	Ohmic value		50Hz	60Hz	Braking time [s]	Discharging capability [kWs]	Duty cycle [%ED]	Average loss [kW]
	1.5	FRN0.75VG7S-2			DB2.2V-21B	1	30	75	7.2	6.0	10	13.9	10	0.165
	2.2	FRN1.5VG7S-2			DB2.2V-21B	1	30	102	14.3	11.9	10	18.9	10	0.165
	3.7	FRN2.2VG7S-2			DB2.2V-21B	1	30	89	21.0	17.5	10	16.5	10	0.165
	5.5	FRN3.7VG7S-2			DB3.7V-21B	1	24	101	35.4	29.5	10	27.8	10	0.278
	7.5	FRN5.5VG7S-2			DB5.5V-21B	1	16	110	52.5	43.8	10	41.3	10	0.413
	11	FRN7.5VG7S-2			DB7.5V-21B	1	12	102	71.4	59.5	10	56.1	10	0.563
	15	FRN11VG7S-2	–	–	DB11V-21B	1	8.0	110	105	87.5	10	82.5	10	0.83
Three-phase 200V	18.5	FRN15VG7S-2			DB15V-21B	1	6.0	110	130	108	10	102	10	1.13
	22	FRN18.5VG7S-2			DB18.5V-21B	1	4.5	110	154	128	10	121	10	1.39
	30	FRN22VG7S-2			DB22V-21B	1	4.0	110	210	175	10	165	10	1.65
	37	FRN30VG7S-2			DB30V-21B	1	2.5	110	259	216	10	204	10	2.25
	45	FRN37VG7S-2			DB37V-21B	1	2.25	110	315	263	10	248	10	2.78
	55	FRN45VG7S-2			DB45V-21B	1	2.0	110	385	321	10	303	10	3.38
	75	FRN55VG7S-2			DB55V-21C	1	1.6	110	525	438	10	413	10	4.13
	90	FRN75VG7S-2	BU55-2C	2	DB75V-21C	1	1.2	110	630	525	10	495	10	5.63
	110	FRN90VG7S-2	BU90-2C	2	DB90V-21C	1	1.0	110	770	642	10	605	10	6.75
	5.5	FRN3.7VG7S-4			DB3.7V-41B	1	96	101	35.4	29.5	10	27.8	10	0.278
	7.5	FRN5.5VG7S-4			DB5.5V-41B	1	64	110	52.5	43.8	10	41.3	10	0.413
	11	FRN7.5VG7S-4			DB7.5V-41B	1	48	102	71.4	59.5	10	56.1	10	0.563
	15	FRN11VG7S-4			DB11V-41B	1	32	110	105	87.5	10	82.5	10	0.825
	18.5	FRN15VG7S-4			DB15V-41B	1	24	110	130	108	10	102	10	1.13
	22	FRN18.5VG7S-4			DB18.5V-41B	1	18	110	154	128	10	121	10	1.39
	30	FRN22VG7S-4	–	–	DB22V-41B	1	16	110	210	175	10	165	10	1.65
	37	FRN30VG7S-4			DB30V-41B	1	10	110	259	216	10	204	10	2.25
	45	FRN37VG7S-4			DB37V-41B	1	9.0	110	315	263	10	248	10	2.78
	55	FRN45VG7S-4			DB45V-41B	1	8.0	110	385	321	10	303	10	3.38
Three-phase 400V	75	FRN55VG7S-4			DB55V-41C	1	6.5	110	525	438	10	413	10	4.13
	90	FRN75VG7S-4			DB75V-41C	1	4.7	110	630	525	10	495	10	5.63
	110	FRN90VG7S-4			DB90V-41C	1	3.9	110	770	642	10	605	10	6.75
	132	FRN110VG7S-4			DB110V-41C	1	3.2	110	924	770	10	726	10	8.25
	160	FRN132VG7S-4	BU220-4C	1	DB132V-41C	1	2.6	110	1120	934	10	880	10	9.9
	200	FRN160VG7S-4	BU220-4C	1	DB160V-41C	1	2.2	110	1401	1167	10	1100	10	12.0
	220	FRN200VG7S-4	BU220-4C	2	DB200V-41C	1	1.75	110	1541	1284	10	1210	10	15.0
	280	FRN220VG7S-4	BU220-4C	2	DB220V-41C	1	1.6	110	1961	1634	10	1540	10	16.5
	315	FRN280VG7S-4	BU220-4C	2	DB160V-41C	2	1.1	110	2206	1838	10	1733	10	21.0
	355	FRN315VG7S-4	BU220-4C	2	DB160V-41C	2	1.1	110	2486	2072	10	1953	10	23.6
	400	FRN355VG7S-4	BU220-4C	3	DB132V-41C	3	0.867	110	2801	2334	10	2200	10	26.6
	500	FRN400VG7S-4	BU220-4C	3	DB132V-41C	3	0.867	110	3501	2918	10	2750	10	30.0

Note 1: Refer to Selection procedure and Notes on Selection.

Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 3: The braking resistor types DB160V-41C to DB220V-41C use two braking resistors when their quantity is described as “1”.
(For example, if the quantity of DB160V-41C is “2”, four braking resistors are used.)

● HT use

Table 8.4.1(3) Braking Unit and Braking Resistor (Standard)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option: Braking unit Type	Option: Braking unit Q'ty	Option: Braking resistor Type	Option: Braking resistor Q'ty	Option: Braking resistor Ohmic value	Maximum braking torque [%]	Torque [N·m] 50Hz	Torque [N·m] 60Hz	Cont. braking (150% torque conversion value) Braking time [s]	Cont. braking (150% torque conversion value) Discharging capability [kWs]	Repetitive braking (100s or less cycle) Duty cycle [%ED]	Repetitive braking (100s or less cycle) Average loss [kW]
Three-phase 200V	3.7	FRN3.7VG7S-2	–	–	DB3.7V-21B	1	24	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG7S-2			DB5.5V-21B	1	16	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG7S-2			DB7.5V-21B	1	12	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG7S-2			DB11V-21B	1	8.0	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG7S-2			DB15V-21B	1	6.0	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG7S-2			DB18.5V-21B	1	4.5	150	177	147	10	139	10	1.39
	22	FRN22VG7S-2			DB22V-21B	1	4.0	150	210	175	10	165	10	1.65
	30	FRN30VG7S-2			DB30V-21B	1	2.5	150	286	239	10	225	10	2.25
	37	FRN37VG7S-2			DB37V-21B	1	2.25	150	353	294	10	278	10	2.78
	45	FRN45VG7S-2			DB45V-21B	1	2.0	150	430	358	10	338	10	3.38
	55	FRN55VG7S-2			DB55V-21C	1	1.6	150	525	438	10	413	10	4.13
Three-phase 400V	3.7	FRN3.7VG7S-4	–	–	DB3.7V-41B	1	96	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG7S-4			DB5.5V-41B	1	64	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG7S-4			DB7.5V-41B	1	48	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG7S-4			DB11V-41B	1	32	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG7S-4			DB15V-41B	1	24	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG7S-4			DB18.5V-41B	1	18	150	177	147	10	139	10	1.39
	22	FRN22VG7S-4			DB22V-41B	1	16	150	210	175	10	165	10	1.65
	30	FRN30VG7S-4			DB30V-41B	1	10	150	286	239	10	225	10	2.25
	37	FRN37VG7S-4			DB37V-41B	1	9.0	150	353	294	10	278	10	2.78
	45	FRN45VG7S-4			DB45V-41B	1	8.0	150	430	358	10	338	10	3.38
	55	FRN55VG7S-4			DB55V-41C	1	6.5	150	525	438	10	413	10	4.13

Note 1: Refer to Selection procedure and Notes on Selection.
Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 3: When the motor speed is reduced to 75%, the maximum braking torque reaches the following rates.
(1) Up to 22kW: 200%, 10s
(2) 30 to 55kW: 170%, 10s

8.4.2 20%ED

● CT use

Table 8.4.2(1) Braking Unit and Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option: Braking unit Type	Option: Braking unit Q'ty	Option: Braking resistor Type	Option: Braking resistor Q'ty	Option: Braking resistor Ohmic value	Maximum braking torque [%]	Torque [N·m] 50Hz	Torque [N·m] 60Hz	Cont. braking (150% torque conversion value) Braking time [s]	Cont. braking (150% torque conversion value) Discharging capability [kWs]	Repetitive braking (100s or less cycle) Duty cycle [%ED]	Repetitive braking (100s or less cycle) Average loss [kW]
Three-phase 200V	0.75	FRN0.75VG7S-2	–	–	DB2.2V-22B	1	32	150	7.16	5.97	20	33.0	20	0.330
	1.5	FRN1.5VG7S-2			DB2.2V-22B	1	32	150	14.3	11.9	20	33.0	20	0.330
	2.2	FRN2.2VG7S-2			DB2.2V-22B	1	32	150	21.0	17.5	20	33.0	20	0.330
	3.7	FRN3.7VG7S-2			DB3.7V-22B	1	24	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG7S-2			DB5.5V-22B	1	16	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG7S-2			DB7.5V-22B	1	12	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG7S-2			DB11V-22B	1	8.0	150	105	87.5	20	165	20	1.65
	15	FRN15VG7S-2			DB15V-22B	1	6.0	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG7S-2			DB18.5V-22B	1	4.5	150	177	147	20	278	20	2.78
	22	FRN22VG7S-2			DB22V-22B	1	4.0	150	210	175	20	330	20	3.30
	30	FRN30VG7S-2			DB30V-22C	1	3.0	150	286	239	20	450	20	4.50
	37	FRN37VG7S-2			DB37V-22C	1	2.4	150	353	294	20	555	20	5.55
	45	FRN45VG7S-2			DB45V-22C	1	2.0	150	430	358	20	675	20	6.75
	55	FRN55VG7S-2			DB55V-22C	1	1.6	150	525	438	20	825	20	8.25
	75	FRN75VG7S-2	BU55-2C	2	DB37V-22C	2	1.2	150	716	597	20	1125	20	11.3
	90	FRN90VG7S-2	BU90-2C	2	DB45V-22C	2	1.0	150	859	716	20	1350	20	13.5
Three-phase 400V	3.7	FRN3.7VG7S-4	–	–	DB3.7V-42B	1	96	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG7S-4			DB5.5V-42B	1	64	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG7S-4			DB7.5V-42B	1	48	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG7S-4			DB11V-42B	1	32	150	105	87.5	20	165	20	1.65
	15	FRN15VG7S-4			DB15V-42B	1	24	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG7S-4			DB18.5V-42B	1	18	150	177	147	20	278	20	2.78
	22	FRN22VG7S-4			DB22V-42B	1	16	150	210	175	20	330	20	3.30
	30	FRN30VG7S-4			DB30V-42C	1	12	150	286	239	20	450	20	4.50
	37	FRN37VG7S-4			DB37V-42C	1	9.0	150	353	294	20	555	20	5.55
	45	FRN45VG7S-4			DB45V-42C	1	8.0	150	430	358	20	675	20	6.75
	55	FRN55VG7S-4			DB55V-42C	1	6.5	150	525	438	20	825	20	8.25
	75	FRN75VG7S-4			DB75V-42C	1	4.7	150	716	597	20	1125	20	11.3
	90	FRN90VG7S-4			DB90V-42C	1	3.9	150	859	716	20	1350	20	13.5
	110	FRN110VG7S-4			DB110V-42C	1	3.2	150	1050	875	20	1650	20	16.5
	132	FRN132VG7S-4	BU220-4C	1	DB132V-42C	1	2.6	150	1261	1050	20	1980	20	19.8
	160	FRN160VG7S-4	BU220-4C	1	DB160V-42C	1	2.2	150	1528	1273	20	2400	20	24.0
	200	FRN200VG7S-4	BU220-4C	2	DB200V-42C	1	1.75	150	1910	1592	20	3000	20	30.0
	220	FRN220VG7S-4	BU220-4C	2	DB220V-42C	1	1.6	150	2101	1751	20	3300	20	33.0
	280	FRN280VG7S-4	BU220-4C	2	DB160V-42C	2	1.1	150	2674	2228	20	4200	20	42.0
	315	FRN315VG7S-4	BU220-4C	2	DB160V-42C	2	1.1	150	3008	2507	20	4725	20	47.3
	355	FRN355VG7S-4	BU220-4C	3	DB132V-42C	3	0.867	150	3390	2825	20	5325	20	53.3
	400	FRN400VG7S-4	BU220-4C	3	DB132V-42C	3	0.867	150	3820	3183	20	6000	20	60.0

Note 1: This option is manufactured on order.
Note 2: The braking unit requires a fan unit (BU-F).
Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 4: The braking resistor types DB200V-42C to DB220V-42C use two braking resistors when their quantity is described as "1".
(For example, if the quantity of DB200V-42C is "2", four braking resistors are used.)

8. Peripheral Equipment

● VT use

Table 8.4.2(2) Braking Unit and Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option: Braking unit Type	Braking unit Q'ty	Braking resistor Type	Braking resistor Q'ty	Ohmic value	Maximum braking torque [%]	Torque [N·m] 50Hz	Torque [N·m] 60Hz	Cont. braking (150% torque conversion value) Braking time [s]	Discharging capability [kWs]	Repetitive braking (100s or less cycle) Duty cycle [%ED]	Average loss [kW]
Three-phase 200V	1.5	FRN0.75VG7S-2	–	–	DB2.2V-22B	1	32	75	7.2	6.0	20	27.8	20	0.330
	2.2	FRN1.5VG7S-2	–	–	DB2.2V-22B	1	32	102	14.3	11.9	20	37.7	20	0.330
	3.7	FRN2.2VG7S-2	–	–	DB2.2V-22B	1	32	89	21.0	17.5	20	32.9	20	0.330
	5.5	FRN3.7VG7S-2	–	–	DB3.7V-22B	1	24	101	35.4	29.5	20	55.6	20	0.555
	7.5	FRN5.5VG7S-2	–	–	DB5.5V-22B	1	16	110	52.5	43.8	20	82.5	20	0.825
	11	FRN7.5VG7S-2	–	–	DB7.5V-22B	1	12	102	71.4	59.5	20	112	20	1.13
	15	FRN11VG7S-2	–	–	DB11V-22B	1	8.0	110	105	87.5	20	165	20	1.65
	18.5	FRN15VG7S-2	–	–	DB15V-22B	1	6.0	110	130	108	20	204	20	2.25
	22	FRN18.5VG7S-2	–	–	DB18.5V-22B	1	4.5	110	154	128	20	242	20	2.78
	30	FRN22VG7S-2	–	–	DB22V-22B	1	4.0	110	210	175	20	330	20	3.30
	37	FRN30VG7S-2	–	–	DB30V-22C	1	3.0	110	259	216	20	407	20	4.50
	45	FRN37VG7S-2	–	–	DB37V-22C	1	2.4	110	315	263	20	495	20	5.55
	55	FRN45VG7S-2	–	–	DB45V-22C	1	2.0	110	385	321	20	605	20	6.75
	75	FRN55VG7S-2	–	–	DB55V-22C	1	1.6	110	525	438	20	825	20	8.25
	90	FRN75VG7S-2	BU55-2C	2	DB37V-22C	2	1.2	110	630	525	20	990	20	11.3
	110	FRN90VG7S-2	BU90-2C	2	DB45V-22C	2	1.0	110	770	642	20	1210	20	13.5
Three-phase 400V	5.5	FRN3.7VG7S-4	–	–	DB3.7V-42B	1	96	101	35.4	29.5	20	55.6	20	0.555
	7.5	FRN5.5VG7S-4	–	–	DB5.5V-42B	1	64	110	52.5	43.8	20	82.5	20	0.825
	11	FRN7.5VG7S-4	–	–	DB7.5V-42B	1	48	102	71.4	59.5	20	112	20	1.13
	15	FRN11VG7S-4	–	–	DB11V-42B	1	32	110	105	87.5	20	165	20	1.65
	18.5	FRN15VG7S-4	–	–	DB15V-42B	1	24	110	130	108	20	204	20	2.25
	22	FRN18.5VG7S-4	–	–	DB18.5V-42B	1	18	110	154	128	20	242	20	2.78
	30	FRN22VG7S-4	–	–	DB22V-42B	1	16	110	210	175	20	330	20	3.30
	37	FRN30VG7S-4	–	–	DB30V-42C	1	12	110	259	216	20	407	20	4.50
	45	FRN37VG7S-4	–	–	DB37V-42C	1	9.0	110	315	263	20	495	20	5.55
	55	FRN45VG7S-4	–	–	DB45V-42C	1	8.0	110	385	321	20	605	20	6.75
	75	FRN55VG7S-4	–	–	DB55V-42C	1	6.5	110	525	438	20	825	20	8.25
	90	FRN75VG7S-4	–	–	DB75V-42C	1	4.7	110	630	525	20	990	20	11.3
	110	FRN90VG7S-4	–	–	DB90V-42C	1	3.9	110	770	642	20	1210	20	13.5
	132	FRN110VG7S-4	–	–	DB110V-42C	1	3.2	110	924	770	20	1452	20	16.5
	160	FRN132VG7S-4	BU220-4C	1	DB132V-42C	1	2.6	110	1120	934	20	1760	20	19.8
	200	FRN160VG7S-4	BU220-4C	1	DB160V-42C	1	2.2	110	1401	1167	20	2200	20	24.0
	220	FRN200VG7S-4	BU220-4C	2	DB200V-42C	1	1.75	110	1541	1284	20	2420	20	30.0
	280	FRN220VG7S-4	BU220-4C	2	DB220V-42C	1	1.6	110	1961	1634	20	3080	20	33.0
	315	FRN280VG7S-4	BU220-4C	2	DB160V-42C	2	1.1	110	2206	1838	20	3465	20	42.0
	355	FRN315VG7S-4	BU220-4C	2	DB160V-42C	2	1.1	110	2486	2072	20	3905	20	47.3
	400	FRN355VG7S-4	BU220-4C	3	DB132V-42C	3	0.867	110	2801	2334	20	4400	20	53.3
	500	FRN400VG7S-4	BU220-4C	3	DB132V-42C	3	0.867	110	3501	2918	20	5500	20	60.0

Note 1: This option is manufactured on order.
Note 2: The braking unit requires a fan unit (BU-F).
Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 4: The braking resistor types DB200V-42C to DB220V-42C use two braking resistors when their quantity is described as “1”.
(For example, if the quantity of DB200V-42C is “2”, four braking resistors are used.)

● HT use

Table 8.4.2(3) Braking Unit and Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor [kW]	Inverter type	Option					Maximum braking torque [%]			Cont. braking (150% torque conversion value)		Repetitive braking (100s or less cycle)	
			Braking unit		Braking resistor				Torque [N·m]		Braking time [s]	Discharging capability [kWs]	Duty cycle [%ED]	Average loss [kW]
			Type	Q'ty	Type	Q'ty	Ohmic value		50Hz	60Hz				
Three-phase 200V	3.7	FRN3.7VG7S-2	–	–	DB3.7V-22B	1	24	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG7S-2			DB5.5V-22B	1	16	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG7S-2			DB7.5V-22B	1	12	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG7S-2			DB11V-22B	1	8.0	150	105	87.5	20	165	20	1.65
	15	FRN15VG7S-2			DB15V-22B	1	6.0	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG7S-2			DB18.5V-22B	1	4.5	150	177	147	20	278	20	2.78
	22	FRN22VG7S-2			DB22V-22B	1	4.0	150	210	175	20	330	20	3.30
	30	FRN30VG7S-2			DB30V-22C	1	3.0	150	286	239	20	450	20	4.50
	37	FRN37VG7S-2			DB37V-22C	1	2.4	150	353	294	20	555	20	5.55
	45	FRN45VG7S-2			DB45V-22C	1	2.0	150	430	358	20	675	20	6.75
	55	FRN55VG7S-2			DB55V-22C	1	1.6	150	525	438	20	825	20	8.25
Three-phase 400V	3.7	FRN3.7VG7S-4	–	–	DB3.7V-42B	1	96	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG7S-4			DB5.5V-42B	1	64	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG7S-4			DB7.5V-42B	1	48	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG7S-4			DB11V-42B	1	32	150	105	87.5	20	165	20	1.65
	15	FRN15VG7S-4			DB15V-42B	1	24	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG7S-4			DB18.5V-42B	1	18	150	177	147	20	278	20	2.78
	22	FRN22VG7S-4			DB22V-42B	1	16	150	210	175	20	330	20	3.30
	30	FRN30VG7S-4			DB30V-42C	1	12	150	286	239	20	450	20	4.50
	37	FRN37VG7S-4			DB37V-42C	1	9.0	150	353	294	20	555	20	5.55
	45	FRN45VG7S-4			DB45V-42C	1	8.0	150	430	358	20	675	20	6.75
	55	FRN55VG7S-4			DB55V-42C	1	6.5	150	525	438	20	825	20	8.25

Note 1: This option is manufactured on order.
Note 2: The braking unit requires a fan unit (BU-F).
Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 4: When the motor speed is reduced to 75%, the maximum braking torque reaches the following rates.
(1) Up to 22kW: 200%, 10s
(2) 30 to 55kW: 170%, 10s

8.4.3 Explanation of %ED

In developing FRENIC5000VG7S series, we changed the definition (calculation method) of %ED value, which is used to measure the braking resistor capacity.
Since the definition applied to VG7 differs from that applied to VG5 series (also all the VG series), be sure to read the following when selecting a braking resistor.

● FRENIC5000VG7S series

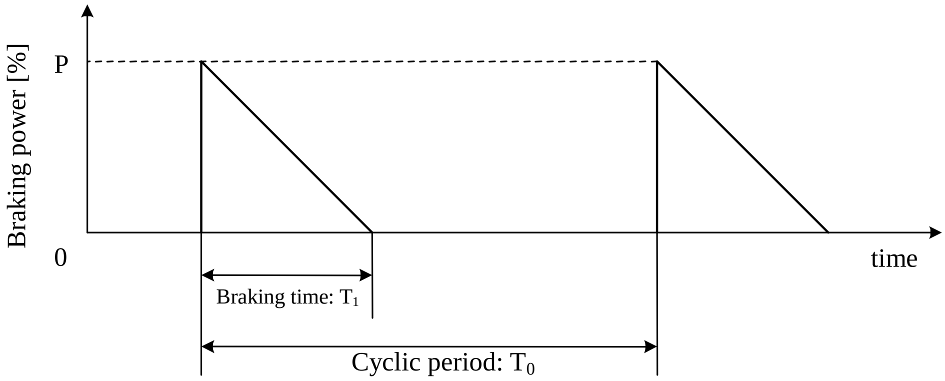


Figure 8.4.3 (a) Definition of %ED (Applied to FRENIC5000VG7S Series)

Duty cycle %ED = $\frac{T_1}{T_0}$ x 100

● FRENIC5000VG5 series

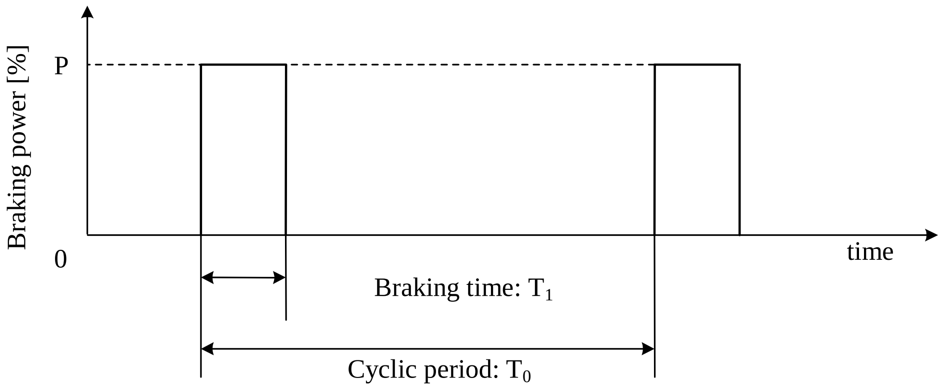


Figure 8.4.3 (b) Definition of %ED (Applied to FRENIC5000VG5 Series)

Duty cycle %ED = $\frac{T_1}{T_0}$ x 100

As illustrated in the above graphs, the duty cycle of FRENIC5000VG7S series is calculated by regarding that the braking power reduces as the time elapses whereas the conventional calculation method is based on the concept that the braking force is constant during braking time. As a result, the duty cycle (%ED) of VG7 has doubled compared with that of VG5 series.
The right table shows the comparison in braking capacity.

Table 8.4.3 Braking Power Comparison Table

Series	FRENIC5000VG7S	FRENIC5000VG5
Braking power	Standard (10%ED)	5%ED
	20%ED	10%ED

We are ready to deliver FRENIC5000VG7S series with a braking capacity of 40%ED, 100%ED, or continuous rating on receiving order.

8.5 Rated Sensitive Current of ELCB

Table 8.5 Rated Sensitive Current of ELCB

Power supply voltage	Nominal applied motor [kW]	Inverter type		Rated current of nominal applied motor [A]	Wiring length and sensitive current					
		CT series, HT series	VT series		10m	30m	50m	100m	200m	300m
Three-phase 200V	0.75	FRN0.75VG7S-2	–	3.6						
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2	6.5						
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2	9.2						
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2	15		30mA				
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	22						
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	29						
	11	FRN11VG7S-2	FRN7.5VG7S-2	42				100mA		
	15	FRN15VG7S-2	FRN11VG7S-2	55						
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	67					200mA	
	22	FRN22VG7S-2	FRN18.5VG7S-2	78						
	30	FRN30VG7S-2	FRN22VG7S-2	107						
	37	FRN37VG7S-2	FRN30VG7S-2	130						
	45	FRN45VG7S-2	FRN37VG7S-2	156						
	55	FRN55VG7S-2	FRN45VG7S-2	198						
	75	FRN75VG7S-2	FRN55VG7S-2	271						500mA
	90	FRN90VG7S-2	FRN75VG7S-2	315						
	110	–	FRN90VG7S-2	383						
Three-phase 400V	3.7	FRN3.7VG7S-4	–	7.5						
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	11						
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4	14.5	30mA					
	11	FRN11VG7S-4	FRN7.5VG7S-4	21						
	15	FRN15VG7S-4	FRN11VG7S-4	27.5						
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	34			100mA			
	22	FRN22VG7S-4	FRN18.5VG7S-4	39						
	30	FRN30VG7S-4	FRN22VG7S-4	54				200mA		
	37	FRN37VG7S-4	FRN30VG7S-4	65						
	45	FRN45VG7S-4	FRN37VG7S-4	78					500mA	
	55	FRN55VG7S-4	FRN45VG7S-4	99						
	75	FRN75VG7S-4	FRN55VG7S-4	135						
	90	FRN90VG7S-4	FRN75VG7S-4	160						
	110	FRN110VG7S-4	FRN90VG7S-4	192						
	132	FRN132VG7S-4	FRN110VG7S-4	226						1000mA
	160	FRN160VG7S-4	FRN132VG7S-4	265						(Special)
	200	FRN200VG7S-4	FRN160VG7S-4	336						
	220	FRN220VG7S-4	FRN200VG7S-4	396						
	280	FRN280VG7S-4	FRN220VG7S-4	500						
	315	FRN315VG7S-4	FRN280VG7S-4							
	355	FRN355VG7S-4	FRN315VG7S-4							
	400	FRN400VG7S-4	FRN355VG7S-4							
	500	–	FRN400VG7S-4							

Note: Rated current of nominal applied motor is based on the value of Fuji standard motor (4 pole, 200V, 50Hz).

8.6 Options

8.6.1 Output Circuit Noise Filter (OFL)

● 400V Series

Table 8.6.1 Output Circuit Noise Filter (OFL)

Power supply voltage	Nominal applied motor [kW]	Inverter type CT use, HT use	Inverter type VT use	Filter type	Rated current [A]	Overload capability	Inverter power input voltage	Carrier frequency allowable range [kHz]	Maximum output frequency [Hz]
Three-phase 400V	3.7	FRN3.7VG7S-4	–	OFL-3.7-4A	9	"150%-1min" "200%-0.5s"	Three-phase 380 to 460[V] 50/60[Hz]	0.75 to 15	400
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	OFL-7.5-4A	18				
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4						
	11	FRN11VG7S-4	FRN7.5VG7S-4	OFL-15-4A	30				
	15	FRN15VG7S-4	FRN11VG7S-4						
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	OFL-22-4A	45				
	22	FRN22VG7S-4	FRN18.5VG7S-4						
	30	FRN30VG7S-4	FRN22VG7S-4	OFL-30-4A	60	"150%-1min" "180%-0.5s"		0.75 to 10	
	37	FRN37VG7S-4	FRN30VG7S-4	OFL-37-4A	75				
	45	FRN45VG7S-4	FRN37VG7S-4	OFL-45-4A	91				
	55	FRN55VG7S-4	FRN45VG7S-4	OFL-55-4A	112				
	75	FRN75VG7S-4	FRN55VG7S-4	OFL-75-4A	150				
	90	FRN90VG7S-4	FRN75VG7S-4	OFL-90-4A	176				
	110	FRN110VG7S-4	FRN90VG7S-4	OFL-110-4A	210				
	132	FRN132VG7S-4	FRN110VG7S-4	OFL-132-4A	253				
	160	FRN160VG7S-4	FRN132VG7S-4	OFL-160-4A	304				
	200	FRN200VG7S-4	FRN160VG7S-4	OFL-200-4A	377				
	220	FRN220VG7S-4	FRN200VG7S-4	OFL-220-4A	415				
	280	FRN280VG7S-4	FRN220VG7S-4	OFL-280-4A	520				
	315	FRN315VG7S-4	FRN280VG7S-4						
	355	FRN355VG7S-4	FRN315VG7S-4						
	400	FRN400VG7S-4	FRN355VG7S-4						
	500	–	FRN400VG7S-4						

8.6.2 EMC Compliance Filter

● 400V series

Table 8.6.2 EMC Compliance Filter (EFL)

Power supply voltage	Nominal applied motor [kW]	Inverter type		Filter			
		CT use, HTuse	VT use	Type	Rated voltage [V]	Rated current [A]	Leakage current [mA]
Three-phase 400V	3.7	FRN3.7VG7S-4	–				
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4				
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4				
	11	FRN11VG7S-4	FRN7.5VG7S-4				
	15	FRN15VG7S-4	FRN11VG7S-4				
	18.5	FRN18.5VG7S-4	FRN15VG7S-4				
	22	FRN22VG7S-4	FRN18.5VG7S-4				
	30	FRN30VG7S-4	FRN22VG7S-4	RF3100-F11	480	100	130
	37	FRN37VG7S-4	FRN30VG7S-4	RF3180-F11		180	
	45	FRN45VG7S-4	FRN37VG7S-4				
	55	FRN55VG7S-4	FRN45VG7S-4				
	75	FRN75VG7S-4	FRN55VG7S-4				
	90	FRN90VG7S-4	FRN75VG7S-4				
	110	FRN110VG7S-4	FRN90VG7S-4	RF3280-F11		280	
	132	FRN132VG7S-4	FRN110VG7S-4				
	160	FRN160VG7S-4	FRN132VG7S-4	RF3400-F11		400	
	200	FRN200VG7S-4	FRN160VG7S-4				
	220	FRN220VG7S-4	FRN200VG7S-4				
	280	FRN280VG7S-4	FRN220VG7S-4	RF3880-F11		880	180
	315	FRN315VG7S-4	FRN280VG7S-4				
	355	FRN355VG7S-4	FRN315VG7S-4				
	400	FRN400VG7S-4	FRN355VG7S-4				
	500	–	FRN400VG7S-4				

8.6.3 DC Reactor (DCR)

• This Reactor is mainly used for normalizing **the power supply or improving power-factor (reducing harmonics)**

Table 8.6.3 DC Reactor (DCR)

Power supply voltage	Nominal applied motor [kW]	Inverter type		DC Reactor (DCR)				
		CT use, HT use	VT use	Type	Rated current [A]	Inductance [mH]	Coil resistance [mΩ]	Generated loss [W]
Three-phase 200V	0.75	FRN0.75VG7S-2	–	DCR2-0.75	5.0	7.0	123	2.8
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2	DCR2-1.5	8.0	4.0	57.5	4.6
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2	DCR2-2.2	11	3.0	43	6.7
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2	DCR2-3.7	18	1.7	21	8.8
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	DCR2-5.5	25	1.2	16	14
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	DCR2-7.5	34	0.8	9.7	16
	11	FRN11VG7S-2	FRN7.5VG7S-2	DCR2-11	50	0.6	7.0	27
	15	FRN15VG7S-2	FRN11VG7S-2	DCR2-15	67	0.4	4.3	27
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	DCR2-18.5	81	0.35	3.1	29
	22	FRN22VG7S-2	FRN18.5VG7S-2	DCR2-22A	98	0.3	2.7	38
	30	FRN30VG7S-2	FRN22VG7S-2	DCR2-30B	136	0.23	1.10	37
	37	FRN37VG7S-2	FRN30VG7S-2	DCR2-37B	167	0.19	0.82	47
	45	FRN45VG7S-2	FRN37VG7S-2	DCR2-45B	203	0.16	0.62	52
	55	FRN55VG7S-2	FRN45VG7S-2	DCR2-55B	244	0.13	0.79	55
	75	FRN75VG7S-2	FRN55VG7S-2	DCR2-75B	341	0.080	0.46	55
	90	FRN90VG7S-2	FRN75VG7S-2	DCR2-90B	410	0.067	0.28	57
	110	–	FRN90VG7S-2	DCR2-110B	526	0.055	0.22	67
Three-phase 400V	3.7	FRN3.7VG7S-4	–	DCR4-3.7	9.0	7.0	74.5	8.1
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	DCR4-5.5	13	4.0	43	10
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4	DCR4-7.5	18	3.5	35.5	15
	11	FRN11VG7S-4	FRN7.5VG7S-4	DCR4-11	25	2.2	23.2	21
	15	FRN15VG7S-4	FRN11VG7S-4	DCR4-15	34	1.8	18.1	28
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	DCR4-18.5	41	1.4	12.1	29
	22	FRN22VG7S-4	FRN18.5VG7S-4	DCR4-22A	49	1.2	10.0	35
	30	FRN30VG7S-4	FRN22VG7S-4	DCR4-30B	71	0.86	4.00	35
	37	FRN37VG7S-4	FRN30VG7S-4	DCR4-37B	88	0.70	2.80	40
	45	FRN45VG7S-4	FRN37VG7S-4	DCR4-45B	107	0.58	1.90	44
	55	FRN55VG7S-4	FRN45VG7S-4	DCR4-55B	131	0.47	1.70	55
	75	FRN75VG7S-4	FRN55VG7S-4	DCR4-75B	178	0.335	1.40	58
	90	FRN90VG7S-4	FRN75VG7S-4	DCR4-90B	214	0.29	1.20	64
	110	FRN110VG7S-4	FRN90VG7S-4	DCR4-110B	261	0.24	0.91	73
	132	FRN132VG7S-4	FRN110VG7S-4	DCR4-132B	313	0.215	0.64	84
	160	FRN160VG7S-4	FRN132VG7S-4	DCR4-160B	380	0.177	0.52	90
	200	FRN200VG7S-4	FRN160VG7S-4	DCR4-200B	475	0.142	0.52	126
	220	FRN220VG7S-4	FRN200VG7S-4	DCR4-220B	524	0.126	0.41	131
	280	FRN280VG7S-4	FRN220VG7S-4	DCR4-280B	649	0.100	0.32	150
	315	FRN315VG7S-4	FRN280VG7S-4	DCR4-315B	739	0.089	0.33	190
	355	FRN355VG7S-4	FRN315VG7S-4	DCR4-355B	833	0.079	0.28	205
	400	FRN400VG7S-4	FRN355VG7S-4	DCR4-400B	938	0.070	0.23	215
	500	–	FRN400VG7S-4	DCR4-500B	1173	0.057	0.20	292

Note: The generated loss is an approximate value calculated by the following conditions:

- Power supply voltage is 200V or 400V, 50Hz. Voltage unbalance is 0(zero)%.
- Power transformer capacity is 500kVA, or 10 times of inverter rated capacity; which is larger one is adopted.
- The load motor is 4 pole standard motor with 100% load.
- No AC Reactor (ACR) is connected.

8.6.4 AC Reactor (ACR)

- This reactor is unnecessary unless an especially stable power supply as DC-bus connection operation (PN-connection operation) is required. Use a DC Reactor (DCR) for reducing harmonics.
- Use this reactor if the power supply voltage fluctuates excessively (for reason such as excessive voltage unbalance between phases).

Table 8.6.4 AC Reactor (ACR)

Power supply voltage	Nominal appplied motor [kW]	Inverter type		AC Reactor (ACR)					
		CT use, HT use	VT use	Type	Rated current [A]	Reactance [mΩ/phase] 50[Hz]	Reactance [mΩ/phase] 60[Hz]	Coil resistance [mΩ]	Generated loss [W]
Three-phase 200V	0.75	FRN0.75VG7S-2	–	ACR2-0.75A	5	493	592	–	12
	1.5	FRN1.5VG7S-2	FRN0.75VG7S-2	ACR2-1.5A	8	295	354		14
	2.2	FRN2.2VG7S-2	FRN1.5VG7S-2	ACR2-2.2A	11	213	256		16
	3.7	FRN3.7VG7S-2	FRN2.2VG7S-2	ACR2-3.7A	17	218	153		23
	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	ACR2-5.5A	25	87.7	105		27
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2	ACR2-7.5A	33	65.0	78.0		30
	11	FRN11VG7S-2	FRN7.5VG7S-2	ACR2-11A	46	45.5	54.7		37
	15	FRN15VG7S-2	FRN11VG7S-2	ACR2-15A	59	34.8	41.8		43
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	ACR2-18.5A	74	28.6	34.3		51
	22	FRN22VG7S-2	FRN18.5VG7S-2	ACR2-22A	87	24.0	28.8		57
	30	FRN30VG7S-2	FRN22VG7S-2	ACR2-37	200	10.8	13.0	0.5	28.6
	37	FRN37VG7S-2	FRN30VG7S-2						40.8
	45	FRN45VG7S-2	FRN37VG7S-2	ACR2-55	270	7.50	9.00	0.375	47.1
	55	FRN55VG7S-2	FRN45VG7S-2						66.1
	75	FRN75VG7S-2	FRN55VG7S-2	ACR2-75	390	5.45	6.54	0.250	55.1
	90	FRN90VG7S-2	FRN75VG7S-2	ACR2-90	450	4.73	5.67	0.198	61.5
	110	–	FRN90VG7S-2	ACR2-110	500	4.25	5.10	0.180	83.4
Three-phase 400V	3.7	FRN3.7VG7S-4	–	ACR4-3.7A	9	512	615	–	17
	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	ACR4-5.5A	13	349	418		22
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4	ACR4-7.5A	18	256	307		27
	11	FRN11VG7S-4	FRN7.5VG7S-4	ACR4-11A	24	183	219		40
	15	FRN15VG7S-4	FRN11VG7S-4	ACR4-15A	30	139	167		46
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	ACR4-18.5A	39	114	137		57
	22	FRN22VG7S-4	FRN18.5VG7S-4	ACR4-22A	45	95.8	115		62
	30	FRN30VG7S-4	FRN22VG7S-4	ACR4-37	100	41.7	50	2.73	38.9
	37	FRN37VG7S-4	FRN30VG7S-4						55.7
	45	FRN45VG7S-4	FRN37VG7S-4	ACR4-55	135	30.8	37	1.61	50.2
	55	FRN55VG7S-4	FRN45VG7S-4						70.7
	75	FRN75VG7S-4	FRN55VG7S-4	ACR4-75 *1	160	25.8	31	1.16	65.3
	90	FRN90VG7S-4	FRN75VG7S-4	ACR4-110	250	16.7	20	0.523	42.2
	110	FRN110VG7S-4	FRN90VG7S-4						60.3
	132	FRN132VG7S-4	FRN110VG7S-4	ACR4-132	270	20.8	25	0.741	119
	160	FRN160VG7S-4	FRN132VG7S-4	ACR4-220 *1	561	10.0	12	0.236	56.4
	200	FRN200VG7S-4	FRN160VG7S-4						90.4
	220	FRN220VG7S-4	FRN200VG7S-4						107
	280	FRN280VG7S-4	FRN220VG7S-4	ACR4-280	825	6.67	8	0.144	108
	315	FRN315VG7S-4	FRN280VG7S-4						
	355	FRN355VG7S-4	FRN315VG7S-4						
	400	FRN400VG7S-4	FRN355VG7S-4						
	500	–	FRN400VG7S-4						

*1) Fan cooling is required (3m/s or over).

*2) The generated loss is an approximate value calculated by the following conditions:

- Power supply voltage is 200V or 400V, 50Hz. Voltage unbalance is 0 (zero)%.
- Power transformer capacity is 500kVA, or 10 times of inverter rated capacity; which is larger one is adopted.
- The load motor is 4 pole standard motor with 100% load.
- The inverters standard-equipped with DC power reactor (DCR) of 75kW or over are indicated as the value with DCR.

8.6.5 Ferrite Ring for Reducing Radio Noise (ACL)

- The applicable wire size depends **on the inner diameter and installation condition** of ferrite ring for reducing radio noise (ACL).

Table 8.6.5 Ferrite Ring for Reducing Radio Noise (ACL)

Type of Ferrite Ring for Reducing Radio Noise	Setting condition		Recommended wire size [mm^2]
	Q'ty [pcs]	No. of turns [time]	
ACL-40B	1	4	2.0
			3.5
			5.5
	2	2	8.0
			14

Type of Ferrite Ring for Reducing Radio Noise	Setting condition		Recommended wire size [mm^2]
	Q'ty [pcs]	No. of turns [time]	
ACL-74B	1	4	8.0
			14
	2	2	22
			38
			60
			5.5×2
			8.0×2
			14×2
			22×2
	4	1	100
			150
			200
			250
			325
			38×2
			60×2
			100×2
			150×2

Note: Selected wire is supposed to be for three-phase.

8.6.6 Power Regenerative PWM Converter (RHC)

- For the actual connection method, refer to the instruction manual for the power regenerative PWM converter (RHC).

Table 8.6.6 Power Regenerative PWM Converter (RHC)

Power supply voltage	Nominal applied motor [kW]	Inverter type		PWM converter main unit type	Exclusive reactor type	Exclusive filter		
		CT use, HT use	VT use			Filter (Reactor type)	Filter (Capacitor type)	Filter (Resistor type)
Three-phase 200V	5.5	FRN5.5VG7S-2	FRN3.7VG7S-2	RHC7.5-2A	LR2-7.5	LFC2-7.5	CF2-7.5	RF2-7.5
	7.5	FRN7.5VG7S-2	FRN5.5VG7S-2					
	11	FRN11VG7S-2	FRN7.5VG7S-2	RHC15-2A	LR2-15	LFC2-15	CF2-15	RF2-15
	15	FRN15VG7S-2	FRN11VG7S-2					
	18.5	FRN18.5VG7S-2	FRN15VG7S-2	RHC22-2A	LR2-22	LFC2-22	CF2-22	RF2-22
	22	FRN22VG7S-2	FRN18.5VG7S-2					
	30	FRN30VG7S-2	FRN22VG7S-2	RHC37-2A	LR2-37L	LFC2-37	CF2-37	GRZG400-1Ω
	37	FRN37VG7S-2	FRN30VG7S-2					
	45	FRN45VG7S-2	FRN37VG7S-2	RHC55-2A	LR2-55L	LFC2-55	CF2-55	GRZG400-0.6Ω
	55	FRN55VG7S-2	FRN45VG7S-2					
	75	FRN75VG7S-2	FRN55VG7S-2	*	*	*	*	*
	90	FRN90VG7S-2	FRN75VG7S-2					
	110	–	FRN90VG7S-2					
Three-phase 400V	5.5	FRN5.5VG7S-4	FRN3.7VG7S-4	RHC7.5-4A	LR4-7.5	LFC4-7.5	CF4-7.5	RF4-7.5
	7.5	FRN7.5VG7S-4	FRN5.5VG7S-4					
	11	FRN11VG7S-4	FRN7.5VG7S-4	RHC15-4A	LR4-15	LFC4-15	CF4-15	RF4-15
	15	FRN15VG7S-4	FRN11VG7S-4					
	18.5	FRN18.5VG7S-4	FRN15VG7S-4	RHC22-4A	LR4-22	LFC4-22	CF4-22	RF4-22
	22	FRN22VG7S-4	FRN18.5VG7S-4					
	30	FRN30VG7S-4	FRN22VG7S-4	RHC37-4A	LR4-37L	LFC4-37	CF4-37	GRZG400-4Ω
	37	FRN37VG7S-4	FRN30VG7S-4					
	45	FRN45VG7S-4	FRN37VG7S-4	RHC55-4A	LR4-55L	LFC4-55	CF4-55	GRZG400-2.4Ω
	55	FRN55VG7S-4	FRN45VG7S-4					
	75	FRN75VG7S-4	FRN55VG7S-4	RHC75-4A	LR4-75L	LFC4-75	CF4-75	RF4-75
	90	FRN90VG7S-4	FRN75VG7S-4	RHC110-4A	LR4-110L	LFC4-110	CF4-110	RF4-110
	110	FRN110VG7S-4	FRN90VG7S-4					
	132	FRN132VG7S-4	FRN110VG7S-4	RHC160-4A	LR4-160L	LFC4-160	CF4-160	RF4-160
	160	FRN160VG7S-4	FRN132VG7S-4					
	200	FRN200VG7S-4	FRN160VG7S-4	RHC220-4A	LR4-220L	LFC4-220	CF4-220	RF4-220
	220	FRN220VG7S-4	FRN200VG7S-4					
	280	FRN280VG7S-4	FRN220VG7S-4	*	*	*	*	*
	315	FRN315VG7S-4	FRN280VG7S-4					
	355	FRN355VG7S-4	FRN315VG7S-4					
	400	FRN400VG7S-4	FRN355VG7S-4					
	500	–	FRN400VG7S-4					

Ask us for the converter data marked with *.

8.6.7 Inverter Generating Loss

Power supply voltage	Inverter type	Inverter generating loss [W]					
		CT use		VT use		HT use	
		Low carrier *1	High carrier *2	Low carrier *1	High carrier *3	Low carrier *1	High carrier *2
Three-phase 200V	FRN0.75VG7S-2	95	110	125	140	–	–
	FRN1.5VG7S-2	125	150	160	180	–	–
	FRN2.2VG7S-2	160	195	250	280	–	–
	FRN3.7VG7S-2	210	280	320	370	180	230
	FRN5.5VG7S-2	310	400	440	510	240	320
	FRN7.5VG7S-2	380	490	560	640	300	390
	FRN11VG7S-2	500	650	700	810	390	520
	FRN15VG7S-2	630	840	780	920	490	670
	FRN18.5VG7S-2	840	1000	1000	1100	710	850
	FRN22VG7S-2	1000	1200	1300	1400	850	1000
	FRN30VG7S-2	1150	1400	1550	1700	950	1150
	FRN37VG7S-2	1400	1750	1800	2050	1150	1450
	FRN45VG7S-2	1700	2050	2100	2350	1450	1800
	FRN55VG7S-2	1950	2400	2800	3100	1750	2150
	FRN75VG7S-2	2750	*4 3100	3350	*5 3500	–	–
	FRN90VG7S-2	3250	*4 3650	3950	*5 4150	–	–
Three-phase 400V	FRN3.7VG7S-4	160	240	210	280	140	210
	FRN5.5VG7S-4	210	330	280	370	180	280
	FRN7.5VG7S-4	270	430	380	500	220	360
	FRN11VG7S-4	330	530	430	590	270	430
	FRN15VG7S-4	420	690	520	710	340	560
	FRN18.5VG7S-4	650	850	700	850	540	730
	FRN22VG7S-4	750	1050	950	1250	650	1000
	FRN30VG7S-4	900	1400	1300	1600	750	1200
	FRN37VG7S-4	1000	1700	1450	1900	850	1450
	FRN45VG7S-4	1150	1950	1700	2200	1000	1650
	FRN55VG7S-4	1400	2300	2050	2700	1150	1900
	FRN75VG7S-4	2000	*4 2800	2650	*5 2950	–	–
	FRN90VG7S-4	2350	*4 3250	2950	*5 3300	–	–
	FRN110VG7S-4	2600	*4 3600	3300	*5 3750	–	–
	FRN132VG7S-4	2950	*4 4150	3900	*5 4450	–	–
	FRN160VG7S-4	3450	*4 4900	4450	*5 5150	–	–
	FRN200VG7S-4	3950	*4 5750	4950	*5 5700	–	–
	FRN220VG7S-4	4400	*4 6350	5800	*5 6700	–	–
	FRN280VG7S-4	5550	*4 8050	6500	*5 7550	–	–
	FRN315VG7S-4	6250	*4 9000	7250	*5 8450	–	–
	FRN355VG7S-4	6950	*4 10200	8250	*5 9550	–	–
	FRN400VG7S-4	7850	*4 11400	10400	*5 12100	–	–

Note: Carrier frequencies are as follows
*1: 2 kHz, *2: 15 kHz, *3: 10 kHz, *4: 10 kHz, *5: 6 kHz

THE INVERTER

IX

Ⅸ. Selecting Inverter Capacity

9. Selecting Inverter Capacity

9.1 Inverter and Motor Selection

9.1.1 Characteristics of Output Torque

Figure 9.1 shows the output torque characteristics. The output torque is classified into the following quadrants by speed and torque-applied direction.

