Fuji Electric
e-Front runners

USER'S MANUAL

FRENIC MEGA SERIES

MEHT536

High Performance, Multifunction Inverter

FRENIC-MEGA

User's Manual

Preface

This manual provides all the information on the FRENIC-MEGA series of inverters including its operating procedure, operation modes, and selection of peripheral equipment. Carefully read this manual for proper use. Incorrect handling of the inverter may prevent the inverter and/or related equipment from operating correctly, shorten their lives, or cause problems.

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

Name	Material No.	Description
Catalog	MEH535	Product scope, features, specifications, external drawings, and options of the product
Instruction Manual	INR-SI47-1457-E	Acceptance inspection, mounting & wiring of the inverter, operation using the keypad, running the motor for a test, troubleshooting, and maintenance and inspection
RS-485 Communication User's Manual	MEH448	Overview of functions implemented by using FRENIC-MEGA RS-485 communications facility, its communications specifications, Modbus RTU/Fuji general-purpose inverter protocol and functions, and related data formats

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

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

Our three-phase, 230 V series inverters of 5 HP or less (FRENIC-MEGA series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

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

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

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

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

Safety precautions

Read this manual and the FRENIC-MEGA Instruction Manual (that comes with the product) thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the product and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

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

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

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

⚠CAUTION
This product is not designed for use in appliances and machinery on which lives depend. Consult your Fuji Electric representative before considering the FRENIC-MEGA series of inverters for equipment and machinery related to nuclear power control, aerospace uses, medical uses or transportation. When the product is to be used with any machinery or equipment on which lives depend or with machinery or equipment which could cause serious loss or damage should this product malfunction or fail, ensure that appropriate safety devices and/or equipment are installed.

How this manual is organized

This manual contains Chapters 1 through 9, Appendices, Glossary and Index.

Chapter 1 INTRODUCTION TO FRENIC-MEGA

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

Chapter 2 SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, and terminal functions for the FRENIC-MEGA series of inverters. It also provides descriptions of the operating and storage environment, product warranty, precautions for use, external dimensions, examples of basic connection diagrams, and details of the protective functions.

Chapter 3 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

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

Chapter 4 SELECTING PERIPHERAL EQUIPMENT

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

Chapter 5 FUNCTION CODES

This chapter contains overview tables of function codes available for the FRENIC-MEGA series of inverters, function code index by purpose, and details of function codes.

Chapter 6 BLOCK DIAGRAMS FOR CONTROL LOGIC

This chapter provides the main block diagrams for the control logic of the FRENIC-MEGA series of inverters.

Chapter 7 KEYPAD FUNCTIONS (OPERATING WITH THE KEYPAD)

This chapter describes the names and functions of the keypad and inverter operation using the keypad. The inverter features three operation modes (Running, Programming and Alarm modes) which enable you to run and stop the motor, monitor running status, set function code data, display running information required for maintenance, and display alarm data.

Chapter 8 RUNNING THROUGH RS-485 COMMUNICATION

This chapter describes an overview of inverter operation through the RS-485 communications facility. Refer to the RS-485 Communication User's Manual for details.

Chapter 9 TROUBLESHOOTING

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

Icons

The following icons are used throughout this manual.

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

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

This icon indicates a reference to more detailed information.

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Chapter 7 KEYPAD FUNCTIONS (OPERATING WITH THE KEYPAD)

Chapter 8 RUNNING THROUGH RS-485 COMMUNICATION

Chapter 9 TROUBLESHOOTING

Chapter 1

INTRODUCTION TO FRENIC-MEGA

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

Contents

1.1 Features

Best vector control for the general-purpose inverter in the class

■ Ideal for highly accurate control such as positioning

Vector control with speed sensor

Effective for applications requiring highly precise and accurate positioning control such as offset printing

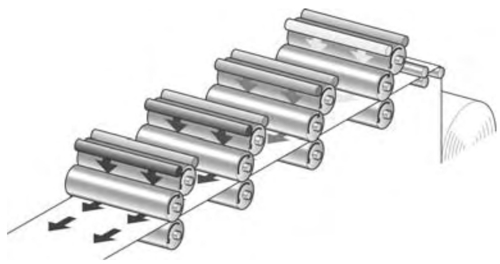
Speed control range: 1:1500

Speed response: 100 Hz

Speed control accuracy: ±0.01%

Current response: 500 Hz

Torque accuracy: ±10%



* The option card is required.

* The above specifications may vary depending on the environment or conditions for use.

■ Maximizing the performance of a general-purpose motor

Vector control without speed sensor

Useful for the application that requires a high starting torque, such as the gondola type multi-level car parking tower

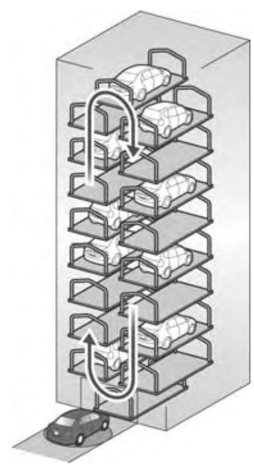
Speed control range: 1:200

Speed response: 20 Hz

Speed control accuracy: ±0.5%

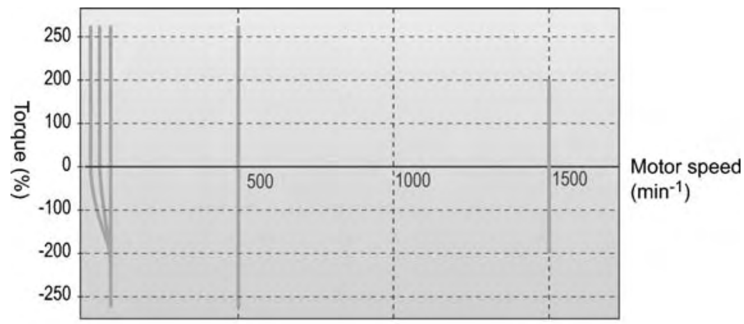
Current response: 500 Hz

Torque accuracy: ±10%



■ Fuji's original dynamic torque vector control has further upgraded.

Besides the dynamic torque vector control, the inverter is equipped with the motor parameter tuning for compensating even a voltage error of the main circuit devices and the magnetic flux observer of a new system. This realizes a high starting torque of 200% even at a low-speed rotation of 0.3 Hz.

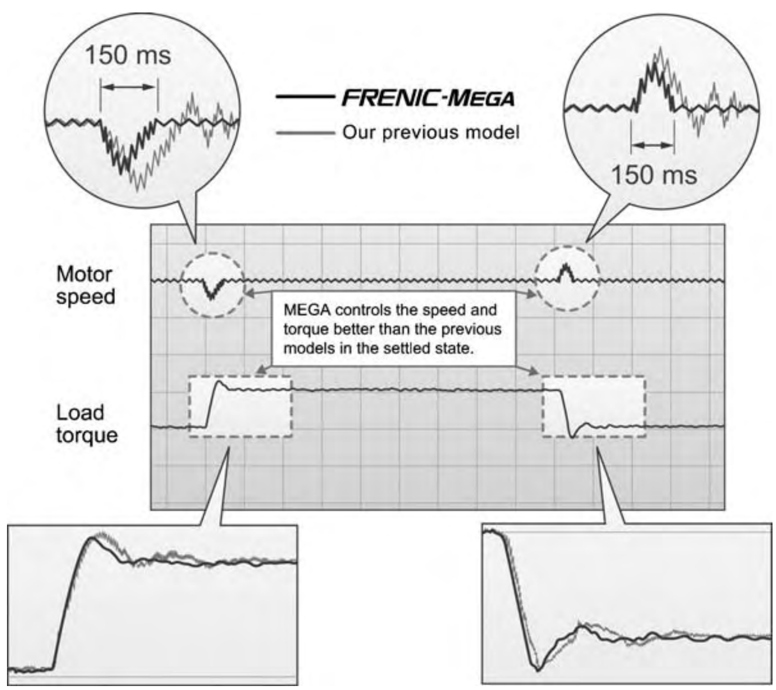


Example torque characteristics [7.5 HP]

■ Improved reaction to the fluctuation of impact load

When a remarkable load fluctuation occurs, the inverter provides the torque response in the class-top level. It controls the flux to minimize the fluctuation in the motor speed while suppressing the vibration. This function is best suited for equipment that requires stable speed such as a cutting machine.

Example:



■ Improved durability in overload operation

Enhancement for extending the current overload durability time of the FRENIC-MEGA longer than that of the Fuji conventional inverters allows the FRENIC-MEGA to run the motor with shorter acceleration/deceleration time. This improves the operation efficiency of machinery such as cutting machines or carrier machines.

Current overload durability: 120% for 1 min.

The standard model is available in the following three drive modes concerning the operation load.

Drive mode	Current overload durability	Major application
LD (Low duty) mode	120% for 1 min	Driving under light duty load
MD (Medium duty) mode	150% for 1 min	Driving under medium duty load
HD (High duty) mode	200% for 3 sec, 150% for 1 min	Driving under heavy duty load

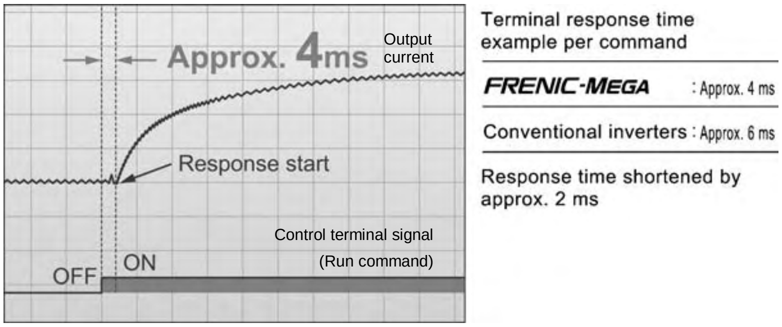
(The MD mode is available for inverters of 150 to 800 HP with three-phase 460 V input.)

■ Quicker response to the run commands

The terminal response to the run commands has had an established reputation. The FRENIC-MEGA has further shortened this response time, achieving the industry-top response time.

This function is effective in shortening the tact time per cycle and effective for use in the process including frequent repetitions.

Example:



■ Expanded capacity for the brake switching circuit built-in type

A brake switching circuit is built in inverters of 40 HP or below as standard. These inverters are applicable to vertical carrier machines and others that run with a certain regenerative load. (Inverters of 15 HP or below also integrate a braking resistor.)

The brake switching circuit built-in type of inverters with a capacity of 50 to 100 HP in 230 V series and 50 to 200 HP in 460 V series is available on request.

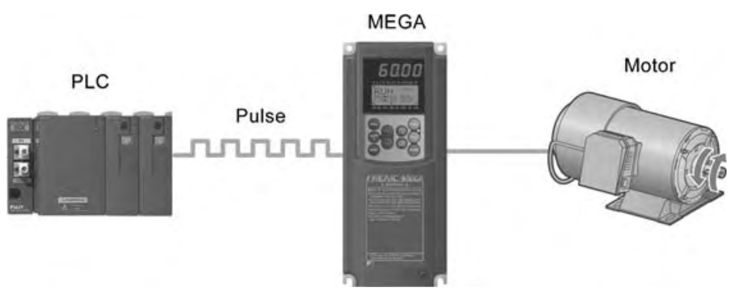
Accommodating various applications

■ Convenient functions for operations at the specified speed

Pulse train input speed command supported as standard

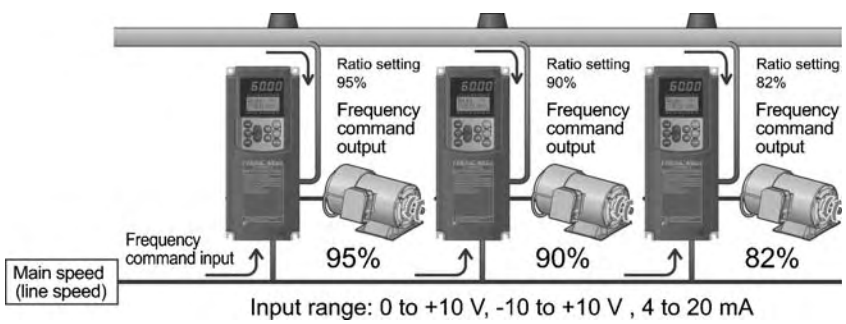
The FRENIC-MEGA can issue a speed command with the pulse train input (single-phase pulse train with sign).

(Maximum pulse input: 100 kHz)



Ratio operation

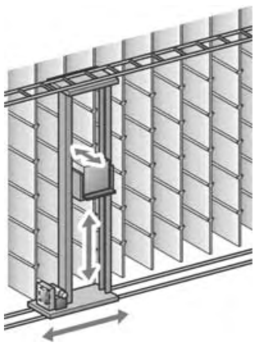
The ratio operation is convenient for synchronous control of two or more carrier machines in a multiline conveyor system. It is possible to specify the ratio of the main speed to other follower motors as a frequency command, so the conveying speed of carrier machines that handle variable loads or loading situations can be synchronously adjusted easily.



$$\text{Frequency command output} = \text{Frequency command input} \times \frac{\text{Analog input (Ratio setting)}}{100\%}$$

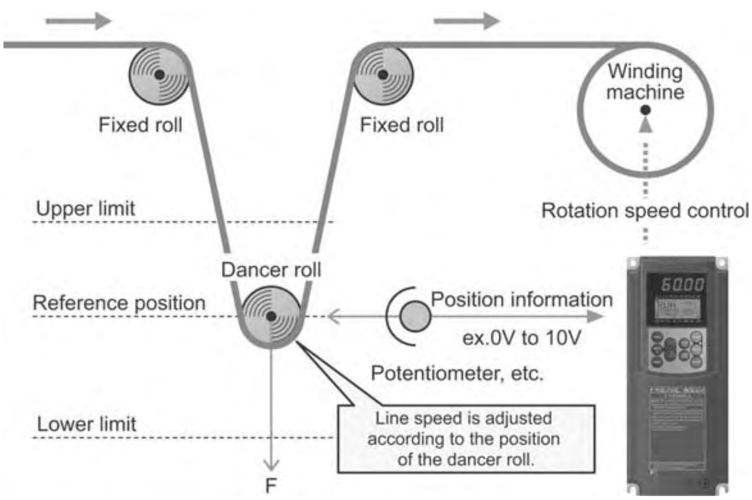
■ Optimum function for preventing an object from slipping down

The reliability of the brake signal was increased for uses such as vertical carrier machines. Conventionally, the current value and the frequency have been monitored when the brake signal is output. By adding a torque value to these two values, the brake timing can be adjusted more easily.



■ Dancer control function optimum for winding control

The PID value, calculated by comparing the feedback value with the speed command value, is added to or subtracted from the reference speed. Since the PID processor gain (in proportional band) can be set low, the inverter can be applied to automatic control systems requiring quick response such as speed control.



■ Thorough protection of the braking circuit

The inverter monitors the braking transistor operation status to protect the braking resistor. **Upon detection of a braking transistor abnormality, the inverter outputs an exclusive signal.** Provide such a circuit that shuts the input power off upon receipt of the exclusive signal, outside the inverter for protecting the braking circuit.

■ More functions are available to meet various requirements

(1) Analog input: Two terminals for voltage input with polarity and one terminal for current input

(2) Slow flowrate level stop function (Pressurized operation is possible before stop of slow flowrate operation.)

(3) Non-linear V/f pattern at 3 points

(4) Mock alarm output function

(5) Selection of up to the 4th motor

(6) S-curve accel./decel. range setting

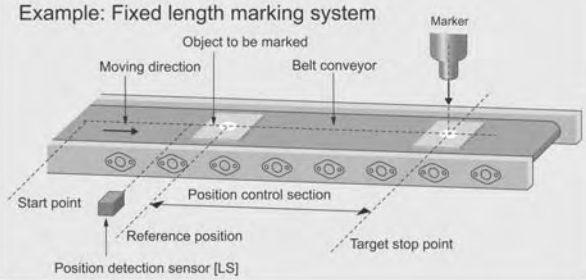
(7) Detection of a PID feedback wire break

MEGA World Keeps Expanding

PG interface card for positioning control

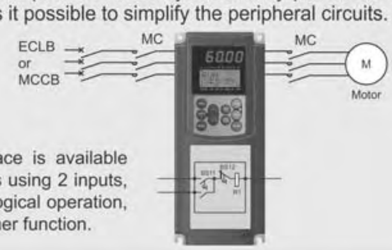
This control function is best suited for the application that requires highly accurate positioning such as that of the conveyance machine. By combined use of the position control device (APR) and PG vector control, the position control accuracy has been remarkably improved. Shortened positioning time by this function will be helpful to reduce the tact time of a cycle.

Example: Fixed length marking system



The customizable logic interface function is adopted in the inverter body.

Logic input/output can be easily created by parameter setting. This makes it possible to simplify the peripheral circuits.



The interface is available in 10 steps using 2 inputs, 1 output, logical operation, and the timer function.

Introducing servo lock function (PG interface card).

This function is effective in adjusting the stop timing or the braking torque when the equipment such as a conveyance machine is stopped by positioning of the motor. This function is helpful when torque is applied externally or holding torque is required during the stop time. The tact time per cycle will be reduced by shortened deceleration time.

Various models to meet customer needs

■ Available model variations

1. Standard inverter

2. Inverter with built-in DC reactor (DCR)

Reduces harmonics and improves power factor.
Available for models rated from 7.5 HP (LD) to 100 HP (LD).

■ Inverters supporting synchronous motors (Available soon)

1. Highly-efficient operation for energy saving

Driving a synchronous motor(s) with the FRENIC-MEGA equipped with our distinctive energy saving control provides higher energy saving effect than conventional inverter operations of induction motors.

2. Compact, light-weight body for space saving

Using advanced, optimum magnetic field analysis technology, thermal analysis technology, and applied analysis technology has attained more compact, light-weight body.

3. General-purpose inverter (supporting synchronous motors) providing high-performance, multi-function operations

(1) Vector control with/without speed sensor

(2) Offline tuning

(3) Acceleration characteristics (under vector control without speed/position sensor): Before startup, the FRENIC-MEGA detects the position of a magnetic pole for smooth, rapid acceleration.

(4) Impact load characteristics (under vector control without speed/position sensor): The FRENIC-MEGA maintains stable motor speed even under 120% of impact load.

(5) Restart after momentary power failure: After a momentary power failure occurs, the FRENIC-MEGA automatically searches for the idling motor speed and starts the motor smoothly without stopping it.

4. Environmental considerations

The FRENIC-MEGA approximately doubles the bearing life of the motor driven (compared with our conventional induction motors). The designed lives of the various consumable parts inside the FRENIC-MEGA have been extended to 10 years. The FRENIC-MEGA is compliant with RoHS Directives and realizes very low noise operation.

Supports for simple maintenance

■ The optional remote keypad equipped with a USB port allows use of an inverter support loader "FRENIC Loader" for easy information control!

Improved working efficiency at the manufacturing site

- A variety of data about the inverter can be saved in the keypad memory so that you can check the information in any place.

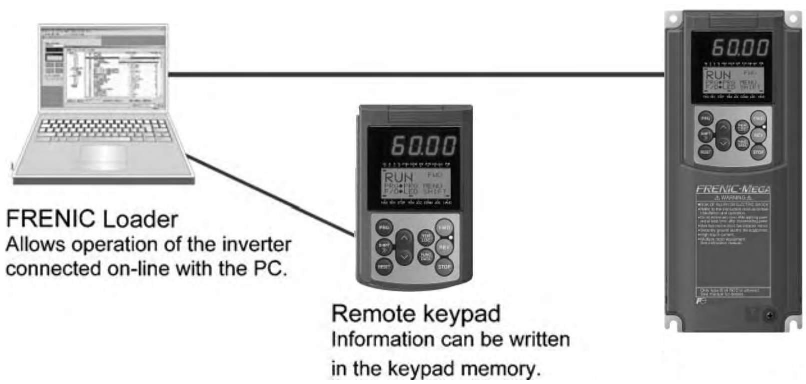
Example of use in the office

Features

1. The remote keypad can be directly connected to the computer through a commercial USB cable (mini B) without using a converter. The computer can be connected online with the inverter.
2. With the FRENIC Loader, the inverter can support the following functions (1) to (5).
   (1) Editing, comparing, and copying the function code data
   (2) Operation monitor, real-time trace
   (3) Alarm history (indicating the latest four alarm records)
   (4) Maintenance information
   (5) Historical trace

- Data can be directly transferred from the keypad via the USB port to the computer (FRENIC Loader) at the manufacturing site.
- Periodical collection of life information can be carried out efficiently.
- The real-time tracing function permits the operator to check the inverter for abnormality.

Example of use at the manufacturing site



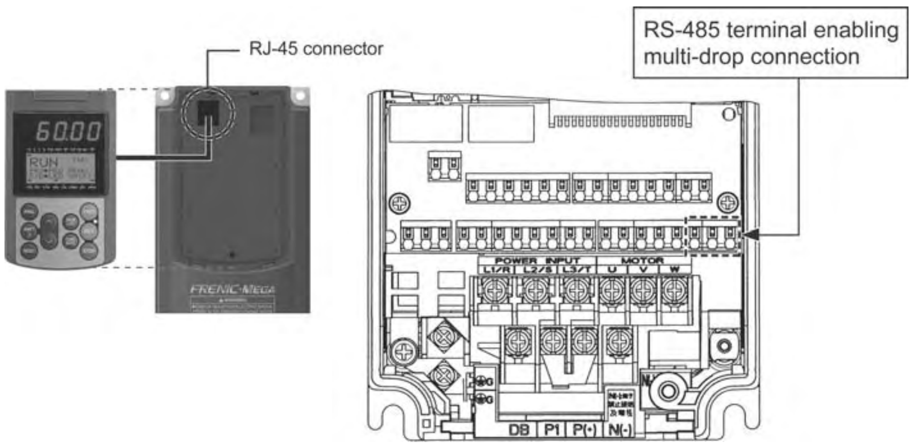
Network connectivity

■ Connectivity to the various FA networks with the following option cards

- SX-bus communications card
- T-Link communications card
- PROFIBUS-DP communications card
- DeviceNet communications card
- CANopen communications card
- CC-Link communications card
- Ethernet communications card

■ RS-485 communication possible as standard (on the terminal block)

Besides the port (RJ-45 connector) shared with the keypad, an RS-485 terminal is provided as standard. With the terminal connection, multi-drop connection can be made easily.



Prolonged service life and improved life judgment function

■ Designed life 10 years

For the various consumable parts inside the inverter, their designed lives have been extended to 10 years, which also extended the equipment maintenance cycles.

Consumable part	Designed life
Main circuit capacitor	10 years
Electrolytic capacitor on PCB	10 years
Cooling fan	10 years
Fuse (150 HP or above)	10 years

The designed lives are based on the following conditions:

- Surrounding temperature: 40ºC (104 ºF)
- Load factor: 80% (LD/MD mode) or 100% (HD mode)

* The designed lives are the calculated values and not the guaranteed ones.

■ Full support of life warnings

The inverter has the following functions for facilitating the maintenance of the machinery.

Item	Purpose
Cumulative run time (Unit: h)	Displays the total run time of the inverter by counting the ON time of the main power, by hours.
Cumulative motor run time (Unit: 10 hours)	Displays the total run time of the motor. Used to judge the service life of machinery (load). Even when the motor is driven by commercial power, it is also possible to count the cumulative motor run time using digital input signals.
Cumulative startup count	Displays the number of motor startups. This count can be used as a guide for replacement timing of machinery parts (such as timing belts) that undergo load in ordinary operation.
Equipment maintenance warning Cumulative motor run time (Unit: 10 hours) Cumulative startup count	Makes it possible manage the total run time of the motor and the number of startups. Such data is usable for preparing the maintenance schedule.
Display of inverter lifetime alarm	Displays the following: - Current capacitance of DC link bus capacitor - Total run time of the cooling fan (with ON/OFF compensation) - Total run time of the electrolytic capacitor on the printed circuit board

Consideration for environment

■ Enhanced resistance to the environmental impacts

Resistance to the environmental impact has been enhanced compared with the conventional inverter.

(1) Enhanced durability of the cooling fan operated under the environmental impact

(2) Adoption of copper bars plated with nickel or tin

In FRENIC-MEGA, resistance to the environmental impact has been increased compared with the conventional model. However, examine the use of the inverter carefully according to the environment in the following cases:

a. Environment is subject to sulfide gas (at tire manufacturer, paper manufacturer, sewage disposer, or part of the process in textile industry).

b. Environment is subject to conductive dust or foreign matters (in metalworking, operation using extruding machine or printing machine, waste disposal).

c. Others: The inverter is used in the environment of which specification exceeds the specified range.

If you are examining use of the inverter under the above conditions, consult us regarding the models with enhanced durability.

■ Compliance with RoHS Directives

MEGA complies with European regulations that limit the use of specific hazardous substances (RoHS) as a standard. This inverter is environment-friendly as the use of the following six hazardous substances is restricted.

<Six hazardous substances>

Lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyl (PBB), and polybrominated biphenyl ether (PBDE)

* Except the parts of some inverter models

<About RoHS>

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

Global compliance

- Compliance with global standards

Europe	North America/Canada
EC Directive (CE marking)	UL standard (cUL certified)
CE	c UL US LISTED

- SINK/SOURCE switching

- Wide input voltage range

- Multilingual display on the multi-function keypad (Japanese, English, German, French, Spanish, Italian, Chinese, and Korean)

1.2 Control System

1.2.1 Theory of inverter

As shown in Figure 1.1, the converter section converts the input commercial power to DC power by means of a full-wave rectifier, which charges the DC link bus capacitor (reservoir capacitor). The inverter section modulates the electric energy charged in the DC link bus capacitor by Pulse Width Modulation (PWM) according to the control circuit signals and feeds the output to the motor. (The PWMed frequency is called the "Carrier Frequency.")

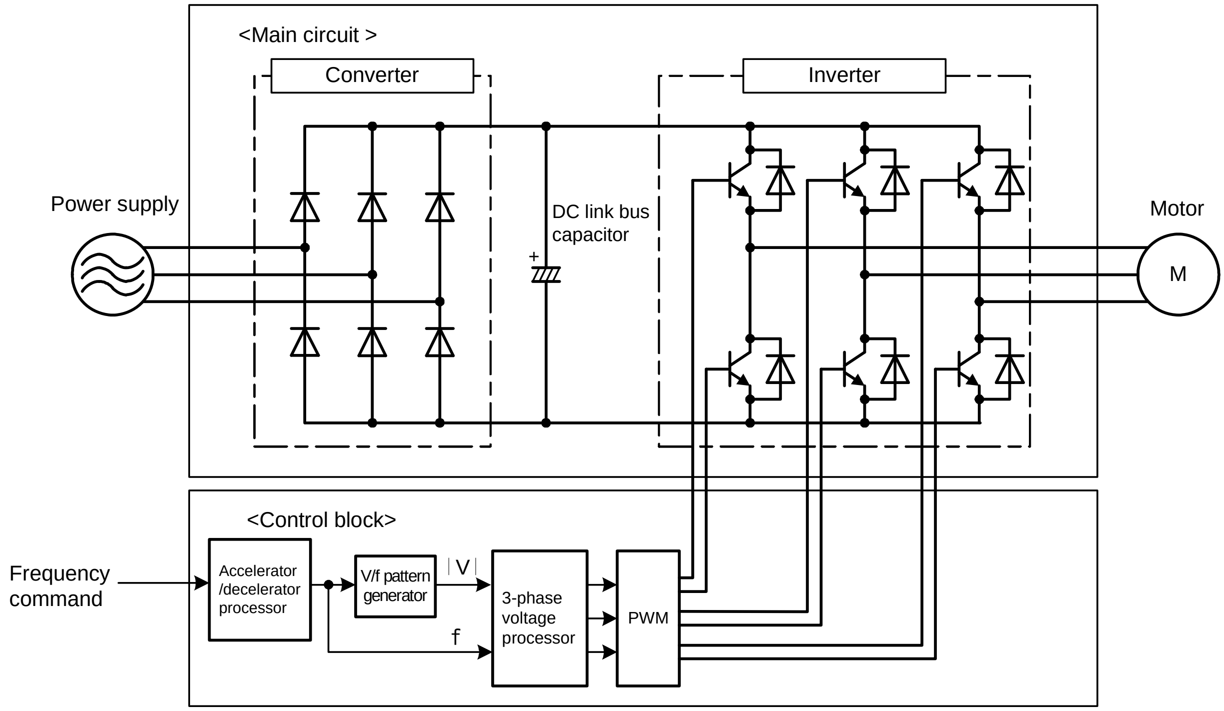


Figure 1.1 Schematic Overview of Theory of Inverter

The voltage applied to the motor has a waveform modulated by the carrier frequency from the dynamic torque vector flux controller that estimates the optimal PWM signal monitoring the inverter output current feedback, as shown on the left-hand side ("PWM voltage waveform") of Figure 1.2. The voltage consists of alternating cycles of positive and negative pulse trains synchronizing with the inverter’s output frequency.

The current running through the motor, on the other hand, has a fairly smooth alternating current (AC) waveform shown on the right-hand side ("Current waveform") of Figure 1.2, thanks to the inductance of the motor coil. The control block section controls the PWM so as to bring this current waveform as close to a sinusoidal waveform as possible.

Figure 1.2 Output Voltage and Current Waveform of the Inverter

For the reference frequency given in the control block, the accelerator/decelerator processor calculates the acceleration/deceleration rate required by run/stop control of the motor and transfers the calculated results to the 3-phase voltage processor directly or via the V/f pattern processor, whose output drives the PWM block to switch the power gates.

1.2.2 Motor drive controls

The FRENIC-MEGA supports the following motor drive controls.

Drive control	Basic control	Speed feedback	Drive control class	Speed control	Other restrictions
V/f control with slip compensation inactive	V/f control	Disable	V/f	Frequency control	—
Dynamic torque vector control				Frequency control with slip compensation	—
V/f control with slip compensation active					—
V/f control with speed sensor *		Enable	PG V/f	Frequency control with automatic speed regulator (ASR)	Maximum frequency: 200 Hz
Dynamic torque vector control with speed sensor *					
Vector control without speed sensor	Vector control	Estimated speed	w/o PG	Speed control with automatic speed regulator (ASR)	Maximum frequency: 120 Hz Not available for MD-mode inverters.
Vector control with speed sensor *		Enable	w/ PG		Maximum frequency: 200 Hz

* The drive controls marked with an asterisk require an optional PG (Pulse Generator) interface card.

For the features of the controls, refer to Chapter 3, Section 3.4.1 "Features of motor drive control."

1.3 External View and Terminal Blocks

(1) External views

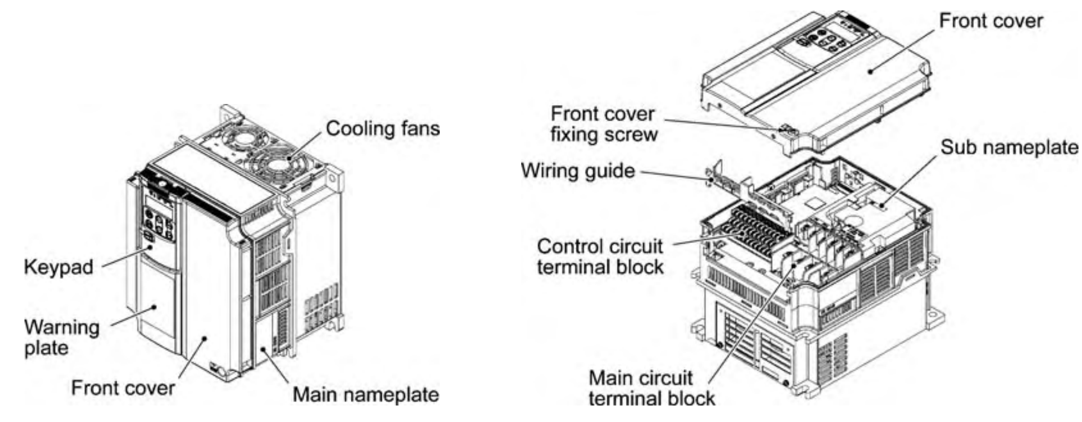


Figure 1.3 FRN020G1S-2U

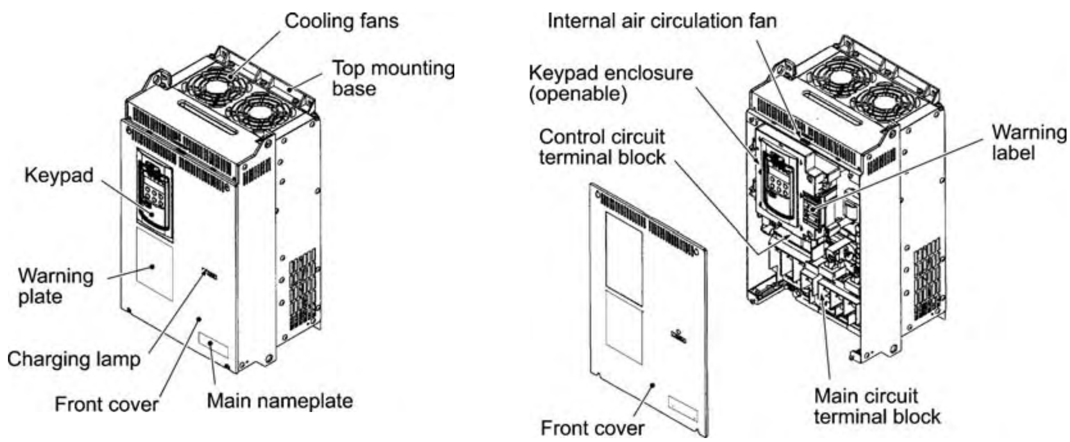
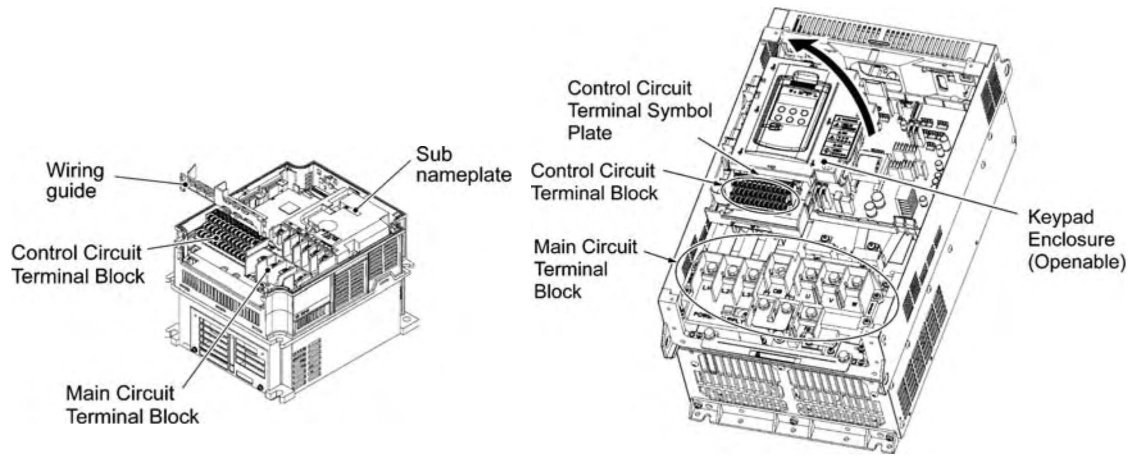


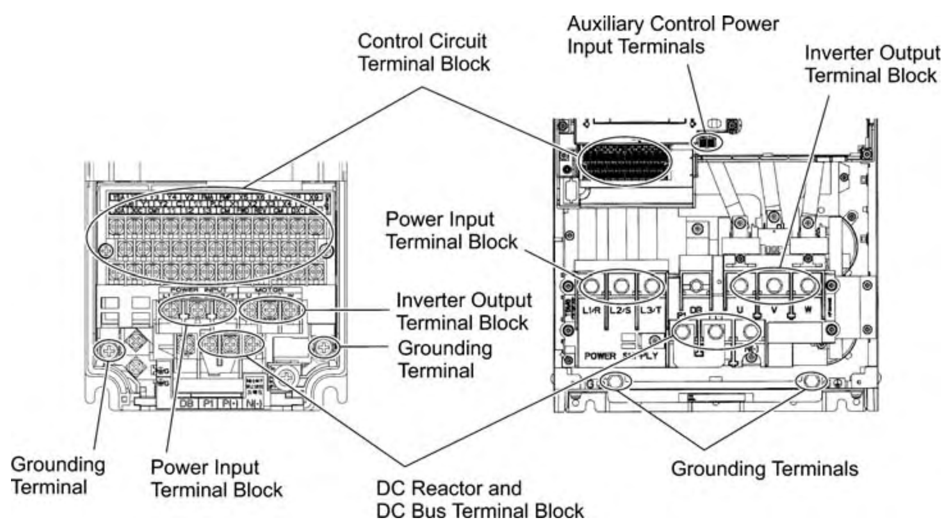
Figure 1.4 FRN050G1S-4U

(2) Terminal block location



(a) FRN020G1S-2U (b) FRN050G1S-2U

Figure 1.5 Terminal Blocks and Keypad Enclosure Location



(a) FRN001G1S-2U (b) FRN050G1S-2U

Figure 1.6 Enlarged View of the Terminal Blocks

Refer to Chapter 2 "SPECIFICATIONS" for details on terminal functions, arrangement and connection and to Chapter 4, Section 4.2.1 "Recommended wires" when selecting wires.

1.4 Recommended Configuration

To control a motor with an inverter correctly, you should consider the rated capacity of both the motor and the inverter and ensure that the combination matches the specifications of the machine or system to be used.

📖 Refer to Chapter 3 "SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES" for details.

After selecting the rated capacities, select appropriate peripheral equipment for the inverter, then connect them to the inverter.

📖 Refer to Chapter 4 "SELECTING PERIPHERAL EQUIPMENT" for details on the selection of peripheral equipment.

Figure 1.7 shows the recommended configuration for an inverter and peripheral equipment.

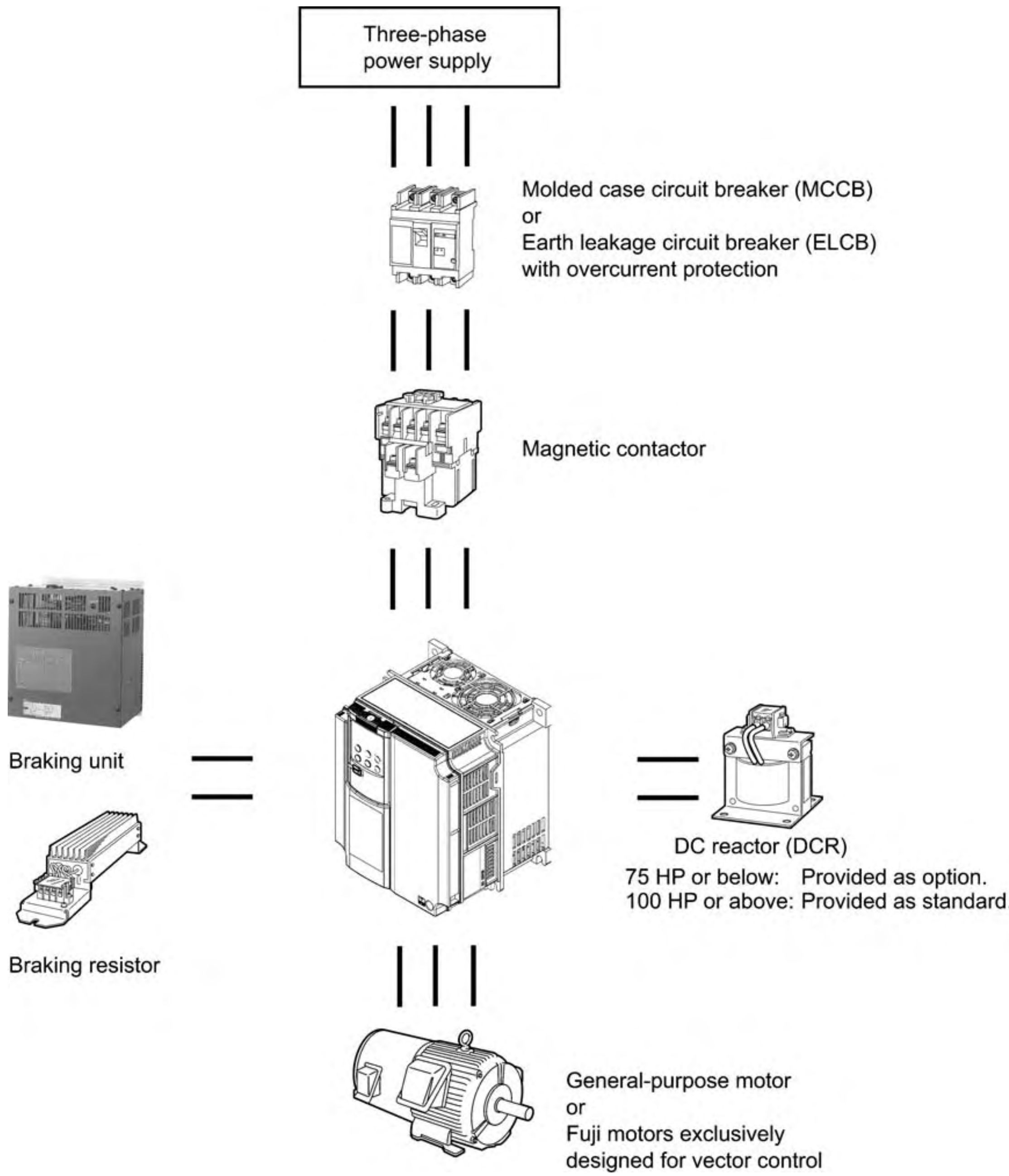


Figure 1.7 Recommended Configuration Diagram

Chapter 2

SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, and terminal functions for the FRENIC-MEGA series of inverters. It also provides descriptions of the operating and storage environment, precautions for using inverters, external dimensions, examples of basic connection diagrams, and details of the protective functions.

Contents

2.1 Standard Model 1 (Standard Inverter)

2.1.1 Three-phase 230 V series

LD (Low Duty)-mode inverters for light load

Item		Specifications																	
Type (FRN_ _ _G1S-2U)		F50	001	002	003	005	007	010	015	020	025	030	040	050	060	075	100	125	150
Nominal applied motor (HP) *1 (Output rating)		0.5	1	2	3	5	7.5	10	15	20	25	30	40	50	60	75	100	125	150
Output ratings	Rated capacity (kVA) *2	1.2	2.0	3.2	4.4	7.2	11	13	18	24	30	35	46	58	72	86	113	138	165
	Rated voltage (V) *3	Three-phase 200 to 240 V (with AVR function)												Three-phase 200 to 230 V (with AVR function)					
	Rated current (A) *4	3	5	8	11	18	27	31.8 (29)	46.2 (42)	59.4 (55)	74.8 (68)	88 (80)	115 (107)	146	180	215	283	346	415
	Overload capability	150%-1 min, 200%-3.0 s						120%-1 min											
Input power	Voltage, frequency	200 to 240 V, 50/60 Hz												200 to 220 V, 50 Hz, 200 to 230 V, 60 Hz					
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *5, Frequency: +5 to -5%																	
	Imput current with DCR	1.5	3	5.5	7.7	13	18.5	25.1	37.6	50.2	62.7	75.3	100	120	145	178	246	291	358
	Imput current with out DCR	2.8	4.7	8.5	11.9	20	28.4	38.6	54.8	72.4	87.7	101	136	167	203	244	-		
	Required capacity (with DCR) (kVA) *6	0.6	1.2	2.2	3.1	5.2	7.4	10.0	15.0	20.0	25.0	30.0	40.0	48.0	58.0	71.0	98.0	116	143
Braking	Torque (%) *7	150%		100%			70%			15%				7 to 12%					
	Braking transistor	Built-in												–					
	Built-in braking resistor	Built-in								–									
	Braking time (s)	5 s					3.7 s		3.4 s	–									
	Duty cycle (%ED)	5	3	5	3	2	2.2		1.4	–									
DC reactor (DCR)		Option															Standard *8		
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP20, UL open type												IP00, UL open type					
Cooling method		Natural cooling			Fan cooling														
Weight / Mass lbs (kg)		3.8 (1.7)	4.4 (2.0)	6.2 (2.8)	6.6 (3.0)	6.6 (3.0)	14 (6.5)	14 (6.5)	14 (6.5)	13 (5.8)	21 (9.5)	21 (9.5)	22 (10)	55 (25)	71 (32)	93 (42)	95 (43)	137 (62)	232 (105)

*1 US 4P-standard induction motor
*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.
*3 Output voltage cannot exceed the power supply voltage.
*4 To use the inverter with the carrier frequency of 3 kHz or more at the surrounding temperature of 40°C (104°F) or higher, manage the load so that the current comes to be within the rated ones enclosed in parentheses ( ) in continuous running.
*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$
If this value is 2 to 3%, use an optional AC reactor (ACR).
*6 Required when a DC reactor (DCR) is used.
*7 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)
*8 The FRN100G1S-2U or higher type comes with a DC reactor (DCR).

Chap. 2 SPECIFICATIONS

HD (High Duty)-mode inverters for heavy load

	Item	Specifications																	
Type (FRN_ _ _G1S-2U)		F50	001	002	003	005	007	010	015	020	025	030	040	050	060	075	100	125	150
Nominal applied motor (HP) *1 (Output rating)		0.5	1	2	3	5	7.5	7.5	10	15	20	25	30	40	50	60	75	100	125
Output ratings	Rated capacity (kVA) *2	1.2	2.0	3.2	4.4	7.2	11	11	15	20	25	30	36	47	58	72	86	113	138
	Rated voltage (V) *3	Three-phase 200 to 240 V (with AVR function)												Three-phase 200 to 230 V (with AVR function)					
	Rated current (A)	3	5	8	11	18	27	27	37	49	63	76	90	119	146	180	215	283	346
	Overload capability	150%-1 min, 200%-3.0 s																	
Input power	Voltage, frequency	200 to 240 V, 50/60 Hz												200 to 220 V, 50 Hz, 200 to 230 V, 60 Hz					
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *5, Frequency: +5 to -5%																	
	Required capacity (with DCR) (kVA) *6	0.6	1.2	2.2	3.1	5.2	7.4	7.4	10	15	20	25	30	40	48	58	71	98	116
	Imput current with DCR	1.5	3	5.5	7.7	13	18.5	18.5	25.1	37.6	50.2	62.7	75.3	100	120	145	178	246	291
	Imput current with out DCR	2.8	4.7	8.5	11.9	20	28.4	28.4	38.6	54.8	72.4	87.7	101	136	167	203	-		
Braking	Torque (%) *7	150%		100%						20%				10 to 15%					
	Braking transistor	Built-in												–					
	Built-in braking resistor	Built-in								–									
	Braking time (s)	5 s								–									
	Duty cycle (%ED)	5	3	5	3	2	3	3	2	–									
DC reactor (DCR)		Option															Standard *8		
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP20, UL open type												IP00, UL open type					
Cooling method		Natural cooling			Fan cooling														
Weight / Mass lbs (kg)		3.8 (1.7)	4.4 (2.0)	6.2 (2.8)	6.6 (3.0)	6.6 (3.0)	14 (6.5)	14 (6.5)	14 (6.5)	13 (5.8)	21 (9.5)	21 (9.5)	22 (10)	55 (25)	71 (32)	93 (42)	95 (43)	137 (62)	232 (105)

*1 US 4P-standard induction motor
*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.
*3 Output voltage cannot exceed the power supply voltage.
*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$
If this value is 2 to 3%, use an optional AC reactor (ACR).
*6 Required when a DC reactor (DCR) is used.
*7 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)
*8 The FRN100G1S-2U or higher type comes with a DC reactor (DCR).

2.1.2 Three-phase 460 V series

LD (Low Duty)-mode inverters for light load (0.5 to 100 HP)

Item		Specifications																
Type (FRN_ _ _G1S-4U)		F50	001	002	003	005	007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		0.5	1	2	3	5	7.5	10	15	20	25	30	40	50	60	75	100		
Output ratings	Rated capacity (kVA) *2	1.2	2.0	3.2	4.4	7.2	11	13.1	18.3	24	29	36	48	60	73	89	120		
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)																	
	Rated current (A)	1.5	2.5	4	5.5	9	13.5	16.5	23	30.5	37	45	60	75	91	112	150		
	Overload capability	150%-1 min, 200%-3.0 s						120%-1 min											
Input power	Voltage, frequency	380 to 480 V, 50/60 Hz																	
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%																	
	Imput current with DCR	0.7	1.5	2.6	4	6.6	9.2	12.5	18.8	25.1	31.3	36.3	50.2	60.2	72.7	89.1	120		
	Imput current with out DCR	1.4	2.6	5.1	7.1	11.3	15	20.1	28.6	38	45.4	52.6	67.7	82	99.1	121	-		
	Required capacity (with DCR) (kVA) *5	0.6	1.2	2.2	3.1	5.2	7.4	10	15	20	25	29	40	48	58	71	96		
Braking	Torque (%) *6	150%		100%			70%			15%				7 to 12%					
	Braking transistor	Built-in												–					
	Built-in braking resistor	Built-in								–									
	Braking time (s)	5 s					3.7 s		3.4 s	–									
	Duty cycle (%ED)	5	3	5	3	2	2.2		1.4	–									
DC reactor (DCR)		Option															Standard *7		
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP20, UL open type												IP00, UL open type					
Cooling method		Natural cooling		Fan cooling															
Weight / Mass lbs (kg)		3.8 (1.7)	4.4 (2.0)	5.7 (2.6)	6.0 (2.7)	6.6 (3.0)	14 (6.5)	14 (6.5)	14 (6.5)	13 (5.8)	21 (9.5)	21 (9.5)	22 (10)	55 (25)	57 (26)	68 (31)	73 (33)		

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*5 Required when a DC reactor (DCR) is used.

*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

*7 The FRN100G1S-4U or higher type comes with a DC reactor (DCR).

(125 to 1000 HP)

Item		Specifications																		
Type (FRN_ _ _G1S-4U)		125	150	200	250	300	350	450	500	600	700	800	900	1000						
Nominal applied motor (HP) *1 (Output rating)		125	150	200	250	300	350	450	500	600	700	800	900	1000						
Output ratings	Rated capacity (kVA) *2	140	167	202	242	300	331	414	518	590	669	765	932	1092						
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)																		
	Rated current (A)	176	210	253	304	377	415	520	650	740	840	960	1170	1370						
	Overload capability	120%-1 min																		
Input power	Voltage, frequency	380 to 440 V, 50 Hz 380 to 480 V, 60 Hz																		
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%																		
	Imput current with DCR	143	175	207	249	311	340	435	547	613	686	766	970	1093						
	Required capacity (with DCR) (kVA) *5	114	140	165	199	248	271	347	436	489	547	611	773	871						
Braking	Torque (%) *6	7 to 12%																		
	Braking transistor	–																		
	Built-in braking resistor	–																		
	Braking time (s)	–																		
	Duty cycle (%ED)	–																		
DC reactor (DCR)		Standard *7																		
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																		
Enclosure (IEC60529)		IP00, UL open type																		
Cooling method		Fan cooling																		
Weight / Mass lbs (kg)		93 (42)	137 (62)	141 (64)	207 (94)	216 (98)	284 (129)	309 (140)	540 (245)	540 (245)	728 (330)	728 (330)	1169 (530)	1169 (530)						

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*5 Required when a DC reactor (DCR) is used.

*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

*7 The FRN100G1S-4U or higher type comes with a DC reactor (DCR).

MD (Medium Duty)-mode inverters for medium load (150 to 700 HP)

Item		Specifications																	
Type (FRN_ _ _G1S-4U)		150	200	250	300	350	450	500	600	700	800								
Nominal applied motor (HP) *1 (Output rating)		150	200	250	300	350	350	450	500	600	700								
Output ratings	Rated capacity (kVA) *2	167	202	242	300	331	373	466	518	590	669								
Output ratings	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)																	
Output ratings	Rated current (A)	210	253	304	377	415	468	585	650	740	840								
Output ratings	Overload capability	150%-1 min																	
Input power	Voltage, frequency	380 to 440 V, 50 Hz 380 to 480 V, 60 Hz																	
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%																	
Input power	Imput current with DCR	175	207	249	311	340	386	486	547	613	686								
Input power	Required capacity (with DCR) (kVA) *5	140	165	199	248	271	308	388	436	489	547								
Braking	Torque (%) *6	7 to 12%																	
Braking	Braking transistor	–																	
Braking	Built-in braking resistor	–																	
Braking	Braking time (s)	–																	
Braking	Duty cycle (%ED)	–																	
DC reactor (DCR)		Standard *7																	
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP00, UL open type																	
Cooling method		Fan cooling																	
Weight / Mass lbs (kg)		137 (62)	141 (64)	207 (94)	216 (98)	284 (129)	309 (140)	540 (245)	540 (245)	728 (330)	728 (330)								

*1 US 4P-standard induction motor
*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.
*3 Output voltage cannot exceed the power supply voltage.
*4

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

If this value is 2 to 3%, use an optional AC reactor (ACR).
*5 Required when a DC reactor (DCR) is used.
*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)
*7 The FRN100G1S-4U or higher type comes with a DC reactor (DCR).

HD (High Duty)-mode inverters for heavy load (0.5 to 75 HP)

Item		Specifications																	
Type (FRN_ _ _G1S-4U)		F50	001	002	003	005	007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		0.5	1	2	3	5	7.5	7.5	10	15	20	25	30	40	50	60	75		
Output ratings	Rated capacity (kVA) *2	1.2	2.0	3.2	4.4	7.2	11	11	15	20	25	31	36	48	60	73	89		
Output ratings	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)																	
Output ratings	Rated current (A)	1.5	2.5	4	5.5	9	13.5	13.5	18.5	24.5	32	39	45	60	75	91	112		
Output ratings	Overload capability	150%-1 min, 200%-3.0 s																	
Input power	Voltage, frequency	380 to 480 V, 50/60 Hz																	
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%																	
Input power	Imput current with DCR	0.7	1.5	2.6	4	6.6	9.2	9.2	12.4	18.8	25	31	36	50	60	72	89		
Input power	Imput current with out DCR	1.4	2.6	5.1	7.1	11.3	15	15	20.1	28.6	38	45.4	52.6	67.7	82	99.1	-		
Input power	Required capacity (with DCR) (kVA) *5	0.6	1.2	2.1	3.2	5.3	7.4	7.4	9.9	15.0	20.0	25.0	29.0	40.0	48.0	58.0	71.0		
Braking	Torque (%) *6	150%		100%						20%				10 to 15%					
Braking	Braking transistor	Built-in												–					
Braking	Built-in braking resistor	Built-in								–									
Braking	Braking time (s)	5 s								–									
Braking	Duty cycle (%ED)	5	3	5	3	2	3	3	2	–									
DC reactor (DCR)		Option															Standard *7		
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP20, UL open type												IP00, UL open type					
Cooling method		Natural cooling		Fan cooling															
Weight / Mass lbs (kg)		3.8 (1.7)	4.4 (2.0)	5.7 (2.6)	6.0 (2.7)	6.6 (3.0)	14 (6.5)	14 (6.5)	14 (6.5)	13 (5.8)	21 (9.5)	21 (9.5)	22 (10)	55 (25)	57 (26)	68 (31)	73 (33)		

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*5 Required when a DC reactor (DCR) is used.

*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

*7 The FRN100G1S-4U or higher type comes with a DC reactor (DCR).

(100 to 900 HP)

Item		Specifications																	
Type (FRN_ _ _G1S-4U)		125	150	200	250	300	350	450	500	600	700	800	900	1000					
Nominal applied motor (HP) *1 (Output rating)		100	125	150	200	250	300	350	400	450	500	600	800	900					
Output ratings	Rated capacity (kVA) *2	120	140	167	202	242	300	330	414	466	518	590	765	932					
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)																	
	Rated current (A)	150	176	210	253	304	377	415	520	585	650	740	960	1170					
	Overload capability	150%-1 min, 200%-3.0 s																	
Input power	Voltage, frequency	380 to 440 V, 50 Hz 380 to 480 V, 60 Hz																	
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%																	
	Imput current with DCR	120	143	176	207	250	311	340	436	487	547	614	767	970					
	Required capacity (with DCR) (kVA) *5	96	114	140	165	199	248	271	347	388	436	489	611	773					
Braking	Torque (%) *6	10 to 15%																	
	Braking transistor	–																	
	Built-in braking resistor	–																	
	Braking time (s)	–																	
	Duty cycle (%ED)	–																	
DC reactor (DCR)		Standard *7																	
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007																	
Enclosure (IEC60529)		IP00, UL open type																	
Cooling method		Fan cooling																	
Weight / Mass lbs (kg)		93 (42)	137 (62)	141 (64)	207 (94)	216 (98)	284 (129)	309 (140)	540 (245)	540 (245)	728 (330)	728 (330)	1169 (530)	1169 (530)					

*1 US 4P-standard induction motor
*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.
*3 Output voltage cannot exceed the power supply voltage.
*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$
If this value is 2 to 3%, use an optional AC reactor (ACR).
*5 Required when a DC reactor (DCR) is used.
*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)
*7 The FRN100G1S-4U or higher type comes with a DC reactor (DCR).

2.2 Standard Model 2 (Inverter with built-in DC reactor)

2.2.1 Three-phase 230 V series

LD (Low Duty)-mode inverters for light load

Item		Specifications												
Type (FRN_ _ _G1H-2U)		007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		7.5	10	15	20	25	30	40	50	60	75	100		
Output ratings	Rated capacity (kVA) *2	11	13	18	24	30	35	46	58	72	86	113		
	Rated voltage (V) *3	Three-phase 200 to 240 V (with AVR function)							Three-phase 200 to 230 V (with AVR function)					
	Rated current (A) *4	27	31.8 (29)	46.2 (42)	59.4 (55)	74.8 (68)	88 (80)	115 (107)	146	180	215	283		
	Overload capability	150%-1 min, 200%-3.0 s	120%-1 min											
Input power	Voltage, frequency	200 to 240 V, 50/60 Hz							200 to 220 V, 50 Hz, 200 to 230 V, 60 Hz					
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *5, Frequency: +5 to -5%												
	Imput current with DCR	19.4	25.7	37.2	50.3	62.8	75.4	101	126	156	186	247		
	Required capacity (kVA)	7.7	10	15	20	25	30	40	50	62	74	98		
Braking	Torque (%) *6	70%		15%					7 to 12%					
	Braking transistor	Built-in							–					
	Built-in braking resistor	Built-in		–										
	Braking time (s)	3.7 s		3.4 s	–									
	Duty cycle (%ED)	2.2		1.4	–									
DC reactor (DCR)		Built-in as standard												
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007												
Enclosure (IEC60529)		IP20, UL open type							IP00, UL open type					
Cooling method		Fan cooling												
Weight / Mass lbs (kg)		24 (10.7)	24 (10.7)	25 (11.1)	25 (11.5)	38 (17.3)	39 (17.6)	41 (18.5)	68 (31)	86 (39)	112 (51)	115 (52)		

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*4 To use the inverter with the carrier frequency of 3 kHz or more at the surrounding temperature of 40°C (104°F) or higher, manage the load so that the current comes to be within the rated ones enclosed in parentheses ( ) in continuous running.

*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

HD (High Duty)-mode inverters for heavy load

Item		Specifications												
Type (FRN_ _ _G1H-2U)		007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		7.5	7.5	10	15	20	25	30	40	50	60	75		
Output ratings	Rated capacity (kVA) *2	11	11	15	20	25	30	36	47	58	72	86		
	Rated voltage (V) *3	Three-phase 200 to 240 V (with AVR function)							Three-phase 200 to 230 V (with AVR function)					
	Rated current (A)	27	27	37	49	63	76	90	119	146	180	215		
	Overload capability	150%-1 min, 200%-3.0 s												
Input power	Voltage, frequency	200 to 240 V, 50/60 Hz							200 to 220 V, 50 Hz, 200 to 230 V, 60 Hz					
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *5, Frequency: +5 to -5%												
	Imput current with DCR	19.4	19.4	26.4	39	52.8	65.3	77.9	106	131	161	194		
	Required capacity (kVA)	7.7	7.7	10.5	15.5	21	26	31	42	52	64	77		
Braking	Torque (%) *6	100%		20%					10 to 15%					
	Braking transistor	Built-in							–					
	Built-in braking resistor	Built-in		–										
	Braking time (s)	5 s		–										
	Duty cycle (%ED)	3	2	–										
DC reactor (DCR)		Built-in as standard												
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007												
Enclosure (IEC60529)		IP20, UL open type							IP00, UL open type					
Cooling method		Fan cooling												
Weight / Mass lbs (kg)		24 (10.7)	24 (10.7)	25 (11.1)	25 (11.5)	38 (17.3)	39 (17.6)	41 (18.5)	68 (31)	86 (39)	112 (51)	115 (52)		

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*6 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

2.2.2 Three-phase 460 V series

LD (Low Duty)-mode inverters for light load

Item		Specifications												
Type (FRN_ _ _G1H-4U)		007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		7.5	10	15	20	25	30	40	50	60	75	100		
Output ratings	Rated capacity (kVA) *2	11	13.1	18.3	24	29	36	48	60	73	89	120		
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)												
	Rated current (A)	13.5	16.5	23	30.5	37	45	60	75	91	112	150		
	Overload capability	150%-1 min, 200%-3.0 s	120%-1 min											
Input power	Voltage, frequency	380 to 480 V, 50/60 Hz												
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%												
	Imput current with DCR	9.7	12.9	18.8	25.5	31.4	37.7	51.5	61.6	76.6	92.9	126		
	Required capacity (kVA)	7.7	10	15	20	25	30	41	49	61	74	100		
Braking	Torque (%) *5	70%		15%					7 to 12%					
	Braking transistor	Built-in							–					
	Built-in braking resistor	Built-in		–										
	Braking time (s)	3.7 s		3.4 s	–									
	Duty cycle (%ED)	2.2		1.4	–									
DC reactor (DCR)		Built-in as standard												
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007												
Enclosure (IEC60529)		IP20, UL open type							IP00, UL open type					
Cooling method		Fan cooling												
Weight / Mass lbs (kg)		24 (10.8)	24 (10.8)	26 (11.9)	26 (11.6)	39 (17.6)	40 (18.1)	41 (18.6)	71 (32)	73 (33)	86 (39)	93 (42)		

*1 US 4P-standard induction motor

*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.

*3 Output voltage cannot exceed the power supply voltage.

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).

*5 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

HD (High Duty)-mode inverters for heavy load

Item		Specifications												
Type (FRN_ _ _G1H-4U)		007	010	015	020	025	030	040	050	060	075	100		
Nominal applied motor (HP) *1 (Output rating)		7.5	7.5	10	15	20	25	30	40	50	60	75		
Output ratings	Rated capacity (kVA) *2	11	11	15	20	25	31	36	48	60	73	89		
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)												
	Rated current (A)	13.5	13.5	18.5	24.5	32	39	45	60	75	91	112		
	Overload capability	150%-1 min, 200%-3.0 s												
Input power	Voltage, frequency	380 to 480 V, 50/60 Hz												
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *4, Frequency: +5 to -5%												
	Imput current with DCR	9.7	9.7	13.4	19.5	26.4	32.7	39	51.5	65.3	80.4	99.2		
	Required capacity (kVA)	7.7	7.7	11	16	21	26	31	41	52	64	79		
Braking	Torque (%) *5	100%			20%				10 to 15%					
	Braking transistor	Built-in							–					
	Built-in braking resistor	Built-in		–										
	Braking time (s)	5 s		–										
	Duty cycle (%ED)	3	2	–										
DC reactor (DCR)		Built-in as standard												
Applicable safety standards		UL508C, C22.2 No.14, EN61800-5-1:2007												
Enclosure (IEC60529)		IP20, UL open type							IP00, UL open type					
Cooling method		Fan cooling												
Weight / Mass lbs (kg)		24 (10.8)	24 (10.8)	26 (11.9)	26 (11.6)	39 (17.6)	40 (18.1)	41 (18.6)	71 (32)	73 (33)	86 (39)	93 (42)		

*1 US 4P-standard induction motor
*2 Rated capacity is calculated assuming the rated output voltage as 230 V for 230 V series and 460 V for 460 V series.
*3 Output voltage cannot exceed the power supply voltage.
*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

If this value is 2 to 3%, use an optional AC reactor (ACR).
*5 Average braking torque for the motor running alone, without external braking resistor. (It varies with the efficiency of the motor.)

2.3 Common Specifications

Item				Explanation	Remarks
Output frequency	Setting range	Maximum frequency		25 to 500 Hz variable (Up to 120 Hz for LD/MD-mode inverters) (Up to 120 Hz under vector control without speed sensor) (Up to 200 Hz under V/f control with speed sensor or vector control with speed sensor)	
		Base frequency		25 to 500 Hz variable (in conjunction with the maximum frequency)	
		Starting frequency		0.1 to 60.0 Hz variable (0.0 Hz under vector control with/without speed sensor)	
		Carrier frequency		• 0.75 to 16 kHz (LD mode: 7 to 30 HP, HD mode: 0.5 to 100 HP) • 0.75 to 10 kHz (LD mode: 40 to 100 HP, HD mode: 120 to 800 HP) • 0.75 to 6 kHz (LD mode: 125 to 900 HP, HD mode: 900 and 1000 HP) • 0.75 to 4 kHz (LD mode: 1000 HP) • 0.75 to 2 kHz (MD mode: 150 to 800 HP) **Note:** The carrier frequency may automatically drop depending upon the surrounding temperature or the output current to protect the inverter. (The automatic drop function can be disabled.)	
	Output frequency accuracy (Stability)			• Analog setting: ±0.2% of maximum frequency (at 25 ±10°C (77 ±18°F)) • Digital setting: ±0.01% of maximum frequency (at -10 to +50°C (14 to 122°F))	
	Frequency setting resolution			• Analog setting: 1/3000 of maximum frequency (1/1500 for V2 input) • Digital setting: 0.01 Hz (99.99 Hz or less), 0.1 Hz (100.0 to 500.0 Hz) • Link operation setting: Selectable from the following. - 1/20000 of maximum frequency - 0.01 Hz (fixed)	
	Under V/f control with speed sensor Under dynamic torque vector control with speed sensor	Speed control range		• 1 : 100 (Minimum speed : Base speed, 4P, 15 to 1500 min^{-1}) • 1 : 2 (Constant torque range : Constant output range)	
		Speed control accuracy		• Analog setting: ±0.2% of maximum frequency (at 25 ±10°C (77 ±18°F)) • Digital setting: ±0.01% of maximum frequency (at -10 to +50°C (14 to 122°F))	
	Under vector control without speed sensor	Speed control range		• 1 : 200 (Minimum speed : Base speed, 4P, 7.5 to 1500 min^{-1}) • 1 : 2 (Constant torque range : Constant output range)	
		Speed control accuracy		• Analog setting: ±0.5% of base speed (at 25 ±10°C (77 ±18°F)) • Digital setting: ±0.5% of base speed (at -10 to +50°C (14 to 122°F))	
	Under vector control with speed sensor	Speed control range		• 1 : 1500 (Minimum speed : Base speed, 4P, 1 to 1500 min^{-1}, 1024 p/r) • 1 : 4 (Constant torque range : Constant output range)	
		Speed control accuracy		• Analog setting: ±0.2% of maximum frequency (at 25 ±10°C (77 ±18°F)) • Digital setting: ±0.01% of maximum frequency (at -10 to +50°C (14 to 122°F))	
Control	Control method			• V/f control • Dynamic torque vector control • V/f control with speed sensor or dynamic torque vector control with speed sensor • Vector control without speed sensor (Not available for MD-mode inverters) • Vector control with speed sensor (with an optional PG interface card mounted)	

Control	V/f characteristics	230 V series	• Possible to set output voltage at base frequency and at maximum output frequency (80 to 240 V). • The AVR control can be turned ON or OFF. ***1**, ***4** • Non-linear V/f setting (3 points): Free voltage (0 to 240 V) and frequency (0 to 500 Hz) can be set. ***1**, ***4**	
		460 V series	• Possible to set output voltage at base frequency and at maximum output frequency (160 to 500 V). • The AVR control can be turned ON or OFF. ***1**, ***4** • Non-linear V/f setting (3 points): Free voltage (0 to 500 V) and frequency (0 to 500 Hz) can be set. ***1**, ***4**	
	Torque boost		• Auto torque boost (For constant torque load) ***1** to ***4** • Manual torque boost : Torque boost value can be set between 0.0 and 20.0%. ***1**, ***3**, ***4** • Select application load with the function code. (Variable torque load or constant torque load) ***1**, ***4**	
	Starting torque (HD mode)		• 40 HP or below: 200% or higher, 50 HP or above: 180% or higher, reference frequency 0.3 Hz, base frequency 50 Hz, with slip compensation and auto torque boost active ***1** to ***4** • 40 HP or below: 200% or higher, 50 HP or above: 180% or higher, reference frequency 0.3 Hz ***6**	
	Start/stop operation		• Keypad ((FWD), (REV) and (STOP) keys), external signals (run forward (run reverse) command, etc.), Communications link (RS-485/fieldbus (option)) • Remote/local operation	
			External signals (digital inputs): Forward (Reverse) rotation, stop command (capable of 3-wire operation), coast-to-stop command, external alarm, alarm reset, etc.	
			Link operation: Operation through RS-485 or fieldbus (option) communications	
			Switching run command: Remote/local switching, link switching	
	Enable input (Safe Torque Off (STO))		Opening the circuit between terminals [EN] and [PLC] stops the inverter's output transistor (coast-to-stop). (Compliant with EN954-1 Cat.3)	
	Frequency setting		Keypad: Settable with (∧) and (∨) keys	"+1 to +5 VDC" can be adjusted with bias and analog input gain.
			External volume: Can be set with external frequency command potentiometer. (1 to 5 kΩ 1/2 W)	
			Analog input: 0 to ±10 V DC (±5 V DC)/ 0 to ±100% (terminals [12] and [V2]), 0 to +10 V DC (+5 V DC)/ 0 to +100% (terminals [12] and [V2]) : +4 to +20 mA DC/ 0 to 100% (terminal [C1])	
			UP/DOWN operation: Frequency can be increased or decreased while the digital input signal is ON.	
			Multi-frequency: Selectable from 16 different frequencies (step 0 to 15)	
			Link operation: Frequency can be specified through RS-485. (Standard setting)	
			Frequency setting: Two types of frequency settings can be switched with an external signal (digital input). Remote/local switching, link switching	
			Auxiliary frequency setting: Inputs at terminal [12], [C1] or [V2] can be added to the main setting as auxiliary frequency settings.	
			Operation at a specified ratio: The ratio can be set by analog input signal.	
			Inverse operation : Switchable from "0 to +10 VDC/0 to 100%" to "+10 to 0 VDC/0 to 100%" by external command. : Switchable from "4 to +20 mA DC/0 to 100%" to "+20 to 4 mA DC/0 to 100%" by external command.	
			Pulse train input (standard): Pulse input = Terminal [X7], Rotational direction = general terminal Complementary output: Max. 100 kHz, Open collector output: Max. 30 kHz	
			Pulse train input (option): PG interface option CW/CCW pulse, pulse + rotational direction Complementary output: Max. 100 kHz, Open collector output: Max. 25 kHz	

*1 Available under V/f control.
*2 Available under dynamic torque vector control.
*3 Available when the slip compensation is made active under V/f control.
*4 Available under V/f control with speed sensor. (PG option required)
*6 Available under vector control without speed sensor.

Control	Acceleration/ deceleration time	Setting range: 0.00 to 6000 s	
		Switching: The four types of acceleration/deceleration time can be set or selected individually (switchable during operation).	
		Acceleration/deceleration pattern: Linear acceleration/deceleration, S-shape acceleration/deceleration (weak, free (strong)), curvilinear acceleration/deceleration (acceleration/deceleration max. capacity of constant output)	
		Acceleration/deceleration pattern: Linear acceleration/deceleration, S-shape acceleration/deceleration (weak, free, (strong)), curvilinear acceleration/deceleration (acceleration/deceleration maximum capacity of constant output)	
		Deceleration mode (coast-to-stop): Shutoff of the run command lets the motor coast to a stop.	
		Forcible stop deceleration time: Deceleration stop by the forcible stop ***STOP***.	
	Frequency limiter (Upper limit and lower limit frequencies)	• Specifies the upper and lower limits in Hz. • It is possible to choose the operation to be performed when the reference frequency drops below the lower limit specified by F16.	
	Bias frequency	• Bias of set frequency and PID command can be independently set (setting range: 0 to ±100%).	
	Analog input	• Gain : Set in the range from 0 to 200% • Offset : Set in the range from -5.0 to +5.0% • Filter : Set in the range from 0.00 s to 5.00 s	
	Jump frequency	• Three operation points and their common jump width (0 to 30.0 Hz) can be set.	
	Jogging operation	• Operation with FWD or REV key, or digital input signal ***FWD*** or ***REV*** (Exclusive acceleration/deceleration time setting, exclusive frequency setting)	
	Auto-restart after momentary power failure	• Trip at power failure: The inverter trips immediately after power failure. • Trip at power recovery: Coast-to-stop at power failure and trip at power recovery • Deceleration stop: Deceleration stop at power failure, and trip after stoppage • Continue to run: Operation is continued using the load inertia energy. • Start at the frequency selected before momentary power failure: Coast-to-stop at power failure and start after power recovery at the frequency selected before momentary stop. *1 to *3 • Start at starting frequency: Coast-to-stop at power failure and start at the starting frequency after power recovery. *1 to *3	
	Hardware current limiter	Limits the current by hardware to prevent an overcurrent trip from being caused by fast load variation or momentary power failure, which cannot be covered by the software current limiter. This limiter can be canceled.	
	Operation by commercial power supply	• With commercial power selection command, the inverter outputs 50/60 Hz (***SW50***, ***SW60***). *1 to *3 • The inverter has the commercial power supply selection sequence.	
	Slip compensation	Compensates for decrease in speed according to the load. *2, *3	
	Droop control	Decreases the speed according to the load torque.	
	Torque limit	• Switchable between 1st and 2nd torque limit values • Torque limit, torque current limit, and power limit are set for each quadrant. *6, *7 • Analog torque limit input	
	Software current limiter	Automatically reduces the frequency so that the output current becomes lower than the preset operation level. *1 to *5	

*1 Available under V/f control.
*2 Available under dynamic torque vector control.
*3 Available when the slip compensation is made active under V/f control.
*4 Available under V/f control with speed sensor. (PG option required)
*5 Available under dynamic torque vector control with speed sensor. (PG option required)
*6 Available under vector control without speed sensor.
*7 Available under vector control with speed sensor. (PG option required)

Control	PID control	• PID processor for process control/dancer control • Normal operation/inverse operation • Low liquid level stop function (pressurized operation possible before low liquid level stop) • PID command: Keypad, analog input (from terminals [12], [C1] and [V2]), RS-485 communication • PID feedback value (from terminals [12], [C1] and [V2]) • Alarm output (absolute value alarm, deviation alarm) • PID output limiter • Integration reset/hold • Anti-reset wind-up function	
	Auto search for idling motor speed	The inverter automatically searches for the idling motor speed to be harmonized and starts to drive it without stopping it. (Motor constants need tuning: Auto-tuning (offline) ***1** to ***3** and ***6**	
	Automatic deceleration	• If the DC link bus voltage or calculated torque exceeds the automatic deceleration level during deceleration, the inverter automatically prolongs the deceleration time to avoid overvoltage trip. (It is possible to select forcible deceleration actuated when the deceleration time becomes three times longer.) • If the calculated torque exceeds automatic deceleration level during constant speed operation, the inverter avoids overvoltage trip by increasing the frequency.	
	Deceleration characteristic (improved braking capacity)	The motor loss is increased during deceleration to reduce the regenerative energy in the inverter to avoid overvoltage trip.	
	Auto energy saving operation	The output voltage is controlled to minimize the total sum of the motor loss and inverter loss at a constant speed. (With digital input signal, auto energy saving mode can be turned ON or OFF by an external device.)	
	Overload prevention control	If the surrounding temperature or IGBT joint temperature increases due to overload, the inverter lowers the output frequency to avoid overload.	
	Auto-tuning (offline)	Tuning the motor while the motor is stopped or running, for setting up motor parameters.	
	Cooling fan ON/OFF control	• Detects inverter internal temperature and stops cooling fan when the temperature is low. • The fan control signal can be output to an external device.	
	2nd to 4th motor settings	• Switchable among the four motors • Code data for four kinds of specific functions can be switched (even during operation). It is possible to set the base frequency, rated current, torque boost, and electronic thermal slip compensation as the data for 1st to 4th motors.	
	Universal DI	The status of external digital signal connected with the universal digital input terminal is transferred to the host controller.	
	Universal DO	Digital command signal from the host controller is output to the universal digital output terminal.	
	Universal AO	The analog command signal from the host controller is output to the analog output terminal.	
	Speed control	Notch filter for vibration suppression ***7**	
	Preliminary excitation	Excitation is carried out to create the motor flux before starting the motor. ***6** and ***7**	
	Zero speed control	The motor speed is held to zero by forcibly zeroing the speed command. ***7**	
	Servo lock	Stops the motor and holds the motor in the stopped position. ***7**	

*1 Available under V/f control.
*2 Available under dynamic torque vector control.
*3 Available when the slip compensation is made active under V/f control.
*6 Available under vector control without speed sensor.
*7 Available under vector control with speed sensor. (PG option required)

Control	Torque control ***6**, ***7**	• Analog torque command input • Speed limit function is provided to prevent the motor from becoming out of control.	
	Rotational direction control	Select either of reverse or forward rotation prevention.	
	Dew condensation prevention	When the motor is stopped, current is automatically supplied to the motor to keep the motor warm and avoid condensation.	
	Customized logic interface	Available in 10 steps with the functions of 2-input, 1-output, logical operation, and timer function	
Display	Running/Stopping	Speed monitor (reference frequency, output frequency, motor speed, load shaft speed, line speed, and speed indication with percent), output current [A], output voltage [V], calculated torque [%], input power [kW], PID command value, PID feedback value, PID output, load factor [%], motor output [kW], torque current [%] ***6 *7**, magnetic flux command [%] ***6 *7**, analog input and input watt-hour	
	Life early warning	• The life early warning of the main circuit capacitors, capacitors on the PC boards and the cooling fan can be displayed. • An external output is issued in a transistor output signal. • Surrounding temperature: 40°C (104°F) Load factor: Inverter rated current 80% (LD/MD mode) or 100% (HD mode)	
	Cumulative run time	• Displays the inverter cumulative run time, input watt-hour, cumulative motor run time, and the number of startups (of each motor). • Outputs the warning when the maintenance time or the number of start times has exceeded the preset.	
	Trip mode	Displays the cause of trip by codes.	
	Light-alarm	Shows the light-alarm display L-AL.	
	Running or trip mode	• Trip history: Saves and displays the cause of the last four trips (with a code). • Saves and displays the detailed operation status data of the last four trips.	
Protection	Overcurrent protection	The inverter is stopped for protection against overcurrent.	OC1 OC2 OC3
	Short-circuit protection	The inverter is stopped for protection against overcurrent caused by a short circuit in the output circuit.	
	Ground fault protection	The inverter is stopped for protection against overcurrent caused by a ground fault in the output circuit. (230 V 40 HP, 460 V 40 HP or below)	
		Detecting zero-phase current of output current, the inverter is stopped for protection against overcurrent caused by a ground fault in the output circuit. (230 V 50 HP, 460 V 50 HP or above)	EF
	Overvoltage protection	An excessive voltage (230 V series: 400 VDC, 460 V series: 800 VDC) in the DC link circuit is detected and the inverter is stopped. If an excessive voltage is applied by mistake, the protection cannot be guaranteed.	OU1 OU2 OU3
	Undervoltage protection	The voltage drop (230 V series: 200 VDC, 460 V series: 400 VDC) in the DC link circuit is detected to stop the inverter. However, the alarm will not be issued when the re-starting after instantaneous stop is selected.	LU
	Input phase loss protection	• The input phase loss is detected to shut off the inverter output. This function protects the inverter. • When the load is small or a DC reactor is connected, a phase loss may not be detected.	Lin
	Output phase loss protection	Detects breaks in inverter output wining during running, to shut off the inverter output.	OPL

*6 Available under vector control without speed sensor.
*7 Available under vector control with speed sensor. (PG option required)

Protection	Overheat protection		Stop the inverter output detecting excess cooling fan temperature in case of a cooling fan fault or overload	OH1
			Stop the inverter output detecting a fault of inner agitating fan. (230 V 75 HP, 460 V 125 HP or above)	
			Stop the inverter output detecting inner temperature of the inverter unit for a cooling fan fault or overload.	OH3
			Protect the braking resistor from over heat by setting the braking resistor electronic thermal function.	dbH
	Overload protection		Stops the inverter output upon detection of the abnormal heat sink temperature and switching element temperature calculated with the output current.	OLU
	External alarm input		With the digital input signal ***THR*** opened, the inverter is stopped with an alarm.	OH2
	Fuse blown		Stop the inverter output detecting the fuse breaking of the main circuit in the inverter. (230 V 125 HP, 460 V 150 HP or above)	FUS
	Charge circuit fault		Stop the inverter output detecting the charge circuit abnormality in the inverter. (230 V 60 HP, 460 V 125 HP or above)	PbF
	Braking transistor broken		Stop the inverter detecting the brake transistor abnormality. (DB transistor built-in type only	dbA
	Overspeed protection ***4** to ***7**		Stop the inverter when the detected speed exceeds 120% of maximum output frequency.	OS
	PG wire break ***4 *5 *7**		Stop the inverter detecting the PG braking.	PG
	Motor protection	Electronic thermal	The inverter is stopped with an electronic thermal function set to protect the motor. Protects the general-purpose motor inverter over all frequency range. (The running level and thermal time constant (0.5 to 75.0 min) can be set.)	OL1 to OL4
		PTC thermistor	A PTC thermistor input stops the inverter to protect the motor. Connect a PTC thermistor between terminals [V2] and [11] and set the switch on control print board and the function code.	OH4
		NTC thermistor	The NTC thermistor detects a motor temperature. Connect a NTC thermistor between terminals [V2] and [11] and set the switch on control print board and the function code.	
		NTC thermistor breaking	Stop the inverter output detecting the built-in motor NTC breaking.	nrb
		Overload early warning	Warning signal is output at the predetermined level before stopping the inverter with electronic thermal function.	
	Memory error		Data is checked upon power-on and data writing to detect any fault in the memory and to stop the inverter if any.	Er1
	Keypad communications error		The keypad is used to detect a communication fault between the keypad and inverter main body during operation and to stop the inverter.	Er2
	CPU error		Stop the invert detecting a CPU error or LSI error caused by noise.	Er3
	Option communications error		When each option is used, a fault of communication with the inverter main body is detected to stop the inverter.	Er4
	Option error		When each option is used, the option detects a fault to stop the inverter.	Er5
	Operation protection		STOP key priority: Pressing the STOP key on the keypad or entering the digital input signal will forcibly decelerate and stop the motor even if the run command through signal input or communication is selected. Er6 will be displayed after the stop.	Er6
			Start check: If the running command is being ordered when switching the running command method from power-on, alarm reset, or the linked operation, the operation starts suddenly. This function bans running and displays Er6.	

*4 Available under V/f control with speed sensor. (PG option required)
*5 Available under dynamic torque vector control with speed sensor. (PG option required)
*6 Available under vector control without speed sensor.
*7 Available under vector control with speed sensor. (PG option required)

Protection	Tuning error	Stop the inverter output when tuning failure, interruption, or any fault as a result of tuning is detected during tuning for motor constant.	Er7
	RS-485 communications error (port 1)	When the connection port of the keypad connected via RS-485 communication port to detect a communication error, the inverter is stopped and displays an error.	Er8
	Speed mismatch or excessive speed deviation ***4** to ***7**	Stop the inverter output when the speed deviation excesses the specified value (difference between speed command and feedback).	ErE
	Data save error upon undervoltage	When the undervoltage protection function works, an alarm is displayed if the data is not properly saved.	ErF
	RS-485 communications error (port 2)	Stop the inverter output detecting the communication error between the inverter main unit and a mate when the RS-485 connection port of the touch panel is used to configure the network.	ErP
	Hardware error	Stop the inverter output detecting the LSI abnormality of the print board for power supply which is mainly caused by noise.	ErH
	Mock alarm	Simulated alarm is output by the keypad operation.	Err
	PID feedback wire break	Stop the inverter output detecting a breaking when the input current is allocated to the PID control feedback. (Select valid/invalid.)	CoF
	Alarm relay output (for any fault)	• The relay signal is output when the inverter stops upon an alarm. • (RESET) key or digital input signal ***RST*** is used to reset the alarm stop state.	
	Light-alarm (warning)	The "light-alarm" display is indicated when alarm or warning matters set as minor troubles occurred. The operation is continued. Light alarm object Heat sink overheat (OH1), External alarm (OH2), Inverter internal overheat (OH3), Braking resistor overheat (dbH), Overload of motor 1 through 4 (OL1 to OL4), Option communications error (Er4), Option error (Er5), RS-485 communications error (COM port 1) (Er8), RS-485 communications error (COM port 2) (ErP), Speed mismatch or excessive speed deviation (ErE), PID feedback wire break (CoF), DC fan locked (FAL), Motor overload early warning (OL), Heat sink overheat early warning (OH), Lifetime alarm (DC link bus capacitor, electrolytic capacitors on printed circuit boards or cooling fans) (LiF), Reference command loss detected (rEF), PID alarm (PID), Low torque output (UTL), PTC thermistor activated (PTC), Inverter life (cumulative run time) (rTE), Inverter life (number of startups) (CnT)	L-AL
	Stall prevention	Operates when the inverter output goes beyond the instantaneous overcurrent limiting level, and avoids tripping, during acceleration and constant speed operation.	
	Retry function	When the motor is tripped and stopped, this function automatically resets the tripping state and restarts operation.	
	Surge protection	The inverter is protected against surge voltage intruding between the main circuit power line and ground.	
	Command loss detection	A loss (breaking, etc.) of the frequency command is detected to output an alarm and the operation is continued at the preset frequency (set at a ratio to the frequency before detection).	
	Protection against momentary power failure	Upon detection of a momentary power failure lasting more than 15 ms, this function stops the inverter output. When "restart after momentary power failure" is selected, this function invokes a restart process if power is restored within a predetermined period (allowable momentary power failure time).	

*4 Available under V/f control with speed sensor. (PG option required)
*5 Available under dynamic torque vector control with speed sensor. (PG option required)
*6 Available under vector control without speed sensor.
*7 Available under vector control with speed sensor. (PG option required)

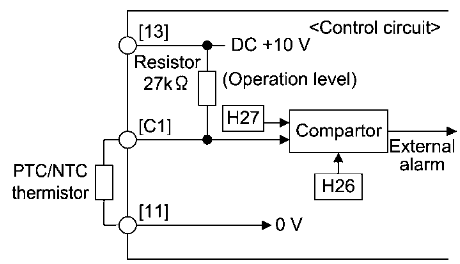
Environment	Installation location	Shall be free from corrosive gases, flammable gases, oil mist, dusts, and direct sunlight. (Pollution degree 2 (IEC60664-1)). Indoor use only.	
	Surrounding temperature	-10 to +50°C (14 to 122°F) (-10 to +40°C (14 to 104°F) when installed side-by-side without clearance (40 HP or below))	
	Relative humidity	5 to 95% RH (without condensation)	
	Altitude	Lower than 3,300 ft (1,000 m)	
	Vibration	230 V 100 HP, 460 V 125 HP or below 0.12 inch (3 mm): 2 to less than 9 Hz, 9.8m/s^2: 9 to less than 20 Hz 2 m/ s^2: 20 to less than 55 Hz, 1m/ s^2: 55 to less than 200 Hz 230V 125 HP, 460 V 150 HP or above 0.12 inch (3 mm): 2 to less than 9 Hz 2 m/s^2: 9 to less than 55 Hz, 1 m/s^2: 55 to less than 200 Hz	
	Storage temperature	-25 to +65°C (-13 to +149°F)	
	Storage humidity	5 to 95% RH (without condensation)	

2.4 Terminal Specifications

2.4.1 Terminal functions

Main circuit and analog input terminals

Classifi-cation	Symbol	Name	Functions
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connect the three-phase input power lines.
	U, V, W	Inverter outputs	Connect a three-phase motor.
	R0, T0	Auxiliary power input for the control circuit	Connect AC power lines.
	P1, P(+)	DC reactor connection	Connect a DC reactor (DCR).
	P(+), DB	Braking resistor	Connect an external braking resistor (option).
	P(+), N(-)	DC link bus	Terminal for DC bus link system.
	R1, T1	Auxiliary power input for the fans	Normally, no need to use these terminals. Use these terminals for an auxiliary power input of the fans in a power system using a power regenerative PWM converter. (For 230 V series of inverters with 60 HP and 460 V series with 125 HP or above)
	⏚ G	Grounding for inverter and motor	Grounding terminals for the inverter's chassis (or case) and motor. Earth one of the terminals and connect the grounding terminal of the motor. Inverters provide a pair of grounding terminals that function equivalently.
Analog input	[13]	Power supply for the potentiometer	Power supply (+10 VDC) for an external frequency command potentiometer (Variable resistor: 1 to 5kΩ) The potentiometer of 1/2 W rating or more should be connected.
	[12]	Analog setting voltage input	(1) The frequency is commanded according to the external voltage input. • 0 to ±10 VDC/0 to ±100% (Normal operation) • +10 to 0 VDC/0 to 100% (Inverse operation) (2) In addition to frequency setting, PID command, PID feedback signal, auxiliary frequency command setting, ratio setting, torque limiter level setting, or analog input monitor can be assigned to this terminal. (3) Hardware specifications • Input impedance: 22kΩ • The maximum input is ±15 VDC, however, the voltage higher than ±10 VDC is handled as ±10 VDC. • Inputting a bipolar analog voltage (0 to ±10 VDC) to terminal [12] requires setting function code C35 to "0."

Classifi-cation	Symbol	Name	Functions
Analog input	[C1]	Analog setting current input	(1) The frequency is commanded according to the external current input. • 4 to 20 mA DC/0 to 100% (Normal operation) • 20 to 4 mA DC/0 to 100 % (Inverse operation) (2) In addition to frequency setting, PID command, PID feedback signal, auxiliary frequency command setting, ratio setting, torque limiter level setting, or analog input monitor can be assigned to this terminal. (3) Hardware specifications • Input impedance: 250Ω • The maximum input is +30 mA DC, however, the current larger than +20 mA DC is handled as +20 mA DC.
		PTC/NTC thermistor input	(1) Connects PTC (Positive Temperature Coefficient)/NTC (Negative Temperature Coefficient) thermistor for motor protection. Ensure that the slide switch SW5 on the control PCB is turned to the PTC/NTC position (see Section 2.4.2 "Setting up the slide switches"). The figure shown at the right illustrates the internal circuit diagram where SW5 (switching the input of terminal [C1] between C1 and PTC/NTC) is turned to the PTC/NTC position. For details on SW5, refer to Section 2.4.2 "Setting up the slide switches." In this case, you must change data of the function code H26.  Figure 2.1 Internal Circuit Diagram (SW5 Selecting PTC/NTC)
	[V2]	Analog setting voltage input	(1) The frequency is commanded according to the external voltage input. • 0 to ±10 VDC/0 to ±100 % (Normal operation) • +10 to 0 VDC/0 to 100% (Inverse operation) (2) In addition to frequency setting, PID command, PID feedback signal, auxiliary frequency command setting, ratio setting, torque limiter level setting, or analog input monitor can be assigned to this terminal. (3) Hardware specifications • Input impedance: 22kΩ • The maximum input is ±15 VDC, however, the voltage higher than ±10 VDC is handled as ±10 VDC. • Inputting a bipolar analog voltage (0 to ±10 VDC) to terminal [V2] requires setting function code C45 to "0."
	[11]	Analog common	Common for analog input/output signals ([13], [12], [C1], [V2], [FM1] and [FM2]). Isolated from terminals [CM] and [CMY].
	Note		- Since low level analog signals are handled, these signals are especially susceptible to the external noise effects. Route the wiring as short as possible (within 66 ft (20 m)) and use shielded wires. In principle, ground the shielded sheath of wires; if effects of external inductive noises are considerable, connection to terminal [11] may be effective. As shown in Figure 2.2, be sure to ground the single end of the shield to enhance the shield effect. - Use a twin-contact relay for low level signals if the relay is used in the control circuit. Do not connect the relay's contact to terminal [11].

Classifi-cation	Symbol	Name	Functions

Note

- When the inverter is connected to an external device outputting the analog signal, the external device may malfunction due to electric noise generated by the inverter. If this happens, according to the circumstances, connect a ferrite core (a toroidal core or equivalent) to the device outputting the analog signal or connect a capacitor having the good cut-off characteristics for high frequency between control signal wires as shown in Figure 2.3.
- Do not apply a voltage of +7.5 VDC or higher to terminal [C1]. Doing so could damage the internal control circuit.

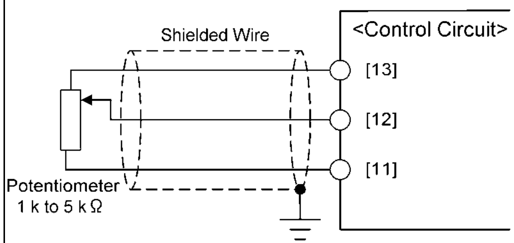


Figure 2.2 Connection of Shielded Wire

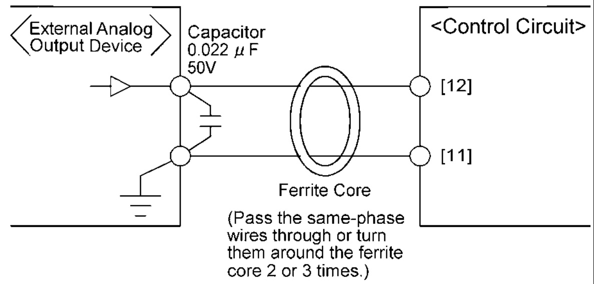


Figure 2.3 Example of Electric Noise Reduction

Classifi-cation	Symbol	Name
Digital input	[X1]	Digital input 1
	[X2]	Digital input 2
	[X3]	Digital input 3
	[X4]	Digital input 4
	[X5]	Digital input 5
	[X6]	Digital input 6
	[X7]	Digital input 7
	[FWD]	Run forward command
	[REV]	Run reverse command

(1) Various signals such as "Coast to a stop," "Enable external alarm trip," and "Select multi-frequency" can be assigned to terminals [X1] to [X7], [FWD] and [REV] by setting function codes E01 to E07, E98, and E99. For details, refer to Chapter 5, Section 5.4 "Details of Function Codes."

(2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to Section 2.4.2, "Setting up the slide switches.") The factory default is SINK.

(3) Switches the logic value (1/0) for ON/OFF of the terminals [X1] to [X7], [FWD], and [REV]. If the logic value for ON of the terminal [X1] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.

(4) Digital input terminal [X7] can be defined as a pulse train input terminal with the function codes.

Maximum wiring length 66 ft (20 m)

Maximum input pulse 30 kHz: When connected to a pulse generator with open collector transistor output (Needs a pull-up or pull-down resistor. See notes on page 2-24.)

100 kHz: When connected to a pulse generator with complementary transistor output

For the settings of the function codes, refer to Chapter 5 "FUNCTION CODES."

(Digital input circuit specifications)

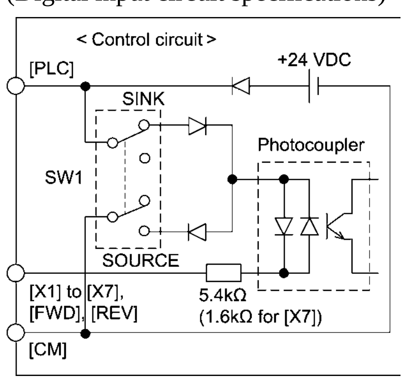
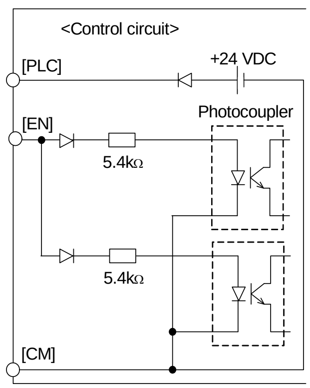
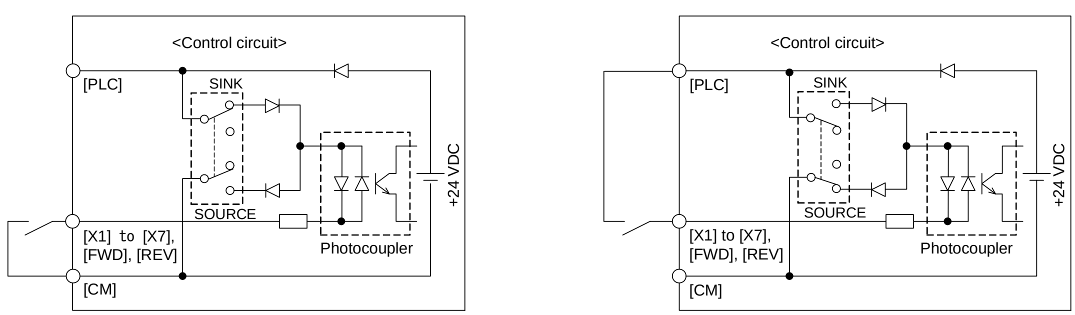


Figure 2.4 Digital Input Circuit

Item		Min.	Max.
Operating voltage (SINK)	ON level	0 V	2 V
	OFF level	22 V	27 V
Operating voltage (SOURCE)	ON level	22 V	27 V
	OFF level	0 V	2 V
Operating current at ON (Input voltage is at 0 V) (For [X7])		2.5 mA (9.7 mA)	5 mA (16 mA)
Allowable leakage current at OFF		–	0.5 mA

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="4">Digital input</td><td>[EN]</td><td>Enable input</td><td>
(1) This terminal has the Safe Torque Off (STO) function that is compliant with EN954-1, Category 3. It allows the hardware circuit to stop the inverter's output transistors and coast the motor to a stop.
(2) This terminal is exclusively used for the source mode input. When it is short-circuited with terminal [PLC], the Enable input is ON (ready for inverter run); when it is opened, the inverter coasts the motor to a stop. (This terminal is not interlocked with the slide switch SW1.)
(3) By factory default, terminals [EN] and [PLC] are short-circuited with each other using a jumper wire, disabling this function. To enable it, be sure to remove the jumper wire.
For details of connection to this terminal and precautions, refer to FRENIC-MEGA Instruction Manual, Chapter 9, Section 9.4 "Compliance with EN954-1, Category 3."
<Terminal [EN] circuit specification>


<table>
<tr><th colspan="2">Item</th><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage (SOURCE)</td><td>ON level</td><td>22 V</td><td>27 V</td></tr>
<tr><td>OFF level</td><td>0 V</td><td>2 V</td></tr>
<tr><td colspan="2">Operating current at ON (Input voltage is at 24 V)</td><td>5 mA</td><td>10 mA</td></tr>
<tr><td colspan="2">Allowable leakage current at OFF</td><td>–</td><td>0.5 mA</td></tr>
</table>
</td></tr>
<tr><td>[PLC]</td><td>PLC signal power</td><td>
(1) Connects to PLC output signal power supply.
Rated voltage: +24 VDC (Allowable range: +22 to +27 VDC), Maximum 100 mA DC
(2) This terminal also supplies a power to the load connected to the transistor output terminals. Refer to "Transistor output" described later in this table for more.
</td></tr>
<tr><td>[CM]</td><td>Digital input common</td><td>
Two common terminals for digital input signals
These terminals are electrically isolated from the terminals [11]s and [CMY].
</td></tr>
<tr><td colspan="3">
Tip
■ Using a relay contact to turn [X1] to [X7], [FWD], and [REV] ON or OFF
Figure 2.5 shows two examples of a circuit that uses a relay contact to turn control signal inputs [X1] to [X7], [FWD], and [REV] ON or OFF. In circuit (a), the slide switch SW1 is turned to SINK, whereas in circuit (b) it is turned to SOURCE.
Note: To configure this kind of circuit, use a highly reliable relay.


(a) With the switch turned to SINK   (b) With the switch turned to SOURCE
Figure 2.5 Circuit Configuration Using a Relay Contact
</td></tr>
</table>

Classification	Symbol	Name	Functions

Digital input

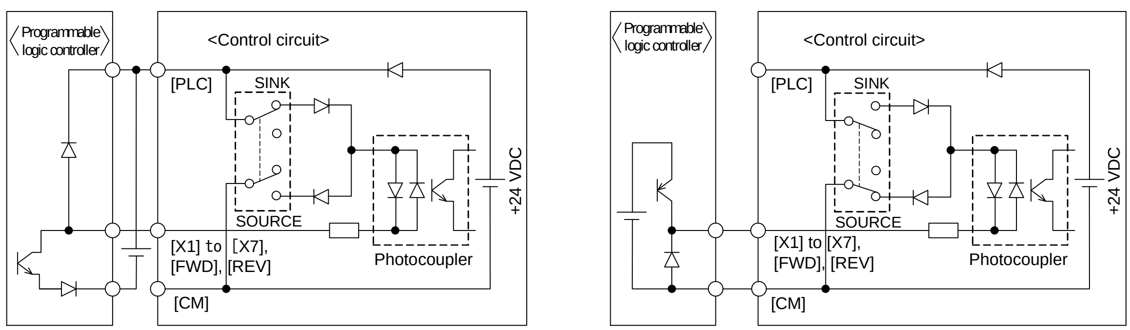
Tip

■ Using a programmable logic controller (PLC) to turn [X1] to [X7], [FWD], and [REV] ON or OFF

Figure 2.6 shows two examples of a circuit that uses a programmable logic controller (PLC) to turn control signal inputs [X1] to [X7], [FWD], and [REV] ON or OFF. In circuit (a), the slide switch SW1 is turned to SINK, whereas in circuit (b) it is turned to SOURCE.

In circuit (a) below, short-circuiting or opening the transistor's open collector circuit in the PLC using an external power supply turns control signals [X1] to [X7], [FWD], and [REV] ON or OFF. When using this type of circuit, observe the following:

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



(a) With the switch turned to SINK

(b) With the switch turned to SOURCE

Figure 2.6 Circuit Configuration Using a PLC

For details about the slide switch setting, refer to Section 2.4.2 "Setting up the slide switches."

Note

■ For inputting a pulse train through the digital input terminal [X7]

• Inputting from a pulse generator with an open collector transistor output

Stray capacity on the wiring between the pulse generator and the inverter may disable transmission of the pulse train. As a countermeasure against this problem, insert a pull-up resistor between the open collector output signal (terminal [X7]) and the power source terminal (terminal [PLC]) if the switch selects the SINK mode input; insert a pull-down resistor between the output signal and the digital common terminal (terminal [CM]) if the switch selects the SOURCE mode input.

A recommended pull-up/down resistor is 1kΩ 2 W. Check if the pulse train is correctly transmitted because stray capacity is significantly affected by the wire types and wiring conditions.

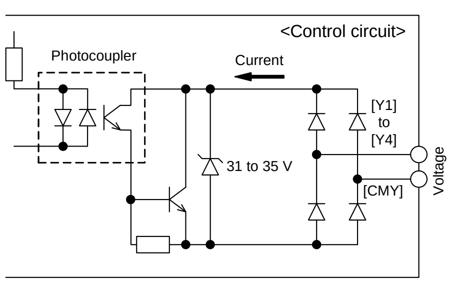
<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="2">Analog output</td><td>[FM1]
[FM2]</td><td>Analog monitor</td><td>Both terminals output monitor signals for analog DC voltage (0 to +10 V) or analog DC current (+4 to +20 mA). The output form (VO/IO) for each of [FM1] and [FM2] can be switched with the slide switches on the control PCB and the function codes, as listed below.
<table>
<tr><th rowspan="2">Terminal</th><th rowspan="2">Terminal function is specified by:</th><th colspan="2">Output form</th><th rowspan="2">Content is specified by:</th></tr>
<tr><th>Analog DC voltage</th><th>Analog DC current</th></tr>
<tr><td rowspan="2">[FM1]</td><td>Slide switch SW4</td><td>VO1</td><td>IO1</td><td rowspan="2">Function code F31</td></tr>
<tr><td>Function code F29</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">[FM2]</td><td>Slide switch SW6</td><td>VO2</td><td>IO2</td><td rowspan="2">Function code F35</td></tr>
<tr><td>Function code F32</td><td>0</td><td>1</td></tr>
</table>
The signal content can be selected from the following with function codes F31 and F35.
• Output frequency • Output current • Output voltage
• Output torque • Load factor • Input power
• PID feedback amount • Speed (PG feedback value) • DC link bus voltage
• Universal AO • Motor output • Calibration
• PID command • PID output, etc.
* Input impedance of the external device: Min. 5kΩ (at 0 to 10 VDC output)
(While the terminal is outputting 0 to 10 VDC, it is capable of driving up to two analog voltmeters with 10 kΩ impedance.)
* Input impedance of the external device: Max. 500Ω (at 4 to 20 mA DC output)
* Adjustable range of the gain: 0 to 300%</td></tr>
<tr><td>[11]</td><td>Analog common</td><td>Two common terminals for analog input and output signals.
These terminals are electrically isolated from terminals [CM] and [CMY].</td></tr>
<tr><td rowspan="4">Transistor output</td><td>[Y1]</td><td>Transistor output 1</td><td rowspan="4">(1) Various signals such as inverter running, speed/freq. arrival and overload early warning can be assigned to any terminals, [Y1] to [Y4] by setting function code E20 to E24. Refer to Chapter 5, Section 5.4 "Details of Function Codes" for details.
(2) Switches the logic value (1/0) for ON/OFF of the terminals between [Y1] to [Y4], and [CMY]. If the logic value for ON between [Y1] to [Y4] and [CMY] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.
(Transistor output circuit specification)


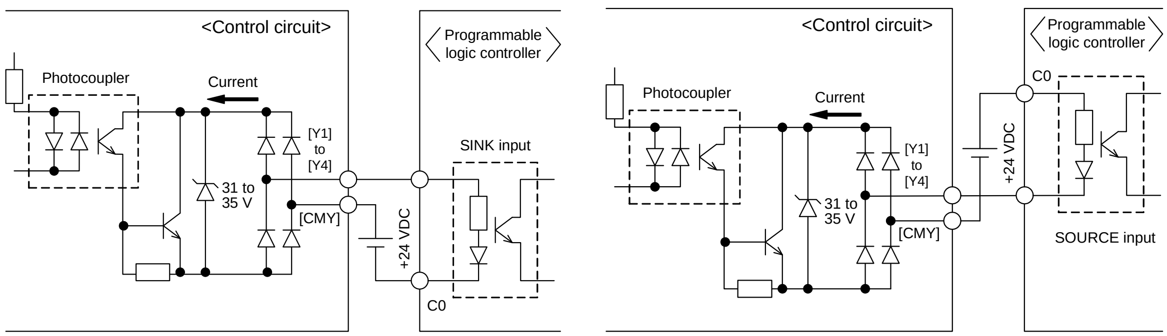
Figure 2.7 Transistor Output Circuit
<table>
<tr><th colspan="2">Item</th><th>Max.</th></tr>
<tr><td rowspan="2">Operation voltage</td><td>ON level</td><td>2 V</td></tr>
<tr><td>OFF level</td><td>27 V</td></tr>
<tr><td colspan="2">Maximum current at ON</td><td>50 mA</td></tr>
<tr><td colspan="2">Leakage current at OFF</td><td>0.1 mA</td></tr>
</table>
Figure 2.8 shows examples of connection between the control circuit and a PLC.
Note
- When a transistor output drives a control relay, connect a surge-absorbing diode across relay's coil terminals.
- When any equipment or device connected to the transistor output needs to be supplied with DC power, feed the power (+24 VDC: allowable range: +22 to +27 VDC, 100 mA max.) through the [PLC] terminal. Short-circuit between the terminals [CMY] and [CM] in this case.</td></tr>
<tr><td>[Y2]</td><td>Transistor output 2</td></tr>
<tr><td>[Y3]</td><td>Transistor output 3</td></tr>
<tr><td>[Y4]</td><td>Transistor output 4</td></tr>
</table>

Classification	Symbol	Name	Functions
Transistor output	[CMY]	Transistor output common	Common terminal for transistor output signals This terminal is electrically isolated from terminals [CM] and [11]s.

Tip

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

Figure 2.8 shows two examples of circuit connection between the transistor output of the inverter's control circuit and a PLC. In example (a), the input circuit of the PLC serves as a SINK for the control circuit output, whereas in example (b), it serves as a SOURCE for the output.

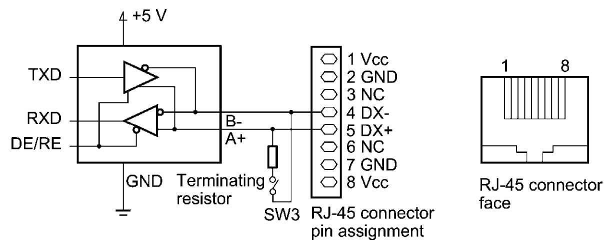


(a) PLC serving as SINK

(b) PLC serving as SOURCE

Figure 2.8 Connecting PLC to Control Circuit

Classification	Symbol	Name	Functions
Relay output	[Y5A/C]	General purpose relay output	(1) A general-purpose relay contact output usable as well as the function of the transistor output terminal [Y1], [Y2], [Y3] or [Y4]. Contact rating: 250 VAC 0.3 A, cos ϕ = 0.3, 48 VDC, 0.5 A (2) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Active ON" (Terminals [Y5A] and [Y5C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [Y5A] and [Y5C] are opened (non-excited) if the signal is active while they are normally closed.).
	[30A/B/C]	Alarm relay output (for any error)	(1) Outputs a contact signal (SPDT) when a protective function has been activated to stop the motor. Contact rating: 250 VAC 0.3 A, cos ϕ = 0.3, 48 VDC, 0.5 A (2) Any one of output signals assigned to terminals [Y1] to [Y4] can also be assigned to this relay contact to use it for signal output. (3) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Active ON" (Terminals [30A] and [30C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [30A] and [30C] are opened (non-excited) if the signal is active while they are normally closed.).

Classification	Symbol	Name	Functions
Communication	[DX+]/ [DX-]/ [SD]	RS-485 communications port 2 (Terminals on control PCB)	A communications port transmits data through the RS-485 multipoint protocol between the inverter and a computer or other equipment such as a PLC. (For setting of the terminating resistor, refer to Section 2.4.2 "Setting up the slide switches.")
	RJ-45 connector for the keypad	RS-485 communications port 1 (Standard RJ-45 connector)	(1) Used to connect the inverter with the keypad. The inverter supplies the power to the keypad through the pins specified below. The extension cable for remote operation also uses wires connected to these pins for supplying the keypad power. (2) Remove the keypad from the standard RJ-45 connector and connect the RS-485 communications cable to control the inverter through the PC or PLC (Programmable Logic Controller). For setting of the terminating resistor, refer to Section 2.4.2 "Setting up the slide switches."  Figure 2.9 RJ-45 Connector and its Pin Assignment* * Pins 1, 2, 7, and 8 are exclusively assigned to power lines for the keypad, so do not use those pins for any other equipment.
	USB connector	USB port (On the optional remote keypad TP-E1U)	A USB port connector (mini B) that connects an inverter to a computer. FRENIC Loader (software) running on the computer supports editing the function codes, transferring them to the inverter, verifying them, test-running an inverter and monitoring the inverter running status. **Note:** The standard keypad has no USB port.

Wiring for control circuit terminals

For FRN125G1S-2U, FRN150G1S-2U and FRN250G1S-4U to FRN1000G1S-4U

(1) As shown in Figure 2.10, route the control circuit wires along the left side panel to the outside of the inverter.

(2) Secure those wires to the wiring support, using a cable tie (e.g., Insulok) with 0.15 inch (3.8 mm) or less in width and 0.059 inch (1.5 mm) or less in thickness.

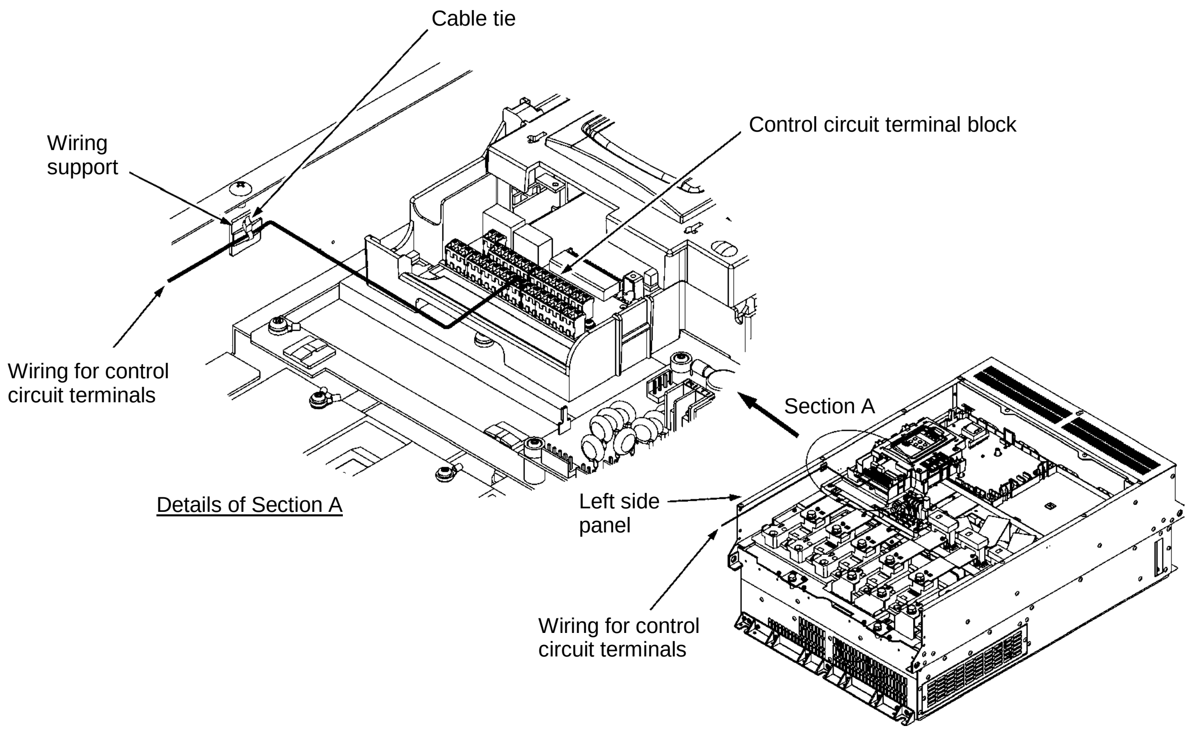


Figure 2.10 Wiring Route and Fixing Position for the Control Circuit Wires

Note

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

2.4.2 Setting up the slide switches

WARNING

Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters of 40 HP or below, or at least ten minutes for those of 50 HP or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

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

Switching the slide switches located on the control PCB allows you to customize the operation mode of the analog output terminals, digital I/O terminals, and communications ports. The locations of those switches are shown in Figure 2.11.

To access the slide switches, remove the front cover so that you can see the control PCB. For inverters of 50 HP or above, open also the keypad enclosure.

For details on how to remove the front cover and how to open and close the keypad enclosure, refer to FRENIC-MEGA Instruction Manual, Section 2.3.1 "Removing and mounting the front cover and the wiring guide."

Table 2.1 lists function of each slide switch.

Table 2.1 Function of Each Slide Switch

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SW1</td><td>Switches the service mode of the digital input terminals between SINK and SOURCE.
▪ This switches the input mode of digital input terminals [X1] to [X7], [FWD] and [REV] to be used as the SINK or SOURCE mode.
▪ The factory default is SINK.</td></tr>
<tr><td>SW2</td><td>Switches the terminating resistor of RS-485 communications port on the inverter ON and OFF. (RS-485 communications port 2, on the control PCB)
▪ If the inverter is connected to the RS-485 communications network as a terminating device, turn SW2 to ON.</td></tr>
<tr><td>SW3</td><td>Switches the terminating resistor of RS-485 communications port on the inverter ON and OFF. (RS-485 communications port 1, for connecting the keypad)
▪ To connect a keypad to the inverter, turn SW3 to OFF. (Factory default)
▪ If the inverter is connected to the RS-485 communications network as a terminating device, turn SW3 to ON.</td></tr>
<tr><td>SW4/SW6</td><td>Switches the output form of analog output terminals [FM1] and [FM2] between voltage and current.
When changing the setting of SW4 and SW6, also change the data of function codes F29 and F32, respectively.
<table>
<tr><th rowspan="2">Output form</th><th colspan="2">[FM1]</th><th colspan="2">[FM2]</th></tr>
<tr><th>SW4</th><th>F29 data</th><th>SW6</th><th>F32 data</th></tr>
<tr><td>Voltage output (Factory default)</td><td>VO1</td><td>0</td><td>VO2</td><td>0</td></tr>
<tr><td>Current output</td><td>IO1</td><td>1</td><td>IO2</td><td>1</td></tr>
</table></td></tr>
<tr><td>SW5</td><td>Switches the property of the analog input terminal [C1] between analog setting current input, PTC thermistor input, and NTC thermistor input.
When changing this switch setting, also change the data of function code H26.
<table>
<tr><th>Function</th><th>SW5</th><th>H26 data</th></tr>
<tr><td>Analog setting current input (Factory default)</td><td>C1</td><td>0</td></tr>
<tr><td>PTC thermistor input</td><td>PTC/NTC</td><td>1 (alarm) or 2 (warning)</td></tr>
<tr><td>NTC thermistor input</td><td>PTC/NTC</td><td>3</td></tr>
</table></td></tr>
</table>

Figure 2.11 shows the location of slide switches on the control PCB for the input/output terminal configuration.

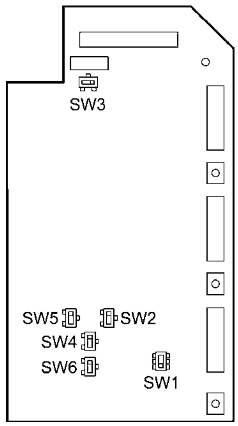


Figure 2.11 Location of the Slide Switches on the Control PCB

Switch Configuration and Factory Defaults

	SW1	SW2	SW3	SW4/SW6	SW5
Factory default	SINK	OFF	OFF	VO1/VO2	C1
---	SOURCE	ON	ON	IO1/IO2	PTC/NTC

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

2.4.3 Terminal arrangement and screw specifications

2.4.3.1 Main circuit terminals

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

Use crimp terminals covered with an insulation sheath or with an insulation tube.

The recommended wires for main circuit terminals are selected according to the sizes conforming to UL508C.

Table 2.2 (1) Screw Specifications

<table>
<tr><th colspan="2">Inverter type</th><th rowspan="3">Refer to:</th><th colspan="8">Screw specifications</th></tr>
<tr><th rowspan="2">Three-phase
230 V</th><th rowspan="2">Three-phase
460 V</th><th colspan="2">Main circuit terminals</th><th colspan="2">Grounding terminals</th><th colspan="2">Auxiliary control power input terminals [R0, T0]</th><th colspan="2">Auxiliary fan power input terminals [R1, T1]</th></tr>
<tr><th>Screw size</th><th>Tightening torque lb-in (N·m)</th><th>Screw size</th><th>Tightening torque lb-in (N·m)</th><th>Screw size</th><th>Tightening torque lb-in (N·m)</th><th>Screw size</th><th>Tightening torque lb-in (N·m)</th></tr>
<tr><td>FRNF50G1S-2U</td><td>FRNF50G1S-4U</td><td rowspan="2">Figure A</td><td rowspan="2">M3.5</td><td rowspan="2">10.6 (1.2)</td><td rowspan="2">M3.5</td><td rowspan="2">10.6 (1.2)</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="16">--</td><td rowspan="16">--</td></tr>
<tr><td>FRN001G1S-2U</td><td>FRN001G1S-4U</td></tr>
<tr><td>FRN002G1S-2U</td><td>FRN002G1S-4U</td><td rowspan="3">Figure B</td><td rowspan="3">M4</td><td rowspan="3">15.9 (1.8)</td><td rowspan="3">M4</td><td rowspan="3">15.9 (1.8)</td><td rowspan="30">M3.5</td><td rowspan="30">10.6 (1.2)</td></tr>
<tr><td>FRN003G1S-2U</td><td>FRN003G1S-4U</td></tr>
<tr><td>FRN005G1S-2U</td><td>FRN005G1S-4U</td></tr>
<tr><td>FRN007G1■-2U</td><td>FRN007G1■-4U</td><td rowspan="4">Figure C</td><td rowspan="4">M5</td><td rowspan="4">31.0 (3.5)</td><td rowspan="4">M5</td><td rowspan="4">31.0 (3.5)</td></tr>
<tr><td>FRN010G1■-2U</td><td>FRN010G1■-4U</td></tr>
<tr><td>FRN015G1■-2U</td><td>FRN015G1■-4U</td></tr>
<tr><td>FRN020G1■-2U</td><td>FRN020G1■-4U</td></tr>
<tr><td>FRN025G1■-2U</td><td>FRN025G1■-4U</td><td rowspan="3">Figure D</td><td rowspan="3">M6</td><td rowspan="3">51.3 (5.8)</td><td rowspan="3">M6</td><td rowspan="3">51.3 (5.8)</td></tr>
<tr><td>FRN030G1■-2U</td><td>FRN030G1■-4U</td></tr>
<tr><td>FRN040G1■-2U</td><td>FRN040G1■-4U</td></tr>
<tr><td rowspan="4">FRN050G1■-2U</td><td>FRN050G1■-4U</td><td rowspan="4">Figure E</td><td rowspan="4">M8</td><td rowspan="4">119 (13.5)</td><td rowspan="9">M8</td><td rowspan="9">119 (13.5)</td></tr>
<tr><td>FRN060G1■-4U</td></tr>
<tr><td>FRN075G1■-4U</td></tr>
<tr><td>FRN100G1■-4U</td></tr>
<tr><td>FRN060G1■-2U</td><td rowspan="3">FRN125G1S-4U</td><td rowspan="3">Figure F</td><td rowspan="5">M10</td><td rowspan="5">239 (27)</td><td rowspan="16">M3.5</td><td rowspan="16">10.6 (1.2)</td></tr>
<tr><td>FRN075G1■-2U</td></tr>
<tr><td>FRN100G1■-2U</td></tr>
<tr><td>--</td><td>FRN150G1S-4U</td><td rowspan="2">Figure G</td></tr>
<tr><td>--</td><td>FRN200G1S-4U</td></tr>
<tr><td>FRN125G1S-2U</td><td>--</td><td>Figure M</td><td rowspan="11">M12</td><td rowspan="11">425 (48)</td><td rowspan="11">M10</td><td rowspan="11">239 (27)</td></tr>
<tr><td>--</td><td>FRN250G1S-4U</td><td rowspan="2">Figure H</td></tr>
<tr><td>--</td><td>FRN300G1S-4U</td></tr>
<tr><td rowspan="2">FRN150G1S-2U</td><td>FRN350G1S-4U</td><td rowspan="2">Figure I</td></tr>
<tr><td>FRN450G1S-4U</td></tr>
<tr><td>--</td><td>FRN500G1S-4U</td><td rowspan="2">Figure J</td></tr>
<tr><td>--</td><td>FRN600G1S-4U</td></tr>
<tr><td>--</td><td>FRN700G1S-4U</td><td rowspan="2">Figure K</td></tr>
<tr><td>--</td><td>FRN800G1S-4U</td></tr>
<tr><td>--</td><td>FRN900G1S-4U</td><td rowspan="2">Figure L</td></tr>
<tr><td>--</td><td>FRN1000G1S-4U</td></tr>
</table>

Note: A box (■) in the above table replaces S or H depending on the enclosure.

⚠WARNING⚠

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

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

Insulation level

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

An electric shock may occur.

Unit: inch (mm)

Figure A

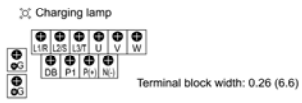


Figure B

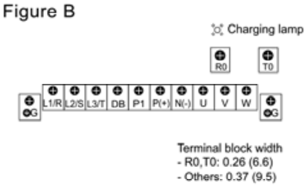


Figure C

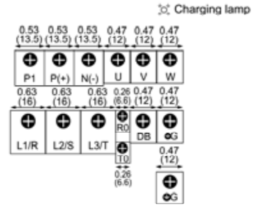


Figure D

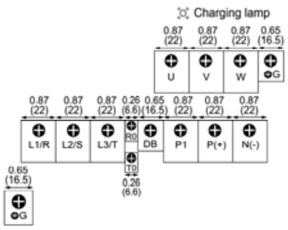


Figure E

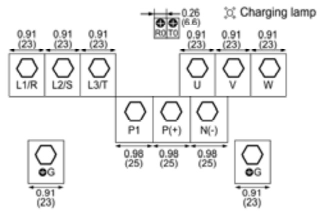


Figure F / Figure G

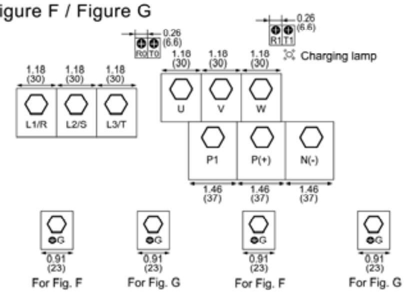


Figure H / Figure I

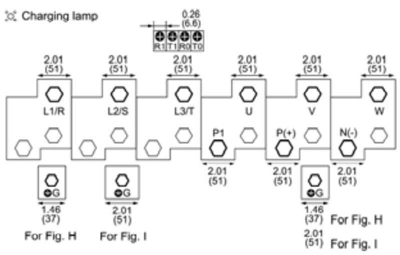


Figure J

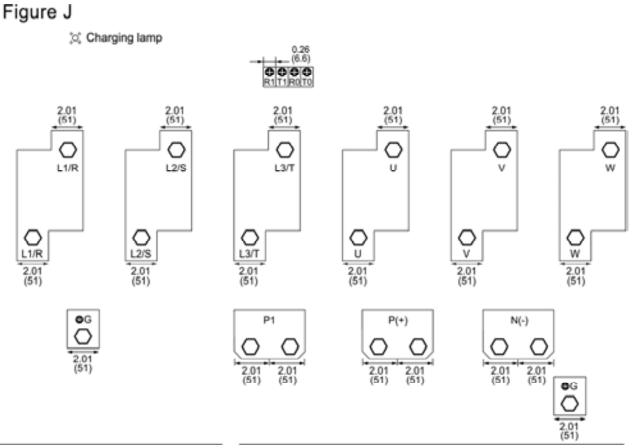


Figure K

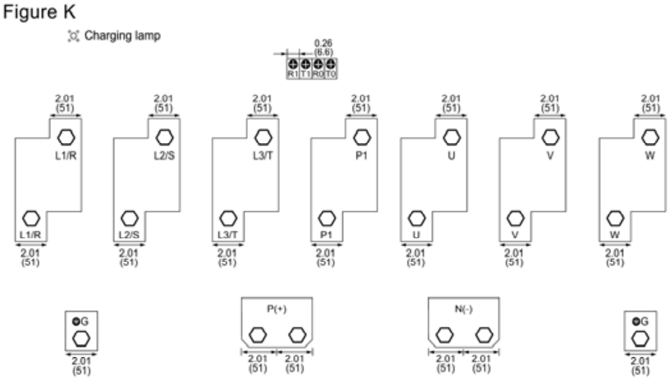


Figure M

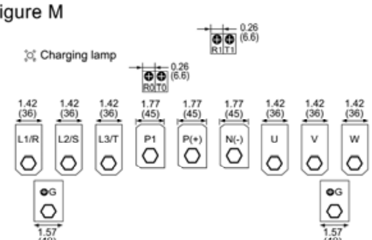


Figure L

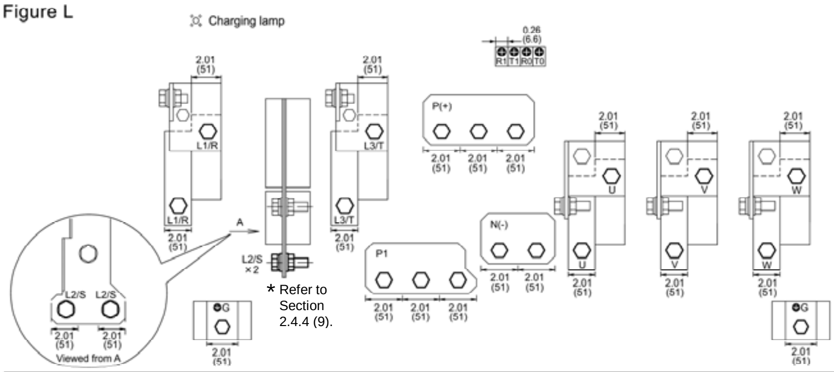


Table 2.2 (2) Recommended Wire Sizes

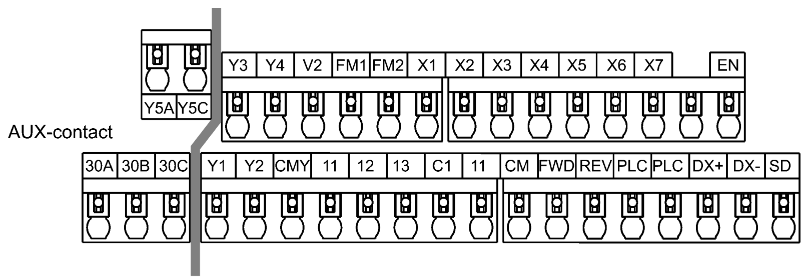
Power supply voltage	Inverter type: LD mode	Inverter type: MD mode	Inverter type: HD mode	Recommended wire size AWG (mm²): L1/R, L2/S, L3/T	Grounding [⏚G]	U, V, W	DCR [P1, P(+)]	Braking resistor [P(+), DB]
Single-phase/ Three-phase 230V	FRNF50G1S-2U	--	FRNF50G1S-2U	14 (2.1)	14 (2.1)	14 (2.1)	14 (2.1)	10 (5.3)
	FRN001G1S-2U	--	FRN001G1S-2U					
	FRN002G1S-2U	--	FRN002G1S-2U		12 (3.3)			
	FRN003G1S-2U	--	FRN003G1S-2U		10 (5.3)			
	FRN005G1S-2U	--	FRN005G1S-2U	10 (5.3)		12 (3.3)	10 (5.3)	
	FRN007G1■-2U	--	FRN007G1■-2U	8 (8.4)		8 (8.4)	8 (8.4)	
	--	--	FRN010G1■-2U					
	FRN010G1■-2U	--	--		8 (8.4)			
	--	--	FRN015G1■-2U					
	FRN015G1■-2U	--	FRN020G1■-2U	6 (13.3)			4 (21.2)	
	FRN020G1■-2U	--	FRN025G1■-2U	4 (21.2)	6 (13.3)	6 (13.3)	3 (26.7)	
	FRN025G1■-2U	--	FRN030G1■-2U	3 (26.7)		4 (21.2)	2 (33.6)	
	FRN030G1■-2U	--	FRN040G1■-2U	2 (33.6)		3 (26.7)	1 (42.4)	
	FRN040G1■-2U	--	--	2/0 (67.4)	4 (21.2)	2 (33.6)	2/0 (67.4)	
	--	--	FRN050G1■-2U			1 (42.4)		--
	FRN050G1■-2U	--	--	3/0 (85)	3 (26.7)	1/0 (53.5)	4/0 (107.2)	
	--	--	FRN060G1■-2U			4/0 (107.2)		
	FRN060G1■-2U	--	FRN075G1■-2U	4/0 (107.2)			250 (127)	
	FRN075G1■-2U	--	FRN100G1■-2U	2/0 (67.4) × 2	2 (33.6)		350 (177)	
	FRN100G1■-2U	--	FRN125G1S-2U	3/0 (85) × 2		3/0 (85) × 2		
	FRN125G1S-2U	--	FRN150G1S-2U	4/0 (107.2) × 2	1 (42.4)	4/0 (107.2) × 2	500 (253)	
	FRN150G1S-2U	--	--	300 (152) × 2	1/0 (53.5)	300 (152) × 2	4/0 (107.2) × 2	
Single-phase/ Three-phase 460V	FRNF05G1S-4U	--	FRNF05G1S-4U	14 (2.1)	14 (2.1)	14 (2.1)	14 (2.1)	10 (5.3)
	FRN001G1S-4U	--	FRN001G1S-4U					
	FRN002G1S-4U	--	FRN002G1S-4U					
	FRN003G1S-4U	--	FRN003G1S-4U					
	FRN005G1S-4U	--	FRN005G1S-4U		12 (3.3)			
	FRN007G1■-4U	--	FRN007G1■-4U	12 (3.3)	10 (5.3)	12 (3.3)	12 (3.3)	
	--	--	FRN010G1■-4U					
	FRN010G1■-4U	--	FRN015G1■-4U	10 (5.3)			10 (5.3)	
	FRN015G1■-4U	--	--	8 (8.4)		10 (5.3)	8 (8.4)	
	--	--	FRN020G1■-4U					
	FRN020G1■-4U	--	--		8 (8.4)	8 (8.4)		
	--	--	FRN025G1■-4U	6 (13.3)		6 (13.3)		
	FRN025G1■-4U	--	FRN030G1■-4U				6 (13.3)	
	FRN030G1■-4U	--	FRN040G1■-4U					
	FRN040G1■-4U	--	--	4 (21.2)	6 (13.3)		4 (21.2)	
	--	--	FRN050G1■-4U			2 (33.6)		--
	FRN050G1■-4U	--	FRN060G1■-4U	3 (26.7)			2 (33.6)	
	FRN060G1■-4U	--	FRN075G1■-4U	2 (33.6)			1 (42.4)	
	FRN075G1■-4U	--	FRN100G1■-4U	1/0 (53.5)	4 (21.2)		1/0 (53.5)	
	FRN100G1■-4U	--	--			1/0 (53.5)		
	--	--	FRN125G1S-4U	2/0 (67.4)		4/0 (107.2)		
	FRN125G1S-4U	--	FRN150G1S-4U				3/0 (85)	
	FRN150G1S-4U	FRN150G1S-4U	FRN200G1S-4U	1/0 (53.5)	3 (26.7)	1/0 (53.5)	4/0 (107.2)	
	FRN200G1S-4U	FRN200G1S-4U	FRN250G1S-4U			2 (33.6)	250 (127)	
	FRN250G1S-4U	FRN250G1S-4U	FRN300G1S-4U	3/0 (85) × 2	2 (33.6)	3/0 (85) × 2	350 (177)	
	FRN300G1S-4U	FRN300G1S-4U	FRN350G1S-4U	4/0 (107.2) × 2	1 (42.4)	250 (127) × 2	600 (304)	
	FRN350G1S-4U	FRN350G1S-4U	FRN450G1S-4U	250 (127) × 2	1/0 (53.5)	300 (152) × 2	4/0 (107.2) × 2	
	--	FRN450G1S-4U	--	300 (152) × 2		350 (177) × 2	250 (127) × 2	
	FRN450G1S-4U	--	--	400 (203) × 2	2/0 (67.4)	400 (203) × 2	300 (152) × 2	
	--	--	FRN500G1S-4U	250 (127) × 2		300 (152) × 2		
	--	FRN500G1S-4U	FRN600G1S-4U	300 (152) × 2		350 (177) × 2	350 (177) × 2	
	FRN500G1S-4U	FRN600G1S-4U	FRN700G1S-4U	400 (203) × 2	3/0 (85)	400 (203) × 2	400 (203) × 2	
	FRN600G1S-4U	FRN700G1S-4U	FRN800G1S-4U	500 (253) × 2		500 (253) × 2	500 (253) × 2	
	FRN700G1S-4U	FRN800G1S-4U	--	600 (304) × 2	4/0 (107.2)	600 (304) × 2	300 (152) × 3	
	FRN800G1S-4U	--	FRN900G1S-4U	350 (177) × 3		400 (203) × 3	400 (203) × 3	
	FRN900G1S-4U	--	FRN1000G1S-4U	500 (253) × 3	250 (127)	600 (304) × 3	600 (304) × 3	
	FRN1000G1S-4U	--	--	600 (304) × 3	350 (177)	500 (253) × 4	400 (203) × 4	

Note: A box (■) in the above table replaces S or H depending on the enclosure.
The wire sizes above are specified for 75°C (167°F) Cu wire.

Terminals common to all inverters	Recommended wire size AWG (mm^2)	Remarks
Auxiliary control power input terminals [R0] and [T0]	14 (2.1)	2 HP or above
Auxiliary fan power input terminals [R1] and [T1]		230 V series with 60 HP or above and 460 V series with 125 HP or above

2.4.3.2 Control circuit terminals (common to all inverter types)

The control circuit terminals are common to all inverter types regardless of their capacities.