		(Speed)	(Torque)	
• Quadrant I	:	+	+	… Driving in forward rotation
• Quadrant II	:	−	+	… Braking in reverse rotation
• Quadrant III	:	−	−	… Driving in reverse rotation
• Quadrant IV	:	+	−	… Braking in forward rotation

In the figure below, **the speed rate (%) is expressed by regarding the base speed as 100%**, and **the torque rate (%) is expressed by regarding the continuous rated torque as 100%**.

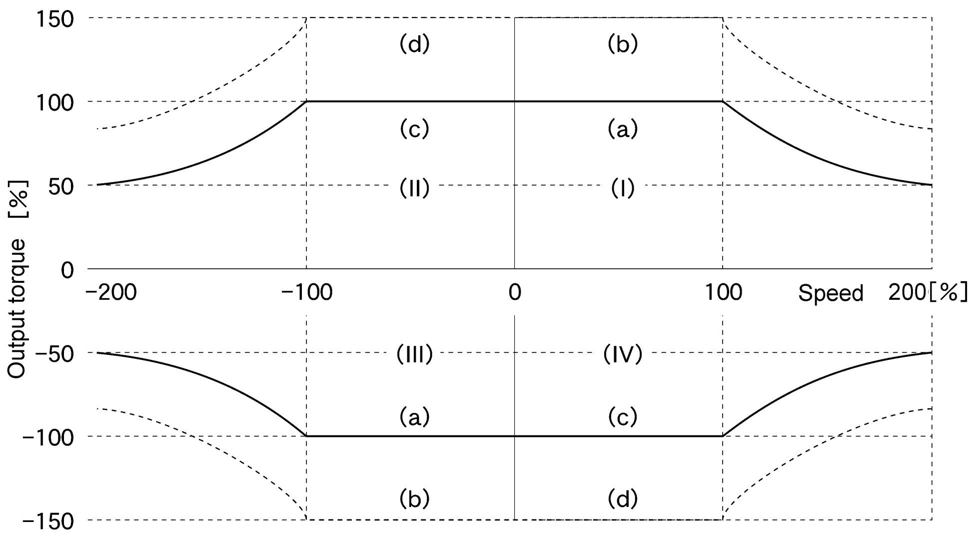


Figure 9-1 Characteristics of the Output Torque (CT Specification)

(1) Allowable continuous driving torque (curve (a) in the 1st and 3rd quadrants)

Curve (a) shows the torque that is available continuously in driving mode.
In the area below the base speed (100%) in the speed control range (0 to 200%), the rated torque is obtained. In the area above the base speed, the constant output is obtained, and the output torque is in inverse to proportion to the speed.
At very low speeds below the speed control range, the allowable torque drops to 80% for less than 0.5Hz converted into inverter output frequency. The motor can be operated continuously considering motor slip in practice.

(2) Max. driving torque in a short-time (curve (b) in the 1st and 3rd quadrants)

Curve (b) shows the torque that is allowed for a short-time (60 seconds) in driving mode.
In general, this torque is 150% of rated torque, and used for acceleration or deceleration.
At very low speeds below the speed control range, due to the restriction of inverter internal temperature, the allowable torque drops to 100% for less than 0.5Hz converted into inverter output frequency.

(3) Starting torque (around speed zero (0) in the 1st and 3rd quadrants)

The starting torque is the torque at speeds around 0 in the 1st and 3rd quadrants.
Although the continuous torque is 80%, the starting torque becomes as high as 150% because the curve passes the very low speed range in quite a short period (30 seconds or less).

(4) Braking torque (the 2nd and 4th quadrants)

The 2nd and 4th quadrants are the braking mode range. Curve (c) shows the braking torque that is available in the continuous rated current range of the inverter; curve (d) is the braking torque that is available for 60-second rated current. In the very low speed range, the torque drops to 80% similar to that in the driving mode.

The time rating of the braking torque is limited by the braking resistor and braking unit capacity, because the energy of the machine system is regenerated.

9.1.2 Selection Procedure

Figure 9-5 shows the general selection procedure for optimal inverter selection. Inverter capacity can be easily selected if there are no limitation regarding acceleration and deceleration time.
The cases such as “Lifting or lowering a load”, “Acceleration and deceleration time is restricted”, or “Highly frequent acceleration and deceleration” make the selection procedure a little bit complex.

(1) Calculation of load torque during constant speed running
(For detailed calculation, see Section 9.1.3.1)
This step is necessary for capacity selection for all loads. Determine the rated torque of the motor during constant speed running higher than that of the load torque, and select a tentative capacity. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load.
To do this, select an appropriate reduction-gear (mechanical transmission) ratio and number of motor poles. If acceleration/deceleration time is not limited and the system is not a lifting machine, capacity selection is completed as it is.

(2) Acceleration time
(For detailed calculation, see Section 9.1.3.2)
When there are specified requirements for the acceleration time, calculate it using the following procedure:

1) Calculate moment of inertia for the load and motor.
Calculate moment of inertia for the load by referring to Section 9.1.3.2. The moment of inertia of motor is shown in Section 2.2.3.
2) Calculate minimum acceleration torque. (See Figure 9-2)
The acceleration torque is the difference between motor short time output torque (60s rating) explained in Section 9.1.1(2) and load torque (τ_L/η_G) during constant speed running calculated in the above (1). Calculate minimum acceleration torque for the whole range of speed.
3) Calculate the acceleration time.
Assign the value calculated above to the expression (3.15) in Section 9.1.3.2 to calculate the acceleration time.
If the calculated acceleration time is longer than the requested time, select one size larger capacity inverter and motor and calculate it again.

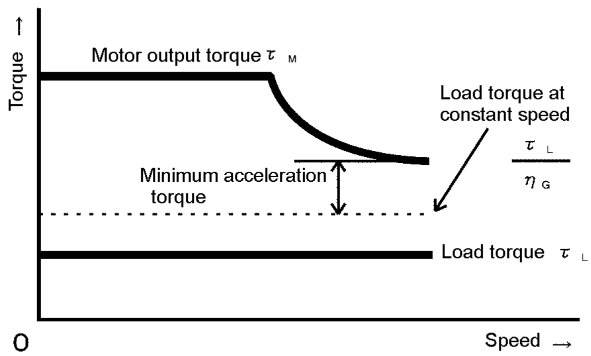


Figure 9-2 Example Study of Minimum Acceleration

(3) Deceleration time

(For detailed calculation, see Section 9.1.3.2)

To calculate the deceleration time, check the motor deceleration torque characteristics for the whole range of speed in the same way as for the acceleration time.

1) Calculate moment of inertia for the load and motor.
   * Same as for acceleration time.
2) Calculate minimum deceleration torque. (See Figure 9-3)
   * Same as for acceleration time.
3) Calculate the deceleration time.
   Assign the value calculated above to the expression (3.16) in Section 9.1.3.2 to calculate the deceleration time.
   If the calculated deceleration time is longer than the requested time, select one size larger capacity and calculate it again.

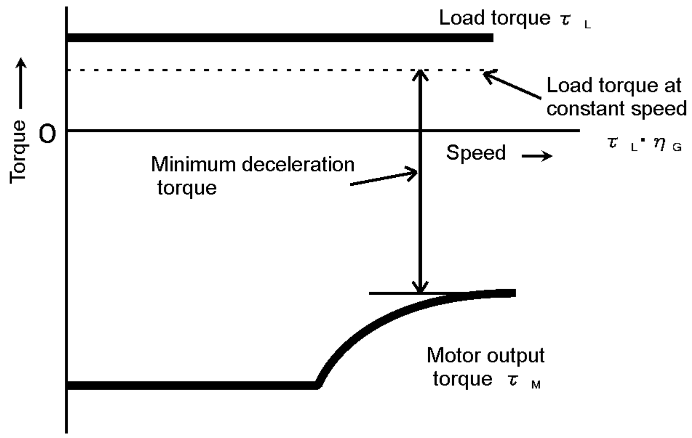


Figure 9-3 Example Study of Minimum Deceleration Torque (1)

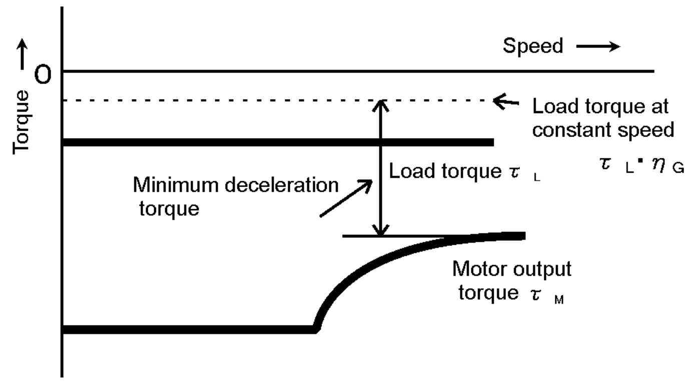


Figure 9-4 Example Study of Minimum Deceleration Torque (2)

However, note that minimum deceleration torque becomes smaller due to regenerative operation when lifting or lowering a load. (See Figure 9-4)

9. Selecting Inverter Capacity

(4) Braking resistor rating
(For detailed calculation, see Section 9.1.3.3)
Braking resistor rating is divided into two types according to the braking periodic duty cycle:

1) When periodic duty cycle is 100s or less:
 - Calculate average loss to determine rated values.

2) When periodic duty cycle is 100s or more:
 - Allowable braking energy depends on maximum braking power.
   The actual value for the maximum braking energy is indicated by the characteristics curve.

(5) Motor RMS current
(For detailed calculation, see Section 9.1.3.4)
In metal processing machine and carriage machinery requiring positioning control, highly frequent running with short time rating is performed. In this case, calculate an equivalent RMS current value not to exceed the allowable value for the motor.

(6) Notes for examining inverter capacity

- When selecting an inverter for driving a Fiji's inverter-dedicated motor, ensure that the root mean square of the motor torque is lower than the inverter rated torque (80% of the rated torque for HT use).
- When selecting a general-purpose motor, ensure that the root mean square of the motor current is lower than the motor rated current for effective motor cooling. In this case, select an inverter so that the root mean square of the current is lower than the inverter rated current (80% of the rated current for HT use).

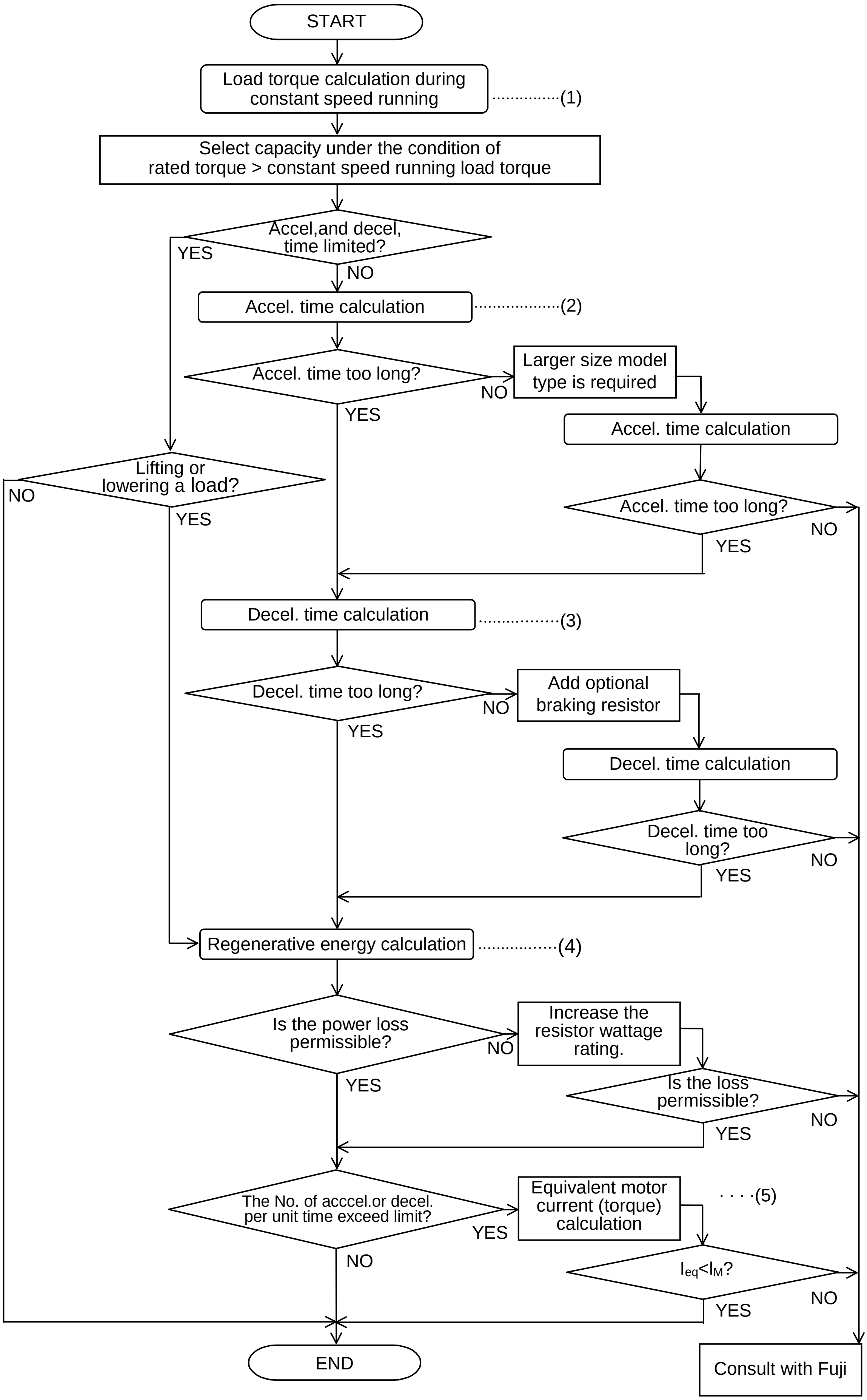


Figure 9-5 Selection Procedure

9.1.3 Calculations for Selecting Capacity

9.1.3.1 Load Torque during Constant Speed Running

(1) General expression

The frictional force acting on a horizontally moved load must be calculated. For loads lifted or lowered vertically or along a slope, the gravity acting on the load must be calculated. Calculation for driving a load along a straight line with the motor is shown below.

Where the force to move a load linearly at constant speed 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:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{F}{\eta_G} \text{ [N·m]} \quad \cdots\cdots (3.1)$$

Where, η_G: Reduction-gear efficiency

When the motor is in braking mode, efficiency works inversely, so the required motor torque should be calculated as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot F \cdot \eta_G \text{ [N·m]} \quad \cdots\cdots (3.2)$$

$(60\ \upsilon)/(2\ \pi \cdot N_M)$ in the above expression is an equivalent rotation radius corresponding to speed υ around the motor shaft.

The value F in the above expressions changes according to the load type.

(2) Moving a load horizontally

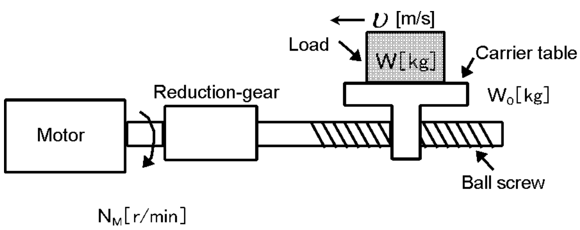


Figure 9-6 Moving a Load Horizontally

As shown in Figure 9-6, where the carrier table weight is W_0 [kg], load is W [kg], and friction coefficient of the ball screw is μ, friction force F [N] is expressed as follows:

$$F = (W_o + W) \cdot g \cdot \mu \text{ [N]} \quad \cdots\cdots (3.3)$$

Where, g : Gravity acceleration ($\approx$ 9.8 m/s^2)

Then, required driving torque around the motor shaft is expressed as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{(W_o + W) \cdot g \cdot \mu}{\eta_G} \text{ [N·m]} \quad \cdots\cdots (3.4)$$

(3) Moving a load vertically

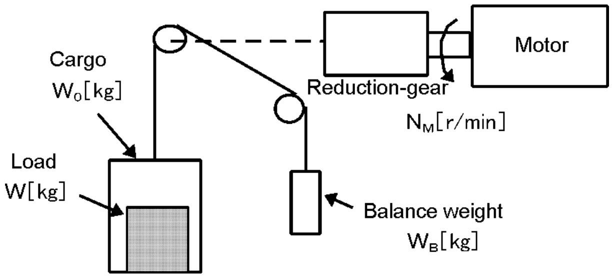


Figure 9-7 Moving a Load

As shown in Figure 9-7, where a cage weight, load weight, and balance-mass weight are W_0, W, and W_B [kg], the force of gravity F [N] is as follows:

(Lifting)

$$F = (W_O + W - W_B)\cdot g \text{ [N]} \quad \cdots\cdots (3.5)$$

(Lowering)

$$F = (W_B + W - W_O)\cdot g \text{ [N]} \quad \cdots\cdots (3.6)$$

Where maximum load is W_{max}, generally W_B equals to $(W_o + W_{max}) / 2$. So, F may become a negative force to brake both lifting and lowering movements depending on the load weight.
Calculate the required torque τ around the motor shaft in the driving mode by expression (3.1) and that in the braking mode by expression (3.2). That is, if F is positive, use expression (3.1); if it is negative, use expression (3.2).

(4) Moving a load along a slope

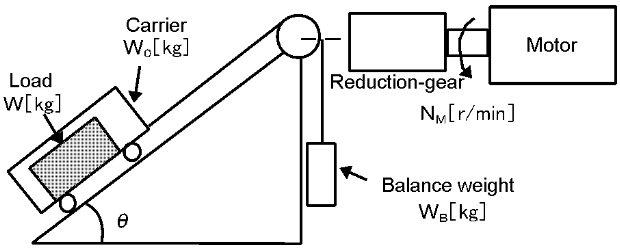


Figure 9-8 Moving a Load Along a Slope

Lifting and lowering a load along a slope may seem to be like lifting and lowering a load vertically, but friction force between the load and the slope cannot be ignored. Therefore, the expression for lifting a load is a little different from that for lowering a load. Where slope angle is θ and friction coefficient is μ, as shown in Figure 9-8, driving force F [N] is as follows:

(Lifting)

$$F = (W_O + W)\ (\sin\theta + \mu\cdot\cos\theta) - W_B\cdot g \text{ [N]} \quad \cdots\cdots (3.7)$$

(Lowering)

$$F = (W_B - (W_O + W)\ (\sin\theta + \mu\cdot\cos\theta)\cdot g \text{ [N]} \quad \cdots\cdots (3.8)$$

The force of gravity F may become a negative force to brake both lifting and lowering movements, depending on the load weight. This is the same as for vertical lifting and lowering. Required torque around the motor shaft can be also calculated similarly.
That is, when F is positive, use expression (3.1); when it is negative, use expression (3.2).

9.1.3.2 Acceleration and Deceleration Time Calculation

When an object whose moment of inertia is J [kg·m^2] rotates at the speed N [r/min], it has the following kinetic energy:

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N}{60}\right)^2 \quad [J] \quad \cdots\cdots (3.9)$$

To accelerate the above rotation, kinetic energy will be increased; to decelerate, kinetic energy must be dis-charged.
The torque required for acceleration and deceleration can be expressed as follows:

$$\tau = J \cdot \frac{2\pi}{60} \left(\frac{dN}{dt}\right) \quad [N \cdot m] \quad \cdots\cdots (3.10)$$

In this way, the mechanical moment of inertia is an important element in acceleration and deceleration. First, calculation method of moment of inertia is described, then that for acceleration and deceleration time are explained.

(1) Calculation of moment of inertia

For an object that rotates around the rotation axis, vertually divide the object into small segments and square the distance from the rotation axis to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia.

Moment of inertia $J = \Sigma (W_i \cdot r_i^2) \quad [kg \cdot m^2] \quad \cdots\cdots (3.11)$

1) Hollow cylinder and solid cylinder

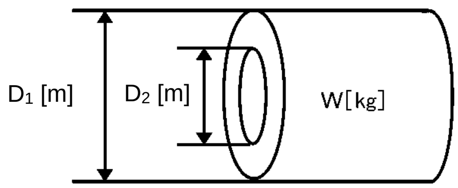


Figure 9-9 Hollow

The common shape of a rotating body is hollow cylinder. The moment of inertia J [J] around the hollow cylinder center axis can be calculated as follows, where the outer and inner diameters are D_1 and D_2 [m] and total weight is W [kg] in Figure 9-9.

$$J = \frac{W \cdot (D_1^2 + D_2^2)}{60} \quad [J] \quad \cdots\cdots (3.12)$$

For a similar shape, a solid cylinder, calculate the moment of inertia as D_2 is 0.

2) For a general rotating body

Table 9-1 lists the calculation expressions of moment of inertia of various rotating bodies including the above cylindrical rotating body.

3) For a load running horizontally

As shown in Figure 9-6, a carrier table can be driven by a motor. If the table speed is υ [m/s] when the motor rotation speed is N_M [r/min], an equivalent distance from the rotation axis is $60\,\upsilon/(2\pi \cdot N_M)$ [m]. Then, the moment of inertia of table and load to the rotation axis is calculated as follows:

$$J = \left(\frac{60\upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_O + W) \quad [kg \cdot m^2] \quad \cdots\cdots (3.13)$$

4) For lifting and lowering load

As shown in Figures 9-7 and 9-8, two loads tied with the rope move in different directions. The moment of inertia can be calculated by obtaining the sum of the moving objects weight as follows:

$$J = \left(\frac{60\upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_O + W + W_B) \quad [kg \cdot m^2] \quad \cdots\cdots (3.14)$$

(2) Calculation of the acceleration time

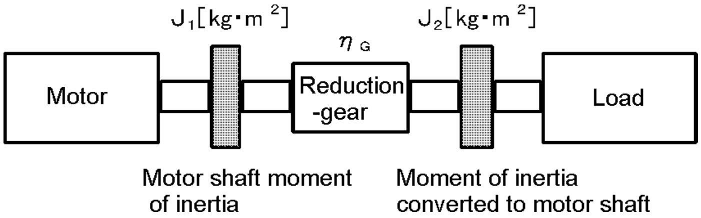


Figure 9-10 Load Model Including Reduction-gear

Figure 9-10 shows a general load model. Here, the load is tied via a reduction-gear with efficiency η_G. The time required to accelerate this load to a speed of N_M [r/min] is calculated with the following expression:

$$t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M - \tau_L / \eta_G} \cdot \frac{2\pi \cdot (N_M - 0)}{60} \quad [s] \quad \cdots\cdots (3.15)$$

Where,

J_1 : Motor shaft moment of inertia [kg·m^2]
J_2 : Load shaft moment of inertia converted to motor shaft [kg·m^2]
τ_M : Minimum motor output torque in driving mode [N·m]
τ_L : Maximum load torque converted to motor shaft [N·m]
η_G : Reduction-gear efficiency

As clarified in the above expression, equivalent moment of inertia becomes (J_1+J_2/η_G) considering the reduction gear efficiency.

(3) Calculation of the deceleration time

In Figure 9-10, the time required to stop the motor rotating at a speed of N_M [r/min] is calculated with the following expression:

$$t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot (0 - N_M)}{60} \quad [s] \quad \cdots\cdots (3.16)$$

Where,

J_1 : Motor shaft moment of inertia [kg·m^2]
J_2 : Load shaft moment of inertia converted to motor shaft [kg·m^2]
τ_M : Minimum motor output torque in braking (deceleration) mode [N·m]
τ_L : Maximum load torque converted to motor shaft [N·m]
η_G : Reduction-gear efficiency

In the above expression, generally output torque τ_M is negative and load torque τ_L is positive. So, deceleration time becomes shorter. However, in a lifted and lowered load, τ_L may become a negative value in braking mode. In this case, the deceleration time becomes longer.

* For lifting or lowering load
In inverter and motor capacity selection for lifted and lowered load, the deceleration time must be calculated by using the maximum value that makes the load torque negative.

(4) Non-linear (S-curve) accel./decel. time

For loads that are frequently accelerated and decelerated, it is often necessary to minimize the accel. and decel. time by using accel. and decel. torques. Vector control inverters are ideal for such operations.

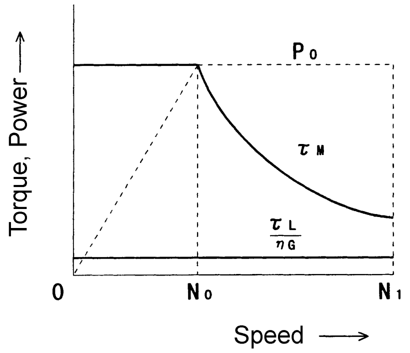


Figure 9-11 Sample of Driving Device which Includes the Constant Power Characteristic

In this operation, the accel. and decel. characteristic becomes non-linear, so the time required to accel. or decel. cannot be expressed by a simple formula.

Therefore, in general, the method employed divides speed N into small sections (ΔN) to calculate the partial accel./decel. time and sums these until accel. or decel. ends.
The smaller the divisions, the higher the calculation accuracy.
The above figure shows a sample torque-speed characteristic of a driving system: the curve shows a constant-torque in the range below N_0 and constant-output in the range from N_0 to N_1.
The accel. time is expressed as follows:

$$\Delta t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M + \tau_L / \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad [s] \quad \cdots\cdots (3.17)$$

Obtaining in advance the moment of inertia of the motor shaft (J_1) and of the load shaft (after conversion into motor shaft) (J_2) and load torque τ_L (after conversion into motor shaft) as well as the efficiency of the reduction speed device (η_G), the maximum motor torque (τ_M) is calculated using one of the following formulas depending on the speed range:

- τ_M when $N \leq N_0$: constant-torque range

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N_O} \quad [N \cdot m] \quad \cdots\cdots (3.18)$$

- τ_M when $N_0 \leq N \leq N_1$: constant-output range (torque is inversely proportional to speed)

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N} \quad [N \cdot m] \quad \cdots\cdots (3.19)$$

If the result of the above calculation differs from the expected result, select a drive system by one frame larger.

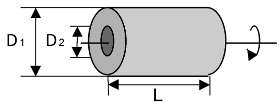
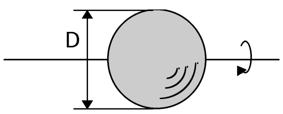
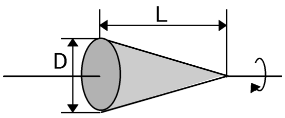
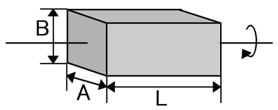
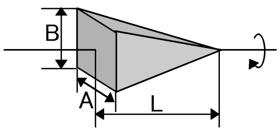
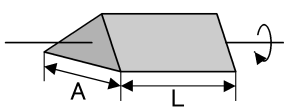
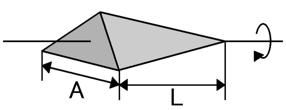
(5) Calculation for nonlinear decelerating time

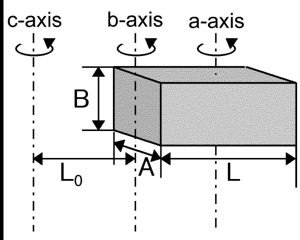
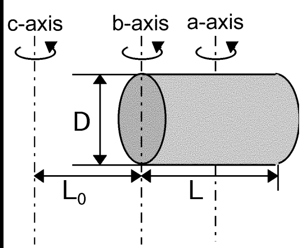
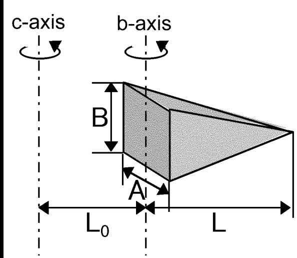
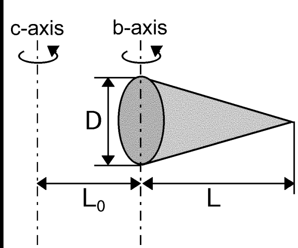
Decelerating time can be calculated by the same formula as used for calculating accelerating time.

$$\Delta t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad [s] \quad \cdots\cdots (3.20)$$

In this formula, because both τ_M and Δ_N are negative value, load torque τ_L generally promotes deceleration. However, lift load has a mode in which τ_L becomes negative. In this mode, the polarity differs between τ_M and τ_L, which blocks deceleration.

Table 9.1 Moment of Inertia of Various Rotating Bodies

Shape	Mass: W [kg] / Moment of inertia: J [kg·m²]
Hollow cylinder 	$W = \frac{\pi}{4} \cdot (D_1^2 - D_2^2) \cdot L \cdot \rho$ $J = \frac{1}{8} \cdot W \cdot (D_1^2 + D_2^2)$
Sphere 	$W = \frac{\pi}{6} \cdot D^3 \cdot \rho$ $J = \frac{1}{10} \cdot W \cdot D^2$
Cone 	$W = \frac{\pi}{12} \cdot D^2 \cdot L \cdot \rho$ $J = \frac{3}{40} \cdot W \cdot D^2$
Rectangular prism 	$W = A \cdot B \cdot L \cdot \rho$ $J = \frac{1}{12} \cdot W \cdot (A^2 + B^2)$
Square cone (pyramid, rectangular base) 	$W = \frac{1}{3} \cdot A \cdot B \cdot L \cdot \rho$ $J = \frac{1}{20} \cdot W \cdot (A^2 + B^2)$
Triangular prism 	$W = \frac{\sqrt{3}}{4} \cdot A^2 \cdot L \cdot \rho$ $J = \frac{1}{3} \cdot W \cdot A^2$
Triangle cone (tetrahedron with equilateral triangular base) 	$W = \frac{\sqrt{3}}{12} \cdot A^2 \cdot L \cdot \rho$ $J = \frac{1}{5} \cdot W \cdot A^2$

Shape	Mass: W [kg] / Moment of inertia: J [kg·m²]
	$W = A \cdot B \cdot L \cdot \rho$ $J_a = \frac{1}{12} \cdot W \cdot (L^2 + A^2)$ $J_b = \frac{1}{12} \cdot W \cdot (L^2 + \frac{1}{4} \cdot A^2)$ $J_c \approx W \cdot (L_0^2 + L_0 \cdot L + \frac{1}{3} \cdot L^2)$
	$W = \frac{\pi}{4} \cdot D^2 \cdot L \cdot \rho$ $J_a = \frac{1}{12} \cdot W \cdot (L^2 + \frac{3}{4} \cdot D^2)$ $J_b = \frac{1}{3} \cdot W \cdot (L^2 + \frac{3}{16} \cdot D^2)$ $J_c \approx W \cdot (L_0^2 + L_0 \cdot L + \frac{1}{3} \cdot L^2)$
	$W = \frac{1}{3} \cdot A \cdot B \cdot L \cdot \rho$ $J_b = \frac{1}{10} \cdot W \cdot (L^2 + \frac{1}{4} \cdot A^2)$ $J_c \approx W \cdot (L_0^2 + \frac{3}{2} \cdot L_0 \cdot L + \frac{3}{5} \cdot L^2)$
	$W = \frac{\pi}{12} \cdot D^2 \cdot L \cdot \rho$ $J_b = \frac{1}{10} \cdot W \cdot (L^2 + \frac{3}{8} \cdot D^2)$ $J_c \approx W \cdot (L_0^2 + \frac{3}{2} \cdot L_0 \cdot L + \frac{3}{5} \cdot L^2)$

Main metal density (at 20°C) ρ[kg/m³]
Carbon steel: 7860, Stainless steel: 7910, Aluminum: 2700

9.1.3.3 Heat Energy Calculation of Braking Resistor

Braking by an inverter causes mechanical energy to be regenerated in the inverter circuit.
This regenerative energy is often discharged to the resistor. In this section, braking resistor rating is explained.

(1) Calculation of regenerative energy

Regenerative energy generated in the inverter operation consists of kinetic energy of a moving object and its potential energy.

1) Kinetic energy of a moving object

When an object with moment of inertia J [kg· m^2] rotates at a speed N_2 [r/min], its kinetic energy is as follows:

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N_2}{60}\right)^2 \ [J] \quad \cdots\cdots (3.21)$$

$$\approx \frac{1}{182.4} \cdot J \cdot N_2^2 \ [J] \quad \cdots\cdots (3.21)'$$

The output energy when this object is decelerated to a speed N_1 [r/min] is as follows:

$$E = \frac{J}{2} \cdot \left[\left(\frac{2\pi \cdot N_2}{60}\right)^2 - \left(\frac{2\pi \cdot N_1}{60}\right)^2\right] \ [J] \quad \cdots\cdots (3.22)$$

$$\approx \frac{1}{182.4} \cdot J \cdot (N_2^2 - N_2^2) \ [J] \quad \cdots\cdots (3.22)'$$

The energy regenerated to the inverter as shown in Figure 9-10 is calculated by considering the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E \approx \frac{1}{182.4} \cdot (J_1 + J_2 \cdot \eta_G) \cdot \eta_M \cdot (N_2^2 - N_1^2) \ [J] \quad \cdots\cdots (3.23)$$

2) Potential energy of an object

When an object of W [kg] is lowered from height h_2 [m] to h_1 [m], the output potential energy is expressed as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \ [J] \quad \cdots\cdots (3.24)$$

Where, $g \approx 9.8065$ [m/s^2]

Regenerative energy to the inverter circuit is calculated by considering the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \cdot \eta_G \cdot \eta_M \ [J] \quad \cdots\cdots (3.25)$$

(2) Braking power loss

The allowable loss changes with the periodic duty cycle T [s] of braking and power limit during braking.

1) When T ≤ 100 [s]

- Average loss is calculated to select capacity.
- From braking energy E [J] per cycle and T, average power loss P_R [kW] is calculated using the following formula:

$$P_R = \frac{E}{T} \times 10^3 \quad [\mathrm{kW}] \qquad \cdots\cdots (3.26)$$

Select the capacity such that the above P_R[kW] does not over the continuous rating of the braking resistor.

- The details of the continuous rating of the braking resistor[kW] is mentioned in the “option” edition. This rating can be calculated by the following formula.

$$\text{Allowable power loss [kW]} = \frac{\text{Rated\%ED}(*) \times 1.5}{100} \times \text{Rated output of motor [kW]} \cdots (3.27)$$

(*)For the braking resistor with 5%ED, an average power loss equivalent to 7.5% the motor rating is allowed; for the braking resistor with 10%ED, an average power loss equivalent to 15% the moter rating is allowed.

- For braking resistors, two types of rated %ED are available: 5%ED and 10%ED. For rated %ED greater than 10%, consult with Fuji.

2) When T > 100 [s]

Permissible braking energy can be obtained with Figure 9-12.

<1> When 150% of braking power is required.

Rated %ED of resistor	5	10
Permissible braking energy [%·s]	750	1500

<2> In the following conditions, the permissible braking energy can be obtained by the graph:

- Conditions: Resistor with 5%ED, 300s duty cycle, 150% braking power
- Braking energy:
  From duty cycle 300s, braking energy is 1750%·s
  From braking power 150%, braking energy is 750%·s

according to this result, 750%·s of braking energy is permissible value.

<3> In the following conditions, the permissible braking energy can be obtained by the graph:

- Conditions: Resistor with 5%ED, 300s duty cycle, 40% braking power
- Braking energy:
  From duty cycle 300s, braking energy is 1750%·s
  From braking power 40%, braking energy is 2000%·s

according to this result, 1750%·s of braking energy is permissible value.

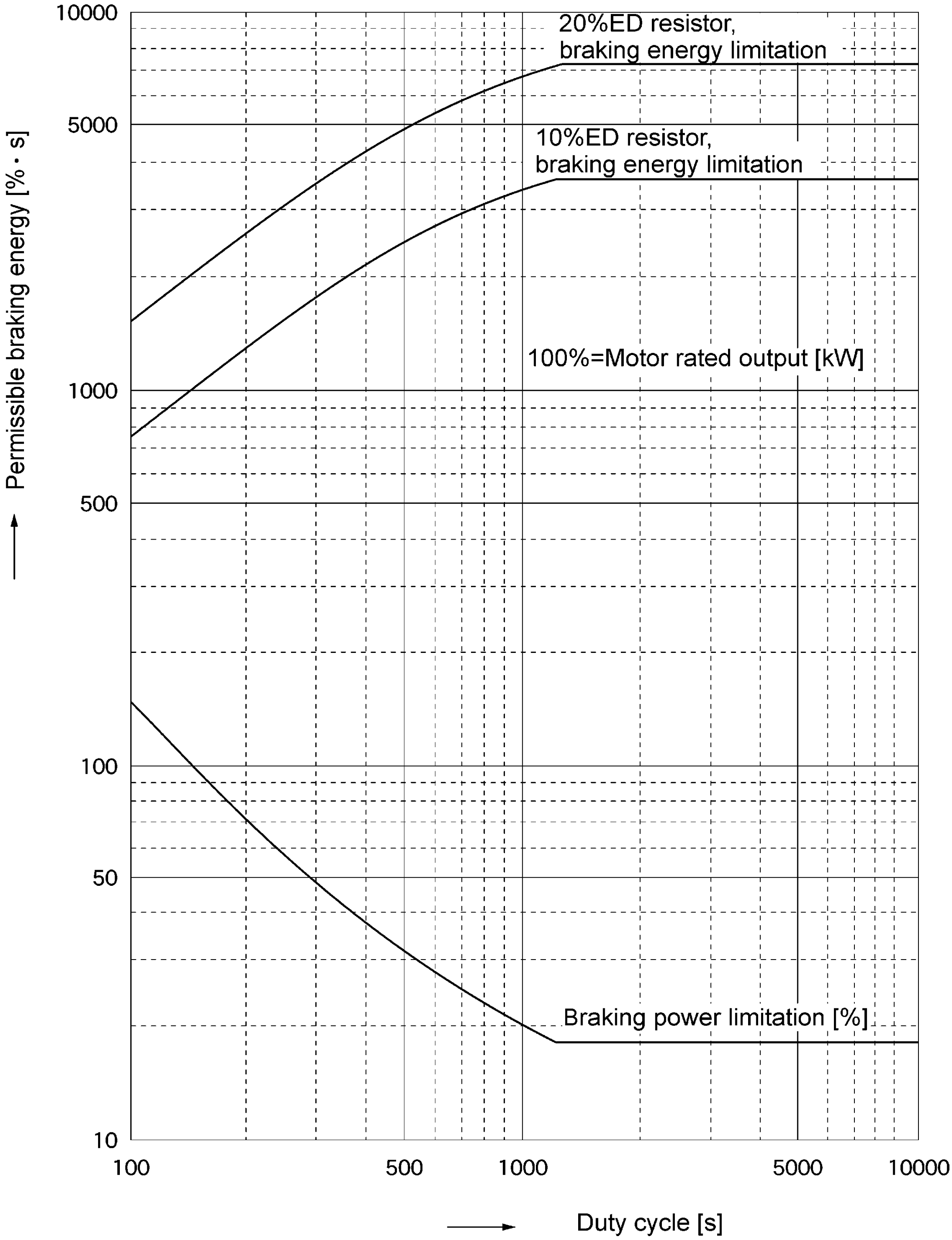


Figure 9-12 Permissible Braking Energy

9.1.3.4 Calculating RMS Rating of Motor

In case of the load which repeats the operation very frequently, the load current fluctuates largely and enters into the short-time rating range of the motor repeatedly. It is, therefore, required to review the thermal allowable value. The exothermicity is approximately considered to be in proportion to the square of the load current. In case of the dedicated motor of VG7S which utilizes the forced cooling fan method, the temperature will increase in proportion to the exothermicity itself.
When the operation is repeated in such an interval as to be short enough compared with the thermal time constant of the motor, calculate the "equivalent RMS current" as mentioned below, and select the unit such that this RMS current does not over the rated current of the motor.

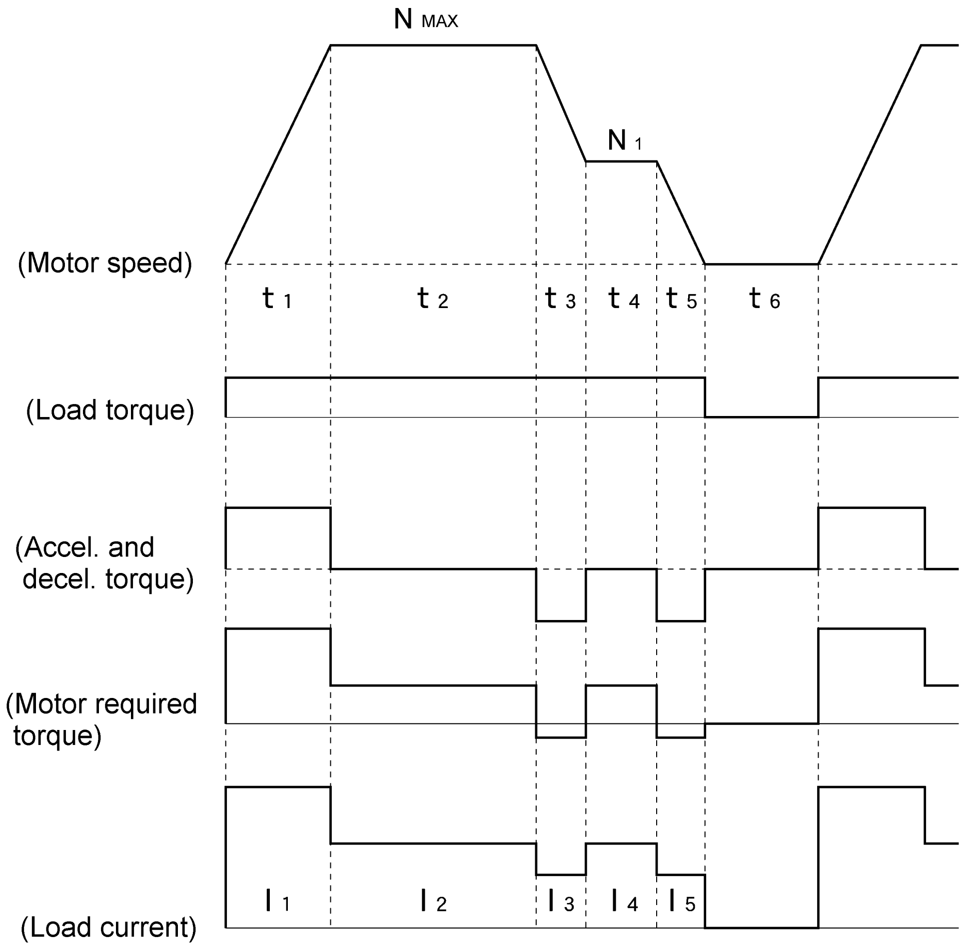


Figure 9-13 Sample of the Repetitive Operation

Firstly, calculate the required torque of each part based on the speed pattern. Then using the torque-current curve of motor, convert this torque to the pattern of the load current. The "equivalent RMS current, I eq" can be finally calculated by the following formula.

$$I_{eq} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1 + t_2 + t_3 + t_4 + t_5 + t_6}} \text{ [A]} \quad \cdots\cdots \text{(3.28)}$$

The torque-current curve for the dedicated motor is not available for actual calculation. So, calculate the load current I from the load torque τ_1 using the following formula (3.29). Then, calculates the equivalent current Ieq.

$$I = \sqrt{\left(\frac{\tau_1}{100} \times It_{100}\right)^2 + Im_{100}^{\;2}} \text{ [A]} \quad \cdots\cdots \text{(3.29)}$$

Here, τ_1: load torque [%], It_{100} = torque current (P09; M1 torque current), Im_{100} = (exciting current) (P08; M1 exciting current)

- For the function code data of P08 and P09, refer to Chapter 14 Replacement data.
- When using the second motor, refer to the torque current and exciting current of A code instead of those of P code.

9.1.3.5 Appendix (Calculation for Other than in Sl Unit)

All the expressions in this document are based on SI units (International System of Units). In this section, how to convert expressions to other units is explained.

(1) Conversion of unit

1) Force

1 [kgf] ≈ 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

$GD^2 = 4J$

$$J = \frac{GD^2}{4}$$

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]

(2) Calculation formula

1) Torque, power and rotation speed

$$P\ [\text{W}] \approx \frac{2\pi}{60} \cdot N\ [\text{r/min}] \cdot \tau\ [\text{N} \cdot \text{m}]$$

$$P\ [\text{W}] \approx 1.026 \cdot N\ [\text{r/min}] \approx T\ [\text{kgf} \cdot \text{m}]$$

$$\tau\ [\text{N} \cdot \text{m}] \approx 9.55 \cdot \frac{P\ [\text{W}]}{N\ [\text{r/min}]}$$

$$T\ [\text{kgf} \cdot \text{m}] \approx 0.974 \cdot \frac{P\ [\text{W}]}{N\ [\text{r/min}]}$$

2) Kinetic energy

$$E\ [\text{J}] \approx \frac{1}{182.4} \cdot J\ [\text{kg} \cdot \text{m}^2] \cdot N^2\ [(\text{r/min})^2]$$

$$E\ [\text{J}] \approx \frac{1}{730} \cdot GD^2\ [\text{kg} \cdot \text{m}^2] \cdot N^2\ [(\text{r/min})^2]$$

3) Torque of linear moving load

[Driving mode]

$$\tau\ [\text{N} \cdot \text{m}] \approx 0.159 \frac{V\ [\text{m/min}]}{N_M\ [\text{r/min}] \cdot \eta_G} \cdot F\ [\text{N}]$$

$$T\ [\text{kgf} \cdot \text{m}] \approx 0.159 \frac{V\ [\text{m/min}]}{N_M\ [\text{r/min}] \cdot \eta_G} \cdot F\ [\text{kgf}]$$

[Braking mode]

$$\tau\ [\text{N} \cdot \text{m}] \approx 0.159 \frac{V\ [\text{m/min}]}{N_M\ [\text{r/min}] \cdot \eta_G} \cdot F\ [\text{N}]$$

$$T\ [\text{kgf} \cdot \text{m}] \approx 0.159 \frac{V\ [\text{m/min}]}{N_M\ [\text{r/min}] \cdot \eta_G} \cdot F\ [\text{kgf}]$$

4) Acceleration torque

[Driving mode]

$$\tau\ [\text{N} \cdot \text{m}] \approx \frac{J\ [\text{kg} \cdot \text{m}^2]}{9.55} \cdot \frac{\Delta N\ [\text{r/min}] \cdot \eta_G}{\Delta t\ [\text{s}]}$$

$$T\ [\text{kgf} \cdot \text{m}] \approx \frac{GD^2\ [\text{kg} \cdot \text{m}^2]}{375} \cdot \frac{\Delta N\ [\text{r/min}] \cdot \eta_G}{\Delta t\ [\text{s}]}$$

[Braking mode]

$$\tau\ [\text{N} \cdot \text{m}] \approx \frac{J\ [\text{kg} \cdot \text{m}^2]}{9.55} \cdot \frac{\Delta N\ [\text{r/min}] \cdot \eta_G}{\Delta t\ [\text{s}]}$$

$$T\ [\text{kgf} \cdot \text{m}] \approx \frac{GD^2\ [\text{kg} \cdot \text{m}^2]}{375} \cdot \frac{\Delta N\ [\text{r/min}] \cdot \eta_G}{\Delta t\ [\text{s}]}$$

5) Acceleration time

$$t_{ACC}\ [\text{s}]\ \frac{J_1 + J_2/\eta_G\ [\text{kg} \cdot \text{m}^2]}{\tau_M - \tau_L/\eta_G\ [\text{N} \cdot \text{m}^2]} \cdot \frac{\Delta N\ [\text{r/min}]}{9.55}$$

$$t_{ACC}\ [\text{s}]\ \frac{GD_1^2 + GD_2^2/\eta_G\ [\text{kg} \cdot \text{m}^2]}{T_M - T_L/\eta_G\ [\text{kgf} \cdot \text{m}]} \cdot \frac{\Delta N\ [\text{r/min}]}{375}$$

6) Deceleration time

$$t_{DEC}\ [\text{s}]\ \frac{J_1 + J_2 \cdot \eta_G\ [\text{kg} \cdot \text{m}^2]}{\tau_M - \tau_L \cdot \eta_G\ [\text{N} \cdot \text{m}^2]} \cdot \frac{\Delta N\ [\text{r/min}]}{9.55}$$

$$t_{DEC}\ [\text{s}]\ \frac{GD_1^2 + GD_2^2/\eta_G\ [\text{kg} \cdot \text{m}^2]}{T_M - T_L/\eta_G\ [\text{kgf} \cdot \text{m}]} \cdot \frac{\Delta N\ [\text{r/min}]}{375}$$

9.2 Braking Unit and Braking Resistor Selection

9.2.1 Selection Procedure

- The following three requirements must be satisfied simultaneously:

(1) Maximum braking torque must not exceed values listed in Tables 8.4.1(1) to 8.4.5(2)in Chapter 8.
To use maximum braking torque exceeding values in the above tables, select one size larger capacity braking unit and resistor.

(2) Discharge energy for a single braking action must not exceed discharging capability [kWs] listed in the Tables 8.4.1 (1) to 8.4.5 (2) in Chapter 8.
For detailed calculation, see Section 9.1.3.3 Heat energy calculation of braking resistor.

(3) Average loss obtained by dividing discharge energy by cyclic period must not exceed the average loss [kW] listed in the Table.

The selecting conditions depend on the periodic duty cycle as described follows:

1) If the periodic duty cycle is 100s or shorter, the above conditions 1) and 3) must be satisfied.
2) If the periodic duty cycle is longer than 100s, the above conditions 1) and 2) must be satisfied.

9.2.2 Notes on Selection

- Braking time and duty cycle (%ED) are converted under deceleration braking conditions based on the rated torque as shown below. However, these value need not be considered when selecting braking unit and resistor capacity.

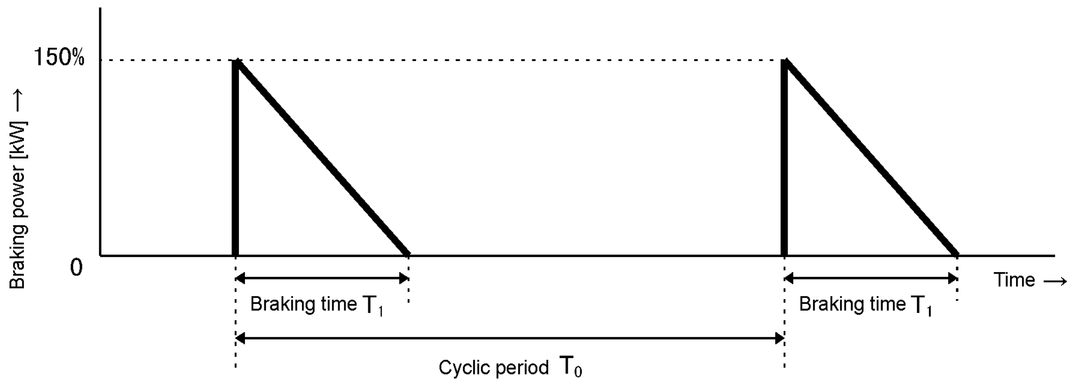


Figure 9-14 Duty Cycle

$$\text{Duty cycle (\%ED)} = \frac{T_1}{T_0} \times 100$$

- MEMO -

Ⅹ. About Motors

10. About Motors

10.1 Vibration and Noise

* Please refer to the “2-2-3 Dedicated Motor Specifications” for the specifications and the external dimensions of the dedicated motors.

Dedicated applicable motor [kW]	No. of poles	Motor type	Vibration level [µm]		Noise level [dB] *3)	
		MVK__A-C	At base speed 1500[r/min]	At max. speed *2) 3600[r/min]	At base speed 1500[r/min]	At max. speed 3600[r/min]
0.75		6096				
1.5		6097			56	60
2.2		6107				
3.7		6115			58	62
5.5		6133		less than 7	60	64
7.5		6135	less than 5			
11		6165			68	72
15		6167				
18.5		6184				73
22		6185			71	
30	4	6206		less than 7		73
37		6207				
45		9221 (6208)	*1) (less than 5)	less than 15 *2) (less than 7 *2))	*1) (71)	88 (73)
55		9250				
75		9252				
90		9280				
110		9282	*1)	less than 15	*1)	88
132		9310				
160		9312				
200		9316				
220		9318				

*1) Please contact Fuji for the individual figures.

*2) The maximum speed (max. speed) for 30 to 37[kW] is 3000[r/min], for 45 to 75[kW], 2400[r/min], and for 90 to 220[kW] max. speed is 2000[r/min].

*3) This noise level was measured at the point which is 1[m] away to the direction of the terminal box from the motor.

10.2 Acceleration Vibration Value

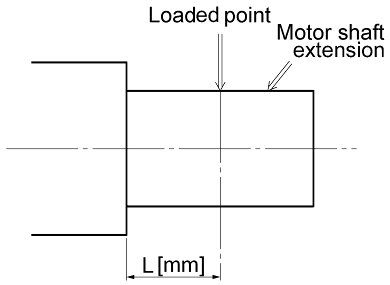
Dedicated applicable motor [kw]	No.of poles	Motor type MVK__A-C	Acceleration vibration value, acceptable [m/s^2]
0.75	4	6096	less than 6.4
1.5		6097	
2.2		6107	
3.7		6115	
5.5		6133	
7.5		6135	
11		6165	
15		6167	
18.5		6184	
22		6185	
30		6206	
37		6207	
45		9221 (6208)	less than 1.0 (less than 6.4)
55		9250	less than 1.0
75		9252	
90		9280	
110		9282	
132		9310	less than 6.4
160		9312	
200		9316	
220		9318	

Note: If the actual vibration is over the figure on this table, other countermeasure is required.

10. About Motors

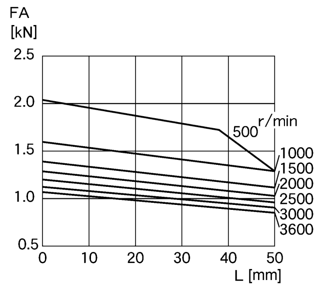
10.3 Allowable Radial Load at Motor Shaft Extension

[Loaded point]

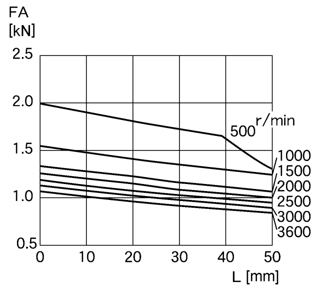


The maximum allowable value of radial load applied by the belt is shown in the figures below. The data is classified by the frame number and the rotation speed.
If the point which is decided by the radial load FA[kN] acting on the motor shaft and the length L[mm] from the stepped joint at shaft end to the center of the pulley (the distance to the FA load points) is within a curve, the motor can be operated by that pulley.
Please refer to the technical leaflet of the induction motor for the details.

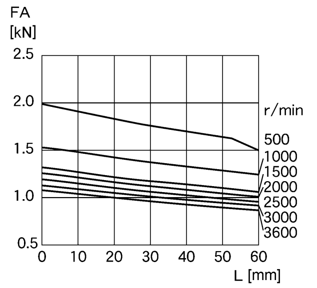
Frame number 90L MVK6096A−C[0.75kW]



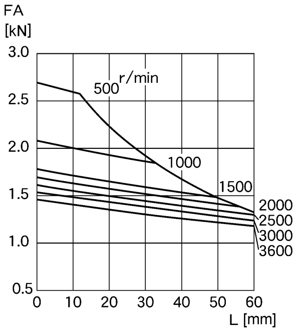
Frame number 90L MVK6097A−C[1.5kW]



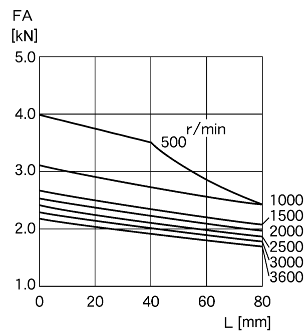
Frame number 100L MVK6107A−C[2.2kW]



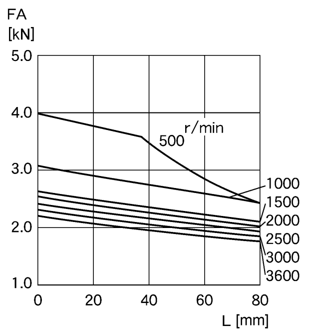
Frame number 112M MVK6115A−C[3.7kW]



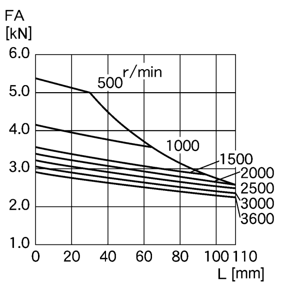
Frame number 132S MVK6133A−C[5.5kW]



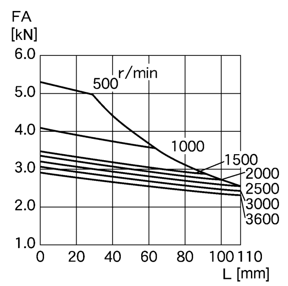
Frame number 132M MVK6135A−C[7.5kW]



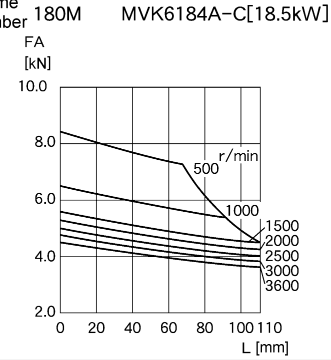
Frame number 160M MVK6165A−C[11kW]

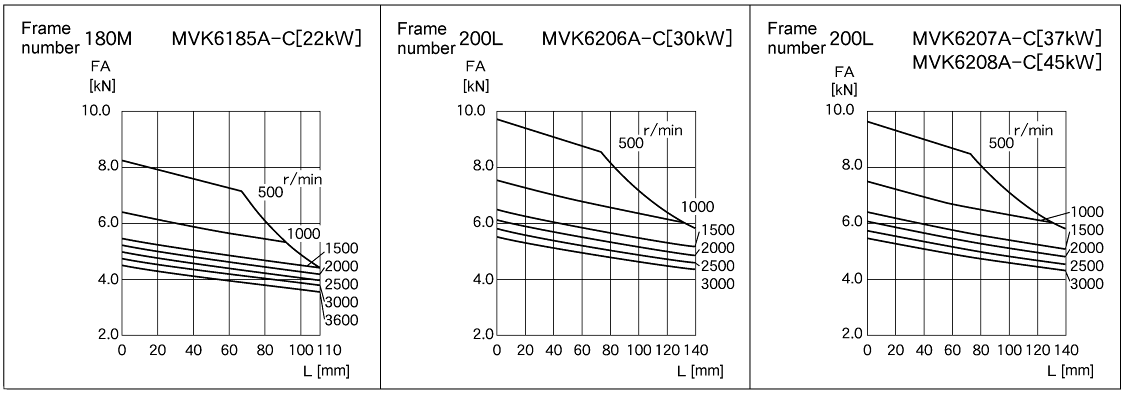


Frame number 160L MVK6167A−C[15kW]



Frame number 180M MVK6184A−C[18.5kW]



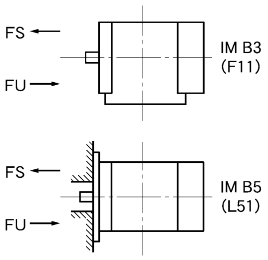
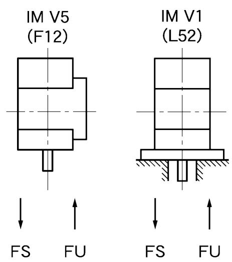
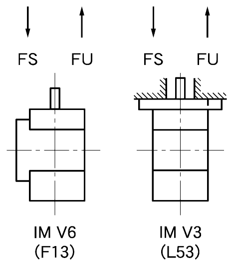


Note: Please contact Fuji individually for the motors whose frame number is over 200L (more than 55kW).

10. About Motors

10.4 Allowable Thrust Load

(Unit:k·N)

Frame number	Type MVK__A-C	Horizontal use IM B3(F11), IM B5(L51)						Vertical use IM V5(F12), IM V1(L52)						Vertical use IM V6(F13), IM V3(L53)					
		Direction of thrust: FS			Direction of thrust: FU			Direction of thrust: FS			Direction of thrust: FU			Direction of thrust: FS			Direction of thrust: FU		
		2 Poles	4 Poles	6 Poles	2 Poles	4 Poles	6 Poles	2 Poles	4 Poles	6 Poles	2 Poles	4 Poles	6 Poles	2 Poles	4 Poles	6 Poles	2 Poles	4 Poles	6 Poles
90L	6096 6097	0.3	0.45	0.55	0.4	0.6	0.7	0.25	0.4	0.5	0.45	0.65	0.75	0.4	0.55	0.65	0.3	0.5	0.6
100L	6107	–	0.65	0.8	–	0.55	0.65	–	0.6	0.7	–	0.6	0.6	–	0.5	0.6	–	0.75	0.85
112M	6115	0.65	0.9	1.1	0.6	0.75	0.95	0.6	0.8	1	0.65	0.85	1	0.55	0.7	0.85	0.75	1	1.2
132S	6133	1	1.4	1.7	0.75	1	1.2	1	1.3	1.7	0.9	1.1	1.4	0.65	0.9	1.1	1.2	1.5	1.9
132M	6135	–			–			–		1.6	–			–		1	–		
160M	6165	1.3	1.8	2.2	1.2	1.5	1.9	1.1	1.6	2	1.5	1.8	2.2	1	1.4	1.7	1.6	2.1	2.5
160L	6167		1.7	2.1			1.8		1.5	1.8					1.3	1.5			
180M	6184 6185	2	2.7	3.3	1.9	2.3	2.8	1.8	2.3	2.9	2.2	2.7	3.4	1.6	2	2.6	2.4	3.2	3.9
200L	6206 6207	1.9	3.8	4.5	2	3.2	3.7	1.5	3.2	3.8	2.6	4	4.8		2.7	3	2.5	4.6	5.6
225S (200L)	9221 (6208)	1.2	5.4	6.5	1.2	5.4	6.5	0.4	4.4	5.3	2.3	6.9	8.2	0.4	4.4	5.3	2.3	6.9	8.2
250S	9250	1.1	5.2	6.2	1.1	5.2	6.2	0.3	4.1	4.8				0.3	4.1	4.8			
250M	9252	1	6.4	7.6	1	6.4	7.6	–	4.9	5.6	–	8.4	10.3	–	4.9	5.6	–	8.4	10.3
280S	9280	0.9	6.2	7.3	0.9	6.2	7.3	–	4.5	5.1	–	8.5	10.4	–	4.5	5.1	–	8.5	10.4
280M	9282	0.8	5.9	6.9	0.8	5.9	6.9	–	3.7	4.2	–	9.2	10.8	–	3.7	4.2	–	9.2	10.8
315S	9310	0.7	5.7	6.7	0.7	5.7	6.7	–	3.1	3.8	–	9.3	10.9	–	3.1	3.8	–	9.3	10.9
315M	9312 9316	* Contact Fuji individually						* Contact Fuji individually						* Contact Fuji individually					
–	9318																		
Mounting method and the direction of thrust																			

Note 1: The above-mentioned figures whose frame number are more than 250S are the allowable thrust (axial) load of the motor for direct connection

Note 2: The above-mentioned allowable thrust (axial) load is calculated on the assumption that the motor would bear the radial load through the normal sized half-coupling.

Note 3: For the motor with shielded type ball bearing, if the thrust load to the anti-driving direction is bigger than the pre-load spring pressure on the anti-driving side, the runout of shaft end shown in the following table will occur on the anti-driving side.

Frame number		90L, 100L	112M	132S, 132M	160M, 160L	180M to 225S	250S to 315M
Preload [N]		166	235	294	343	568	*Contact Fuji individually.
Runout of shaft end [mm]	*Std	0.6			1.2		
	Max.	1.4			2.0		

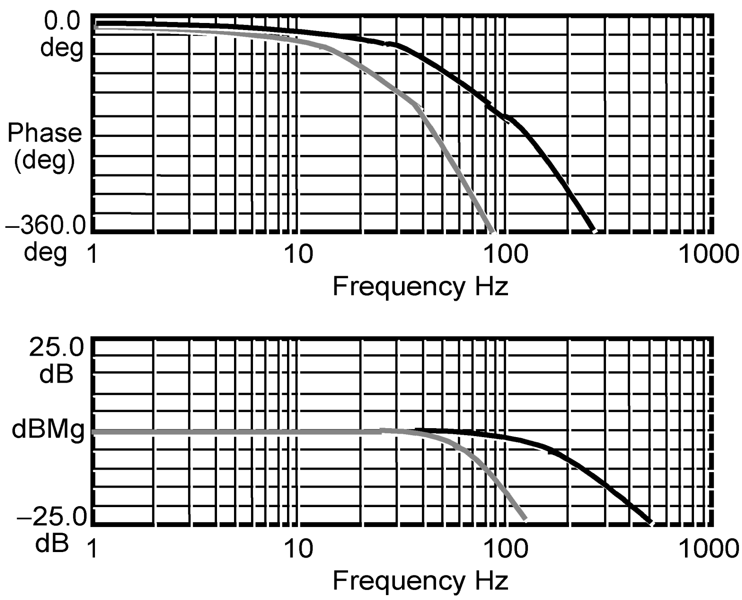
*Std.: Standard

XI

XI. Operation Data

11. Operation Data

11.1 Frequency Response Characteristics

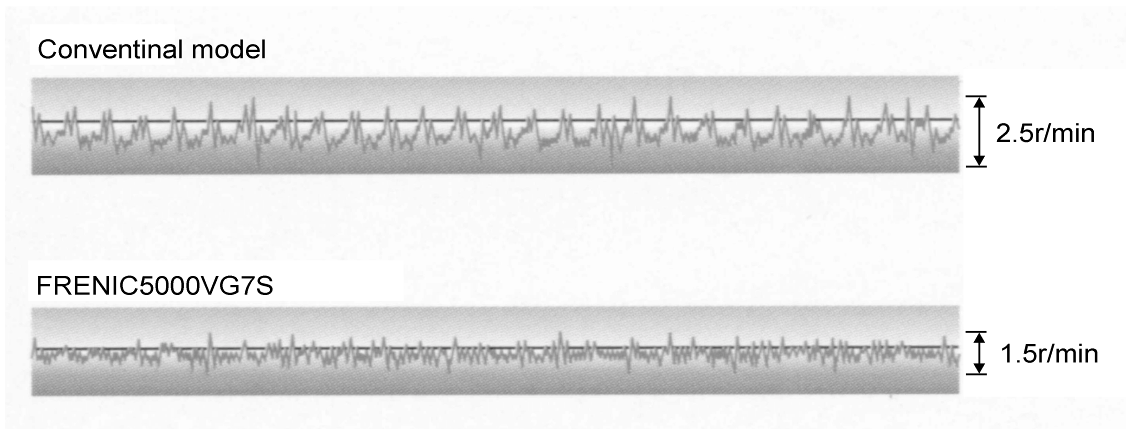


FRN37VG7S–4
VG7S : 105Hz, –3dB
VG5 (conventional model) : 54Hz, –3dB

- Because of the improvement of the frequency response,
  1) The motor wow was reduced to approximately 60% of the conventional one.
  2) Follow-up characteristics at the time of load fluctuation improved.
  3) Position synchronizing accuracy improved.
  4) Step response characteristics of speed improved.

Inverter	; FRN37VG7S-4
Motor	; MVK6207A-C, 37kW, 1500/3600r/min
Test condition	; Motor only

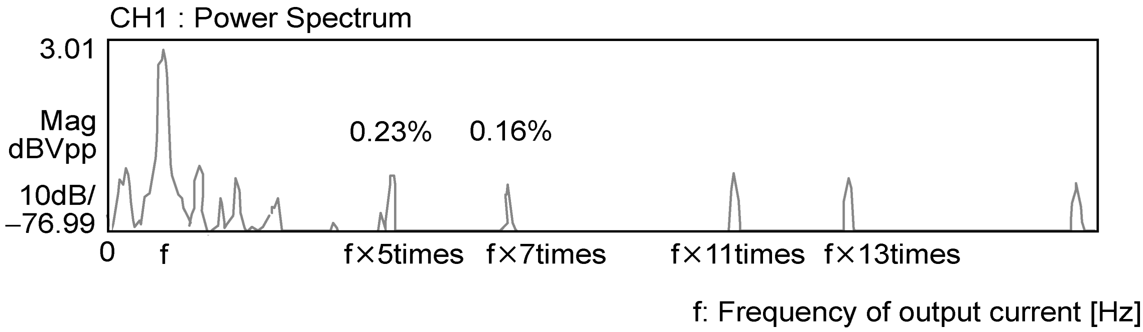
11.2 Sample Measurement of Motor Wow



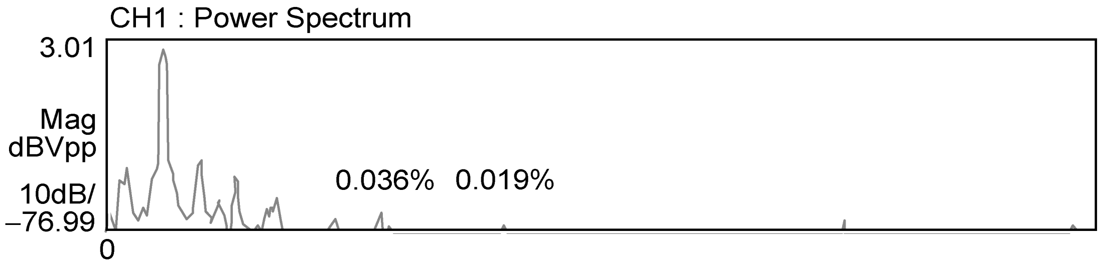
Inverter	; FRN37VG7S-4
Motor	; MVK6207A-C, 37kW, 1500/3600r/min
Test condition	; Motor only

11.3 Current Response Characteristics

FRENIC5000VG5



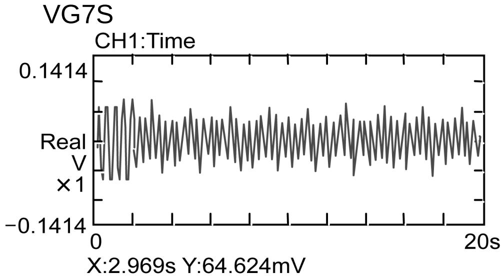
FRENIC5000VG7S

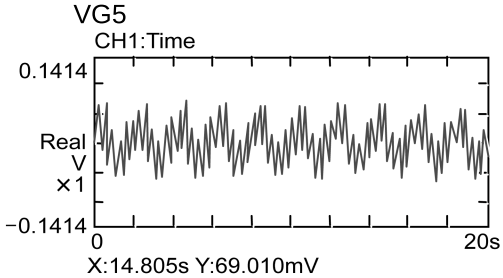


- By realizing the current response of 800Hz, the waveform distortion of output current was reduced.
- The harmonic of 5,7,11,13 times caused from PWM control was reduced. This leads to the reduction of torque ripple.

Inverter	; FRN37VG7S-4
Motor	; MVK6207A-C, 37kW, 1500/3600r/min
Test condition	; 100% load

11.4 Torque Ripple

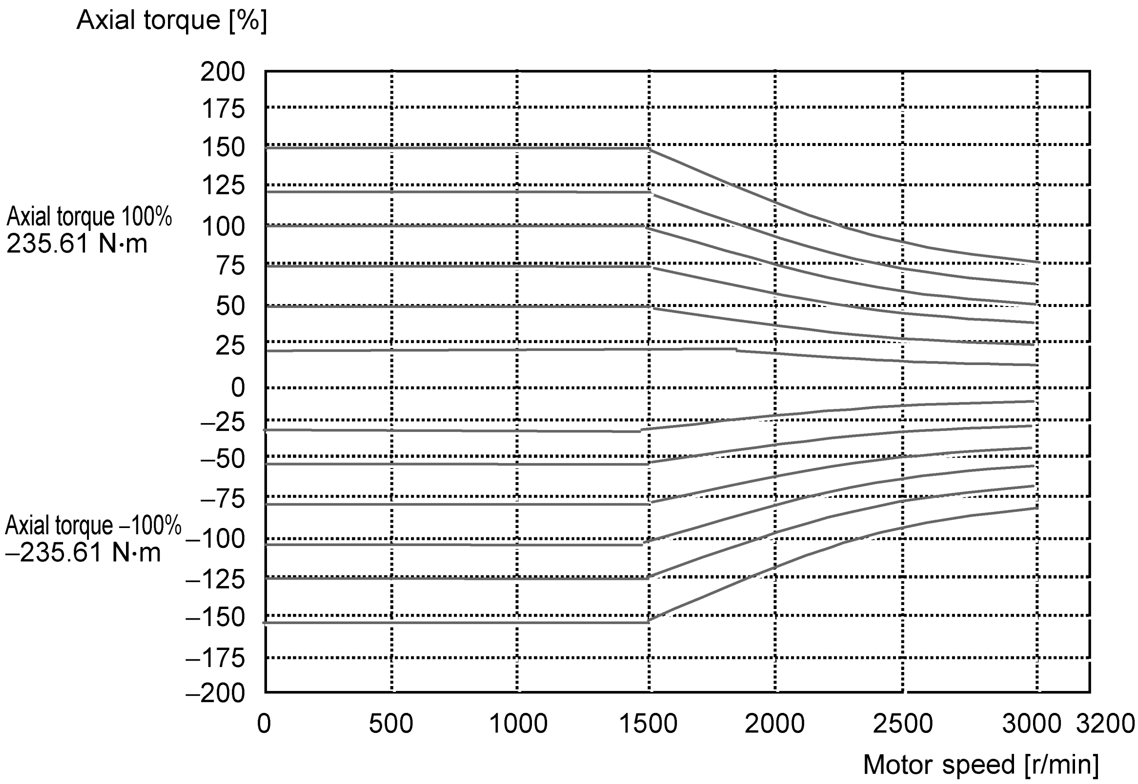




	Torque ripple P–P 100%:Rated torque			
	1 time	2 times	4 times	6 times
VG7S	0.23%	0.22%	0.10%	1.49%
VG5	0.70%	0.20%	0.09%	1.60%

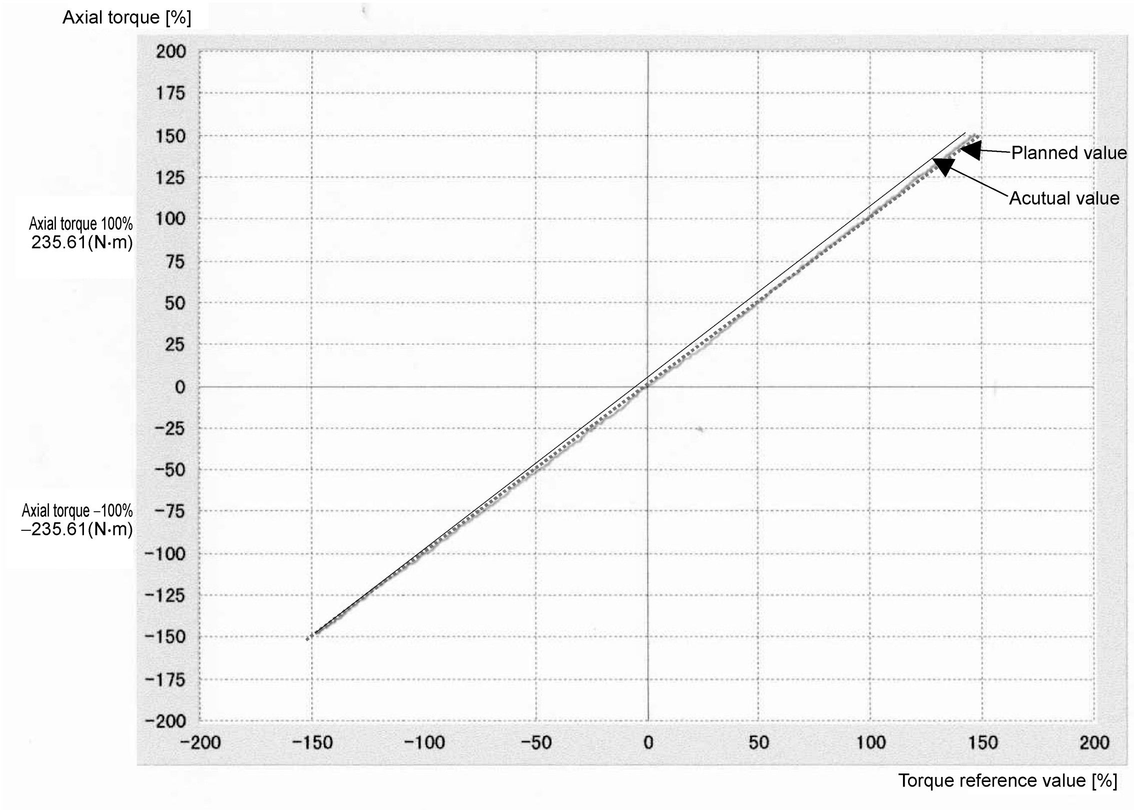
Inverter	; FRN37VG7S-4
Motor	; MVK6207A-C, 37kW, 1500/3600r/min
Test condition	; Motor constraint

11.5 Speed-torque Characteristics (PG Vector Control)



Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

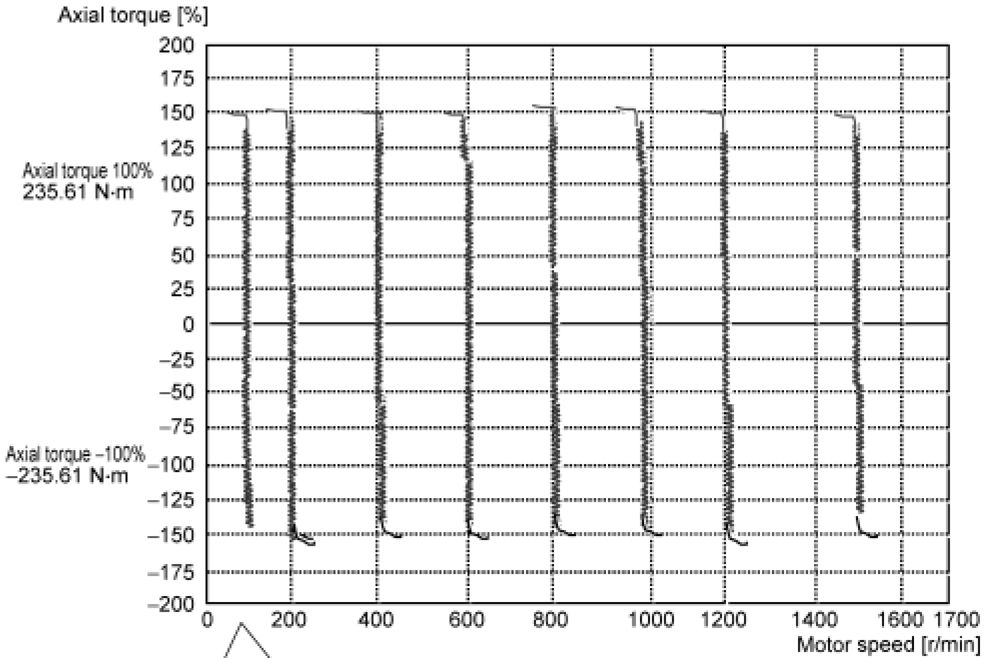
11.6 Torque Control Accuracy (PG Vector Control)



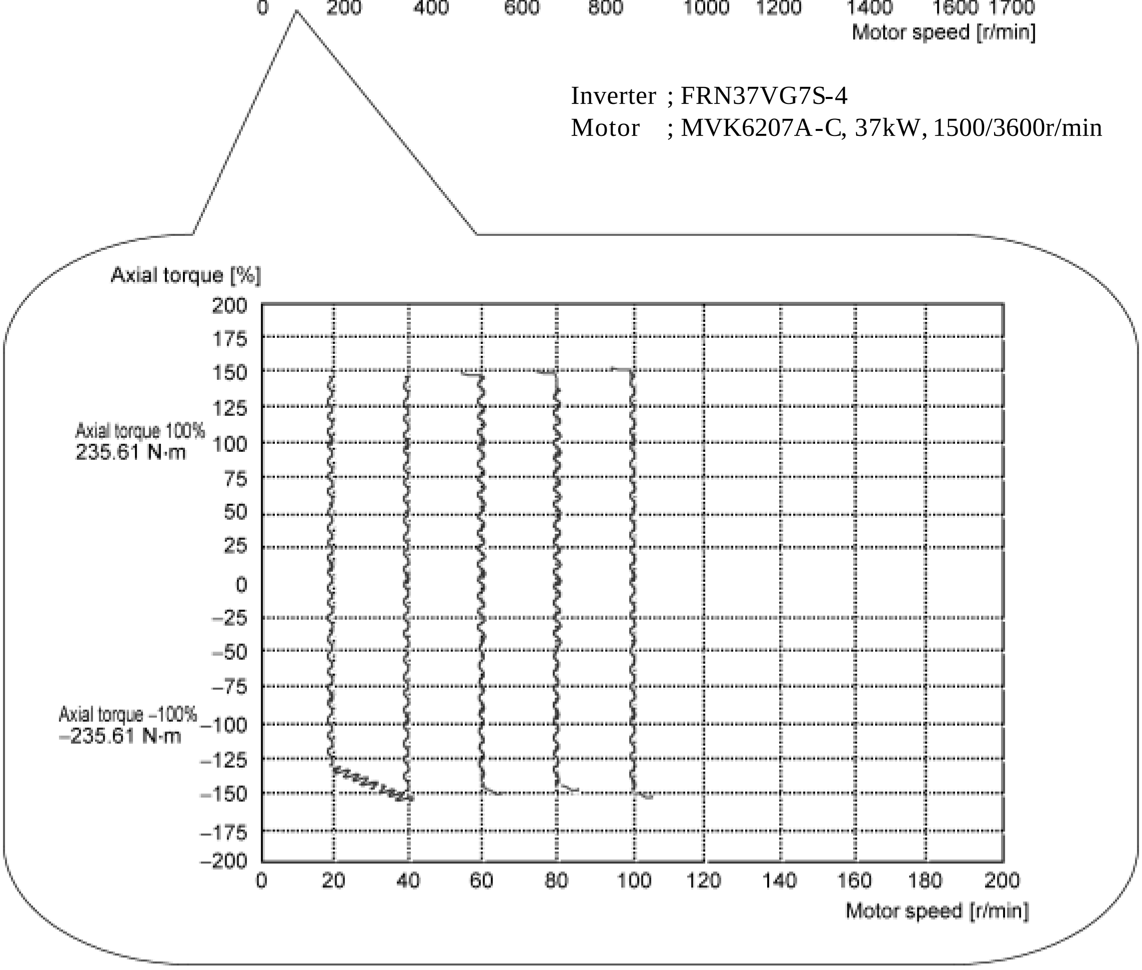
Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

Operation Data

11.7 Speed-torque Characteristics (Sensorless Vector Control)

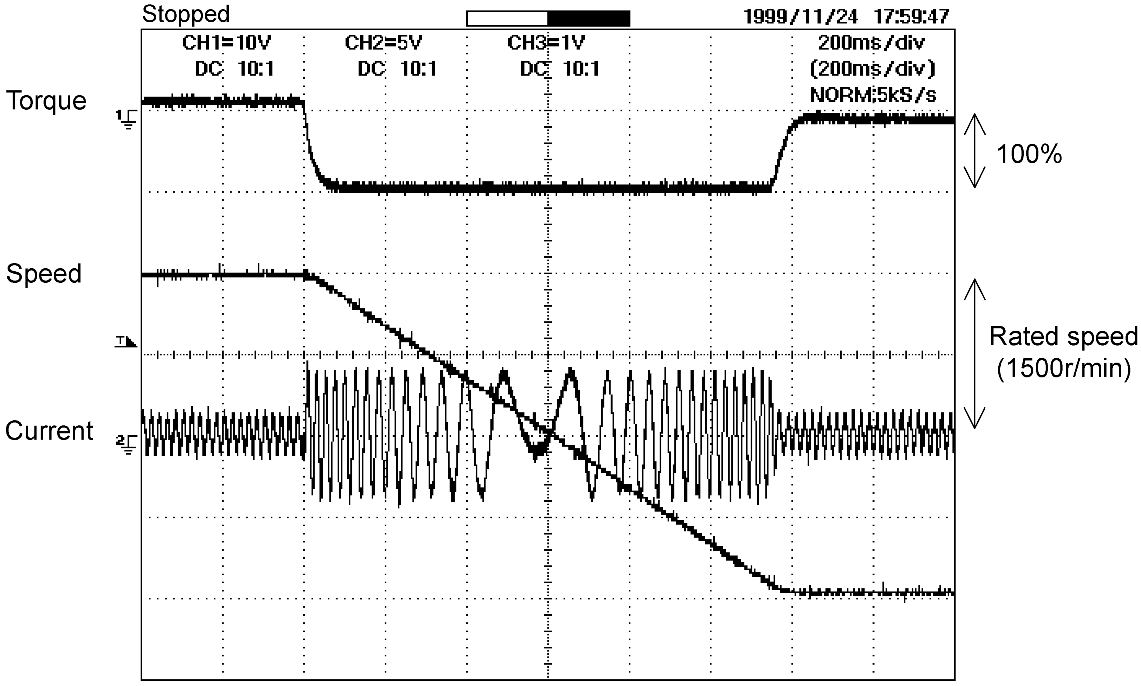


Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min



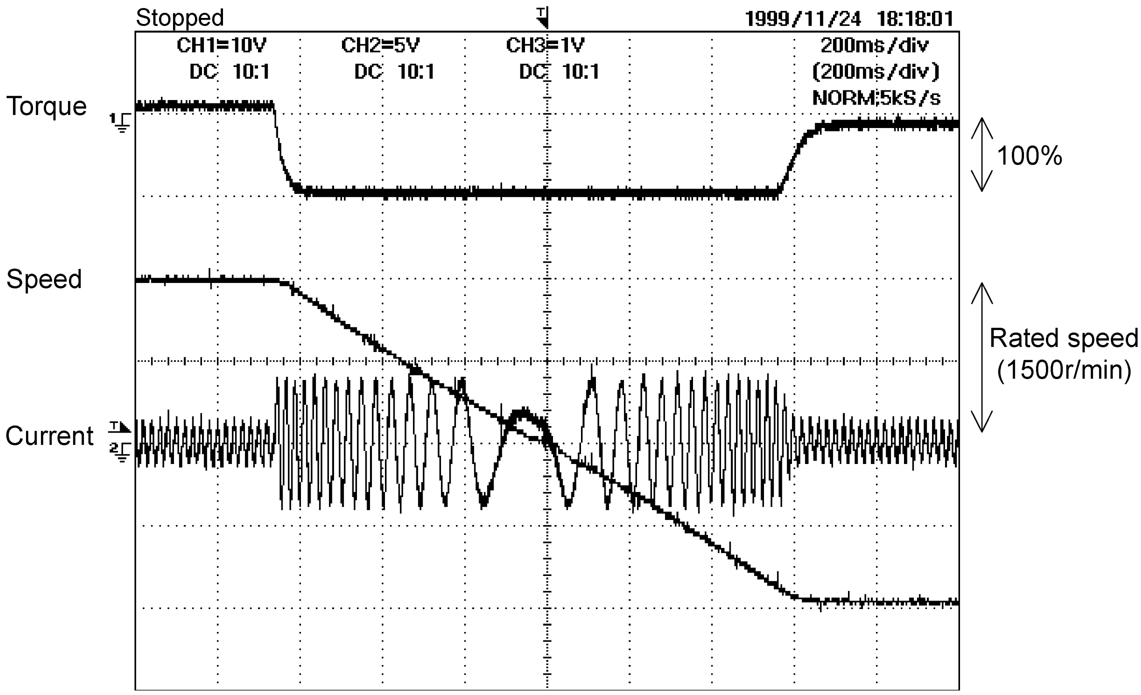
Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

11.8 Deceleration and Acceleration via Zero Speed (PG Vector Control)



Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

11.9 Deceleration and Acceleration via Zero Speed (Sensorless Vector Control)



Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

Operation Data

11. Operation Data

11.10 Comparison of Radiation Noise

1. Motor speed	: 1000r/min
2. Measurement distance	: 1.0m
3. Motor capacity	: 5.5kW-200V
4. Carrier frequency	: 10kHz

THE INVERTER

XII

XII. Function Code List

12. Function Code List

12.1 Function Code Configuration

12.1.1 Identification Code Displayed on KEYPAD Panel

F 0 0

Code number

Identification code

Function code		Function		Notes
Fundamental functions	F00 to F80	Fundamental function		Displayed on KEYPAD panel always
Extensional terminal functions	E01 to E84	Terminal function		Some codes are displayed only when options are installed
			E10 to E13	Function codes for OPC-VG7-DIOA option
			E20 to E27	Function codes for OPC-VG7-DIOA option
			E51, 52	Function codes for OPC-VG7-AIO option
			E55, 56	Function codes for OPC-VG7-AIO option
			E59, 60	Function codes for OPC-VG7-AIO option
			E63, 64	Function codes for OPC-VG7-AIO option
			E67, 68	Function codes for OPC-VG7-AIO option
			E72, 73	Function codes for OPC-VG7-AIO option
			E77, 78	Function codes for OPC-VG7-AIO option
			E82, 83	Function codes for OPC-VG7-AIO option
Control functions of frequency	C01 to C73	Control function		Displayed on KEYPAD panel always
Motor Parameters	P01 to P30	Motor parameter function for M1		
High performance functions	H01 to H73	High performance function		
Alternative motor parameters	A01 to A50	Motor parameters for M2 and M3		
Optional functions	o01 to o41	Option function		Displayed when options are installed. PG (PR) option codes are displayed always.
			o01 to o04	Function codes for OPC-VG7-DIA and DIB options
			o05	Function codes for OPC-VG7-PG (PD) option
			o06 to o08	Function codes for OPC-VG7-PG (LD) digital line speed detection option
			o09 to o11	Function codes for OPC-VG7-PMPG synchronous motor PG option
			o12 to o19	Function codes for OPC-VG7-PG (PR) pulse train input option
			o30 to o32	Function codes for OPC-VG7-TL field bus option
			o33, o34	Function code for OPC-VG7-SI (MWS) multi-winding system option
			o35 to o37	Function codes for OPC-VG7-SI (UPAC) option
			o38 to o41	Function codes for OPC-VG7-UPAC option
Lift functions	L01 to L14	Lift functions		
User functions	U01 to U64	User functions (UPAC, OM)		You can use for UPAC option. Displayed on KEYPAD panel always.
Serial communication functions	S01 to S12	Command functions		You cannot refer to or change in LOC mode (KEYPAD panel). You can use in COM mode (T-Link, RS485, UPAC, optical communication, SX, and field bus).
Monitoring functions	M01 to M60	Data monitor functions		

12.2 Function Code List

12.2.1 Function Code List Description

Item	Description
Fcode	Identification codes for function codes.
Communication address 485 number	Address used with integrated RS485 or UPAC option (OPC-VG7-UPAC) to refer to or change function codes.
Communication address Link number	Address used with field bus options (OPC-VG7-TL, OPC-VG7-SX and field bus options) to refer to or change function codes. You cannot use a filed bus option for a function code without a communication address Link number.
Function name	Name assigned to a group of function codes with a similar nature.
Function directory name	Name of an individual function of a function code.
Setting range	Indicates the setting range and the data definition.
Factory setting	Data specified by FUJI before delivery. Modified data are displayed with ∗ (asterisk) on the KEYPAD panel. You can use the initialization function code to reset them to the factory setting.
Type	Indicates a format type used to refer to or change data through communication system (such as 485 and filed bus). See 12.3 "Function Code List Dedicated for Communication" for more information.
Copy	Indicates whether to be copied or not to another inverter when you use the copy function of the KEYPAD panel to copy entire data stored in the KEYPAD panel.
Initialization	Indicates whether to be initialized (reset to the factory setting) or not by the function code H03 "Data initializing". 1: Initialized, 2: Not initialized.
Control type: Available/ Not available	Indicates whether available or not in individual control types (PG: Vector control with PG, LES: Sensorless vector control, VF: V/f control, SM: Vector control to drive synchronous motor).