Recommended wire size: AWG 19 or 18 (0.7 to 0.8 mm^2)*

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

2.4.4 Wiring precautions

Follow the rules below when performing wiring for the inverter.

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

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

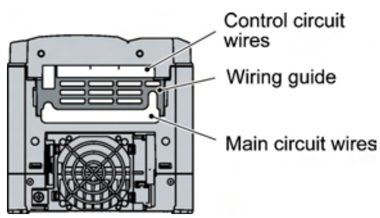
(3) Always connect the grounding terminal to prevent electric shock, fire or other disasters and to reduce electric noise.

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

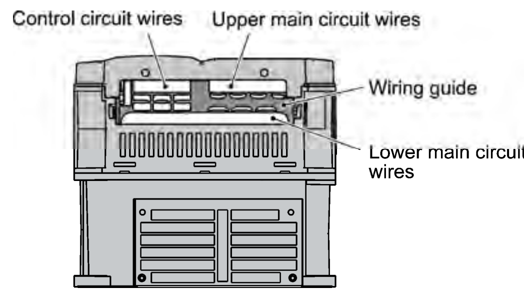
(5) Keep the power supply wiring (primary circuit) and motor wiring (secondary circuit) of the main circuit, and control circuit wiring as far away as possible from each other.

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

(7) Use the wiring guide to separate wiring. For inverters of 5 HP or below, the wiring guide separates the main circuit wires and the control circuit wires. For those of 7.5 to 40 HP, it separates the upper and lower main circuit wires, and control circuit wires. Be careful about the wiring order.



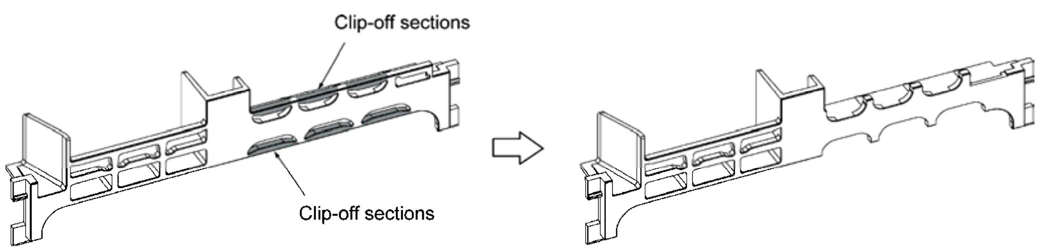
e.g. FRN005G1S-4U



e.g. FRN020G1S-4U

■ **Preparing for the wiring guide**

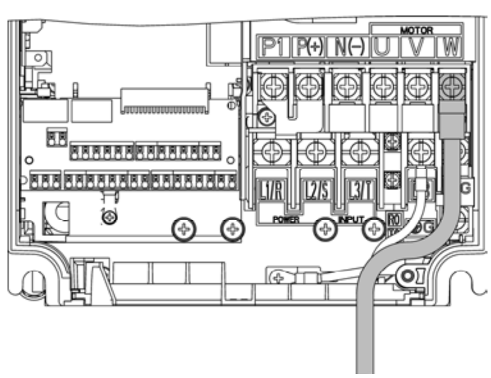
Inverters of 20 to 40 HP (three-phase, 230 V series) are sometimes lacking in wiring space for main circuit wires depending upon the wire materials used. To assure a sufficient wiring space, remove the clip-off sections (see below) as required with a nipper. Note that the enclosure rating of IP20 may not be ensured when the wiring guide itself is removed to secure a space for thick main circuit wiring.



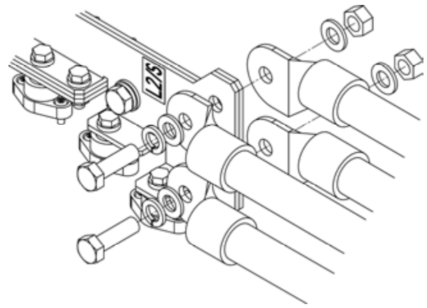
Before removal of clip-off sections　　After removal of clip-off sections

Wiring Guide (e.g. FRN025G1S-4U)

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



(9) For inverters of 900 and 1000 HP, two L2/S input terminals are arranged vertically to the terminal block. When connecting wires to these terminals, use the bolts, washers and nuts that come with the inverter, as shown below.



⚠WARNING

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

Otherwise, a fire could occur.

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

Doing so could cause a fire.

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

Otherwise, an electric shock or fire could occur.

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

Otherwise, electric shock could occur.

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

Otherwise, electric shock or injuries could occur.

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

Otherwise, a fire or an accident could occur.

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

Doing so could cause fire or an accident.

2.5 Operating Environment and Storage Environment

2.5.1 Operating environment

Install the inverter in an environment that satisfies the requirements listed in Table 2.3.

Table 2.3 Environmental Requirements

<table>
<tr><th>Item</th><th colspan="2">Specifications</th></tr>
<tr><td>Site location</td><td colspan="2">Indoors</td></tr>
<tr><td>Surrounding/ambient temperature</td><td colspan="2">-10 to +50°C (14 to 122°F) (Note 1)</td></tr>
<tr><td>Relative humidity</td><td colspan="2">5 to 95% (No condensation)</td></tr>
<tr><td>Atmosphere</td><td colspan="2">The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gases, oil mist, vapor or water drops.
Pollution degree 2 (IEC60664-1) (Note 2)
The atmosphere can contain a small amount of salt.
(0.01 mg/cm^2 or less per year)
The inverter must not be subjected to sudden changes in temperature that will cause condensation to form.</td></tr>
<tr><td>Altitude</td><td colspan="2">3300 ft (1000 m) max. (Note 3)</td></tr>
<tr><td>Atmospheric pressure</td><td colspan="2">86 to 106 kPa</td></tr>
<tr><td rowspan="2">Vibration</td><td>Inverters of
100 HP or below (230 V series)
125 HP or below (460 V series)</td><td>Inverters of
125 HP or above (230 V series)
150 HP or above (460 V series)</td></tr>
<tr><td>0.12 inch (3 mm) : 2 to less than 9 Hz
(Max. amplitude)
9.8 m/s^2 : 9 to less than 20 Hz
2 m/s^2 : 20 to less than 55 Hz
1 m/s^2 : 55 to less than 200 Hz</td><td>0.12 inch (3 mm) : 2 to less than 9 Hz
(Max. amplitude)
2 m/s^2 : 9 to less than 55 Hz
1 m/s^2 : 55 to less than 200 Hz</td></tr>
</table>

(Note 1) When inverters (40 HP or below) are mounted side-by-side without any clearance between them, the surrounding temperature should be within the range from -10 to +40°C (14 to 104°F). This specification also applies to the inverters (40 HP) equipped with a NEMA1 kit.

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

(Note 3) If you use the inverter in an altitude above 3300 ft (1000 m), you should apply an output current derating factor as listed in Table 2.4.

Table 2.4 Output Current Derating Factor in Relation to Altitude

Altitude	Output current derating factor
3300 ft (1000 m) or lower	1.00
3300 to 4900 ft (1000 to 1500 m)	0.97
4900 to 6600 ft (1500 to 2000 m)	0.95
6600 to 8200 ft (2000 to 2500 m)	0.91
8200 to 9800 ft (2500 to 3000 m)	0.88

2.5.2 Storage environment

2.5.2.1 Temporary storage

Store the inverter in an environment that satisfies the requirements listed below.

Table 2.5 Storage and Transport Environments

Item	Specifications	
Storage temperature *1	-25 to +70°C (-13 to +158°F)	Places not subjected to abrupt temperature changes or condensation or freezing
Relative humidity	5 to 95% *2	
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm^2 or less per year)	
Atmospheric pressure	86 to 106 kPa (during storage)	
	70 to 106 kPa (during transportation)	

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

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

Precautions for temporary storage

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

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

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

2.5.2.2 Long-term storage

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

(1) The storage site must satisfy the requirements specified for temporary storage.
However, for storage exceeding three months, the surrounding temperature range should be within the range from -10 to 30°C (14 to 86°F). This is to prevent electrolytic capacitors in the inverter from deterioration.

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

(3) If the inverter has been installed to the equipment or panel at construction sites where it may be subjected to humidity, dust or dirt, then temporarily remove the inverter and store it in the environment specified in Table 2.5.

Precautions for storage over 1 year

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

2.6 Precautions for Using Inverters

2.6.1 Precautions in introducing inverters

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

■ Installation environment

Install the inverter in an environment that satisfies the requirements listed in Table 2.3 in Section 2.5.1.

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

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

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

Environments	Possible problems	Sample measures	Applications
Highly concentrated sulfidizing gas or other corrosive gases	Corrosive gases cause parts inside the inverter to corrode, resulting in an inverter malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel with IP6X or air-purge mechanism. - Place the panel in a room free from influence of the gases.	Paper manufacturing, sewage disposal, sludge treatment, tire manufacturing, metal processing, and a particular process in textile factories.
A lot of conductive dust or foreign material (e.g., metal powders or shavings, carbon fibers, or carbon dust)	Entry of conductive dust into the inverter causes a short circuit.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel. - Place the panel in a room free from influence of the conductive dust.	Wiredrawing machines, metal processing, extruding machines, printing presses, combustors, and industrial waste treatment.
A lot of fibrous or paper dust	Fibrous or paper dust accumulated on the heat sink lowers the cooing effect. Entry of dust into the inverter causes the electronic circuitry to malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel that shuts out dust. - Ensure a maintenance space for periodical cleaning of the heat sink in panel engineering design. - Employ external cooling when mounting the inverter in a panel for easy maintenance and perform periodical maintenance.	Textile manufacturing and paper manufacturing.
High humidity or dew condensation	In an environment where a humidifier is used or where the air conditioner is not equipped with a dehumidifier, high humidity or dew condensation results, which causes a short-circuiting or malfunction of electronic circuitry inside the inverter.	- Put a heating module such as a space heater in the panel.	Outdoor installation. Film manufacturing line, pumps and food processing.

Environments	Possible problems	Sample measures	Applications
Vibration or shock exceeding the specified level	If a large vibration or shock exceeding the specified level is applied to the inverter, for example, due to a carrier running on seam joints of rails or blasting at a construction site, the inverter structure gets damaged.	- Insert shock-absorbing materials between the mounting base of the inverter and the panel for safe mounting.	Installation of an inverter panel on a carrier or self-propelled machine. Ventilating fan at a construction site or a press machine.
Fumigation for export packaging	Halogen compounds such as methyl bromide used in fumigation corrodes some parts inside the inverter.	- When exporting an inverter built in a panel or equipment, pack them in a previously fumigated wooden crate. When packing an inverter alone for export, use a laminated veneer lumber (LVL).	Exporting.

■ Wiring precautions

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

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

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

(4) Drive output terminals (U, V, W)

1) Connect these terminals to a 3-phase motor in the correct phase sequence. If the direction of motor rotation is incorrect, exchange any two of the U, V, and W phases.

2) Do not connect a power factor correction capacitor or surge absorber to the inverter output.

3) If the cable from the inverter to the motor is very long, a high-frequency current may be generated by stray capacitance between the cables and result in an overcurrent trip of the inverter, an increase in leakage current, or a reduction in current indication precision.

When a motor is driven by a PWM-type inverter, the motor terminals may be subject to surge voltage generated by inverter element switching. If the motor cable (with 460 V series motors, in particular) is particularly long, surge voltage will deteriorate motor insulation. To prevent this, use the following guidelines:

Inverter 7.5 HP and larger			
Motor Insulation Level	1000 V	1300 V	1600 V
460 VAC Input Voltage	66 ft (20 m)	328 ft (100 m)	1312 ft (400 m)*
230 VAC Input Voltage	1312 ft (400 m)*	1312 ft (400 m)*	1312 ft (400 m)*

Inverter 5 HP and smaller			
Motor Insulation Level	1000 V	1300 V	1600 V
460 VAC Input Voltage	66 ft (20 m)	165 ft (50 m)*	165 ft (50 m)*
230 VAC Input Voltage	328 ft (100 m)*	328 ft (100 m)*	328 ft (100 m)*

* For this case the cable length is determined by secondary effects and not voltage spiking.

Note

- When a motor protective thermal O/L relay is inserted between the inverter and the motor, the thermal O/L relay may malfunction (particularly in the 460 V series), even when the cable length is 165 ft (50 m) or less. To correct, insert a filter or reduce the carrier frequency. (Use function code F26 "Motor sound".)
- For the vector control mode, wiring length is 328 ft (100 m) or less.

(5) When an output circuit filter is inserted in the secondary circuit or the wiring between the inverter and the motor is long, a voltage loss occurs due to reactance of the filter or wiring so that the insufficient voltage may cause output current oscillation or a lack of motor output torque. To avoid it, select the constant torque load by setting the function code F37 (Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1) to "1" and keep the inverter output voltage at a higher level by configuring H50/H52 (Non-linear V/f Pattern, Frequency) and H51/H53 (Non-linear V/f Pattern, Voltage).

■ Precautions for connection of peripheral equipment

(1) Phase-advancing capacitors for power factor correction

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

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

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

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

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

If the input voltage unbalance rate is 2% to 3%, use an optional AC reactor (ACR).

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

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

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

DCR models	Input power factor	Remarks
DCR2/4-□□/□□A/□□B	Approx. 90% to 95%	The last letter identifies the capacitance.
DCR2/4-□□C	Approx. 86% to 90%	Exclusively designed for inverters of 50 HP or above.

Note For selecting DCR models, refer to Chapter 2 "SPECIFICATIONS."

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

Using a PWM converter (High power-factor, regenerative PWM converter, RHC series) corrects the inverter power factor up to nearly 100%. When combining an inverter with a PWM converter, disable the main power down detection by setting the function code H72 to "0." If the main power loss detection is enabled (H72 = 1 by factory default), the inverter interprets the main power as being shut down, ignoring an entry of a run command.

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

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

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

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

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

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

Tip

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

  When the sequence is employed, connecting the MC's primary power line to the inverter's auxiliary control power input makes it possible to monitor the inverter's alarm status on the keypad.
- The breakdown of a braking unit or misconnection of an external braking resistor may trigger that of the inverter's internal parts (e.g., charging resistor). To avoid such a breakdown linkage, introduce an MC and configure a sequence that shuts down the MC if a DC link voltage establishment signal is not issued within three seconds after the MC is switched on.
- For the braking transistor built-in type of inverters, assign a transistor error output signal ***DBAL*** on inverter's programmable output terminals to switch off the MC in the input circuit.

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

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

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

(8) Surge absorber/surge killer

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

■ Noise reduction

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

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

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

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

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

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

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

■ Leakage current

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

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

■ Selecting inverter capacity

(1) To drive a general-purpose motor, select an inverter according to the nominal applied motor rating listed in the standard specifications table. When high starting torque is required or quick acceleration or deceleration is required, select an inverter with one rank higher capacity than the standard.

(2) Special motors may have larger rated current than general-purpose ones. In such a case, select an inverter that meets the following condition.

Inverter rated current > Motor rated current

2.6.2 Precautions in running inverters

Precautions for running inverters to drive motors or motor-driven machinery are described below.

■ Motor temperature

When an inverter is used to run a general-purpose motor, the motor temperature becomes higher than when it is operated with a commercial power supply. In the low-speed range, the motor cooling effect will be weakened, so decrease the output torque of the motor when running the inverter in the low-speed range.

■ Motor noise

When a general-purpose motor is driven by an inverter, the noise level is higher than that when it is driven by a commercial power supply. To reduce noise, raise carrier frequency of the inverter. Operation at 60 Hz or higher can also result in higher noise level.

■ Machine vibration

When an inverter-driven motor is mounted to a machine, resonance may be caused by the natural frequencies of the motor-driven machinery. Driving a 2-pole motor at 60 Hz or higher may cause abnormal vibration. If it happens, do any of the following:

- Consider the use of a rubber coupling or vibration-proof rubber.
- Use the inverter's jump frequency control feature to skip the resonance frequency zone(s).
- Use the vibration suppression related function codes that may be effective. For details, refer to the description of H80 in Chapter 5 "FUNCTION CODES."

2.6.3 Precautions in using special motors

When using special motors, note the followings.

■ Explosion-proof motors

When driving an explosion-proof motor with an inverter, use a combination of a motor and an inverter that has been approved in advance.

■ Submersible motors and pumps

These motors have a larger rated current than general-purpose motors. Select an inverter whose rated output current is greater than that of the motor. These motors differ from general-purpose motors in thermal characteristics. Decrease the thermal time constant of the electronic thermal overload protection to match the motor rating.

■ Brake motors

For motors equipped with parallel-connected brakes, their power supply for braking must be supplied from the inverter input (primary) circuit. If the power supply for braking is mistakenly connected to the inverter's output (secondary) circuit, the brake may not work when the inverter output is shut down. Do not use inverters for driving motors equipped with series-connected brakes.

■ Geared motors

If the power transmission mechanism uses an oil-lubricated gearbox or speed changer/reducer, then continuous operation at low speed may cause poor lubrication. Avoid such operation.

■ Synchronous motors

It is necessary to take special measures suitable for this motor type. Contact your Fuji Electric representative for details.

■ Single-phase motors

Single-phase motors are not suitable for inverter-driven variable speed operation.

■ High-speed motors

If the reference frequency is set to 120 Hz or higher to drive a high-speed motor, test-run the combination of the inverter and motor beforehand to check it for the safe operation.

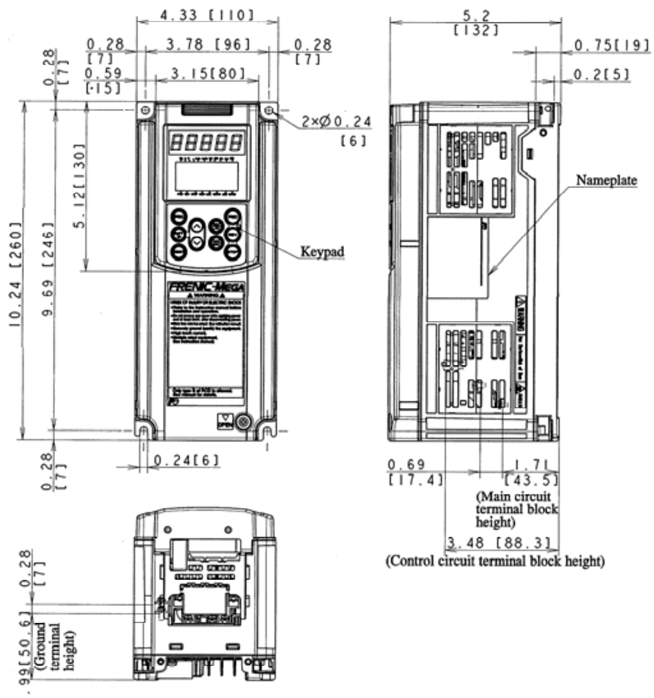
2.7 External Dimensions

2.7.1 Standard Inverter

The diagrams below show external dimensions of the FRENIC-MEGA series of inverters according to the inverter capacity. (Three-phase 230/460 V series)

Unit: inch [mm]

■ FRNF50G1S-2U/4U



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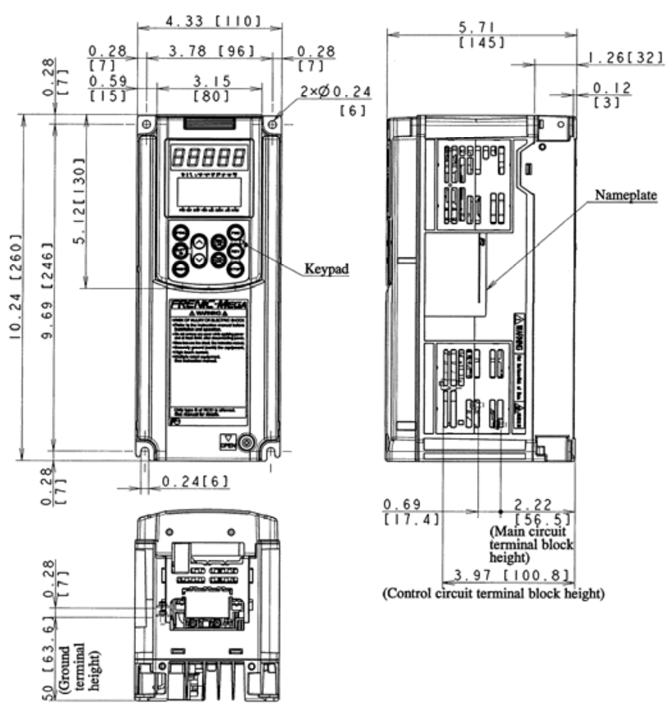
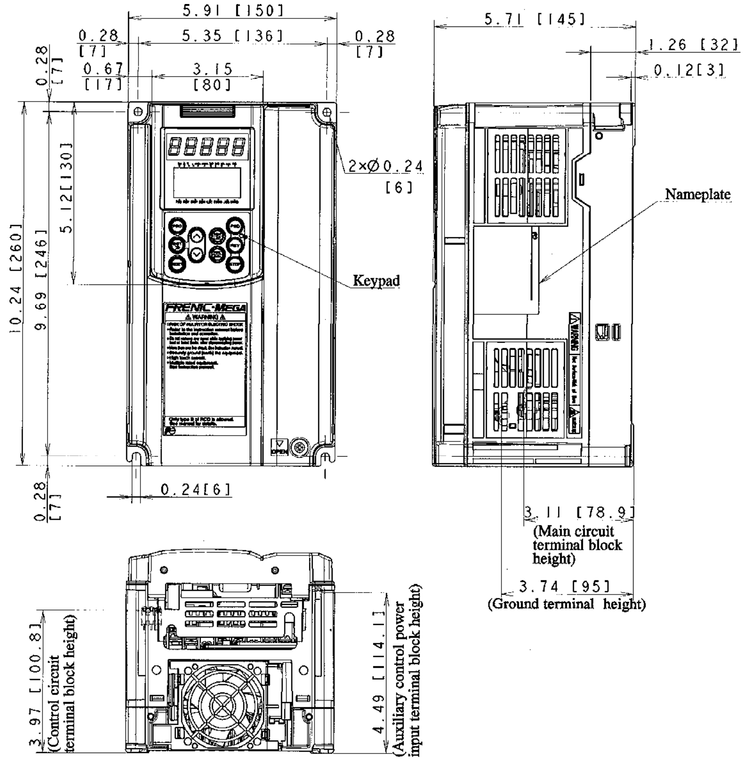
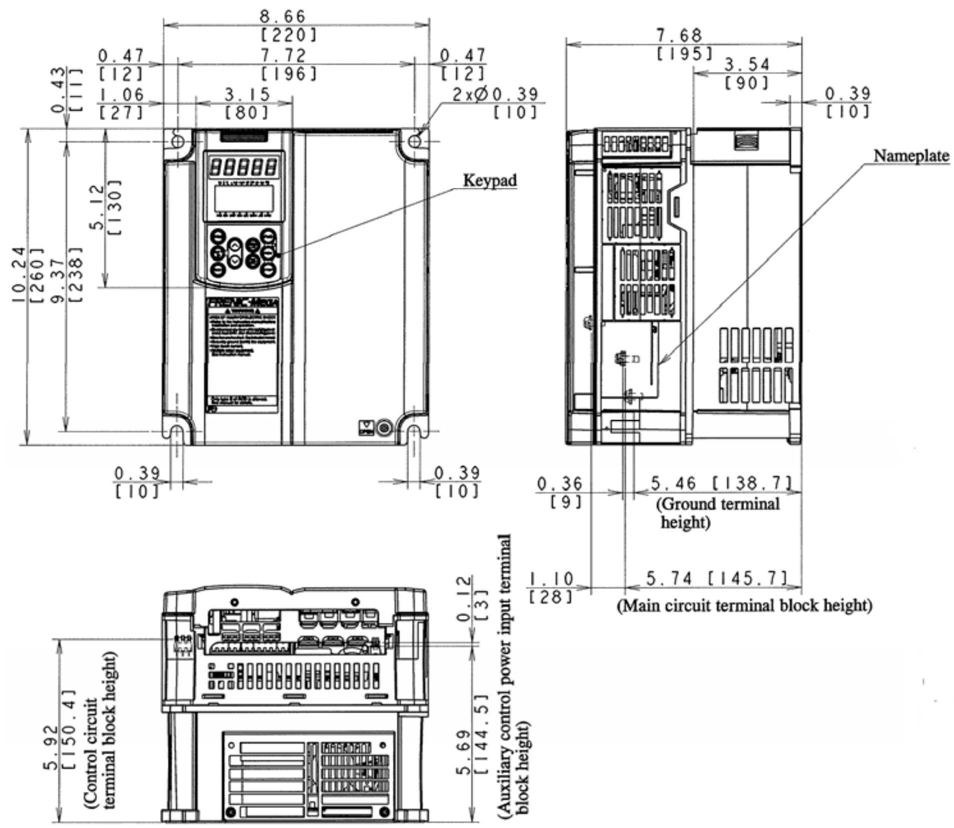


Unit: inch [mm]

■ FRN002G1S-2U/4U, FRN003G1S-2U/4U, FRN005G1S-2U/4U

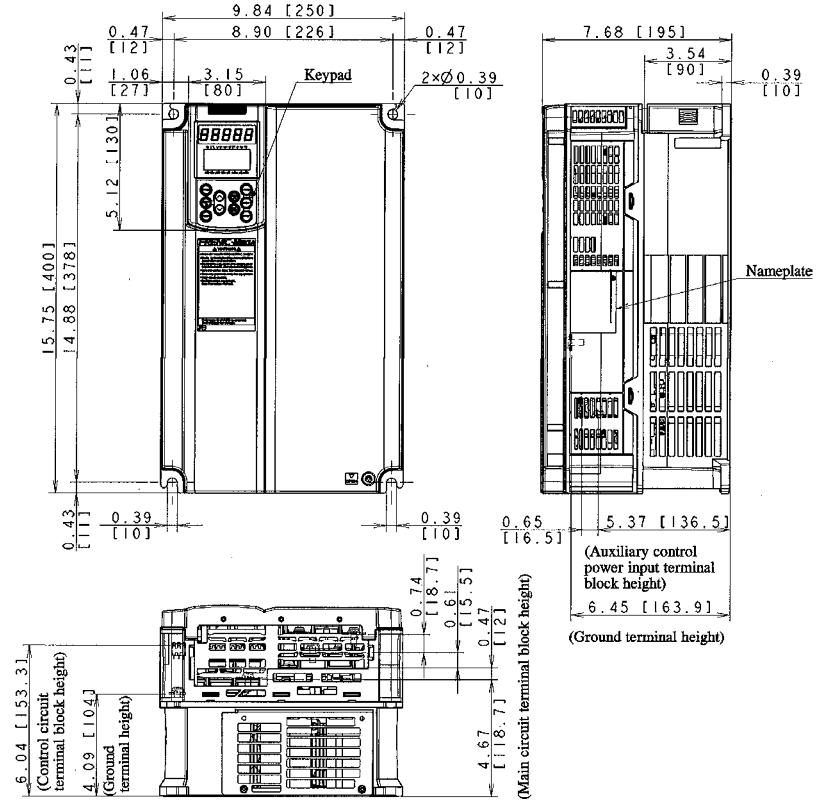


■ FRN007G1S-2U/4U, FRN010G1S-2U/4U, FRN015G1S-2U/4U, FRN020G1S-2U/4U

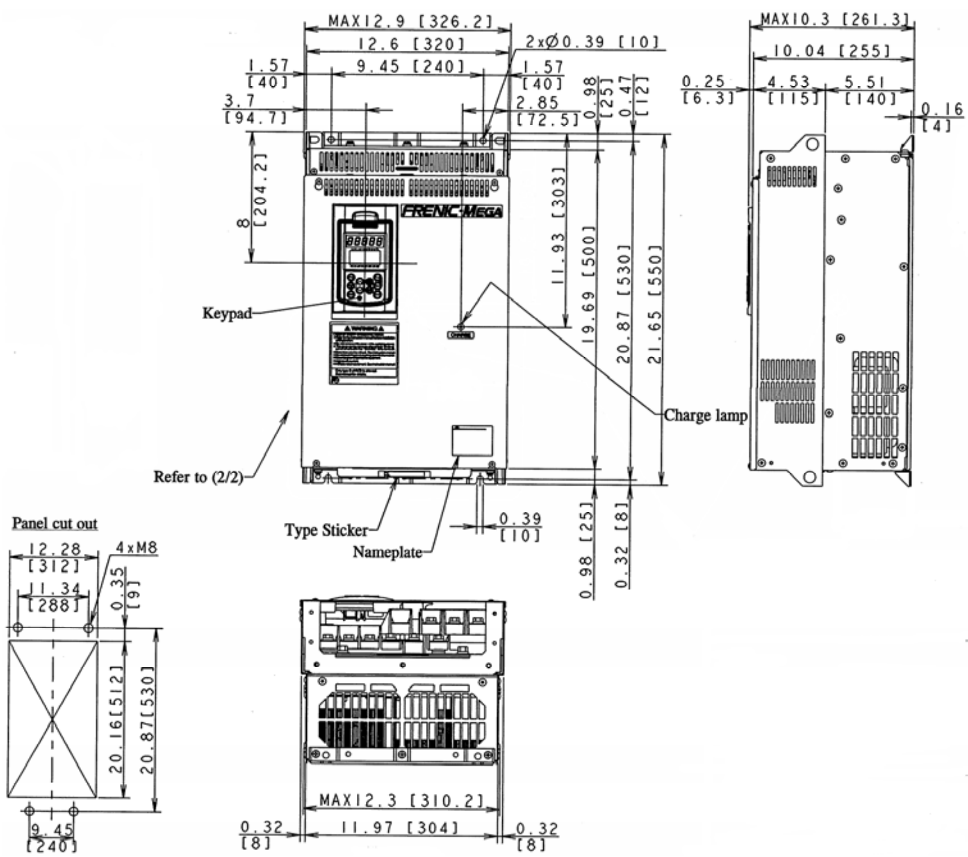


Unit: inch [mm]

■ FRN025G1S-2U/4U, FRN030G1S-2U/4U, FRN040G1S-2U/4U

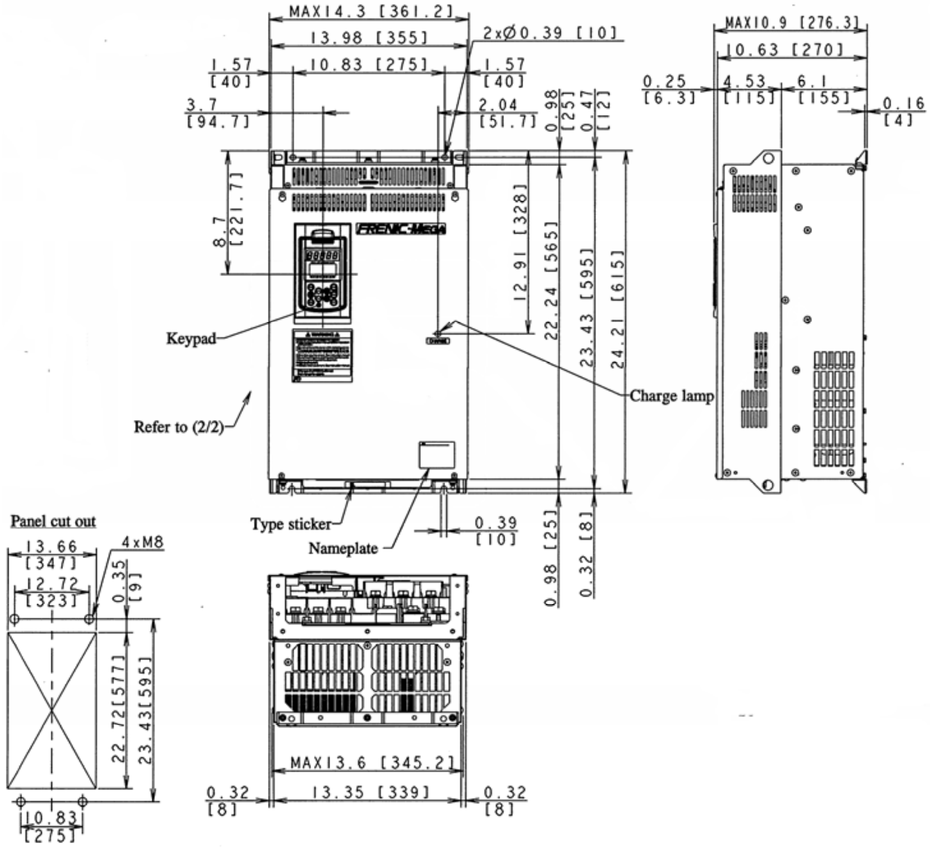


■ FRN050G1S-2U/4U, FRN060G1S-4U

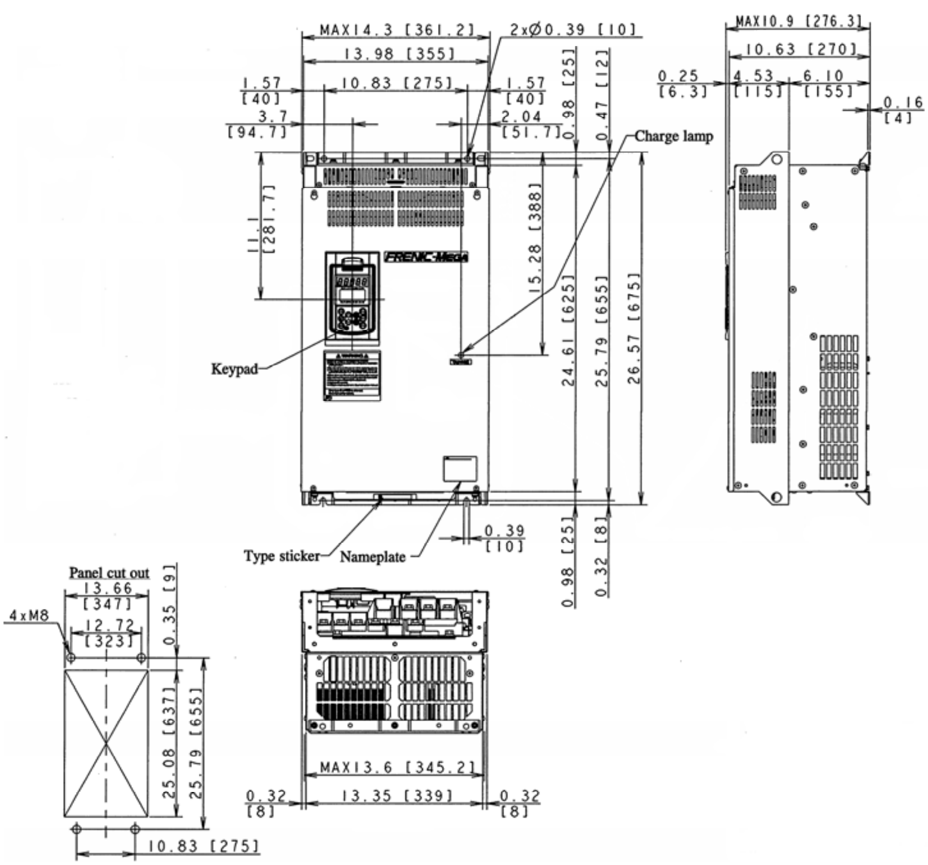


Unit: inch [mm]

■ FRN060G1S-2U, FRN075G1S-4U

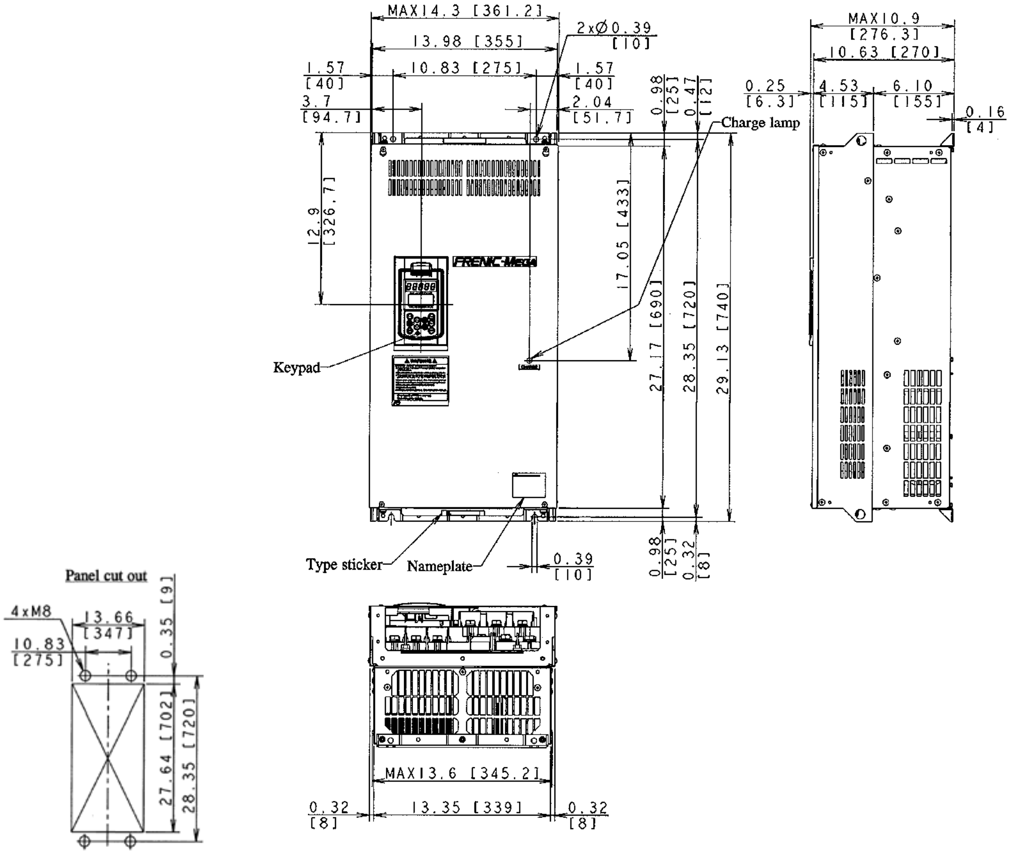


■ FRN100G1S-4U

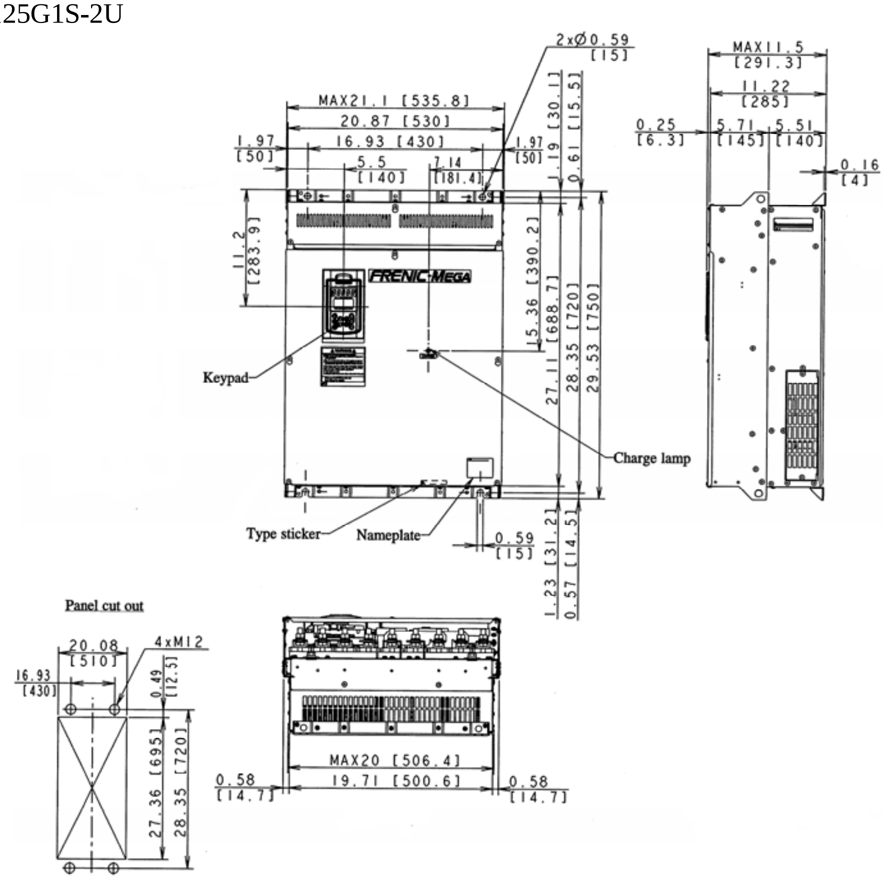


Unit: inch [mm]

■ FRN075G1S-2U, FRN100G1S-2U, FRN125G1S-4U

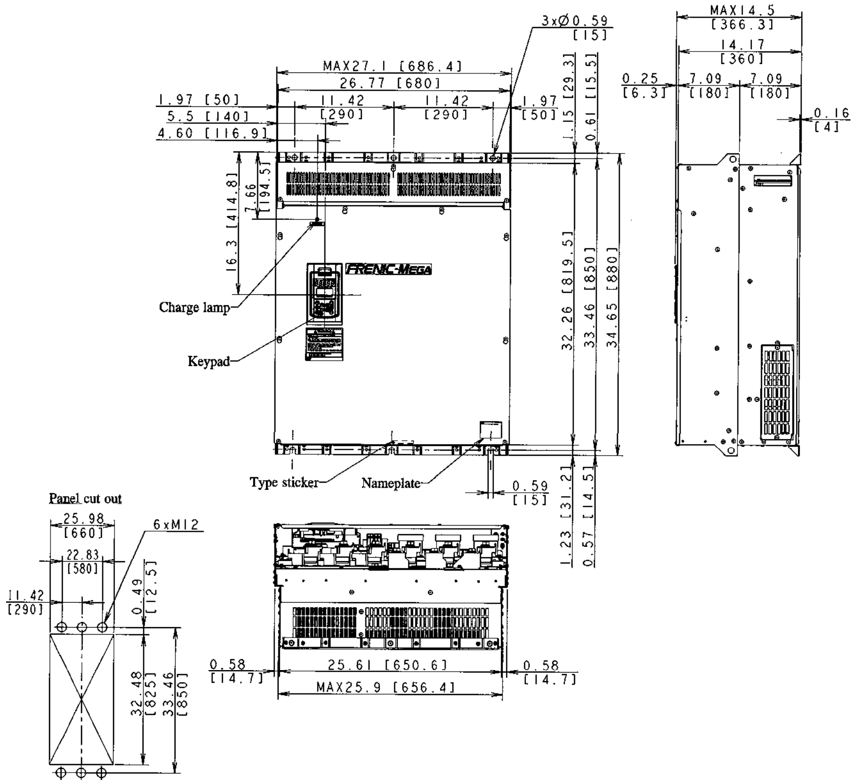


■ FRN125G1S-2U

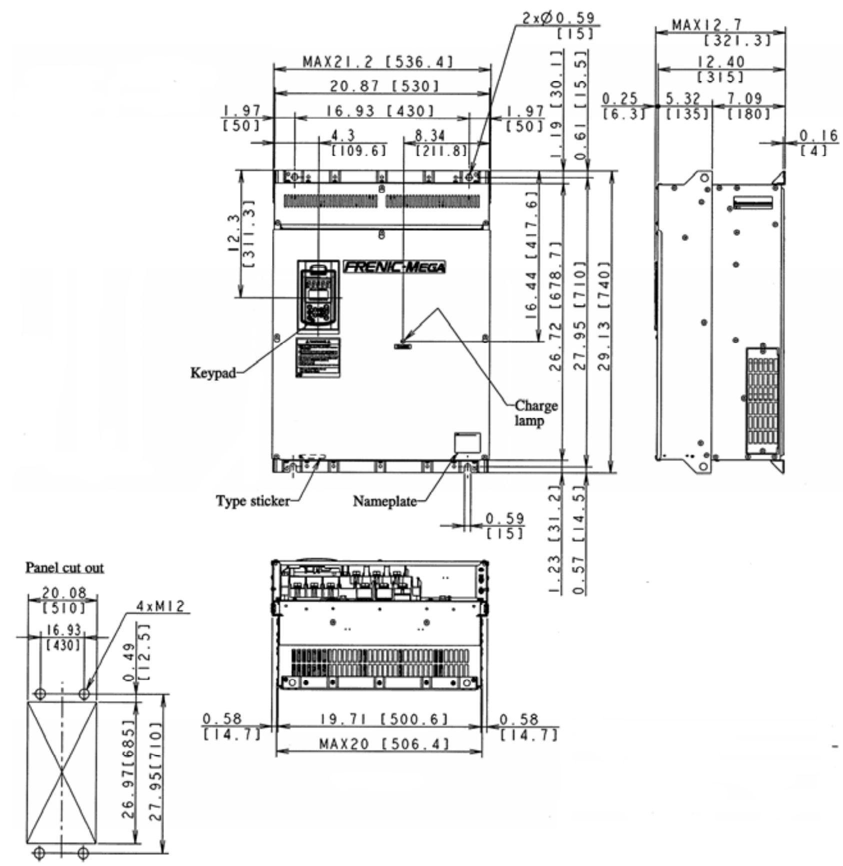


Unit: inch [mm]

■ FRN150G1S-2U

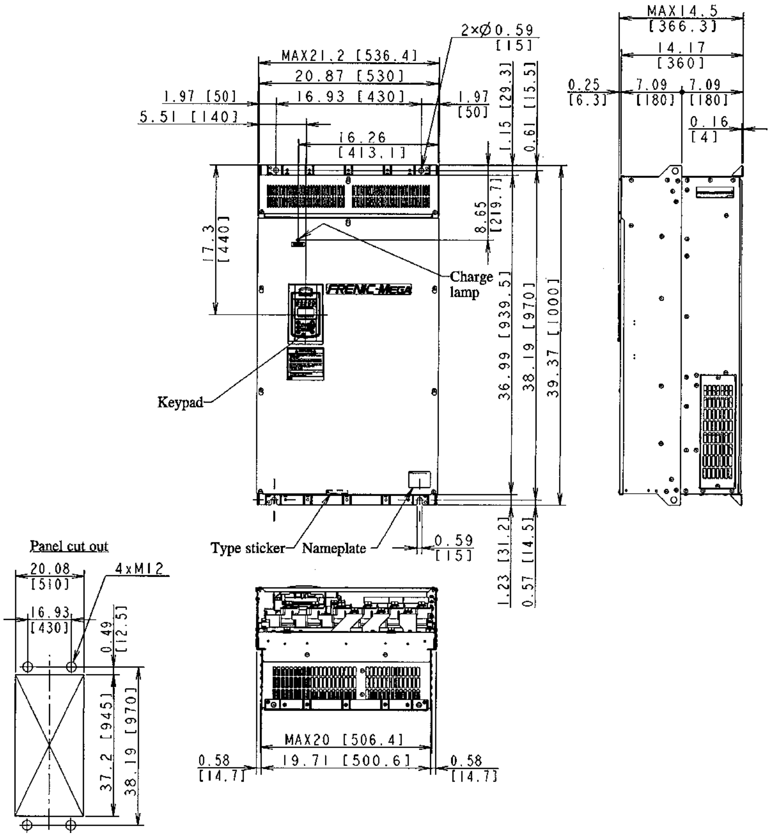


■ FRN150G1S-4U, FRN200G1S-4U,

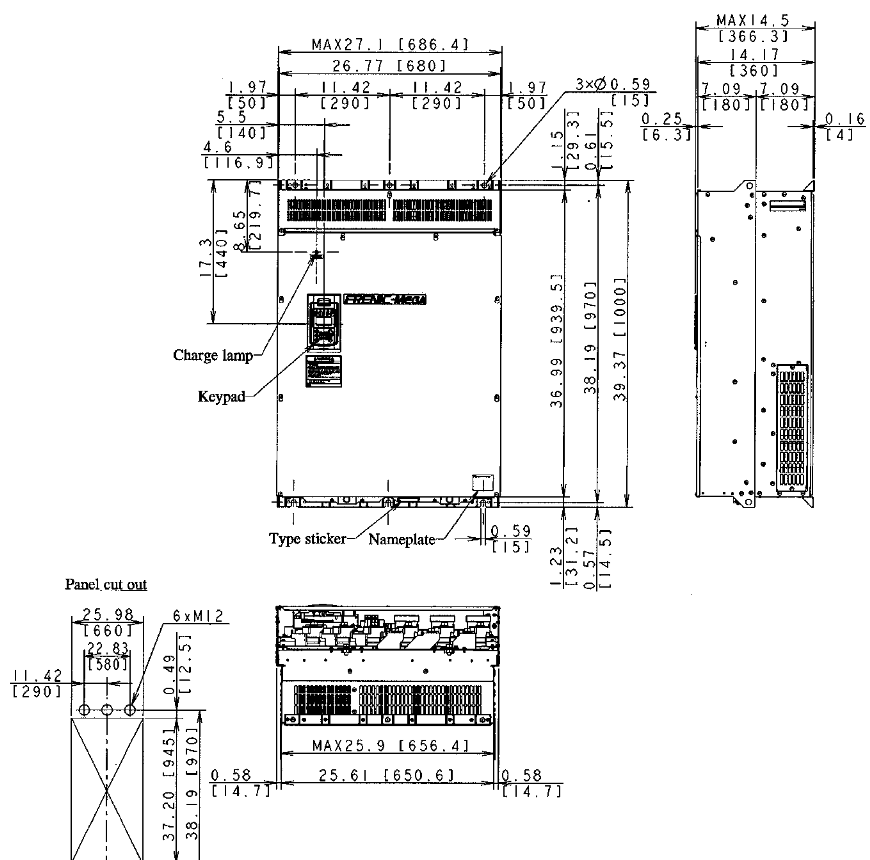


Unit: inch [mm]

■ FRN250G1S-4U, FRN300G1S-4U

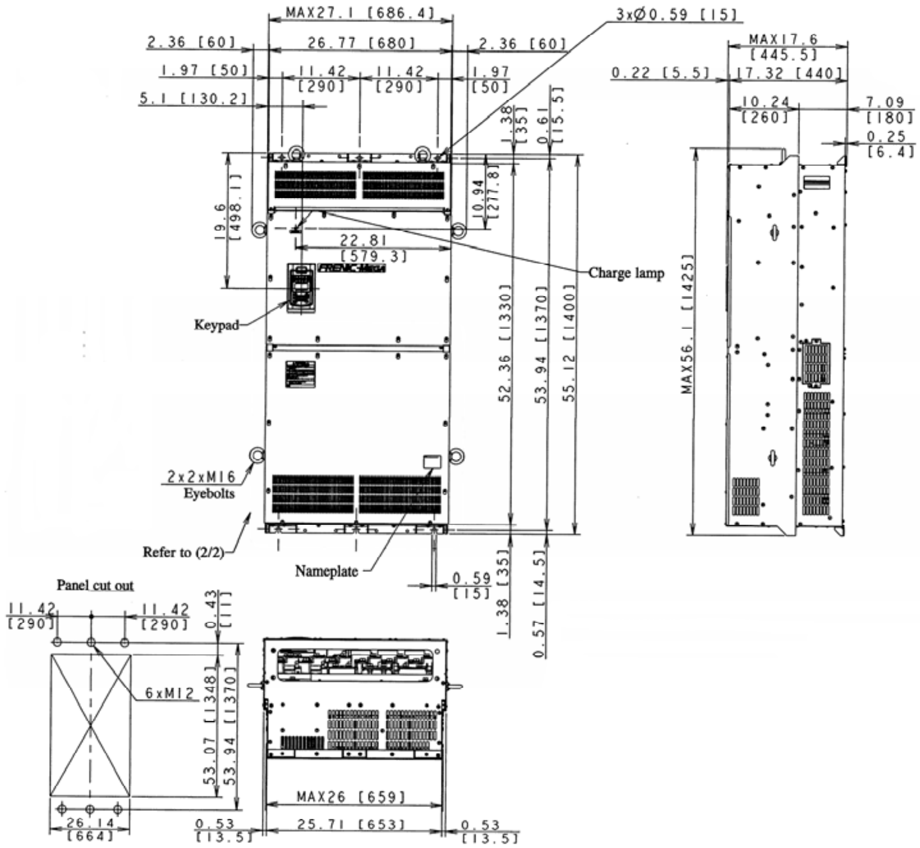


■ FRN350G1S-4U, FRN450G1S-4U

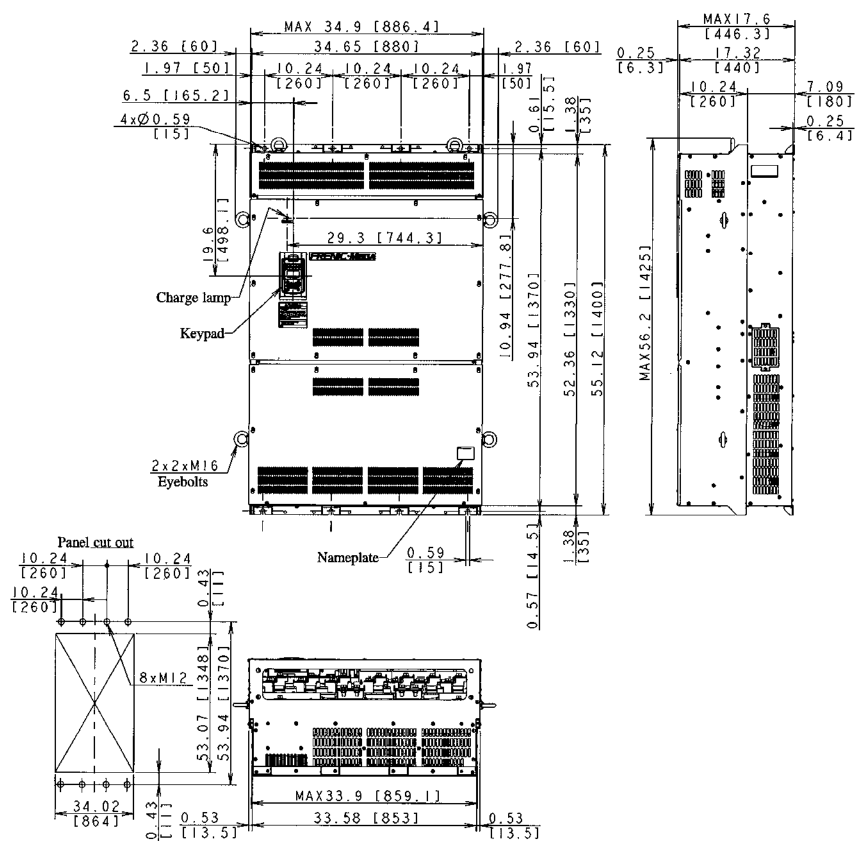


Unit: inch [mm]

■ FRN500G1S-4U, FRN600G1S-4U

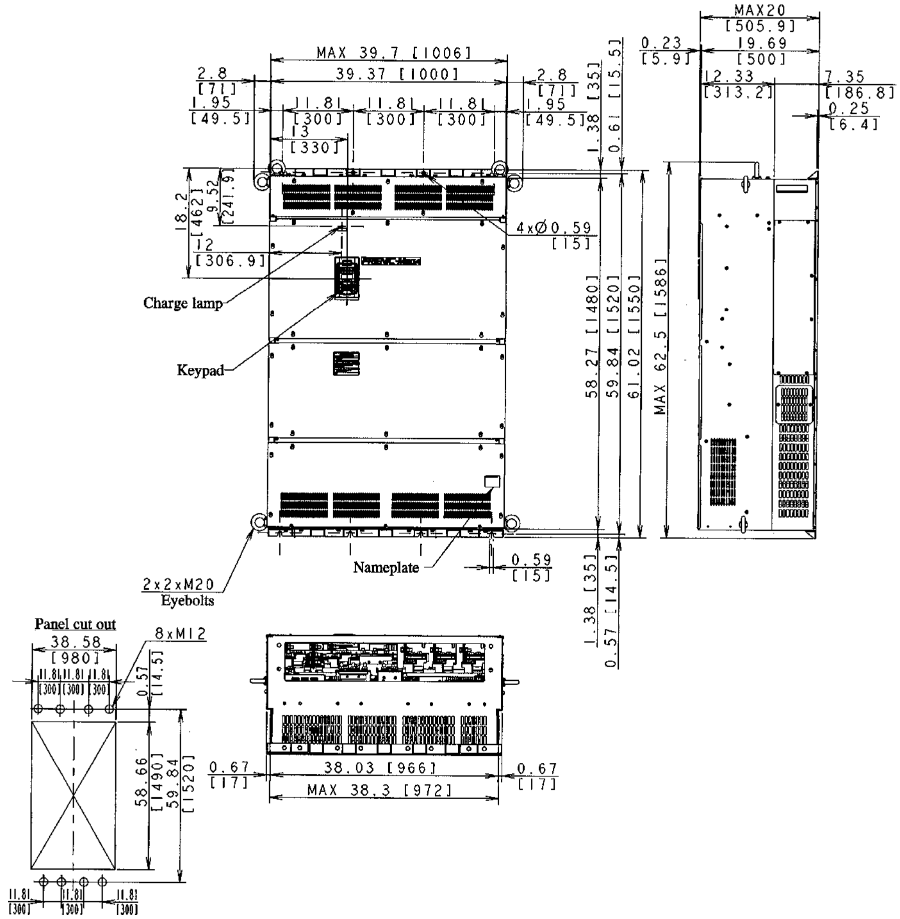


■ FRN700G1S-4U, FRN800G1S-4U



Unit: inch [mm]

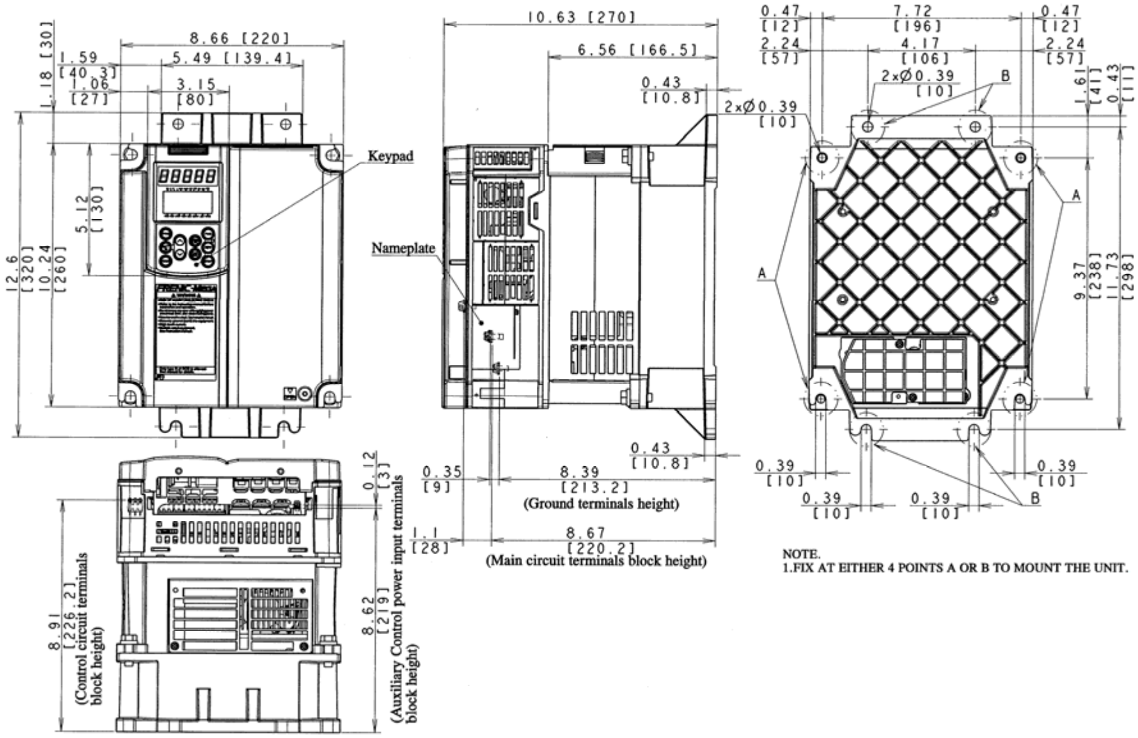
■ FRN900G1S-4U, FRN1000G1S-4U



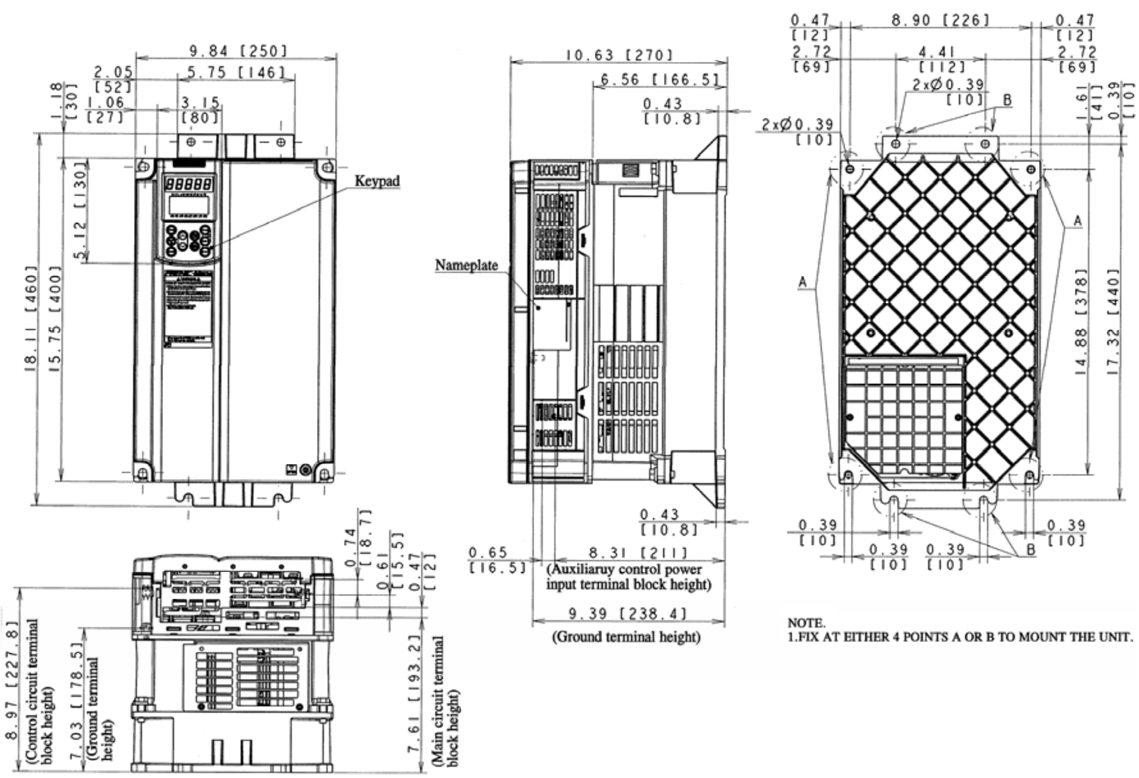
2.7.2 Inverter with built-in DC reactor

Unit: inch [mm]

■ FRN007G1H-2U/4U, FRN010G1H-2U/4U, FRN015G1H-2U/4U, FRN020G1H-2U/4U

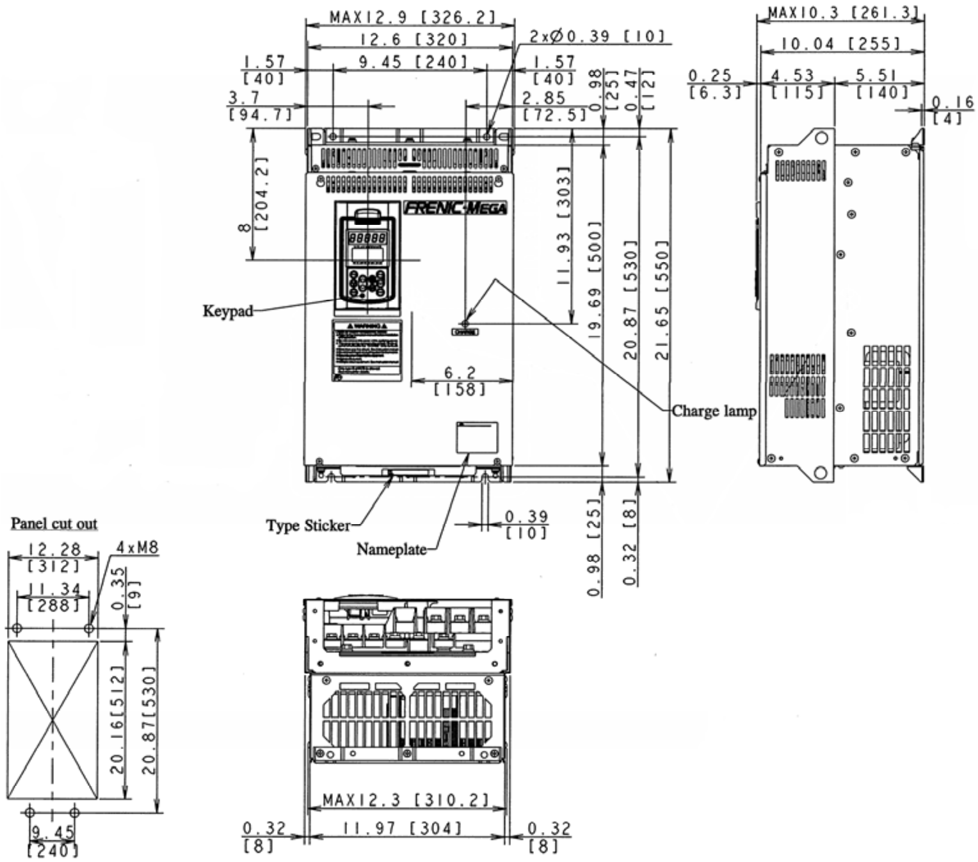


■ FRN025G1H-2U/4U, FRN030G1H-2U/4U, FRN040G1H-2U/4U

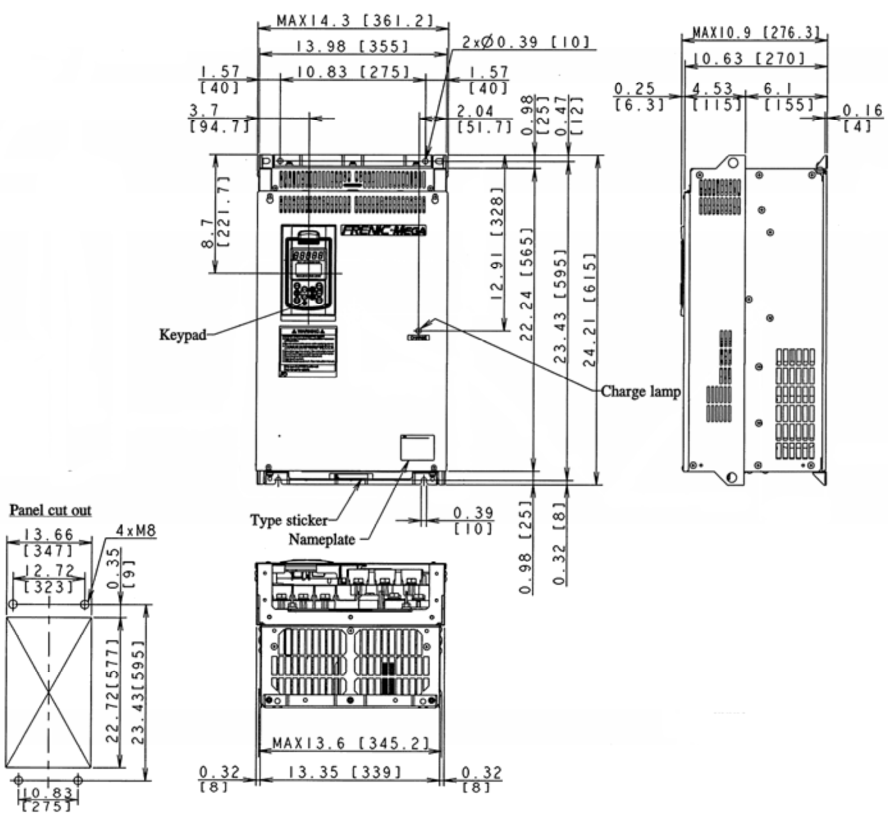


Unit: inch [mm]

■ FRN050G1H-2U/4U, FRN060G1H-4U

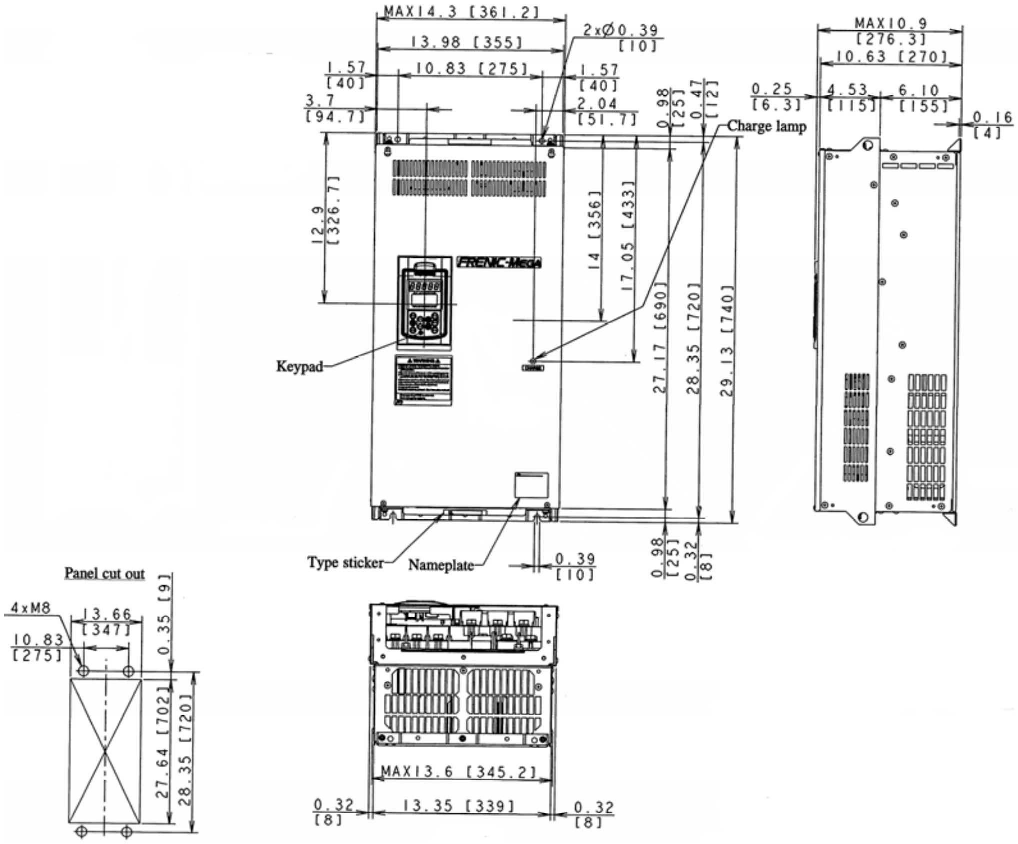


■ FRN060G1H-2U, FRN075G1H-4U

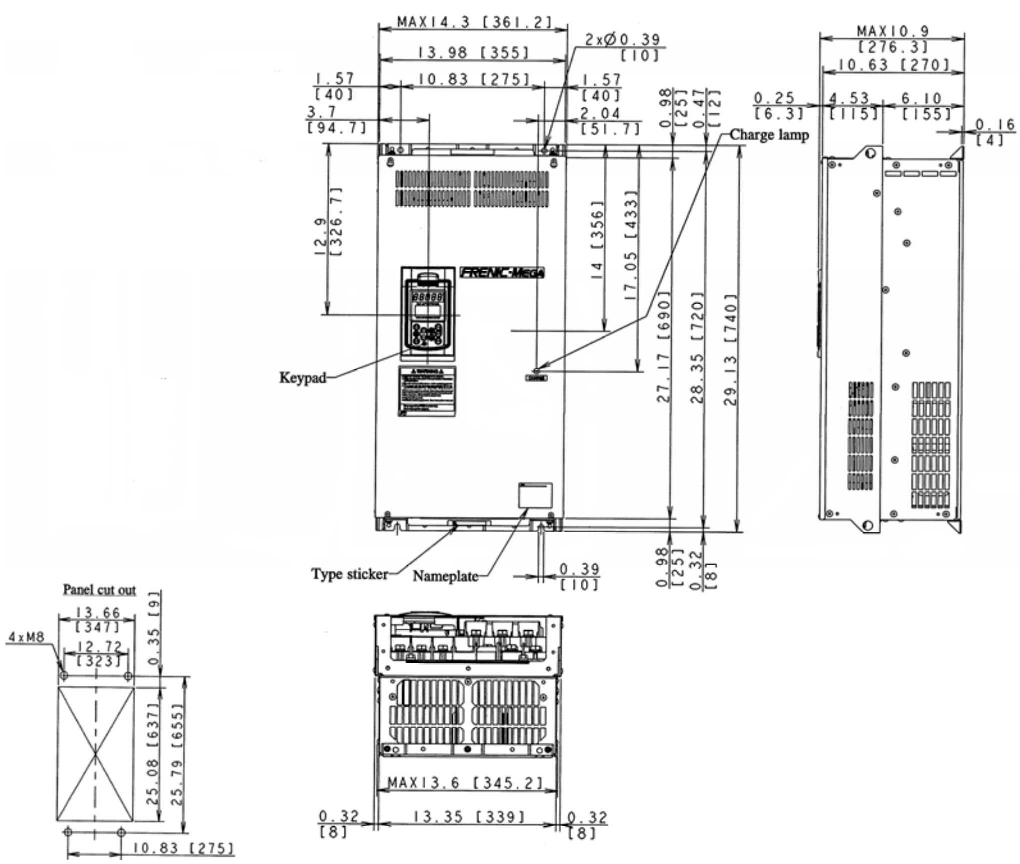


Unit: inch [mm]

■ FRN075G1H-2U, FRN100G1H-2U

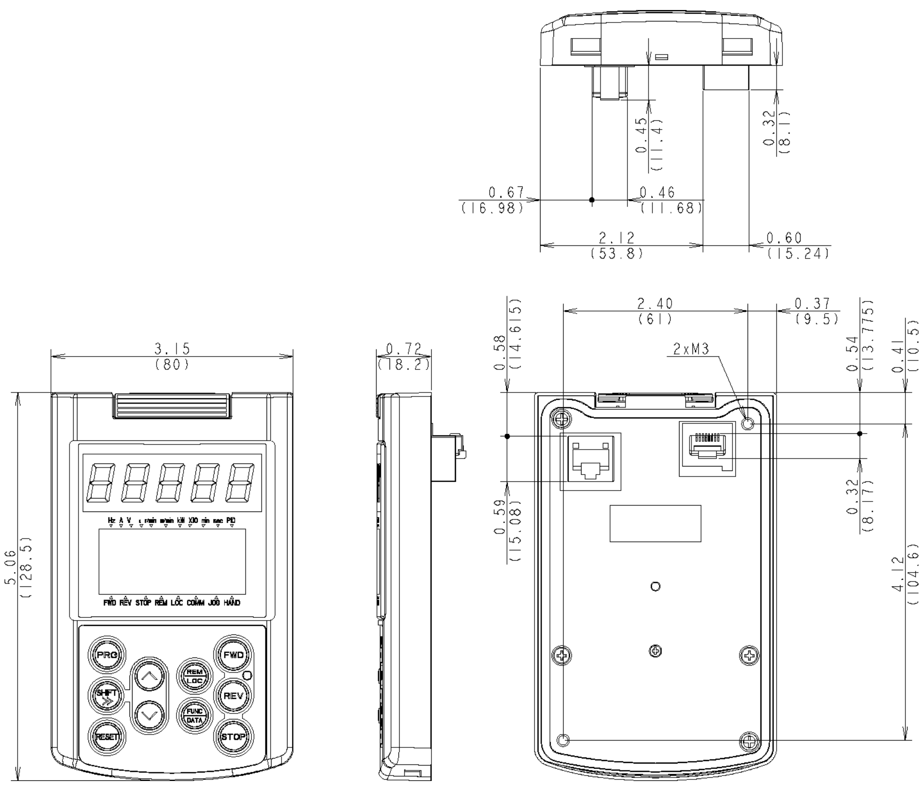


■ FRN100G1H-4U

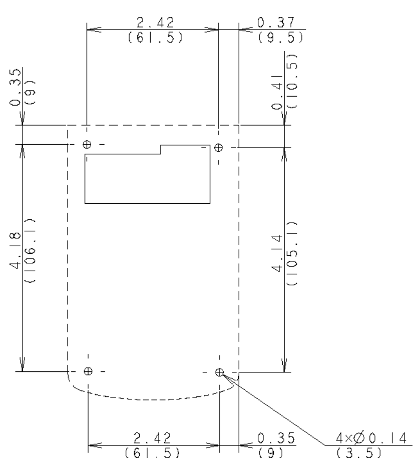


2.7.3 Keypad (TP-G1W-J1)

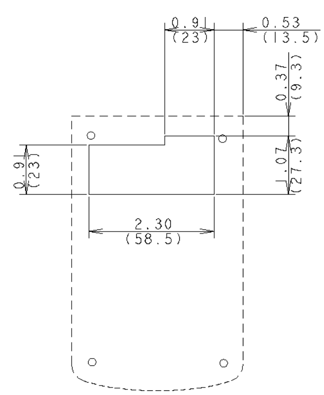
Unit: inch (mm)



Drill four screw holes and cut a square hole in a panel as specified below.



Location of Screw Holes in Panel (viewed from back)



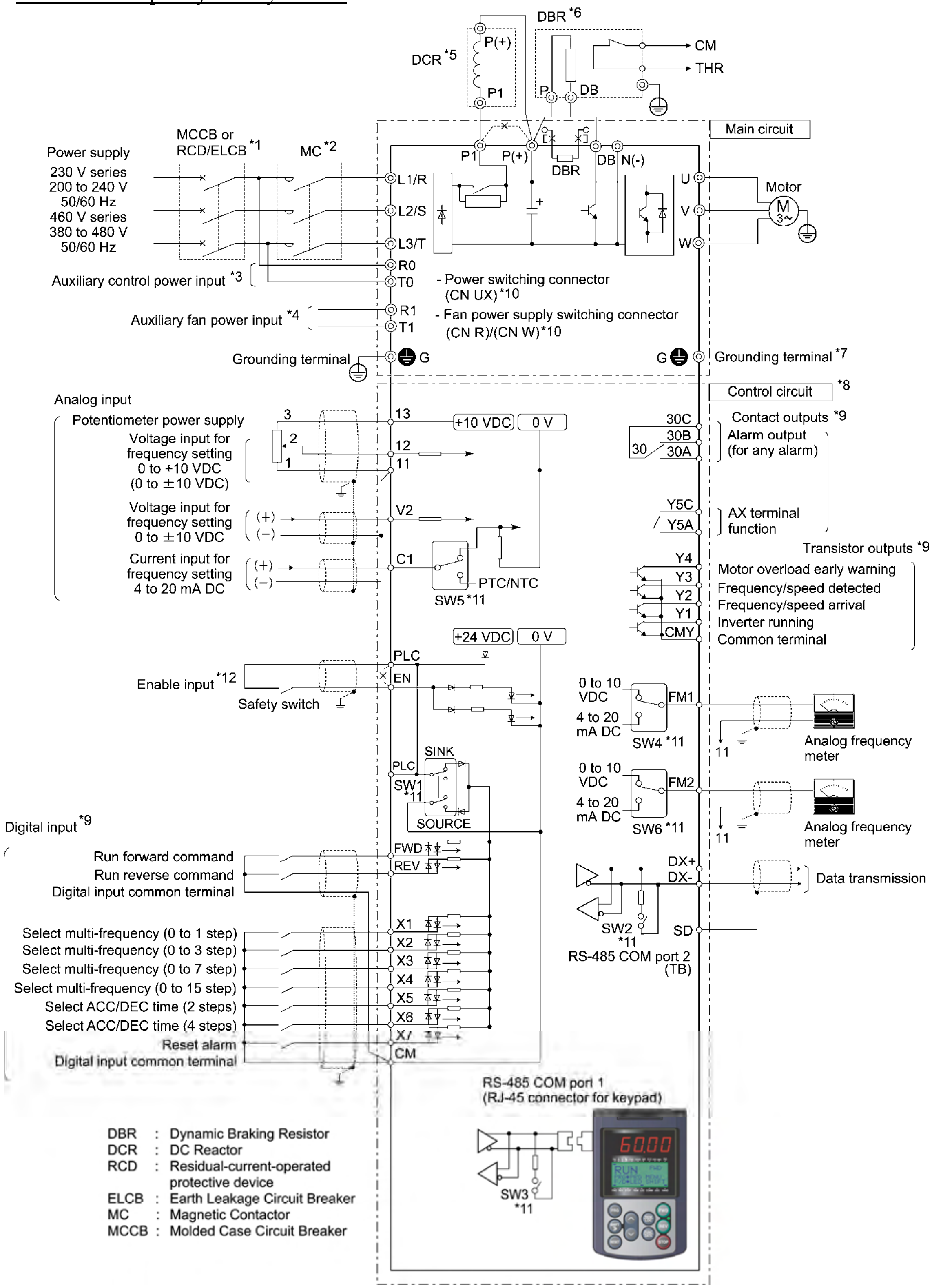
Dimensions of Panel Cutting

2.8 Connection Diagrams

This section shows connection diagrams with the Enable input function used.

2.8.1 Running a standard motor

SINK mode input by factory default



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

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

*3 The R0 and T0 terminals are provided for inverters of 2 HP or above.
To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

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

*5 When connecting an optional DC reactor (DCR), remove the jumper bar from the terminals P1 and P(+).
The FRN100G1S-2/4U and higher types come with a DCR. Be sure to connect the DCR.

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

The Inverter with built-in DC reactor has no DCR at this location.

*6 Inverters of 15 HP or below have a built-in braking resistor (DBR) between the terminals P(+) and DB.

When connecting an external braking resistor (DBR), be sure to disconnect the built-in one.

*7 A grounding terminal for a motor. Use this terminal if needed.

*8 For control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of them to the common terminals of the control circuit. To prevent malfunction due to noise, keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 3.9 inches (10 cm) or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

*9 The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X7], [FWD] and [REV], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C] and [30A/B/C].

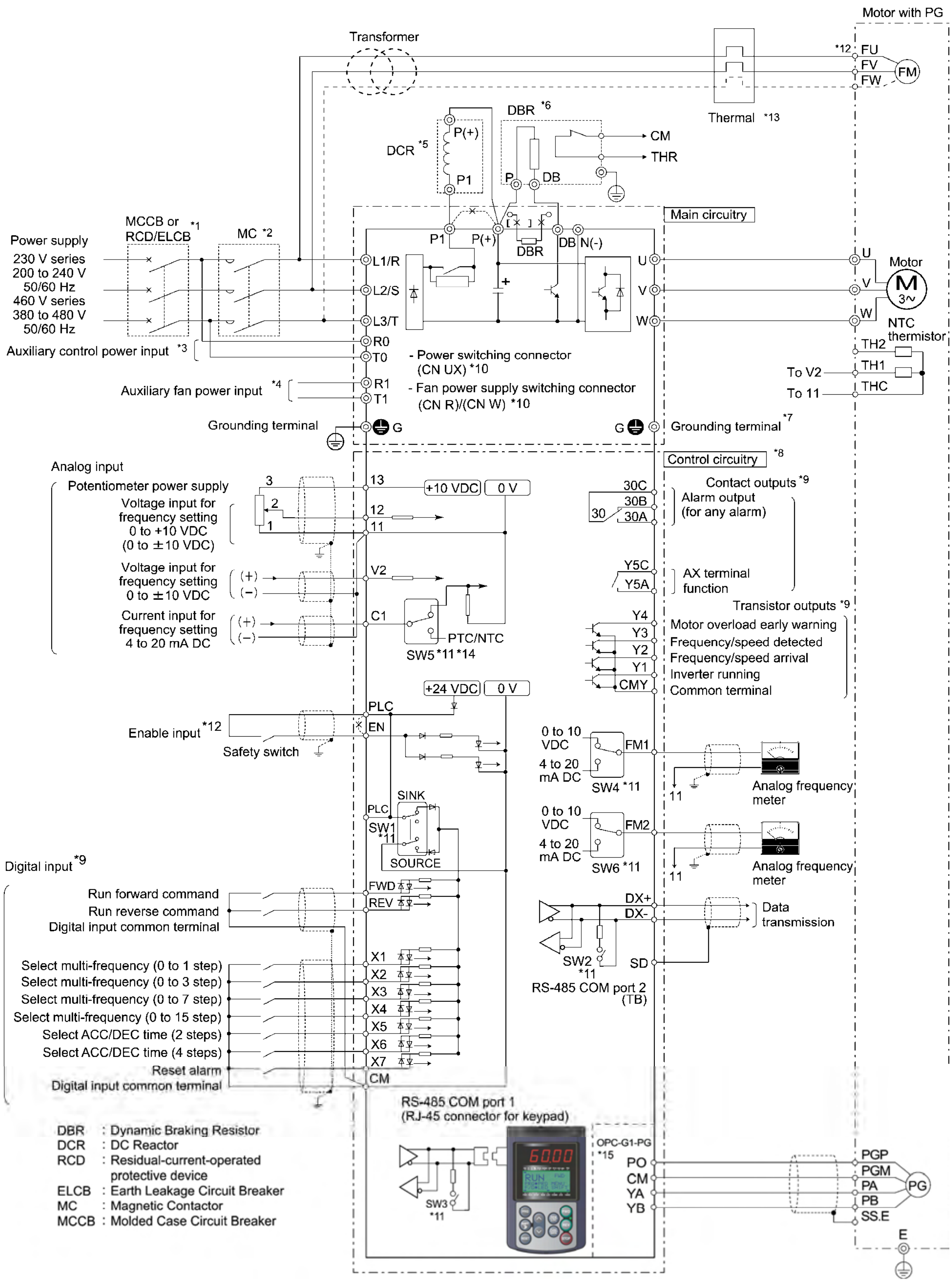
*10 Switching connectors in the main circuits. For details, refer to "⑥ Switching connectors" later in this section.

*11 Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Section 2.4.2 "Setting up the slide switches."

*12 When using the Enable input function, be sure to remove the jumper wire from terminals [EN] and [PLC]. For opening and closing the hardware circuit between terminals [EN] and [PLC], use safety components such as safety relays and safety switches that comply with EN954-1, Category 3 or higher. Be sure to use shielded wires exclusive to terminals [EN] and [PLC]. (Do not put them together with any other control signal wire in the same shielded core.) Ground the shielding layer. For details, refer to FRENIC-MEGA Instruction Manual, Chapter 9, Section 9.4 "Compliance with EN954-1, Category 3."

When not using the Enable input function, keep the terminals between [EN] and [PLC] short-circuited with the jumper wire (factory default).

2.8.2 Running a Fuji motor exclusively designed for vector control



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

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

*3 The R0 and T0 terminals are provided for inverters of 2 HP or above.
To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

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

*5 When connecting an optional DC reactor (DCR), remove the jumper bar from the terminals P1 and P(+).
The FRN100G1S-2/4U and higher types come with a DCR. Be sure to connect the DCR.

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

The Inverter with built-in DC reactor has no DCR at this location.

*6 Inverters of 15 HP or below have a built-in braking resistor (DBR) between the terminals P(+) and DB.

When connecting an external braking resistor (DBR), be sure to disconnect the built-in one.

*7 A grounding terminal for a motor. Use this terminal if needed.

*8 For control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of them to the common terminals of the control circuit. To prevent malfunction due to noise, keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 3.9 inches (10 cm) or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

*9 The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X7], [FWD] and [REV], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C] and [30A/B/C].

*10 Switching connectors in the main circuits. For details, refer to "⑥ Switching connectors" later in this section.

*11 Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Section 2.4.2 "Setting up the slide switches."

*12 When using the Enable input function, be sure to remove the jumper wire from terminals [EN] and [PLC]. For opening and closing the hardware circuit between terminals [EN] and [PLC], use safety components such as safety relays and safety switches that comply with EN954-1, Category 3 or higher. Be sure to use shielded wires exclusive to terminals [EN] and [PLC]. (Do not put them together with any other control signal wire in the same shielded core.) Ground the shielding layer. For details, refer to FRENIC-MEGA Instruction Manual, Chapter 9, Section 9.4 "Compliance with EN954-1, Category 3."

When not using the Enable input function, keep the terminals between [EN] and [PLC] short-circuited with the jumper wire (factory default).

*13 Use auxiliary contacts of the thermal relay (manually restorable) to trip the molded case circuit breaker (MCCB) or magnetic contactor (MC).

*14 To connect an NTC thermistor to this terminal, turn SW5 on the control printed circuit board to the PTC/NTC side and set the function code H26 data to "3."

*15 The PG interface card (OPC-G1-PG) is optional.

2.9 Protective Functions

The table below lists the name of the protective functions, description, alarm codes on the LED monitor, and presence of alarm output at terminals [30A/B/C]. If an alarm code appears on the LED monitor, remove the cause of activation of the alarm function referring to Chapter 9 "TROUBLESHOOTING."

<table>
<tr><th>Name</th><th colspan="2">Description</th><th>LED monitor displays</th><th>Alarm output [30A/B/C] (Note)</th></tr>
<tr><td>Overcurrent protection</td><td>Stops the inverter output to protect the inverter from an overcurrent resulting from overload.</td><td>During acceleration</td><td>OC1</td><td rowspan="3">Yes</td></tr>
<tr><td>Short-circuit protection</td><td>Stops the inverter output to protect the inverter from overcurrent due to a short-circuiting in the output circuit.</td><td>During deceleration</td><td>OC2</td></tr>
<tr><td rowspan="2">Ground fault protection</td><td>Stops the inverter output to protect the inverter from overcurrent due to a ground fault in the output circuit.
(For 230 V series with 40 HP and 460 V series with 40 HP or below)</td><td>During running at constant speed</td><td>OC3</td></tr>
<tr><td>Detects a zero-phase current in the output current and stops the inverter output to protect the inverter from overcurrent due to a ground fault in the output circuit.
(For 230 V series with 50 HP and 460 V series with 50 HP or above)</td><td>—</td><td>EF</td><td>Yes</td></tr>
<tr><td rowspan="3">Overvoltage protection</td><td rowspan="3">Stops the inverter output upon detection of an overvoltage condition (400 VDC for 230 V series, 800 VDC for 460 V series) in the DC link bus.
This protection is not assured if extremely large AC line voltage is applied inadvertently.</td><td>During acceleration</td><td>OU1</td><td rowspan="3">Yes</td></tr>
<tr><td>During deceleration</td><td>OU2</td></tr>
<tr><td>During running at constant speed (stopped)</td><td>OU3</td></tr>
<tr><td>Undervoltage</td><td colspan="2">Stops the inverter output when the DC link bus voltage drops below the undervoltage level (200 VDC for 230 V series, 400 VDC for 460 V series).
Note that, if the restart mode after momentary power failure is selected, no alarm is output even if the DC link bus voltage drops.</td><td>LU</td><td>Yes*</td></tr>
<tr><td>Input phase loss protection</td><td colspan="2">Protects the inverter or stops the inverter output when an input phase loss is detected.
If connected load is light or a DC reactor is connected to the inverter, this function may not detect input phase loss if any.</td><td>Lin</td><td>Yes*</td></tr>
<tr><td>Output phase loss protection</td><td colspan="2">Detects breaks in inverter output wiring during running, stopping the inverter output.</td><td>OPL</td><td>Yes*</td></tr>
</table>

Note: In Alarm output [30A/B/C] column, "Yes*" means that an alarm may not be issued depending upon function code setting.

Name	Description	LED monitor displays	Alarm output [30A/B/C] **(Note)**
Overheat protection	- Stops the inverter output upon detecting excess heat sink temperature in case of cooling fan failure or overload. - Detects a failure of the internal air circulation DC fan and stops the inverter (For models of 75 HP in 230 V series and 125 HP or above in 460 V series)	OH1	Yes
	Stops the inverter output upon detecting an excessively high surrounding temperature inside the inverter caused by a failure or an overload condition of the cooling fan.	OH3	Yes
	The electronic thermal protection for the braking resistor stops the inverter output to prevent the braking resistor from overheating. (For models of 40 HP in 230 V series and 40 HP or below in 460 V series) * Function codes must be set according to the braking resistor.	dbH	Yes*
Overload protection	Stops the inverter output upon detection of the abnormal heat sink temperature and switching element temperature calculated with the output current.	OLU	Yes
External alarm input	Places the inverter in alarm-stop state upon receiving digital input signal ***THR***.	OH2	Yes*
Fuse blown	Upon detection of a fuse blown in the inverter's main circuit, this function stops the inverter output. (For models of 125 HP in 230 V series and 150 HP or above in 460 V series)	FUS	Yes
Abnormal condition in charger circuit	Upon detection of an abnormal condition in the charger circuit inside the inverter, this function stops the inverter output. (For models of 60 HP in 230 V series and 125 HP or above in 460 V series)	PbF	Yes
Braking transistor broken	Stops the inverter output if a breakdown of the braking transistor is detected. (Only for braking transistor built-in type inverters)	dbA	Yes*
Overspeed *1 to *4	Stops the inverter output if the detected speed is 120% or over of the maximum frequency	OS	Yes
PG wire break *1, *2, *4	Stops the inverter output if a PG wire break is detected.	PG	Yes

Note: In Alarm output [30A/B/C] column, "Yes*" means that an alarm may not be issued depending upon function code setting.

*1 Available under V/f control with speed sensor. (PG option required)

*2 Available under dynamic torque vector control with speed sensor. (PG option required)

*3 Available under vector control without speed sensor.

*4 Available under vector control with speed sensor. (PG option required)

Name		Description	LED monitor displays	Alarm output [30A/B/C] **(Note)**
Motor protection	Electronic thermal overload	In the following cases, the inverter stops running the motor to protect the motor in accordance with the electronic thermal overload protection setting. - Protects general-purpose motors over the entire frequency range (F10 = 1.) - Protects inverter motors over the entire frequency range (F10 = 2.) The operation level and thermal time constant can be set. (0.5 to 75.0 minutes)	OL1 OL2 OL3 OL4	Yes*
	PTC thermistor	A PTC thermistor input stops the inverter output for motor protection. Connect a PTC thermistor between terminals [V2] and [11] and set the function codes and slide switch on the interface PCB accordingly.	OH4	Yes*
	NTC thermistor	An NTC thermistor input detects the motor temperature. Connect an NTC thermistor between terminals [V2] and [11] and set the function codes and slide switch on the interface PCB accordingly.		
	NTC wire break error	Stops the inverter upon detecting the NTC wire break inside the inverter.	nrb	Yes
	Overload early warning	Outputs a preliminary alarm at a preset level before the inverter is stopped by the electronic thermal overload protection for the motor. (Only for the first motor only)	—	—
Memory error detection		The inverter checks memory data after power-on and when the data is written. If a memory error is detected, the inverter stops.	Er1	Yes
Keypad communications error detection		Stops the inverter output upon detecting a communications error between the inverter and the keypad during operation using the keypad.	Er2	Yes
CPU error detection		If the inverter detects a CPU error or LSI error caused by noise or some other factors, this function stops the inverter.	Er3	Yes
Option communications error detection		Upon detection of an error in the communication between the inverter and an optional card, stops the inverter output.	Er4	—
Option error detection		When an option card has detected an error, this function stops the inverter output.	Er5	—

Note: In Alarm output [30A/B/C] column, "Yes*" means that an alarm may not be issued depending upon function code setting.

Name	Description		LED monitor displays	Alarm output [30A/B/C] **(Note)**
Operation protection	STOP key priority	Pressing the STOP key on the keypad forces the inverter to decelerate and stop the motor even if the inverter is running by any run commands given via the terminals or communications (link operation). After the motor stops, the inverter issues alarm Er6.	Er6	Yes
	Start check function	To prevent a sudden start, the inverter prohibits any run operations and displays Er6 on the 7-segment LED monitor if any run command is present when: - Powering up - An alarm is released (the RESET key is turned ON or an alarm reset ***RST*** is input.) - "Enable communications link ***LE***" has been activated and the run command is active in the linked source.	Er6	Yes*
Tuning error detection	During tuning of motor parameters, if the tuning has failed or has aborted, or an abnormal condition has been detected in the tuning result, the inverter stops its output.		Er 7	Yes
RS-485 communications error detection (COM port 1)	When the inverter is connected to a communications network via the RS-485 port designed for the keypad, detecting a communications error stops the inverter output.		Er8	Yes*
Excessive speed deviation *1 to *4	Stops the inverter output if the speed deviation (difference between the speed command value and the feedback value) exceeds the preset value.		ErE	Yes*
Data save error during under-voltage	If the data could not be saved during activation of the undervoltage protection function, the inverter displays the alarm code.		ErF	Yes
RS-485 communications error detection (COM port 2)	When the inverter is connected to a communications network via the RS-485 port on the control terminals DX+ and DX-, detecting a communications error stops the inverter output.		ErP	Yes*
Hardware error detection	Stops the inverter output upon detecting a malfunction of LSI on the power printed circuit board.		ErH	Yes
Mock alarm	Mock alarm can be generated with keypad operations.		Err	Yes
PID feedback wire break detection	When the PID feedback is assigned to the current input, if a wire break is detected, whether the warning with transistor output or the alarm output can be selected.		CoF	Yes*
Positioning control error detection	Stops the inverter output upon detection of an excessive positioning deviation when the servo-lock function is activated.		Ero	Yes*
Enable circuit failure detection	Stops the inverter output upon detection of an Enable circuit failure.		ECF	Yes

Note: In Alarm output [30A/B/C] column, "Yes*" means that an alarm may not be issued depending upon function code setting.

*1 Available under V/f control with speed sensor. (PG option required)

*2 Available under dynamic torque vector control with speed sensor. (PG option required)

*3 Available under vector control without speed sensor.

*4 Available under vector control with speed sensor. (PG option required)

Name	Description	LED monitor displays	Alarm output [30A/B/C] **(Note)**
Alarm relay output (for any fault)	The inverter outputs a relay contact signal when the inverter issues an alarm and stops the inverter output. < Alarm reset > The alarm stop state is reset by pressing the RESET key or by the digital input signal ***RST***. < Saving the alarm history and detailed data > The information on the previous 4 alarms can be saved and displayed.	—	Yes
Stall prevention	When the output current exceeds the current limiter level (F44) during acceleration/deceleration or constant speed running, this function decreases the output frequency to avoid an overcurrent trip.	—	—
Retry	When the inverter has stopped because of a trip, this function allows the inverter to automatically reset itself and restart. (You can specify the number of retries and the latency between stop and reset.)	—	—
Surge protection	Protects the inverter against surge voltages which might appear between one of the power lines for the main circuit and the ground.	—	—
Command loss detected	Upon detecting a loss of a frequency command (because of a broken wire, etc.), this function issues an alarm and continues the inverter operation at the preset reference frequency (specified as a ratio to the frequency just before the detection).	rEF	—
Protection against momentary power failure	Upon detecting a momentary power failure lasting more than 15 ms, this function stops the inverter output. If restart after momentary power failure is selected, this function invokes a restart process when power has been restored within a predetermined period (allowable momentary power failure time).	—	—
Light alarm (warning)	Upon detecting a failure or warning status that has been registered as a light alarm item, the inverter displays L-AL on the LED monitor without stopping the operation. <u>Light alarm object</u> Heat sink overheat (OH1), External alarm (OH2), Inverter internal overheat (OH3), Braking resistor overheat (dbH), Overload of motor 1 through 4 (OL1 to OL4), Option communications error (Er-4), Option error (Er-5), RS-485 communications error (COM port 1) (Er-8), RS-485 communications error (COM port 2) (Er-P), Speed mismatch or excessive speed deviation (Er-E), PID feedback wire break (CoF), DC fan locked (FAL), Motor overload early warning (OL), Heat sink overheat early warning (OH), Lifetime alarm (DC link bus capacitor, electrolytic capacitors on printed circuit boards or cooling fans) (LiF), Reference command loss detected (rEF), PID alarm (PID), Low torque output (UTL), PTC thermistor activated (PTC), Inverter life (cumulative run time) (rTE), Inverter life (number of startups) (CnT)	L-AL	—

Note: In Alarm output [30A/B/C] column, "Yes*" means that an alarm may not be issued depending upon function code setting.

Chapter 3

SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

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

Contents

3.1 Selecting Motors and Inverters

When selecting a general-purpose inverter, first select a motor and then inverter as follows:

(1) Key point for selecting a motor: Determine what kind of machinery is to be used, calculate its moment of inertia, and then select the appropriate motor capacity.

(2) Key point for selecting an inverter: Taking into account the operation requirements (e.g., acceleration time, deceleration time, and frequency in operation) of the machinery to be driven by the motor selected in (1) above, calculate the acceleration/deceleration/braking torque.

This section describes the selection procedure for (1) and (2) above. First, it explains the output torque characteristics obtained by using the motor driven by the inverter (FRENIC-MEGA).

3.1.1 Motor output torque characteristics

Figures 3.1 and 3.2 graph the output torque characteristics of motors at the rated output frequency individually for 50 Hz and 60 Hz base. The horizontal and vertical axes show the output frequency and output torque (%), respectively. Curves (a) through (f) depend on the running conditions.

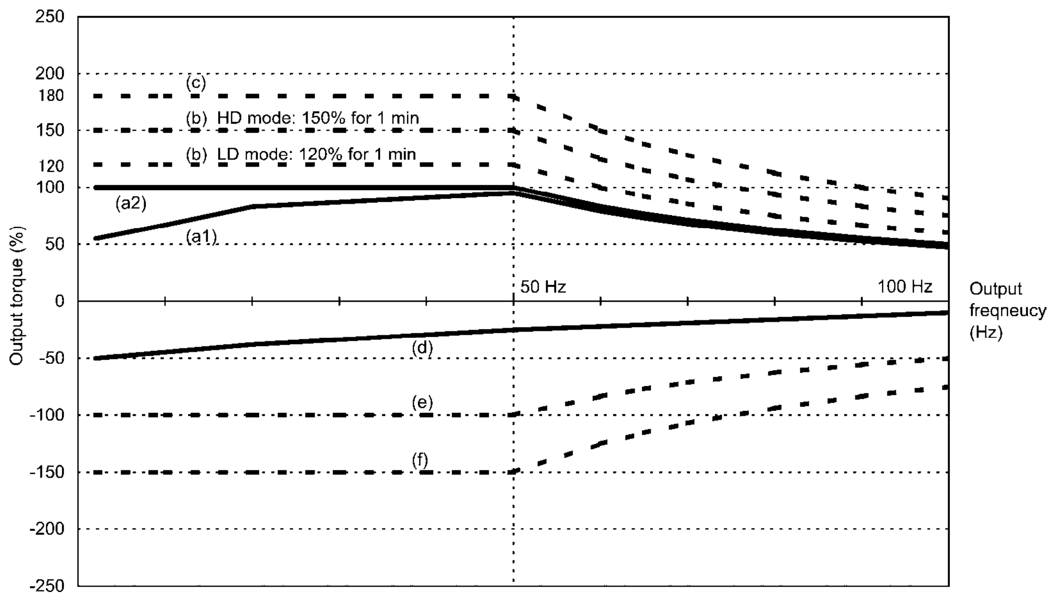


Figure 3.1 Output Torque Characteristics (Base frequency: 50 Hz)

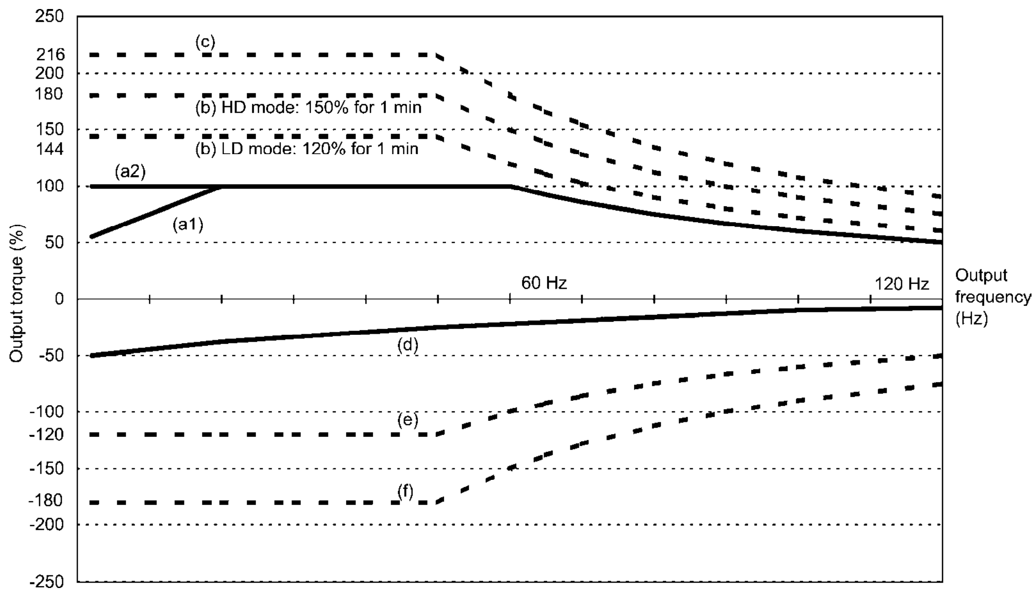


Figure 3.2 Output Torque Characteristics (Base frequency: 60 Hz)

(1) Continuous allowable driving torque

① Standard motor (Curve (a1) in Figures 3.1 and 3.2)

Curve (a1) shows the torque characteristic that can be obtained in the range of the inverter continuous rated current, where the standard motor's cooling characteristic is taken into consideration. When the motor runs at the base frequency of 60 Hz, 100 % output torque can be obtained; at 50 Hz, the output torque is somewhat lower than that in commercial power, and it further lowers at lower frequencies. The reduction of the output torque at 50 Hz is due to increased loss by inverter driving, and that at lower frequencies is mainly due to heat generation caused by the decreased ventilation performance of the motor cooling fan.

② Motor exclusively designed for vector control (Curve (a2) in Figures 3.1 and 3.2)

Curve (a2) shows the torque characteristic that can be obtained in the range of the inverter continuous rated current, where the motor exclusively designed for vector control is connected. In the motor exclusively designed for vector control, the attached forced-cooling fan reduces heat generation from the motor, so that the torque does not drop in the low-speed range, compared to the standard motor.

(2) Maximum driving torque in a short time (Curves (b) and (c) in Figures 3.1 and 3.2)

Curve (b) shows the torque characteristic that can be obtained in the range of the inverter overload capability in a short time (LD mode: output torque is 120% for 1 minute, HD mode: output torque is 150% for 1 minute and 200% for 3 seconds) when torque-vector control is enabled. At that time, the motor cooling characteristics have little effect on the output torque.

Curve (c) shows an example of the torque characteristic when one class higher capacity inverter is used to increase the short-time maximum torque. In this case, the short-time torque is 20 to 30% greater than that when the standard capacity inverter is used.

(3) Starting torque (around the output frequency 0 Hz in Figures 3.1 and 3.2)

The maximum torque in a short time applies to the starting torque as it is.

(4) Braking torque (Curves (d), (e), and (f) in Figures 3.1 and 3.2)

In braking the motor, kinetic energy is converted to electrical energy and regenerated to the DC link bus capacitor (reservoir capacitor) of the inverter. Discharging this electrical energy to the braking resistor produces a large braking torque as shown in curve (e). If no braking resistor is provided, however, only the motor and inverter losses consume the regenerated braking energy so that the torque becomes smaller as shown in curve (d).

When an optional braking resistor is used, the braking torque is allowable only for a short time. Its time ratings are mainly determined by the braking resistor ratings. This manual and associated catalogs list the allowable values (kW) obtained from the average discharging loss and allowable values (kWs) obtained from the discharging capability that can be discharged at one time.

Note that the torque % value varies according to the inverter capacity.

Selecting an optimal brake unit enables a braking torque value to be selected comparatively freely in the range below the short-time maximum torque in the driving mode, as shown in curve (f).

For braking-related values when the inverter and braking resistor are normally combined, refer to Chapter 4, Section 4.4.1.1 "Braking resistors (DBRs) and braking units."

3.1.2 Selection procedure

Figure 3.3 shows the general selection procedure for optimal inverters. Items numbered (1) through (5) are described on the following pages.

You may easily select inverter capacity if there are no restrictions on acceleration and deceleration times. If "there are any restrictions on acceleration or deceleration time" or "acceleration and deceleration are frequent," then the selection procedure is more complex.

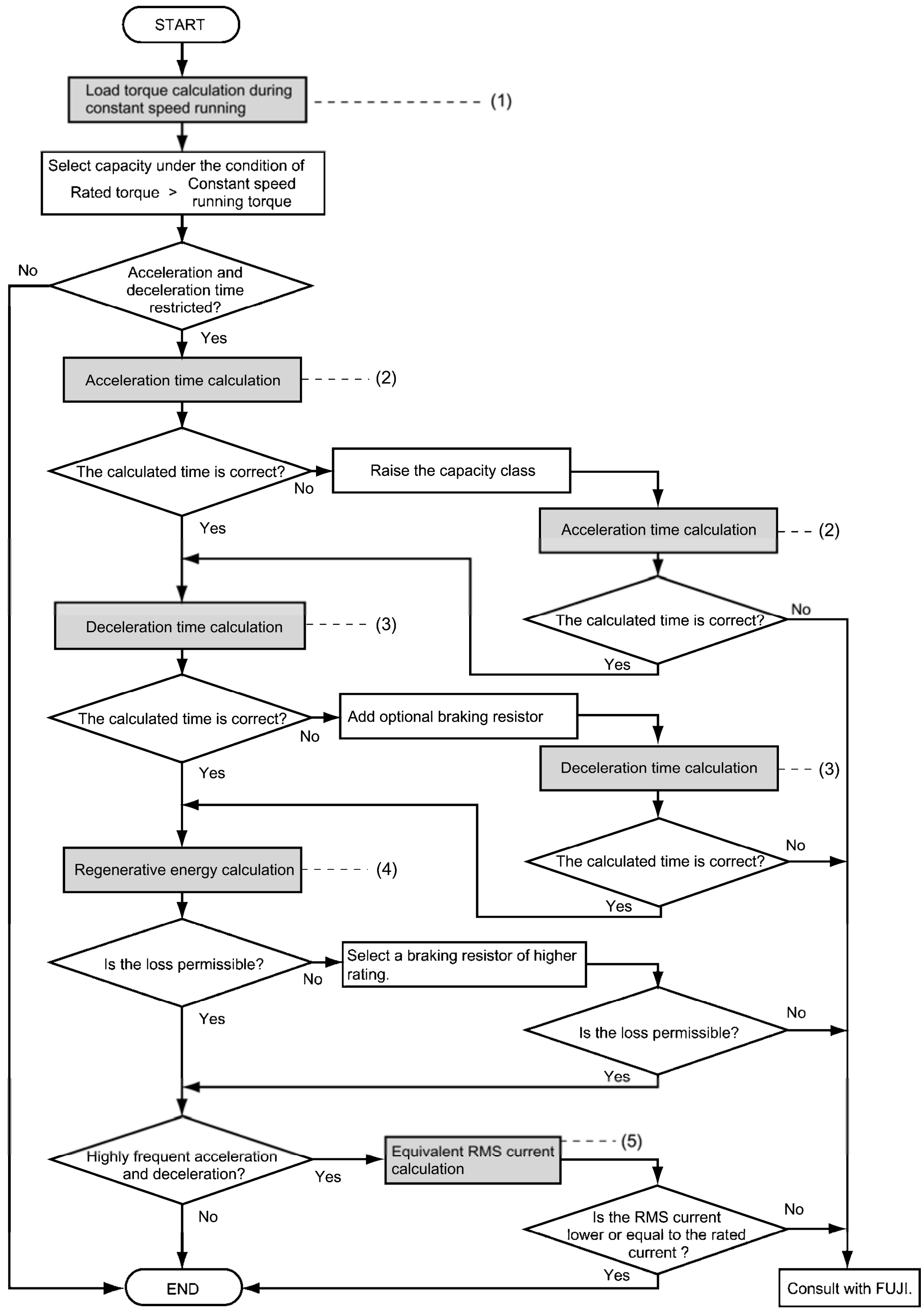


Figure 3.3 Selection Procedure

(1) Calculating the load torque during constant speed running (For detailed calculation, refer to Section 3.1.3.1)

It is essential to calculate the load torque during constant speed running for all loads.

First calculate the load torque of the motor during constant speed running and then select a tentative capacity so that the continuous rated torque of the motor during constant speed running becomes higher than the load torque. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load. To do this, select an appropriate reduction-gear (mechanical transmission) ratio and the number of motor poles.

If the acceleration or deceleration time is not restricted, the tentative capacity can apply as a defined capacity.

(2) Calculating the acceleration time (For detailed calculation, refer to Section 3.1.3.2)

When there are some specified requirements for the acceleration time, calculate it according to the following procedure:

1) Calculate the moment of inertia for the load and motor
Calculate the moment of inertia for the load, referring to Section 3.1.3.2, "Acceleration and deceleration time calculation." For the motor, refer to the related motor catalogs.

2) Calculate the minimum acceleration torque (See Figure 3.4)
The acceleration torque is the difference between the motor short-time output torque (base frequency: 60 Hz) explained in Section 3.1.1 (2), "Maximum driving torque in a short time" and the load torque (τ_L / η_G) during constant speed running calculated in the above (1). Calculate the minimum acceleration torque for the whole range of speed.

3) Calculate the acceleration time
Assign the value calculated above to the equation (3.15) in Section 3.1.3.2, "Acceleration and deceleration time calculation" to calculate the acceleration time. If the calculated acceleration time is longer than the expected time, select the inverter and motor having one class larger capacity and calculate it again.

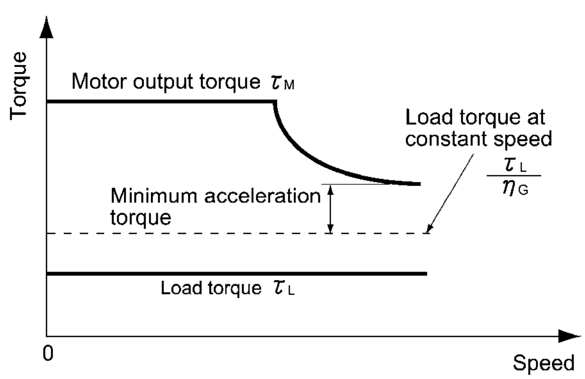


Figure 3.4 Example Study of Minimum Acceleration Torque

(3) Deceleration time (For detailed calculation, refer to Section 3.1.3.2)

To calculate the deceleration time, check the motor deceleration torque characteristics for the whole range of speed in the same way as for the acceleration time.

1) Calculate the moment of inertia for the load and motor
Same as for the acceleration time.

2) Calculate the minimum deceleration torque (See Figures 3.5 and 3.6.)
Same as for the deceleration time.

3) Calculate the deceleration time
Assign the value calculated above to the equation (3.16) to calculate the deceleration time in the same way as for the acceleration time. If the calculated deceleration time is longer than the requested time, select the inverter and motor having one class larger capacity and calculate it again.

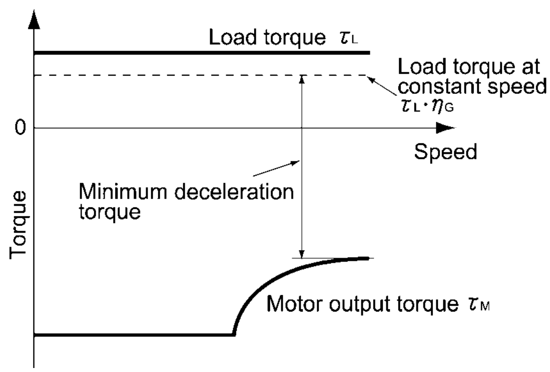


Figure 3.5 Example Study of Minimum Deceleration Torque (1)

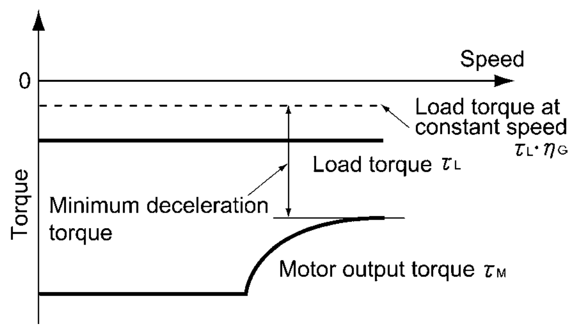


Figure 3.6 Example Study of Minimum Deceleration Torque (2)

(4) Braking resistor rating (For detailed calculation, refer to Section 3.1.3.3)

Braking resistor rating is classified into two types according to the braking periodic duty cycle.

1) When the periodic duty cycle is 100 sec or less:
Calculate the average loss to determine rated values.

2) When the periodic duty cycle exceeds 100 sec:
The allowable braking energy depends on the maximum regenerative braking capacity. The allowable values are listed in Chapter 4, Section 4.4.1.1 "Braking resistors (DBRs) and braking units."

(5) Motor RMS current (For detailed calculation, refer to Section 3.1.3.4)

In metal processing machine and materials handling machines requiring positioning control, highly frequent running for a short time is repeated. In this case, calculate the maximum equivalent RMS current value (effective value of current) not to exceed the allowable value (rated current) for the motor.

3.1.3 Equations for selections

Expressions given in this section are based on SI units (International System of Units). For other units, make a conversion, referring to the following.

(inch) ÷ 0.03937 = (mm)
(inch) ÷ 39.37 = (m)
(ft) ÷3.2808 = (m)
(N) = (kg·m/s^2)
(lbs) ÷ 2.2046 = (kg)
(N·m) × 8.8507 = (lb-in)

3.1.3.1 Load torque during constant speed running

[1] General equation

The frictional force acting on a horizontally moved load must be calculated. Calculation for driving a load along a straight line with the motor is shown below.

Where the force to move a load linearly at constant speed υ (m/s) is F (N) and the motor speed for driving this is N_M (min^{-1}), the required motor output torque τ_M (N·m) is as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{F}{\eta_G} \quad (N \cdot m) \qquad (3.1)$$

where, η_G is Reduction-gear efficiency.

When the inverter brakes the motor, efficiency works inversely, so the required motor torque should be calculated as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot F \cdot \eta_G \quad (N \cdot m) \qquad (3.2)$$

(60·υ) / (2π·N_M) in the above equation is an equivalent turning radius corresponding to speed υ (m/s) around the motor shaft.

The value F (N) in the above equations depends on the load type.

[2] Obtaining the required force F

■ Moving a load horizontally

A simplified mechanical configuration is assumed as shown in Figure 3.7. If the mass of the carrier table is W_0 (kg), the load is W (kg), and the friction coefficient of the ball screw is μ, then the friction force F (N) is expressed as follows, which is equal to a required force for driving the load:

$$F = (W_0 + W) \bullet g \bullet \mu \quad (N) \qquad (3.3)$$

where, g is the gravity acceleration (≈ 9.8 (m/s^2)).

Then, the driving torque around the motor shaft is expressed as follows:

$$\tau_M = \frac{60 \bullet \upsilon}{2\pi \bullet N_M} \bullet \frac{(W_0 + W) \bullet g \bullet \mu}{\eta_G} \quad (N \bullet m) \qquad (3.4)$$

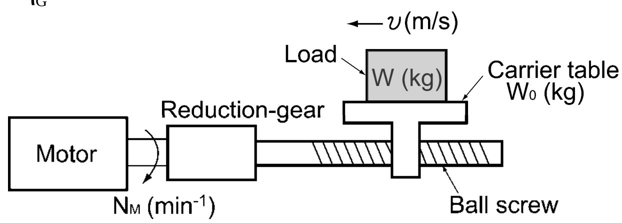


Figure 3.7 Moving a Load Horizontally

■ Vertical lift load

A simplified mechanical configuration is assumed as shown in Figure 3.8. If the mass of the cage is W_0 (kg), the load is W (kg), and the balance weight is W_B (kg), then the forces F (N) required for lifting the load up and down are expressed as follows:

$$F = (W_0 + W - W_B) \bullet g \ (N) \qquad \text{(For lifting up)} \qquad (3.5)$$

$$F = (W_0 - W - W_B) \bullet g \ (N) \qquad \text{(For lifting down)} \qquad (3.6)$$

Assuming the maximum load is W_{max}, the mass of the balance weight W_B (kg) is generally obtained with the expression $W_B = W_O + W_{max}/2$. Depending on the mass of load W (kg), the values of F (N) may be negative in both cases of lifting up and down, which means the lift is in braking mode. So, be careful in motor and inverter selection.

For calculation of the required output torque τ around the motor shaft, apply the expression (3.1) or (3.2) depending on the driving or braking mode of the lift, that is, apply the expression (3.1) if the value of F (N) is positive, and the (3.2) if negative.

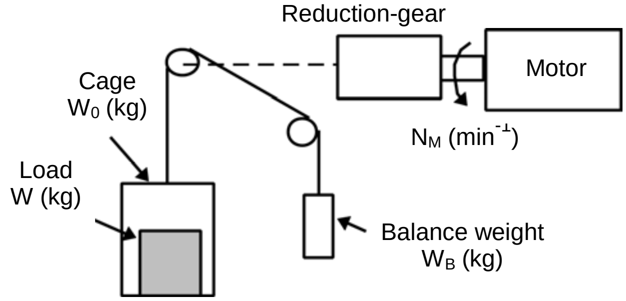


Figure 3.8 Vertical Lift Load

■ Inclined lift load

Although the mechanical configuration of an inclined lift load is similar to that of a vertical lift load, unignorable friction force in the inclined lift makes a difference; in an inclined lift load, there is a distinct difference between the expression to calculate the lift force F (N) for lifting up and that for lifting down.

If the incline angle is θ, and the friction coefficient is μ, as shown in the figure 3.9, the driving force F (N) is expressed as follows:

$$F = ((W_0 + W)(\sin\theta + \mu \bullet \cos\theta) - W_B) \bullet g \ \text{(N)} \quad \text{(For lifting up)} \quad (3.7)$$

$$F = ((W_B - (W_0 + W)(\sin\theta + \mu \bullet \cos\theta)) \bullet g \ \text{(N)} \quad \text{(For lifting down)} \quad (3.8)$$

The braking mode applies to both lifting up and down as in the vertical lift load. And the calculation of the required output torque τ around the motor shaft is the same as in the vertical lift load; apply the expression (3.1) if the value of F (N) is positive, and the (3.2) if negative.

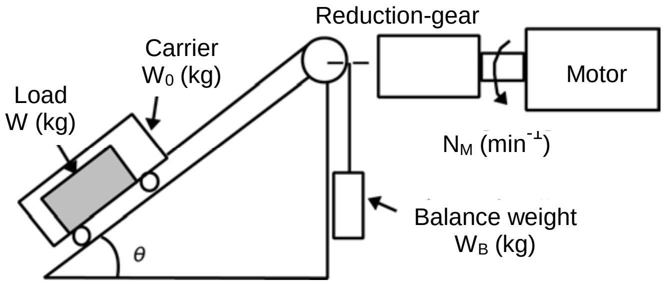


Figure 3.9 Inclined Lift Load

3.1.3.2 Acceleration and deceleration time calculation

When an object whose moment of inertia is J ($kg\cdot m^2$) rotates at the speed N (min^{-1}), it has the following kinetic energy:

$$E = \frac{J}{2} \bullet \left(\frac{2\pi \bullet N}{60}\right)^2 \quad (J) \qquad (3.9)$$

To accelerate the above rotational object, the kinetic energy will be increased; to decelerate the object, the kinetic energy must be discharged. The torque required for acceleration and deceleration can be expressed as follows:

$$\tau = J \bullet \frac{2\pi}{60} \left(\frac{dN}{dt}\right) \quad (N \bullet m) \qquad (3.10)$$

This way, the mechanical moment of inertia is an important element in the acceleration and deceleration. First, calculation method of moment of inertia is described, then those for acceleration and deceleration time are explained.

[1] Calculation of moment of inertia

For an object that rotates around the shaft, virtually divide the object into small segments and square the distance from the shaft to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia.

$$J = \sum (W_i \bullet r_i^2) \quad (kg \bullet m^2) \qquad (3.11)$$

The following describes equations to calculate moment of inertia having different shaped loads or load systems.

(1) Hollow cylinder and solid cylinder

The common shape of a rotating body is hollow cylinder. The moment of inertia J ($kg\cdot m^2$) around the hollow cylinder center axis can be calculated as follows, where the outer and inner diameters are D_1 and D_2 (m) and total mass is W (kg) in Figure 3.10.

$$J = \frac{W \bullet (D_1^2 + D_2^2)}{8} \quad (kg \bullet m^2) \qquad (3.12)$$

For a similar shape, a solid cylinder, calculate the moment of inertia as D_2 is 0.

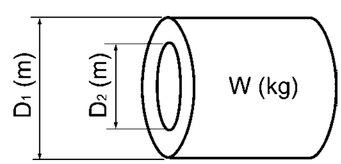
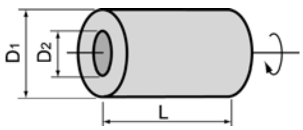
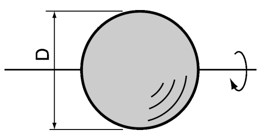
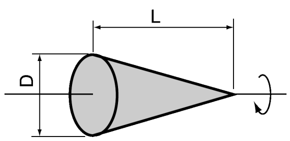
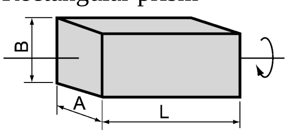
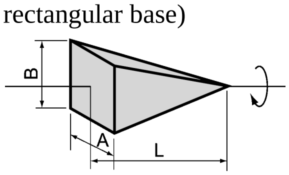
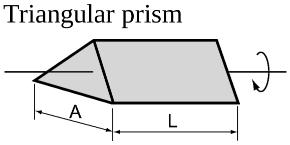
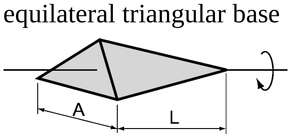


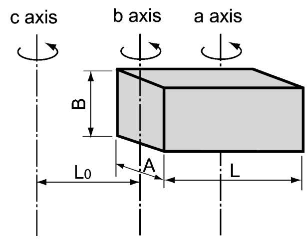
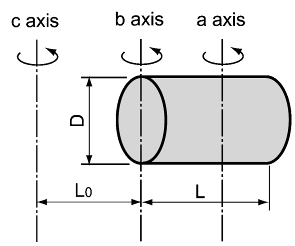
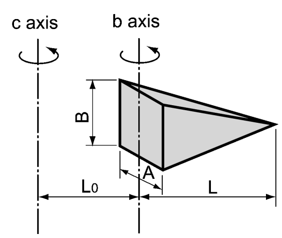
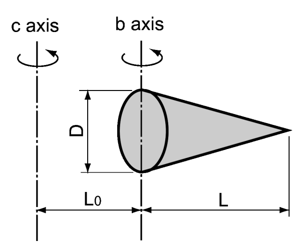
Figure 3.10 Hollow Cylinder

(2) For a general rotating body

Table 3.1 lists the calculation equations of moment of inertia of various rotating bodies including the above cylindrical rotating body.

Table 3.1 Moment of Inertia of Various Rotating Bodies

Shape	Mass: W (kg)	Moment of inertia: J ($kg \cdot m^2$)
Hollow cylinder 	$W = \frac{\pi}{4} \bullet (D_1^2 - D_2^2) \bullet L \bullet \rho$	$J = \frac{1}{8} \bullet W \bullet (D_1^2 + D_2^2)$
Sphere 	$W = \frac{\pi}{6} \bullet D^3 \bullet \rho$	$J = \frac{1}{10} \bullet W \bullet D^2$
Cone 	$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$	$J = \frac{3}{40} \bullet W \bullet D^2$
Rectangular prism 	$W = A \bullet B \bullet L \bullet \rho$	$J = \frac{1}{12} \bullet W \bullet (A^2 + B^2)$
Square cone (Pyramid, rectangular base) 	$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$	$J = \frac{1}{20} \bullet W \bullet (A^2 + B^2)$
Triangular prism 	$W = \frac{\sqrt{3}}{4} \bullet A^2 \bullet L \bullet \rho$	$J = \frac{1}{3} \bullet W \bullet A^2$
Tetrahedron with an equilateral triangular base 	$W = \frac{\sqrt{3}}{12} \bullet A^2 \bullet L \bullet \rho$	$J = \frac{1}{5} \bullet W \bullet A^2$

Shape	Mass: W (kg)	Moment of inertia: J ($kg \cdot m^2$)
	$W = A \bullet B \bullet L \bullet \rho$	$J_a = \frac{1}{12} \bullet W \bullet (L^2 + A^2)$ $J_b = \frac{1}{12} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
	$W = \frac{\pi}{4} \bullet D^2 \bullet L \bullet \rho$	$J_a = \frac{1}{12} \bullet W \bullet (L^2 + \frac{3}{4} \bullet D^2)$ $J_b = \frac{1}{3} \bullet W \bullet (L^2 + \frac{3}{16} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
	$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$	$J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$
	$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$	$J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{3}{8} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$

Main metal density (at 20°C (68 °F)) ρ(kg/m^3) Iron: 7860, Copper: 8940, Aluminum: 2700

(3) For a load running horizontally

Assume a carrier table driven by a motor as shown in Figure 3.7. If the table speed υ (m/s) when the motor speed is N_M (min^{-1}), then an equivalent distance from the shaft is equal to $60 \cdot \upsilon / (2\pi \cdot N_M)$ (m). The moment of inertia of the table and load to the shaft is calculated as follows:

$$J = \left(\frac{60 \bullet \upsilon}{2\pi \bullet N_M}\right)^2 \bullet (W_0 + W) \quad (kg \bullet m^2) \qquad (3.13)$$

(4) For a vertical or inclined lift load

The moment of inertia J ($kg \cdot m^2$) of the loads connected with a rope as shown in Figures 3.8 and 3.9 is calculated with the following equation using the mass of all moving objects, although the motion directions of those loads are different.

$$J = \left(\frac{60 \bullet \upsilon}{2\pi \bullet N_M}\right)^2 \bullet (W_0 + W + W_B) \quad (kg \bullet m^2) \qquad (3.14)$$

[2] Calculation of the acceleration time

Figure 3.11 shows a general load model. Assume that a motor drives a load via a reduction-gear with efficiency η_G. The time required to accelerate this load in stop state to a speed of N_M (min^{-1}) is calculated with the following equation:

$$t_{ACC} = \frac{J_1 + J_2/\eta_G}{\tau_M - \tau_L/\eta_G} \bullet \frac{2\pi \bullet (N_M - 0)}{60} \quad (s) \qquad (3.15)$$

where,

J_1: Motor shaft moment of inertia ($kg \cdot m^2$)
J_2: Load shaft moment of inertia converted to motor shaft ($kg \cdot m^2$)
τ_M: Minimum motor output torque in driving motor ($N \cdot m$)
τ_L: Maximum load torque converted to motor shaft ($N \cdot m$)
η_G: Reduction-gear efficiency.

As clarified in the above equation, the equivalent moment of inertia becomes ($J_1 + J_2/\eta_G$) by considering the reduction-gear efficiency.

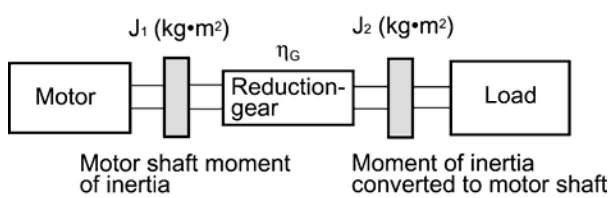


Figure 3.11 Load Model Including Reduction-gear

[3] Calculation of the deceleration time

In a load system shown in Figure 3.11, the time needed to stop the motor rotating at a speed of N_M (min^{-1}) is calculated with the following equation:

$$t_{DEC} = \frac{J_1 + J_2 \bullet \eta_G}{\tau_M - \tau_L \bullet \eta_G} \bullet \frac{2\pi \bullet (0 - N_M)}{60} \quad (s) \qquad (3.16)$$

where,

J_1: Motor shaft moment of inertia ($kg \cdot m^2$)
J_2: Load shaft moment of inertia converted to motor shaft ($kg \cdot m^2$)
τ_M: Minimum motor output torque in braking (or decelerating) motor ($N \cdot m$)
τ_L: Maximum load torque converted to motor shaft ($N \cdot m$)
η_G: Reduction-gear efficiency

In the above equation, generally output torque τ_M is negative and load torque τ_L is positive. So, deceleration time becomes shorter.

Tip For lift applications, calculate the deceleration time using the negative value of τ_L (maximum load torque converted to motor shaft).

[4] Calculating non-linear acceleration/deceleration time

In applications requiring frequent acceleration/deceleration, the inverter can accelerate/decelerate the motor in the shortest time utilizing all torque margin. The inverter in a vector control mode can easily perform this type of operation.

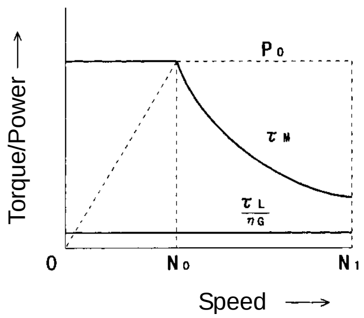


Figure 3.12 An Example of Driving Characteristics with a Constant Output Range

In this case, the acceleration/deceleration vs. speed curve will form a non-linear figure, and the acceleration/deceleration time cannot be calculated by a single expression.

Generally, the acceleration/deceleration time is obtained by calculating the acceleration/deceleration time of ΔN that is a difference of speed N broken into small parts, and then integrating it to obtain the total acceleration/deceleration time from start to end. Because the smaller ΔN provides higher accuracy, this numerical calculation needs an aid of a computer program.

The following is a guide for the numerical calculation method using a computer program.

Figure 3.12 illustrates an example of driving characteristics with a constant output range. In the figure, the range under N_0 is of constant torque characteristics, and the range between N_0 and N_1 is of a constant output with the non-linear acceleration/deceleration characteristics.

[4-1]   Calculating non-linear acceleration time

The expression (3.17) gives an acceleration time Δt_{ACC} within a ΔN speed thread.

$$\Delta t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M - \tau_L / \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad (s) \qquad (3.17)$$

Before proceeding this calculation, obtain the motor shaft moment of inertia J_1, the load shaft moment of inertia converted to motor shaft J_2, maximum load torque converted to motor shaft τ_L, and the reduction-gear efficiency η_G. Apply the maximum motor output torque τ_M according to an actual speed thread ΔN as follows.

[τ_M in $N \leq N_0$]   Constant output torque range

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N_0} \quad (N.m) \qquad (3.18)$$

[τ_M in $N_0 \leq N \leq N_1$]   Constant output power range
(The motor output torque is inversely proportional to the motor speed)

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N} \quad (N.m) \qquad (3.19)$$

If the result obtained by the above calculation does not satisfy the target value, select an inverter with one rank higher capacity.

[4-2]   Calculating non-linear deceleration time

Use the following expression to obtain the non-linear deceleration time as well as for the acceleration time shown in [4-1].

$$\Delta t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad (s) \qquad (3.20)$$

In this expression, both τ_M, and ΔN are generally negative values so that the load torque τ_L serves to assist the deceleration operation. For a lift load, however, the load torque τ_L is a negative value in some modes. In this case, the τ_M, and τ_L will take polarity opposite to each other and the τ_L will serve to prevent the deceleration operation of the lift.

3.1.3.3 Heat energy calculation of braking resistor

If the inverter brakes the motor, the kinetic energy of mechanical system is converted to electric energy to be regenerated into the inverter circuit. This regenerative energy is often consumed in so-called braking resistors as heat. The following explains the braking resistor rating.

[1] Calculation of regenerative energy

In the inverter operation, one of the regenerative energy sources is the kinetic energy that is generated at the time an object is moved by an inertial force.

(1) Kinetic energy of a moving object

When an object with moment of inertia J ($kg \cdot m^2$) rotates at a speed N_2 (min^{-1}), its kinetic energy is as follows:

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N_2}{60}\right)^2 \quad (J = Ws) \qquad (3.21)$$

$$\approx \frac{1}{182.4} \cdot J \cdot N_2^2 \quad (J) \qquad (3.21)'$$

When this object is decelerated to a speed N_1 (min^{-1}), the output energy is as follows:

$$E = \frac{J}{2} \cdot \left[\left(\frac{2\pi \cdot N_2}{60}\right)^2 - \left(\frac{2\pi \cdot N_1}{60}\right)^2\right] \quad (J) \qquad (3.22)$$

$$\approx \frac{1}{182.4} \cdot J \cdot (N_2^2 - N_1^2) \quad (J) \qquad (3.22)'$$

The energy regenerated to the inverter as shown in Figure 3.11 is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E \approx \frac{1}{182.4} \cdot (J_1 + J_2 \cdot \eta_G) \cdot \eta_M \cdot (N_2^2 - N_1^2) \quad (J) \qquad (3.23)$$

(2) Potential energy of a lift

When an object whose mass is W (kg) falls from the height h_2 (m) to the height h_1 (m), the output energy is as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \ (J=Ws) \qquad (3.24)$$

$$g \approx 9.8065 \ (m/s^2)$$

The energy regenerated to the inverter is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \bullet \eta_G \bullet \eta_M \ (J) \qquad (3.25)$$

3.1.3.4 Calculating the RMS rating of the motor

In case of the load which is repeatedly and very frequently driven by a motor, the motor current fluctuates largely and enters the short-time rating range of the motor repeatedly. Therefore, you have to review the allowable thermal rating of the motor. The heat value is assumed to be approximately proportional to the square of the motor current.