12.2.2 List

F: Fundamental Functions

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
F00	0h	80(50 h)	Data protection		0 to 1 0 : Data change enable 1 : Data protection This is a function to protect writing from the Keypad panel. The protection of writing from the link (T-Link, RS485, etc.) is defined with H29 "Link function protection".	40	x	1	o	o	o	o
F01	1h	(h)	Speed setting N1		0 to 7 0 : KEYPAD operation (∧ and ∨ key) 1 : Analog input (0 to ±10VDC) 2 : Analog input (0 to +10VDC) 3 : UP/DOWN control 1 (initial speed = 0 r/min) 4 : UP/DOWN control 2 (initial speed = last value) 5 : UP/DOWN control 3 (initial speed = Creep speed 1 or 2) 6 : DIA card input 7 : DIB card input	41	o	1	o	o	o	o
F02	2h	(h)	Operation method		0 to 1 The method of operation is set. 0 : KEYPAD operation (FWD or REV or STOP key) (LOCAL) 1 : FWD or REV signal input (REMOTE) The change of REMOTE/LOCAL is possible also by RST+STOP key to the keypad panel. This operation corresponds to writing data of F02.	42	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
F03	3h	81(51 h)	M1 Maximum speed	M1 Maximum speed	50 to 1500 to 24000 r/min	0	o	2	o	o	o	o
F04	4h	82(52 h)		M1-Rated speed	50 to 24000 r/min	0	o	2	o	o	o	o
F05	5h	83(53 h)		M1-Rated voltage	80 to 999 V	0	o	2	o	o	o	o
F07	7h	84(54 h)	Acceleration time 1		0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
F08	8h	85(55 h)	Deceleration time 1		0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
F10	Ah	86(56 h)	M1 Electronic thermal overload relay	M1 Electronic thermal overload relay (Select)	0 to 2 The motor overheating protection operates by using NTC thermistor with the motor only for VG. In this case, please make setting F10 Electronic thermal "Inactive". 0 : Inactive (When you use the motor only for VG) 1 : Active (for 4-pole standard motor, with self-cooling fan) 2 : Active (for Inverter motor, with separate cooling fan)	85	o	2	o	o	o	o
F11	Bh	87(57 h)		M1 Electronic thermal overload relay (Level)	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	o	o
F12	Ch	88(58 h)		M1 Electronic thermal overload relay (Thermal time constant)	0.5 to 75.0 min	2	o	2	o	o	o	o
F14	Eh	(h)	Restart mode after momentary power failure		0 to 5 0 : Inactive (Trip and alarm when power failure occurs.) 1 : Inactive (Trip, and alarm when power recovers.) 2 : Inactive (Deceleration to stop, and trip and alarm.) 3 : Active (Smooth recovery by continuous operation mode) 4 : Active (Momentarily stops and restarts at speed on power failure) 5 : Active (Momentarily stops and restarts at starting speed)	0	o	1	o	o	o	o
F17	11h	(h)	Gain (terminal 12 input)		0.0 to 100 to 200.0 %	2	o	1	o	o	o	o
F18	12h	(h)	Bias (terminal 12 input)		-24000 to 0 to 24000 r/min	5	o	1	o	o	o	o
F20	14h	89(59 h)	DC brake (Starting speed)	DC brake (Starting speed)	0 to 3600 r/min	0	o	1	o	o	o	o
F21	15h	90(5A h)		DC brake (Braking level)	0 to 100 %	16	o	1	o	o	o	o
F22	16h	91(5B h)		DC brake (Braking time)	0.0 to 30.0 s 0.0 : (Inactive) 0.1 to 30.0 s	2	o	1	o	o	o	o
F23	17h	92(5C h)	Starting speed (Speed)		0.0 to 150.0 r/min (The frequency is limited so as not to become 0.1Hz or less. (When using sensoless or V/F control))	2	o	1	o	o	o	o
F24	18h	93(5D h)	Starting speed (Holding time)		0.00 to 10.00 s	3	o	1	o	o	o	o
F26	1Ah	94(5E h)	Motor sound (Carrier Freq.)		0.75 to 7 to 15 kHz A factory setting value of 75kW or more is 10kHz.	10	o	1	o	o	o	o
F27	1Bh	95(5F h)	Motor sound (Sound tone)		0 to 3 0 : level 0 1 : level 1 2 : level 2 3 : level 3	0	o	1	o	o	o	o
F36	24h	(h)	30RY operation mode		0 to 1 0 : The relay(30) exites on alarm mode. 1 : The relay(30) exites on normal mode.	43	o	1	o	o	o	o
F37	25h	96(60 h)	Stop speed (Level)	Stop speed (Level)	0.0 to 10.0 to 150.0 r/min (The frequency is limited so as not to become 0.1Hz or less. (When using sensoless or VF control))	2	o	1	o	o	o	o
F38	26h	97(61 h)		Stop speed (Detection method)	0 to 1 0 : Reference value 1 : Detected value It is fixed 0 to use the V/F control.	90	o	1	o	o	x	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
F39	27h	98(62 h)		Stop speed (Zerospeed holding time)	0.00 to 0.50 to 10.00 s	3	o	1	o	o	o	o
F40	28h	99(63 h)	Torque limiter	Torque limiting mode 1	0 to 3 0 : Torque limiting invalid 1 : Torque limiting 2 : Power limiting 3 : Torque current limiting	44	o	1	o	o	x	o
F41	29h	100(64 h)		Torque limiting mode 2	0 to 3 0 : Same limiting level (level 1) for 4 quadrants 1 : Drive torque limiting (level 1), and Brake torque limiting (level 2) 2 : Upper torque limiting (level 1), and Lower torque limiting (level 2) 3 : Same limiting level for 4 quadrants (level 1 and level 2 changeover) Level 1 and 2 is the data setting of the definition by F42, 43 ahead.	45	o	1	o	o	x	o
F42	2Ah	101(65 h)		Level 1 selection	0 to 5 0 : Internal preset value by F44 1 : Ai terminal input value [TL-REF1] 2 : DIA card input 3 : DIB card input 4 : Link enabled 5 : PID output	46	o	1	o	o	x	o
F43	2Bh	102(66 h)		Level 2 selection	0 to 5 0 : Internal preset value by F45 1 : Ai terminal input value [TL-REF2] 2 : DIA card input 3 : DIB card input 4 : Link enabled 5 : PID output	47	o	1	o	o	x	o
F44	2Ch	103(67 h)		Internal set 1	-300 to 150 to 300 %	5	o	1	o	o	x	o
F45	2Dh	104(68 h)		Internal set 2	-300 to 10 to 300 %	5	o	1	o	o	x	o
F46	2Eh	105(69 h)		Mechanical loss compensation	-300.00 to 0.00 to 300.00 % This is used when mechanical loss of the load makes amends.	7	o	1	o	o	x	o
F47	2Fh	106(6A h)		Torque bias set 1	-300.00 to 0.00 to 300.00 % This set value can be added to the torque reference value. TB1, 2 and 3 are switched by DI and are used.	7	o	1	o	o	x	o
F48	30h	(h)		Torque bias set 2	-300.00 to 0.00 to 300.00 % This set value can be added to the torque reference value. TB1, 2 and 3 are switched by DI and are used.	7	o	1	o	o	x	o
F49	31h	(h)		Torque bias set 3	-300.00 to 0.00 to 300.00 % This set value can be added to the torque reference value. TB1, 2 and 3 are switched by DI and are used.	7	o	1	o	o	x	o
F50	32h	(h)		Torque bias activation timer	0.00 to 1.00 s (300% / 1.00s) Time up to 300% is set.	3	o	1	o	o	x	o
F51	33h	251(FB h)		Torque reference monitor (polarity)	0 to 1 Polarity selection of the data output related to torque (AO, Keypad panel,code M) 0 : Display with torque polarity 1 : (+) for driving mode, and (-) for braking mode	48	o	1	o	o	o	o
F52	34h	(h)	LED monitor coefficient	Display coefficient A	-999.00 to 1.00 to 999.00 The conversion coefficient to decide load axis rotation speed and the display value at the line speed displayed in LED are set. Display value = Motor speed × (0.01 to 200.00) The set data is effective only by 0.01 to 200.00 and outside the range is invalid.	12	o	1	o	o	o	o
F53	35h	(h)		Display coefficient B	-999.00 to 1.00 to 999.00 The conversion coefficient to decide the reference value of the PID adjustment machine and the display value (amount of the process) of the amount of feedback is set by using display coefficient A and B. Display coefficient A ; Maximum value Display coefficient B ; Minimum value Display value = (Reference value or feedback value) * (Display coefficient A - B) + B	12	o	1	o	o	o	o

You can change the setting of a function indicated by ▢ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
F54	36h	(h)		LED display filter	0.0 to 0.2 to 5.0 s Filter to prevent LED from flickering by change of the display data. The filter is effective in all the data selected with F55.	2	o	1	o	o	o	o
F55	37h	(h)		LED (Selection)	0 to 28 0 : Detected speed 1 or reference speed (r/min) (depending on F56 while motor is stopped) 1 : Speed reference value 4 (ASR input) (r/min) 2 : Output frequency after slip compensation (Hz) 3 : Torque current reference (%) 4 : Torque reference value (%) 5 : Torque (calculated value) (%) 6 : Inverter input power (kW or HP) (depending on F60) 7 : Output current (A) 8 : Output voltage (V) 9 : DC link circuit voltage (V) 10 : Magnetic flux reference (%) 11 : Magnetic flux (calculated value) (%) 12 : Motor temperature (°C) ("---" is displayed when NTC thermistor unused.) 13 : Load shaft speed (r/min) (depending on F56) 14 : Line speed (m/min) (depending on F56) 15 : Ai adjusted value (12) (%) 16 : Ai adjusted value (Ai1) (%) 17 : Ai adjusted value (Ai2) (%) 18 : Ai adjusted value (Ai3) (%) 19 : Ai adjusted value (Ai4) (%) The following data becomes non-display by the mode on the option. 20 : PID reference (%) (Display at the PID mode) 21 : PID feedback value (%) (Display at the PID mode) 22 : PID output value (%) (Display at the PID mode) 23 : Option monitor 1 (HEX) (Displayed with use of option) 24 : Option monitor 2 (HEX) (Displayed with use of option) 25 : Option monitor 3 (DEC) (Displayed with use of option) 26 : Option monitor 4 (DEC) (Displayed with use of option) 27 : Option monitor 5 (DEC) (Displayed with use of option) 28 : Option monitor 6 (DEC) (Displayed with use of option)	49	o	1	o	o	o	o
F56	38h	(h)		LED (Display at stop mode)	0 to 1 Change of the display on F55 when the motor is stopping. The corresponding data is speed (0), load shaft rotation speed (13), and line speed (14). 0 : Speed reference (r/min) 1 : Speed feedback (r/min)	50	o	1	o	o	o	o
F57	39h	(h)	LCD monitor	LCD (Selection)	0 to 1 Change of operation mode display on Keypad panel 0 : Operation guide (State of operation, Direction of rotation) 1 : Bar graph monitor (Speed, Current, Torque)	51	o	1	o	o	o	o
F58	3Ah	(h)		LCD (Language)	0 to 6 0 : Japanese 1 : English 2 : German 3 : French 4 : Spanish 5 : Italian 6 : Chinese	52	o	1	o	o	o	o
F59	3Bh	(h)		LCD (Contrast)	0 to 5 to 10 0 (Soft) to 10 (Hard)	0	o	1	o	o	o	o
F60	3Ch	(h)	Output unit selection (kW or HP)		0 to 1 The unit of inverter power consumption and motor (M1,2,3) of the function setting is defined. 0 : kW 1 : HP	53	o	1	o	o	o	o
F61	3Dh	107(6B h)	ASR1	P-gain	0.1 to 10.0 to 200.0 (times)	2	o	1	o	o	x	o
F62	3Eh	108(6C h)		I-gain	0.010 to 0.200 to 1.000 s P control when setting 1.000	4	o	1	o	o	x	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
F63	3Fh	109(6D h)		Feed forward gain	0.000 to 9.999 s	4	o	1	o	o	x	o
F64	40h	110(6E h)		Input filter	0.000 to 0.040 to 5.000 s	4	o	1	o	o	o	o
F65	41h	111(6F h)		Detection filter	0.000 to 0.005 to 0.100 s	4	o	1	o	o	x	o
F66	42h	112(70 h)		Output filter	0.000 to 0.002 to 0.100 s	4	o	1	o	o	x	o
F67	43h	113(71 h)		S-curve (Acc start side)	0 to 50 %	0	o	1	o	o	o	o
F68	44h	114(72 h)		S-curve (Acc end side)	0 to 50 %	0	o	1	o	o	o	o
F69	45h	115(73 h)		S-curve (Dec start side)	0 to 50 %	0	o	1	o	o	o	o
F70	46h	116(74 h)		S-curve (Dec end side)	0 to 50 %	0	o	1	o	o	o	o
F73	49h	(h)	Magnetic flux at light leal	Magnetic flux at light leal	10 to 100 %	16	o	1	o	o	x	x
F74	4Ah	117(75 h)		Pre-exiting time	0.0 to 10.0 s	2	o	1	o	o	x	x
F75	4Bh	118(76 h)		Pre-excitation initial Level	100 to 400 %	0	o	1	o	o	x	x
F76	4Ch	(h)	Speed limitier	Speed limiter (Mode select)	0 to 3 0 : Limiting level 1 for forward rotation, and limiting level 2 for reverse rotation 1 : Limiting level 1 for both side rotation 2 : Limiting level 1 for upper limit, and limiting level 2 for lower limit 3 : Forword (Level 1) and reverse (Level 2). Add the [12] input as a bias.	91	o	1	o	o	o	o
F77	4Dh	(h)		Speed limiting (Level 1)	-110.0 to 100.0 to 110.0 %	6	o	1	o	o	o	o
F78	4Eh	(h)		Speed limiting (Level 2)	-110.0 to 100.0 to 110.0 %	6	o	1	o	o	o	o
F79	4Fh	119(77 h)	Motor selection (M1, M2, M3)		0 to 2 An effective motor (M1, 2 or 3) is selected by the function or terminal. 0 : M1 select The signal input by the terminal is given to priority. M1 select ; (MCH2,MCH3)=(OFF,OFF) (If there is no allocation) M2 select ; (MCH2,MCH3)=(ON ,OFF)(ON,ON) 1 : M2 select (x function inactive) 2 : M3 select (x function inactive)	54	o	2	o	o	o	o
F80	50h	(h)	Current rating switching		0 to 2 0 : CT (Overload current 150%) 1 : VT (Overload current 110%) 2 : HT (Overload torque 200/170%)	56	o	2	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

E: Extension Terminal Functions

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
E01	101h	120(78 h)	X1 terminal function	X1 terminal function	0 to 63 0 to 3 : Multistep speed selection (1 to 15 steps) (0 : SS1, 1 : SS2, 2 : SS4, 3 : SS8) 4, 5 : ASR and ACC/DEC time selection (4 steps) (4 : RT1, 5 : RT2) 6 : 3 wire operation stop command (HLD) 7 : Coast-to-stop command (BX) 8 : Alarm reset (RST) 9 : Trip command (External fault) (THR) 10 : Jogging operation (JOG) 11 : Speed setting 2 / Speed setting 1 (N2/N1) 12 : Motor M2 selection (M-CH2) 13 : Motor M3 selection (M-CH3) 14 : DC brake command (DCBRK) 15 : ACC/DEC cleared to zero (CLR) 16 : Creep speed switching in UP/DOWN control (CRP-N2/N1) 17 : UP command (UP) 18 : DOWN command (DOWN) 19 : Write enable for KEYPAD (WE-KP) 20 : PID control cancel (N/PID) 21 : Inverse mode changeover (IVS) 22 : Interlock signal for 52-2 (IL) 23 : Write enable through link (WE-LK) 24 : Operation selection through link (LE) 25 : Universal DI (U-DI) 26 : Pick up start mode (STM) 27 : Synchronization command (PG (PR) optional function) (SYC) 28 : Zero speed locking command (LOCK) 29 : Pre-exiting command (EXITE) 30 : Speed reference limiter cancel (N-LIM) (Related function : F76, F77, F78) 31 : H41 [torque reference] cancel (H41-CCL) 32 : H42 [torque current reference] cancel (H42-CCL) 33 : H43 [magnetic flux reference] cancel (H43-CCL) 34 : F40 [torque limiter mode 1] cancel (F40-CCL) 35 : Torque limiter 2 / Torque limiter 1 (TL2/TL1) 36 : Bypass from ramp function generator (BPS) 37, 38 : Torque bias reference 1/2 (37 : TB1, 38 : TB2) 39 : DROOP selection (DROOP) 40 : Zero hold command for Ai1 (ZH-AI1) 41 : Zero hold command for Ai2 (ZH-AI2) 42 : Zero hold command for Ai3 (option) (ZH-AI3) 43 : Zero hold command for Ai4 (option) (ZH-AI4) 44 : Ai1 polarity change (REV-AI1) 45 : Ai2 polarity change (REV-AI2) 46 : Ai3 polarity change (option) (REV-AI3) 47 : Ai4 polarity change (option) (REV-AI4) 48 : Inverse mode of PID output (PID-INV) 49 : PG alarm cancel (PG-CCL) 50 : Undervoltage cancel (LU-CCL) 51 : Ai torque bias hold [H-TB] 52 : STOP1 (The motor stops with normal deceleration time.) (STOP1) 53 : STOP2 (The motor stops with deceleratime 4) (STOP2) 54 : STOP3 (The motor stops with max, torque.) (STOP3) 55 : DIA data latch (DIA option) (DIA) 56 : DIB data latch (DIB option) (DIB) 57 : Mulitiwinding motor cancel (SI (MWS) option) (MT-CCL) 58 to 63 : Option Di 1/2/3/4/5/6 (O-DI1 to 6)	57	o	1	o	o	o	o
E02	102h	121(79 h)		X2 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E03	103h	122(7A h)		X3 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E04	104h	123(7B h)		X4 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E05	105h	124(7C h)		X5 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E06	106h	125(7D h)		X6 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E07	107h	126(7E h)		X7 terminal function	* Same as (E01)	57	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
E08	108h	127(7F h)		X8 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E09	109h	128(80 h)		X9 terminal function	* Same as (E01)	57	o	1	o	o	o	o
E10	10Ah	129(81 h)		X11 terminal function	* Same as (E01) (When the DIO option is installed, this is displayed.)	57	o	1	o	o	o	o
E11	10Bh	130(82 h)		X12 terminal function	* Same as (E01) (When the DIO option is installed, this is displayed.)	57	o	1	o	o	o	o
E12	10Ch	131(83 h)		X13 terminal function	* Same as (E01) (When the DIO option is installed, this is displayed.)	57	o	1	o	o	o	o
E13	10Dh	132(84 h)		X14 terminal function	* Same as (E01) (When the DIO option is installed, this is displayed.)	57	o	1	o	o	o	o
E14	10Eh	(h)	X terminal function normal open/close		0000 to 01FF Setting of normal state of X1-X9. 0 : Normally open 1 : Normally closed	35	o	1	o	o	o	o
E15	10Fh	133(85 h)	Y1 terminal function	Y1 terminal function	0 to 1 to 47 0 : Inverter running (RUN) 1 : Speed existence signal (N-EX) 2 : Speed agreement signal (N-AG) 3 : Speed egilivarent signal (N-AR) 4 : Speed level detection 1 (N-DT1) 5 : Speed level detection 2 (N-DT2) 6 : Speed level detection 3 (N-DT3) 7 : Stopping on undervoltage (LU) 8 : Detected torque polarity (Braking/Driving) (B/D) 9 : Torque limiting (TL) 10 : Torque detection 1 (T-DT1) 11 : Torque detection 2 (T-DT2) 12 : KEYPAD operation mode (KP) 13 : Inverter stopping (STP) 14 : Operation ready output (RDY) 15 : Magnetic flux detection signal (MF-DT) 16 : Motor M2 selection status (SW-M2) 17 : Motor M3 selection status (SW-M3) 18 : Mechanical brake release signal (BRK) 19 : Alarm indication signal 1 (AL1) 20 : Alarm indication signal 2 (AL2) 21 : Alarm indication signal 4 (AL4) 22 : Alarm indication signal 8 (AL8) 23 : Fan operation signal (FAN) 24 : Auto-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 warning (INV-OL) 32 : Motor overheat early warning (M-OH) 33 : Motor overload early warning (M-OL) 34 : DB overload early warning (DB-OL) 35 : Link transmission error (LK-ERR) 36 : Load adaptive control under limiting (ANL) 37 : Load adaptive control under calculation (ANC) 38 : Analog torque bias hold (TBH) 39 to 47 : Option DO1 to 9 (O-DO1 to O-DO9)	58	o	1	o	o	o	o
E16	110h	134(86 h)		Y2 terminal function	* Same as (E15)	58	o	1	o	o	o	o
E17	111h	135(87 h)		Y3 terminal function	* Same as (E15)	58	o	1	o	o	o	o
E18	112h	136(88 h)		Y4 terminal function	* Same as (E15)	58	o	1	o	o	o	o
E19	113h	137(89 h)		Y5 terminal function	* Same as (E15)	58	o	1	o	o	o	o
E20	114h	138(8A h)		Y11 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E21	115h	139(8B h)		Y12 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E22	116h	140(8C h)		Y13 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E23	117h	141(8D h)		Y14 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
E24	118h	142(8E h)		Y15 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E25	119h	143(8F h)		Y16 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E26	11Ah	144(90 h)		Y17 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E27	11Bh	145(91 h)		Y18 terminal function	* Same as (E15) (When the DIOA option is installed, this is displayed.)	58	o	1	o	o	o	o
E28	11Ch	(h)	Y terminal function normally open/closed		0000 to 001F Setting of normal state of Y1 to Y4,RY. 0 : Normally open 1 : Normally closed	36	o	1	o	o	o	o
E29	11Dh	146(92 h)	PG pulse output selection		0 to 9 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 inputs are output after being divided. 7 : Pulse oscillation mode (A/B 90° phase difference signal) Internal speed reference is output after pulse conversion. 8 : PG (PD) Pulse inputs for position encoder are directly output. 9 : PG (PR) Pulse inputs for position command are directly output.	92	o	1	o	x	x	o
E30	11Eh	(h)	Motor OH protection	Motor OH protection (temperature)	100 to 150 to 200 °C It is effective when NTC thermistor is used with selected motor (M1,M2).	0	o	1	o	o	o	o
E31	11Fh	(h)		M-OH early warning (temperature)	50 to 75 to 200 °C It is effective when NTC thermistor is used with selected motor (M1,M2).	0	o	1	o	o	o	o
E32	120h	205(CD h)		M1-M3 (operation level PTC)	0.00 to 1.60 to 5.00 V	3	o	1	o	o	x	o
E33	121h	(h)		INV-OL early warning	25 to 90 to 100 %	0	o	1	o	o	o	o
E34	122h	(h)		M-OL early warning	25 to 90 to 100 %	0	o	1	o	o	o	o
E35	123h	(h)		DB overload protection	0 to 10 to 100 %	0	o	1	o	o	o	o
E36	124h	(h)		DB-OL early warning	0 to 80 to 100 %	0	o	1	o	o	o	o
E37	125h	(h)		DB thermal time constant	0 to 100 to 1000 s	0	o	1	o	o	o	o
E38	126h	147(93 h)	Speed detection method	Speed detection method	000 to 111 (N-DT1) (N-DT2) (N-DT3) 0 : Detected speed 1 : Speed reference Only reference values are effective under VF control.	9	o	1	o	o	x	o
E39	127h	148(94 h)		N-DT1 Level	0 to 1500 to 24000 r/min	0	o	1	o	o	o	o
E40	128h	149(95 h)		N-DT2 Level	-24000 to 1500 to 24000 r/min	5	o	1	o	o	o	o
E41	129h	150(96 h)		N-DT3 Level	-24000 to 1500 to 24000 r/min	5	o	1	o	o	o	o
E42	12Ah	151(97 h)		N-AR detection width	1.0 to 3.0 to 20.0 %	2	o	1	o	o	o	o
E43	12Bh	152(98 h)		N-AG detection width	1.0 to 3.0 to 20.0 %	2	o	1	o	o	x	o
E44	12Ch	153(99 h)		N-AG off-delay timer	0.000 to 0.100 to 1.000 s	4	o	1	o	o	x	o
E45	12Dh	154(9A h)		Speed disagreement alarm	0 to 1 0 : Inactive 1 : Active	0	o	1	o	x	x	o
E46	12Eh	155(9B h)		Torque detection level 1	0 to 30 to 300 % When the V/F control is used, the calculation value is set.	16	o	1	o	o	o	o
E47	12Fh	156(9C h)		Torque detection level 2	0 to 30 to 300 % When the V/F control is used, the calculation value is set.	16	o	1	o	o	o	o
E48	130h	157(9D h)		Magnetic flux detection level	10 to 100 %	16	o	1	o	o	x	x

You can change the setting of a function indicated by [shaded] during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
E49	131h	(h)	Ai function selection	Ai1 function selection	0 to 18 0 : Input signal off (OFF) 1 : Auxiliary speed setting 1 (before ramp function) (±10 V / ±Nmax) (AUX-N1) 2 : Auxiliary speed setting 2 (after ramp function) (±10 V / ±Nmax) (AUX-N2) 3 : Torque limiter level 1 (±10 V / ±150 %) (TL-REF1) 4 : Torque limiter level 2 (±10 V / ±150 %) (TL-REF2) 5 : Torque bias reference (±10 V / ±150 %) (TB-REF) 6 : Torque reference (before limit function) (±10 V / ±150 %) (T-REF) 7 : Torque current reference (±10 V / ±150 %) (IT-REF) 8 : Creep speed 1 for UP/DOWN control (±10 V / ±Nmax) (CRP-N1) 9 : Creep speed 2 for UP/DOWN control (±10 V / ±Nmax) (CRP-N2) 10 : Magnetic flux reference (+10 V / +100 %) (MF-REF) 11 : Detected line speed (±10 V / ±Nmax) (LINE-N) 12 : Motor temperature (+10 V / 200 °C) (M-TMP) 13 : Speed override (±10 V / ±50 %) (N-OR) 14 : Universal Ai (±10 V / ±4000 (h)) (U-AI) 15 : PID feedback (±10 V / ±20000 (d)) (PID-FB) 16 : PID reference (±10 V / ±20000 (d)) (PID-REF) 17 : PID correction gain (±10 V / ±4000 (h)) (PID-G) 18 : Option Ai (±10 V / ±7FFF (h)) (O-AI)	59	o	1	o	o	o	o
E50	132h	(h)		Ai2 function selection	* Same as (E49)	59	o	1	o	o	o	o
E51	133h	(h)		Ai3 function selection	* Same as (E49) (When the AIO option is installed, this is displayed.)	59	o	1	o	o	o	o
E52	134h	(h)		Ai4 function selection	* Same as (E49) (When the AIO option is installed, this is displayed.)	59	o	1	o	o	o	o
E53	135h	(h)	Gain adjustment for analog input	Gain (Ai1)	-10.000 to 1.000 to 10.000 (times) Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory.	8	o	1	o	o	o	o
E54	136h	(h)		Gain (Ai2)	-10.000 to 1.000 to 10.000 (times) Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory.	8	o	1	o	o	o	o
E55	137h	(h)		Gain (Ai3)	-10.000 to 1.000 to 10.000 (times) Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory. (When the AIO option is installed, this is displayed.)	8	o	1	o	o	o	o
E56	138h	(h)		Gain (Ai4)	-10.000 to 1.000 to 10.000 (times) Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory. (When the AIO option is installed, this is displayed.)	8	o	1	o	o	o	o
E57	139h	(h)	Bias adjustment for analog input	Bias (Ai1)	-100.0 to 0.0 to 100.0 % Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory.	6	o	1	o	o	o	o
E58	13Ah	(h)		Bias (Ai2)	-100.0 to 0.0 to 100.0 % Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory.	6	o	1	o	o	o	o
E59	13Bh	(h)		Bias (Ai3)	-100.0 to 0.0 to 100.0 % Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory. (When the AIO option is installed, this is displayed.)	6	o	1	o	o	o	o
E60	13Ch	(h)		Bias (Ai4)	-100.0 to 0.0 to 100.0 % Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel. Using F/D key causes data writing onto nonvolatile memory. (When the AIO option is installed, this is displayed.)	6	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
E61	13Dh	(h)	Filter adjustment for analog input	Filter (Ai1)	0.000 to 0.010 to 0.500 s	4	o	1	o	o	o	o
E62	13Eh	(h)		Filter (Ai2)	0.000 to 0.010 to 0.500 s	4	o	1	o	o	o	o
E63	13Fh	(h)		Filter (Ai3)	0.000 to 0.010 to 0.500 s (When the AIO option is installed, this is displayed.)	4	o	1	o	o	o	o
E64	140h	(h)		Filter (Ai4)	0.000 to 0.010 to 0.500 s (When the AIO option is installed, this is displayed.)	4	o	1	o	o	o	o
E65	141h	(h)	Increment/decremrnt limiter	Inc/dec limiter (Ai1)	0.00 to 60.00 s	3	o	1	o	o	o	o
E66	142h	(h)		Inc/dec limiter (Ai2)	0.00 to 60.00 s	3	o	1	o	o	o	o
E67	143h	(h)		Inc/dec limiter (Ai3)	0.00 to 60.00 s (When the AIO option is installed, this is displayed.)	3	o	1	o	o	o	o
E68	144h	(h)		Inc/dec limiter (Ai4)	0.00 to 60.00 s (When the AIO option is installed, this is displayed.)	3	o	1	o	o	o	o
E69	145h	(h)	AO function selection	AO1 function selection	0 to 1 to 15, 30, 31 0 : Detected speed 1 (0 to 10 Vdc / 0 to ±Nmax speed) (N-FB1+) 1 : Detected speed 1 (0 to ±10 Vdc / 0 to ±Nmax speed) (N-FB1±) 2 : Speed settig 2 (before ACC/DEC calculating) (0 to ±10 Vdc / 0 to ±Nmax) (N-REF2) 3 : Speed settig 4 (ASR input) (0 to ±10 Vdc / 0 to ±Nmax) (N-REF4) 4 : Detected speed 2 (ASR input) (0 to ±10 Vdc / 0 to ±Nmax) (N-FB2±) 5 : Detected line speed (0 to ±10 Vdc / 0 to ±Nmax) (LINE-N±) 6 : Torque current reference (0 to ±10 Vdc / 0 to ±150 %) (IT-REF±) 7 : Torque current reference (0 to 10 Vdc / 0 to ±150 %) (IT-REF+) 8 : Torque reference (0 to ±10 Vdc / 0 to ±150 %) (T-REF±) 9 : Torque reference (0 to 10 Vdc / 0 to ±150 %) (T-REF+) 10 : Motor current (0 to 10 Vdc / 0 to 200 %) (I-AC) 11 : Motor voltage (0 to 10 Vdc / 0 to 200 %) (V-AC) 12 : Input power (0 to 10 Vdc / 0 to 200 %) (PWR) 13 : DC link circuit voltage (0 to 10 Vdc / 0 to 800 V) (V-DC) 14 : Test voltage output (+10 Vdc) (P10) 15 : Test voltage output (-10 Vdc) (N10) 30 : Universal analog output (U-AO) 31 : Option AO (O-AO)	60	o	1	o	o	o	o
E70	146h	(h)		AO2 function selection	* Same as (E69)	60	o	1	o	o	o	o
E71	147h	(h)		AO3 function selection	* Same as (E69)	60	o	1	o	o	o	o
E72	148h	(h)		AO4 function selection	* Same as (E69) (When the AIO option is installed, this is displayed.)	60	o	1	o	o	o	o
E73	149h	(h)		AO5 function selection	* Same as (E69) (When the AIO option is installed, this is displayed.)	60	o	1	o	o	o	o
E74	14Ah	(h)	Gain adjustment for analog output	Gain (AO1)	-100.00 to 1.00 to 100.00 (times)	7	o	1	o	o	o	o
E75	14Bh	(h)		Gain (AO2)	-100.00 to 1.00 to 100.00 (times)	7	o	1	o	o	o	o
E76	14Ch	(h)		Gain (AO3)	-100.00 to 1.00 to 100.00 (times)	7	o	1	o	o	o	o
E77	14Dh	(h)		Gain (AO4)	-100.00 to 1.00 to 100.00 (times) (When the AIO option is installed, this is displayed.)	7	o	1	o	o	o	o
E78	14Eh	(h)		Gain (AO5)	-100.00 to 1.00 to 100.00 (times) (When the AIO option is installed, this is displayed.)	7	o	1	o	o	o	o
E79	14Fh	(h)	Bias adjustment for analog output	Bias (AO1)	-100.0 to 0.0 to 100.0 %	6	o	1	o	o	o	o
E80	150h	(h)		Bias (AO2)	-100.0 to 0.0 to 100.0 %	6	o	1	o	o	o	o
E81	151h	(h)		Bias (AO3)	-100.0 to 0.0 to 100.0 %	6	o	1	o	o	o	o
E82	152h	(h)		Bias (AO4)	-100.0 to 0.0 to 100.0 % (When the AIO option is installed, this is displayed.)	6	o	1	o	o	o	o
E83	153h	(h)		Bias (AO5)	-100.0 to 0.0 to 100.0 % (When the AIO option is installed, this is displayed.)	6	o	1	o	o	o	o
E84	154h	(h)	Filter adjustment for analog output (AO1-5)		0.000 to 0.010 to 0.500 s	4	o	1	o	o	o	o

You can change the setting of a function indicated by ▢ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

C: Control Functions of Frequency

Fcode	Communication address: 485 number	Communication address: Link number	Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available: PG	LES	VF	SM
C01	201h	(h)	Jump speed control	Jump speed (Speed 1)	0 to 24000 r/min	0	o	1	o	o	o	o
C02	202h	(h)		Jump speed (Speed 2)	0 to 24000 r/min	0	o	1	o	o	o	o
C03	203h	(h)		Jump speed (Speed 3)	0 to 24000 r/min	0	o	1	o	o	o	o
C04	204h	(h)		Jump speed (Hysteresis)	0 to 1000 r/min	0	o	1	o	o	o	o
C05	205h	158(9E h)	Multistep speed setting	Multistep speed 1	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C06	206h	159(9F h)		Multistep speed 2	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C07	207h	160(A0 h)		Multistep speed 3	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C08	208h	161(A1 h)		Multistep speed 4	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C09	209h	162(A2 h)		Multistep speed 5	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C10	20Ah	163(A3 h)		Multistep speed 6	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C11	20Bh	164(A4 h)		Multistep speed 7	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C12	20Ch	(h)		Multistep speed 8	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C13	20Dh	(h)		Multistep speed 9	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C14	20Eh	(h)		Multistep speed 10	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C15	20Fh	(h)		Multistep speed 11	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C16	210h	(h)		Multistep speed 12	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C17	211h	(h)		Multistep speed 13	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C18	212h	(h)		Multistep speed 14 /Creep speed 1	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C19	213h	(h)		Multistep speed 15 /Creep speed 2	0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21)	0	o	1	o	o	o	o
C20	214h	(h)		Multistep speed agreement timer	0.000 to 0.100 s	4	o	1	o	o	o	o
C21	215h	(h)		Multistep speed setting definition	0 to 2 0 : 0 to 24000 r/min 1 : 0.00 to 100.00% 2 : 0.0 to 999.9 m/m Defines setting methods of C05 to C19. With selection of "1", the setting range applies to the max speeds (F03, A06, A40) of selected motor. Refer to F79 for motor selection.	93	o	1	o	o	o	o
C25	219h	(h)	Speed setting N2		0 to 7 * Same as (F01)	41	o	1	o	o	o	o
C29	21Dh	(h)	Jogging speed		0 to 50 to 24000 r/min	0	o	1	o	o	o	o
C30	21Eh	(h)	ASR-JOG	P-gain	0.1 to 10.0 to 200.0 (times)	2	o	1	o	o	x	o
C31	21Fh	(h)		I-gain	0.010 to 0.200 to 1.000 s P control when setting 1.000	4	o	1	o	o	x	o
C32	220h	(h)		Input filter	0.000 to 0.040 to 5.000 s	4	o	1	o	o	o	o
C33	221h	(h)		Detection filter	0.000 to 0.005 to 0.100 s	4	o	1	o	o	x	o
C34	222h	(h)		Output filter	0.000 to 0.002 to 0.100 s	4	o	1	o	o	x	o
C35	223h	(h)		Acceleration time JOG	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C36	224h	(h)		Deceleration time JOG	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C37	225h	(h)		S-curve JOG (Start side)	0 to 50 %	0	o	1	o	o	o	o
C38	226h	(h)		S-curve JOG (End side)	0 to 50 %	0	o	1	o	o	o	o

You can change the setting of a function indicated by ▒ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address: 485 number	Communication address: Link number	Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/Not available: PG	LES	VF	SM
C40	228h	(h)	ASR2	P-gain	0.1 to 10.0 to 200.0 (times)	2	o	1	o	o	x	o
C41	229h	(h)		I-gain	0.010 to 0.200 to 1.000 s P control when setting 1.000	4	o	1	o	o	x	o
C42	22Ah	(h)		F/F-gain	0.000 to 9.999 s	4	o	1	o	o	x	o
C43	22Bh	(h)		Input filter	0.000 to 0.040 to 5.000 s	4	o	1	o	o	o	o
C44	22Ch	(h)		Detection filter	0.000 to 0.005 to 0.100 s	4	o	1	o	o	x	o
C45	22Dh	(h)		Output filter	0.000 to 0.002 to 0.100 s	4	o	1	o	o	x	o
C46	22Eh	(h)		Acceleration time 2	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C47	22Fh	(h)		Deceleration time 2	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C48	230h	(h)		S-curve 2 (Start side)	0 to 50 %	0	o	1	o	o	o	o
C49	231h	(h)		S-curve 2 (End side)	0 to 50 %	0	o	1	o	o	o	o
C50	232h	(h)	ASR3	P-gain	0.1 to 10.0 to 200.0 (times)	2	o	1	o	o	x	o
C51	233h	(h)		I-gain	0.010 to 0.200 to 1.000 s P control when setting 1.000	4	o	1	o	o	x	o
C52	234h	(h)		F/F-gain	0.000 to 9.999 s	4	o	1	o	o	x	o
C53	235h	(h)		Input filter	0.000 to 0.040 to 5.000 s	4	o	1	o	o	o	o
C54	236h	(h)		Detection filter	0.000 to 0.005 to 0.100 s	4	o	1	o	o	x	o
C55	237h	(h)		Output filter	0.000 to 0.002 to 0.100 s	4	o	1	o	o	x	o
C56	238h	(h)		Acceleration time 3	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C57	239h	(h)		Deceleration time 3	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C58	23Ah	(h)		S-curve 3 (Start side)	0 to 50 %	0	o	1	o	o	o	o
C59	23Bh	(h)		S-curve 3 (End side)	0 to 50 %	0	o	1	o	o	o	o
C60	23Ch	(h)	ASR4	P-gain	0.1 to 10.0 to 200.0 (times)	2	o	1	o	o	x	o
C61	23Dh	(h)		I-gain	0.010 to 0.200 to 1.000 s P control when setting 1.000	4	o	1	o	o	x	o
C62	23Eh	(h)		F/F-gain	0.000 to 9.999 s	4	o	1	o	o	x	o
C63	23Fh	(h)		Input filter	0.000 to 0.040 to 5.000 s	4	o	1	o	o	o	o
C64	240h	(h)		Detection filter	0.000 to 0.005 to 0.100 s	4	o	1	o	o	x	o
C65	241h	(h)		Output filter	0.000 to 0.002 to 0.100 s	4	o	1	o	o	x	o
C66	242h	(h)		Acceleration time 4	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C67	243h	(h)		Deceleration time 4	0.01 to 5.00 to 99.99s 100.0 to 999.9s 1000 to 3600s	13	o	1	o	o	o	o
C68	244h	(h)		S-curve 4 (Start side)	0 to 50 %	0	o	1	o	o	o	o
C69	245h	(h)		S-curve 4 (End side)	0 to 50 %	0	o	1	o	o	o	o
C70	246h	(h)	ASR switching time		0.00 to 1.00 to 2.55 s	3	o	1	o	o	x	o
C71	247h	165(A5 h)	ACC/DEC switching speed		0.00 to 100.00 %	3	o	1	o	o	o	o
C72	248h	166(A6 h)	ASR switching time		0.00 to 100.00 %	3	o	1	o	o	x	o
C73	249h	(h)	Creep speed select (at UP/DOWN mode)		00 to 11 (Creep Speed 1)(Creep Speed 2) 0:Function setting (C18,19) 1:Analog input (CRP-N1, CRP-N2)	9	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

P: Motor Parameters

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
P01	301h	(　h)	M1 Control method		0 to 3 0 : Vector control 1 : Sensorless vector control 2 : Simulation operation mode 3 : Vector control (Synchronous motors)	55	o	2	o	o	o	o
P02	302h	(　h)	M1 selection	M1 selection (for Motor parameter setting)	0 to 37 Display (kW,HP) changes by setting F60. 0 to 35: Settings for motors dedicated for VG7 Data at F04, F05, and P03 to P27are automatically set and write-protected. 36: P-OTHER 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.	82	o	2	o	o	x	o
P03	303h	167(A7 h)		M1-Rated capacity	0.00 to 500.00kW at F60=0 0.00 to 600.00HP at F60=1	3	o	2	o	o	x	o
P04	304h	168(A8 h)		M1-Rated current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	o
P05	305h	169(A9 h)		M1-Poles	2 to 4 to 20 (poles)	1	o	2	o	o	x	o
P06	306h	170(AA h)		M1-%R1	0.00 to 30.00 %	3	o	2	o	o	x	o
P07	307h	171(AB h)		M1-%X	0.00 to 30.00 %	3	o	2	o	o	x	o
P08	308h	172(AC h)		M1-Exciting current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	o
P09	309h	173(AD h)		M1-Torque current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	o
P10	30Ah	174(AE h)		M1-Slip (Driving)	0.001 to 10.000 Hz	4	o	2	o	o	x	x
P11	30Bh	175(AF h)		M1-Slip (Braking)	0.001 to 10.000 Hz	4	o	2	o	o	x	x
P12	30Ch	176(B0 h)		M1-Iron loss coefficient 1	0.00 to 10.00 %	3	o	2	o	o	x	o
P13	30Dh	177(B1 h)		M1-Iron loss coefficient 2	0.00 to 10.00 %	3	o	2	o	o	x	o
P14	30Eh	178(B2 h)		M1-Iron loss coefficient 3	0.00 to 10.00 %	3	o	2	o	o	x	o
P15	30Fh	179(B3 h)		M1-Magnetic satararion coefficient 1	0.0 to 100.0 %	2	o	2	o	o	x	x
P16	310h	180(B4 h)		M1-Magnetic satararion coefficient 2	0.0 to 100.0 %	2	o	2	o	o	x	x
P17	311h	181(B5 h)		M1-Magnetic satararion coefficient 3	0.0 to 100.0 %	2	o	2	o	o	x	x
P18	312h	182(B6 h)		M1-Magnetic satararion coefficient 4	0.0 to 100.0 %	2	o	2	o	o	x	x
P19	313h	183(B7 h)		M1-Magnetic satararion coefficient 5	0.0 to 100.0 %	2	o	2	o	o	x	x
P20	314h	184(B8 h)		M1-Secondary time constant	0.001 to 9.999 s	4	o	2	o	o	x	x
P21	315h	185(B9 h)		M1-Induced voltagge coefficient	0 to 999 V	0	o	2	o	o	x	o
P22	316h	186(BA h)		M1-R2 correction coefficient 1	0.500 to 5.000	4	o	2	o	o	x	x
P23	317h	187(BB h)		M1-R2 correction coefficient 2	0.500 to 5.000	4	o	2	o	o	x	x
P24	318h	188(BC h)		M1-R2 correction coefficient 3	0.010 to 5.000	4	o	2	o	o	x	x
P25	319h	189(BD h)		M1-Exciting current correction coefficient.	0.000 to 5.000	4	o	2	o	o	x	x
P26	31Ah	190(BE h)		M1-ACR-P gain	0.1 to 20.0	2	o	2	o	o	x	o
P27	31Bh	191(BF h)		M1-ACR-I gain	0.5 to 100.0 ms	2	o	2	o	o	x	o
P28	31Ch	192(C0 h)	M1-PG pulses		100 to 1024 to 60000	0	o	2	o	o	x	o
P29	31Dh	214(D6 h)	M1-External PG correction coefficient		0000 to 4000 to 7FFF	9	o	2	o	x	x	o
P30	31Eh	193(C1 h)	M1-thermistor selection		0 to 1 to 3 0 : No use thermistor 1 : NTC thermistor 2 : PTC thermistor 3 : Ai (M-TMP) Please do the protection level setting of the motor at E30-E32.	84	o	2	o	o	x	o

You can change the setting of a function indicated by [grey box] during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

H: High Performance Functions

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
H01	401h	(h)	Tuning operation selection		0 to 4 After writing the data, this function's data code automatically returns to 0. 0 : Inactive 1 : ASR system tuning 2 : R1,Lσ tuning 3 : Motor parameters tuning at stopping mode 4 : Motor parameters tuning at runing mode The data after the tuning goes out when the power supply is turned off. H02 “All save function" must operate when the maintenance (preservation) of the data is necessary.	61	x	0	o	o	o	x
H02	402h	14(E h)	All Save Function		0 to 1 When tuning is executed at H01 and the internal data is written, or when the data is written by way of the link system (T-Link, field bus, and RS458, etc.), the data goes out when the power supply of the inverter is turned off. This function must operate when preservation is necessary. After writing the data, this function's data code automatically returns to 0.	11	x	0	o	o	o	o
H03	403h	(h)	Data initializing (Data reset)		0 to 1 The data which the customer rewrote is returned to the state of the factory setting value. Target functions for initialization are all fields of F, E, C, H, o, L, and U except motor parameter field (P,A). After writing the data, this function's data code automatically returns to 0.	11	x	0	o	o	o	o
H04	404h	(h)	Auto-reset (Times)		0 to 10 0 : (Inactive) 1 to 10 times The auto-resetting signal can be output to the output terminal.	0	o	1	o	o	o	o
H05	405h	(h)	Auto-reset (Reset interval)		0.01 to 5.00 to20.00 s	3	o	1	o	o	o	o
H06	406h	(h)	Fan stop operation		0 to 1 The temperature of the cooling fan in the inverter is detected and it is a function to control the cooling fan automatically ON/OFF. It always rotates when inactive is selected. 0 : Inactive 1 : Active The signal indicating the cooling fan operation can be output by synchronizing with this function.	68	o	1	o	o	o	o
H08	408h	(h)	Rev.phase sequence lock		0 to 1 0 : Inactive 1 : Active	68	o	1	o	o	x	o
H09	409h	194(C2 h)	Start mode (rotating motor pick up)		0 to 2 0 : Inactive 1 : Active (at after momentary power failure) 2 : Active (at all start mode)	0	o	1	o	o	o	o
H10	40Ah	195(C3 h)	Energy-saving operation		0 to 1 0 : Inactive 1 : Active	68	o	1	o	o	x	o
H11	40Bh	(h)	Automatic operation OFF function		0 to 2 It is a function when becoming following the stop speed setting to turn off the inverter automatically. 0 : Deceleration stop with FWD or REV shorted to CM between FWD-CM and REV-CM. 1 : The inverter is turned off below the stop speed even for ON between FWD-CM and REV-CM. 2: Coast-to-stop with FWD or REV shorted to CM	0	o	1	o	o	o	o
H13	40Dh	196(C4 h)	Restart after momentary power failure	Restart waiting time	0.1 to 0.5 to 5.0 s	2	o	1	o	o	o	o
H14	40Eh	(h)		Fall rate	1 to 500 to 3600 (r/min/s)	0	o	1	o	o	o	o
H15	40Fh	(h)		Holding voltage on continuous operation	3ph 200V : 200 to 235 to 300V 3ph 400V : 400 to 470 to 600V	0	o	1	o	o	o	o

You can change the setting of a function indicated by ▒ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
H16	410h	(h)		Operation command selfhold setting	<u>0</u> to 1 0 : Set at H17 1 : Maximum time (The inverter judges that it is a power failure momentarily and self-maintains the operation command while the control power supply in the inverter establishes or until the main circuit DC voltage becomes almost 0.)	94	o	1	o	o	o	o
H17	411h	(h)		Operation command selfhold time	0.0 to <u>30.0</u> s	2	o	1	o	o	o	o
H19	413h	197(C5 h)	Active Drive		<u>0</u> to 1 0 : Inactive 1 : Active	68	o	1	o	o	x	o
H20	414h	198(C6 h)	PID control	PID control (Mode select)	<u>0</u> to 2 0 : Inactive 1 : Active (normal mode output) 2 : Active (inverse mode output)	69	o	1	o	o	x	o
H21	415h	199(C7 h)		Command select	<u>0</u> to 1 0 : Keypad panel or 12 input 1 : Analog input (PIDS)	70	o	1	o	o	x	o
H22	416h	201(C9 h)		P-gain	0.000 to <u>1.000</u> to 10.000 (times)	4	o	1	o	o	x	o
H23	417h	202(CA h)		I-gain	0.00 to <u>1.00</u> to 100.00 s	3	o	1	o	o	x	o
H24	418h	203(CB h)		D-gain	<u>0.000</u> to 10.000 s	4	o	1	o	o	x	o
H25	419h	200(C8 h)		PID control (Upper limit)	-300 to <u>100</u> to 300 %	5	o	1	o	o	x	o
H26	41Ah	204(CC h)		PID control (Lower limit)	-300 to <u>-100</u> to 300 %	5	o	1	o	o	x	o
H27	41Bh	206(CE h)		PID control (Speed reference)	<u>0</u> to 2 0 : Inactive 1 : PID select 2 : Auxiliary speed	95	o	1	o	o	x	o
H28	41Ch	207(CF h)	Droop control		<u>0.0</u> to 25.0 %	2	o	1	o	o	x	o
H29	41Dh	(h)	Link function	Data protect via serial link	<u>0</u> to 1 Function not to write data from link (T-Link, RS485, etc.) by mistake. 0 : Non-protect 1 : Protect via serial link There are two writing from the link about usual function field and serial data field. This S field is defined at H30.	40	o	1	o	o	o	o
H30	41Eh	208(D0 h)		Serial link (Function select)	<u>0</u> to 3 (Monitor) (Speed reference) (Operation command) 0 : o x x 1 : o o x 2 : o x o 3 : o o o	72	o	1	o	o	o	o
H31	41Fh	(h)	RS485	RS485 (Address)	0 to <u>1</u> to 255 Setting of the station address of RS485. broadcast : (0 : RTU) , (99 : Fuji) address : 1 to 255	0	o	2	o	o	o	o
H32	420h	(h)		RS485 (Mode select on no response error)	0 to <u>3</u> 0 : Trip and alarm (Er5) 1 : Operation for H33 timer , and alarm (Er5) 2 : Operation for H33 timer , and retry to communicate. * If the retry fails, then the inverter trips. ("Er5") 3 : Continuous operation	73	o	1	o	o	o	o
H33	421h	(h)		RS485 (Timer)	0.01 to <u>2.00</u> to 20.00 s	3	o	1	o	o	o	o
H34	422h	(h)		RS485 (Baud rate)	<u>0</u> to 4 0 : 38400 bps 1 : 19200 bps 2 : 9600 bps 3 : 4800 bps 4 : 2400 bps	74	o	2	o	o	o	o
H35	423h	(h)		RS485 (Data length)	<u>0</u> to 1 0 : 8 bits 1 : 7 bits	75	o	2	o	o	o	o
H36	424h	(h)		RS485 (Parity check)	0 to <u>1</u> to 2 0 : No checking 1 : Even parity 2 : Odd parity	76	o	2	o	o	o	o
H37	425h	(h)		RS485 (Stop bits)	0 to <u>1</u> 0 : 2 bits 1 : 1 bit	77	o	2	o	o	o	o

You can change the setting of a function indicated by ▢ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
H38	426h	(h)		RS485 (No response error detection time)	0.0 to 60.0 s 0.0 : Detection of communication break invalid 0.1 to 60.0s : Detection of communication break valid It is a function to do Er5 trip detecting the access disappearing for each station which includes an own station in the set time due to some abnormality (no response etc.) from operation via RS485.	2	o	1	o	o	o	o
H39	427h	(h)		RS485 (Response interval)	0.00 to 0.05 to 1.00 s The time to return the response is set to the demand by a host device.	3	o	1	o	o	o	o
H40	428h	(h)		RS485 (Protocol)	0 to 1 to 2 0 : FUJI inverter protocol 1 : SX bus (FUJI private link) protocol 2 : Modbus RTU protocol Please set 1 (SX bus protocol) when you use the PC loader of the VG7 exclusive use.	78	o	2	o	o	o	o
H41	429h	209(D1 h)	Torque reference selection	Torque reference selection	0 to 5 0 : Internal ASR output 1 : AI terminal input (T-REF) 2 : DIA card input 3 : DIB card input 4 : Link input 5 : PID	64	o	1	o	o	x	o
H42	42Ah	210(D2 h)		Torque current reference selection	0 to 4 0 : Internal ASR output 1 : AI terminal input (IT-REF) 2 : DIA card input 3 : DIB card input 4 : Link input	65	o	1	o	o	x	o
H43	42Bh	211(D3 h)		Magnetic flux reference selection	0 to 3 0 : Internal calculation value 1 : AI terminal input (MF-REF) 2 : Function setting value (H44) 3 : Link input	66	o	1	o	o	x	x
H44	42Ch	212(D4 h)		Magnetic flux reference value	10 to 100 %	16	o	1	o	o	x	x
H46	42Eh	215(D7 h)	Observer (Mode select)	Observer (Mode select)	0 to 2 0 : Inactive 1 : Active (load disturbance observer) 2 : Active (oscillation suppressing observer)	79	o	1	o	o	x	o
H47	42Fh	216(D8 h)		(P-gain 1)(M1)	0.00 to 1.00 (times)	3	o	1	o	o	x	o
H48	430h	(h)		(P-gain 2)(M2)	0.00 to 1.00 (times)	3	o	1	o	o	x	o
H49	431h	217(D9 h)		(I-gain 1)(M1)	0.005 to 0.100 to 1.000 s	4	o	1	o	o	x	o
H50	432h	(h)		(I-gain 2)(M2)	0.005 to 0.100 to 1.000 s	4	o	1	o	o	x	o
H51	433h	218(DA h)		Load inertia M1	0.001 to 50.000 (kg.m^2)	4	o	2	o	o	x	o
H52	434h	(h)		Load inertia M2	0.001 to 50.000 (kg.m^2)	4	o	2	o	o	x	o
H53	435h	213(D5 h)	Line speed feedback selection		0 to 3 0 : Line speed disabled 1 : Line speed (analog input) (AI-LINE) 2 : Line speed (digital input) (PG(LD)) 3 : High level selected signal	67	o	1	o	x	x	o
H55	437h	(h)	Zero speed control	Gain	0 to 5 to 100 (times)	0	o	1	o	x	x	o
H56	438h	(h)		Completion range	0 to 100 (pulse)	0	o	1	o	x	x	o
H57	439h	(h)	OU trip prevention	OU trip prevention	0 to 1 0 : Inactive 1 : Active	68	o	1	o	o	o	o
H58	43Ah	(h)		OC trip prevention	0 to 1 0 : Inactive 1 : Active	68	o	1	o	o	o	o
H60	43Ch	(h)	Load adaptive control function 1	Load adaptive control function 1	0 to 3 0 : Inactive 1 : Method 1 2 : Method 2 3 : Method 3	80	o	1	o	x	x	o
H61	43Dh	(h)		Load adaptive control function 2	0 to 1 0 : Winding up on forward rotation 1 : Winding down on forward rotation	81	o	1	o	x	x	o
H62	43Eh	(h)		Winding up speed	0.0 to 999.9 m/min	2	o	1	o	x	x	o
H63	43Fh	(h)		Counter weight	0.00 to 600.00 (t)	3	o	1	o	x	x	o

You can change the setting of a function indicated by ▢ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
H64	440h	(h)		Safety coefficient (for rated torque)	0.50 to 1.00 to 1.20	3	o	1	o	x	x	o
H65	441h	(h)		Machine efficiency	0.500 to 1.000	4	o	1	o	x	x	o
H66	442h	(h)		Rated loading	0.00 to 600.00 (t)	3	o	1	o	x	x	o
H68	444h	(h)	Alarm data delete		0 to 1 If these tuning are finished, this data code returns to 0.	11	x	0	o	o	o	o
H70	446h	(h)	Reserved	Reserved 1	0 to 9999 0 : Standard 1 : Lift 2 to 9999 : Undecided	0	o	2	o	o	x	o
H71	447h	(h)		Reserved 2	0 to 6 It is not necessary to set usually. If these tuning are finished, this data code returns to 0. 0 : Inactive 1 : ACR system tuning 2 : Voltage gain tuning (execution without connecting motor) 3 : Voltage sensor offset tuning 4 : Current sensor balance tuning 5 : Magnet pole position tuning (for SM driving) 6 : Shunt resistor gain tuning	62	x	0	o	o	o	o
H72	448h	(h)		Reserved 3	0 to 9999 0 : standard 1 to 9999 : Undecided (Displayed when n-code can be displayed or the display mask function is cancelled (N40=2)).	0	x	2	o	o	o	o
H73	449h	(h)		Reserved 4	0 to 9999 0 : standard 1 to 9999 : Undecided (Displayed when n-code can be displayed or the display mask function is cancelled (N40=2)).	0	x	2	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

A: Alternative Motor Parameters

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
A01	501h	(h)	Setting M2 parameter	M2-Control method	0 to 1 M2 is an induction motor only for the vector control. 0 : Vector control with PG 1 : Vector control without PG	55	o	2	o	o	x	x
A02	502h	(h)		M2-Rated capacity	0.00 to 500.00kW at F60=0 0.00 to 600.00HP at F60=1	3	o	2	o	o	x	x
A03	503h	(h)		M2-Rated current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	x
A04	504h	(h)		M2-Rated voltage	80 to 999 V	0	o	2	o	o	x	x
A05	505h	(h)		M2-Rated speed	50 to 1500 to 24000 r/min	0	o	2	o	o	x	x
A06	506h	(h)		M2-Maximum speed	50 to 1500 to 24000 r/min	0	o	2	o	o	x	x
A07	507h	(h)		M2-Poles	2 to 4 to 12 (poles)	1	o	2	o	o	x	x
A08	508h	(h)		M2-%R1	0.00 to 30.00 %	3	o	2	o	o	x	x
A09	509h	(h)		M2-%X	0.00 to 30.00 %	3	o	2	o	o	x	x
A10	50Ah	(h)		M2-Exciting current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	x
A11	50Bh	(h)		M2-Torque current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	x
A12	50Ch	(h)		M2-Slip (Driving)	0.001 to 10.000 Hz	4	o	2	o	o	x	x
A13	50Dh	(h)		M2-Slip (Braking)	0.001 to 10.000 Hz	4	o	2	o	o	x	x
A14	50Eh	(h)		M2-Iron loss coefficient 1	0.00 to 10.00 %	3	o	2	o	o	x	x
A15	50Fh	(h)		M2-Iron loss coefficient 2	0.00 to 10.00 %	3	o	2	o	o	x	x
A16	510h	(h)		M2-Iron loss coefficient 3	0.00 to 10.00 %	3	o	2	o	o	x	x
A17	511h	(h)		M2-Magnetic saturation coefficient 1	0.0 to 100.0 %	2	o	2	o	o	x	x
A18	512h	(h)		M2-Magnetic saturation coefficient 2	0.0 to 100.0 %	2	o	2	o	o	x	x

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address: 485 number	Communication address: Link number	Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available: PG	LES	VF	SM
A19	513h	(h)		M2-Magnetic saturation coefficient 3	0.0 to 100.0 %	2	o	2	o	o	x	x
A20	514h	(h)		M2-Magnetic saturation coefficient 4	0.0 to 100.0 %	2	o	2	o	o	x	x
A21	515h	(h)		M2-Magnetic saturation coefficient 5	0.0 to 100.0 %	2	o	2	o	o	x	x
A22	516h	(h)		M2-Secondary time constant	0.001 to 9.999 s	4	o	2	o	o	x	x
A23	517h	(h)		M2-Induced voltage coefficient	0 to 999 V	0	o	2	o	o	x	x
A24	518h	(h)		M2-R2 correction coefficient 1	0.000 to 5.000	4	o	2	o	o	x	x
A25	519h	(h)		M2-R2 correction coefficient 2	0.000 to 5.000	4	o	2	o	o	x	x
A26	51Ah	(h)		M2-R2 correction coefficient 3	0.010 to 5.000	4	o	2	o	o	x	x
A27	51Bh	(h)		M2-Exciting current correction coefficient	0.000 to 5.000	4	o	2	o	o	x	x
A28	51Ch	(h)		M2-ACR-P gain	0.1 to 1.0 to 20.0	2	o	2	o	o	x	x
A29	51Dh	(h)		M2-ACR-I gain	0.5 to 1.0 to 100.0 ms	2	o	2	o	o	x	x
A30	51Eh	(h)	M2-PG pulses		100 to 1024 to 60000	0	o	2	o	x	x	x
A31	51Fh	(h)	M2-thermistor selection		0 to 1 to 3 0 : No use thermistor 1 : NTC thermistor 2 : PTC thermistor 3 : Ai (M-TMP) Please do the protection level setting of the motor at E30-E32.	84	o	2	o	o	x	x
A32	520h	(h)	M2-Electronic thermal overload relay (selection)	M2-Electronic thermal overload relay (Selection)	0 to 2 The motor overheating protection operates by using NTC thermistor with the motor only for VG. In this case, please make setting a Electronic thermal "Inactive". 0 : Inactive 1 : Active (for standard motor, self-cooling fan) 2 : Active (for inverter motor, separate cooling fan)	85	o	2	o	o	x	x
A33	521h	(h)		M2-Electronic thermal overload relay (Level)	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	o	o	x	x
A34	522h	(h)		M2-Electronic thermal overload relay (Thermal time constant)	0.5 to 75.0 min	2	o	2	o	o	x	x
A35	523h	229(E5 h)	Setting M3 parameter for V/F control motor	M3-Rated capacity	0.00 to 500.00kW at F60=0 0.00 to 600.00HP at F60=1	3	o	2	x	x	o	x
A36	524h	230(E6 h)		M3-Rated current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	x	x	o	x
A37	525h	231(E7 h)		M3-Rated voltage	80 to 999 V	0	o	2	x	x	o	x
A38	526h	232(E8 h)		M3-Maximum voltage	80 to 999 V	0	o	2	x	x	o	x
A39	527h	233(E9 h)		M3-Rated speed	50 to 1500 to 24000 r/min	0	o	2	x	x	o	x
A40	528h	234(EA h)		M3-Maximum speed	50 to 1500 to 24000 r/min	0	o	2	x	x	o	x
A41	529h	235(EB h)		M3-Poles	2 to 4 to 12 (poles)	1	o	2	x	x	o	x
A42	52Ah	236(EC h)		M3-%R1	0.00 to 30.00 %	3	o	2	x	x	o	x
A43	52Bh	237(ED h)		M3-%X	0.00 to 30.00 %	3	o	2	x	x	o	x
A44	52Ch	238(EE h)		M3-Exciting current	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	x	x	o	x
A45	52Dh	239(EF h)		M3-Slip compensation control	-20.000 to 0.000 to 5.000 Hz	8	o	2	x	x	o	x
A46	52Eh	240(F0 h)	M3-Torque boost		0.0 to 20.0 0.0 : Automatic torque boost (for CT load) 0.1 to 0.9 : Manual torque boost (for Square torque load) 1.0 to 1.9 : Manual torque boost (for VT load) 2.0 to 20.0 : Manual torque boost (for CT load)	2	o	2	x	x	o	x
A47	52Fh	241(F1 h)	M3-Thermistor selection		0 to 1 to 3 0 : No use thermistor 1 : NTC thermistor 2 : PTC thermistor 3 : Ai (M-TMP) Please do the protection level setting of the motor at E30-E37.	84	o	2	x	x	o	x

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
A48	530h	242(F2 h)	M3-Electronic thermal overload relay (selection)	M3-Electronic thermal overload relay (Selection)	0 to 2 0 : Inactive (when using PTC thermistor) 1 : Active (for standard motor, self-cooling fan) 2 : Active (for inverter motor, separate-cooling fan)	85	o	2	x	x	o	x
A49	531h	243(F3 h)		M3-Electronic thermal overload relay (Level)	0.01 to 99.99A 100.0 to 999.9A 1000 to 2000A	13	o	2	x	x	o	x
A50	532h	244(F4 h)		M3-Electronic thermal overload relay (Thermal time constant)	0.5 to 75.0 min	2	o	2	x	x	o	x

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

O: Optional Functions

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
o01	601h	245(F5 h)	DIA , DIB option setting	DIA function select	0 to 1 0 : Binary 1 : BCD	86	o	1	o	o	o	o
o02	602h	246(F6 h)		DIB function select	0 to 1 0 : Binary 1 : BCD	86	o	1	o	o	o	o
o03	603h	(h)		DIA BCD input speed setting	99 to 1000 to 7999	0	o	1	o	o	o	o
o04	604h	(h)		DIB BCD input speed setting	99 to 1000 to 7999	0	o	1	o	o	o	o
o05	605h	(h)	PG (PD) option setting	Pulse feedback select	0 to 1 0 : Build-in PG 1 : PG(PD) option	96	o	1	o	x	x	o
o06	606h	(h)	PG (LD) option setting	Line speed detection (digital) (PG pulses)	100 to 1024 to 60000 (P/R)	0	o	1	o	o	x	o
o07	607h	(h)		Line speed detection (digital) (Pulse correction function 1)	0 to 1000 to 9999	0	o	1	o	o	x	o
o08	608h	(h)		Line speed detection (digital) (Pulse correction function 2)	0 to 1000 to 9999	0	o	1	o	o	x	o
o09	609h	(h)	PMPG option setting	Definition of absolute PG signal input	0 to 16	0	o	1	x	x	x	o
o10	60Ah	(h)		Magnetic pole position offset	0000 to 03FF	9	o	1	x	x	x	o
o11	60Bh	(h)		Salient pole ratio	1.000 to 3.000	4	o	1	x	x	x	o
o12	60Ch	(h)	PG (PR) pulse-string option setting	Pulse reference select	0 to 1 0 : PG(PR) option 1 : Internal input	97	o	1	o	x	x	o
o13	60Dh	(h)		Pulse train input form selection	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	98	o	1	o	x	x	o
o14	60Eh	247(F7 h)		Reference pulse correction 1	0 to 1000 to 9999	0	o	1	o	x	x	o
o15	60Fh	248(F8 h)		Reference pulse correction 2	0 to 1000 to 9999	0	o	1	o	x	x	o
o16	610h	249(F9 h)		APR P-gain	0.0 to 10.0 to 999.9 (times)	2	o	1	o	x	x	o
o17	611h	250(FA h)		Feed forward gain	0.0 to 1.5 (times)	2	o	1	o	x	x	o
o18	612h	(h)		Deviation over width	0 to 65535 (pulse)	0	o	1	o	x	x	o
o19	613h	(h)		Deviation zero width	0 to 20 to 1000 (pulse)	0	o	1	o	x	x	o
o30	61Eh	(h)	Field option setting	Action on communication error	0 to 3 0: Forced stop 1: Stops after preset operation time. 2: Stops if transmission error continues longer than the operation time. 3 : Continuous operation.	73	o	1	o	o	o	o
o31	61Fh	(h)		LINK error (Timer)	0.01 to 0.10 to 20.00 s	3	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
o32	620h	(h)		LINK format select	0 to 1 0 : 4W + 4W 1 : 8W + 8W	87	o	2	o	o	o	o
o33	621h	253(FD h)	SI (MWS) option setting	Multi-winding motor system (mode)	0 to 1 0 : Inactive 1 : Active	68	o	1	o	o	x	o
o34	622h	(h)		Multi-winding motor system (Slave station number)	1 to 5 The numbers of slave units except master unit are set when multi-winding motor system is effective.	0	o	1	o	o	x	o
o35	623h	(h)	SI (UPAC) option setting	SI PARA1	0000 to FFFF	9	o	1	o	o	o	o
o36	624h	(h)		SI PARA2	0000 to FFFF	9	o	1	o	o	o	o
o37	625h	(h)		SI PARA3	0000 to FFFF	9	o	1	o	o	o	o
o38	626h	(h)	UPAC (Mode)	UPAC (Start/stop)	0 to 2 0 : Stop UPAC 1 : Start UPAC 2 : Start UPAC (Intialized start) Definition whether the instruction data from UPAC option is made active or inactive.	68	o	1	o	o	o	o
o39	627h	(h)		UPAC memory	0000 to 001F When the UPAC stop is changed, a pertinent field is set. 0 : Hold 1 : zero clear 1bit : IQ field 2bit : M field 3bit : RM field 4bit : FM field 5bit : SFM field	9	o	1	o	o	o	o
o40	628h	(h)		UPAC address	100 to 255 Setting of UPAC address number in which RS485 communication is used when personal-computer accesses UPAC application.	0	o	2	o	o	o	o
o41	629h	(h)		UPAC slave station number	0 to 11 Number of slave station inverters when two or more inverters are driven by using SI option communication as master inverter equipped with UPAC option.	0	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

L: Lift Functions

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
L01	901h	(h)	Password data 1		0 to 9999	0	o	2	o	o	x	o
L02	902h	(h)	Password data 2		0 to 9999	0	o	2	o	o	x	o
L03	903h	(h)	Lift rated speed		0.0 to 100.0 to 999.9 m/min	2	o	1	o	o	x	o
L04	904h	(h)	Preset S-curve (selection)	Preset S-curve	0 to 2 0 : Inactive <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, and SS4 all OFF.	80	o	1	o	o	x	o
L05	905h	(h)		S-curve 1	0 to 50 %	0	o	1	o	o	x	o
L06	906h	(h)		S-curve 2	0 to 50 %	0	o	1	o	o	x	o
L07	907h	(h)		S-curve 3	0 to 50 %	0	o	1	o	o	x	o
L08	908h	(h)		S-curve 4	0 to 50 %	0	o	1	o	o	x	o
L09	909h	(h)		S-curve 5	0 to 50 %	0	o	1	o	o	x	o
L10	90Ah	(h)		S-curve 6	0 to 50 %	0	o	1	o	o	x	o
L11	90Bh	(h)		S-curve 7	0 to 50 %	0	o	1	o	o	x	o
L12	90Ch	(h)		S-curve 8	0 to 50 %	0	o	1	o	o	x	o
L13	90Dh	(h)		S-curve 9	0 to 50 %	0	o	1	o	o	x	o
L14	90Eh	(h)		S-curve 10	0 to 50 %	0	o	1	o	o	x	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

U: User Functions

Fcode	Communication address: 485 number	Communication address: Link number	Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available: PG	LES	VF	SM
U01	B01h	219(DB h)	USER P1		-32768 to 32767	5	o	1	o	o	o	o
U02	B02h	220(DC h)	USER P2		-32768 to 32767	5	o	1	o	o	o	o
U03	B03h	221(DD h)	USER P3		-32768 to 32767	5	o	1	o	o	o	o
U04	B04h	222(DE h)	USER P4		-32768 to 32767	5	o	1	o	o	o	o
U05	B05h	223(DF h)	USER P5		-32768 to 32767	5	o	1	o	o	o	o
U06	B06h	224(E0 h)	USER P6		-32768 to 32767	5	o	1	o	o	o	o
U07	B07h	225(E1 h)	USER P7		-32768 to 32767	5	o	1	o	o	o	o
U08	B08h	226(E2 h)	USER P8		-32768 to 32767	5	o	1	o	o	o	o
U09	B09h	227(E3 h)	USER P9		-32768 to 32767	5	o	1	o	o	o	o
U10	B0Ah	228(E4 h)	USER P10		-32768 to 32767	5	o	1	o	o	o	o
U11	B0Bh	(h)	USER P11		-32768 to 32767	5	o	1	o	o	o	o
U12	B0Ch	(h)	USER P12		-32768 to 32767	5	o	1	o	o	o	o
U13	B0Dh	(h)	USER P13		-32768 to 32767	5	o	1	o	o	o	o
U14	B0Eh	(h)	USER P14		-32768 to 32767	5	o	1	o	o	o	o
U15	B0Fh	(h)	USER P15		-32768 to 32767	5	o	1	o	o	o	o
U16	B10h	(h)	USER P16		-32768 to 32767	5	o	1	o	o	o	o
U17	B11h	(h)	USER P17		-32768 to 32767	5	o	1	o	o	o	o
U18	B12h	(h)	USER P18		-32768 to 32767	5	o	1	o	o	o	o
U19	B13h	(h)	USER P19		-32768 to 32767	5	o	1	o	o	o	o
U20	B14h	(h)	USER P20		-32768 to 32767	5	o	1	o	o	o	o
U21	B15h	(h)	USER P21		-32768 to 32767	5	o	1	o	o	o	o
U22	B16h	(h)	USER P22		-32768 to 32767	5	o	1	o	o	o	o
U23	B17h	(h)	USER P23		-32768 to 32767	5	o	1	o	o	o	o
U24	B18h	(h)	USER P24		-32768 to 32767	5	o	1	o	o	o	o
U25	B19h	(h)	USER P25		-32768 to 32767	5	o	1	o	o	o	o
U26	B1Ah	(h)	USER P26		-32768 to 32767	5	o	1	o	o	o	o
U27	B1Bh	(h)	USER P27		-32768 to 32767	5	o	1	o	o	o	o
U28	B1Ch	(h)	USER P28		-32768 to 32767	5	o	1	o	o	o	o
U29	B1Dh	(h)	USER P29		-32768 to 32767	5	o	1	o	o	o	o
U30	B1Eh	(h)	USER P30		-32768 to 32767	5	o	1	o	o	o	o
U31	B1Fh	(h)	USER P31		-32768 to 32767	5	o	1	o	o	o	o
U32	B20h	(h)	USER P32		-32768 to 32767	5	o	1	o	o	o	o
U33	B21h	(h)	USER P33		-32768 to 32767	5	o	1	o	o	o	o
U34	B22h	(h)	USER P34		-32768 to 32767	5	o	1	o	o	o	o
U35	B23h	(h)	USER P35		-32768 to 32767	5	o	1	o	o	o	o
U36	B24h	(h)	USER P36		-32768 to 32767	5	o	1	o	o	o	o
U37	B25h	(h)	USER P37		-32768 to 32767	5	o	1	o	o	o	o
U38	B26h	(h)	USER P38		-32768 to 32767	5	o	1	o	o	o	o
U39	B27h	(h)	USER P39		-32768 to 32767	5	o	1	o	o	o	o
U40	B28h	(h)	USER P40		-32768 to 32767	5	o	1	o	o	o	o
U41	B29h	(h)	USER P41		-32768 to 32767	5	o	1	o	o	o	o
U42	B2Ah	(h)	USER P42		-32768 to 32767	5	o	1	o	o	o	o
U43	B2Bh	(h)	USER P43		-32768 to 32767	5	o	1	o	o	o	o
U44	B2Ch	(h)	USER P44		-32768 to 32767	5	o	1	o	o	o	o
U45	B2Dh	(h)	USER P45		-32768 to 32767	5	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12. Function Code List

Fcode	Communication address		Function name	Function directory name	Setting range	Type	Copy	Initialization	Control type: Available/ Not available			
	485 number	Link number							PG	LES	VF	SM
U46	B2Eh	(h)	USER P46		-32768 to 32767	5	o	1	o	o	o	o
U47	B2Fh	(h)	USER P47		-32768 to 32767	5	o	1	o	o	o	o
U48	B30h	(h)	USER P48		-32768 to 32767	5	o	1	o	o	o	o
U49	B31h	(h)	USER P49		-32768 to 32767	5	o	1	o	o	o	o
U50	B32h	(h)	USER P50		-32768 to 32767	5	o	1	o	o	o	o
U51	B33h	(h)	USER P51		-32768 to 32767	5	o	1	o	o	o	o
U52	B34h	(h)	USER P52		-32768 to 32767	5	o	1	o	o	o	o
U53	B35h	(h)	USER P53		-32768 to 32767	5	o	1	o	o	o	o
U54	B36h	(h)	USER P54		-32768 to 32767	5	o	1	o	o	o	o
U55	B37h	(h)	USER P55		-32768 to 32767	5	o	1	o	o	o	o
U56	B38h	(h)	USER P56		-32768 to 32767	5	o	1	o	o	o	o
U57	B39h	(h)	USER P57		-32768 to 32767	5	o	1	o	o	o	o
U58	B3Ah	(h)	USER P58		-32768 to 32767	5	o	1	o	o	o	o
U59	B3Bh	(h)	USER P59		-32768 to 32767	5	o	1	o	o	o	o
U60	B3Ch	(h)	USER P60		-32768 to 32767	5	o	1	o	o	o	o
U61	B3Dh	(h)	USER P61		-32768 to 32767	5	o	1	o	o	o	o
U62	B3Eh	(h)	USER P62		-32768 to 32767	5	o	1	o	o	o	o
U63	B3Fh	(h)	USER P63		-32768 to 32767	5	o	1	o	o	o	o
U64	B40h	(h)	USER P64		-32768 to 32767	5	o	1	o	o	o	o

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

12.3 Function Code List Dedicated for Communication

You can refer to or change the following functions only through the integrated RS485 or the field bus options (T-Link, SX, field bus). The S area is write-only and the M area is read-only. The S and the M areas are common to FUJI inverters. Any FUJI inverters that you can link to communication system can use these areas.
See 12.4 "Data Format List" to refer to or change a function code after you check the "Type" column of the function code in the list.

12.3.1 S Function Code

This is a write-only area. You should use the function code H30 "Serial link" to initialize. See the function description of H30 for more details.

Fcode	Communication address		Function code name	Setting range	Min increment	Unit	Type
	485 number	Link number					
S01	701h	1(1 h)	Frequency/speed reference (Setting 1)	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
S02	702h	2(2 h)	Torque reference	0.01% / 1d	0.01	%	7
S03	703h	3(3 h)	Torque current reference	0.01% / 1d	0.01	%	7
S04	704h	4(4 h)	Magnetic-flux reference	0.01% / 1d	0.01	%	7
S05	705h	5(5 h)	Orientation position reference	0000 to FFFF	1	-	9
S06	706h	6(6 h)	Operation method 1	0000 to FFFF	1	-	32
S07	707h	7(7 h)	Universal Do	0000 to FFFF	1	-	33
S08	708h	8(8 h)	Acceleration time	0.0 to 3600.0 s	0.1	s	2
S09	709h	9(9 h)	Deceleration time	0.0 to 3600.0 s	0.1	s	2
S10	70Ah	10(A h)	Torque limiter level 1	0.01% / 1d	0.01	%	7
S11	70Bh	11(B h)	Torque limiter level 2	0.01% / 1d	0.01	%	7
S12	70Ch	12(C h)	Operation method 2	0000 to FFFF	1	-	9

12.3.2 M Function Code

This is a read-only area. You can always access this area without any restrictions.

Fcode	Communication address		Function code name	Setting range	Min increment	Unit	Type
	485 number	Link number					
M01	801h	15(F h)	Speed setting 4 (ASR input)	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M02	802h	16(10 h)	Torque reference	0.01% / 1d	0.01	%	7
M03	803h	17(11 h)	Toque current reference	0.01% / 1d	0.01	%	7
M04	804h	18(12 h)	Magnetic-flux reference	0.01% / 1d	0.01	%	7
M05	805h	19(13 h)	Output frequency reference	0.1Hz / 1d	0.1	Hz	2
M06	806h	20(14 h)	Detected speed value	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M07	807h	21(15 h)	Calculated torque value	0.01% / 1d	0.01	%	7
M08	808h	22(16 h)	Calculated torque current value	0.01% / 1d	0.01	%	7
M09	809h	23(17 h)	Output frequency	0.1Hz / 1d	0.1	Hz	2
M10	80Ah	24(18 h)	Motor output	0.1kW / 1d	0.1	kW	2
M11	80Bh	25(19 h)	Output current rms value	0.1A / 1d	0.1	A	2
M12	80Ch	26(1A h)	Output voltage rms value	0.1V / 1d	0.1	V	2

12. Function Code List

Fcode	Communication address		Function code name	Setting range	Min increment	Unit	Type
	485 number	Link number					
M13	80Dh	27(1B h)	Operation method (final command)	0000 to FFFF	1	-	32
M14	80Eh	28(1C h)	Operation status	0000 to FFFF	1	-	21
M15	80Fh	29(1D h)	Output terminals Y1 - Y18	0000 to FFFF	1	-	33
M16	810h	30(1E h)	Latest alarm data	0 to 48	1	-	14
M17	811h	31(1F h)	Last alarm data	0 to 48	1	-	15
M18	812h	32(20 h)	Second last alarm data	0 to 48	1	-	15
M19	813h	33(21 h)	Third last alarm data	0 to 48	1	-	15
M20	814h	34(22 h)	Accumulated operation time	0 to 65535 h	1	h	0
M21	815h	35(23 h)	DC link circuit voltage	1V / 1d	1	V	0
M22	816h	36(24 h)	Motor temperature	1°C / 1d	1	°C	5
M23	817h	37(25 h)	Type code	0000 to FFFF	1	-	29
M24	818h	38(26 h)	Capacity code	0 to 29	1	-	28
M25	819h	39(27 h)	Inverter ROM (main control) version	0000 to FFFF	1	-	9
M26	81Ah	40(28 h)	Communication error code	0 to 65535	1	-	34
M27	81Bh	41(29 h)	Speed setting on alarm	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M28	81Ch	42(2A h)	Torque reterence on alarm	0.01% / 1d	0.01	%	7
M29	81Dh	43(2B h)	Torque current reference on alarm	0.01% / 1d	0.01	%	7
M30	81Eh	44(2C h)	Magnetic-flux reference on alarm	0.01% / 1d	0.01	%	3
M31	81Fh	45(2D h)	Output frequency reference on alarm	0.1Hz / 1d	0.1	Hz	2
M32	820h	46(2E h)	Detected speed on alarm	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M33	821h	47(2F h)	Calculated torque on alarm	0.01% / 1d	0.01	%	7
M34	822h	48(30 h)	Calculated torque current on alarm	0.01% / 1d	0.01	%	7
M35	823h	49(31 h)	Output frequency on alarm	0.1Hz / 1d	0.1	Hz	2
M36	824h	50(32 h)	Motor output on alarm	0.1kW / 1d	0.1	kW	2
M37	825h	51(33 h)	Output current rms value on alarm	0.1A / 1d	0.1	A	2
M38	826h	52(34 h)	Output voltage rms value on alarm	0.1V / 1d	0.1	V	2
M39	827h	53(35 h)	Operation method on alarm	0000 to FFFF	1	-	32
M40	828h	54(36 h)	Operation status on alarm	0000 to FFFF	1	-	21
M41	829h	55(37 h)	Output terminal on alarm	0000 to FFFF	1	-	33
M42	82Ah	56(38 h)	Accumulated operation time on alarm	0 to 65535 h	1	h	0
M43	82Bh	57(39 h)	DC link circuit voltage on alarm	0.1V / 1d	0.1	V	2
M44	82Ch	58(3A h)	Inverter intemal temperature on alarm	1°C / 1d	1	°C	6
M45	82Dh	59(3B h)	Heat sink temperature on alarm	1°C / 1d	1	°C	6
M46	82Eh	60(3C h)	Main circuit capacitor capacity	0 to 100 %	1	%	0

Fcode	Communication address		Function code name	Setting range	Min increment	Unit	Type
	485 number	Link number					
M47	82Fh	61(3D h)	PC board capacitor life on alarm	0 to 65535 h	1	h	0
M48	830h	62(3E h)	Cooling fan life	0 to 65535 h	1	h	0
M49	831h	63(3F h)	Speed setting 1 (before multistep speed	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M50	832h	64(40 h)	Speed setting 2 (before calculation of accel/decel.)	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M51	833h	65(41 h)	Speed setting 3 (after speed limit)	-24000 to 24000 r/min : (data)*Nmax/20000	1	r/min	31
M52	834h	66(42 h)	Control output 1	0000 to FFFF	1	-	125
M53	835h	67(43 h)	Control output 2	0000 to FFFF	1	-	126
M54	836h	68(44 h)	Control output 3	0000 to FFFF	1	-	127
M55	837h	69(45 h)	Option monitor 1	0000 to FFFF	1	-	9
M56	838h	70(46 h)	Option monitor 2	0000 to FFFF	1	-	9
M57	839h	71(47 h)	Option monitor 3	0 to 65535	1	-	0
M58	83Ah	72(48 h)	Option monitor 4	0 to 65535	1	-	0
M59	83Bh	73(49 h)	Option monitor 5	-32768 to 32767	1	-	5
M60	83Ch	74(4A h)	Option monitor 6	-32768 to 32767	1	-	5

12. Function Code List

12.4 Data Format List

You can use the following formats to access function codes through the link and these formats are common to the FRENICS500VG7S models.

12.4.1 Data Type 0 to 13

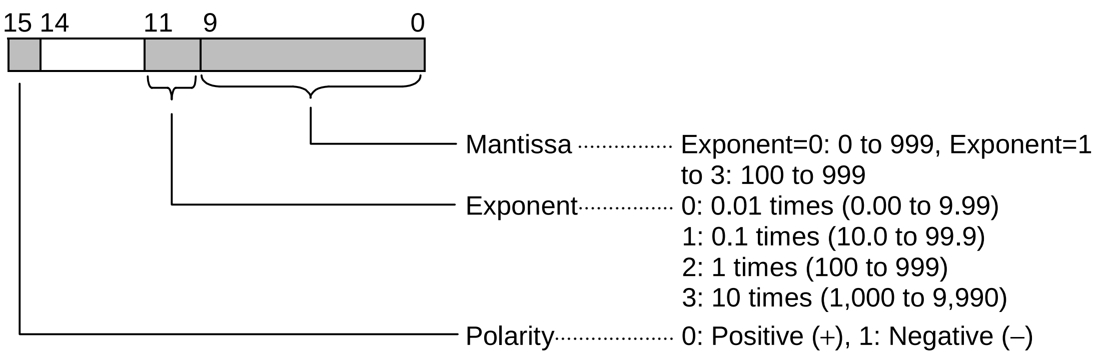
You can basically exchange data in the data types from 0 to 13.

Code	Description	Display/setting	Resolution	Notes
0	Integer	0, 1, 2, 3, ...	1	
1	Integer	0, 2, 4, 6, ...	2	Only for pole number of motor
2	Fixed point	0.0, 0.1, 0.2, ...	0.1	
3		0.00, 0.01, 0.02, ...	0.01	
4		0.001, 0.002, 0.003, ...	0.001	
5	Integer (signed)	-2, -1, 0, 1, 2, ...	1	
6	Fixed point (signed)	-0.1, 0.0, 0.1, ...	0.1	
7		-0.01, 0.00, 0,01, ...	0.01	
8		-0.001, 0.000, 0.001, ...	0.001	
9	Hexadecimal	1A8E	1h	Initial cursor position is left end. Cursor does not move automatically. When setting range is from 00 to 11, you should specify individual digits to set only 00, 01, 10, or 11.
10	Special data 3	0.75, 1, 2, ... 14, 15		Carrier frequency setting
11	Operation data		1	Reset to 0 after writing
12	Exponent/mantissa 1		0.01	See 12.4.2 "Data Type 12 to 34"
13	Exponent/mantissa 2		0.01	

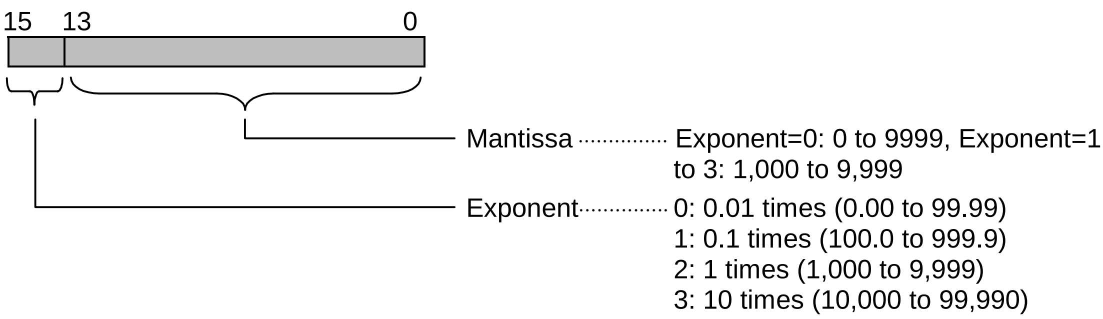
12.4.2 Data Type 12 to 34

The following data have special formats.

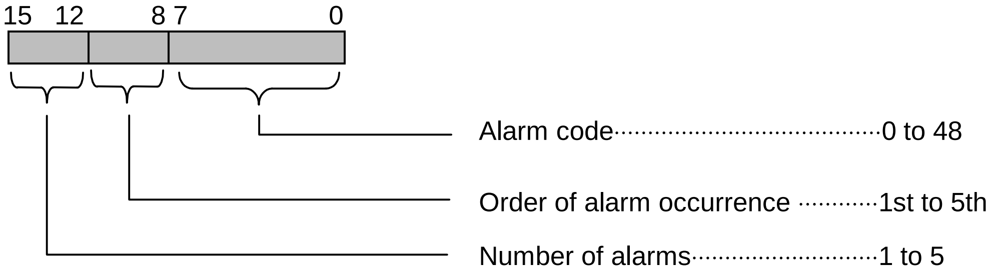
(1) Type [12]: Time, current, power, PID process values



(2) Type [13]: Current and others



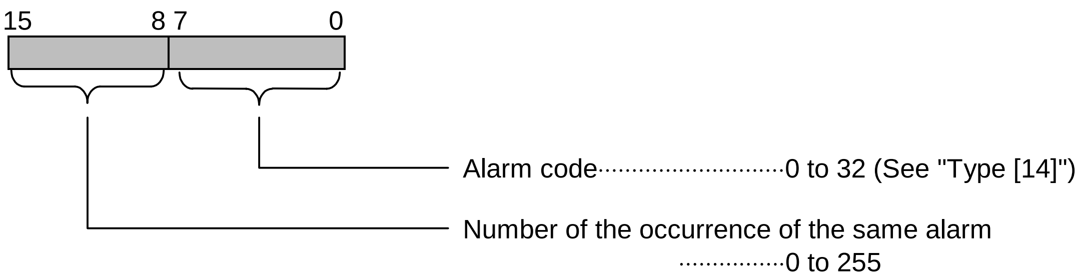
(3) Type [14]: Cause of alarm



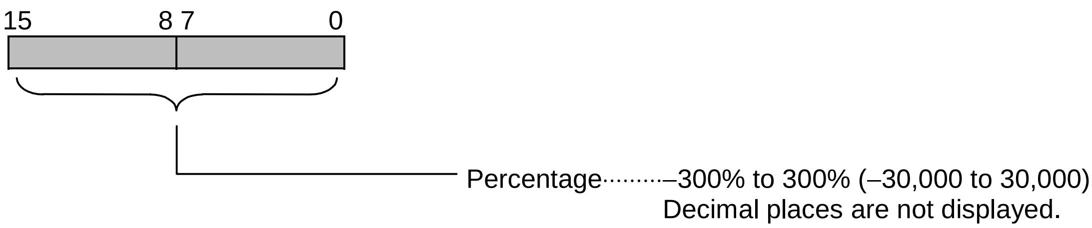
Alarm codes

Code	Display	Description	Code	Display	Description	Code	Display	Description
0	---	No alarm	17	Lin	Input phase loss	34	Ar1	Error code 1 for specific user application
1	CnU	Converter error	18	LU	Undervoltage	35	Ar2	Error code 2 for specific user application
2	dbH	DB resistor overheating	19	nrb	NTC thermistor disconnection	36	Ar3	Error code 3 for specific user application
3	dCF	DC fuse blown	20	OC	Overcurrent	37	Ar4	Error code 4 for specific user application
4	dO	Excessive position deviation	21	OH1	Overheating at heat sink	38	Ar5	Error code 5 for specific user application
5	EF	Ground fault	22	OH2	External alarm	39	Ar6	Error code 6 for specific user application
6	Er1	Memory error	23	OH3	Inverter internal overheat	40	Ar7	Error code 7 for specific user application
7	Er2	KEYPAD panel communication error	24	OH4	Motor overheat	41	Ar8	Error code 8 for specific user application
8	Er3	CPU error	25	OL1	Motor 1 overload	42	Ar9	Error code 9 for specific user application
9	Er4	Network error	26	OL2	Motor 2 overload	43	ArA	Error code A for specific user application
10	Er5	RS485 communication error	27	OL3	Motor 3 overload	44	ArB	Error code B for specific user application
11	Er6	Operation procedure error	28	OLU	Inverter unit overload	45	ArC	Error code C for specific user application
12	Er7	Output wiring error	29	OS	Overspeed	46	ArD	Error code D for specific user application
13	Er8	A/D converter error	30	OU	Overvoltage	47	ArE	Error code E for specific user application
14	Er9	Speed disagreement	31	PbF	Charging circuit error	48	ArF	Error code F for specific user application
15	ErA	UPAC error	32	P9	PG error			
16	Erb	Inter-inverter communication error	33	Ar0	Error code 0 for specific user application			

(4) Type [15]: Alarm history



(5) Type [16]: Percentage



(6) Type [21]: Operation status

15 8 7 0

- 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: OFF
1: ON

- 12) 0: REM/LOC, 1: COM
- 13) } 0: KEYPAD panel, 1: RS485, 2: link option
- 14) Not used
- 15) Writing········0: OFF, 1: ON

(7) Type [22]: DIA, DIB input information

15 8 7 0

16-bit terminal input information: 0000 to FFFF

• Option installation information is available from the option information.

(8) Type [28]: Inverter capacity

Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity
0	0.05	8	5.5	16	45	24	220
1	0.1	9	7.5	17	55	25	250
2	0.2	10	11	18	75	26	280
3	0.4	11	15	19	90	27	315
4	0.75	12	18.5	20	110	28	355
5	1.5	13	22	21	132	29	400
6	2.2	14	30	22	160		
7	3.7	15	37	23	200		

(9) Type [29]: Inverter model (common to entire FUJI inverter system)

The number is fixed to 1213h or 1214h for the VG inverters.

200V system: fixed to 1213h
400V system: fixed to 1214h

Code	Model		Development code		Series		Voltage	
	Division	Display	Division	Display	Division	Display	Division	Display
0	-		-		-		-	
1	VG	VG	11 series	11	Standard for domestic		Single-phase 100V	6
2	G	G	7 series	7	Standard for Asia		Single-phase 200V	7
3	P	P			Standard for China		Three-phase 200V	2
4	E	E			Standard for Europe		Three-phase 400V	4
5	C	C			Standard for USA		Three-phase 575V	5
6	S	S						

(10) Type [31]: Speed

15 8 7 0

Data (0 to ±20,000) → (0 to ±12,000 × r/min) : (Data) × Nmax/20,000 conversion

(Example) When the maximum speed is Nmax=1,500r/min,

- If you want to direct a speed reference of 1,000r/min,

  Specify a data of $\frac{1,000}{1,500} \times 20,000 \rightarrow 13,333$.

- If the read out data is 3,500,

  You can determine the speed is $\frac{1,500}{20,000} \times 3,500 \rightarrow 262.5$r/min.

(11) Type [32]: Operation commands, [33]: Y1 to Y18

This type is the same as S06 and S07.

15 8 7 0

Bit	[32]	[33]
0)	FWD (forward operation command)	Y1
1)	REV (reverse operation command)	Y2
2)	X1	Y3
3)	X2	Y4
4)	X3	RY
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

0: OFF
1: ON

12. Function Code List

(12) Type [34]: Communication error codes

15 8 7 0

Description of alarms in the communication through the link (RS485, T-Link, field bus). The following data is set to the monitor data M26 according to the communication status. The codes listed in the column "KEYPAD panel display" is displayed on the KEYPAD panel as a communication error .

Code	KEYPAD panel display	Communication error name	Description	
0	-	No communication error	1 Normal communication 2 A data is written to an unused address of the function code (writing to address out of the specified range is defined separately). 3 A data is read from an unused address. The data will be "0000". 4 Writing to the S area while link operation is disabled. The data will not be reflected and cause no error. 5 A data out of range is written to the S area. The data is written after adjusted to the upper or the lower limit. 6 Access from another link or the KEYPAD panel occurs during data writing (EEPROM other than the S area is accessed). 7 Writing to operation data (such as tuning or initialization) during multiple function codes are being written once through the link. The inverter decides that the procedure is canceled and continues the writing. 8 Writing to/reading from option function codes that are not displayed on the KEYPAD panel.	
1 to 32	-	Alarm codes specific to the VG7S	Alarm codes specific to models other than communication errors.	
33 to 70	-	Not used		
71	-	Checksum error, CRC error	Software error	Checksum value or CRC value does not match.
72	-	Parity error	Hardware error	Parity does not match.
73	-	Others (such as overrun, framing)		Physical (reception) errors other than above.
74	01	Format error	Incorrect format. Characters requesting transmission are incorrect. Characters terminating transmission are not in the specified order.	
75	01	Command error	Codes other than the specified commands are transmitted.	
76	07	Link priority error	1 Writing to the S area through RS485 while a link option is installed. 2 Writing to the S area through a link with lower priority while multiple link options are installed.	
77	07	No right to write function code data	Not used for VG7S	
78	02	Function code error	1 Access to a data out of the address range of the function codes (such as access to a data over F80). 2 Writing data over 16 words.	
79	07	Error on writing to write-disabled data	1 Write-disabled function codes (Read-only data or the M area). 2 Function codes write-disabled during operation. 3 Writing through the link to data out of the S area in "write-disabled through link" mode. Note that F00 or "Write enable for KEYPAD" cannot protect from writing through the link. 4 Function codes that cannot be written through the link (link function codes: H31 to 40, o5x, o6x, and o8x). 5 Writing to M1 function code (P) area when motor parameters are protected. 6 Writing through the link in the copy mode operation of the KEYPAD panel.	
80	03	Data error	Written data is out of the setting range in the area other than the S area.	
81	07	Error during writing	Another writing request comes from the same source while writing function code data (EEPROM other than the S area is accessed).	

Note: The alarm codes 1 to 32 constitute a code system specific to the VG7S different from the assignment for the general-purpose inverters.
The communication error codes 71 to 81 are common to the different models. Note that some causes of alarm are specific to models.
The KEYPAD panel does not display raw communication error codes but the values in the "KEYPAD panel display" column in the table above.
The KEYPAD panel displays "∗∗" when it receives data that does not have a corresponding "KEYPAD panel display" in the table above.

(13) Type [35]: X function normally open/closed
(14) Type [36]: Y function normally open/closed

15 8 7 0

Bit	X function	Y function
0)	X1	Y1
1)	X2	Y2
2)	X3	Y3
3)	X4	Y4
4)	X5	Y5
5)	X6	
6)	X7	
7)	X8	
8)	X9	

0: Normally open
1: Normally closed

(15) Type [40] to [99]

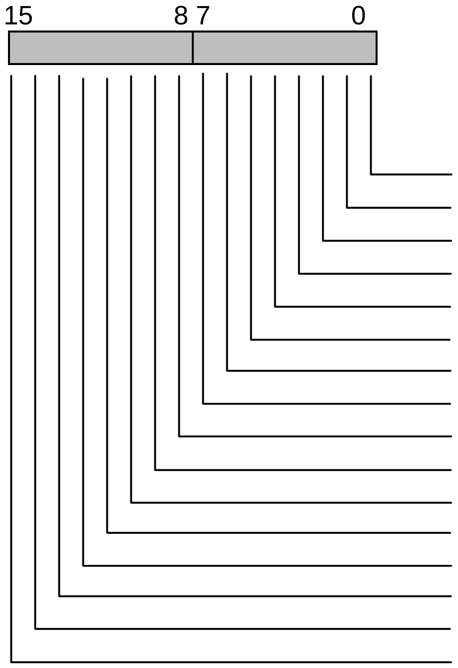
These types are reserved for the manufacturer. Users can considers these types as type [0] to use.

(16) Type [125]: Control output 1

15 8 7 0

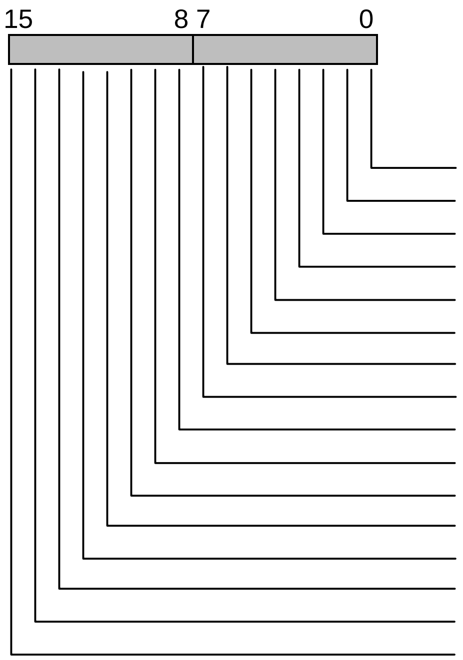
0) Inverter running [RUN]
1) Speed existence [N-EX]
2) Speed agreement [N-AG]
3) Speed equivalence [N-AR]
4) Detected speed 1 [N-DT1]
5) Detected speed 2 [N-DT2]
6) Detected speed 3 [N-DT3]
7) Stopping on undervoltage [LU]
8) Detected torque polarity (braking/driving)[B/D]
9) Torque limiting [TL]
10) Detected torque 1 [T-DT1]
11) Detected torque 2 [T-DT2]
12) KEYPAD operation mode [KP]
13) Inverter stoppage [STOP]
14) Operation ready output [RDY]
15) Magnetic-flux detection signal [MF-DT]

(17) Type [126]: Control output 2



0)	Motor M2 selection status	[SW-M2]
1)	Motor M3 selection status	[SW-M3]
2)	Brake release signal	[BRK]
3)	Alarm indication	[AL1]
4)	Alarm indication	[AL2]
5)	Alarm indication	[AL4]
6)	Alarm indication	[AL8]
7)	Fan operation signal	[FAN]
8)	Auto-resetting	[TRY]
9)	Universal DO	[U-DO]
10)	Heat sink overheat early warning	[INV-OH]
11)	Synchronization completion signal	[SY-C]
12)	Lifetime alarm	[LIFE]
13)	Under accelerating	[U-ACC]
14)	Under decelerating	[U-DEC]
15)	Inverter overload early warning	[INV-OL]

(18) Type [127]: Control output 3



0)	Motor temperature early warning	[M-OH]
1)	Motor overload early warning	[M-OL]
2)	DB overload early warning	[DB-OL]
3)	Link transmission error	[LK-ERR]
4)	Load adaptive control under limiting	[ANL]
5)	Load adaptive control under calculation	[ANC]
6)	Analog torque bias hold	[TBH]
7)	Optional Do 1	[O-DI1]
8)	Optional Do 2	[O-DI2]
9)	Optional Do 3	[O-DI3]
10)	Optional Do 4	[O-DI4]
11)	Optional Do 5	[O-DI5]
12)	Optional Do 6	[O-DI6]
13)	Optional Do 7	[O-DI7]
14)	Optional Do 8	[O-DI8]
15)	Optional Do 9	[O-DI9]

THE INVERTER

XIII

XIII. Replacement Data

13. Replacement Data

When replacing the former inverters (VG, VG3, VG5) with VG7, please refer to this section.