If an inverter drives a motor in duty cycles that are much shorter than the thermal time constant of the motor, calculate the "equivalent RMS current" as mentioned below, and select the motor so that this RMS current will not exceed the rated current of the motor.

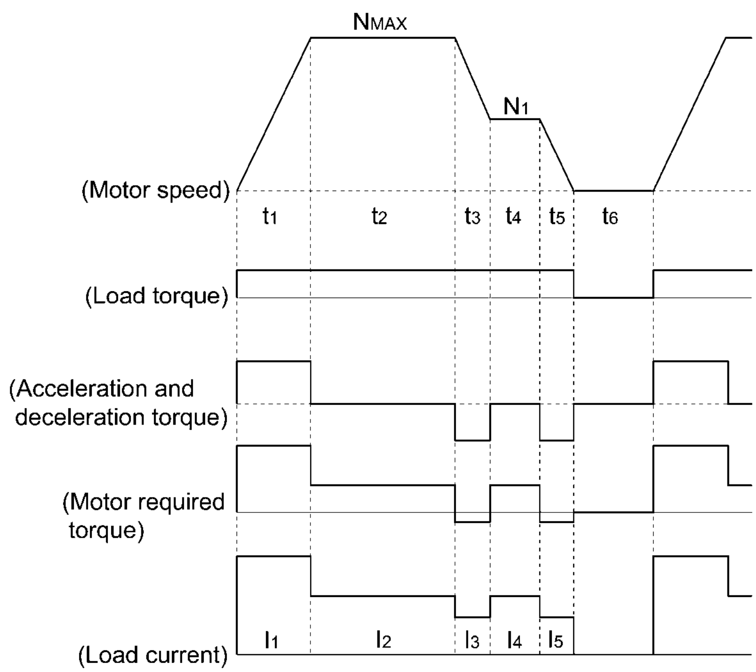


Figure 3.13 Sample of the Repetitive Operation

First, calculate the required torque of each part based on the speed pattern. Then using the torque-current curve of the motor, convert the torque to the motor current. The "equivalent RMS current, I_{eq}" can be finally calculated by the following equation:

$$I_{eq} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1 + t_2 + t_3 + t_4 + t_5 + t_6}} \quad (A) \qquad (3.26)$$

The torque-current curve for the dedicated motor is not available for actual calculation. Therefore, calculate the motor current I from the load torque τ_1 using the following equation (3.27). Then, calculate the equivalent current I_{eq}:

$$I = \sqrt{\left(\frac{\tau_1}{100} \times I_{t100}\right)^2 + I_{m100}^2} \quad (A) \qquad (3.27)$$

Where, τ_1 is the load torque (%), I_{t100} is the torque current, and I_{m100} is exciting current.

3.2 Selecting a Braking Resistor

3.2.1 Selection procedure

Depending on the cyclic period, the following requirements must be satisfied.

① If the cyclic period is 100 s or less: Requirements 1) and 3) below
② If the cyclic period exceeds 100 s: Requirements 1) and 2) below

1) The maximum braking torque should not exceed values listed in Tables 4.6 to 4.9 in Chapter 4, Section 4.4.1.1 "Braking resistors (DBRs) and braking units." To use the maximum braking torque exceeding values in those tables, select the braking resistor having one class larger capacity.
2) The discharge energy for a single braking action should not exceed the discharging capability (kWs) listed in Tables 4.6 to 4.9 in Chapter 4, Section 4.4.1.1 "Braking resistors (DBRs) and braking units." For detailed calculation, refer to Section 3.1.3.3 "Heat energy calculation of braking resistor."
3) The average loss that is calculated by dividing the discharge energy by the cyclic period must not exceed the average allowable loss (kW) listed in Tables 4.6 to 4.9 in Chapter 4, Section 4.4.1.1 "Braking resistors (DBRs) and braking units."

3.2.2 Notes on selection

The braking time T_1, cyclic period T_0, and duty cycle %ED are converted under deceleration braking conditions based on the rated torque as shown below. However, you do not need to consider these values when selecting the braking resistor capacity.

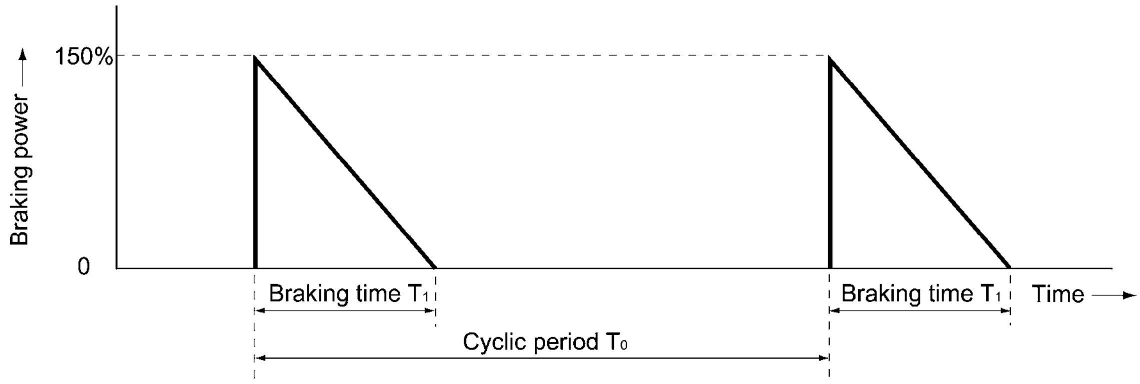


Figure 3.14 Duty Cycle

$$\text{Duty cycle \%ED} = \frac{T1}{T0} \times 100\ (\%)$$

3.3 Selecting an Inverter Drive Mode (LD/MD/HD)

3.3.1 Precaution in making the selection

The FRENIC-MEGA series of inverters is applicable to three ratings--low duty (LD) for light load applications, medium duty (MD) for medium load ones, and high duty (HD) for heavy load ones. The MD mode is available for inverters of 150 to 800 HP with three-phase 460 V input.

Note: For 7.5 HP and smaller, when LD mode is selected, the HD mode specification applies.

Select the inverter drive mode appropriate to the user application, considering the motor capacity, overload characteristics, and LD/MD/HD mode referring to Section 3.3.2 "Guideline for selecting inverter drive mode and capacity."

LD mode designed for light duty load applications

Apply to variable load equipment such as fans, pumps, and centrifugal machines where the inverter's load current in normal operations is less than the inverter rated current, and the load current in overcurrent operation is less than 120% of the rated current for 1 minute.

MD mode designed for medium duty load applications

Apply to equipment where the inverter's load current in normal operations is less than the inverter rated current, and the load current in overcurrent operation is less than 150% of the rated current for 1 minute.

HD mode designed for heavy duty load applications

Apply to general-purpose equipment where the inverter's load current in normal operations is less than the inverter rated current, and the load current in overcurrent operation is less than 150% of the rated current for 1 minute and 200% for 3 seconds.

3.3.2 Guideline for selecting inverter drive mode and capacity

Table 3.2 lists the differences between LD, MD, and HD modes.

Note: The MD mode is available for inverters of 150 to 800 HP with three-phase 460 V input.
Note: For inverters of 7.5 HP and smaller, when LD mode is selected, the HD mode specification applies.

Table 3.2 Differences between LD, MD, and HD modes

Function	LD mode	MD mode	HD mode	Remarks
Application	Light duty load	Medium duty load	Heavy duty load	—
Function code data setting (Switching between LD, MD, and HD modes)	F80 = 1 (Factory default)	F80 = 2	F80 = 0	—
Continuous current rating level (inverter rated current level)	Drives a motor whose capacity is the same as the inverter's one.	Drives a motor whose capacity is the same as the inverter's one or derates a motor one rank lower than the inverter's capacity.	Derates a motor one rank or two ranks lower than the inverter's capacity.	Switching to the MD/HD mode increases the overload capability (%) against the continuous current level up to 150%, but it requires derating the motor one or two ranks lower than the inverter's capacity. For the rated current level, refer to Chapter 2 "SPECIFICATIONS."
Overload capability	120% for 1 min.	150% for 1 min.	150% for 1 min. 200% for 3 s	
Maximum frequency	Setting range: 25 to 500 Hz Upper limit: 120 Hz		Setting range: 25 to 500 Hz Upper limit: 500 Hz	In the LD/MD mode, if the maximum frequency exceeds 120 Hz, the actual output frequency is internally limited to 120 Hz.
DC braking (Braking level)	Setting range: 0 to 80%		Setting range: 0 to 100%	In the LD/MD mode, a value out of the range, if specified, automatically changes to the maximum value allowable in the LD mode.
Motor sound (Carrier frequency)	Setting range: 0.75 to 16 kHz (0.5 to 30 HP) 0.75 to 10 kHz (40 to 100 HP) 0.75 to 6 kHz (125 to 900 HP) 0.75 to 4 kHz (1000 HP)	Setting range: 0.75 to 2 kHz (150 to 800 HP)	Setting range: 0.75 to 16 kHz (0.5 to 100 HP) 0.75 to 10 kHz (125 to 800 HP) 0.75 to 6 kHz (900 and 1000 HP)	
Current limiter (Level)	Initial value: 130%	Initial value: 145%	Initial value: 160%	Switching the drive mode between LD, MD, and HD with function code F80 automatically initializes the F44 data to the value specified at left.
Current indication and output	Based on the rated current level for LD mode	Based on the rated current level for MD mode	Based on the rated current level for HD mode	—

3.4 Selecting a Motor Drive Control

3.4.1 Features of motor drive controls

The FRENIC-MEGA supports the following motor drive controls.

This section shows their basic configurations and describes their features.

<table>
<tr><th>Drive control</th><th>Basic control</th><th>Speed feedback</th><th>Drive control class</th><th>Speed control</th><th>Other restrictions</th></tr>
<tr><td>V/f control
with slip compensation inactive</td><td rowspan="5">V/f control</td><td rowspan="3">Disable</td><td rowspan="3">V/f</td><td>Frequency control</td><td>—</td></tr>
<tr><td>Dynamic torque vector control</td><td rowspan="2">Frequency control
with slip compensation</td><td>—</td></tr>
<tr><td>V/f control
with slip compensation active</td><td>—</td></tr>
<tr><td>V/f control
with speed sensor *</td><td rowspan="2">Enable</td><td rowspan="2">PG V/f</td><td rowspan="2">Frequency control
with automatic speed regulator (ASR)</td><td rowspan="2">Maximum frequency: 200 Hz</td></tr>
<tr><td>Dynamic torque vector control
with speed sensor *</td></tr>
<tr><td>Vector control
without speed sensor</td><td rowspan="2">Vector control</td><td>Estimated speed</td><td>w/o PG</td><td rowspan="2">Speed control
with automatic speed regulator (ASR)</td><td>Maximum frequency: 120 Hz
Not available for MD-mode inverters.</td></tr>
<tr><td>Vector control
with speed sensor *</td><td>Enable</td><td>w/ PG</td><td>Maximum frequency: 200 Hz</td></tr>
</table>

Note that the controls marked with an asterisk (*) require an optional PG (Pulse Generator) interface card.

■ V/f control with slip compensation inactive

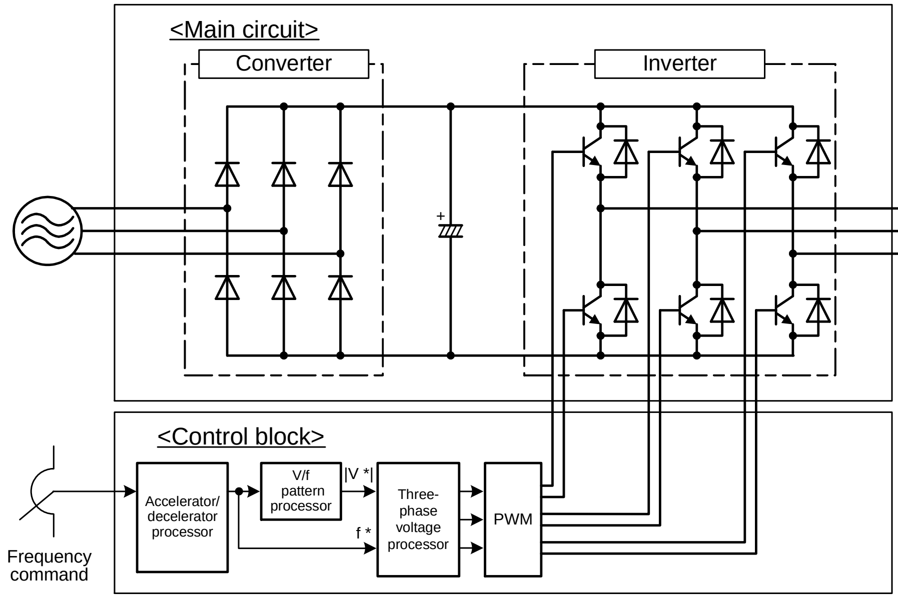


Figure 3.15 Schematic Block Diagram of V/f Control with Slip Compensation Inactive

As shown in the above configuration, the inverter does not receive any speed information feedback from the target machinery being controlled and it controls the load shaft speed only with a frequency command given by the frequency setting device (open-loop control). The inverter outputs the voltage/frequency following the V/f pattern processor's output to drive a motor. This control disables all automatically controlled features (such as the slip compensation), causing no unpredictable output fluctuation and enabling stable operation with constant output frequency.

This control is suitable for applications that do not need quick speed change such as variable torque load equipment, fans and pumps.

■ Dynamic torque vector control

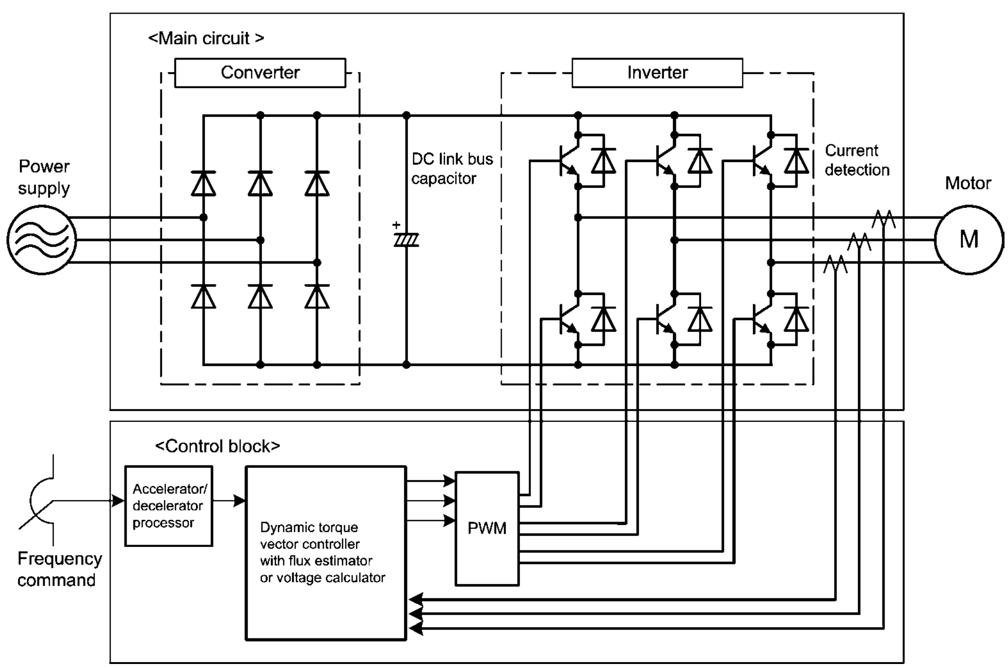


Figure 3.16 Schematic Block Diagram of Dynamic Torque Vector Control

The FRENIC-MEGA features the dynamic torque vector controller with the flux estimator, which is always correcting the magnetic flux phase while monitoring the inverter output current as the feedback. This feature allows the inverter to always apply the drive power with an optimal voltage and current and consequently respond to quick load variation or speed change.

The feature also estimates the generated torque of the motor from the estimated flux data and output current to the motor to improve the motor efficiency for matching the current operation situation.

This control mode is effective for applications that need large torque in low speed range or that have quick load fluctuations. Selecting the dynamic torque vector control automatically enables the auto-torque boost and slip compensation.

■ V/f control with slip compensation active

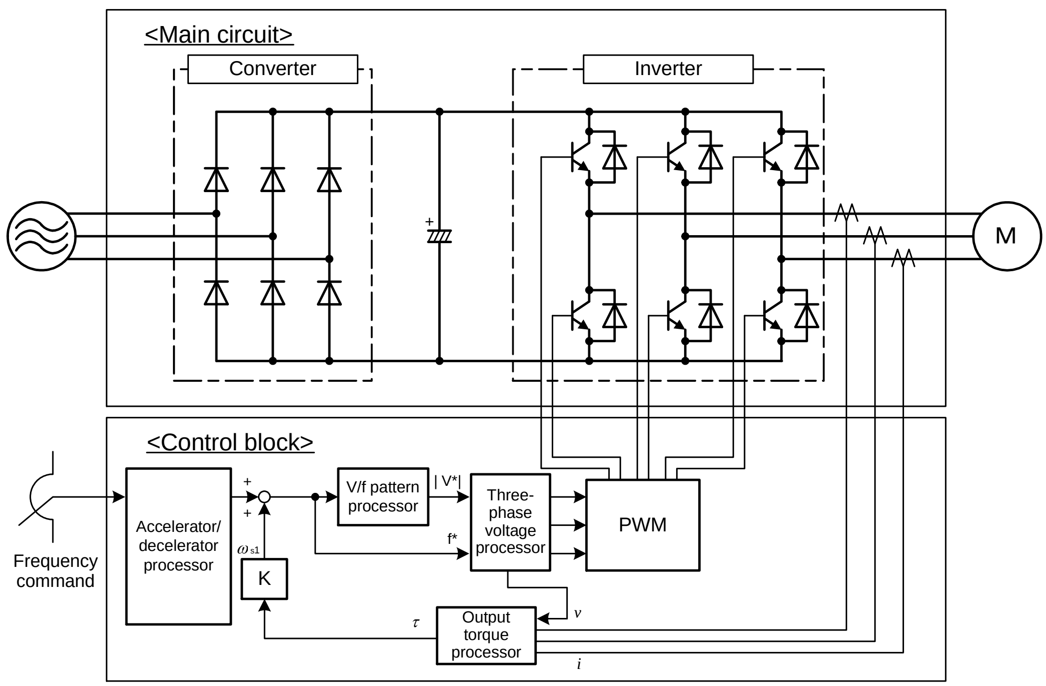


Figure 3.17 Schematic Block Diagram of V/f Control with Slip Compensation Active

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. The inverter's slip compensation function first presumes the slip value of the motor based on the motor torque generated and raises the output frequency to compensate for the decrease in motor rotation. This prevents the motor from decreasing the rotation due to the slip.

That is, this function is effective for improving the motor speed control accuracy.

■ Vector control without speed sensor

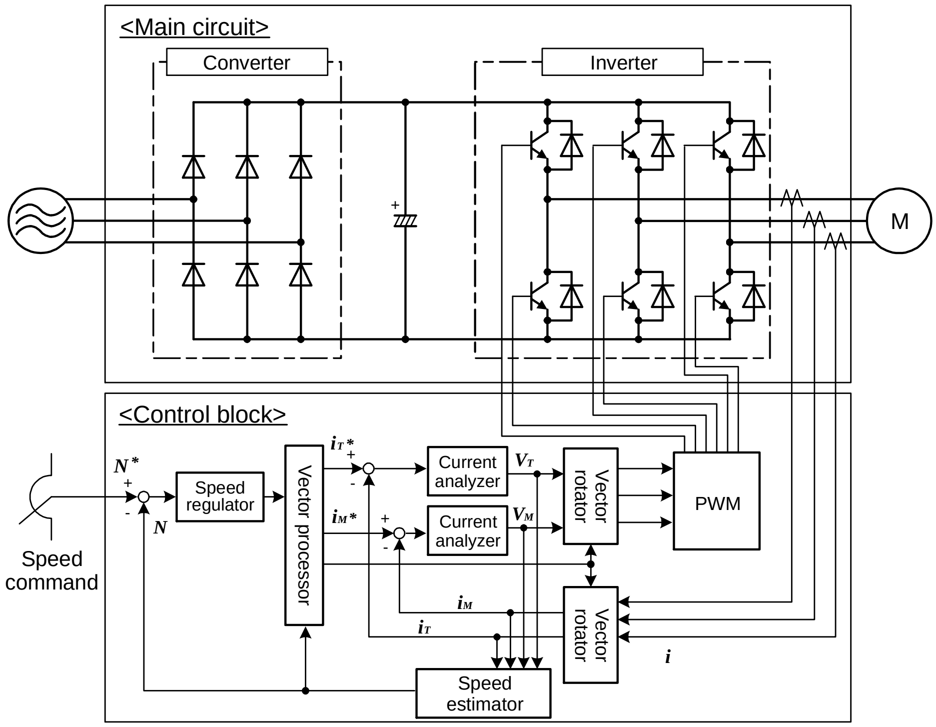


Figure 3.18 Schematic Block Diagram of Vector Control without Speed Sensor

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

The vector control without speed sensor in the FRENIC-MEGA series has adopted the magnetic flux observer system, improving the control performance in the low speed domain.

Since this control controls the motor current, it is necessary to secure some voltage margin between the voltage that the inverter can output and the induced voltage of the motor, by keeping the former lower than the latter. Usually the voltage of the general-purpose motor has been adjusted to match the commercial power, however, in order to secure the voltage margin, it is necessary to keep the motor terminal voltage low.

If the motor is driven under this control with the motor terminal voltage being low, the rated torque cannot be obtained even when the rated current originally specified for the motor is applied. To secure the rated torque, therefore, it is necessary to use a motor with higher rated current. (This also applies to the vector control with speed sensor.)

This control is not available for MD-mode inverters, so do not set F42 data to "5" for those inverters.

■ Vector control with speed sensor

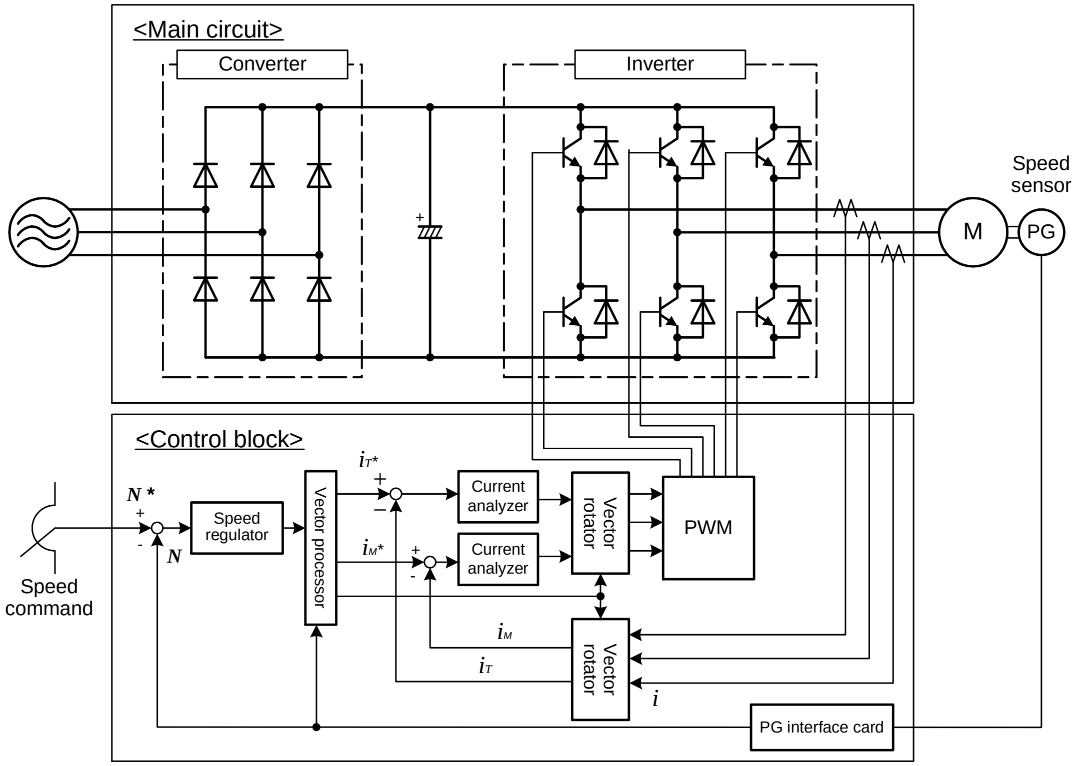


Figure 3.19 Schematic Block Diagram of Vector Control with Speed Sensor

As shown in the above configuration, the inverter is equipped with an optional PG (Pulse Generator) interface card and receives the feedback signals from the PG to detect the motor rotational position and speed. This enables rapid-response control of the motor speed with high accuracy. (It is recommended to use Fuji motors exclusively designed for vector control.)

By dividing the current flowing across the motor into the exciting current and torque current to control them separately, the inverter can control an induction motor with as high controllability as a DC motor.

This control is suitable for:

- Applications that need to minimize the speed fluctuation over quick load variations
- Applications that need highly precise positioning
- Applications that need the servo-lock function to generate a holding torque negating external disturbances even while the motor is stopping
- Applications that need large torque output in low speed operation
- Applications that need to protect the equipment from an unexpectedly outputted large torque, because the torque limiting/controlling function is available

3.4.2 Selecting a Motor Drive Control by Purpose

Listed below is a general guide for selecting a motor drive control by purpose. Use this guide just for reference. In individual cases, selection should be made carefully after a technical consultation regarding the detailed specifications of your system.

Table 3.3 Motor Drive Control by Purpose

Drive control abbreviation: "V/f" (V/f control), "Torque vector" (Dynamic torque vector control), "w/o PG" (Vector control without speed sensor), "w/ PG" (Vector control with speed sensor)

Type of industry	Applications	Segment	Drive control			
			V/f	Torque vector	w/o PG	w/ PG
Delivery equipment	Crane (Hoisting)	Large crane	N	N	N	Y
		Overhead crane	N	N	N	Y
		Compact hoist-type crane	N	Y	Y	Y
	(Traveling)	1 : 1	Y*	Y*	Y*	Y
	(Traveling)	1 : N	Y	N	N	N
	(Traversing)		N	Y*	Y*	Y
	(Traversing)	With anti-sway control	N	N	N	Y
	Traveling dolly	Single motor	Y	Y	Y	Y
		Multiple motors	Y	Y	N	Y*
	Roller table		N	N	N	Y
	Parking tower (Elevator type)	Less than 50 m/min	Y*	Y	Y	Y
		50 m/min or above	Y*	Y*	Y*	Y
		50 m/min or above, zero speed required	N	N	N	Y*
	Parking tower (Circulation type)		Y*	Y	Y	Y
	Multistory warehouse (Stacker crane)	With position compensation	N	N	Y*	Y
		Without position compensation	Y	Y	Y	Y
	Variable speed escalator		Y*	Y	Y	Y
Plastic	Extruding machine	Low precision	N	Y	N	Y
		High precision	N	N	N	Y
Metalworking	Wire drawing machine	Straight type with dancer	N	N	N	Y
		Storage type	Y*	Y	Y	Y
	Drawbench		Y*	Y	Y	Y
	Twisting machine	Main unit	N	N	N	Y
		Auxiliary machine	N	N	N	Y
	Press main engine driving	Standard type	Y	Y	Y	Y
		High-speed press	Y*	Y	Y	Y
	Winder/unwinder for iron and steel		N	N	N	Y*
Printing and binding	Cut-sheet printer		N	N	N	Y
	Offset printer		N	N	N	Y
	Continuous feed printer (Rotary press)	Line shaft	N	N	N	Y
Textile	Synthetic fiber spinning	Winder	N	N	N	Y
		Traverser	N	N	N	Y
		Various rolls, gear pump	Y	Y	Y	Y
	Preparing machine	Taking-up	N	N	N	Y*
		Feeding	N	N	N	Y*

Y: Applicable (Examination required), Y*: Examination required, N: Not applicable

Table 3.3 Motor Drive Control by Purpose (Continued)

Drive control abbreviation: "V/f" (V/f control), "Torque vector" (Dynamic torque vector control), "w/o PG" (Vector control without speed sensor), "w/ PG" (Vector control with speed sensor)

Type of industry	Applications	Segment	Drive control			
			V/f	Torque vector	w/o PG	w/ PG
Others	Winder without dancer	Center drive (winding off)	N	N	N	Y*
		Surface drive	N	N	N	Y
	Winder with dancer	Center drive (winding off)	Y*	Y	Y	Y
		Center drive (taking up)	Y*	Y	Y	Y
	(Cement) kiln		Y*	Y	Y	Y
	Centrifuge		Y*	Y	Y	Y
	Agitator		Y*	Y	Y	Y
	Crusher		Y*	Y	Y*	Y
	Vibration exciter		N	N	N	Y*
	Straightening machine		N	N	N	Y
	Grinder		N	N	N	Y
	Machine tool (large)		N	N	N	Y
	Automotive test equipment	Mission tester	N	N	N	Y*

Y: Applicable (Examination required), Y*: Examination required, N: Not applicable

Chapter 4

SELECTING PERIPHERAL EQUIPMENT

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

Contents

4.1 Configuring the FRENIC-MEGA

This section lists the names and features of peripheral equipment and options for the FRENIC-MEGA series of inverters and includes a configuration example for reference. Refer to Figure 4.1 for a quick overview of available options.

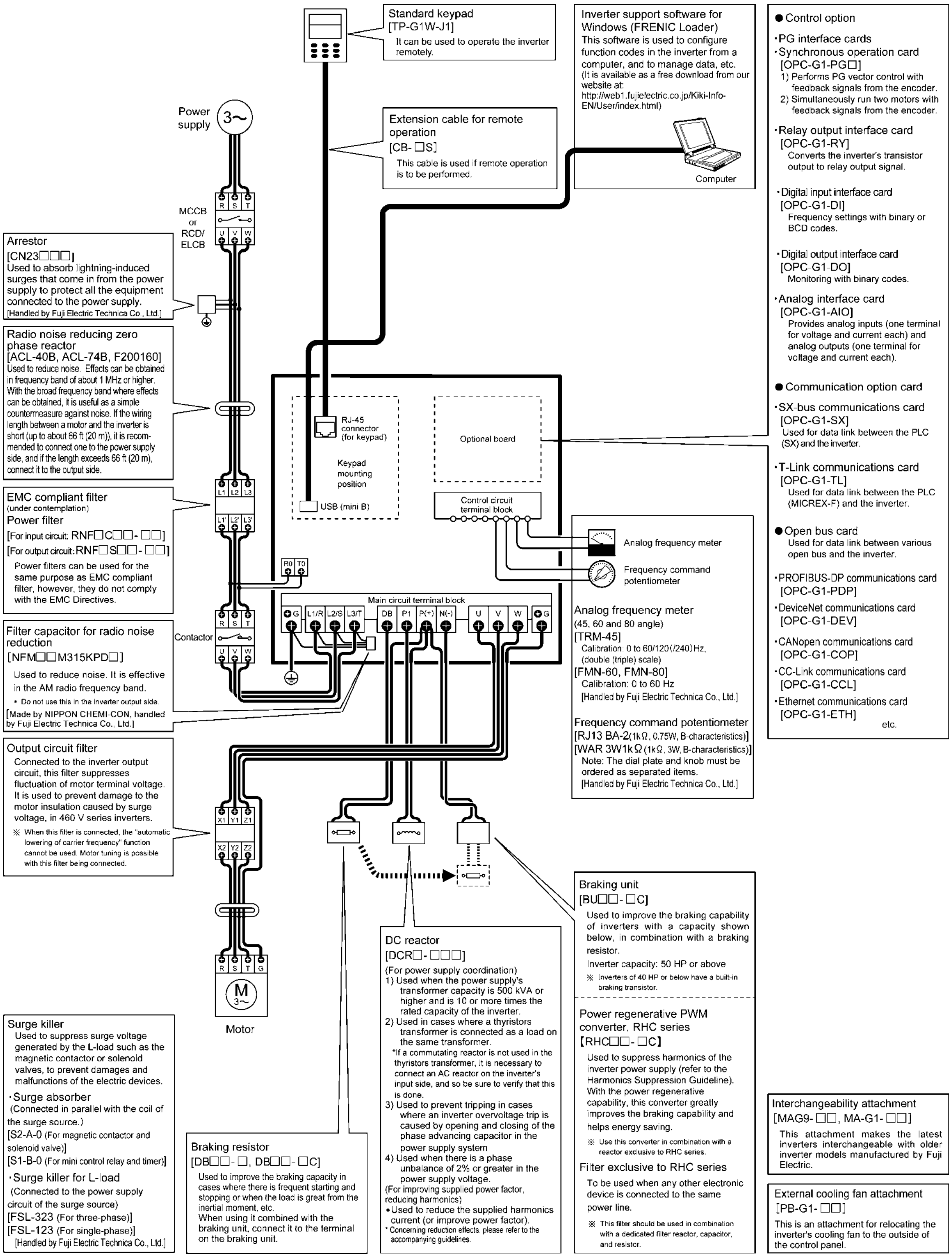


Figure 4.1 Quick Overview of Options

4.2 Selecting Wires and Crimp Terminals

This section contains information needed to select wires for connecting the inverter to commercial power lines, motor or any of the optional/peripheral equipment. The level of electric noise issued from the inverter or received by the inverter from external sources may vary depending upon wiring and routing. To solve such noise-related problems, refer to Appendix A "Advantageous Use of Inverters (Notes on electrical noise)."

Select wires that satisfy the following requirements:

- Sufficient capacity to flow the rated average current (allowable current capacity).
- Protective coordination with an MCCB or RCD/ELCB with overcurrent protection in the overcurrent zone.
- Voltage loss due to the wiring length is within the allowable range.
- Suitable for the type and size of terminals of the optional equipment to be used.

Recommended wires are listed below. Use these wires unless otherwise specified.

■ 600 V class of vinyl-insulated wires (IV wires)

Use this class of wire for the power circuits. This class of wire is hard to twist, so using it for the control signal circuits is not recommended. Maximum surrounding temperature for this wire is 60°C (140°F).

■ 600 V grade heat-resistant PVC insulated wires or 600 V polyethylene insulated wires (HIV wires)

As wires in this class are smaller in diameter and more flexible than IV wires and can be used at a higher surrounding temperature (75°C (167°F)), they can be used for both of the main power and control signal circuits. To use this class of wire for the control circuits, you need to correctly twist the wires and keep the wiring length for equipment being connected as short as possible.

■ 600 V cross-linked polyethylene-insulated wires

Use this class of wire mainly for power and grounding circuits. These wires are smaller in diameter and more flexible than those of the IV and HIV classes of wires, meaning that these wires can be used to save on space and increase operation efficiency of your power system, even in high temperature environments. The maximum allowable surrounding temperature for this class of wires is 90°C (194°F). The (Boardlex) wire range available from Furukawa Electric Co., Ltd. satisfies these requirements.

■ Shielded-Twisted cables for internal wiring of electronic/electric equipment

Use this category of cables for the control circuits of the inverter so as to prevent the signal lines from being affected by noise from external sources, including the power input/output lines of the inverter themselves. Even if the signal lines are inside the power control panel, always use this category of cables when the length of wiring is longer than normal. Cables satisfying these requirements are the Furukawa's BEAMEX S shielded cables of the XEBV and XEWV ranges.

Currents Flowing across the Inverter Terminals

Table 4.1 summarizes average (effective) electric currents flowing across the terminals of each inverter model for ease of reference when selecting peripheral equipment, options and electric wires for each inverter--including supplied power voltage and applicable motor rating.

Table 4.1 Currents Flowing through Inverter

LD (Low Duty) mode: Light duty load applications
HD (High Duty) mode: Heavy duty load applications

Power supply voltage	LD/HD mode	Nominal applied motor (HP)	Inverter type	230 V, 60 Hz					Braking resistor circuit current (A)
				Standard inverter			Inverter with built-in DC reactor		
				Input RMS current(A) DC reactor (DCR)		DC link bus current (A)	Input RMS current(A)	DC link bus current (A)	
				w/ DCR	w/o DCR				
Three-phase 230 V	LD/HD	0.5	FRNF50G1S-2U	1.5	2.8	1.8	-	-	1.2
	LD/HD	1	FRN001G1S-2U	3.0	4.7	3.7	-	-	1.6
	LD/HD	2	FRN002G1S-2U	5.5	8.5	6.7	-	-	3.6
	LD/HD	3	FRN003G1S-2U	7.7	11.9	9.4	-	-	3.5
	LD/HD	5	FRN005G1S-2U	13.0	20.0	15.9	-	-	4.1
	LD/HD	7.5	FRN007G1■-2U	18.5	28.4	22.7	19.4	23.8	6.4
	HD	7.5	FRN010G1■-2U	18.5	28.4	22.7	19.4	23.8	6.4
	LD	10		25.0	38.6	30.6	25.7	31.5	6.4
	HD	10	FRN015G1■-2U	25.1	38.6	30.7	26.4	32.3	6.1
	LD	15		37.6	54.8	46.1	37.2	45.6	6.1
	HD	15	FRN020G1■-2U	37.6	54.8	46.1	39.0	47.8	9.1
	LD	20		50.2	72.4	61.5	50.3	61.6	9.1
	HD	20	FRN025G1■-2U	50.2	72.4	61.5	52.8	64.7	11.0
	LD	25		62.7	87.7	76.8	62.8	76.9	11.0
	HD	25	FRN030G1■-2U	62.7	87.7	76.8	65.3	80.0	14.0
	LD	30		75.3	101	92.2	75.4	92.3	14.0
	HD	30	FRN040G1■-2U	75.3	101	92.2	77.9	95.4	15.0
	LD	40		100	136	122	101	123.7	15.0
	HD	40	FRN050G1■-2U	100	136	122	106	129.8	19.0
	LD	50		120	167	147	126	154.3	19.0
	HD	50	FRN060G1■-2U	120	167	147	131	160.4	25.0
	LD	60		145	203	178	156	191.1	25.0
	HD	60	FRN075G1■-2U	145	203	178	161	197.2	30.0
	LD	75		178	244	218	186	227.8	30.0
	HD	75	FRN100G1■-2U	178	-	218	194	237.6	37.0
	LD	100		246	-	301	247	302.5	37.0
	HD	100	FRN125G1S-2U	246	-	301	-	-	49.0
	LD	125		291	-	356	-	-	49.0
	HD	125	FRN150G1S-2U	291	-	356	-	-	62.0
	LD	150		358	-	438	-	-	62.0

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  40 HP or below: Power supply capacity 500 kVA, Power supply impedance 5%

  50 HP or above: Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric Systems.

- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 200 VAC.
- The braking current is always constant, independent of braking resistor specifications, including built-in, standard and 10%ED models.

Table 4.1 Currents Flowing through Inverter (continued)

LD (Low Duty) mode: Light duty load applications
MD (Medium Duty) mode: Medium duty load applications
HD (High Duty) mode: Heavy duty load applications

Power supply voltage	LD/MD/HD mode	Nominal applied motor (HP)	Inverter type	460 V, 60 Hz					Braking resistor circuit current (A)
				Standard inverter			Inverter with built-in DC reactor		
				Input RMS current (A) DC reactor (DCR)		DC link bus current (A)	Input RMS current (A)	DC link bus current (A)	
				w/ DCR	w/o DCR				
Three-phase 460 V	LD/HD	0.5	FRNF50G1S-4U	0.7	1.4	0.9	-	-	0.8
	LD/HD	1	FRN001G1S-4U	1.5	2.6	1.8	-	-	1.1
	LD/HD	2	FRN002G1S-4U	2.6	5.1	3.2	-	-	1.8
	LD/HD	3	FRN003G1S-4U	4.0	7.1	4.9	-	-	1.8
	LD/HD	5	FRN005G1S-4U	6.6	11.3	8.1	-	-	2.1
	LD/HD	7.5	FRN007G1■-4U	9.2	15.0	11.3	9.7	11.9	3.2
	HD	7.5	FRN010G1■-4U	9.2	15.0	11.3	9.7	11.9	3.2
	LD	10		12.5	20.1	15.3	12.9	15.8	3.2
	HD	10	FRN015G1■-4U	12.4	20.1	15.2	13.4	16.4	3.1
	LD	15		18.8	28.6	23.0	18.8	23.0	3.1
	HD	15	FRN020G1■-4U	18.8	28.6	23.0	19.5	23.9	4.5
	LD	20		25.1	38.0	30.7	25.5	31.2	4.5
	HD	20	FRN025G1■-4U	25.0	38.0	30.6	26.4	32.3	5.7
	LD	25		31.3	45.4	38.3	31.4	38.5	5.7
	HD	25	FRN030G1■-4U	31.0	45.4	38.0	32.7	40.0	7.2
	LD	30		36.3	52.6	44.5	37.7	46.2	7.2
	HD	30	FRN040G1■-4U	36.0	52.6	44.1	39.0	47.8	7.7
	LD	40		50.2	67.7	61.5	51.5	63.1	7.7
	HD	40	FRN050G1■-4U	50.0	67.7	61.2	51.5	63.1	10.0
	LD	50		60.2	82.0	73.7	61.6	75.4	10.0
	HD	50	FRN060G1■-4U	60.0	82.0	73.5	65.3	80.0	12.0
	LD	60		72.7	99.1	89.0	76.6	93.8	12.0
	HD	60	FRN075G1■-4U	72.0	99.1	88.2	80.4	98.5	15.0
	LD	75		89.1	121	109	92.9	113.8	15.0
	HD	75	FRN100G1■-4U	89.0	-	109	99.2	121.5	19.0
	LD	100		120	-	147	126	154	19.0
	HD	100	FRN125G1S-4U	120	-	147	-	-	24.0
	LD	125		143	-	175	-	-	24.0
	HD	125	FRN150G1S-4U	143	-	175	-	-	31.0
	MD	150		175	-	214	-	-	35.0
	LD	150		175	-	214	-	-	31.0

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  40 HP or below: Power supply capacity 500 kVA, Power supply impedance 5%

  50 HP or above: Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric Systems.

- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 400 VAC.
- The braking current is always constant, independent of braking resistor specifications, including built-in, standard and 10%ED models.

Table 4.1 Currents Flowing through Inverter (continued)

LD (Low Duty) mode: Light duty load applications
MD (Medium Duty) mode: Medium duty load applications
HD (High Duty) mode: Heavy duty load applications

Power supply voltage	LD/MD/HD mode	Nominal applied motor (HP)	Inverter type	460 V, 60 Hz					Braking resistor circuit current (A)
				Standard inverter			Inverter with built-in DC reactor		
				Input RMS current (A)		DC link bus current (A)	Input RMS current (A)	DC link bus current (A)	
				DC reactor (DCR)					
				w/ DCR	w/o DCR				
Three-phase 460 V	HD	150	FRN200G1S-4U	176	-	216	-	-	35.0
	MD	200		207	-	254	-	-	42.0
	LD	200		207	-	254	-	-	35.0
	HD	200	FRN250G1S-4U	207	-	254	-	-	42.0
	MD	250		249	-	305	-	-	50.0
	LD	250		249	-	305	-	-	42.0
	HD	250	FRN300G1S-4U	250	-	306	-	-	50.0
	MD	300		311	-	381	-	-	62.0
	LD	300		311	-	381	-	-	50.0
	HD	300	FRN350G1S-4U	311	-	381	-	-	62.0
	MD	350		340	-	416	-	-	71.0
	LD	350		340	-	416	-	-	62.0
	HD	350	FRN450G1S-4U	340	-	416	-	-	71.0
	MD	350		386	-	473	-	-	100
	LD	450		435	-	533	-	-	71.0
	HD	400	FRN500G1S-4U	436	-	534	-	-	100
	MD	450		486	-	595	-	-	100
	LD	500		547	-	670	-	-	100
	HD	450	FRN600G1S-4U	487	-	596	-	-	100
	MD	500		547	-	670	-	-	124
	LD	600		613	-	751	-	-	124
	HD	500	FRN700G1S-4U	547	-	670	-	-	124
	MD	600		613	-	751	-	-	124
	LD	700		686	-	840	-	-	124
	HD	600	FRN800G1S-4U	614	-	752	-	-	124
	MD	700		686	-	840	-	-	150
	LD	800		766	-	938	-	-	124
	HD	800	FRN900G1S-4U	767	-	939	-	-	186
	LD	900		970	-	1188	-	-	186
	HD	900	FRN1000G1S-4U	970	-	1188	-	-	212
	LD	1000		1093	-	1339	-	-	212

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  40 HP or below: Power supply capacity 500 kVA, Power supply impedance 5%

  50 HP or above: Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric Systems.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 400 VAC.
- The braking current is always constant, independent of braking resistor specifications, including built-in, standard and 10%ED models.

4.2.1 Recommended wires

Table 4.2 lists the recommended wires according to the internal temperature of your power control panel.

Table 4.2 Recommended Wire Sizes

LD (Low Duty) mode: Light duty load applications
MD (Medium Duty) mode: Medium duty load applications
HD (High Duty) mode: Heavy duty load applications

<table>
<tr><th rowspan="3">Power supply voltage</th><th colspan="3">Inverter type</th><th colspan="8">Recommended wire size AWG (mm²)</th></tr>
<tr><th rowspan="2">LD mode</th><th rowspan="2">MD mode</th><th rowspan="2">HD mode</th><th rowspan="2">L1/R, L2/S, L3/T</th><th>Grounding</th><th rowspan="2">U, V, W</th><th>DCR</th><th>Braking resistor</th><th rowspan="2">Control circuit</th><th>Auxiliary control power input</th><th>Auxiliary fan power input</th></tr>
<tr><th>[⏚G]</th><th>[P1, P(+)]</th><th>[P(+), DB]</th><th>[R0, T0]</th><th>[R1, T1]</th></tr>
<tr><td rowspan="22">Three-phase 230 V</td><td>FRNF50G1S-2U</td><td>-</td><td>FRNF50G1S-2U</td><td rowspan="4">14 (2.1)</td><td rowspan="2">14 (2.1)</td><td rowspan="4">14 (2.1)</td><td rowspan="4">14 (2.1)</td><td rowspan="14">10 (5.3)</td><td rowspan="22">0.75</td><td rowspan="22">2.0</td><td rowspan="16">-</td></tr>
<tr><td>FRN001G1S-2U</td><td>-</td><td>FRN001G1S-2U</td></tr>
<tr><td>FRN002G1S-2U</td><td>-</td><td>FRN002G1S-2U</td><td>12 (3.3)</td></tr>
<tr><td>FRN003G1S-2U</td><td>-</td><td>FRN003G1S-2U</td><td rowspan="4">10 (5.3)</td></tr>
<tr><td>FRN005G1S-2U</td><td>-</td><td>FRN005G1S-2U</td><td>10 (5.3)</td><td>12 (3.3)</td><td>10 (5.3)</td></tr>
<tr><td>FRN007G1■-2U</td><td>-</td><td>FRN007G1■-2U</td><td rowspan="4">8 (8.4)</td><td rowspan="5">8 (8.4)</td><td rowspan="4">8 (8.4)</td></tr>
<tr><td>-</td><td>-</td><td>FRN010G1■-2U</td></tr>
<tr><td>FRN010G1■-2U</td><td>-</td><td>-</td><td rowspan="3">8 (8.4)</td></tr>
<tr><td>-</td><td>-</td><td>FRN015G1■-2U</td></tr>
<tr><td>FRN015G1■-2U</td><td>-</td><td>FRN020G1■-2U</td><td>6 (13.3)</td><td>4 (21.2)</td></tr>
<tr><td>FRN020G1■-2U</td><td>-</td><td>FRN025G1■-2U</td><td>4 (21.2)</td><td rowspan="3">6 (13.3)</td><td>6 (13.3)</td><td>3 (26.7)</td></tr>
<tr><td>FRN025G1■-2U</td><td>-</td><td>FRN030G1■-2U</td><td>3 (26.7)</td><td>4 (21.2)</td><td>2 (33.6)</td></tr>
<tr><td>FRN030G1■-2U</td><td>-</td><td>FRN040G1■-2U</td><td>2 (33.6)</td><td>3 (26.7)</td><td>1 (42.4)</td></tr>
<tr><td>FRN040G1■-2U</td><td>-</td><td>-</td><td rowspan="2">2/0 (67.4)</td><td rowspan="2">4 (21.2)</td><td>2 (33.6)</td><td rowspan="2">2/0 (67.4)</td></tr>
<tr><td>-</td><td>-</td><td>FRN050G1■-2U</td><td>1 (42.4)</td><td rowspan="8">-</td></tr>
<tr><td>FRN050G1■-2U</td><td>-</td><td>-</td><td rowspan="2">3/0 (85)</td><td rowspan="3">3 (26.7)</td><td>1/0 (53.5)</td><td rowspan="2">4/0 (107.2)</td></tr>
<tr><td>-</td><td>-</td><td>FRN060G1■-2U</td><td rowspan="3">4/0 (107.2)</td><td rowspan="6">2.0 (60 HP or above)</td></tr>
<tr><td>FRN060G1■-2U</td><td>-</td><td>FRN075G1■-2U</td><td>4/0 (107.2)</td><td>250 (127)</td></tr>
<tr><td>FRN075G1■-2U</td><td>-</td><td>FRN100G1■-2U</td><td>2/0 (67.4) × 2</td><td rowspan="2">2 (33.6)</td><td rowspan="2">350 (177)</td></tr>
<tr><td>FRN100G1■-2U</td><td>-</td><td>FRN125G1S-2U</td><td>3/0 (85) × 2</td><td>3/0 (85) × 2</td></tr>
<tr><td>FRN125G1S-2U</td><td>-</td><td>FRN150G1S-2U</td><td>4/0 (107.2) × 2</td><td>1 (42.4)</td><td>4/0 (107.2) × 2</td><td>500 (253)</td></tr>
<tr><td>FRN150G1S-2U</td><td>-</td><td>-</td><td>300 (152) × 2</td><td>1/0 (53.5)</td><td>300 (152) × 2</td><td>4/0 (107.2) × 2</td></tr>
</table>

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

The wire sizes above are specified for 75°C (167°F) Cu wire.

Table 4.2 Recommended Wire Sizes (continued)

LD (Low Duty) mode: Light duty load applications
MD (Medium Duty) mode: Medium duty load applications
HD (High Duty) mode: Heavy duty load applications

Power supply voltage	Inverter type			Recommended wire size AWG (mm^2)							
	LD mode	MD mode	HD mode	L1/R, L2/S, L3/T	Grounding [⏚G]	U, V, W	DCR [P1, P(+)]	Braking resistor [P(+), DB]	Control circuit	Auxiliary control power input [R0, T0]	Auxiliary fan power input [R1, T1]
Three-phase 460 V	FRNF05G1S-4U	-	FRNF05G1S-4U	14 (2.1)	14 (2.1)	14 (2.1)	14 (2.1)	10 (5.3)	0.75	2.0	-
	FRN001G1S-4U	-	FRN001G1S-4U								
	FRN002G1S-4U	-	FRN002G1S-4U								
	FRN003G1S-4U	-	FRN003G1S-4U								
	FRN005G1S-4U	-	FRN005G1S-4U		12 (3.3)						
	FRN007G1■-4U	-	FRN007G1■-4U	12 (3.3)	10 (5.3)	12 (3.3)	12 (3.3)				
	-	-	FRN010G1■-4U								
	FRN010G1■-4U	-	FRN015G1■-4U	10 (5.3)			10 (5.3)				
	FRN015G1■-4U	-	-	8 (8.4)		10 (5.3)	8 (8.4)				
	-	-	FRN020G1■-4U								
	FRN020G1■-4U	-	-		8 (8.4)	8 (8.4)					
	-	-	FRN025G1■-4U	6 (13.3)		6 (13.3)					
	FRN025G1■-4U	-	FRN030G1■-4U				6 (13.3)				
	FRN030G1■-4U	-	FRN040G1■-4U								
	FRN040G1■-4U	-	-	4 (21.2)	6 (13.3)		4 (21.2)				
	-	-	FRN050G1■-4U			2 (33.6)		-			
	FRN050G1■-4U	-	FRN060G1■-4U	3 (26.7)			2 (33.6)				
	FRN060G1■-4U	-	FRN075G1■-4U	2 (33.6)			1 (42.4)				
	FRN075G1■-4U	-	FRN100G1■-4U	1/0 (53.5)	4 (21.2)		1/0 (53.5)				
	FRN100G1■-4U	-	-			1/0 (53.5)					
	-	-	FRN125G1S-4U	2/0 (67.4)		4/0 (107.2)					2.0 (125 HP or above)
	FRN125G1S-4U	-	FRN150G1S-4U				3/0 (85)				
	FRN150G1S-4U	FRN150G1S-4U	FRN200G1S-4U	1/0 (53.5)	3 (26.7)	1/0 (53.5)	4/0 (107.2)				
	FRN200G1S-4U	FRN200G1S-4U	FRN250G1S-4U			2 (33.6)	250 (127)				
	FRN250G1S-4U	FRN250G1S-4U	FRN300G1S-4U	3/0 (85) × 2	2 (33.6)	3/0 (85) × 2	350 (177)				
	FRN300G1S-4U	FRN300G1S-4U	FRN350G1S-4U	4/0 (107.2) × 2	1 (42.4)	250 (127) × 2	600 (304)				
	FRN350G1S-4U	FRN350G1S-4U	FRN450G1S-4U	250 (127) × 2	1/0 (53.5)	300 (152) × 2	4/0 (107.2) × 2				
	-	FRN450G1S-4U	-	300 (152) × 2		350 (177) × 2	250 (127) × 2				
	FRN450G1S-4U	-	-	400 (203) × 2	2/0 (67.4)	400 (203) × 2	300 (152) × 2				
	-	-	FRN500G1S-4U	250 (127) × 2		300 (152) × 2					
	-	FRN500G1S-4U	FRN600G1S-4U	300 (152) × 2		350 (177) × 2	350 (177) × 2				
	FRN500G1S-4U	FRN600G1S-4U	FRN700G1S-4U	400 (203) × 2	3/0 (85)	400 (203) × 2	400 (203) × 2				
	FRN600G1S-4U	FRN700G1S-4U	FRN800G1S-4U	500 (253) × 2		500 (253) × 2	500 (253) × 2				
	FRN700G1S-4U	FRN800G1S-4U	-	600 (304) × 2	4/0 (107.2)	600 (304) × 2	300 (152) × 3				
	FRN800G1S-4U	-	FRN900G1S-4U	350 (177) × 3		400 (203) × 3	400 (203) × 3				
	FRN900G1S-4U	-	FRN1000G1S-4U	500 (253) × 3	250 (127)	600 (304) × 3	600 (304) × 3				
	FRN1000G1S-4U	-	-	600 (304) × 3	350 (177)	500 (253) × 4	400 (203) × 4				

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

The wire sizes above are specified for 75°C (167°F) Cu wire.

4.3 Peripheral Equipment

4.3.1 Molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) and magnetic contactor (MC)

[1] Functional overview

■ MCCBs and RCDs/ELCBs*

* With overcurrent protection

Molded Case Circuit Breakers (MCCBs) are designed to protect the power circuits between the power supply and inverter's main circuit terminals ([L1/R], [L2/S] and [L3/T]) from overload or short-circuit, which in turn prevents secondary accidents caused by the broken inverter.

Residual-Current-Operated Protective Devices (RCDs)/Earth Leakage Circuit Breakers (ELCBs) function in the same way as MCCBs.

Built-in overcurrent/overload protective functions protect the inverter itself from failures related to its input/output lines.

■ MCs

An MC can be used at both the power input and output sides of the inverter. At each side, the MC works as described below. When inserted in the output circuit of the inverter, the MC can also switch the motor drive power supply between the inverter output and commercial power lines.

<u>At the power supply side</u>

Insert an MC in the power supply side of the inverter in order to:

(1) Forcibly cut off the inverter from the power supply (generally, commercial/factory power lines) with the protective function built into the inverter, or with the external signal input.

(2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

(3) Cut off the inverter from the power supply when the MCCB inserted in the power supply side cannot cut it off for maintenance or inspection purpose. For the purpose only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

Note: Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result.

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

If frequent start/stop of the motor is required, use ***FWD***/***REV*** terminal signals or the FWD / REV / STOP keys on the inverter's keypad.

At the output side

Insert an MC in the power output side of the inverter in order to:

(1) Prevent externally turned-around current from being applied to the inverter power output terminals ([U], [V], and [W]) unexpectedly. An MC should be used, for example, when a circuit that switches the motor driving power supply between the inverter output and commercial power lines is connected to the inverter.

Tip

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

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

(2) Drive more than one motor selectively by a single inverter.

(3) Selectively cut off the motor whose thermal overload relay or equivalent devices have been activated.

Driving the motor using commercial power lines

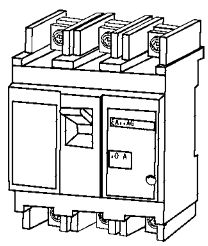
MCs can also be used to switch the power supply of the motor driven by the inverter to a commercial power supply.

Select the MC so as to satisfy the rated currents listed in Table 4.1, which are the most critical RMS currents for using the inverter. (Refer to Table 4.3) For switching the motor drive source between the inverter output and commercial power lines, use the MC of class AC3 specified by JIS C8325 in the commercial line side.

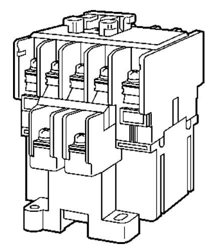
[2] Connection example and criteria for selection of circuit breakers

Figure 4.2 shows a connection example for MCCB or RCD/ELCB (with overcurrent protection) and MC in the inverter input circuit. Table 4.3 lists the rated current for the MCCB and corresponding inverter models. Table 4.4 lists the applicable grades of RCD/ELCB sensitivity.

⚠WARNING
Insert an MCCB or RCD/ELCB (with overcurrent protection) recommended for each inverter for its input circuits. Do not use an MCCB or RCD/ELCB of a higher rating than that recommended. **Doing so could result in a fire.**



Molded case circuit breaker or
residual-current-operated protective device/
earth leakage circuit breaker



Magnetic contactor

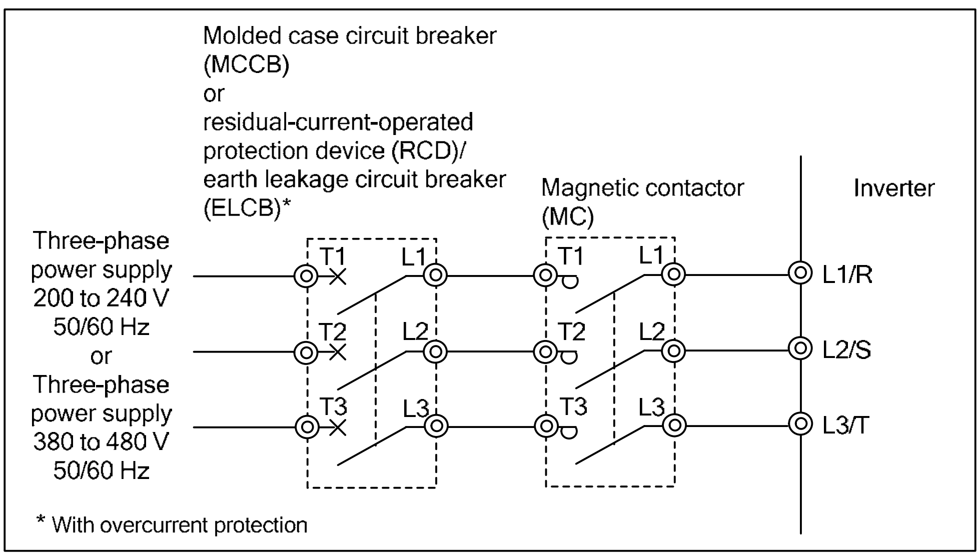


Figure 4.2 External Views of MCCB or RCD/ELCB and MC and Connection Example

Table 4.3 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB)

LD (Low Duty) mode: Light duty load applications
HD (High Duty) mode: Heavy duty load applications

Power supply voltage	Nominal applied motor (HP)	Inverter type	LD/HD mode	MCCB or RCD/ELCB Rated current	
				w/ DCR	w/o DCR
Three-phase 230V	0.5	FRNF50G1S-2U	LD/HD	5	5
	1	FRN001G1S-2U			10
	2	FRN002G1S-2U		10	15
	3	FRN003G1S-2U			20
	5	FRN005G1S-2U		20	30
	7.5	FRN007G1■-2U		30	50
		FRN010G1■-2U	HD		
	10		LD	40	75
		FRN015G1■-2U	HD		
	15		LD	50	100
		FRN020G1■-2U	HD		
	20		LD	75	125
		FRN025G1■-2U	HD		
	25		LD	100	150
		FRN030G1■-2U	HD		
	30		LD		175
		FRN040G1■-2U	HD		
	40		LD	150	200
		FRN050G1■-2U	HD		
	50		LD	175	250
		FRN060G1■-2U	HD		
	60		LD	200	300
		FRN075G1■-2U	HD		
	75		LD	250	350
		FRN100G1■-2U	HD		
	100		LD	350	-
		FRN125G1S-2U	HD		
	125		LD	400	
		FRN150G1S-2U	HD		
	150		LD	500	

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCDs/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the MCCBs' and RCDs'/ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- Use RCDs/ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 4.3 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) (continued)

LD (Low Duty) mode: Light duty load applications
MD (Medium Duty) mode: Medium duty load applications
HD (High Duty) mode: Heavy duty load applications

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (HP)</th><th rowspan="2">Inverter type</th><th rowspan="2">LD/MD/HD mode</th><th colspan="2">MCCB or RCD/ELCB Rated current</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="39">Three-phase 460V</td><td>0.5</td><td>FRNF50G1S-4U</td><td rowspan="6">LD/HD</td><td rowspan="3">5</td><td rowspan="2">5</td></tr>
<tr><td>1</td><td>FRN001G1S-4U</td></tr>
<tr><td>2</td><td>FRN002G1S-4U</td><td>10</td></tr>
<tr><td>3</td><td>FRN003G1S-4U</td><td rowspan="2">10</td><td>15</td></tr>
<tr><td>5</td><td>FRN005G1S-4U</td><td>20</td></tr>
<tr><td rowspan="2">7.5</td><td>FRN007G1■-4U</td><td rowspan="2">15</td><td rowspan="2">30</td></tr>
<tr><td rowspan="2">FRN010G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">10</td><td>LD</td><td rowspan="2">20</td><td rowspan="2">40</td></tr>
<tr><td rowspan="2">FRN015G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">15</td><td>LD</td><td rowspan="2">30</td><td rowspan="2">50</td></tr>
<tr><td rowspan="2">FRN020G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">20</td><td>LD</td><td rowspan="4">40</td><td rowspan="2">60</td></tr>
<tr><td rowspan="2">FRN025G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">25</td><td>LD</td><td rowspan="2">75</td></tr>
<tr><td rowspan="2">FRN030G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">30</td><td>LD</td><td rowspan="2">50</td><td rowspan="2">100</td></tr>
<tr><td rowspan="2">FRN040G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">40</td><td>LD</td><td rowspan="2">75</td><td rowspan="4">125</td></tr>
<tr><td rowspan="2">FRN050G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">50</td><td>LD</td><td rowspan="4">100</td></tr>
<tr><td rowspan="2">FRN060G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">60</td><td>LD</td><td rowspan="2">150</td></tr>
<tr><td rowspan="2">FRN075G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">125</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN100G1■-4U</td><td>HD</td></tr>
<tr><td rowspan="2">100</td><td>LD</td><td rowspan="2">175</td><td rowspan="14">-</td></tr>
<tr><td rowspan="2">FRN125G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">125</td><td>LD</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN150G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">150</td><td>LD/MD</td><td rowspan="2">250</td></tr>
<tr><td rowspan="2">FRN200G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">200</td><td>LD/MD</td><td rowspan="2">300</td></tr>
<tr><td rowspan="2">FRN250G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">250</td><td>LD/MD</td><td rowspan="2">350</td></tr>
<tr><td rowspan="2">FRN300G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">300</td><td>LD/MD</td><td rowspan="4">500</td></tr>
<tr><td rowspan="2">FRN350G1S-4U</td><td>HD</td></tr>
<tr><td rowspan="2">350</td><td>LD/MD</td></tr>
<tr><td>FRN450G1S-4U</td><td>HD</td></tr>
</table>

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCDs/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C (122°F). The rated current is factored by a correction coefficient of 0.85 as the MCCBs' and RCDs'/ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C (104°F) or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- Use RCDs/ELCBs with overcurrent protection.

- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 4.4 lists the relationship between the rated leakage current sensitivity of RCDs/ELCBs (with overcurrent protection) and wiring length of the inverter output circuits. Note that the sensitivity levels listed in the table are estimated values based on the results obtained by the test setup in the Fuji laboratory where each inverter drives a single motor.

Table 4.4 Rated Current Sensitivity of Residual-Current-Operated Protective Devices (RCDs)/ Earth Leakage Circuit Breakers (ELCBs)

Power supply voltage	Nominal applied motor (HP)	Wiring length and current sensitivity					
		33 ft (10 m)	98 ft (30 m)	164 ft (50 m)	328 ft (100 m)	656 ft (200 m)	984 ft (300 m)
	0.5						
	1						
	2						
	3		30 mA				
	5						
	7.5						
	10				100 mA		
	15						
Three-phase 230 V	20						
	25					200 mA	
	30						
	40						
	50						
	60						
	75						
	100						500 mA
	125						
	150						
	0.5						
	1						
	2						
	3						
	5	30 mA					
	7.5						
	10						
	15			100 mA			
	20						
	25						
	30				200 mA		
	40						
	50						
	60					500 mA	
Three-phase 460 V	75						
	100						
	125						
	150						
	200						1000 mA
	250						(Special)
	300						
	350						
	400						
	450						
	500						
	600						3000 mA
	700						(Special)
	800						
	900						
	1000						

- Values listed above were obtained using Fuji ELCB EG or SG series applied to the test setup.
- The rated current of applicable motor rating indicates values for Fuji standard motor (4 poles, 50 Hz and 230 V three-phase).
- The leakage current is calculated based on grounding of the single wire for 200 V class delta connection and neutral grounding for 400 V class Y-connection power lines.
- Values listed above are calculated based on the static capacitance to the earth when the 600 V class of vinyl-insulated IV wires are used in a wiring through metal conduit pipes.
- Wiring length is the total length of wiring between the inverter and motor. If more than one motor is to be connected to a single inverter, the wiring length should be the total length of wiring between the inverter and motors.

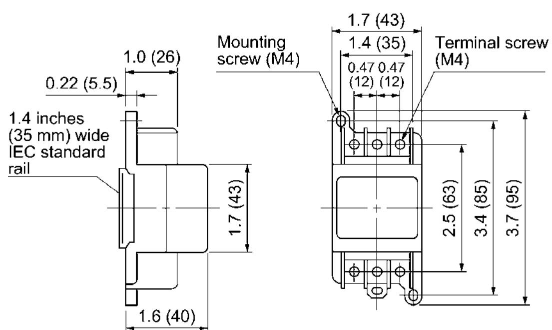
4.3.2 Surge killers for L-load

A surge killer absorbs surge voltage induced by L-load of an electro magnetic switch or solenoid valve. Use of a surge killer is effective in preventing the electronic equipment, including inverters, from damage or malfunctioning caused by such surges.

Install a surge killer near the power coil of the surge source. Connected to the inverter's power source side, as shown in Figure 4.3, a surge killer absorbs the surge voltage, preventing the electronic equipment, from damage or malfunctioning.

Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

Note: Do not connect the surge killers in the secondary (output) circuit of the inverter.



Unit: inch (mm)

Note: Available rated capacity of nominal applied motors is 5 HP or less.

Available from Fuji Electric Technica Co., Ltd.

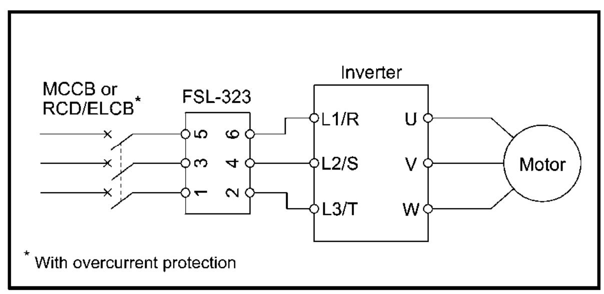


Figure 4.3 Dimensions of Surge Killer and Connection Example

4.3.3 Arresters

An arrester suppresses surge currents induced by lightning invaded from the power supply lines. Common use of the grounding wire that is used for electric equipment in the panel, with the arrester, is effective in preventing electronic equipment from damage or malfunctioning caused by such surges.

Applicable arrester models are CN23232 for three-phase 230 V series, and CN2324E and CN2324L for three-phase 460 V series. (CN233 series with 20 kA of discharging capability is also available.) Figure 4.4 shows their external dimensions and connection examples. Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

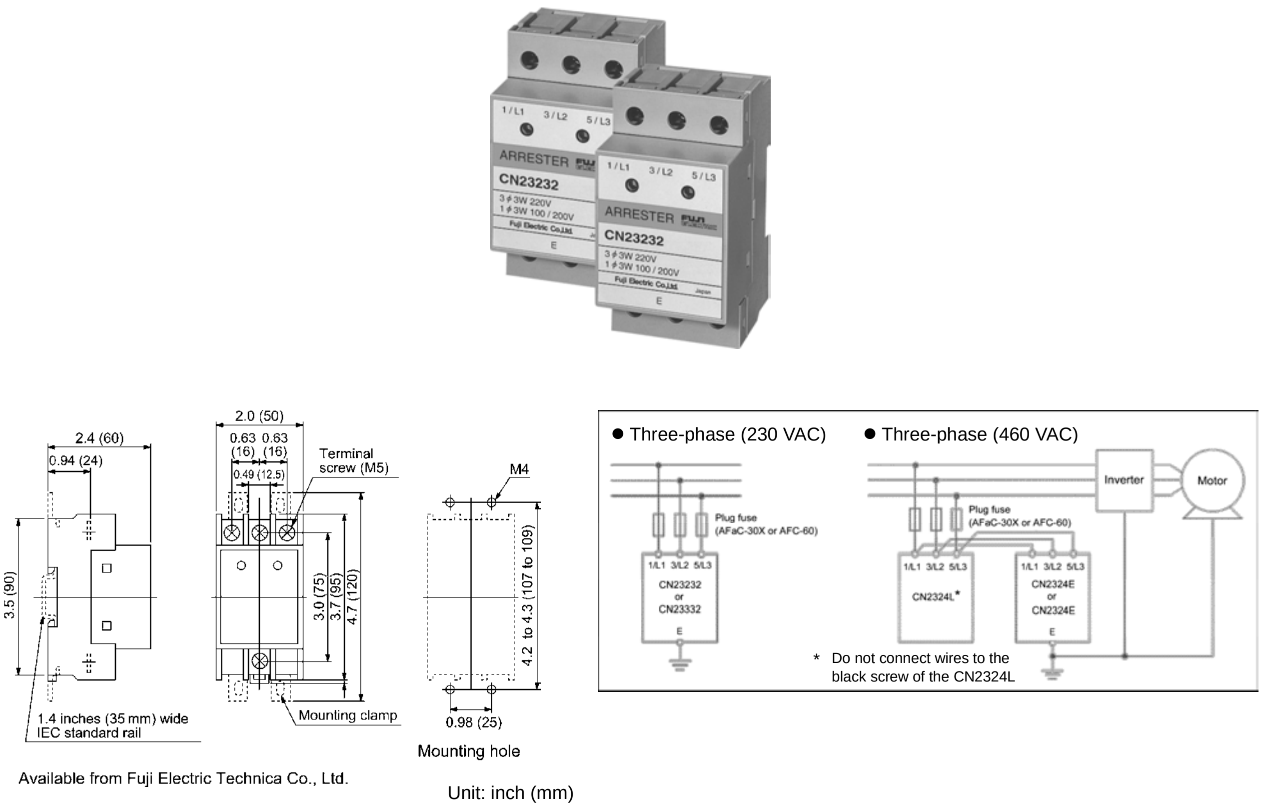


Figure 4.4 Arrester Dimensions and Connection Examples

4.3.4 Surge absorbers

A surge absorber absorbs surges or noises generated by a magnetic contactor (MC) or solenoid valve in the power system to effectively protect electronic equipment in the panel from malfunctions or breakdown. Installed parallel to a coil of an MC, solenoid valve, or L load, a surge absorber absorbs a surge voltage.

Applicable surge absorber models are the S2-A-O and S1-B-O. Figure 4.5 shows their external dimensions.

The surge absorbers are available from Fuji Electric Technica Co., Ltd.

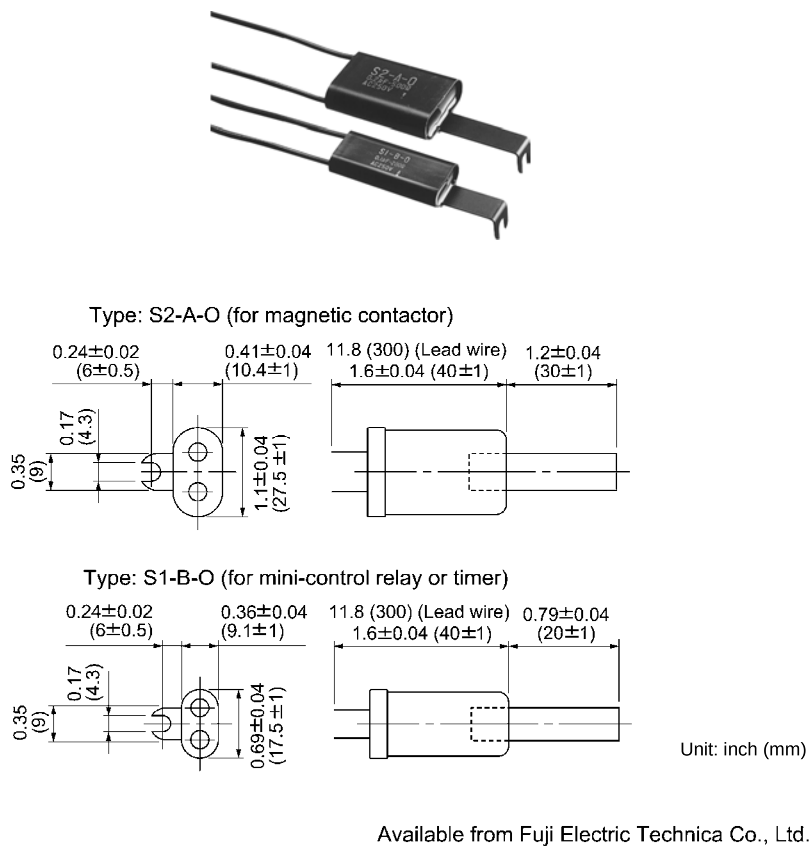


Figure 4.5 Surge Absorber Dimensions

4.3.5 Filtering capacitors suppressing AM radio band noises

These capacitors are effective to suppress AM radio band (less than 1 MHz) noises. Using them with Zero-phase reactors upgrades capability.

Applicable models are NFM25M315KPD1 for 230 V series inverters and NFM60M315KPD for 460 V series. Use one of them no matter what the inverter capacity. Figure 4.6 shows their external dimensions. These products are available from Fuji Electric Technica Co., Ltd.

Note: Do not use the capacitor in the inverter secondary (output) line.

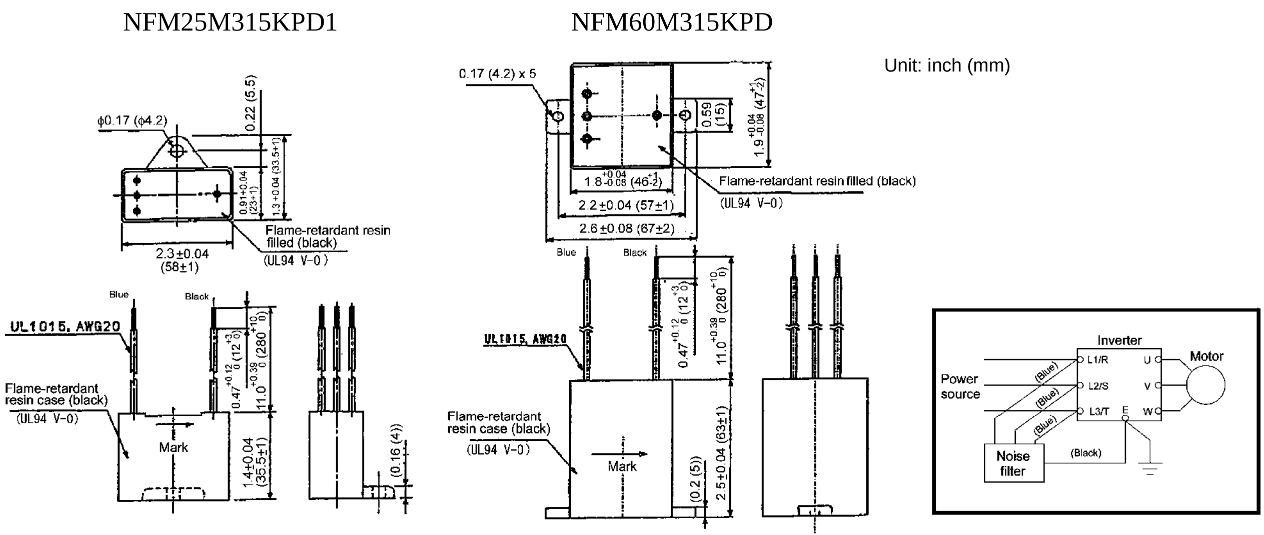


Figure 4.6 Filtering Capacitors Dimensions

4.4 Selecting Options

4.4.1 Peripheral equipment options

4.4.1.1 Braking resistors (DBRs) and braking units

[1] Braking resistors (DBRs)

A braking resistor converts regenerative energy generated from deceleration of the motor to heat for consumption. Use of a braking resistor results in improved deceleration performance of the inverter.

Refer to Chapter 3, Section 3.2 "Selecting a Braking Resistor."

The standard model of a braking resistor does not support overheating detection or warning output, so an electronic thermal overload relay needs to be set up using function codes F50 and F51 to protect the braking resistor from overheating.

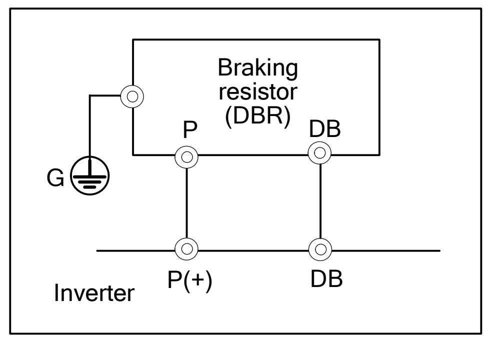


Figure 4.7 Braking Resistor (Standard Model) and Connection Example

For the specifications and external dimensions of the braking resistors, refer to [3] and [4] in this section.

[2] Braking units

For inverters of 50 HP or above, add a braking unit to the braking resistor to upgrade the braking capability of inverters with the following capacity.

Figure 4.8 Braking Unit

📖 For the specifications and external dimensions of the braking units, refer to [3] and [4] in this Section.

[3] Specifications

Table 4.5 Generated Loss in Braking Unit

Model	Generated loss (W)
BU37-2C	40
BU55-2C	50
BU90-2C	60
BU37-4C	35
BU55-4C	40
BU90-4C	50
BU132-4C	60
BU220-4C	80

*10%ED

Table 4.6 Braking Unit and Braking Resistor (Standard Model) for LD-mode Inverters

Power supply voltage	Nominal applied motor (HP)	Inverter type	Option					Maximum braking torque (%)			Continuous braking (100% braking torque)		Repetitive braking (each cycle is less than 100 (s))	
			Braking unit		Braking resistor									
		LD mode	Type	Q'ty	Type	Q'ty	Resistance (Ω)		50 Hz (N·m)	60 Hz (N·m)	Discharging capability (kWs)	Braking time (s)	Average allowable loss (kW)	Duty cycle (%ED)
Three-phase 230 V	0.5	FRNF50G1S-2U	-		DB0.75-2C	1	100	150	4.02	3.32	50	250	0.075	37
	1	FRN001G1S-2U							7.57	6.25	50	133	0.075	20
	2	FRN002G1S-2U			DB2.2-2C	1	40		15	12.4	55	73	0.110	14
	3	FRN003G1S-2U							22	18.2	55	50	0.110	10
	5	FRN005G1S-2U			DB3.7-2C	1	33		37.1	30.5	140	75	0.185	10
	7.5	FRN007G1■-2U			DB5.5-2C	1	20	100	49.6	41	55	15	0.275	10
	10	FRN010G1■-2U							49.6	41	55	15	0.275	10
	15	FRN015G1■-2U			DB7.5-2C	1	15		72	59.7	37	7	0.375	10
	20	FRN020G1■-2U			DB11-2C	1	10		98.1	81.4	55	7	0.55	10
	25	FRN025G1■-2U			DB15-2C	1	8.6		121	100	75	7	0.75	7
	30	FRN030G1■-2U			DB22-2C	1	5.8		144	119	93	7	0.925	7
	40	FRN040G1■-2U							195	162	110	7	1.1	7
	50	FRN050G1■-2U	BU37-2C	1	DB30-2C	1	4	75	180	150	150	10	1.50	10
	60	FRN060G1■-2U			DB37-2C	1	3		219	182	185	10	1.85	10
	75	FRN075G1■-2U	DB55-2C	1	DB45-2C	1	2.5		269	223	225	10	2.25	10
	100	FRN100G1■-2U			BU55-2C	1	2		365	303	275	10	2.75	10
	125	FRN125G1S-2U	BU90-2C	1	DB75-2C	1	1.6		439	364	375	10	3.75	10
	150	FRN150G1S-2U			DB110-2C	1	1.2		534	444	450	10	4.50	10
Three-phase 460 V	0.5	FRNF50G1S-4U	-		DB0.75-4C	1	200	150	4.02	3.32	50	250	0.075	37
	1	FRN001G1S-4U							7.57	6.25	50	133	0.075	20
	2	FRN002G1S-4U			DB2.2-4C	1	160		15	12.4	55	73	0.110	14
	3	FRN003G1S-4U							22	18.2	55	50	0.110	10
	5	FRN005G1S-4U			DB3.7-4C	1	130		37.1	30.5	140	75	0.185	10
	7.5	FRN007G1■-4U			DB5.5-4C	1	80	100	49.6	41	55	15	0.275	10
	10	FRN010G1■-4U							49.6	41	55	15	0.275	10
	15	FRN015G1■-4U			DB7.5-4C	1	60		72	59.7	38	7	0.375	10
	20	FRN020G1■-4U			DB11-4C	1	40		98.1	81.4	55	7	0.55	10
	25	FRN025G1■-4U			DB15-4C	1	34.4		121	100	75	7	0.75	7
	30	FRN030G1■-4U			DB22-4C	1	22		144	119	93	7	0.925	7
	40	FRN040G1■-4U							195	162	110	7	1.1	7
	50	FRN050G1■-4U	BU37-4C	1	DB30-4C	1	15	75	180	150	150	10	1.50	10
	60	FRN060G1■-4U			DB37-4C	1	12		219	182	185	10	1.85	10
	75	FRN075G1■-4U	BU55-4C	1	DB45-4C	1	10		269	223	225	10	2.25	10
	100	FRN100G1■-4U			DB55-4C	1	7.5		365	303	275	10	2.75	10
	125	FRN125G1S-4U	BU90-4C	1	DB75-4C	1	6.5		439	364	375	10	3.75	10
	150	FRN150G1S-4U			DB110-4C	1	4.7		534	444	450	10	4.50	10
	200	FRN200G1S-4U	BU132-4C	1					641	533	550	10	5.50	10
	250	FRN250G1S-4U			DB132-4C	1	3.9		777	646	660	10	6.60	10
	300	FRN300G1S-4U	BU220-4C	1	DB160-4C	1	3.2		971	807	800	10	8.00	10
	350	FRN350G1S-4U			DB200-4C	1	2.6		1068	888	1000	10	10.0	10
	450	FRN450G1S-4U			DB220-4C	1	2.2		1360	1130	1100	10	11.0	10
	500	FRN500G1S-4U		2	DB160-4C	2	1.6		1724	1433	1400	10	14.0	10
	600	FRN600G1S-4U							1942	1614	1775	10	1.75	10
	700	FRN700G1S-4U			DB200-4C		1.3		2185	1816	2000	10	20.0	10
	800	FRN800G1S-4U							2428	2018	2000	10	20.0	10
	900	FRN900G1S-4U		3		3	0.867		3067	2556	2500	10	25.0	10
	1000	FRN1000G1S-4U			DB220-4C		0.733		3457	2881	3150	10	31.5	10

Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

Table 4.7 Braking Unit and Braking Resistor (Standard Model) for MD-mode Inverters

Power supply voltage	Nominal applied motor (HP)	Inverter type MD mode	Options: Braking unit Type	Braking unit Q'ty	Braking resistor Type	Braking resistor Q'ty	Resistance (Ω)	Maximum braking torque (%)	50 Hz (N•m)	60 Hz (N•m)	Continuous braking (100% braking torque): Discharging capability (kWs)	Braking time (s)	Repetitive braking (each cycle is less than 100 s): Average allowable loss (kW)	Duty cycle (%ED)
Three-phase 460 V	150	FRN150G1S-4U	BU132-4C	1	DB110-4C	1	4.7	100	712	592	550	10	5.50	10
	200	FRN200G1S-4U			DB132-4C		3.9		855	710	660	10	6.60	10
	250	FRN250G1S-4U	BU220-4C		DB160-4C		3.2		1036	861	800	10	8.00	10
	300	FRN300G1S-4U			DB200-4C		2.6		1295	1078	1000	10	10.0	10
	350	FRN350G1S-4U			DB220-4C		2.2		1424	1184	1100	10	11.0	10
	350	FRN450G1S-4U	BU132-4C	2	DB132-4C	2	1.95		1623	1352	1250	10	12.5	10
	450	FRN500G1S-4U	BU220-4C		DB160-4C		1.6		2039	1695	1575	10	15.8	10
	500	FRN600G1S-4U			DB200-4C		1.3		2298	1910	1775	10	17.8	10
	600	FRN700G1S-4U							2590	2152	2000	10	20.0	10
	700	FRN800G1S-4U		3	DB160-4C	3	1.067		2913	2421	2250	10	22.5	10

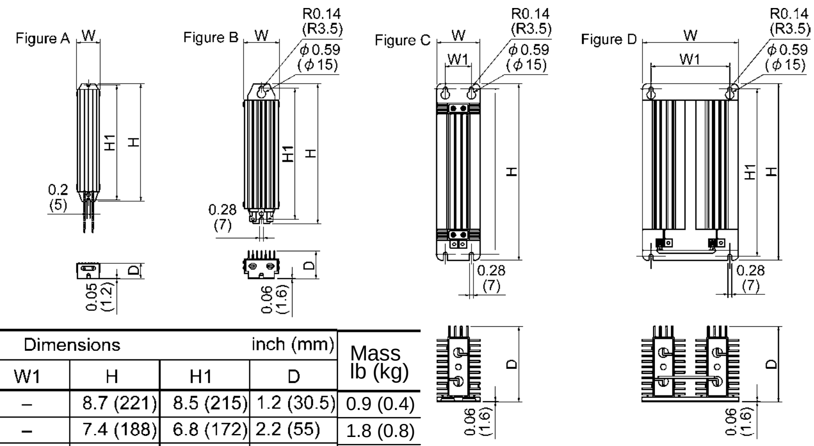
Table 4.8 Braking Unit and Braking Resistor (Standard Model) for HD-mode Inverters

Power supply voltage	Nominal applied motor (HP)	Inverter type HD mode	Option: Braking unit Type	Braking unit Q'ty	Braking resistor Type	Braking resistor Q'ty	Resistance (Ω)	Maximum braking torque (%)	50 Hz (N·m)	60 Hz (N·m)	Continuous braking (100% braking torque): Discharging capability (kWs)	Braking time (s)	Repetitive braking (each cycle is less than 100 (s)): Average allowable loss (kW)	Duty cycle (%ED)
Three-phase 230 V	0.5	FRNF50G1S-2U	-		DB0.75-2C	1	100	150	4.02	3.32	50	250	0.075	37
	1	FRN001G1S-2U							7.57	6.25	50	133	0.075	20
	2	FRN002G1S-2U			DB2.2-2C	1	40		15	12.4	55	73	0.110	14
	3	FRN003G1S-2U							22	18.2	55	50	0.110	10
	5	FRN005G1S-2U			DB3.7-2C	1	33		37.1	30.5	140	75	0.185	10
	7.5	FRN007G1■-2U			DB5.5-2C	1	20		54.3	45	55	20	0.275	10
	7.5	FRN010G1■-2U					20		54.3	45	55	20	0.275	10
	10	FRN015G1■-2U			DB7.5-2C	1	15		73.6	61.6	37	10	0.375	10
	15	FRN020G1■-2U			DB11-2C	1	10		108	89.5	55	10	0.55	10
	20	FRN025G1■-2U			DB15-2C	1	8.6		147	122	75	10	0.75	10
	25	FRN030G1■-2U			DB22-2C	1	5.8		182	151	92	10	0.925	10
	30	FRN040G1■-2U							216	179	110	10	1.1	10
	40	FRN050G1■-2U	BU37-2C	1	DB30-2C	1	4	100	195	162	150	10	1.50	10
	50	FRN060G1■-2U			DB37-2C	1	3		240	200	185	10	1.85	10
	60	FRN075G1■-2U	BU55-2C	1	DB45-2C	1	2.5		292	243	225	10	2.25	10
	75	FRN100G1■-2U			DB55-2C	1	2		359	298	275	10	2.75	10
	100	FRN125G1S-2U	BU90-2C	1	DB75-2C	1	1.6		487	405	375	10	3.75	10
	125	FRN150G1S-2U			DB110-2C	1	1.2		585	486	450	10	4.50	10
Three-phase 460 V	0.5	FRNF50G1S-4U	-		DB0.75-4C	1	200	150	4.02	3.32	50	250	0.075	37
	1	FRN001G1S-4U							7.57	6.25	50	133	0.075	20
	2	FRN002G1S-4U			DB2.2-4C	1	160		15	12.4	55	73	0.110	14
	3	FRN003G1S-4U							22	18.2	55	50	0.110	10
	5	FRN005G1S-4U			DB3.7-4C	1	130		37.1	30.5	140	75	0.185	10
	7.5	FRN007G1■-4U			DB5.5-4C	1	80		54.3	45	55	20	0.275	10
	7.5	FRN010G1■-4U					80		54.3	45	55	20	0.275	10
	10	FRN015G1■-4U			DB7.5-4C	1	60		73.6	61.6	37	10	0.375	10
	15	FRN020G1■-4U			DB11-4C	1	40		108	89.5	55	10	0.55	10
	20	FRN025G1■-4U			DB15-4C	1	34.4		147	122	75	10	0.75	10
	25	FRN030G1■-4U			DB22-4C	1	22		182	151	92	10	0.925	10
	30	FRN040G1■-4U							216	179	110	10	1.1	10
	40	FRN050G1■-4U	BU37-4C	1	DB30-4C	1	15	100	195	162	150	10	1.50	10
	50	FRN060G1■-4U			DB37-4C	1	12		240	200	185	10	1.85	10
	60	FRN075G1■-4U	BU55-4C	1	DB45-4C	1	10		292	243	225	10	2.25	10
	75	FRN100G1■-4U			DB55-4C	1	7.5		359	298	275	10	2.75	10
	100	FRN125G1S-4U	BU90-4C	1	DB75-4C	1	6.5		487	405	375	10	3.75	10
	125	FRN150G1S-4U			DB110-4C	1	4.7		585	486	450	10	4.50	10
	150	FRN200G1S-4U	BU132-4C	1					712	592	550	10	5.50	10
	200	FRN250G1S-4U			DB132-4C	1	3.9		855	710	660	10	6.60	10
	250	FRN300G1S-4U	BU220-4C	1	DB160-4C	1	3.2		1036	861	800	10	8.00	10
	300	FRN350G1S-4U			DB200-4C	1	2.6		1295	1076	1000	10	10.0	10
	350	FRN450G1S-4U			DB220-4C	1	2.2		1424	1184	1100	10	11.0	10
	450	FRN500G1S-4U		2	DB160-4C	2	1.6		1813	1506	1400	10	14.0	10
	500	FRN600G1S-4U							2039	1695	1575	10	15.8	10
	600	FRN700G1S-4U			DB200-4C		1.3		2298	1910	1775	10	17.8	10
	700	FRN800G1S-4U							2590	2152	2000	10	20.0	10
	800	FRN900G1S-4U		3		3	0.867		3237	2691	2500	10	25.0	10
	900	FRN1000G1S-4U			DB220-4C		0.733		4090	3408	3150	10	31.5	10

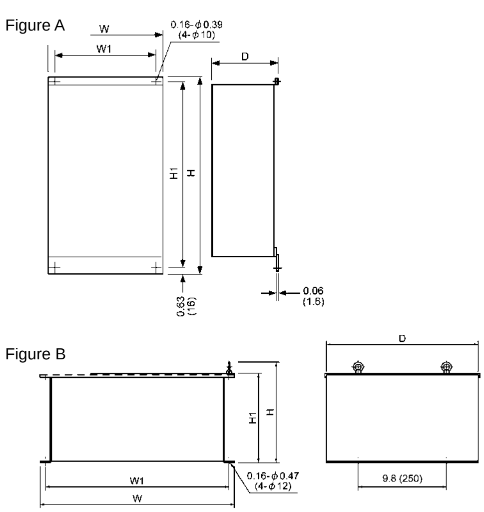
Note: A box (■) in the above table replaces S (Standard inverter) or H (Inverter with built-in DC reactor) depending on the enclosure.

[4] External dimensions

Braking resistors, standard models



Type	Figure	Dimensions W	W1	H	H1	D inch (mm)	Mass lb (kg)
DB0.75-2C/4C	A	1.7 (43)	–	8.7 (221)	8.5 (215)	1.2 (30.5)	0.9 (0.4)
DB2.2-2C/4C	B	2.6 (67)	–	7.4 (188)	6.8 (172)	2.2 (55)	1.8 (0.8)
DB3.7-2C/4C	B	2.6 (67)	–	12.9 (328)	12.3 (312)	2.2 (55)	3.1 (1.4)
DB5.5-2C/4C	B	3.2 (80)	–	14.9 (378)	14.3 (362)	3.1 (78)	5.7 (2.6)
DB7.5-2C/4C	B	3.2 (80)	–	16.5 (418)	15.8 (402)	3.1 (78)	6.2 (2.8)
DB11-2C/4C	C	3.2 (80)	2.0 (50)	18.1 (460)	17.3 (440)	5.5 (140)	9.5 (4.3)
DB15-2C/4C	C	3.2 (80)	2.0 (50)	22.8 (580)	22.1 (560)	5.5 (140)	12 (5.6)
DB22-2C/4C	D	7.1 (180)	5.7 (144)	15.8 (400)	15.1 (383)	5.7 (145)	19 (8.4)



Power supply voltage	Type	Figure	Dimensions W	W1	H	H1	D inch (mm)	Mass lb (kg)
230V series	DB30-2C	A	15.8 (400)	14.5 (368)	26.0 (660)	24.7 (628)	5.5 (140)	22 (10)
	DB37-2C	A					9.5 (240)	29 (13)
	DB45-2C	A						40 (18)
	DB55-2C		15.9 (405)		29.5 (750)	28.3 (718)		49 (22)
	DB75-2C	B	17.7 (450)	16.5 (420)	11.1 (283)	9.5 (240)	17.3 (440)	77 (35)
	DB110-2C		21.7 (550)	20.5 (520)				71 (32)
460V series	DB30-4C	A	16.5 (420)	15.3 (388)	26.0 (660)	24.7 (628)	5.5 (140)	11 (5.0)
	DB37-4C	A					9.5 (240)	31 (14)
	DB45-4C	A						42 (19)
	DB55-4C		16.7 (425)		29.5 (750)	28.3 (718)		46 (21)
	DB75-4C	B	21.7 (550)	20.5 (520)	11.1 (283)	9.5 (240)	17.3 (440)	57 (26)
	DB110-4C							66 (30)
	DB132-4C		25.6 (650)	24.4 (620)				90 (41)
	DB160-4C		29.5 (750)	28.4 (720)				126 (57)
	DB200-4C							95 (43)
	DB220-4C *		23.6 (600)	22.4 (570)				163 (74)

* DB220-4C should be used in pairs. The dimension above is for one unit.

Chap. 4 SELECTING PERIPHERAL EQUIPMENT

Braking units

Figure A

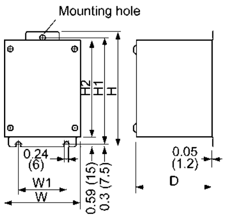
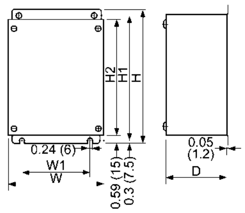


Figure B



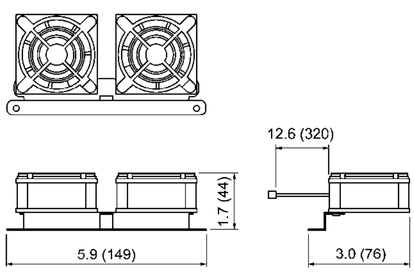
Power supply voltage	Type	Figure	Dimensions inch (mm)						Mass lb (kg)
			W	W1	H	H1	H2	D	
230 V series	BU37-2C	A	5.9 (150)	3.9 (100)	9.5 (240)	8.9 (225)	8.3 (210)	6.3 (160)	8.8 (4)
	BU55-2C	B	9.1 (230)	5.1 (130)	9.5 (240)	8.9 (225)			13 (6)
	BU90-2C		9.8 (250)	5.9 (150)	14.6 (370)	14.0 (355)	13.4 (340)		20 (9)
460 V series	BU37-4C	B	5.9 (150)	3.9 (100)	11.0 (280)	10.4 (265)	9.8 (250)	6.3 (160)	8.8 (4)
	BU55-4C		9.1 (230)	5.1 (130)					12 (5.5)
	BU90-4C								
	BU132-4C		9.8 (250)	5.9 (150)	14.6 (370)	14.0 (355)	13.4 (340)		20 (9)
	BU220-4C				17.7 (450)	17.1 (435)	16.5 (420)		29 (13)

Fan units for braking units

Using this option improves the duty cycle [%ED] from 10%ED to 30%ED.

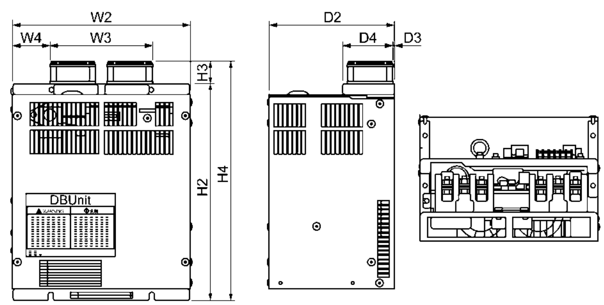
■ Fan unit

● BU-F



■ Braking unit + Fan unit

●BU37 to 220 - 2C/4C + BU-F



[Braking unit + Fan unit]

Power supply voltage	Type	Dimensions inch (mm)								
		W2	W3	W4	H2	H3	H4	D2	D3	D4
230 V series	BU37-2C+BU-F	5.9 (150)	5.3 (135)	0.3 (7.5)	9.5 (240)	1.2 (30)	10.6 (270)	6.3 (160)	0.05 (1.2)	2.5 (64)
	BU55-2C+BU-F	9.1 (230)		1.9 (47.5)						
	BU90-2C+BU-F	9.8 (250)		2.3 (57.5)	14.6 (370)		15.8 (400)			
460 V series	BU37-4C+BU-F	5.9 (150)	5.3 (135)	0.3 (7.5)	11.0 (280)	1.2 (30)	12.2 (310)	6.3 (160)	0.05 (1.2)	2.5 (64)
	BU55-4C+BU-F	9.1 (230)		1.9 (47.5)						
	BU90-4C+BU-F									
	BU132-4C+BU-F	9.8 (250)		2.3 (57.5)	14.6 (370)		15.8 (400)			
	BU220-4C+BU-F				17.7 (450)		18.9 (480)			

4.4.1.2 Power regenerative PWM converters, RHC series

[1] Overview

● Possible to reduce power supply facility capacity
Its power-factor control realizes the same phase current as the power-supply phase-voltage. The equipment, thus, can be operated with the power-factor of almost "1."
This makes it possible to reduce the power transformer capacity and downsize the other devices, compared with those required without the converter.

● Upgraded braking performance
Regenerated energy occurring at highly frequent accelerating and decelerating operation and elevating machine operation is entirely returned to power supply side.
Thus, energy saving during regenerative operation is possible.
As the current waveform is sinusoidal during regenerative operation, no troubles are caused to the power supply system.

Rated continuous regeneration :	100%
Rated regeneration for 1 min	150% (CT use)
	120% (VT use)

● Enhanced maintenance/protective functions
Failure can be easily analyzed with the trace back function (option).

(1) The past 10 alarms can be displayed with the 7-segment LEDs.
This helps you analyze the alarm causes and take countermeasures.

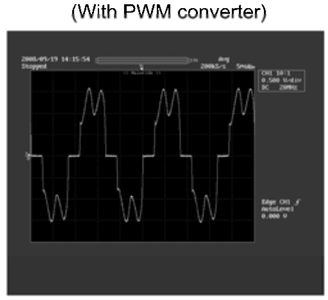
(2) When momentary power failure occurs, the converter shuts out the gate to enable continuous operation after recovery.

(3) The converter can issue warning signals like overload, heat sink overheating, or the end of service life prior to converter tripping.

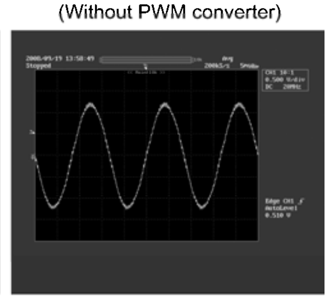
● Enhanced network support
The converter can be connected to MICREX-SX, F series and CC-Link master devices (using option).
The RS-485 interface is provided as standard.

Comparison of Input Current Waveforms

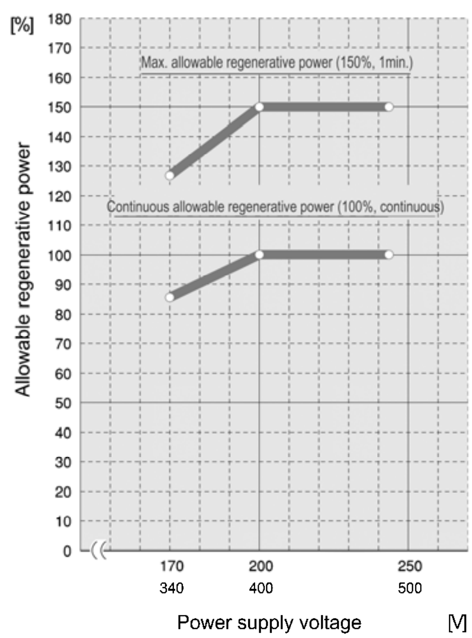
(With PWM converter)



(Without PWM converter)



Allowable characteristics of the RHC unit



[2] Specifications

[2.1] Standard specifications

■ 200 V class series

Item			Standard specifications										
Type RHC□□□-2C			200 V class series										
			7.5	11	15	18.5	22	30	37	45	55	75	90
CT mode	Applicable inverter capacity (kW)		7.5	11	15	18.5	22	30	37	45	55	75	90
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103
		Overload rating	150% of continuous rating for 1 minute										
		Voltage 200 V	320 to 355 VDC (Variable with input power voltage) (*1)										
	Required power supply (kVA)		9.5	14	19	24	29	38	47	57	70	93	111
	Carrier frequency		15 kHz (typical)									10 kHz (typical)	
VT mode	Applicable inverter capacity (kW)		11	15	18.5	22	30	37	45	55	75	90	110
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126
		Overload rating	120% of continuous rating for 1 minute										
		Voltage 200 V	320 to 355 VDC (Variable with input power voltage) (*1)										
	Required power supply (kVA)		14	19	24	29	38	47	57	70	93	111	136
	Carrier frequency		10 kHz (typical)									6 kHz (typical)	
Input power	Number of phases, voltage, frequency		Three-phase three lines, 200 to 220 V 50 Hz, 220 to 230 V 50 Hz (*2), 200 to 230 V 60 Hz										
	Voltage/frequency fluctuation		Voltage: –15 to +10%, Frequency: ±5%, Voltage unbalance: 2% or less (*3)										

■ 400 V class series

Item			Standard specifications																					
Type RHC□□□-4C			400 V class series																					
			7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
CT mode	Applicable inverter capacity (kW)		7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560	705
		Overload rating	150% of continuous rating for 1 min																					
		Voltage 200 V	640 to 710 V (Variable with input power voltage) (*1)																					
	Required power supply (kVA)		9.5	14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610	762
	Carrier frequency		15 kHz (typical)									10 kHz (typical)											6 kHz (typical)	
VT mode	Applicable inverter capacity (kW)		11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500		
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560		
		Overload rating	120% of continuous rating for 1 min																					
		Voltage 200 V	640 to 710 V (Variable with input power voltage) (*1)																					
	Required power supply (kVA)		14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610		
	Carrier frequency		10 kHz (typical)									6 kHz (typical)												
Input power	Number of phases, voltage, frequency		Three-phase three lines, 380 to 440 V 50 Hz, 380 to 460 V 60 Hz (*4)																					
	Voltage/frequency fluctuation		Voltage: –15 to +10%, Frequency: ±5%, Voltage unbalance: 2% or less (*3)																					

(*1) When the power supply voltage is 200/400 V, 220/440 V, or 230/460 V, the output voltage is approximate 320/640 VDC, 343/686 VDC, 355/710 VDC, respectively.

(*2) The 220 to 230 V/50 Hz models are available on request.

(*3) Voltage unbalance (%) = (Max. voltage (V) - Min. voltage (V)) / Three-phase average voltage (V) x 67

(*4) When the power supply voltage is 380 to 398 V/50 Hz and 380 to 430 V/60 Hz, tap-switching is required in the converter.

[2.2] Common specifications

Item		Specifications
Control	Control method	AVR constant control with DC ACR minor
	Running/Stopping	Starts rectification when the converter is powered ON after connection. Starts boosting when it receives a run signal (terminals [RUN] and [CM] short-circuited or a run command via the communications link). After that, the converter is ready to run.
	Running status signal	Running, power running, regenerative operation, ready-to-run, alarm output (for any alarm), etc.
	CT/VT switching	Switching between CT and VT modes. CT: 150% of overload rating for 1 min VT: 120% of overload rating for 1 min
	Carrier frequency	Fixed to high carrier frequency
	Input power factor	0.99 or above
	Restart after momentary power failure	Shields the gate when the voltage level reaches the undervoltage level if a momentary power failure occurs, and the converter can automatically restart after the power recovers.
	Power limiting control	Controls the power not to exceed the preset limit value.
Indication	Alarm display (Protective functions)	AC fuse blown, AC overvoltage, AC undervoltage, AC overcurrent, AC input current error, input phase loss, synchronous power supply frequency error, DC fuse blown, DC overvoltage, DC undervoltage, charge circuit fault, heat sink overheat, external alarm, converter internal overheat, overload, memory error, keypad communications error, CPU error, network device error, operation procedure error, A/D converter error, optical network error, IPM error
	Alarm history	Saves and displays the most recent 10 alarms. Saves and displays the detailed information of the trip cause for the previous alarm.
	Monitor	Displays input power, input current in RMS, input voltage in RMS, DC link bus voltage and power supply frequency.
	Load factor	Allows the user to measure the load factor with the keypad.
	Language	Allows the user to specify or refer to function codes in any of the three languages--Japanese, English or Chinese.
	Charging lamp	Lights when the DC link bus capacitor is charged.

[3] Function specifications

■ Terminal functions

Classifi-cation	Symbol	Name	Functions
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connects with the three-phase input power lines through a dedicated reactor.
	P(+), N(-)	Converter outputs	Connects with the power input terminals P(+) and N(-) on an inverter.
	⏚ G	Grounding	Grounding terminal for the converter's chassis (or casing).
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect the power lines same as that of the main power input.
Voltage detection	R1, S1, T1	Synchronous power input for voltage detection	Voltage detection terminals for the internal control of the converter. Connect with the power supply side of the dedicated reactor or filter.
	R2, T2	Inputs for control monitoring	Detection terminal for AC fuse blown.
Input signal	[RUN]	Run command	Short-circuiting terminals [RUN] and [CM] runs the converter; opening them stops the converter.
	[RST]	Reset alarm command	When the converter stops due to an alarm, removing the alarm factor and short-circuiting the terminals [RST] and [CM] cancels the protective function, restarting the converter.
	[X1]	General-purpose transistor input	0: Enable external alarm trip ***THR*** 1: Cancel current limiter ***LMT-CCL*** 2: 73 answerback ***73ANS*** 3: Switch current limiter ***I-LIM*** 4: Option DI ***OPT-DI***
	[CM]	Digital input common	Common terminal for digital input signals.
	[PLC]	PLC signal power	Connects to PLC output signal power supply. (Rated voltage: 24 VDC (22 to 27 VDC)
Output signal	[30A/B/C]	Alarm relay output (for any alarm)	Outputs a signal when the protective function is activated to stop the converter. (Contact: [1C], Terminals [30A] and [30C] are closed: Signal ON) (Contact rating: 250 VAC, max. 50 mA)
	[Y1], [Y2], [Y3], [Y11] to [Y18]	General-purpose transistor output	0: Converter running ***RUN*** 1: Converter ready to run ***RDY*** 2: Power supply current limiting ***IL*** 3: Lifetime alarm ***LIFE*** 4: Heat sink overheat early warning ***PRE-OH*** 5: Overload early warning ***PRE-OL*** 6: Power running ***DRV*** 7: Regenerating ***REG*** 8: Current limiting early warning ***CUR*** 9: Restarting after momentary power failure ***U-RES*** 10: Synchronizing power supply frequency ***SY-HZ*** 11: Alarm content 1 ***AL1*** 12: Alarm content 2 ***AL2*** 13: Alarm content 4 ***AL4*** 14: Option DO ***OPT-DO*** * Mounting the OPC-VG7-DIOA option makes 8 points of DO extended functions available. (DI functions are not available.)
	[CME]	Digital output common	
	[Y5A/C]	Relay output	
	[A01], [A04], [A05]	General-purpose analog output	0: Input power ***PWR*** 1: Input current in RMS ***I-AC*** 2: Input voltage in RMS ***V-AC*** 3: DC link bus voltage ***V-DC*** 4: Power supply frequency ***FREQ*** 5: +10 V test ***P10*** 6: -10 V test ***N10*** * Mounting the OPC-VG7-AIO option makes 2 points of AO extended functions available. (AI functions are not available.)

Classification	Symbol	Name	Functions
Output signal	[M]	Analog output common	Common terminal for analog output signal.
	[73A], [73C]	Charging resistor input relay outputs	Control output for the input relay of the external charging resistor (73).

■ Communications specifications

Item		Specifications
General communication specifications		Monitoring the running information, running status and function code data, and controlling (selecting) the terminals [RUN], [RST] and [X1]. * Writing to function codes is not possible.
RS-485 (standard)		Communicating with a PC or PLC. (The converter supports the Fuji general-purpose inverter protocol and Modbus RTU protocol.)
T-Link (option)		Mounting the OPC-VG7-TL option enables communication with a T-Link module of MICREX-F or MICREX-SX via a T-Link network.
SX-bus (option)		Mounting the OPC-VG7-SX option enables communication with a MICREX-SX via an SX bus network.
CC-Link (option)		Mounting the OPC-VG7-CCL option enables communication with a CC-Link master.
Traceback (option)	Hardware	Mounting the OPC-RHC-TR option enables tracing back of the running status data of the converter. WPS-LD-TR software is required.
	Software	Installing the WPS-RHC-TR software enables collecting of traceback data on the PC.

■ Function settings

Function code	Name	Function code	Name
F00	Data protection	E17	Under current limiting (Hysteresis width)
F01	High frequency filter selection	E18 to E20	A01, A04 and A05, function selection
F02	Restart mode after momentary power failure (Mode selection)	E21 to E23	A01, A04 and A05, gain setting
		E24 to E26	A01, A04 and A05, bias setting
F03	Current rating switching	E27	A01, A04 and A05, filter setting
F04	LED monitor, item selection	S01	Operation method
F05	LCD monitor, item selection	S02, S03	Power supply current limiting (driving/braking)
F06	LCD monitor, language selection	H01	Station address
F07	LCD monitor, contrast control	H02	Communications error processing
F08	Carrier frequency	H03	Timer
E01	Terminal [X1] function	H04	Baud rate
E02 to E13	Terminal [Y1], [Y2], [Y3,], [Y5], [Y11] to [Y18] function	H05	Data length
		H06	Parity bits
E14	I/O function normal open/closed	H07	Stop bits
E15	RHC overload early warning level	H08	No-response error detection time
E16	Cooling fan ON/OFF control	H09	Response interval

Function code	Name	Function code	Name
H10	Protocol selection	M09	Power supply frequency
H11	TL transmission format	M10	Input power
H12	Parallel system	M11	Input current in RMS
H13	Number of slave stations in parallel system	M12	Input voltage in RMS
H14	Clear alarm data	M13	Run command
H15, H16	Power supply current limiter (driving 1/2)	M14	Running status
H17, H18	Power supply current limiter (braking 1/2)	M15	Output terminals [Y1] to [Y18]
H19, H20	Current limiting early warning (level/timer)		

■ Protective functions

Item	LED monitor displays:	Description	Remarks
AC fuse blown	ACF	Stops the converter output if the AC fuse (R-/T-phase only) is blown.	
AC overvoltage	AOV	Stops the converter output upon detection of an AC overvoltage condition.	
AC undervoltage	ALV	Stops the converter output upon detection of an AC undervoltage condition.	
AC overcurrent	AOC	Stops the converter output if the peak value of the input current exceeds the overcurrent level.	
AC input current error	ACE	Stops the converter output upon detection of the excessive deviation of the AC reactor from the AC input.	
Input phase loss	LPV	Stops the converter output upon detection of an input phase loss.	
Synchronous power frequency error	Fr-E	After the MC for charging circuit (73) is turned on, the converter checks the power frequency. If it detects a power frequency error, this function stops the converter output. An error during converter running (e.g., momentary power failure) triggers no alarm.	
DC fuse blown	dCF	Stops the converter output if the DC fuse (P side) is blown.	30 HP (18.5 kW) or above
DC overvoltage	dOV	Stops the converter output upon detection of a DC overvoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: 400 V ±3 V 400 V class series: 800 V ±5 V
DC undervoltage	dLV	Stops the converter output upon detection of a DC undervoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: Stops at 185 V, restarts at 208 V. 400 V class series: Stops at 371 V, restarts at 417 V.

Item	LED monitor displays:	Description	Remarks
Charging circuit fault	PbF	Stops the converter output upon detection of a charging circuit fault, provided that the answerback signal from 73 is enabled.	Condition: ***73ANS*** (Answerback from 73) is assigned to terminal [X1].
Heat sink overheat	OH1	Stops the converter output upon detection of a heat sink overheat.	
External alarm	OH2	Stops the converter output upon receipt of an external signal ***THR***.	Condition: ***THR*** (Enable external alarm trip) is assigned to terminal [X1].
Converter internal overheat	OH3	Stops the converter output upon detection of an internal overheat of the converter.	
Converter overload	OLU	Stops the converter output with the inverse-time characteristics due to the input current.	Activate at 105%, 150% for 1 min
Memory error	Er-1	Stops the converter output if a data writing error or any other memory error occurs (when the checksums of the EEPROM and RAM do not match).	
Keypad communications error	Er-2	Displays "Er-2" upon detection of a wire break in initial communication with the keypad. This does not affect the converter operation.	
CPU error	Er-3	Activated if a CPU error occurs.	
Network device error	Er-4	Stops the converter output if a fatal error (including no power supply connection) occurs in the master unit in the network.	Applies to T-Link, SX-bus, and CC-Link devices.
Operation procedure error	Er-6	Stops the converter output upon detection of an error in the operation procedure.	
A/D converter error	Er-8	Stops the converter output upon detection of a failure in the A/D converter circuit.	
Optical network error	Er-b	Stops the converter output upon detection of an optical cable break or a fatal error in the optical option.	
IPM error	IPE	Activated when the IPM's self-diagnosis function works due to an overcurrent or overheat.	25 HP (15 kW) or below

■ Required structure and environment

Item		Required structure, environment and standards	Remarks
Structure	Structure	Mounting in a panel or mounting for external cooling	
	Enclosure	IP00	
	Cooling system	Forced air cooling	
	Installation	Vertical installation	
	Coating color	Munsell 5Y3/0.5, eggshell (Same color as our inverter FRENIC 5000VG7S series.)	
	Maintainability	Structure designed for easy parts replacement	
Environment	Site location	Shall be free from corrosive gases, flammable gases, dusts, and direct sunlight. Indoor use only.	
	Surrounding temperature	-10 to +50°C (14 to 122°F)	
	Relative humidity	5 to 95% RH (No condensation)	
	Altitude	9,800 ft (3,000 m) max. (For use in an altitude between 3,300 to 9,800 ft (1,001 to 3,000 m), the output current should be derated.)	
	Vibration	2 to 9 Hz: Amplitude = 0.12 inch (3 mm), 9 to 20 Hz: 9.8 m/s^2, 20 to 55 Hz: 2 m/s^2 (9 to 55 Hz: 2 m/s^2 for 150 HP (90 kW) or above), 55 to 200 Hz: 1 m/s^2	
	Storage temperature	-20 to +55°C (-4 to +131°F)	
	Storage humidity	5 to 95% RH	

[4] Converter configuration

■ List of configurators

CT mode

Power supply	Nominal applied motor		PWM converter type	MC for charging circuit		MC for power supply		Charging circuit box (*1)		Charging resistor		Fuse		Boosting reactor		Filtering resistor		Filtering reactor		Filtering capacitor		MC for filtering circuit	
	kW	HP		(73)	Q'ty	(52)	Q'ty	(CU)	Q'ty	(R0)	Q'ty	(F)	Q'ty	(Lr)	Q'ty	(Rf)	Q'ty	(Lf)	Q'ty	(Cf)	Q'ty	(6F)	Q'ty
230 V series	7.5	10	RHC7.5-2C	SC-5-1	1			CU7.5-2C	1	(80W 7.5Ω)	(3)	(CR2LS-50/UL)	(2)	LR2-7.5C	1	GRZG80 0.42Ω	3	LFC2-7.5C	1	CF2-7.5C	1		
	11	15	RHC11-2C	SC-N1	1			CU11-2C	1	(HF5C5504)		(CR2LS-75/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1		
	15	20	RHC15-2C	SC-N2	1			CU15-2C	1			(CR2LS-100/UL)	(2)										
	18.5	25	RHC18.5-2C	SC-N3	1			CU18.5-2C	1	(GRZG120 2Ω)	(3)			LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	30	RHC22-2C					CU22-2C	1			(CR2L-150/UL)	(2)										
	30	40	RHC30-2C	SC-N4	1			CU30-2C	1			(CR2L-200/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1		
	37	50	RHC37-2C	SC-N5	1			CU45-2C	1			(CR2L-260/UL)	(2)										
	45	60	RHC45-2C	SC-N7	1									LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	75	RHC55-2C	SC-N8	1			CU55-2C	1			(CR2L-400/UL)	(2)										
	75	100	RHC75-2C	SC-N11	1			CU75-2C	1					LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	125	RHC90-2C					CU90-2C	1	(GRZG400 1Ω)	(3)	(A50P600-4)	(2)	LR2-110C	1	GRZG400 0.12Ω (2 pcs in parallel)	6	LFC2-110C	1	CF2-110C	1		
460 V series	7.5	10	RHC7.5-4C	SC-05	1			CU7.5-4C	1	(TK50B 30Ω J)	(3)	(CR6L-30/UL)	(2)	LR4-7.5C	1	GRZG80 1.74Ω	3	LFC4-7.5C	1	CF4-7.5C	1		
	11	15	RHC11-4C	SC-4-0	1			CU15-4C	1	(HF5B0416)		(CR6L-50/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1		
	15	20	RHC15-4C	SC-5-1	1																		
	18.5	25	RHC18.5-4C	SC-N1	1			CU18.5-4C	1	(80W 7.5Ω)	(3)			LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	30	RHC22-4C					CU22-4C	1	(HF5C0416)		(CR6L-75/UL)	(2)										
	30	40	RHC30-4C	SC-N2	1			CU30-4C	1			(CR6L-100/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	50	RHC37-4C	SC-N2S	1			CU45-4C	1			(CR6L-150/UL)	(2)										
	45	60	RHC45-4C	SC-N3	1									LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1		
	55	75	RHC55-4C	SC-N4	1			CU55-4C	1			(CR6L-200/UL)	(2)										
	75	100	RHC75-4C	SC-N5	1			CU75-4C	1					LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	125	RHC90-4C	SC-N7	1			CU90-4C	1			(CR6L-300/UL)	(2)	LR4-110C	1	GRZG400 0.53Ω (2 pcs in parallel)	6	LFC4-110C	1	CF4-110C	1		
	110	150	RHC110-4C	SC-N8	1			CU110-4C	1	(GRZG120 2Ω)	(3)												
	132	200	RHC132-4C					CU132-4C	1			(A50P400-4)	(2)	LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	250	RHC160-4C	SC-N11	1			CU160-4C	1			(A50P600-4)	(2)										
	200	300	RHC200-4C	SC-N12	1			CU200-4C	1	(GRZG400 1Ω)	(3)			LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	350	RHC220-4C					CU220-4C	1			(A70QS800-4)	(2)										
	280	400	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω (2 pcs in parallel)	6	A70QS800-4	2	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1	SC-N4	1
	315	450	RHC315-4C									A70P1600-4TA	2	LR4-315C	1	RF4-315C	1	LFC4-315C	1	CF4-315C	1		
	355	500	RHC355-4C											LR4-355C	1	RF4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	600	RHC400-4C			SC-N16	1							LR4-400C	1	RF4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	800	RHC500-4C			SC-N11	3							LR4-500C	1	RF4-500C	1	LFC4-500C	1	CF4-500C	1(*2)		
	630	900	RHC630-4C			SC-N12	3					A70P2000-4	2	LR4-630C	1	RF4-630C	1	LFC4-630C	1	CF4-630C	1(*2)	SC-N7	1

VT mode

Power supply	Nominal applied motor		PWM converter type	MC for charging circuit		MC for power supply		Charging circuit box (*1)		Charging resistor		Fuse		Boosting reactor		Filtering resistor		Filtering reactor		Filtering capacitor		MC for filtering circuit	
	kW	HP		(73)	Q'ty	(52)	Q'ty	(CU)	Q'ty	(R0)	Q'ty	(F)	Q'ty	(Lr)	Q'ty	(Rf)	Q'ty	(Lf)	Q'ty	(Cf)	Q'ty	(6F)	Q'ty
230 V series	11	15	RHC7.5-2C	SC-N1	1			CU7.5-2C	1	(80W 7.5Ω) (HF5C5504)	(3)	(CR2LS-50/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1		
	15	20	RHC11-2C	SC-N2	1			CU11-2C	1			(CR2LS-75/UL)	(2)										
	18.5	25	RHC15-2C	SC-N3	1			CU15-2C	1	(GRZG120 2Ω)		(CR2LS-100/UL)	(2)	LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	30	RHC18.5-2C					CU18.5-2C	1		(3)												
	30	40	RHC22-2C	SC-N4	1			CU22-2C	1			(CR2L-150/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1		
	37	50	RHC30-2C	SC-N5	1			CU30-2C	1			(CR2L-200/UL)	(2)										
	45	60	RHC37-2C	SC-N7	1			CU45-2C	1			(CR2L-260/UL)	(2)	LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	75	RHC45-2C	SC-N8	1																		
	75	100	RHC55-2C	SC-N11	1			CU55-2C	1			(CR2L-400/UL)	(2)	LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	125	RHC75-2C					CU75-2C	1	(GRZG400 1Ω)				LR2-110C	1	GRZG400 0.12Ω (2 pcs in parallel)	6	LFC2-110C	1	CF2-110C	1		
	110	150	RHC90-2C	SC-N12	1			CU90-2C	1	(TK50B 30Ω J)	(3)	(A50P600-4)	(2)										
460 V series	11	15	RHC7.5-4C	SC-4-0	1			CU7.5-4C	1	(HF5B0416)	(3)	(CR6L-30/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1		
	15	20	RHC11-4C	SC-5-1	1			CU15-4C	1			(CR6L-50/UL)	(2)										
	18.5	25	RHC15-4C	SC-N1	1					(80W 7.5Ω)				LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	30	RHC18.5-4C					CU18.5-4C	1	(HF5C5504)	(3)												
	30	40	RHC22-4C	SC-N2	1			CU22-4C	1			(CR6L-75/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	50	RHC30-4C	SC-N2S	1			CU30-4C	1			(CR6L-100/UL)	(2)										
	45	60	RHC37-4C	SC-N3	1			CU45-4C	1			(CR6L-150/UL)	(2)	LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1		
	55	75	RHC45-4C	SC-N4	1																		
	75	100	RHC55-4C	SC-N5	1			CU55-4C	1			(CR6L-200/UL)	(2)	LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	125	RHC75-4C	SC-N7	1			CU75-4C	1					LR4-110C	1	GRZG400 0.53Ω (2 pcs in parallel)	6	LFC4-110C	1	CF4-110C	1		
	110	150	RHC90-4C	SC-N8	1			CU90-4C	1	(GRZG120 2Ω)		(CR6L-300/UL)	(2)										
	132	200	RHC110-4C					CU110-4C	1		(3)			LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	250	RHC132-4C	SC-N11	1			CU132-4C	1			(A50P400-4)	(2)										
	200	300	RHC160-4C	SC-N12	1			CU160-4C	1	(GRZG400 1Ω)		(A50P600-4)	(2)	LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	350	RHC200-4C					CU200-4C	1		(3)												
	315	450	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω (2 pcs in parallel)	6	A70QS800-4	2	LR4-315C	1	RF4-315C	1	LFC4-315C	1	CF4-315C	1	SC-N4	1
	355	500	RHC315-4C									A70P1600-4TA	2	LR4-355C	1	RF4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	600	RHC355-4C			SC-N16	1							LR4-400C	1	RF4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	800	RHC400-4C			SC-N11	3							LR4-500C	1	RF4-500C	1	LFC4-500C	1	CF4-500C	1(*2)		

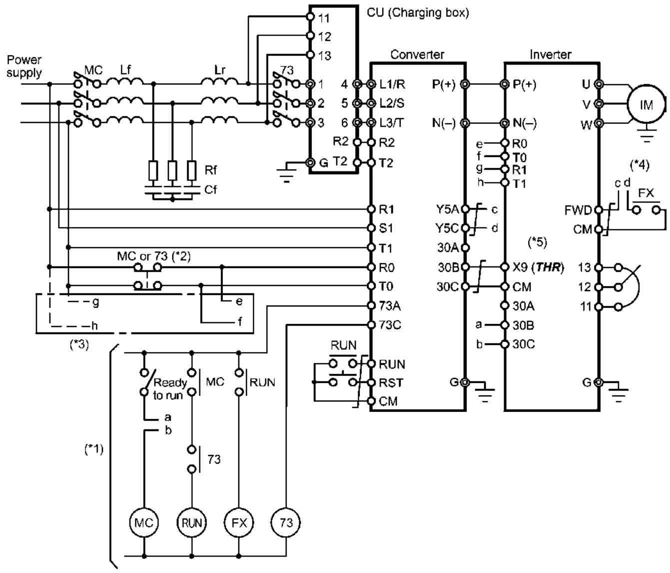
(*1) The charging box (CU) contains a combination of a charging resistor (R0) and a fuse (F). If no CU is used, it is necessary to prepare the charging resistor (R0) and fuse (F) at your end.

(*2) The filtering capacitor consists of two pieces of capacitors. For an order of quantity "1," two pieces of capacitors are to be delivered.

■ Basic connection diagrams

- RHC7.5-2C to RHC90-2C
- RHC7.5-4C to RHC220-4C

*When a charging box is connected



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
CU	Charging box
73	Magnetic contactor for charging circuit

(*1) For the 400 V class power supply, connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.

(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC).

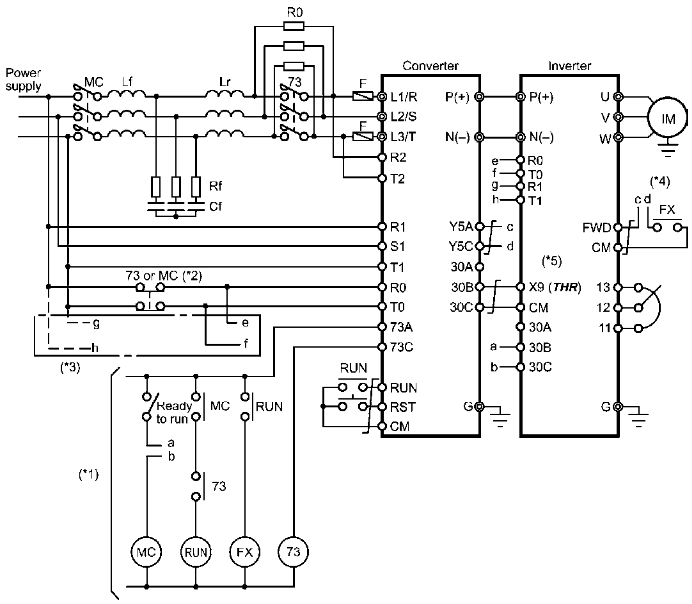
If 73 uses SC-05, SC-4-0, or SC-5-1, connect an auxiliary contact unit to the MC's B contact or 73.

(*3) Be sure to connect the auxiliary power input terminals R0 and T0 of the inverter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC). For 200 V class series of inverters with a capacity of 60 HP (37 kW) or above and 400 V class series with 125 HP (75 kW) or above, connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

(*5) Assign the external alarm ***THR*** to any of terminals [X1] to [X7] on the inverter.

- RHC7.5-2C to RHC90-2C
- RHC7.5-4C to RHC220-4C



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charging resistor
F	Fuse
73	Magnetic contactor for charging circuit

(*1) For the 400 V class power supply, connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.

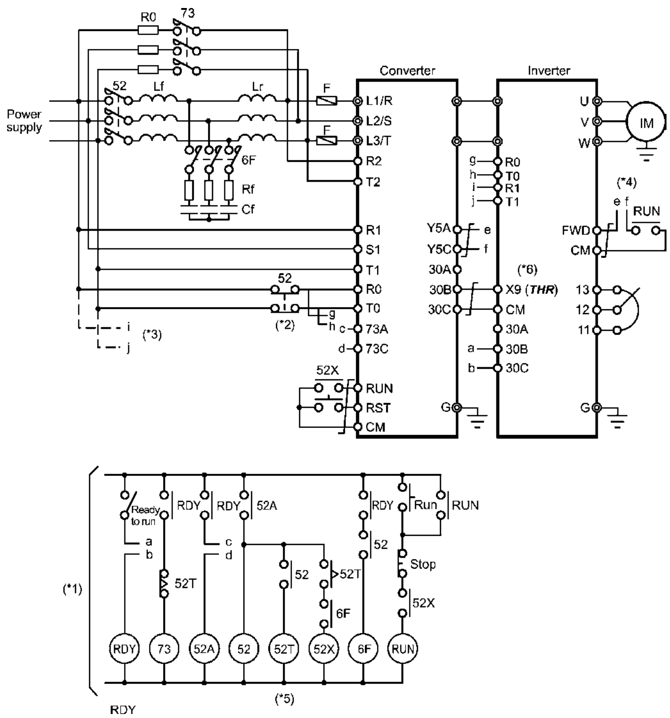
(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC).
If 73 uses SC-05, SC-4-0, or SC-5-1, connect an auxiliary contact unit to the MC's B contact or 73.

(*3) Be sure to connect the auxiliary power input terminals R0 and T0 of the inverter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC). For 200 V class series of inverters with a capacity of 60 HP (37 kW) or above and 400 V class series with 125 HP (75 kW) or above, connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

(*5) Assign the external alarm ***THR*** to any of terminals [X1] to [X7] on the inverter.

• RHC280-4C to RHC400-4C



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charging resistor
F	Fuse
73	Magnetic contactor for charging circuit
52	Magnetic contactor for power supply
6F	Magnetic contactor for filtering circuit

(*1) Connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.

(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter and the inverter to the main power input lines via B contacts of magnetic contactors of the power supply circuit (52).

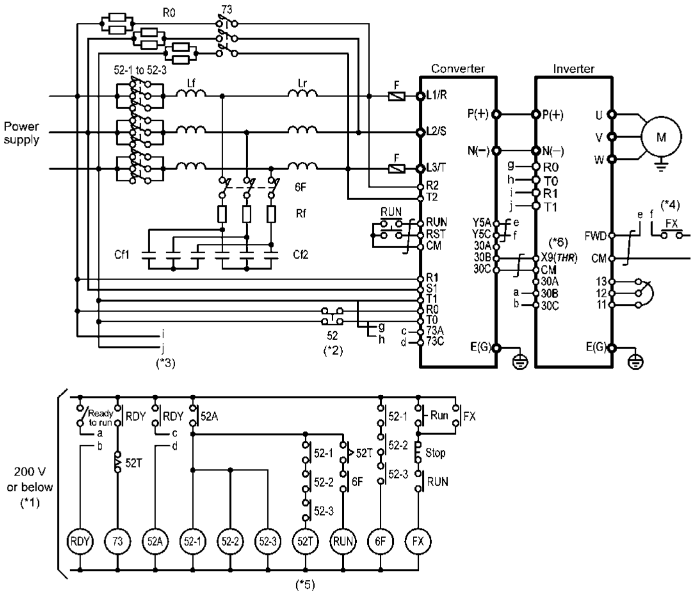
(*3) Connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the B contacts of 52, since the inverter's AC fans are supplied with power from these terminals.

(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

(*5) Set the timer 52T at 1 sec.

(*6) Assign the external alarm ***THR*** to any of terminals [X1] to [X7] on the inverter.

- RHC400-4C in VT mode
- RHC500-4C and RHC630-4C



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charging resistor
F	Fuse
73	Magnetic contactor for charging circuit
52	Magnetic contactor for power supply
6F	Magnetic contactor for filtering circuit

(*1) Connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.
(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter and the inverter to the main power input lines via B contacts of magnetic contactors of the power supply circuit (52).
(*3) Connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the B contacts of 73 or 52, since the inverter's AC fans are supplied with power from these terminals.
(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.
(*5) Set the timer 52T at 1 sec.
(*6) Assign the external alarm ***THR*** to any of terminals [X1] to [X7] on the inverter.
(*7) Wiring for terminals L1/R, L2/S, L3/T, R2, T2, R1, S1, and T1 should match with the phase sequence.