13.1 Classification of Replacement

	Inverter	Motor	Possibility
A: Both inverter and motor are replaced.	VG5 ⇒ VG7S	VG ⇒ VG7	Possible
	VG3/VG3N ⇒ VG7S	VG3 ⇒ VG7	Possible
	VG5S/VG5N ⇒ VG7S	VG5 ⇒ VG7 (Same product)	Possible
B: Only the inverter is replaced.	VG5 ⇒ VG7S	VG	Possible (Note1)
	VG3/VG3N ⇒ VG7S	VG3	Possible (Note1)
	VG5S/VG5N ⇒ VG7S	VG5	Possible
C: Only the motor is replaced.	VG	VG ⇒ VG7	Impossible (Note2)
	VG3	VG3 ⇒ VG7	Impossible (Note2)
	VG5	VG5 ⇒ VG7 (Same product)	Possible

Note 1: The rated current of VG and VG3 is bigger than that of VG5,VG7. For this reason, the inverter in one-rank upper grade is required if only the inverter is changed from VG or VG3.

Note 2: For VG and VG3, the maximum output voltage, to which the stable current control is possible, is lower than that of VG5 and VG7. Therefore, if these inverters are combined with VG5 or VG7 motors, the characteristics (torque accuracy or motor wow) at around the base speed or at higher speed will deteriorate.

13.2 External Dimensions Comparison

13.2.1 Replacing VG5S

● 200V series

	FRENIC5000 VG5S							FRENIC5000 VG7S						
	External Dimensions			Installation dimensions		Mounting Method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	Mass (kg)
Ca-pac-ity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
0.75														
1.5	205	350	245	183	328		10	205	300	245	181	278		7
2.2														
3.7														
5.5	205	350	245	183	328		11	205	300	245	181	278		8
7.5														
11	255	440	255	233	418		17	250	380	245	226	358		12.5
15	320	480		298	458	Wall type	25						Wall type	
18.5	320	480	255	298	458		25	340	480	255	240	460		25
22														
30	340	550		326	530		36	340	550	255	240	530		30
37	375	615	255	275	595		45	375	615	270	275	595		37
45					730		58		740					46
55	530	750	270	430	720		60	375		270	275	720		48
75			285				76	530	750	285	430			70
90	680	880	360	580	860	Floor type	141	680	880	360	580	850		115

● 400V series

	FRENIC5000 VG5S							FRENIC5000 VG7S						
	External dimensions			Installation dimensions		Mounting Method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	Mass (kg)
Ca-pac-ity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
3.7	205	350	245	183	328		10	205	300	245	181	278		7
5.5	205	350	245	183	328		11	205	300	245	181	278		8.5
7.5														
11	255	440	255	233	418		17	250	380	245	226	358		12.5
15														
18.5	320	480	255	298	458		25	340	480	255	240	460		25
22														
30	340	550		240	530	Wall type	35	340	550	255	240	530		30
37	375		255	275			36	375			275		Wall type	35
45		675			655		42		675	270		655		40
55					645		53	375			275	655		41
75			270				60			270				49
90	530	740	315	430	710		86		740	315		720		72
110								530			430			
132					970		116					970		100
160		1000	360				121		1000	360				
200	680			580	980	Floor type	173	680			580	970		140
220														

Larger than VG5.

An adapter is required for replacement.

The control panel containing VG5S should be modified.

13.2.2 Replacing VG3

● 200V series

	FRENIC5000 VG3							FRENIC5000 VG7S						
	External dimensions			Installation dimensions		Mounting method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	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														
1.5							14	205	300	245	181	278		7
2.2	255	440	252	155	425									
3.7														
5.5							16	205	300	245	181	278		8
7.5	280	480	252	180	465		20							
11	320	480	252	220	460	Wall type	24	250	380	245	226	358		12.5
15		520			500		27						Wall type	
18.5	340	550	252	240	530		30	340	480	255	240	460		25
22														
30	375	615		275	596		40	340	550	255	240	530		30
37	390	800	252	290	775		53	375	615	270	275	595		37
45									740					46
55	540	750	267	440	720		70	375		270	275	720		48
75	850	880	–	750	855	Floor type	130	530	750	285	430			70
90								680	880	360	580	850		115

● 400V series

	FRENIC5000 VG3							FRENIC5000 VG7S						
	External dimensions			Installation dimensions		Mounting method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	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	280	440	252	180	425		20	205	300	245	181	278		7
5.5								205	300	245	181	278		8.5
7.5	280	480	252	180	465		22							
11								250	380	245	226	358		12.5
15	320	520	252	220	500		27							
18.5								340	480	255	240	460		25
22	340	550	252	240	530	Wall type	30							
30		615			596		35	340	550	255	240	530		30
37	375	675	252	275	656		43	375			275		Wall type	35
45									675	270		655		40
55							85	375			275	655		41
75	530	880	322	430	850					270				49
90							95		740	315		720		72
110			337		1020		105	530			430			
132	680	1050		580			135					970		100
160	850		–	750	1025	Floor type	170		1000	360				
200								680			580	970		140
220	–	–	–	–	–	–	–							

Larger than VG3.

An adapter is required for replacement.

The control panel containing VG3 should be modified.

13.2.3 Replacing VG

● 200V series

	VG							VG7S						
	External dimensions			Installation dimensions		Mounting method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	Mass (kg)
Ca-pac-ity (Kw)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
0.75														
1.5	–	–	–	–	–		–	205	300	235	181	278		7
2.2														
3.7	240	500	280	180	480		15							
5.5								205	300	235	181	278		8
7.5	280	550	280	200	530	Wall type	25							
11	350	550	310	280	530		30	250	380	235	226	358		12.5
15													Wall type	
18.5	420	650	310	280	620		45	340	480	255	240	460		25
22														
30	420	750	310	280	720		60	340	550	255	240	530		30
37	500	900	320	380	870		80	375	615	270	275	595		37
45									740					46
55	880	1000	445	750	975	Floor type	180	375		270	275	720		48
75								530	750	285	430			70
90	–	–	–	–	–		–	680	880	360	580	850		115

● 400V series

	VG							VG7S						
	External dimensions			Installation dimensions		Mounting method	Mass (kg)	External dimensions			Installation dimensions		Mounting method	Mass (kg)
Ca-pac-ity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
3.7	240	550	295	180	530		20	205	300	235	181	278		7
5.5								205	300	235	181	278		8.5
7.5	350	600	340	280	580		35							
11								250	380	235	226	358		12.5
15						Wall type								
18.5	420	700	360	280	670		50	340	480	255	240	460		25
22														
30	420	800	360	280	770		65	340	550	255	240	530		30
37	500	900	370	380	870		85	375			275		Wall type	35
45									675	270		655		40
55	580	1150	410	450	1125	Floor type	110	375			275	655		41
75	730	1150	415	600	1125		150			270				49
90									740	315		720		72
110								530			430			
132	–	–	–	–	–	–	–					970		100
160									1000	360				
200								680			580	970		140
220														

The control panel containing VG should be modified

Replacement Data

13. Replacement Data

13.3 Terminal Size

13.3.1 Replacing VG5S

● Main circuit terminal (200V series)

	FRENIC5000 VG5S					FRENIC5000 VG7S				
	Terminal size and arrangement					Terminal size and arrangement				
	Input	DC link	Output	GRD*	APS*	Input	DC link	Output	GRD*	APS*
Ca-pac-ity (kW)	R,S,T	P1,P(+),DB, N(–)	U,V,W	E(G)	R0,T0	LI/R,L2/S, L3/T	DB,P1, P(+),N(–)	U,V,W	G	R0,T0
0.75	M5	M5	M5	M5	M4	M4	M4	M4	M4	M4
1.5										
2.2										
3.7	M5	M5	M5	M5	M4	M5	M5	M5	M5	M4
5.5										
7.5										
11	M6	M6	M6	M6	M4	M6	M6	M6	M6	M4
15	M8	M8	M8	M8						
18.5	M8	M8	M8	M8	M4	M6	M6	M6	M6	M4
22										
	R,S,T	P1,P(+),DB, N(–)	U,V,W	E(G)	R0,T0	LI/R,L2/S, L3/T	P1,P(+),DB, N(–)	U,V,W	G	R0,T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M4
37	M10	M10	M10	M8	M4	M10	M10	M10	M8	M4
45										
55										
	R,S,T	P1,P(+), N(–)	U,V,W	E(G)	R0,T0	LI/R,L2/S, L3/T	P1,P(+), N(–)	U,V,W	G	R0,T0
75	M10	M10	M10	M8	M4	M12	M12	M12	M10	M4
90	M12	M12	M12	M10	M4					

*GRD: Ground
*APS: Auxiliary power supply

● Main circuit terminal (400V series)

	FRENIC5000 VG5S					FRENIC5000 VG7S				
	Terminal size and arrangement					Terminal size and arrangement				
Ca-pac-ity (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	M4
5.5										
7.5										
11	M6	M6	M6	M6	M4	M6	M6	M6	M6	M4
15										
18.5	M8	M8	M8	M8	M4	M6	M6	M6	M6	M4
22										
	R,S,T	P1,P(+), DB, N(–)	U, V, W	E(G)	R0,T0	L1/R,L2/S, L3/T	P1,P(+), DB,N(–)	U,V,W	G	R0,T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M4
37										
45										
55										
	R,S,T	DB,P1,P(+), N(–)	U,V,W	E(G)	R0,T0	L1/R,L2/S, L3/T	P1,P(+), DB,N(–)	U,V,W	G	R0,T0
75	M10	M10	M10	M8	M4	M10	M10	M10	M8	M4
90		M10 (No DB terminal)								
110										
	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
132	M10	M10	M10	M8	M4	M12	M12	M12	M10	M4
160	M12	M12	M12	M10						
200										
220										

*GRD: Ground
*APS: Auxiliary power supply

● Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG5S	FRENIC5000 VG7S
Common to all capacities M3	Common to all capacities M3

13.3.2 Replacing VG3

● Main circuit terminal (200V series)

	FRENIC5000 VG3					FRENIC5000 VG7S				
Capacity (kW)	Terminal size and arrangement					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
0.75	M5	M5	M5	M5	M4	M4	M4	M4	M4	M4
1.5										
2.2										
3.7						M5	M5	M5	M5	M4
5.5										
7.5										
11	M6	M6	M6	M6	M4	M6	M6	M6	M6	M4
15	M8	M8	M8	M6	M4					
18.5						M6	M6	M6	M6	M4
	R,S,T	U,V,W	DB,P1,P	E(G)	R0,T0					
22	M8	M8	M8	M6	M4					
	R,S,T	U,V,W	DB,P1,P	E(G)	R0,T0	L1/R,L2/S, L3/T	P1,P(+),DB, N(–)	U,V,W	G	R0,T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M4
37	M10	M10	M10	M8	M4	M10	M10	M10	M8	M4
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	M4
90										

*GRD: Ground
*APS: Auxiliary power supply

● Main circuit terminal (400V series)

	FRENIC5000 VG3					FRENIC5000 VG7S				
	Terminal size and arrangement					Terminal size and arrangement				
Ca-pac-ity (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
3.7	M4	M4	M4	M4	M4					
5.5						M5	M5	M5	M5	M4
7.5	M5	M5	M5	M5	M4					
11						M6	M6	M6	M6	M4
15	M6	M6	M6	M6	M4					
18.5						M6	M6	M6	M6	M4
	R,S,T	U,V,W	DB,P1,P	E(G)	R0,T0					
22	M6	M6	M6	M6	M4					
	R,S,T	P1,P(+), DB,N(–)	U,V,W	E(G)	R0,T0	L1/R,L2/S, L3/T	P1,P(+),DB, N(–)	U,V,W	G	R0,T0
30										
37	M8	M8	M8	M8	M4	M8	M8	M8	M8	M4
45										
55										
75	M10	M10	M10	M8	M4					
90						M10	M10	M10	M8	M4
110										
	Input/Output R,U,S,V,T,W		DC link N,P1,P	GRD* E(G)	APS* R0,T0	L1/R,L2/S, L3/T	P1,P(+), N(–)	U,V,W	G	R0,T0
132										
160	M12		M12	M10	M4	M12	M12	M12	M10	M4
200										
220	–		–	–	–					

*GRD: Ground
*APS: Auxiliary power supply

● Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG3	FRENIC5000 VG7S
Common to all capacities M3	Common to all capacities M3

Replacement Data

13. Replacement Data

13.3.3 Replacing VG

● Main circuit terminal (200V series)

Capacity (kW)	FRENIC5000 VG: Terminal size and arrangement					FRENIC5000 VG7S: Terminal size and arrangement				
	Input R,S,T	Output U,V,W	DC link DC2,DB1, DB2	GRD* E(G)	APS* R0,S0, 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	–	–	–	–	–	M4	M4	M4	M4	M4
1.5	–	–	–	–	–	M4	M4	M4	M4	M4
2.2	–	–	–	–	–	M4	M4	M4	M4	M4
3.7	M4	M4	M4	M3.5	M3.5	M5	M5	M5	M5	M4
5.5	M4	M4	M4	M3.5	M3.5	M5	M5	M5	M5	M4
7.5	M6	M6	M5	M3.5	M3.5	M5	M5	M5	M5	M4
11	M6	M6	M5	M3.5	M3.5	M6	M6	M6	M6	M4
15	R,S,T	U,V,W	DC1,DC2, DB1,DB2	E(G)	R0,S0, T0	M6	M6	M6	M6	M4
15	M6	M6	M6	M3.5	M3.5	M6	M6	M6	M6	M4
18.5	M6	M6	M6	M3.5	M3.5	M6	M6	M6	M6	M4
22	M6	M6	M6	M3.5	M3.5	M6	M6	M6	M6	M4
	R,S,T	U,V,W	DC1,DC2, DB1,DB2	E(G)	R0,S0, T0	L1/R,L2/S, L3/T	P1,P(+), DB, N(–)	U,V,W	G	R0,T0
30	M8	M8	M8	M3.5	M3.5	M8	M8	M8	M8	M4
37	M8	M8	M8	M3.5	M3.5	M10	M10	M10	M8	M4
45	M8	M8	M8	M3.5	M3.5	M10	M10	M10	M8	M4
55	DC link DB1,DB2, DC1,DC2	Input/ Output R,U,S,V,T,W		GRD* E(G)	APS* R0,S0, T0	M10	M10	M10	M8	M4
55	M10	M10		M4	M4	M10	M10	M10	M8	M4
	M10	M10		M4	M4	L1/R,L2/S, L3/T	P1,P(+), N(–)	U,V,W	G	R0,T0
75	M10	M10		M4	M4	M12	M12	M12	M10	M4
90	–	–	–	–	–	M12	M12	M12	M10	M4

*GRD: Ground
*APS: Auxiliary power supply

● Main circuit terminal (400V series)

	FRENIC5000 VG					FRENIC5000 VG7S				
	Terminal size and arrangement					Terminal size and arrangement				
Capacity (kW)	Input R,S,T	Output U,V,W	DC link DC2, DB1, DB2	GRD* E(G)	APS* R0,S0, 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	M3.5	M3.5					
5.5						M5	M5	M5	M5	M4
7.5	M5	M5	M5	M3.5	M3.5					
11						M6	M6	M6	M6	M4
	R,S,T	U,V,W	DC1,DC2, DB1,DB2	E(G)	R0,S0, T0					
15										
18.5						M6	M6	M6	M6	M4
22	M6	M6	M6	M3.5	M3.5					
						L1/R,L2/S, L3/T	P1,P(+),DB, N(–)	U,V,W	G	R0,T0
30										
37	M8	M8	M8	M3.5	M3.5	M8	M8	M8	M8	M4
45										
	DC link DC1,DC2, DB1,DB2	Input/Output R,U,S,V,T,W		GRD* E(G)	APS* R0,S0, T0					
55										
	M8	M8		M4	M4	L1/R,L2/S, L3/T	P1,P(+),DB, N(–)	U,V,W	G	R0,T0
75										
90						M10	M10	M10	M8	M4
110										
	–	–	–	–	–	L1/R,L2/S, L3/T	P1,P(+),N(–)	U,V,W	G	R0,T0
132										
160						M12	M12	M12	M10	M4
200										
220										

*GRD: Ground
*APS: Auxiliary power supply

Replacement Data

13. Replacement Data

13.4 Terminal Symbol

13.4.1 Replacing VG5

Category	FRENIC5000 VG5S		FRENIC5000 VG7S	
	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 reference (before limit)	[T-REF]	Torque reference (before limit)
	[ATCS]	Torque current reference	[IT-REF]	Torque current reference
	[AJSS1]	Creep speed 1	[CRP-N1]	Creep speed 1
	[AJSS2]	Creep speed 2	[CRP-N2]	Creep speed 2
	[AFLUX]	Magnetic-flux reference	[MF-REF]	Magnetic-flux reference
	[ASFB]	Speed feedback	[LINE-N]	Speed override
	[AMTMP]	Motor temperature	[M-TMP]	Motor temperature
	[ASOR]	Speed override	[N-OR]	Speed override
	M	Analog input common	M	Analog input common
Digital input	FWD	Forward operation · stop command	FWD	Forward operation · stop command
	REV	Reverse operation · stop command	REV	Reverse operation · stop command
	X1 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
	[CCLR]	Zero clear command in UP/DOWN setter	[CLR]	ACC/DEC zero clear command
	[CJSC]	Creep switch	[CRP-N2/N1]	Creep speed switching in UP/DOWN setting
	[CSUC]	ACC/DEC · UP/DOWN switch	[N2/N1]	Speed setting N2/N1
	[CSRL]	Speed reference limiter	[N-LIM]	Speed reference cancel
	[CSTC]	Speed control/Torque limiter switch	[H41-CCL]	H41[torque reference] cancel
	[CTL]	Torque limiter	[F40-CCI]	F40 [torque limiter mode] cancel
	[CADT]	ACC/DEC time selection	[RT1][RT2]	ASR, ACC/DEC selection

Category	FRENIC5000 VG5S		FRENIC5000 VG7S	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Digital input	[CADB]	ACC/DEC time bypass	[BPS]	Bypass
	[CTB1]	Torque bias reference 1	[TB1]	Torque bias reference 1
	[CTB2]	Torque bias reference 2	[TB2]	Torque bias reference 2
	[CDRP]	Droop function	[DROOP]	Droop selection
	[CPI]	ASR PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CPPI]	ASR P/PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CAI1Z]	Ai1-ACC/DEC zero hold	[ZH-Ai1]	Ai1 zero hold
	[CAI2Z]	Ai2-ACC/DEC zero hold	[ZH-Ai2]	Ai2 zero hold
	[CSAD]	Analog/Digital switch (speed)	[N2/N1]	Speed setting N2/N1
	[CTAD]	Analog/Digital switch (torque)	[H41-CCL]	H41[torque reference]cancel
	[CDILS]	Di card input latch signal (speed)	[DIA]	DiA card input latch signal
	[CDILT]	Di card input latch signal (torque)	[DIB]	DiB card input latch signal
	[CTEN]	T-Link enable	[LE],[WE-LK]	Operation selection through link, Write enable command through link
	[CTDI]	DI command for transmission	[U-DI]	Universal DI
	[CREN]	RS485 enable	[LE],[WE-LK]	Operation selection through link, Write enable command through link
	RST	Alarm reset	[RST]	Alarm reset
	THR	External alarm	[THR]	External alarm
	–		PLC	PLC signal power supply
	CM	Digital input common	CM	Digital input common
Analog output	Ao1	Analog output 1	Ao1	Analog output 1
	Ao2	Analog output 2	Ao2	Analog output 2
	Ao3	Analog output 3	Ao3	Analog output 3
	[BSM1]	Speedometer (one-way deflection)	[N-FB1+]	Speed detection (Speedometer, one-way deflection)
	[BSM2]	Speedometer (two-way deflection)	[N-FB1±]	Speed detection (Speedometer, two-way deflection)
	[BSR0]	Speed setting 0	[N-REF2]	Speed setting2 (before ACC/DEC calculation)
	[BSR1]	Speed setting 1	[N-REF4]	Speed setting4 (ASR input)
	[BSR2]	Speed setting 2	[N-REF4]	Speed setting4 (ASR input)
	[BSR]	Speed setting	[N-REF4]	Speed setting4 (ASR input)
	[BSFB]	Speed feedback	[N-FB2±]	Speed detection (ASR input)
	[BTC1]	Torque ammeter (two-way deflection)	[IT-REF±]	Torque current reference (torque ammeter, two-way deflection)
	[BTC2]	Torque ammeter (one-way deflection)	[IT-REF+]	Torque current reference (torque ammeter, one-way deflection)
	[BTM1]	Torque meter (two-way deflection)	[T-REF±]	Torque reference (torque meter, two-way deflection)
	[BTM2]	Torque meter (one-way deflection)	[T-REF+]	Torque reference (torque meter, one-way deflection)
	[BTR]	Torque reference output	[T-REF±]	Torque reference (torque meter, two-way deflection)
	[BMC]	Effective detected value of motor current	[I-AC]	Motor current
	[BMV]	Effective detected value of motor voltage	[V-AC]	Motor voltage
	[BMTMP]	Motor temperature detected value	[TMP-M]	Motor temperature
	[BVDC]	Main circuit DC voltage	[V-DC]	DC link circuit voltage
	M	Analog output common	M	Analog output common
Transistor output	Y1	Digital output 1	Y1	Digital output 1
	Y2	Digital output 2	Y2	Digital output 2
	Y3	Digital output 3	Y3	Digital output 3
	–		Y4	Digital output 4
	[DVDC]	Establishment of main circuit DC voltage	[RDY]	Ready for operation
	[DRUN]	Running	[RUN]	Running
	[DACC]	Accelerating	[U-ACC]	Accelerating
	[DDEC]	Decelerating	[U-DEC]	Decelerating
	[DNZS]	Speed existence	[N-EX]	Speed existence
	[DSAR]	Arrival at the preset speed	[N-AR]	Arrival at the preset speed
	[DSAG]	Speed agreement	[N-AG]	Speed agreement
	[DSD1]	Speed detection	[N-DT1]	Speed detection 1
	[DSD2]	Speed detection	[N-DT2]	Speed detection 2
	[DSD3]	Speed detection	[N-DT3]	Speed detection 3
	[DTLM]	Torque limiting	[TL]	Torque limiting
	[DTD]	Torque detection	[T-DT1]	Torque detection
	[DOL]	Inverter overload early warning	[INV-OL]	Inverter overload early warning
	[DMOH]	Motor temperature overheat early warning	[M-OH]	Motor temperature overheat early warning

13. Replacement Data

Category	FRENIC5000 VG5S		FRENIC5000 VG7S	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Transistor output	[DMOL]	Motor overload early warning	[M-OL]	Motor overload early warning
	[DBRS]	Brake release signal	[BRK]	Brake release signal
	[DBRK]	Braking	[B/D]	Torque polarity detection
	[DTDO]	DO for transmission	[U-DO]	Universal DO
	[DTER]	Transmission error	[LK-ERR]	Transmission error
	[DSYN]	Synchronizing	[SY-C]	Synchronization control completion
	CME	Digital output common	CME	Digital output common
Relay output	RYA,RYC	Relay output	Y5A,Y5C	Relay output
	30A,30B,30C	Alarm output for any fault	30A,30B,30C	Alarm output for any fault
Communication	DXA,DXB	RS485 communication input/output	RX(+),RX(–), TX(+),TX(–),SD	RS485 communication input/output (dedicated connector)
Speed detection	PA,PB	Pulse generator 2-phase signal input	PA,PB	Pulse generator 2-phase signal input
	PGP,PGM	Pulse generator power supply	PGP,PGM	Pulse generator power supply
	FA,FB	Pulse generator output	FA,FB	Pulse generator output
	CM	Common to pulse generator output	CM	Common to pulse generator output
Temperature detection	TH1	Connects a motor thermistor	TH1	Connects a motor thermistor (Motor temperature can be detected with NTC,PTC thermistors)
	THC	Common to motor thermistor	THC	Common to motor thermistor
Option power supply	P24	Power supply to option (+24V)	–	Please utilize the power supply on the market.
	M24	Common terminal to +24V	–	
	P15	Power supply for option (+15V)	–	
	(M)	Common terminal to ±15V	–	
	N15	Power supply to option (–15V)	–	

13.4.2 Replacing VG3

Category	FRENIC5000 VG3 Terminal symbol	FRENIC5000 VG3 Terminal name	FRENIC5000 VG7S Terminal symbol	FRENIC5000 VG7S Terminal name
Main circuit	R,S,T	Power input	L1/R,L2/S,L3/T	Power input
	U,V,W	Inverter output	U,V,W	Inverter output
	P,DB	Connects a barking resistor	P(+),DB	Connects a barking resistor
	P,N	Connects a braking unit	P(+),N(–)	Connects a braking unit
	P,P1	Connects a DC REACTOR	P(+),P1	Connects a DC REACTOR
	P,N1	Connects a backup capacitor	P(+),N(–)	Connects a backup condenser
	E(G)	To ground the inverter	G	To ground the inverter
	R0,T0	Auxiliary control power supply	R0,T0	Auxiliary control power supply
Analog input	11	Common to analog input	11	Common to analog input
	13	Power supply for potentiometer	13	Power supply for potentiometer
	12	Speed setting voltage input	12	Speed setting voltage input
	M	Common to analog input	M	Common to analog input
	Ai1	Analog input 1	Ai1	Analog input 1
	Ai2	Analog input 2	Ai2	Analog input 2
	[AV2]	Auxiliary speed setting 2	[AUX-N1]	Auxiliary speed setting 1
	[AV3]	Auxiliary speed setting 3	[AUX-N2]	Auxiliary speed setting 2
	[ATL1]	Torque limiter value 1 / Torque bias reference value 1	[TL-REF1]	Torque limiter (level 1)
	[ATL2]	Torque limiter value 2 / Torque bias reference value 2	[TL-REF2]	Torque limiter (level 2)
	[ATL3]	Torque limiter value 3 / Torque bias reference value 3	–	–
	[ATL4]	Torque limiter value 4	–	–
	[ATIN]	Torque reference input	[T-REF]	Torque reference (before limit)
	[ATR]	Torque reference		
	[AFAI]	Magnetic-flux reference input	[MF-REF]	Magnetic-flux reference
	[ANFI]	Speed feedback input	[LINE-N]	Speed override
	[ANJF]	Creep setting value in UP/DOWN setter	[CRP-N1]	Creep speed 1
			[CRP-N2]	Creep speed 2
	[ATM]	Motor temperature input	[M-TMP]	Motor temperature
	V1	Voltage input for auxiliary speed setting	[AUX-N1]	Auxiliary speed setting 1
Digital input	CM	Digital input common	CM	Digital input common
	FWD	Forward operation · stop command	FWD	Forward operation · stop command
	REV	Reverse operation · stop command	REV	Reverse operation · stop command
	X1 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
	[CNR1]	Multistep speed setting selection 1	[SS1]	Multistep speed setting selection 1
	[CNR2]	Multistep speed setting selection 2	[SS2]	Multistep speed setting selection 2
	[CNR4]	Multistep speed setting selection 4	[SS4]	Multistep speed setting selection 4
	[CUP]	ACC command in UP/DOWN setter	[UP]	UP command in UP/DOWN setting
	[CDWN]	DEC command in UP/DOWN setter	[DOWN]	DOWN command in UP/DOWN setting
	[CCLR]	Clear command in UP/DOWN setter	[CLR]	ACC/DEC zero clear command
	[CBSS]	Soft start · stop bypass	[BPS]	Bypass
	[CRT]	Soft start · stop time switch	[RT1]	ASR,ACC/DEC selection
	[CNL]	Reverse rotation lock command	H08	Reverse rotation lock
	[CPI]	ASR PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CPPI]	ASR P/PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CSTC]	Speed control/Torque control switch	[H41-CCL]	H41 [Torque reference] cancel
	[CDRP]	Droop function	[DROOP]	Droop selection
	[CTL]	Torque limiter	[F40-CCL]	F40 (Torque limiter mode) cancel
	[CTB1]	Torque bias reference 1	[TB1]	Torque bias reference 1
	[CTB2]	Torque bias reference 2	[TB2]	Torque bias reference 2

13. Replacement Data

Category	FRENIC5000 VG3 Terminal symbol	FRENIC5000 VG3 Terminal name	FRENIC5000 VG7S Terminal symbol	FRENIC5000 VG7S Terminal name
	[CPOS]	Simplified position control command	–	–
	RST	Alarm reset	[RST]	Alarm reset
	THR	External alarm	[THR]	External alarm
	EXT	Pre-exciting command	[EXITE]	Pre-exciting command
	–		PLC	PLC signal power supply
Analog output	Ao	Analog output	Ao1	Analog output 1
			Ao2	Analog output 2
			Ao3	Analog output 3
	[BNF0]	Speed feedback output 0	[N-FB1+]	Speedometer one-way deflection
	[BNR0]	Speed setting 0	[N-REF2]	Speed setting 2
	[BNR1]	Speed setting 1	[N-REF4]	Speed setting 4
	[BNR2]	Speed setting 2	[N-REF4]	Speed setting 4
	[BT0]	Torque reference output 0	[T-REF±]	Torque meter two-way deflection
	[BT1]	Torque reference output 1	[T-REF±]	Torque meter two-way deflection
	[BIT]	Torque current reference	[IT-REF±]	Torque ammeter two-way deflection
	[BNR]	Speed setting	[N-REF4]	Speed setting 4
	[BNA]	Speed feedback	[N-FB2±]	Speed detection
	[BNAB]	Speed feedback absolute value	[N-FB1+]	Speedometer one-way deflection
	[BTAB]	Torque reference output absolute value	[T-REF+]	Torque meter one-way deflection
	[BITAB]	Torque current reference output absolute value	[IT-REF+]	Torque ammeter one-way deflection
	[BIM]	Motor current detected value	[I-AC]	Motor current
	LM	For load meter	[IT-REF±]	Torque current reference (torque ammeter two-way deflection)
			[IT-REF+]	Torque current reference (torque ammeter one-way deflection)
			[T-REF±]	Torque reference (torque meter two-way deflection)
			[T-REF+]	Torque reference (torque meter one-way deflection)
	SM	For speedometer	[N-FB1+]	Speed detection (speedometer one-way deflection)
			[N-FB1±]	Speed detection (speedometer two-way deflection)
	M	Common to analog output	M	Common to analog output
Transistor output	Y1	Digital output 1	Y1	Digital output 1
	Y2	Digital output 2	Y2	Digital output 2
	Y3	Digital output 3	Y3	Digital output 3
	–		Y4	Digital output 4
	[DUV]	Establishment of link voltage (undervoltage)	[RDY]	Ready for operation
	[DZS]	Speed existence (zero speed)	[N-EX]	Speed existence
	[DSAR]	Arrival at the preset speed	[N-AR]	Arrival at the preset speed
	[DSAG]	Speed agreement	[N-AG]	Speed agreement
	[DSDA]	Arbitrary speed (absolute value)	[N-DT1]	Speed detection 1
	[DSDP]	Arbitrary speed (with polarity)	[N-DT2]	Speed detection 2
	[DTLM]	Torque limiting	[TL]	Torque limiting
	[DTDT]	Torque detection	[T-DT1]	Torque detection 1
	[DAX]	Inverter running	[RUN]	Inverter running
	[DACC]	Accelerating	[U-ACC]	Accelerating
	[DDEC]	Decelerating	[U-DEC]	Decelerating
	[DOL]	Inverter overload early warning	[INV-OL]	Inverter overload early warning
	[DOLM]	Motor temperature overheat early warning	[M-OH]	Motor temperature overheat early warning
	[DTY4]	Transmission data Y4	[U-DO]	Universal DO
	[DTY5]	Transmission data Y5		
	[DTFT]	Transmission data error	[LK-ERR]	Transmission error
	CME	Digital output common	CME	Digital output common
Relay output	RYA,RYC	Relay output	Y5A,Y5C	Relay output
	30A,30B,30C	Alarm output for any fault	30A,30B,30C	Alarm output for any fault
Relay output	RYA,RYC	Relay output	Y5A,Y5C	Relay output
	30A,30B,30C	Alarm output for any fault	30A,30B,30C	Alarm output for any fault
Speed detection	PA,PB	Pulse generator 2-phase signal input	PA,PB	Pulse generator 2-phase signal input
	PGP,PGM	Pulse generator power supply	PGP,PGM	Pulse generator power supply
Temperature detection	THT	Connects motor thermistor	TH1	Connects motor thermistor (Motor temperature can be detected with the NTC and the PTC thermistors).
	THC	Common to motor thermistor	THC	Common to motor thermistor

Category	FRENIC5000 VG3		FRENIC5000 VG7S	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Option power supply	P24	Power supply for option (+24V)	–	Please utilize the power supply on the market.
	M24	For +24V common	–	
	P15	Power supply for option (+15V)	–	
	(M)	For ±15V common	–	
	N15	Power supply for option (–15V)	–	

13.4.3 Replacing VG

Category	FRENIC5000 VG Terminal symbol	FRENIC5000 VG Terminal name	FRENIC5000 VG7S Terminal symbol	FRENIC5000 VG7S Terminal name
Main circuit	R,S,T	Power input	L1/R,L2/S,L3/T	Power input
Main circuit	U,V,W	Inverter output	U,V,W	Inverter output
Main circuit	DC1,DC2	Connects a DC REACTOR	P1,P(+)	Connects a DC REACTOR
Main circuit	DB1,DB2	Connects a braking unit	P(+),N(–)	Connects a braking unit
Main circuit	DB1,DB2	Connects a braking resistor	P(+),DB	Connects a braking resistor
Main circuit	E	To ground the inverter	G	To ground the inverter
Main circuit	DBR1,DBR2	Connects a braking resistor thermal sensor.	[THR]	External fault
Main circuit	R0,S0,T0	Auxiliary control power supply	R0,T0	Auxiliary control power supply
Analog input	13	Power supply for potentiometer	13	Power supply for potentiometer
Analog input	12	Voltage input for speed setting	12	Voltage input for speed setting
Analog input	11	Analog input common	11	Analog input common
Analog input	V1	Auxiliary speed setting input	[AUX-N1]	Auxiliary speed setting input 1
Analog input	M	Analog input common	M	Analog input common
Digital input	FWD	Forward operation · stop command	FWD	Forward operation · stop command
Digital input	REV	Reverse operation · stop command	REV	Reverse operation · stop command
Digital input	BX	Inverter cut-off command	[BX]	Coast-to stop command
Digital input	ILS	DEC stop command of torque limiter	[STOP3]	STOP3 (Torque limiter stop)
Digital input	ITL	External torque limiter command	[F40-CCL]	Torque limiter (mode 1) cancel
Digital input	RST	Reset command of external fault	[RST]	Alarm reset
Digital input	EXT	Pre-exciting command	[EXITE]	Pre-exciting command
Digital input	CM	Digital input common	CM	Digital input common
Analog output	SM+,SM–	Speedometer signal	[N-FB1+]	Speedometer (one-way deflection)
Analog output	SP	Speed signal with polarity	[N-FB1±]	Speedometer (two-way deflection)
Analog output	LM+,LM–	Torque ammeter signal	[IT-REF±]	Torque ammeter (two-way deflection)
Analog output	DM+,DM–	Speedometer (digital) signal	FA,FB	Pulse generator output
Analog output	M	Analog output common	M	Analog output common
Relay output	SST1,SST2	Speed existence signal	[N-EX]	Speed existence*1)
Relay output	SAR1,SAR2	Signal for arrival at the preset speed.	[N-AR]	Arrival at the preset speed*1)
Relay output	UV1,UV2	Link voltage existence signal	[RDY]	Ready for operation*1)
Relay output	30A,30B,30C	Alarm output for any fault	30A,30B,30C	Alarm output for any fault
Speed detection	A+,B+	Pulse generator 2-phase signal input	PA,PB	Pulse generator 2-phase signal input
Speed detection	PGP,PGM	Pulse generator power supply	PGP,PGM	Pulse generator power supply
Temperature detection	TH1, TH2	Connects the standard motor thermistor Connects the spare motor thermistor	TH1	Connects the motor thermistor (Motor temperature can be detected with the NTC and the PTC thermistors).
Temperature detection	THRC, PGS	Common to motor thermistor Shield terminal for motor thermistor	THC	Common to motor thermistor
Option power supply	P24	Power supply for option (+24V)	–	Please utilize the power supply on the market.
Option power supply	M24	For +24V common	–	
Option power supply	P15	Power supply for option (+15V)	–	
Option power supply	(M)	For ±15V common	–	
Option power supply	N15	Power supply for option (–15V)	–	

*1) VG7 has only one terminal for relay output, and the remaining are for transistor output.
Therefore, when replacing the relay output signal of VG, take some measures such as sending the signals to the external relays.

13.5 KEYPAD Panel

● Appearance

LED monitor
Operation mode:
Displays the setting frequency, output current, output voltage, motor speed, and line speed.
Trip mode:
Displays the cause of a trip.

Unit indication
Displays the unit for the information that appears on the LED monitor.

Up/Down keys
Operation mode:
Increases or decreases the speed.
Program mode:
Changes the function codes and specified data values.

Program key
Switches the display to the menu screen or the initial screens for the operation and alarm modes.

Shift key (column shift)
Used to move the cursor horizontally for data change and to jump to another function block (when pressed with the UP/DOWN keys)

Reset key
Program mode:
Cancels the current input data and changes the screen.
Trip mode:
Releases from a trip stoppage.

LCD monitor
Displays different information ranging from operation status to function data.
Operation guidance is displayed scrolling at the bottom.

FWD/REV keys
Operation mode:
Pressing the FWD or REV key lights the RUN lamp.
Invalid when the function code F02 (Operation method) is set to 1 (external signal operation).

Stop key
Invalid when the function code F02 (Operation method) is set to 1 (external signal operation).

Function/Data select key
Used to switch the displayed value of LED monitor, input the speed setting and store the function code data.

13. Replacement Data

● Difference of operationability of the KEYPAD panel

Item	FRENIC5000 VG5S		FRENIC5000 VG7S	
LED Monitor	● Displays the set speed and the actual speed. ● Displays the inverter's operation status. ● Alarm display.		● Displays the set speed and the actual speed. ● Displays the inverter's operation status. ● Alarm display.	
LCD Monitor	● Displays the function codes and their abbrebiations. ● Displays the function data and the setting range. ● Alarm display. ● Displays the operation status (selection) in a graph. ● Displays the operation guidance. ● Function code display scrolls. ● The shift of the digit is possible when the function data is changed. ● Displays the list of the changed function codes. ● Displays the current value and the changed value.		● Displays the function codes and their abbrebiations. ● Displays the function data and the setting range. ● Alarm display. ● Displays the operation status (selection) in a graph. ● Displays the operation guidance. ● Function code display scrolls. ● The shift of the digit is possible when the function data is changed. ● Displays the list of the changed function codes. ● Displays the current value and the changed value.	
	Screen size : 13chr. x 4lines		Screen size : 13chr. x 5lines (One line is for the indicator display).	
Touch Keys	RUN	Command key to operate the inverter.	FWD,REV	Command key to operate the inverter.
	STOP	Command key to stop the inverter.	STOP	Command key to stop the inverter.
	∧ ∨	● Increases/Decreases the setting value of the speed. ● Up/Down the cursor (screen scrolls). ● Increases/Decreases the setting value of the function.	∧ ∨	● Increases/Decreases the setting value of the speed. ● Up/Down the cursor (screen scrolls). ● Increases/Decreases the setting value of the function.
	PRG	Switches the operation mode and program mode.	PRG	Switches the operation mode and program mode.
	>>	Switches the unit indication. Digit shift in case of the function data change.	SHIFT >>	Switches the unit indication. Digit shift in case of the function data change.
	FUNC DATA	Reads and writes the function data.	FUNC DATA	Reads and writes the function data.
	RESET	Reset of the alarm state.	RESET	Reset of the alarm state.
Operation Mode	Displays the switching between the KEYPAD panel and external signal operation.		Displays the switching between the KEYPAD panel and external signal operation. REM/LOC/COMM/JOG,etc. displays the mode.	
Unit Indication	r/min,Hz,A,V,%		r/min,Hz,A,V,kW,%	
Function Code	● Fundamental function and 7 function block ● The number of function codes : 165		● Fundamental function and 10 function block ● The number of function codes : 539	
Language	Japanese/English		Japanese/English/German/French/Italian/Spanish/Chinese	
LCD brightness	Electrical volume (to be adjusted through the function code)		Electrical volume (to be adjusted through the function code)	
Mode Switch	–		● Switches remote and local. ● Switches JOG mode.	

13.6 Function Codes

13.6.1 Replacing VG5

FRENIC5000 VG5S		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
01	Speed setting	F01	Speed setting N1
02	Operation method	F02	Operation method
03	Max. speed	F03	M1 max. speed
04	Acceleration time 1	F07	Acceleration time 1
05	Deceleration time 1	F08	Deceleration time 1
06	S-curve acceleration/deceleration 1	F67 to F70	S-curve acceleration/deceleration 1
07	Multistep speed 1	C05	Multistep speed 1
08	Multistep speed 2	C06	Multistep speed 2
09	Multistep speed 3	C07	Multistep speed 3
10	Multistep speed 4	C08	Multistep speed 4
11	Multistep speed 5	C09	Multistep speed 5
12	Multistep speed 6 / Creep speed 1	C10/C18	Multistep speed 6 / Creep speed 1
13	Multistep speed 7 / Creep speed 2	C11/C19	Multistep speed 7 / Creep speed 2
14	ASR1 (P gain)	F61	ASR1-P(Gain)
15	(I gain)	F62	ASR1-I (Constant of integration)
16	Constant on filtering (Speed setting)	F64	ASR1 input filter
17	(Speed detection)	F65	ASR1 detection filter
18	Torque limiter (Method selection)	F40,41	Torque limiter mode
19	(Limiter value selection)	F42,43	Torque limiter value selection
20	Torque limiter (Level 1)	F44	Torque limiter (Level 1)
21	(Level 2)	F45	(Level 2)
22	Motor electronic thermal (Select)	F10	M1 motor electronic thermal (Select)
23	(Level)	F11	(Level)
24	Restart after momentary power failure	F14	Restart after momentary power failure (Operation selection)
25	DC brake (Time)	F22	DC brake (Braking time)
26	(Level)	F21	(Operation level)
27	Pre-excitation (Time)	F74	Pre-excitation time
30	Function block (31-44) selection	–	
31	Droop control	H28	Droop control
32	Filtering time constant (ASR output)	F66	ASR1 output filter
33	Acceleration time 2	C46	Acceleration time 2
34	Deceleration time 2	C47	Deceleration time 2
35	S-curve acceleration/deceleration 2	C49,C50	S-curve acceleration/deceleration 2
36	Ratio setting	F17	Gain (Speed setting signal 12)
37	ASR2 (P gain)	C40	ASR2-P (Gain)
38	(I gain)	C41	ASR2-I (Constant of integration)
39	ASR1,2 switching characteristic	C70	ASR switching time
40	Torque bias (Level1)	F47	Torque bias T1
41	(Level2)	F48	Torque bias T2
42	Selection between torque control and torque current control	H41,H42	Torque reference and torque current reference selection
43	Magnetic-flux reference (Select)	H43	Magnetic-flux reference selection
44	Magnetic-flux reference at light load	F73	Magnetic-flux level at light load
50	Function block (51-55) selection	–	
51	ASR tuning (Action selection)	H46	Observer type selection
52	(Operation selection)	H01	Tuning operation selection
53	Observer data (Compensation gain)	H47,H48	Observer settings (Compensation gain)
54	(Integration time)	H49,H50	(Integration time)
55	(Load inertia)	H51,H52	(Load inertia)
60	Function block (61-74) selection	–	
61	Motor overheat protection (temp.)	E30	Motor overheat protection (temp.)
62	Motor overheat early warning (temp.)	E31	Motor overheat early warning (temp.)
63	Inverter overload early warning (Level)	E33	Inverter overload early warning
64	Motor overload early warning (Level)	E34	Motor overload early warning
65	Zero speed detection (Level)	F37	Stop speed

13. Replacement Data

FRENIC5000 VG5S		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
66	Speed detection (Level 1)	E39	Speed detection level 1
67	(Level 2)	E40	Speed detection level 2
68	(Level 3)	E41	Speed detection level 3
69	Speed detection method	E38	Speed detection method
70	Speed equivalence (Detection range)	E42	Speed equivalence (Detection range)
71	Speed agreement (Detection range)	E43	Speed agreement (Detection range)
72	(Off delay timer)	E44	(Off delay timer)
73	Torque detection (Level)	E46	Torque detection level 1
74	Timer for continuous operation	F39	Stop speed (Zero speed holding time)
80	Function block (81-101) selection	–	
81	Auto-restart (Times)	H04	Auto-restart (Times)
82	(Interval)	H05	(Interval)
83	Speed bias setting	F18	Bias (Speed setting signal 12)
84	Speed limiter (Method selection)	F76	Speed limiter (Method selection)
85	Speed limiter (Level 1)	F77	Speed limiter level 1
86	(Level 2)	F78	Speed limiter level 2
87	Creep selection (Setting selection)	C73	Creep speed switching (on UP/DOWN control)
87	Operation method changeover switch	–	Function selection Di [IVS]
89	Speed feedback (Signal selection)	H53	Line speed feedback selection
90	Suppressing function	H57	Overvoltage suppressing function
91	Operation method selection	H11	Automatic operation OFF function
92	Torque reference monitor	F51	Torque reference monitor (Polarity selection)
93	Language	F58	LCD monitor (Language selection)
94	LCD brightness adjustment	F59	LCD monitor (Contrast adjustment)
95	LED monitor selection	F55	LED monitor (Display selection)
96	Display of load speed (Coefficient 1)	F52	LED monitor (Display coefficient A)
97	(Coefficient 2)	F53	LED monitor (Display coefficient B)
98	LCD monitor selection	F57	LCD monitor (Display selection)
99	Motor sound selection	F26	Motor sound (Carrier freq.)
100	Data initialization	H03	Data initialization
101	All save	H02	All save
110	Function block (111-134) selection	–	
111	Selection of X1 to X5 functions (X1,X2)	E01,E02	Selection of X1 function, Selection of X2 function
112	(X3,X4)	E03,E04	Selection of X3 function, Selection of X4 function
113	(X5)	E05	X5 function selection
114	Timer for multistep speed reference agreement	C20	Timer for multistep speed reference agreement
115	Y1 to Y3,RY function selection (Y1,Y2)	E15,E16	Y1 function selection,Y2 function selection
116	(Y3,RY)	E17,E19	Y3 function selection,Y5 function selection
117	Ai1,Ai2 function selection	E49,E50	Ai1 function selection, Ai2 function selection
118	Increment/decrement limiter (Ai1)	E65	Increment/decrement limiter (Ai1)
119	(Ai2)	E66	Increment/decrement limiter (Ai2)
120	Offset setting (12)	F17	Gain (Speed setting signal 12)
121	(Ai1)	E57	Ai1 bias setting
122	(Ai2)	E58	Ai2 bias setting
123	Gain setting (12)	F18	Bias (Speed setting signal 12)
124	(Ai1)	E53	Ai1 gain setting
125	(Ai2)	E54	Ai2 gain setting
126	AO1 to AO3 function selection	E69 to E71	AO1 function selection, AO2 function selection, AO3 function selection
127	Bias adjustment (AO1)	E79	AO1 bias setting
128	(AO2)	E80	AO2 bias setting
129	(AO3)	E81	AO3 bias setting
130	Gain adjustment (AO1)	E74	AO1 gain setting
131	(AO2)	E75	AO2 gain setting
132	(AO3)	E76	AO3 gain setting
133	Filter selection (AO1,AO2,AO3)	E84	AO1-5 filter setting
140	Function block (140-169) selection	–	
141	Operation command selection	H30	Serial link
142	Control input through transmission	S06	Operation method 1 (through communication)

FRENIC5000 VG5S		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
143	Speed reference through transmission	S01	Speed reference
144	Action on T-Link error (Mode)	o30	T-Link option setting (Action on transmission error)
145	(Action time)	o31	(Action time on transmission error)
146	Standard built-in RS485 address	H31	RS485 (Station address)
147	Action on RS485 error (Mode)	H32	Action on RS485 error Operation (Mode select on error)
148	(Action time)	H33	(Timer operating time)
149	(No response error detection time)	H38	(No response error detection time)
150	(Response interval)	H39	(Response interval)
151	X11 to X14 function selection (X11,X12)	E10,E11	X11 function selection, X12 function selection
152	(X13,X14)	E12,E13	X13 function selection, X14 function selection
153	Y11 to Y13 function selection (Y11,Y12)	E20,E21	Y11 function selection, Y12 function selection
154	(Y13)	E22	Y13 function selection
155	Function selection of OPCII-VG5-DI	o01,o02	DIA function selection, DIB function selection
156	BCD input speed	o03,o04	DIA BCD input setting, DIB BCD input setting
157	Reference pulse correction 1	o14	Reference pulse correction 1
158	Reference pulse correction 2	o15	Reference pulse correction 2
159	APR gain	o16	APR gain
160	F/F gain	o17	F/F gain
161	Deviation excess range	o18	Deviation excess range
162	Deviation zero range	o19	Deviation zero range
170	Function block (171-197) selection	–	
171	Motor selection	P02	M1 motor selection
172	PG pulse number	P28	M1-PG pulse number
173	NTC thermistor selection	P30	M1 thermistor selection
174	Motor ratings (Capacity)	P03	M1 rated capacity
175	(Voltage)	F05	M1 rated voltage
176	(Current)	P04	M1 rated current
177	(Base speed)	F04	M1 rated speed
178	(No. of pole)	P05	M1 number of pole
179	Overload capability	–	
180	Auto-tuning of motor characteristic (Protection)	–	
181	(Operation)	H01	Tuning operation selection
182	Motor characteristic (%R1)	P06	M1-%R1
183	(%X)	P07	M1-%X
184	(Exciting current)	P08	M1 exciting current
185	(Torque current)	P09	M1 torque current
186	(Slip on driving)	P10	M1 slip on driving
187	(Slip on braking)	P11	M1 slip on braking
188	(Iron loss coefficient 1)	P12	M1 iron loss coefficient 1
189	(Iron loss coefficient 2)	P13	M1 iron loss coefficient 2
190	(Iron loss coefficient 3)	P14	M1 iron loss coefficient 3
191	(Magnetic saturation coefficient 1)	P15	M1 magnetic saturation coefficient 1
192	(Magnetic saturation coefficient 2)	P16	M1 magnetic saturation coefficient 2
193	(Magnetic saturation coefficient 3)	P17	M1 magnetic saturation coefficient 3
194	(Magnetic saturation coefficient 4)	P18	M1 magnetic saturation coefficient 4
195	(Magnetic saturation coefficient 5)	P19	M1 magnetic saturation coefficient 5
196	(Secondary time constant)	P20	M1 secondary time constant
197	(Induced voltage coefficient)	P21	M1 induced voltage coefficient
200	Data protection	F00	Data protection

13.6.2 Replacing VG3

FRENIC5000 VG3		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
01	Motor rotating speed detection value display	–	LED monitor
02	Motor rotating speed setting value display	–	LED monitor
03	Load speed detection value display	–	LED monitor
04	Torque current reference value display	–	LED monitor
05	Torque reference value display	–	LED monitor
06	Motor output display	–	LED monitor
07	Inverter output current display	–	LED monitor
08	Motor temperature display	–	LED monitor
09	Input signal (1) display	–	LCD monitor
0A	Input signal (2) display	–	LCD monitor
0B	Output signal display	–	LCD monitor
0C	Operation mode display	–	LCD monitor
0D	Soft switch (1) display	–	LCD monitor
0E	Soft switch (2) display		LCD monitor
0F	Magnetic-flux quantity	–	LED monitor
10	Protection of setting data (11-3F)	–	
11	Acceleration time 1	F07	Acceleration time 1
12	Deceleration time 1	F08	Deceleration time 1
13	S-curve applied range	F67 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)	C41	ASR2 P
25	ASR I (2)	C42	ASR2 I
26	Speed setting constant on filtering (2)	C43	ASR2 input filter
27	Speed detection constant on filtering (2)	C44	ASR2 detection filter
28	Droop quantity	H28	Droop control
29	ASR time constant of P changeover switch	C70	ASR switching time
2A	Torque limiter value 1/Torque bias reference value 1	F44	Torque limiter value (Level 1)
2B	Torque limiter value 2/Torque bias reference value 2	F45	Torque limiter value (Level 2)
2C	Torque limiter value 3/Torque bias reference value 3	–	
2D	Torque limiter value 4	–	
2E	Magnetic-flux reference level	H44	Magnetic-flux reference value
2F	Magnetic-flux reference level at light load	F73	Magnetic-flux level at light load
30	Zero speed detection level	F37	Stop speed
31	Arbitrary speed detection level (Absolute value)	E39	Speed detection level 1
32	Arbitrary speed detection level (With polarity)	E40	Speed detection level 2
33	Speed equivalence detection level	E42	Speed equivalence
34	Speed agreement detection level	E43	Speed agreement
35	Torque detection level	E46	Torque detection level 1
36	Overload early warning detection level	E33	Inverter overload early warning
37	Motor overheat early warning detection level	E31	Motor overheat early warning
38	Output calibration coefficient of load meter	–	Adjustment is possible through E69 to 71, by allocating the torque meter into AO1 to 3.
39	Output calibration coefficient of speedometer	–	Adjustment is possible through E69 to 71, by allocating the speedometer into AO1 to 3.

FRENIC5000 VG3		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
3A	Stop position by the simplified position control	–	
40	First fault	–	LED monitor
41	Second fault	–	LED monitor
42	Fault condition	–	LCD monitor
43	Speed setting value at the occurrence of fault.	–	LCD monitor
44	Speed detection value at the occurrence of fault.	–	LCD monitor
45	Torque current reference value at the occurrence of fault.	–	LCD monitor
46	Motor current value (U-phase) at the occurrence of fault.	–	LCD monitor
47	Motor current value (W-phase) at the occurrence of fault.	–	LCD monitor
48	Operation mode (LED display) at the occurrence of fault.	–	LCD monitor
49	Operation mode (HEX display) at the occurrence of fault.	–	LCD monitor
4A	Soft switch 1 (LED display) at the occurrence of fault.	–	LCD monitor
4B	Soft switch 2 (LED display) at the occurrence of fault.	–	LCD monitor
4C	Soft switch (HEX display) at the occurrence of fault.	–	LCD monitor
4D	Last fault (First fault)	–	LCD monitor
4E	Fault before last (First fault)	–	LCD monitor
4F	Fault before and before last (First fault)	–	LCD monitor
50	Protection of setting data (51-8F)	–	
51	Max. speed of motor	F03	M1 max. speed
52	Base speed of motor	F04	M1 rated speed
53	DC brake using/not using.	F22	DC brake (Braking time)
54			
55	DC braking time	F22	DC brake (Braking time)
56			
57	Speed setting limiter value (Upper limit)	F77	Speed limiter level 1
58	Definition of the operation method (1)	–	
59	Definition of the operation method (2)	H11	Automatic operation OFF function
5A	Definition of the Speed setting method (1)	F01	Speed setting N1
5B	Definition of forward• reverse command	–	Possible through function selection DI [IVS].
5C	Calibration coefficient of load speed	F52,53	LED monitor (Display coefficient)
5D	Definition of the speed detection area	H53	Line speed feedback selection
5E	Definition of the Speed setting method (2)	C25	Speed setting N2
5F	Creep setting of U/D setter	C73	Creep speed switching
60	Definition of the torque limiter method	F40	Torque limiter mode
61	Definition of the torque limiter value 1/Torque bias reference value 1.	F42	Torque limiter value (Level1) selection
62	Definition of the torque limiter value 2/Torque bias reference value 2.	F43	Torque limiter value (Level2) selection
63	Definition of the torque limiter value 3/Torque bias reference value 3.	–	
64	Definition of the torque limiter value 4.	–	
65	In use/not in use of external Ai for the torque reference.	H41	Torque reference selection
66	Definition of the magnetic-flux reference value.	H43	Magnetic-flux reference selection
70	LM terminal definition	–	Possible through function selection from AO1 to 3.
71	SM terminal definition	–	Possible through function selection from AO1 to 3.
72	DI definition (X1 to X4,X6,X7)	E01 to 04	X1 to X4 function selection
73	DI definition (X5)	E05	X5 function selection
74	DO definition (Y1 to Y5)	E15 to 18	Y1 to Y4 function selection
75	DO definition (RY)	E19	Y5 function selection
76	AI definition (Ai1)	E49	Ai1 function selection
77	AI definition (Ai2)	E50	Ai2 function selection
78	AO definition (AO1)	E69	AO1 function selection
79	AO definition (AO2,AO3)	E70,71	A02,A03 function selection
7A	No. of motor poles, specification for the pulse generator	P28	No. of PG pulses
7B	V1 enabled/disabled	–	Possible through function selection Ai [OFF].
80	Calibration coefficient of BCD input for speed setting	o03,04	DI BCD input setting.
81	Definition of the initial setting value of UP/DOWN settor.	F01,C25	Speed setting N1,N2
82	Enabled/disabled of transmission data	H30	Serial link
83	Transmission ID code	–	

13. Replacement Data

FRENIC5000 VG3		FRENIC5000 VG7S	
Function codes	Name	Function codes	Name
84			
85	AO adjustment	–	Possible through AO function selection [P10], [N10].
86	AI1 filter	E61	Ai1 filter
87	AI2 filter	E62	Ai2 filter
88	12 offset adjustment value	F18	Bias (Speed setting signal 12)
89	12 gain adjustment value	F17	Gain (Speed setting signal 12)
8A	V1 offset adjustment value	–	
8B	V1 gain adjustment value	–	
8C	AI1 offset adjustment value	E57	AI1 bias setting
8D	AI1 gain adjustment value	E53	AI1 gain setting
8E	AI2 offset adjustment value	E58	AI2 bias setting
8F	AI2 gain adjustment value	E54	AI2 gain setting
90	Display of the transmitted and written DI data	S06	Operation method 1
91	Transmission speed setting mode selection	H30	Serial link
92	Transmission speed setting	S01	Speed reference
93	Transmission speed setting bias	–	
94	Transmission torque reference mode selection	H41	Torque reference selection
95	Transmission torque reference	S02	Torque reference
96	General purpose DO	S07	Universal DO
97	Trace data mode	–	
98			
99			
9A	Confirmation of data saving condition	H02	All save
9B	ALL SAVE function	H02	All save

13.7 Motor Parameters

13.7.1 Replacing VG5S

● 200V series

Motor specification						Motor parameters												
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188
			VG7S code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Max. speed	Rated speed	Rated voltage	Rated capacity	Rated current	No. of poles	%R1	%X	Pre-exciting current	Torque current	Slip on driving	Slip On braking	Iron loss co-ef*. 1
MVK6096A	0.75kW	4	1500/3600 r/min	188V	4.3A	1500r/min	1500r/min	188V	0.75kW	4.3A	4	4.34%	9.07%	3.21A	2.92A	1.320Hz	1.185Hz	7.60%
MVK6097A	1.5kW	4	1500/3600 r/min	188V	7.0A	1500r/min	1500r/min	188V	5.5kW	7.0A	4	7.06%	14.76%	3.21A	5.83A	2.640Hz	2.370Hz	3.80%
MVK6107A	2.2kW	4	1500/3600 r/min	188V	11A	1500r/min	1500r/min	188V	2.2KW	11A	4	8.27%	12.95%	3.81A	9.75A	2.622Hz	3.059Hz	3.00%
MVK6115A	3.7kW	4	1500/3600 r/min	188V	18A	1500r/min	1500r/min	188V	3.7kW	18A	4	6.86%	12.69%	8.11A	15.69A	2.500Hz	2.370Hz	3.00%
MVK6133A	5.5kW	4	1500/3600 r/min	188V	30A	1500r/min	1500r/min	188V	5.5kW	30A	4	6.05%	13.44%	12.98A	21.92A	1.490Hz	1.440Hz	3.00%
MVK6135A	7.5kW	4	1500/3600 r/min	188V	37A	1500r/min	1500r/min	188V	7.5kW	37A	4	6.70%	12.45%	15.62A	30.66A	1.771Hz	1.871Hz	2.32%
MVK6165A	11kW	4	1500/3600 r/min	188V	50A	1500r/min	1500r/min	188V	11kW	50A	4	4.26%	11.64%	24.79A	40.30A	0.988Hz	0.824Hz	4.53%
MVK6167A	15kW	4	1500/3600 r/min	188V	65A	1500r/min	1500r/min	188V	15kW	65A	4	4.47%	12.25%	26.99A	53.96A	1.067Hz	1.067Hz	0.00%
MVK6184A	18.5kW	4	1500/3600 r/min	188V	74A	1500r/min	1500r/min	188V	18.5kW	74A	4	3.22%	10.68%	30.58A	72.83A	0.934Hz	0.931Hz	3.50%
MVK6185A	22kW	4	1500/3600 r/min	188V	90A	1500r/min	1500r/min	188V	22kW	90A	4	3.59%	11.78%	34.17A	83.43A	0.606Hz	0.855Hz	1.30%
MVK6206A	30kW	4	1500/3000 r/min	188V	116A	1500r/min	1500r/min	188V	30kW	116A	4	2.53%	12.13%	53.42A	108.18A	0.606Hz	0.648Hz	2.50%
MVK6207A	37kW	4	1500/3000 r/min	188V	143A	1500r/min	1500r/min	188V	37kW	143A	4	2.47%	14.69%	60.09A	133.20A	0.497Hz	0.536Hz	1.80%
MVK6208A	45kW	4	1500/3000 r/min	188V	170A	1500r/min	1500r/min	188V	45kW	170A	4	2.73%	15.26%	56.71A	169.70A	0.947Hz	0.901Hz	1.00%
MVK9250A	55kW	4	1500/2400 r/min	185V	216A	1500r/min	1500r/min	185V	55kW	216A	4	2.08%	12.36%	66.22A	197.97A	0.621Hz	0.595Hz	3.00%
MVK9252A	75kW	4	1500/2400 r/min	183V	276A	1500r/min	1500r/min	183V	75kW	276A	4	1.70%	15.29%	99.34A	261.62A	0.638Hz	0.665Hz	2.00%
MVK9280A	90kW	4	1500/2000 r/min	183V	345A	1500r/min	1500r/min	183V	90kW	345A	4	2.28%	20.12%	89.3A	332.34A	0.669Hz	0.546Hz	0.00%

Motor specification						Motor parameters												
			VG5S code No.			189	190	191	192	193	194	195	196	197	C03	C04	1.000	C14
			VG7S code No.			P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Iron loss co-ef*. 2	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef*. 4	Magnetic saturation co-ef*. 5	Secondary time constant	Induced voltage co-ef*.	R2 correction co-ef*. 1	R2 correctionc o-ef*. 2	R3 correction co-ef*.	Pre-exciting current correction co-ef*.
MVK6096A	0.75kW	4	1500/3600 r/min	188V	4.3A	7.60%	10.00%	93.0%	85.8%	72.6%	60.0%	47.6%	0.108s	149V	1.360	1.480	1.000	0.000
MVK6097A	1.5kW	4	1500/3600 r/min	188V	7.0A	3.80%	5.00%	93.0%	85.8%	72.6%	60.0%	47.6%	0.108s	149V	1.360	1.480	1.000	0.000
MVK6107A	2.2kW	4	1500/3600 r/min	188V	11A	4.00%	1.00%	85.2%	73.7%	59.1%	47.6%	37.4%	0.051s	140V	2.530	1.133	1.000	0.000
MVK6115A	3.7kW	4	1500/3600 r/min	188V	18A	2.95%	2.50%	88.4%	80.1%	66.4%	54.1%	43.0%	0.084s	146V	0.899	1.320	1.000	0.022
MVK6133A	5.5kW	4	1500/3600 r/min	188V	30A	2.50%	3.00%	88.3%	79.5%	66.0%	54.1%	43.0%	0.090s	149V	1.925	1.985	1.000	0.026
MVK6135A	7.5kW	4	1500/3600 r/min	188V	37A	1.76%	3.00%	85.3%	70.7%	53.8%	43.7%	34.4%	0.070s	155V	0.900	0.900	1.000	0.000
MVK6165A	11kW	4	1500/3600 r/min	188V	50A	1.88%	0.22%	84.9%	75.0%	61.6%	50.0%	39.4%	0.087s	175V	0.900	2.343	1.000	0.000
MVK6167A	15kW	4	1500/3600 r/min	188V	65A	1.50%	1.00%	88.7%	80.7%	67.2%	55.2%	44.0%	0.133s	160V	1.689	1.689	1.000	0.000
MVK6184A	18.5kW	4	1500/3600 r/min	188V	74A	0.50%	0.50%	90.7%	83.2%	69.5%	56.8%	44.4%	0.240s	160V	1.465	1.803	1.000	0.097
MVK6185A	22kW	4	1500/3600 r/min	188V	90A	0.77%	2.00%	91.1%	83.2%	69.1%	56.8%	44.6%	0.387s	160V	4.000	2.200	1.000	0.089
MVK6206A	30kW	4	1500/3000 r/min	188V	116A	3.50%	5.00%	84.4%	74.0%	59.5%	48.9%	38.0%	0.173s	166V	2.268	2.078	1.000	0.000
MVK6207A	37kW	4	1500/3000 r/min	188V	143A	3.00%	5.00%	85.4%	75.7%	62.3%	50.5%	39.9%	0.184s	168V	3.200	2.560	1.000	0.180
MVK6208A	45kW	4	1500/3000 r/min	188V	170A	0.00%	0.15%	89.2%	81.6%	67.6%	56.2%	43.4%	0.295s	164V	1.229	1.813	1.000	0.178
MVK9250A	55kW	4	1500/2400 r/min	185V	216A	0.83%	0.21%	91.5%	83.8%	70.6%	57.8%	45.6%	0.413s	168V	1.615	1.753	1.000	0.000
MVK9252A	75kW	4	1500/2400 r/min	183V	276A	2.00%	0.00%	90.4%	83.0%	68.4%	57.4%	46.4%	0.409s	165V	1.856	1.785	1.000	0.091
MVK9280A	90kW	4	1500/2000 r/min	183V	345A	5.00%	0.00%	91.1%	85.1%	70.9%	59.2%	48.7%	0.490s	181V	1.331	1.428	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of VG7.

13. Replacement Data

● 400V series

Motor specification						Motor parameters													
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188	189
			VG7S code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Max. speed	Rated speed	Rated voltage	Rated capacity	Rated current	No. of poles	%R1	%X	Pre-exciting current	Torque current	Slip On driving	Slip On braking	Iron loss co-ef*. 1	Iron loss co-ef*. 2
MVK6115A	3.7kW	4	1500/3600 r/min	376V	9A	1500r/min	1500r/min	376V	3.7kW	9A	4	6.86%	13.94%	3.93A	7.78A	2.510Hz	2.340Hz	2.35%	2.55%
MVK6133A	5.5kW	4	1500/3600 r/min	376V	15A	1500r/min	1500r/min	376V	5.5kW	15A	4	5.50%	12.78%	7.15A	10.74A	1.311Hz	1.370Hz	2.00%	5.00%
MVK6135A	7.5kW	4	1500/3600 r/min	376V	18.5A	1500r/min	1500r/min	376V	7.5kW	18.5A	4	4.37%	13.72%	7.81A	15.33A	1.465Hz	1.686Hz	7.61%	2.00%
MVK6165A	11kW	4	1500/3600 r/min	376V	25.0A	1500r/min	1500r/min	376V	11kW	25A	4	4.27%	11.67%	12.39A	20.15A	0.988Hz	0.824Hz	4.53%	1.88%
MVK6167A	15kW	4	1500/3600 r/min	376V	31.7A	1500r/min	1500r/min	376V	15kW	31.7A	4	4.48%	13.69%	14.47A	28.63A	1.290Hz	1.269Hz	1.00%	0.50%
MVK6184A	18.5kW	4	1500/3600 r/min	376V	37A	1500r/min	1500r/min	376V	18.5kW	37A	4	2.66%	12.45%	14.02A	36.06A	0.882Hz	0.882Hz	1.00%	3.00%
MVK6185A	22kW	4	1500/3600 r/min	376V	45A	1500r/min	1500r/min	376V	22kW	45A	4	3.61%	14.06%	16.81A	41.72A	0.903Hz	0.891Hz	1.50%	1.50%
MVK6206A	30kW	4	1500/3000 r/min	376V	58A	1500r/min	1500r/min	376V	30kW	58A	4	2.55%	12.16%	25.74A	52.52A	0.666Hz	0.648Hz	2.50%	3.50%
MVK6207A	37kW	4	1500/3000 r/min	376V	143A	1500r/min	1500r/min	376V	37kW	71A	4	2.49%	14.11%	30.07A	65.54A	0.497Hz	0.498Hz	1.79%	1.80%
MVK6208A	45kW	4	1500/3000 r/min	376V	85A	1500r/min	1500r/min	376V	45kW	85A	4	2.73%	15.30%	28.36A	84.85A	0.947Hz	0.937Hz	0.50%	1.50%
MVK9250A	55kW	4	1500/2400 r/min	376V	108A	1500r/min	1500r/min	376V	55kW	108A	4	2.05%	12.20%	33.11A	98.98A	0.621Hz	0.595Hz	3.00%	0.83%
MVK9252A	75kW	4	1500/2400 r/min	365V	138A	1500r/min	1500r/min	365V	75kW	138A	4	1.71%	15.39%	49.67A	130.81A	0.638Hz	0.665Hz	2.00%	2.00%
MVK9280A	90kW	4	1500/2000 r/min	370V	173A	1500r/min	1500r/min	370V	90kW	173A	4	2.23%	18.47%	44.37A	164.10A	0.685Hz	0.647Hz	0.00%	2.00%
MVK9282A	110kW	4	1500/3000 r/min	375V	206A	1500r/min	1500r/min	375V	110kW	206A	4	2.14%	16.83%	53.03A	195.87A	0.557Hz	0.606Hz	0.44%	0.00%
MVK9310A	132kW	4	1500/3000 r/min	375V	248A	1500r/min	1500r/min	375V	132kW	248A	4	1.56%	17.21%	62.05A	237.35A	0.481Hz	0.531Hz	0.00%	0.39%
MVK9312A	160kW	4	1500/2400 r/min	375V	297A	1500r/min	1500r/min	375V	160kW	297A	4	1.15%	17.47%	70.71A	28637A	0.518Hz	0.518Hz	0.00%	0.00%
MVK9316A	200kW	4	1500/2400 r/min	375V	369A	1500r/min	1500r/min	369A	200kW	369A	4	1.15%	14.98%	107.66A	341.50A	0.470Hz	0.441Hz	0.00%	2.50%
MVK9318A	220kW	4	1500/2000 r/min	370V	409A	1500r/min	1500r/min	370V	220kW	409A	4	1.63%	14.54%	98.64A	385.37A	0.447Hz	0.458Hz	1.00%	1.00%

Motor specification						Motor parameters											
			VG5S code No.			190	191	192	193	194	195	196	197	C03	C04	1.000	C14
			VG7S code No.			P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef*. 4	Magnetic saturation co-ef*. 5	Secondary time constant	Induced voltage co-ef*.	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R3 Correction co-ef*.	Pre- exciting Current correction co-ef*.
MVK6115A	3.7kW	4	1500/3600 r/min	376V	9A	1.20%	90.5%	82.4%	68.7%	57.0%	45.3%	0.104s	294V	0.880	1.440	1.000	0.028
MVK6133A	5.5kW	4	1500/3600 r/min	376V	15A	7.00%	88.0%	79.2%	65.6%	53.6%	42.2%	0.078s	299V	2.361	1.985	1.000	0.019
MVK6135A	7.5kW	4	1500/3600 r/min	376V	18.5A	1.00%	85.9%	76.9%	63.4%	51.6%	40.5%	0.064s	310V	1.607	1.427	1.000	0.000
MVK6165A	11kW	4	1500/3600 r/min	376V	25.0A	0.22%	84.9%	75.0%	61.6%	50.0%	39.4%	0.087s	348V	0.910	2.343	1.000	0.000
MVK6167A	15kW	4	1500/3600 r/min	376V	31.7A	1.00%	88.7%	81.7%	67.2%	55.2%	44.0%	0.133s	306V	1.090	1.318	1.000	0.027
MVK6184A	18.5kW	4	1500/3600 r/min	376V	37A	3.00%	92.5%	84.3%	70.3%	57.1%	45.1%	0.295s	321V	1.825	1.825	1.000	0.018
MVK6185A	22kW	4	1500/3600 r/min	376V	45A	3.00%	91.1%	83.2%	69.1%	56.5%	44.6%	0.387s	320V	1.357	1.673	1.000	0.037
MVK6206A	30kW	4	1500/3000 r/min	376V	58A	9.50%	84.4%	74.0%	59.5%	48.9%	38.0%	0.173s	331V	2.268	2.078	1.000	0.070
MVK6207A	37kW	4	1500/3000 r/min	376V	143A	5.00%	85.4%	75.7%	62.3%	50.5%	39.9%	0.184s	336V	3.200	3.064	1.000	0.095
MVK6208A	45kW	4	1500/3000 r/min	376V	85A	1.85%	89.2%	81.6%	67.6%	56.2%	43.4%	0.295s	328V	1.229	1.502	1.000	0.089
MVK9250A	55kW	4	1500/2400 r/min	376V	108A	0.21%	91.5%	83.8%	70.6%	57.8%	45.6%	0.413s	336V	1.615	1.753	1.000	0.000
MVK9252A	75kW	4	1500/2400 r/min	365V	138A	0.00%	90.4%	83.0%	68.4%	57.4%	46.4%	0.409s	330V	1.856	1.785	1.000	0.091
MVK9280A	90kW	4	1500/2000 r/min	370V	173A	0.00%	90.7%	83.7%	69.0%	57.1%	44.9%	0.590s	348V	1.093	1.212	1.000	0.163
MVK9282A	110kW	4	1500/3000 r/min	375V	206A	0.00%	90.1%	82.6%	67.7%	56.3%	44.2%	0.577s	350V	1.488	1.172	1.000	0.090
MVK9310A	132kW	4	1500/3000 r/min	375V	248A	0.00%	90.1%	81.2%	67.7%	56.2%	45.9%	0.689s	336V	1.468	1.424	1.000	0.000
MVK9312A	160kW	4	1500/2400 r/min	375V	297A	0.00%	91.0%	84.3%	71.8%	59.1%	47.7%	1.127s	330V	1.496	1.496	1.000	0.000
MVK9316A	200kW	4	1500/2400 r/min	375V	369A	0.00%	93.8%	87.6%	74.8%	60.6%	48.2%	1.026s	342V	1.175	1.358	1.000	0.104
MVK9318A	220kW	4	1500/2000 r/min	370V	409A	0.00%	95.1%	88.5%	75.0%	63.1%	51.3%	1.758s	361V	1.535	1.513	1.000	0.078

*co-ef.: coefficient

Note : The above table shows the setting values of VG7.

13.7.2 Replacing VG3

● 200V series

Motor specification			VG7S code No.			Motor parameters F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Max. speed	Rated speed	Rated voltage	Rated capacity	Rated current	No. of poles	%R1	%X	Pre-exciting current	Torque current	Slip on driving	Slip on braking	Iron loss co-ef*. 1
MVK6097A	0.75Kw	4	1500/3600 r/min	160V	4.0A	1500r/min	1500r/min	160V	0.75kW	5.4A	4	4.62%	9.16%	2.65A	4.55A	2.360Hz	2.560Hz	2.30%
MVK6097A	1.5kW	4	1500/3600 r/min	160V	8.0A	1500r/min	1500r/min	160V	1.5kW	9.8A	4	8.36%	16.59%	2.65A	9.09A	4.700Hz	5.100Hz	2.30%
MVK6098A	2.2kW	4	1500/3600 r/min	160V	12.5A	1500r/min	1500r/min	160V	2.2KW	12.2A	4	7.82%	13.73%	4.15A	11.00A	3.340Hz	3.600Hz	4.80%
MVK6115A	3.7kW	4	1500/3600 r/min	160V	20A	1500r/min	1500r/min	160V	3.7kW	19.9A	4	7.06%	14.40%	7.25A	18.60A	2.540Hz	3.440Hz	0.00%
MVK6133A	5.5kW	4	1500/3600 r/min	160V	31A	1500r/min	1500r/min	160V	5.5kW	30.2A	4	4.88%	13.44%	14.93A	26.10A	1.680Hz	2.200Hz	0.00%
MVK6135A	7.5kW	4	1500/3600 r/min	160V	41A	1500r/min	1500r/min	160V	7.5kW	41.8A	4	4.96%	13.75%	18.90A	37.30A	1.960Hz	2.000Hz	0.00%
MVK6165A	11kW	4	1500/3600 r/min	160V	58A	1500r/min	1500r/min	160V	11kW	54.7A	4	3.80%	13.99%	24.00A	49.10A	1.320Hz	1.500Hz	0.00%
MVK6167A	15kW	4	1500/3600 r/min	160V	74A	1500r/min	1500r/min	160V	15kW	70.5A	4	3.17%	13.21%	28.20A	64.60A	1.320Hz	1.520Hz	0.00%
MVK6184A	18.5kW	4	1500/3600 r/min	160V	90A	1500r/min	1500r/min	160V	18.5kW	89.6A	4	2.63%	13.94%	36.80A	81.70A	0.820Hz	0.940Hz	0.00%
MVK6185A	22kW	4	1500/3600 r/min	160V	106A	1500r/min	1500r/min	160V	22kW	104.3A	4	2.49%	13.21%	45.70A	93.80A	0.780Hz	1.000Hz	0.00%
MVK6206A	30kW	4	1500/3000 r/min	160V	142A	1500r/min	1500r/min	160V	30kW	140.6A	4	2.59%	15.06%	51.20A	130.90A	0.800Hz	0.940Hz	0.00%
MVK6207A	37kW	4	1500/3000 r/min	160V	177A	1500r/min	1500r/min	160V	37kW	164.5A	4	2.46%	14.03%	51.10A	156.30A	0.720Hz	0.940Hz	0.00%
MVK6207A	45kW	4	1500/3000 r/min	160V	203A	1500r/min	1500r/min	160V	45kW	195.6A	4	2.50%	16.36%	54.40A	187.90A	0.960Hz	1.100Hz	0.00%

Motor specification			VG7S code No.			Motor parameters P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current	Iron loss co-ef*. 2	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef*. 4	Magnetic saturation co-ef*. 5	Secondary time constant	Induced voltage co-ef*.	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R3 correction co-ef*.	Pre-exciting current correction co-ef*.
MVK6097A	0.75Kw	4	1500/3600 r/min	160V	4.0A	1.90%	0.10%	94.1%	87.8%	74.9%	62.7%	50.2%	0.152s	96V	1.000	1.000	1.000	0.000
MVK6097A	1.5kW	4	1500/3600 r/min	160V	8.0A	1.90%	0.10%	94.1%	87.8%	74.9%	62.7%	50.2%	0.152s	96V	1.000	1.000	1.000	0.000
MVK6098A	2.2kW	4	1500/3600 r/min	160V	12.5A	0.00%	0.10%	93.7%	87.1%	74.1%	60.8%	47.8%	0.096s	116V	1.000	1.000	1.000	0.000
MVK6115A	3.7kW	4	1500/3600 r/min	160V	20A	0.00%	0.10%	89.4%	80.4%	66.7%	54.5%	42.7%	0.172s	115V	1.000	1.000	1.000	0.000
MVK6133A	5.5kW	4	1500/3600 r/min	160V	31A	0.00%	0.00%	87.1%	77.6%	63.5%	51.8%	40.8%	0.200s	122V	1.000	1.000	1.000	0.000
MVK6135A	7.5kW	4	1500/3600 r/min	160V	41A	0.00%	0.00%	82.8%	72.3%	58.6%	48.0%	38.3%	0.220s	120V	1.000	1.000	1.000	0.000
MVK6165A	11kW	4	1500/3600 r/min	160V	58A	0.00%	0.00%	77.6%	79.6%	65.9%	53.7%	43.1%	0.320s	130V	1.000	1.000	1.000	0.000
MVK6167A	15kW	4	1500/3600 r/min	160V	74A	0.00%	0.00%	91.0%	83.1%	69.0%	56.9%	45.1%	0.336s	135V	1.000	1.000	1.000	0.000
MVK6184A	18.5kW	4	1500/3600 r/min	160V	90A	0.00%	0.00%	89.4%	80.0%	62.7%	50.2%	40.0%	0.364s	131V	1.000	1.000	1.000	0.000
MVK6185A	22kW	4	1500/3600 r/min	160V	106A	0.00%	0.00%	89.4%	81.2%	67.5%	50.2%	43.9%	0.384s	136V	1.000	1.000	1.000	0.000
MVK6206A	30kW	4	1500/3000 r/min	160V	142A	0.00%	0.00%	89.8%	80.4%	65.9%	53.7%	42.4%	0.568s	133V	1.000	1.000	1.000	0.000
MVK6207A	37kW	4	1500/3000 r/min	160V	177A	0.00%	0.00%	90.6%	80.4%	65.9%	54.1%	43.1%	0.484s	137V	1.000	1.000	1.000	0.000
MVK6207A	45kW	4	1500/3000 r/min	160V	203A	0.00%	0.00%	91.4%	82.7%	69.0%	57.3%	45.5%	0.732s	138V	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

13. Replacement Data

● 400V series

Motor specification						Motor parameters												
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
					VG7S code No.	Max. speed	Rated speed	Rated voltage	Rated capacity	Rated current	No. of poles	%R1	%X	Pre-exciting current	Torque current	Slip on driving	Slip on braking	Iron loss co-ef*. 1
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current													
MVK6115A	3.7kW	4	1500/3600 r/min	320V	10A	1500r/min	1500r/min	320V	3.7kW	10A	4	7.07%	14.40%	3.62A	9.30A	2.540Hz	3.280Hz	0.00%
MVK6133A	5.5kW	4	1500/3600 r/min	320V	15.5A	1500r/min	1500r/min	320V	5.5kW	15.1A	4	4.89%	13.44%	7.50A	13.10A	1.680Hz	1.880Hz	0.00%
MVK6135A	7.5kW	4	1500/3600 r/min	320V	20.5A	1500r/min	1500r/min	320V	7.5kW	20.3A	4	4.84%	13.35%	9.30A	18.00A	1.960Hz	2.000Hz	0.00%
MVK6165A	11kW	4	1500/3600 r/min	320V	29A	1500r/min	1500r/min	320V	11kW	27.4A	4	3.79%	14.03%	12.00A	24.60A	1.320Hz	1.420Hz	0.00%
MVK6167A	15kW	4	1500/3600 r/min	320V	37A	1500r/min	1500r/min	320V	15kW	35.3A	4	3.17%	13.24%	14.10A	32.30A	1.200Hz	1.400Hz	0.00%
MVK6185A	18.5kW	4	1500/3600 r/min	320V	45A	1500r/min	1500r/min	320V	18.5kW	44.5A	4	2.60%	13.86%	18.10A	39.00A	0.940Hz	0.960Hz	1.10%
MVK6185A	22kW	4	1500/3600 r/min	320V	53A	1500r/min	1500r/min	320V	22kW	53.2A	4	2.52%	13.46%	19.90A	47.60A	0.960Hz	1.000Hz	2.20%
MVK6206A	30kW	4	1500/3000 r/min	320V	71A	1500r/min	1500r/min	320V	30kW	70.3A	4	2.57%	15.08%	25.60A	65.50A	0.800Hz	0.940Hz	0.00%
MVK6207A	37kW	4	1500/3000 r/min	320V	89A	1500r/min	1500r/min	320V	37kW	78.4A	4	2.35%	13.38%	25.20A	74.30A	0.740Hz	0.860Hz	0.00%
MVK6208A	45kW	4	1500/3000 r/min	320V	102A	1500r/min	1500r/min	320V	45kW	97.8A	4	2.49%	16.38%	27.20A	94.00A	0.840Hz	1.100Hz	0.00%
MVK5256A	75kW	4	1500/2400 r/min	320V	170A	1500r/min	1500r/min	320V	75kW	170A	4	1.73%	14.88%	47.38A	162.78A	0.840Hz	0.960Hz	0.00%

Motor specification						Motor parameters												
						P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
					VG7S code No.	Iron loss co-ef*. 2	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef* . 4	Magnetic saturation co-ef* . 5	Secondary time constant	Induced voltage co-ef* .	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R3 correction co-ef*.	Pre-exciting current correctionco-ef*.
Type	Capacity	No. of poles	Speed (Rated/Max.)	Voltage	Current													
MVK6115A	3.7kW	4	1500/3600 r/min	320V	10A	0.00%	0.00%	89.4%	80.4%	66.7%	54.5%	42.7%	0.172s	230V	1.000	1.000	1.000	0.000
MVK6133A	5.5kW	4	1500/3600 r/min	320V	15.5A	0.00%	0.00%	87.1%	77.6%	63.5%	51.8%	40.8%	0.200s	242V	1.000	1.000	1.000	0.000
MVK6135A	7.5kW	4	1500/3600 r/min	320V	20.5A	0.00%	0.00%	86.7%	76.1%	60.8%	49.4%	38.4%	0.224s	241V	1.000	1.000	1.000	0.000
MVK6165A	11kW	4	1500/3600 r/min	320V	29A	0.00%	0.00%	88.6%	79.6%	65.9%	53.7%	43.1%	0.320s	258V	1.000	1.000	1.000	0.000
MVK6167A	15kW	4	1500/3600 r/min	320V	37A	0.00%	0.00%	91.0%	83.1%	69.0%	56.9%	45.1%	0.336s	268V	1.000	1.000	1.000	0.000
MVK6185A	18.5kW	4	1500/3600 r/min	320V	45A	3.10%	1.70%	91.4%	83.1%	68.6%	56.1%	45.9%	0.412s	274V	1.000	1.000	1.000	0.000
MVK6185A	22kW	4	1500/3600 r/min	320V	53A	1.60%	0.70%	92.9%	85.1%	71.4%	58.8%	46.7%	0.412s	267V	1.000	1.000	1.000	0.000
MVK6206A	30kW	4	1500/3000 r/min	320V	71A	0.00%	0.00%	89.8%	80.4%	65.9%	53.7%	42.4%	0.568s	265V	1.000	1.000	1.000	0.000
MVK6207A	37kW	4	1500/3000 r/min	320V	89A	0.00%	0.00%	90.6%	80.8%	67.5%	52.5%	40.8%	0.460s	288V	1.000	1.000	1.000	0.000
MVK6208A	45kW	4	1500/3000 r/min	320V	102A	0.00%	0.00%	91.4%	82.7%	69.0%	57.3%	45.5%	0.732s	277V	1.000	1.000	1.000	0.000
MVK5256A	75kW	4	1500/2400 r/min	320V	170A	0.00%	0.00%	92.6%	85.2%	72.3%	60.5%	48.4%	0.576s	266V	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

13.7.3 Replacing VG

- 200V series

Motor specification			VG7S code No.			Motor parameters F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
Type	Capacity	No.of pole	Speed (Rated/Max.)	Voltage	Current	Max.speed	Rated speed	Rated voltage	Rated capacity	Rated current	No.of pole	%R1	%X	Pre-exciting current	Torque current	Slip on driving	Slip on braking	Iron loss co-ef*. 1
MVK3115A	3.7kW	4	1500/3600 r/min	160V	20A	1500r/min	1500r/min	160V	3.7kW	19.9A	4	7.07%	14.40%	7.25A	18.60A	2.540Hz	3.440Hz	0.00%
MVK3133A	5.5kW	4	1500/3600 r/min	160V	31A	1500r/min	1500r/min	160V	5.5kW	30.2A	4	4.89%	13.44%	14.93A	26.10A	1.680Hz	2.200Hz	0.00%
MVK3135A	7.5kW	4	1500/3600 r/min	160V	41A	1500r/min	1500r/min	160V	7.5kW	41.8A	4	4.98%	13.75%	18.90A	37.30A	1.960Hz	2.000Hz	0.00%
MVK3165A	11kW	4	1500/3600 r/min	160V	58A	1500r/min	1500r/min	160V	11kW	54.7A	4	3.79%	13.97%	24.00A	49.10A	1.320Hz	1.500Hz	0.00%
MVK3167A	15kW	4	1500/3600 r/min	160V	74A	1500r/min	1500r/min	160V	15kW	70.5A	4	3.17%	13.21%	28.20A	64.60A	1.320Hz	1.520Hz	0.00%
MVK3184A	18.5kW	4	1500/3600 r/min	160V	86.3A	1500r/min	1500r/min	160V	18.5kW	86.3A	4	2.55%	13.58%	31.69A	80.28A	0.920Hz	1.060Hz	0.00%
MVK5187A	22kW	4	1500/3600 r/min	160V	106A	1500r/min	1500r/min	160V	22kW	106A	4	2.49%	13.21%	42.28A	95.60A	0.960Hz	0.960Hz	0.00%
MVK5206A	30kW	4	1500/3000 r/min	160V	142A	1500r/min	1500r/min	160V	30kW	142A	4	2.49%	11.74%	57.83A	135.3A	1.200Hz	1.200Hz	0.00%
MVK5207A	37kW	4	1500/3000 r/min	160V	178A	1500r/min	1500r/min	160V	37kW	178A	4	1.24%	7.30%	70.97A	160.9A	0.685Hz	0.685Hz	0.00%
MVK5223A	45kW	4	1500/3000 r/min	160V	210A	1500r/min	1500r/min	160V	45kW	210A	4	2.01%	14.34%	68.97A	191.9A	0.854Hz	0.854Hz	0.00%

Motor specification			VG7S code No.			Motor parameters P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity	No.of pole	Speed (Rated/Max.)	Voltage	Current	Iron loss co-ef*. 2	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef*. 4	Magnetic saturation co-ef*. 5	Secondary time constant	Induced voltage co-ef*.	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R3 correction co-ef*.	Pre-exciting current Correction co-ef*.
MVK3115A	3.7kW	4	1500/3600 r/min	160V	20A	0.00%	0.00%	89.4%	80.4%	66.7%	54.5%	42.7%	0.172s	115V	1.000	1.000	1.000	0.000
MVK3133A	5.5kW	4	1500/3600 r/min	160V	31A	0.00%	0.00%	87.1%	77.6%	63.5%	51.8%	40.8%	0.200s	122V	1.000	1.000	1.000	0.000
MVK3135A	7.5kW	4	1500/3600 r/min	160V	41A	0.00%	0.00%	82.8%	72.3%	58.6%	48.0%	38.3%	0.220s	120V	1.000	1.000	1.000	0.000
MVK3165A	11kW	4	1500/3600 r/min	160V	58A	0.00%	0.00%	77.6%	79.6%	65.9%	53.7%	43.1%	0.320s	130V	1.000	1.000	1.000	0.000
MVK3167A	15kW	4	1500/3600 r/min	160V	74A	0.00%	0.00%	91.0%	83.1%	69.0%	56.9%	45.1%	0.336s	135V	1.000	1.000	1.000	0.000
MVK3184A	18.5kW	4	1500/3600 r/min	160V	86.3A	0.00%	0.00%	91.8%	84.0%	71.1%	58.2%	45.7%	0.312s	133V	1.000	1.000	1.000	0.000
MVK5187A	22kW	4	1500/3600 r/min	160V	106A	0.00%	0.00%	92.6%	84.8%	71.1%	58.6%	46.5%	0.412s	136V	1.000	1.000	1.000	0.000
MVK5206A	30kW	4	1500/3000 r/min	160V	142A	0.00%	0.00%	92.7%	85.4%	70.8%	57.6%	45.0%	0.349s	129V	1.000	1.000	1.000	0.000
MVK5207A	37kW	4	1500/3000 r/min	160V	178A	0.00%	0.00%	90.5%	81.3%	67.3%	55.3%	44.3%	0.423s	146V	1.000	1.000	1.000	0.000
MVK5223A	45kW	4	1500/3000 r/min	160V	210A	0.00%	0.00%	91.0%	83.1%	69.5%	57.9%	46.3%	0.483s	149V	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

13. Replacement Data

● 400V series

Motor specification			VG7S code No.			Motor parameters												
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
Type	Capacity	No.of pole	Speed (Rated/Max.)	Voltage	Current	Max.speed	Rated speed	Rated voltage	Rated capacity	Rated current	No.of pole	%R1	%X	Pre-exciting current	Torque current	Slip on driving	Slip on braking	Iron loss co-ef*. 1
MVK3115A	3.7kW	4	1500/3600 r/min	320V	10A	1500r/min	1500r/min	320V	3.7kW	10A	4	7.07%	14.40%	3.62A	9.30A	2.540Hz	3.280Hz	0.00%
MVK3133A	5.5kW	4	1500/3600 r/min	320V	15.5A	1500r/min	1500r/min	320V	5.5kW	15.1A	4	4.89%	13.44%	7.50A	13.10A	1.680Hz	1.880Hz	0.00%
MVK3135A	7.5kW	4	1500/3600 r/min	320V	20.5A	1500r/min	1500r/min	320V	7.5kW	20.3A	4	4.84%	13.35%	9.30A	18.00A	1.960Hz	2.000Hz	0.00%
MVK3165A	11kW	4	1500/3600 r/min	320V	29A	1500r/min	1500r/min	320V	11kW	27.4A	4	3.79%	14.03%	12.00A	24.60A	1.320Hz	1.420Hz	0.00%
MVK3167A	15kW	4	1500/3600 r/min	320V	37A	1500r/min	1500r/min	320V	15kW	35.3A	4	3.17%	13.24%	14.10A	32.30A	1.200Hz	1.400Hz	0.00%
MVK3184A	18.5kW	4	1500/3600 r/min	320V	45A	1500r/min	1500r/min	320V	18.5kW	45A	4	2.55%	13.58%	15.85A	40.14A	0.920Hz	1.060Hz	0.00%
MVK5187A	22kW	4	1500/3600 r/min	320V	53A	1500r/min	1500r/min	320V	22kW	53A	4	2.49%	13.21%	21.14A	47.79A	0.960Hz	0.960Hz	0.00%
MVK5206A	30kW	4	1500/3000 r/min	320V	69.8A	1500r/min	1500r/min	320V	30kW	69.8A	4	2.49%	11.74%	28.92A	67.66A	1.200Hz	1.200Hz	0.00%
MVK5207A	37kW	4	1500/3000 r/min	320V	89A	1500r/min	1500r/min	320V	37kW	89A	4	2.52%	14.59%	35.49A	80.40A	0.685Hz	0.685Hz	0.00%
MVK5223A	45kW	4	1500/3000 r/min	320V	105A	1500r/min	1500r/min	320V	45kW	105A	4	2.01%	14.34%	34.49A	95.93A	0.854Hz	0.854Hz	0.00%