[5] External dimensions

■ PWM converter

Figure A

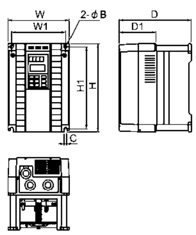


Figure B

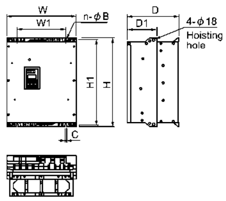


Figure C

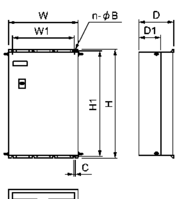
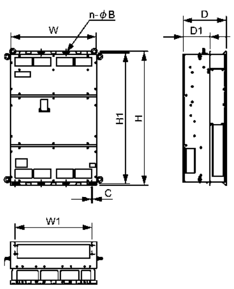


Figure D



PWM converter type		Figure	Dimensions W	W1	H	H1	D	D1	n	B	C inch (mm)	Mass lb (kg)
230 V series	RHC7.5-2C RHC11-2C RHC15-2C	A	9.8 (250)	8.9 (226)	15.0 (380)	14.1 (358)	9.7 (245)	4.9 (125)	0.08 (2)	0.39 (10)	0.39 (10)	28 (12.5)
	RHC18.5-2C RHC22-2C	B	13.4 (340)	9.5 (240)	18.9 (480)	18.1 (460)	10.0 (255)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	53 (24)
	RHC30-2C	B	13.4 (340)	9.5 (240)	21.7 (550)	20.9 (530)	10.0 (255)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	64 (29)
	RHC37-2C	B	14.8 (375)	10.8 (275)	24.2 (615)	23.4 (595)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	79 (36)
	RHC45-2C	B	14.8 (375)	10.8 (275)	29.1 (740)	28.4 (720)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	93 (42)
	RHC55-2C	B	14.8 (375)	10.8 (275)	29.1 (740)	28.4 (720)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	97 (44)
	RHC75-2C	C	20.9 (530)	16.9 (430)	29.5 (750)	28.4 (720)	11.2 (285)	5.7 (145)	0.08 (2)	0.59 (15)	0.59 (15)	154 (70)
	RHC90-2C	C	26.8 (680)	22.8 (580)	34.7 (880)	33.5 (850)	14.2 (360)	8.7 (220)	0.12 (3)	0.59 (15)	0.59 (15)	254 (115)
460 V series	RHC7.5-4C RHC11-4C RHC15-4C	A	9.8 (250)	8.9 (226)	15.0 (380)	14.1 (358)	9.7 (245)	4.9 (125)	0.08 (2)	0.39 (10)	0.39 (10)	18 (8)
	RHC18.5-4C RHC22-4C	B	13.4 (340)	9.5 (240)	18.9 (480)	18.1 (460)	10.0 (255)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	53 (24)
	RHC30-4C	B	13.4 (340)	9.5 (240)	21.7 (550)	20.9 (530)	10.0 (255)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	64 (29)
	RHC37-4C	B	14.8 (375)	10.8 (275)	21.7 (550)	20.9 (530)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	75 (34)
	RHC45-4C RHC55-4C	B	14.8 (375)	10.8 (275)	26.6 (675)	25.8 (655)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	84 (38)
	RHC75-4C	B	14.8 (375)	10.8 (275)	29.1 (740)	28.4 (720)	10.6 (270)	5.7 (145)	0.08 (2)	0.39 (10)	0.39 (10)	106 (48)
	RHC90-4C RHC110-4C	C	20.9 (530)	16.9 (430)	29.1 (740)	28.0 (710)	12.4 (315)	5.7 (145)	0.08 (2)	0.59 (15)	0.59 (15)	154 (70)
	RHC132-4C RHC160-4C	C	20.9 (530)	16.9 (430)	39.4 (1000)	38.2 (970)	14.2 (360)	8.7 (220)	0.08 (2)	0.59 (15)	0.59 (15)	220 (100)
	RHC200-4C RHC220-4C	C	26.8 (680)	22.8 (580)	39.4 (1000)	38.2 (970)	14.2 (360)	8.7 (220)	0.12 (3)	0.59 (15)	0.59 (15)	309 (140)
	RHC280-4C RHC315-4C	C	26.8 (680)	22.8 (580)	55.1 (1400)	53.9 (1370)	17.7 (450)	11.2 (285)	0.12 (3)	0.59 (15)	0.59 (15)	705 (320)
	RHC355-4C RHC400-4C	C	34.7 (880)	30.7 (780)	55.1 (1400)	53.9 (1370)	17.7 (450)	11.2 (285)	0.16 (4)	0.59 (15)	0.59 (15)	904 (410)
	RHC500-4C RHC630-4C	D	39.3 (999)	35.4 (900)	61.0 (1550)	59.8 (1520)	19.7 (500)	12.3 (313.2)	0.16 (4)	0.59 (15)	0.59 (15)	1157 (525)

< Boosting reactor >

Figure A

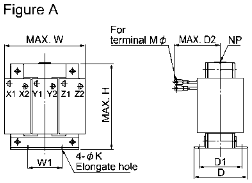


Figure B

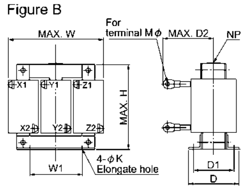


Figure C

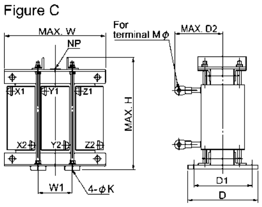
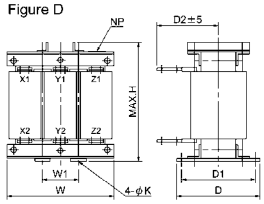


Figure D



Boosting reactor type		Figure	Dimensions W	W1	H	D	D1	D2	K	M inch (mm)	Mass lb (kg)
230 V series	LR2-7.5C	A	7.1 (180)	3.0 (75)	8.1 (205)	4.1 (105)	3.4 (85)	3.7 (95)	0.28 (7)	M5	26 (12)
	LR2-15C	B	7.7 (195)	3.0 (75)	8.5 (215)	5.2 (131)	4.3 (110)	5.1 (130)	0.28 (7)	M8	40 (18)
	LR2-22C	C	9.5 (240)	3.2 (80)	13.4 (340)	8.5 (215)	7.1 (180)	5.7 (145)	0.39 (10)	M8	73 (33)
	LR2-37C	C	11.2 (285)	3.7 (95)	16.5 (420)	9.5 (240)	8.1 (205)	5.9 (150)	0.47 (12)	M10	110 (50)
	LR2-55C	C	11.2 (285)	3.7 (95)	16.5 (420)	9.8 (250)	8.5 (215)	6.3 (160)	0.47 (12)	M12	128 (58)
	LR2-75C	C	13.0 (330)	4.3 (110)	17.3 (440)	10.0 (255)	8.7 (220)	6.5 (165)	0.47 (12)	M12	154 (70)
	LR2-110C	C	13.6 (345)	4.5 (115)	19.7 (500)	11.0 (280)	9.7 (245)	7.3 (185)	0.47 (12)	M12	220 (100)
460 V series	LR4-7.5C	B	7.1 (180)	3.0 (75)	8.1 (205)	4.1 (105)	3.4 (85)	3.5 (90)	0.28 (7)	M4	26 (12)
	LR4-15C	A	7.7 (195)	3.0 (75)	8.5 (215)	5.2 (131)	4.3 (110)	4.7 (120)	0.28 (7)	M5	40 (18)
	LR4-22C	C	9.5 (240)	3.2 (80)	13.4 (340)	8.5 (215)	7.1 (180)	4.7 (120)	0.39 (10)	M6	73 (33)
	LR4-37C	C	11.2 (285)	3.7 (95)	15.9 (405)	9.5 (240)	8.1 (205)	5.1 (130)	0.47 (12)	M8	110 (50)
	LR4-55C	C	11.2 (285)	3.7 (95)	16.3 (415)	9.8 (250)	8.5 (215)	5.7 (145)	0.47 (12)	M10	128 (58)
	LR4-75C	C	13.0 (330)	4.3 (110)	17.3 (440)	10.0 (255)	8.7 (220)	5.9 (150)	0.47 (12)	M10	154 (70)
	LR4-110C	C	13.6 (345)	4.5 (115)	19.3 (490)	11.0 (280)	9.7 (245)	6.7 (170)	0.47 (12)	M12	220 (100)
	LR4-160C	C	15.0 (380)	4.9 (125)	21.7 (550)	11.8 (300)	10.2 (260)	7.3 (185)	0.59 (15)	M12	309 (140)
	LR4-220C	C	17.7 (450)	5.9 (150)	24.4 (620)	13.0 (330)	11.4 (290)	9.1 (230)	0.59 (15)	M12	441 (200)
	LR4-280C	C	18.9 (480)	6.3 (160)	29.1 (740)	13.0 (330)	11.4 (290)	9.5 (240)	0.59 (15)	M16	551 (250)
	LR4-315C	C	18.9 (480)	6.3 (160)	29.9 (760)	13.4 (340)	11.8 (300)	9.8 (250)	0.59 (15)	M16	595 (270)
	LR4-355C	C	18.9 (480)	6.3 (160)	32.7 (830)	14.0 (355)	12.4 (315)	10.0 (255)	0.59 (15)	M16	683 (310)
	LR4-400C	C	18.9 (480)	6.3 (160)	35.0 (890)	15.0 (380)	13.0 (330)	10.2 (260)	0.75 (19)	M16	750 (340)
	LR4-500C	C	20.7 (525)	6.9 (175)	37.8 (960)	16.1 (410)	14.2 (360)	11.4 (290)	0.75 (19)	M16	926 (420)
	LR4-630	D	23.6 (600)	7.9 (200)	25.2 (640)	17.3 (440)	15.4 (390)	11.2 (285)	0.75 (19)	--	992 (450)

< Filtering reactor >

Figure A

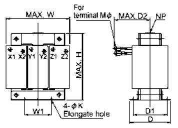


Figure B

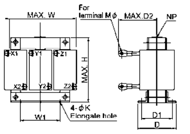


Figure C

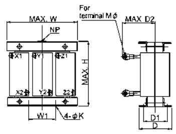


Figure D

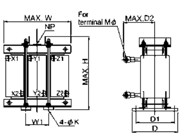
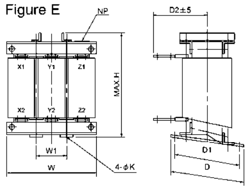


Figure E



Filtering reactor type		Figure	Dimensions inch (mm)								Mass lb (kg)
			W	W1	H	D	D1	D2	K	M	
230 V series	LFC2-7.5C	B	4.9 (125)	1.6 (40)	3.9 (100)	3.4 (85)	2.6 (67)	3.4 (85)	0.24 (6)	M5	4.9 (2.2)
	LFC2-15C	B	4.9 (125)	1.6 (40)	3.9 (100)	3.7 (93)	3.0 (75)	3.5 (90)	0.24 (6)	M8	5.5 (2.5)
	LFC2-22C	B	4.9 (125)	1.6 (40)	3.9 (100)	3.7 (93)	3.0 (75)	4.1 (105)	0.24 (6)	M8	6.6 (3.0)
	LFC2-37C	B	5.9 (150)	2.4 (60)	4.5 (115)	4.1 (103)	3.4 (85)	4.9 (125)	0.24 (6)	M10	11 (5.0)
	LFC2-55C	B	6.9 (175)	2.4 (60)	5.7 (145)	4.3 (110)	3.5 (90)	5.5 (140)	0.24 (6)	M12	18 (8.0)
	LFC2-75C	B	7.7 (195)	3.2 (80)	7.9 (200)	4.7 (120)	3.9 (100)	5.9 (150)	0.28 (7)	M12	29 (13)
	LFC2-110C	C	10.0 (255)	3.4 (85)	9.1 (230)	4.7 (118)	3.7 (95)	6.5 (165)	0.28 (7)	M12	44 (20)
460 V series	LFC4-7.5C	A	4.9 (125)	1.6 (40)	3.9 (100)	3.4 (85)	2.6 (67)	3.0 (75)	0.24 (6)	M4	4.9 (2.2)
	LFC4-15C	A	4.9 (125)	1.6 (40)	3.9 (100)	3.7 (93)	3.0 (75)	3.5 (90)	0.24 (6)	M5	5.5 (2.5)
	LFC4-22C	A	4.9 (125)	1.6 (40)	3.9 (100)	3.7 (93)	3.0 (75)	3.7 (95)	0.24 (6)	M6	6.6 (3.0)
	LFC4-37C	B	5.9 (150)	2.4 (60)	4.5 (115)	4.3 (108)	3.5 (90)	4.3 (110)	0.24 (6)	M8	11 (5.0)
	LFC4-55C	B	6.9 (175)	2.4 (60)	5.7 (145)	4.3 (110)	3.5 (90)	4.7 (120)	0.24 (6)	M10	18 (8.0)
	LFC4-75C	B	7.7 (195)	3.2 (80)	7.9 (200)	4.5 (113)	3.7 (93)	5.1 (130)	0.28 (7)	M10	26 (12)
	LFC4-110C	C	10.0 (255)	3.4 (85)	8.7 (220)	4.5 (113)	3.5 (90)	5.7 (145)	0.28 (7)	M12	42 (19)
	LFC4-160C	C	10.0 (255)	3.4 (85)	9.7 (245)	5.4 (137)	4.3 (110)	5.9 (150)	0.39 (10)	M12	49 (22)
	LFC4-220C	D	11.8 (300)	3.9 (100)	12.6 (320)	8.3 (210)	7.1 (180)	6.7 (170)	0.39 (10)	M12	77 (35)
	LFC4-280C	D	13.0 (330)	4.3 (110)	13.0 (330)	9.1 (230)	7.7 (195)	7.7 (195)	0.47 (12)	M16	95 (43)
	LFC4-315C	D	12.4 (315)	4.1 (105)	14.4 (365)	9.1 (230)	7.7 (195)	7.9 (200)	0.47 (12)	M16	106 (48)
	LFC4-355C	D	12.4 (315)	4.1 (105)	15.6 (395)	9.3 (235)	7.9 (200)	8.3 (210)	0.47 (12)	M16	117 (53)
	LFC4-400C	D	13.6 (345)	4.5 (115)	16.5 (420)	9.3 (235)	7.9 (200)	9.3 (235)	0.47 (12)	M16	132 (60)
	LFC4-500C	D	13.6 (345)	4.5 (115)	18.9 (480)	9.5 (240)	8.1 (205)	9.5 (240)	0.47 (12)	M16	159 (72)
	LFC4-630C	E	17.1 (435)	5.7 (145)	21.7 (550)	11.6 (295)	10.0 (255)	7.9 (200)	0.59 (15)	--	386 (175)

< Filtering capacitor >

Figure A

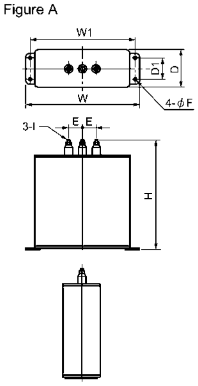
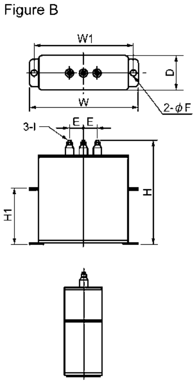


Figure B



Filtering capacitor type		Figure	Dimensions inch (mm)									Mass lb (kg)
			W	W1	H	H1	D	D1	E	F	I	
230 V series	CF2-7.5C	A	6.5 (165)	5.9 (150)	7.3 (185)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	4.2 (1.9)
	CF2-15C	A	8.1 (205)	6.8 (173)	9.7 (245)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	7.7 (3.5)
	CF2-22C	A	11.0 (280)	10.4 (265)	10.2 (260)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M5	13.0 (6.0)
	CF2-37C	A	11.0 (280)	10.4 (265)	11.4 (290)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M5	15.0 (7.0)
	CF2-55C	A	11.0 (280)	10.4 (265)	13.4 (340)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M8	19.0 (8.5)
	CF2-75C	A	11.0 (280)	10.4 (265)	11.4 (290)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M6	15.0 (7.0)
	CF2-110C	A	11.0 (280)	10.4 (265)	13.4 (340)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M8	19.0 (8.5)
460 V series	CF4-7.5C	A	6.5 (165)	5.9 (150)	5.3 (135)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	2.9 (1.3)
	CF4-15C	A	6.5 (165)	5.9 (150)	8.5 (215)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	5.1 (2.3)
	CF4-22C	A	8.1 (205)	7.5 (190)	7.3 (185)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	5.5 (2.5)
	CF4-37C	A	8.1 (205)	7.5 (190)	8.1 (205)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	6.4 (2.9)
	CF4-55C	A	8.1 (205)	7.5 (190)	9.7 (245)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	7.7 (3.5)
	CF4-75C	A	8.1 (205)	7.5 (190)	8.1 (205)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	6.4 (2.9)
	CF4-110C	A	8.1 (205)	7.5 (190)	9.7 (245)	--	2.8 (70)	1.6 (40)	1.2 (30)	0.28 (7)	M5	7.7 (3.5)
	CF4-160C	A	11.0 (280)	10.4 (265)	10.2 (260)	--	3.5 (90)	2.2 (55)	3.2 (80)	0.28 (7)	M6	13.0 (6.0)
	CF4-220C	B	17.1 (435)	15.8 (400)	12.2 (310)	4.9 (125)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	29.0 (13.0)
	CF4-280C	B	17.1 (435)	15.8 (400)	13.8 (350)	6.5 (165)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	33.0 (15.0)
	CF4-315C	B	17.1 (435)	15.8 (400)	18.1 (460)	10.8 (275)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	44.0 (20.0)
	CF4-355C	B	17.1 (435)	15.8 (400)	20.5 (520)	13.2 (335)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	51.0 (23.0)
	CF4-400C	B	17.1 (435)	15.8 (400)	24.0 (610)	16.7 (425)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	60 (27.0)
	CF4-500C	B	17.1 (435)	15.8 (400)	12.2 (310)	4.9 (125)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	29.0 (13.0)
	CF4-630C	B	17.1 (435)	15.8 (400)	18.1 (460)	10.8 (275)	3.9 (100)	--	3.2 (80)	0.59 x 0.79* (15 x 20)	M12	44.0 (20.0)

* Elongate hole

< Filtering resistor >

Figure A

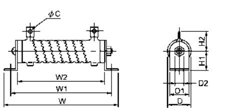


Figure B

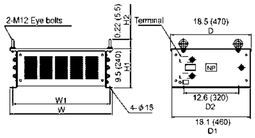
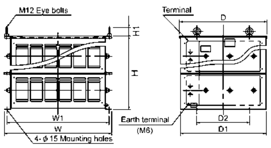


Figure C



Filtering resistor type		Figure	Dimensions W	W1	W2	H1	H2	D	D1	D2	C inch (mm)	Mass lb (kg)	Q'ty
230 V series	GRZG80 0.42Ω	A	6.6 (167)	5.8 (148)	4.5 (115)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.4 (0.19)	3
	GRZG150 0.2Ω	A	9.7 (247)	9.0 (228)	7.7 (195)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.4 (0.19)	3
	GRZG200 0.13Ω	A	12.1 (306)	11.3 (287)	10.0 (254)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.8 (0.35)	3
	GRZG400 0.1Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (0.85)	3
	GRZG400 0.12Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (0.85)	3
460 V series	GRZG80 1.74Ω	A	6.6 (167)	5.8 (148)	4.5 (115)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.4 (0.19)	3
	GRZG150 0.79Ω	A	9.7 (247)	9.0 (228)	7.7 (195)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.4 (0.19)	3
	GRZG200 0.53Ω	A	12.1 (306)	11.3 (287)	10.0 (254)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.8 (0.35)	3
	GRZG400 0.38Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (0.85)	3
	GRZG400 0.26Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (0.85)	3
	GRZG400 0.53Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (0.85)	6
	RF4-160C	B	15.8 (400)	14.6 (370)	--	9.5 (240)	2.2 (55)	18.5 (470)	18.1 (460)	12.6 (320)	--	49 (22)	1
	RF4-220C											55 (25)	1
	RF4-280C	C	25.8 (655)	24.6 (625)	--	9.5 (240)	2.2 (55)	18.5 (470)	18.1 (460)	12.6 (320)	--	68.3 (31)	1
	RF4-315C											77.2 (35)	1
	RF4-355C											79.4 (36)	1
	RF4-400C											83.8 (38)	1
	RF4-500C											90 (41)	1
	RF4-630C	C	25.8 (655)	24.6 (625)	--	17.3 (440)	2.2 (55)	20.9 (530)	20.5 (520)	12.6 (320)	--	154 (70)	1

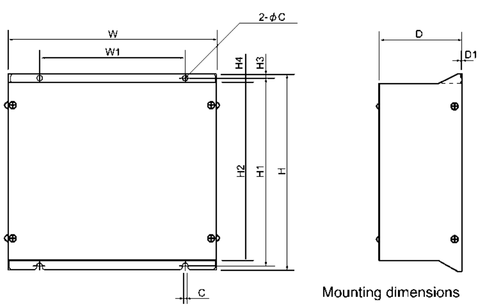
< Charging box >

The charging box contains a combination of a charging resistor and a fuse, which is essential in the configuration of the RHC-C series of PWM converters. Using this charging box eases mounting and wiring jobs.

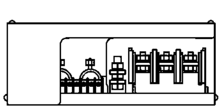
Capacity range

200 V class series: 15 to 150 HP (7.5 to 90 kW) in 10 types,
400 V class series: 15 to 450 HP (7.5 to 220 kW) in 14 types, Total 24 types

As for 400 V class series of 500 to 800 HP (280 to 400 kW), the charging resistor and the fuse are separately provided as before.



Mounting dimensions



Fuse type		Dimensions W	W1	H	H1	H2	H3	H4	D	D1	C inch (mm)	Mounting bolt	Mass lb (kg)
230 V series	CU7.5-2C	10.6 (270)	6.7 (170)	11.8 (300)	11.2 (285)	10.6 (270)	0.3 (7.5)	0.59 (15)	3.9 (100)	0.09 (2.4)	0.24 (6)	M5	13 (6)
	CU11-2C												
	CU15-2C												
	CU18.5-2C												
	CU22-2C												
	CU30-2C	11.8 (300)	7.9 (200)	12.2 (310)	11.6 (295)	11.0 (280)			4.3 (110)				15 (7)
	CU45-2C	13.0 (330)	9.1 (230)						5.1 (130)				17.6 (8)
	CU55-2C												
	CU75-2C	16.9 (430)	13.0 (330)	22.1 (560)	21.1 (536)	20.1 (510)	0.47 (12)	0.98 (25)	5.9 (150)	0.13 (3.2)	0.39 (10)	M8	37.5 (17)
	CU90-2C												44.1 (20)
460 V series	CU7.5-4C	10.6 (270)	6.7 (170)	11.8 (300)	11.2 (285)	10.6 (270)	0.3 (7.5)	0.59 (15)	3.9 (100)	0.09 (2.4)	0.24 (6)	M5	12.1 (5.5)
	CU15-4C												
	CU18.5-4C												13 (6)
	CU22-4C												
	CU30-4C	11.8 (300)	7.9 (200)	12.2 (310)	11.6 (295)	11.0 (280)			4.3 (110)				15 (7)
	CU45-4C												
	CU55-4C												
	CU75-4C	13.0 (330)	9.1 (230)						5.1 (130)				17.6 (8)
	CU90-4C												
	CU110-4C												
	CU132-4C	16.9 (430)	13.0 (330)	22.1 (560)	21.1 (536)	20.1 (510)	0.47 (12)	0.98 (25)	5.9 (150)	0.13 (3.2)	0.39 (10)	M8	40 (18)
	CU160-4C												
	CU200-4C												44.1 (20)
	CU220-4C												

< Charging resistor >

Figure A

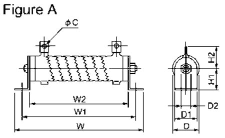


Figure B

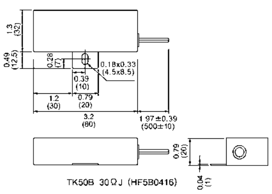
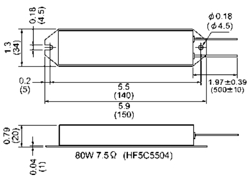


Figure C



Charging resistor type	Figure	Dimensions inch (mm)									Mass lb (g)
		W	W1	W2	H1	H2	D	D1	D2	C	
GRZG120 2Ω	A	8.5 (217)	7.8 (198)	6.5 (165)	0.87 (22)	1.3 (32)	1.3 (33)	1.0 (26)	0.24 (6)	0.22 (5.5)	0.6 (250)
GRZG400 1Ω	A	16.2 (411)	15.2 (385)	13.0 (330)	1.6 (40)	1.5 (39)	1.9 (47)	1.6 (40)	0.37 (9.5)	0.22 (5.5)	1.9 (850)
TK50B 30Ω J (HF5B0416)	B	--	--	--	--	--	--	--	--	--	0.3 (150)
80W 7.5Ω (HF5C5504)	C	--	--	--	--	--	--	--	--	--	--

< Fuse >

Figure A

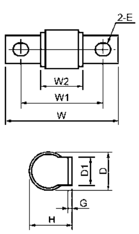


Figure B

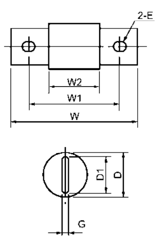
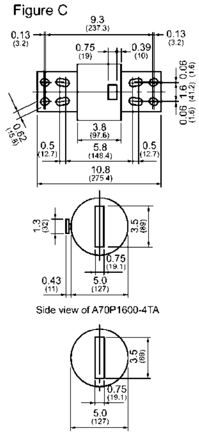


Figure C



Side view of A70P1600-4TA

Side view of A70P2000-4

Fuse type		Figure	Dimensions inch (mm)								Mass lb (g)
			W	W1	W2	H	D	D1	G	E	
230 V series	CR2LS-50/UL CR2LS-75/UL CR2LS-100/UL	A	2.2 (56)	1.7 (42)	1.0 (26)	0.73 (18.5)	0.69 (17.5)	0.47 (12)	0.08 (2)	0.26x0.33 (6.5x8.5)	0.1 (28)
	CR2L-150/UL	A	3.2 (80)	2.3 (58)	1.2 (29.5)	1.2 (30.5)	1.1 (27)	0.79 (20)	0.12 (3)	0.35x0.43 (9x11)	0.2 (100)
	CR2L-200/UL CR2L-260/UL	A	3.4 (85)	2.4 (60)	1.2 (30)	1.3 (33.5)	1.2 (30)	0.98 (25)	0.13 (3.2)	0.43x0.51 (11x13)	0.3 (130)
	CR2L-400/UL	A	3.7 (95)	2.8 (70)	1.2 (31)	1.7 (42)	1.5 (37)	1.2 (30)	0.16 (4)	0.43x0.51 (11x13)	0.5 (230)
	A50P600-4	B	4.5 (113.5)	3.2 (81.75)	2.2 (56.4)	--	2.0 (50.8)	1.5 (38.1)	0.25 (6.4)	0.41x0.72 (10.3x18.2)	1.2 (540)
460 V series	CR6L-30/UL CR6L-50/UL	A	3.0 (76)	2.4 (62)	1.9 (47)	0.73 (18.5)	0.69 (17.5)	0.47 (12)	0.08 (2)	0.26x0.33 (6.5x8.5)	0.1 (42)
	CR6L-75/UL CR6L-100/UL CR6L-150/UL	A	3.7 (95)	2.8 (70)	1.6 (40)	1.3 (34)	1.2 (30)	0.98 (25)	0.13 (3.2)	0.43x0.51 (11x13)	0.3 (150)
	CR6L-200/UL CR6L-300/UL	A	4.2 (107)	3.2 (82)	1.7 (43)	1.7 (42)	1.5 (37)	1.2 (30)	0.16 (4)	0.43x0.51 (11x13)	0.5 (246)
	A50P400-4	B	4.3 (110)	3.1 (78.6)	2.1 (53.1)	--	1.5 (38.1)	1.0 (25.4)	0.25 (6.4)	0.41x0.72 (10.3x18.4)	0.6 (290)
	A50P600-4	B	4.5 (113.5)	3.2 (81.75)	2.2 (56.4)	--	2.0 (50.8)	1.5 (38.1)	0.25 (6.4)	0.41x0.72 (10.3x18.4)	1.2 (540)
	A70QS800-4	B	7.1 (180.2)	5.1 (129.4)	2.8 (72.2)	--	2.5 (63.5)	2.0 (50.8)	0.37 (9.5)	0.53x0.72 (13.5x18.3)	2.4 (1080)
	A70P1600-4TA	C	--	--	--	--	--	--	--	--	16.3 (7400)
	A70P2000-4	C	--	--	--	--	--	--	--	--	17.6 (8000)

■ Generated loss

In CT mode

PWM converter		Boosting reactor		Filtering reactor		Filtering resistor		
Type	Generated loss (W)	Type	Generated loss (W)	Type	Generated loss (W)	Type	Q'ty	Generated loss (W)
RHC7.5-2C	400	LR2-7.5C	95	LFC2-7.5C	10	GRZG80 0.42Ω	3	16
RHC11-2C	500	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC15-2C	650							
RHC18.5-2C	700	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC22-2C	800							
RHC30-2C	1000	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC37-2C	1350							
RHC45-2C	1500	LR2-55C	450	LFC2-55C	43			240
RHC55-2C	1750							
RHC75-2C	2050	LR2-75C	520	LFC2-75C	74			137
RHC90-2C	2450	LR2-110C	720	LR2-110C	115	GRZG400 0.12Ω (2 parts in parallel)	6	374
RHC7.5-4C	400	LR4-7.5C	90	LFC4-7.5C	9	GRZG80 1.74Ω	3	15
RHC11-4C	500	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC15-4C	600							
RHC18.5-4C	650	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC22-4C	900							
RHC30-4C	1200	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC37-4C	1550							
RHC45-4C	1800	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC55-4C	2050							
RHC75-4C	2150	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC90-4C	2600	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parts in parallel)	6	405
RHC110-4C	3050							
RHC132-4C	3500	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC160-4C	4150							
RHC200-4C	5100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC220-4C	5600							
RHC280-4C	7100	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC315-4C	8000	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC355-4C	8900	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC400-4C	10100	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454

In VT mode

PWM converter		Boosting reactor		Filtering reactor		Filtering resistor		
Type	Generated loss (W)	Type	Generated loss (W)	Type	Generated loss (W)	Type	Q'ty	Generated loss (W)
RHC7.5-2C	450	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC11-2C	550							
RHC15-2C	650	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC18.5-2C	750							
RHC22-2C	850	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC30-2C	1200							
RHC37-2C	1500	LR2-55C	450	LFC2-55C	43			240
RHC45-2C	1600							
RHC55-2C	2100	LR2-75C	520	LFC2-75C	74			137
RHC75-2C	2300	LR2-110C	720	LFC2-110C	115	GRZG400 0.12Ω (2 parts in parallel)	6	374
RHC90-2C	2650							
RHC7.5-4C	400	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC11-4C	500							
RHC15-4C	600	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC18.5-4C	600							
RHC22-4C	950	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC30-4C	1200							
RHC37-4C	1450	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC45-4C	1750							
RHC55-4C	2250	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC75-4C	1950	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parts in parallel)	6	405
RHC90-4C	2400							
RHC110-4C	2900	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC132-4C	3250							
RHC160-4C	4100	LR4-220C	1240	LFC4-220C	200	LFC4-220C	1	751
RHC200-4C	4400							
RHC220-4C	5600	LR4-280C	1430	LFC4-280C	220	LFC4-280C	1	1027
RHC280-4C	6250	LR4-315C	1660	LFC4-315C	260	LFC4-315C	1	1154
RHC315-4C	7000	LR4-355C	1910	LFC4-355C	300	LFC4-355C	1	1286
RHC355-4C	8050	LR4-400C	2160	LFC4-400C	350	LFC4-400C	1	1454
RHC400-4C	8950	LR4-500C	2470	LFC4-500C	450	LFC4-500C	1	1821

Note: Generated losses listed in the above tables are approximate values that are calculated according to the following conditions:
- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

4.4.1.3 DC reactors (DCRs)

A DCR is mainly used for power supply matching and for input power factor correction (for reducing harmonic components).

■ For power supply matching

- Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more the rated inverter capacity. In this case, the percent reactance of the power supply decreases, and harmonic components and their peak value increase. These factors may break rectifiers or capacitors in the converter section of inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).
- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.
- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

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

■ For input power factor correction (for suppressing harmonics)

Generally a capacitor is used to improve the power factor of the load, however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of inverter's power supply so as to decrease harmonic components on the power supply lines and improve the power factor of inverter. Using a DCR improves the input power factor to approximately 86% to 95%.

Note

- At the time of shipping, a jumper bar is connected across terminals P1 and P (+) on the terminal block. Remove the jumper bar when connecting a DCR.
- If a DCR is not going to be used, do not remove the jumper bar.

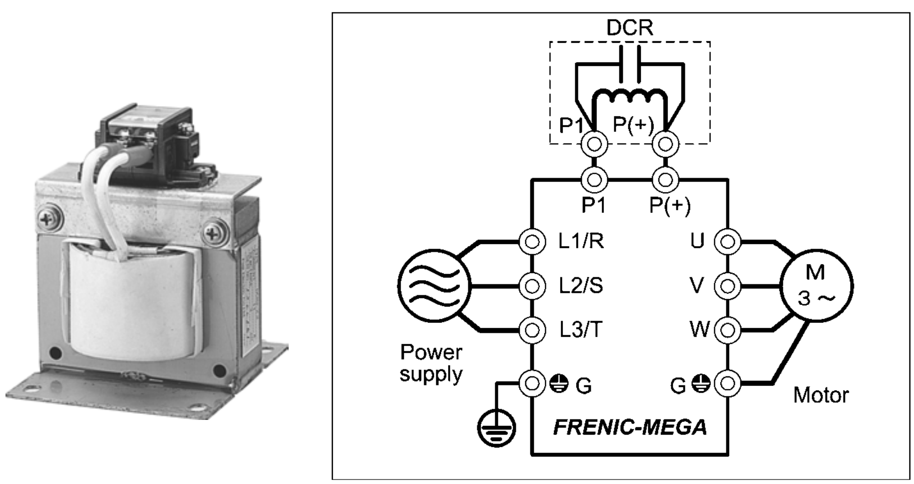


Figure 4.9 External View of a DC Reactor (DCR) and Connection Example

Table 4.11 DC Reactors (DCRs)

The table below lists the combination of LD-mode inverters and DC reactors.

Power supply voltage	Inverter type	Option/ Standard	DC reactor type	Rated current (A)	Inductance (mH)	Generated loss (W)
230V	FRN100G1S-2U	Standard	DCR2-75C	358	0.05	96
	FRN125G1S-2U		DCR2-90C	431	0.042	100
	FRN150G1S-2U		DCR2-110C	552	0.034	126

Note 1: 100 HP or above type comes with a DC reactor (DCR) suitable for the LD-mode use.

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Table 4.11 DC Reactors (DCRs) (continued)

The table below lists the combination of LD-mode inverters and DC reactors.

Power supply voltage	Inverter type	Option/ Standard	DC reactor type	Rated current (A)	Inductance (mH)	Generated loss (W)
460V	FRN100G1S-4U	Standard	DCR4-75C	178	0.23	97
	FRN125G1S-4U		DCR4-90C	214	0.2	111
	FRN150G1S-4U		DCR4-110C	261	0.166	122
	FRN200G1S-4U		DCR4-132C	313	0.148	159
	FRN250G1S-4U		DCR4-160C	380	0.122	185
	FRN300G1S-4U		DCR4-200C	475	0.098	218
	FRN350G1S-4U		DCR4-220C	524	0.087	231
	FRN450G1S-4U		DCR4-280C	649	0.069	270
	FRN500G1S-4U		DCR4-355C	833	0.054	308
	FRN600G1S-4U		DCR4-400C	938	0.048	323
	FRN700G1S-4U		DCR4-450C	1056	0.043	338
	FRN800G1S-4U		DCR4-500C	1173	0.039	384
	FRN900G1S-4U		DCR-630C	1477	0.031	620
	FRN1000G1S-4U		DCR-710C	1666	0.028	600

Note 1: 100 HP or above type comes with a DC reactor (DCR) suitable for the LD-mode use.

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Figure A

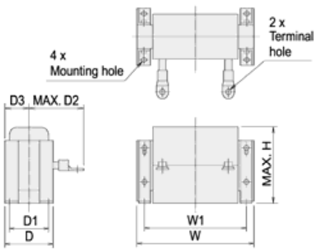


Figure B

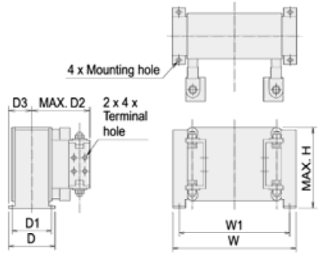
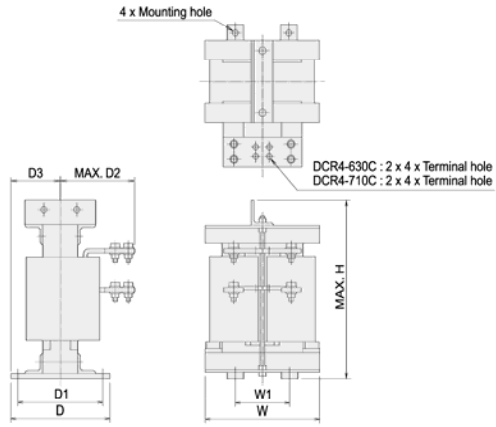


Figure C



Power supply voltage	Inverter type FRN□□□GIS -2U/4U	Option/ Standard	Reactor	Refer to:	Dimensions inch (mm)									Mass lb (kg)
					W	W1	D	D1	D2	D3	H	Mounting hole	Terminal hole	
230 V	100	Standard	DCR2-75C	Figure A	10.04±0.39 (255±10)	8.86 (225)	4.17±0.08 (106±2)	3.39 (86)	5.71 (145)	2.09±0.04 (53±1)	5.71 (145)	M6	M12	25 (11.4)
	125		DCR2-90C				4.57±0.08 (116±2)	3.78 (96)	6.1 (155)	2.28±0.04 (58±1)				31 (14)
	150		DCR2-110C		11.81±0.39 (300±10)	10.43 (265)	4.57±0.16 (116±4)	3.54 (90)	7.28 (185)		6.3 (160)	M8		37 (17)

Note: 100 HP or above type comes with a DC reactor (DCR) suitable for the LD-mode use

Power supply voltage	Inverter type FRN□□□GIS -2U/4U	Option/ Standard	Reactor	Refer to:	Dimensions inch (mm)									Mass lb (kg)
					W	W1	D	D1	D2	D3	H	Mounting hole	Terminal hole	
460 V	100	Standard	DCR4-75C	Figure A	10.04±0.39 (255±10)	8.86 (225)	4.17±0.08 (106±2)	3.39 (86)	4.92 (125)	2.09±0.04 (53±1)	5.71 (145)	M6	M10	27 (12.4)
	125		DCR4-90C				4.57±0.08 (116±2)	3.78 (96)	5.51 (140)	2.28±0.04 (58±1)			M12	32 (14.7)
	150		DCR4-110C		11.81±0.39 (300±10)	10.43 (265)		3.54 (90)	6.89 (175)		6.1 (155)	M8		41 (18.4)
	200		DCR4-132C				4.96±0.16 (126±4)	3.94 (100)	7.09 (180)	2.48±0.08 (63±2)	6.3 (160)			49 (22)
	250		DCR4-160C		13.78±0.39 (350±10)	12.2 (310)	5.16±0.16 (131±4)	4.06 (103)		2.58±0.08 (65.5±2)	7.48 (190)	M10		56 (25.5)
	300		DCR4-200C				5.55±0.16 (141±4)	4.45 (113)	7.28 (185)	2.78±0.08 (70.5±2)				65 (29.5)
	350		DCR4-220C				5.75±0.16 (146±4)	4.65 (118)	7.87 (200)	2.87±0.08 (73±2)				72 (32.5)
	450		DCR4-280C	Figure B	13.78±0.39 (350±10)	12.2 (310)	6.34±0.16 (161±4)	5.24 (133)	8.27 (210)	3.17±0.08 (80.5±2)	7.48 (190)	M10	M16	79 (36)
	500		DCR4-355C		15.75±0.39 (400±10)	13.58 (345)	6.14±0.16 (156±4)	5.04 (128)	7.87 (200)	3.07±0.04 (78±1)	8.86 (225)		Ø15	104 (47)
	600		DCR4-400C		17.52±0.39 (445±10)	15.16 (385)	5.71±0.16 (145±4)	4.61 (117)	8.39 (213)	2.85±0.04 (72.5±1)	9.65 (245)			115 (52)
	700		DCR4-450C		17.32±0.39 (440±10)		5.91±0.16 (150±4)	4.8 (122)	8.46 (215)	2.95±0.08 (75±2)				132 (60)
	800		DCR4-500C		17.52±0.39 (445±10)	15.35 (390)	6.5±0.16 (165±4)	5.39 (137)	8.66 (220)	3.25±0.08 (82.5±2)				154 (70)
	900		DCR4-630C	Figure C	11.22±0.39 (285±10)	5.71 (145)	7.99±0.16 (203±4)	6.69 (170)	7.68 (195)	4.09±0.08 (104±2)	18.9 (480)	M12		165 (75)
	1000		DCR4-710C		13.39±0.39 (340±10)	6.3 (160)	11.61±0.16 (295±4)	10.04 (255)	8.86 (225)	4.21±0.08 (107±2)				209 (95)

Note: 100 HP or above type comes with a DC reactor (DCR) suitable for the LD-mode use

4.4.1.4 AC reactors (ACRs)

Use an ACR when the converter part of the inverter should supply very stable DC power, for example, in DC link bus operation (shared PN operation). Generally, ACRs are used for correction of voltage waveform and power factor or for power supply matching, but not for suppressing harmonic components in the power lines. For suppressing harmonic components, use a DCR.

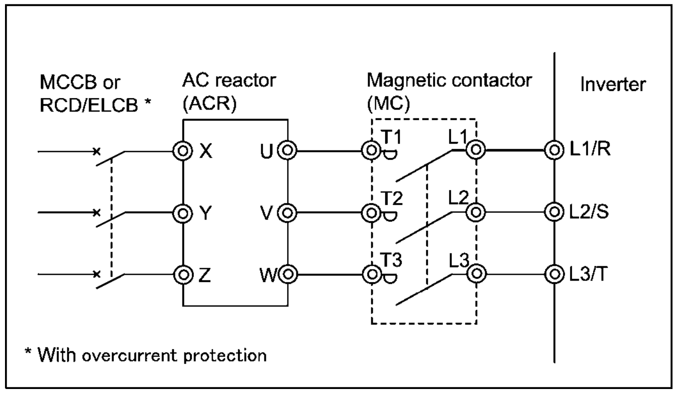


Figure 4.10 External View of AC Reactor (ACR) and Connection Example

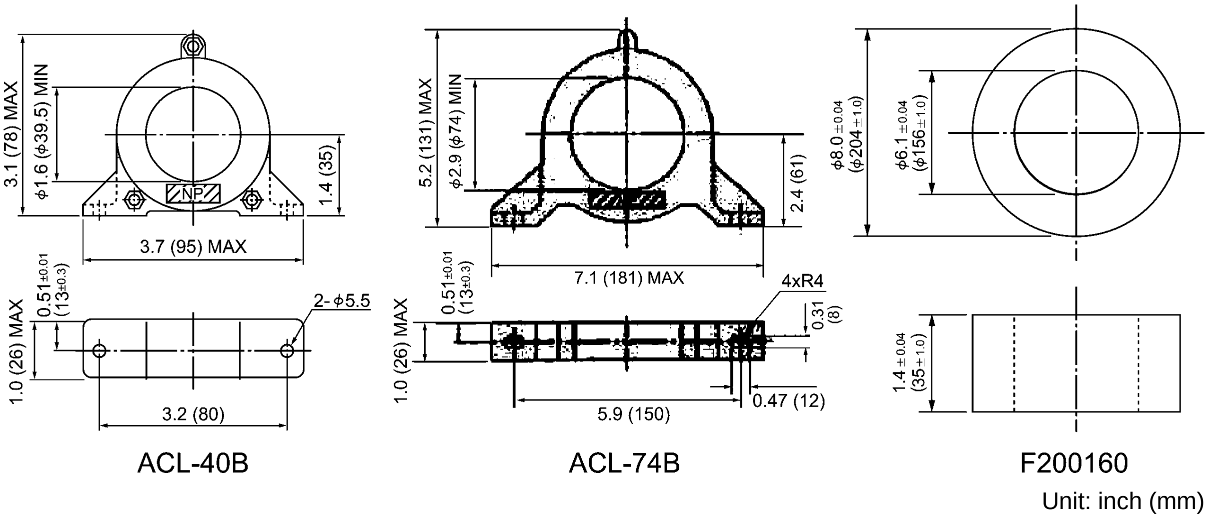
4.4.1.5 Zero-phase reactors for reducing radio noise (ACLs)

An ACL is used to reduce radio frequency noise emitted by the inverter.

An ACL suppresses the outflow of high frequency harmonics caused by switching operation for the power supply lines inside the inverter. Pass the power supply lines together through the ACL.

If wiring length between the inverter and motor is less than 66 ft (20 m), insert an ACL to the power supply lines; if it is more than 66 ft (20 m), insert it to the power output lines of the inverter.

Wire size is determined depending upon the ACL size (I.D.) and installation requirements.



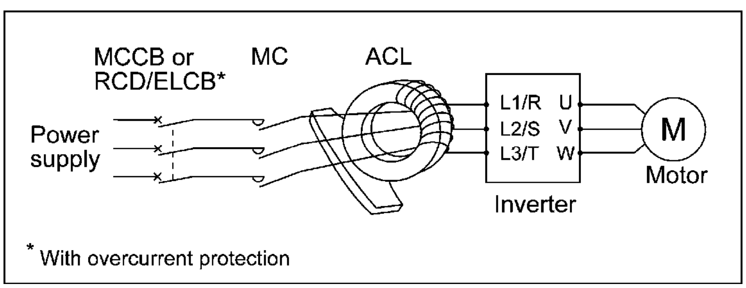


Figure 4.11 Dimensions of Zero-phase Reactor for Reducing Radio Noise (ACL) and Connection Example

Table 4.13 Zero-phase Reactors for Reducing Radio Noise (ACLs)

Zero-phase reactor type	Installation requirements		Wire size (mm^2)
	Qty.	Number of through	
ACL-40B	1	4	2.0, 3.5, 5.5
	2	2	8, 14
ACL-74B	1	4	8, 14
	2	2	22, 38, 60, 5.5×2, 8×2, 14×2, 22×2
	4	1	100, 150, 200, 250, 325, 38×2, 60×2, 100×2, 150×2
F200160	4	1	200×2, 250×2, 325×2

The selected wires are for use with 3-phase input/output lines (3 wires).

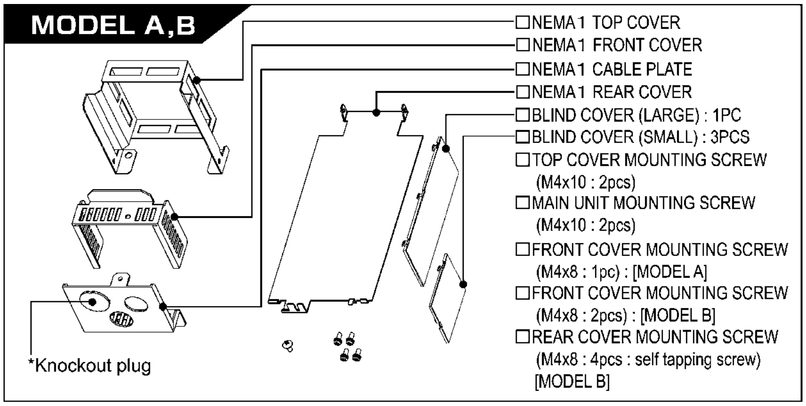
Note: Use the insulated wire of 75°C (167°F), 600 V, HIV-insulated.

4.4.1.6 Enclosed - Type 1 Kit

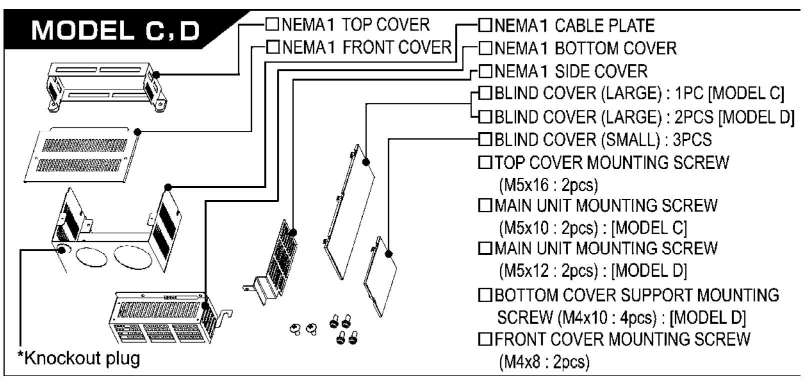
[1] Overview

Mounting the Enclosed - Type 1 Kit to a FRENIC-MEGA series general-purpose inverter provides inverter with a Type 1 Enclosure.

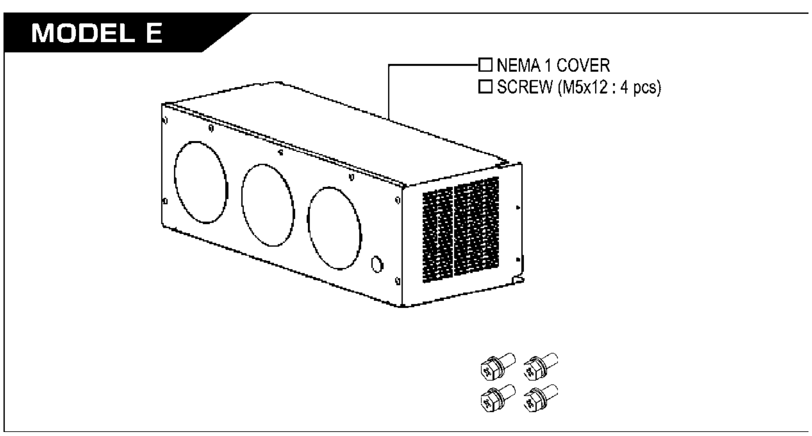
[2] Configuration



Note: To wire the control signal lines, remove the knockout plug.
The mounting parts are slightly different for each model.



Note: To wire the control signal lines, remove the knockout plug.
The mounting parts are slightly different for each model.



[3] Specifications

This product can only be attached to FRENIC-MEGA (Standard inverter).

The specifications to be changed are stated here. All the other specifications which are not mentioned are equivalent with FRENIC-MEGA (Standard inverter).

Applicable inverters

When an Enclosed - Type 1 Kit is installed to an inverter unit, the unit type changes to a type shown in a column "Inverter type after installation."

	Applicable inverter model	Option type	Inverter type after installation	MODEL
230 V, Three-phase	FRNF50G1S-2U	NEMA-0.4G1-24	FRNF50G1U-2U	A
	FRN001G1S-2U	NEMA-0.75G1-24	FRN001G1U-2U	
	FRN002G1S-2U	NEMA-3.7G1-24	FRN002G1U-2U	B
	FRN003G1S-2U		FRN003G1U-2U	
	FRN005G1S-2U		FRN005G1U-2U	
	FRN007G1S-2U	NEMA-11G1-24	FRN007G1U-2U	C
	FRN010G1S-2U		FRN010G1U-2U	
	FRN015G1S-2U		FRN015G1U-2U	
	FRN020G1S-2U		FRN020G1U-2U	
	FRN025G1S-2U	NEMA-22G1-24	FRN025G1U-2U	D
	FRN030G1S-2U		FRN030G1U-2U	
	FRN040G1S-2U	NEMA-22G1-2	FRN040G1U-2U	
	FRN050G1S-2U	NEMA-37G1-24	FRN050G1U-2U	E
	FRN060G1S-2U	NEMA-75G1-24	FRN060G1U-2U	
	FRN075G1S-2U		FRN075G1U-2U	
	FRN100G1S-2U		FRN100G1U-2U	
	FRN125G1S-2U	NEMA-75G1-2	FRN125G1U-2U	
	FRN150G1S-2U	NEMA-220G1-24	FRN150G1U-2U	

	Applicable inverter model	Option type	Inverter type after installation	MODEL
460 V, Three-phase	FRNF50G1S-4U	NEMA-0.4G1-24	FRNF50G1U-4U	A
	FRN001G1S-4U	NEMA-0.75G1-24	FRN001G1U-4U	
	FRN002G1S-4U	NEMA-3.7G1-24	FRN002G1U-4U	B
	FRN003G1S-4U		FRN003G1U-4U	
	FRN005G1S-4U		FRN005G1U-4U	
	FRN007G1S-4U	NEMA-11G1-24	FRN007G1U-4U	C
	FRN010G1S-4U		FRN010G1U-4U	
	FRN015G1S-4U		FRN015G1U-4U	
	FRN020G1S-4U		FRN020G1U-4U	
	FRN025G1S-4U	NEMA-22G1-24	FRN025G1U-4U	D
	FRN030G1S-4U		FRN030G1U-4U	
	FRN040G1S-4U		FRN040G1U-4U	
	FRN050G1S-4U	NEMA-37G1-24	FRN050G1U-4U	E
	FRN060G1S-4U		FRN060G1U-4U	
	FRN075G1S-4U	NEMA-75G1-24	FRN075G1U-4U	
	FRN100G1S-4U		FRN100G1U-4U	
	FRN125G1S-4U		FRN125G1U-4U	
	FRN150G1S-4U	NEMA-110G1-4	FRN150G1U-4U	
	FRN200G1S-4U		FRN200G1U-4U	
	FRN250G1S-4U	NEMA-160G1-4	FRN250G1U-4U	
	FRN300G1S-4U		FRN300G1U-4U	
	FRN350G1S-4U	NEMA-220G1-24	FRN350G1U-4U	
	FRN450G1S-4U		FRN450G1U-4U	
	FRN500G1S-4U	NEMA-315G1-4	FRN500G1U-4U	
	FRN600G1S-4U		FRN600G1U-4U	
	FRN700G1S-4U	NEMA-400G1-4	FRN700G1U-4U	
	FRN800G1S-4U		FRN800G1U-4U	
	FRN900G1S-4U	NEMA-630G1-4	FRN900G1U-4U	
	FRN1000G1S-4U		FRN1000G1U-4U	

Rated output current

For 3 phase 230 V input LD (Low Duty) specifications, see Table 4.14 below.

Table 4.14 Rated output current for LD (Low Duty) specifications

Items		Specifications					
Applied inverter series (FRN□□□G1S-2U)		010	015	020	025	030	040
Rated output	Rated current (A)	29	42	55	68	80	107

Ambient temperature (Except for FRN050G1U-□U and above)

-10 to +40˚C (14 to +104˚F)

No. of installable option P.C.B. (Except for FRN050G1U-□U and above)

1 P.C.B.

Any options can be installed. Connection port depends on an each option P.C.B.

[4] Change settings

Switch IP20/40 enclosure (Bit 7)

For protection coordination, it is necessary to switch to the protection level suitable for the protection rating IP40 by setting Bit 7 (Switch IP20/IP40 enclosure) of function code H98. (Protection/Maintenance Function (Mode selection)) to "1" (IP40).

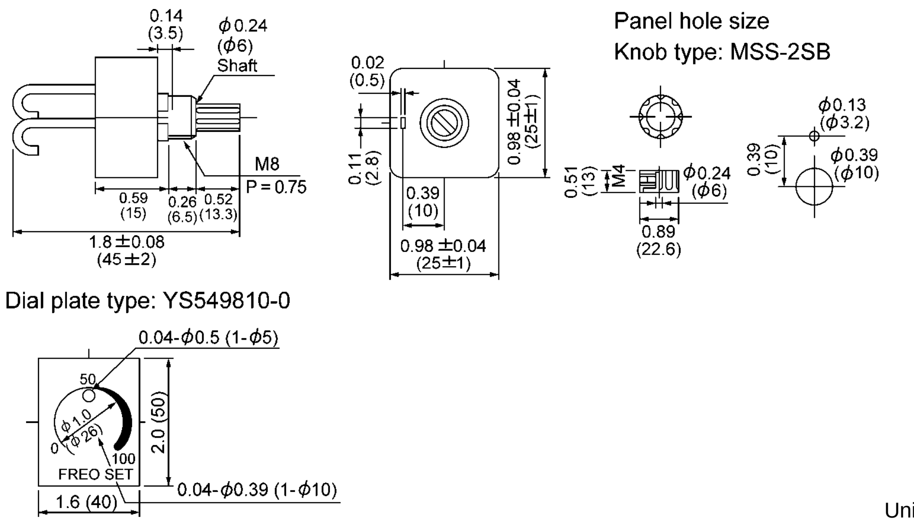
*An optional Enclosed - Type 1 Kit for the DC reactor is also available.

4.4.2 Options for operation and communication

4.4.2.1 External frequency command potentiometer

An external frequency command potentiometer may be used to set the drive frequency. Connect the potentiometer to control signal terminals [11] through [13] of the inverter as shown in Figure 4.13.

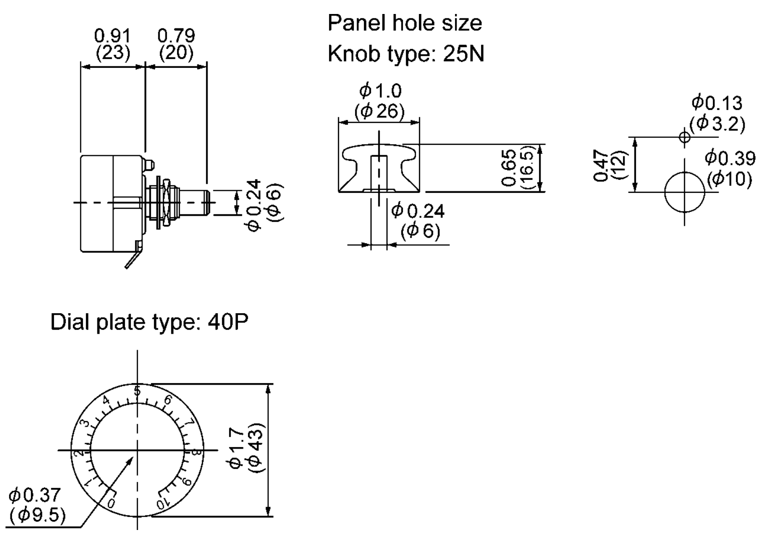
Model: RJ-13 (BA-2 B-characteristics, 1 kΩ)



Unit: inch (mm)

Note: The dial plate and knob must be ordered as separated items.
Available from Fuji Electric Technica Co., Ltd.

Model: WAR3W (3W B-characteristics, 1 kΩ)



Unit: inch (mm)

Note: The dial plate and knob must be ordered as separated items.
Available from Fuji Electric Technica Co., Ltd.

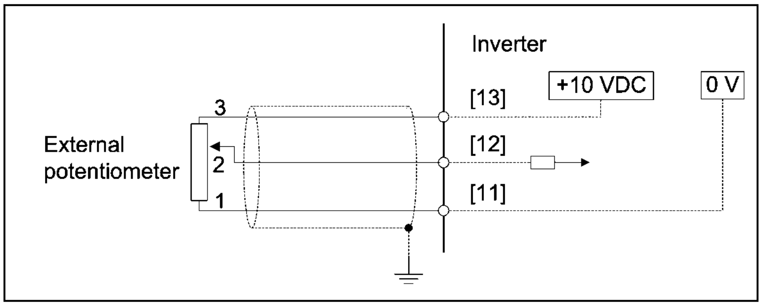


Figure 4.12 Dimensions of External Frequency Command Potentiometer and Connection Example

4.4.2.2 Extension cable for remote operation

The extension cable connects the inverter with the keypad (standard or remote) or USB–RS-485 converter to enable remote operation of the inverter. The cable is a straight type with RJ-45 jacks and its length is selectable from 16, 9.8, and 3.3 ft (5, 3, and 1 m).

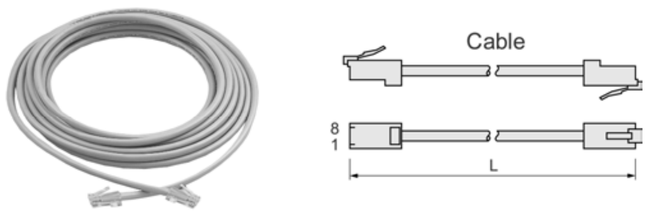


Table 4.13 Extension Cable Length for Remote Operation

Type	Length ft (m)
CB-5S	16 (5)
CB-3S	9.8 (3)
CB-1S	3.3 (1)

4.4.2.3 Inverter support loader software

FRENIC Loader is support software which enables the inverter to be operated via the RS-485 communications facility. The main functions include the following:

- Easy editing of function code data
- Monitoring the operation statuses of the inverter such as I/O monitor and multi-monitor
- Operation of inverters on a PC screen (Windows-based only)

Refer to Chapter 8 "RUNNING THROUGH RS-485 COMMUNICATION" for details.

4.4.2.4 PG interface card (OPC-G1-PG)

The PG interface card has a two-shifted pulse train (ABZ phase) input circuit for speed feedback and a power output circuit for feeding power to the connected PG (pulse generator). Mounting this interface card on the FRENIC-MEGA enables the following:

(1) Speed control (vector control with speed sensor, V/f control with speed sensor, dynamic torque vector control with speed sensor) using PG feedback signals, and servo-lock function

(2) Pulse train input as frequency commands

Note: Mounting this interface card disables the pulse train input function assigned to the inverter's [X7] terminal.

Ports available for the interface card

This interface card can be connected to the C-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

PG interface specifications

Table 4.16 lists PG specifications of this interface card.

Table 4.16 Specifications of Applicable PG and PG Interface Card

Item	Specifications
Encoder pulse resolution	20 to 3000 P/R, A-, B- and Z-phase pulse trains in incremental format
Pulse output circuit	Open collector (Maximum cable length: 66 ft (20 m)) Complementary (Maximum cable length: 328 ft (100 m))
Input power requirements	High level ≥ 8 VDC, Low level ≤ 3 VDC (For 12 VDC power source) High level ≥ 10 VDC, Low level ≤ 3 VDC (For 15 VDC power source)
Pulse output current	8 mA or below
PG power supply*	12 VDC ±10%, 120 mA or below, or 15 VDC ±10%. 120 mA or below

* If a power level required by the PG exceeds 120 mA, use an external power source.

Pulse train input interface specifications

Table 4.17 lists pulse train input interface specifications of this interface card.

Table 4.17 Specifications for Pulse Train Inputs

Item	Specifications
PG output pulse frequency	30 kHz max. (Open collector) 100 kHz max. (Complementary)
PG pulse output circuit	Open collector circuit (Maximum cable length: 66 ft (20 m)) Complementary circuit (Maximum cable length: 328 ft (100 m))
Input pulse threshold	High level ≥ 8 VDC, Low level ≤ 3 VDC (For 12 VDC power source) High level ≥ 10 VDC, Low level ≤ 3 VDC (For 15 VDC power source)
PG pulse input current	8 mA or below

Terminal functions

Terminal	Name	Specification
[P1]	External power input *1	Power input terminal from the external device for PG +12 VDC ±10% or +15 VDC ±10% (Use the power source 150 mA or above which is larger than the PG current consumption.)
[PO]	Power output to PG *2	Power output terminal for PG +12 VDC ±10%, 120 mA or +15 VDC ±10%, 120 mA
[CM]	PG common	Common terminal for power supply to PG (Equipotent with the inverter's terminal [CM])
[XA]	Command input for A-phase pulse train	Input terminal for A-phase command pulse train
[XB]	Command input for B-phase pulse train	Input terminal for B-phase command pulse train
[XZ]	---	Not used.
[YA]	Feedback input for A-phase pulse train	Input terminal for A-phase pulse train fed back from PG
[YB]	Feedback input for B-phase pulse train	Input terminal for B-phase pulse train fed back from PG
[YZ]	Feedback input for Z-phase pulse train	Input terminal for Z-phase pulse train fed back from PG

*1 Use an external power source if the PG current consumption exceeds 120 mA.
*2 Turn the internal switch to the proper position according to the PG power requirement.

Circuit configuration of the PG interface card

Figure 4.14 shows the internal circuit configuration of the optional PG interface card. This figure is of supplying the PG power from the internal +12 VDC source.

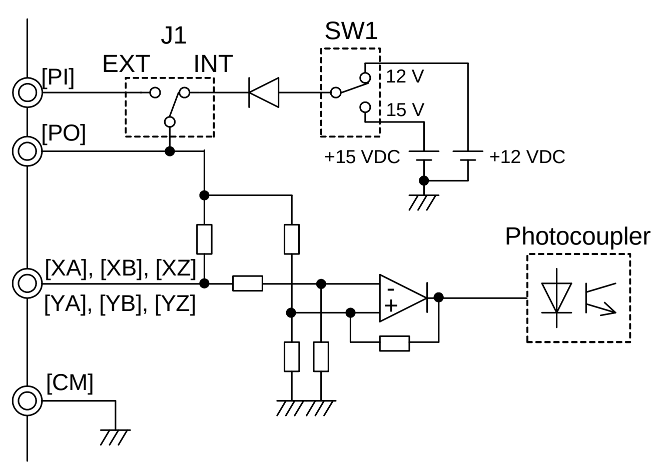


Figure 4.14 Internal Circuit Configuration of the Optional PG Interface Card

Drive control

Speed control (Vector control with speed sensor, V/f control with speed sensor, and Dynamic torque vector control with speed sensor)

To control the motor speed, the inverter equipped with this interface card detects feedback signals sent from the PG (pulse generator) mounted on the motor output shaft, enabling high-response speed control.

(A recommended motor for this control is a FUJI VG motor exclusively designed for vector control.)

The table below lists inverter specifications under this control.

Item		Specifications	Remarks
Control specifications *1	Maximum frequency	25 to 200 Hz	When a VG motor (1024 P/R) is connected.
	Speed control range	Under vector control with speed sensor Minimum speed : Base speed = 1 : 1500 (For 4-pole standard models, 1 to 1500 min^{-1}) Under V/f control with speed sensor or dynamic torque vector control with speed sensor Minimum speed : Base speed = 1 : 100 (For 4-pole standard models, 15 to 1500 min^{-1})	
	Speed control accuracy	Within ±0.2% of the rated speed (min^{-1}) at 25 ±10°C (77 ±18°F)	

*1 The controllability values specified here greatly vary depending on the pulse resolution, P/R (Pulses/Revolution). The recommended P/R is 1024 or more.

Pulse train input

This function gives a frequency command to the inverter in pulse train format. Available formats are three types of a pulse train input with its sign/pulse train input, run forward/run reverse pulse train, and 90 degree phase shifted A/B pulse trains. Use terminals [XA] and [XB] for the pulse train frequency command input.

The table below summarizes pulse train command input operations of this optional card.

Pulse input format	Operations
Pulse train input with its sign/pulse train	Gives the speed command to the inverter, following the pulse input frequency on the terminal [XB]. Switching the terminal [XA] ON/OFF determines polarity of the speed command. *1
Run forward/run reverse pulse train	Gives the run forward speed command to the inverter, following the pulse input frequency on the terminal [XB], if any. Gives the run reverse speed command to the inverter, following the pulse input frequency on the terminal [XA], if any.*1
90 degree phase shifted A/B pulse trains	Gives the run forward or run reverse speed command to the inverter, following 90 degree phase shift and frequency information of two pulse inputs on terminals [XA] and [XB]. *1

*1 Actual rotation direction of the motor is specified by a combination of the pulse input command polarity and ***FWD***/***REV*** command in the inverter.

For details, refer to the PG Interface Card Instruction Manual (INR-SI47-1283-E).

4.4.2.5 PG interface (5 V line driver) card (OPC-G1-PG2)

The PG interface (5 V line driver) card has the following circuits:

- Shifted phase pulse train (A, B, and Z phases) input circuit for speed feedback (5 V line driver output type PG)
- Wire break detection circuit (Detection of wire breaks on the Z phase can be cancelled.)
- Power output circuit for feeding power to the connected PG (pulse generator)

Mounting this interface card on the FRENIC-MEGA enables the following:

(1) Speed control (vector control with speed sensor, V/f control with speed sensor, dynamic torque vector control with speed sensor) using PG feedback signals, and servo-lock function

(2) Pulse train input as frequency commands

Ports available for the interface card

This interface card can be connected to the C-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

PG interface specifications

Item		Specifications
Applicable PG	Pulse resolution	20 to 3000 P/R
	Maximum response frequency	100 kHz
	Pulse output system	Line driver (Equivalent to 26C31 or 26LS31) Source current: +20 mA (max.) Sink current: –20 mA (max.)
	Maximum wiring length *1	328 ft (100 m) (when using AWG16)
PG power supply *2		+5 VDC ±10%, 200 mA or below

*1 Table 4.18 shows the relationship between the wiring length and the minimum diameter of wires connectable.

*2 If the PG power current exceeds 200 mA, use an external power supply.

Table 4.18 Relationship Between the Wiring Length and the Minimum Diameter of Wires Connectable

PG power requirements	Wiring length				
	Up to 66 ft (Up to 20 m)	Up to 98 ft (Up to 30 m)	Up to 164 ft (Up to 50 m)	Up to 246 ft (Up to 75 m)	Up to 328 ft (Up to 100 m)
5 V ±10%, 200 mA	AWG24 (0.25 mm^2)	AWG22 (0.34 mm^2)	AWG20 (0.50 mm^2)	AWG18 (0.75 mm^2)	AWG16 (1.25 mm^2)

Terminal functions

Terminal	Name	Specification
[P1]	External power input *1	Power input terminal from the external device for PG +5 VDC ±10% input *2 (Use the power supply 200 mA or above which is larger than the PG current consumption.)
[PO]	Power output to PG	Power output terminal for PG +5 VDC -0% to +10%, 200 mA output
[CM]	PG common	Common terminal for power supply to PG (Equipotent with the inverter's terminal [CM])
[YA]	Feedback input for A(+) phase pulse train	Input terminal for A(+) phase pulse train fed back from PG
[*YA]	Feedback input for A(-) phase pulse train	Input terminal for A(-) phase pulse train fed back from PG
[YB]	Feedback input for B(+) phase pulse train	Input terminal for B(+) phase pulse train fed back from PG
[*YB]	Feedback input for B(-) phase pulse train	Input terminal for B(-) phase pulse train fed back from PG
[YZ]	Feedback input for Z(+) phase pulse train	Input terminal for Z(+) phase pulse train fed back from PG
[*YZ]	Feedback input for Z(-) phase pulse train	Input terminal for Z(-) phase pulse train fed back from PG

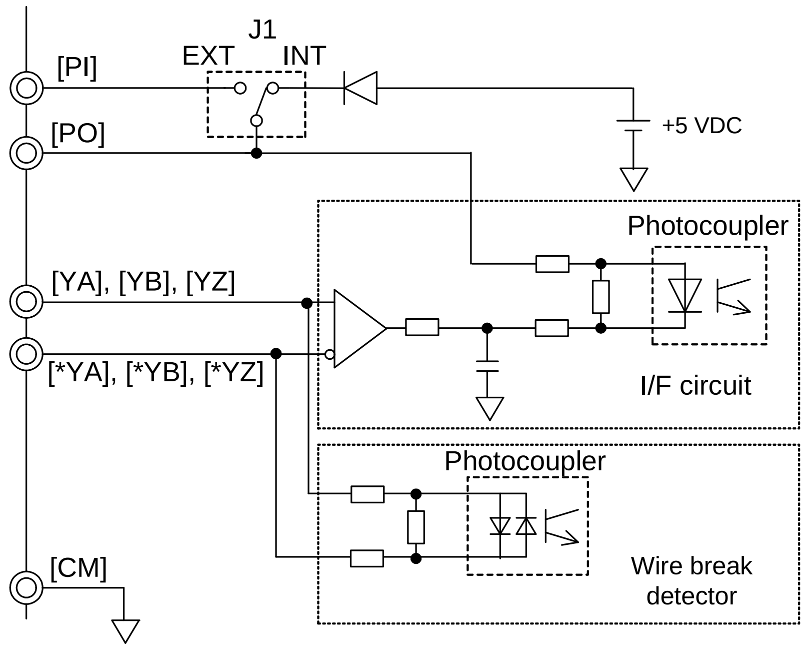
*1 If the PG current consumption exceeds 200 mA, use an external power supply.

*2 Use an external power supply whose rating meets the allowable voltage range of the PG. Regulate the external power supply voltage within the PI voltage range (upper limit +10%), taking into account the voltage drop caused by the PG-inverter wiring impedance. Or, use a wire with a larger diameter.

Internal block diagram

Shown below is the internal block diagram example where the internal power source (5 V) supplies power to the PG. (J1 is set to the INT position.)

Each phase input circuit has a wire break detector. The A- and B-phase wire break detectors are always ON. The Z-phase wire break detector toggles ON and OFF by turning SW1 (shown in Figure 4.15) to ON and OFF, respectively. The factory default of SW1 is OFF.



Circuit Diagram

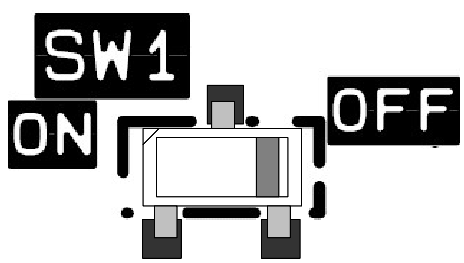


Figure 4.15 Z-phase Wire Break Detector ON/OFF Switch (SW1)

Drive control

Speed control (Vector control with speed sensor, V/f control with speed sensor, and Dynamic torque vector control with speed sensor)

To control the motor speed, the inverter equipped with this interface card detects feedback signals sent from the PG (pulse generator) mounted on the motor output shaft, decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector, enabling high-accuracy and high-response speed control.

For configuration and adjustment of the vector control, refer to Chapter 5, "FUNCTION CODES."

(A recommended motor for this control is a FUJI VG motor exclusively designed for vector control.)

The table below lists inverter specifications under this control.

Item		Specifications	Remarks
Control specifications *1	Maximum frequency	25 to 200 Hz	When a VG motor (1024 P/R) is connected.
	Speed control range	Under vector control with speed sensor Minimum speed : Base speed = 1 : 1500 (For 4-pole standard models, 1 to 1500 min^{-1}) Under V/f control with speed sensor or dynamic torque vector control with speed sensor Minimum speed : Base speed = 1 : 100 (For 4-pole standard models, 15 to 1500 min^{-1})	
	Speed control accuracy	Analog setting: ±0.2% or less of maximum frequency at 25 ±10°C (77 ±18°F) Digital setting: ±0.01% or less of maximum frequency at -10 to +50°C (14 to 122°F)	

*1 The controllability values specified here greatly vary depending on the pulse resolution, P/R (Pulses/Revolution). The recommended P/R is 1024 or more.

For details, refer to the PG2 Interface Card Instruction Manual (INR-SI47-1250-JE).

4.4.2.6 PG interface (5 V line driver x 2) card (OPC-G1-PG22)

The PG interface (5 V line driver x 2) card has the following circuits:

- Shifted phase pulse train (YA, YB, YZ, and XA, XB, XZ) input circuit for speed feedback (5 V line driver output type PG)
- Wire break detection circuit (Detection of wire breaks on the YZ, XA, XB, and XZ phases can be cancelled.)
- Power output circuit for feeding power to the connected PG (pulse generator)

Mounting this interface card on the FRENIC-MEGA enables the following, using PG feedback signals:

- Synchronous operation of two motors equipped with a PG (pulse generator)
- Positioning control (available soon) and resonance damping control
- Pulse train input as frequency commands

Ports available for the interface card

This interface card can be connected to the C-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA. Mounting this card occupies also the B-port space so that any option card cannot be connected to the B-port.

PG interface specifications

When synchronous operation is selected, the reference and slave sides should use a PG of the same pulse resolution.

Item		Specifications
Applicable PG	Pulse resolution	20 to 3600 P/R (during synchronous operation) 20 to 60000 P/R (except during synchronous operation)
	Maximum response frequency	100 kHz
	Pulse output system	Line driver (Equivalent to 26C31 or 26LS31) Source current: +20 mA (max.), Sink current: -20 mA (max.)
	Maximum wiring length *1	328 ft (100 m)
PG power supply		+5 VDC ±10%, 300 mA or below *2

*1 When the PG power requirements are not satisfied due to the voltage drop caused by the PG-inverter wiring impedance, use a wire with a larger diameter (see the "Relationship between Wiring Length and Applicable Minimum Wire Size" table below) or use an external power supply.

*2 When the total PG current consumption exceeds 300 mA, use an external power supply.

Relationship between Wiring Length and Applicable Minimum Wire Size

PG power requirements	Wiring length				
	Up to 66 ft (Up to 20 m)	Up to 98 ft (Up to 30 m)	Up to 164 ft (Up to 50 m)	Up to 246 ft (Up to 75 m)	Up to 328 ft (Up to 100 m)
5 V ±10%, 300 mA	AWG24 (0.25 mm^2)	AWG22 (0.34 mm^2)	AWG20 (0.50 mm^2)	AWG18 (0.75 mm^2)	AWG16 (1.25 mm^2)

Pulse train input interface specifications

Item		Specifications
Pulse train generator	Maximum response frequency	100 kHz
	Pulse output system	Line driver (Equivalent to 26C31 or 26LS31) Source current: +20 mA (max.) Sink current: -20 mA (max.)
	Maximum wiring length	328 ft (100 m)

Terminal functions

Terminal symbol		Name	Functions
Power supply	PI	External power supply input *1	Power input terminal from the external device for the PG +5 VDC ±10% input *2 (A power supply to be connected should assure the PG current consumption or larger.)
	PO	Internal power supply output	Power output terminal for the PG +5 VDC -0% to +10%, 300 mA output
	CM	PG power common	Common terminal for power supply for PG (Equipotent with [CM] terminal of the inverter)
PG/pulse input	YA	YA(+) phase pulse input from slave PG	Input terminal for A(+) phase signal fed back from the slave PG
	*YA	YA(-) phase pulse input from slave PG	Input terminal for A(-) phase signal fed back from the slave PG
	YB	YB(+) phase pulse input from slave PG	Input terminal for B(+) phase signal fed back from the slave PG
	*YB	YB(-) phase pulse input from slave PG	Input terminal for B(-) phase signal fed back from the slave PG
	YZ	YZ(+) phase pulse input from slave PG	Input terminal for Z(+) phase signal fed back from the slave PG
	*YZ	YZ(-) phase pulse input from slave PG	Input terminal for Z(-) phase signal fed back from the slave PG
	XA	XA(+) phase pulse input from reference PG	Input terminal for A(+) phase signal fed back from the reference PG
	*XA	XA(-) phase pulse input from reference PG	Input terminal for A(-) phase signal fed back from the reference PG
	XB	XB(+) phase pulse input from reference PG	Input terminal for B(+) phase signal fed back from the reference PG
	*XB	XB(-) phase pulse input from reference PG	Input terminal for B(-) phase signal fed back from the reference PG
	XZ	XZ(+) phase pulse input from reference PG	Input terminal for Z(+) phase signal fed back from the reference PG
	*XZ	XZ(-) phase pulse input from reference PG	Input terminal for Z(-) phase signal fed back from the reference PG

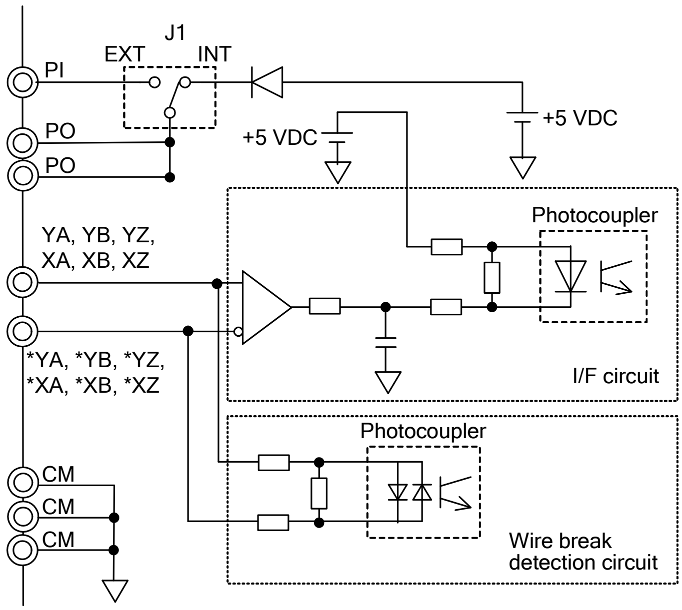
*1 If the PG current consumption exceeds 300 mA, use an external power supply.

*2 Use an external power supply whose rating meets the allowable voltage range of the PG. Regulate the external power supply voltage within the PI voltage range (upper limit +10%), taking into account the voltage drop caused by the PG-inverter wiring impedance. Or, use a wire with a larger diameter.

Internal block diagram

Shown below is the internal block diagram example where the internal power source (5 V) supplies power to the PG. (J1 is set to the INT position.)

Each phase input circuit has a wire break detector. The YA- and YB-phase wire break detectors are always ON. The YZ-, XA-, XB-, and XZ-phase wire break detectors can be disabled.



Circuit Diagram

Drive control

The inverter equipped with this interface card enables the following control:

(1) Vector control with speed sensor

(2) V/f control with speed sensor and torque vector control with speed sensor

(3) Pulse train input

(4) Synchronous operation

(5) Positioning control (available soon) and resonance damping control

4.4.2.7 Relay output interface card (OPC-G1-RY)

The relay output interface card converts an inverter's digital output to a mechanical contact (one transfer contact) output. It has two independent transfer contacts so that using two cards allows the user to activate up to four contact outputs.

A signal to be output to each contact can be defined with function codes E20 to E23. Selecting "Active OFF" for a contact output with the function code enables the contact to be turned ON without relay coil excitation. This is useful for a fail-safe application for the power system.

Ports available for the interface card and functionality assignments

A FRENIC-MEGA inverter has three option connection ports. Note that each port has some limitations as shown below.

Option connection port	Output signal	Assignment	Notes
A-port	Relay contact output 1 Relay contact output 2	Function code E20 (Y1) Function code E21 (Y2)	Do not connect this card to the inverter's terminal [Y1] or [Y2].
B-port	Relay contact output 1 Relay contact output 2	Function code E22 (Y3) Function code E23 (Y4)	Do not connect this card to the inverter's terminal [Y3] or [Y4].
C-port	Not available for the relay output interface card		

Terminal functions

Symbol	Name	Descriptions
[1A] [1B] [1C]	Relay contact output 1	Relay contacts to output signals selected by function codes E20 and E22, such as Inverter Running, Frequency Arrival and Overload Early Warning. In "active ON", the contact [1A] – [1C] closes and [1B] – [1C] opens while the signal is active.
[2A] [2B] [2C]	Relay contact output 2	Relay contacts to output signals selected by function codes E21 and E23, such as Inverter Running, Frequency Arrival and Overload Early Warning. In "active ON", the contact [1A] – [1C] closes and [1B] – [1C] opens while the signal is active.

Electrical requirements

Item	Specifications
Contact capacity	250 VAC, 0.3A, cosΦ = 0.3, or 48 VDC, 0.5A (resistor load)
Contact life	200,000 times (ON/OFF every 1 second) at 250 VAC, 0.3A 200,000 times (ON/OFF every 1 second) at 48 VDC, 0.5A **Note:** When frequent ON/OFF switching is anticipated (for example, when using the current limit function with the inverter output limiting signal), use the terminals [Y1] to [Y4] (transistor outputs) instead.
Safety Standards/Directives	EN61800-5-1:2003, Overvoltage Category II (Reinforced Insulation) 250 VAC class

Internal circuits

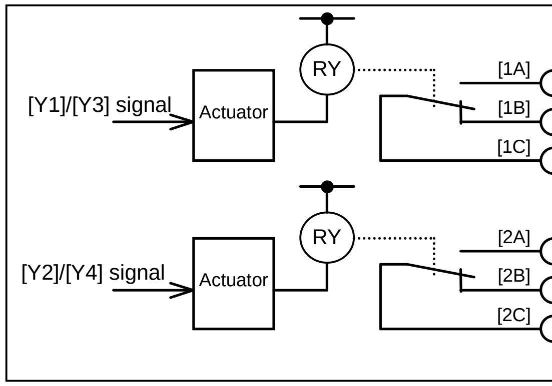


Figure 4.16 Internal Circuits

The relationship between function codes and relay output functions is as follows.

Function code	Functions	Setting range
E20	Terminal [Y1] (Function selection)	0 to 105 (For normal logic), or 1000 to 1105 (For negative logic)
E21	Terminal [Y2] (Function selection)	
E22	Terminal [Y3] (Function selection)	
E23	Terminal [Y4] (Function selection)	

E20 through E23 assign output signals to general-purpose, programmable output terminals [Y1], [Y2], [Y3], and [Y4]. These function codes can also switch the logic system between normal and negative to define the property of those output terminals so that the inverter logic can interpret either the ON or OFF status of each terminal as active.

When a negative logic is employed, all output signals are active (e.g. an alarm would be recognized) while the inverter is powered OFF. To avoid causing system malfunctions by this, interlock these signals to keep them ON using an external power supply. Furthermore, the validity of these output signals is not guaranteed for approximately 1.5 seconds after power ON, so introduce such a mechanism that masks them during the transient period.

4.4.2.8 Digital input interface card (OPC-G1-DI)

The digital input interface card has 16 digital input terminals (switchable between SINK and SOURCE). Mounting this interface card on the FRENIC-MEGA enables the user to specify frequency commands with binary code (8, 12, 15, or 16 bits) or BCD (4-bit Binary Coded Decimal) code.

Ports available for the interface card

This interface card can be connected to any one of the three option connection ports (A-, B-, and C-ports) on the FRENIC-MEGA.

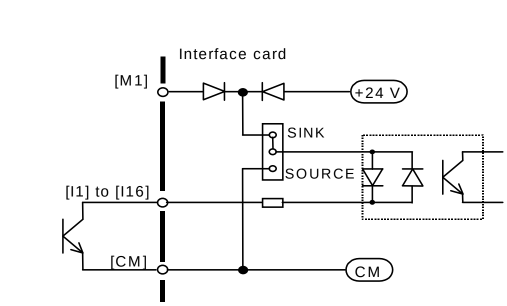
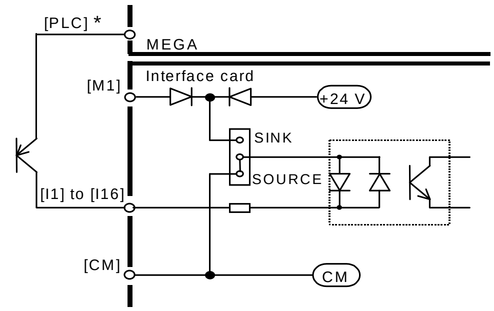
Electrical specifications

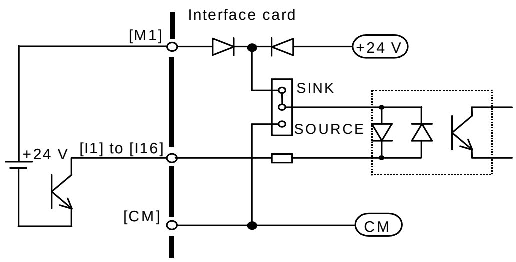
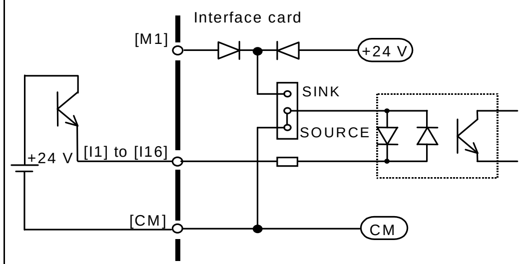
Terminal symbol	Item		Specifications	
			Min.	Max.
[I1] to [I16]	Operating voltage (SINK)	ON level	0 V	2 V
		OFF level	22 V	27 V
	Operating voltage (SOURCE)	ON level	22 V	27 V
		OFF level	0 V	2 V
	Operating current at ON (Input voltage is at 0 V)		2.5 mA	5 mA
	Allowable leakage current at OFF		-	0.5 mA

Terminal functions

Terminal symbol	Name	Functions
[I1] to [I16]	Digital inputs 1 to 16	(1) These digital inputs specify a frequency command according to the settings made by function codes o19 and o20. For details, refer to the "Configuring inverter's function codes" on the next page. (2) SINK/SOURCE is switchable with the slide switch SW1.
[M1]	External power supply input	Power input terminal from the external device for the interface card (+22 to +27 VDC)
[CM]	Digital common	Common terminal for digital input signals (Equipotent with the inverter's terminal [CM])

Connection example

<table>
<tr><th rowspan="2">Power supply</th><th colspan="2">Connection example</th></tr>
<tr><th>SINK mode</th><th>SOURCE mode</th></tr>
<tr><td>Internal</td><td>
</td><td>

* The maximum allowable current for terminal [PLC] on the FRENIC-MEGA is 100 mA.</td></tr>
<tr><td>External</td><td>
</td><td>
</td></tr>
</table>

Configuring inverter's function codes

To enable frequency command inputs from this interface card, it is necessary to set function code F01 (Frequency Command 1) or C30 (Frequency Command 2) to "11" (Digital input interface card). Also specify the polarity and input mode of the frequency command using function codes o19 (DI polarity) and o20 (DI mode) provided for options, respectively.

Turning the terminal input OFF or ON sets each bit data to "0" or "1," respectively.

No.	o19	o20	Input signal name	Terminal function and configuration details
①	0	0	8-bit binary frequency command	Setting resolution = Maximum frequency × (1/255)
②	0	1	12-bit binary frequency command	Setting resolution = Maximum frequency × (1/4095)
③	0	2	15-bit binary frequency command	Setting resolution = Maximum frequency × (1/32767)
④	0	3	16-bit binary frequency command	Setting resolution = Maximum frequency × (1/65535)
⑤	0, 1	4	4-digit BCD frequency command (0 to 99.99 Hz)	Frequency can be specified within the range of 0 to 99.99 Hz (Setting resolution = 0.01 Hz). If a frequency command exceeding the maximum frequency is input, the maximum frequency applies.

No.	o19	o20	Input signal name	Terminal function and configuration details
⑥	0, 1	5	4-digit BCD frequency command (0 to 500.0 Hz)	Frequency can be specified within the range of 0 to 500.0 Hz (Setting resolution = 0.1 Hz). If a frequency command exceeding the maximum frequency is input, the maximum frequency applies.
⑦	1	0	8-bit binary frequency command	Frequency setting range: -(Maximum frequency) to +(Maximum frequency) = -128 to +127 Setting resolution = Maximum frequency × (1/127)
⑧	1	1	12-bit binary frequency command	Frequency setting range: -(Maximum frequency) to +(Maximum frequency) = -2048 to +2047 Setting resolution = Maximum frequency × (1/2047)
⑨	1	2	15-bit binary frequency command	Frequency setting range: -(Maximum frequency) to +(Maximum frequency) = -16384 to +16383 Setting resolution = Maximum frequency × (1/16383)
⑩	1	3	16-bit binary frequency command	Frequency setting range: -(Maximum frequency) to +(Maximum frequency) = -32768 to +32767 Setting resolution = Maximum frequency × (1/32767)

(Note) "Without polarity" when o20 = 4 or 5 (BCD).

4.4.2.9 Digital output interface card (OPC-G1-DO)

The digital output interface card has eight transistor output terminals (switchable between SINK and SOURCE). Mounting this interface card on the FRENIC-MEGA enables the user to monitor the output frequency and other items with binary code (8 bits).

Ports available for the interface card

This interface card can be connected to any of the three option connection ports (A-, B-, and C-ports) on the FRENIC-MEGA.

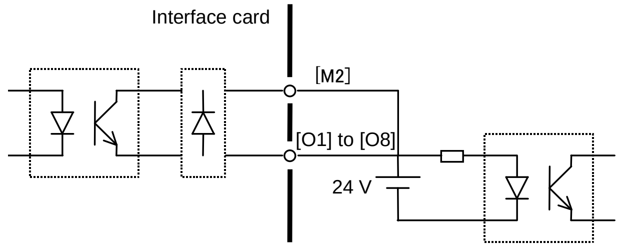
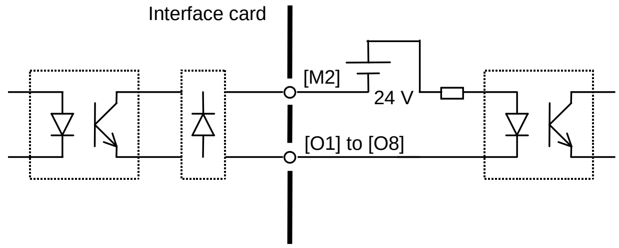
Electrical specifications

Terminal symbol	Item		Specifications
			Max.
[O1] to [O8]	Operating voltage	ON level	2 V
		OFF level	27 V
	Operating current at ON		50 mA
	Allowable leakage current at OFF		0.1 mA

Terminal functions

Terminal symbol	Name	Functions
[O1] to [O8]	Transistor output 1 to 8	These digital terminals output various status signals (e.g., output frequency, output current) specified by function code o21 as an 8-bit parallel signal.
[M2]	Transistor output common	Common terminal for transistor output signals. This terminal is electrically isolated from terminals [CM], [11]s, and [CMY].

Connection example

SINK mode	
SOURCE mode	

Configuring inverter's function code

Function code o21 (DO mode selection) provided for options specifies the item to be monitored by digital signals of this interface card.

The table below lists the function code and its parameters.

Turning the terminal output OFF or ON sets each bit data to "0" or "1," respectively.

Function code	Data	Output signal name	Terminal function and configuration details
o21	0	Output frequency (before slip compensation)	Terminal output = (Output frequency/Maximum frequency) × 255
	1	Output frequency (after slip compensation)	Terminal output = (Output frequency/Maximum frequency) × 255
	2	Output current	Terminal output = (Output current/(Inverter rated output current × 2)) × 255
	3	Output voltage	Terminal output = (Output voltage/250 V) × 255, for 230 V series = (Output voltage/500 V) × 255, for 460 V series
	4	Output torque	Terminal output = (Output torque/(Motor rated torque x 2)) × 255
	5	Load factor	Terminal output = (Load factor/(Motor rated load x 2)) × 255
	6	Input power	Terminal output = (Input power/ (Inverter rated output x 2)) × 255
	7	PID feedback value	Terminal output = (PID feedback amount/100% of feedback value) × 255
	8	PG feedback value	Terminal output = (PG feedback value/100% of synchronous speed at maximum frequency) × 255
	9	DC link bus voltage	Terminal output = (DC link bus voltage/500 V) × 255, for 230 V series = (DC link bus voltage/1000 V) × 255, for 460 V series
	13	Motor output	Terminal output = (Motor output/(Motor rated output × 2)) × 255
	15	PID command (SV)	Terminal output = (PID command/100% of feedback value) × 255
	16	PID output (MV)	Terminal output = (PID output/Maximum frequency) × 255

4.4.2.10 Analog interface card (OPC-G1-AIO)

The analog interface card has the terminals listed below. Mounting this interface card on the FRENIC-MEGA enables analog input and analog output to/from the inverter.

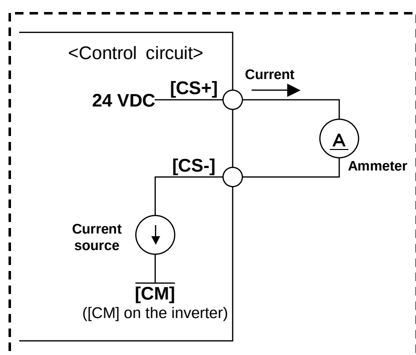
- One analog voltage input point (0 to ±10 V)
- One analog current input point (4 to 20 mA)
- One analog voltage output point (0 to ±10 V)
- One analog current output point (4 to 20 mA)

<u>Ports available for the interface card</u>

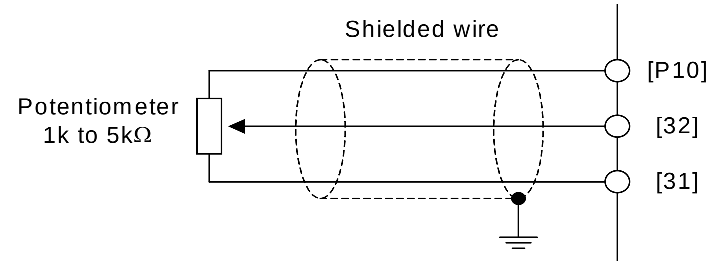
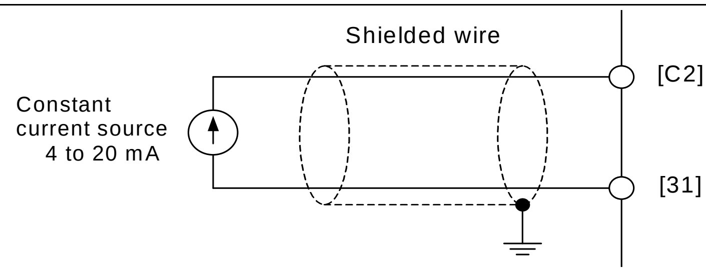
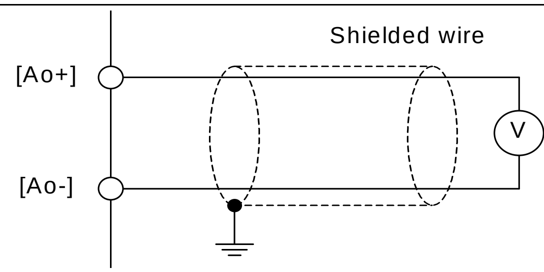
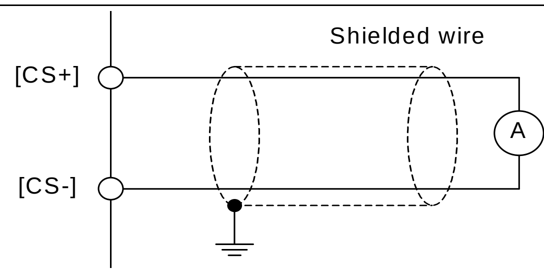
This interface card can be connected to any one of the three option connection ports (A-, B-, and C-ports) on the FRENIC-MEGA.

<u>Terminal functions</u>

Classifi-cations	Symbol	Name	Functions	Remarks
Analog input	[P10]	Power supply for the potentiometer	Power supply for frequency command potentiometer (Variable resistor: 1 to 5 kΩ) (10 VDC, 10 mA DC max.)	
	[32]	Analog voltage input	- Used as analog voltage input from external equipment. 0 to ±10 VDC/0 to ±100% (0 to ±5 VDC/0 to ±100%) - One of the following signals can be assigned to this terminal. - Auxiliary frequency command - PID command - PID feedback amount - Ratio setting - Torque limiter level - Analog input monitor - Resolution: 1/3000	Input impedance: 22kΩ Max. input: ±15 VDC
	[C2]	Analog current input	- Used as analog current input from external equipment. 4 to 20 mA DC/0 to 100% - One of the following signals can be assigned to this terminal. - Auxiliary frequency command - PID command - PID feedback amount - Ratio setting - Torque limiter level - Analog input monitor - Resolution: 1/3000	Input impedance: 250Ω Max. input: 30 mA DC
	[31]	Analog common	- Reference terminal for [P10], [32], [C2].	Equipotent with the inverter's terminal [11]

Classifi-cations	Symbol	Name	Functions	Remarks
Analog output	[Ao+]	Analog voltage output (+)	- Outputs the monitor signal of analog DC voltage (0 to ±10 VDC). - One of the following signals can be issued from this terminal. - Output frequency (before or after slip compensation) - Output current - Output voltage - Output torque - Load factor - Input power - PID feedback amount - PG feedback value - DC link bus voltage - Universal AO - Motor output - Analog output test - PID command - PID output - Resolution: 1/3000 * Capable of driving up to two analog voltmeters with 10kΩ impedance.	
	[Ao-]	Analog voltage output (-)	- Reference terminal for [Ao+].	Equipotent with the inverter's terminal [11]
	[CS+]	Analog current output (+)	- Outputs the monitor signal of analog DC current (4 to 20 mA DC) - One of the following signals can be issued from this terminal. - Output frequency (before slip compensation, after slip compensation) - Output current - Output voltage - Output torque - Load factor - Input power - PID feedback amount - PG feedback value - DC link bus voltage - Universal AO - Motor output - Calibration - PID command (SV) - PID output (MV) - Resolution: 1/3000  * Input impedance of the external device: Max. 500Ω	Isolated from terminals [31], [Ao-], and [11]
	[CS-]	Analog current output (-)		

Connection example

Symbol	Connection of shielded wire
[32]	
[C2]	
[Ao]	
[CS]	

Function code settings

Function Codes and Their Parameters for Terminal [32]

Function code	Name	Data	Description	Remarks
o60	Terminal [32] function (Mode selection)	0	No assignment	
		1	Auxiliary frequency command 1	
		2	Auxiliary frequency command 2	
		3	PID command	
		5	PID feedback value	
		6	Ratio setting	
		7	Analog torque limit value A	
		8	Analog torque limit value B	
		20	Analog input monitor	

Function Codes and Their Parameters for Terminal [32] (Continued)

Function code	Name	Data	Description	Remarks
o61	(Offset adjustment)	-5.0 to +5.0%	Offset adjustment amount	
o62	(Gain adjustment)	0.00 to 200.00%	Gain adjustment amount	
o63	(Filter setting)	0.00 to 5.00 s	Filter constant	
o64	(Gain base point)	0.00 to 100.00%	Gain base point	
o65	(Polarity)	0	Bipolar	
		1	Unipolar	
o66	Terminal [C2] function (Mode selection)	0	No assignment	
		1	Auxiliary frequency command 1	
		2	Auxiliary frequency command 2	
		3	PID command	
		5	PID feedback amount	
		6	Ratio setting	
		7	Analog torque limit value A	
		8	Analog torque limit value B	
		20	Analog input monitor	
o67	(Offset adjustment)	-5.0 to +5.0%	Offset adjustment amount	
o68	(Gain adjustment)	0.00 to 200.00%	Gain adjustment amount	
o69	(Filter setting)	0.00 to 5.00 s	Filter constant	
o70	(Gain base point)	0.00 to 100.00%	Gain base point	

Function Codes and Their Parameters for Terminal [Ao]

Function code	Name	Data	Description	Remarks
o71	Terminal [Ao] function (Mode selection)	0	Output frequency 1 (before slip compensation)	
		1	Output frequency 2 (after slip compensation)	
		2	Output frequency	
		3	Output voltage	
		4	Output torque	
		5	Load factor	
		6	Input power	
		7	PID feedback amount	
		8	PG feedback value (speed)	
		9	DC link bus voltage	
		10	Universal AO	
		13	Motor output	
		14	Calibration (+)	
		15	PID command (SV)	
		16	PID output (MV)	

Function Codes and Their Parameters for Terminal [Ao] (Continued)

Function code	Name	Data	Description	Remarks
o72	(Gain to output voltage)	0 to 300%	-	
o73	(Polarity)	0	Bipolar	
		1	Unipolar	

Function Codes and Their Parameters for Terminal [CS]

Function code	Name	Data	Description	Remarks
o74	Terminal [CS] function (Mode selection)	0	Output frequency 1 (before slip compensation)	
		1	Output frequency 2 (after slip compensation)	
		2	Output frequency	
		3	Output voltage	
		4	Output torque	
		5	Load factor	
		6	Input power	
		7	PID feedback value	
		8	PG feedback value (speed)	
		9	DC link bus voltage	
		10	Universal AO	
		13	Motor output	
		14	Calibration (+)	
		15	PID command (SV)	
		16	PID output (MV)	
o75	(Gain to output voltage)	0 to 300%	-	

4.4.2.11 T-Link communications card (OPC-G1-TL)

The T-Link communications card is used to connect the FRENIC-MEGA series to a Fuji MICREX series of programmable logic controllers via a T-Link network. Mounting the communications card on the FRENIC-MEGA enables the user to specify and monitor run and frequency commands and configure and check inverter's function codes required for inverter running from the MICREX.

Ports available for the interface card

This communications card can be connected to the A-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: Once the inverter is equipped with this communications card, no more communications card (e.g., DeviceNet and SX-bus communications cards) is allowed on the inverter. Mounting more than one card on the inverter causes the Er-4 trip that cannot be reset until those cards are removed except a single card.

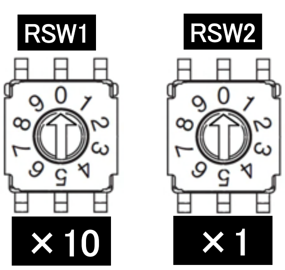
T-Link specifications

Item	Specifications
Applicable controller	MICREX series
Transmission specifications	T-Link slave I/O transmission
Number of words occupied in transmission	Total 8 words (MICREX → Inverter: 4 W, Inverter → MICREX: 4 W)
Number of units connectable	Max. 12 units
Recommended cable	Furukawa Electric twisted pair cable CPEV-SB 0.9 dia. x 1 pair or Furukawa Electric twisted pair cable KPEV-SB 0.5 mm^2 x 1 pair
Max. transmission speed	500 kbps

For the items not contained in the table above, the T-Link specifications apply.

Station address switches (RSW1 and RSW2)

The station address of the communications card on the T-Link should be configured with the station address switches (rotary switches RSW1 and RSW2) on the communications card. The setting range is from 00 to 99 in decimal. RSW1 specifies a 10s digit of the station address and the RSW2, a 1s digit.



RSW1: Upper bit (x10)
RSW2: Lower bit (x1)

* When two or more communications cards are used on the same T-Link network, the same station address should not be double assigned.

* Factory default: RSW1 = 0, RSW2 = 0 (Station address = 00)

Inverter's function codes dedicated to T-Link communication

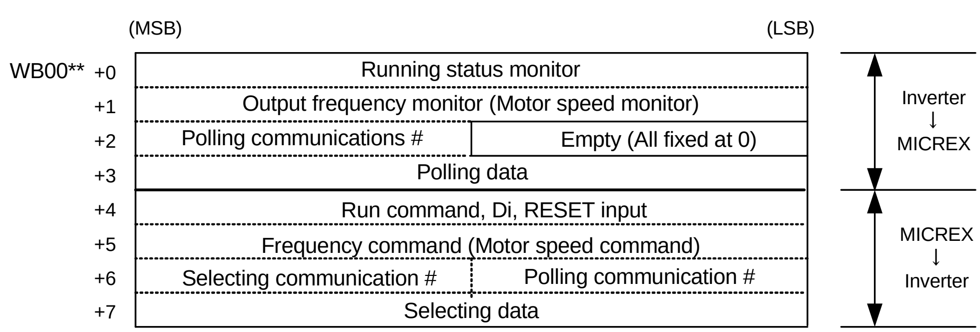
<table>
<tr><th>Function code</th><th>Function</th><th>Data setting range *</th><th>Description</th></tr>
<tr><td>y98</td><td>Select run/frequency command sources</td><td><u>0</u> to 3</td><td>Select from the following choices:<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>T-Link</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>T-Link</td></tr><tr><td>3</td><td>T-Link</td><td>T-Link</td></tr></table></td></tr>
<tr><td rowspan="7">o27</td><td rowspan="7">Select error processing for T-Link network breaks</td><td><u>0</u>, 4 to 9</td><td>Immediately coast to a stop and trip with Er-5.</td></tr>
<tr><td>1</td><td>After the time specified by o28, coast to a stop and trip with Er-5.</td></tr>
<tr><td>2</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, coast to a stop and trip with Er-5.</td></tr>
<tr><td>3, 13 to 15</td><td>Continue to run, ignoring the error (No Er-5 trip).</td></tr>
<tr><td>10</td><td>Immediately decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>11</td><td>After the time specified by o28, decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>12</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, decelerate to a stop and trip with Er-5.</td></tr>
<tr><td>o28</td><td>Set the operation timer to be used in error processing for network breaks</td><td><u>0.0</u> to 60.0 s</td><td>Applies when o27 = 1, 2, 11, or 12.</td></tr>
<tr><td rowspan="3">o30</td><td rowspan="3">Specify T-Link communications format</td><td><u>0</u></td><td>G11 standard format</td></tr>
<tr><td>2</td><td>G9 compatible format</td></tr>
<tr><td>1, 3 to 255</td><td>Not allowed.</td></tr>
</table>

* <u>The underlined values</u> are factory defaults.

Communications format

■ G11 standard format

When the G11 (FRENIC5000G11S) standard format is selected (o30 = 0), an eight-word area per inverter is used in the I/O relay area as shown below. The lower four words are status area for reading out data from the inverter to the MICREX; the upper four words are control area for writing data from the MICREX into the inverter.

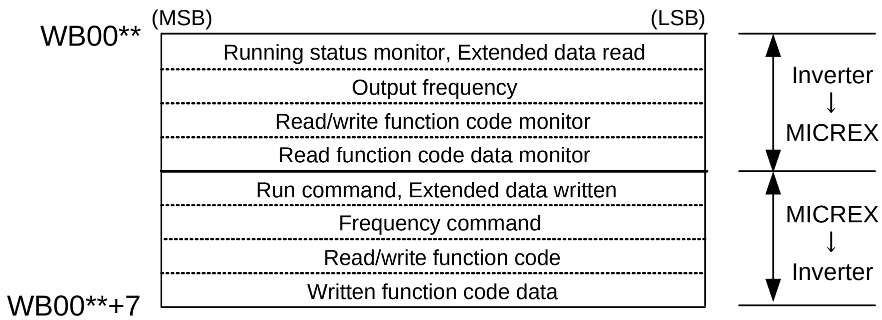


(Note) Asterisks (**) denote a T-Link station address configured by the RSW1 and RSW2.

■ G9 compatible format

When the G9 (FRENIC5000 G9) compatible format is selected (o30 = 2), an eight-word area per inverter is used in the I/O relay area as shown below. The lower four words are status area for reading out data from the inverter to the MICREX; the upper four words are control area for writing data from the MICREX into the inverter.

This format has been designed to minimize the program change in the controller when the FRENIC5000 G9 series is replaced with the FRENIC-MEGA series.



(Note) Asterisks (**) denote a T-Link station address configured by the RSW1 and RSW2.

4.4.2.12 SX-bus communications card (OPC-G1-SX)

The SX-bus communications card is used to connect the FRENIC-MEGA series to a Fuji MICREX-SX series of programmable logic controllers via an SX bus. Mounting the communications card on the FRENIC-MEGA enables programmed control and monitoring of the inverter and configuring and checking of function codes required for inverter running, from the MICREX-SX.

Ports available for the interface card

This communications card can be connected to the A-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: The SX-bus communications card uses also a part of the B-port function so that the B-port cannot accept any other card except the relay output interface card.

Note: Once the inverter is equipped with the SX-bus communications card, no more communications card (e.g., DeviceNet and PROFIBUS DP cards) is allowed on the inverter. Mounting such a card on the inverter causes the Er-4 trip.

Hardware specifications

Item	Specifications
Name	SX bus communications card
Transmission specifications	SX bus slave, I/O transmission
Transmission speed	25 Mbps
Number of words occupied in transmission	Standard format (16 words, 8W + 8W)
Terminals, Bus cable	IN and OUT, SX bus dedicated cable *NP1C-P3 (1 ft (0.3 m)) to NP1C-25 (82 ft (25 m))
Station address switches RSW1 and RSW2 (Rotary switches)	Address switches for configuring an arbitrary station address, from 1 to 238.
Status indicator LEDs (RUN and ERR)	LEDs for indicating the current status (running or error) of the inverter on which the communications card is mounted.

Inverter's function codes dedicated to SX-bus communication

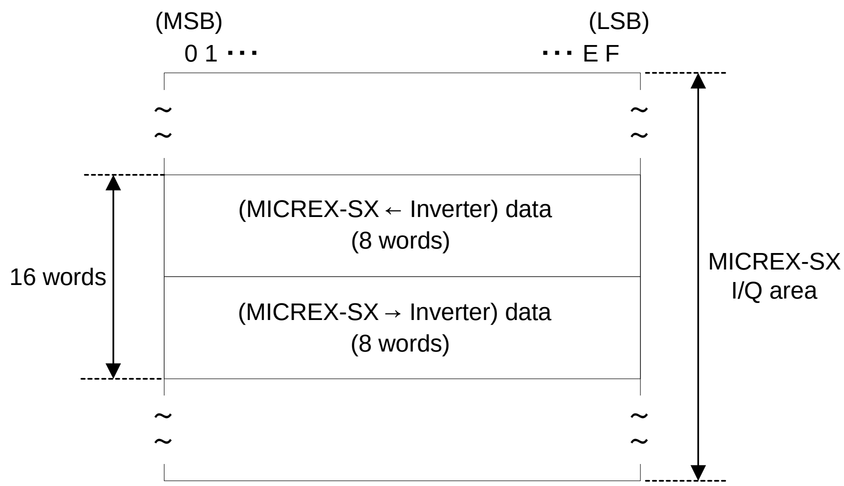
<table>
<tr><th>Function code</th><th>Function</th><th>Data setting range *</th><th>Description</th></tr>
<tr><td>y98</td><td>Select run/frequency command sources</td><td>0 to 3</td><td>Select from the following choices:<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>SX bus</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>SX bus</td></tr><tr><td>3</td><td>SX bus</td><td>SX bus</td></tr></table></td></tr>
<tr><td rowspan="8">o27</td><td rowspan="8">Select error processing for SX-bus network breaks</td><td>0, 4 to 9</td><td>Immediately coast to a stop and trip with Er-5.</td></tr>
<tr><td>1</td><td>After the time specified by o28, coast to a stop and trip with Er-5.</td></tr>
<tr><td>2</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, coast to a stop and trip with Er-5.</td></tr>
<tr><td>3, 13 to 15</td><td>Keep the current operation, ignoring the communications error.
(No Er-5 trip)</td></tr>
<tr><td>10</td><td>Immediately decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>11</td><td>After the time specified by o28, decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>12</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, decelerate to a stop and trip with Er-5.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>o28</td><td>Set the operation timer to be used in error processing for network breaks</td><td>0.0 to 60.0 sec</td><td>Applies when o27 = 1, 2, 11, or 12.</td></tr>
<tr><td rowspan="2">o30</td><td rowspan="2">Specify SX-bus communications format</td><td>0</td><td>Standard format</td></tr>
<tr><td>1 to 255</td><td>Specification not allowed</td></tr>
</table>

* The underlined values are factory defaults.

Area occupied in MICREX-SX and data allocation address

■ Standard Format

When the standard format is selected (o30 = 0), SX-bus communication uses a 16-word area per inverter in the MICREX-SX I/O area as shown below. (A maximum of 10 inverters can be connected.) The lower 8-word area is used as a status area for reading out data from the inverter to the MICREX-SX, the upper 8-word one, as a control area for writing data from the MICREX-SX to the inverter.



Address	(MSB)	(LSB)	Direction
%IW****.0	Function code group (1) polled	Function code number (1) polled	INV → MICREX-SX
%IW****.1	Function code group (2) polled	Function code number (2) polled	
%IW****.2	Data of function code (1) polled		
%IW****.3	Data of function code (2) polled		
%IW****.4	Empty (Fixed at 0)		
%IW****.5	Empty (Fixed at 0)		
%IW****.6	Output frequency monitor (Motor speed monitor)		
%IW****.7	Running status monitor		
%QW****.8	Selecting function code group (1)	Selecting function code number (1)	MICREX-SX → INV
%QW****.9	Selecting function code group (2)	Selecting function code number (2)	
%QW****.A	Data of function code (1) selected		
%QW****.B	Data of function code (2) selected		
%QW****.C	Frequency command		
%QW****.D	Run command		
%QW****.E	Polling function code group (1)	Polling function code number (1)	
%QW****.F	Polling function code group (2)	Polling function code number (2)	

(Note) Asterisks (****) denote a SX bus station address configured by the RSW1 and RSW2.

4.4.2.13 CC-Link communications card (OPC-G1-CCL)

CC-Link (Control & Communication Link) is an FA open field network system.

The CC-Link communications card connects the inverter to a CC-Link master via CC-Link using a dedicated cable. It supports the transmission speed of 156 kbps to 10 Mbps and the total length of 328 to 3,900 ft (100 to 1,200 m) so that it can be used in wide range of systems requiring a high-speed or long-distance transmission, enabling a flexible system configuration.

Ports available for the communications card

This communications card can be connected to the A-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: Once the inverter is equipped with this communications card, no more communications card (e.g., DeviceNet and SX-bus communications cards) is allowed on the inverter. Mounting more than one card on the inverter causes the Er-4 trip that cannot be reset until those cards are removed except a single card.

CC-Link specifications

Item	Specifications				
Applicable controller	Mitsubishi Electric sequencer, etc. (CC-Link master)				
Transmission system	CC-Link version 1.10 and 2.0 (Broadcast polling system)				
Number of inverters connectable	Max. 42 units (one station occupied/unit)				
Number of stations occupied	CC-Link version 1.10: 1 station occupied CC-Link version 2.0: 1 station occupied (Selectable from among 2X, 4X and 8X settings)				
Transmission speed (Baud rate)	10 Mbps/5 Mbps/2.5 Mbps/625 kbps/156 kbps				
Maximum cable length (When using the CC-Link dedicated cable)	10 Mbps	5 Mbps	2.5 Mbps	625 kbps	156 kbps
	328 ft (100 m)	492 ft (150 m)	656 ft (200 m)	2000 ft (600 m)	3900 ft (1200 m)
Insulation	500 VDC (photocoupler insulation)				
Station type	Remote device station				
Remote device type	Inverter (0x20)				

For items not contained in the above table, the CC-Link specifications apply.

Inverter's function codes dedicated to CC-Link communication

<table>
<tr><th>Function code</th><th>Function</th><th>Data setting range *1</th><th>Description</th></tr>
<tr><td>y98</td><td>Select run/frequency command sources</td><td>0 to 3</td><td>Select from the following choices:<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>CC-Link</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>CC-Link</td></tr><tr><td>3</td><td>CC-Link</td><td>CC-Link</td></tr></table></td></tr>
<tr><td rowspan="7">o27</td><td rowspan="7">Select error processing for CC-Link network breaks</td><td>0, 4 to 9</td><td>Immediately coast to a stop and trip with Er-5.</td></tr>
<tr><td>1</td><td>After the time specified by o28, coast to a stop and trip with Er-5.</td></tr>
<tr><td>2</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, coast to a stop and trip with Er-5.</td></tr>
<tr><td>3, 13 to 15</td><td>Keep the current operation, ignoring the communications error. (No Er-5 trip)</td></tr>
<tr><td>10</td><td>Immediately decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>11</td><td>After the time specified by o28, decelerate to a stop. Issue Er-5 after stopping.</td></tr>
<tr><td>12</td><td>If the communications link is restored within the time specified by o28, ignore the communications error. If a timeout occurs, decelerate to a stop and trip with Er-5.</td></tr>
<tr><td>o28</td><td>Set the operation timer to be used in error processing for network breaks</td><td>0.0 to 60.0 sec.</td><td>Applies when o27 = 1, 2, 11, or 12</td></tr>
<tr><td rowspan="5">o30</td><td rowspan="5">CC-Link extension</td><td>5 to 255</td><td>No operation</td></tr>
<tr><td>0, 1</td><td>1 station occupied
(CC-Link version 1.10)</td></tr>
<tr><td>2</td><td>1 station occupied, 2X setting
(CC-Link version 2.00)</td></tr>
<tr><td>3</td><td>1 station occupied, 4X setting
(CC-Link version 2.00)</td></tr>
<tr><td>4</td><td>1 station occupied, 8X setting
(CC-Link version 2.00)</td></tr>
<tr><td>o31</td><td>Station address *2</td><td>0, 1 to 64</td><td>Any of 1 to 64 should be specified for a slave station.
Specifying any other value causes the L.ERR LED to light.</td></tr>
<tr><td>o32</td><td>Transmission speed *2</td><td>0 to 4</td><td>0: 156 kbps, 1: 625 kbps, 2: 2.5 Mbps,
3: 5 Mbps, 4: 10 Mbps
Specifying any other value causes the L.ERR LED to light.</td></tr>
</table>

*1 The underlined values are factory defaults.

*2 If the station address (o31) or the transmission speed (o32) is modified when the inverter power is ON, the L.ERR LED flashes and the communications link is lost. Turning the terminal command ***RST*** ON or restarting both the inverter and the communications card validates the new setting.

4.4.2.14 PROFIBUS-DP communications card (OPC-G1-PDP)

The PROFIBUS-DP communications card is used to connect the FRENIC-MEGA series to a PROFIBUS-DP master via PROFIBUS. Mounting the communications card on the FRENIC-MEGA enables the user to control the FRENIC-MEGA as a slave unit by configuring and monitoring run and frequency commands and accessing inverter's function codes from the PROFIBUS master.

The communications card has the following features:

- PROFIBUS version : DP-V0 compliant
- Transmission speed : 9,600 bps to 12 Mbps
- Applicable profile : PROFIDrive V2
- Able to read and write all function codes supported in the FRENIC-MEGA

Ports available for the communications card

This communications card can be connected to the A-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: Once the inverter is equipped with this communications card, no more communications card (e.g., DeviceNet and SX-bus communications cards) is allowed on the inverter. Mounting more than one card on the inverter causes the Er-4 trip that cannot be reset until those cards are removed except a single card.

PROFIBUS-DP specifications

Item		Specifications	Remarks
Transmission section	Lines	RS-485 (insulated cable)	
	Cable length	See the table below.	
	Transmission speed	9.6 kbps to 12 Mbps (auto configuration)	To be specified in the master node
	Protocol	PROFIBUS-DP (DP-V0)	IEC 61158 and 61784
Connector		Pluggable, six-pin terminal block	Manufactured by Phoenix Contact Inc.
Control section	Controller	SPC3 (Siemens)	
	Comm. buffer	1472 bytes (SPC3 built-in memory)	
Addressing		- By on-board node address switches (rotary switches) (0 to 99) or - By inverter’s function code o31 (data = 0 to 125)	Setting both node address switches SW1 and SW2 to "0" enables the o31 setting.
Diagnostics		Detection of cable break	Indicated by the OFFL LED
		Detection of the illegal configuration	Indicated by the ERR LED

The maximum cable length per segment for a PROFIBUS-DP specified cable is listed below.

Transmission speed	Maximum cable length ft (m) per segment
9.6 kbps	3900 (1200)
19.2 kbps	3900 (1200)
45.45 kbps	3900 (1200)
93.75 kbps	3300 (1000)
187.5 kbps	3300 (1000)
500 kbps	1300 (400)
1.5 Mbps	656 (200)
3 Mbps	328 (100)
6 Mbps	328 (100)
12 Mbps	328 (100)

Inverter's function codes dedicated to PROFIBUS-DP communication

The inverter's function codes listed in Table 4.19 should be configured for specifying run and frequency commands via PROFIBUS.

Table 4.19 Inverter's Function Codes Required for Enabling Run and Frequency Commands via PROFIBUS

Function code	Description	Factory default	Function code data to be set	Remarks
y98	Select run/frequency command sources	0	3	Select from the following choices: y98 / Frequency command source / Run command source 0 / Inverter / Inverter 1 / PROFIBUS / Inverter 2 / Inverter / PROFIBUS 3 / PROFIBUS / PROFIBUS
y99	Loader Link Function (Run/frequency commands from Loader)	0	0	No change is required from the factory default.
E01 or above	Terminal Xn Function (n: Terminal number)	--	Any data except "24 (1024), ***LE*** " (For all terminals Xn)	Even if ***LE*** is selected, ***LE*** = ON makes parameter y98 valid, but ***LE*** = OFF makes y98 invalid and run/frequency commands in the inverter are valid.

Table 4.20 lists the other related inverter's function codes.

Table 4.20 Related Inverter's Function Codes

Function code	Description	Factory default	Data setting range	Remarks
o27	Select error processing for PROFIBUS network breaks	0	0 to 15	
o28	Set the operation timer to be used in error processing for network breaks	0.0 s	0.0 to 60.0 s	
o30	Select PPO type	0	0 to 255	For details about o30, refer to the instruction manual of this communications card.
o31	Select PROFIBUS station address	0	0 to 125	Valid when rotary switches SW1 and SW2 are set to "00."
o40 to o43	Assign function code data to be written, 1 to 4	0000	0x0000 to 0xFFFF	Configure function codes for writing to the data mapped I/O. Functionally equivalent to PNU915.
o48 to o51	Assign function code data to be read, 1 to 4	0000	0x0000 to 0xFFFF	Configure function codes for reading from the data mapped I/O. Functionally equivalent to PNU916.

Node address

(1) Configuring node address switches (SW1 and SW2)

Before the inverter power is turned ON, the node address of the communications card should be specified with SW1 and SW2 (rotary switches) on the card. The setting range is from 00 to 99 in decimal. SW1 specifies a 10s digit of the node address and the SW2, a 1s digit.

Node address = (SW1 setting x 10) + (SW2 setting x 1)

Note: The node address switches should be accessed with the inverter being OFF. Setting these switches with the inverter being ON requires restarting the inverter to enable the new settings.

Note: To specify a node address exceeding 99, use the function code o31 as described in (2) below.

(2) Configuring the o31 data

The node address can also be specified with the inverter's function code o31. The setting range is from 0 to 125.

With both SW1 and SW2 being OFF, restarting the inverter validates the setting made with the function code 31. If those switches are set to any value other than 00, the setting made with those switches remains valid.

Setting the o31 data to 126 or greater flashes the ERR LED on the communications card, telling an occurrence of a data setting error.

Selecting the PPO type

This communications card supports PPO types 1 through 4. For details about the PPO, refer to the instruction manual of the PROFIBUS-DP communications card.

The same PPO type should be specified at both the inverter keypad and the PROFIBUS master. If not, the communications card cannot start data exchange with the PROFIBUS master and flashes the ERR LED, telling an occurrence of a data setting error.

■ From the inverter keypad

The PPO type of the communications card can be specified with the inverter's function code o30 that is accessible from the inverter keypad after the communications card is mounted on the inverter.

After the setting of the PPO type is modified, the inverter should be restarted to validate the new setting.

o30	PPO type
0, 1, 6 to 255	PPO 1
2	PPO 2
3	PPO 3
4	PPO 4
5	PPO 2

■ From the PROFIBUS master

The PROFIBUS master sends the definition of the communications card in its configuration frame. The definition is stored in the GSD file. For the configuration procedure, refer to the PROFIBUS master's manual.

4.4.2.15 DeviceNet communications card (OPC-G1-DEV)

The DeviceNet communications card is used to connect the FRENIC-MEGA series to a DeviceNet master via DeviceNet. Mounting the communications card on the FRENIC-MEGA enables the user to control the FRENIC-MEGA as a slave unit by configuring and monitoring run and frequency commands and accessing inverter's function codes from the DeviceNet master.

Ports available for the communications card

This interface card can be connected to any one of the three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: Once the inverter is equipped with this communications card, no more communications card (e.g., CC-Link and SX-bus communications cards) is allowed on the inverter. Mounting more than one card on the inverter causes the Er-4 trip that cannot be reset until those cards are removed except a single card.

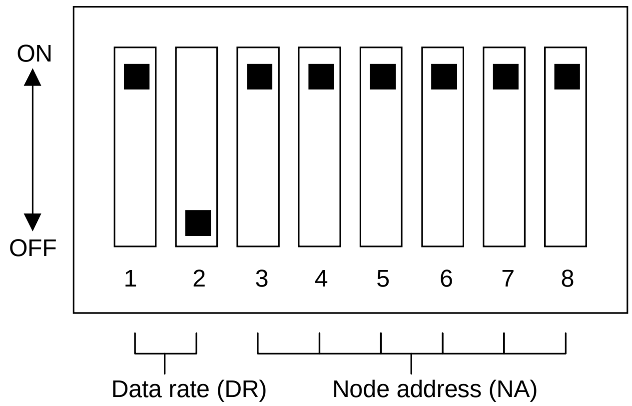
DeviceNet specifications

<table>
<tr><th>Item</th><th colspan="4">Specifications</th></tr>
<tr><td>Number of nodes connectable</td><td colspan="4">Max. 64 (including the master)</td></tr>
<tr><td>MAC ID</td><td colspan="4">0 to 63</td></tr>
<tr><td>Insulation</td><td colspan="4">500 VDC (photocoupler insulation)</td></tr>
<tr><td>Transmission rate</td><td colspan="4">500, 250, or 125 kbps</td></tr>
<tr><td rowspan="4">Maximum cable length
(When using thick cables)</td><td>Transmission rate</td><td>500 kbps</td><td>250 kbps</td><td>125 kbps</td></tr>
<tr><td>Trunk line length</td><td>328 ft (100 m)</td><td>820 ft (250 m)</td><td>1600 (500 m)</td></tr>
<tr><td>Drop line length</td><td>20 ft (6 m)</td><td>20 ft (6 m)</td><td>20 ft (6 m)</td></tr>
<tr><td>Total length of drop lines</td><td>128 ft (39 m)</td><td>256 ft (78 m)</td><td>512 ft (156 m)</td></tr>
<tr><td>Messages supported</td><td colspan="4">1. I/O Message (Poll, Change of State)
2. Explicit Message</td></tr>
<tr><td>Vendor ID</td><td colspan="4">319 (Registered name: Fuji Electric Group)</td></tr>
<tr><td>Device type</td><td colspan="4">AC drive (code: 2)</td></tr>
<tr><td>Product code</td><td colspan="4">9219</td></tr>
<tr><td>Applicable device profile</td><td colspan="4">AC Drive</td></tr>
<tr><td>Number of input/output bytes</td><td colspan="4">Max. 8 bytes for each of input and output
* Depending on the format selected. Refer to "Communications Formats" on page 4-97.</td></tr>
<tr><td>Applicable DeviceNet Specifications</td><td colspan="4">CIP Specifications
Volume 1, Edition 2.2 Japanese version and Volume 3, Edition 1.1 Japanese version</td></tr>
<tr><td>Node type</td><td colspan="4">Group 2 only server (noncompliant with UCMM)</td></tr>
<tr><td>Network power consumption</td><td colspan="4">80 mA, 24 VDC
(Note) The network power is supplied by an external power source.</td></tr>
</table>

For the items not contained in the table above, the DeviceNet Specifications apply.

DIP switch configuration

The DIP switch specifies the communication data rate (baud rate) and the node address (MAC ID) on DeviceNet as shown below. It offers a choice of baud rates (125, 250, and 500 kbps) and a choice of node address (MAC ID) ranging from 0 to 63. The DIP switch should be configured before the inverter and the communications card are turned ON. If the switch is configured when they are turned ON, the new configuration does not go into effect until they are restarted.



DR	DIP 1-2
125 kbps	00
250 kbps	01
500 kbps	10
Not allowed	11

NA	DIP 3-8
0	000000
1	000001
2	000010
3	000011
…	…
62	111110
63	111111

DIP Switch Configuration (showing an example of Data Rate = 500 kbps and Node Address = 63

Inverter's function codes dedicated to DeviceNet communication

<table>
<tr><th>Function code</th><th>Description</th><th>Factory default</th><th>Function code data</th><th>Remarks</th></tr>
<tr><td>y98</td><td>Select run/frequency command sources</td><td>0</td><td>Select from the following choices:<table><tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr><tr><td>0</td><td>Inverter</td><td>Inverter</td></tr><tr><td>1</td><td>DeviceNet</td><td>Inverter</td></tr><tr><td>2</td><td>Inverter</td><td>DeviceNet</td></tr><tr><td>3</td><td>DeviceNet</td><td>DeviceNet</td></tr></table></td><td></td></tr>
<tr><td>o27</td><td>Select error processing for DeviceNet breaks</td><td>0</td><td>Refer to the instruction manual of the DeviceNet communications card.</td><td></td></tr>
<tr><td>o28</td><td>Set the operation timer to be used in error processing for network breaks</td><td>0.0 s</td><td>0.0 to 60.0 s</td><td></td></tr>
<tr><td>o31</td><td>Select output assembly instance.</td><td>0</td><td>See Table 4.22.</td><td rowspan="4">Restart the inverter to validate the new settings.</td></tr>
<tr><td>o32</td><td>Select input assembly instance</td><td>0</td><td>See Table 4.22.</td></tr>
<tr><td>o40 to o43</td><td>Assign the function code writing data, 1 to 4.</td><td>0000</td><td>See Note below.</td></tr>
<tr><td>o48 to o51</td><td>Assign the function code reading data, 1 to 4.</td><td>0000</td><td>See Note below.</td></tr>
</table>

Note: Configuring o40 to o43 and o48 to o51

Specify the function code group (shown in Table 4.21) and number in a 4-digit hexadecimal notation.

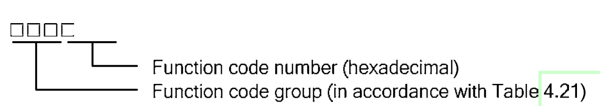


Table 4.21 Function Code Group

Group	Group code		Group name	Group	Group code		Group name	Group	Group code		Group name
S	2	02h	Command/function data	A	9	09h	Motor 2 parameters	b	19	13h	Motor 3 parameters
M	3	03h	Monitored data	o	10	0Ah	Option functions	r	12	0Ch	Motor 4 parameters
F	4	04h	Fundamental functions	J	14	0Eh	Application functions 1	d	20	14h	Application functions 2
E	5	05h	Extension terminal functions	y	15	0Fh	Link functions				
C	6	06h	Control functions	W	16	10h	Monitored data 2				
P	7	07h	Motor 1 parameters	X	17	11h	Alarm 1				
H	8	08h	High performance functions	Z	18	12h	Alarm 2				

Example: For F26 F ⇒ Group code 04
26 ⇒ 1A (hexadecimal) } "041A"

Communications formats

Table 4.22 lists the communications formats supported. The output formats should be selected by function code o31 and the input formats, by function code o32. Restarting the inverter validates the new settings of o31 and o32.

Table 4.22 List of Communications Formats Supported

Function codes o31, o32	Type	Instance ID	Description	Length (words)
o31 = 20	Output (from master to inverter)	20	Basic Speed Control Output	4
o31 = 21 or 0 (Factory default)		21	Extended Speed Control Output	4
o31 = 100		100	Fuji Drive Assembly Output	4
o31 = 102		102	User Defined Assembly Output	8
o31 = 104 (Note)		104	Request for Access to Function Codes	8
o32 = 70	Input (from inverter to master)	70	Basic Speed Control Input	4
o32 = 71 or 0 (Factory default)		71	Extended Speed Control Input	4
o32 = 101		101	Fuji Drive Assembly Input	4
o32 = 103		103	User Defined Assembly Input	8
o32 = 105 (Note)		105	Response to Function Codes Access Request	8

(Note) When o31 is set at 104 (Request for Access to Function Codes), o32 should be set at 105 (Response to Request for Access to Function Codes). For details, refer to the instruction manual of the DeviceNet communications card.

4.4.2.16 CANopen communications card (OPC-G1-COP)

The CANopen communications card is used to connect the FRENIC-MEGA series to a CANopen master unit (e.g., PC and PLC) via a CANopen network. Mounting the communications card on the FRENIC-MEGA allows the user to control the FRENIC-MEGA as a slave unit by configuring run and frequency commands and accessing inverter's function codes from the CANopen master unit.

Ports available for the communications card

This communications card can be connected to the A-port only, out of three option connection ports (A-, B-, and C-ports) provided on the FRENIC-MEGA.

Note: Once the inverter is equipped with this communications card, no more communications card (e.g., DeviceNet and SX-bus communications cards) is allowed on the inverter. Mounting more than one card on the inverter causes the Er-4 trip that cannot be reset until those cards are removed except a single card.

CANopen specifications

Item	Specifications	Remarks
Physical layer	CAN (ISO11898)	
Baud rate	20, 50, 125, 250, 500, 800 kbits/s or 1 Mbit/s	Specified by o32
Maximum cable length	8200 ft (2500 m) (at 20 kbits/s) to 82 ft (25 m) (at 1 Mbit/s)	
Node ID	1 to 127	Specified by o31
Applicable profile	Compliant with the following profiles; - CiA DS-301 Ver. 4.02 - CiA DS-402 Ver. 2.0 with Velocity Mode	

Inverter's function codes dedicated to CANopen communication

The inverter's function codes listed below should be configured for performing communication between the communications card and CANopen master unit.

Inverter's Function Codes Required for CANopen Communication

Function code	Function code name	Factory default	Data setting range	Description
o31 *1	Node ID setting	0	0 to 255 (Valid range: 0 to 127)	Setting 0 or 128 or greater is regarded as 127
o32 *1	Baud rate setting	0	0 to 255 (Valid range: 0 to 7)	0: 125 kbits/s 1: 20 kbits/s 2: 50 kbits/s 3: 125 kbits/s 4: 250 kbits/s 5: 500 kbits/s 6: 800 kbits/s 7: 1 Mbit/s 8 to 255: 1 Mbit/s

*1 After configuring the function code o31 or o32, restart the inverter or send ResetNode command from the CANopen master to validate the new setting.

The table below lists the other related inverter's function codes. Configure those function codes if necessary.

Related Inverter's Function Codes

<table>
<tr><th>Function code</th><th>Function code name</th><th>Factory default</th><th>Data setting range</th><th>Description</th></tr>
<tr><td>o27</td><td>Select error processing for CANopen network breaks</td><td>0</td><td>0 to 15</td><td></td></tr>
<tr><td>o28</td><td>Set the operation timer to be used in error processing for network breaks</td><td>0</td><td>0 to 60.0 s</td><td></td></tr>
<tr><td>o40 to o43
*2</td><td>Assign the function code to be written via RPDO 3</td><td>0x0000</td><td>0x0000 to 0xFFFF</td><td>Specify the function code as follows:
0xXX■■
XX: Group (Refer to the table below)
■■: Number
ex. F07-> 0x0407</td></tr>
<tr><td>o48 to o51
*2</td><td>Assign the function code to be monitored via TPDO 3</td><td>0x0000</td><td>0x0000 to 0xFFFF</td><td>Same as above.</td></tr>
<tr><td>y98</td><td>Select run/frequency command sources</td><td>0</td><td>0 to 3</td><td>Select from the following choices:<table>
<tr><th>y98</th><th>Frequency command source</th><th>Run command source</th></tr>
<tr><td>0</td><td>Inverter</td><td>Inverter</td></tr>
<tr><td>1</td><td>CANopen</td><td>Inverter</td></tr>
<tr><td>2</td><td>Inverter</td><td>CANopen</td></tr>
<tr><td>3</td><td>CANopen</td><td>CANopen</td></tr>
</table></td></tr>
</table>

*2 After configuring the function codes o40 to o43 and o48 to o51, restart the inverter or send Reset Node command from the CANopen master to validate the new setting.