Motor specification			VG7S code No.			Motor parameters												
						P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity	No.of pole	Speed (Rated/Max.)	Voltage	Current	Iron loss co-ef*. 2	Iron loss co-ef*. 3	Magnetic saturation co-ef*. 1	Magnetic saturation co-ef*. 2	Magnetic saturation co-ef*. 3	Magnetic saturation co-ef*. 4	Magnetic saturation co-ef*. 5	Secondary time constant	Induced voltage co-ef*.	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R3 correction co-ef*.	Pre-exciting current correction co-ef*.
MVK3115A	3.7kW	4	1500/3600 r/min	320V	10A	0.00%	0.00%	89.4%	80.4%	66.7%	54.5%	42.7%	0.172s	230V	1.000	1.000	1.000	0.000
MVK3133A	5.5kW	4	1500/3600 r/min	320V	15.5A	0.00%	0.00%	87.1%	77.6%	63.5%	51.8%	40.8%	0.200s	242V	1.000	1.000	1.000	0.000
MVK3135A	7.5kW	4	1500/3600 r/min	320V	20.5A	0.00%	0.00%	86.7%	76.1%	60.8%	49.4%	38.4%	0.224s	241V	1.000	1.000	1.000	0.000
MVK3165A	11kW	4	1500/3600 r/min	320V	29A	0.00%	0.00%	88.6%	79.6%	65.9%	53.7%	43.1%	0.320s	258V	1.000	1.000	1.000	0.000
MVK3167A	15kW	4	1500/3600 r/min	320V	37A	0.00%	0.00%	91.0%	83.1%	69.0%	56.9%	45.1%	0.336s	268V	1.000	1.000	1.000	0.000
MVK3184A	18.5kW	4	1500/3600 r/min	320V	45A	0.00%	0.00%	91.8%	84.0%	71.1%	58.2%	45.7%	0.312s	267V	1.000	1.000	1.000	0.000
MVK5187A	22kW	4	1500/3600 r/min	320V	53A	0.00%	0.00%	92.6%	84.8%	71.1%	58.6%	46.5%	0.412s	267V	1.000	1.000	1.000	0.000
MVK5206A	30kW	4	1500/3000 r/min	320V	69.8A	0.00%	0.00%	92.7%	85.4%	70.8%	57.6%	45.0%	0.349s	257V	1.000	1.000	1.000	0.000
MVK5207A	37kW	4	1500/3000 r/min	320V	89A	0.00%	0.00%	90.5%	81.3%	67.3%	55.3%	44.3%	0.423s	291V	1.000	1.000	1.000	0.000
MVK5223A	45kW	4	1500/3000 r/min	320V	105A	0.00%	0.00%	91.0%	83.1%	69.5%	57.9%	46.3%	0.483s	298V	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above value is the setting value of VG7

13.8 Protective Functions

13.8.1 Replacing VG5

FRENIC5000 VG5S		FRENIC5000 VG7S	
–		dbH	DB resistor overheat
dcF	DC fuse blown	dcF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
Er1	Memory error	Er1	Memory error
Er2	KEYPAD panel communication error	Er2	KEYPAD panel communication error
Er3	CPU error	Er3	CPU error
Er4	T-Link communication error	Er4	Network error
Er5	RS485 error	Er5	RS485 communication error
Er6	Operation procedure error	Er6	Operation procedure error
Er7	Output wiring error	Er7	Output wiring error
Er8	A/D converter error	Er8	A/D converter error
–		Er9	Speed disagreement
–		ErA	UPAC error
–		Erb	Inter-inverter communication error
–		Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
nrb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Overheating at heat sink	OH1	Overheating at heat sink
OH2	External alarm	OH2	External alarm
OH3	Inverter internal overheat	OH3	Inverter internal overheat
OH4	Motor overheat	OH4	Motor overheat
OL	Motor overload	OL1	Motor 1 overload
–		OL2	Motor 2 overload
–		OL3	Motor 3 overload
OLU	Inverter overload	OLU	Inverter unit overload
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
PbF	Charging circuit error	PbF	Charging circuit error
P9	PG disconnection	P9	PG disconnection

13.8.2 Replacing VG3

FRENIC5000 VG3		FRENIC5000 VG7S	
–		dbH	DB resistor overheat
dcF	DC fuse blown	dcF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
Rf	Memory error	Er1	Memory error
–		Er2	KEYPAD panel communication error
–		Er3	CPU error
OPF	T-Link communication error	Er4	Network error
–		Er5	RS485 communication error
–		Er6	Operation procedure error
–		Er7	Output wiring error
CF	Current detection circuit error	–	
–		Er8	A/D converter error
–		Er9	Speed disagreement
–		ErA	UPAC error
–		Erb	Inter-inverter communication error
–		Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
rb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Inverter overheat	OH1	Overheating at heat sink
OH3	External alarm	OH2	External alarm
–		OH3	Inverter internal overheat
OH2	Motor overheat	OH4	Motor overheat
–		OL1	Motor 1 overload
–		OL2	Motor 2 overload
–		OL3	Motor 3 overload
OL	Inverter overload	OLU	Inverter unit overload
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
–		PbF	Charging circuit error
–		P9	PG disconnection

13.8.3 Replacing VG

FRENIC5000 VG		FRENIC5000 VG7S	
–		dbH	DB resistor overheat
–	DC fuse blown	dcF	DC fuse blown
–		dO	Excessive position deviation
–		EF	Ground fault
–		Er1	Memory error
–		Er2	KEYPAD panel communication error
–	CPU error	Er3	CPU error
–		Er4	Network error
–		Er5	RS485 communication error
–		Er6	Operation procedure error
–		Er7	Output wiring error
–		Er8	A/D converter error
–		Er9	Speed disagreement
–		ErA	UPAC error
–		Erb	Inter-inverter communication error
–		Lin	Input phase loss
–	Undervoltage	LU	Undervoltage
–	NTC thermistor disconnection	nrb	NTC thermistor disconnection
–	Overcurrent	OC	Overcurrent
–	Inverter overheat	OH1	Overheating at heat sink
–	DB resistor overheat	OH2	External alarm
–		OH3	Inverter internal overheat
–	Motor overheat	OH4	Motor overheat
–		OL1	Motor 1 overload
–		OL2	Motor 2 overload
–		OL3	Motor 3 overload
–	Inverter overload	OLU	Inverter unit overload
–	Overspeed	OS	Overspeed
–	Overvoltage	OU	Overvoltage
–		PbF	Charging circuit error
–		P9	PG disconnection

13.9 Options

13.9.1 Replacing VG5S

Name	FRENIC5000 VG5S option	Possibility of combination with VG7	Alternative FRENIC5000 VG7S option
Adder	OPCII-VG3-AD	Impossible	
I/V,V/I converter	OPCII-VG3-IV	Impossible	
Comparator	OPCII-VG3-CP	Impossible	
Isolation converter	OPCII-VG3-IA	Impossible	
F/V converter	OPCII-VG3-FV	Impossible	OPC-VG7-FV
Synchro. interface	OPCII-VG3-SN	Impossible	OPC-VG7-SN
Di interface card	OPCII-VG5-DIN	Impossible	OPC-VG7-DI (DIA,DIB)
	OPCII-VG5-DIT	Impossible	OPC-VG7-DI (DIA,DIB)
DIO expansion card	OPCII-VG5-DIO	Impossible	OPC-VG7-DIO (DIOA)
T-Link interface card	OPCII-VG5-TL	Impossible	OPC-VG7-TL
PG interface extension card	OPCII-VG5-PG1	Impossible	Built-in.
	OPCII-VG5-PG2	Impossible	OPC-VG7-PG
Pulse train interface card	OPCII-VG5-PTI	Impossible	OPC-VG7-PG
Adder	MCAII-VG3-AD	Impossible	
I/V,V/I converter	MCAII-VG3-IV	Impossible	
Comparator	MCAII-VG3-CP	Impossible	
Isolation converter	MCAII-VG3-IA	Impossible	
F/V converter	MCAII-VG3-FV	Impossible	MCA-VG7-FV
Synchro. interface	MCAII-VG5-SN	Impossible	MCA-VG7-SN
Dancer controller	MCAII-PU	Possible	
Relay unit	MCAII-RY	Impossible	
PG switcher	MCAII-VG5-CPG	Possible	
Braking unit	Depends on the capacity	Possible	Depends on the capacity (Built-in for 55kW or less of 200V series, and for 110kW or less of 400V series)
Braking resistor	Depends on the capacity	Possible	Depends on the capacity
AC reactor	Depends on the capacity	Possible	Depends on the capacity
DC REACTOR	Depends on the capacity	Possible	Depends on the capacity (Provided as standard for units of more than 75kW).
Ferrite ring for reducing radio noise.	ACL-40B,ACL-74B	Possible	
KEYPAD panel extension cable	CBIII-10R-2S CBIII-10R-1C CBIII-10R-2C	Possible	

13.9.2 Replacing VG3

Name	FRENIC5000 VG3 option	Possibility of combination with VG7	Alternative FRENIC5000 VG7S option
Adder	OPCII-VG3-AD	Impossible	
I/V,V/I converter	OPCII-VG3-IV	Impossible	
Comparator	OPCII-VG3-CP	Impossible	
Isolation converter	OPCII-VG3-IA	Impossible	
F/V converter	OPCII-VG3-FV	Impossible	OPC-VG7-FV
Synchro. interface	OPCII-VG3-SN	Impossible	OPC-VG7-SN
Di interface card	OPCII-VG3-DI	Impossible	OPC-VG7-DI (DIA,DIB)
AO interface	OPCII-VG3-AO	Impossible	OPC-VG7-AIO
T-Link interface card	OPCII-VG3-T2 OPCII-VG3-TL	Impossible	OPC-VG7-TL
Adder	MCAII-VG3-AD	Impossible	
I/V,V/I converter	MCAII-VG3-IV	Impossible	
Comparator	MCAII-VG3-CP	Impossible	
Isolation converter	MCAII-VG3-IA	Impossible	
F/V converter	MCAII-VG3-FV	Impossible	MCA-VG7-FV
Synchro. interface	MCAII-VG5-SN	Impossible	MCA-VG7-SN
Dancer controller	MCAII-PU	Possible	
Relay unit	MCAII-RY	Impossible	
Ground fault detection unit	MCAII-GFD-1 MCAII-GFD-2	Impossible	Ground fault detection function of the output wiring is a standard built-in for the inverter more than 18.5kW.
Braking unit	Depends on the capacity	Possible	Depends on the capacity (Built-in for 55kW or less of 200V series, and for 110kW or less of 400V series)
Braking resistor	Depends on the capacity	Possible	Depends on the capacity
AC reactor	Depends on the capacity	Possible	Depends on the capacity
DC REACTOR	Depends on the capacity	Possible	Depends on the capacity (Provided as standard for units of more than 75kW)
Ferrite ring for reducing radio noise.	ACL-10A	Possible	

13.9.3 Replacing VG

Name	FRENIC5000 VG option	Possibility of combination with VG7	Alternative FRENIC5000 VG7S option
Adder	OPCII-AD	Impossible	
I/V,V/I converter	OPCII-IV	Impossible	
Comparator	OPCII-CP	Impossible	
Isolation converter	OPCII-IA	Impossible	
F/V converter	OPCII-FV	Impossible	OPC-VG7-FV
Soft start stop	OPCII-RA	Impossible	Standard built-in.
Di interface card	OPCII-BI OPCII-BC	Impossible	OPC-VG7-DI (DIA,DIB)
T-Link interface card	OPCII-TL-1 OPCII-TL-2	Impossible	OPC-VG7-TL
Adder	MCAII-AD	Impossible	
I/V,V/I converter	MCAII-IV	Impossible	
Comparator	MCAII-CP	Impossible	
Isolation converter	MCAII-IA	Impossible	
F/V converter	MCAII-FV	Impossible	MCA-VG7-FV
Dancer controller	MCAII-PU	Possible	
High-precision correction unit	MCAII-SP	Impossible	Standard built-in.
Soft start/stop	MCAII-RA	Impossible	Standard built-in.
Braking unit	Depends on the capacity	Possible	Depends on the capacity (Built-in for 55kW or less of 200V series, and for 110kW or less of 400V series)
Braking resistor	Depends on the capacity	Possible	Depends on the capacity
AC reactor	Depends on the capacity	Possible	Depends on the capacity
DC REACTOR	Depends on the capacity	Possible	Depends on the capacity (Provided as standard for units of more than 75kW)
REACTOR for noise reduction (For elevators)	Depends on the capacity	Impossible	Not necessary because of the high carrier PWM.

XIV

XIV. Appendix

14. Appendix

Appendix 1. Advantageous Use of Inverters (with Regard to Electrical Noise)

Excerpt from Technical Document
of the Japan Electrical
Manufacturers' Association (JEMA)
(April, 1994)

1 Effect of Inverters on other Devices

This paper describes the effect that inverters, for which the field of applications is expanding, have on electronic devices already installed and on devices installed in the same system as the inverters. Measures to counter these effects are also introduced.
(Refer to 3.3 Specific examples for further details.)

1.1 Effect on AM Radios

(1) When operating an inverter, nearby AM radios may pickup noise from the inverter. (The inverter has almost no effect on FM radios or televisions)
(2) It is considered that radios receive noise radiated from the inverter.
(3) Measures to provide a noise filter on the power supply side of the inverter are effective.

1.2 Effect on Telephones

(1) When operating an inverter, telephones may pickup noise during a conversation, making it difficult to hear.
(2) It is considered that a high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables.
(3) It is effective to commonly connect the grounding terminals of the motors and return the common grounding line to the grounding terminal of the inverter.

1.3 Effect on Proximity Limit Switches

(1) When operating an inverter, proximity limit switches (capacitance-type) may malfunction.
(2) It is considered that malfunction occurs because the capacitance-type proximity limit switches have inferior noise immunity.
(3) Connecting a filter to the input terminals of the inverter or changing the power supply treatment of the proximity limit switches is effective. In addition, the proximity limit switches can be changed to superior noise immunity types such as the magnetic type.

1.4 Effect on Pressure Sensors

(1) When operating an inverter, pressure sensors may malfunction.
(2) It is considered that malfunction occurs because noise penetrates through a grounding wire into the signal line.
(3) It is effective to install a noise filter on the power supply side of the inverter or to change the wiring.

1.5 Effect on Position Detectors (Pulse Generators; PGs, or Pulse Encoders)

(1) When operating an inverter, erroneous pulses from pulse converters may shift the stop position of a machine.
(2) Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
(3) The influence of induction noise and radiation noise can be reduced by separating the signal lines of the PG and power lines. Providing noise filters at the input and output terminals is also an effective measure.

2 Noise

A summary of the noise generated in inverters and its effect on devices susceptible to noise is described below.

2.1 Inverter Noise

Figure 1 shows an outline of the inverter configuration. The inverter converts AC to DC (rectification) in a converter unit, and converts DC to AC (inversion) with 3-phase variable voltage and variable frequency. The conversion (inversion) is performed by PWM implemented by switching 6 transistors, and is used for variable speed motor control.

Switching noise is generated by the high-speed on/off switching of the 6 transistors. Noise current (i) is emitted and at each high-speed on/off switching the noise current flows through stray capacitance (C) of the inverter, cable and motor to the ground. The amount of the noise current,

$$i = C \cdot dv / dt$$

is related to the stray capacitance (C) and dv/dt (switching speed of the transistors). Further, this noise current is related to the carrier frequency since the noise current flows each time the transistors are switched on/off.

The frequency band of this noise is less than approximately 30 to 40MHz. Therefore, devices such as AM radios that use the low frequency band are affected by the noise, but FM radios and television using higher frequency than this frequency band are virtually unaffected.

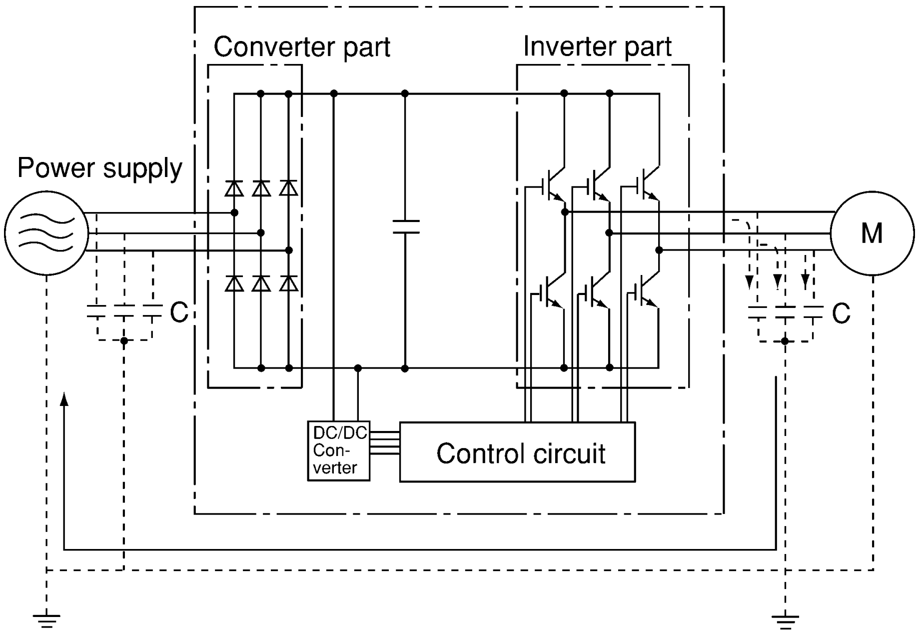


Figure 1 Outline of Inverter Configuration

2.2 Types of Noise

The noise generated in the inverter is propagated through the main circuit wiring to the power supply and the motor, and effects a wide range from the power supply transformer to the motor.
The various propagation routes are shown in Figure 2, but these are roughly classified into 3 routes of conduction noise, induction noise and radiation noise.

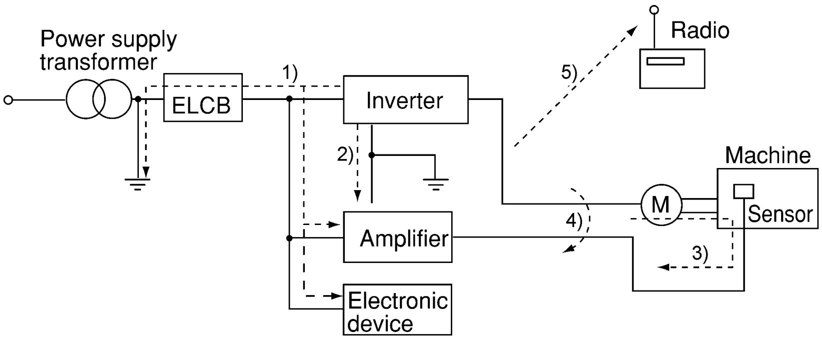


Figure 2 Noise Propagation Routes

(1) Conduction noise

Conduction noise is generated in the inverter, propagates through the conductor and power supply, and effects peripheral devices of the inverter (Figure 3) Some conduction noise 1) propagates through the main circuit. If the ground lines are connected with a common connection, there is conduction through route 2). There is also noise 3) through the signal line and shielded wire.

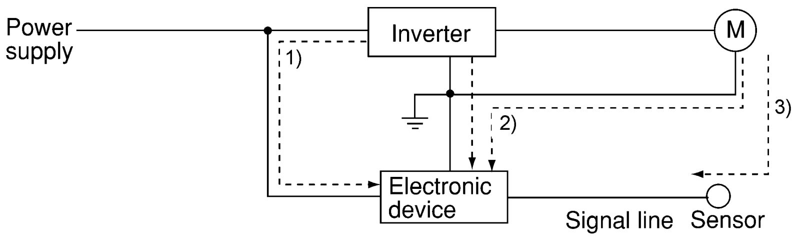


Figure 3 Conduction Noise

(2) Induction noise

When the wire and signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter, noise is induced in the wire and signal lines of the devices by electromagnetic induction (Figure 4) and electrostatic induction (Figure 5). This is induction noise 4).

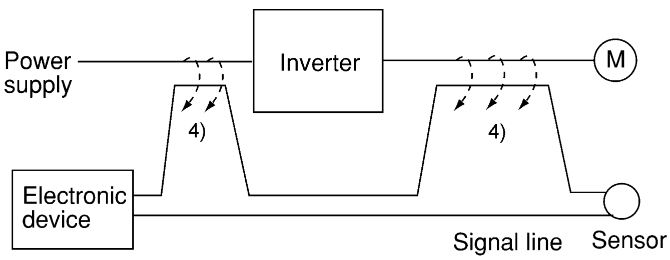


Figure 4 Electromagnetic Noise

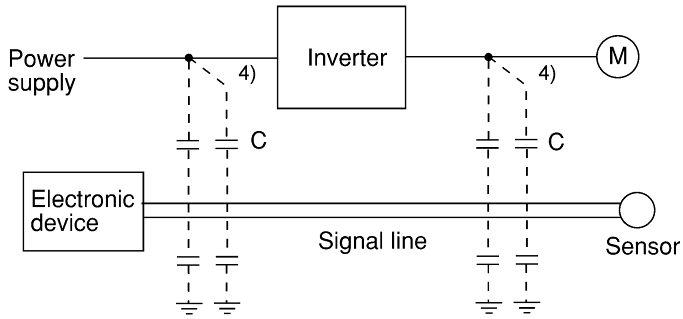


Figure 5 Electrostatic Noise

(3) Radiation noise

Noise generated in the inverter is radiated through the air from antennas consisting of wires at the input and output sides of the inverter. This noise is radiation noise 5) (Figure 6). The antennas that emit radiation noise are not limited only to wires, the motor frame and panel containing the inverter may also act as antennas.

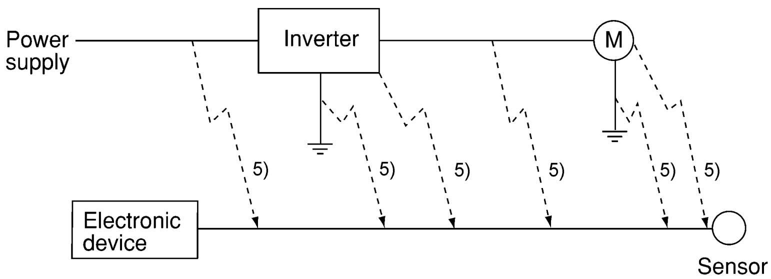


Figure 6 Radiation Noise

3 Noise Prevention Measures

As noise prevention measures are strengthened, they become more effective. With the use of appropriate measures, noise problems may be resolved simply. Therefore, it is necessary to implement economical noise prevention measures according to the noise level and the equipment condition.

3.1 Noise Prevention Treatments Prior to Installation

Before inserting an inverter in a control panel or installing an inverter panel, it is necessary to consider the noise. Once noise problems occur, great expenditures of apparatuses, materials and time are required.

Noise prevention treatments prior to installation are listed below.

1) Separation of the wiring of the main circuit and control circuit
2) Insertion of the main circuit wiring into a metal pipe (conduit pipe)
3) Use of shielded wire or twisted shielded wire in the control circuit.
4) Implementation of appropriate grounding work and grounding wiring.

These treatments can avoid most noise problems.

3.2 Implementation of Noise Prevention Measures

There are two types of noise prevention measures, those that correspond to the propagation route and those that counteract the effect of noise on the receiving side (side that is adversely affected by the noise).

The basic measure to lessen the effect of noise on the receiving side is to:

1) Separate the main circuit wiring from the control circuit wiring, making it more difficult to receive noise.

The basic measures to lessen the effect of noise on the generating side are to:

2) Install a noise filter to reduce the noise level.
3) Apply a metal conduit pipe or metal control panel to confine the noise level, and
4) Apply an insulated transformer for the power supply to cut off the noise propagation route.

Table 1 lists the methods for preventing the noise problems, their goals and the propagation routes.

Next, noise prevention measures are presented for the inverter drive configuration.

(1) Wiring and grounding

Separating the main circuit and control circuit as much as possible, both inside and outside the control panel, and the use of shielded wire and twisted shielded wire, makes it more difficult to receive noise and allows wiring distances to be minimized (refer to Figure 7). Take notice that the wiring of the main circuit and control circuit does not become bundled or parallel wiring.

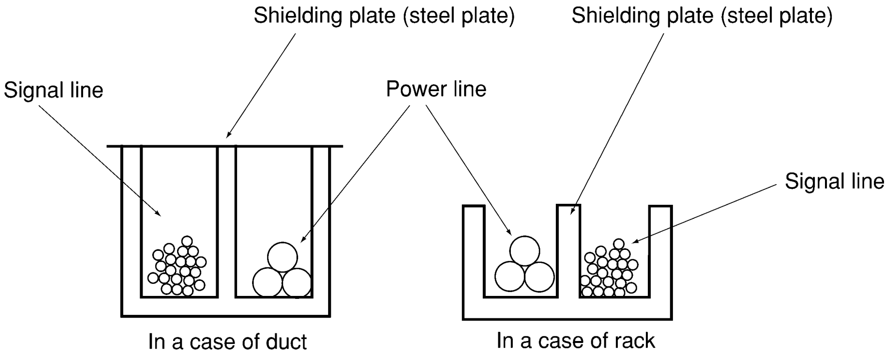


Figure 7 Method of Separating Wiring

For the main circuit wiring, a metal conduit pipe is used and grounded through a grounding wiring to prevent noise propagation (refer to Figure 8).
The shield (braided wire) of the shielded wire is securely connected to the base (common) side of the signal line at only one point to avoid the loop formation resulting from a multi-point connection (refer to Figure 9).
The grounding is effective to not only to reduce the risk of electric shocks, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be No. 3 grounding work (300V AC or less) and special No. 3 grounding work (300 to 600V AC). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

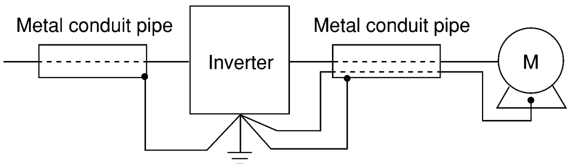


Figure 8 Grounding of Metal Conduit Pipe

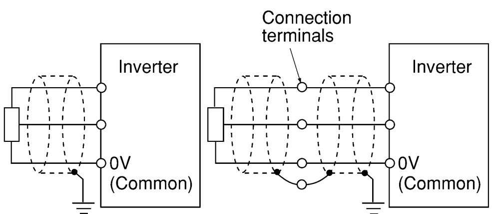


Figure 9 Treatment of Braided Wire of Shielded Wire

Table 1 Noise Prevention Methods

Noise prevention method		Goal of noise prevention measure: Make it more difficult to receive noise	Goal of noise prevention measure: Cutoff noise conduction	Goal of noise prevention measure: Confine noise	Goal of noise prevention measure: Reduce noise level	Conduction route: Conduction noise	Conduction route: Induction noise	Conduction route: Radiation noise
Wiring and installation	Separate main circuit and control circuit	○				○		
	Minimum wiring distance	○			○		○	○
	Avoid parallel and bundled wiring	○					○	
	Use appropriate grounding	○			○		○	
	Use shielded wire and twisted shielded wire	○					○	○
	Use shielded cable in main circuit			○				○
	Use metal conduit pipe			○			○	○
Control panel	Appropriate arrangement of devices in panel	○					○	○
	Metal control panel			○			○	○
Anti-noise device	Line filter	○			○	○		○
	Insulation transformer		○			○		○
Treatment on the noise receiving side	Use passing capacitor	○					○	○
	Use ferrite core for control circuit	○					○	○
	Line filter	○				○		
Others	Separate power supply systems		○			○		
	Lower the carrier frequency					○	○	○

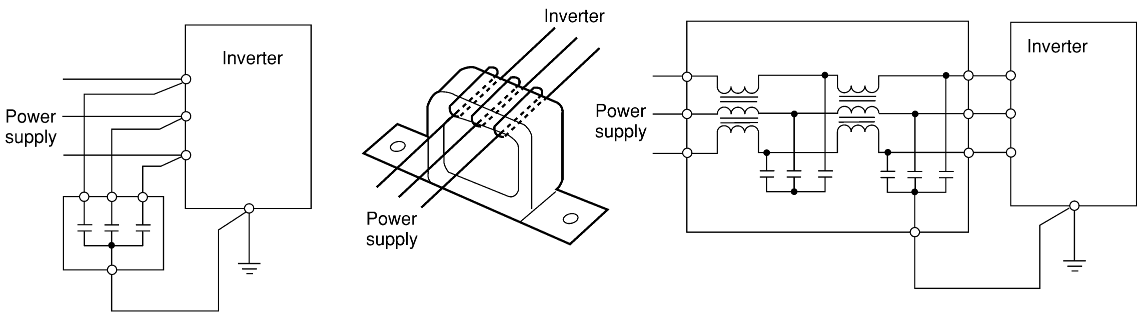
(2) Control panel

The control panel containing the inverter is generally made of metal, and this metal box can shield noise radiated from the inverter itself.

Further, when installing other electronic devices such as a programmable logic controller in the same control panel, attention should be paid to the arrangement of each device. When necessary, a noise prevention measure should be implemented, such as installing a shielding plate between the inverter and peripheral devices.

(3) Anti-noise devices

To reduce the noise propagated through the electrical circuits and the noise radiated from the main circuit wiring to the air, a line filter and power supply transformer are utilized (refer to Figure 10).
Among line filters, there are the simple type filters, such as a capacitive filter connected in parallel to the power supply line and an inductive filter connected in series to the power supply line, as well as orthodox filters (LC filters). These filters are used according to the targeted effect for reducing noise.
In power supply transformers, there are common insulated transformers, shielded transformers, noise-cut transformers, etc. These transformers have different effectiveness in blocking noise propagation.



(a) Capacitive filter (b) Inductive filter (zero-phase reactor or ferrite ring) (c) LC filter

Figure 10 Various Filters and their Connection Methods

(4) Noise prevention measures on the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter and/or located near the inverter.
Line filters and shielded or twisted shielded wire is used to block the penetration of noise in the signal lines of these devices. The following treatments are also implemented.

1) The circuit impedance is lowered by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) The circuit impedance for noise is increased by inserting choke coils in series in the signal circuit, or, passing the signal through ferrite core beads.
   It is also effective to widen the signal base line (0 V line) or grounding line.

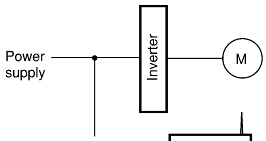
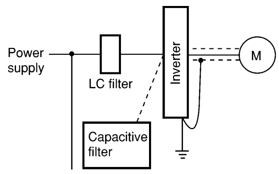
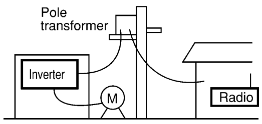
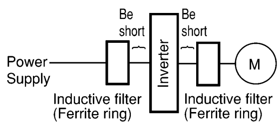
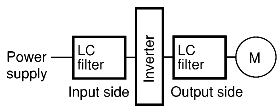
(5) Other

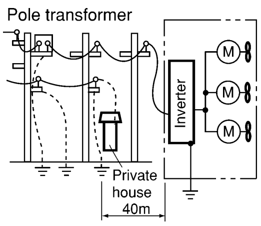
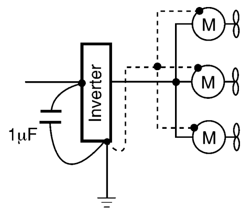
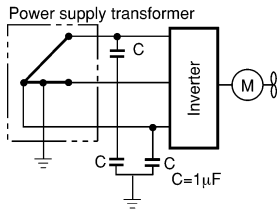
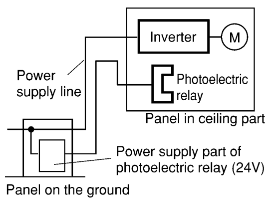
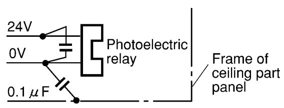
The generating (propagating) level of noise changes with the carrier frequency of the inverter, the higher the carrier frequency, the higher the generated level of noise.
In the case of an inverter for which the carrier frequency can be changed, lowering the carrier frequency can reduce the generation of electrical noise and result in a good balance with the audible noise of the motor under driving conditions.

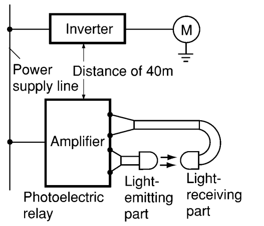
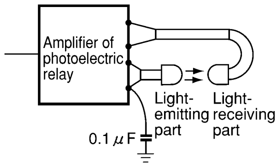
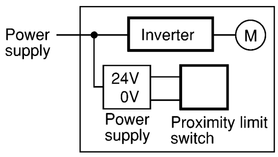
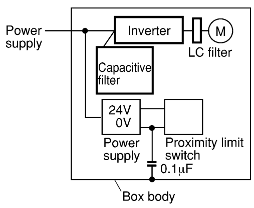
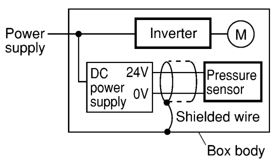
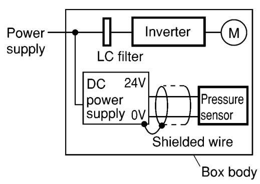
3.3 Specific Examples

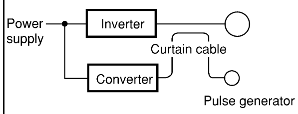
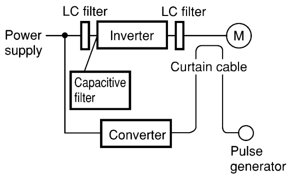
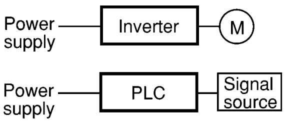
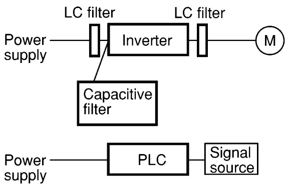
Table 2 lists specific examples of the measures to prevent noise generated by operation of the inverter.

Table 2 Specific Examples of Noise Prevention Measures

No.	Target device	Phenomena	Noise prevention measures	Notes
1	AM radio	When operating an inverter, noise entered into AM radio broadcast (500 to 1500kHz).  <Estimated cause> It is considered that the AM radio receives noise radiated from wires at the power supply and output sides of the inverter.	1) Install an LC filter on the power supply side of the inverter. (A simple method is to install a capacitive filter.) 2) Install a metal conduit wiring between the motor and inverter.  Note: Minimize the distance between the LC filter and inverter as much as possible (within 1m).	1) The radiation noise of the wiring is reduced. 2) The conduction noise to the power supply side is reduced. Further, shielded wiring is used. Note: Sufficient improvement may not be expected in narrow regions such as between mountains.
2	AM radio	When operating an inverter, noise entered into AM radio broadcast (500 to 1500kHz).  <Estimated cause> It is considered that the AM radio receives noise radiated from the power line at the power supply side of the inverter.	1) Install inductive filters at the input and output sides of the inverter.  The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. Further, wiring between the inverter and the zero-phase reactor (or ferrite ring) should be short as possible. (within 1m) 2) When further improvement is necessary, install LC filters. 	1) The radiation noise of the wiring is reduced.

No.	Target device	Phenomena	Noise prevention measures	Notes
3	Telephone (in a common private residence at a distance of 40m)	When driving a ventilation fan with an inverter, noise entered a telephone in a private residence at a distance of 40m.  <Estimated 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 1μF 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 the ground. 
4	Photoelectric relay	A photoelectric relay malfunctioned when the inverter was operated. [The inverter and motor are installed in the same place (for overhead traveling)]  <Estimated 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 25mm over a distance of 30 to 40m. Due to conditions of the installation, these lines cannot be separated.	1) As a temporary measure, insert a 0.1μF capacitor between the 0V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and a frame of the overhead panel.  2) As a permanent measure, move the 24V power supply from the ground to the overhead unit so that signals are sent to the ground side with relay contacts in the ceiling part.	1) The wiring is separated. (by more than 30cm.) 2) When separation is impossible, signals can be received and sent with dry contacts etc. 3) Do not wire weak-current signal lines and power lines in parallel.

No.	Target device	Phenomena	Noise prevention measures	Notes
5	Photoelectric relay	A photoelectric relay malfunctioned when the inverter was operated.  <Estimated cause> Although the inverter and photoelectric relay are separated by a sufficient distance, since the power supplies share a common connection, it is considered that conduction noise entered through the power supply line into the photoelectric relay.	1) Insert a 0.1µF capacitor between the output common terminal of the amplifier of the photoelectric relay and a frame.  	1) If a weak-current circuit on the malfunctioning side is observed, the countermeasures may be simple and economical.
6	Proximity limit switch (electrostatic type)	A proximity limit switch malfunctioned.  <Estimated cause> It is considered that the capacitance type proximity limit switch is susceptible to conduction and radiation noise because of its low noise immunity.	1) Install an LC filter on the output side of the inverter. 2) Install a capacitive filter on the input side of the inverter. 3) Ground the 0 V (common) line of the DC power supply of the proximity limit switch through a capacitor to the box body of the machine.  	1) Noise generated in the inverter is reduced. 2) The switch is superseded by a proximity limit switch of superior noise immunity (such as a magnetic type).
7	Pressure sensor	A pressure sensor malfunctioned.  <Estimated cause> It is considered that the pressure sensor signal malfunction was due to noise that came from the box body and traveled through the shield of the shielded wire.	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) of the pressure sensor, changing the original connection.  	1) The shielded parts of shield wire for sensor signals are connected to a common point in the system. 2) Conduction noise from the inverter is reduced.

No.	Target device	Phenomena	Noise prevention measures	Notes
8	Position detector (pulse generator: PG)	Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.  <Estimated cause> It is considered that erroneous pulses are output by induction noise since the power line of the motor and the signal line of the PG are bundled in a lump.	1) Install an LC filter and a capacitive filter on the input side of the inverter. 2) Install an LC filter on 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 on the output side of the inverter are reduced.
9	Programma-ble logic controller (PLC)	The PLC program sometimes malfunctions.  <Estimated cause> Since the power supply system is the same for the PLC and inverter, it is considered that noise enters the PLC through the power supply.	1)Install a capacitive filter and an LC filter on the input side of the inverter. 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 are reduced.

Appendix 2. Effect on Insulation of General-purpose Motor Driven with 400V Class Inverter

Excerpt from Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (March, 1995)

Introduction

When an inverter drives a motor, surge voltages generated by switching the inverter elements are superimposed on the inverter output voltage and applied to the motor terminals. If the surge voltages are too high they may have an effect on the motor insulation and some cases have resulted in damage.
For preventing such cases this document describes the generating mechanism of the surge voltages and countermeasures against them.

1 Operating Principle of Inverter

1.1 Main Circuit Configuration of Inverter

The main circuit of an inverter is configured with a converter part and an inverter part. The former part rectifies a commercial power source voltage and eliminates resulting ripple components, and the latter part converts DC voltage to AC voltage through a 3-phase bridge circuit composed of switching elements like transistors. (Refer to Figure 1)

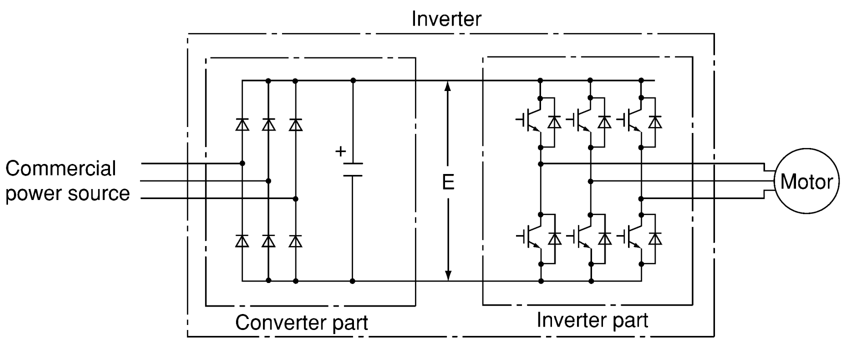


Figure 1 Main Circuit Configuration of Inverter

1.2 Control Method of Inverter

The PWM (Pulse Width Modulation) control is commonly adopted in general-purpose inverters. This method generates multiple switching pulses in one output cycle because both the output voltage and frequency are simultaneously controlled in the inverter part. The output voltage control is carried out by varying the pulse width while the pulse magnitude is kept constant.
The number of switching pulses generated in one second is designated as a carrier frequency and is normally high up to 0.7 to 16kHz. So transistors capable of high-speed switching (IGBT, etc.) are used for inverter elements.

2 Generating Mechanism of Surge Voltages

As the inverter rectifies a commercial power source voltage and smoothes into a DC voltage, the magnitude E of the DC voltage becomes about $\sqrt{2}$ times of that of the source voltage (about 620V in case of an input voltage of 440V AC). The peak value of the output voltage is usually close to this DC voltage value.
But, as there exists inductance (L) and stray capacitance (C) in wiring between the inverter and the motor, the voltage variation due to switching the inverter elements causes a surge voltage originating in LC resonance and results in the addition of a high voltage to the motor terminals. (Refer to Figure 2)
This voltage sometimes reaches up to about twice of the inverter DC voltage (620V $\times$ 2 = about 1,200V) depending on a switching speed of the inverter elements and a wiring condition.

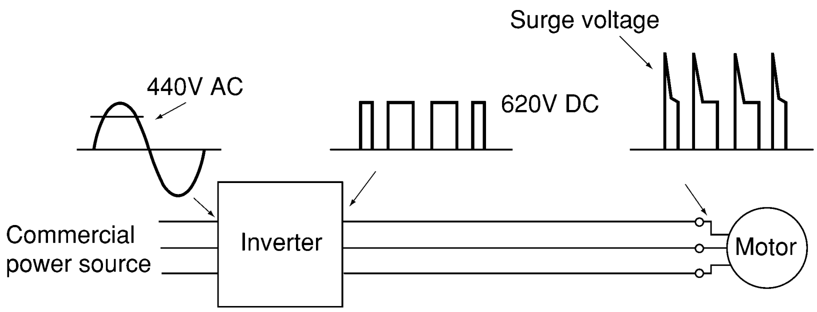
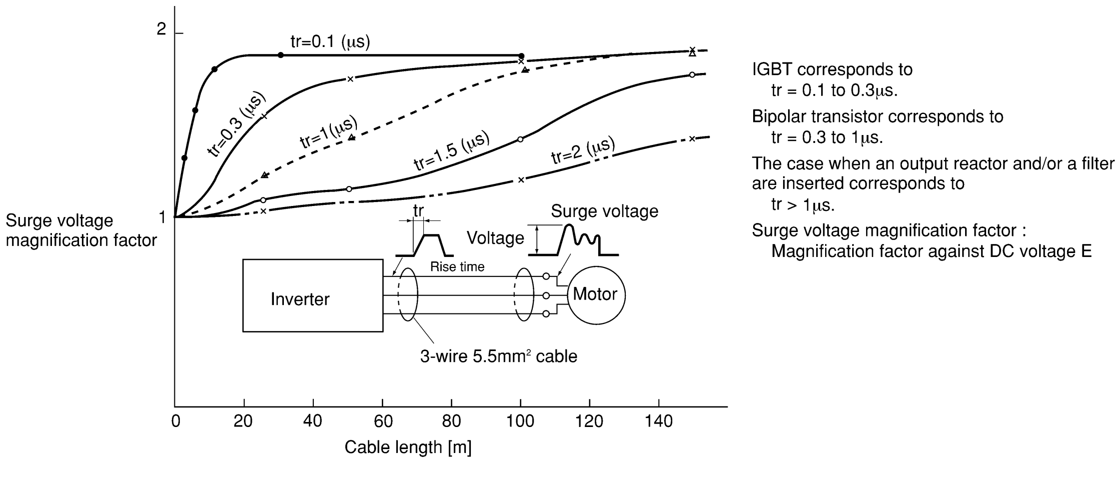


Figure 2 Voltage Wave Shapes of Individual Positions

A measured example in Figure 3 illustrates relation of a peak value of the motor terminal voltage with a wiring length between the inverter and the motor.
From this it can be confirmed that the peak value of the motor terminal voltage ascends as the wiring length increases and becomes saturated at about twice of the inverter DC voltage.
Besides the shorter a pulse rise time becomes, the higher the motor terminal voltage rises even in case of a short wiring length.



Excerpt from [J. IEE Japan, Vol. 107, No.7, 1987]

Figure 3 Measured Example of Wiring Length and Peak Value of Motor Terminal Voltage

3 Effect of Surge Voltages

The surge voltages originating in LC resonance of wiring may be applied to the motor input terminals and depending on their magnitude sometimes cause damage to the motor insulation.
When the motor is driven with a 200V class inverter, as for dielectric strength of the insulation it is no problem that the peak value at the motor terminal voltage increases twice due to the surge voltages, since the DC voltage is only about 300V.
But in case of a 400V class inverter the DC voltage becomes about 600V and depending on wiring length the surge voltages may highly rise and sometimes result in damage to the insulation.

4 Countermeasures Against Surge Voltages

The following methods are countermeasures against damage to the motor insulation by the surge voltages in case of a motor driven with a 400V class inverter.

4.1 Method to Use Motors with Enhanced Insulation

Enhanced insulation of a motor winding allows its surge proof strength to be improved.

4.2 Method to Suppress Surge Voltages

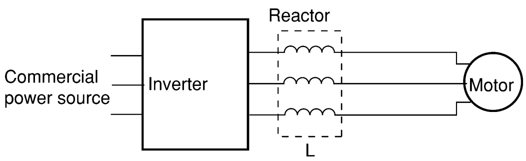
There are two methods for suppressing the surge voltages, one is to reduce the voltage rising and another is to reduce the voltage peak value.

(1) Output reactor

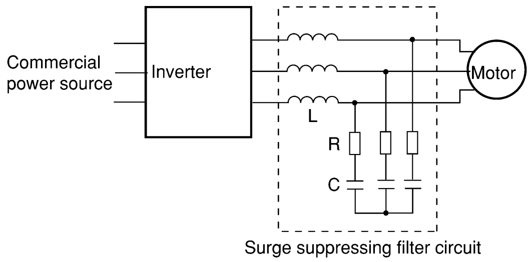
If wiring length is relatively short the surge voltages can be suppressed by reducing the voltage rising (dv/dt) with installation of an AC reactor on the output side of the inverter. (Refer to Figure 4 (1)) However, if the wiring length becomes long, suppressing the peak voltage due to surge voltage may be difficult.

(2) Output filter

Installing a filter on the output side of the inverter allows a peak value of the motor terminal voltage to be reduced. (Refer to Figure 4 (2))



(1) Output reactor



(2) Output filter

Figure 4 Method to Suppress Surge Voltage

5 Regarding Existing Equipment

5.1 In Case of Motor being Driven with 400V Class Inverter

The last five years survey on motor insulation damage due to the surge voltages originating from switching of inverter elements shows that the damage incidence is 0.013% under the surge voltage condition of over 1,100V and most of the damage occurs in several months after commissioning of the inverter. Therefore there seems to be little probability of occurrence of motor insulation damage after a lapse of several months of commissioning.

5.2 In Case of Existing Motor Driven Newly with 400V Class Inverter

We recommend to suppress the surge voltages with the method of 4.2.

Appendix 3. Example Calculation of Energy Savings

The energy saving that results from use of an inverter is calculated based on a specific calculation result (in the case of a fan and pump). The Q-P characteristic curve corresponding to damper use in Figure 1 changes depending on the motor capacity and manufacturer. Therefore, characteristic curves should be obtained individually when performing a detailed calculation.

1 Calculating Condition

[Use]

- Fan for air conditioning

[Usage period]

- 250 days / year (24 hours / day)

[Reduced rate of air flow with damper]

- In accordance with general output characteristics (Q-P curve) in Figure 1

[Reducing rate of air flow with an inverter (frequency)]

- 60Hz → 40Hz

[Electric power at maximum air flow rate : P_0 [kW]]

- P_0 = Applied motor [kW] × 1 / Motor efficiency → P_0
  = Applied motor [kW] × 1 / 0.9

<In a case of a motor of 37kW>

- $P_0 = 37 \times 1 / 0.9$
  $= 41.1$ kW

[Power rate per 1 kWh : M_2 [US$]]

- Suppose US$0.14 / kWh

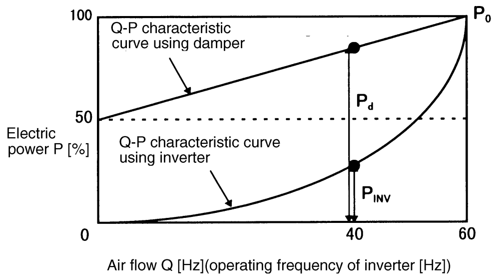


Figure 1 Q-P Characteristic Curve

2 Calculation of Shaft Driving Power

[Shaft driving power with damper control : P_d]

$P_d = ((50 + 50 \times (40 / 60)) / 100 \times P_0$

$= 0.833\ P_0$ [kW]

[Shaft driving power with inverter control : P_{INV}]

$P_{INV} = (40 / 60)^3 \times P_0$

$= 0.296 \times P_0$ [kW]

3 Calculation of Energy Savings

A specific example of the energy savings is calculated with the following formula.

<Formula>

- $M_1 = (P_d - P_{INV}) \times T \times M_2$ [US$ / year]

where M_2 : Electricity bill of the energy saving [US$ / year]
T : Operating time per year [h]
M_2 : Power rate per 1 kWh [US$]

■ Calculation example

- $M_1 = (P_d - P_{INV}) \times T \times M_2$ [US$ / year]
  $= (0.833 - 0.296) \times P_0 \times T \times M_2$
  $= 0.537 \times 41.1 \times (250 \times 24) \times 0.14$
  $= 18{,}539$ [US$ / year]

Therefore, energy savings of approximately US$18,500 / year are obtained.

Fuji Electric Co., Ltd.
ED & C · Drive Systems Company

Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome
Shinagawa-ku, Tokyo 141-0032, Japan
Phone: +81-3-5435-7139 Fax: +81-3-5435-7460

Printed on recycled paper

Printed in Japan 2000-5 20CM