Function Code Group (Function codes o40 to o43 and o48 to o51)

Group	Group code		Group name	Group	Group code		Group name	Group	Group code		Group name
S	2	02h	Command/function data	A	9	09h	Motor 2 parameters	b	19	13h	Motor 3 parameters
M	3	03h	Monitored data	o	10	0Ah	Option functions	r	12	0Ch	Motor 4 parameters
F	4	04h	Fundamental functions	J	14	0Eh	Application functions 1	d	20	14h	Application functions 2
E	5	05h	Extension terminal functions	y	15	0Fh	Link functions				
C	6	06h	Control functions	W	16	10h	Monitored data 2				
P	7	07h	Motor 1 parameters	X	17	11h	Alarm 1				
H	8	08h	High performance functions	Z	18	12h	Alarm 2				

Communication

The communications card is a slave of CANopen and supports the following services.

Item	Services	Remarks
PDO	- 3 RPDOs / 3 TPDOs - Sync, Cyclic and Async (Change of state event) supported for 3 TPDOs	All PDO cannot be remapped by PDO Mapping parameters.
SDO	- Expedited and Segmented protocol supported - Only Default SDO supported	Block protocol not supported
Emergency (EMCY) Object	EMCY Producer	EMCY Consumer not supported
Network Management (NMT)	NMT Slave (DS-301 state machine) Guarding Heartbeat Producer Heartbeat Consumer Boot-up Protocol	NMT master not supported

4.4.3 List of Option Cards and Connection Ports

The table below lists the option cards and option connection ports.

(Function enhancement or version update in the future may provide new options. For options not listed below, contact Fuji Electric.)

Option type	Model name	Option connection ports			Remarks
		A-port	B-port	C-port	
Relay output	OPC-G1-RY	√	√	--	Two option cards connectable at a time to A- and B-ports (4 outputs).
PG feedback	OPC-G1-PG	--	--	√	
	OPC-G1-PG2	--	--	√	
I/O	OPC-G1-DI	√	√	√	A single option card connectable at a time to any one of A-, B- and C-ports.
	OPC-G1-DO	√	√	√	A single option card connectable at a time to any one of A-, B- and C-ports.
	OPC-G1-AIO	√	√	√	A single option card connectable at a time to any one of A-, B- and C-ports.
Communications	OPC-G1-DEV	√	√	√	Only one of these communications option cards connectable to the inverter at a time. (e.g. Connection of both OPC-G1-DEV and OPC-G1-TL at a time is not possible.) When the OPC-G1-SX is connected to the A-port, the OPC-G1-RY only can be connected to the B-port.
	OPC-G1-TL	√	--	--	
	OPC-G1-COP	√	--	--	
	OPC-G1-PDP	√	--	--	
	OPC-G1-CCL	√	--	--	
	OPC-G1-SX	√	--	--	
	OPC-G1-ETH	√	--	--	

Note: Mounting an Enclosed - Type 1 Kit option on inverters of 40 HP or below limits the number of connectable option cards to one (except that two relay output interface cards (OPC-G1-RY) can be connected at a time).

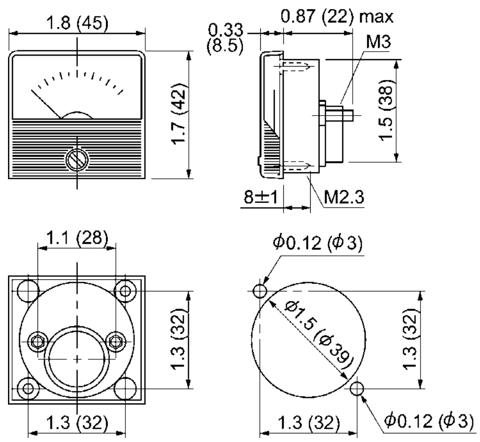
4.4.4 Meter options

4.4.4.1 Frequency meters

Connect a frequency meter to analog signal output terminals [FM1]/[FM2] and [11] of the inverter to measure the frequency component selected by function code F31. Figure 4.17 shows the dimensions of the frequency meters and the connection example.

Model: TRM-45 (10 VDC, 1 mA)

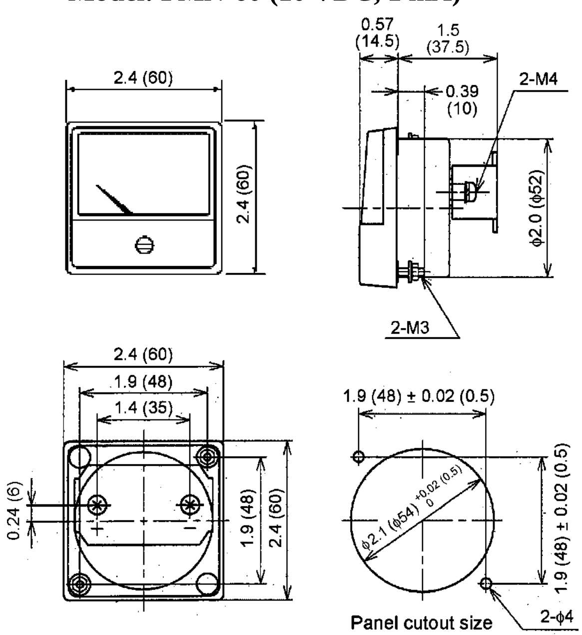
This model has two types of calibration: "0 to 60/120 Hz" and "60/120/240 Hz."



Unit: inch (mm)

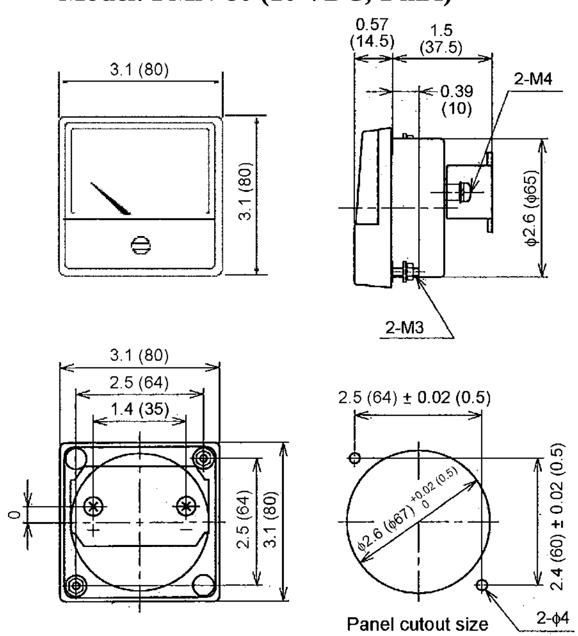
Available from Fuji Electric Technica Co., Ltd.

Model: FMN-60 (10 VDC, 1 mA)



(View from the front of the panel)

Model: FMN-80 (10 VDC, 1 mA)



Unit: inch (mm)

(View from the front of the panel)

Available from Fuji Electric Technica Co., Ltd.

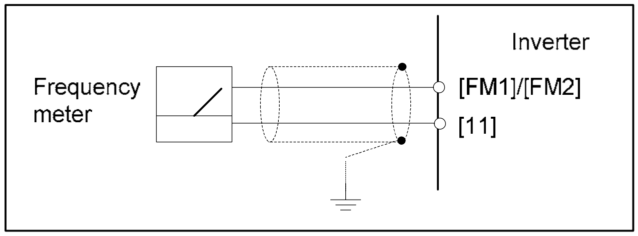


Figure 4.17 Frequency Meter Dimensions and Connection Example

Chapter 5

FUNCTION CODES

This chapter contains overview tables of function codes available for the FRENIC-MEGA series of inverters, function code index by purpose, and details of function codes.

Contents

5.1 Overview of Function Codes

Function codes enable the FRENIC-MEGA series of inverters to be set up to match your system requirements.

Each function code consists of a 3-letter alphanumeric string. The first letter is an alphabet that identifies its group and the following two letters are numerals that identify each individual code in the group. The function codes are classified into 13 groups: Fundamental Functions (F codes), Extension Terminal Functions (E codes), Control Functions (C codes), Motor 1 Parameters (P codes), High Performance Functions (H codes), Motor 2, 3 and 4 Parameters (A, b and r codes), Application Functions 1, 2 and 3 (J, d and U codes), Link Functions (y codes) and Option Functions (o codes). To determine the property of each function code, set data to the function code.

This manual does not contain the descriptions of Option Functions (o codes). For o codes, refer to the instruction manual for each option.

5.2 Function Code Tables

The following descriptions supplement those given in the function code tables on page 5-4 and subsequent pages.

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

Function codes are indicated by the following based on whether they can be changed or not when the inverter is running:

Notation	Change when running	Validating and saving function code data
Y*	Possible	If the data of the codes marked with Y* is changed with [∧] and [∨] keys, the change will immediately take effect; however, the change is not saved into the inverter's memory. To save the change, press the [FUNC/DATA] key. If you press the [RESET] key without pressing the [FUNC/DATA] key to exit the current state, then the changed data will be discarded and the previous data will take effect for the inverter operation.
Y	Possible	Even if the data of the codes marked with Y is changed with [∧] and [∨] keys, the change will not take effect. Pressing the [FUNC/DATA] key will make the change take effect and save it into the inverter's memory.
N	Impossible	—

■ Copying data

The keypad is capable of copying the function code data stored in the inverter's memory into the keypad's memory (refer to Menu #7 "Data copying" in Programming mode). With this feature, you can easily transfer the data saved in a source inverter to other destination inverters.

If the specifications of the source and destination inverters differ, some code data may not be copied to ensure safe operation of your power system. Whether data will be copied or not is detailed with the following symbols in the "Data copying" column of the function code tables given on page 5-4 and subsequent pages.

Y: Will be copied unconditionally.
Y1: Will not be copied if the rated capacity differs from the source inverter.
Y2: Will not be copied if the rated input voltage differs from the source inverter.
N: Will not be copied. (The function code marked with "N" is not subject to the Verify operation, either.)

■ Using negative logic for programmable I/O terminals

The negative logic signaling system can be used for the programmable, digital input and output terminals by setting the function code data specifying the properties for those terminals. Negative logic refers to the inverted ON/OFF (logical value 1 (true)/0 (false)) state of input or output signal. An active-ON signal (the function takes effect if the terminal is short-circuited.) in the normal logic system is functionally equivalent to active-OFF signal (the function takes effect if the terminal is opened.) in the negative logic system. Active-ON signals can be switched to active-OFF signals, and vice versa, with the function code data setting, except some signals.

To set the negative logic system for an input or output terminal, enter data of 1000s (by adding 1000 to the data for the normal logic) in the corresponding function code.

Example: "Coast to a stop" command ***BX*** assigned to any of digital input terminals [X1] to [X7] using any of function codes E01 through E07

Function code data	Description
7	Turning ***BX*** ON causes the motor to coast to a stop. (Active-ON)
1007	Turning ***BX*** OFF causes the motor to coast to a stop. (Active-OFF)

■ Drive control

The FRENIC-MEGA runs under any of the following drive controls. Some function codes apply exclusively to the specific drive control, which is indicated by letters Y (Applicable) and N (Not applicable) in the "Drive control" column in the function code tables given on the following pages.

Abbreviation in "Drive control" column in function code tables	Control target (H18)	Drive control (F42)
V/f	Speed (Frequency for V/f and PG V/f)	V/f control Dynamic torque vector control
PG V/f		V/f control with speed sensor Dynamic torque vector control with speed sensor
w/o PG		Vector control without speed sensor
w/ PG		Vector control with speed sensor
Torque control	Torque	Vector control with/without speed sensor

For details about the drive control, refer to the description of F42 "Drive Control Selection 1."

Note: The FRENIC-MEGA is a general-purpose inverter whose operation is customized by frequency-basis function codes, like conventional inverters. Under the speed-basis drive control, however, the control target is a motor speed, not a frequency, so convert the frequency to the motor speed according to the following expression.

Motor speed (min^{-1}) = 120 × Frequency (Hz) ÷ Number of poles

Note: Difference of notation between standard keypad and remote keypad

Descriptions in this manual are based on the standard keypad having an LCD monitor and a *five*-digit, 7-segment LED monitor (as shown in Chapter 3). The FRENIC-MEGA also provides a remote keypad as an option, which has no LCD monitor and has a *four*-digit, 7-segment LED and a USB port.

If the standard keypad is replaced with an optional remote keypad, the display notation differs as shown below.

<table>
<tr><th>Function code</th><th>Name</th><th>Standard keypad (TP-G1W-J1)</th><th>Remote keypad (TP-E1U)</th></tr>
<tr><td>H42</td><td>Capacitance of DC Link Bus Capacitor</td><td rowspan="9">Decimal notation</td><td rowspan="9">Hexadecimal notation</td></tr>
<tr><td>H44</td><td>Startup Counter for Motor 1</td></tr>
<tr><td>H47</td><td>Initial Capacitance of DC Link Bus Capacitor</td></tr>
<tr><td>H79</td><td>Preset Startup Count for Maintenance (M1)</td></tr>
<tr><td>A52</td><td>Startup Counter for Motor 2</td></tr>
<tr><td>b52</td><td>Startup Counter for Motor 3</td></tr>
<tr><td>r52</td><td>Startup Counter for Motor 4</td></tr>
<tr><td>d15</td><td>Feedback Input (Encoder pulse resolution)</td></tr>
<tr><td>d60</td><td>Command (Pulse Rate Input) (Encoder pulse resolution)</td></tr>
<tr><td>H43</td><td>Cumulative Run Time of Cooling Fan</td><td rowspan="9">Display by hours</td><td rowspan="9">Display in units of 10 hours</td></tr>
<tr><td>H48</td><td>Cumulative Run Time of Capacitors on Printed Circuit Boards</td></tr>
<tr><td>H77</td><td>Service Life of DC Link Bus Capacitor (Remaining time)</td></tr>
<tr><td>H78</td><td>Maintenance Interval (M1)</td></tr>
<tr><td>H94</td><td>Cumulative Motor Run Time 1</td></tr>
<tr><td>A51</td><td>Cumulative Motor Run Time 2</td></tr>
<tr><td>b51</td><td>Cumulative Motor Run Time 3</td></tr>
<tr><td>r51</td><td>Cumulative Motor Run Time 4</td></tr>
<tr><td>d78</td><td>Synchronous Operation (Excessive deviation detection range)</td><td>Display in units of 10 pulses</td><td>Display in units of 10 pulses
(For 10000 pulses or more: Display in units of 100 pulses, with the x10 LED ON)</td></tr>
</table>

The following tables list the function codes available for the FRENIC-MEGA series of inverters.

F codes: Fundamental Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	Drive control: PG V/f	Drive control: w/o PG	Drive control: w/ PG	Drive control: Torque control	Refer to page:
F00	Data Protection	0: Disable both data protection and digital reference protection 1: Enable data protection and disable digital reference protection 2: Disable data protection and enable digital reference protection 3: Enable both data protection and digital reference protection	Y	Y	0	Y	Y	Y	Y	Y	5-34
F01	Frequency Command 1	0: ∧ / ∨ keys on keypad 1: Voltage input to terminal [12] (-10 to +10 VDC) 2: Current input to terminal [C1] (4 to 20 mA DC) 3: Sum of voltage and current inputs to terminals [12] and [C1] 5: Voltage input to terminal [V2] (-10 to +10 VDC) 7: Terminal command ***UP/DOWN*** control 8: ∧ / ∨ keys on keypad (balanceless-bumpless switching available) 11: Digital input interface card (option) 12: Pulse train input	N	Y	0	Y	Y	Y	Y	N	
F02	Operation Method	0: Keypad 1: Terminal command ***FWD*** or ***REV*** 2: Keypad (Forward direction) 3: Keypad (Reverse direction)	N	Y	0	Y	Y	Y	Y	Y	5-42
F03	Maximum Frequency 1	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	5-43
F04	Base Frequency 1	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	
F05	Rated Voltage at Base Frequency 1	0: Output a voltage in proportion to input voltage 80 to 240 V: Output an AVR-controlled voltage (for 230 V series) 160 to 500 V: Output an AVR-controlled voltage (for 460 V series)	N	Y2	 230 460	Y	Y	Y	Y	Y	
F06	Maximum Output Voltage 1	80 to 240 V: Output an AVR-controlled voltage (for 230 V series) 160 to 500 V: Output an AVR-controlled voltage (for 460 V series)	N	Y2	230 460	Y	Y	N	N	Y	
F07	Acceleration Time 1	0.00 to 6000 s	Y	Y	*1	Y	Y	Y	Y	N	5-45
F08	Deceleration Time 1	Note: Entering 0.00 cancels the acceleration time, requiring external soft-start.	Y	Y	*1	Y	Y	Y	Y	N	
F09	Torque Boost 1	0.0% to 20.0% (percentage with respect to "Rated Voltage at Base Frequency 1")	Y	Y	0.0	Y	Y	N	N	N	5-48 5-64
F10	Electronic Thermal Overload Protection for Motor 1 (Select motor characteristics)	1: For a general-purpose motor with shaft-driven cooling fan 2: For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan	Y	Y	1	Y	Y	Y	Y	Y	5-49
F11	(Overload detection level)	0.00: Disable 1% to 135% of the rated current (allowable continuous drive current) of the motor	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	
F12	(Thermal time constant)	0.5 to 75.0 min	Y	Y	*3	Y	Y	Y	Y	Y	
F14	Restart Mode after Momentary Power Failure (Mode selection)	0: Trip immediately 1: Trip after a recovery from power failure 2: Trip after decelerate-to-stop 3: Continue to run, for heavy inertia or general loads 4: Restart at the frequency at which the power failure occurred, for general loads 5: Restart at the starting frequency	Y	Y	0	Y	Y	Y	Y	N	5-51
F15	Frequency Limiter (High)	0.0 to 500.0 Hz	Y	Y	70.0	Y	Y	Y	Y	N	5-57
F16	(Low)	0.0 to 500.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	
F18	Bias (Frequency command 1)	-100.00% to 100.00%	Y*	Y	0.00	Y	Y	Y	Y	N	5-34 5-58
F20	DC Braking 1 (Braking starting frequency)	0.0 to 60.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	5-58
F21	(Braking level)	0% to 80% (LD/MD mode) *4, 0% to 100% (HD mode)	Y	Y	0	Y	Y	Y	Y	N	
F22	(Braking time)	0.00 (Disable); 0.01 to 30.00 s	Y	Y	0.00	Y	Y	Y	Y	N	

The shaded function codes ( ) are applicable to the quick setup.

*1 6.00 s for inverters of 40 HP or below; 20.00 s for those of 50 HP or above

*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).

*3 5.0 min for inverters of 40 HP or below; 10.0 min for those of 50 HP or above

*4 0% to 100% for inverters of 7.5 HP or below

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	Drive control PG V/f	Drive control w/o PG	Drive control w/ PG	Drive control Torque control	Refer to page:
F23	Starting Frequency 1	0.0 to 60.0 Hz	Y	Y	0.5	Y	Y	Y	Y	N	5-59
F24	(Holding time)	0.00 to 10.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
F25	Stop Frequency	0.0 to 60.0 Hz	Y	Y	0.2	Y	Y	Y	Y	N	
F26	Motor Sound (Carrier frequency)	0.75 to 16 kHz (LD-mode inverters of 0.5 to 30 HP and HD-mode ones of 0.5 to 100 HP) 0.75 to 10 kHz (LD-mode inverters of 40 to 100 HP and HD-mode ones of 125 to 800 HP) 0.75 to 6 kHz (LD-mode inverters of 125 to 900 HP and HD-mode ones of 900 and 1000 HP) 0.75 to 4 kHz (LD-mode inverters of 1000 HP) 0.75 to 2 kHz (MD-mode inverters of 150 to 800 HP)	Y	Y	2	Y	Y	Y	Y	Y	5-62
F27	(Tone)	0: Level 0 (Inactive) 1: Level 1 2: Level 2 3: Level 3	Y	Y	0	Y	Y	N	N	Y	
F29	Analog Output [FM1] (Mode selection)	0: Output in voltage (0 to 10 VDC) 1: Output in current (4 to 20 mA DC)	Y	Y	0	Y	Y	Y	Y	Y	5-63
F30	(Voltage adjustment)	0% to 300%	Y*	Y	100	Y	Y	Y	Y	Y	
F31	(Function)	Select a function to be monitored from the followings. 0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback amount (PV) 8: PG feedback value 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Calibration (+) 15: PID command (SV) 16: PID output (MV) 17: Positional deviation in synchronous running	Y	Y	0	Y	Y	Y	Y	Y	
F32	Analog Output [FM2] (Mode selection)	0: Output in voltage (0 to 10 VDC) 1: Output in current (4 to 20 mA DC)	Y	Y	0	Y	Y	Y	Y	Y	
F34	(Voltage adjustment)	0% to 300%	Y*	Y	100	Y	Y	Y	Y	Y	
F35	(Function)	Select a function to be monitored from the followings. 0: Output frequency 1 (before slip compensation) 1: Output frequency 2 (after slip compensation) 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback amount (PV) 8: PG feedback value 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Calibration (+) 15: PID command (SV) 16: PID output (MV) 17: Positional deviation in synchronous running	Y	Y	0	Y	Y	Y	Y	Y	
F37	Load Selection/ Auto Torque Boost/ Auto Energy Saving Operation 1	0: Variable torque load 1: Constant torque load 2: Auto torque boost 3: Auto energy saving (Variable torque load during ACC/DEC) 4: Auto energy saving (Constant torque load during ACC/DEC) 5: Auto energy saving (Auto torque boost during ACC/DEC)	N	Y	1	Y	Y	N	Y	N	5-64
F38	Stop Frequency (Detection mode)	0: Detected speed 1: Reference speed	N	Y	0	N	N	N	Y	N	5-59
F39	(Holding Time)	0.00 to 10.00 s	Y	Y	0.00	Y	Y	Y	Y	N	5-66
F40	Torque Limiter 1-1	-300% to 300%; 999 (Disable)	Y	Y	999	Y	Y	Y	Y	Y	5-66
F41	1-2	-300% to 300%; 999 (Disable)	Y	Y	999	Y	Y	Y	Y	Y	
F42	Drive Control Selection 1	0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with speed sensor 4: Dynamic torque vector control with speed sensor 5: Vector control without speed sensor 6: Vector control with speed sensor	N	Y	0	Y	Y	Y	Y	Y	5-73

The shaded function codes ( ) are applicable to the quick setup.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
F43	Current Limiter (Mode selection)	0: Disable (No current limiter works.) 1: Enable at constant speed (Disable during ACC/DEC) 2: Enable during ACC/constant speed operation	Y	Y	2	Y	Y	N	N	N	5-75
F44	(Level)	20% to 200% (The data is interpreted as the rated output current of the inverter for 100%.)	Y	Y	*5	Y	Y	N	N	N	
F50	Electronic Thermal Overload Protection for Braking Resistor (Discharging capability)	0 (Braking resistor built-in type), 1 to 9000 kWs, OFF (Disable)	Y	Y1 Y2	*6	Y	Y	Y	Y	Y	5-76
F51	(Allowable average loss)	0.001 to 99.99 kW	Y	Y1 Y2	0.001	Y	Y	Y	Y	Y	
F52	(Resistance)	0.01 to 999Ω	Y	Y1 Y2	0.01	Y	Y	Y	Y	Y	
F80	Switching between LD, MD and HD drive modes	0: HD (High Duty) mode 1: LD (Low Duty) mode 2: MD (Medium Duty) mode	N	Y	1	Y	Y	Y	Y	Y	5-77

*5 160% for inverters of 7.5 HP or below; 130% for those of 10 HP or above
*6 0 for inverters of 15 HP or below; OFF for those of 20 HP or above

E codes: Extension Terminal Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
		Selecting function code data assigns the corresponding function to terminals [X1] to [X7] as listed below.									5-79
E01	Terminal [X1] Function	0 (1000): Select multi-frequency (0 to 1 steps) (***SS1***)	N	Y	0	Y	Y	Y	Y	N	
E02	Terminal [X2] Function	1 (1001): Select multi-frequency (0 to 3 steps) (***SS2***)	N	Y	1	Y	Y	Y	Y	N	
E03	Terminal [X3] Function	2 (1002): Select multi-frequency (0 to 7 steps) (***SS4***)	N	Y	2	Y	Y	Y	Y	N	
E04	Terminal [X4] Function	3 (1003): Select multi-frequency (0 to 15 steps) (***SS8***)	N	Y	3	Y	Y	Y	Y	N	
E05	Terminal [X5] Function	4 (1004): Select ACC/DEC time (2 steps) (***RT1***)	N	Y	4	Y	Y	Y	Y	N	
E06	Terminal [X6] Function	5 (1005): Select ACC/DEC time (4 steps) (***RT2***)	N	Y	5	Y	Y	Y	Y	N	
E07	Terminal [X7] Function	6 (1006): Enable 3-wire operation (***HLD***)	N	Y	8	Y	Y	Y	Y	Y	
		7 (1007): Coast to a stop (***BX***)				Y	Y	Y	Y	Y	
		8 (1008): Reset alarm (***RST***)				Y	Y	Y	Y	Y	
		9 (1009): Enable external alarm trip (***THR***) (9 = Active OFF, 1009 = Active ON)				Y	Y	Y	Y	Y	
		10 (1010): Ready for jogging (***JOG***)				Y	Y	Y	Y	N	
		11 (1011): Select frequency command 2/1 (***Hz2/Hz1***)				Y	Y	Y	Y	N	
		12 (1012): Select motor 2 (***M2***)				Y	Y	Y	Y	Y	
		13: Enable DC braking (***DCBRK***)				Y	Y	Y	Y	N	
		14 (1014): Select torque limiter level 2/1 (***TL2/TL1***)				Y	Y	Y	Y	Y	
		15: Switch to commercial power (50 Hz) (***SW50***)				Y	Y	N	N	N	
		16: Switch to commercial power (60 Hz) (***SW60***)				Y	Y	N	N	N	
		17 (1017): UP (Increase output frequency) (***UP***)				Y	Y	Y	Y	N	
		18 (1018): DOWN (Decrease output frequency) (***DOWN***)				Y	Y	Y	Y	N	
		19 (1019): Enable data change with keypad (***WE-KP***)				Y	Y	Y	Y	Y	
		20 (1020): Cancel PID control (***Hz/PID***)				Y	Y	Y	Y	N	
		21 (1021): Switch normal/inverse operation (***IVS***)				Y	Y	Y	Y	N	
		22 (1022): Interlock (***IL***)				Y	Y	Y	Y	Y	
		23 (1023): Cancel torque control (***Hz/TRQ***)				N	N	N	N	Y	
		24 (1024): Enable communications link via RS-485 or fieldbus (option) (***LE***)				Y	Y	Y	Y	Y	
		25 (1025): Universal DI (***U-DI***)				Y	Y	Y	Y	Y	
		26 (1026): Enable auto search for idling motor speed at starting (***STM***)				Y	Y	Y	N	Y	
		30 (1030): Force to stop (***STOP***) (30 = Active OFF, 1030 = Active ON)				Y	Y	Y	Y	Y	
		32 (1032): Pre-excitation (***EXITE***)				N	N	Y	Y	N	
		33 (1033): Reset PID integral and differential components (***PID-RST***)				Y	Y	Y	Y	N	
		34 (1034): Hold PID integral component (***PID-HLD***)				Y	Y	Y	Y	N	
		35 (1035): Select local (keypad) operation (***LOC***)				Y	Y	Y	Y	Y	
		36 (1036): Select motor 3 (***M3***)				Y	Y	Y	Y	Y	
		37 (1037): Select motor 4 (***M4***)				Y	Y	Y	Y	Y	
		39: Protect motor from dew condensation (***DWP***)				Y	Y	Y	Y	Y	
		40: Enable integrated sequence to switch to commercial power (50 Hz) (***ISW50***)				Y	Y	N	N	N	
		41: Enable integrated sequence to switch to commercial power (60 Hz) (***ISW60***)				Y	Y	N	N	N	
		47 (1047): Servo-lock command (***LOCK***)				N	N	N	Y	N	
		48: Pulse train input (available only on terminal [X7] (E07)) (***PIN***)				Y	Y	Y	Y	Y	
		49 (1049): Pulse train sign (available on terminals except [X7] (E01 to E06)) (***SIGN***)				Y	Y	Y	Y	Y	
		70 (1070): Cancel constant peripheral speed control (***Hz/LSC***)				Y	Y	Y	Y	N	
		71 (1071): Hold the constant peripheral speed control frequency in the memory (***LSC-HLD***)				Y	Y	Y	Y	N	
		72 (1072): Count the run time of commercial power-driven motor 1 (***CRUN-M1***)				Y	Y	N	N	Y	
		73 (1073): Count the run time of commercial power-driven motor 2 (***CRUN-M2***)				Y	Y	N	N	Y	
		74 (1074): Count the run time of commercial power-driven motor 3 (***CRUN-M3***)				Y	Y	N	N	Y	
		75 (1075): Count the run time of commercial power-driven motor 4 (***CRUN-M4***)				Y	Y	N	N	Y	
		76 (1076): Select droop control (***DROOP***)				Y	Y	Y	Y	N	
		77 (1077): Cancel PG alarm (***PG-CCL***)				N	Y	N	Y	Y	
		80 (1080): Cancel customizable logic (***CLC***)				Y	Y	Y	Y	Y	
		81 (1081): Clear all customizable logic timers (***CLTC***)				Y	Y	Y	Y	Y	
		100: No function assigned (***NONE***)				Y	Y	Y	Y	Y	
		Setting the value in parentheses ( ) shown above assigns a negative logic input to a terminal.									

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	Drive control: PG V/f	Drive control: w/o PG	Drive control: w/ PG	Drive control: Torque control	Refer to page:
E10	Acceleration Time 2	0.00 to 6000 s	Y	Y	*1	Y	Y	Y	Y	N	5-45
E11	Deceleration Time 2	Note: Entering 0.00 cancels the acceleration time, requiring external soft-start and -stop.	Y	Y	*1	Y	Y	Y	Y	N	5-90
E12	Acceleration Time 3		Y	Y	*1	Y	Y	Y	Y	N	
E13	Deceleration Time 3		Y	Y	*1	Y	Y	Y	Y	N	
E14	Acceleration Time 4		Y	Y	*1	Y	Y	Y	Y	N	
E15	Deceleration Time 4		Y	Y	*1	Y	Y	Y	Y	N	
E16	Torque Limiter 2-1	-300% to 300%; 999 (Disable)	Y	Y	999	Y	Y	Y	Y	Y	5-66
E17	Torque Limiter 2-2	-300% to 300%; 999 (Disable)	Y	Y	999	Y	Y	Y	Y	Y	5-90
		Selecting function code data assigns the corresponding function to terminals [Y1] to [Y5A/C] and [30A/B/C] as listed below.									5-91
E20	Terminal [Y1] Function	0 (1000): Inverter running (***RUN***)	N	Y	0	Y	Y	Y	Y	Y	
E21	Terminal [Y2] Function	1 (1001): Frequency (speed) arrival signal (***FAR***)	N	Y	1	Y	Y	Y	Y	N	
E22	Terminal [Y3] Function	2 (1002): Frequency (speed) detected (***FDT***)	N	Y	2	Y	Y	Y	Y	Y	
E23	Terminal [Y4] Function	3 (1003): Undervoltage detected (Inverter stopped) (***LU***)	N	Y	7	Y	Y	Y	Y	Y	
E24	Terminal [Y5A/C] Function	4 (1004): Torque polarity detected (***B/D***)	N	Y	15	Y	Y	Y	Y	Y	
E27	Terminal [30A/B/C] Function	5 (1005): Inverter output limiting (***IOL***)	N	Y	99	Y	Y	Y	Y	Y	
	(Relay output)	6 (1006): Auto-restarting after momentary power failure (***IPF***)				Y	Y	Y	Y	Y	
		7 (1007): Motor overload early warning (***OL***)				Y	Y	Y	Y	Y	
		8 (1008): Keypad operation enabled (***KP***)				Y	Y	Y	Y	Y	
		10 (1010): Inverter ready to run (***RDY***)				Y	Y	Y	Y	Y	
		11: Switch motor drive source between commercial power and inverter output (For MC on commercial line) (***SW88***)				Y	Y	N	N	N	
		12: Switch motor drive source between commercial power and inverter output (For secondary side) (***SW52-2***)				Y	Y	N	N	N	
		13: Switch motor drive source between commercial power and inverter output (For primary side) (***SW52-1***)				Y	Y	N	N	N	
		15 (1015): Select ***AX*** terminal function (For MC on primary side) (***AX***)				Y	Y	Y	Y	Y	
		22 (1022): Inverter output limiting with delay (***IOL2***)				Y	Y	Y	Y	Y	
		25 (1025): Cooling fan in operation (***FAN***)				Y	Y	Y	Y	Y	
		26 (1026): Auto-resetting (***TRY***)				Y	Y	Y	Y	Y	
		27 (1027): Universal DO (***U-DO***)				Y	Y	Y	Y	Y	
		28 (1028): Heat sink overheat early warning (***OH***)				Y	Y	Y	Y	Y	
		29 (1029): Synchronization completed (***SY***)				N	Y	N	Y	N	
		30 (1030): Lifetime alarm (***LIFE***)				Y	Y	Y	Y	Y	
		31 (1031): Frequency (speed) detected 2 (***FDT2***)				Y	Y	Y	Y	Y	
		33 (1033): Reference loss detected (***REF OFF***)				Y	Y	Y	Y	Y	
		35 (1035): Inverter output on (***RUN2***)				Y	Y	Y	Y	Y	
		36 (1036): Overload prevention control (***OLP***)				Y	Y	Y	Y	N	
		37 (1037): Current detected (***ID***)				Y	Y	Y	Y	Y	
		38 (1038): Current detected 2 (***ID2***)				Y	Y	Y	Y	Y	
		39 (1039): Current detected 3 (***ID3***)				Y	Y	Y	Y	Y	
		41 (1041): Low current detected (***IDL***)				Y	Y	Y	Y	Y	
		42 (1042): PID alarm (***PID-ALM***)				Y	Y	Y	Y	N	
		43 (1043): Under PID control (***PID-CTL***)				Y	Y	Y	Y	N	
		44 (1044): Motor stopped due to slow flowrate under PID control (***PID-STP***)				Y	Y	Y	Y	N	
		45 (1045): Low output torque detected (***U-TL***)				Y	Y	Y	Y	Y	
		46 (1046): Torque detected 1 (***TD1***)				Y	Y	Y	Y	Y	
		47 (1047): Torque detected 2 (***TD2***)				Y	Y	Y	Y	Y	
		48 (1048): Motor 1 selected (***SWM1***)				Y	Y	Y	Y	Y	
		49 (1049): Motor 2 selected (***SWM2***)				Y	Y	Y	Y	Y	
		50 (1050): Motor 3 selected (***SWM3***)				Y	Y	Y	Y	Y	
		51 (1051): Motor 4 selected (***SWM4***)				Y	Y	Y	Y	Y	
		52 (1052): Running forward (***FRUN***)				Y	Y	Y	Y	Y	
		53 (1053): Running reverse (***RRUN***)				Y	Y	Y	Y	Y	
		54 (1054): In remote operation (***RMT***)				Y	Y	Y	Y	Y	
		56 (1056): Motor overheat detected by thermistor (***THM***)				Y	Y	Y	Y	Y	
		57 (1057): Brake signal (***BRKS***)				Y	Y	Y	Y	N	
		58 (1058): Frequency (speed) detected 3 (***FDT3***)				Y	Y	Y	Y	Y	
		59 (1059): Terminal [C1] wire break (***C1OFF***)				Y	Y	Y	Y	Y	

*1 6.00 s for inverters of 40 HP or below; 20.00 s for those of 50 HP or above

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
		70 (1070): Speed valid (***DNZS***)				N	Y	Y	Y	Y	5-91
		71 (1071): Speed agreement (***DSAG***)				N	Y	Y	Y	N	
		72 (1072): Frequency (speed) arrival signal 3 (***FAR3***)				Y	Y	Y	Y	N	
		76 (1076): PG error detected (***PG-ERR***)				N	Y	Y	Y	N	
		82 (1082): Positioning completion signal (***PSET***)				N	N	N	Y	N	
		84 (1084): Maintenance timer (***MNT***)				Y	Y	Y	Y	Y	
		98 (1098): Light alarm (***L-ALM***)				Y	Y	Y	Y	Y	
		99 (1099): Alarm output (for any alarm) (***ALM***)				Y	Y	Y	Y	Y	
		101 (1101): Enable circuit failure detected (***DECF***)				Y	Y	Y	Y	Y	
		102 (1102): Enable input OFF (***EN OFF***)				Y	Y	Y	Y	Y	
		105 (1105): Braking transistor broken (***DBAL***)				Y	Y	Y	Y	Y	
		111 (1111): Customizable logic output signal 1 (***CLO1***)				Y	Y	Y	Y	Y	
		112 (1112): Customizable logic output signal 2 (***CLO2***)				Y	Y	Y	Y	Y	
		113 (1113): Customizable logic output signal 3 (***CLO3***)				Y	Y	Y	Y	Y	
		114 (1114): Customizable logic output signal 4 (***CLO4***)				Y	Y	Y	Y	Y	
		115 (1115): Customizable logic output signal 5 (***CLO5***)				Y	Y	Y	Y	Y	
		Setting the value in parentheses ( ) shown above assigns a negative logic output to a terminal.									
E30	Frequency Arrival (Hysteresis width)	0.0 to 10.0 Hz	Y	Y	2.5	Y	Y	Y	Y	N	5-96
E31	Frequency Detection 1 (Level)	0.0 to 500.0 Hz	Y	Y	60.0	Y	Y	Y	Y	Y	
E32	(Hysteresis width)	0.0 to 500.0 Hz	Y	Y	1.0	Y	Y	Y	Y	Y	
E34	Overload Early Warning/Current Detection (Level)	0.00 (Disable); Current value of 1% to 200% of the inverter rated current	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	5-97
E35	(Timer)	0.01 to 600.00s	Y	Y	10.00	Y	Y	Y	Y	Y	
E36	Frequency Detection 2 (Level)	0.0 to 500.0 Hz	Y	Y	60.0	Y	Y	Y	Y	Y	5-96 5-98
E37	Current Detection 2/ Low Current Detection (Level)	0.00 (Disable); Current value of 1% to 200% of the inverter rated current	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	5-97 5-98
E38	(Timer)	0.01 to 600.00 s	Y	Y	10.00	Y	Y	Y	Y	Y	
E40	PID Display Coefficient A	-999 to 0.00 to 9990	Y	Y	100	Y	Y	Y	Y	N	5-98
E41	PID Display Coefficient B	-999 to 0.00 to 9990	Y	Y	0.00	Y	Y	Y	Y	N	
E42	LED Display Filter	0.0 to 5.0 s	Y	Y	0.5	Y	Y	Y	Y	Y	5-99
E43	LED Monitor (Item selection)	0: Speed monitor (select by E48) 3: Output current 4: Output voltage 8: Calculated torque 9: Input power 10: PID command 12: PID feedback amount 14: PID output 15: Load factor 16: Motor output 17: Analog input 23: Torque current (%) 24: Magnetic flux command (%) 25: Input watt-hour	Y	Y	0	Y	Y	Y	Y	Y	5-100
E44	(Display when stopped)	0: Specified value 1: Output value	Y	Y	0	Y	Y	Y	Y	Y	5-101
E45	LCD Monitor (Item selection)	0: Running status, rotational direction and operation guide 1: Bar charts for output frequency, current and calculated torque	Y	Y	0	Y	Y	Y	Y	Y	
E46	(Language selection)	Type: TP-G1W-J1 0: Japanese 1: English 2: German 3: French 4: Spanish 5: Italian	Y	Y	1	Y	Y	Y	Y	Y	5-102
E47	(Contrast control)	0 (Low) to 10 (High)	Y	Y	5	Y	Y	Y	Y	Y	
E48	LED Monitor (Speed monitor item)	0: Output frequency 1 (Before slip compensation) 1: Output frequency 2 (After slip compensation) 2: Reference frequency 3: Motor speed in min^{-1} 4: Load shaft speed in min^{-1} 5: Line speed in m/min 7: Display speed in %	Y	Y	0	Y	Y	Y	Y	Y	5-100 5-102

*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	PG V/f	w/o PG	w/ PG	Torque control	Refer to page:
E50	Coefficient for Speed Indication	0.01 to 200.00	Y	Y	30.00	Y	Y	Y	Y	Y	5-102
E51	Display Coefficient for Input Watt-hour Data	0.000 (Cancel/reset), 0.001 to 9999	Y	Y	0.010	Y	Y	Y	Y	Y	
E52	Keypad (Menu display mode)	0: Function code data editing mode (Menus #0, #1, and #7) 1: Function code data check mode (Menus #2 and #7) 2: Full-menu mode	Y	Y	0	Y	Y	Y	Y	Y	
E54	Frequency Detection 3 (Level)	0.0 to 500.0 Hz	Y	Y	60.0	Y	Y	Y	Y	Y	5-96 5-103
E55	Current Detection 3 (Level)	0.00 (Disable); Current value of 1% to 200% of the inverter rated current	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	5-97 5-103
E56	(Timer)	0.01 to 600.00 s	Y	Y	10.00	Y	Y	Y	Y	Y	
E61	Terminal [12] Extended Function	0: None 1: Auxiliary frequency command 1 2: Auxiliary frequency command 2 3: PID command 1 5: PID feedback amount 6: Ratio setting 7: Analog torque limit value A 8: Analog torque limit value B 10: Torque command 11: Torque current command 20: Analog input monitor	N	Y	0	Y	Y	Y	Y	Y	5-104
E62	Terminal [C1] Extended Function		N	Y	0	Y	Y	Y	Y	Y	
E63	Terminal [V2] Extended Function		N	Y	0	Y	Y	Y	Y	Y	
E64	Saving of Digital Reference Frequency	0: Automatic saving (when main power is turned OFF) 1: Saving by pressing key	Y	Y	1	Y	Y	Y	Y	Y	
E65	Reference Loss Detection (Continuous running frequency)	0: Decelerate to stop, 20% to 120%, 999: Disable	Y	Y	999	Y	Y	Y	Y	Y	5-105
E78	Torque Detection 1 (Level)	0% to 300%	Y	Y	100	Y	Y	Y	Y	Y	
E79	(Timer)	0.01 to 600.00 s	Y	Y	10.00	Y	Y	Y	Y	Y	
E80	Torque Detection 2/ Low Torque Detection (Level)	0% to 300%	Y	Y	20	Y	Y	Y	Y	Y	
E81	(Timer)	0.01 to 600.00 s	Y	Y	20.00	Y	Y	Y	Y	Y	
		Selecting function code data assigns the corresponding function to terminals [FWD] and [REV] as listed below.									5-79 5-106
E98	Terminal [FWD] Function	0 (1000): Select multi-frequency (0 to 1 steps) (***SS1***)	N	Y	98	Y	Y	Y	Y	N	
E99	Terminal [REV] Function	1 (1001): Select multi-frequency (0 to 3 steps) (***SS2***)	N	Y	99	Y	Y	Y	Y	N	
		2 (1002): Select multi-frequency (0 to 7 steps) (***SS4***)				Y	Y	Y	Y	N	
		3 (1003): Select multi-frequency (0 to 15 steps) (***SS8***)				Y	Y	Y	Y	N	
		4 (1004): Select ACC/DEC time (2 steps) (***RT1***)				Y	Y	Y	Y	N	
		5 (1005): Select ACC/DEC time (4 steps) (***RT2***)				Y	Y	Y	Y	N	
		6 (1006): Enable 3-wire operation (***HLD***)				Y	Y	Y	Y	Y	
		7 (1007): Coast to a stop (***BX***)				Y	Y	Y	Y	Y	
		8 (1008): Reset alarm (***RST***)				Y	Y	Y	Y	Y	
		9 (1009): Enable external alarm trip (***THR***) (9 = Active OFF, 1009 = Active ON)				Y	Y	Y	Y	Y	
		10 (1010): Ready for jogging (***JOG***)				Y	Y	Y	Y	N	
		11 (1011): Select frequency command 2/1 (***Hz2/Hz1***)				Y	Y	Y	Y	N	
		12 (1012): Select motor 2 (***M2***)				Y	Y	Y	Y	Y	
		13: Enable DC braking (***DCBRK***)				Y	Y	Y	Y	N	
		14 (1014): Select torque limiter level 2/1 (***TL2/TL1***)				Y	Y	Y	Y	Y	
		15: Switch to commercial power (50 Hz) (***SW50***)				Y	Y	N	N	N	
		16: Switch to commercial power (60 Hz) (***SW60***)				Y	Y	N	N	N	
		17 (1017): UP (Increase output frequency) (***UP***)				Y	Y	Y	Y	N	
		18 (1018): DOWN (Decrease output frequency) (***DOWN***)				Y	Y	Y	Y	N	
		19 (1019): Enable data change with keypad (***WE-KP***)				Y	Y	Y	Y	Y	
		20 (1020): Cancel PID control (***Hz/PID***)				Y	Y	Y	Y	N	
		21 (1021): Switch normal/inverse operation (***IVS***)				Y	Y	Y	Y	N	
		22 (1022): Interlock (***IL***)				Y	Y	Y	Y	Y	
		23 (1023): Cancel torque control (***Hz/TRQ***)				N	N	N	N	Y	
		24 (1024): Enable communications link via RS-485 or fieldbus (***LE***)				Y	Y	Y	Y	Y	
		25 (1025): Universal DI (***U-DI***)				Y	Y	Y	Y	Y	
		26 (1026): Enable auto search for idling motor speed at starting (***STM***)				Y	Y	Y	N	Y	

The shaded function codes ( ) are applicable to the quick setup.
*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
		30 (1030): Force to stop (***STOP***) ((30 = Active OFF, 1030 = Active ON)				Y	Y	Y	Y	Y	5-79 5-106
		32 (1032): Pre-excitation (***EXITE***)				N	N	Y	Y	N	
		33 (1033): Reset PID integral and differential components (***PID-RST***)				Y	Y	Y	Y	N	
		34 (1034): Hold PID integral component (***PID-HLD***)				Y	Y	Y	Y	N	
		35 (1035): Select local (keypad) operation (***LOC***)				Y	Y	Y	Y	Y	
		36 (1036): Select motor 3 (***M3***)				Y	Y	Y	Y	Y	
		37 (1037): Select motor 4 (***M4***)				Y	Y	Y	Y	Y	
		39: Protect motor from dew condensation (***DWP***)				Y	Y	Y	Y	Y	
		40: Enable integrated sequence to switch to commercial power (50 Hz) (***ISW50***)				Y	Y	N	N	N	
		41: Enable integrated sequence to switch to commercial power (60 Hz) (***ISW60***)				Y	Y	N	N	N	
		47 (1047): Servo-lock command (***LOCK***)				N	N	N	Y	N	
		49 (1049): Pulse train sign (***SIGN***)				Y	Y	Y	Y	Y	
		70 (1070): Cancel constant peripheral speed control (***Hz/LSC***)				Y	Y	Y	Y	N	
		71 (1071): Hold the constant peripheral speed control frequency in the memory (***LSC-HLD***)				Y	Y	Y	Y	N	
		72 (1072): Count the run time of commercial power-driven motor 1 (***CRUN-M1***)				Y	Y	N	N	Y	
		73 (1073): Count the run time of commercial power-driven motor 2 (***CRUN-M2***)				Y	Y	N	N	Y	
		74 (1074): Count the run time of commercial power-driven motor 3 (***CRUN-M3***)				Y	Y	N	N	Y	
		75 (1075): Count the run time of commercial power-driven motor 4 (***CRUN-M4***)				Y	Y	N	N	Y	
		76 (1076): Select droop control (***DROOP***)				Y	Y	Y	Y	N	
		77 (1077): Cancel PG alarm (***PG-CCL***)				N	Y	N	Y	Y	
		80 (1080): Cancel customizable logic (***CLC***)				Y	Y	Y	Y	Y	
		81 (1081): Clear all customizable logic timers (***CLTC***)				Y	Y	Y	Y	Y	
		98: Run forward (***FWD***)				Y	Y	Y	Y	Y	
		99: Run reverse (***REV***)				Y	Y	Y	Y	Y	
		100: No function assigned (***NONE***)				Y	Y	Y	Y	Y	
		Setting the value in parentheses ( ) shown above assigns a negative logic input to a terminal.									

C codes: Control Functions of Frequency

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	PG V/f	w/o PG	w/ PG	Torque control	Refer to page:
C01	Jump Frequency 1	0.0 to 500.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	5-107
C02	2		Y	Y	0.0	Y	Y	Y	Y	N	
C03	3		Y	Y	0.0	Y	Y	Y	Y	N	
C04	(Hysteresis width)	0.0 to 30.0 Hz	Y	Y	3.0	Y	Y	Y	Y	N	
C05	Multi-frequency 1	0.00 to 500.00 Hz	Y	Y	0.00	Y	Y	Y	Y	N	
C06	2		Y	Y	0.00	Y	Y	Y	Y	N	
C07	3		Y	Y	0.00	Y	Y	Y	Y	N	
C08	4		Y	Y	0.00	Y	Y	Y	Y	N	
C09	5		Y	Y	0.00	Y	Y	Y	Y	N	
C10	6		Y	Y	0.00	Y	Y	Y	Y	N	
C11	7		Y	Y	0.00	Y	Y	Y	Y	N	
C12	8		Y	Y	0.00	Y	Y	Y	Y	N	
C13	9		Y	Y	0.00	Y	Y	Y	Y	N	
C14	10		Y	Y	0.00	Y	Y	Y	Y	N	
C15	11		Y	Y	0.00	Y	Y	Y	Y	N	
C16	12		Y	Y	0.00	Y	Y	Y	Y	N	
C17	13		Y	Y	0.00	Y	Y	Y	Y	N	
C18	14		Y	Y	0.00	Y	Y	Y	Y	N	
C19	15		Y	Y	0.00	Y	Y	Y	Y	N	
C20	Jogging Frequency	0.00 to 500.00 Hz	Y	Y	0.00	Y	Y	Y	Y	N	5-109
C30	Frequency Command 2	0: Enable ∧ / ∨ keys on the keypad 1: Voltage input to terminal [12] (-10 to +10 VDC) 2: Current input to terminal [C1] (4 to 20 mA DC) 3: Sum of voltage and current inputs to terminals [12] and [C1] 5: Voltage input to terminal [V2] (-10 to +10 VDC) 7: Terminal command ***UP***/***DOWN*** control 8: Enable ∧ / ∨ keys on the keypad (balanceless-bumpless switching available) 11: Digital input interface card (option) 12: Pulse train input	N	Y	2	Y	Y	Y	Y	N	5-34 5-109
C31	Analog Input Adjustment for [12] (Offset)	-5.0% to 5.0%	Y*	Y	0.0	Y	Y	Y	Y	Y	5-109
C32	(Gain)	0.00% to 400.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C33	(Filter time constant)	0.00 to 5.00 s	Y	Y	0.05	Y	Y	Y	Y	Y	
C34	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C35	(Polarity)	0: Bipolar 1: Unipolar	N	Y	1	Y	Y	Y	Y	Y	
C36	Analog Input Adjustment for [C1] (Offset)	-5.0% to 5.0%	Y*	Y	0.0	Y	Y	Y	Y	Y	
C37	(Gain)	0.00% to 400.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C38	(Filter time constant)	0.00 to 5.00s	Y	Y	0.05	Y	Y	Y	Y	Y	
C39	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C41	Analog Input Adjustment for [V2] (Offset)	-5.0% to 5.0%	Y*	Y	0.0	Y	Y	Y	Y	Y	
C42	(Gain)	0.00% to 400.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C43	(Filter time constant)	0.00 to 5.00 s	Y	Y	0.05	Y	Y	Y	Y	Y	
C44	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00	Y	Y	Y	Y	Y	
C45	(Polarity)	0: Bipolar 1: Unipolar	N	Y	1	Y	Y	Y	Y	Y	
C50	Bias (Frequency command 1) (Bias base point)	0.00% to 100.00%	Y*	Y	0.00	Y	Y	Y	Y	Y	5-34 5-110
C51	Bias (PID command 1) (Bias value)	-100.00% to 100.00%	Y*	Y	0.00	Y	Y	Y	Y	Y	5-110
C52	(Bias base point)	0.00% to 100.00%	Y*	Y	0.00	Y	Y	Y	Y	Y	
C53	Selection of Normal/Inverse Operation (Frequency command 1)	0: Normal operation 1: Inverse operation	Y	Y	0	Y	Y	Y	Y	Y	5-79 5-110

Chap. 5 FUNCTION CODES

Function Code Tables
F codes
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d codes
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P codes: Motor 1 Parameters

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	Drive control PG V/f	Drive control w/o PG	Drive control w/ PG	Drive control Torque control	Refer to page:
P01	Motor 1 (No. of poles)	2 to 22 poles	N	Y1 Y2	4	Y	Y	Y	Y	Y	5-111
P02	(Rated capacity)	0.01 to 1000 kW (when P99 = 0, 2, 3 or 4) 0.01 to 1000 HP (when P99 = 1)	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
P03	(Rated current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
P04	(Auto-tuning)	0: Disable 1: Tune while the motor stops. (%R1, %X and rated slip frequency) 2: Tune while the motor is rotating under V/f control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c") 3: Tune while the motor is rotating under vector control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c." Available when the vector control is enabled.)	N	N	0	Y	Y	Y	Y	Y	5-112
P05	(Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	5-113
P06	(No-load current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
P07	(%R1)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P08	(%X)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P09	(Slip compensation gain for driving)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	5-114
P10	(Slip compensation response time)	0.01 to 10.00 s	Y	Y1 Y2	0.12	Y	Y	N	N	N	
P11	(Slip compensation gain for braking)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
P12	(Rated slip frequency)	0.00 to 15.00 Hz	N	Y1 Y2	*7	Y	Y	Y	Y	N	
P13	(Iron loss factor 1)	0.00% to 20.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P14	(Iron loss factor 2)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
P15	(Iron loss factor 3)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
P16	(Magnetic saturation factor 1)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P17	(Magnetic saturation factor 2)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P18	(Magnetic saturation factor 3)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P19	(Magnetic saturation factor 4)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P20	(Magnetic saturation factor 5)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P21	(Magnetic saturation extension factor "a")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P22	(Magnetic saturation extension factor "b")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P23	(Magnetic saturation extension factor "c")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
P53	(%X correction factor 1)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	5-115
P54	(%X correction factor 2)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
P55	(Torque current under vector control)	0.00 to 2000 A	N	Y1 Y2	*7	N	N	Y	Y	Y	
P56	(Induced voltage factor under vector control)	50% to 100%	N	Y1 Y2	85 (90) *8	N	N	Y	Y	Y	
P57	Reserved *9	—	-	-	-	-	-	-	-	-	—
P99	Motor 1 Selection	0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (HP rating motors) 2: Motor characteristics 2 (Fuji motors exclusively designed for vector control) 3: Motor characteristics 3 (Fuji standard motors, 6-series) 4: Other motors	N	Y1 Y2	1	Y	Y	Y	Y	Y	5-115

The shaded function codes ( ) are applicable to the quick setup.

*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.
*8 85% for inverters of 150 HP or less; 90% for those of 175 HP or above.
*9 Factory use. Do not access these function codes.

H codes: High Performance Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
H03	Data Initialization	0: Disable initialization 1: Initialize all function code data to the factory defaults 2: Initialize motor 1 parameters 3: Initialize motor 2 parameters 4: Initialize motor 3 parameters 5: Initialize motor 4 parameters	N	N	0	Y	Y	Y	Y	Y	5-116
H04	Auto-reset (Times)	0: Disable; 1 to 10	Y	Y	0	Y	Y	Y	Y	Y	5-117
H05	(Reset interval)	0.5 to 20.0 s	Y	Y	5.0	Y	Y	Y	Y	Y	
H06	Cooling Fan ON/OFF Control	0: Disable (Always in operation) 1: Enable (ON/OFF controllable)	Y	Y	0	Y	Y	Y	Y	Y	5-118
H07	Acceleration/Deceleration Pattern	0: Linear 1: S-curve (Weak) 2: S-curve (Arbitrary, according to H57 to H60 data) 3: Curvilinear	Y	Y	0	Y	Y	Y	Y	N	5-45 5-118
H08	Rotational Direction Limitation	0: Disable 1: Enable (Reverse rotation inhibited) 2: Enable (Forward rotation inhibited)	N	Y	0	Y	Y	Y	Y	N	5-118
H09	Starting Mode (Auto search)	0: Disable 1: Enable (At restart after momentary power failure) 2: Enable (At restart after momentary power failure and at normal start)	N	Y	0	Y	Y	N	N	N	5-119
H11	Deceleration Mode	0: Normal deceleration 1: Coast-to-stop	Y	Y	0	Y	Y	Y	Y	N	5-120
H12	Instantaneous Overcurrent Limiting (Mode selection)	0: Disable 1: Enable	Y	Y	1	Y	Y	N	N	N	5-75 5-120
H13	Restart Mode after Momentary Power Failure (Restart time)	0.1 to 20.0 s	Y	Y1 Y2	*10	Y	Y	Y	Y	N	5-51 5-120
H14	(Frequency fall rate)	0.00: Deceleration time selected by F08, 0.01 to 100.00 Hz/s, 999: Follow the current limit command	Y	Y	999	Y	Y	Y	N	N	
H15	(Continuous running level)	200 to 300 V for 230 V series 400 to 600 V for 460 V series	Y	Y2	235 470	Y	Y	N	N	N	
H16	(Allowable momentary power failure time)	0.0 to 30.0 s 999: Automatically determined by inverter	Y	Y	999	Y	Y	Y	Y	N	
H18	Torque Control (Mode selection)	0: Disable (Speed control) 2: Enable (Torque current command) 3: Enable (Torque command)	N	Y	0	N	N	Y	Y	Y	5-121
H26	Thermistor (for motor) (Mode selection)	0: Disable 1: PTC (The inverter immediately trips with OH4 displayed.) 2: PTC (The inverter issues output signal ***THM*** and continues to run.) 3: NTC (When connected)	Y	Y	0	Y	Y	Y	Y	Y	5-122
H27	(Level)	0.00 to 5.00 V	Y	Y	0.35	Y	Y	Y	Y	Y	5-123
H28	Droop Control	-60.0 to 0.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	5-124
H30	Communications Link Function (Mode selection)	Frequency command / Run command 0: F01/C30 / F02 1: RS-485 (Port 1) / F02 2: F01/C30 / RS-485 (Port 1) 3: RS-485 (Port 1) / RS-485 (Port 1) 4: RS-485 (Port 2) / F02 5: RS-485 (Port 2) / RS-485 (Port 1) 6: F01/C30 / RS-485 (Port 2) 7: RS-485 (Port 1) / RS-485 (Port 2) 8: RS-485 (Port 2) / RS-485 (Port 2)	Y	Y	0	Y	Y	Y	Y	Y	
H42	Capacitance of DC Link Bus Capacitor	Indication for replacement of DC link bus capacitor 0 to 65535	Y	N	-	Y	Y	Y	Y	Y	5-125
H43	Cumulative Run Time of Cooling Fan	Indication for replacement of cooling fan 0 to 99990 hours	Y	N	-	Y	Y	Y	Y	Y	
H44	Startup Counter for Motor 1	Indication of cumulative startup count 0 to 65535 times	Y	N	-	Y	Y	Y	Y	Y	5-126
H45	Mock Alarm	0: Disable 1: Enable (Once a mock alarm occurs, the data automatically returns to 0.)	Y	N	0	Y	Y	Y	Y	Y	5-127
H46	Starting Mode (Auto search delay time 2)	0.1 to 20.0 s	Y	Y1 Y2	*7	Y	Y	Y	N	Y	5-119 5-127
H47	Initial Capacitance of DC Link Bus Capacitor	Indication for replacement of DC link bus capacitor 0 to 65535	Y	N	-	Y	Y	Y	Y	Y	5-125 5-127
H48	Cumulative Run Time of Capacitors on Printed Circuit Boards	Indication for replacement of capacitors 0 to 99990 hours (The cumulative run time can be modified or reset.)	Y	N	-	Y	Y	Y	Y	Y	

*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B
*10 The factory default differs depending upon the inverter's capacity. See Table A.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
H49	Starting Mode (Auto search delay time 1)	0.0 to 10.0 s	Y	Y	0.0	Y	Y	Y	Y	Y	5-119 5-127
H50	Non-linear V/f Pattern 1 (Frequency)	0.0: Cancel, 0.1 to 500.0 Hz	N	Y	0.0	Y	Y	N	N	N	5-43
H51	(Voltage)	0 to 240: Output an AVR-controlled voltage (for 230 V series) 0 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	0	Y	Y	N	N	N	5-127
H52	Non-linear V/f Pattern 2 (Frequency)	0.0: Cancel, 0.1 to 500.0 Hz	N	Y	0.0	Y	Y	N	N	N	
H53	(Voltage)	0 to 240: Output an AVR-controlled voltage (for 230 V series) 0 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	0	Y	Y	N	N	N	
H54	Acceleration Time (Jogging)	0.00 to 6000 s	Y	Y	*1	Y	Y	Y	Y	N	5-45
H55	Deceleration Time (Jogging)	0.00 to 6000 s	Y	Y	*1	Y	Y	Y	Y	N	5-127
H56	Deceleration Time for Forced Stop	0.00 to 6000 s	Y	Y	*1	Y	Y	Y	Y	N	
H57	1st S-curve acceleration range (Leading edge)	0% to 100%	Y	Y	10	Y	Y	Y	Y	N	
H58	2nd S-curve acceleration range (Trailing edge)	0% to 100%	Y	Y	10	Y	Y	Y	Y	N	
H59	1st S-curve deceleration range (Leading edge)	0% to 100%	Y	Y	10	Y	Y	Y	Y	N	
H60	2nd S-curve deceleration range (Trailing edge)	0% to 100%	Y	Y	10	Y	Y	Y	Y	N	
H61	UP/DOWN Control (Initial frequency setting)	0: 0.00 Hz 1: Last ***UP***/***DOWN*** command value on releasing the run command	N	Y	1	Y	Y	Y	Y	N	5-34 5-127
H63	Low Limiter (Mode selection)	0: Limit by F16 (Frequency limiter: Low) and continue to run 1: If the output frequency lowers below the one limited by F16 (Frequency limiter: Low), decelerate to stop the motor.	Y	Y	0	Y	Y	Y	Y	N	5-57 5-127
H64	(Lower limiting frequency)	0.0: Depends on F16 (Frequency limiter, Low) 0.1 to 60.0 Hz	Y	Y	1.6	Y	Y	N	N	N	5-127
H65	Non-linear V/f Pattern 3 (Frequency)	0.0: Cancel, 0.1 to 500.0 Hz	N	Y	0.0	Y	Y	N	N	N	5-43
H66	(Voltage)	0 to 240: Output an AVR-controlled voltage (for 230 V series) 0 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	0	Y	Y	N	N	N	5-127
H67	Auto Energy Saving Operation (Mode selection)	0: Enable during running at constant speed 1: Enable in all modes	Y	Y	0	Y	Y	N	Y	N	5-64 5-127
H68	Slip Compensation 1 (Operating conditions)	0: Enable during ACC/DEC and at base frequency or above 1: Disable during ACC/DEC and enable at base frequency or above 2: Enable during ACC/DEC and disable at base frequency or above 3: Disable during ACC/DEC and at base frequency or above	N	Y	0	Y	Y	N	N	N	5-73 5-127
H69	Automatic Deceleration (Mode selection)	0: Disable 2: Torque limit control with Force-to-stop if actual deceleration time exceeds three times the specified one 3: DC link bus voltage control with Force-to-stop if actual deceleration time exceeds three times the specified one 4: Torque limit control with Force-to-stop disabled 5: DC link bus voltage control with Force-to-stop disabled	Y	Y	0	Y	Y	Y	Y	N	5-128
H70	Overload Prevention Control	0.00: Follow the deceleration time selected 0.01 to 100.0 Hz/s 999: Cancel	Y	Y	999	Y	Y	Y	Y	N	5-129
H71	Deceleration Characteristics	0: Disable 1: Enable	Y	Y	0	Y	Y	N	N	N	
H72	Main Power Down Detection (Mode selection)	0: Disable 1: Enable	Y	Y	1	Y	Y	Y	Y	Y	

*1 6.00 s for inverters of 40 HP or below; 20.00 s for those of 50 HP or above

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	Drive control PG V/f	Drive control w/o PG	Drive control w/ PG	Drive control Torque control	Refer to page:
H73	Torque Limiter (Operating conditions)	0: Enable during ACC/DEC and running at constant speed 1: Disable during ACC/DEC and enable during running at constant speed 2: Enable during ACC/DEC and disable during running at constant speed	N	Y	0	Y	Y	Y	Y	Y	5-66 5-129
H74	(Control target)	0: Motor-generating torque limit 1: Torque current limit 2: Output power limit	N	Y	1	N	N	Y	Y	Y	
H75	(Target quadrants)	0: Drive/brake 1: Same for all four quadrants 2: Upper/lower limits	N	Y	0	N	N	Y	Y	Y	
H76	(Frequency increment limit for braking)	0.0 to 500.0 Hz	Y	Y	5.0	Y	Y	N	N	N	5-128 5-129
H77	Service Life of DC Link Bus Capacitor (Remaining time)	0 to 87600 hours	Y	N	-	Y	Y	Y	Y	Y	5-130
H78	Maintenance Interval (M1)	0: Disable; 1 to 99990 hours	Y	N	87600	Y	Y	Y	Y	Y	5-126
H79	Preset Startup Count for Maintenance (M1)	0: Disable; 1 to 65535 times	Y	N	0	Y	Y	Y	Y	Y	5-130
H80	Output Current Fluctuation Damping Gain for Motor 1	0.00 to 1.00	Y	Y	0.20	Y	Y	N	N	Y	5-130
H81	Light Alarm Selection 1	0000 to FFFF (hex.)	Y	Y	0000	Y	Y	Y	Y	Y	
H82	Light Alarm Selection 2	0000 to FFFF (hex.)	Y	Y	0000	Y	Y	Y	Y	Y	
H84	Pre-excitation (Initial level)	100% to 400%	Y	Y	100	N	N	Y	Y	Y	5-133
H85	(Time)	0.00: Disable; 0.01 to 30.00 s	Y	Y	0.00	N	N	Y	Y	Y	
H86	Reserved *9	—	-	-	-	-	-	-	-	-	5-134
H87	Reserved *9	—	-	-	-	-	-	-	-	-	
H88	Reserved *9	—	-	-	-	-	-	-	-	-	
H89	Reserved *9	—	-	-	-	-	-	-	-	-	
H90	Reserved *9	—	-	-	-	-	-	-	-	-	
H91	PID Feedback Wire Break Detection	0.0: Disable alarm detection 0.1 to 60.0 s	Y	Y	0.0	Y	Y	Y	Y	N	5-134
H92	Continuity of Running (P)	0.000 to 10.000 times; 999	Y	Y1Y2	999	Y	Y	N	N	N	5-51
H93	(I)	0.010 to 10.000 s; 999	Y	Y1Y2	999	Y	Y	N	N	N	5-134
H94	Cumulative Motor Run Time 1	0 to 99990 hours (The cumulative run time can be modified or reset.)	N	N	-	Y	Y	Y	Y	Y	5-126 5-134
H95	DC Braking (Braking response mode)	0: Slow 1: Quick	Y	Y	1	Y	Y	N	N	N	5-58 5-134
H96	STOP Key Priority/ Start Check Function	Data / STOP key priority / Start check function 0: Disable / Disable 1: Enable / Disable 2: Disable / Enable 3: Enable / Enable	Y	Y	3	Y	Y	Y	Y	Y	5-134
H97	Clear Alarm Data	0: Disable 1: Enable (Setting "1" clears alarm data and then returns to "0.")	Y	N	0	Y	Y	Y	Y	Y	
H98	Protection/Maintenance Function (Mode selection)	0 to 255: Display data in decimal format Bit 0: Lower the carrier frequency automatically (0: Disabled; 1: Enabled) Bit 1: Detect input phase loss (0: Disabled; 1: Enabled) Bit 2: Detect output phase loss (0: Disabled; 1: Enabled) Bit 3: Select life judgment threshold of DC link bus capacitor (0: Factory default level; 1: User setup level) Bit 4: Judge the life of DC link bus capacitor (0: Disabled; 1: Enabled) Bit 5: Detect DC fan lock (0: Enabled; 1: Disabled) Bit 6: Detect braking transistor error (for 40 HP or below) (0: Disabled; 1: Enabled) Bit 7: Switch IP20/IP40 enclosure (0: IP20; 1: IP40)	Y	Y	83	Y	Y	Y	Y	Y	5-135

*9 Factory use. Do not access these function codes.

A codes: Motor 2 Parameters

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	Drive control: PG V/f	Drive control: w/o PG	Drive control: w/ PG	Drive control: Torque control	Refer to page:
A01	Maximum Frequency 2	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	—
A02	Base Frequency 2	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	
A03	Rated Voltage at Base Frequency 2	0: Output a voltage in proportion to input voltage 80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	 230 460	Y	Y	Y	Y	Y	
A04	Maximum Output Voltage 2	80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	230 460	Y	Y	N	N	Y	
A05	Torque Boost 2	0.0% to 20.0% (percentage with respect to "A03: Rated Voltage at Base Frequency 2")	Y	Y	0.0	Y	Y	N	N	N	
A06	Electronic Thermal Overload Protection for Motor 2 (Select motor characteristics)	1: For a general-purpose motor with shaft-driven cooling fan 2: For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan	Y	Y	1	Y	Y	Y	Y	Y	
A07	(Overload detection level)	0.00: Disable 1% to 135% of the rated current (allowable continuous drive current) of the motor	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	
A08	(Thermal time constant)	0.5 to 75.0 min	Y	Y	*3	Y	Y	Y	Y	Y	
A09	DC Braking 2 (Braking starting frequency)	0.0 to 60.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	
A10	(Braking level)	0% to 80% (LD/MD mode)*4, 0% to 100% (HD mode)	Y	Y	0	Y	Y	Y	Y	N	
A11	(Braking time)	0.00: Disable; 0.01 to 30.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
A12	Starting Frequency 2	0.0 to 60.0 Hz	Y	Y	0.5	Y	Y	Y	Y	N	
A13	Load Selection/ Auto Torque Boost Auto Energy Saving Operation 2	0: Variable torque load 1: Constant torque load 2: Auto-torque boost 3: Auto-energy saving operation (Variable torque load during ACC/DEC) 4: Auto-energy saving operation (Constant torque load during ACC/DEC) 5: Auto-energy saving operation (Auto-torque boost during ACC/DEC)	N	Y	1	Y	Y	N	Y	N	
A14	Drive Control Selection 2	0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with speed sensor 4: Dynamic torque vector control with speed sensor 5: Vector control without speed sensor 6: Vector control with speed sensor	N	Y	0	Y	Y	Y	Y	Y	
A15	Motor 2 (No. of poles)	2 to 22 poles	N	Y1 Y2	4	Y	Y	Y	Y	Y	
A16	(Rated capacity)	0.01 to 1000 kW (when A39 = 0, 2. 3 or 4) 0.01 to 1000 HP (when A39 = 1)	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
A17	(Rated current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	

*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).
*3 5.0 min for inverters of 40 HP or below; 10.0 min for those of 50 HP or above
*4 0% to 100% for inverters of 7.5 HP or below
*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	Drive control PG V/f	Drive control w/o PG	Drive control w/ PG	Drive control Torque control	Refer to page:
A18	Motor 2 (Auto-tuning)	0: Disable 1: Tune while the motor stops. (%R1, %X and rated slip frequency) 2: Tune while the motor is rotating under V/f control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c") 3: Tune while the motor is rotating under vector control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c." Available when the vector control is enabled.	N	N	0	Y	Y	Y	Y	Y	—
A19	(Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	
A20	(No-load current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
A21	(%R1)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A22	(%X)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A23	(Slip compensation gain for driving)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
A24	(Slip compensation response time)	0.01 to 10.00s	Y	Y1 Y2	0.12	Y	Y	N	N	N	
A25	(Slip compensation gain for braking)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
A26	(Rated slip frequency)	0.00 to 15.00 Hz	N	Y1 Y2	*7	Y	Y	Y	Y	N	
A27	(Iron loss factor 1)	0.00% to 20.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A28	(Iron loss factor 2)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
A29	(Iron loss factor 3)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
A30	(Magnetic saturation factor 1)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A31	(Magnetic saturation factor 2)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A32	(Magnetic saturation factor 3)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A33	(Magnetic saturation factor 4)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A34	(Magnetic saturation factor 5)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A35	(Magnetic saturation extension factor "a")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A36	(Magnetic saturation extension factor "b")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A37	(Magnetic saturation extension factor "c")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
A39	Motor 2 Selection	0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (HP rating motors) 2: Motor characteristics 2 (Fuji motors exclusively designed for vector control) 3: Motor characteristics 3 (Fuji standard motors, 6-series) 4: Other motors	N	Y1 Y2	1	Y	Y	Y	Y	Y	
A40	Slip Compensation 2 (Operating conditions)	0: Enable during ACC/DEC and at base frequency or above 1: Disable during ACC/DEC and enable at base frequency or above 2: Enable during ACC/DEC and disable at base frequency or above 3: Disable during ACC/DEC and at base frequency or above	N	Y	0	Y	Y	N	N	N	
A41	Output Current Fluctuation Damping Gain for Motor 2	0.00 to 1.00	Y	Y	0.20	Y	Y	N	N	N	
A42	Motor/Parameter Switching 2 (Mode selection)	0: Motor (Switch to the 2nd motor) 1: Parameter (Switch to particular A codes)	N	Y	0	Y	Y	Y	Y	Y	5-137
A43	Speed Control 2 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.020	N	Y	Y	Y	N	—
A44	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.005	N	Y	Y	Y	N	
A45	P (Gain)	0.1 to 200.0 times	Y*	Y	10.0	N	Y	Y	Y	N	
A46	I (Integral time)	0.001 to 9.999 s	Y*	Y	0.100	N	Y	Y	Y	N	
A48	(Output filter)	0.000 to 0.100 s	Y	Y	0.002	N	Y	Y	Y	N	
A49	(Notch filter resonance frequency)	1 to 200 Hz	Y	Y	200	N	N	N	Y	N	
A50	(Notch filter attenuation level)	0 to 20 dB	Y	Y	0	N	N	N	Y	N	
A51	Cumulative Motor Run Time 2	0 to 99990 hours (The cumulative run time can be modified or reset.)	N	N	-	Y	Y	Y	Y	Y	
A52	Startup Counter for Motor 2	Indication of cumulative startup count 0 to 65535 times	Y	N	-	Y	Y	Y	Y	Y	
A53	Motor 2 (%X correction factor 1)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
A54	(%X correction factor 2)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
A55	(Torque current under vector control)	0.00 to 2000 A	N	Y1 Y2	*7	N	N	Y	Y	Y	
A56	(Induced voltage factor under vector control)	50 to 100	N	Y1 Y2	85 (90) *8	N	N	Y	Y	Y	
A57	Reserved *9	—	-	-	-	-	-	-	-	-	

*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.
*8 85% for inverters of 150 HP or less; 90% for those of 175 HP or above.
*9 Factory use. Do not access these function codes.

b codes: Motor 3 Parameters

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
b01	Maximum Frequency 3	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	—
b02	Base Frequency 3	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	
b03	Rated Voltage at Base Frequency 3	0: Output a voltage in proportion to input voltage 80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	 230 460	Y	Y	Y	Y	Y	
b04	Maximum Output Voltage 3	80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	230 460	Y	Y	N	N	Y	
b05	Torque Boost 3	0.0% to 20.0% (percentage with respect to "b03: Rated Voltage at Base Frequency 3")	Y	Y	0.0	Y	Y	N	N	N	
b06	Electronic Thermal Overload Protection for Motor 3 (Select motor characteristics)	1: For a general-purpose motor with shaft-driven cooling fan 2: For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan	Y	Y	1	Y	Y	Y	Y	Y	
b07	(Overload detection level)	0.00: Disable 1% to 135% of the rated current (allowable continuous drive current) of the motor	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	
b08	(Thermal time constant)	0.5 to 75.0 min	Y	Y	*3	Y	Y	Y	Y	Y	
b09	DC Braking 3 (Braking starting frequency)	0.0 to 60.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	
b10	(Braking level)	0% to 80% (LD/MD mode)*4, 0% to 100% (HD mode)	Y	Y	0	Y	Y	Y	Y	N	
b11	(Braking time)	0.00: Disable; 0.01 to 30.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
b12	Starting Frequency 3	0.0 to 60.0 Hz	Y	Y	0.5	Y	Y	Y	Y	N	
b13	Load Selection/ Auto Torque Boost/ Auto Energy Saving Operation 3	0: Variable torque load 1: Constant torque load 2: Auto-torque boost 3: Auto-energy saving operation (Variable torque load during ACC/DEC) 4: Auto-energy saving operation (Constant torque load during ACC/DEC) 5: Auto-energy saving operation (Auto-torque boost during ACC/DEC)	N	Y	1	Y	Y	N	Y	N	
b14	Drive Control Selection 3	0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with speed sensor 4: Dynamic torque vector control with speed sensor 5: Vector control without speed sensor 6: Vector control with speed sensor	N	Y	0	Y	Y	Y	Y	Y	
b15	Motor 3 (No. of poles)	2 to 22 poles	N	Y1 Y2	4	Y	Y	Y	Y	Y	
b16	(Rated capacity)	0.01 to 1000 kW (when b39 = 0, 2, 3 or 4) 0.01 to 1000 HP (when b39 = 1)	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
b17	(Rated current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
b18	(Auto-tuning)	0: Disable 1: Tune while the motor stops. (%R1, %X and rated slip frequency) 2: Tune while the motor is rotating under V/f control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c") 3: Tune while the motor is rotating under vector control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c." Available when the vector control is enabled.)	N	N	0	Y	Y	Y	Y	Y	
b19	(Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	
b20	(No-load current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
b21	(%R1)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b22	(%X)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b23	(Slip compensation gain for driving)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
b24	(Slip compensation response time)	0.01 to 10.00 s	Y	Y1 Y2	0.12	Y	Y	N	N	N	
b25	(Slip compensation gain for braking)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
b26	(Rated slip frequency)	0.00 to 15.00 Hz	N	Y1 Y2	*7	Y	Y	Y	Y	N	
b27	(Iron loss factor 1)	0.00% to 20.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	

*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).
*3 5.0 min for inverters of 40 HP or below; 10.0 min for those of 50 HP or above
*4 0% to 100% for inverters of 7.5 HP or below
*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
b28	(Iron loss factor 2)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	—
b29	(Iron loss factor 3)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
b30	(Magnetic saturation factor 1)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b31	(Magnetic saturation factor 2)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b32	(Magnetic saturation factor 3)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b33	(Magnetic saturation factor 4)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b34	(Magnetic saturation factor 5)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b35	Motor 3 (Magnetic saturation extension factor "a")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b36	(Magnetic saturation extension factor "b")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b37	(Magnetic saturation extension factor "c")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
b39	Motor 3 Selection	0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (HP rating motors) 2: Motor characteristics 2 (Fuji motors exclusively designed for vector control) 3: Motor characteristics 3 (Fuji standard motors, 6-series) 4: Other motors	N	Y1 Y2	1	Y	Y	Y	Y	Y	
b40	Slip Compensation 3 (Operating conditions)	0: Enable during ACC/DEC and at base frequency or above 1: Disable during ACC/DEC and enable at base frequency or above 2: Enable during ACC/DEC and disable at base frequency or above 3: Disable during ACC/DEC and at base frequency or above	N	Y	0	Y	Y	N	N	N	
b41	Output Current Fluctuation Damping Gain for Motor 3	0.00 to 1.00	Y	Y	0.20	Y	Y	N	N	N	
b42	Motor/Parameter Switching 3 (Mode selection)	0: Motor (Switch to the 3rd motor) 1: Parameter (Switch to particular b codes)	N	Y	0	Y	Y	Y	Y	Y	5-137
b43	Speed Control 3 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.020	N	Y	Y	Y	N	—
b44	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.005	N	Y	Y	Y	N	
b45	P (Gain)	0.1 to 200.0 times	Y*	Y	10.0	N	Y	Y	Y	N	
b46	I (Integral time)	0.001 to 9.999 s	Y*	Y	0.100	N	Y	Y	Y	N	
b48	(Output filter)	0.000 to 0.100 s	Y	Y	0.002	N	Y	Y	Y	N	
b49	(Notch filter resonance frequency)	1 to 200 Hz	Y	Y	200	N	N	N	Y	N	
b50	(Notch filter attenuation level)	0 to 20 dB	Y	Y	0	N	N	N	Y	N	
b51	Cumulative Motor Run Time 3	0 to 99990 hours (The cumulative run time can be modified or reset.)	N	N	-	Y	Y	Y	Y	Y	
b52	Startup Counter for Motor 3	Indication of cumulative startup count 0 to 65535 times	Y	N	-	Y	Y	Y	Y	Y	
b53	Motor 3 (%X correction factor 1)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
b54	(%X correction factor 2)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
b55	(Torque current under vector control)	0.00 to 2000 A	N	Y1 Y2	*7	N	N	Y	Y	Y	
b56	(Induced voltage factor under vector control)	50 to 100	N	Y1 Y2	85 (90) *8	N	N	Y	Y	Y	
b57	Reserved *9	—	-	-	-	-	-	-	-	-	

*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.
*8 85% for inverters of 150 HP or less; 90% for those of 175 HP or above.
*9 Factory use. Do not access these function codes.

r codes: Motor 4 Parameters

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
r01	Maximum Frequency 4	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	—
r02	Base Frequency 4	25.0 to 500.0 Hz	N	Y	60.0	Y	Y	Y	Y	Y	
r03	Rated Voltage at Base Frequency 4	0: Output a voltage in proportion to input voltage 80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	 230 460	Y	Y	Y	Y	Y	
r04	Maximum Output Voltage 4	80 to 240: Output an AVR-controlled voltage (for 230 V series) 160 to 500: Output an AVR-controlled voltage (for 460 V series)	N	Y2	230 460	Y	Y	N	N	Y	
r05	Torque Boost 4	0.0% to 20.0% (percentage with respect to "r03: Rated Voltage at Base Frequency 4")	Y	Y	0.0	Y	Y	N	N	N	
r06	Electronic Thermal Overload Protection for Motor 4 (Select motor characteristics)	1: For a general-purpose motor with shaft-driven cooling fan 2: For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan	Y	Y	1	Y	Y	Y	Y	Y	
r07	(Overload detection level)	0.00: Disable 1% to 135% of the rated current (allowable continuous drive current) of the motor	Y	Y1 Y2	*2	Y	Y	Y	Y	Y	
r08	(Thermal time constant)	0.5 to 75.0 min	Y	Y	*3	Y	Y	Y	Y	Y	
r09	DC Braking 4 (Braking starting frequency)	0.0 to 60.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	
r10	(Braking level)	0% to 80% (LD/MD mode)*4, 0% to 100% (HD mode)	Y	Y	0	Y	Y	Y	Y	N	
r11	(Braking time)	0.00: Disable; 0.01 to 30.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
r12	Starting Frequency 4	0.0 to 60.0 Hz	Y	Y	0.5	Y	Y	Y	Y	N	
r13	Load Selection/ Auto Torque Boost/ Auto Energy Saving Operation 4	0: Variable torque load 1: Constant torque load 2: Auto-torque boost 3: Auto-energy saving operation (Variable torque load during ACC/DEC) 4: Auto-energy saving operation (Constant torque load during ACC/DEC) 5: Auto-energy saving operation (Auto-torque boost during ACC/DEC)	N	Y	1	Y	Y	N	Y	N	
r14	Drive Control Selection 4	0: V/f control with slip compensation inactive 1: Dynamic torque vector control 2: V/f control with slip compensation active 3: V/f control with speed sensor 4: Dynamic torque vector control with speed sensor 5: Vector control without speed sensor 6: Vector control with speed sensor	N	Y	0	Y	Y	Y	Y	Y	
r15	Motor 4 (No. of poles)	2 to 22 poles	N	Y1 Y2	4	Y	Y	Y	Y	Y	
r16	(Rated capacity)	0.01 to 1000 kW (when r39 = 0, 2, 3 or 4) 0.01 to 1000 HP (when r39 = 1)	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
r17	(Rated current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
r18	(Auto-tuning)	0: Disable 1: Tune while the motor stops. (%R1, %X and rated slip frequency) 2: Tune while the motor is rotating under V/f control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c") 3: Tune while the motor is rotating under vector control (%R1, %X, rated slip frequency, no-load current, magnetic saturation factors 1 to 5, and magnetic saturation extension factors "a" to "c." Available when the vector control is enabled.)	N	N	0	Y	Y	Y	Y	Y	
r19	(Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	
r20	(No-load current)	0.00 to 2000 A	N	Y1 Y2	*7	Y	Y	Y	Y	Y	
r21	(%R1)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r22	(%X)	0.00% to 50.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r23	(Slip compensation gain for driving)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
r24	(Slip compensation response time)	0.01 to 10.00 s	Y	Y1 Y2	0.12	Y	Y	N	N	N	
r25	(Slip compensation gain for braking)	0.0% to 200.0%	Y*	Y	100.0	Y	Y	Y	Y	N	
r26	(Rated slip frequency)	0.00 to 15.00 Hz	N	Y1 Y2	*7	Y	Y	Y	Y	N	
r27	(Iron loss factor 1)	0.00% to 20.00%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	

*2 The motor rated current is automatically set. See Table B (P03/A17/b17/r17).
*3 5.0 min for inverters of 40 HP or below; 10.0 min for those of 50 HP or above
*4 0% to 100% for inverters of 7.5 HP or below
*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	PG V/f	w/o PG	w/ PG	Torque control	Refer to page:
r28	(Iron loss factor 2)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	—
r29	(Iron loss factor 3)	0.00% to 20.00%	Y	Y1 Y2	0.00	Y	Y	Y	Y	Y	
r30	(Magnetic saturation factor 1)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r31	(Magnetic saturation factor 2)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r32	(Magnetic saturation factor 3)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r33	(Magnetic saturation factor 4)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r34	(Magnetic saturation factor 5)	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r35	(Magnetic saturation extension factor "a")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r36	(Magnetic saturation extension factor "b")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r37	(Magnetic saturation extension factor "c")	0.0% to 300.0%	Y	Y1 Y2	*7	Y	Y	Y	Y	Y	
r39	Motor 4 Selection	0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (HP rating motors) 2: Motor characteristics 2 (Fuji motors exclusively designed for vector control) 3: Motor characteristics 3 (Fuji standard motors, 6-series) 4: Other motors	N	Y1 Y2	1	Y	Y	Y	Y	Y	
r40	Slip Compensation 4 (Operating conditions)	0: Enable during ACC/DEC and at base frequency or above 1: Disable during ACC/DEC and enable at base frequency or above 2: Enable during ACC/DEC and disable at base frequency or above 3: Disable during ACC/DEC and at base frequency or above	N	Y	0	Y	Y	N	N	N	
r41	Output Current Fluctuation Damping Gain for Motor 4	0.00 to 1.00	Y	Y	0.20	Y	Y	N	N	N	
r42	Motor/Parameter Switching 4 (Mode selection)	0: Motor (Switch to the 4th motor) 1: Parameter (Switch to particular r codes)	N	Y	0	Y	Y	Y	Y	Y	5-137
r43	Speed Control 4 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.020	N	Y	Y	Y	N	—
r44	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.005	N	Y	Y	Y	N	
r45	P (Gain)	0.1 to 200.0 times	Y*	Y	10.0	N	Y	Y	Y	N	
r46	I (Integral time)	0.001 to 9.999 s	Y*	Y	0.100	N	Y	Y	Y	N	
r48	(Output filter)	0.000 to 0.100 s	Y	Y	0.002	N	Y	Y	Y	N	
r49	(Notch filter resonance frequency)	1 to 200 Hz	Y	Y	200	N	N	N	Y	N	
r50	(Notch filter attenuation level)	0 to 20 dB	Y	Y	0	N	N	N	Y	N	
r51	Cumulative Motor Run Time 4	0 to 99990 hours (The cumulative run time can be modified or reset.)	N	N	-	Y	Y	Y	Y	Y	
r52	Startup Counter for Motor 4	Indication of cumulative startup count 0 to 65535 times	Y	N	-	Y	Y	Y	Y	Y	
r53	Motor 4 (%X correction factor 1)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
r54	(%X correction factor 2)	0% to 300%	Y	Y1 Y2	100	Y	Y	Y	Y	Y	
r55	(Torque current under vector control)	0.00 to 2000 A	N	Y1 Y2	*7	N	N	Y	Y	Y	
r56	(Induced voltage factor under vector control)	50 to 100	N	Y1 Y2	85 (90) *8	N	N	Y	Y	Y	
r57	Reserved *9	—	-	-	-	-	-	-	-	-	

*7 The motor parameters are automatically set, depending upon the inverter's capacity. See Table B.
*8 85% for inverters of 150 HP or less; 90% for those of 175 HP or above.
*9 Factory use. Do not access these function codes.

J codes: Application Functions 1

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control V/f	Drive control PG V/f	Drive control w/o PG	Drive control w/ PG	Drive control Torque control	Refer to page:
J01	PID Control (Mode selection)	0: Disable 1: Enable (Process control, normal operation) 2: Enable (Process control, inverse operation) 3: Enable (Dancer control)	N	Y	0	Y	Y	Y	Y	N	5-140
J02	(Remote command SV)	0: ∧ / ∨ keys on keypad 1: PID command 1 (Analog input terminals [12], [C1], and [V2]) 3: UP/DOWN 4: Command via communications link	N	Y	0	Y	Y	Y	Y	N	5-141
J03	P (Gain)	0.000 to 30.000 times	Y	Y	0.100	Y	Y	Y	Y	N	5-146
J04	I (Integral time)	0.0 to 3600.0 s	Y	Y	0.0	Y	Y	Y	Y	N	
J05	D (Differential time)	0.00 to 600.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
J06	(Feedback filter)	0.0 to 900.0 s	Y	Y	0.5	Y	Y	Y	Y	N	
J08	(Pressurization starting frequency)	0.0 to 500.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	5-149
J09	(Pressurizing time)	0 to 60 s	Y	Y	0	Y	Y	Y	Y	N	
J10	(Anti reset windup)	0% to 200%	Y	Y	200	Y	Y	Y	Y	N	5-150
J11	(Select alarm output)	0: Absolute-value alarm 1: Absolute-value alarm (with Hold) 2: Absolute-value alarm (with Latch) 3: Absolute-value alarm (with Hold and Latch) 4: Deviation alarm 5: Deviation alarm (with Hold) 6: Deviation alarm (with Latch) 7: Deviation alarm (with Hold and Latch)	Y	Y	0	Y	Y	Y	Y	N	5-151
J12	(Upper level alarm (AH))	-100% to 100%	Y	Y	100	Y	Y	Y	Y	N	
J13	(Lower level alarm (AL))	-100% to 100%	Y	Y	0	Y	Y	Y	Y	N	
J15	(Stop frequency for slow flowrate)	0.0: Disable; 1.0 to 500.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	5-149
J16	(Slow flowrate level stop latency)	0 to 60 s	Y	Y	30	Y	Y	Y	Y	N	5-152
J17	(Starting frequency)	0.0 to 500.0 Hz	Y	Y	0.0	Y	Y	Y	Y	N	
J18	(Upper limit of PID process output)	-150% to 150%; 999: Depends on setting of F15	Y	Y	999	Y	Y	Y	Y	N	5-152
J19	(Lower limit of PID process output)	-150% to 150%; 999: Depends on setting of F16	Y	Y	999	Y	Y	Y	Y	N	
J21	Dew Condensation Prevention (Duty)	1% to 50%	Y	Y	1	Y	Y	Y	Y	Y	
J22	Commercial Power Switching Sequence	0: Keep inverter operation (Stop due to alarm) 1: Automatically switch to commercial-power operation	N	Y	0	Y	Y	N	N	Y	5-79 5-153
J56	PID Control (Speed command filter)	0.00 to 5.00 s	Y	Y	0.10	Y	Y	Y	Y	N	5-153
J57	(Dancer reference position)	-100% to 0% to 100%	Y	Y	0	Y	Y	Y	Y	N	
J58	(Detection width of dancer position deviation)	0: Disable switching PID constant 1% to 100% (Manually set value)	Y	Y	0	Y	Y	Y	Y	N	
J59	P (Gain) 2	0.000 to 30.000 times	Y	Y	0.100	Y	Y	Y	Y	N	
J60	I (Integral time) 2	0.0 to 3600.0 s	Y	Y	0.0	Y	Y	Y	Y	N	
J61	D (Differential time) 2	0.00 to 600.00 s	Y	Y	0.00	Y	Y	Y	Y	N	
J62	(PID control block selection)	0 to 3 bit 0: PID output polarity 0: Plus (add), 1: Minus (subtract) bit 1: Select compensation factor for PID output 0 = Ratio (relative to the main setting) 1 = Speed command (relative to maximum frequency)	N	Y	0	Y	Y	Y	Y	N	
J68	Brake Signal (Brake-OFF current)	0% to 300%	Y	Y	100	Y	Y	Y	Y	N	5-154
J69	(Brake-OFF frequency/speed)	0.0 to 25.0 Hz	Y	Y	1.0	Y	Y	N	N	N	
J70	(Brake-OFF timer)	0.0 to 5.0 s	Y	Y	1.0	Y	Y	Y	Y	N	
J71	(Brake-ON frequency/speed)	0.0 to 25.0 Hz	Y	Y	1.0	Y	Y	N	N	N	
J72	(Brake-ON timer)	0.0 to 5.0 s	Y	Y	1.0	Y	Y	Y	Y	N	
J95	(Brake-OFF torque)	0% to 300%	Y	Y	100	N	N	Y	Y	N	
J96	(Speed condition selection (Braking conditions))	0 to 31	N	Y	0						
		Bit 0: Criterion speed for brake-ON (0: Detected speed, 1: Reference speed)				N	N	Y	Y	N	
		Bit 1: Reserved.				N	N	N	N	N	
		Bit 2: Response for brake-OFF current (0: Slow response, 1: Quick response)				Y	Y	Y	Y	N	
		Bit 3: Criterion frequency for brake-ON (0: Stop frequency (F25), 1: Brake-ON frequency (J71))				N	N	Y	Y	N	
		Bit 4: Output condition of brake signal (0: Independent of a run command ON/OFF 1: Only when a run command is OFF)				N	N	Y	Y	N	
J97	Servo-lock (Gain)	0.00 to 10.00 times	Y*	Y	0.10	N	N	N	Y	N	5-157
J98	(Completion timer)	0.000 to 1.000 s	Y	Y	0.100	N	N	N	Y	N	
J99	(Completion range)	0 to 9999 pulses	Y	Y	10	N	N	N	Y	N	

d codes: Application Functions 2

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	PG V/f	w/o PG	w/ PG	Torque control	Refer to page:
d01	Speed Control 1 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.020	N	Y	Y	Y	N	5-159
d02	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.005	N	Y	Y	Y	N	
d03	P (Gain)	0.1 to 200.0 times	Y*	Y	10.0	N	Y	Y	Y	N	
d04	I (Integral time)	0.001 to 9.999 s	Y*	Y	0.100	N	Y	Y	Y	N	
d06	(Output filter)	0.000 to 0.100 s	Y	Y	0.002	N	Y	Y	Y	N	
d07	(Notch filter resonance frequency)	1 to 200 Hz	Y	Y	200	N	N	N	Y	N	5-160
d08	(Notch filter attenuation level)	0 to 20 dB	Y	Y	0	N	N	N	Y	N	
d09	Speed Control (Jogging) (Speed command filter)	0.000 to 5.000 s	Y	Y	0.020	N	Y	Y	Y	N	5-159 5-160
d10	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.005	N	Y	Y	Y	N	
d11	P (Gain)	0.1 to 200.0 times	Y*	Y	10.0	N	Y	Y	Y	N	
d12	I (Integral time)	0.001 to 9.999 s	Y*	Y	0.100	N	Y	Y	Y	N	
d13	(Output filter)	0.000 to 0.100 s	Y	Y	0.002	N	Y	Y	Y	N	
d14	Feedback Input (Pulse input format)	0: Pulse train sign/Pulse train input 1: Forward rotation pulse/Reverse rotation pulse 2: A/B phase with 90 degree phase shift	N	Y	2	N	Y	N	Y	Y	5-161
d15	(Encoder pulse resolution)	20 to 60000 pulses	N	Y	1024	N	Y	N	Y	Y	
d16	(Pulse count factor 1)	1 to 9999	N	Y	1	N	Y	N	Y	Y	
d17	(Pulse count factor 2)	1 to 9999	N	Y	1	N	Y	N	Y	Y	
d21	Speed Agreement/PG Error (Hysteresis width)	0.0% to 50.0%	Y	Y	10.0	N	Y	Y	Y	N	5-162
d22	(Detection timer)	0.00 to 10.00 s	Y	Y	0.50	N	Y	Y	Y	N	
d23	PG Error Processing	0: Continue to run 1 1: Stop running with alarm 1 2: Stop running with alarm 2 3: Continue to run 2 4: Stop running with alarm 3 5: Stop running with alarm 4	N	Y	2	N	Y	Y	Y	Y	
d24	Zero Speed Control	0: Not permit at startup 1: Permit at startup	N	Y	0	N	N	Y	Y	N	5-59 5-163
d25	ASR Switching Time	0.000 to 1.000 s	Y	Y	0.000	N	Y	Y	Y	Y	5-137 5-163
d32	Torque Control (Speed limit 1)	0 to 110 %	Y	Y	100	N	N	Y	Y	Y	5-121
d33	(Speed limit 2)	0 to 110 %	Y	Y	100	N	N	Y	Y	Y	5-163
d41	Application-defined Control	0: Disable (Ordinary control)	N	Y	0	Y	Y	Y	Y	Y	5-163
		1: Enable (Constant peripheral speed control)				N	Y	N	N	N	
		2: Enable (Simultaneous synchronization, without Z phase)				N	Y	N	Y	N	
		3: Enable (Standby synchronization)				N	Y	N	Y	N	
		4: Enable (Simultaneous synchronization, with Z phase)				N	Y	N	Y	N	
d51	Reserved *9	—	-	-	-	-	-	-	-	-	5-165
d52	Reserved *9	—	-	-	-	-	-	-	-	-	
d53	Reserved *9	—	-	-	-	-	-	-	-	-	
d54	Reserved *9	—	-	-	-	-	-	-	-	-	
d55	Reserved *9	—	-	-	-	-	-	-	-	-	
d59	Command (Pulse Rate Input) (Pulse input format)	0: Pulse train sign/Pulse train input 1: Forward rotation pulse/Reverse rotation pulse 2: A/B phase with 90 degree phase shift	N	Y	0	Y	Y	Y	Y	Y	5-34 5-165
d60	(Encoder pulse resolution)	20 to 3600 pulses	N	Y	1024	N	Y	N	Y	N	5-166
d61	(Filter time constant)	0.000 to 5.000 s	Y	Y	0.005	Y	Y	Y	Y	Y	5-165
d62	(Pulse count factor 1)	1 to 9999	N	Y	1	Y	Y	Y	Y	Y	
d63	(Pulse count factor 2)	1 to 9999	N	Y	1	Y	Y	Y	Y	Y	
d67	Starting Mode (Auto search)	0: Disable 1: Enable (At restart after momentary power failure) 2: Enable (At restart after momentary power failure and at normal start)	N	Y	2	N	N	Y	N	Y	5-119
d68	Reserved *9	—	-	-	-	-	-	-	-	-	5-165
d69	Reserved *9	—	-	-	-	-	-	-	-	-	
d70	Speed Control Limiter	0.00 to 100.00%	Y	Y	100.00	N	Y	N	Y	N	5-166

*9 Factory use. Do not access these function codes.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
d71	Synchronous Operation (Main speed regulator gain)	0.00 to 1.50 times	Y	Y	1.00	N	Y	N	Y	N	5-166
d72	(APR P gain)	0.00 to 200.00 times	Y	Y	1500	N	Y	N	Y	N	
d73	(APR positive output limiter)	20 to 200%, 999: No limiter	Y	Y	999	N	Y	N	Y	N	
d74	(APR negative output limiter)	20 to 200%, 999: No limiter	Y	Y	999	N	Y	N	Y	N	
d75	(Z phase alignment gain)	0.00 to 10.00 times	Y	Y	1.00	N	Y	N	Y	N	
d76	(Synchronous offset angle)	0 to 359 degrees	Y	Y	0	N	Y	N	Y	N	
d77	(Synchronization completion detection angle)	0 to 100 degrees	Y	Y	15	N	Y	N	Y	N	
d78	(Excessive deviation detection range)	0 to 65535 (in units of 10 pulses)	Y	Y	65535	N	Y	N	Y	N	
d98	Reserved *9	—	-	-	-	-	-	-	-	-	
d99	Reserved *9	—	-	-	-	-	-	-	-	-	5-165

*9 Factory use. Do not access these function codes.

U codes: Application Functions 3

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
U00	Customizable Logic (Mode selection)	0: Disable 1: Enable (Customizable logic operation)	N	Y	0	Y	Y	Y	Y	Y	5-167
U01	Customizable Logic: (Input 1)	0 (1000): Inverter running (***RUN***)	N	Y	0	Y	Y	Y	Y	Y	
U02	Step 1 (Input 2)	1 (1001): Frequency (speed) arrival signal (***FAR***)	N	Y	0	Y	Y	Y	Y	N	
		2 (1002): Frequency (speed) detected (***FDT***)				Y	Y	Y	Y	Y	
		3 (1003): Undervoltage detected (Inverter stopped) (***LU***)				Y	Y	Y	Y	Y	
		4 (1004): Torque polarity detected (***B/D***)				Y	Y	Y	Y	Y	
		5 (1005): Inverter output limiting (***IOL***)				Y	Y	Y	Y	Y	
		6 (1006): Auto-restarting after momentary power failure (***IPF***)				Y	Y	Y	Y	Y	
		7 (1007): Motor overload early warning (***OL***)				Y	Y	Y	Y	Y	
		8 (1008): Keypad operation enabled (***KP***)				Y	Y	Y	Y	Y	
		10 (1010): Inverter ready to run (***RDY***)				Y	Y	Y	Y	Y	
		11: Switch motor drive source between commercial power and inverter output (For MC on commercial line) (***SW88***)				Y	Y	N	N	N	
		12: Switch motor drive source between commercial power and inverter output (For secondary side) (***SW52-2***)				Y	Y	N	N	N	
		13: Switch motor drive source between commercial power and inverter output (For primary side) (***SW52-1***)				Y	Y	N	N	N	
		15 (1015): Select ***AX*** terminal function (For MC on primary side) (***AX***)				Y	Y	Y	Y	Y	
		22 (1022): Inverter output limiting with delay (***IOL2***)				Y	Y	Y	Y	Y	
		25 (1025): Cooling fan in operation (***FAN***)				Y	Y	Y	Y	Y	
		26 (1026): Auto-resetting (***TRY***)				Y	Y	Y	Y	Y	
		28 (1028): Heat sink overheat early warning (***OH***)				Y	Y	Y	Y	Y	
		29 (1029): Synchronization completed (***SY***)				N	Y	N	Y	N	
		30 (1030): Lifetime alarm (***LIFE***)				Y	Y	Y	Y	Y	
		31 (1031): Frequency (speed) detected 2 (***FDT2***)				Y	Y	Y	Y	Y	
		33 (1033): Reference loss detected (***REF OFF***)				Y	Y	Y	Y	Y	
		35 (1035): Inverter output on (***RUN2***)				Y	Y	Y	Y	Y	
		36 (1036): Overload prevention control (***OLP***)				Y	Y	Y	Y	N	
		37 (1037): Current detected (***ID***)				Y	Y	Y	Y	Y	
		38 (1038): Current detected 2 (***ID2***)				Y	Y	Y	Y	Y	
		39 (1039): Current detected 3 (***ID3***)				Y	Y	Y	Y	Y	
		41 (1041): Low current detected (***IDL***)				Y	Y	Y	Y	Y	
		42 (1042): PID alarm (***PID-ALM***)				Y	Y	Y	Y	N	
		43 (1043): Under PID control (***PID-CTL***)				Y	Y	Y	Y	N	
		44 (1044): Motor stopped due to slow flowrate under PID control (***PID-STP***)				Y	Y	Y	Y	N	
		45 (1045): Low output torque detected (***U-TL***)				Y	Y	Y	Y	Y	
		46 (1046): Torque detected 1 (***TD1***)				Y	Y	Y	Y	Y	
		47 (1047): Torque detected 2 (***TD2***)				Y	Y	Y	Y	Y	
		48 (1048): Motor 1 selected (***SWM1***)				Y	Y	Y	Y	Y	
		49 (1049): Motor 2 selected (***SWM2***)				Y	Y	Y	Y	Y	
		50 (1050): Motor 3 selected (***SWM3***)				Y	Y	Y	Y	Y	
		51 (1051): Motor 4 selected (***SWM4***)				Y	Y	Y	Y	Y	
		52 (1052): Running forward (***FRUN***)				Y	Y	Y	Y	Y	
		53 (1053): Running reverse (***RRUN***)				Y	Y	Y	Y	Y	
		54 (1054): In remote operation (***RMT***)				Y	Y	Y	Y	Y	
		56 (1056): Motor overheat detected by thermistor (***THM***)				Y	Y	Y	Y	Y	
		57 (1057): Brake signal (***BRKS***)				Y	Y	Y	Y	N	
		58 (1058): Frequency (speed) detected 3 (***FDT3***)				Y	Y	Y	Y	Y	
		59 (1059): Terminal [C1] wire break (***C1OFF***)				Y	Y	Y	Y	Y	
		70 (1070): Speed valid (***DNZS***)				N	Y	Y	Y	Y	
		71 (1071): Speed agreement (***DSAG***)				N	Y	Y	Y	N	
		72 (1072): Frequency (speed) arrival signal 3 (***FAR3***)				Y	Y	Y	Y	N	
		76 (1076): PG error detected (***PG-ERR***)				N	Y	Y	Y	N	
		82 (1082): Positioning completion signal (***PSET***)				N	N	N	Y	N	

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
		84 (1084): Maintenance timer (***MNT***)				Y	Y	Y	Y	Y	5-167
		98 (1098): Light alarm (***L-ALM***)				Y	Y	Y	Y	Y	
		99 (1099): Alarm output (for any alarm) (***ALM***)				Y	Y	Y	Y	Y	
		101 (1101): Enable circuit failure detected (***DECF***)				Y	Y	Y	Y	Y	
		102 (1102): Enable input OFF (***EN OFF***)				Y	Y	Y	Y	Y	
		105 (1105): Braking transistor broken (***DBAL***)				Y	Y	Y	Y	Y	
		2001 (3001): Output of step 1 (***SO01***)				Y	Y	Y	Y	Y	
		2002 (3002): Output of step 2 (***SO02***)				Y	Y	Y	Y	Y	
		2003 (3003): Output of step 3 (***SO03***)				Y	Y	Y	Y	Y	
		2004 (3004): Output of step 4 (***SO04***)				Y	Y	Y	Y	Y	
		2005 (3005): Output of step 5 (***SO05***)				Y	Y	Y	Y	Y	
		2006 (3006): Output of step 6 (***SO06***)				Y	Y	Y	Y	Y	
		2007 (3007): Output of step 7 (***SO07***)				Y	Y	Y	Y	Y	
		2008 (3008): Output of step 8 (***SO08***)				Y	Y	Y	Y	Y	
		2009 (3009): Output of step 9 (***SO09***)				Y	Y	Y	Y	Y	
		2010 (3010): Output of step 10 (***SO10***)				Y	Y	Y	Y	Y	
		4001 (5001): Terminal [X1] input signal (***X1***)				Y	Y	Y	Y	Y	
		4002 (5002): Terminal [X2] input signal (***X2***)				Y	Y	Y	Y	Y	
		4003 (5003): Terminal [X3] input signal (***X3***)				Y	Y	Y	Y	Y	
		4004 (5004): Terminal [X4] input signal (***X4***)				Y	Y	Y	Y	Y	
		4005 (5005): Terminal [X5] input signal (***X5***)				Y	Y	Y	Y	Y	
		4006 (5006): Terminal [X6] input signal (***X6***)				Y	Y	Y	Y	Y	
		4007 (5007): Terminal [X7] input signal (***X7***)				Y	Y	Y	Y	Y	
		4010 (5010): Terminal [FWD] input signal (***FWD***)				Y	Y	Y	Y	Y	
		4011 (5011): Terminal [REV] input signal (***REV***)				Y	Y	Y	Y	Y	
		6000 (7000): Final run command (***FL_RUN***)				Y	Y	Y	Y	Y	
		6001 (7001): Final FWD run command (***FL_FWD***)				Y	Y	Y	Y	Y	
		6002 (7002): Final REV run command (***FL_REV***)				Y	Y	Y	Y	Y	
		6003 (7003): During acceleration (***DACC***)				Y	Y	Y	Y	Y	
		6004 (7004): During deceleration (***DDEC***)				Y	Y	Y	Y	Y	
		6005 (7005): Under anti-regenerative control (***REGA***)				Y	Y	Y	Y	Y	
		6006 (7006): Within dancer reference position (***DR_REF***)				Y	Y	Y	Y	Y	
		6007 (7007): Alarm factor presence (***ALM_ACT***)				Y	Y	Y	Y	Y	
		Setting the value in parentheses ( ) shown above assigns a negative logic output to a terminal. (True if OFF.)									
U03	(Logic circuit)	0: No function assigned 1: Through output + General-purpose timer 2: ANDing + General-purpose timer 3: ORing + General-purpose timer 4: XORing + General-purpose timer 5: Set priority flip-flop + General-purpose timer 6: Reset priority flip-flop + General-purpose timer 7: Rising edge detector + General-purpose timer 8: Falling edge detector + General-purpose timer 9: Rising and falling edge detector + General-purpose timer 10: Input hold + General-purpose timer 11: Increment counter 12: Decrement counter 13: Timer with reset input	N	Y	0	Y	Y	Y	Y	Y	
U04	(Type of timer)	0: No timer 1: On-delay timer 2: Off-delay timer 3: Pulse 4: Retriggerable timer 5: Pulse train output	N	Y	0	Y	Y	Y	Y	Y	
U05	(Timer)	0.00 to 600.00	N	Y	0.00	Y	Y	Y	Y	Y	
U06	Customizable Logic: (Input 1)	See U01.	N	Y	0	See U01.					
U07	Step 2 (Input 2)	See U02.	N	Y	0	See U02.					
U08	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U09	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U10	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control: V/f	PG V/f	w/o PG	w/ PG	Torque control	Refer to page:
U11	Customizable Logic: Step 3 (Input 1)	See U01.	N	Y	0	See U01.					5-167
U12	(Input 2)	See U02.	N	Y	0	See U02.					
U13	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U14	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U15	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U16	Customizable Logic: Step 4 (Input 1)	See U01.	N	Y	0	See U01.					
U17	(Input 2)	See U02.	N	Y	0	See U02.					
U18	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U19	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U20	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U21	Customizable Logic: Step 5 (Input 1)	See U01.	N	Y	0	See U01.					
U22	(Input 2)	See U02.	N	Y	0	See U02.					
U23	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U24	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U25	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U26	Customizable Logic: Step 6 (Input 1)	See U01.	N	Y	0	See U01.					
U27	(Input 2)	See U02.	N	Y	0	See U02.					
U28	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U29	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U30	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U31	Customizable Logic: Step 7 (Input 1)	See U01.	N	Y	0	See U01.					
U32	(Input 2)	See U02.	N	Y	0	See U02.					
U33	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U34	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U35	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U36	Customizable Logic: Step 8 (Input 1)	See U01.	N	Y	0	See U01.					
U37	(Input 2)	See U02.	N	Y	0	See U02.					
U38	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U39	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U40	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U41	Customizable Logic: Step 9 (Input 1)	See U01.	N	Y	0	See U01.					
U42	(Input 2)	See U02.	N	Y	0	See U02.					
U43	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U44	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U45	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U46	Customizable Logic: Step 10 (Input 1)	See U01.	N	Y	0	See U01.					
U47	(Input 2)	See U02.	N	Y	0	See U02.					
U48	(Logic circuit)	See U03.	N	Y	0	Y	Y	Y	Y	Y	
U49	(Type of timer)	See U04.	N	Y	0	Y	Y	Y	Y	Y	
U50	(Timer)	See U05.	N	Y	0.00	Y	Y	Y	Y	Y	
U71	Customizable Logic Output Signal 1 (Output selection)	0: Disable 1: Step 1 output (***SO01***) 2: Step 2 output (***SO02***) 3: Step 3 output (***SO03***) 4: Step 4 output (***SO04***) 5: Step 5 output (***SO05***) 6: Step 6 output (***SO06***) 7: Step 7 output (***SO07***) 8: Step 8 output (***SO08***) 9: Step 9 output (***SO09***) 10: Step 10 output (***SO10***)	N	Y	0	Y	Y	Y	Y	Y	
U72	Customizable Logic Output Signal 2		N	Y	0	Y	Y	Y	Y	Y	
U73	Customizable Logic Output Signal 3		N	Y	0	Y	Y	Y	Y	Y	
U74	Customizable Logic Output Signal 4		N	Y	0	Y	Y	Y	Y	Y	
U75	Customizable Logic Output Signal 5		N	Y	0	Y	Y	Y	Y	Y	

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
U81	Customizable Logic Output Signal 1 (Function selection)	0 (1000): Select multi-frequency (0 to 1 step) (***SS1***)	N	Y	100	Y	Y	Y	Y	N	5-167
		1 (1001): Select multi-frequency (0 to 3 steps) (***SS2***)				Y	Y	Y	Y	N	
U82	Customizable Logic Output Signal 2	2 (1002): Select multi-frequency (0 to 7 steps) (***SS4***)	N	Y	100	Y	Y	Y	Y	N	
U83	Customizable Logic Output Signal 3	3 (1003): Select multi-frequency (0 to 15 steps) (***SS8***)	N	Y	100	Y	Y	Y	Y	N	
U84	Customizable Logic Output Signal 4	4 (1004): Select ACC/DEC time (2 steps) (***RT1***)	N	Y	100	Y	Y	Y	Y	N	
U85	Customizable Logic Output Signal 5	5 (1005): Select ACC/DEC time (4 steps) (***RT2***)	N	Y	100	Y	Y	Y	Y	N	
		6 (1006): Enable 3-wire operation (***HLD***)				Y	Y	Y	Y	Y	
		7 (1007): Coast to a stop (***BX***)				Y	Y	Y	Y	Y	
		8 (1008): Reset alarm (***RST***)				Y	Y	Y	Y	Y	
		9 (1009): Enable external alarm trip (***THR***) (9 = Active OFF, 1009 = Active ON)				Y	Y	Y	Y	Y	
		10 (1010): Ready for jogging (***JOG***)				Y	Y	Y	Y	N	
		11 (1011): Select frequency command 2/1 (***Hz2/Hz1***)				Y	Y	Y	Y	N	
		12 (1012): Select motor 2 (***M2***)				Y	Y	Y	Y	Y	
		13: Enable DC braking (***DCBRK***)				Y	Y	Y	Y	N	
		14 (1014): Select torque limiter level 2/1 (***TL2/TL1***)				Y	Y	Y	Y	Y	
		15: Switch to commercial power (50 Hz) (***SW50***)				Y	Y	N	N	N	
		16: Switch to commercial power (60 Hz) (***SW60***)				Y	Y	N	N	N	
		17 (1017): UP (Increase output frequency) (***UP***)				Y	Y	Y	Y	N	
		18 (1018): DOWN (Decrease output frequency) (***DOWN***)				Y	Y	Y	Y	N	
		20 (1020): Cancel PID control (***Hz/PID***)				Y	Y	Y	Y	N	
		21 (1021): Switch normal/inverse operation (***IVS***)				Y	Y	Y	Y	N	
		22 (1022): Interlock (***IL***)				Y	Y	Y	Y	Y	
		23 (1023): Cancel torque control (***Hz/TRQ***)				N	N	N	N	Y	
		24 (1024): Enable communications link via RS-485 or fieldbus (***LE***)				Y	Y	Y	Y	Y	
		25 (1025): Universal DI (***U-DI***)				Y	Y	Y	Y	Y	
		26 (1026): Enable auto search for idling motor speed at starting (***STM***)				Y	Y	Y	N	Y	
		30 (1030): Force to stop (***STOP***) (30 = Active OFF, 1030 = Active ON)				Y	Y	Y	Y	Y	
		32 (1032): Pre-excitation (***EXITE***)				N	N	Y	Y	N	
		33 (1033): Reset PID integral and differential components (***PID-RST***)				Y	Y	Y	Y	N	
		34 (1034): Hold PID integral component (***PID-HLD***)				Y	Y	Y	Y	N	
		35 (1035): Select local (keypad) operation (***LOC***)				Y	Y	Y	Y	Y	
		36 (1036): Select motor 3 (***M3***)				Y	Y	Y	Y	Y	
		37 (1037): Select motor 4 (***M4***)				Y	Y	Y	Y	Y	
		39: Protect motor from dew condensation (***DWP***)				Y	Y	Y	Y	Y	
		40: Enable integrated sequence to switch to commercial power (50 Hz) (***ISW50***)				Y	Y	N	N	N	
		41: Enable integrated sequence to switch to commercial power (60 Hz) (***ISW60***)				Y	Y	N	N	N	
		47 (1047): Servo-lock command (***LOCK***)				N	N	N	Y	N	
		49 (1049): Pulse train sign (***SIGN***)				Y	Y	Y	Y	Y	
		70 (1070): Cancel constant peripheral speed control (***Hz/LSC***)				Y	Y	Y	Y	N	
		71 (1071): Hold the constant peripheral speed control frequency in the memory (***LSC-HLD***)				Y	Y	Y	Y	N	
		72 (1072): Count the run time of commercial power-driven motor 1 (***CRUN-M1***)				Y	Y	N	N	Y	
		73 (1073): Count the run time of commercial power-driven motor 2 (***CRUN-M2***)				Y	Y	N	N	Y	
		74 (1074): Count the run time of commercial power-driven motor 3 (***CRUN-M3***)				Y	Y	N	N	Y	
		75 (1075): Count the run time of commercial power-driven motor 4 (***CRUN-M4***)				Y	Y	N	N	Y	
		76 (1076): Select droop control (***DROOP***)				Y	Y	Y	Y	N	
		77 (1077): Cancel PG alarm (***PG-CCL***)				N	Y	N	Y	Y	
		81 (1081): Clear all customizable logic timers (***CLTC***)				Y	Y	Y	Y	Y	
		98: Run forward (***FWD***)				Y	Y	Y	Y	Y	
		99: Run reverse (***REV***)				Y	Y	Y	Y	Y	
		100: No function assigned (***NONE***)				Y	Y	Y	Y	Y	
		Setting the value of 1000s in parentheses ( ) shown above assigns a negative logic input to a terminal.									

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque	
U91	Customizable Logic Timer Monitor (Step selection)	1: Step 1 2: Step 2 3: Step 3 4: Step 4 5: Step 5 6: Step 6 7: Step 7 8: Step 8 9: Step 9 10: Step 10	N	Y	1	Y	Y	Y	Y	Y	5-167

y codes: LINK Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
y01	RS-485 Communication 1 (Station address)	1 to 255	N	Y	1	Y	Y	Y	Y	Y	5-176
y02	(Communications error processing)	0: Immediately trip with alarm Er8 1: Trip with alarm Er8 after running for the period specified by timer y03 2: Retry during the period specified by timer y03. If the retry fails, trip with alarm Er8. If it succeeds, continue to run. 3: Continue to run	Y	Y	0	Y	Y	Y	Y	Y	
y03	(Timer)	0.0 to 60.0 s	Y	Y	2.0	Y	Y	Y	Y	Y	
y04	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps	Y	Y	3	Y	Y	Y	Y	Y	
y05	(Data length)	0: 8 bits 1: 7 bits	Y	Y	0	Y	Y	Y	Y	Y	
y06	(Parity check)	0: None (2 stop bits) 1: Even parity (1 stop bit) 2: Odd parity (1 stop bit) 3: None (1 stop bit)	Y	Y	0	Y	Y	Y	Y	Y	
y07	(Stop bits)	0: 2 bits 1: 1 bit	Y	Y	0	Y	Y	Y	Y	Y	
y08	RS-485 Communication 1 (No-response error detection time)	0: No detection; 1 to 60 s	Y	Y	0	Y	Y	Y	Y	Y	
y09	(Response interval)	0.00 to 1.00 s	Y	Y	0.01	Y	Y	Y	Y	Y	
y10	(Protocol selection)	0: Modbus RTU protocol 1: FRENIC Loader protocol (SX protocol) 2: Fuji general-purpose inverter protocol	Y	Y	1	Y	Y	Y	Y	Y	
y11	RS-485 Communication 2 (Station address)	1 to 255	N	Y	1	Y	Y	Y	Y	Y	
y12	(Communications error processing)	0: Immediately trip with alarm ErP 1: Trip with alarm ErP after running for the period specified by timer y13 2: Retry during the period specified by timer y13. If the retry fails, trip with alarm ErP. If it succeeds, continue to run. 3: Continue to run	Y	Y	0	Y	Y	Y	Y	Y	
y13	(Timer)	0.0 to 60.0 s	Y	Y	2.0	Y	Y	Y	Y	Y	
y14	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps	Y	Y	3	Y	Y	Y	Y	Y	
y15	(Data length)	0: 8 bits 1: 7 bits	Y	Y	0	Y	Y	Y	Y	Y	
y16	(Parity check)	0: None (2 stop bits) 1: Even parity (1 stop bit) 2: Odd parity (1 stop bit) 3: None (1 stop bit)	Y	Y	0	Y	Y	Y	Y	Y	
y17	(Stop bits)	0: 2 bits 1: 1 bit	Y	Y	0	Y	Y	Y	Y	Y	
y18	(No-response error detection time)	0: No detection; 1 to 60 s	Y	Y	0	Y	Y	Y	Y	Y	
y19	(Response interval)	0.00 to 1.00 s	Y	Y	0.01	Y	Y	Y	Y	Y	
y20	(Protocol selection)	0: Modbus RTU protocol 2: Fuji general-purpose inverter protocol	Y	Y	0	Y	Y	Y	Y	Y	
y97	Communication Data Storage Selection	0: Save into nonvolatile storage (Rewritable times limited) 1: Write into temporary storage (Rewritable times unlimited) 2: Save all data from temporary storage to nonvolatile one (After saving data, the y97 data automatically returns to "1.")	Y	Y	0	Y	Y	Y	Y	Y	5-179
y98	Bus Link Function (Mode selection)	Frequency command / Run command 0: Follow H30 data / Follow H30 data 1: Via fieldbus option / Follow H30 data 2: Follow H30 data / Via fieldbus option 3: Via fieldbus option / Via fieldbus option	Y	Y	0	Y	Y	Y	Y	Y	5-124 5-179
y99	Loader Link Function (Mode selection)	Frequency command / Run command 0: Follow H30 and y98 data / Follow H30 and y98 data 1: Via RS-485 link (FRENIC Loader) / Follow H30 and y98 data 2: Follow H30 and y98 data / Via RS-485 link (FRENIC Loader) 3: Via RS-485 link (FRENIC Loader) / Via RS-485 link (FRENIC Loader)	Y	N	0	Y	Y	Y	Y	Y	5-179

Table A Factory Defaults Depending upon Inverter Capacity

Inverter capacity HP	Auto-restart after momentary power failure H13	Inverter capacity HP	Auto-restart after momentary power failure H13
0.5	0.5	100	1.5
1		125	
2		150	
3		200	
5		250	2.0
7		300	
10		350	2.5
15		450	
20	1.0	500	
25		600	4.0
30		700	
40		800	5.0
50		900	
60		1000	
75	1.5		

Table B Motor Parameters

When the "HP rating motors" is selected with P99/A39/b39/r39 (data = 1)

Three-phase 230 V series (FRN_ _ _G1■-2U)

Motor capacity (HP)	Nominal applied motor (HP)	Rated current (A)	No-load current (A)	%R1	%X	Rated slip frequency (Hz)	Iron loss factor 1 (%)	Magnetic saturation factor 1 (%)	Magnetic saturation factor 2 (%)	Magnetic saturation factor 3 (%)	Magnetic saturation factor 4 (%)	Magnetic saturation factor 5 (%)	Magnetic saturation extension factor "a" (%)	Magnetic saturation extension factor "b" (%)	Magnetic saturation extension factor "c" (%)	Torque current under vector control (A)	Starting mode (Auto search delay time 2)
P02/A16/b16/r16	--	P03/A17/b17/r17	P06/A20/b20/r20	P07/A21/b21/r21	P08/A22/b22/r22	P12/A26/b26/r26	P13/A27/b27/r27	P16/A30/b30/r30	P17/A31/b31/r31	P18/A32/b32/r32	P19/A33/b33/r33	P20/A34/b34/r34	P21/A35/b35/r35	P22/A36/b36/r36	P23/A37/b37/r37	P55/A55/b55/r55	H46
0.01 to 0.11	0.1	0.44	0.40	13.79	11.75	2.50	14.00	93.8	87.5	75.0	62.5	50.0	106.3	112.5	118.8	0.21	0.5
0.12 to 0.24	0.12	0.68	0.55	12.96	12.67	2.50	14.00	93.3	86.1	74.4	63.6	50.7	108.8	118.7	129.6	0.27	
0.25 to 0.49	0.25	1.40	1.12	11.02	13.84	2.50	12.60	89.7	81.9	66.9	54.5	43.3	111.0	129.3	148.4	0.53	
0.50 to 0.99	0.5	2.00	1.22	6.15	8.80	2.50	9.88	88.7	81.3	67.0	55.2	43.8	112.1	126.5	144.3	1.09	
1.00 to 1.99	1	3.00	1.54	3.96	8.86	2.50	7.40	88.3	77.7	62.6	51.8	41.1	112.4	129.2	148.4	2.21	
2.00 to 2.99	2	5.80	2.80	4.29	7.74	2.50	5.85	92.1	82.8	71.1	58.1	46.2	111.4	126.1	143.9	4.43	
3.00 to 4.99	3	7.90	3.57	3.15	20.81	1.17	5.91	85.1	74.6	61.7	50.3	39.8	115.7	133.5	150.6	6.64	0.6
5.00 to 7.49	5	12.6	4.78	3.34	23.57	1.50	5.24	86.0	76.9	61.3	49.5	39.1	115.6	133.2	154.1	11.07	0.8
7.50 to 9.99	7.5	18.6	6.23	2.65	28.91	1.17	4.75	88.6	79.2	64.9	52.7	41.8	114.3	133.1	155.6	16.60	1.0
10.00 to 14.99	10	25.3	8.75	2.43	30.78	1.17	4.03	87.7	80.0	67.1	56.1	45.6	111.7	128.4	149.2	22.15	1.2
15.00 to 19.99	15	37.3	12.7	2.07	29.13	1.00	3.92	91.3	83.3	69.9	58.0	47.0	114.1	130.2	147.9	33.22	1.3
20.00 to 24.99	20	49.1	9.20	2.09	29.53	1.00	3.32	90.5	83.5	72.1	60.7	49.5	109.0	121.3	137.8	44.30	2.0
25.00 to 29.99	25	60.0	16.70	1.75	31.49	1.00	3.34	90.7	83.0	70.7	59.9	48.7	112.1	127.9	147.5	55.37	
30.00 to 39.99	30	72.4	19.80	1.90	32.55	1.00	3.28	89.7	81.3	68.9	59.1	48.4	114.1	130.2	151.8	66.45	
40.00 to 49.99	40	91.0	13.60	1.82	25.32	0.47	3.10	90.2	81.6	68.7	57.2	45.8	114.8	132.3	153.9	88.60	2.3
50.00 to 59.99	50	115.0	18.70	1.92	24.87	0.58	2.30	88.7	78.9	65.4	54.2	43.4	112.2	126.4	143.6	110.7	2.5
37.00 to 44.99	60	137.0	20.80	1.29	26.99	0.35	2.18	89.0	79.7	66.8	55.4	44.4	112.3	126.0	141.8	132.9	
75.00 to 99.99	75	174.0	28.60	1.37	27.09	0.35	2.45	89.2	79.3	64.7	53.6	43.1	117.2	136.2	157.8	166.1	2.6
100.0 to 124.9	100	226.0	37.40	1.08	23.80	0.23	2.33	88.1	78.0	64.3	54.2	42.9	114.9	129.8	144.6	221.5	2.8
125.0 to 149.9	125	268.0	29.80	1.05	22.90	0.35	2.31	88.8	79.0	65.0	54.0	44.0	115.0	130.0	145.0	276.9	3.2
150.0 or above	150	337.0	90.40	0.96	21.61	0.39	1.73	90.5	82.6	70.7	58.7	47.8	112.2	126.1	142.4	332.2	3.5

Note: A box (■) replaces S or H depending on the enclosure.

Table B Motor Parameters (Continued)

Three-phase 460 V series (FRN_ _ _G1■-4U)

Motor capacity (HP)	Nominal applied motor (HP)	Rated current (A)	No-load current (A)	%R1	%X	Rated slip frequency (Hz)	Iron loss factor 1 (%)	Magnetic saturation factor 1 (%)	Magnetic saturation factor 2 (%)	Magnetic saturation factor 3 (%)	Magnetic saturation factor 4 (%)	Magnetic saturation factor 5 (%)	Magnetic saturation extension factor "a" (%)	Magnetic saturation extension factor "b" (%)	Magnetic saturation extension factor "c" (%)	Torque current under vector control (A)	Starting mode (Auto search delay time 2)
P02/A16/b16/r16	--	P03/A17/b17/r17	P06/A20/b20/r20	P07/A21/b21/r21	P08/A22/b22/r22	P12/A26/b26/r26	P13/A27/b27/r27	P16/A30/b30/r30	P17/A31/b31/r31	P18/A32/b32/r32	P19/A33/b33/r33	P20/A34/b34/r34	P21/A35/b35/r35	P22/A36/b36/r36	P23/A37/b37/r37	P55/A55/b55/r55	H46
0.01 to 0.11	0.1	0.22	0.20	13.79	11.75	2.50	14.00	93.8	87.5	75.0	62.5	50.0	106.3	112.5	118.8	0.10	0.5
0.12 to 0.24	0.12	0.34	0.27	12.96	12.67	2.50	14.00	93.3	86.1	74.4	63.6	50.7	108.8	118.7	129.6	0.13	
0.25 to 0.49	0.25	0.70	0.56	11.02	13.84	2.50	12.60	89.7	81.9	66.9	54.5	43.3	111.0	129.3	148.4	0.27	
0.50 to 0.99	0.5	1.00	0.61	6.15	8.80	2.50	9.88	88.7	81.3	67.0	55.2	43.8	112.1	126.5	144.3	0.55	
1.00 to 1.99	1	1.50	0.77	3.96	8.86	2.50	7.40	88.3	77.7	62.6	51.8	41.1	112.4	129.2	148.4	1.11	
2.00 to 2.99	2	2.90	1.40	4.29	7.74	2.50	5.85	92.1	82.8	71.1	58.1	46.2	111.4	126.1	143.9	2.21	
3.00 to 4.99	3	4.00	1.79	3.15	20.81	1.17	5.91	85.1	74.6	61.7	50.3	39.8	115.7	133.5	150.6	3.32	0.6
5.00 to 7.49	5	6.30	2.39	3.34	23.57	1.50	5.24	86.0	76.9	61.3	49.5	39.1	115.6	133.2	154.1	5.54	0.8
7.50 to 9.99	7.5	9.30	3.12	2.65	28.91	1.17	4.75	88.6	79.2	64.9	52.7	41.8	114.3	133.1	155.6	8.30	1.0
10.00 to 14.99	10	12.7	4.37	2.43	30.78	1.17	4.03	87.7	80.0	67.1	56.1	45.6	111.7	128.4	149.2	11.07	1.2
15.00 to 19.99	15	18.7	6.36	2.07	29.13	1.00	3.92	91.3	83.3	69.9	58.0	47.0	114.1	130.2	147.9	16.61	1.3
20.00 to 24.99	20	24.6	4.60	2.09	29.53	1.00	3.32	90.5	83.5	72.1	60.7	49.5	109.0	121.3	137.8	22.15	2.0
25.00 to 29.99	25	30.0	8.33	1.75	31.49	1.00	3.34	90.7	83.0	70.7	59.9	48.7	112.1	127.9	147.5	27.69	
30.00 to 39.99	30	36.2	9.88	1.90	32.55	1.00	3.28	89.7	81.3	68.9	59.1	48.4	114.1	130.2	151.8	33.22	
40.00 to 49.99	40	45.5	6.80	1.82	25.32	0.47	3.10	90.2	81.6	68.7	57.2	45.8	114.8	132.3	153.9	44.30	2.3
50.00 to 59.99	50	57.5	9.33	1.92	24.87	0.58	2.30	88.7	78.9	65.4	54.2	43.4	112.2	126.4	143.6	55.37	2.5
60.00 to 74.99	60	68.7	10.4	1.29	26.99	0.35	2.18	89.0	79.7	66.8	55.4	44.4	112.3	126.0	141.8	66.45	
75.00 to 99.99	75	86.9	14.3	1.37	27.09	0.35	2.45	89.2	79.3	64.7	53.6	43.1	117.2	136.2	157.8	83.06	2.6
100.0 to 124.9	100	113.0	18.7	1.08	23.80	0.23	2.33	88.1	78.0	64.3	54.2	42.9	114.9	129.8	144.6	110.7	2.8
125.0 to 149.9	125	134.0	14.9	1.05	22.90	0.35	2.31	88.8	79.0	65.0	54.0	44.0	115.0	130.0	145.0	138.4	3.2
150.0 to 174.9	150	169.0	45.2	0.96	21.61	0.39	1.73	90.5	82.6	70.7	58.7	47.8	112.2	126.1	142.4	166.1	3.5
175.0 to 199.9	175	169.0	45.2	0.96	21.61	0.39	1.80	90.3	81.9	69.8	57.8	46.6	112.9	127.6	144.8	183.0	4.1
200.0 to 249.9	200	231.0	81.8	0.72	20.84	0.23	1.50	92.2	84.8	71.1	58.6	46.9	114.6	130.5	148.0	209.2	4.5
250.0 to 299.9	250	272.0	41.1	0.71	18.72	0.35	1.36	91.9	85.5	72.3	60.0	47.6	109.8	122.7	136.4	261.5	4.7
300.0 to 324.9	300	323.0	45.1	0.53	18.44	0.23	1.25	93.1	86.1	72.9	60.8	48.6	108.7	118.8	130.9	313.8	
325.0 to 349.9	325	323.0	45.1	0.53	18.44	0.23	1.33	92.2	84.9	72.7	60.5	48.9	109.9	122.2	137.8	339.9	5.0
350.0 to 399.9	350	375.0	68.3	0.99	19.24	0.46	1.27	92.7	85.6	72.9	60.9		109.3	120.2	133.5	366.1	5.5
400.0 to 449.9	400	429.0	80.7	1.11	18.92	0.46	1.81									418.4	5.6
450.0 to 499.9	450	481.0	85.5	0.95	19.01	0.48	1.77									470.7	
500.0 to 599.9	500	534.0	99.2	1.05	18.39	0.45	1.58									523.0	7.5
600.0 to 699.9	600	638.0	140.0	0.85	18.38	0.39	1.84									627.6	9.8
700.0 to 749.9	700	756.0	164.0	1.02	21.92	0.70	1.80									732.1	
750.0 to 799.9	750	806.0	144.0	1.15	24.53	0.53	1.61									784.4	
800.0 to 849.9	800	870.0	209.0	1.17	21.69	0.45	1.29									836.7	10.5
850.0 to 899.9	850	923.0	172.0	1.34	25.44	0.60	0.97									889.0	
900.0 or above	900	994.0	239.0	1.40	23.79	0.55										941.3	

Note: A box (■) replaces S or H depending on the enclosure.

Chap. 5 FUNCTION CODES

5.3 Function Code Index by Purpose

5.3.1 Configuring the minimal requirements for the inverter to just run the motor

To run the motor simply with constant torque load under V/f control, the following function codes should be configured as minimal requirements. These function codes are displayed in the quick setup (Menu #0).

To	Function code	Name	Refer to page:
Set the command source that specifies reference frequency 1.	F01	Frequency Command 1	5-57
Select the source that specifies a run command that runs or stops the motor.	F02	Operation Method	5-65
Specify the maximum frequency to limit the output frequency (motor rotation).	F03	Maximum Frequency 1	5-66
Limit the reference frequency.	F16	Frequency Limiter (Low)	5-84
Enter the motor ratings printed on its nameplate to run the motor properly.	F04 F05 F06	Base Frequency 1 Rated Voltage at Base Frequency 1 Maximum Output Voltage 1	5-66
Specify the acceleration/deceleration time.	F07 F08	Acceleration Time 1 Deceleration Time 1	5-69
Adjust the output voltage with the torque boost to secure a sufficient starting torque.	F09	Torque Boost 1	5-72
Protect the motor.	 F10 F11	Electronic Thermal Overload Protection for Motor 1 (Select motor characteristics) (Overload detection level)	5-72
Select the restart mode to apply after momentary power failure.	F14	Restart Mode after Momentary Power Failure (Mode selection)	5-76
Reduce an audible noise generated by the motor.	F26	Motor Sound (Carrier frequency)	5-90
Select the full-menu mode to use various checking functions on the keypad.	E52	Keypad (Menu display mode)	5-145
Specify the motor parameters.	 P02 P03 P04 P99	Motor 1 (Rated capacity) (Rated current) (Auto-tuning) Motor 1 Selection	5-155 5-156 5-159

5.3.2 Setting up the frequency

5.3.2.1 Frequency setting from the keypad

To	Function code	Name	Refer to page:
Set up the reference frequency from the keypad.	F01 E64	Frequency Command 1 Saving of Digital Reference Frequency	5-57 5-147

5.3.2.2 Frequency setting by analog input

To	Function code	Name	Refer to page:
Set up the reference frequency using analog input (voltage or current) applied to terminal [12], [C1], or [V2] from external equipment (analog frequency command source).	F01	Frequency Command 1	5-57
Apply bias and gain (e.g., 1 to 5V) to the analog frequency setting to configure an arbitrary relationship between the analog input and frequency setting.	F18 C50	Bias (Frequency command 1) Bias (Frequency command 1) (Bias base point)	5-57
	C32 C34 C37 C39 C42 C44	Analog Input Adjustment for: [12] (Gain) [12] (Gain base point) [C1] (Gain) [C1] (Gain base point) [V2] (Gain) [V2] (Gain base point)	5-153
Select the polarity for terminal [12] or [V2]--bipolar (e.g., ±10 V) or unipolar (e.g., -10 V).	C35 C45	Analog Input Adjustment for: [12] (Polarity) [V2] (Polarity)	5-153
Cancel the offset of external equipment which analog input (voltage or current) comes from.	C31 C36 C41	Analog Input Adjustment for: [12] (Offset) [C1] (Offset) [V2] (Offset)	5-153
Suppress noise superimposed on analog input with the filter.	C33 C38 C43	Analog Input Adjustment for: [12] (Filter time constant) [C1] (Filter time constant) [V2] (Filter time constant)	5-153
Combine the normal/inverse operation for analog frequency command and the normal/inverse switching terminal command, e.g., for air-conditioners that require switching between cooling and heating.	C53 E01-E07	Selection of Normal/Inverse Operation (Frequency command 1) Terminal [X1] to [X7] Functions (***IVS***)	5-154 5-111
Detect an external frequency command source failure or wire break to issue a warning signal and continue running the motor with the specified running frequency.	E65 E20-E24	Reference Loss Detection (Continuous running frequency) Terminal [Y1] to [Y5A/C] Functions (***REF OFF***)	5-147 5-128

5.3.2.3 Other frequency settings

To		Function code	Name	Refer to page:
UP/***DOWN***	Set up the reference frequency with the terminal command ***UP*** or ***DOWN***.	F01 E01-E07	Frequency Command 1 Terminal [X1] to [X7] Functions (***UP, DOWN***)	5-57 5-111
	Reset the initial values of terminal commands ***UP*** and ***DOWN*** to 0 Hz at the start of running.	H61	***UP***/***DOWN*** Control (Initial frequency setting)	5-57
Multi-frequency	Define different frequency settings beforehand and switch them with the combination of the ON/OFF states of the frequency selection terminal commands.	F01 E01-E07 C05-C19	Frequency Command 1 Terminal [X1] to [X7] Functions (***SS1, SS2, SS4, SS8***) Multi-frequency 1 to 15	5-57 5-111 5-150

Chap. 5 FUNCTION CODES

To		Function code	Name	Refer to page:
Pulse train input	Set up the reference frequency with pulse train input.	F01	Frequency Command 1	5-57
	Receive pulses from other motor's PG to perform ratio operation.	d59 d61 d62 d63 E01-E07	Command (Pulse Rate Input) (Pulse input format) (Filter time constant) (Pulse count factor 1) (Pulse count factor 2) Terminal [X1] to [X7] Functions (Pulse train input ***PIN***, available only on terminal [X7]) (Pulse train sign ***SIGN***, available on terminals except [X7])	5-221 5-111
Switching between remote and proximal command sources	Switch the frequency command source between analog current (4 to 20 mA) supplied from a remote electric room and analog voltage (0 to 10 V) specified from an operation device.	F01 C30 E01-E07	Frequency Command 1 Frequency Command 2 Terminal [X1] to [X7] Functions (***Hz2/Hz1***)	5-57 5-111
Auxiliary frequency setting	Add auxiliary frequency setting to the reference frequency, using analog input.	E61 E62 E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-146
Ratio setting	Apply the ratio setting using analog input to multiply the reference frequency by the ratio for override control.			
Digital input interface card (option)	Specify frequency commands with binary code (8, 12, 15, or 16 bits) or BCD (4-bit Binary Coded Decimal) code. (For details, refer to the Digital Input Interface Card Instruction Manual.)	F01	Frequency Command 1	5-57

5.3.3 Entering a run command

To		Function code	Name	Refer to page:
Keypad	Run or stop the motor with the keys on the keypad.	F02 E98 E99 E20-E24	Operation Method Terminal [FWD] Function Terminal [REV] Function Terminal [Y1] to [Y5A/C] Functions (***KP***)	5-65 5-111 5-128
External signals	Run or stop the motor with terminal commands ***FWD*** and ***REV*** assigned to terminals [FWD] and [REV] (2-wire operation).	F02 E98 E99	Operation Method Terminal [FWD] Function Terminal [REV] Function	5-65 5-111
	Run or stop the motor with terminal commands ***FWD***, ***REV***, and ***HOLD*** assigned to terminals [FWD], [REV], and [X1] to [X7] (3-wire operation).	F02 E98 E99 E01-E07	Operation Method Terminal [FWD] Function Terminal [REV] Function Terminal [X1] to [X7] Functions (***HLD***)	5-65 5-111

5.3.4 Starting/stopping the motor

To		Function code	Name	Refer to page:
Starting frequency	Start the motor smoothly.	F23 F24	Starting Frequency 1 Starting Frequency 1 (Holding time)	5-87
Auto search	Search for the idling motor speed to restart the motor without stopping and shock.	H09 H49 H46 E01-E07	Starting Mode (Auto search) (Auto search delay time 1) (Auto search delay time 2) Terminal [X1] to [X7] Functions (***STM***)	5-163 5-111
Pre-excitation	Compensate for insufficient torque (due to magnetic flux lag) at startup to accelerate the motor promptly.	H84 H85 E01-E07	Pre-excitation (Initial level) (Time) Terminal [X1] to [X7] Functions (***EXITE***)	5-184 5-111
Stopping the motor	Stop the motor smoothly. Prevent torque from being insufficient in a low speed zone when stopping the motor.	F25 F38 F39	Stop Frequency Stop Frequency (Detection mode) Stop Frequency (Holding time)	5-87
DC braking	Prevent the motor from running by inertia during decelerate-to-stop operation with DC braking.	F20 F21 F22 H95	DC Braking 1 (Braking starting frequency) (Braking level) (Braking time) DC Braking (Braking response mode)	5-85
	Apply DC braking with a terminal command sent from external equipment.	E01-E07	Terminal [X1] to [X7] Functions (***DCBRK***)	5-111
Forced stop	Forcedly stop the motor for safety.	H56 E01-E07	Deceleration Time for Forced Stop Terminal [X1] to [X7] Functions (***STOP***)	5-69 5-111
Coast to a stop	Use coast-to-stop for safety.	E01-E07	Terminal [X1] to [X7] Functions (***BX***)	5-111

5.3.5 Specifying the acceleration/deceleration (time, mode, and pattern)

To		Function code	Name	Refer to page:
Acceleration/ deceleration time	Accelerate or decelerate the motor within the specified time.	F07 F08	Acceleration Time 1 Deceleration Time 1	5-69
Switch between ACC/DEC times	Switch the acceleration or deceleration time.	E01-E07 E10 E11 E12 E13 E14 E15	Terminal [X1] to [X7] Functions (***RT1***, ***RT2***) Acceleration Time 2 Deceleration Time 2 Acceleration Time 3 Deceleration Time 3 Acceleration Time 4 Deceleration Time 4	5-111 5-69

To		Function code	Name	Refer to page:
Coast-to-stop	Allow the motor to coast to a stop when the run command is turned OFF in order to minimize the variation of deceleration torque.	H11	Deceleration Mode	5-165
	Allow the motor to coast to a stop in order to prevent conflict with the mechanical brake.			
S-curve acceleration/ deceleration	Apply S-curve to the acceleration/deceleration pattern to gradually accelerates/decelerates the motor to reduce an impact that acceleration/deceleration would make on the machinery.	H07 H57 H58 H59 H60	Acceleration/Deceleration Pattern 1st S-curve acceleration range (Leading edge) 2nd S-curve acceleration range (Trailing edge) 1st S-curve deceleration range (Leading edge) 2nd S-curve deceleration range (Trailing edge)	5-69
Curvilinear acceleration/ deceleration	Select the curvilinear acceleration/ deceleration pattern to accelerate or decelerate the motor with its maximum performance.	H07	Acceleration/Deceleration Pattern	5-69
Acceleration/ deceleration with the torque limiter	Enable the torque limiter during acceleration/ deceleration to run the motor with its maximum performance or arbitrary performance.	F40 F41 E16 E17 H73 H76	Torque Limiter 1-1 Torque Limiter 1-2 Torque Limiter 2-1 Torque Limiter 2-2 Torque Limiter (Operating conditions) Torque Limiter (Frequency increment limit for braking)	5-96
		E01-E07	Terminal [X1] to [X7] Functions (***TL2/TL1***)	5-111
		E20-E24	Terminals [Y1] to [Y5A/C] Functions (***IOL***, ***IOL2***)	5-128

5.3.6 Adjusting the running performance

To		Function code	Name	Refer to page:
V/f control	Select V/f control pattern suited for the machinery (load).	F37	Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1	5-93
	Configure V/f control pattern suited for the machinery (load) by specifying frequency or voltage components at arbitrary points.	 H50 H51 H52 H53 H65 H66	Non-linear V/f Pattern 1 (Frequency) (Voltage) Non-linear V/f Pattern 2 (Frequency) (Voltage) Non-linear V/f Pattern 3 (Frequency) (Voltage)	5-66
Torque boost	Ensure a sufficient starting torque.	F09	Torque Boost 1	5-93
	Prevent the motor from over-excitation while assuring a sufficient starting torque.	F37	Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1	5-93
Jump frequency	Skip resonance caused by the motor speed and natural frequency of the machinery (load) in running the motor.	C01-C04	Jump Frequency 1 to 4	5-150

To		Function code	Name	Refer to page:
Suppression of output current fluctuation	Suppress the fluctuation of the inverter output current.	H80	Output Current Fluctuation Damping Gain for Motor 1	5-181
Motor sound	Reduce an audible noise generated by the motor.	F26 F27	Motor Sound (Carrier frequency) (Tone)	5-90

5.3.7 Controlling the motor

5.3.7.1 Motor drive control to be selected

To		Function code	Name	Refer to page:
Drive control	Select the motor drive control (e.g., V/f or vector control) suited for the characteristics of the machinery (load).	F42	Drive Control Selection 1	5-103
Slip compensation	Improve the motor speed control accuracy by compensating for the decrease (slip) in motor rotation.	H68	Slip Compensation 1 (Operating conditions)	5-103
Speed control under vector control	Control the speed control sequence in normal operation.	d01 d02 d03 d04 d06	Speed Control 1 (Speed command filter) (Speed detection filter) P (Gain) I (Integral time) (Output filter)	5-212 5-213
	Apply a speed zero command.	d24	Zero Speed Control	5-87
	Apply a servo-lock command (Available only under vector control with speed sensor.)	E01-E07 E20-E24 J97 J98 J99	Terminal [X1] to [X7] Functions (***LOCK***) Terminals [Y1] to [Y5A/C] Functions (***PSET***) Servo-lock (Gain) (Completion timer) (Completion range)	5-111 5-128 5-210
	Control the speed control sequence for jogging operations to obtain higher speed response than that of normal operations.	d09 d10 d11 d12 d13	Speed control (Jogging) (Speed command filter) (Speed detection filter) P (Gain) I (Integral time) (Output filter)	5-214
	Customize the speed feedback input. (Available only under vector control with speed sensor.)	d14 d15 d16 d17	Feedback Input (Pulse input format) (Encoder pulse resolution) (Pulse count factor 1) (Pulse count factor 2)	5-215

To		Function code	Name	Refer to page:
Speed control under vector control	Switch the gain and other speed control parameters between two control modes.	A42 d25 E01-E07	Motor/Parameter Switching 2 ASR Switching Time Terminals [X1] to [X7] Functions (***M2***)	5-190 5-111
		 d01 d02 d03 d04 d06	Speed Control 1 (Speed command filter) (Speed detection filter) P (Gain) I (Integral time) (Output filter)	5-212
		 A43 A44 A45 A46 A48	Speed Control 2 (Speed command filter) (Speed detection filter) P (Gain) I (Integral time) (Output filter)	–
	Decrease the speed loop gain only in the vicinity of the predetermined resonance points, suppressing the mechanical resonance (Only under vector control with speed sensor)	 d07 d08	Speed Control 1 (Notch filter resonance frequency) (Notch filter attenuation level)	5-213
Speed Control Limiter	Specify a limiter for the PI value output calculated in speed control sequence. (Only under V/f control with speed sensor or dynamic torque vector with speed sensor)	d70	Speed Control Limiter	5-221
Torque Control	Control the motor-generating torque according to a torque command sent from external sources.	H18 E01-E07 E61-E63 E98, E99	Torque Control (Mode selection) Terminal [X1] to [X7] Functions Terminal [12], [C1], [V2] Extended Functions Terminal [FWD], [REV] Functions	– 5-111 5-146 5-111

5.3.7.2 Motor parameters to be set up

To	Function code	Name	Refer to page:
Use HP rating motors.	P99 P02 H03	Motor 1 Selection Motor 1 (Rated capacity) Data Initialization	5-159 5-155 5-160
Check the motor nameplate and specify the motor parameters.	P99 F04 F05 F06 F03 P01 P02 P03	Motor 1 Selection Base Frequency 1 Rated Voltage at Base Frequency 1 Maximum Output Voltage 1 Maximum Frequency 1 Motor 1 (No. of poles) (Rated capacity) (Rated current)	5-159 5-66 5-155
Perform motor parameter tuning (offline).	P04	Motor 1 (Auto-tuning)	5-156
Identify motor parameters covering the motor temperature change (online tuning) to decrease the motor speed fluctuation.	P05	Motor 1 (Online tuning)	5-165

To	Function code	Name	Refer to page:
Set up motor parameters according to tuning or the motor manufacturer's data sheet. (To use the data sheet, conversion is required.)	P06 P07 P08 P53, P54 P09 P10 P11 P12 P13-P15 P16-P20 P21-P23	Motor 1 (No-load current) (%R1) (%X) (%X correction factor 1, 2) (Slip compensation gain for driving) (Slip compensation response time) (Slip compensation gain for braking) (Rated slip frequency) (Iron loss factor 1 to 3) (Magnetic saturation factor 1 to 5) (Magnetic saturation extension factor "a" to "c")	5-157 5-159 5-158
	P55 P56	Motor 1 (Torque current under vector control) (Induced voltage factor under vector control)	5-159

5.3.8 Setting up I/O terminals

To		Function code	Name	Refer to page:
Assignment of functions to general-purpose input terminals	Assign functions (commands) to the digital input terminals to control the inverter.	E01-E07	Terminal [X1] to [X7] Functions	5-111
Assignment of functions to general-purpose output terminals	Output inverter or motor running status to the transistor or contact output signals.	E20-E24	Terminal [Y1] to [Y5A/C] Functions	5-128
Negative logic signaling system for general-purpose I/O terminals	Switch active-ON I/O signals to active-OFF ones, and vice versa.	E01-E07 E20-E24	Terminal [X1] to [X7] Functions Terminal [Y1] to [Y5A/C] Functions	5-111 5-128

5.3.9 Outputting monitored data

To		Function code	Name	Refer to page:
Analog output	Output various monitored data for meters in an analog DC voltage or current via terminal [FM1]/[FM2]	F29/F32 Slide switch SW4/SW6 F30/F34 F31/F35	Analog Output [FM1]/[FM2] (Mode selection) Voltage/current output switch for terminal [FM1]/[FM2] (Voltage adjustment) (Function)	5-91 2-26

5.3.10 Keeping on running the motor

To		Function code	Name	Refer to page:
Reset	Enable the auto-reset function that makes the inverter automatically attempt to reset the tripped state and restart even if an alarm occurs.	H04 H05 E20-E24	Auto-reset (Times) (Reset interval) Terminal [Y1] to [Y5A/C] Functions (***TRY***)	5-161 5-128
Restart after momentary power failure	Continue to run the motor even if a momentary power failure occurs. Restart the inverter at the frequency at which a power failure occurred. Restart the inverter at the starting frequency if a power failure occurs.	F14 H13 H14 H15 H16 H92 H93 E20-E24 E01-E07	Restart Mode after Momentary Power Failure (Mode selection) (Restart time) (Frequency fall rate) (Continuous running level) (Allowable momentary power failure time) Continuity of Running (P) Continuity of Running (I) Terminal [Y1] to [Y5A/C] Functions (***LU***) Terminal [X1] to [X7] Functions (***IL***)	5-76 5-128 5-111
	Search for the idling motor speed to restart the motor without stopping and shock after a momentary power failure.	H09 H46 d67	Starting Mode (Auto search) (Auto search delay time 2) (Auto search)	5-163
Automatic deceleration (Anti-regenerative control)	Prevent the inverter from tripping due to activation of the overvoltage protection in the system not equipped with a DB resistor.	H69 H76 E20-E24	Automatic Deceleration (Mode selection) Torque Limiter (Frequency increment limit for braking) Terminal [Y1] to [Y5A/C] Functions (***IOL***, ***IOL2***)	5-177 5-128
Improvement of the braking capability		H71	Deceleration Characteristics	5-179
Overload prevention control	Decelerate the output frequency in order to decrease the load before the inverter trips due to an overload (heat sink overheat or inverter overload).	H70 E20-E24	Overload Prevention Control Terminal [Y1] to [Y5A/C] Functions (***OLP***)	5-178 5-128
Detection of reference loss	Detect an external frequency command potentiometer failure or a potentiometer wire break, output an alarm, and continue the inverter operation.	E65 E20-E24	Reference Loss Detection (Continuous running frequency) Terminal [Y1] to [Y5A/C] Functions (***REF OFF***)	5-147 5-128
Light alarm	Let the inverter continue the current operation without tripping even if a particular minor alarm occurs.	H81 H82 E20-E24	Light Alarm Selection 1 Light Alarm Selection 2 Terminal [Y1] to [Y5A/C] Functions (***L-ALM***)	5-182 5-128

5.3.11 Outputting status signals

To		Function code	Name	Refer to page:
Detection of frequency	Detect the motor running speed level.	 E31 E32 E36 E54 E20-E24	Frequency Detection 1 (Level) (Hysteresis width) Frequency Detection 2 (Level) Frequency Detection 3 (Level) Terminal [Y1] to [Y5A/C] Functions (***FDT***, ***FDT2***, ***FDT3***)	5-139 5-128
Frequency arrival	Judge whether the motor speed arrives at the target value.	E30 E20-E24	Frequency Arrival (Hysteresis width) Terminal [Y1] to [Y5A/C] Functions (***FAR***, ***FAR3***)	5-138 5-128
Torque detection	Check that the output torque reaches the predetermined level and is not excessively large.	 E78 E79 E20-E24	Torque Detection 1 (Level) (Timer) Terminal [Y1] to [Y5A/C] Functions (***B/D***, ***TD1***)	5-148 5-128
Low torque detection	Detect low torque (no-load state) to signal a belt break or other problems in the driven machinery.	 E80 E81 E20-E24	Torque Detection 2/Low Torque Detection (Level) (Timer) Terminal [Y1] to [Y5A/C] Functions (***B/D***, ***U-TL***, ***TD2***)	5-148 5-128
Current detection	Check that the current more than the predetermined level flows and excessive current does not flow.	 E34 E35 E55 E56 E20-E24	Overload Early Warning/Current Detection (Level) (Timer) Frequency Detection 3 (Level) (Timer) Terminal [Y1] to [Y5A/C] Functions (***ID***, ***ID3***, ***OL***)	5-139 5-139 5-128
Low output current detection	Detect low torque (no-load state) to signal a belt break or other problems in the driven machinery.	 E37 E38 E20-E24	Current Detection 2/Low Current Detection (Level) (Timer) Terminal [Y1] to [Y5A/C] Functions (***ID2***, ***ITL***, ***IDL***)	5-139 5-128
Low voltage	Output low voltage status.	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***LU***)	5-128

5.3.12 Running in various operation modes

To		Function code	Name	Refer to page:
Jogging	Jog (inch) the motor with the keys on the keypad. Jog (inch) the motor with input signals to terminal [FWD] or [REV].	C20 H54 H55 E01-E07	Jogging Frequency Acceleration Time (Jogging) Deceleration Time (Jogging) Terminal [X1] to [X7] Functions (***JOG***)	5-152 5-69 5-111
Auto energy saving operation	Enable auto energy saving operation.	F37 H67	Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1 Auto Energy Saving Operation (Mode selection)	5-93
	Manage energy.	E51 E01-E07	Display Coefficient for Input Watt-hour Data Terminal [X1] to [X7] Functions (***SW50***, ***SW60***)	5-144 5-111
Commercial power switching sequence	Switch to commercial-power operation for energy saving or backup power supply to be used when an alarm occurs in the inverter.	J22 H13 E01-E07 E20-E24	Commercial Power Switching Sequence Restart Mode after Momentary Power Failure (Restart time) Terminal [X1] to [X7] Functions (***ISW50***, ***ISW60***) Terminal [Y1] to [Y5A/C] Functions (***SW88***, ***SW52-1***, ***SW52-2***)	5-206 5-165 5-111 5-128
Switching between motors	Drive two or more motors with a single inverter by switching between those motors.	A42 b42 r42 E01-E07 E20-E24	Motor/Parameter Switching 2 to 4 (Mode selection) Terminal [X1] to [X7] Functions (***M2***, ***M3***, ***M4***) Terminal [Y1] to [Y5A/C] Functions (***SWM1, 2, 3, 4***)	5-190 5-111 5-128
Brake signal	Use brake signals available for vertical carrier machines.	 J68 J69 J70 J71 J72 J95 J96 E20-E24	Brake Signal (Brake-OFF current) (Brake-OFF frequency/speed) (Brake-OFF timer) (Brake-ON frequency/speed) (Brake-ON timer) (Brake-OFF torque) (Speed selection) Terminal [Y1] to [Y5A/C] Functions (***BRKS***)	5-208 5-128
Switching between control parameters	Run the motor with control parameters suited for variable conditions (e.g., inertia) of the machinery equipped with gear change.	A42 b42 r42 E01-E07 E20-E24 d25	Motor/Parameter Switching 2 to 4 (Mode selection) Terminal [X1] to [X7] Functions (***M2***, ***M3***, ***M4***) Terminal [Y1] to [Y5A/C] Functions (***SWM1, 2, 3, 4***) ASR Switching Time	5-190 5-111 5-128 5-190

To		Function code	Name	Refer to page:
Synchronous operation	Perform synchronous operation using an optional PG interface card (OPC-G1-PG/ OPC-G1-PG22).	E01-E07 E20-E24	Terminal [X1] to [X7] Functions (***Hz2/Hz1***) Terminal [Y1] to [Y5A/C] Functions (***SY***)	5-111 5-128
		 d14 d15 d16 d17	Feedback Input (Pulse input format) (Encoder pulse resolution) (Pulse count factor 1) (Pulse count factor 2)	5-215
		d41	Application-defined Control	5-???
		 d59 d60 d61 d62 d63	Command (Pulse Rate Input) (Pulse input format) (Encoder pulse resolution) (Filter time constant) (Pulse count factor 1) (Pulse count factor 2)	5-???
		 d71 d72 d73 d74 d75 d76 d77 d78	Synchronous Operation (Main speed regulator gain) (APR P gain) (APR positive output limiter) (APR negative output limiter) (Z phase alignment gain) (Synchronous offset angle) (Synchronization completion detection angle) (Excessive deviation detection range)	5-???

5.3.13 Setting up controls suited for individual applications

5.3.13.1 Droop control

To	Function code	Name	Refer to page:
Eliminate load unbalance using droop control.	H28 E01-E07	Droop Control Terminals [X1] to [X7] Functions (***DROOP***)	5-169 5-111

5.3.13.2 PID process control

To		Code	Name	Refer to page:
Exercise process control for pressure, flow, temperature, etc.		J01	PID Control (Mode selection)	5-193
Normal/inverse operation	Switch between normal/reverse operation for the PID output in cooling and heating.	J01 E01-E07	PID Control (Mode selection) Terminal [X1] to [X7] Functions (***IVS***)	5-193 5-111
PID command	Specify a PID command using the keypad.	J02	PID Control (Remote command ***SV***)	5-194
	Specify a PID command with analog input.	J02 E61 E62 E63	PID Control (Remote command ***SV***) Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-194 5-146
		C51 C52	Bias (PID command 1) (Bias value) (Bias base point)	5-154
		C32 C34 C37 C39 C42 C44	Analog Input Adjustment for: [12] (Gain) [12] (Gain base point) [C1] (Gain) [C1] (Gain base point) [V2] (Gain) [V2] (Gain base point)	5-153
		C31 C36 C41	Analog Input Adjustment for: [12] (Offset) [C1] (Offset) [V2] (Offset)	5-153
		C33 C38 C43	Analog Input Adjustment for: [12] (Filter time constant) [C1] (Filter time constant) [V2] (Filter time constant)	5-153
		C35 C45	Analog Input Adjustment for: [12] (Polarity) [V2] (Polarity)	5-153
	Specify a PID command with ***UP*** or ***DOWN*** command.	J02 E01-E07 H61	PID Control (Remote command ***SV***) Terminal [X1] to [X7] Functions (***UP***, ***DOWN***) ***UP***/***DOWN*** Control (Initial frequency setting)	5-194 5-111 5-57
	Specify a PID command via a communications link.	J02	PID Control (Remote command ***SV***)	5-194

To		Code	Name	Refer to page:
PID command	Define two or more PID commands beforehand and switch between them with "Select multi-frequency" terminal commands.	J02 E01-E07 C08 C12 C16	PID Control (Remote command ***SV***) Terminal [X1] to [X7] Functions (***SS4***, ***SS8***) Multi-frequency 4 Multi-frequency 8 Multi-frequency 12	5-194 5-111 5-150
PID feedback	Set up analog input feedback for PID control.	E61 E62 E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-146
		C32 C34 C37 C39 C42 C44	Analog Input Adjustment for: [12] (Gain) [12] (Gain base point) [C1] (Gain) [C1] (Gain base point) [V2] (Gain) [V2] (Gain base point)	5-153
		C31 C36 C41	Analog Input Adjustment for: [12] (Offset) [C1] (Offset) [V2] (Offset)	5-153
		C33 C38 C43	Analog Input Adjustment for: [12] (Filter time constant) [C1] (Filter time constant) [V2] (Filter time constant)	5-153
PID optimization	Optimize the PID processor.	J03 J04 J05 J06 J56	PID Control P (Gain) I (Integral time) D (Differential time) (Feedback filter) (Speed command filter)	5-198 5-207
Anti reset windup	Suppress overshoot in control with the PID processor.	J10	PID Control (Anti reset windup)	5-204
Alarm output	Output an alarm signal associated with PID control (e.g., deviation alarm and absolute-value alarm).	J11 J12 J13 E20-E24	PID Control (Select alarm output) (Upper level alarm (AH)) (Lower level alarm (AL)) Terminal [Y1] to [Y5A/C] Functions (***PID-ALM***)	5-204 5-128
	Detect a wire break for PID feedback.	H91 E20-E24	PID Feedback Wire Break Detection Terminal [Y1] to [Y5A/C] Functions (***C1OFF***)	5-186 5-128
Slow flowrate stop feature	Use the slow flowrate stop feature, enabling energy saving operation.	J15 J16 J17 E20-E24 J08 J09	PID Control (Stop frequency for slow flowrate) (Slow flowrate level stop latency) (Starting frequency) Terminal [Y1] to [Y5A/C] Functions (***PID-STP***) PID Control (Pressurization starting frequency) PID Control (Pressurizing time)	5-202 5-128 5-202
Output limiter	Limit the PID output with the upper and lower limiters.	J18 J19	PID Control (Upper limit of PID process output) (Lower limit of PID process output)	5-206

Chap. 5 FUNCTION CODES

To		Code	Name	Refer to page:
PID control	Hold/reset the PID processor or cancel PID control from external equipment.	E01-E07	Terminal [X1] to [X7] Functions (***PID-HLD***, ***Hz/PID***, ***PID-RST***)	5-111
"Under PID control" signal output	Output the "Under PID control" signal from the specified output terminal.	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***PID-CTL***)	5-128
Display of process value	Convert a control amount into a physical quantity of the process and display it on the keypad.	E40 E41	PID Display Coefficient A PID Display Coefficient B	5-141

5.3.13.3 PID dancer control

To		Function code	Name	Refer to page:
Exercise speed control for dancer positioning, etc.		J01 J62	PID Control (Mode selection) (PID control block selection)	5-193 5-207
PID command	Specify a PID command using the keypad.	J02 J57	PID Control (Remote command ***SV***) (Dancer reference position)	5-194 5-207
	Specify a PID command with analog input.	J02 E61 E62 E63	PID Control (Remote command ***SV***) Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-194 5-146
		C51 C52	Bias (PID command 1) (Bias value) (Bias base point)	5-154
		C32 C34 C37 C39 C42 C44	Analog Input Adjustment for: [12] (Gain) [12] (Gain base point) [C1] (Gain) [C1] (Gain base point) [V2] (Gain) [V2] (Gain base point)	5-153
		C31 C36 C41	Analog Input Adjustment for: [12] (Offset) [C1] (Offset) [V2] (Offset)	5-153
		C33 C38 C43	Analog Input Adjustment for: [12] (Filter time constant) [C1] (Filter time constant) [V2] (Filter time constant)	5-153
		C35 C45	Analog Input Adjustment for: [12] (Polarity) [V2] (Polarity)	5-153
	Specify a PID command with ***UP*** or ***DOWN*** command.	J02 E01-E07 H61	PID Control (Remote command ***SV***) Terminal [X1] to [X7] Functions (***UP***, ***DOWN***) ***UP***/***DOWN*** Control (Initial frequency setting)	5-194 5-111 5-57
	Specify a PID command via a communications link.	J02	PID Control (Remote command ***SV***)	5-194

To		Function code	Name	Refer to page:
PID command	Define two or more PID commands beforehand and switch between them with "Select multi-frequency" terminal commands.	J02 E01-E07 C08 C12 C16	PID Control (Remote command ***SV***) Terminal [X1] to [X7] Functions (***SS4***, ***SS8***) Multi-frequency 4 Multi-frequency 8 Multi-frequency 12	5-194 5-111 5-150
PID feedback	Set up analog input feedback for PID control.	E61 E62 E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-146
		C32 C34 C37 C39 C42 C44	Analog Input Adjustment for: [12] (Gain) [12] (Gain base point) [C1] (Gain) [C1] (Gain base point) [V2] (Gain) [V2] (Gain base point)	5-153
		C31 C36 C41	Analog Input Adjustment for: [12] (Offset) [C1] (Offset) [V2] (Offset)	5-153
		C33 C38 C43	Analog Input Adjustment for: [12] (Filter time constant) [C1] (Filter time constant) [V2] (Filter time constant)	5-153
PID optimization	Optimize the PID processor.	J03 J04 J05 J06 J56	PID Control P (Gain) I (Integral time) D (Differential time) (Feedback filter) (Speed command filter)	5-198 5-207
	Switch the PID processor constants if the dancer roll comes into the vicinity of the target position.	J58 J59 J60 J61	PID Control (Detection width of dancer position deviation) P (Gain) 2 I (Integral time) 2 D (Differential time) 2	5-207
Anti reset windup	Suppress overshoot in control with the PID processor.	J10	PID Control (Anti reset windup)	5-204
Alarm output	Output an alarm signal associated with PID control (e.g., deviation alarm and absolute-value alarm).	J11 J12 J13 E20-E24	PID Control (Select alarm output) (Upper level alarm (AH)) (Lower level alarm (AL)) Terminal [Y1] to [Y5A/C] Functions (***PID-ALM***)	5-204 5-128
	Detect a wire break for PID feedback.	H91 E20-E24	PID Feedback Wire Break Detection Terminal [Y1] to [Y5A/C] Functions (***C1OFF***)	5-186 5-128
Output limiter	Limit the PID output with the upper and lower limiters.	J18 J19	PID Control (Upper limit of PID process output) (Lower limit of PID process output)	5-206
PID control	Hold/reset the PID processor or cancel PID control from external equipment.	E01-E07	Terminal [X1] to [X7] Functions (***PID-HLD***, ***Hz/PID***, ***PID-RST***)	5-111

To		Function code	Name	Refer to page:
"Under PID control" signal output	Output the "Under PID control" signal from the specified output terminal.	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***PID-CTL***)	5-128
Display of process value	Convert a control amount into a physical quantity of the process and display it on the keypad.	E40 E41	PID Display Coefficient A PID Display Coefficient B	5-141
Constant peripheral speed control	Select constant peripheral speed control that suppresses an increase in peripheral speed (line speed) resulting from the increasing radius of the take-up roll in a winder system.	d41 E01-E07	Application-defined Control Terminal [X1] to [X7] Functions	5-218 5-111

5.3.14 Customizing the keypad

To	Function code	Name	Refer to page:
Protect function code data from accidentally getting changed.	F00 E01-E07	Data Protection Terminal [X1] to [X7] Functions (***WE-KP***)	5-56 5-111
Revert function code data to the initial values.	H03	Data Initialization	5-160
Initialize motor parameters.			
Remove restrictions on the menu display to use various checking functions on the keypad.	E52	Keypad (Menu display mode)	5-145
Suppress fluctuation of unstable, hard-to-read display on the keypad.	E42	LED Display Filter	5-142
Specify the running status item to be monitored and displayed on the LED monitor.	 E43 E48	LED Monitor (Item selection) (Speed monitor item)	5-143
Display the output frequency even when the inverter is stopped.	E44	LED Monitor (Display when stopped)	5-144
Set up the display items for the multi-function keypad.	 E45 E46 E47	LCD Monitor (Item selection) (Language selection) (Contrast control)	–
Receive external analog sensor signals from sensors and convert their values into physical quantities to display.	E61 E62 E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-146
	E40 E41	PID Display Coefficient A PID Display Coefficient B	5-141
Display the load shaft speed and line speed.	E50	Coefficient for Speed Indication	5-144
Display the input watt-hour data (kWh) multiplied by a display coefficient.	E51	Display Coefficient for Input Watt-hour Data	5-144
Convert a PID command and its feedback into physical quantities to display.	E40 E41	PID Display Coefficient A PID Display Coefficient B	5-141

5.3.15 Controlling the inverter via communications line

To	Function code	Name	Refer to page:
Specify communications conditions.		RS-485 Communication 1	5-244
	y01	(Station address)	
	y02	(Communications error processing)	
	y03	(Timer)	
	y04	(Baud rate)	
	y05	(Data length)	
	y06	(Parity check)	
	y07	(Stop bits)	
	y08	(No-response error detection time)	
	y09	(Response interval)	
	y10	(Protocol selection)	
	SW3	< Switching the terminating resistor of the RS-485 communications port 1 >	2-26
		RS-485 Communication 2	5-244
	y11	(Station address)	
	y12	(Communications error processing)	
	y13	(Timer)	
	y14	(Baud rate)	
	y15	(Data length)	
	y16	(Parity check)	
	y17	(Stop bits)	
	y18	(No-response error detection time)	
	y19	(Response interval)	
	y20	(Protocol selection)	
	SW2	< Switching the terminating resistor of the RS-485 communications port 2 >	2-26
Specify the sources of run and frequency commands.	H30	Communications Link Function (Mode selection)	5-170
	y98	Bus Link Function (Mode selection)	5-247
	y99	Loader Link Function (Mode selection)	5-248
Change function code data frequently via the communications link.	y97	Communication Data Storage Selection	5-247
Switch between frequency or run commands via the communications link.	E01-E07	Terminal [X1] to [X7] Functions (***LE***)	5-111
Use inverter input/output signals as general-purpose DI/DO.	E01-E07	Terminal [X1] to [X7] Functions (***U-DI***)	5-111
	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***U-DO***)	5-128

5.3.16 Using the customizable logic

To	Function code	Name	Refer to page:
Enable the sequence configured by the customizable logic function. *2	U00	Customizable Logic (Mode selection)	5-222
Form a logic circuit for digital input/output signals, modify them arbitrarily, and configure a simple relay sequence inside the inverter.	U01-U50 U71-U75 U81-U85 U91	Customizable Logic: Steps 1 to 10 (Mode selection) Customizable Logic Output Signals 1 to 5 (Output selection) Customizable Logic Output Signals 1 to 5 (Function selection) Customizable Logic Timer Monitor (Step selection)	5-222
	E01-E07	Terminal [X1] to [X7] Functions	5-111
	E20-E27	Terminal [Y1] to [Y4] Functions Terminal [Y5A/C] Function Terminal [30A/B/C] Function (Relay output)	5-128
	E98, E99	Terminal [FWD], [REV] Functions	5-111

5.3.17 Activating the protective functions

5.3.17.1 Protection of machinery with limiters

To	Function code	Name	Refer to page:
Limit the frequency to protect the machinery.	F15 F16 H63	Frequency Limiter (High) (Low) Low Limiter (Mode selection)	5-84
	F03	Maximum Frequency 1	5-66
	H64	Low Limiter (Lower limiting frequency)	5-177
Limit the motor rotational direction to protect the machinery.	H08	Rotational Direction Limitation	5-163
Limit the motor output torque with the current limiter to protect the machinery.	F43 F44 E20-E24	Current Limiter (Mode selection) (Level) Terminal [Y1] to [Y5A/C] Functions (***IOL***, ***IOL2***)	5-106 5-128

To	Function code	Name	Refer to page:
Limit the motor output torque with the torque limiter to protect the machinery.	F40 F41 E16 E17	Torque Limiter 1-1 Torque Limiter 1-2 Torque Limiter 2-1 Torque Limiter 2-1	5-96
	E61 E62 E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	5-146
	 H73 H74 H75 H76	Torque Limiter (Operating conditions) (Control target) (Target quadrants) (Frequency increment limit for braking)	5-96
	E01-E07	Terminal [X1] to [X7] Functions (***TL2/TL1***)	5-111
	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***IOL***, ***IOL2***)	5-128
Limit the overspeed level with the speed limiter to protect the machinery.	 d32 d33	Torque control (Speed limit 1) (Speed limit 2)	5-218

5.3.17.2 Protection of motors

To		Function code	Name	Refer to page:
Electronic thermal overload protection	Protect the motor with the electronic thermal overload protection function.	 F10 F11 F12	Electronic Thermal Overload Protection for Motor 1 (Select motor characteristics) (Overload detection level) (Thermal time constant)	5-72
Overload early warning	Output an overload early warning before the inverter trips with the electronic thermal overload protection.	 F10 F12	Electronic Thermal Overload Protection for Motor 1 (Select motor characteristics) (Thermal time constant)	5-72
		E34	Overload Early Warning/Current Detection (Level)	5-139
		E20-E24	Terminal [Y1] to [Y5A/C] Functions (***OL***)	5-128
Motor overheat	Protect the motor from overheating with the PTC or NTC thermistor embedded in the motor.	 H26 H27	Thermistor (for motor) (Mode selection) (Level)	5-168
	Use the Fuji motor exclusively designed for vector control having a built-in NTC thermistor.	SW5	< Switching the terminal [C1] function between C1 and PTC/NTC >	2-26
Detection with thermistor	Detect the current voltage with the PTC thermistor embedded in the motor and issue an alarm.	 H26 H27	Thermistor (for motor) (Mode selection) (Level)	5-168
		SW5	< Switching the terminal [C1] function between C1 and PTC/NTC >	2-26
		E20-E24	Terminal [Y1] to [Y5A/C] Functions (***THM***)	5-128

To		Function code	Name	Refer to page:
Dew condensation prevention	Prevent the motor being stopped from dew condensation by feeding DC power when the motor is used in cold climates.	J21 F21 F22 E01-E07	Dew Condensation Prevention (Duty) DC Braking 1 (Braking level) (Braking time) Terminal [X1] to [X7] Functions (***DWP***)	5-206 5-85 5-111

5.3.17.3 Using other protective and safety functions

To		Function code	Name	Refer to page:
Trip after momentary power failure (No restart)	Trip the inverter immediately if a momentary power failure occurs. Shut down the inverter output immediately to allow the motor to coast to a stop without trip if a momentary power failure occurs. Trip the inverter when the power is restored. Decelerate the motor to a stop immediately if a momentary power failure occurs. Trip the inverter after the frequency drops down to zero.	F14 H15 H92 H93 E20-E24 E01-E07	Restart Mode after Momentary Power Failure (Mode selection) (Continuous running level) Continuity of Running (P) Continuity of Running (I) Terminal [Y1] to [Y5A/C] Functions (***LU***, ***IPF***) Terminal [X1] to [X7] Functions (***IL***)	5-76 5-128 5-111
External alarm	Shut down the inverter output immediately in the event of an abnormal situation in peripheral equipment.	E01-E07	Terminal [X1] to [X7] Functions (***THR***)	5-111
Protective/ maintenance functions	Enable or disable the following functions. - Automatic lowering of carrier frequency - Input/output phase loss protection - Judgment on the life of DC link bus capacitor - DC fan lock detection - Braking transistor failure detection	H98	Protection/Maintenance Function (Mode selection)	5-187
Braking resistor	Use an external braking resistor and protect it with the electronic thermal overload protection function.	F50 F51 F52	Electronic Thermal Overload Protection for Braking Resistor (Discharging capability) (Allowable average loss) (Resistance)	5-107
Braking transistor	Detect a breakdown of the braking resistor to protect the inverter.	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***DBAL***)	5-128
Communications error	Detect a communications error.	y02 y03 y08 y12 y13 y18	RS-485 Communication 1 (Communications error processing) (Timer) (No-response error detection time) RS-485 Communication 2 (Communications error processing) (Timer) (No-response error detection time)	5-244
PID feedback wire break	Stop the system if a PID feedback wire breaks (current input on [C1]).	H91	PID Feedback Wire Break Detection	5-186

To		Function code	Name	Refer to page:
Speed deviation out of the specified range	Detect that a deviation between the reference speed and detected one is out of the specified range.	 d21 d22 d23 E20-E24	Speed Agreement/PG Error (Hysteresis width) (Detection timer) PG Error Processing Terminal [Y1] to [Y5A/C] Functions (***PG-ERR***)	5-217 5-128
PG error (PG wire break)	Detect a PG error such as a PG wire break.	 d21 d22 E20-E24	Speed Agreement/PG Error (Hysteresis width) (Detection timer) Terminal [Y1] to [Y5A/C] Functions (***PG-ERR***)	5-217 5-128
	Ignore a PG wire break alarm.	E01-E07	Terminal [X1] to [X7] Functions (***PG-CCL***)	5-111
Forced stop	Use the forced stop function for safety.	H56 E01-E07	Deceleration Time for Forced Stop Terminal [X1] to [X7] Functions (***STOP***)	5-69 5-111
Coast to a stop	Use the coast-to-stop function for safety.	E01-E07	Terminal [X1] to [X7] Functions (***BX***)	5-111
STOP key priority	Always enable the STOP key for safety.	H96	STOP Key Priority/Start Check Function	5-186
Start check function	Check in specified situation changes whether any run command has been turned ON for safety. This is to prevent the motor from running suddenly.	H96	STOP Key Priority/Start Check Function	5-186
Heat sink overheat early warning	Issue a heat sink overheat early warning before an overheat trip actually happens.	E20-E24	Terminal [Y1] to [Y5A/C] Functions (***OH***)	5-128
Cancel of current limit processing	Cancel the current limit processing if invoking it drops the motor toque temporarily, causing a problem.	H12	Instantaneous Overcurrent Limiting (Mode selection)	5-106
Alarm	Clear alarm history and relevant information stored in the inverter.	E01-E07 H97 E20-E24	Terminal [X1] to [X7] Functions Clear Alarm Data Terminal [Y1] to [Y5A/C] Functions	5-111 5-187 5-128
	Cause the inverter to generate a mock alarm.	H45	Mock Alarm	5-176

Chap. 5 FUNCTION CODES

5.3.18 Maintenance

5.3.18.1 Maintenance of inverters

To		Function code	Name	Refer to page:
Service life of DC link bus capacitor	Set up the load conditions that match the actual operating conditions at the user site for measuring the service life of the DC link bus capacitor.	H42 H47	Capacitance of DC Link Bus Capacitor Initial Capacitance of DC Link Bus Capacitor	5-172
Judgment on service life	Disable the judgment on the service life of the DC link bus capacitor, if accurate measurement of the capacitance is not available due to the use of auxiliary input for control power.	H98	Protection/Maintenance Function (Mode selection)	5-187
Cooling fan ON/OFF control	Prolong the service life of the inverter cooling fans and reduce fan noise during the inverter stop.	H06 E20-E24	Cooling Fan ON/OFF Control Terminal [Y1] to [Y5A/C] Functions (***FAN***, ***LIFE***)	5-162 5-128

5.3.18.2 Maintenance of machinery

To		Function code	Name	Refer to page:
Cumulative motor run time	Check the cumulative motor run time.	H94	Cumulative Motor Run Time 1	5-180
	Count the cumulative motor run time even when the motor is driven by commercial power.	E01-E07	Terminal [X1] to [X7] Functions (***CRUN-M1, M2, M3, M4***)	5-111
Startup count for motor	Check the startup count for judging the service life of the drive belt used in the machinery if the belt deteriorates due to the starting torque applied every time of startups.	H44	Startup Counter for Motor 1	5-175
Maintenance timer	Signal the need of the maintenance, based on the cumulative motor run time.	H78 E20-E24	Maintenance Interval (M1) Terminal [Y1] to [Y5A/C] Functions (***MNT***)	5-180 5-128
	Signal the need of the maintenance, based on the inverter startup count.	H79 E20-E24	Preset Startup Count for Maintenance (M1) Terminal [Y1] to [Y5A/C] Functions (***MNT***)	5-181 5-128
Switching between remote and local modes	Separate the inverter from the system and drive it with commands entered from the keypad, for maintenance.	E01-E07 E20-E24	Terminal [X1] to [X7] Functions (***LOC***) Terminal [Y1] to [Y5A/C] Functions (***RMT***)	5-111 5-128

5.4 Details of Function Codes

This section provides the details of the function codes. The descriptions are, in principle, arranged in the order of function code groups and in numerical order. However, highly relevant function codes are collectively described where one of them first appears.

5.4.1 F codes (Fundamental functions)

F00	Data Protection

F00 specifies whether to protect function code data (except F00) and digital reference data (such as frequency command and PID command) from accidentally getting changed by pressing the ⌃ / ⌄ keys on the keypad.

Data for F00	Changing function code data		Changing digital reference data with the ⌃ / ⌄ keys
	From the keypad	Via communications link	
0	Allowed	Allowed	Allowed
1	Not allowed *	Allowed	Allowed
2	Allowed	Allowed	Not allowed
3	Not allowed *	Allowed	Not allowed

*Only F00 data can be modified with the keypad, while all other function codes cannot.

To change F00 data, simultaneous keying of STOP + ⌃ (from 0 to 1) or STOP + ⌄ (from 1 to 0) keys is required.

For similar purposes, ***WE-KP***, a signal enabling editing of function code data from the keypad is provided as a terminal command for digital input terminals. (Refer to the descriptions of E01 through E07. data = 19)

The relationship between the terminal command ***WE-KP*** and F00 data are as shown below.

WE-KP	Changing function code data	
	From the keypad	Via communications link
OFF	Not allowed	Allowed
ON	Follow the F00 setting	

Note
- If you mistakenly assign a ***WE-KP*** to any digital input terminal, you can no longer edit or modify function code data. In such a case, temporarily turn this ***WE-KP***-assigned terminal ON and reassign the ***WE-KP*** to a correct command.
- ***WE-KP*** is only a signal that allows you to change function code data, so it does not protect the frequency settings or PID command specified by the ⌃ and ⌄ keys.

Tip
Even when F00 = 1 or 3, function code data can be changed via the communications link.

F01	Frequency Command 1	F18 (Bias, Frequency command 1) C30 (Frequency Command 2) C31 to C35 (Analog Input Adjustment for [12]) C36 to C39 (Analog Input Adjustment for [C1]) C41 to C45 (Analog Input Adjustment for [V2]) C50 (Bias (Frequency command 1), Bias base point) H61 (*UP/DOWN* Control, Initial frequency setting) d59, d61 to d63 (Command (Pulse Rate Input))

F01 or C30 sets the command source that specifies reference frequency 1 or reference frequency 2, respectively.

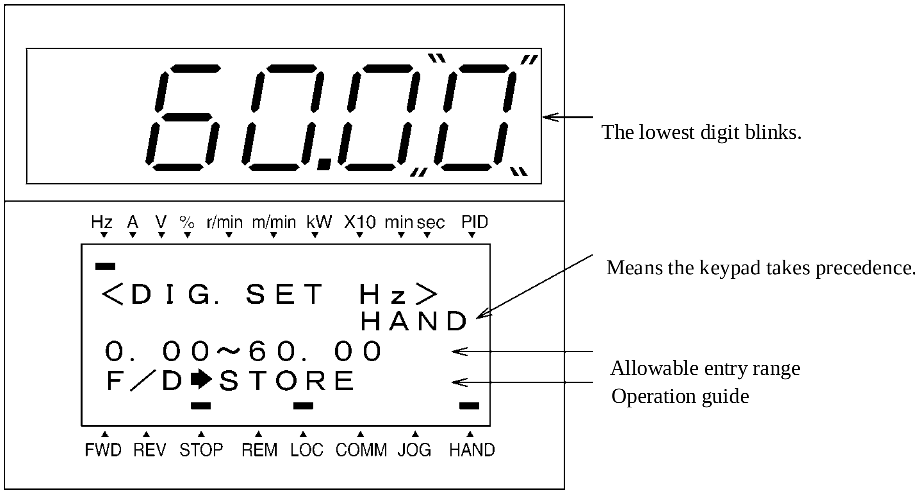
Data for F01, C30	Function
0	Enable ∧ / ∨ keys on the keypad.
1	Enable the voltage input to terminal [12] (0 to ±10 VDC, maximum frequency obtained at ±10 VDC).
2	Enable the current input to terminal [C1] (+4 to +20 mA DC, maximum frequency obtained at +20 mA DC). (SW5 on the control circuit board should be turned to the C1 position (factory default).)
3	Enable the sum of voltage (0 to ±10 VDC) and current inputs (+4 to +20 mA DC) given to terminals [12] and [C1], respectively. See the two items listed above for the setting range and the value required for maximum frequencies. Note: If the sum exceeds the maximum frequency (F03), the maximum frequency will apply.
5	Enable the voltage input to terminal [V2] (0 to ±10 VDC, maximum frequency obtained at ±10 VDC).
7	Enable ***UP*** and ***DOWN*** commands assigned to digital input terminals. The ***UP*** and ***DOWN*** should be assigned to any of digital input terminals [X1] to [X7] beforehand with any of E01 to E07 (data = 17, 18).
8	Enable ∧ / ∨ keys on the keypad (balanceless-bumpless switching available).
11	Enable a digital input interface card (option). (For details, refer to the Digital Input Interface Card Instruction Manual.)
12	Enable the "Pulse train input" ***PIN*** command assigned to digital input terminal [X7] with E07 (data = 48), or the optional PG interface card.

Configuring a reference frequency

[1] Using ∧ and ∨ keys (F01 = 0 (factory default) or 8)

(1) Set function code F01 at "0" or "8" (∧ / ∨ keys on keypad). This cannot be done when the keypad is in Programming or Alarm mode. To enable frequency setting using the ∧ and ∨ keys, first place the keypad in Running mode.

(2) Press the ∧ or ∨ key. The 7-segment LED monitor displays the reference frequency and the LCD monitor displays the related information including the operation guide, as shown below.



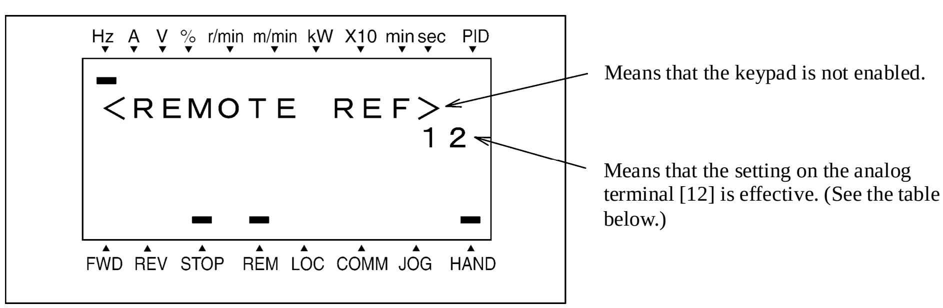
Example of Reference Frequency Configuration Screen

(3) To change the reference frequency, press the ∧ or ∨ key again. To save the new setting into the inverter's memory, press the FUNC/DATA key (when E64 = 1 (factory default)). When the power is turned ON next time, the new setting will be used as an initial reference frequency.

In addition to saving with the FUNC/DATA key described above, "Automatic saving when the main power is turned OFF" is also possible (when E64 = 0).

Tip

- When you start accessing the reference frequency or any other parameter with the ∧ and ∨ keys, the least significant digit on the display blinks and starts changing. As you are holding down the key, blinking gradually moves to the upper digit places and the upper digits becomes changeable.
- Pressing the SHIFT key moves the changeable digit place (blinking), making it easy to change upper digits.
- Setting function code C30 at "0" (Enable ∧ / ∨ keys on the keypad) and selecting frequency command 2 as a frequency command source makes it possible to access the reference frequency in the same manner using the ∧ and ∨ keys.
- If you have set function code F01 at "0" (∧ / ∨ keys on keypad) but have selected a frequency command source other than frequency 1 (i.e., frequency 2, via communications link, or as a multi-frequency), then using the ∧ or ∨ key cannot change the frequency command even if the keypad is in Running mode. Pressing either of these keys just displays the currently selected frequency command.
- Setting function code F01 at "8" (∧ / ∨ keys on keypad) enables the balanceless-bumpless switching. When the frequency command source is switched to the keypad from any other source, the inverter inherits the current frequency that has applied before switching, providing smooth switching and shockless running.
- When the frequency command source is other than the digital reference setting, the LCD monitor displays the following.



The table below lists the available command sources and their symbols.

Available Command Sources

Symbol	Command source	Symbol	Command source	Symbol	Command source
HAND	Keypad	MULTI	Multi-frequency	PID-HAND	PID keypad command
12	Terminal [12]			PID-P1	PID command 1 (Analog command)
C1	Terminal [C1]	RS485-1	RS-485 (Port 1) *1	PID-P2	PID command 2 (Analog command)
12 + C1	Terminal [12] + Terminal [C1]	RS485-2	RS-485 (Port 2) *2	PID-U/D	PID UP/DOWN command
V2	Terminal [V2]	BUS	Bus option	PID_LINK	PID communications command
U/D	UP/DOWN control	LOADER	Inverter support software "FRENIC Loader"	PID+MULTI	PID multi-frequency command

*1 COM port 1 which refers to the RJ-45 connector on the inverter.
*2 COM port 2 which is on the inverter's terminal block.

[2] Using analog input (F01 = 1 to 3, or 5)

When any analog input (voltage input to terminals [12] and [V2], or current input to terminal [C1]) is selected by F01, it is possible to arbitrarily specify the reference frequency by multiplying the gain and adding the bias. The polarity can be selected and the filter time constant and offset can be adjusted.

Adjustable elements of frequency command 1

Data for F01	Input terminal	Input range	Bias		Gain		Polarity	Filter time constant	Offset
			Bias	Base point	Gain	Base point			
1	[12]	0 to +10 V, -10 to +10V	F18	C50	C32	C34	C35	C33	C31
2	[C1]	4 to 20 mA	F18	C50	C37	C39	-	C38	C36
3	[12] + [C1] (Sum of the two values)	0 to +10 V, -10 to +10 V	F18	C50	C32	C34	C35	C33	C31
		4 to 20 mA	F18	C50	C37	C39	-	C38	C36
5	[V2]	0 to +10 V, -10 to +10 V	F18	C50	C42	C44	C45	C43	C41

■ Offset (C31, C36, C41)

C31, C36 or C41 specifies an offset for analog input voltage or current. The offset also applies to signals sent from the external equipment.

■ Filter time constant (C33, C38, C43)

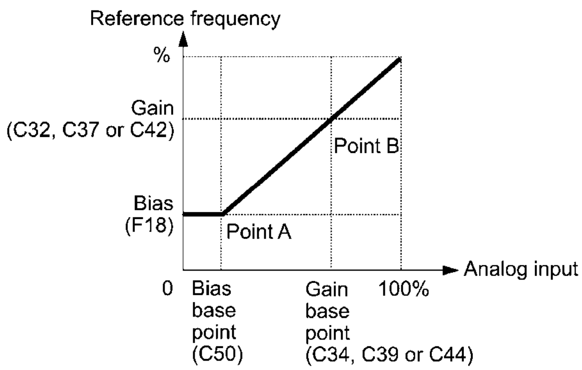
C33, C38, or C43 specifies a filter time constant for analog input voltage or current. Choose an appropriate value for the time constant taking into account the response speed of the machinery system since a large time constant slows down the response. When the input voltage fluctuates due to noise, specify a larger time constant.

■ Polarity (C35, C45)

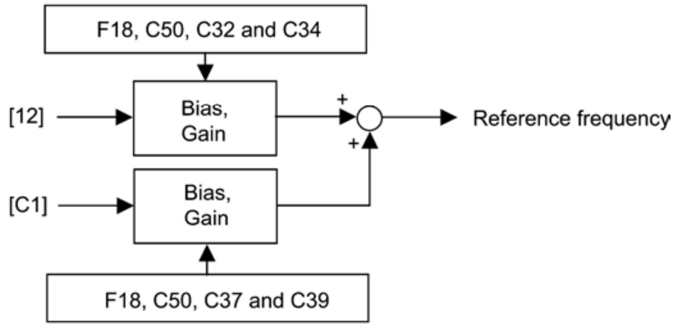
C35 or C45 specifies the input range for analog input voltage.

Data for C35/C45	Terminal input specifications
0	-10 to +10 VDC
1	0 to +10 VDC (negative value of voltage is regarded as 0 V)

■ Gain and bias



Note If F01 = 3 (the sum of [12] + [C1] is enabled), the bias and gain are independently applied to each of the voltage and current inputs given to terminals [12] and [C1], and the sum of the two values is applied as the reference frequency.



In the case of unipolar input
(terminal [12] with C35 = 1, terminal [C1], terminal [V2] with C45 = 1)

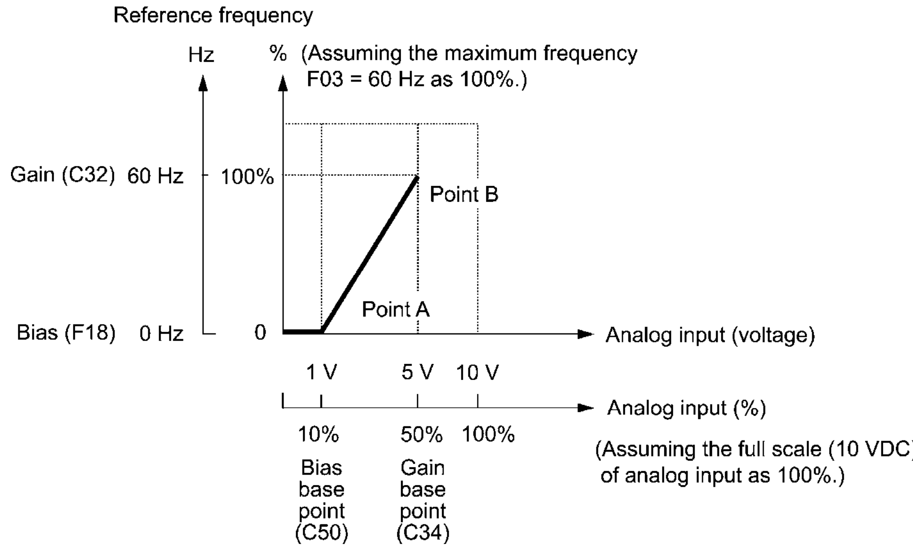
As shown in the graph above, the relationship between the analog input and the reference frequency specified by frequency command 1 is determined by points "A" and "B." Point "A" is defined by the combination of the bias (F18) and its base point (C50); Point "B," by the combination of the gain (C32, C37 or C42) and its base point (C34, C39 or C44).

The combination of C32 and C34 applies to terminal [12], that of C37 and C39, to [C1], and that of C42 and C44, to [V2].

Configure the bias (F18) and gain (C32, C37 or C42), assuming the maximum frequency as 100%, and the bias base point (C50) and gain base point (C34, C39 or C44), assuming the full scale (10 VDC or 20 mA DC) of analog input as 100%.

Note
- The analog input less than the bias base point (C50) is limited by the bias value (F18).
- Specifying that the data of the bias base point (C50) is equal to or greater than that of each gain base point (C34, C39 or C44) will be interpreted as invalid, so the inverter will reset the reference frequency to 0 Hz.

Example: Setting the bias, gain, and their base points when the reference frequency 0 to 60 Hz follows the analog input of 1 to 5 VDC applied on terminal [12] with the maximum frequency 60 Hz (F03)



(Point A)

To set the reference frequency to 0 Hz for an analog input being at 1 V, set the bias to 0% (F18 = 0). Since 1 V is the bias base point and it is equal to 10% of 10 V (full scale of terminal [12]), set the bias base point to 10% (C50 = 10).

(Point B)

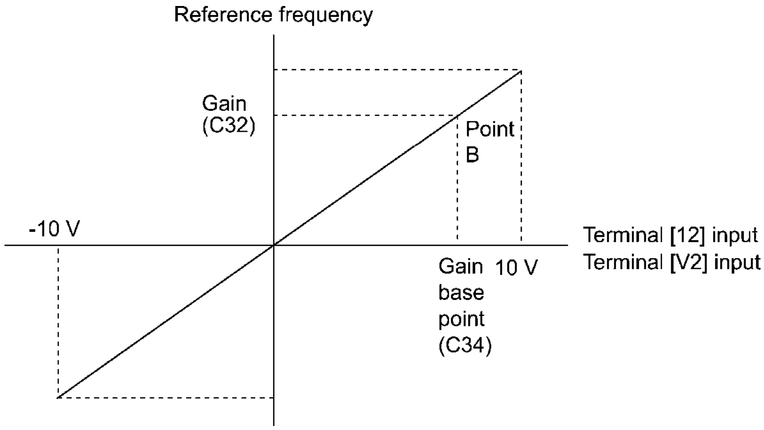
To specify the maximum frequency equal to the reference frequency for an analog input being at 5 V, set the gain to 100% (C32 = 100). Since 5 V is the gain base point and it is equal to 50% of 10 V (full scale of terminal [12]), set the gain base point to 50% (C34 = 50).

Note: The setting procedure for specifying a gain or bias alone without changing any base points is the same as that of Fuji conventional inverters of FRENIC5000G11S/P11S series, FVR-E11S series, etc.

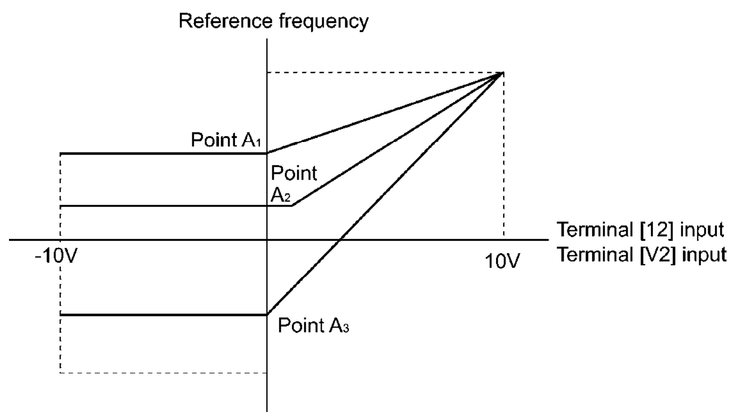
In the case of bipolar input
(terminal [12] with C35 = 0, terminal [V2] with C45 = 0)

Setting C35 and C45 data to "0" enables terminals [12] and [V2] to be used for bipolar input (-10 V to +10 V), respectively.

When both F18 (Bias) and C50 (Bias base point) are set to "0," the negative and positive voltage inputs produce reference frequencies symmetric about the origin point as shown below.



Note: Configuring F18 (Bias) and C50 (Bias base point) to specify an arbitrary value (Points A1, A2, and A3) gives the bias as shown below.



Note:

- To input bipolar analog voltage (0 to ±10 VDC) to terminals [12] and [V2], set C35 and C45 data to "0." Setting C35 and C45 data to "1" enables the voltage range from 0 to +10 VDC and interprets the negative polarity input from 0 to -10 VDC as 0 V.
- A reference frequency can be specified not only with the frequency (Hz) but also with other menu items, depending on the setting of function code E48 (= 3 to 5, or 7).

[3] Using digital input signals *UP/DOWN* (F01 = 7)

When ***UP/DOWN*** control is selected for frequency setting with a run command ON, turning the terminal command ***UP*** or ***DOWN*** ON causes the output frequency to increase or decrease, respectively, within the range from 0 Hz to the maximum frequency as listed below.

To enable ***UP/DOWN*** control for frequency setting, it is necessary to set F01 data to "7" and assign the ***UP*** and ***DOWN*** commands to any of digital input terminals [X1] to [X7], [FWD] and [REV] with any of E01 to E07 (data = 17, 18).

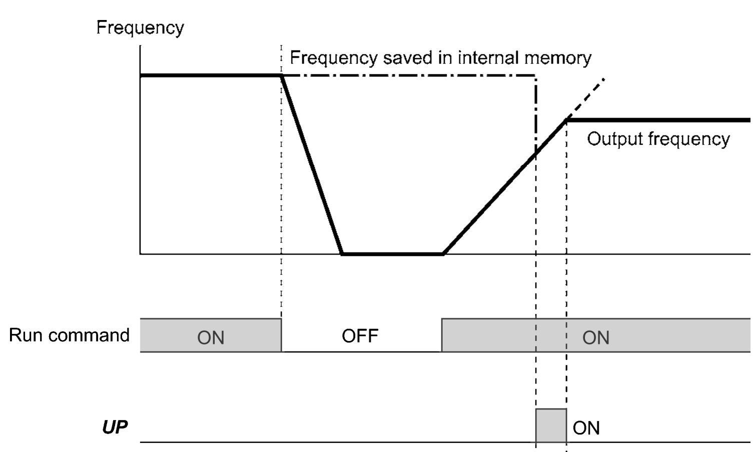
UP	***DOWN***	Function
Data = 17	Data = 18	
OFF	OFF	Keep the current output frequency.
ON	OFF	Increase the output frequency with the acceleration time currently specified.
OFF	ON	Decrease the output frequency with the deceleration time currently specified.
ON	ON	Keep the current output frequency.

■ Specifying the initial value for ***UP/DOWN*** control

Specify the initial value to start ***UP/DOWN*** control.

Data for H61	Initial value to start ***UP/DOWN*** control
0	Mode fixing the value at "0": The inverter automatically clears the value to "0" when restarted (including powered ON). Speed up by the ***UP*** command.
1	Mode holding the final output frequency in the previous ***UP/DOWN*** control: The inverter internally holds the last output frequency set by ***UP/DOWN*** control and applies the held frequency at the next restart (including powering ON).

Note: At the time of restart, if an ***UP*** or ***DOWN*** terminal command is entered before the internal frequency reaches the output frequency saved in the memory, the inverter saves the current output frequency into the memory and starts ***UP/DOWN*** control with the new frequency. Pressing one of these keys overwrites the frequency held in the inverter.



<Initial frequency for ***UP/DOWN*** control when the frequency command source is switched>

When the frequency command source is switched to ***UP/DOWN*** control from other sources, the initial frequency for ***UP/DOWN*** control is as listed below:

Frequency command source	Switching command	Initial frequency for ***UP/DOWN*** control	
		H61 = 0	H61 = 1
Other than ***UP***/***DOWN*** (F01, C30)	Select frequency command 2/1 (***Hz2***/***Hz1***)	Reference frequency given by the frequency command source used just before switching	
PID control	Cancel PID control (***Hz***/***PID***)	Reference frequency given by PID control (PID processor output)	
Multi-frequency	Select multi-frequency (***SS1***, ***SS2***, ***SS4*** and ***SS8***)	Reference frequency given by the frequency command source used just before switching	Reference frequency at the time of previous ***UP/DOWN*** control
Communications link	Enable communications link via RS-485 or fieldbus (***LE***)		

[4] Using pulse train input (F01 = 12)

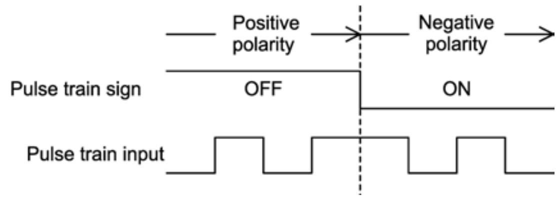
■ Selecting the pulse train input format (d59)

A pulse train in the format selected by the function code d59 can give a frequency command to the inverter. Three types of formats are available; the pulse train sign/pulse train input, the forward rotation pulse/reverse rotation pulse, and the A and B phases with 90 degree phase difference. If no optional PG interface card is mounted, the inverter ignores the setting of the function code d59 and accepts only the pulse train sign/pulse train input.

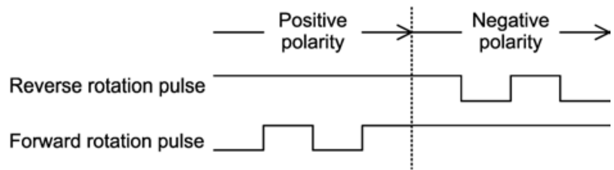
The table below lists pulse train formats and their operations.

Pulse train input format selected by d59	Operation overview
0: Pulse train sign/ Pulse train input	Frequency/speed command according to the pulse train rate is given to the inverter. The pulse train sign specifies the polarity of the frequency/speed command. • For the inverter without an optional PG interface card Pulse train input: ***PIN*** assigned to the digital terminal [X7] (data = 48) Pulse train sign: ***SIGN*** assigned to a digital terminal other than [X7] (data = 49) If no ***SIGN*** is assigned, polarity of any pulse train input is positive.
1: Forward rotation pulse/Reverse rotation pulse	Frequency/speed command according to the pulse train rate is given to the inverter. The forward rotation pulse gives a frequency/speed command with positive polarity, and a reverse rotation pulse, with negative polarity.
2: A and B phases with 90 degree phase difference	Pulse trains generated by A and B phases with 90 degree phase difference give a frequency/speed command based on their pulse rate and the phase difference to an inverter.

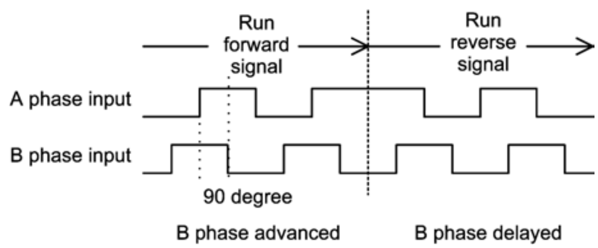
For details of operations using the optional PG interface card, refer to the Instruction Manual for it.



Pulse train sign/Pulse train input



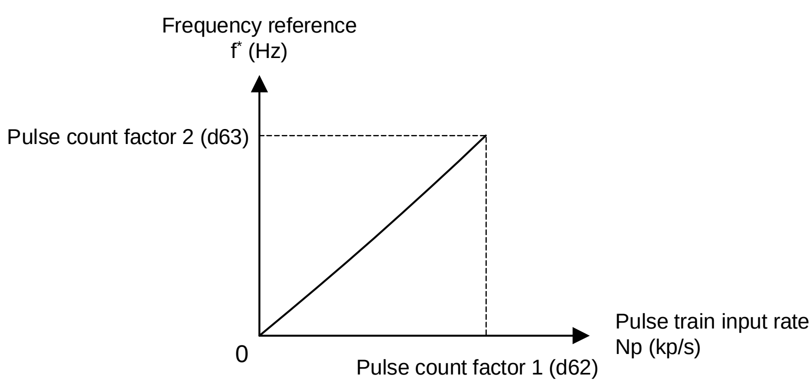
Forward rotation pulse/Reverse rotation pulse



A and B phases with 90 degree phase difference

■ Pulse count factor 1 (d62), Pulse count factor 2 (d63)

For the pulse train input, function codes d62 (Command (Pulse rate input), (Pulse count factor 1)) and d63 (Command (Pulse rate input), (Pulse count factor 2)) define the relationship between the input pulse rate and the frequency command (reference).



Relationship between the Pulse Train Input Rate and Frequency Command (Reference)

As shown in the figure above, enter the pulse train input rate into function code d62 (Command (Pulse rate input), (Pulse count factor 1)), and enter the frequency reference defined by d62 into d63 (Command (Pulse rate input), (Pulse count factor 2)). The relationship between the pulse train input rate (kp/s) inputted to the ***PIN*** terminal and the frequency reference f* (Hz) (or speed command) is given by the expression below.

$$f^{*}\ (\text{Hz}) = \text{Np (kp/s)} \times \frac{\text{Pulse count factor 2 (d63)}}{\text{Pulse count factor 1 (d62)}}$$

f^{*} (Hz) : Frequency reference

Np (kp/s) : Input pulse rate

In the case of A and B phases with 90 degree phase difference, note that the pulse train rate is not the one 4-multiplied.

The pulse train sign, forward/reverse rotation pulse, and A/B phase difference define the polarity of the pulse train input. Combination of the polarity of the pulse train input and the ***FWD***/***REV*** command determines the rotational direction of the motor. The table below shows the relationship between the polarity of the pulse train input and the motor rotational direction.

Pulse Train Polarity	Run command	Motor rotational direction
Positive (+)	***FWD*** (Run forward command)	Forward
Positive (+)	***REV*** (Run reverse command)	Reverse
Negative (-)	***FWD*** (Run forward command)	Reverse
Negative (-)	***REV*** (Run reverse command)	Forward

Note Mounting an optional PG interface card automatically switches the pulse train input source to the card and disables the input from the terminal [X7].

■ Filter time constant (d61)

d61 specifies a filter time constant for pulse train input. Choose an appropriate value for the time constant taking into account the response speed of the machinery system since a large time constant slows down the response. When the reference frequency fluctuates due to small number of pulses, specify a larger time constant.

Switching frequency command

Using the terminal command ***Hz2/Hz1*** assigned to one of the digital input terminals switches between frequency command 1 (F01) and frequency command 2 (C30).

For details about ***Hz2/Hz1***, refer to E01 to E07 (data = 11).

Terminal command ***Hz2/Hz1***	Frequency command source
OFF	Follow F01 (Frequency command 1)
ON	Follow C30 (Frequency command 2)

F02	Operation Method

F02 selects the source that specifies a run command. The table below lists the run command sources and the rotational directions of the motor.

Data for F02		Description
0	Keypad	Enables the FWD, REV, and STOP keys to run the motor in the forward and reverse directions, and stop the motor.
1	Terminal command ***FWD*** or ***REV***	Enables input terminal commands ***FWD*** and ***REV*** to run the motor in the forward and reverse directions, and stop the motor.
2	Keypad (Forward rotation)	Enables the FWD and STOP keys to run the motor in the forward direction and stop it. Running the motor in the reverse direction is not possible.
3	Keypad (Reverse rotation)	Enables the REV and STOP keys to run the motor in the reverse direction and stop it. Running the motor in the forward direction is not possible.

For details about ***FWD*** and ***REV***, refer to E98 and E99 (data = 98, 99).

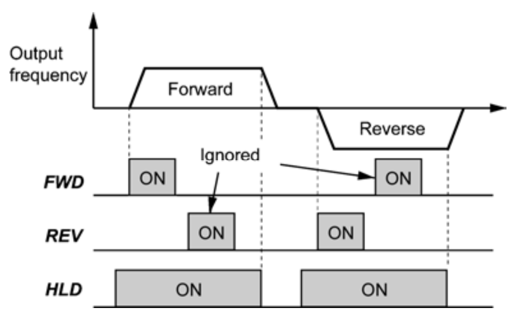
Note
- When F02 = 1, the "Run forward" ***FWD*** and "Run reverse" ***REV*** terminal commands must be assigned to terminals [FWD] and [REV], respectively.
- When the ***FWD*** or ***REV*** is ON, the F02 data cannot be changed.
- When setting the F02 data at "1" and changing a terminal command assigned to terminal [FWD] or [REV] to the ***FWD*** or ***REV*** from any other command, be sure to turn the target terminal OFF beforehand; otherwise, the motor may unintentionally rotate.

■ 3-wire operation with external input signals (digital input terminal commands)

The default setting of the ***FWD*** and ***REV*** are 2-wire. Assigning the terminal command ***HLD*** self-holds the forward ***FWD*** or reverse ***REV*** run command, to enable 3-wire inverter operation.

For details about ***HLD***, refer to E01 to E07 (data = 6).

Short-circuiting the ***HLD***-assigned terminal and [CM] (i.e., when ***HLD*** is ON) self-holds the first ***FWD*** or ***REV*** at its rising edge. Turning the ***HLD*** OFF releases the self-holding. When no ***HLD*** is assigned, 2-wire operation involving only ***FWD*** and ***REV*** takes effect.



In addition to the run command sources described above, higher priority command sources including and local modes (see Section 7.3.6) and communications link are provided.

F03 Maximum Frequency 1

F03 specifies the maximum frequency to limit the output frequency. Specifying the maximum frequency exceeding the rating of the equipment driven by the inverter may cause damage or a dangerous situation. Make sure that the maximum frequency setting matches the equipment rating.

- Data setting range: 25.0 to 500.0 (Hz)

Drive mode	Drive control	Maximum setting value	Remarks
LD/MD mode	V/f control	120 Hz	Internally limited*
	Vector control with/without speed sensor	120 Hz	Internally limited*
HD mode	V/f control	500 Hz	
	Vector control with/without speed sensor	200 Hz	Internally limited*

* If a setting exceeding the maximum setting value (e.g., 500 Hz) is made, the reference speed and analog output ([FM1]/[FM2]) will be based on the full scale/reference value (10V/500 Hz). However, the frequency is internally limited. Even if 10 V is inputted, the frequency 500 Hz will be internally limited to 200 Hz.

Note
- For LD/MD-mode inverters, set the maximum frequency at 120 Hz or below.
- Under vector control with speed sensor, set the maximum frequency at 200 Hz or below, and under vector control without speed sensor, at 120 Hz or below.

⚠WARNING

The inverter can easily accept high-speed operation settings. When changing the speed setting, carefully check the specifications of motors or equipment beforehand.

Otherwise injuries could occur.

Note Modifying F03 data to allow a higher output frequency requires also changing F15 data specifying a frequency limiter (high).

F04, F05 F06 Base Frequency 1, Rated Voltage at Base Frequency 1 Maximum Output Voltage 1

H50, H51 (Non-linear V/f Pattern 1, Frequency and Voltage)
H52, H53 (Non-linear V/f Pattern 2, Frequency and Voltage)
H65, H66 (Non-linear V/f Pattern 3, Frequency and Voltage)

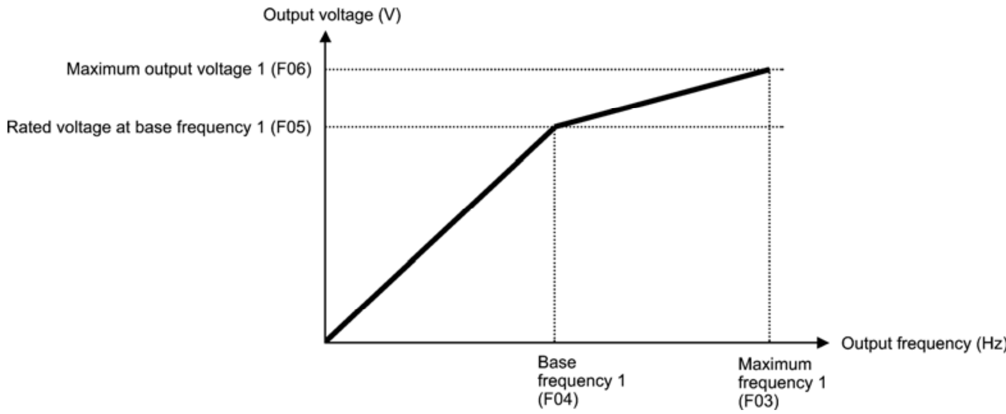
These function codes specify the base frequency and the voltage at the base frequency essentially required for running the motor properly. If combined with the related function codes H50 through H53, H65 and H66, these function codes may profile the non-linear V/f pattern suitable for the load by specifying increase or decrease in voltage at any point on the V/f pattern.

The following descriptions include setups required for the non-linear V/f patterns.

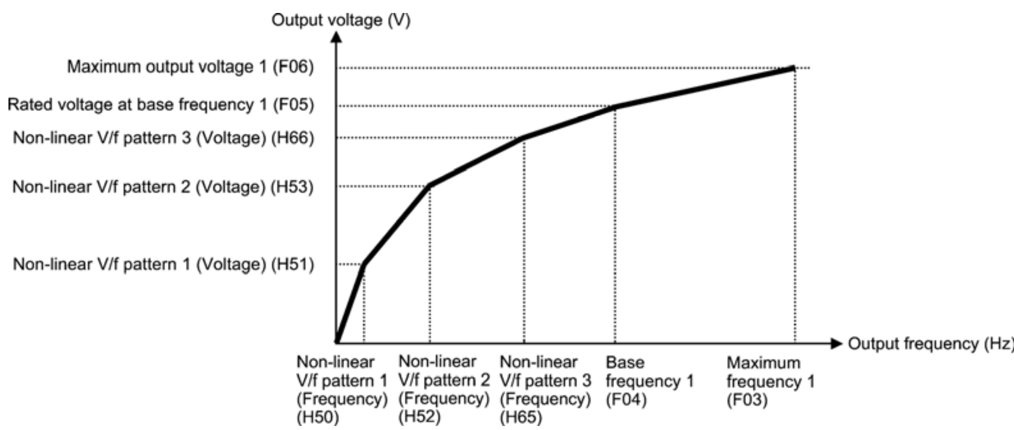
At high frequencies, the motor impedance may increase, resulting in an insufficient output voltage and a decrease in output torque. To prevent this problem, use F06 (Maximum Output Voltage 1) to increase the voltage. Note, however, that the inverter cannot output voltage exceeding its input power voltage.

V/f point	Function code		Remarks
	Frequency	Voltage	
Maximum frequency	F03	F06	The setting of the maximum output voltage is disabled when the auto torque boost, torque vector control, vector control without speed sensor, or vector control with speed sensor is selected.
Base frequency	F04	F05	
Non-linear V/f pattern 3	H65	H66	Disabled when the auto torque boost, torque vector control, vector control without speed sensor, or vector control with speed sensor is selected.
Non-linear V/f pattern 2	H52	H53	
Non-linear V/f pattern 1	H50	H51	

■ Normal (linear) V/f pattern



■ V/f pattern with three non-linear points



■ Base Frequency 1 (F04)

Set F04 data to the rated frequency printed on the nameplate labeled on the motor.

- Data setting range: 25.0 to 500.0 (Hz)

■ Rated Voltage at Base Frequency 1 (F05)

Set F05 data to "0" or the rated voltage printed on the nameplate labeled on the motor.

- Data setting range:

0	: Output a voltage in proportion to input voltage (The Automatic Voltage Regulator (AVR) is disabled.)
80 to 240 (V)	: Output an AVR-controlled voltage for 230 V series
160 to 500 (V)	: Output an AVR-controlled voltage for 460 V series

- If F05 = 0, the rated voltage at base frequency is at the same level as the inverter input voltage. The output voltage will fluctuate in line with the input voltage fluctuation.
- If F05 = an arbitrary value other than 0, the inverter automatically keeps the output voltage constant in line with the setting. When any control function such as auto torque boost, auto energy saving, slip compensation, etc. is enabled, the F05 data should be equal to the rated voltage of the motor (printed on the nameplate of the motor).

Note: In vector control, current feedback control is performed. In the current feedback control, the current is controlled with the difference between the motor induced voltage and the inverter output voltage. For a proper control, the inverter output voltage should be sufficiently higher than the motor induced voltage. Generally, the voltage difference is about 20 V for 230 V series, about 40 V for 460 V series.

The voltage the inverter can output is at the same level as the inverter input voltage. Configure these voltages correctly in accordance with the motor specifications.

When enabling vector control without speed sensor for a general-purpose motor, set the F05 (Rated Voltage at Base Frequency 1) data at the rated voltage of the motor. The voltage difference described above is specified by function code P56 (Induced voltage factor under vector control). Generally, there is no need to modify the initial setting.

■ Non-linear V/f Patterns 1, 2 and 3 for Frequency (H50, H52 and H65)

H50, H52, or H65 specifies the frequency component at an arbitrary point in the non-linear V/f pattern.

- Data setting range: 0.0 (cancel)
  0.1 to 500.0 (Hz)

Note: Setting "0.0" to H50, H52 or H65 disables the non-linear V/f pattern operation.

■ Non-linear V/f Patterns 1, 2 and 3 for Voltage (H51, H53 and H66)

H51, H53, or H66 specifies the voltage component at an arbitrary point in the non-linear V/f pattern.

- Data setting range:
  0 to 240 (V) : Output an AVR-controlled voltage for 230 V series
  0 to 500 (V) : Output an AVR-controlled voltage for 460 V series

Note: The factory default values for H50 and H51 differ depending on the inverter capacity. Refer to the table below.

Voltage	230 V series		460 V series	
Capacity	40 HP or below	50 HP or above	50 HP or below	60 HP or above
H50	0.0	5.0 (Hz)	0.0	5.0 (Hz)
H51	0	20 (V)	0	40 (V)

■ Maximum Output Voltage 1 (F06)

F06 specifies the voltage for the maximum frequency 1 (F03).

- Data setting range:
  80 to 240 (V) : Output an AVR-controlled voltage for 230 V series
  160 to 500 (V): Output an AVR-controlled voltage for 460 V series

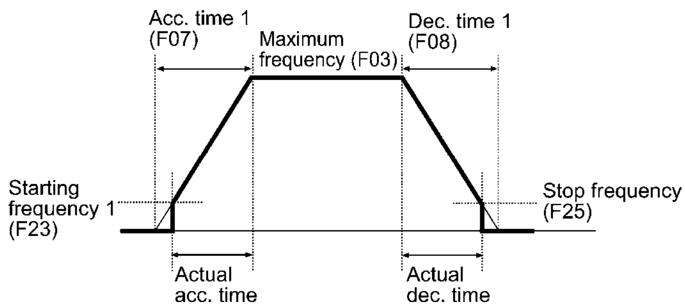
Note: If F05 (Rated Voltage at Base Frequency 1) is set to "0," settings of H50 through H53, H65, H66 and F06 do not take effect. (When the non-linear point is below the base frequency, the linear V/f pattern applies; when it is above, the output voltage is kept constant.)

F07, F08	**Acceleration Time 1, Deceleration Time 1** **E10, E12, E14 (Acceleration Time 2, 3 and 4)** **E11, E13, E15 (Deceleration Time 2, 3 and 4)** **H07 (Acceleration/Deceleration Pattern)** **H56 (Deceleration Time for Forced Stop)** **H54, H55 (Acceleration Time/Deceleration Time, Jogging)** **H57 to H60 (1st and 2nd S-curve Acceleration/Deceleration Range)**

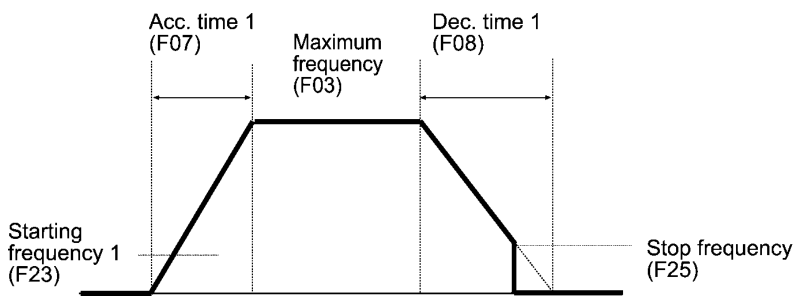
F07 specifies the acceleration time, the length of time the frequency increases from 0 Hz to the maximum frequency. F08 specifies the deceleration time, the length of time the frequency decreases from the maximum frequency down to 0 Hz.

- Data setting range: 0.00 to 6000 (s)

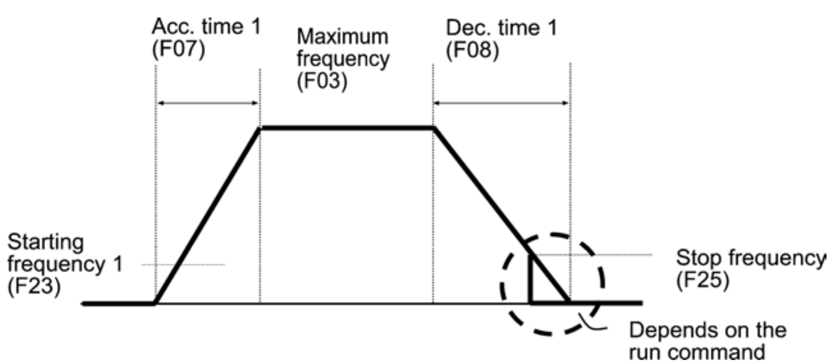
V/f control



Vector control without speed sensor



Vector control with speed sensor



■ Acceleration/deceleration time

<table>
<tr><th rowspan="2">Acceleration/ deceleration time</th><th colspan="2">Function code</th><th colspan="3" rowspan="2">Switching factor of acceleration/deceleration time (Refer to the descriptions of E01 to E07.)</th></tr>
<tr><th>ACC time</th><th>DEC time</th></tr>
<tr><td rowspan="2">Acceleration/ deceleration time 1</td><td rowspan="2">F07</td><td rowspan="2">F08</td><td>RT2</td><td>RT1</td><td rowspan="5">The combinations of ON/OFF states of the two terminal commands RT2 and RT1 offer four choices of acceleration/ deceleration time 1 to 4. (Data = 4, 5)

If no terminal command is assigned, only the acceleration/deceleration time 1 (F07/F08) is effective.</td></tr>
<tr><td>OFF</td><td>OFF</td></tr>
<tr><td>Acceleration/ deceleration time 2</td><td>E10</td><td>E11</td><td>OFF</td><td>ON</td></tr>
<tr><td>Acceleration/ deceleration time 3</td><td>E12</td><td>E13</td><td>ON</td><td>OFF</td></tr>
<tr><td>Acceleration/ deceleration time 4</td><td>E14</td><td>E15</td><td>ON</td><td>ON</td></tr>
<tr><td>At jogging operation</td><td>H54</td><td>H55</td><td colspan="3">When the terminal command JOG is ON, jogging operation is possible. (Data = 10)
(Refer to the description of C20.)</td></tr>
<tr><td>At forced stop</td><td>—</td><td>H56</td><td colspan="3">When the terminal command STOP is OFF, the motor decelerates to a stop in accordance with the deceleration time for forced stop (H56). After the motor stops, the inverter enters the alarm state with the alarm Er6 displayed. (Data = 30)</td></tr>
</table>

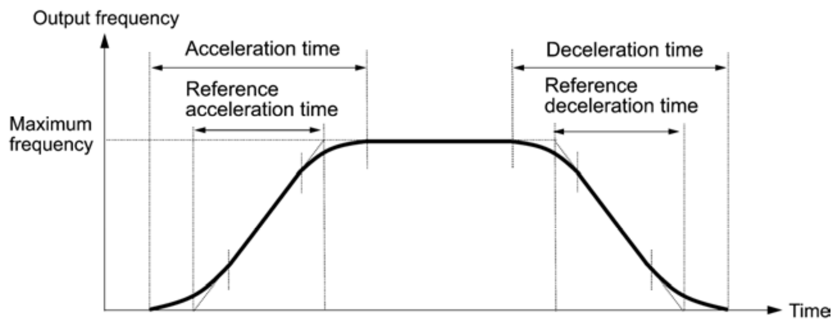
■ Acceleration/Deceleration pattern (H07)

H07 specifies the acceleration and deceleration patterns (patterns to control output frequency).

<table>
<tr><th>Data for H07</th><th>Acceleration/ deceleration pattern</th><th colspan="2">Motion</th><th>Function code</th></tr>
<tr><td>0</td><td>Linear</td><td colspan="2">The inverter runs the motor with the constant acceleration and deceleration.</td><td>—</td></tr>
<tr><td>1</td><td>S-curve (Weak)</td><td rowspan="2">To reduce an impact that acceleration/deceleration would make on the machine, the inverter gradually accelerates or decelerates the motor in both the starting and ending zones of acceleration or deceleration.</td><td>Weak:
The acceleration/deceleration rate to be applied to all of the four inflection zones is fixed at 5% of the maximum frequency.</td><td>—</td></tr>
<tr><td>2</td><td>S-curve (Arbitrary)</td><td>Arbitrary:
The acceleration/deceleration rate can be arbitrarily specified for each of the four inflection zones.</td><td>H57
H58
H59
H60</td></tr>
<tr><td>3</td><td>Curvilinear</td><td colspan="2">Acceleration/deceleration is linear below the base frequency (constant torque) but it slows down above the base frequency to maintain a certain level of load factor (constant output).
This acceleration/deceleration pattern allows the motor to accelerate or decelerate with the maximum performance of the motor.</td><td>—</td></tr>
</table>

S-curve acceleration/deceleration

To reduce an impact that acceleration/deceleration would make on the machine, the inverter gradually accelerates or decelerates the motor in both the starting and ending zones of acceleration or deceleration. Two types of S-curve acceleration/deceleration rates are available; applying 5% (weak) of the maximum frequency to all of the four inflection zones, and specifying arbitrary rate for each of the four zones with function codes H57 to H60. The reference acceleration/deceleration time determines the duration of acceleration/deceleration in the linear period; hence, the actual acceleration/deceleration time is longer than the reference acceleration/deceleration time.



	Acceleration		Deceleration	
	Starting zone	Ending zone	Starting zone	Ending zone
S-curve (Weak)	5%	5%	5%	5%
S-curve (Arbitrary) Setting range: 0 to 100%	H57 Acceleration rate for the 1st S-curve (Leading edge)	H58 Acceleration rate for the 2nd S-curve (Trailing edge)	H59 Deceleration rate for the 1st S-curve (Leading edge)	H60 Deceleration rate for the 2nd S-curve (Trailing edge)

<S-curve acceleration/deceleration (weak): when the frequency change is 10% or more of the maximum frequency>

Acceleration or deceleration time (s) = (2 × 5/100 + 90/100+ 2 × 5/100) × (reference acceleration or deceleration time)
= 1.1 × (reference acceleration or deceleration time)

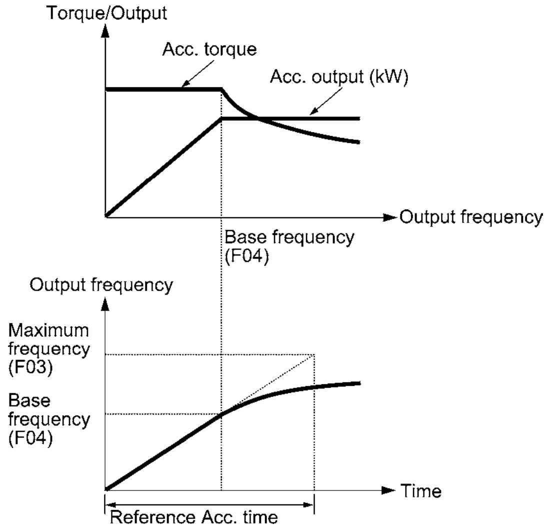
<S-curve acceleration/deceleration (arbitrary): when the frequency change is 30% or more of the maximum frequency--10% at the leading edge and 20% at the trailing edge>

Acceleration or deceleration time (s) = (2 × 10/100 + 70/100 + 2 × 20/100) × (reference acceleration or deceleration time)
= 1.3 × (reference acceleration or deceleration time)

Curvilinear acceleration/deceleration

Acceleration/deceleration is linear below the base frequency (constant torque) but it slows down above the base frequency to maintain a certain level of load factor (constant output).

This acceleration/deceleration pattern allows the motor to accelerate or decelerate with its maximum performance.



The figures at left show the acceleration characteristics. Similar characteristics apply to the deceleration.

Note

- If you choose S-curve acceleration/deceleration or curvilinear acceleration/deceleration in Acceleration/Deceleration Pattern (H07), the actual acceleration/deceleration times are longer than the specified ones.
- Specifying an improperly short acceleration/deceleration time may activate the current limiter, torque limiter, or anti-regenerative control (automatic deceleration), resulting in a longer acceleration/deceleration time than the specified one.

F09	**Torque Boost 1**	**(Refer to F37.)**

Refer to the description of F37.

F10 to F12	Electronic Thermal Overload Protection for Motor 1 (Select motor characteristics, Overload detection level, Thermal time constant)

F10 through F12 specify the thermal characteristics of the motor for its electronic thermal overload protection that is used to detect overload conditions of the motor inside the inverter.

F10 selects the motor cooling mechanism to specify its characteristics, F11 specifies the overload detection current, and F12 specifies the thermal time constant.

Upon detection of overload conditions of the motor, the inverter shuts down its output and issues a motor overload alarm OL1 to protect motor 1.

Note

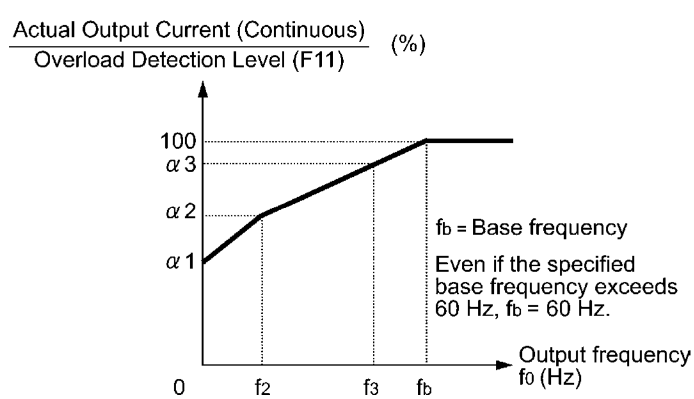
- Thermal characteristics of the motor specified by F10 and F12 are also used for the overload early warning. Even if you need only the overload early warning, set these characteristics data to these function codes. (Refer to the description of E34.)
- To disable the electronic thermal overload protection, set F11 data to "0.00."
- For motors with PTC thermistor, connecting the PTC thermistor to the terminal [C1] enables the motor overheat protective function. For details, refer to the description of H26.

■ Select motor characteristics (F10)

F10 selects the cooling mechanism of the motor--shaft-driven or separately powered cooling fan.

Data for F10	Function
1	For a general-purpose motor with shaft-driven cooling fan (The cooling effect will decrease in low frequency operation.)
2	For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan (The cooling effect will be kept constant regardless of the output frequency.)

The figure below shows operating characteristics of the electronic thermal overload protection when F10 = 1. The characteristic factors α1 through α3 as well as their corresponding output frequencies f_2 and f_3 differ depending on the characteristics of the motor. The tables below list the factors of the motor selected by P99 (Motor 1 Selection).



Cooling Characteristics of Motor with Shaft-driven Cooling Fan

Nominal Applied Motor and Characteristic Factors when P99 (Motor 1 selection) = 0 or 4

Nominal applied motor (HP)	Thermal time constant τ (Factory default)	Reference current for setting the thermal time constant (Imax)	Output frequency for motor characteristic factor		Characteristic factor (%)		
			f2	f3	α1	α2	α3
0.5, 1	5 min	Allowable continuous current × 150%	5 Hz	7 Hz	75	85	100
2 to 5					85	85	100
7.5 to 15				6 Hz	90	95	100
20				7 Hz	85	85	100
25, 30				5 Hz	92	100	100
40 to 60	10 min		Base frequency × 33%	Base frequency × 83%	54	85	95
75 to 125					51	95	95
150 or above					53	85	90

Nominal Applied Motor and Characteristic Factors when P99 (Motor 1 Selection) = 1 or 3

Nominal applied motor (HP)	Thermal time constant τ (Factory default)	Reference current for setting the thermal time constant (Imax)	Output frequency for motor characteristic factor		Characteristic factor (%)		
			f2	f3	α1	α2	α3
0.25 to 30	5 min	Allowable continuous current × 150%	Base frequency × 33%	Base frequency × 33%	69	90	90
40 to 60	10 min			Base frequency × 83%	54	85	95
75 to 125					51	95	95
150 or above					53	85	90

If F10 is set to "2," changes of the output frequency do not affect the cooling effect. Therefore, the overload detection level (F11) remains constant.

■ Overload detection level (F11)

F11 specifies the level at which the electronic thermal overload protection becomes activated.

- Data setting range: 1 to 135% of the rated current (allowable continuous drive current) of the inverter

In general, set the F11 data to the allowable continuous current of motor when driven at the base frequency (i.e. 1.0 to 1.1 times of the rated current of the motor.) To disable the electronic thermal overload protection, set the F11 data to "0.00."

■ Thermal time constant (F12)

F12 specifies the thermal time constant of the motor. If the current of 150% of the overload detection level specified by F11 flows for the time specified by F12, the electronic thermal overload protection becomes activated to detect the motor overload. The thermal time constant for general-purpose motors is approx. 5 minutes for motors of 30 HP or below and 10 minutes for motors of 40 HP or above by factory default.

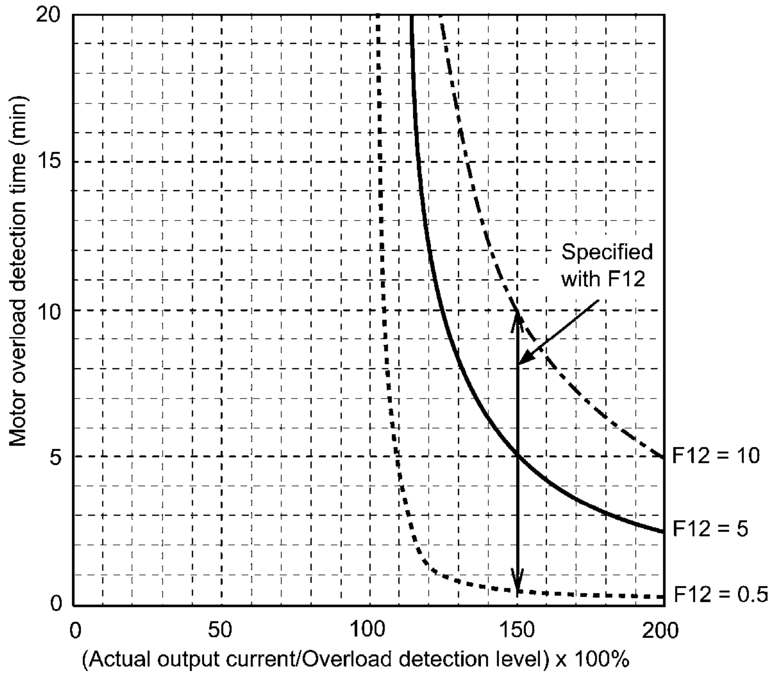
- Data setting range: 0.5 to 75.0 (minutes)

(Example) When the F12 data is set at 5 minutes

As shown on the next page, the electronic thermal overload protection is activated to detect an alarm condition (alarm code OL1) when the output current of 150% of the overload detection level (specified by F11) flows for 5 minutes, and 120% for approx. 12.5 minutes.

The actual time required for issuing a motor overload alarm tends to be shorter than the specified value, taking into account the time period from when the output current exceeds the allowable continuous drive current (100%) until it reaches 150% of the overload detection level.

Example of Thermal Overload Detection Characteristics



F14	Restart Mode after Momentary Power Failure (Mode selection) H13 (Restart time) H14 (Frequency fall rate) H15 (Continuous running level) H16 (Allowable momentary power failure time) H92 and H93 (Continuity of Running, P and I)

F14 specifies the action to be taken by the inverter such as trip and restart in the event of a momentary power failure.

■ Restart mode after momentary power failure (Mode selection) (F14)

• **Under V/f control**

<table>
<tr><th rowspan="2">Data for F14</th><th colspan="2">Description</th></tr>
<tr><th>Auto search disabled</th><th>Auto search enabled</th></tr>
<tr><td>0: Trip immediately</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter issues undervoltage alarm LU and shuts down its output so that the motor enters a coast-to-stop state.</td></tr>
<tr><td>1: Trip after recovery from power failure</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down its output so that the motor enters a coast-to-stop state, but it does not enter the undervoltage state or issue undervoltage alarm LU.
The moment the power is restored, an undervoltage alarm LU is issued, while the motor remains in a coast-to-stop state.</td></tr>
<tr><td>2: Trip after decelerate-to-stop</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-shop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm LU is issued.</td></tr>
<tr><td rowspan="3">3: Continue to run (for heavy inertia or general loads)</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, continuous running control is invoked. Continuous running control regenerates kinetic energy from the load’s moment of inertia, continues running, and waits the recovery of power. When an undervoltage condition is detected due to a lack of energy to be regenerated, the output frequency at that time is saved, the output of the inverter is shut down, and the motor enters a coast-to-stop state.</td></tr>
<tr><td>If a run command has been input, restoring power restarts the inverter at the output frequency saved when undervoltage was detected.</td><td>If a run command has been input, restoring power performs auto search for idling motor speed and restarts running the motor at the frequency calculated based on the searched speed.</td></tr>
<tr><td colspan="2">This setting is ideal for fan applications with a large moment of inertia.</td></tr>
<tr><td rowspan="3">4: Restart at the frequency at which the power failure occurred (for general loads)</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down the output so that the motor enters a coast-to-stop state.</td></tr>
<tr><td>If a run command has been input, restoring power restarts the inverter at the output frequency saved when undervoltage was detected.</td><td>If a run command has been input, restoring power performs auto search for idling motor speed and restarts running the motor at the frequency calculated based on the searched speed.</td></tr>
<tr><td colspan="2">This setting is ideal for applications with a moment of inertia large enough not to slow down the motor quickly, such as fans, even after the motor enters a coast-to-stop state upon occurrence of a momentary power failure.</td></tr>
</table>

<table>
<tr><th rowspan="2">Data for F14</th><th colspan="2">Description</th></tr>
<tr><th>Auto search disabled</th><th>Auto search enabled</th></tr>
<tr><td rowspan="3">5: Restart at the starting frequency</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down the output so that the motor enters a coast-to-stop state.</td></tr>
<tr><td>If a run command has been input, restoring power restarts the inverter at the starting frequency specified by function code F23.</td><td>If a run command has been input, restoring power performs auto search for idling motor speed and restarts running the motor at the frequency calculated based on the searched speed.</td></tr>
<tr><td colspan="2">This setting is ideal for heavy load applications such as pumps, having a small moment of inertia, in which the motor speed quickly goes down to zero as soon as it enters a coast-to-stop state upon occurrence of a momentary power failure.</td></tr>
<tr><td colspan="3">Auto search is enabled by turning ON the digital terminal command STM ("Enable auto search for idling motor speed at starting") or setting the H09 data to "1" or "2."
For details about the digital terminal command STM and auto search, refer to the description of H09 (Starting Mode, Auto search).</td></tr>
</table>

- **Under vector control without speed sensor**

<table>
<tr><th rowspan="2">Data for F14</th><th colspan="2">Description</th></tr>
<tr><th>Auto search disabled</th><th>Auto search enabled</th></tr>
<tr><td>0: Trip immediately</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter issues undervoltage alarm LU and shuts down its output so that the motor enters a coast-to-stop state.</td></tr>
<tr><td>1: Trip after recovery from power failure</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down its output so that the motor enters a coast-to-stop state, but it does not enter the undervoltage state or issue undervoltage alarm LU.
The moment the power is restored, an undervoltage alarm LU is issued, while the motor remains in a coast-to-stop state.</td></tr>
<tr><td>2: Trip after decelerate-to-stop</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-shop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm LU is issued.</td></tr>
<tr><td rowspan="2">3: Continue to run
4: Restart at the frequency at which the power failure occurred</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down the output so that the motor enters a coast-to-stop state.
Even if the F14 data is set to "3," the "Continue to run" function is disabled.</td></tr>
<tr><td>If a run command has been input, restoring power restarts the inverter at the output frequency saved when undervoltage was detected.</td><td>If a run command has been input, restoring power performs auto search for idling motor speed and restarts running the motor at the frequency calculated based on the searched speed.</td></tr>
<tr><td rowspan="3">5: Restart at the starting frequency</td><td colspan="2">As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down the output so that the motor enters a coast-to-stop state.</td></tr>
<tr><td>If a run command has been input, restoring power restarts the inverter at the starting frequency specified by function code F23.</td><td>If a run command has been input, restoring power performs auto search for idling motor speed and restarts running the motor at the frequency calculated based on the searched speed.</td></tr>
<tr><td colspan="2">This setting is ideal for heavy load applications such as pumps, having a small moment of inertia, in which the motor speed quickly goes down to zero as soon as it enters a coast-to-stop state upon occurrence of a momentary power failure.</td></tr>
<tr><td colspan="3">Auto search is enabled by turning ON the digital terminal command STM ("Enable auto search for idling motor speed at starting") or setting the d67 data to "1" or "2."
For details about the digital terminal command STM and auto search, refer to the description of d67 (Starting Mode, Auto search).</td></tr>
</table>

- **Under vector control with speed sensor**

Data for F14	Description
0: Trip immediately	As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter issues undervoltage alarm LU and shuts down its output so that the motor enters a coast-to-stop state.
1: Trip after recovery from power failure	As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down its output so that the motor enters a coast-to-stop state, but it does not enter the undervoltage state or issue undervoltage alarm LU. The moment the power is restored, an undervoltage alarm LU is issued, while the motor remains in a coast-to-stop state.
2: Trip after decelerate-to-stop	As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-shop control is invoked. Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm LU is issued.
3: Continue to run 4: Restart at the frequency at which the power failure occurred 5: Restart at the starting frequency	As soon as the DC link bus voltage drops below the undervoltage detection level due to a momentary power failure, the inverter shuts down the output so that the motor enters a coast-to-stop state. Even if the F14 data is set to "3," the "Continue to run" function is disabled. If a run command has been input, restoring power restarts the inverter at the motor speed detected by the speed sensor.

⚠WARNING

If you enable the "Restart mode after momentary power failure" (Function code F14 = 3, 4, or 5), the inverter automatically restarts the motor running when the power is recovered. Design the machinery or equipment so that human safety is ensured after restarting.

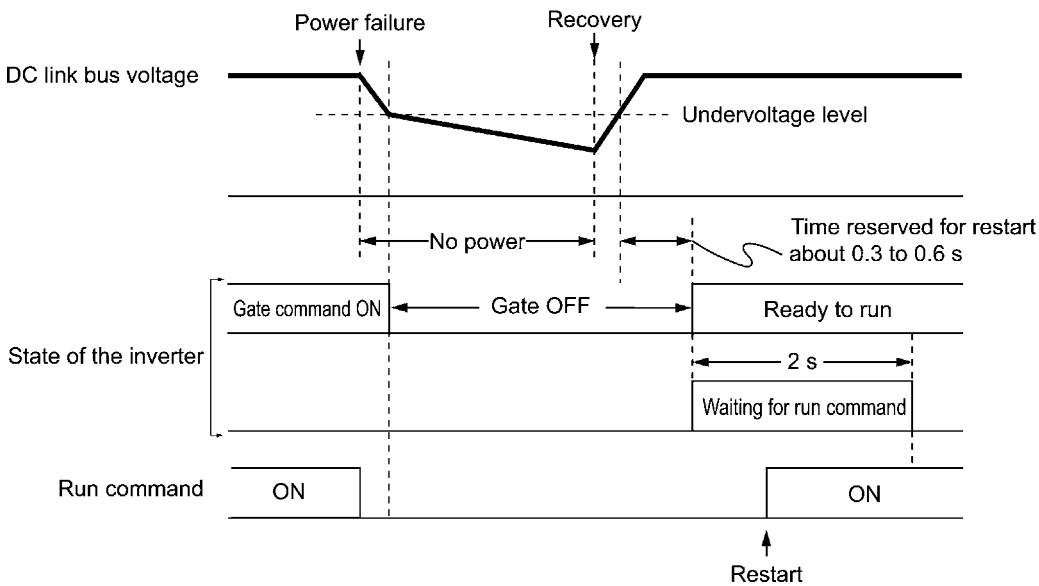
Otherwise an accident could occur.

■ Restart mode after momentary power failure (Basic operation: Auto search disabled)

The inverter recognizes a momentary power failure upon detecting the condition that DC link bus voltage goes below the undervoltage detection level, while the inverter is running. If the load of the motor is light and the duration of the momentary power failure is extremely short, the voltage drop may not be great enough for a momentary power failure to be recognized, and the motor may continue to run uninterrupted.

Upon recognizing a momentary power failure, the inverter enters the restart mode (after a recovery from momentary power failure) and prepares for restart. When power is restored, the inverter goes through an initial charging stage and enters the ready-to-run state. When a momentary power failure occurs, the power supply voltage for external circuits such as relay sequence circuits may also drop so as to turn the run command OFF. In consideration of such a situation, the inverter waits 2 seconds for a run command input after the inverter enters a ready-to-run state. If a run command is received within 2 seconds, the inverter begins the restart processing in accordance with the F14 data (Mode selection). If no run command has been received within 2-second wait period, the inverter cancels the restart mode (after a recovery from momentary power failure) and needs to be started again from the ordinary starting frequency. Therefore, ensure that a run command is entered within 2 seconds after recovery of power or held with an off-delay timer or a mechanical latch relay.

When run commands are entered via the keypad, the above operation is also necessary for the mode (F02 = 0) in which the rotational direction is determined by the terminal command, ***FWD*** or ***REV***. In the modes where the rotational direction is fixed (F02 = 2 or 3), the run command is retained inside the inverter so that the restart will begin as soon as the inverter enters the ready-to-run state.



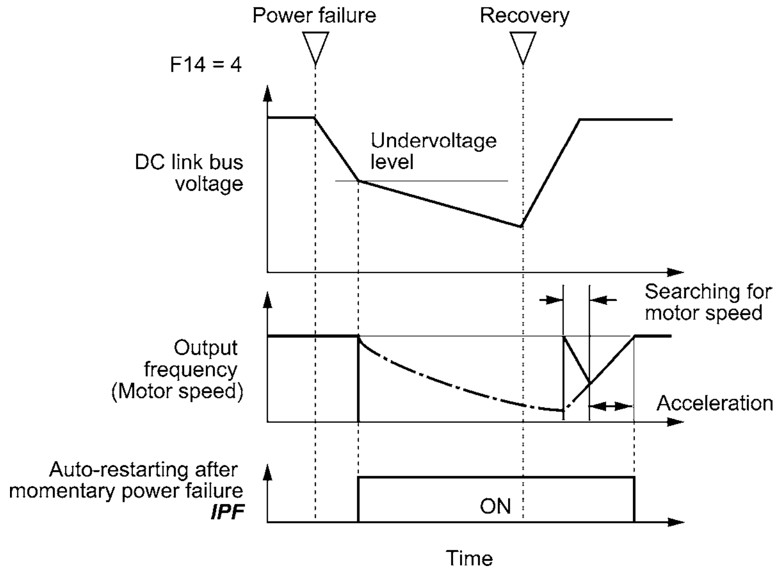
Note

- When the power is restored, the inverter will wait 2 seconds for input of a run command. However, if the allowable momentary power failure time (H16) has elapsed after the power failure was recognized, the inverter will no longer wait 2 seconds for input of a run command and start operation in the normal starting sequence.
- If the terminal command ***BX*** ("Coast to a stop") is entered during the power failure, the inverter gets out of the restart mode and enters the normal running mode. When a run command is entered with power supply applied, the inverter will start from the normal starting frequency.
- The inverter recognizes a momentary power failure by detecting an undervoltage condition when the voltage of the DC link bus goes below the lower limit. In a configuration where a magnetic contactor is installed on the output side of the inverter, the inverter may fail to recognize a momentary power failure because the momentary power failure shuts down the operating power of the magnetic contactor, causing the contactor circuit to open. When the contactor circuit is open, the inverter is cut off from the motor and load so that the voltage drop in the DC link bus may not be great enough to be recognized as a power failure. In such an event, the restart after a recovery from momentary power failure does not work properly as designed. To solve this, connect the auxiliary contact of the magnetic contactor to the inverter terminal which the ***IL*** ("Interlock") is assigned to so that a momentary power failure can sure be detected.

📖 For details about ***IL***, refer to E01 to E07 (data = 22).

IL	Description
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Restart after a momentary power failure enabled)

During a momentary power failure, the motor slows down. After power is restored, the inverter restarts at the frequency just before the momentary power failure. Then, the current limiting function works and the output frequency of the inverter automatically decreases. When the output frequency matches the motor speed, the motor accelerates up to the original output frequency. See the figure below. In this case, the instantaneous overcurrent limiting must be enabled (H12 = 1).



• Auto-restarting after momentary power failure ***IPF***

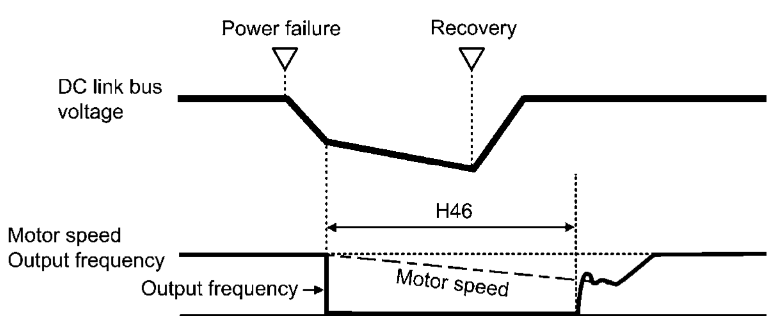
This output signal is ON during the period after the occurrence of momentary power failure until the completion of a restart sequence (until the output reaches the reference frequency). When the ***IPF*** is ON, the motor slows down, so perform necessary operations.

📖 For details about ***IPF***, refer to E01 through E07 (data = 6).

■ Restart mode after momentary power failure (Basic operation: Auto search enabled)

Auto search for idling motor speed will become unsuccessful if it is done while the motor retains residual voltage. It is, therefore, necessary to leave the motor for the time (auto search delay time) enough to discharge the residual voltage. The delay time is specified by H46 (Starting Mode (Auto search delay time 2)).

The inverter will not start unless the time specified by H46 has elapsed, even if the starting conditions are satisfied. (📖 For details, refer to H09 and d67.)



Note
- To use auto search for idling motor speed, it is necessary to tune the inverter beforehand.
- When the estimated speed exceeds the maximum frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum frequency or the upper limit frequency, whichever is lower.

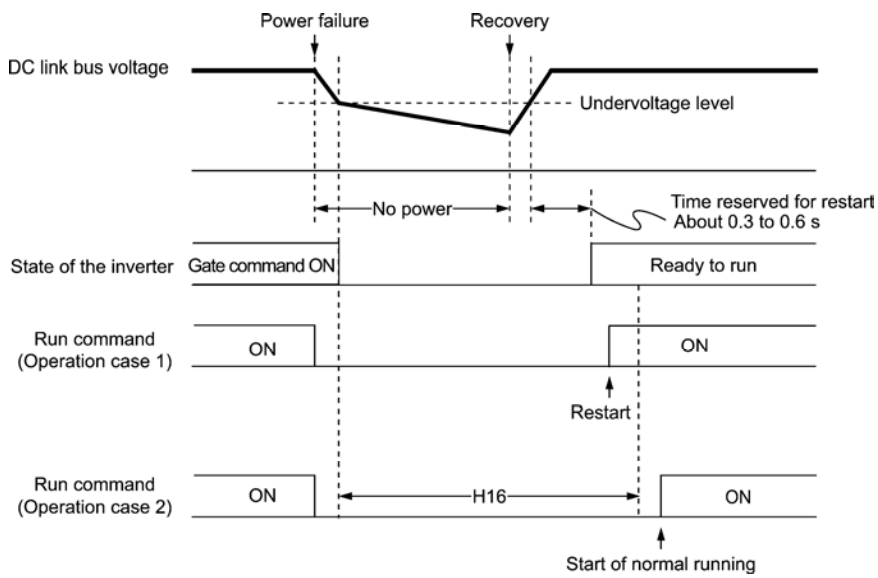
Note

- During auto search, if an overcurrent or overvoltage trip occurs, the inverter restarts the suspended auto search.
- Perform auto search at 60 Hz or below.
- Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.
- Do not execute motor tuning with an output filter unless the filter is a reactor type only. A tuning error may result if any other type filter is in use.

■ Restart mode after momentary power failure (Allowable momentary power failure time) (H16)

H16 specifies the maximum allowable duration (0.0 to 30.0 seconds) from an occurrence of a momentary power failure (undervoltage) until the restart of the inverter. Specify the coast-to-stop time during which the machine system and facility can be tolerated.

If the power is restored within the specified duration, the inverter restarts in the restart mode specified by F14. If not, the inverter recognizes that the power has been shut down so that the inverter does not apply the restart mode and starts normal running.



If H16 (Allowable momentary power failure time) is set to "999," restart will take place until the DC link bus voltage drops down to the allowable voltage for restart after a momentary power failure (50 V for 230 V series and 100 V for 460 V series). If the DC link bus voltage drops below the allowable voltage, the inverter recognizes that the power has been shut down so that the inverter does not apply the restart mode and starts normal running.

Power supply voltage	Allowable voltage for restart after momentary power failure
230 V series	50 V
460 V series	100 V

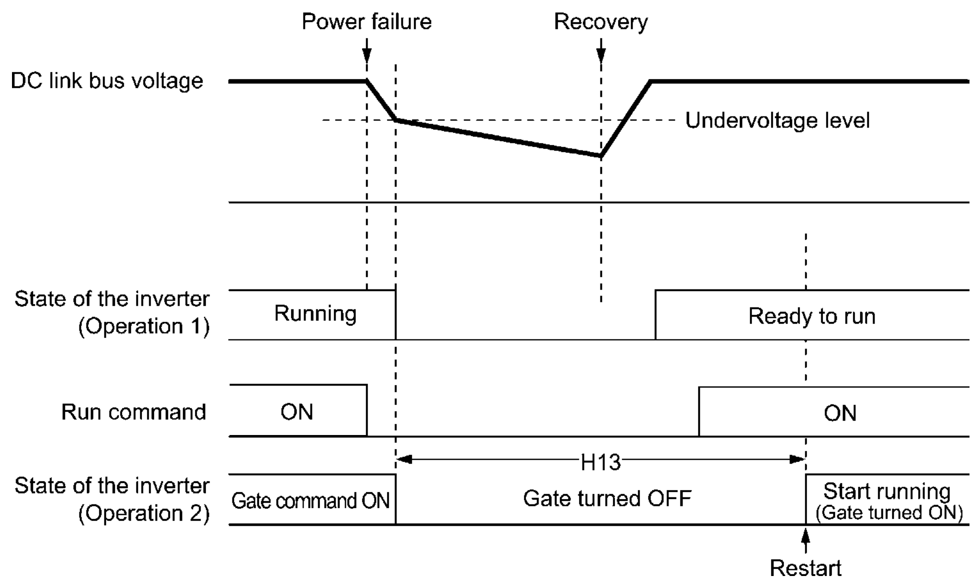
Note

The time required from when the DC link bus voltage drops from the threshold of undervoltage until it reaches the allowable voltage for restart after a momentary power failure, greatly varies depending on the inverter capacity, the presence of options, and other factors.

■ Restart mode after momentary power failure (Restart time) (H13)

H13 specifies the time period from an occurrence of a momentary power failure until the restart of the inverter. (When auto search is enabled, H46 (Auto search delay time 2) applies.)

If the inverter starts the motor while motor's residual voltage is still in a high level, a high inrush current may flow or an overvoltage alarm may occur due to an occurrence of temporary regeneration. For safety, therefore, it is advisable to set H13 to a certain level so that the restart will take place only after the residual voltage has dropped to a low level. Note that even when power is restored, restart will not take place until the restart time (H13) has elapsed.



Factory default

By factory default, H13 is set to the value suitable for the standard motor (see Table A given on the last page of the function code tables). Basically, it is not necessary to change H13 data. However, if the long restart time causes the flow rate of the pump to overly decrease or causes any other problem, you might as well reduce the setting to about a half of the default value. In such a case, make sure that no alarm occurs.

Note The restart time specified by H13 also applies to the switching operation (terminal commands ***ISW50***/***ISW60***) between line and inverter. Refer to E01 through E07 (data = 40, 41) for terminals [X1] to [X7].

■ Restart mode after momentary power failure (Frequency fall rate) (H14)

During restart after a momentary power failure, if the inverter output frequency and the idling motor speed cannot be harmonized with each other, an overcurrent will flow, activating the overcurrent limiter. If it happens, the inverter automatically reduces the output frequency to match the idling motor speed according to the reduction rate (Frequency fall rate: Hz/s) specified by H14.

Data for H14	Inverter's action for the output frequency fall
0.00	Follow the specified deceleration time
0.01 to 100.00 (Hz/s)	Follow data specified by H14
999	Follow the setting of the PI processor in the current limiter. (The PI constant is prefixed inside the inverter.)

Note If the frequency fall rate is too high, regeneration may take place at the moment the motor speed matches the inverter output frequency, causing an overvoltage trip. On the contrary, if the frequency fall rate is too low, the time required for the output frequency to match the motor speed (duration of current limiting action) may be prolonged, triggering the inverter overload prevention control.

■ Restart after momentary power failure (Continuous running level) (H15)
Continuity of running (P and I) (H92, H93)

• Trip after decelerate-to-stop (F14 = 2)

If a momentary power failure occurs when F14 is set to "2" (Trip after decelerate-to-stop), the inverter enters the control sequence of the decelerate-to-stop when the DC link bus voltage drops below the continuous running level specified by H15.

Under decelerate-to-stop control, the inverter decelerates its output frequency keeping the DC link bus voltage constant using the PI processor. P (proportional) and I (integral) components of the PI processor are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.

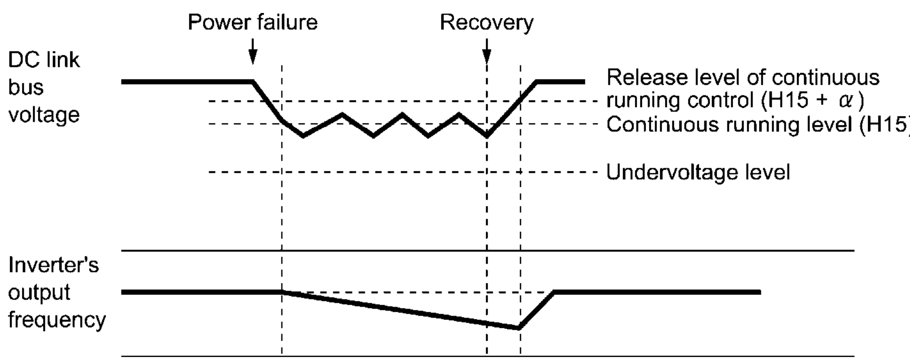
• Continue to run (F14 = 3)

If a momentary power failure occurs when F14 is set to "3" (Continue to run), the inverter enters the control sequence of the continuous running when the DC link bus voltage drops below the continuous running level specified by H15.

Under the continuous running control, the inverter continues to run keeping the DC link bus voltage constant using the PI processor.

P (proportional) and I (integral) components of the PI processor are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.



Power supply voltage	α	
	40 HP or below	50 HP or above
230 V series	5 V	10 V
460 V series	10 V	20 V

Note: Even if you select "Trip after decelerate-to-stop" or "Continue to run," the inverter may not be able to do so when the load's inertia is small or the load is heavy, due to undervoltage caused by a control delay. In such a case, when "Trip after decelerate-to-stop" is selected, the inverter allows the motor to coast to a stop; when "Continue to run" is selected, the inverter saves the output frequency being applied when the undervoltage alarm occurred and restarts at the saved frequency after a recovery from the momentary power failure.

When the input power voltage for the inverter is high, setting the continuous running level high makes the control more stable even if the load's inertia is relatively small. Raising the continuous running level too high, however, might cause the continuous running control activated even during normal operation.

When the input power voltage for the inverter is extremely low, continuous running control might be activated even during normal operation, at the beginning of acceleration or at an abrupt change in load. To avoid this, lower the continuous running level. Lowering it too low, however, might cause undervoltage that results from voltage drop due to a control delay.

Before you change the continuous running level, make sure that the continuous running control will be performed properly, by considering the fluctuations of the load and the input voltage.

F15, F16	Frequency Limiter (High and Low)	H63 (Low Limiter, Mode selection)

■ Frequency Limiter (High and Low) (F15, F16)

F15 and F16 specify the upper and lower limits of the output frequency or reference frequency, respectively. The object to which the limit is applied differs depending on the control system.

Frequency Limiter		Object to which the limit is applied	
		V/f control	Vector control with/without speed sensor
Frequency Limiter (High)	F15	Output frequency	Reference speed (reference frequency)
Frequency Limiter (Low)	F16	Reference frequency	Reference speed (reference frequency)

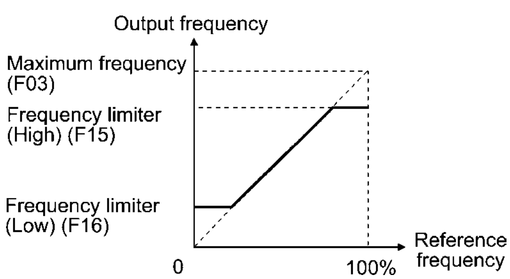
Note: When the limit is applied to the reference frequency or reference speed, delayed responses of control may cause an overshoot or undershoot, and the frequency may temporarily go beyond the limit level.

- Data setting range: 0.0 to 500.0 (Hz)

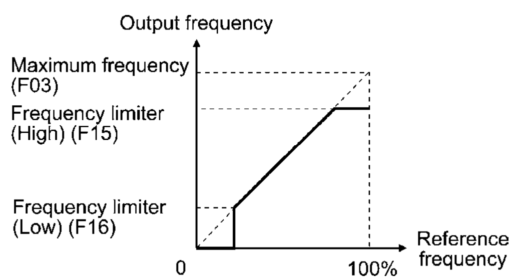
■ Low Limiter (Mode selection) (H63)

H63 specifies the operation to be carried out when the reference frequency drops below the low level specified by F16, as follows:

Data for H63	Operation
0	The output frequency will be held at the low level specified by F16.
1	The inverter decelerates to stop the motor.



(H63 = 0)



(H63 = 1)

Note

- When you change the frequency limiter (High) (F15) in order to raise the reference frequency, be sure to change the maximum frequency (F03) accordingly.
- Maintain the following relationship among the data for frequency control:

  F15 > F16, F15 > F23, and F15 > F25

  F03 > F16

  where, F23 and F25 specify the starting and stop frequencies, respectively.

  If you specify any wrong data for these function codes, the inverter may not run the motor at the desired speed, or cannot start it normally.

F18	Bias (Frequency command 1) Refer to F01.

Refer to the description of F01.

F20 to F22 H95	DC Braking 1 (Braking starting frequency, Braking level and Braking time) DC Braking (Braking response mode)

These function codes specify the DC braking that prevents motor 1 from running by inertia during decelerate-to-stop operation.

If the motor enters a decelerate-to-stop operation by turning OFF the run command or by decreasing the reference frequency below the stop frequency, the inverter activates the DC braking by flowing a current at the braking level (F21) for the braking time (F22) when the output frequency goes down to the DC braking starting frequency (F20).

Setting the braking time to "0.0" (F22 = 0) disables the DC braking.

■ Braking starting frequency (F20)

F20 specifies the frequency at which the DC braking starts its operation during motor decelerate-to-stop state.

- Data setting range: 0.0 to 60.0 (Hz)

■ Braking level (F21)

F21 specifies the output current level to be applied when the DC braking is activated. The function code data should be set, assuming the rated output current of the inverter as 100%, in increments of 1%.

- Data setting range: 0 to 80 (%) LD/MD-mode inverters
  0 to 100 (%) HD-mode inverters

Note: The inverter rated output current differs between the LD/MD and HD modes.
0% to 100% for inverters of 7.5 HP or below.

■ Braking time (F22)

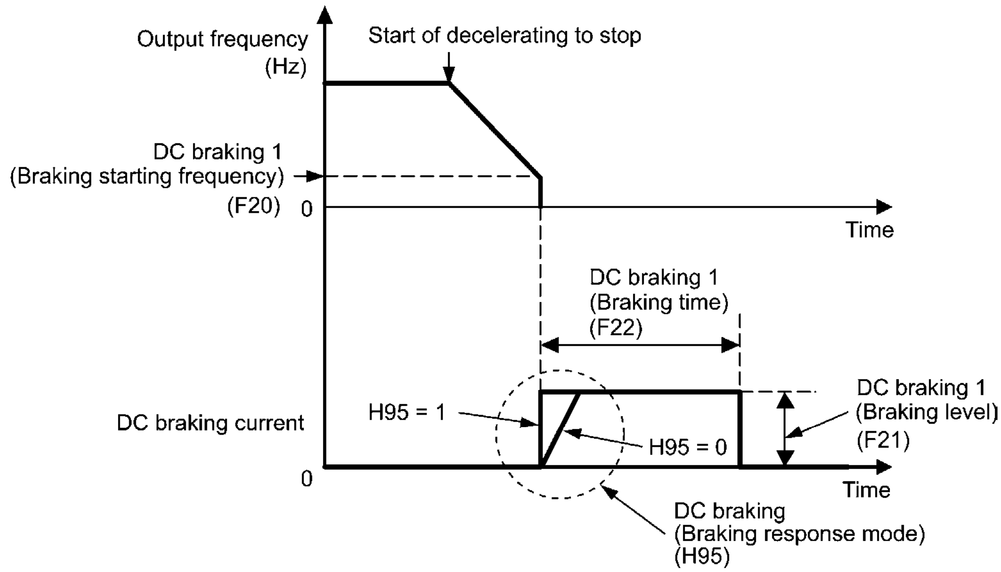
F22 specifies the braking period that activates DC braking.

- Data setting range: 0.01 to 30.00 (s)
  0.00 (Disable)

■ Braking response mode (H95)

H95 specifies the DC braking response mode. Under vector control with/without speed sensor, the response is constant.

Data for H95	Characteristics	Note
0	Slow response. Slows the rising edge of the current, thereby preventing reverse rotation at the start of DC braking.	Insufficient braking torque may result at the start of DC braking.
1	Quick response. Quickens the rising edge of the current, thereby accelerating the build-up of the braking torque.	Reverse rotation may result depending on the moment of inertia of the mechanical load and the coupling mechanism.



Tip It is also possible to use an external digital input signal as the terminal command ***DCBRK*** ("Enable DC braking").

As long as the ***DCBRK*** is ON, the inverter performs DC braking, regardless of the braking time specified by F22.

📖 For details about ***DCBRK***, refer to E01 through E07 (data = 13).

Turning the ***DCBRK*** ON even when the inverter is in a stopped state activates the DC braking. This feature allows the motor to be excited before starting, resulting in smoother acceleration (quicker build-up of acceleration torque) (under V/f control).

When vector control with/without speed sensor is selected, use the pre-exciting feature for establishing the magnetic flux. (📖 For details, refer to H84.)

In general, DC braking is used to prevent the motor from running by inertia during the stop process. Under vector control with speed sensor, however, zero speed control will be more effective for applications where load is applied to the motor even in a stopped state.

If the zero speed control continues for a long time, the motor may slightly rotate due to a control error. To fix the motor shaft, use the servo-lock function. (📖 For details, refer to J97.)

Note In general, specify data of function code F20 at a value close to the rated slip frequency of motor. If you set it at an extremely high value, control may become unstable and an overvoltage alarm may result in some cases.

⚠WARNING

Even if the motor is stopped by DC braking, voltage is output to inverter output terminals [U], [V], and [W].

An electric shock may occur.

⚠CAUTION

The DC braking function of the inverter does not provide any holding mechanism.

Injuries could occur.

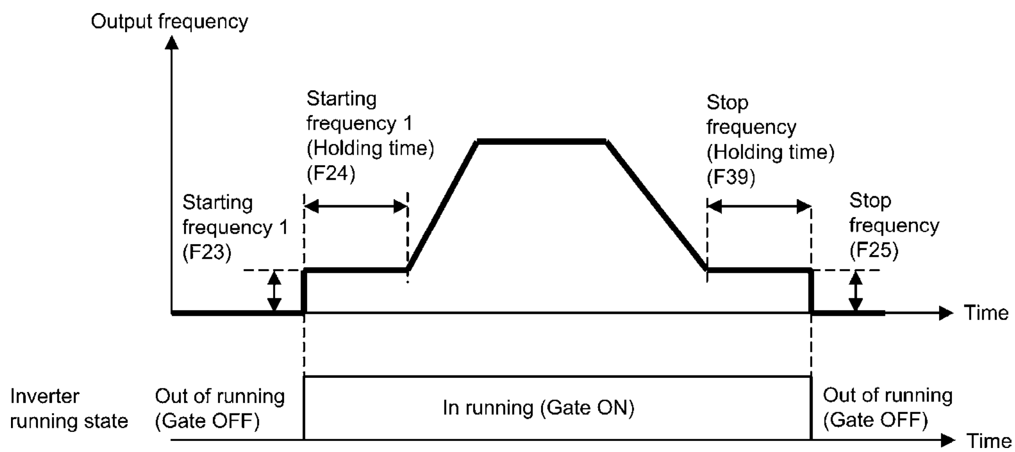
F23 to F25	**Starting Frequency 1, Starting Frequency 1 (Holding time) and Stop Frequency** **F38 and F39 (Stop Frequency, Detection mode and Holding time)** **H92 and H93 (Continuity of Running, P and I)** **d24 (Zero Speed Control)**

Under V/f control

At the startup of an inverter, the initial output frequency is equal to the starting frequency. The inverter stops its output when the output frequency reaches the stop frequency.

Set the starting frequency to a level at which the motor can generate enough torque for startup. Generally, set the motor's rated slip frequency as the starting frequency.

Specifying the holding time for the starting frequency compensates for the delay time for the establishment of a magnetic flux in the motor; specifying that for the stop frequency stabilizes the motor speed at the stop of the inverter.



■ Starting Frequency 1 (F23)

F23 specifies the starting frequency at the startup of an inverter.

- Data setting range: 0.0 to 60.0 (Hz)

Under V/f control, even if the starting frequency is set at 0.0 Hz, the inverter starts at 0.1 Hz.

■ Starting Frequency 1 (Holding time) (F24)

F24 specifies the holding time for the starting frequency 1.

- Data setting range: 0.00 to 10.00 (s)

■ Stop Frequency (F25)

F25 specifies the stop frequency at the stop of the inverter.

- Data setting range: 0.0 to 60.0 (Hz)

Under V/f control, even if the stop frequency is set at 0.0 Hz, the inverter stops its output at 0.1 Hz.

■ Stop Frequency (Holding time) (F39)

F39 specifies the holding time for the stop frequency.

- Data setting range: 0.00 to 10.00 (s)

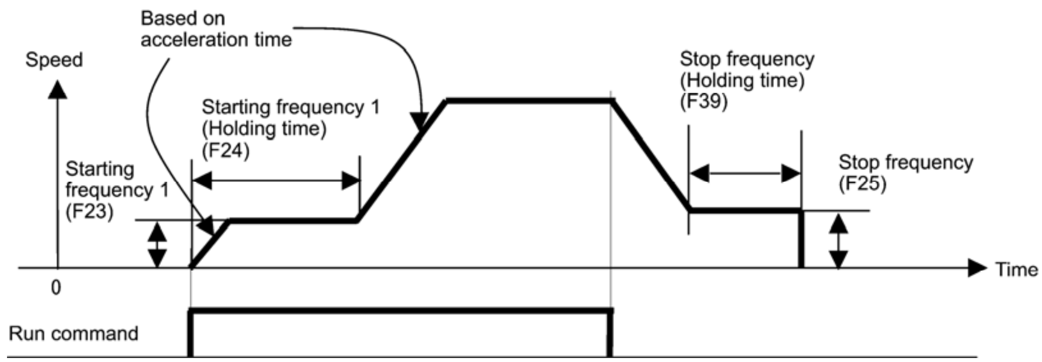
Note: If the starting frequency is lower than the stop frequency, the inverter does not output any power as long as the reference frequency does not exceed the stop frequency.

Under vector control with/without speed sensor

At the startup, the inverter first starts at the "0" speed and accelerates to the starting frequency according to the specified acceleration time. After holding the starting frequency for the specified period, the inverter again accelerates to the reference speed according to the specified acceleration time.

The inverter stops its output when the reference speed or detected one (specified by F38 under vector control with speed sensor only) reaches the stop frequency specified by F25.

Specifying the holding time for the starting frequency compensates for the delay time for the establishment of a magnetic flux in the motor; specifying that for the stop frequency stabilizes the motor speed at the stop of the inverter.



■ Starting Frequency 1 (F23)

F23 specifies the starting frequency at the startup of an inverter.

- Data setting range: 0.0 to 60.0 (Hz)

■ Starting Frequency 1 (Holding time) (F24)

F24 specifies the holding time for the starting frequency 1.

- Data setting range: 0.00 to 10.00 (s)

■ Stop Frequency (F25)

F25 specifies the stop frequency at the stop of the inverter.

- Data setting range: 0.0 to 60.0 (Hz)

■ Stop Frequency (Holding time) (F39)

F39 specifies the holding time for the stop frequency.

- Data setting range: 0.00 to 10.00 (Hz)

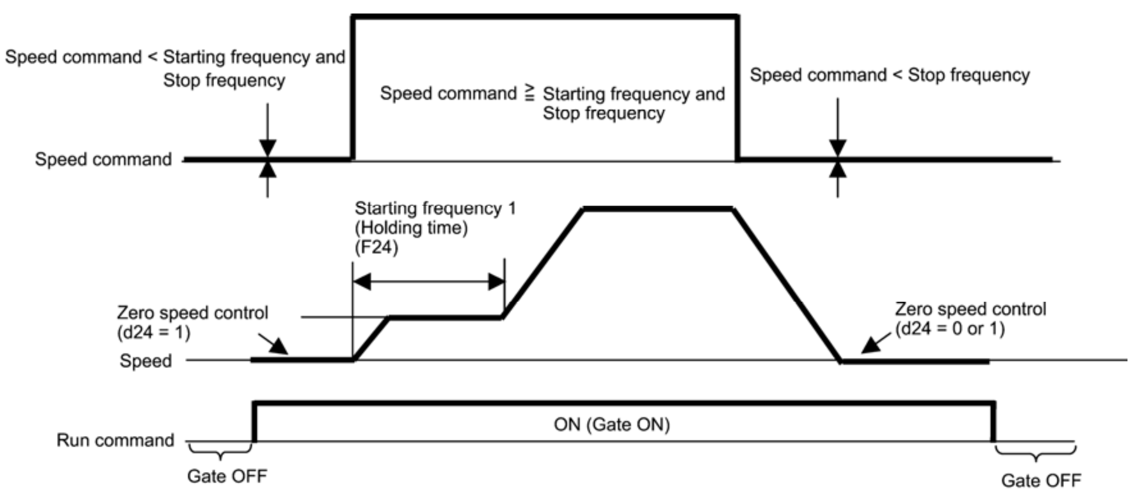
■ Zero Speed Control (d24) (Under vector control with speed sensor only)

To enable zero speed control under vector control with speed sensor, it is necessary to set the speed command (frequency command) below the starting and stop frequencies. If the starting and stop frequencies are 0.0 Hz, however, zero speed control is enabled only when the speed command is 0.00 Hz. d24 specifies the operation for zero speed control at the startup of the inverter.

Data for d24	Zero speed control at startup	Descriptions
0	Not allowed	Even setting the speed command at below the starting and stop frequencies and turning a run command ON does not enable zero speed control. To enable zero speed control, set the speed command at above the starting frequency and then start up the inverter again.
1	Allowed	Setting the speed command at below the starting and stop frequencies and turning a run command ON enables zero speed control.

The table below shows the conditions for zero speed control to be enabled or disabled.

	Speed command	Run command	Data for d24	Operation
At startup	Below the starting and stop frequencies	OFF	—	Stop (Gate OFF)
		ON	0	Stop (Gate OFF)
			1	Zero speed control
At stop	Below the stop frequency	ON	—	Zero speed control
		OFF	—	Stop (Gate OFF)



■ Stop Frequency (Detection mode) (F38) (Under vector control with speed sensor only)

F38 specifies whether to use the detected speed or reference one as a decision criterion to shut down the inverter output. Usually the inverter uses the detected speed. However, if the inverter undergoes a load exceeding its capability, e.g., an external excessive load, it cannot stop because the motor cannot stop so that the detected speed may not reach the stop frequency level. If such a situation could arise, select the reference speed that can reach the stop frequency level even if the detected speed does not, in order to stop the inverter without fail for general fail-safe operation.

- Data setting range: 0 (Detected speed)
  1 (Reference speed)

F26, F27 Motor Sound (Carrier frequency and Tone)

H98 (Protection/Maintenance Function, Mode selection)

■ Motor Sound (Carrier frequency) (F26)

F26 controls the carrier frequency to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, and to decrease a leakage current from the main output (secondary) wirings.

Item	Characteristics	Remarks
Carrier frequency	0.75 to 16 kHz	0.5 to 30 HP (LD mode) 0.5 to 100 HP (HD mode)
	0.75 to 10 kHz	40 to 100 HP (LD mode) 125 to 800 HP (HD mode)
	0.75 to 6 kHz	125 to 900 HP (LD mode) 900 to 1000 HP (HD mode)
	0.75 to 4 kHz	1000 HP (LD mode)
	0.75 to 2 kHz	150 to 800 HP (MD mode)
Motor sound noise emission	High ↔ Low	
Motor temperature (due to harmonics components)	High ↔ Low	
Ripples in output current waveform	Large ↔ Small	
Leakage current	Low ↔ High	
Electromagnetic noise emission	Low ↔ High	
Inverter loss	Low ↔ High	

Note Specifying a too low carrier frequency will cause the output current waveform to have a large amount of ripples. As a result, the motor loss increases, causing the motor temperature to rise. Furthermore, the large amount of ripples tends to cause a current limiting alarm. When the carrier frequency is set to 1 kHz or below, therefore, reduce the load so that the inverter output current comes to be 80% or less of the rated current.

When a high carrier frequency is specified, the temperature of the inverter may rise due to a surrounding temperature rise or an increase of the load. If it happens, the inverter automatically decreases the carrier frequency to prevent the inverter overload alarm OLU. With consideration for motor noise, the automatic reduction of carrier frequency can be disabled. Refer to the description of H98.

It is recommended to set the carrier frequency at 5 kHz or above under vector control with/without speed sensor. DO NOT set it at 1 kHz or below.

■ Motor Sound (Tone) (F27)

F27 changes the motor running sound tone (only for motors under V/f control). This setting is effective when the carrier frequency specified by function code F26 is 7 kHz or lower. Changing the tone level may reduce the high and harsh running noise from the motor.

Data for F27	Function
0	Disable (Tone level 0)
1	Enable (Tone level 1)
2	Enable (Tone level 2)
3	Enable (Tone level 3)

Note If the tone level is set too high, the output current may become unstable, or mechanical vibration and noise may increase. Also, this function code may not be very effective for certain types of motor.

F29 to F31 F32, F34, F35	**Analog Output [FM1] and [FM2] (Mode selection, Voltage adjustment, Function)**

These function codes allow terminals [FM1] and [FM2] to output monitored data such as the output frequency and the output current in an analog DC voltage or current. The magnitude of such analog voltage or current is adjustable.

■ Mode selection (F29 and F32)

F29 and F32 specify the property of the output to terminals [FM1] and [FM2], respectively. It is necessary to set the slide switches on the control printed circuit board (control PCB).

For details of the slide switches on the control PCB, refer to Chapter 2 "SPECIFICATIONS."

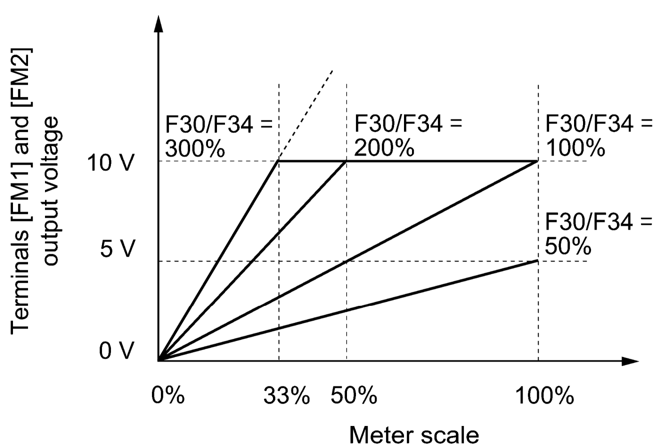
Output form	Terminal [FM1]		Terminal [FM2]	
	Data for F29	Position of slide switch SW4 on the control PCB	Data for F32	Position of slide switch SW6 on the control PCB
Voltage (0 to +10 VDC)	0	VO1	0	VO2
Current (4 to +20 mA DC)	1	IO1	1	IO2

Note The output current is not isolated from analog input, and does not have an isolated power supply. Therefore, if an electrical potential relationship between the inverter and peripheral equipment has been established, e.g., by connecting an analog, cascade connection of a current output device is not available.

Keep the connection wire length as short as possible.

■ Voltage adjustment (F30 and F34)

F30 and F34 specify the adjustment percentage of the output voltage on terminals [FM1] and [FM2] within the range of 0 to 300%, respectively.



■ Function (F31 and F35)

F31 and F35 specify what is output to analog output terminals [FM1] and [FM2], respectively.

Data for F31/F35	[FM1]/[FM2] output	Function (Monitor the following)	Meter scale (Full scale at 100%)
0	Output frequency 1 (before slip compensation)	Output frequency of the inverter (Equivalent to the motor synchronous speed)	Maximum frequency (F03)
1	Output frequency 2 (after slip compensation)	Output frequency of the inverter	Maximum frequency (F03)
2	Output current	Output current (RMS) of the inverter	Twice the inverter rated current
3	Output voltage	Output voltage (RMS) of the inverter	250 V for 230 V series, 500 V for 460 V series
4	Output torque	Motor shaft torque	Twice the rated motor torque
5	Load factor	Load factor (Equivalent to the indication of the load meter)	Twice the rated motor load
6	Input power	Input power of the inverter	Twice the rated output of the inverter
7	PID feedback amount (PV)	Feedback amount under PID control	100% of the feedback amount
8	PG feedback value (speed)	Speed detected through the PG interface, or estimated speed under vector control without speed sensor	Maximum speed as 100%
9	DC link bus voltage	DC link bus voltage of the inverter	500 V for 230 V series, 1000 V for 460 V series
10	Universal AO	Command via communications link (Refer to the RS-485 Communication User's Manual.)	20000 as 100%
13	Motor output	Motor output (kW)	Twice the rated motor output
14	Calibration (+)	Full scale output for the meter calibration	This always outputs the full-scale (100%).
15	PID command (SV)	Command value under PID control	100% of the feedback amount
16	PID output (MV)	Output level of the PID processor under PID control (Frequency command)	Maximum frequency (F03)
17	Positional deviation in synchronous running	Deviation in angle	0% to 50% to 100%, representing -180° to 0° to +180° of the deviation

Note: If F31/F35 = 16 (PID output), J01 = 3 (Dancer control), and J62 = 2 or 3 (Ratio compensation enabled), the PID output is equivalent to the ratio against the primary reference frequency and may vary within ±300% of the frequency. The monitor displays the PID output in a converted absolute value (%). To indicate the value up to the full-scale of 300%, set F30/F34 data to "33" (%).

F37 — Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1

F09 (Torque Boost 1)
H67 (Auto Energy Saving Operation, Mode selection)

F37 specifies V/f pattern, torque boost type, and auto energy saving operation in accordance with the characteristics of the load.

Specify the torque boost level with F09 in order to assure sufficient starting torque.

Data for F37	V/f pattern	Torque boost	Auto energy saving	Applicable load
0	Variable torque V/f pattern	Torque boost specified by F09	Disable	Variable torque load (General-purpose fans and pumps)
1	Linear V/f pattern			Constant torque load
2		Auto torque boost		Constant torque load (To be selected if a motor may be over-excited at no load.)
3	Variable torque V/f pattern	Torque boost specified by F09	Enable	Variable torque load (General-purpose fans and pumps)
4	Linear V/f pattern			Constant torque load
5		Auto torque boost		Constant torque load (To be selected if a motor may be over-excited at no load.)

Note If a required "load torque + acceleration toque" is more than 50% of the motor rated torque, it is recommended to select the linear V/f pattern (factory default).

Tip

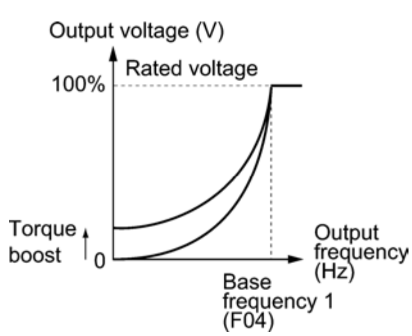
- Under vector control with speed sensor, F37 is used to specify whether the auto energy saving operation is enabled or disabled. (V/f pattern and torque boost are disabled.)

Data for F37	Operation
0 to 2	Auto energy saving operation OFF
3 to 5	Auto energy saving operation ON

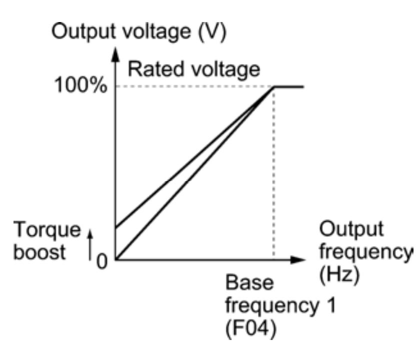
- Under vector control without speed sensor, both F37 and F09 are disabled. The auto energy saving operation is also disabled.

■ V/f characteristics

The FRENIC-MEGA series of inverters offer a variety of V/f patterns and torque boosts, which include V/f patterns suitable for variable torque load such as general fans and pumps and for constant torque load (including special pumps requiring high starting torque). Two types of torque boosts are available: manual and automatic.



Variable torque V/f pattern (F37 = 0)

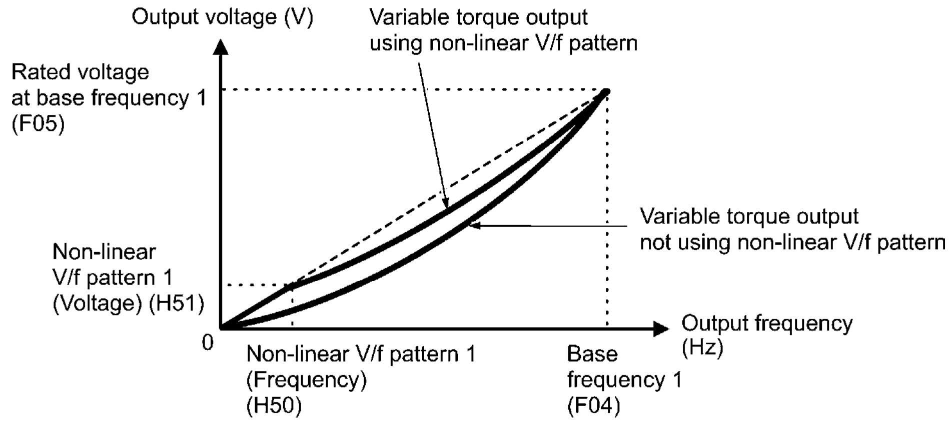


Linear V/f pattern (F37 = 1)

Tip

When the variable torque V/f pattern is selected (F37 = 0 or 3), the output voltage may be low at a low frequency zone, resulting in insufficient output torque, depending on the characteristics of the motor and load. In such a case, it is recommended to increase the output voltage at the low frequency zone using the non-linear V/f pattern.

Recommended value: H50 = 1/10 of the base frequency
H51 = 1/10 of the voltage at base frequency



■ Torque boost

- Manual torque boost (F09)

- Data setting range: 0.0 to 20.0 (%), (100%/Rated voltage at base frequency)

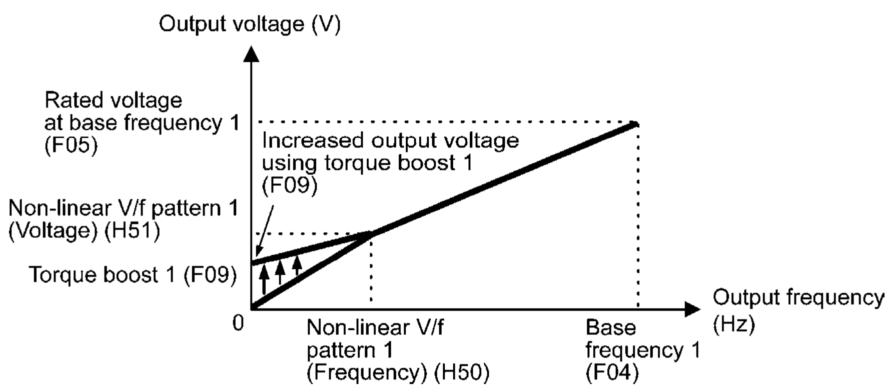
In torque boost using F09, constant voltage is added to the basic V/f pattern, regardless of the load. To secure a sufficient starting torque, manually adjust the output voltage to optimally match the motor and its load by using F09. Specify an appropriate level that guarantees smooth start-up and yet does not cause over-excitation at no or light load.

Torque boost using F09 ensures high driving stability since the output voltage remains constant regardless of the load fluctuation.

Specify the F09 data in percentage to the rated voltage at base frequency 1 (F05).

Note

- Specifying a high torque boost level will generate a high torque, but may cause overcurrent due to over-excitation at no load. If you continue to drive the motor, it may overheat. To avoid such a situation, adjust torque boost to an appropriate level.
- When the non-linear V/f pattern and the torque boost are used together, the torque boost takes effect below the frequency on the non-linear V/f pattern's point.



Chap. 5 FUNCTION CODES

Function Code Details
F40-F41
E codes
C codes
P codes
H codes
A codes
b codes
r codes
J codes
d codes
U codes
y codes

• Auto torque boost

If the auto torque boost is selected, the inverter automatically optimizes the output voltage to fit the motor with its load. Under light load, auto torque boost decreases the output voltage to prevent the motor from over-excitation. Under heavy load, it increases the output voltage to increase the output torque of the motor.

Note
- Since this function relies also on the characteristics of the motor, set the base frequency 1 (F04), the rated voltage at base frequency 1 (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto-tuning (P04).
- When a special motor is driven or the load does not have sufficient rigidity, the maximum torque might decrease or the motor operation might become unstable. In such cases, do not use auto torque boost but choose manual torque boost using F09 (F37 = 0 or 1).

■ Auto energy saving operation (H67)

If the auto energy saving operation is enabled, the inverter automatically controls the supply voltage to the motor to minimize the total power loss of motor and inverter. (Note that this feature may not be effective depending upon the motor or load characteristics. Check the advantage of energy saving before you actually apply this feature to your machinery.)

You can select whether applying this feature to constant speed operation only or applying to constant speed operation and accelerating/decelerating operation.

Data for H67	Auto energy saving operation
0	Enable only during running at constant speed (In accelerating/decelerating, the torque boost by F09 or the auto torque boost applies depending on the F37 setting.)
1	Enable during running at constant speed or accelerating/decelerating (Note: For accelerating/decelerating, enable only when the load is light.)

If auto energy saving operation is enabled, the response to a motor speed change from constant speed operation may be slow. Do not use this feature for such machinery that requires quick acceleration/deceleration.

Note
- Use auto energy saving only where the base frequency is 60 Hz or lower. If the base frequency is set at 60 Hz or higher, you may get a little or no energy saving advantage. The auto energy saving operation is designed for use with the frequency lower than the base frequency. If the frequency becomes higher than the base frequency, the auto energy saving operation will be invalid.
- Since this function relies also on the characteristics of the motor, set the base frequency 1 (F04), the rated voltage at base frequency 1 (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto-tuning (P04).
- Under vector control without speed sensor, the auto energy saving operation is disabled.

F38, F39	Stop Frequency (Detection mode and Holding time) Refer to F23.

For details about the setting of the stop frequency (detection mode and holding time), refer to the description of F23.

F40, F41	Torque Limiter 1-1, 1-2 E16 and E17 (Torque Limiter 2-1, 2-2) H73 (Torque Limiter, Operating conditions) H76 (Torque Limiter, Frequency increment limit for braking)

Under V/f control

If the inverter's output torque exceeds the specified levels of the torque limiters (F40, F41, E16, E17, and E61 to E63), the inverter controls the output frequency and limits the output torque for preventing a stall.

To use the torque limiters, it is necessary to configure the function codes listed in the table below.

Note: In braking, the inverter increases the output frequency to limit the output torque. Depending on the conditions during operation, the output frequency could dangerously increase. H76 (Frequency increment limit for braking) is provided to limit the increasing frequency component.

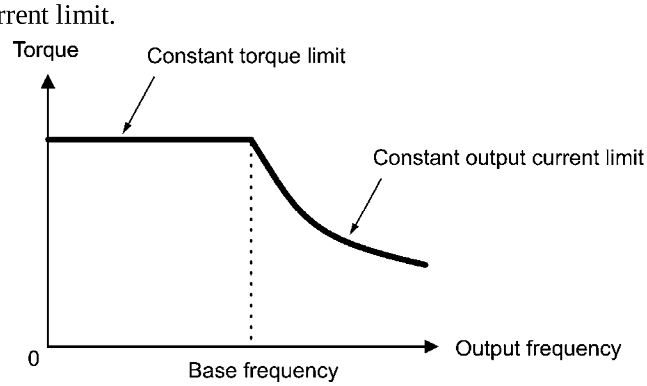
Related function codes

Function code	Name	V/f control	Remarks
F40	Torque Limiter 1-1	Y	
F41	Torque Limiter 1-2	Y	
E16	Torque Limiter 2-1	Y	
E17	Torque Limiter 2-2	Y	
H73	Torque Limiter (Operating conditions)	Y	
H74	Torque Limiter (Control target)	N	
H75	Torque Limiter (Target quadrants)	N	
H76	Torque Limiter (Frequency increment limit for braking)	Y	
E61 to E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	Y	7: Analog torque limit value A 8: Analog torque limit value B

■ Torque limit control mode

Torque limit is performed by limiting torque current flowing across the motor.

The graph below shows the relationship between the torque and the output frequency at the constant torque current limit.



Chap. 5 FUNCTION CODES

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d codes
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y codes

■ Torque limiters 1-1, 1-2, 2-1 and 2-2 (F40, F41, E16 and E17)

Data setting range: -300 to 300 (%), 999 (Disable)

These function codes specify the operation level at which the torque limiters become activated, as the percentage of the motor rated torque.

Function code	Name	Torque limit feature
F40	Torque limiter 1-1	Driving torque current limiter 1
F41	Torque limiter 1-2	Braking torque current limiter 1
E16	Torque limiter 2-1	Driving torque current limiter 2
E17	Torque limiter 2-2	Braking torque current limiter 2

Note

Although the data setting range for F40, F41, E16, and E17 is from positive to negative values (–300% to +300%), specify positive values in practice. Specifying a negative value causes the inverter to interpret it as an absolute value.

The torque limiter determined depending on the overload current actually limits the torque current output. Therefore, the torque current output is automatically limited at a value lower than 300%, the maximum setting value.

■ Analog torque limit values (E61 to E63)

The torque limit values can be specified by analog inputs through terminals [12], [C1], and [V2] (voltage or current). Set E61, E62, and E63 (Terminal [12] Extended Function, Terminal [C1] Extended Function, and Terminal [V2] Extended Function) as listed below.

Data for E61, E62, or E63	Function	Description
7	Analog torque limit value A	Use the analog input as the torque limit value specified by function code data (= 7 or 8). Input specifications: 200% / 10 V or 20 mA
8	Analog torque limit value B	

If the same setting is made for different terminals, the priority order is E61>E62>E63.

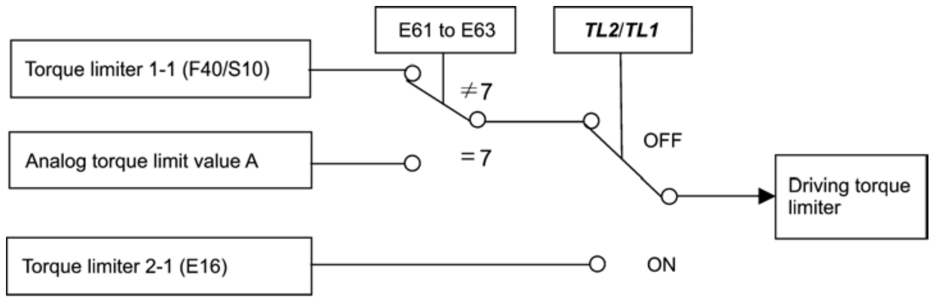
■ Torque limiter levels specified via communications link (S10, S11)

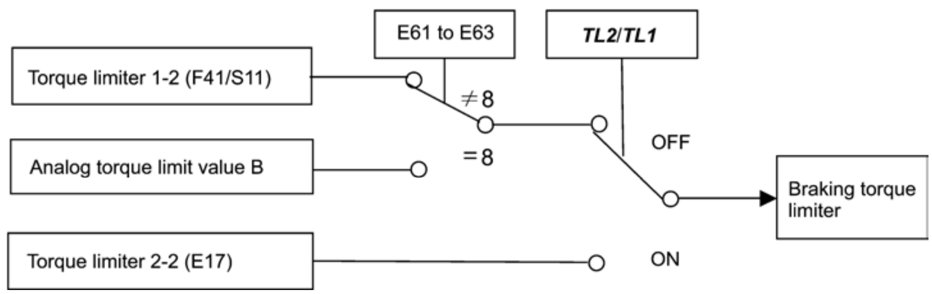
The torque limiter levels can be changed via the communications link. Function codes S10 and S11 exclusively reserved for the communications link respond to function codes F40 and F41.

■ Switching torque limiters

The torque limiters can be switched by the function code setting and the terminal command ***TL2/TL1*** ("Select torque limiter level 2/1") assigned to any of the digital input terminals.

To assign the ***TL2/TL1*** as the terminal function, set any of E01 through E07 to "14." If no ***TL2/TL1*** is assigned, torque limiter levels 1-1 and 1-2 (F40 and F41) take effect by default.





■ Torque limiter (Operating conditions) (H73)

H73 specifies whether the torque limiter is enabled or disabled during acceleration/ deceleration and running at constant speed.

Data for H73	During accelerating/decelerating	During running at constant speed
0	Enable	Enable
1	Disable	Enable
2	Enable	Disable

■ Torque limiter (Frequency increment limit for braking) (H76)

Data setting range: 0.0 to 500.0 (Hz)

H76 specifies the increment limit of the frequency in limiting torque for braking. The factory default is 5.0 Hz. If the increasing frequency during braking reaches the limit value, the torque limiters no longer function, resulting in an overvoltage trip. Such a problem may be avoided by increasing the setting value of H76.

Note: The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting (undesirable oscillation of the system). Avoid concurrent activation of these limiters.

Under vector control with/without speed sensor

If the inverter's output torque exceeds the specified levels of the torque limiters (F40, F41, E16, E17, and E61 to E63), the inverter controls the speed regulator's output (torque command) in speed control or a torque command in torque control in order to limit the motor-generating torque.

To use the torque limiters, it is necessary to configure the function codes listed in the table below.

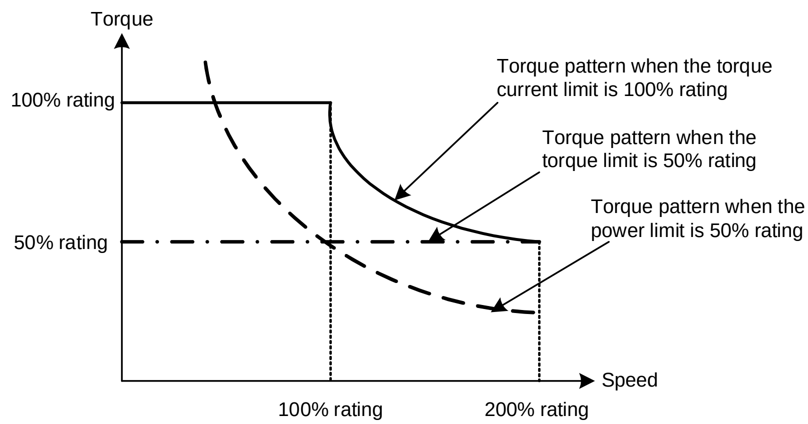
Related function codes

Function code	Name	Vector control	Remarks
F40	Torque Limiter 1-1	Y	
F41	Torque Limiter 1-2	Y	
E16	Torque Limiter 2-1	Y	
E17	Torque Limiter 2-2	Y	
H73	Torque Limiter (Operating conditions)	Y	
H74	Torque Limiter (Control target)	Y	
H75	Torque Limiter (Target quadrants)	Y	
H76	Torque Limiter (Frequency increment limit for braking)	N	
E61 to E63	Terminal [12] Extended Function Terminal [C1] Extended Function Terminal [V2] Extended Function	Y	7: Analog torque limit value A 8: Analog torque limit value B

■ Torque Limiter (Control target) (H74)

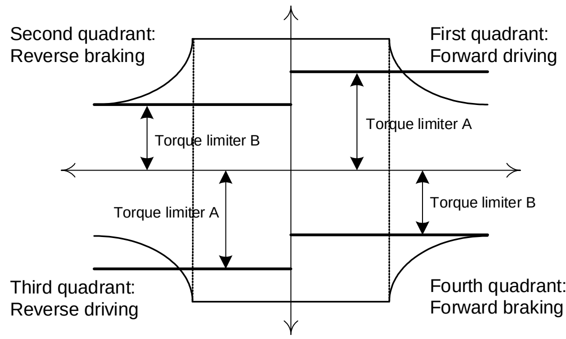
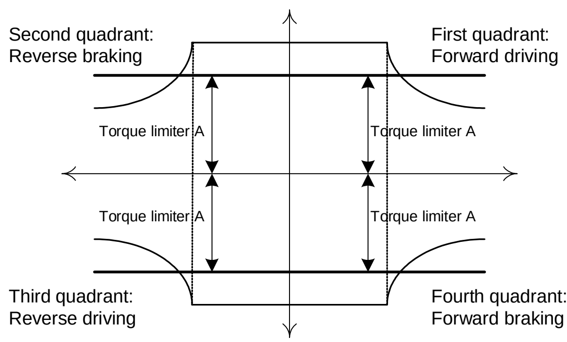
Under vector control, the inverter can limit motor-generating torque or output power, as well as a torque current (default).

Data for H74	Control target
0	Motor-generating torque limit
1	Torque current limit
2	Output power limit

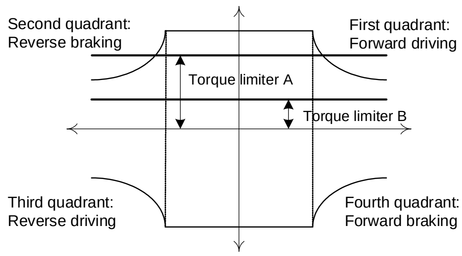


■ Torque Limiter (Target quadrants) (H75)

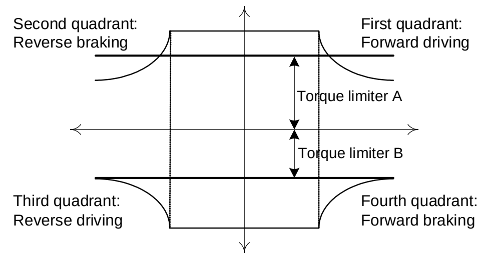
H75 selects the configuration of target quadrants (Drive/brake, Forward/reverse rotation) in which the specified torque limiter(s) is activated, from "Drive/brake torque limit," "Same torque limit for all four quadrants," and "Upper/lower torque limits" shown in the table below.

Data for H75	Target quadrants
0: Drive/brake	Torque limiter A applies to driving (both of forward and reverse), and torque limiter B to braking (both of forward and reverse). 
1: Same for all four quadrants	Torque limiter A applies to all four quadrants; that is, the same torque limit applies to both driving and braking in the forward and reverse rotations. 

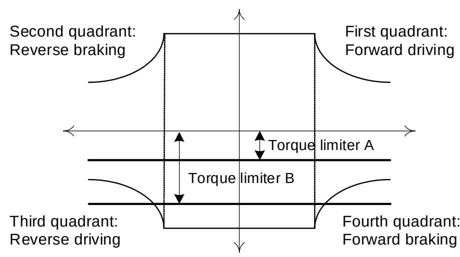
<table>
<tr>
<td>2: Upper/lower limits</td>
<td>
Torque limiter A applies to the upper limit, and torque limiter B to the lower limit. Depending upon the polarity of torque limiters A and B, the following patterns are available.
<table>
<tr><th></th><th>Torque limiter A</th><th>Torque limiter B</th></tr>
<tr><td>Pattern 1</td><td>Positive</td><td>Positive</td></tr>
<tr><td>Pattern 2</td><td>Positive</td><td>Negative</td></tr>
<tr><td>Pattern 3</td><td>Negative</td><td>Negative</td></tr>
</table>



Pattern 1



Pattern 2



Pattern 3

Note

If the value of torque limiter A is less than that of torque limiter B, torque limiter A applies to both the upper and lower limits.
Selecting the "Upper/lower torque limits" may cause reciprocating oscillation between the upper and lower limit values, depending upon a small difference between the upper and lower limits, a slow response from the speed control sequence, and other conditions.

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</tr>
</table>

■ Torque limiters 1-1, 1-2, 2-1 and 2-2 (F40, F41, E16 and E17)

Data setting range: -300 to 300 (%), 999 (Disable)

These function codes specify the operation level at which the torque limiters become activated, as the percentage of the motor rated torque.

Function code	Name
F40	Torque limiter 1-1
F41	Torque limiter 1-2
E16	Torque limiter 2-1
E17	Torque limiter 2-2

Note

Although the data setting range for F40, F41, E16, and E17 is from positive to negative values (–300% to +300%), specify positive values in practice except when the "Upper/lower torque limits" (H75 = 2) is selected. Specifying a negative value causes the inverter to interpret it as an absolute value.

The torque limiter determined depending on the overload current actually limits the torque current output. Therefore, the torque current output is automatically limited at a value lower than 300%, the maximum setting value.

■ Analog torque limit values (E61 to E63)

The torque limit values can be specified by analog inputs through terminals [12], [C1], and [V2] (voltage or current). Set E61, E62, and E63 (Terminal [12] Extended Function, Terminal [C1] Extended Function, and Terminal [V2] Extended Function) as listed below.

Data for E61, E62, or E63	Function	Description
7	Analog torque limit value A	Use the analog input as the torque limit value specified by function code data (= 7 or 8). Input specifications: 200% / 10 V or 20 mA
8	Analog torque limit value B	

If the same setting is made for different terminals, the priority order is E61>E62>E63.

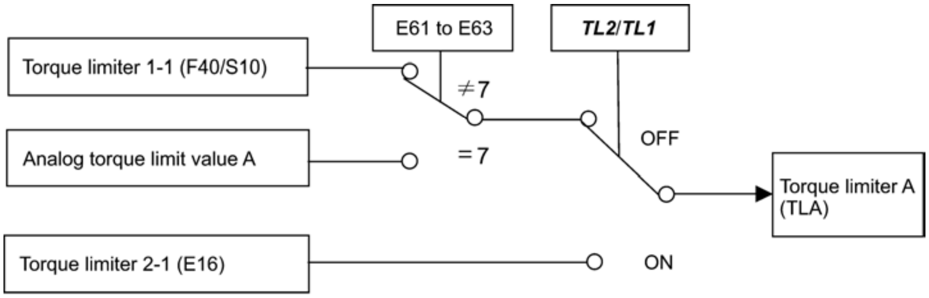
■ Torque limiter levels specified via communications link (S10, S11)

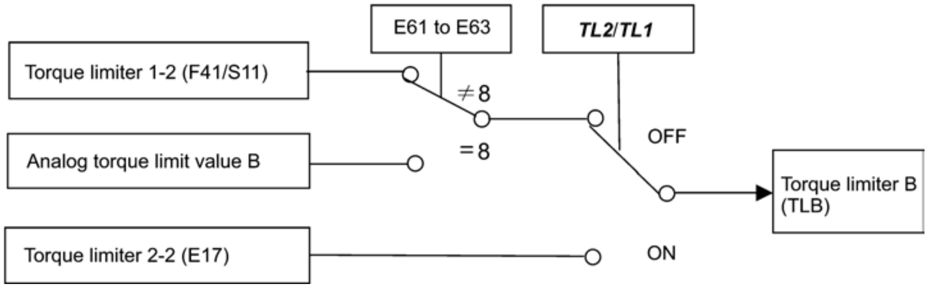
The torque limiter levels can be changed via the communications link. Function codes S10 and S11 exclusively reserved for the communications link respond to function codes F40 and F41.

■ Switching torque limiters

The torque limiters can be switched by the function code setting and the terminal command ***TL2/TL1*** ("Select torque limiter level 2/1") assigned to any of the digital input terminals.

To assign the ***TL2/TL1*** as the terminal function, set any of E01 through E07 to "14." If no ***TL2/TL1*** is assigned, torque limiter levels 1-1 and 1-2 (F40 and F41) take effect by default.





■ Torque limiter (Operating conditions) (H73)

H73 specifies whether the torque limiter is enabled or disabled during acceleration/ deceleration and running at constant speed.

Data for H73	During accelerating/decelerating	During running at constant speed
0	Enable	Enable
1	Disable	Enable
2	Enable	Disable

Note: The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting (undesirable oscillation of the system). Avoid concurrent activation of these limiters.

F42 — Drive Control Selection 1 — H68 (Slip Compensation 1, Operating conditions)

F42 specifies the motor drive control.

<table>
<tr><th>Data for F42</th><th>Drive control</th><th>Basic control</th><th>Speed feedback</th><th>Speed control</th></tr>
<tr><td>0</td><td>V/f control with slip compensation inactive</td><td rowspan="5">V/f control</td><td rowspan="3">Disable</td><td>Frequency control</td></tr>
<tr><td>1</td><td>Dynamic torque vector control (with slip compensation and auto torque boost)</td><td rowspan="2">Frequency control with slip compensation</td></tr>
<tr><td>2</td><td>V/f control with slip compensation active</td></tr>
<tr><td>3</td><td>V/f control with speed sensor</td><td rowspan="2">Enable</td><td rowspan="2">Frequency control with automatic speed regulator (ASR)</td></tr>
<tr><td>4</td><td>Dynamic torque vector control with speed sensor</td></tr>
<tr><td>5</td><td>Vector control without speed sensor</td><td rowspan="2">Vector control</td><td>Estimated speed</td><td rowspan="2">Speed control with automatic speed regulator (ASR)</td></tr>
<tr><td>6</td><td>Vector control with speed sensor</td><td>Enable</td></tr>
</table>

■ V/f control with slip compensation inactive

Under this control, the inverter controls a motor with the voltage and frequency according to the V/f pattern specified by function codes. This control disables all automatically controlled features such as the slip compensation, so no unpredictable output fluctuation occurs, enabling stable operation with constant output frequency.

■ V/f control with slip compensation active

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. The inverter's slip compensation function first presumes the slip value of the motor based on the motor torque generated and raises the output frequency to compensate for the decrease in motor rotation. This prevents the motor from decreasing the rotation due to the slip.

That is, this function is effective for improving the motor speed control accuracy.

Function code		Operation
P12	Rated slip frequency	Specify the rated slip frequency.
P09	Slip compensation gain for driving	Adjust the slip compensation amount for driving. Slip compensation amount for driving = Rated slip x Slip compensation gain for driving
P11	Slip compensation gain for braking	Adjust the slip compensation amount for braking. Slip compensation amount for braking = Rated slip x Slip compensation gain for braking
P10	Slip compensation response time	Specify the slip compensation response time. Basically, there is no need to modify the default setting.

To improve the accuracy of slip compensation, perform auto-tuning.

H68 enables or disables the slip compensation function according to the motor driving conditions.

Data for H68	Motor driving conditions		Motor driving frequency zone	
	Accl/Decel	Constant speed	Base frequency or below	Above the base frequency
0	Enable	Enable	Enable	Enable
1	Disable	Enable	Enable	Enable
2	Enable	Enable	Enable	Disable
3	Disable	Enable	Enable	Disable

■ Dynamic torque vector control

To get the maximal torque out of a motor, this control calculates the motor torque matched to the load applied and uses it to optimize the voltage and current vector output.

Selecting this control automatically enables the auto torque boost and slip compensation function so that it is effective for improving the system response to external disturbances such as load fluctuation, and the motor speed control accuracy.

Note that the inverter may not respond to a rapid load fluctuation since this control is an open-loop V/f control that does not perform current control, unlike vector control. Other advantage of this control is that the maximum torque per output current is larger than that of vector control.

■ V/f control with speed sensor

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. Under V/f control with speed sensor, the inverter detects the motor rotation using the encoder mounted on the motor shaft and compensates for the decrease in slip frequency by the PI control to match the motor rotation with the reference speed. This improves the motor speed control accuracy.

■ Dynamic torque vector control with speed sensor

The difference from "V/f control with speed sensor" stated above is to calculate the motor torque matched to the load applied and use it to optimize the voltage and current vector output for getting the maximal torque out of a motor.

This control is effective for improving the system response to external disturbances such as load fluctuations, and the motor speed control accuracy.

■ Vector control without speed sensor

This control estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. It also decomposes the motor drive current into the exciting and torque current components, and controls each of those components in vector. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

The control regulating the motor current requires some voltage margin between the voltage that the inverter can output and the induced voltage of the motor. Usually a general-purpose motor is so designed that the voltage matches the commercial power. Under the control, therefore, it is necessary to suppress the motor terminal voltage to the lower level in order to secure the voltage margin required.

However, driving the motor with the motor terminal voltage suppressed to the lower level cannot generate the rated torque even if the rated current originally specified for the motor is applied. To ensure the rated torque, it is necessary to increase the rated current. (This also applies to vector control with speed sensor.)

The control is not available in MD-mode inverters, so do not set F42 data to "5" for those inverters.

■ Vector control with speed sensor

This control requires an optional PG (pulse generator) and an optional PG interface card to be mounted on a motor shaft and an inverter, respectively. The inverter detects the motor's rotational position and speed according to PG feedback signals and uses them for speed control. It also decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector.

It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

The control enables speed control with higher accuracy and quicker response than vector control without speed sensor.

Note

Since slip compensation, dynamic torque vector control, and vector control with/without speed sensor use motor parameters, the following conditions should be satisfied to obtain full control performance.

- A single motor is controlled per inverter.
- Motor parameters P02, P03, P06 to P23, P55 and P56 are properly configured. Or, auto-tuning (P04) is performed.
- Under dynamic torque vector control, the capacity of the motor to be controlled is two or more ranks lower than that of the inverter; under vector control with/without speed sensor, it is the same as that of the inverter. Otherwise, the inverter may not control the motor due to decrease of the current detection resolution.
- The wiring distance between the inverter and motor is 164 ft (50 m) or less. If it is longer, the inverter may not control the motor due to leakage current flowing through stray capacitance to the ground or between wires. Especially, small capacity inverters whose rated current is also small may be unable to control the motor correctly even if the wiring is less than 164 ft (50 m). In that case, make the wiring length as short as possible or use a wire with small stray capacitance (e.g., loosely-bundled cable) to minimize the stray capacitance.

F43, F44 — Current Limiter (Mode selection and Level)

H12 (Instantaneous Overcurrent Limiting, Mode selection)

When the output current of the inverter exceeds the level specified by the current limiter (F44), the inverter automatically manages its output frequency to prevent a stall and limits the output current. The default setting of the current limiter is 130%, 145% and 160% for LD-, MD- and HD-mode inverters, respectively. (Once the LD, MD, or HD mode is selected by F80, the current limit for each mode is automatically specified.)

Note that for LD- and HD-mode inverters of 7.5 HP or below, the current limiter is initialized to 160% with F80.

If overload current, 130% (145% or 160%) or more of the current limit level, flows instantaneously so that an output frequency decrease problem arises due to the current limiter, consider increasing the current limit level.

The current limiter mode should be also selected with F43. If F43 = 1, the current limiter is enabled only during constant speed operation. If F43 = 2, it is enabled during both of acceleration and constant speed operation. Choose F43 = 1 if you need to run the inverter at full capability during acceleration and to limit the output current during constant speed operation.

■ Mode selection (F43)

F43 selects the motor running state in which the current limiter becomes activated.

Data for F43	Running states that enable the current limiter		
	During acceleration	During constant speed	During deceleration
0	Disable	Disable	Disable
1	Disable	Enable	Disable
2	Enable	Enable	Disable

■ Level (F44)

F44 specifies the operation level at which the output current limiter becomes activated, in ratio to the inverter rating.

- Data setting range: 20 to 200 (%) (in ratio to the inverter rating)

Note: The inverter's rated current differs depending upon the LD, MD, or HD mode selected.

■ Instantaneous Overcurrent Limiting (Mode selection) (H12)

H12 specifies whether the inverter invokes the current limit processing or enters the overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level. Under the current limit processing, the inverter immediately turns OFF its output gate to suppress the further current increase and continues to control the output frequency.

Data for H12	Function
0	Disable An overcurrent trip occurs at the instantaneous overcurrent limiting level.
1	Enable

If any problem could occur when the motor torque temporarily drops during current limiting processing, it is necessary to cause an overcurrent trip (H12 = 0) and actuate a mechanical brake at the same time.

Note

- Since the current limit operation with F43 and F44 is performed by software, it may cause a delay in control. If you need a quick response current limiting, also enable the instantaneous overcurrent limiting with H12.
- If an excessive load is applied when the current limiter operation level is set extremely low, the inverter will rapidly lower its output frequency. This may cause an overvoltage trip or dangerous turnover of the motor rotation due to undershooting. Depending on the load, extremely short acceleration time may activate the current limiting to suppress the increase of the inverter output frequency, causing hunting (undesirable oscillation of the system) or activating the inverter overvoltage trip (alarm 0U). When specifying the acceleration time, therefore, you need to take into account machinery characteristics and moment of inertia of the load.
- The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting. Avoid concurrent activation of these limiters.
- Vector control itself contains the current control system, so it disables the current limiter specified by F43 and F44, as well as automatically disabling the instantaneous overcurrent limiting (specified by H12). Accordingly, the inverter causes an overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level.

F50 to F52 Electronic Thermal Overload Protection for Braking Resistor (Discharging capability, Allowable average loss and Resistance)

These function codes specify the electronic thermal overload protection feature for the braking resistor.

Set the discharging capability, allowable average loss and resistance to F50, F51 and F52, respectively. These values are determined by the inverter and braking resistor models. For the discharging capability, allowable average loss and resistance, refer to Chapter 4, Section 4.4.1.1 "Braking resistor (DBR) and braking unit, [3] Specifications." The values listed in the tables are for standard models and 10% ED models of the braking resistors which Fuji Electric provides. When using a braking resistor of any other manufacturer, confirm the corresponding values with the manufacture and set the function codes accordingly.

Note

Depending on the thermal marginal characteristics of the braking resistor, the electronic thermal overload protection feature may act so that the inverter issues the overheat protection alarm dbH even if the actual temperature rise is not large enough. If it happens, review the relationship between the performance index of the braking resistor and settings of related function codes.

Tip

Using the standard models of braking resistor or using the braking unit and braking resistor together can output temperature detection signal for overheat. Assign terminal command ***THR*** ("Enable external alarm trip") to any of digital input terminals [X1] to [X7], [FWD] and [REV] and connect that terminal and its common terminal to braking resistor's terminals 2 and 1.

Calculating the discharging capability and allowable average loss of the braking resistor and configuring the function code data

When using any non-Fuji braking resistor, inquire of the resistor manufacturer about the resistor rating and then configure the related function codes.

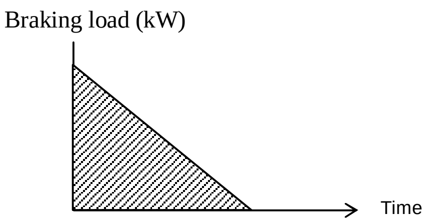
The calculation procedures for the discharging capability and allowable average loss of the braking resistor differ depending on the application of the braking load as shown below.

Applying braking load during deceleration

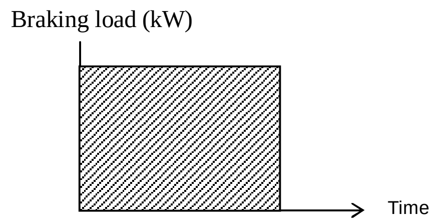
In usual deceleration, the braking load decreases as the speed slows down. In the deceleration with constant torque, the braking load decreases in proportion to the speed. Use Expressions (1) and (3) given below.

Applying braking load during running at a constant speed

Different from during deceleration, in applications where the braking load is externally applied during running at a constant speed, the braking load is constant. Use Expressions (2) and (4) given below.



Applying braking load during deceleration



Applying braking load during running at a constant speed

■ Discharging capability (F50)

The discharging capability refers to kWs allowable for a single braking cycle, which is obtained based on the braking time and the motor rated capacity.

Data for F50	Function
0	To be applied to the braking resistor built-in type
1 to 9000	1 to 9000 (kWs)
OFF	Disable the electronic thermal overload protection

During deceleration:

$$\text{Discharging capability (kWs)} = \frac{\text{Braking time (s)} \times \text{Motor rated capacity (HP)} \times 0.75}{2} \qquad \text{Expression (1)}$$

During running at a constant speed:

$$\text{Discharging capability (kWs)} = \text{Braking time (s)} \times \text{Motor rated capacity (HP)} \times 0.75 \qquad \text{Expression (2)}$$

Tip When the F50 is set to "0" (To be applied to the braking resistor built-in type), no specification of the discharging capability is required.

■ Allowable average loss (F51)

The allowable average loss refers to a tolerance for motor continuous operation, which is obtained based on the %ED (%) and motor rated capacity (HP).

Data for F51	Function
0.001 to 99.99	0.001 to 99.99 (kW)

During deceleration:

$$\text{Allowable average loss (kW)} = \frac{\frac{\%ED(\%)}{100} \times \text{Motor rated capacity (HP)} \times 0.75}{2} \qquad \text{Expression (3)}$$

During constant speed operation:

$$\text{Allowable average loss (kW)} = \frac{\%ED(\%)}{100} \times \text{Motor rated capacity (HP)} \times 0.75 \qquad \text{Expression (4)}$$

■ Resistance (F52)

F52 specifies the resistance of the braking resistor.

F80 Switching between LD, MD and HD drive modes

F80 specifies whether to drive the inverter in the low duty (LD), medium duty (MD) or high duty (HD) mode.

To change the F80 data, it is necessary to press the STOP + ∧ keys or STOP + ∨ keys (simultaneous keying).

Data for F80	Drive mode	Application	Continuous current rating level	Overload capability	Maximum frequency
1	LD (Low Duty) mode	Light load	Drive a motor whose capacity is the same as the inverter's one.	120% for 1 min.	120 Hz
2	MD (Medium Duty) mode	Medium load	Drives a motor whose capacity is the same as the inverter's one or derates a motor one rank lower than the inverter's capacity.	150% for 1 min.	120 Hz
0	HD (High Duty) mode	Heavy load	Derates a motor one or two ranks lower than the inverter's capacity.	150% for 1 min. 200% for 3 s	500 Hz

Switching to the MD/HD mode increases the overload capability (%) against the continuous current level up to 150%, but it requires derating the motor one or two ranks lower than the inverter's capacity.

Note: For 7.5 HP or smaller, when LD mode is selected, the HD mode specification applies.

For the rated current level, see Chapter 2 "SPECIFICATIONS."

The LD/MD-mode inverters are subject to restrictions on the function code data setting range and internal processing as listed below.

Function codes	Name	LD mode	MD mode	HD mode	Remarks
F21*	DC braking (Braking level)	Setting range: 0 to 80%		Setting range: 0 to 100%	In the LD/MD mode, a value out of the range, if specified, automatically changes to the maximum value allowable in the LD mode.
F26	Motor sound (Carrier frequency)	Setting range: 0.75 to 16 kHz (0.5 to 30 HP) 0.75 to 10 kHz (40 to 100 HP) 0.75 to 6 kHz (125 to 900 HP) 0.75 to 4 kHz (1000 HP)	Setting range: 0.75 to 2 kHz (150 to 800 HP)	Setting range: 0.75 to 16 kHz (0.5 to 100 HP) 0.75 to 10 kHz (125 to 800 HP) 0.75 to 6 kHz (900 and 1000 HP)	
F44	Current limiter (Level)	Initial value: 130%	Initial value: 145%	Initial value: 160%	Switching the drive mode between LD, MD and HD with function code F80 automatically initializes the F44 data to the value specified at left.
F03*	Maximum frequency	Setting range: 25 to 500 Hz Upper limit: 120 Hz		Setting range: 25 to 500 Hz Upper limit: 500 Hz	In the LD/MD mode, if the maximum frequency exceeds 120 Hz, the actual output frequency is internally limited to 120 Hz.
—	Current indication and output	Based on the rated current level for LD mode	Based on the rated current level for MD mode	Based on the rated current level for HD mode	—

Even switching to the MD/HD mode cannot automatically change the motor rated capacity (P02*), so configure the P02 data to match the applied motor rating as required.

* These function codes are shown with motor 1 only. For motors 2 to 4, replace those asterisked function codes with respective motor dedicated ones.

📖 For the function codes dedicated to motors 2 to 4, see Section 5.4.6.

5.4.2 E codes (Extension terminal functions)

E01 to E07 — **Terminal [X1] to [X7] Functions**

E98 and E99 (Terminal [FWD] and [REV] Functions)

E01 to E07, E98 and E99 assign commands (listed below) to general-purpose, programmable, digital input terminals, [X1] to [X7], [FWD], and [REV].

These function codes can also switch the logic system between normal and negative to define how the inverter logic interprets the ON or OFF state of each terminal. The factory default setting is normal logic system "Active ON." So, descriptions that follow are given in normal logic system. They are, in principle, arranged in the numerical order of assigned data. However, highly relevant signals are collectively described where one of them first appears. Refer to the function codes in the "Related function codes" column, if any.

The FRENIC-MEGA runs under "V/f control," "dynamic torque vector control," "V/f control with speed sensor," "dynamic torque vector control with speed sensor," "vector control without speed sensor," or "vector control with speed sensor." Some terminal commands assigned apply exclusively to the specific drive control, which is indicated by letters Y (Applicable) and N (Not applicable) in the "Drive control" column in the table given below.

⚠CAUTION

- Ensure safety before modifying the function code settings.
  Run commands (e.g., "Run forward" ***FWD***), stop commands (e.g., "Coast to a stop" ***BX***), and frequency change commands can be assigned to digital input terminals. Depending upon the assignment states of those terminals, modifying the function code setting may cause a sudden motor start or an abrupt change in speed.
- When the inverter is controlled with the digital input signals, switching run or frequency command sources with the related terminal commands (e.g., ***SS1***, ***SS2***, ***SS4***, ***SS8***, ***Hz2/Hz1***, ***Hz/PID***, ***IVS***, and ***LE***) may cause a sudden motor start or an abrupt change in speed.

An accident or physical injury may result.

Function code data		Terminal commands assigned	Symbol	Drive control					Related function codes
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control	
0	1000	Select multi-frequency (0 to 15 steps)	***SS1***	Y	Y	Y	Y	N	C05 to C19
1	1001		***SS2***	Y	Y	Y	Y	N	
2	1002		***SS4***	Y	Y	Y	Y	N	
3	1003		***SS8***	Y	Y	Y	Y	N	
4	1004	Select ACC/DEC time (2 steps)	***RT1***	Y	Y	Y	Y	N	F07, F08, E10 to E15
5	1005	Select ACC/DEC time (4 steps)	***RT2***	Y	Y	Y	Y	N	
6	1006	Enable 3-wire operation	***HLD***	Y	Y	Y	Y	Y	F02
7	1007	Coast to a stop	***BX***	Y	Y	Y	Y	Y	—
8	1008	Reset alarm	***RST***	Y	Y	Y	Y	Y	—
1009	9	Enable external alarm trip	***THR***	Y	Y	Y	Y	Y	—
10	1010	Ready for jogging	***JOG***	Y	Y	Y	Y	N	C20, H54, H55, d09 to d13
11	1011	Select frequency command 2/1	***Hz2/Hz1***	Y	Y	Y	Y	N	F01, C30
12	1012	Select motor 2	***M2***	Y	Y	Y	Y	Y	A42
13	—	Enable DC braking	***DCBRK***	Y	Y	Y	Y	N	F20 to F22
14	1014	Select torque limiter level 2/1	***TL2/TL1***	Y	Y	Y	Y	Y	F40, F41, E16, E17

Function code data		Terminal commands assigned	Symbol	Drive control					Related function codes
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control	
15	—	Switch to commercial power (50 Hz)	***SW50***	Y	Y	N	N	N	—
16	—	Switch to commercial power (60 Hz)	***SW60***	Y	Y	N	N	N	—
17	1017	UP (Increase output frequency)	***UP***	Y	Y	Y	Y	N	Frequency command: F01, C30 PID command: J02
18	1018	DOWN (Decrease output frequency)	***DOWN***	Y	Y	Y	Y	N	
19	1019	Enable data change with keypad	***WE-KP***	Y	Y	Y	Y	Y	F00
20	1020	Cancel PID control	***Hz/PID***	Y	Y	Y	Y	N	J01 to J19, J56 to J62
21	1021	Switch normal/inverse operation	***IVS***	Y	Y	Y	Y	N	C53, J01
22	1022	Interlock	***IL***	Y	Y	Y	Y	Y	F14
23	1023	Cancel torque control	***Hz/TRQ***	N	N	N	N	Y	H18
24	1024	Enable communications link via RS-485 or fieldbus (option)	***LE***	Y	Y	Y	Y	Y	H30, y98
25	1025	Universal DI	***U-DI***	Y	Y	Y	Y	Y	—
26	1026	Enable auto search for idling motor speed at starting	***STM***	Y	Y	Y	N	Y	H09, d67
1030	30	Force to stop	***STOP***	Y	Y	Y	Y	Y	F07, H56
32	1032	Pre-excitation	***EXITE***	N	N	Y	Y	N	H84, H85
33	1033	Reset PID integral and differential components	***PID-RST***	Y	Y	Y	Y	N	J01 to J19, J56 to J62
34	1034	Hold PID integral component	***PID-HLD***	Y	Y	Y	Y	N	
35	1035	Select local (keypad) operation	***LOC***	Y	Y	Y	Y	Y	(See Section 7.3.6.)
36	1036	Select motor 3	***M3***	Y	Y	Y	Y	Y	A42, b42
37	1037	Select motor 4	***M4***	Y	Y	Y	Y	Y	A42, r42
39	—	Protect motor from dew condensation	***DWP***	Y	Y	Y	Y	Y	J21
40	—	Enable integrated sequence to switch to commercial power (50 Hz)	***ISW50***	Y	Y	N	N	N	J22
41	—	Enable integrated sequence to switch to commercial power (60 Hz)	***ISW60***	Y	Y	N	N	N	
47	1047	Servo-lock command	***LOCK***	N	N	N	Y	N	J97 to J99
48	—	Pulse train input (available only on terminal [X7])	***PIN***	Y	Y	Y	Y	Y	F01, C30, d62, d63
49	1049	Pulse train sign (available on terminals except [X7])	***SIGN***	Y	Y	Y	Y	Y	
70	1070	Cancel constant peripheral speed control	***Hz/LSC***	Y	Y	Y	Y	N	d41
71	1071	Hold the constant peripheral speed control frequency in the memory	***LSC-HLD***	Y	Y	Y	Y	N	

Function code data		Terminal commands assigned	Symbol	Drive control					Related function codes
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control	
72	1072	Count the run time of commercial power-driven motor 1	***CRUN-M1***	Y	Y	N	N	Y	H44, H94
73	1073	Count the run time of commercial power-driven motor 2	***CRUN-M2***	Y	Y	N	N	Y	
74	1074	Count the run time of commercial power-driven motor 3	***CRUN-M3***	Y	Y	N	N	Y	
75	1075	Count the run time of commercial power-driven motor 4	***CRUN-M4***	Y	Y	N	N	Y	
76	1076	Select droop control	***DROOP***	Y	Y	Y	Y	N	H28
77	1077	Cancel PG alarm	***PG-CCL***	N	Y	N	Y	Y	—
80	1080	Cancel customizable logic	***CLC***	Y	Y	Y	Y	Y	E01 to E07 U81 to U85
81	1081	Clear all customizable logic timers	***CLTC***	Y	Y	Y	Y	Y	
98	—	Run forward (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	***FWD***	Y	Y	Y	Y	Y	F02
99	—	Run reverse (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	***REV***	Y	Y	Y	Y	Y	
100	—	No function assigned	***NONE***	Y	Y	Y	Y	Y	U81 to U85

Note

Some negative logic (Active OFF) commands cannot be assigned to the functions marked with "–" in the "Active OFF" column.

The "Enable external alarm trip" (data = 1009) and "Force to stop" (data = 1030) are fail-safe terminal commands. In the case of "Enable external alarm trip," when data = 1009, "Active ON" (alarm is triggered when ON); when data = 9, "Active OFF" (alarm is triggered when OFF).

Terminal function assignment and data setting

■ Select multi-frequency (0 to 15 steps) -- ***SS1***, ***SS2***, ***SS4***, and ***SS8*** (Function code data = 0, 1, 2, and 3)

The combination of the ON/OFF states of digital input signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** selects one of 16 different frequency commands defined beforehand by 15 function codes C05 to C19 (Multi-frequency 0 to 15). With this, the inverter can drive the motor at 16 different preset frequencies.

📖 Refer to C05 through C19.

■ Select ACC/DEC time -- ***RT1*** and ***RT2*** (Function code data = 4 and 5)

These terminal commands switch between ACC/DEC time 1 to 4 (F07, F08 and E10 through E15).

📖 Refer to F07 and F08.

■ Enable 3-wire operation -- ***HLD*** (Function code data = 6)

Turning this terminal command ON self-holds the forward ***FWD*** or reverse ***REV*** run command, to enable 3-wire inverter operation.

📖 Refer to F02.

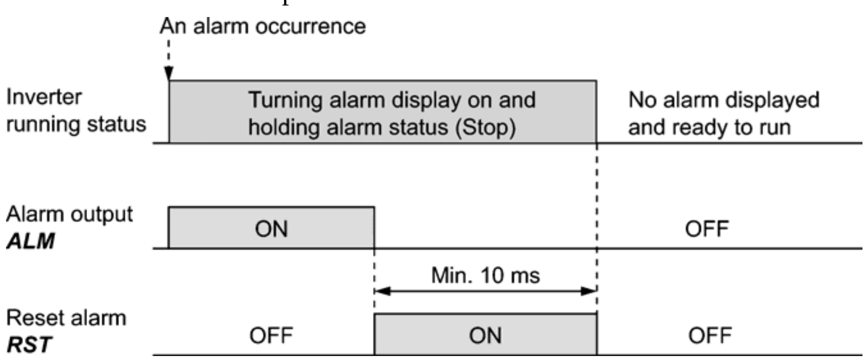
■ Coast to a stop -- ***BX*** (Function code data = 7)

Turning this terminal command ON immediately shuts down the inverter output so that the motor coasts to a stop, without issuing any alarms.

■ Reset alarm -- ***RST*** (Function code data = 8)

Turning this terminal command ON clears the ***ALM*** state--alarm output (for any alarm). Turning it OFF erases the alarm display and clears the alarm hold state.

When you turn the ***RST*** command ON, keep it ON for 10 ms or more. This command should be kept OFF for the normal inverter operation.



■ Enable external alarm trip -- ***THR*** (Function code data = 9)

Turning this terminal command OFF immediately shuts down the inverter output (so that the motor coasts to a stop), displays the alarm OH2, and issues the alarm output (for any alarm) ***ALM***. The ***THR*** command is self-held, and is reset when an alarm reset takes place.

Tip: Use this alarm trip command from external equipment when you have to immediately shut down the inverter output in the event of an abnormal situation in peripheral equipment.

■ Ready for jogging -- ***JOG*** (Function code data = 10)

This terminal command is used to jog or inch the motor for positioning a workpiece.

Turning this command ON makes the inverter ready for jogging.

📖 Refer to C20.

■ Select frequency command 2/1 -- ***Hz2***/***Hz1*** (Function code data = 11)

Turning this terminal command ON and OFF switches the frequency command source between frequency command 1 (F01) and frequency command 2 (C30).

📖 Refer to F01.

■ Select motor 2, 3 and 4 -- ***M2***, ***M3***, ***M4*** (Function code data = 12, 36 and 37)

The combination of digital input terminal commands ***M2***, ***M3*** and ***M4*** switches to any of the 1st to 4th motors. When the motor is switched, the function code group with which the inverter drives the motor is also switched to the one corresponding to the motor.

📖 Refer to A42.

■ Enable DC braking -- ***DCBRK*** (Function code data = 13)

This terminal command gives the inverter a DC braking command through the inverter's digital input.

(Requirements for DC braking must be satisfied.)

📖 Refer to F20 through F22.

■ Select torque limiter level 2/1 -- ***TL2***/***TL1*** (Function code data = 14)

This terminal command switches between torque limiter 1 (F40 and F41) and torque limiter 2 (E16 and E17).

📖 Refer to F40 and F41.

■ Switch to commercial power for 50 Hz or 60 Hz -- ***SW50*** and ***SW60***
(Function code data = 15 and 16)

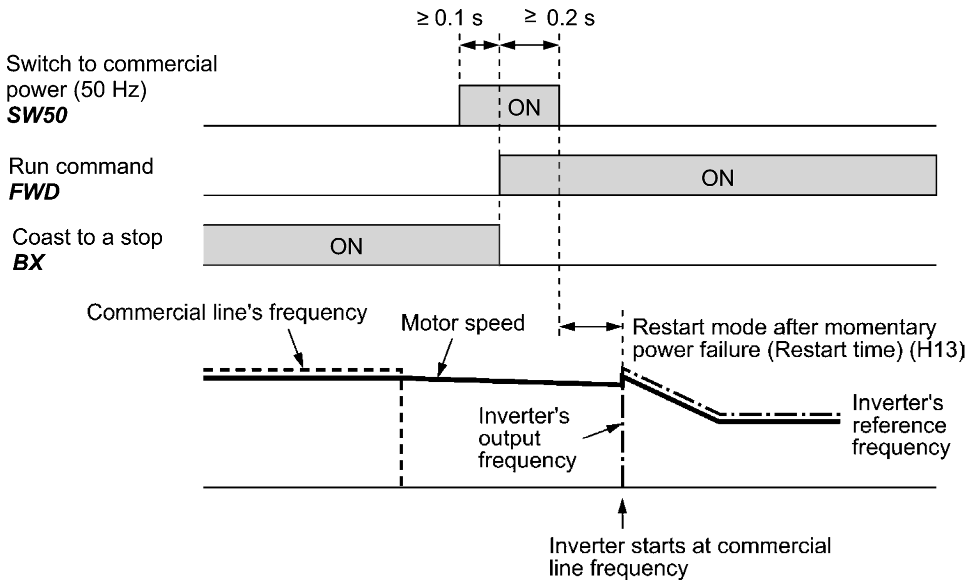
When an external sequence switches the motor drive power from the commercial line to the inverter, the terminal command ***SW50*** or ***SW60*** enables the inverter to start running the motor with the current commercial power frequency, regardless of settings of the reference/output frequency in the inverter. A running motor driven by commercial power is carried on into inverter operation. This command helps you smoothly switch the motor drive power source from the commercial power to the inverter power.

For details, refer to the table below, the operation schemes, an example of external sequence and its operation time scheme on the following pages.

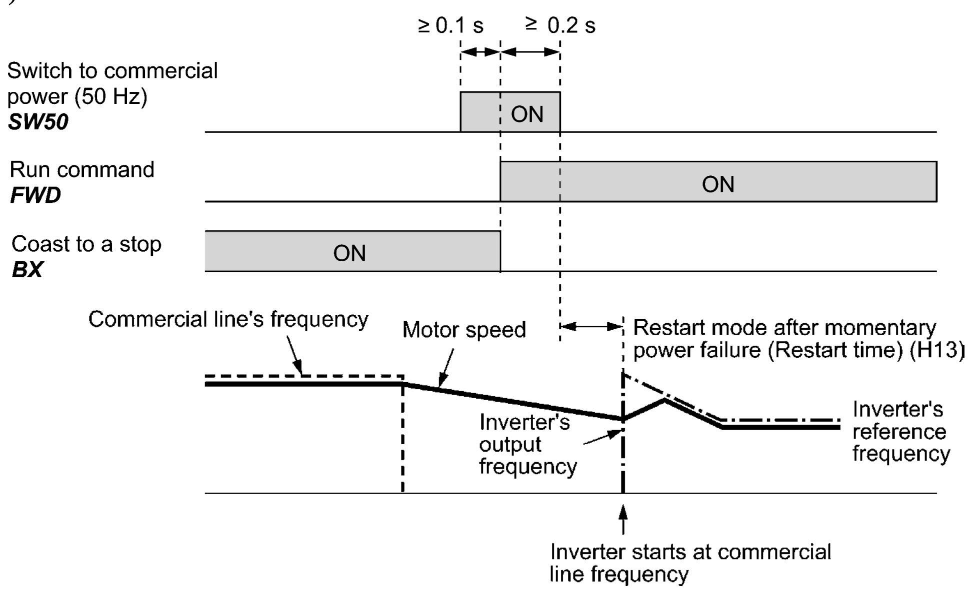
Assignment	The inverter:	Description
SW50	Starts at 50 Hz.	Note: Do not concurrently assign both ***SW50*** and ***SW60***.
SW60	Starts at 60 Hz.	

Operation Schemes

• When the motor speed remains almost the same during coast-to-stop:



• When the motor speed decreases significantly during coast-to-stop (with the current limiter activated):

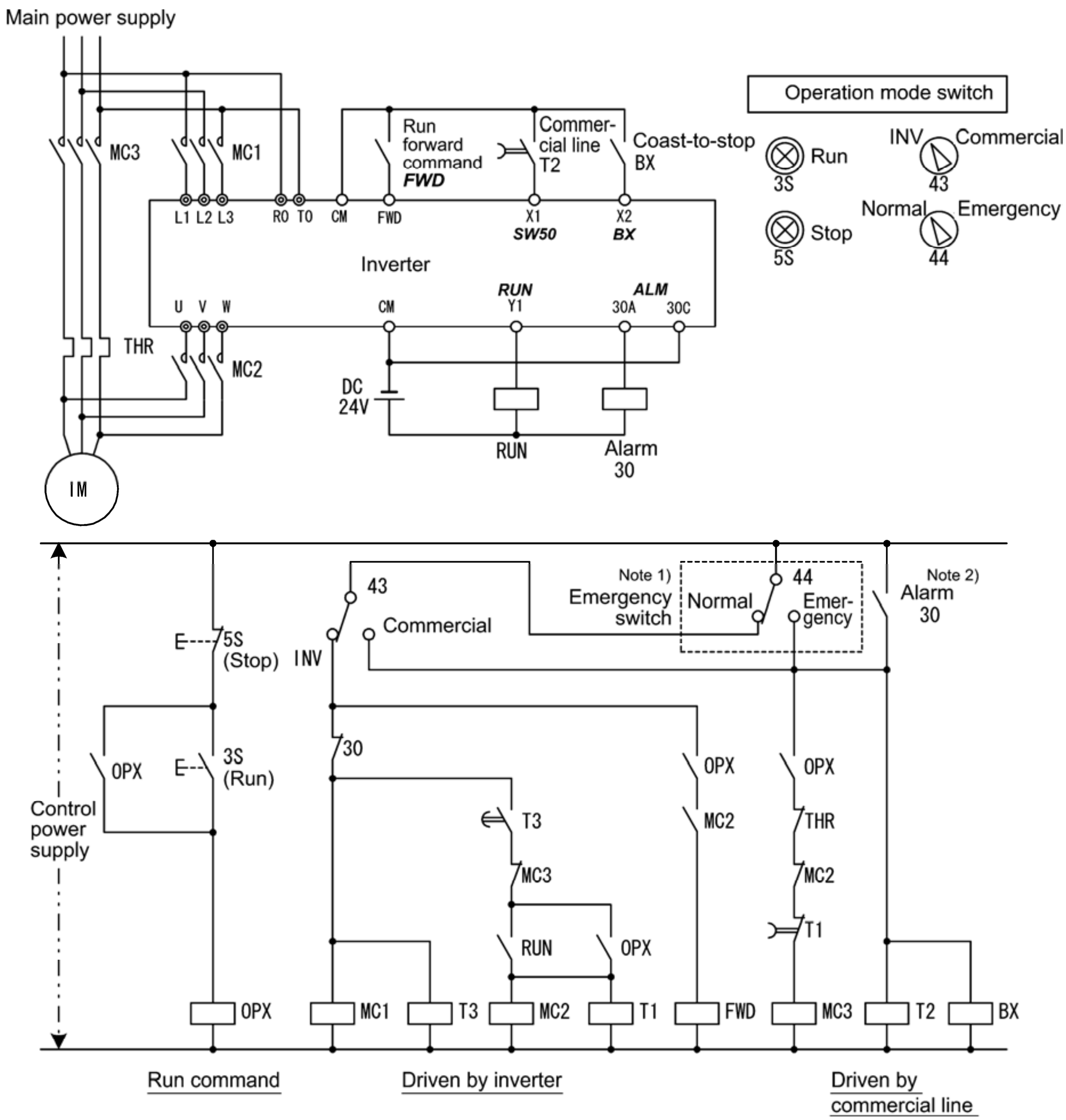


Note

- Secure more than 0.1 second after turning ON the "Switch to commercial power" signal before turning ON a run command.
- Secure more than 0.2 second of an overlapping period with both the "Switch to commercial power" signal and run command being ON.
- If an alarm has been issued or ***BX*** has been ON when the motor drive source is switched from the commercial power to the inverter, the inverter will not be started at the commercial power frequency and will remain OFF. After the alarm has been reset or ***BX*** turned OFF, operation at the frequency of the commercial power will not be continued, and the inverter will be started at the ordinary starting frequency.

  If you wish to switch the motor drive source from the commercial line to the inverter, be sure to turn ***BX*** OFF before the "Switch to commercial power" signal is turned OFF.
- When switching the motor drive source from the inverter to commercial power, adjust the inverter's reference frequency at or slightly higher than that of the commercial power frequency beforehand, taking into consideration the motor speed down during the coast-to-stop period produced by switching.
- Note that when the motor drive source is switched from the inverter to the commercial power, a high inrush current will be generated, because the phase of the commercial power usually does not match the motor speed at the switching. Make sure that the power supply and all the peripheral equipment are capable of withstanding this inrush current.
- If you have enabled "Restart after momentary power failure" (F14 = 3, 4, or 5), keep ***BX*** ON during commercial power driven operation to prevent the inverter from restarting after a momentary power failure.

Example of Sequence Circuit

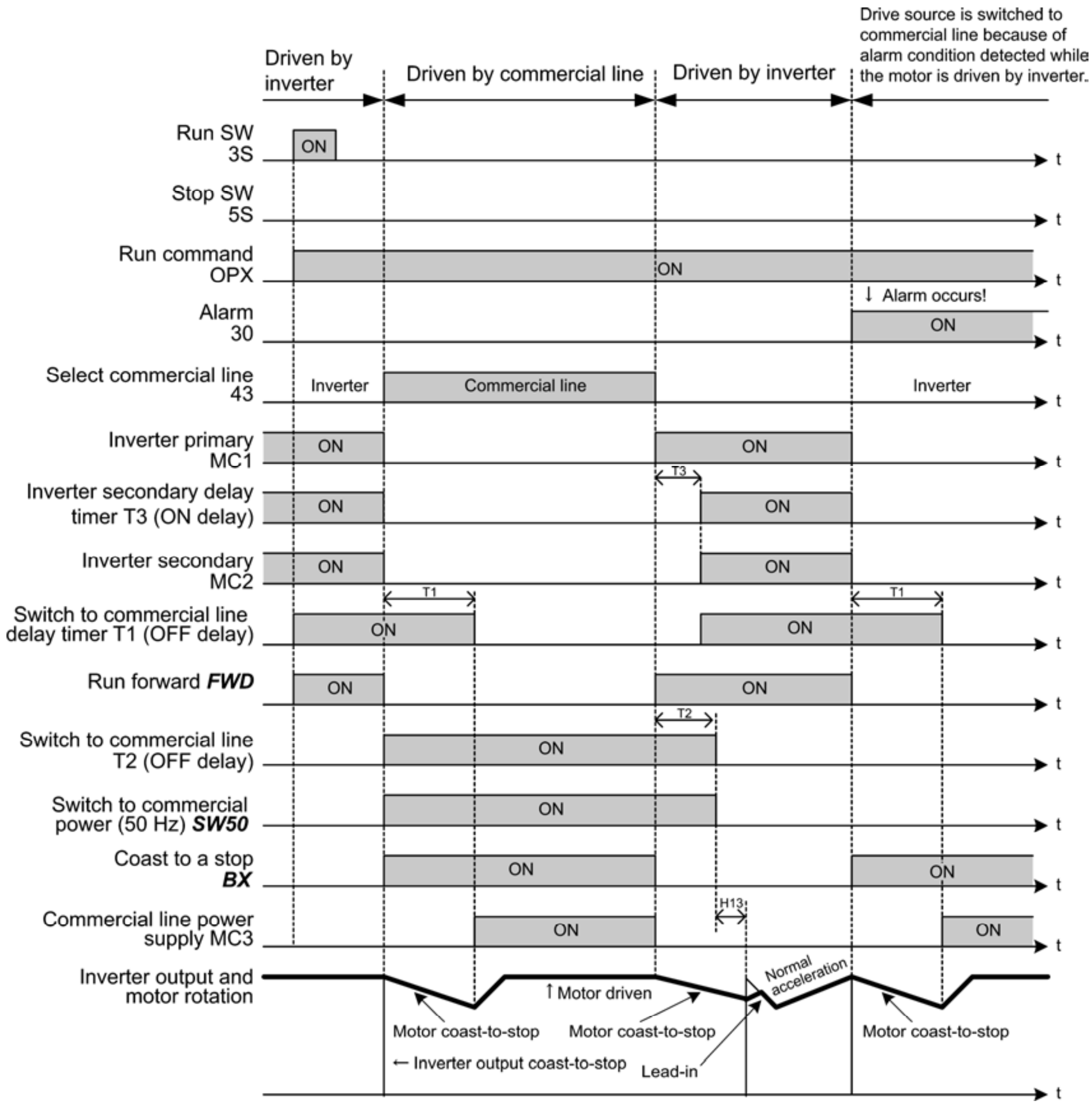


Note 1) Emergency switch

Manual switch provided for the event that the motor drive source cannot be switched normally to the commercial power due to a serious problem of the inverter

Note 2) When any alarm has occurred inside the inverter, the motor drive source will automatically be switched to the commercial power.

Example of Operation Time Scheme



Tip Alternatively, you may use the integrated sequence by which some of the actions above are automatically performed by the inverter itself. For details, refer to the description of ***ISW50*** and ***ISW60***.

■ UP (Increase output frequency) and DOWN (Decrease output frequency) commands -- ***UP*** and ***DOWN*** (Function code data = 17 and 18)

• Frequency setting

Turning the terminal command ***UP*** or ***DOWN*** ON causes the output frequency to increase or decrease, respectively, within the range from 0 Hz to the maximum frequency.

📖 Refer to F01 (data = 7).

• PID command

Turning the terminal command ***UP*** or ***DOWN*** ON causes the PID command value to increase or decrease, respectively, within the range from 0 to 100%.

📖 Refer to J02 (data = 3).

■ Enable data change with keypad -- ***WE-KP*** (Function code data = 19)

Turning the terminal command ***WE-KP*** OFF protects function code data from accidentally getting changed by pressing the keys on the keypad.

Only when this terminal command is ON, you can change function code data from the keypad.
📖 Refer to F00.

■ Cancel PID control -- ***Hz/PID*** (Function code data = 20)

Turning this terminal command ON disables PID control.

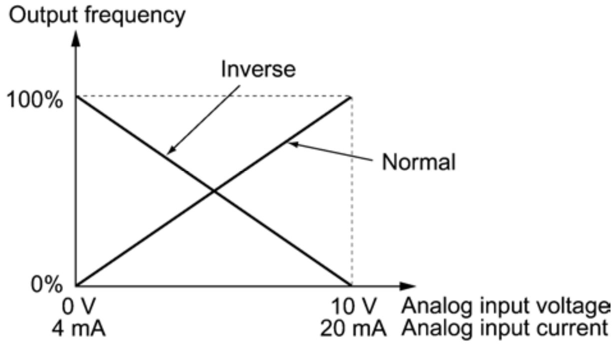
If the PID control is disabled with this command, the inverter runs the motor with the reference frequency manually set by any of the multi-frequency, keypad, analog input, etc.

Terminal command ***Hz/PID***	Function
OFF	Enable PID control
ON	Disable PID control/Enable manual settings

📖 Refer to J01 through J19 and J56 through J62.

■ Switch normal/inverse operation -- ***IVS*** (Function code data = 21)

This terminal command switches the output frequency control between normal (proportional to the input value) and inverse in analog frequency setting or under PID process control. To select the inverse operation, turn the ***IVS*** ON.



Tip: The normal/inverse switching operation is useful for air-conditioners that require switching between cooling and heating. In cooling, the speed of the fan motor (output frequency of the inverter) is increased to lower the temperature. In heating, it is reduced to lower the temperature. This switching is realized by the ***IVS***.

- When the inverter is driven by an external analog frequency command sources (terminals [12], [C1] and [V2]):

Switching normal/inverse operation can apply only to the analog frequency command sources (terminals [12], [C1] and [V2]) in frequency command 1 (F01) and does not affect frequency command 2 (C30) or UP/DOWN control.

As listed below, the combination of the "Selection of normal/inverse operation for frequency command 1" (C53) and the terminal command ***IVS*** determines the final operation.

Combination of C53 and ***IVS***

Data for C53	***IVS***	Final operation
0: Normal operation	OFF	Normal
	ON	Inverse
1: Inverse operation	OFF	Inverse
	ON	Normal

- When process control is performed by the PID processor integrated in the inverter:

The terminal command ***Hz/PID*** ("Cancel PID control") can switch PID control between enabled (process is to be controlled by the PID processor) and disabled (process is to be controlled by the manual frequency setting). In either case, the combination of the "PID control" (J01) or "Selection of normal/inverse operation for frequency command 1" (C53) and the terminal command ***IVS*** determines the final operation as listed below.

When PID control is enabled:

The normal/inverse operation selection for the PID processor output (reference frequency) is as follows.

PID control (Mode selection) (J01)	***IVS***	Final operation
1: Enable (normal operation)	OFF	Normal
	ON	Inverse
2: Enable (inverse operation)	OFF	Inverse
	ON	Normal

When PID control is disabled:

The normal/inverse operation selection for the manual reference frequency is as follows.

Selection of normal/inverse operation for frequency command 1 (C53)	***IVS***	Final operation
0: Normal operation	–	Normal
1: Inverse operation	–	Inverse

Note: When process control is performed by the PID control facility integrated in the inverter, the ***IVS*** is used to switch the PID processor output (reference frequency) between normal and inverse, and has no effect on any normal/inverse operation selection of the manual frequency setting.

📖 Refer to the descriptions of J01 through J19 and J56 through J62.

■ Interlock -- ***IL*** (Function code data = 22)

In a configuration where a magnetic contactor (MC) is installed in the power output (secondary) circuit of the inverter, the momentary power failure detection feature provided inside the inverter may not be able to accurately detect a momentary power failure by itself. Using a digital signal input with the interlock command ***IL*** assures the accurate detection.

📖 Refer to F14.

Terminal command ***IL***	Meaning
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Restart after a momentary power failure enabled)

■ Enable communications link via RS-485 or fieldbus (option) -- ***LE*** (Function code data = 24)

Turning this terminal command ON gives priorities to frequency commands or run commands received via the RS-485 communications link (H30) or the fieldbus option (y98).

No ***LE*** assignment is functionally equivalent to the ***LE*** being ON.

📖 Refer to H30 (Communications link function) and y98 (Bus link function).

■ Universal DI -- ***U-DI*** (Function code data = 25)

Using ***U-DI*** enables the inverter to monitor digital signals sent from the peripheral equipment via an RS-485 communications link or a fieldbus option by feeding those signals to the digital input terminals. Signals assigned to the universal DI are simply monitored and do not operate the inverter.

For an access to universal DI via the RS-485 or fieldbus communications link, refer to their respective Instruction Manuals.

■ Enable auto search for idling motor speed at starting -- ***STM*** (Function code data = 26)

This digital terminal command determines, at the start of operation, whether or not to search for idling motor speed and follow it.

Refer to H09 (Starting mode).

■ Force to stop -- ***STOP*** (Function code data = 30)

Turning this terminal command OFF causes the motor to decelerate to a stop in accordance with the H56 data (Deceleration time for forced stop). After the motor stops, the inverter enters the alarm state with the alarm Er-6 displayed.

Refer to F07.

■ Pre-excitation -- ***EXITE*** (Function code data = 32)

Turning this terminal command ON activates the pre-exciting feature. Even if this pre-excitation command is not assigned, specifying H85 (Pre-excitation: Time) to other than "0.00" enables the inverter to automatically start pre-exciting of the motor when it is turned ON. (This applies exclusively to the inverters under vector control with speed sensor.)

Refer to H84 and H85.

■ Reset PID integral and differential components -- ***PID-RST*** (Function code data = 33)

Turning this terminal command ON resets the integral and differential components of the PID processor.

Refer to J01 through J19 and J56 through J62.

■ Hold PID integral component -- ***PID-HLD*** (Function code data = 34)

Turning this terminal command ON holds the integral components of the PID processor.

Refer to J01 through J19 and J56 through J62.

■ Select local (keypad) operation -- ***LOC*** (Function code data = 35)

This terminal command switches the sources of run and frequency commands between remote and local.

For details of switching between remote and local modes, refer to Chapter 7, Section 7.3.6 "Switching between remote and local modes."

■ Protect motor from dew condensation -- ***DWP*** (Function code data = 39)

Turning this terminal command ON supplies a DC current to the motor in a stopped state in order to generate heat, preventing dew condensation.

Refer to J21.

■ Enable integrated sequence to switch to commercial power for 50 Hz and 60 Hz
-- ***ISW50*** and ***ISW60*** (Function code data = 40 and 41)

With the terminal command ***ISW50*** or ***ISW60*** assigned, the inverter controls the magnetic contactor that switches the motor drive source between the commercial power and the inverter output according to the integrated sequence.

This control is effective when not only ***ISW50*** or ***ISW60**** has been assigned to the input terminal but also the ***SW88*** and ***SW52-2*** signals have been assigned to the output terminals. (It is not essential to assign the ***SW52-1*** signal.)

*The ***ISW50*** or ***ISW60*** should be selected depending upon the frequency of the commercial power; the former for 50 Hz and the latter for 60 Hz.

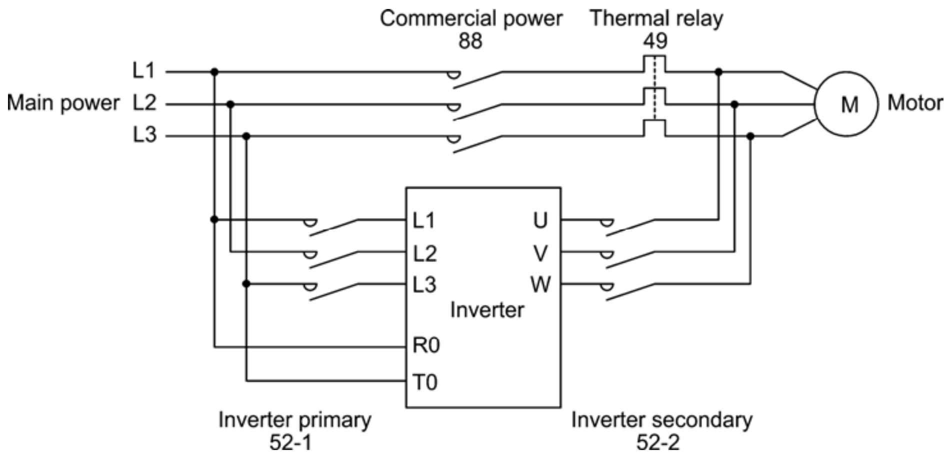
📖 For details about ***SW88*** and ***SW52-2*** ("Switch motor drive source between commercial power and inverter output"), refer to E20 to E27.

For details of these commands, refer to the circuit diagrams and timing schemes on the following pages.

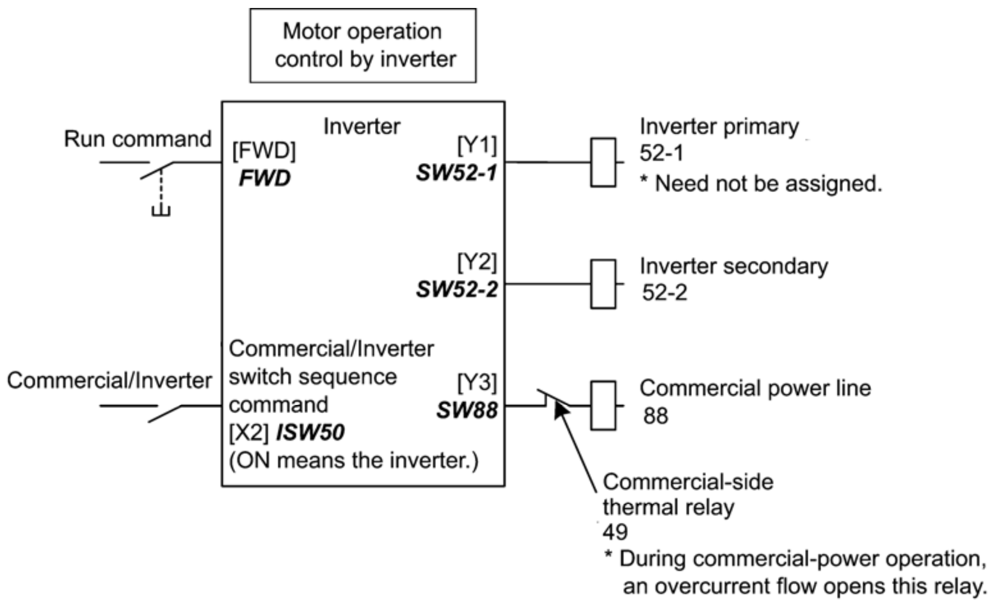
Terminal command assigned	Operation (Switching from commercial power to inverter)
ISW50 Enable integrated sequence to switch to commercial power (50 Hz)	Start at 50 Hz.
ISW60 Enable integrated sequence to switch to commercial power (60 Hz)	Start at 60 Hz.

Note: Do not assign both ***ISW50*** and ***ISW60*** at the same time. Doing so cannot guarantee the result.

Circuit Diagram and Configuration



Main Circuit



Configuration of Control Circuit

Summary of Operation

Input		Output (Status signal and magnetic contactor)			Inverter operation
ISW50 or ***ISW60***	Run command	***SW52-1*** 52-1	***SW52-2*** 52-2	***SW88*** 88	
OFF (Commercial power)	ON	OFF	OFF	ON	OFF
	OFF			OFF	
ON (Inverter)	ON	ON	ON	OFF	ON
	OFF				OFF

Timing Scheme

Switching from inverter operation to commercial-power operation ***ISW50***/***ISW60***: ON → OFF

(1) The inverter output is shut OFF immediately. (Power gate IGBT OFF)

(2) The inverter primary circuit ***SW52-1*** and the inverter secondary side ***SW52-2*** are turned OFF immediately.

(3) If a run command is present after an elapse of t1 (0.2 sec + time specified by H13), the commercial power circuit ***SW88*** is turned ON .

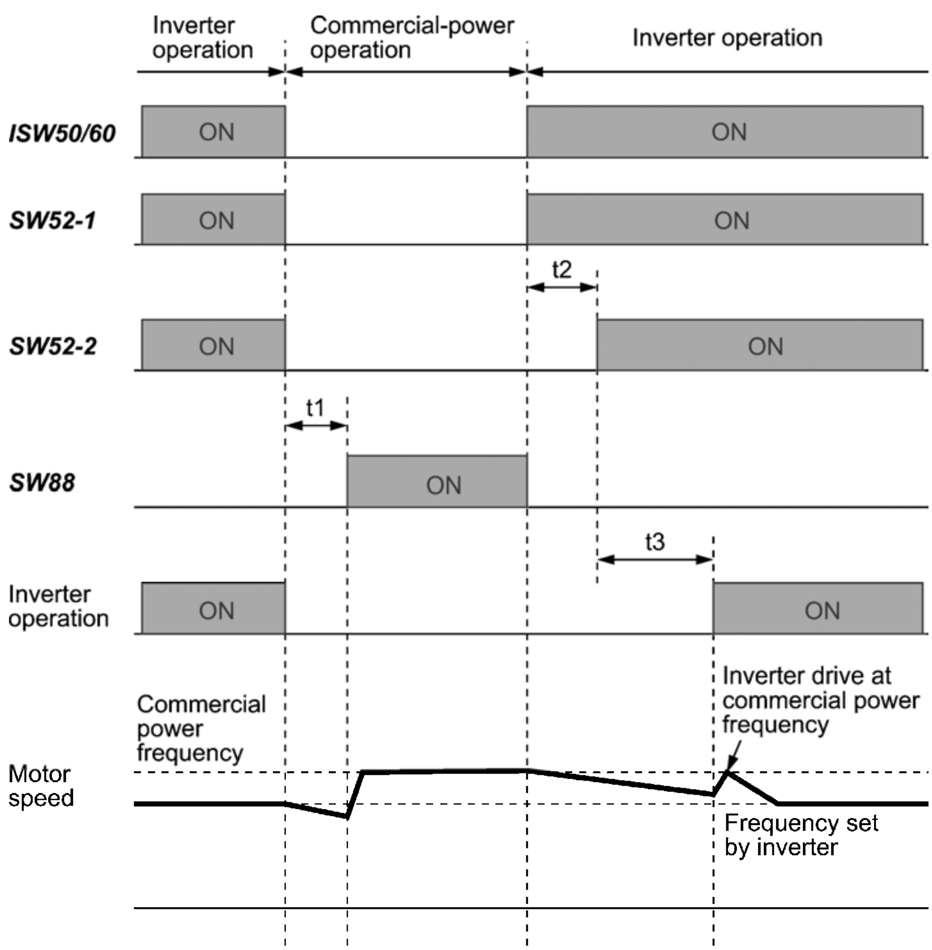
Switching from commercial-power operation to inverter operation ***ISW50***/***ISW60***: OFF → ON

(1) The inverter primary circuit ***SW52-1*** is turned ON immediately.

(2) The commercial power circuit ***SW88*** is turned OFF immediately.

(3) After an elapse of t2 (0.2 sec + time required for the main circuit to get ready) from when ***SW52-1*** is turned ON, the inverter secondary circuit ***SW52-2*** is turned ON.

(4) After an elapse of t3 (0.2 sec + time specified by H13) from when ***SW52-2*** is turned ON, the inverter harmonizes once the motor that has been freed from the commercial power to the commercial power frequency. Then the motor returns to the operation driven by the inverter.



t1: 0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

t2: 0.2 sec + Time required for the main circuit to get ready

t3: 0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

Selection of Commercial Power Switching Sequence

J22 specifies whether or not to automatically switch to commercial-power operation when an inverter alarm occurs.

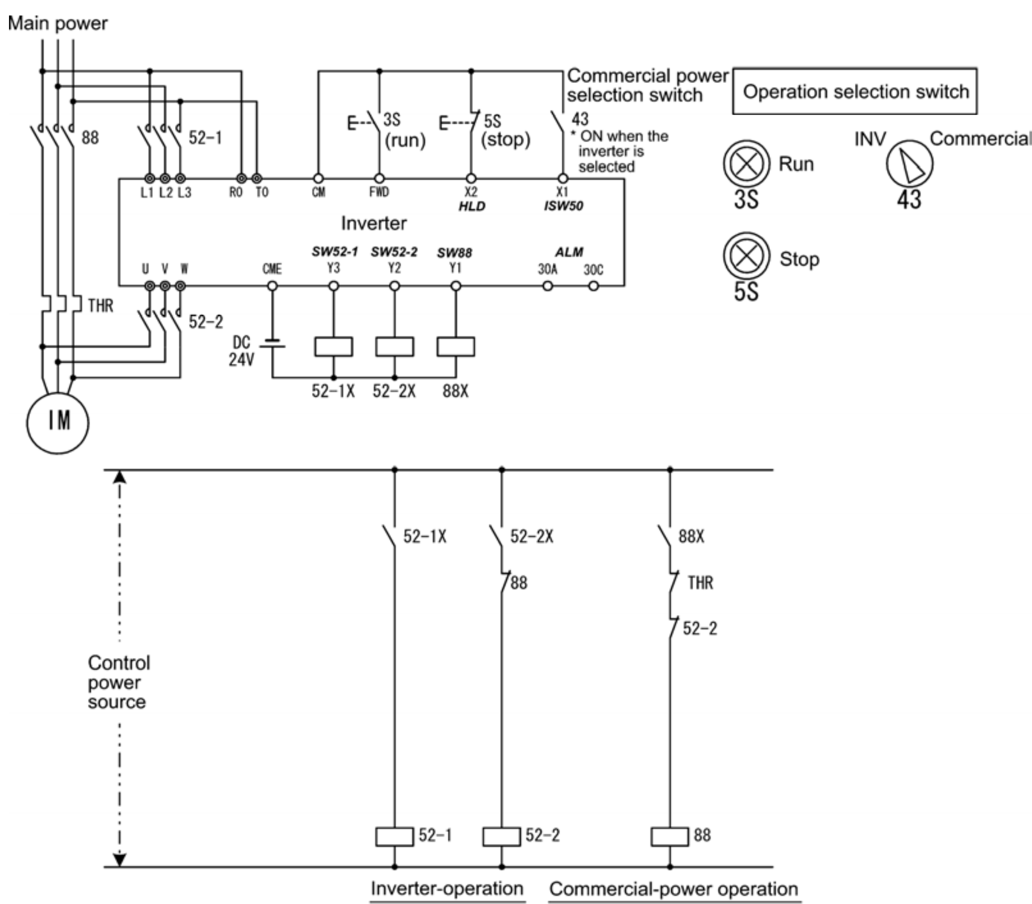
Data for J22	Sequence (upon occurrence of an alarm)
0	Keep inverter-operation (Stop due to alarm.)
1	Automatically switch to commercial-power operation

Note

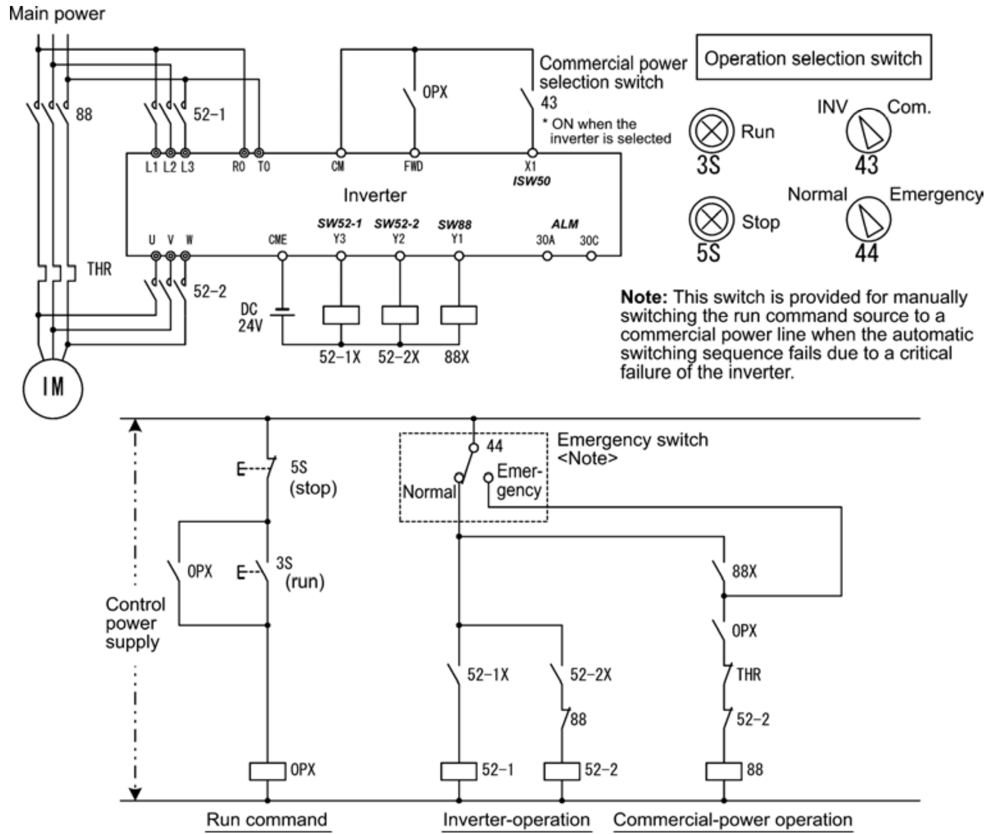
- The sequence operates normally also even when ***SW52-1*** is not used and the main power of the inverter is supplied at all times.
- Using ***SW52-1*** requires connecting the input terminals [R0] and [T0] for an auxiliary control power. Without the connection, turning ***SW52-1*** OFF loses also the control power.
- The sequence operates normally even if an alarm occurs in the inverter except when the inverter itself is broken. Therefore, for a critical facility, be sure to install an emergency switching circuit outside the inverter.
- Turning ON both the magnetic contactor MC (88) at the commercial-power side and the MC (52-2) at the inverter output side at the same time supplies main power mistakenly from the output (secondary) side of the inverter, which may damage the inverter. To prevent it, be sure to set up an interlocking logic outside the inverter.

Examples of Sequence Circuits

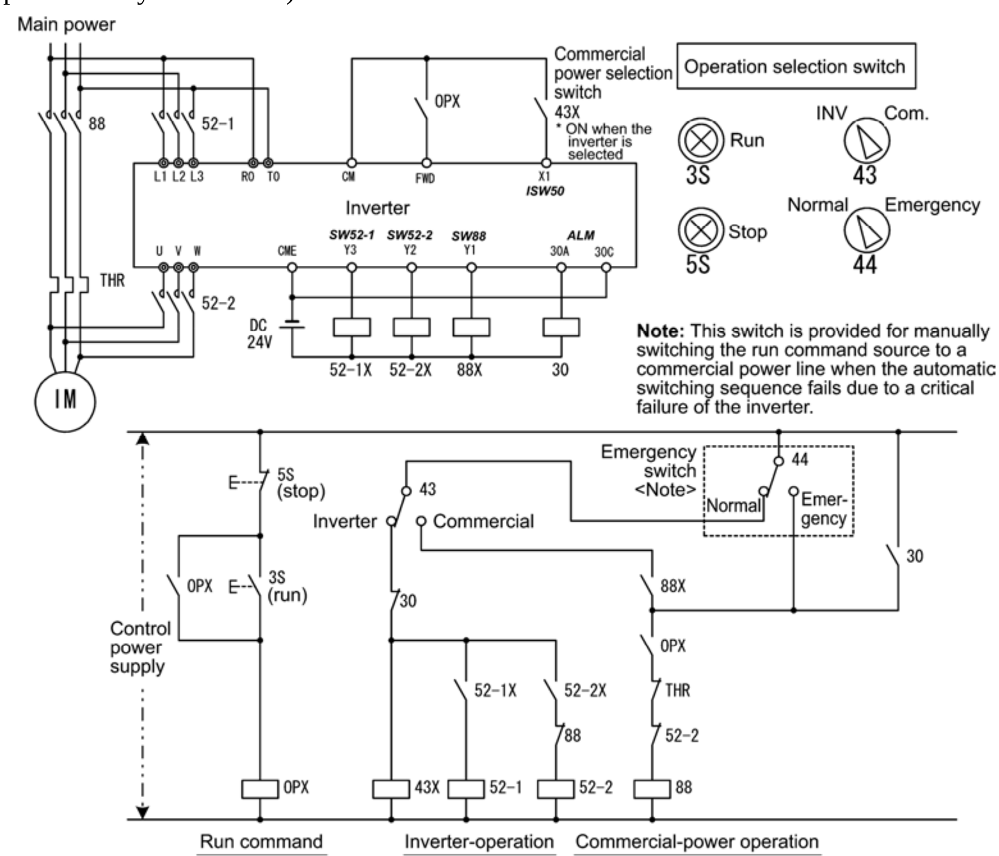
1) Standard sequence



2) Sequence with an emergency switching function



3) Sequence with an emergency switching function --Part 2 (Automatic switching by the alarm output issued by the inverter)



■ Servo-lock command -- ***LOCK*** (Function code data = 47)

Turning this terminal command ON enables a servo-lock command; turning it OFF disables a servo-lock command.

📖 Refer to J97 through J99.

■ Pulse train input -- ***PIN*** (available only on terminal [X7]) (Function code data = 48)
Pulse train sign -- ***SIGN*** (available on terminals except [X7]) (Function code data = 49)

Assigning the command ***PIN*** to digital input terminal [X7] enables the frequency command by the pulse train input. Assigning the command ***SIGN*** to one of the digital input terminals except [X7] enables the pulse train sign input to specify the polarity of frequency command.

📖 Refer to F01.

■ Count the run time of commercial power-driven motors 1 to 4
-- ***CRUN-M1***, ***CRUN-M2***, ***CRUN-M3*** and ***CRUN-M4***
(Function code data = 72, 73, 74 and 75)

These four terminal commands enable the inverter to count the cumulative run time of motors 1 to 4 even when they are driven by commercial power (not by the inverter).

When the ***CRUN-M1***, ***CRUN-M2***, ***CRUN-M3*** or ***CRUN-M4*** is ON, the inverter judges that the motor 1, 2, 3 or 4 is driven by commercial power, respectively, and counts the run time of the corresponding motor.

■ Select droop control -- ***DROOP*** (Function code data = 76)

This terminal command ***DROOP*** toggles droop control on and off.

DROOP	Droop control
ON	Enable
OFF	Disable

📖 Refer to H28.

■ Cancel PG alarm-- ***PG-CCL*** (Function code data = 77)

When this terminal command is ON, the inverter ignores a PG wire break alarm. Use this terminal command when changing PG wires in switching motors, for example, to prevent it from being interpreted as a wire break.

■ Run forward -- ***FWD*** (Function code data = 98)

Turning this terminal command ON runs the motor in the forward direction; turning it OFF decelerates it to stop.

Tip: This terminal command can be assigned only by E98 or E99.

■ Run reverse -- ***REV*** (Function code data = 99)

Turning this terminal command ON runs the motor in the reverse direction; turning it OFF decelerates it to stop.

Tip: This terminal command can be assigned only by E98 or E99.

E10 to E15 — Acceleration Time 2 to 4, Deceleration Time 2 to 4 (Refer to F07)

Refer to the description of F07.

E16, E17	Torque Limiter 2-1, 2-2 (Refer to F40.)

Refer to the description of F40.

E20 to E23 E24, E27	Terminal [Y1] to [Y4] Functions Terminal [Y5A/C] and [30A/B/C] Functions (Relay output)

E20 through E24 and E27 assign output signals (listed on the following pages) to general-purpose, programmable output terminals, [Y1] to [Y4], [Y5A/C] and [30A/B/C].

These function codes can also switch the logic system between normal and negative to define how the inverter interprets the ON or OFF state of each terminal. The factory default setting is normal logic system "Active ON."

Terminals [Y1] to [Y4] are transistor outputs and terminals [Y5A/C] and [30A/B/C] are relay contact outputs. In normal logic, if an alarm occurs, the relay will be energized so that [30A] and [30C] will be closed, and [30B] and [30C] opened. In negative logic, the relay will be deenergized so that [30A] and [30C] will be opened, and [30B] and [30C] closed. This may be useful for the implementation of failsafe power systems.

Note

- When negative logic is employed, all output signals are active (e.g. an alarm would be recognized) while the inverter is powered OFF. To avoid causing system malfunctions by this, interlock these signals to keep them ON using an external power supply. Furthermore, the validity of these output signals is not guaranteed for approximately 1.5 seconds (for 40 HP or below) or 3 seconds (for 50 HP or above) after power-ON, so introduce such a mechanism that masks them during the transient period.
- Terminals [Y5A/C] and [30A/B/C] use mechanical contacts that cannot stand frequent ON/OFF switching. Where frequent ON/OFF switching is anticipated (for example, limiting a current by using signals subjected to inverter output limit control such as switching to commercial power line or direct-on-line starting), use transistor outputs [Y1], [Y2], [Y3] and [Y4] instead.

  The service life of a relay is approximately 200,000 times if it is switched ON and OFF at one-second intervals.

The tables given on the following pages list functions that can be assigned to terminals [Y1] to [Y4], [Y5A/C], and [30A/B/C].

The descriptions are, in principle, arranged in the numerical order of assigned data. However, highly relevant signals are collectively described where one of them first appears. Refer to the function codes or signals in the "Related function codes/signals (data)" column, if any.

The FRENIC-MEGA runs under "V/f control," "dynamic torque vector control," "V/f control with speed sensor," "dynamic torque vector control with speed sensor," "vector control without speed sensor," or "vector control with speed sensor." Some output signals assigned apply exclusively to the specific drive control, which is indicated by letters Y (Applicable) and N (Not applicable) in the "Drive control" column of the table given below.

Explanations of each function are given in normal logic system "Active ON."

Function code data		Functions assigned	Symbol	Drive control					Related function codes/ signals (data)
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control	
0	1000	Inverter running	***RUN***	Y	Y	Y	Y	Y	—
1	1001	Frequency (speed) arrival signal	***FAR***	Y	Y	Y	Y	N	E30
2	1002	Frequency (speed) detected	***FDT***	Y	Y	Y	Y	Y	E31, E32
3	1003	Undervoltage detected (Inverter stopped)	***LU***	Y	Y	Y	Y	Y	—
4	1004	Torque polarity detected	***B/D***	Y	Y	Y	Y	Y	—
5	1005	Inverter output limiting	***IOL***	Y	Y	Y	Y	Y	—
6	1006	Auto-restarting after momentary power failure	***IPF***	Y	Y	Y	Y	Y	F14
7	1007	Motor overload early warning	***OL***	Y	Y	Y	Y	Y	E34, F10, F12
8	1008	Keypad operation enabled	***KP***	Y	Y	Y	Y	Y	—
10	1010	Inverter ready to run	***RDY***	Y	Y	Y	Y	Y	—
11	—	Switch motor drive source between commercial power and inverter output (For MC on commercial line)	***SW88***	Y	Y	N	N	N	E01 to E07 ***ISW50*** (40) ***ISW60*** (41) J22
12	—	Switch motor drive source between commercial power and inverter output (For secondary side)	***SW52-2***	Y	Y	N	N	N	
13	—	Switch motor drive source between commercial power and inverter output (For primary side)	***SW52-1***	Y	Y	N	N	N	
15	1015	Select AX terminal function (For MC on primary side)	***AX***	Y	Y	Y	Y	Y	—
22	1022	Inverter output limiting with delay	***IOL2***	Y	Y	Y	Y	Y	***IOL*** (5)
25	1025	Cooling fan in operation	***FAN***	Y	Y	Y	Y	Y	H06
26	1026	Auto-resetting	***TRY***	Y	Y	Y	Y	Y	H04, H05
27	1027	Universal DO	***U-DO***	Y	Y	Y	Y	Y	—
28	1028	Heat sink overheat early warning	***OH***	Y	Y	Y	Y	Y	—
29	1029	Synchronization completed	***SY***	N	Y	N	Y	N	(See the PG Interface Card instruction manual.)
30	1030	Lifetime alarm	***LIFE***	Y	Y	Y	Y	Y	H42
31	1031	Frequency (speed) detected 2	***FDT2***	Y	Y	Y	Y	Y	E32, E36
33	1033	Reference loss detected	***REF OFF***	Y	Y	Y	Y	Y	E65
35	1035	Inverter output on	***RUN2***	Y	Y	Y	Y	Y	***RUN*** (0)
36	1036	Overload prevention control	***OLP***	Y	Y	Y	Y	N	H70
37	1037	Current detected	***ID***	Y	Y	Y	Y	Y	E34, E35, E37, E38, E55, E56
38	1038	Current detected 2	***ID2***	Y	Y	Y	Y	Y	
39	1039	Current detected 3	***ID3***	Y	Y	Y	Y	Y	
41	1041	Low current detected	***IDL***	Y	Y	Y	Y	Y	
42	1042	PID alarm	***PID-ALM***	Y	Y	Y	Y	N	J11 to J13
43	1043	Under PID control	***PID-CTL***	Y	Y	Y	Y	N	J01

Function code data		Functions assigned	Symbol	Drive control					Related function codes/ signals (data)
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control	
44	1044	Motor stopped due to slow flowrate under PID control	***PID-STP***	Y	Y	Y	Y	N	J08, J09
45	1045	Low output torque detected	***U-TL***	Y	Y	Y	Y	Y	E78 to E81
46	1046	Torque detected 1	***TD1***	Y	Y	Y	Y	Y	
47	1047	Torque detected 2	***TD2***	Y	Y	Y	Y	Y	
48	1048	Motor 1 selected	***SWM1***	Y	Y	Y	Y	Y	A42, b42, r42
49	1049	Motor 2 selected	***SWM2***	Y	Y	Y	Y	Y	
50	1050	Motor 3 selected	***SWM3***	Y	Y	Y	Y	Y	
51	1051	Motor 4 selected	***SWM4***	Y	Y	Y	Y	Y	
52	1052	Running forward	***FRUN***	Y	Y	Y	Y	Y	—
53	1053	Running reverse	***RRUN***	Y	Y	Y	Y	Y	—
54	1054	In remote operation	***RMT***	Y	Y	Y	Y	Y	(See Section 7.3.6.)
56	1056	Motor overheat detected by thermistor	***THM***	Y	Y	Y	Y	Y	H26, H27
57	1057	Brake signal	***BRKS***	Y	Y	Y	Y	N	J68 to J72
58	1058	Frequency (speed) detected 3	***FDT3***	Y	Y	Y	Y	Y	E32, E54
59	1059	Terminal [C1] wire break	***C1OFF***	Y	Y	Y	Y	Y	—
70	1070	Speed valid	***DNZS***	N	Y	Y	Y	Y	F25, F38
71	1071	Speed agreement	***DSAG***	N	Y	Y	Y	N	d21, d22
72	1072	Frequency (speed) arrival signal 3	***FAR3***	Y	Y	Y	Y	N	E30
76	1076	PG error detected	***PG-ERR***	N	Y	Y	Y	N	d21 to d23
82	1082	Positioning completion signal	***PSET***	N	N	N	Y	N	J97 to J99
84	1084	Maintenance timer	***MNT***	Y	Y	Y	Y	Y	H44, H78, H79
98	1098	Light alarm	***L-ALM***	Y	Y	Y	Y	Y	H81, H82
99	1099	Alarm output (for any alarm)	***ALM***	Y	Y	Y	Y	Y	—
101	1101	Enable circuit failure detected	***DECF***	Y	Y	Y	Y	Y	—
102	1102	Enable input OFF	***EN OFF***	Y	Y	Y	Y	Y	—
105	1105	Braking transistor broken	***DBAL***	Y	Y	Y	Y	Y	H98
111	1111	Customizable logic output signal 1	***CLO1***	Y	Y	Y	Y	Y	U71 to U75, U81 to U85
112	1112	Customizable logic output signal 2	***CLO2***	Y	Y	Y	Y	Y	
113	1113	Customizable logic output signal 3	***CLO3***	Y	Y	Y	Y	Y	
114	1114	Customizable logic output signal 4	***CLO4***	Y	Y	Y	Y	Y	
115	1115	Customizable logic output signal 5	***CLO5***	Y	Y	Y	Y	Y	

Note: Any negative logic (Active OFF) command cannot be assigned to the functions marked with "–" in the "Active OFF" column.

■ Inverter running -- ***RUN*** (Function code data = 0)
Inverter output on -- ***RUN2*** (Function code data = 35)

These output signals tell the external equipment that the inverter is running at a starting frequency or higher.

If assigned in negative logic (Active OFF), these signals can be used to tell the "Inverter being stopped" state.

Output signal	Basic function	Remarks
RUN	These signals come ON when the inverter is running. Under V/f control: These signals come ON if the inverter output frequency exceeds the starting frequency, and go OFF if it drops below the stop frequency. The ***RUN*** signal can also be used as a "Speed valid" signal ***DNZS***.	Goes OFF even during DC braking or dew condensation prevention.
RUN2		Comes ON even during DC braking, pre-exciting, zero speed control, or dew condensation prevention.

Under vector control, both ***RUN*** and ***RUN2*** come ON also when zero speed control or servo-lock function is enabled.

■ Frequency (speed) arrival signal -- ***FAR*** (Function code data = 1)
Frequency (speed) arrival signal 3 -- ***FAR3*** (Function code data = 72)

These output signals come ON when the difference between the output frequency (detected speed) and reference frequency (reference speed) comes within the frequency arrival hysteresis width specified by E30.

📖 Refer to E30.

■ Frequency (speed) detected -- ***FDT*** (Function code data = 2)
Frequency (speed) detected 2 -- ***FDT2*** (Function code data = 31)
Frequency (speed) detected 3 -- ***FDT3*** (Function code data = 58)

The output signal ***FDT***, ***FDT2*** or ***FDT3*** comes ON when the output frequency (detected speed) exceeds the frequency detection level specified by E31, E36 or E54, respectively, and it goes OFF when the output frequency (detected speed) drops below the "Frequency detection level (E31, E36 or E54) - Hysteresis width (E32)."

📖 Refer to E31 and E32.

■ Undervoltage detected (Inverter stopped) -- ***LU*** (Function code data = 3)

This output signal comes ON when the DC link bus voltage of the inverter drops below the specified undervoltage level, and it goes OFF when the voltage exceeds the level.

This signal is ON also when the undervoltage protective function is activated so that the motor is in an abnormal stop state (e.g., tripped).

When this signal is ON, a run command is disabled if given.

■ Torque polarity detected -- ***B/D*** (Function code data = 4)

The inverter issues the driving or braking polarity signal to this digital output judging from the internally calculated torque or torque command. This signal goes OFF when the detected torque is a driving one, and it comes ON when it is a braking one.

■ Inverter output limiting -- ***IOL*** (Function code data = 5)
Inverter output limiting with delay -- ***IOL2*** (Function code data = 22)

The output signal ***IOL*** comes ON when the inverter is limiting the output frequency by activating any of the following actions (minimum width of the output signal: 100 ms). The output signal ***IOL2*** comes ON when any of the following output limiting operation continues for 20 ms or more.

- Torque limiting (F40, F41, E16 and E17, Maximum internal value)
- Current limiting by software (F43 and F44)
- Instantaneous overcurrent limiting by hardware (H12 = 1)
- Automatic deceleration (Anti-regenerative control) (H69)

Note When the ***IOL*** is ON, it may mean that the output frequency may have deviated from the reference frequency because of the limiting functions above.

■ Auto-restarting after momentary power failure -- ***IPF*** (Function code data = 6)

This output signal is ON either during continuous running after a momentary power failure or during the period from when the inverter detects an undervoltage condition and shuts down its output until the completion of a restart sequence (until the output reaches the reference frequency).

Refer to F14.

■ Motor overload early warning -- ***OL*** (Function code data = 7)

This output signal is used to issue a motor overload early warning that enables you to take an corrective action before the inverter detects a motor overload alarm OL1 and shuts down its output.

Refer to E34.

■ Keypad operation enabled -- ***KP*** (Function code data = 8)

This output signal comes ON when the keypad is specified as a run command source.

■ Inverter ready to run -- ***RDY*** (Function code data = 10)

This output signal comes ON when the inverter becomes ready to run by completing hardware preparation (such as initial charging of DC link bus capacitors and initialization of the control circuit) and no protective functions are activated.

■ Switch motor drive source between commercial power and inverter output
-- ***SW88***, ***SW52-2*** and ***SW52-1*** (Function code data = 11, 12, and 13)

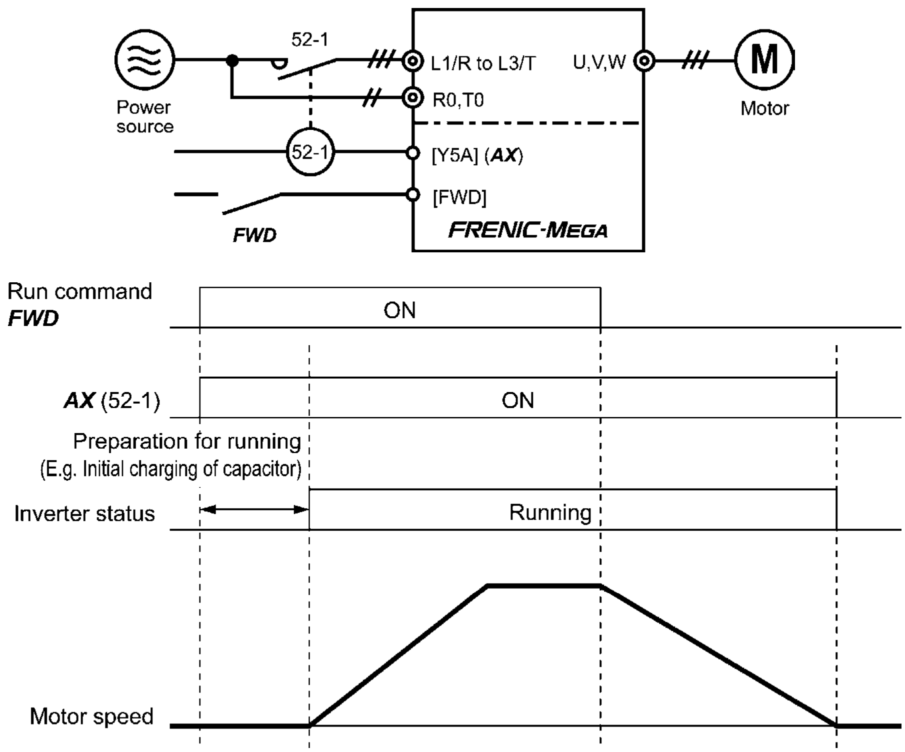
Assigning these output signals to transistor output terminals [Y1], [Y2], [Y3] and [Y4] enables the terminal command ***ISW50*** or ***ISW60*** that controls the magnetic contactor for switching the motor drive source between the commercial power and the inverter output according to the integrated sequence.

Refer to E01 through E07 (data = 40 and 41).

■ Select ***AX*** terminal function -- ***AX*** (Function code data = 15)

In response to a run command ***FWD***, this output signal controls the magnetic contactor on the commercial-power supply side. It comes ON when the inverter receives a run command and it goes OFF after the motor decelerates to stop with a stop command received.

This signal immediately goes OFF upon receipt of a coast-to-stop command or when an alarm occurs.



■ Cooling fan in operation -- ***FAN*** (Function code data = 25)

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control.

📖 Refer to H06.

■ Auto-resetting -- ***TRY*** (Function code data = 26)

This output signal comes ON when auto resetting (resetting alarms automatically) is in progress.

📖 Refer to H04 and H05.

■ Universal DO -- ***U-DO*** (Function code data = 27)

Assigning this output signal to an inverter's output terminal and connecting the terminal to a digital input terminal of peripheral equipment via the RS-485 communications link or the fieldbus, allows the inverter to send commands to the peripheral equipment.

The universal DO can also be used as an output signal independent of the inverter operation.

📖 For the procedure for access to Universal DO via the RS-485 communications link or fieldbus, refer to the respective instruction manual.

■ Heat sink overheat early warning -- ***OH*** (Function code data = 28)

This output signal is used to issue a heat sink overheat early warning that enables you to take a corrective action before an overheat trip OH1 actually happens.

This signal comes ON when the temperature of the heat sink exceeds the "overheat trip temperature minus 5°C (41°F)," and it goes OFF when it drops down to the "overheat trip temperature minus 8°C (46°F)."

This signal comes ON also when the internal air circulation DC fan (75 kW or above for 230 V series, 125 HP or above for 460 V series) has locked.

■ Synchronization completed -- ***SY*** (Function code data = 29)

This output signal comes ON when the control target comes inside the synchronization completion detection angle in synchronous running.

For details about synchronous operation, refer to the PG Interface Card instruction manual.

■ Lifetime alarm -- ***LIFE*** (Function code data = 30)

This output signal comes ON when it is judged that the service life of any one of capacitors (DC link bus capacitors and electrolytic capacitors on the printed circuit boards) and cooling fan has expired.

This signal should be used as a guide for replacement of the capacitors and cooling fan. If this signal comes ON, use the specified maintenance procedure to check the service life of these parts and determine whether the parts should be replaced or not.

Refer to H42.

This signal comes ON also when the internal air circulation DC fan (75 HP or above for 230 V series, 125 HP or above for 460 V series) has locked.

■ Reference loss detected -- ***REF OFF*** (Function code data = 33)

This output signal comes ON when an analog input used as a frequency command source is in a reference loss state (as specified by E65) due to a wire break or a weak connection. This signal goes OFF when the normal operation under the analog input is resumed.

Refer to E65.

■ Overload prevention control -- ***OLP*** (Function code data = 36)

This output signal comes ON when overload prevention control is activated. The minimum ON-duration is 100 ms.

Refer to H70.

■ Current detected -- ***ID*** (Function code data = 37)
Current detected 2 -- ***ID2*** (Function code data = 38)
Current detected 3 -- ***ID3*** (Function code data = 39)

The output signal ***ID***, ***ID2*** or ***ID3*** comes ON when the output current of the inverter exceeds the level specified by E34, E37 or E55 (Current detection (Level)) and stays above that level for the period longer than the one specified by E35, E38 or E56 (Current detection (Timer)), respectively. The minimum ON-duration is 100 ms.

Refer to E34.

■ Low current detected -- ***IDL*** (Function code data = 41)

This output signal comes ON when the output current drops below the low current detection level specified by E37 for the period specified by E38 (Low current detection (Timer)). The minimum ON-duration is 100 ms.

Refer to E34.

■ PID alarm -- ***PID-ALM*** (Function code data = 42)

Assigning this output signal enables PID control to output absolute-value alarm or deviation alarm.

📖 Refer to J11 through J13.

■ Under PID control -- ***PID-CTL*** (Function code data = 43)

This output signal comes ON when PID control is enabled ("Cancel PID control" (***Hz/PID***) = OFF) and a run command is ON.

📖 Refer to J01.

Note: When PID control is enabled, the inverter may stop due to the slow flowrate stopping function or other reasons, with the ***PID-CTL*** signal being ON. As long as the ***PID-CTL*** signal is ON, PID control is effective, so the inverter may abruptly resume its operation, depending on the feedback value in PID control.

⚠WARNING

When PID control is enabled, even if the inverter stops its output during operation because of sensor signals or other reasons, operation will resume automatically.

Design your machinery so that safety is ensured even in such cases.

Otherwise, an accident could occur.

■ Motor stopped due to slow flowrate under PID control -- ***PID-STP***
(Function code data = 44)

This output signal is ON when the inverter is in a stopped state due to the slow flowrate stopping function under PID control.)

📖 Refer to J08 through J09.

■ Low output torque detected -- ***U-TL*** (Function code data = 45)

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Detect low torque (Level)) for the period specified by E81 (Detect low torque (Timer)). The minimum ON-duration is 100 ms.

📖 Refer to E78 through E81.

■ Torque detected 1 -- ***TD1*** (Function code data = 46)
Torque detected 2 -- ***TD2*** (Function code data = 47)

This output signal ***TD1*** or ***TD2*** comes ON when the torque value calculated by the inverter or torque command exceeds the level specified by E78 or E80 (Torque detection (Level)) for the period specified by E79 or E81 (Torque detection (Timer)), respectively. The minimum ON-duration is 100 ms.

📖 Refer to E78 through E81.

■ Motor 1, 2, 3 and 4 selected -- ***SWM1***, ***SWM2***, ***SWM3*** and ***SWM4***
(Function code data = 48, 49, 50 and 51)

The output signal ***SWM1***, ***SWM2***, ***SWM3*** or ***SWM4*** comes ON corresponding to the motor selected by the signals ***M2***, ***M3*** and ***M4*** or the selected function code group.

📖 Refer to A42.

■ Running forward -- ***FRUN*** (Function code data = 52)
Running reverse -- ***RRUN*** (Function code data = 53)

Output signal	Assigned data	Running forward	Running reverse	Inverter stopped
FRUN	52	ON	OFF	OFF
RRUN	53	OFF	ON	OFF

■ In remote operation -- ***RMT*** (Function code data = 54)

This output signal comes ON when the inverter switches from local to remote mode.

📖 For details of switching between remote and local modes, refer to Chapter 7, Section 7.3.6 "Switching between remote and local modes."

■ Motor overheat detected by thermistor -- ***THM*** (Function code data = 56)

Even when the PTC thermistor on the motor detects an overheat, the inverter turns this signal ON and continues to run, without entering the alarm OH4 state. This feature applies only when H26 data is set to "2."

📖 Refer to H26 and H27.

■ Brake signal -- ***BRKS*** (Function code data = 57)

This signal outputs a brake control command that releases or activates the brake.

📖 Refer to J68 through J72.

■ Terminal [C1] wire break -- ***C1OFF*** (Function code data = 59)

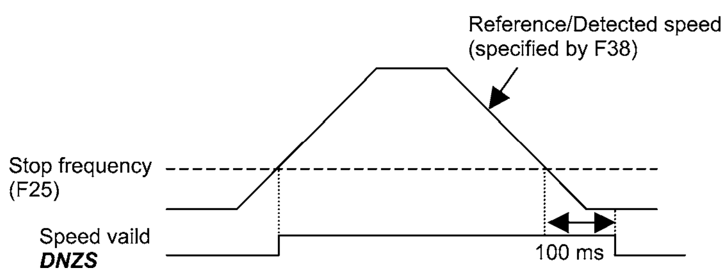
This output signal comes ON when the inverter detects that the input current to terminal [C1] drops below 2 mA interpreting it as the terminal [C1] wire broken.

■ Speed valid -- ***DNZS*** (Function code data = 70)

This output signal comes ON when the reference speed or detected one exceeds the stop frequency specified by function code F25. It goes OFF when the speed is below the stop frequency for 100 ms or longer.

Under vector control with speed sensor, F38 switches the decision criterion between the reference speed and detected one. Under vector control without speed sensor, the reference speed is used as a decision criterion.

📖 Refer to F25 and F38.



■ Speed agreement -- ***DSAG*** (Function code data = 71)

This output signal comes ON when the deviation of the detected speed from the speed command output of acceleration/deceleration processor is within the allowable range specified by d21. It goes OFF when the deviation is beyond the range for longer than the period specified by d22. This feature allows you to check whether the speed controller externally installed is working correctly.

📖 Refer to d21 and d22.

■ PG error detected -- ***PG-ERR*** (Function code data = 76)

This output signal comes ON when the inverter detects a PG error with the d23 (PG error processing) data being set to "0: Continue to run," in which the inverter does not enter the alarm state.

📖 Refer to d21 through d23.

■ Positioning completion signal -- ***PSET*** (Function code data = 82)

This output signal comes ON as a positioning completion signal.

📖 Refer to J97 through J99.

■ Maintenance timer -- ***MNT*** (Function code data = 84)

Once the inverter's cumulative run time or the startup times for the motor 1 exceeds the previously specified count, this output signal comes ON.

📖 Refer to H78 and H79.

■ Light alarm -- ***L-ALM*** (Function code data = 98)

This output signal comes ON when a light alarm occurs.

📖 Refer to H81 and H82.

■ Alarm output (for any alarm) -- ***ALM*** (Function code data = 99)

This output signal comes ON if any of the protective functions is activated and the inverter enters Alarm mode.

■ Enable circuit failure detected -- ***DECF*** (Function code data = 101)

This output signal comes ON when the inverter detects a failure of the Enable circuit.

📖 Refer to Chapter 9 "TROUBLESHOOTING."

■ Enable input OFF -- ***EN OFF*** (Function code data = 102)

This output signal comes ON when the terminal [EN] input is turned OFF.

■ Braking transistor broken -- ***DBAL*** (Function code data = 105)

If the inverter detects a breakdown of the braking transistor, it issues the braking transistor alarm (dbA) and also the output signal ***DBAL***. Detection of the breakdown of a braking transistor can be cancelled by H98. (40 HP or below)

📖 Refer to H98.

Note: A breakdown of the braking transistor could lead to a damage of the braking resistor or inverter's internal units. To prevent the secondary damage, use ***DBAL*** to cut off power to the magnetic contactor in inverter primary circuits upon detection of a breakdown of the built-in braking transistor.

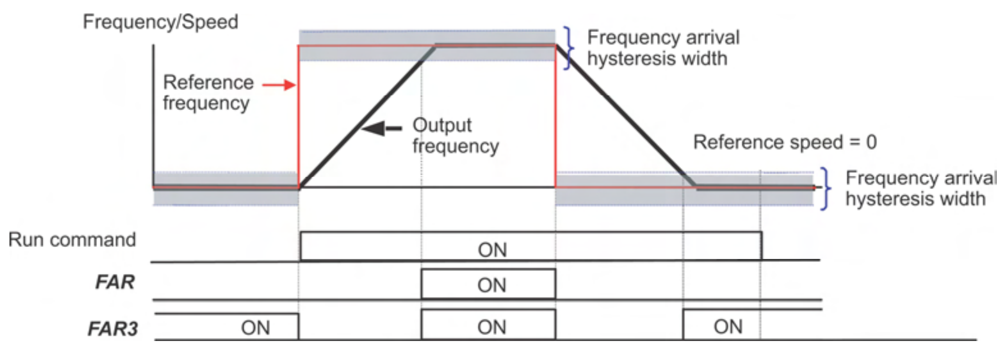
E30 Frequency Arrival (Hysteresis width)

E30 specifies the detection level (hysteresis width) for the "Frequency (speed) arrival signal" ***FAR*** and the "Frequency (speed) arrival signal 3" ***FAR3***.

Output signal	Data assigned to output terminal	Operating condition 1	Operating condition 2
Frequency (speed) arrival signal ***FAR***	1	Both signals come ON when the difference between the output frequency (estimated/detected speed) and the reference frequency (reference speed) comes within the frequency arrival hysteresis width specified by E30.	***FAR*** always goes OFF when the run command is OFF or the reference speed is "0."
Frequency (speed) arrival signal 3 ***FAR3***	72		When the run command is OFF, the inverter regards the reference speed as "0," so ***FAR3*** comes ON as long as the output frequency (estimated/detected speed) is within the range of "0 ± the frequency arrival hysteresis width specified by E30."

- Data setting range: 0.0 to 10.0 (Hz)

The operation timings of each signal are as shown below.



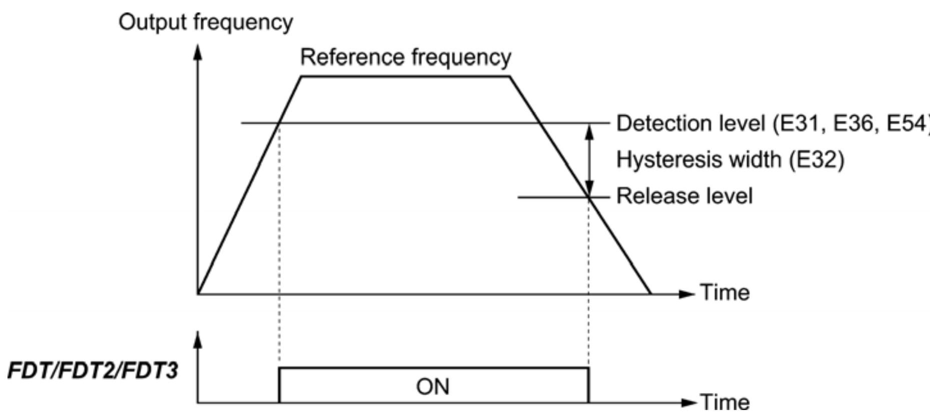
E31, E32 — Frequency Detection (Level and Hysteresis width)

E36 (Frequency Detection 2, Level)
E54 (Frequency Detection 3, Level)

When the output frequency (estimated/detected speed) exceeds the frequency detection level specified by E31, the "Frequency (speed) detected signal" comes ON; when it drops below the "Frequency detection level minus Hysteresis width specified by E32," it goes OFF.

The following three settings are available.

Output signal	Data assigned to output terminal	Operation level	Hysteresis width
		Range: 0.0 to 500.0 Hz	Range: 0.0 to 500.0 Hz
Frequency (speed) detected signal ***FDT***	2	E31	E32
Frequency (speed) detected signal 2 ***FDT2***	31	E36	
Frequency (speed) detected signal 3 ***FDT3***	58	E54	



E34, E35 — Overload Early Warning/Current Detection (Level and Timer)

E37, E38 (Current Detection 2/Low Current Detection, Level and Timer)
E55, E56 (Current Detection 3, Level and Timer)

These function codes define the detection level and time for the "Motor overload early warning" ***OL***, "Current detected" ***ID***, "Current detected 2" ***ID2***, "Current detected 3" ***ID3***, and "Low current detected" ***IDL*** output signals.

Output signal	Data assigned to output terminal	Operation level	Timer	Motor characteristics	Thermal time constant
		Range: See below	Range: 0.01 to 600.00 s	Range: See below	Range: 0.5 to 75.0 min
OL	7	E34	-	F10	F12
ID	37	E34	E35	-	-
ID2	38	E37	E38		
ID3	39	E55	E56		
IDL	41	E37	E38		

- Data setting range

  Operation level: 0.00 (Disable), 1 to 200% of inverter rated current

  Motor characteristics 1: Enable (For a general-purpose motor with shaft-driven cooling fan)
  2: Enable (For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan)

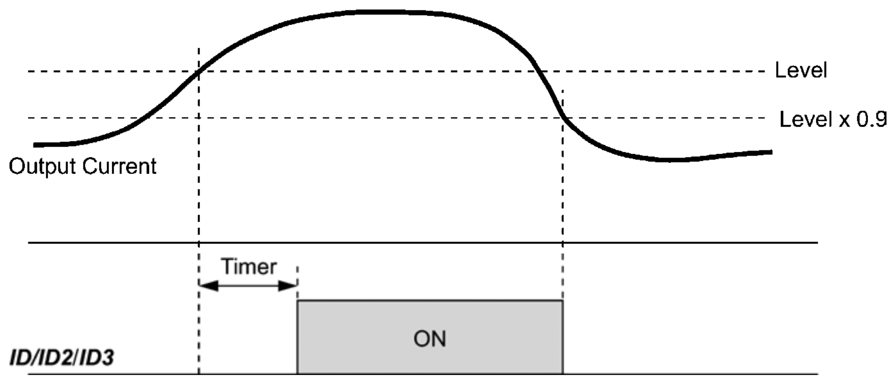
■ Motor overload early warning signal -- ***OL***

The ***OL*** signal is used to detect a symptom of an overload condition (alarm code OL1) of the motor so that the user can take an appropriate action before the alarm actually happens.

The ***OL*** signal turns ON when the inverter output current exceeds the level specified by E34. In typical cases, set E34 data to 80 to 90% against F11 data (Electronic thermal overload protection for motor 1, Overload detection level). Specify also the thermal characteristics of the motor with F10 (Select motor characteristics) and F12 (Thermal time constant).

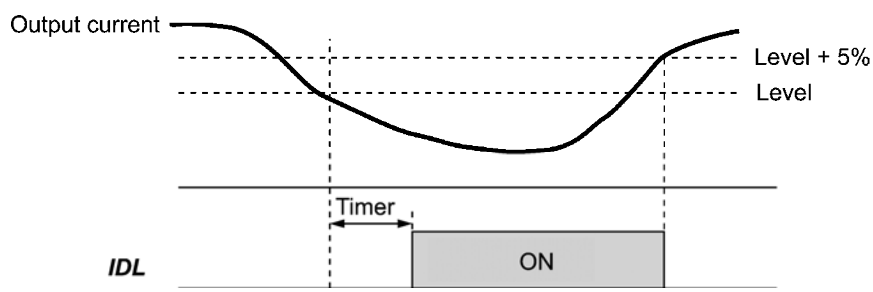
■ Current detected, Current detected 2 and Current detected 3 -- ***ID***, ***ID2*** and ***ID3***

When the inverter output current exceeds the level specified by E34, E37 or E55 for the period specified by E35, E38 or E56, the ***ID***, ***ID2*** or ***ID3*** signal turns ON, respectively. When the output current drops below 90% of the rated operation level, the ***ID***, ***ID2*** or ***ID3*** turns OFF. (The minimum ON-duration is 100 ms.)



■ Low current detected -- ***IDL***

This signal turns ON when the output current drops below the level specified by E37 (Low current detection, Level) for the period specified by E38 (Timer). When the output current exceeds the "Low current detection level plus 5% of the inverter rated current," it goes OFF. (The minimum ON-duration is 100 ms.)



E36	**Frequency Detection 2 (Level)**	**(Refer to E31.)**

Refer to the description of E31.

E37, E38	**Current Detection 2/Low Current Detection (Level and Timer)**	**(Refer to E34.)**

Refer to the description of E34.

E40, E41	PID Display Coefficient A, B

These function codes specify PID display coefficients A and B to convert a PID command (process command or dancer position command) and its feedback into easy-to-understand physical quantities to display.

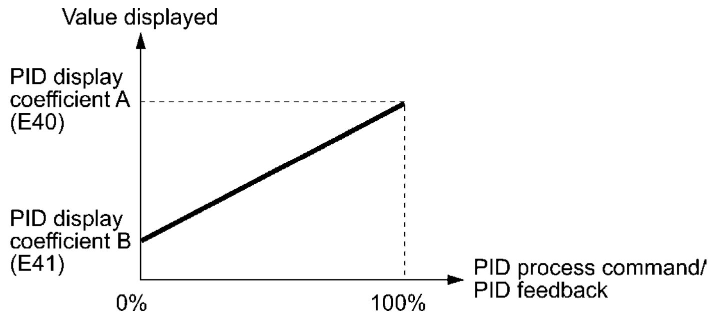
- Data setting range: -999 to 0.00 to 9990 for PID display coefficients A and B

■ Display coefficients for PID process command and its feedback (J01 = 1 or 2)

E40 specifies coefficient A that determines the display value at 100% of the PID process command or its feedback, and E41 specifies coefficient B that determines the display value at 0%.

The display value is determined as follows:

Display value = (PID process command or its feedback (%))/100 × (Display coefficient A - B) + B



Example

Maintaining the pressure around 16 kPa (sensor voltage 3.13 V) while the pressure sensor can detect 0 to 30 kPa over the output voltage range of 1 to 5 V:

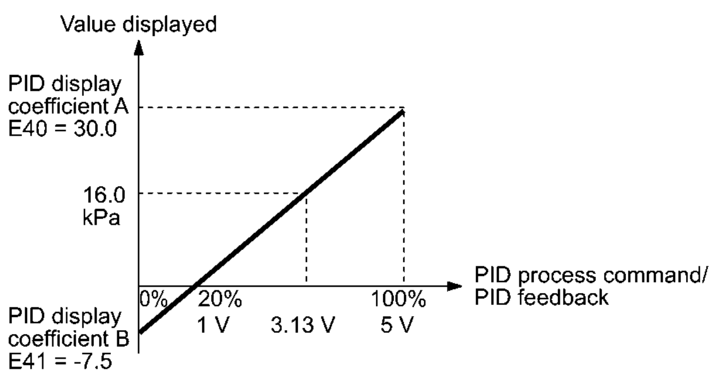
Select terminal [12] as a feedback terminal and set the gain to 200% so that 5 V corresponds to 100%.

The following E40 and E41 settings allow you to monitor or specify the values of the PID process command and its feedback on the keypad as pressure.

PID display coefficient A (E40) = 30.0, that determines the display value at 100% of PID process command or its feedback

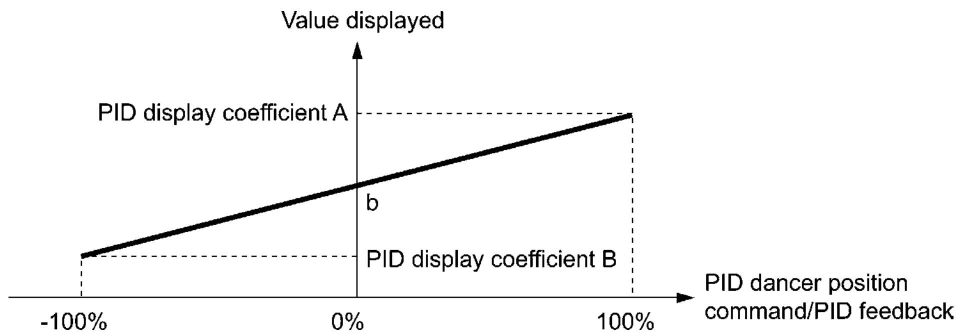
PID display coefficient B (E41) = -7.5, that determines the display value at 0% of PID process command or its feedback

To control the pressure at 16 kPa on the keypad, set the value to 16.0.



■ Display coefficients for PID dancer position command and its feedback (J01 = 3)

Under PID dancer control, the PID command and its feedback operate within the range ±100%, so specify the value at +100% of the PID dancer position command or its feedback as coefficient A with E40, and the value at -100% as coefficient B with E41.



If the sensor output is unipolar, PID dancer control operates within the range from 0 to +100%, so virtually specify the value at -100% as coefficient B.

That is, suppose "b" = "Display value at 0%," then:

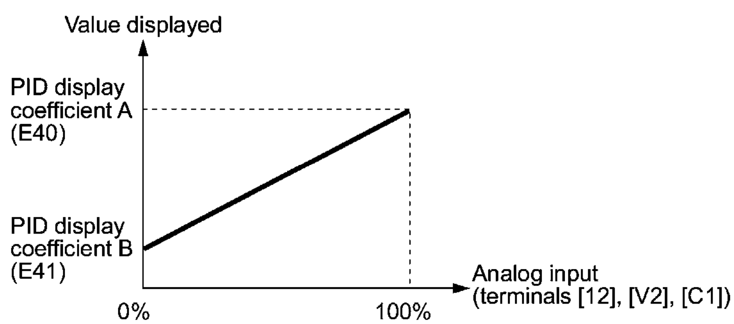
Display coefficient B = 2b - A

📖 For details about PID control, refer to the description of J01 and later.

📖 For the display method of the PID command and its feedback, refer to the description of E43.

■ Display coefficient for analog input monitor

By inputting analog signals from various sensors such as temperature sensors in air conditioners to the inverter, you can monitor the state of peripheral devices via the communications link. By using an appropriate display coefficient, you can also have various values converted into physical values such as temperature and pressure before they are displayed.



📖 To set up the analog input monitor, use function codes E61 through E63. Use E43 to choose the item to be displayed.

E42	LED Display Filter

E42 specifies a filter time constant to be applied for displaying the monitored running status except the speed monitor (E43 = 0) on the LED monitor on the keypad. If the display varies unstably so as to be hard to read due to load fluctuation or other causes, increase this filter time constant.

- Data setting range: 0.0 to 5.0 (s)

E43 LED Monitor (Item selection) — E48 (LED Monitor, Speed monitor item)

E43 specifies the running status item to be monitored and displayed on the LED monitor.

Specifying the speed monitor with E43 provides a choice of speed-monitoring formats selectable with E48 (LED Monitor).

Monitor item	Display sample on the LED monitor	Unit	Meaning of displayed value	Function code data for E43
Speed monitor	Function code E48 specifies what to be displayed on the LED monitor.			0
Output frequency 1 (before slip compensation)	50.00	Hz	Frequency actually being output	(E48 = 0)
Output frequency 2 (after slip compensation)	50.00	Hz	Frequency actually being output	(E48 = 1)
Reference frequency	50.00	Hz	Reference frequency being set	(E48 = 2)
Motor speed	1500	min^{-1}	Output frequency (Hz) $\times \frac{120}{P01}$	(E48 = 3)
Load shaft speed	300.0	min^{-1}	Output frequency (Hz) × E50	(E48 = 4)
Line speed	300.0	m/min	Output frequency (Hz) × E50	(E48 = 5)
Display speed (%)	50.0	%	$\frac{\text{Output frequency}}{\text{Maximum frequency}} \times 100$	(E48 = 7)
Output current	12.34	A	Current output from the inverter in RMS	3
Output voltage	200	V	Voltage output from the inverter in RMS	4
Calculated torque	50	%	Motor output torque in % (Calculated value)	8
Input power	10.25	kW	Input power to the inverter	9
PID command	10.00.	–	PID command and its feedback converted into physical quantities of the object to be controlled (e.g. temperature) Refer to function codes E40 and E41 for details.	10
PID feedback amount	9.00.	–		12
PID output	100.0.	%	PID output in % as the maximum frequency (F03) being at 100%	14
Load factor	50	%	Load factor of the motor in % as the rated output being at 100%	15
Motor output	9.85	kW	Motor output in kW	16
Analog input	82.00	–	An analog input to the inverter in a format suitable for a desired scale. Refer to function codes E40 and E41 for details.	17
Torque current	48	%	Torque current command value or calculated torque current	23
Magnetic flux command	50	%	Magnetic flux command value (Available only under vector control)	24
Input watt-hour	100.0	kWh	$\frac{\text{Input watt-hour (kWh)}}{100}$	25

E44	LED Monitor (Display when stopped)

E44 specifies whether the specified value (data = 0) or the output value (data = 1) to be displayed on the LED monitor of the keypad when the inverter is stopped. The monitored item depends on the E48 (LED monitor, Speed monitor item) setting as shown below.

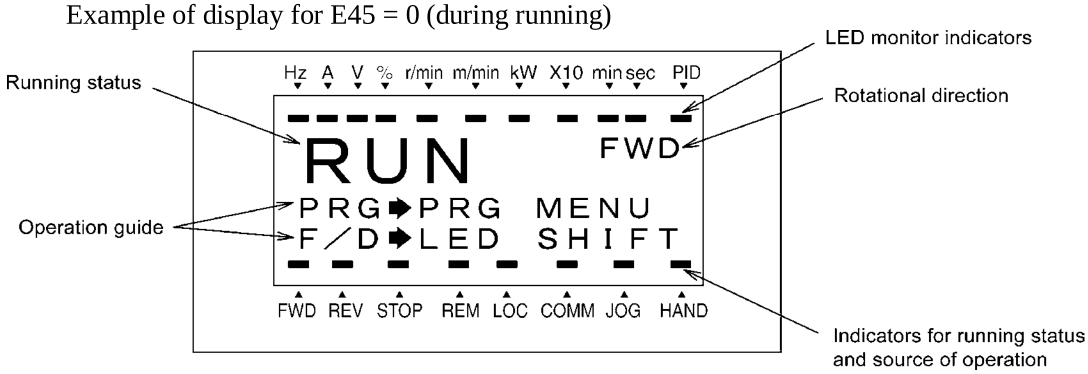
Data for E48	Monitored item	What to be displayed when the inverter stopped	
		E44 = 0 (Specified value)	E44 = 1 (Output value)
0	Output frequency 1 (before slip compensation)	Reference frequency	Output frequency 1 (before slip compensation)
1	Output frequency 2 (after slip compensation)	Reference frequency	Output frequency 2 (after slip compensation)
2	Reference frequency	Reference frequency	Reference frequency
3	Motor speed	Reference motor speed	Motor speed
4	Load shaft speed	Reference load shaft speed	Load shaft speed
5	Line speed	Reference line speed	Line speed
7	Display speed (%)	Reference display speed	Display speed

E45	LCD Monitor (Item selection)

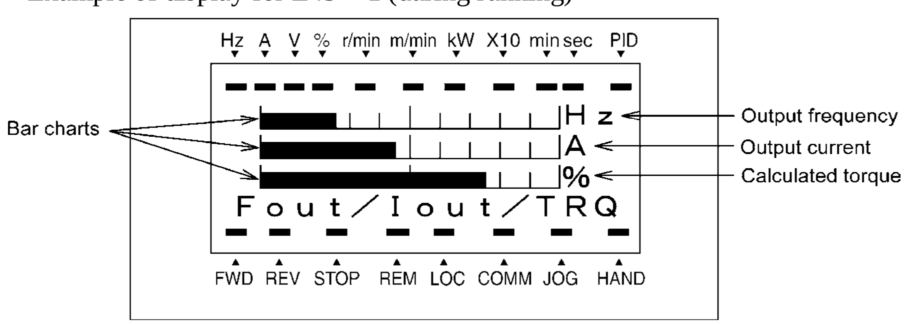
E45 specifies the LCD monitor display mode to be applied when the inverter is in Running mode.

Data for E45	Function
0	Running status, rotational direction and operation guide
1	Bar charts for output frequency, current and calculated torque

Example of display for E45 = 0 (during running)



Example of display for E45 = 1 (during running)



Full-scale values on bar charts

Item displayed	Full scale
Output frequency	Maximum frequency
Output current	Inverter rated current × 200%
Calculated torque	Motor rated torque × 200%

E46 LCD Monitor (Language selection)

E46 specifies the language to display on the keypad (TP-G1W-J1) as follows:

Data for E46	Language
0	Japanese
1	English
2	German
3	French
4	Spanish
5	Italian

E47 LCD Monitor (Contrast level)

E47 adjusts the contrast of the LCD monitor on the keypad as follows:

Data for E47	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Contrast	Low ←→ High

E48 LED Monitor (Speed monitor item) Refer to E43.

Refer to the description of E43.

E50 Coefficient for Speed Indication

E50 specifies the coefficient that is used when the load shaft speed or line speed is displayed on the LED monitor. (Refer to the description of E43.)

Load shaft speed (min^{-1}) = (E50: Coefficient for speed indication) × (Output frequency Hz)

Line speed (m/min) = (E50: Coefficient for speed indication) × (Output frequency Hz)

- Data setting range: 0.01 to 200.00

E51 Display Coefficient for Input Watt-hour Data

E51 specifies a display coefficient (multiplication factor) for displaying the input watt-hour data (5_ 10) in a part of maintenance information on the keypad.

Input watt-hour data = Display coefficient (E51 data) × Input watt-hour (kWh)

- Data setting range: 0.000 (cancel/reset)
  0.001 to 9999

Note Setting E51 data to 0.000 clears the input watt-hour and its data to "0." After clearing, be sure to restore E51 data to the previous value; otherwise, input watt-hour data will not be accumulated.

E52 Keypad (Menu display mode)

E52 provides a choice of three menu display modes for the remote keypad TP-E1U (option) as listed below.

Data for E52	Menu display mode	Menus to be displayed
0	Function code data editing mode	Menus #0, #1 and #7
1	Function code data check mode	Menus #2 and #7
2	Full-menu mode	Menus #0 through #7

The menus available on the remote keypad TP-E1U (option) are described below.

Menu #	Menu	LED monitor shows:	Main functions	
0	"Quick Setup"	0.Fnc	Displays only basic function codes to customize the inverter operation.	
1	"Data Setting"	1.F_ _	F codes (Fundamental functions)	Selecting each of these function codes enables its data to be displayed/ changed.
		1.E_ _	E codes (Extension terminal functions)	
		1.C_ _	C codes (Control functions)	
		1.P_ _	P codes (Motor 1 parameters)	
		1.H_ _	H codes (High performance functions)	
		1.A_ _	A codes (Motor 2 parameters)	
		1.b_ _	b codes (Motor 3 parameters)	
		1.r_ _	r codes (Motor 4 parameters)	
		1.J_ _	J codes (Application functions)	
		1.d_ _	d codes (Application functions 2)	
		1.U_ _	U codes (Application functions 3)	
		1.y_ _	y codes (Link functions)	
		1.o_ _	o codes (Optional function)	

Menu #	Menu	LED monitor shows:	Main functions
2	"Data Checking"	2.rEP	Displays only function codes that have been changed from their factory defaults. You can refer to or change those function code data.
3	"Drive Monitoring"	3.oPE	Displays the running information required for maintenance or test running.
4	"I/O Checking"	4. I_o	Displays external interface information.
5	"Maintenance Information"	5.CHE	Displays maintenance information including cumulative run time.
6	"Alarm Information"	6.AL	Displays the recent four alarm codes. You can refer to the running information at the time when the alarm occurred.
7	"Data Copying"	7.CPY	Allows you to read or write function code data, as well as verifying it.

For details of each menu item, refer to Chapter 7 "KEYPAD FUNCTIONS."

E54 Frequency Detection 3 (Level) Refer to E31.

For details, refer to the description of E31.

E55, E56 Current Detection 3 (Level, Timer) Refer to E34.

For details, refer to the description of E34.

E61 to E63 Terminal [12] Extended Function
Terminal [C1] Extended Function
Terminal [V2] Extended Function

E61, E62, and E63 define the function of the terminals [12], [C1], and [V2], respectively.

There is no need to set up these terminals if they are to be used for frequency command sources.

Data for E61, E62, or E63	Input assigned to [12], [C1] and [V2]:	Description
0	None	—
1	Auxiliary frequency command 1	Auxiliary frequency input to be added to the reference frequency given by frequency command 1 (F01). This is not added to any other reference frequencies given by frequency command 2 and multi-frequency commands, etc.
2	Auxiliary frequency command 2	Auxiliary frequency input to be added to all reference frequencies given by frequency command 1, frequency command 2, multi-frequency commands, etc.
3	PID command 1	Command sources such as temperature and pressure under PID control. It is also necessary to configure function code J02.
5	PID feedback amount	Feedback amounts such as temperature and pressure under PID control.
6	Ratio setting	This is used to multiply the final frequency command value by this value, for use in the constant line speed control by calculating the winder diameter or in ratio operation with multiple inverters.

Data for E61, E62, or E63	Input assigned to [12], [C1] and [V2]:	Description
7	Analog torque limit value A	This is used when analog inputs are used as torque limiters. (📖 Refer to F40 (Torque Limiter 1-1).)
8	Analog torque limit value B	This is used when analog inputs are used as torque limiters. (📖 Refer to F40 (Torque Limiter 1-1).)
10	Torque command	Analog inputs to be used as torque commands under torque control. (📖 Refer to H18 (Torque Control).)
11	Torque current command	Analog inputs to be used as torque current commands under torque control. (📖 Refer to H18 (Torque Control).)
20	Analog signal input monitor	By inputting analog signals from various sensors such as the temperature sensors in air conditioners to the inverter, you can monitor the state of external devices via the communications link. By using an appropriate display coefficient, you can also have various values to be converted into physical quantities such as temperature and pressure before they are displayed.

Note If these terminals have been set up to have the same data, the operation priority is given in the following order:

E61 > E62 > E63

When UP/DOWN control is selected for a frequency command source (F01, C30 = 7), the auxiliary frequency commands 1 and 2 are disabled.

E64 Saving of Digital Reference Frequency

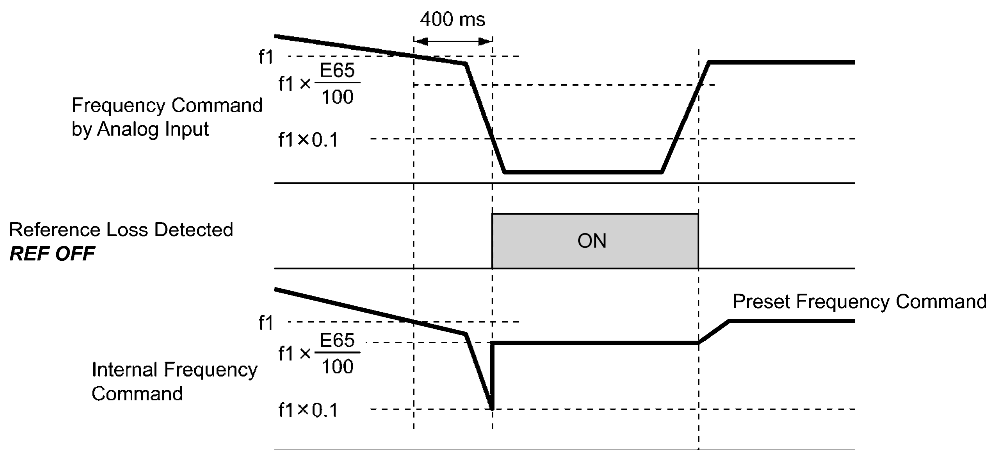
E64 specifies how to save the reference frequency specified in digital formats by the ⋀/⋁ keys on the keypad as shown below.

Data for E64	Function
0	Automatic saving when the main power is turned OFF The reference frequency will be automatically saved when the main power is turned OFF. At the next power-on, the reference frequency at the time of the previous power-off applies.
1	Saving by pressing FUNC/DATA key Pressing the FUNC/DATA key saves the reference frequency. If the control power is turned OFF without pressing the FUNC/DATA key, the data will be lost. At the next power-on, the inverter uses the reference frequency saved when the FUNC/DATA key was pressed last.

E65 Reference Loss Detection (Continuous running frequency)

When the analog frequency command (setting through terminal [12], [C1], or [V2]) has dropped below 10% of the reference frequency within 400 ms, the inverter presumes that the analog frequency command wire has been broken and continues its operation at the frequency determined by the ratio specified by E65 to the reference frequency. 📖 Refer to E20 through E24 and E27 (data = 33).

When the frequency command level (in voltage or current) returns to a level higher than that specified by E65, the inverter presumes that the broken wire has been fixed and continues to run following the frequency command.



In the diagram above, f1 is the level of the analog frequency command sampled at any given time. The sampling is repeated at regular intervals to continually monitor the wiring connection of the analog frequency command.

- Data setting range: 0 (Decelerate to stop)
  20 to 120 %
  999 (Disable)

Note

Avoid an abrupt voltage or current change for the analog frequency command. An abrupt change may be interpreted as a wire break.

Setting E65 data at "999" (Disable) allows the ***REF OFF*** signal ("Reference loss detected") to be issued, but does not allow the reference frequency to change (the inverter runs at the analog frequency command as specified).

When E65 = "0" or "999," the reference frequency level at which the broken wire is recognized as fixed is "f1 × 0.2."

When E65 = "100" (%) or higher, the reference frequency level at which the wire is recognized as fixed is "f1 × 1."

The reference loss detection is not affected by the setting of analog input adjustment (filter time constants: C33, C38, and C43).

Chap. 5 FUNCTION CODES

Function Code Details
F codes
E codes
C01-C19
P codes
H codes
A codes
b codes
r codes
J codes
d codes
U codes
y codes

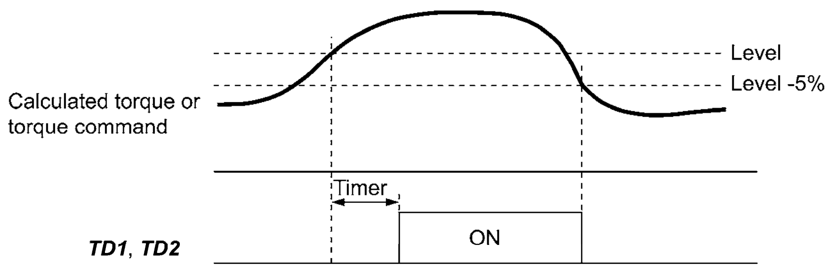
E78, E79 E80, E81	Torque Detection 1 (Level and Timer) Torque Detection 2/Low Torque Detection (Level and Timer)

E78 specifies the operation level and E79 specifies the timer, for the output signal ***TD1***. E80 specifies the operation level and E81 specifies the timer, for the output signal ***TD2*** or ***U-TL***.

Output signal	Assigned data	Operation level	Timer
		Range: 0 to 300%	Range: 0.01 to 600.00 s
TD1	46	E78	E79
TD2	47	E80	E81
U-TL	45	E80	E81

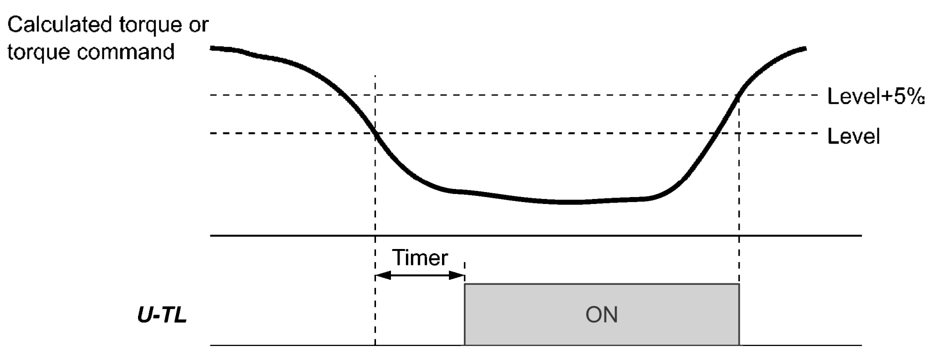
■ Torque detected 1 -- ***TD1***, Torque detected 2 -- ***TD2***

The output signal ***TD1*** or ***TD2*** comes ON when the torque value calculated by the inverter or torque command exceeds the level specified by E78 or E80 (Torque detection (Level)) for the period specified by E79 or E81 (Torque detection (Timer)), respectively. The signal turns OFF when the calculated torque drops below "the level specified by E78 or E80 minus 5% of the motor rated torque." The minimum ON-duration is 100 ms.



■ Low output torque detected--***U-TL***

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Low torque detection (Level)) for the period specified by E81 (Low torque detection (Timer)). The signal turns OFF when the calculated torque exceeds the "level specified by E80 plus 5% of the motor rated torque." The minimum ON-duration is 100 ms.



In the inverter's low frequency operation, as a substantial error in torque calculation occurs, no low torque can be detected within the operation range at less than 20% of the base frequency (F04). (In this case, the result of recognition before entering this operation range is retained.)

The ***U-TL*** signal goes off when the inverter is stopped.

Since the motor parameters are used in the calculation of torque, it is recommended that auto-tuning be applied by function code P04 to achieve higher accuracy.

E98, E99	Terminal [FWD] Function Terminal [REV] Function (Refer to E01 to E07.)

For details, refer to the descriptions of E01 to E07.

Chap. 5 FUNCTION CODES

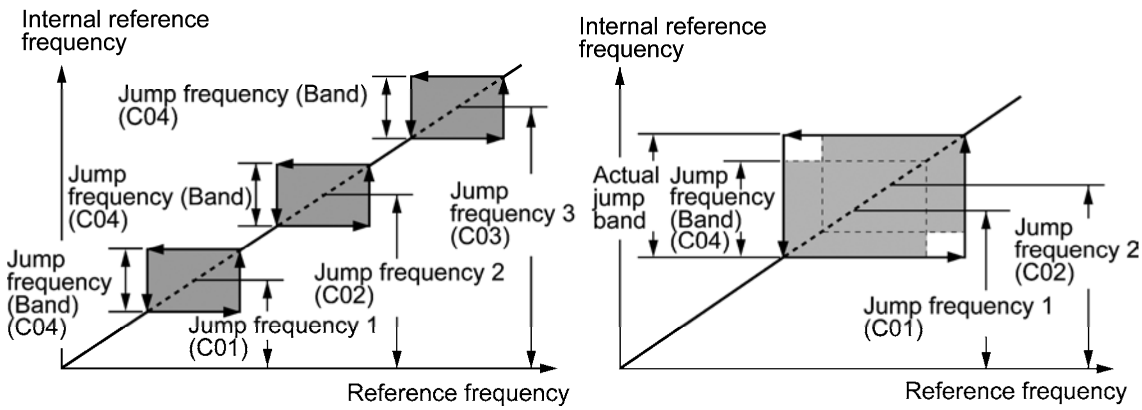
Function Code Details
F codes
E codes
C01-C19
P codes
H codes
A codes
b codes
r codes
J codes
d codes
U codes
y codes

5.4.3 C codes (Control functions)

C01 to C03 C04	Jump Frequency 1, 2 and 3 Jump Frequency (Hysteresis width)

These function codes enable the inverter to jump over three different points on the output frequency in order to skip resonance caused by the motor speed and natural frequency of the driven machinery (load).

- When the inverter is being increased the reference frequency, the moment the reference frequency reaches the bottom of the jump frequency band, the inverter keeps the output at that bottom frequency. When the reference frequency exceeds the upper limit of the jump frequency band, the internal reference frequency takes on the value of the reference frequency. When the inverter is being decreased the reference frequency, the situation will be reversed.
- When more than two jump frequency bands overlap, the inverter actually takes the lowest frequency within the overlapped bands as the bottom frequency and the highest as the upper limit. Refer to the figure on the lower right.



■ Jump frequencies 1, 2 and 3 (C01, C02 and C03)

Specify the center of the jump frequency band.

- Data setting range: 0.0 to 500.0 (Hz) (Setting to 0.0 results in no jump frequency band.)

■ Jump frequency hysteresis width (C04)

Specify the jump frequency hysteresis width.

- Data setting range: 0.0 to 30.0 (Hz) (Setting to 0.0 results in no jump frequency band.)

C05 to C19	Multi-frequency 1 to 15

These function codes specify 15 frequencies required for driving the motor at frequencies 1 to 15.

Turning terminal commands ***SS1***, ***SS2***, ***SS4*** and *SS8* ON/OFF selectively switches the reference frequency of the inverter in 15 steps. To use these features, you need to assign ***SS1***, ***SS2***, ***SS4*** and ***SS8*** ("Select multi-frequency") to the digital input terminals with C05 to C19 (data = 0, 1, 2, and 3).

■ Multi-frequency 1 to 15 (C05 through C19)

- Data setting range: 0.00 to 500.0 (Hz)

The combination of ***SS1***, ***SS2***, ***SS4*** and ***SS8*** and the selected frequencies are as follows.

SS8	***SS4***	***SS2***	***SS1***	Selected frequency command
OFF	OFF	OFF	OFF	Other than multi-frequency *
OFF	OFF	OFF	ON	C05 (multi-frequency 1)
OFF	OFF	ON	OFF	C06 (multi-frequency 2)
OFF	OFF	ON	ON	C07 (multi-frequency 3)
OFF	ON	OFF	OFF	C08 (multi-frequency 4)
OFF	ON	OFF	ON	C09 (multi-frequency 5)
OFF	ON	ON	OFF	C10 (multi-frequency 6)
OFF	ON	ON	ON	C11 (multi-frequency 7)
ON	OFF	OFF	OFF	C12 (multi-frequency 8)
ON	OFF	OFF	ON	C13 (multi-frequency 9)
ON	OFF	ON	OFF	C14 (multi-frequency 10)
ON	OFF	ON	ON	C15 (multi-frequency 11)
ON	ON	OFF	OFF	C16 (multi-frequency 12)
ON	ON	OFF	ON	C17 (multi-frequency 13)
ON	ON	ON	OFF	C18 (multi-frequency 14)
ON	ON	ON	ON	C19 (multi-frequency 15)

* "Other than multi-frequency" includes frequency command 1 (F01), frequency command 2 (C30) and other command sources except multi-frequency commands.

■ When enabling PID control (J01 = 1, 2, or 3)

Under PID control, a multi-frequency command can be specified as a preset value (3 different frequencies). It can also be used for a manual speed command even with PID control being canceled (***Hz***/***PID*** = ON) or for a primary reference frequency under PID dancer control.

• PID command

SS8	***SS4***	***SS1***, ***SS2***	Command
OFF	OFF	–	Command specified by J02
OFF	ON	–	Multi-frequency by C08
ON	OFF	–	Multi-frequency by C12
ON	ON	–	Multi-frequency by C16

C08, C12, and C16 can be specified in increments of 1 Hz. The following gives the conversion formula between the PID command value and the data to be specified.

$$\text{Data to be specified} = \text{PID command (\%)} \times \text{Maximum frequency (F03)} \div 100$$

$$\text{PID command (\%)} = \frac{\text{Data to be specified (C08, C12, C16)}}{\text{Maximum frequency (F03)}} \times 100$$

• Manual speed command

SS8, ***SS4***	***SS2***	***SS1***	Selected frequency command
–	OFF	OFF	Other than multi-frequency
–	OFF	ON	C05 (Multi-frequency 1)
–	ON	OFF	C06 (Multi-frequency 2)
–	ON	ON	C07 (Multi-frequency 3)

C20	Jogging Frequency	H54, H55 (Acceleration/Deceleration Time, Jogging) d09 to d13 (Speed Control (Jogging))

To jog or inch the motor for positioning a workpiece, specify the jogging conditions using the jogging-related function codes (C20, H54, H55, and d09 through d13) beforehand, make the inverter ready for jogging, and then enter a run command.

■ Making the inverter ready for jogging

Turning ON the "Ready for jogging" terminal command ***JOG*** (Function code data = 10) readies the inverter for jogging.

Pressing the "STOP + ∧ keys" simultaneously in Running mode also readies the inverter for jogging (when the run command source is "Keypad" (F02 = 0, 2 or 3)). Pressing these keys toggles between "ready for jogging" and "normal operation."

Note: Switching between the normal operation state and ready-to-jog state is possible only when the inverter is stopped.

■ Starting jogging

Holding down the FWD or REV key or turning the input terminal command ***FWD*** or ***REV*** ON jogs the motor.

In jogging with the FWD or REV key, the inverter jogs only when the key is held down. Releasing the key decelerates the motor to a stop.

Note: To start jogging operation by simultaneously entering the ***JOG*** terminal command and a run command (e.g., ***FWD***), the input delay time between the two commands should be within 100 ms. If a run command ***FWD*** is entered first, the inverter does not jog the motor but runs it ordinarily until the next input of the ***JOG***.

The jogging conditions should be specified beforehand using the following function codes.

Function code		Data setting range	Description
C20	Jogging Frequency	0.00 to 500.00 Hz	Reference frequency for jogging operation
H54	Acceleration Time (Jogging)	0.00 to 6000 s	Acceleration time for jogging operation
H55	Deceleration Time (Jogging)	0.00 to 6000 s	Deceleration time for jogging operation
d09	Speed control (Jogging) (Speed command filter)	0.000 to 5.000 s	Modification items related to speed control for jogging operation under vector control with/without speed sensor For adjustments, refer to the descriptions of d01 to d06.
d10	Speed control (Jogging) (Speed detection filter)	0.000 to 0.100 s	
d11	Speed control (Jogging) P (Gain)	0.1 to 200.0 times	
d12	Speed control (Jogging) I (Integral time)	0.001 to 1.000 s	
d13	Speed control (Jogging) (Output filter)	0.000 to 0.100 s	

For details about jogging operation, refer to Chapter 7, Section 7.3.5 "Jogging (inching) the motor."

C30	Frequency Command 2 (Refer to F01.)

For details of frequency command 2, refer to the description of F01.

C31 to C35 C36 to C39 C41 to C45	Analog Input Adjustment for [12] (Offset, Gain, Filter time constant, Gain base point, Polarity) Analog Input Adjustment for [C1] (Offset, Gain, Filter time constant, Gain base point) Analog Input Adjustment for [V2] (Offset, Gain, Filter time constant, Gain base point, Polarity) F01 (Frequency Command 1)

Setting up a reference frequency using analog input

You can adjust the gain, polarity, filter time constant, and offset which are applied to analog inputs (voltage inputs to terminals [12] and [V2], and current input to terminal [C1]).

Adjustable items for analog inputs

Input terminal	Input range	Gain		Polarity	Filter time constant	Offset
		Gain	Base point			
[12]	0 to +10 V, -10 to +10 V	C32	C34	C35	C33	C31
[C1]	4 to 20 mA	C37	C39	—	C38	C36
[V2]	0 to +10 V, -10 to +10 V	C42	C44	C45	C43	C41

■ Offset (C31, C36, C41)

C31, C36 or C41 configures an offset for an analog voltage/current input. The offset also applies to signals sent from the external equipment.

- Data setting range: -5.0 to +5.0 (%)

■ Filter time constant (C33, C38, C43)

C33, C38 or C43 configures a filter time constant for an analog voltage/current input. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noises, increase the time constant.

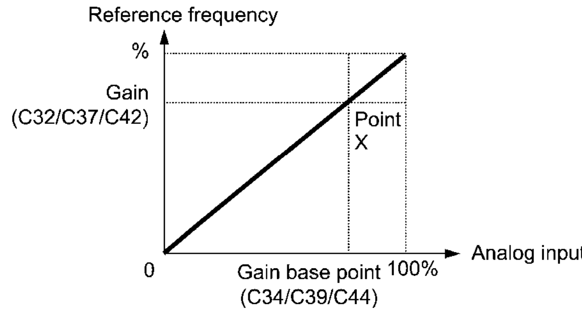
- Data setting range: 0.00 to 5.00 (s)

■ Polarity (C35, C45)

C35 and C45 configure the input range for analog input voltage.

Data for C35 and C45	Specifications for terminal inputs
0	-10 to +10 V
1	0 to +10 V (A minus component of the input will be regarded as 0 VDC.)

■ Gain



Note: To input bipolar analog voltage (0 to ±10 VDC) to terminals [12] and [V2], set C35 and C45 data to "0." Setting C35 and C45 data to "1" enables the voltage range from 0 to +10 VDC and interprets the negative polarity input from 0 to -10 VDC as 0 V.

C50 | Bias (Frequency command 1) (Bias base point) (Refer to F01.)

For details, refer to the description of F01.

C51, C52 | Bias (PID command 1) (Bias value and Bias base point)

These function codes (and the gain-related function codes) specify the gain and bias of the analog PID command 1, enabling it to define arbitrary relationship between the analog input and PID commands.

The actual setting is the same as that of F18. For details, refer to F18 given in the description of F01.

Note: Gain-related function codes C32, C34, C37, C39, C42, and C44 are shared by frequency commands.

■ Bias value (C51)

- Data setting range: -100.00 to 100.00 (%)

■ Bias base point (C52)

- Data setting range: 0.00 to 100.00 (%)

C53 | Selection of Normal/Inverse Operation (Frequency command 1)

C53 switches the reference frequency sourced by frequency command 1 (F01) between normal and inverse.

For details, refer to E01 through E07 (data = 21) for the terminal command ***IVS*** ("Switch normal/inverse operation").

5.4.4 P codes (Motor 1 parameters)

The FRENIC-MEGA drives the motor under "V/f control," "dynamic torque vector control," "V/f control with speed sensor," "dynamic torque vector control with speed sensor," "vector control without speed sensor," or "vector control with speed sensor," which can be selected with function codes.

To use the integrated automatic control functions such as auto torque boost, torque calculation monitoring, auto energy saving operation, torque limiter, automatic deceleration (anti-regenerative control), auto search for idling motor speed, slip compensation, torque vector control, droop control, and overload stop, it is necessary to build a motor model in the inverter by specifying proper motor parameters including the motor capacity and rated current.

The FRENIC-MEGA provides built-in motor parameters for HP rating motors. To use these motors, it is enough to specify motor parameters for P99 (Motor 1 Selection). If the cabling between the inverter and the motor is long (generally, 66 ft (20 m) or longer) or a reactor is inserted between the motor and the inverter, however, the apparent motor parameters are different from the actual ones, so auto-tuning or other adjustments are necessary. For the auto-tuning procedure, refer to the FRENIC-MEGA Instruction Manual, Chapter 4 "RUNNING THE MOTOR."

When using a motor made by other manufacturers or a non-standard motor, obtain the datasheet of the motor and specify the motor parameters manually or perform auto-tuning.

Chap. 5 FUNCTION CODES

P01 Motor 1 (No. of poles)

P01 specifies the number of poles of the motor. Enter the value given on the nameplate of the motor. This setting is used to monitor the motor speed (see E43) and control the speed. The following expression is used for the conversion.

$$\text{Motor speed (min}^{-1}\text{)} = \frac{120}{\text{No. of poles}} \times \text{Frequency (Hz)}$$

- Data setting range: 2 to 22 (poles)

P02 Motor 1 (Rated capacity)

P02 specifies the rated capacity of the motor. Enter the rated value given on the nameplate of the motor.

Data for P02	Unit	Function
0.01 to 1000	HP	When P99 (Motor 1 Selection) = 1
	kW	When P99 (Motor 1 Selection) = 0, 2, 3 or 4

When accessing P02 with the keypad, take into account that the P02 data automatically updates data of P03, P06 through P23, P53 through P56, and H46.

P03 Motor 1 (Rated current)

P03 specifies the rated current of the motor. Enter the rated value given on the nameplate of the motor.

- Data setting range: 0.00 to 2000 (A)

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F codes
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C31-C-53
P01-P03
H codes
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b codes
r codes
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d codes
U codes
y codes

P04	Motor 1 (Auto-tuning)

The inverter automatically detects the motor constants and saves them as parameters in its internal memory. Basically, no tuning is required as long as a HP rating motor is used with standard connection with the inverter.

There are three types of auto-tuning as listed below. Select appropriate one considering the limitations in your equipment and control mode.

Data for P04	Auto-tuning	Operation	Motor parameters to be tuned
0	Disable	N/A	N/A
1	Tune while the motor stops	The inverter performs tuning while the motor is stopped.	Primary resistance (%R1) (P07) Leakage reactance (%X) (P08) Rated slip frequency (P12) %X correction factors 1 and 2 (P53 and P54)
2	Tune while the motor is rotating under V/f control	After tuning while the motor is stopped, the inverter performs tuning again, with the motor running at 50% of the base frequency.	No-load current (P06) Primary resistance (%R1) (P07) Leakage reactance (%X) (P08) Rated slip frequency (P12) Magnetic saturation factors 1 to 5 (P16 through P20) Magnetic saturation extension factors "a" to "c" (P21 through P23) %X correction factors 1 and 2 (P53 and P54)
3	Tune while the motor is rotating under vector control	After tuning while the motor is stopped, the inverter performs tuning, with the motor running at 50% of the base frequency twice.	No-load current (P06) Primary resistance (%R1) (P07) Leakage reactance (%X) (P08) Rated slip frequency (P12) Magnetic saturation factors 1 to 5 (P16 to P20) Magnetic saturation extension factors "a" to "c" (P21 to P23) %X correction factors 1 and 2 (P53 and P54)

For details of auto-tuning, refer to the FRENIC-MEGA Instruction Manual, Chapter 4 "RUNNING THE MOTOR."

Note: In any of the following cases, perform auto-tuning since the motor parameters are different from those of standard motors so that the full performance may not be obtained under some controls.

- The motor to be driven is a non-standard motor.
- Cabling between the motor and the inverter is long. (Generally, 66 ft (20 m) or longer)
- A reactor is inserted between the motor and the inverter.

■ Functions that are affected by motor parameters in running capability

Function	Related function codes (representative)
Auto torque boost	F37
Output torque monitor	F31, F35
Load factor monitor	F31, F35
Auto energy saving operation	F37
Torque limiter	F40
Anti-regenerative control (Automatic deceleration)	H69
Auto search	H09
Slip compensation	F42
Dynamic torque vector control	F42
Droop control	H28
Torque detection	E78 through E81
Vector control with/without speed sensor	F42
Brake signal (Brake-OFF torque)	J95

P05 Motor 1 (Online tuning)

Long run under "Dynamic torque vector control" or "Slip compensation control" causes motor temperature change, varying the motor parameters. This changes the motor speed compensation amount, resulting in motor speed deviation from the initial rpm.

Enabling online tuning (P05 = 1) identifies motor parameters covering the motor temperature change to decrease the motor speed fluctuation.

To perform online tuning enabled with P05, set P04 (Auto-tuning) to "2.

Note Online tuning can be performed only when F42 = 1 (Dynamic torque vector control) or when F42 = 2 (V/f control with slip compensation active) and F37 = 2 or 5 (Auto torque boost).

P06 to P08 Motor 1 (No-load current, %R1 and %X)

P06 through P08 specify no-load current, %R1 and %X, respectively. Obtain the appropriate values from the test report of the motor or by calling the motor manufacturer.

Performing auto-tuning automatically sets these parameters.

■ No-load current (P06)

Enter the value obtained from the motor manufacturer.

■ %R1 (P07)

Enter the value calculated by the following expression.

$$\%R1 = \frac{R1 + \text{Cable } R1}{V / (\sqrt{3} \times I)} \times 100\ (\%)$$

where,

R1: Primary resistance of the motor (Ω)
Cable R1: Resistance of the output cable (Ω)
V: Rated voltage of the motor (V)
I: Rated current of the motor (A)

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■ %X (P08)

Enter the value calculated by the following expression.

$$\%X = \frac{X1 + X2 \times XM \ / \ (X2 + XM) + \text{Cable } X}{V \ / \ (\sqrt{3} \times I\ )} \times 100\ (\%)$$

where,

X1: Primary leakage reactance of the motor (Ω)
X2: Secondary leakage reactance of the motor (converted to primary) (Ω)
XM: Exciting reactance of the motor (Ω)
Cable X: Reactance of the output cable (Ω)
V: Rated voltage of the motor (V)
I: Rated current of the motor (A)

Note: For reactance, use the value at the base frequency (F04).

P09 to P11 | **Motor 1 (Slip compensation gain for driving, Slip compensation response time, and Slip compensation gain for braking)**

P09 and P11 determine the slip compensation amount in % for driving and braking respectively and adjust the slip amount from internal calculation. Specification of 100% fully compensates for the rated slip of the motor. Excessive compensation (P09, P11 > 100%) may cause hunting (undesirable oscillation of the system), so carefully check the operation on the actual machine.

P10 determines the response time for slip compensation. Basically, there is no need to modify the default setting. If you need to modify it, consult your Fuji Electric representatives.

Function code		Operation (Slip compensation)
P09	Slip compensation gain for driving	Adjust the slip compensation amount for driving. Slip compensation amount for driving = Rated slip x Slip compensation gain for driving
P11	Slip compensation gain for braking	Adjust the slip compensation amount for braking. Slip compensation amount for braking = Rated slip x Slip compensation gain for braking
P10	Slip compensation response time	Specify the slip compensation response time. Basically, there is no need to modify the default setting.

For details about slip compensation control, refer to the description of F42.

P12 | **Motor 1 (Rated slip frequency)**

P12 specifies rated slip frequency. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Performing auto-tuning automatically sets these parameters.

- Rated slip frequency: Convert the value obtained from the motor manufacturer to Hz using the following expression and enter the converted value.

(Note: The motor rating given on the nameplate sometimes shows a larger value.)

$$\text{Rated slip frequency (Hz)} = \frac{(\text{Synchronous speed - Rated speed})}{\text{Synchronous speed}} \times \text{Base frequency}$$

For details about slip compensation control, refer to the description of F42.

P13 to P15	Motor 1 (Iron loss factors 1 to 3)

P13 to P15 compensates the iron loss caused inside the motor under vector control with speed sensor, in order to improve the torque control accuracy.

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value. Basically, there is no need to modify the setting.

P16 to P20 P21 to P23	Motor 1 (Magnetic saturation factors 1 to 5) Motor 1 (Magnetic saturation extension factors "a" to "c")

These function codes specify the characteristics of the exciting current to generate magnetic flux inside the motor and the characteristics of the magnetic flux generated.
The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.
Performing auto-tuning while the motor is rotating (P04 = 2 or 3) specifies these factors automatically.

P53, P54	Motor 1 (%X correction factors 1 and 2)

P53 and P54 specify the factors to correct fluctuations of leakage reactance (%X).

Basically, there is no need to modify the setting.

P55	Motor 1 (Torque current under vector control)

P55 specifies the rated torque current under vector control with/without speed sensor.

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.

Basically, there is no need to modify the setting.

P56	Motor 1 (Induced voltage factor under vector control)

P56 specifies the induced voltage factor under vector control with/without speed sensor.

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.

Basically, there is no need to modify the setting.

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P99 Motor 1 Selection

P99 specifies the type of motor 1 to be used.

Data for P99	Motor type
0	Motor characteristics 0 (Fuji standard motors, 8-series)
1	Motor characteristics 1 (HP rating motors)
2	Motor characteristics 2 (Fuji motors exclusively designed for vector control)
3	Motor characteristics 3 (Fuji standard motors, 6-series)
4	Other motors

To select the motor drive control or to run the inverter with the integrated automatic control functions such as auto torque boost and torque calculation monitoring, it is necessary to specify the motor parameters correctly. First select the motor type to be used with P99, specify the motor rated capacity with P02, and then initialize the motor parameters with H03. This process automatically configures the related motor parameters (P01, P03, P06 through P23, P53 through P56, and H46).

The data of F09 (Torque Boost 1), H13 (Restart Mode after Momentary Power Failure (Restart time)), and F11 (Electronic Thermal Overload Protection for Motor 1, Overload detection level) depends on the motor capacity, but the process stated above does not change them. Specify and adjust the data during a test run if needed.

5.4.5 H codes (High performance functions)

H03	Data Initialization

H03 initializes the current function code data to the factory defaults or initializes the motor parameters.

To change the H03 data, it is necessary to press the STOP + ⌃ keys or STOP + ⌄ keys (simultaneous keying).

Data for H03	Function
0	Disable initialization (Settings manually made by the user will be retained.)
1	Initialize all function code data to the factory defaults
2	Initialize motor 1 parameters in accordance with P02 (Rated capacity) and P99 (Motor 1 selection)
3	Initialize motor 2 parameters in accordance with A16 (Rated capacity) and A39 (Motor 2 selection)
4	Initialize motor 3 parameters in accordance with b16 (Rated capacity) and b39 (Motor 3 selection)
5	Initialize motor 4 parameters in accordance with r16 (Rated capacity) and r39 (Motor 4 selection)

- To initialize the motor parameters, set the related function codes as follows.

Step	Item	Action	Function code			
			1st motor	2nd motor	3rd motor	4th motor
(1)	Motor selection	Selects the motor type	P99	A39	b39	r39
(2)	Motor (rated capacity)	Sets the motor capacity (HP)	P02	A16	b16	r16
(3)	Data initialization	Initialize motor parameters	H03 = 2	H03 = 3	H03 = 4	H03 = 5
Function code data to be initialized		If "Data = 0, 1, 3, or 4" in Step (1)	P01, P03, P06 to P23, P53 to P56, H46	A15, A17, A20 to A37, A53 to A56	b15, b17, b20 to b37, b53 to b56	r15, r17, r20 to r37, r53 to r56
		If "Data = 2" in Step (1), function codes listed at the right are also initialized	F04, F05	A02, A03	b02, b03	r02, r03

- Upon completion of the initialization, the H03 data reverts to "0" (factory default).
- If P02, A16, b16 or r16 data is set to a value other than the standard nominal applied motor rating, data initialization with H03 internally converts the specified value forcibly to the standard nominal applied motor rating. (See Table B given on the last page of the function code tables.)
- Motor parameters to be initialized are for motors listed below under V/f control. When the base frequency, rated voltage, and the number of poles are different from those of the listed motors, or when non-standard motors are used, change the rated current data to that printed on the motor nameplate.

Data for P99/A39/b39/r39	Motor selection	V/f control data		
1	HP rating motors	4 poles	230 V/60 Hz,	460 V/60 Hz
2	Fuji motors exclusively designed for vector control	4 poles	—/50 Hz,	—/50 Hz
0 or 4	Fuji standard motors, 8-series	4 poles	200 V/50 Hz,	400 V/50 Hz
3	Fuji standard motors, 6-series	4 poles	200 V/50 Hz,	400 V/50 Hz

Note: When accessing function code P02 with the keypad, take into account that P02 data automatically updates data of function codes P03, P06 through P23, P53 through P56, and H46. Also, when accessing function code A16, b16 or r16, data of related function codes for each are automatically updated.

H04, H05 Auto-reset (Times and Reset interval)

H04 and H05 specify the auto-reset function that makes the inverter automatically attempt to reset the tripped state and restart without issuing an alarm output (for any alarm) even if any protective function subject to reset is activated and the inverter enters the forced-to-stop state (tripped state).

If the protective function is activated in excess of the times specified by H04, the inverter will issue an alarm output (for any alarm) and not attempt to auto-reset the tripped state.

Listed below are the protective functions subject to auto-reset.

Protective function	LED monitor displays:	Protective function	LED monitor displays:
Overcurrent protection	OC1, OC2 or OC3	Motor overheat	OH4
Overvoltage protection	OU1, OU2 or OU3	Braking resistor overheat	dbH
Heat sink overheat	OH1	Motor overload	OL1 to OL4
Inverter internal overheat	OH3	Inverter overload	OLU

■ Number of reset times (H04)

H04 specifies the number of reset times for the inverter to automatically attempt to escape the tripped state. When H04 = 0, the auto-reset function will not be activated.

- Data setting range: 0 (Disable), 1 to 10 (times)

⚠WARNING

If the "auto-reset" function has been specified, the inverter may automatically restart and run the motor stopped due to a trip fault, depending on the cause of the tripping.

Design the machinery so that human body and peripheral equipment safety is ensured even when the auto-resetting succeeds.

Otherwise an accident could occur.

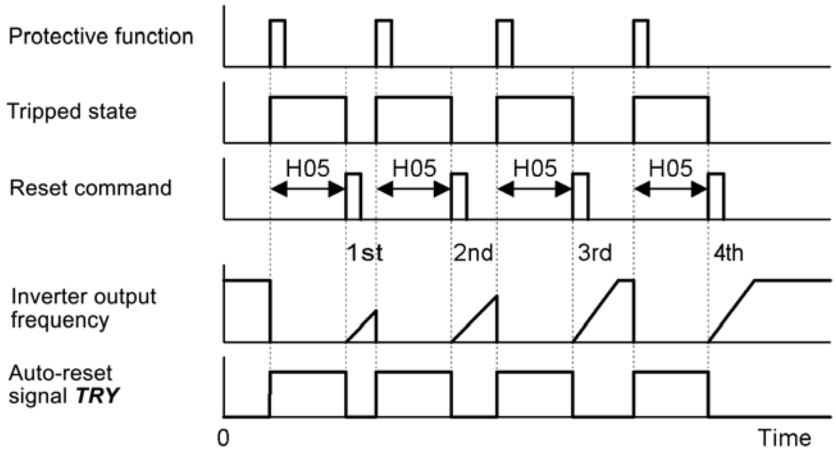
■ Reset interval (H05)

- Data setting range: 0.5 to 20.0 (s)

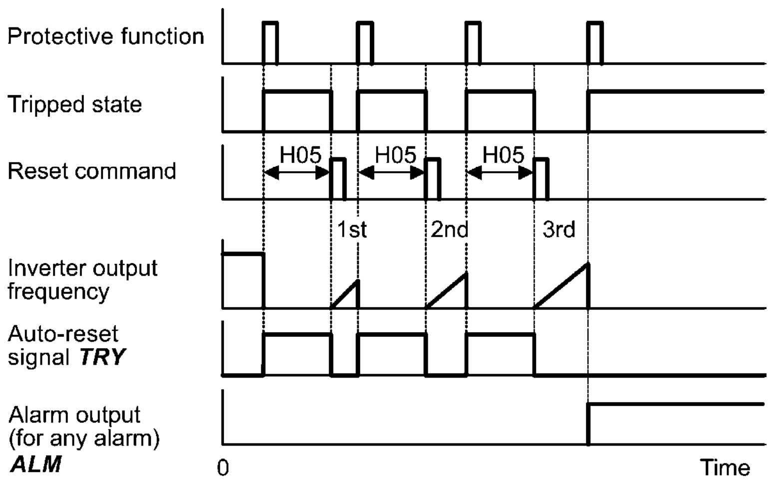
H05 specifies the reset interval time from when the inverter enters the tripped state until it issues the reset command to attempt to auto-reset the state. Refer to the timing scheme diagrams below.

<Operation timing scheme>

- In the figure below, normal operation restarts in the 4th retry.



- In the figure below, the inverter fails to restart normal operation within the number of reset times specified by H04 (in this case, 3 times (H04 = 3)), and issues the alarm output (for any alarm) ***ALM***.



The auto-reset operation can be monitored from the external equipment by assigning the digital output signal ***TRY*** to any of the programmable, output terminals [Y1] to [Y4], [Y5A/C], and [30A/B/C] with any of E20 through E24 and E27 (data = 26).

H06 Cooling Fan ON/OFF Control

To prolong the service life of the cooling fan and reduce fan noise during running, the cooling fan stops when the temperature inside the inverter drops below a certain level while the inverter stops. However, since frequent switching of the cooling fan shortens its service life, the cooling fan keeps running for 10 minutes once started.

H06 specifies whether to keep running the cooling fan all the time or to control its ON/OFF.

Data for H06	Cooling fan ON/OFF
0	Disable (Always in operation)
1	Enable (ON/OFF controllable)

■ Cooling fan in operation -- ***FAN*** (E20 to E24 and E27, data = 25)

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for ON/OFF control

H07 Acceleration/Deceleration Pattern (Refer to F07.)

For details, refer to the description of F07.

H08 Rotational Direction Limitation

H08 inhibits the motor from running in an unexpected rotational direction due to miss-operation of run commands, miss-polarization of frequency commands, or other mistakes.

Data for H08	Function
0	Disable
1	Enable (Reverse rotation inhibited)
2	Enable (Forward rotation inhibited)

Under vector control, some restrictions apply to the speed command. Under vector control without speed sensor, a speed estimation error caused by a motor constant error or other errors may slightly rotate the motor in the direction other than the specified one.

H09 d67	Starting Mode (Auto search)	H49 (Starting Mode, Auto search delay time 1) H46 (Starting Mode, Auto search delay time 2)

H09 specifies the starting mode--whether to enable the auto search for idling motor speed to run the idling motor without stopping it.

The auto search can apply to the restart of the inverter after a momentary power failure and the normal startup of the inverter individually.

If the terminal command ***STM*** ("Enable auto search for idling motor speed at starting") is assigned to a digital input terminal with any of E01 to E07 (data = 26), then the combination of the H09 data and the ***STM*** status switches the starting modes (whether auto search is enabled or disabled). If no ***STM*** is assigned, the inverter interprets ***STM*** as being OFF by default.

■ H09/d67 (Starting mode, auto search) and terminal command ***STM*** ("Enable auto search for idling motor speed at starting")

The combination of H09/d67 data and the ***STM*** status determines whether to perform auto search as listed below.

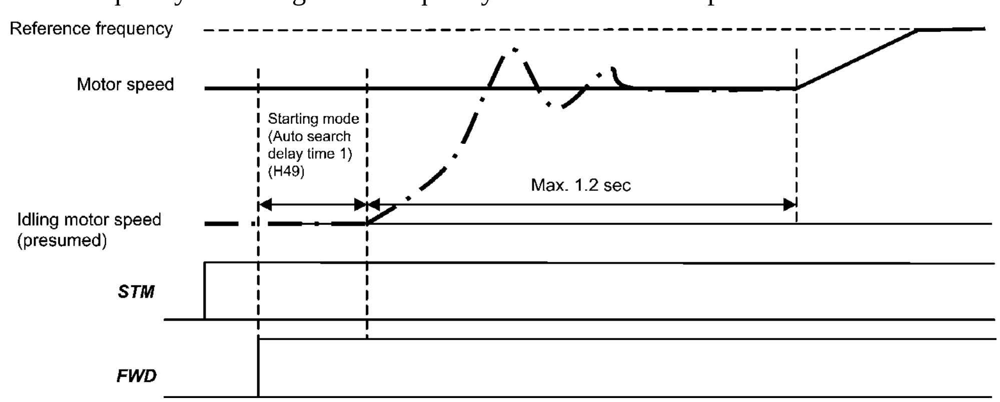
Function code	Drive control	Factory default
H09	V/f control (F42 = 0 to 2)	0: Disable
d67	Vector control without speed sensor (F42 = 5)	2: Enable

Data for H09/d67	***STM***	Auto search for idling motor speed at starting	
		For restart after momentary power failure (F14 = 3 to 5)	For normal startup
0: Disable	OFF	Disable	Disable
1: Enable	OFF	Enable	Disable
2: Enable	OFF	Enable	Enable
—	ON	Enable	Enable

When ***STM*** is ON, auto search for idling motor speed at starting is enabled regardless of the H09/d67 setting. Refer to E01 to E07 (data = 26).

Auto search for idling motor speed

Starting the inverter (with a run command ON, ***BX*** OFF, auto-reset, etc.) with ***STM*** being ON searches for the idling motor speed for a maximum of 1.2 seconds to run the idling motor without stopping it. After completion of the auto search, the inverter accelerates the motor up to the reference frequency according to the frequency command and the preset acceleration time.



Auto search for idling motor speed to follow

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d codes
U codes
y codes

■ Starting Mode (Auto search delay time 1) (H49)

- Data setting range: 0.0 to 10.0 (s)

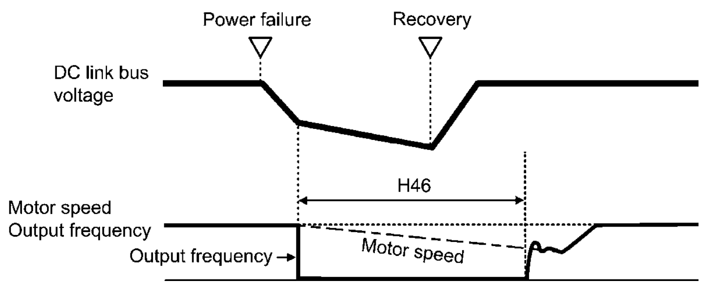
Auto search for the idling motor speed will become unsuccessful if it is done while the motor retains residual voltage. It is, therefore, necessary to leave the motor for an enough time for residual voltage to disappear. H49 specifies that time (0.0 to 10.0 sec.).

At the startup triggered by a run command ON, auto search starts with the delay specified by H49. Using H49, therefore, eliminates the need of the run command timing control when two inverters drive a single motor alternately, allow the motor to coast to a stop, and restart it under auto search control at each time of inverter switching.

■ Starting Mode (Auto search delay time 2) (H46)

- Data setting range: 0.0 to 20.0 (s)

At the restart after a momentary power failure, at the start by turning the terminal command ***BX*** ("Coast to a stop") OFF and ON, or at the restart by auto-reset, the inverter applies the delay time specified by H46. The inverter will not start unless the time specified by H46 has elapsed, even if the starting conditions are satisfied.



Under auto search control, the inverter searches the motor speed with the voltage applied at the motor start and the current flowing in the motor, based on the model built with the motor parameters. Therefore, the search is greatly influenced by the residual voltage in the motor.

H46 is available for motor 1 only.

At factory shipment, H46 data is preset to a correct value according to the motor capacity for the general-purpose motor, and basically there is no need to modify the data.

Depending on the motor characteristics, however, it may take time for residual voltage to disappear (due to the secondary thermal time constant of the motor). In such a case, the inverter starts the motor with the residual voltage remaining, which will cause an error in the speed search and may result in occurrence of an inrush current or an overvoltage alarm.

If it happens, increase the value of H46 data and remove the influence of residual voltage. (If possible, it is recommended to set the value around two times as large as the factory default value allowing a margin.)

Note

- Be sure to auto-tune the inverter preceding the start of auto search for the idling motor speed.
- When the estimated speed exceeds the maximum frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum frequency or the upper limit frequency, whichever is lower.
- During auto search, if an overcurrent or overvoltage trip occurs, the inverter restarts the suspended auto search.
- Perform auto search at 60 Hz or below.
- Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.

H11	Deceleration Mode

H11 specifies the deceleration mode to be applied when a run command is turned OFF.

Data for H11	Function
0	Normal deceleration
1	Coast-to-stop The inverter immediately shuts down its output, so the motor stops according to the inertia of the motor and machinery (load), and their kinetic energy losses.

Note: When reducing the reference frequency, the inverter decelerates the motor according to the deceleration commands even if H11 = 1 (Coast-to-stop).

H12	Instantaneous Overcurrent Limiting (Mode selection) (Refer to F43.)

Refer to the descriptions of F43 and F44.

H13, H14 H15, H16	Restart Mode after Momentary Power Failure (Restart time, Frequency fall rate, Continuous running level, and Allowable momentary power failure time) (Refer to F14.)

For instructions on how to set these function codes (Restart time, Frequency fall rate, Continuous running level and Allowable momentary power failure time), refer to the description of F14.

H18	Torque Control (Mode selection) d32, d33 (Torque Control, Speed limits 1 and 2)

When vector control with/without speed sensor is selected, the inverter can control the motor-generating torque according to a torque command sent from external sources.

■ Torque Control (Mode selection) (H18)

H18 specifies whether to enable or disable the torque control. Enabling the torque control offers two choices: with torque current command and with torque command.

Data for H18	Available control
0	Disable (Speed control)
2	Enable (Torque control with torque current command)
3	Enable (Torque control with torque command)

■ Torque Commands

Torque commands can be given as analog voltage input (via terminals [12] and [V2]) or analog current input (via terminal [C1]), or via the communications link (communication-dedicated function codes S02 and S03). To use analog voltage/current inputs, it is necessary to set E61 (for terminal [12]), E62 (for terminal [C1]), or E63 (for terminal [V2]) data to "10" or "11."

Input	Command form	Function code setting	Specifications
Terminal [12] (-10 V to 10 V)	Torque command	E61 = 10	Motor rated torque ±200% / ±10 V
	Torque current command	E61 = 11	Motor rated torque current ±200% / ±10V
Terminal [V2] (-10 V to 10 V)	Torque command	E63 = 10	Motor rated torque ±200% / ±10V
	Torque current command	E63 = 11	Motor rated torque current ±200% / ±10V
Terminal [C1] (4 to 20 mA)	Torque command	E62 = 10	Motor rated torque 200% / 20 mA
	Torque current command	E62 = 11	Motor rated torque current 200% / 20 mA
S02 (-327.68 to 327.67%)	Torque command	—	Motor rated torque / ±100.00%
S03 (-327.68 to 327.67%)	Torque current command	—	Motor rated torque current / ±100.00%

■ Polarity of Torque Commands

The polarity of a torque command switches according to the combination of the polarity of an external torque command and a run command on terminal [FWD] or [REV], as listed below.

Polarity of torque command	Run command (ON)	Torque polarity
Positive	***FWD***	Positive torque (Forward driving/Reverse braking)
	REV	Negative torque (Forward braking/Reverse driving)
Negative	***FWD***	Negative torque (Forward braking/Reverse driving)
	REV	Positive torque (Forward driving/Reverse braking)

■ Cancel torque control -- ***Hz/TRQ*** (E01 to E07, data = 23)

When torque control is enabled (H18 = 2 or 3), assigning the terminal command ***Hz/TRQ*** ("Cancel torque control") to any of the general-purpose digital input terminals (data = 23) enables switching between speed control and torque control.

Cancel torque control signal ***Hz/TRQ***	Operation
ON	Cancel torque control (Enable speed control)
OFF	Enable torque control

■ Torque Control (Speed limits 1 and 2) (d32, d33)

Torque control controls the motor-generating torque, not the speed. The speed is determined secondarily by torque of the load, inertia of the machinery, and other factors. To prevent a dangerous situation, therefore, the speed limit functions (d32 and d33) are provided inside the inverter.

If a regenerative load (which is not generated usually) is generated under droop control or function codes are incorrectly configured, then the motor may rotate at an unintended high speed. To protect the machinery, it is possible to specify the overspeed level with d32 and d33 as follows.

- Forward overspeed level = Maximum frequency 1 (F03) x Speed limit 1 (d32) x 120 (%)
- Reverse overspeed level = Maximum frequency 1 (F03) x Speed limit 2 (d33) x 120 (%)

Note **Running/stopping the motor**

Under torque control, the inverter does not control the speed, so it does not perform acceleration or deceleration by soft-start and stop (acceleration/deceleration time) at the time of startup and stop. Turning ON a run command starts the inverter to run and output the commanded torque. Turning it OFF stops the inverter so that the motor coasts to a stop.

At the start of torque control under the "Vector control without speed sensor," the starting operation differs depending upon whether auto search is enabled or disabled by d67 as shown below.

Data for d67	Operation
0: Disable 1: Enable (At restart after momentary power failure)	At startup, the inverter first starts at zero frequency. Then it accelerates according to a torque command. Select this operation for use in which the motor is surely stopped before startup.
2: Enable (At normal start and at restart after momentary power failure)	At startup, the inverter searches for idling motor speed and restarts running the motor at the frequency based on the searched speed. Then it starts torque control.

H26, H27 Thermistor (for motor) (Mode selection and Level)

These function codes specify the PTC (Positive Temperature Coefficient)/NTC (Negative Temperature Coefficient) thermistor embedded in the motor. The thermistor is used to protect the motor from overheating or output an alarm signal.

■ Thermistor (for motor) (Mode selection) (H26)

H26 selects the function operation mode (protection or alarm) for the PTC/NTC thermistor as shown below.

Data for H26	Action
0	Disable
1	Enable When the voltage sensed by PTC thermistor exceeds the detection level, the motor protective function (alarm OH4) is triggered, causing the inverter to enter an alarm stop state.
2	Enable When the voltage sensed by the PTC thermistor exceeds the detection level, a motor alarm signal is output but the inverter continues running. You need to assign the "Motor overheat detected by thermistor" signal (***THM***) to one of the digital output terminals beforehand, by which a temperature alarm condition can be detected by the thermistor (PTC) (E20 to E24 and E27, data = 56).
3	Enable When the inverter is connected with the NTC thermistor built in the motor exclusively designed for vector control, the inverter senses the motor temperature and uses the information for control. If the motor overheats and the temperature exceeds the protection level, the inverter issues the Motor protection alarm OH4 and stops the motor.

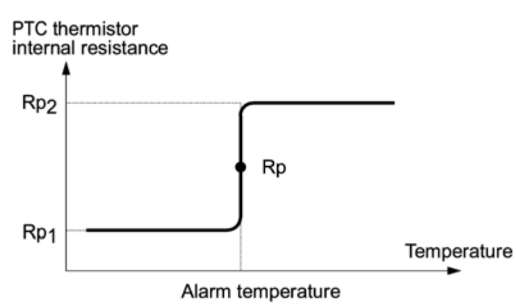
If H26 data is set to "1" or "2" (PTC thermistor), the inverter monitors the voltage sensed by PTC thermistor and protects the motor even when any of the 2nd to 4th motors is selected. If H26 data is set to "3" (NTC thermistor) and any of the 2nd to 4th motors is selected, the inverter does not perform these functions.

■ Thermistor (for motor) (Level) (H27)

H27 specifies the detection level (expressed in voltage) for the temperature sensed by the PTC thermistor.

- Data setting range: 0.00 to 5.00 (V)

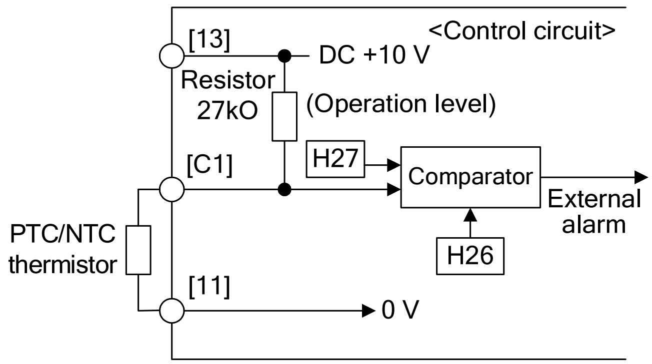
The alarm temperature at which the overheat protection becomes activated depends on the characteristics of the PTC thermistor. The internal resistance of the thermistor changes significantly at the alarm temperature. The detection level (voltage) is specified based on the change of the internal resistance.



Suppose that the internal resistance of the PTC thermistor at the alarm temperature is Rp, the detection level (voltage) V_{C1} is calculated by the expression below. Set the result V_{C1} to function code H27.

$$V_{c1} = \frac{R_p}{27000 + Rp} \times 10.5 \text{ (V)}$$

Connect the PTC thermistor as shown below. The voltage obtained by dividing the input voltage on terminal [C1] with a set of internal resistors is compared with the detection level voltage specified by H27.

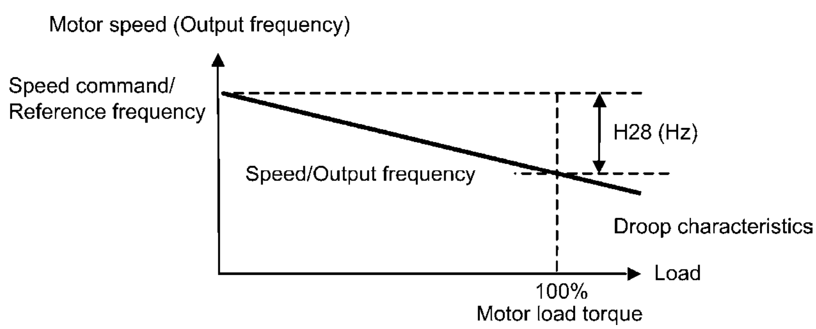


Note: When using the terminal [C1] for PTC/NTC thermistor input, also turn SW5 on the control printed circuit board to the PTC/NTC side. For details, refer to Chapter 2, "SPECIFICATIONS."

H28 Droop Control

In a system in which two or more motors drive single machinery, any speed gap between inverter-driven motors results in some load unbalance between motors. Droop control allows each inverter to drive the motor with the speed droop characteristics for increasing its load, eliminating such kind of load unbalance.

- Data setting range: -60.0 to 0.0 (Hz), (0.0: Disable)



■ Select droop control -- ***DROOP*** (E01 to E07, data = 76)

The terminal command ***DROOP*** toggles droop control on and off.

DROOP	Droop control
ON	Enable
OFF	Disable

Chap. 5 FUNCTION CODES
Function Code Details
F codes
E codes
C codes
P codes
H30
A codes
b codes
r codes
J codes
d codes
U codes
y codes

Note To use droop control, be sure to auto-tune the inverter for the motor beforehand.

Under V/f control, to prevent the inverter from tripping even at an abrupt change in load, droop control applies the acceleration/deceleration time to the frequency obtained as a result of droop control. This may delay reflection of the frequency compensated during droop control on the motor speed, thereby running the inverter as if droop control is disabled.

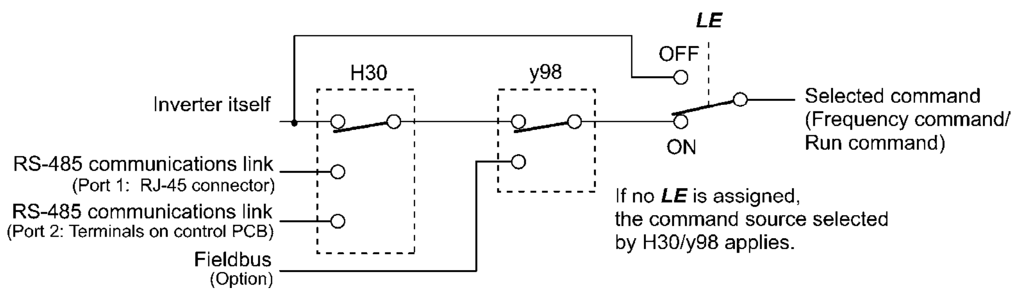
By contrast, under vector control with/without speed sensor, the current control system works so that the inverter does not trip even at an abrupt change in load. No acceleration/deceleration time is applied to the frequency obtained as a result of droop control. It is, therefore, possible to eliminate load unbalance even during acceleration/deceleration.

H30 Communications Link Function (Mode selection)

y98 (Bus Link Function, Mode selection)

Using the RS-485 communications link (standard/option) or fieldbus (option) allows you to issue frequency commands and run commands from a computer or PLC at a remote location, as well as monitoring the inverter running information and the function code data.

H30 and y98 specify the sources of those commands--"inverter itself" or "computers or PLCs via the RS-485 communications link or fieldbus." H30 is for the RS-485 communications link; y98 for the fieldbus.



Command sources selectable

Command sources	Description
Inverter itself	Sources except RS-485 communications link and fieldbus Frequency command source: Specified by F01/C30, or multi-frequency command Run command source: Via the keypad or digital input terminals selected by F02
RS-485 communications link (port 1)	Via the standard RJ-45 port used for connecting a keypad
RS-485 communications link (port 2)	Via the terminals DX+, DX- and SD on the control PCB
Fieldbus (option)	Via fieldbus (option) using FA protocol such as DeviceNet or PROFIBUS-DP

Command sources specified by H30 (Communications link function, Mode selection)

Data for H30	Frequency command	Run command
0	Inverter itself (F01/C30)	Inverter itself (F02)
1	RS-485 communications link (port 1)	Inverter itself (F02)
2	Inverter itself (F01/C30)	RS-485 communications link (port 1)
3	RS-485 communications link (port 1)	RS-485 communications link (port 1)
4	RS-485 communications link (port 2)	Inverter itself (F02)
5	RS-485 communications link (port 2)	RS-485 communications link (port 1)
6	Inverter itself (F01/C30)	RS-485 communications link (port 2)
7	RS-485 communications link (port 1)	RS-485 communications link (port 2)
8	RS-485 communications link (port 2)	RS-485 communications link (port 2)

Command sources specified by y98 (Bus link function, Mode selection)

Data for y98	Frequency command	Run command
0	Follow H30 data	Follow H30 data
1	Via fieldbus (option)	Follow H30 data
2	Follow H30 data	Via fieldbus (option)
3	Via fieldbus (option)	Via fieldbus (option)

Combination of command sources

		Frequency command			
		Inverter itself	Via RS-485 communications link (port 1)	Via RS-485 communications link (port 2)	Via fieldbus (option)
Run command source	Inverter itself	H30 = 0 y98 = 0	H30 = 1 y98 = 0	H30=4 y98=0	H30=0 (1 or 4) y98=1
	Via RS-485 communications link (port 1)	H30 = 2 y98 = 0	H30 = 3 y98 = 0	H30=5 y98=0	H30=2 (3 or 5) y98=1
	Via RS-485 communications link (port 2)	H30 = 6 y98 = 0	H30 = 7 y98 = 0	H30=8 y98=0	H30=6 (7 or 8) y98=1
	Via fieldbus (option)	H30 = 0 (2 or 6) y98 = 2	H30 = 1 (3 or 7) y98 = 2	H30 = 4 (5 or 8) y98 = 2	H30 = 0 (1 to 8) y98 = 3

For details, refer to the RS-485 Communication User's Manual or the Field Bus Option Instruction Manual.

- When the terminal command ***LE*** ("Enable communications link via RS-485 or fieldbus") is assigned to a digital input terminal, turning ***LE*** ON makes the settings of H30 and y98 enabled. When ***LE*** is OFF, those settings are disabled so that both frequency commands and run commands specified from the inverter itself take control.

  (Refer to the descriptions of E01 through E07, data = 24.)

  No ***LE*** assignment is functionally equivalent to the ***LE*** being ON.

H42, H43 H48	**Capacitance of DC Link Bus Capacitor, Cumulative Run Time of Cooling Fan** **Cumulative Run Time of Capacitors on Printed Circuit Boards** **H47 (Initial Capacitance of DC Link Bus Capacitor)** **H98 (Protection/Maintenance Function)**

■ Life prediction function

The inverter has the life prediction function for some parts which measures the discharging time or counts the voltage applied time, etc. The function allows you to monitor the current lifetime state on the LED monitor and judge whether those parts are approaching the end of their service life.

The life prediction function can also issue early warning signals if the lifetime alarm command ***LIFE*** is assigned to any of the digital output terminals by any of E20 through E24 and E27.

The predicted values should be used only as a guide since the actual service life is influenced by the surrounding temperature and other usage environments.

Object of life prediction	Prediction function	End-of-life criteria	Prediction timing	On the LED monitor
DC link bus capacitor	Measurement of discharging time Measures the discharging time of the DC link bus capacitor when the main power is shut down and calculates the capacitance.	85% or lower of the initial capacitance at shipment (See "[1] Measuring the capacitance of DC link bus capacitor in comparison with initial one at shipment" on the next page.)	At periodic inspection (H98: Bit 3 = 0)	5_05 (Capacitance)
		85% or lower of the reference capacitance under ordinary operating conditions at the user site (See "[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions" on page 5-174.)	During ordinary operation (H98: Bit 3 = 1)	5_05 (Capacitance)
	ON-time counting Counts the time elapsed when the voltage is applied to the DC link bus capacitor, while correcting it according to the capacitance measured above.	Exceeding 87,600 hours (10 years)	During ordinary operation	5_26 (Elapsed time) 5_27 (Time remaining before the end of life)
Electrolytic capacitors on printed circuit boards	Counts the time elapsed when the voltage is applied to the capacitors, while correcting it according to the surrounding temperature.	Exceeding 87,600 hours (10 years)	During ordinary operation	5_06 (Cumulative run time)
Cooling fans	Counts the run time of the cooling fans.	Exceeding 87,600 hours (10 years)	During ordinary operation	5_07 (Cumulative run time)

■ Capacitance measurement of DC link bus capacitor (H42)

Calculating the capacitance of DC link bus capacitor

- The discharging time of the DC link bus capacitor depends largely on the inverter's internal load conditions, e.g. options attached or ON/OFF of digital I/O signals. If actual load conditions are so different from the ones at which the initial/reference capacitance is measured that the measurement result falls out of the accuracy level required, then the inverter does not perform measuring.
- The capacitance measuring conditions at shipment are extremely restricted, e.g., all input terminals being OFF in order to stabilize the load and measure the capacitance accurately. Those conditions are, therefore, different from the actual operating conditions in almost all cases. If the actual operating conditions are the same as those at shipment, shutting down the inverter power automatically measures the discharging time; however, if they are different, no automatic measurement is performed. To perform it, put those conditions back to the factory default ones and shut down the inverter. For the measuring procedure, see [1] given below.
- To measure the capacitance of the DC link bus capacitor *under ordinary operating conditions* when the power is turned OFF, it is necessary to set up the load conditions for ordinary operation and measure the reference capacitance (initial setting) when the inverter is introduced. For the reference capacitance setup procedure, see [2] on the next page. Performing the setup procedure automatically detects and saves the measuring conditions of the DC link bus capacitor.

  Setting bit 3 of H98 data to 0 restores the inverter to the measurement in comparison with the initial capacitance measured at shipment.

Note: When the inverter uses an auxiliary control power input, the load conditions widely differ so that the discharging time cannot be accurately measured. In this case, measuring of the discharging time can be disabled with the function code H98 (Bit 4 = 0) for preventing unintended measuring.

ON-time counting of DC link bus capacitor

- In a machine system where the inverter main power is rarely shut down, the inverter does not measure the discharging time. For such an inverter, the ON-time counting is provided. If the capacitance measurement is made, the inverter corrects the ON-time according to the capacitance measured.

  The ON-time counting result can be represented as "elapsed time" and "remaining time before the end of life."

[1] Measuring the capacitance of DC link bus capacitor in comparison with initial one at shipment

When bit 3 of H98 data is 0, the measuring procedure given below measures the capacitance of DC link bus capacitor in comparison with initial one at shipment when the power is turned OFF. The measuring result can be displayed on the keypad as a ratio (%) to the initial capacitance.

------------------------------------Capacitance measuring procedure------------------------------

1) To ensure validity in the comparative measurement, put the condition of the inverter back to the state at factory shipment.
   - Remove the option card (if already in use) from the inverter.
   - In case another inverter is connected via the DC link bus to the P(+) and N(-) terminals of the main circuit, disconnect the wires. (You do not need to disconnect a DC reactor (optional), if any.)
   - Disconnect power wires for the auxiliary input to the control circuit (R0, T0).
   - In case the standard keypad has been replaced with an optional multi-function keypad after the purchase, put back the original standard keypad.
   - Turn OFF all the digital input signals fed to terminals [FWD], [REV], and [X1] through [X7] of the control circuit.
   - If a potentiometer is connected to terminal [13], disconnect it.
   - If an external apparatus is attached to terminal [PLC], disconnect it.

- Ensure that transistor output signals ([Y1] to [Y4]) and relay output signals ([Y5A] - [Y5C], and [30A/B/C]) will not be turned ON.
- Disable the RS-485 communications link.

Note: If negative logic is specified for the transistor output and relay output signals, they are considered ON when the inverter is not running. Specify positive logic for them.

- Keep the surrounding temperature within 25 ±10°C.

2) Turn ON the main circuit power.
3) Confirm that the cooling fan is rotating and the inverter is in stopped state.
4) Turn OFF the main circuit power.
5) The inverter automatically starts the measurement of the capacitance of the DC link bus capacitor. Make sure that " . . . . " appears on the LED monitor.

Note: If " . . . . " does not appear on the LED monitor, the measurement has not started. Check the conditions listed in 1).

6) After " . . . . " has disappeared from the LED monitor, turn ON the main circuit power again.
7) Select Menu #5 "Maintenance Information" in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor).

----

[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions

When bit 3 of H98 data is 1, the inverter automatically measures the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF. This measurement requires setting up the load conditions for ordinary operation and measuring the reference capacitance when the inverter is introduced to the practical operation, using the setup procedure given below.

Function code	Name	Data
H42	Capacitance of DC link bus capacitor	• Capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0) • Measurement failure (1)
H47	Initial capacitance of DC link bus capacitor	• Initial capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0) • Measurement failure (1)

When replacing parts, clear or modify the H42 and H47 data. For details, refer to the documents for maintenance.

----------------------------- Reference capacitance setup procedure -------------------------------

1) Set function code H98 (Protection/maintenance function) to enable the user to specify the judgment criteria for the service life of the DC link bus capacitor (Bit 3 = 1) (refer to function code H98).
2) Turn OFF all run commands.
3) Make the inverter ready to be turned OFF under ordinary operating conditions.
4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to "0."

5) Turn OFF the inverter, and the following operations are automatically performed.

The inverter measures the discharging time of the DC link bus capacitor and saves the result in function code H47 (Initial capacitance of DC link bus capacitor).

The conditions under which the measurement has been conducted will be automatically collected and saved.

During the measurement, " . . . . " will appear on the LED monitor.

6) Turn ON the inverter again.

Confirm that H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) hold right values. Shift to Menu #5 "Maintenance Information" and confirm that the relative capacitance (ratio to full capacitance) is 100%.

Note: If the measurement has failed, "1" is entered into both H42 and H47. Remove the factor of the failure and conduct the measurement again.

Hereafter, each time the inverter is turned OFF, it automatically measures the discharging time of the DC link bus capacitor if the above conditions are met. Periodically check the relative capacitance of the DC link bus capacitor (%) with Menu #5 "Maintenance Information" in Programming mode.

Note: The condition given above tends to produce a rather large measurement error. If this mode gives you a lifetime alarm, set H98 (Protection/maintenance function) back to the default setting (Bit 3 (Select life judgment threshold of DC link bus capacitor) = 0) and conduct the measurement under the condition at the time of factory shipment.

■ Cumulative Run Time of Capacitors on Printed Circuit Boards (H48)

Function code	Name	Description
H48	Cumulative run time of capacitors on printed circuit boards	Displays the cumulative run time of capacitor on the printed circuit board in units of ten hours. • Data setting range: 0 to 99990 (hours)

When replacing capacitors on printed circuit boards, clearing or modifying H48 data is required. For details, refer to the materials for maintenance.

■ Cumulative Run Time of Cooling Fan (H43)

Function code	Name	Description
H43	Cumulative run time of cooling fan	Displays the cumulative run time of cooling fan in units of ten hours. • Data setting range: 0 to 99990 (hours)

When replacing the cooling fan, clearing or modifying H43 data is required. For details, refer to the maintenance related documents.

H44 Startup Counter for Motor 1

H44 counts the number of inverter startups and displays it . Check the displayed number on the maintenance screen of the keypad, and use it as a guide for maintenance timing for parts such as belts. To start the counting over again, e.g. after a belt replacement, set the H44 data to "0."

H45	Mock Alarm	H97 (Clear Alarm Data)

H45 causes the inverter to generate a mock alarm in order to check whether external sequences function correctly at the time of machine setup.

Setting the H45 data to "1" displays mock alarm Err on the LED monitor. It also issues alarm output (for any alarm) ***ALM*** (if assigned to a digital output terminal by any of E20 to E24 and E27). (Accessing the H45 data requires simultaneous keying of "STOP key + ∧ key.") After that, the H45 data automatically reverts to "0," allowing you to reset the alarm.

Just as data (alarm history and relevant information) of those alarms that could occur in running the inverter, the inverter saves mock alarm data, enabling you to confirm the mock alarm status.

To clear the mock alarm data, use H97. (Accessing the H97 data requires simultaneous keying of "STOP key + ∧ key.") H97 data automatically returns to "0" after clearing the alarm data.

Tip: A mock alarm can be issued also by simultaneous keying of "STOP key + FUNC/DATA key" on the keypad for 5 seconds or more.

H46	Starting Mode (Auto search delay time 2)	(Refer to H09.)

For details, refer to the description of H09.

H47, H48	Initial Capacitance of DC Link Bus Capacitor Cumulative Run Time of Capacitors on Printed Circuit Boards	(Refer to H42.)

For details, refer to the description of H42.

H49	Starting Mode (Auto search delay time 1)	(Refer to H09.)

For details, refer to the description of H09.

H50, H51 H52, H53	Non-linear V/f Pattern 1 (Frequency and Voltage) Non-linear V/f Pattern 2 (Frequency and Voltage)	(Refer to F04.)

For details, refer to the description of F04.

H54, H55 H56 H57 to H60	Acceleration Time, Deceleration Time Deceleration Time for Forced Stop 1st/2nd S-curve Acceleration/Deceleration Range	(Refer to F07.)

For details, refer to the description of F07.

H61	***UP/DOWN*** Control (Initial frequency setting)	(Refer to F01.)

For details, refer to the description of F01.

H63 Low Limiter (Mode selection) (Refer to F15.)

For details, refer to the description of F15.

H64 Low Limiter (Lower limiting frequency)

H64 specifies the lower limit of frequency to be applied when the current limiter, torque limiter, automatic deceleration (anti-regenerative control), or overload prevention control is activated. Normally, it is not necessary to change this data.

- Data setting range: 0.0 to 60.0 (Hz)

H65, H66 Non-linear V/f Pattern 3 (Frequency and Voltage) (Refer to F04.)

For details, refer to the description of F04.

H67 Auto Energy Saving Operation (Mode selection) (Refer to F37.)

For details, refer to the description of F37.

H68 Slip Compensation 1 (Operating conditions) (Refer to F42.)

For details, refer to the description of F42.

H69 Automatic Deceleration (Mode selection)
H76 (Torque Limiter, Frequency increment limit for braking)

H69 toggles anti-regenerative control on and off.

In the inverter not equipped with a PWM converter or braking unit, if the regenerative energy returned exceeds the inverter's braking capability, an overvoltage trip occurs.

To avoid such an overvoltage trip, enable the automatic deceleration (anti-regenerative control) with this function code, and the inverter controls the output frequency.

The FRENIC-MEGA series of inverters have two braking control modes; torque limit control and DC link bus voltage control. Understand the feature of each control and select the suitable one.

Control mode	Control process	Operation mode	Features
Torque limit control (H69=2 or 4)	Controls the output frequency to keep the braking torque at around "0."	Enabled during acceleration, running at the constant speed, and deceleration.	Quick response. Causes less overvoltage trip with heavy impact load.
DC link bus voltage control (H69=3 or 5)	Control the output frequency to lower the DC link bus voltage if the voltage exceeds the limiting level.	Enabled during deceleration. Disabled during running at the constant speed.	Shorter deceleration time by making good use of the inverter's regenerative capability.

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P codes
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A codes
b codes
r codes
J codes
d codes
U codes
y codes

In addition, during deceleration triggered by turning the run command OFF, anti-regenerative control increases the output frequency so that the inverter may not stop the load depending on the load state (huge moment of inertia, for example). To avoid that, H69 provides a choice of cancellation of anti-regenerative control to apply when three times the specified deceleration time is elapsed, thus decelerating the motor forcibly.

Data for H69	Function	
	Control mode	Force-to-stop with actual deceleration time exceeding three times the specified one
0	Disable automatic deceleration	—
2	Torque limit control	Enable
3	DC link bus voltage control	Enable
4	Torque limit control	Disable
5	DC link bus voltage control	Disable

■ Torque Limiter (Frequency increment limit for braking) (H76)

- Data setting range: 0.0 to 500.0 (Hz)

Since increasing the output frequency too much in the torque limit control mode is dangerous, the inverter has a torque limiter (Frequency increment limit for braking) that can be specified by H76. The torque limiter limits the inverter's output frequency to less than "Reference frequency + H76 setting."

Note that the torque limiter activated restrains the anti-regenerative control, resulting in an overvoltage trip in some cases. Increasing the H76 data improves the anti-regenerative control capability.

Note

- Enabling the automatic deceleration (anti-regenerative control) may automatically increase the deceleration time.
- When a braking unit is connected, disable anti-regenerative control. Automatic deceleration control may be activated at the same time when a braking unit starts operation, which may make the deceleration time fluctuate.
- If the set deceleration time is too short, the DC link bus voltage of the inverter rises quickly, and consequently, the automatic deceleration may not follow the voltage rise. In such a case, specify a longer deceleration time.

H70 Overload Prevention Control

H70 specifies the decelerating rate of the output frequency to prevent a trip from occurring due to an overload. This control decreases the output frequency of the inverter before the inverter trips due to a heat sink overheat or inverter overload (with an alarm indication of OH1 or OLU, respectively). It is useful for equipment such as pumps where a decrease in the output frequency leads to a decrease in the load and it is necessary to keep the motor running even when the output frequency drops.

Data for H70	Function
0.00	Decelerate the motor by deceleration time 1 (F08) or 2 (E11)
0.01 to 100.0	Decelerate the motor by deceleration rate from 0.01 to 100.0 (Hz/s)
999	Disable overload prevention control

■ Overload prevention control -- ***OLP***
(E20 to E24 and E27, data = 36)

This output signal comes ON when the overload prevention control is activated and the output frequency changed.

Note: In equipment where a decrease in the output frequency does not lead to a decrease in the load, the overload prevention control is of no use and should not be enabled.

H71 Deceleration Characteristics

Setting the H71 data to "1" enables forced brake control. If regenerative energy produced during the deceleration of the motor and returned to the inverter exceeds the inverter's braking capability, an overvoltage trip will occur. The forced brake control increases the motor energy loss during deceleration, increasing the deceleration torque.

Data for H71	Function
0	Disable
1	Enable

Note: This function is aimed at controlling the torque during deceleration; it has no effect if there is a braking load.
Enabling the automatic deceleration (anti-regenerative control, H69 = 2 or 4) in the torque limit control mode disables the deceleration characteristics specified by H71.

H72 Main Power Down Detection (Mode selection)

H72 monitors the inverter alternate-current input power source, and disables the inverter operation if it is not established.

Data for H72	Function
0	Disable
1	Enable

In cases where the power is supplied via a PWM converter or the inverter is connected via the DC link bus, there is no alternate-current input. In such cases, set H72 data to "0," otherwise the inverter cannot operate.

H73 to H75 Torque Limiter (Operating conditions, Control target, and Target quadrants) (Refer to F40.)

For details about the operating conditions, refer to the description of F40.

H76 Torque Limiter (Frequency increment limit for braking) (Refer to H69.)

For details, refer to the description of H69.

H77	Service Life of DC Link Bus Capacitor (Remaining time)

H77 displays the remaining time before the service life of DC link bus capacitor expires.

At the time of a printed circuit board replacement, transfer the service life data of the DC link bus capacitor to the new board.

- Data setting range: 0 to 87600 (hours)

H78 H94	Maintenance Interval (M1) Cumulative Motor Run Time 1

H78 specifies the maintenance interval.

- Data setting range: 0 (Disable)
  1 to 99990 (hours)

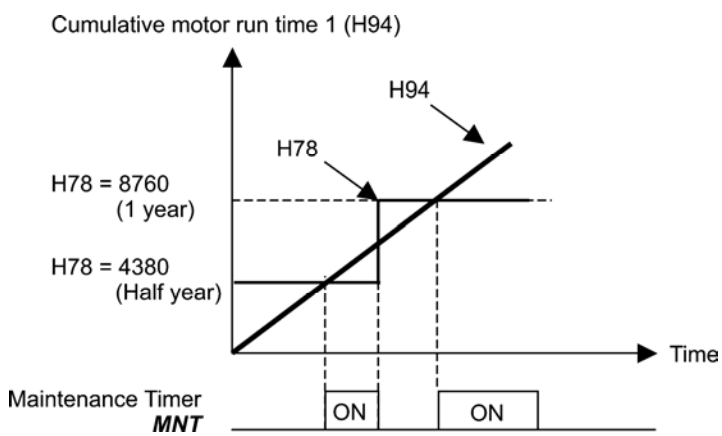
■ Maintenance timer -- ***MNT*** (E20 to E24 and E27, data = 84)

When the cumulative motor run time 1 (H94) reaches the setting specified by H78, the inverter outputs the maintenance timer signal ***MNT*** (if assigned to any digital terminal with any of E20 to E24 and E27) to remind the user of the need of the maintenance of the machinery.

■ Cumulative motor run time 1 (H94)

Operating the keypad can display the cumulative run time of the 1st motor. This feature is useful for management and maintenance of the machinery. Using H94 can modify the cumulative run time to the desired value to be used as an arbitrary initial data on which the replacement timing of machine parts or inverter is based. Specifying "0" clears the cumulative run time of the motor.

<Biannual maintenance>



Note: If the maintenance interval counter reaches the specified value, set a new value for the next maintenance in H78 and press the FUNC/DATA key to reset the output signal and restart counting. This function is exclusively applied to the 1st motor.

■ Count the run time of commercial power-driven motor 1, 2, 3 and 4
-- ***CRUN-M1***, ***CRUN-M2***, ***CRUN-M3*** and ***CRUN-M4***
(E01 to E07, data = 72, 73, 74 and 75)

Even when a motor is driven by commercial power, not by the inverter, it is possible to count the cumulative motor run time 1 to 4 (H94, A51, b51, r51) by detecting the ON/OFF state of the auxiliary contact of the magnetic contactor for switching to the commercial power line.

Note: Check the cumulative motor run time with 5_23 on Menu #5 "Maintenance Information" of the keypad.

H79	Preset Startup Count for Maintenance (M1) H44 (Startup Counter for Motor 1)

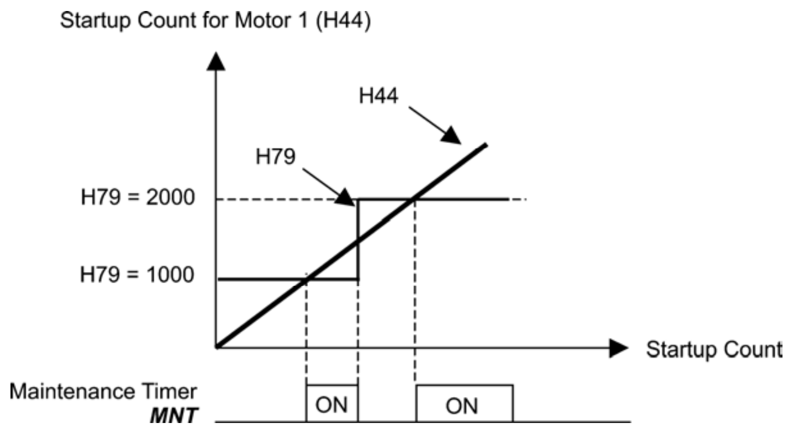
H79 specifies the number of inverter startup times to determine the next maintenance timing, e.g., for replacement of a belt.

- Data setting range: 0 (Disable)
  1 to 65535 (times)

■ Maintenance timer -- ***MNT*** (E20 to E24 and E27, data = 84)

When the startup counter for motor 1 (H44) reaches the number specified by H79 (Preset startup count for maintenance (M1)), the inverter outputs the maintenance timer signal ***MNT*** (if assigned to any digital terminal with any to E20 to E24 and E27) to remind the user of the need of the maintenance of the machinery.

< Maintenance every 1,000 times of startups >



Note: If the startup counter reaches the specified value, set a new value for the next maintenance in H79 and press the FUNC/DATA key to reset the output signal and restart counting. This function is exclusively applied to motor 1.

H80	Output Current Fluctuation Damping Gain for Motor 1 A41 (Output Current Fluctuation Damping Gain for Motor 2)

The inverter output current driving the motor may fluctuate due to the motor characteristics and/or backlash in the machinery (load). Modifying the H80 data adjusts the controls in order to suppress such fluctuation. However, as incorrect setting of this gain may cause larger current fluctuation, do not modify the default setting unless it is necessary.

- Data setting range: 0.00 to 1.00

H81, H82	Light Alarm Selection 1 and 2

If the inverter detects a minor abnormal state "light alarm," it can continue the current operation without tripping while displaying the "light alarm" indication L-AL on the LED monitor.

In addition to the indication L-AL, the inverter displays the "L-ALARM" (blinking) on the LCD monitor and outputs the "light alarm" signal ***L-ALM*** to a digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the ***L-ALM***, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E20 through E24 and E27 to "98.").

Function codes H81 and H82 specify which alarms should be categorized as "light alarm."

The table below lists alarms selectable as "light alarm."

Code	Name	Description
OH1	Heat sink overheat	Heat sink temperature increased to the trip level.
OH2	External alarm	An error that has occurred in peripheral equipment turned the external alarm signal ***THR*** ON.
OH3	Inverter internal overheat	The temperature inside the inverter abnormally has increased.
dbH	Braking resistor overheat	Estimated temperature of the coil in the braking resistor exceeded the allowable level.
OL1 to OL4	Overload of motor 1 through 4	Motor temperature calculated with the inverter output current reached the trip level.
Er-4	Option communications error	Communications error between the inverter and an option.
Er-5	Option error	An option judged that an error occurred.
Er-8 Er-P	RS-485 communications error (COM port 1) RS-485 communications error (COM port 2)	RS-485 communications error between the COM ports 1 and 2.
Er-E	Speed mismatch or excessive speed deviation	The deviation of the automatic speed regulator (between the reference speed and detected one) is out of the specified range (d21) for the period specified by d22.
CoF	PID feedback wire break	The PID feedback signal wire(s) is broken.
FAL	DC fan locked	Failure of the air circulation DC fan inside the inverter. 230 V series: 75 HP or above 460 V series: 125 HP or above
OL	Motor overload early warning	Early warning before a motor overload
OH	Heat sink overheat early warning	Early warning before a heat sink overheat trip
LiF	Lifetime alarm	It is judged that the service life of any one of the capacitors (DC link bus capacitors and electrolytic capacitors on the printed circuit boards) and cooling fan has expired. Or, failure of the air circulation DC fan inside the inverter. 230 V series: 75 HP or above 460 V series: 125 HP or above
rEF	Reference command loss detected	Analog frequency command was lost.
PId	PID alarm	Warning related to PID control (absolute-value alarm or deviation alarm)
UTL	Low torque output	Output torque drops below the low torque detection level for the specified period.
PTC	PTC thermistor activated	The PTC thermistor on the motor detected a temperature.
rTE	Inverter life (Motor cumulative run time)	The motor cumulative run time reached the specified level.

Code	Name	Description
Cnt	Inverter life (Number of startups)	Number of startups reached the specified level.
Ero	Positioning control error	In synchronous operation, a positioning deviation has become excessive. (See the PG Interface Card instruction manual.) Note: Even if a positioning control error is regarded as a light alarm with H82, the error that occurred when the inverter was servo-locked does not cause a light alarm operation but trips the inverter.

Set data for selecting "light alarms" in hexadecimal. For details on how to select the codes, see the next page.

- Data setting range: 0000 to FFFF (Hexadecimal)

■ Selecting light alarm factors

To set and display the light alarm factors in hexadecimal format, each light alarm factor has been assigned to bits 0 to 15 as listed in Tables 5.1 and 5.2. Set the bit that corresponds to the desired light alarm factor to "1." Table 5.3 shows the relationship between each of the light alarm factor assignments and the LED monitor display.

Table 5.4 gives the conversion table from 4-bit binary to hexadecimal.

Table 5.1 Light Alarm Selection 1 (H81), Bit Assignment of Selectable Factors

Bit	Code	Content	Bit	Code	Content
15	—	—	7	OL3	Overload of motor 3
14	—	—	6	OL2	Overload of motor 2
13	Er-P	RS-485 communications error (COM port 2)	5	OL1	Overload of motor 1
12	Er-8	RS-485 communications error (COM port 1)	4	dbH	Braking resistor overheat
11	Er-5	Option error	3	—	—
10	Er-4	Option communications error	2	OH3	Inverter internal overheat
9	—	—	1	OH2	External alarm
8	OL4	Overload of motor 4	0	OH1	Heat sink overheat

Table 5.2 Light Alarm Selection 2 (H82), Bit Assignment of Selectable Factors

Bit	Code	Content	Bit	Code	Content
15	—	—	7	LiF	Lifetime alarm
14	—	—	6	OH	Heat sink overheat early warning
13	Cnt	Inverter life (Number of startups)	5	OL	Motor overload early warning
12	rTE	Inverter life (Cumulative run time)	4	FAL	DC fan locked
11	PTC	PTC thermistor activated	3	CoF	PID feedback wire break
10	UTL	Low torque output	2	Ero	Positioning control error
9	Pid	PID alarm	1	—	—
8	rEF	Reference command loss detected	0	Er-E	Speed mismatch or excessive speed deviation

Table 5.3 Display of Light Alarm Factor

(Example) Light alarm factors "RS-485 communications error (COM port 2)," "RS-485 communications error (COM port 1)," "Option communications error," "Overload of motor 1" and "Heat sink overheat" are selected by H81.

LED No.		LED4				LED3				LED2				LED1			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Code		—	—	Er-P	Er-8	Er-5	Er-4	—	OL4	OL3	OL2	OL1	dbH	—	OH3	OH2	OH1
Example	Binary	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	1
	Hexa-decimal (See Table 5.4.)	3				4				2				1			
	Hexa-decimal on the LED monitor	LED4 LED3 LED2 LED1 3 4 2 1															

■ Hexadecimal expression

A 4-bit binary number can be expressed in hexadecimal format (1 hexadecimal digit). The table below shows the correspondence between the two notations. The hexadecimals are shown as they appear on the LED monitor.

Table 5.4 Binary and Hexadecimal conversion

Binary				Hexadecimal	Binary				Hexadecimal
0	0	0	0	0	1	0	0	0	8
0	0	0	1	1	1	0	0	1	9
0	0	1	0	2	1	0	1	0	A
0	0	1	1	3	1	0	1	1	b
0	1	0	0	4	1	1	0	0	C
0	1	0	1	5	1	1	0	1	d
0	1	1	0	6	1	1	1	0	E
0	1	1	1	7	1	1	1	1	F

Note With the H26 data being set to "1" (PTC (The inverter immediately trips with OH4 displayed)), if the PTC thermistor is activated, the inverter does not perform light alarm processing but stops its output, regardless of the assignment of bit 11 (PTC thermistor activated) by H82 (Light Alarm Selection 2).

■ Light alarm--*L-ALM* (E20 to E24 and E27, data = 98)

This output signal comes ON when a light alarm occurs.

H84, H85 — Pre-excitation (Initial level, Time)

A motor generates torque with magnetic flux and torque current. Lag elements of the rising edge of magnetic flux causes a phenomenon in which enough torque is not generated at the moment of the motor start. To obtain enough torque even at the moment of motor start, enable the pre-excitation with H84 and H85 so that magnetic flux is established before a motor start.

■ Pre-excitation (Initial level) (H84)

H84 specifies the forcing function for the pre-excitation. It is used to shorten the pre-excitation time. Basically, there is no need to modify the default setting.

- Data setting range: 100 to 400 (%)

■ Pre-excitation (Time) (H85)

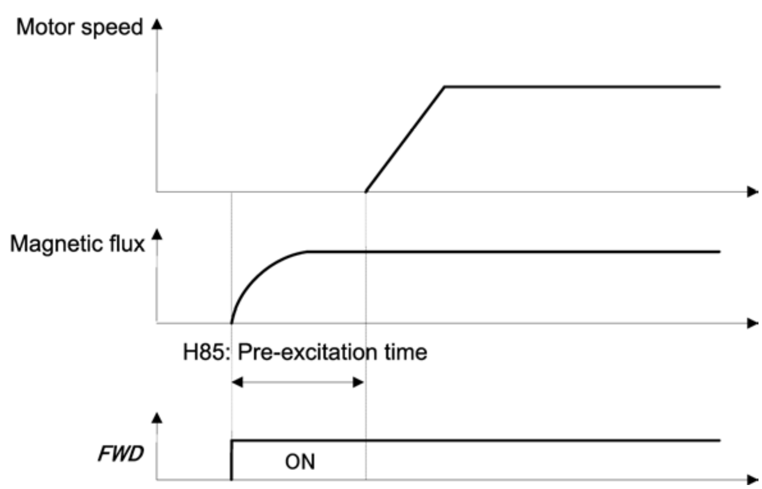
H85 specifies the pre-excitation time before starting operation.

- Data setting range: 0.00 (Disable)
  0.01 to 30.00 (s)

When a run command is inputted, the pre-excitation starts.

After the pre-excitation time specified by H85 has elapsed, the inverter judges magnetic flux to have been established and starts acceleration.

Specify H85 data so that enough time is secured for establishing magnetic flux. The appropriate value for H85 data depends on the motor capacity. Use the default setting value of H13 data as a guide.

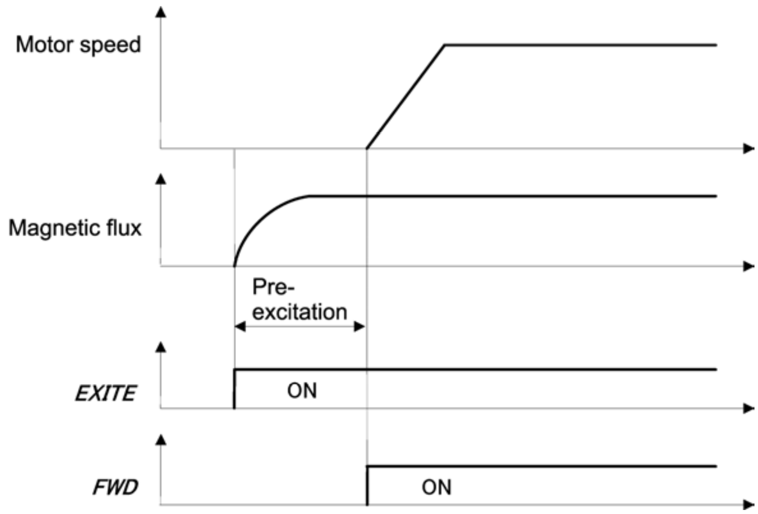


■ Pre-excitation--***EXITE*** (E01 to E07, data = 32)

Turning this input signal ON starts pre-excitation.

After the delay time for establishing magnetic flux has elapsed, a run command is inputted. Inputting the run command terminates pre-excitation and starts acceleration.

Use an external sequence to control the time for establishing magnetic flux.



Note: Under V/f control (including auto torque boost and torque vector), pre-excitation is disabled, so use DC braking or hold the starting frequency instead.

Note: A transient phenomenon, which may occur when the loss of the machinery (load) is small, may rotate the motor during pre-excitation. If a motor rotation during pre-excitation is not allowed in your system, install a mechanical brake or other mechanism to stop the motor.

⚠WARNING

Even if the motor stops due to pre-excitation, voltage is output to inverter's output terminals [U], [V], and [W].

An electric shock may occur.

H86 to H90 Reserved

These function codes and their data appear on the LED monitor, but they are reserved for particular manufacturers. Do not access them.

H91 PID Feedback Wire Break Detection

Using the terminal [C1] (current input) for PID feedback signal enables wire break detection and alarm (CoF) issuance. H91 specifies whether the wire break detection is enabled, or the duration of detection. (The inverter judges an input current to the terminal [C1] below 2 mA as a wire break.)

- Data setting range: 0.0 (Disable alarm detection)
  0.1 to 60.0 s (Detect wire break and issue CoF alarm within the time)

H92, H93 — Continuity of Running (P and I) (Refer to F14.)

Refer to the description of F14.

H94 — Cumulative Motor Run Time 1 (Refer to H78.)

Refer to the description of H78.

H95 — DC Braking (Braking response mode) (Refer to F20 through F22.)

Refer to the descriptions of F20 through F22.

H96 — STOP Key Priority/Start Check Function

H96 specifies a functional combination of "STOP key priority" and "Start check function" as listed below.

Data for H96	STOP key priority	Start check function
0	Disable	Disable
1	Enable	Disable
2	Disable	Enable
3	Enable	Enable

■ STOP key priority

Even when a run command is entered from a digital input terminal (F02 = 1) or via the RS-485 communications link (link operation), pressing the STOP key forces the inverter to decelerate and stop the motor. After that, Er-6 appears on the LED monitor.

■ Start check function

For safety, this function checks whether a run command has been turned ON or not in each of the following situations. If it has been turned ON, the inverter does not start up with alarm code Er-6 displayed on the LED monitor.

- When the power to the inverter is turned ON.
- When the RESET key is pressed to release an alarm status or when the digital input terminal command ***RST*** ("Reset alarm") is turned ON.
- When the run command source is switched by a digital input terminal command such as ***LE*** ("Enable communications link via RS-485 or fieldbus") or ***LOC*** ("Select local (keypad) operation").

H97 Clear Alarm Data

H45 (Mock Alarm)

H97 clears alarm data (alarm history and relevant information) stored in the inverter. To clear alarm data, simultaneous keying of "STOP key + ∧ key" is required.

Data for H97	Function
0	Disable
1	Enable (Setting "1" clears alarm data and then returns to "0.")

H98 Protection/Maintenance Function (Mode selection)

H98 specifies whether to enable or disable automatic lowering of carrier frequency, input phase loss protection, output phase loss protection, judgment threshold on the life of DC link bus capacitor, judgment on the life of DC link bus capacitor, DC fan lock detection, braking transistor error detection, and IP20/IP40 switching, in combination (Bit 0 to Bit 7).

Automatic lowering of carrier frequency (Bit 0)

This function should be used for important machinery that requires keeping the inverter running.

Even if a heat sink overheat or overload occurs due to excessive load, abnormal surrounding temperature, or cooling system failure, enabling this function lowers the carrier frequency to avoid tripping (OH1, OH3 or OLU). Note that enabling this function results in increased motor noise.

Input phase loss protection (Lin) (Bit 1)

Upon detection of an excessive stress inflicted on the apparatus connected to the main circuit due to phase loss or line-to-line voltage unbalance in the three-phase power supplied to the inverter, this protection feature stops the inverter and displays an alarm Lin.

Note In configurations where only a light load is driven or a DC reactor is connected, phase loss or line-to-line voltage unbalance may not be detected because of the relatively small stress on the apparatus connected to the main circuit.

Output phase loss protection (OPL) (Bit 2)

Upon detection of output phase loss while the inverter is running, this feature stops the inverter and displays an alarm OPL.

Note Where a magnetic contactor is installed in the inverter output circuit, if the magnetic contactor goes OFF during operation, all the phases will be lost. In such a case, this protection feature does not work.

Judgment threshold on the life of DC link bus capacitor (Bit 3)

Bit 3 is used to select the threshold for judging the life of the DC link bus capacitor--the factory default level or a user-defined one.

Note Before specifying a user-defined threshold, measure and confirm the reference level in advance. 📖 Refer to H42.

Judgment on the life of DC link bus capacitor (Bit 4)

Whether the DC link bus capacitor has reached its life is judged by measuring the discharging time after power OFF. The discharging time is determined by the capacitance of the DC link bus capacitor and the load inside the inverter. Therefore, if the load inside the inverter fluctuates significantly, the discharging time cannot be accurately measured, and as a result, it may be mistakenly determined that the DC link bus capacitor has reached the end of its life. To avoid such an error, you can disable the judgment based on the discharging time. (Even if it is disabled, the judgment based on the "ON-time counting" while the voltage is applied to the DC link bus capacitor is continued.)

📖 For details about the life prediction function, refer to H42.

Since load may fluctuate significantly in the following cases, disable the judgment on the life during operation. During periodical maintenance, either conduct the measurement with the judgment enabled under appropriate conditions or conduct the measurement under the operating conditions matching the actual ones.

- Auxiliary input for control power is used.
- An option card or remote keypad is used.
- Another inverter or equipment such as a PWM converter is connected to terminals of the DC link bus.

DC fan lock detection (Bit 5)
(75 HP or above for 230 V series, 125 HP or above for 460 V series)

Inverters specified above are equipped with the internal air circulation DC fan. When the inverter detects that the DC fan is locked by a failure or other cause, you can select either continuing the inverter operation or having the inverter enter into the alarm state.

Entering alarm state: The inverter issues the alarm OH1 and allows the motor to coast to a stop.

Continuing operation: The inverter does not enter the alarm state and continues to run the motor.

Note that, however, the inverter turns ON the ***OH*** and ***LIFE*** signals on the transistor output terminals whenever the DC fan lock is detected regardless of your selection.

Note: If the ON/OFF control of the cooling fan is enabled (H06 = 1), the cooling fan may stop depending on the operating condition of the inverter. In this case, the DC fan lock detection feature is considered normal (e.g., the cooling fan is normally stopped by the stop fan command.) so that the inverter may turn OFF the ***LIFE*** or ***OH*** signal output, or enable to cancel the alarm OH1, even if the internal air circulation DC fan is locked due to a failure etc. (When you start the inverter in this state, it automatically issues the run fan command. Then the inverter detects the DC fan lock state, and turns ON the ***LIFE*** or ***OH*** output or enters the alarm OH1 state.)

Note that, operating the inverter with the DC fan being locked for a long time may shorten the service life of electrolytic capacitors on the PCBs due to local high temperature inside the inverter. Be sure to check with the ***LIFE*** signal etc., and replace the broken fan as soon as possible.

Braking transistor error detection (Bit 6) dbA: (40 HP or below)

Upon detection of a built-in braking transistor error, this feature stops the inverter and displays an alarm dbA. Set data of this bit to "0" when the inverter does not use a braking transistor and there is no need of entering an alarm state.

Switch IP20/IP40 enclosure (Bit 7) (for basic type of inverters only)

Mounting an IP40 option to inverters of 40 HP or below enables them to conform to IP40. In such a case, switch Bit 7 to "1" for the protection coordination. For details, refer to the instruction manual of the IP40 option.

To set data of function code H98, assign the setting of each function to each bit and then convert the 8-bit binary to the decimal number.

Refer to the assignment of each function to each bit and a conversion example below.

Bit	Function	Bit data = 0	Bit data = 1	Factory default
0	Lower the carrier frequency automatically	Disable	Enable	1: Enable
1	Detect input phase loss	Continue to run	Enter alarm processing	1: Enter alarm processing
2	Detect output phase loss	Continue to run	Enter alarm processing	0: Continue to run
3	Select life judgment threshold of DC link bus capacitor	Factory default	User-defined setting	0: Factory default
4	Judge the life of DC link bus capacitor	Disable	Enable	1: Enable
5	Detect DC fan lock	Enter alarm processing	Continue to run	0: Enter alarm processing
6	Detect braking transistor error	Continue to run	Enter alarm processing	1: Enter alarm processing
7	Switch IP20/IP40 enclosure	IP20	IP40	0: IP20

An example of conversion from binary to decimal (for the number configured by the factory default setting shown above)

$$\begin{aligned}\text{Decimal} &= \text{Bit 7} \times 2^7 + \text{Bit 6} \times 2^6 + \text{Bit 5} \times 2^5 + \text{Bit 4} \times 2^4 + \text{Bit 3} \times 2^3 + \text{Bit 2} \times 2^2 + \text{Bit 1} \times 2^1 + \text{Bit 0} \times 2^0 \\ &= \text{Bit 7} \times 128 + \text{Bit 6} \times 64 + \text{Bit 5} \times 32 + \text{Bit 4} \times 16 + \text{Bit 3} \times 8 + \text{Bit 2} \times 4 + \text{Bit 1} \times 2 + \text{Bit 0} \times 1 \\ &= 0 \times 128 + 1 \times 64 + 0 \times 32 + 1 \times 16 + 0 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 \\ &= 64 + 16 + 2 + 1 \\ &= 83\end{aligned}$$

5.4.6 A codes (Motor 2 parameters) b codes (Motor 3 parameters) r codes (Motor 4 parameters)

The FRENIC-MEGA can switch control parameters even when it is running so that a single inverter can drive four motors by switching them or turn the energy saving operation ON or OFF for the setup change (e.g., gear switching) that causes the moment of inertia of the machinery to change.

Function code	Motor to drive	Remarks
F/E/P and other codes	Motor 1	Including function codes commonly applied to motors 1 to 4.
A codes	Motor 2	
b codes	Motor 3	
r codes	Motor 4	

Note: This manual describes function codes applied to motor 1 only. For ones applied to motors 2 to 4 except A42, b42, and r42 (Motor/Parameter Switching 2 to 4), refer to the corresponding function codes prepared for motor 1 in Table 5.5 on the next page.

A42, b42, r42 — Motor/Parameter Switching 2, 3, 4 (Mode selection)

d25 (ASR Switching Time)

The combination of digital input terminal commands ***M2***, ***M3*** and ***M4*** (Select motor 2, 3 and 4) switches between the 1st, 2nd, 3rd and 4th motors as listed below. (Function codes E01 through E07, data = 12, 36, or 37) When the motor is switched, the function code group with which the inverter drives the motor is also switched to the corresponding one.

At the same time, the inverter outputs the corresponding signal ("Motor 1 selected" signal ***SWM1*** through the "Motor 4 selected" signal ***SWM4*** , Function codes E20 through E27 data = 48, 49, 50, or 51) in order to switch the external switch to that selected motor.

Terminal command			Inverter-driven motor selected (Function code group enabled)	Output signals			
M2	***M3***	***M4***		***SWM1***	***SWM2***	***SWM3***	***SWM4***
OFF	OFF	OFF	1st motor (Default codes)	ON	OFF	OFF	OFF
ON	—	—	2nd motor (A codes)	OFF	ON	OFF	OFF
OFF	ON	—	3rd motor (b codes)	OFF	OFF	ON	OFF
OFF	OFF	ON	4th motor (r codes)	OFF	OFF	OFF	ON

A42, b42 or r42 selects whether the combination of terminal commands ***M2***, ***M3*** and ***M4*** switches the actual motors (to the 2nd, 3rd, and 4th motors) or the particular parameters (A codes, b codes, or r codes).

Data for A42, b42 or r42	Function	Switching is possible:
0	Motor (Switch to the 2nd, 3rd or 4th motor)	Only when the inverter is stopped (all run commands are OFF).
1	Parameter (Switch to particular A codes, b codes or r codes)	Even when the inverter is running.

Note: From the point of view of signal timing, a combination of ***M2***, ***M3*** and ***M4*** must be determined at least 2 ms before the signal of a run command is established.

Function Code Details
F codes
E codes
C codes
P codes
H codes
A42
b42
r42
J codes
d codes
U codes
y codes

If A42, b42 or r42 is set to "0" (Motor (Switch to the 2nd, 3rd or 4th motor)), the combination of ***M2***, ***M3*** and ***M4*** switches the motor to any of the 2nd to 4th motors and also switches the function code group enabled to the one corresponding to the selected motor, as listed in Table 5.5. Note that, however, the functions listed in Table 5.6 are unavailable when any of the 2nd to 4th motors are selected.

If A42, b42 or r42 is set to "1" (Parameter (Switch to particular A codes, b codes or r codes)), the combination of ***M2***, ***M3*** and ***M4*** switches the particular parameters marked with Y in the "Object of parameter switching" column in Table 5.5. For other parameters, ones in the 1st motor column remain effective.

Table 5.5 Function Codes to be Switched

Name	Function code				Object of parameter switching
	1st motor	2nd motor	3rd motor	4th motor	
Maximum frequency	F03	A01	b01	r01	
Base frequency	F04	A02	b02	r02	
Rated voltage at base frequency	F05	A03	b03	r03	
Maximum output voltage	F06	A04	b04	r04	
Torque boost	F09	A05	b05	r05	
Electronic thermal overload protection for motor (Select motor characteristics)	F10	A06	b06	r06	
(Overload detection level)	F11	A07	b07	r07	
(Thermal time constant)	F12	A08	b08	r08	
DC braking (Braking starting frequency)	F20	A09	b09	r09	
(Braking level)	F21	A10	b10	r10	
(Braking time)	F22	A11	b11	r11	
Starting frequency	F23	A12	b12	r12	
Load selection/ Auto torque boost/ Auto energy saving operation	F37	A13	b13	r13	Y
Drive control selection	F42	A14	b14	r14	
Motor (No. of poles)	P01	A15	b15	r15	
(Rated capacity)	P02	A16	b16	r16	
(Rated current)	P03	A17	b17	r17	
(Auto-tuning)	P04	A18	b18	r18	
(Online tuning)	P05	A19	b19	r19	
(No-load current)	P06	A20	b20	r20	
(%R1)	P07	A21	b21	r21	
(%X)	P08	A22	b22	r22	
(Slip compensation gain for driving)	P09	A23	b23	r23	Y
(Slip compensation response time)	P10	A24	b24	r24	Y
(Slip compensation gain for braking)	P11	A25	b25	r25	Y
(Rated slip frequency)	P12	A26	b26	r26	
(Iron loss factor 1)	P13	A27	b27	r27	
(Iron loss factor 2)	P14	A28	b28	r28	
(Iron loss factor 3)	P15	A29	b29	r29	
(Magnetic saturation factor 1)	P16	A30	b30	r30	
(Magnetic saturation factor 2)	P17	A31	b31	r31	
(Magnetic saturation factor 3)	P18	A32	b32	r32	
(Magnetic saturation factor 4)	P19	A33	b33	r33	

Table 5.5 Function Codes to be Switched (continued)

Name	Function code 1st motor	2nd motor	3rd motor	4th motor	Object of parameter switching
(Magnetic saturation factor 5)	P20	A34	b34	r34	
(Magnetic saturation extension factor "a")	P21	A35	b35	r35	
(Magnetic saturation extension factor "b")	P22	A36	b36	r36	
(Magnetic saturation extension factor "c")	P23	A37	b37	r37	
Motor selection	P99	A39	b39	r39	
Slip compensation (Operating conditions)	H68	A40	b40	r40	Y
Output current fluctuation damping gain for motor	H80	A41	b41	r41	Y
Speed control (Speed command filter)	d01	A43	b43	r43	Y
(Speed detection filter)	d02	A44	b44	r44	Y
P (Gain)	d03	A45	b45	r45	Y
I (Integral time)	d04	A46	b46	r46	Y
(Output filter)	d06	A48	b48	r48	Y
(Notch filter resonance frequency)	d07	A49	b49	r49	
(Notch filter attenuation level)	d08	A50	b50	r50	
Cumulative motor run time	H94	A51	b51	r51	
Startup counter for motor	H44	A52	b52	r52	
Motor (%X correction factor 1)	P53	A53	b53	r53	
(%X correction factor 2)	P54	A54	b54	r54	
(Torque current under vector control)	P55	A55	b55	r55	
(Induced voltage factor under vector control)	P56	A56	b56	r56	
Reserved for particular manufacturers	d51	d52	d53	d54	
	P57	A57	b57	r57	

Table 5.6 Function Codes Unavailable for the 2nd to 4th Motors

Name	Function codes	Operation in 2nd to 4th motors
Non-linear V/f pattern	H50 to H53, H65, H66	Disabled
Starting frequency 1 (Holding time)	F24	Disabled
Stop frequency (Holding time)	F39	Disabled
Overload early warning/ Current detection	E34 and E35	Disabled
Droop control	H28	Disabled
UP/***DOWN*** control	H61	Fixed at the initial setting (0 Hz)
PID control	J01 to J06, J08 to J13, J15 to J19, J56 to J62, E40, E41, H91	Disabled
Dew condensation prevention	J21, F21, F22	Disabled
Brake signal	J68 to J72, J95 and J96	Disabled
Current limiter	F43 and F44	Disabled
Rotational direction limitation	H08	Disabled
Pre-excitation	H84 and H85	Disabled
Maintenance Interval/ Preset Startup Count for Maintenance	H78 and H79	Disabled
NTC thermistor	H26 and H27	Disabled

■ ASR Switching Time (d25)

Parameter switching is possible even during operation. For example, speed control P (Gain) and I (Integral time) listed in Table 5.5 can be switched. Switching these parameters during operation may cause an abrupt change of torque and result in a mechanical shock, depending on the driving condition of the load. To reduce such a mechanical shock, the inverter decreases the abrupt torque change using the ramp function of ASR Switching Time (d25).

- Data setting range: 0.000 to 1.000 (s)

5.4.7 J codes (Application functions 1)

J01	PID Control (Mode selection)

Under PID control, the inverter detects the state of a control target object with a sensor or the similar device and compares it with the commanded value (e.g., temperature control command). If there is any deviation between them, PID control operates to minimize it. That is, it is a closed loop feedback system that matches controlled variable (feedback amount). PID control expands the application area of the inverter to process control (e.g., flow control, pressure control, and temperature control) and speed control (e.g., dancer control).

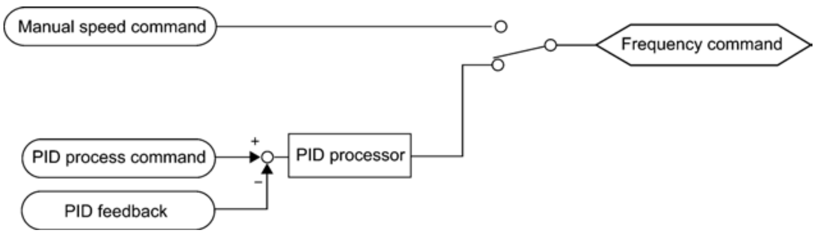
If PID control is enabled (J01 = 1, 2 or 3), the frequency control of the inverter is switched from the drive frequency command generator block to the PID command one.

■ Mode selection (J01)

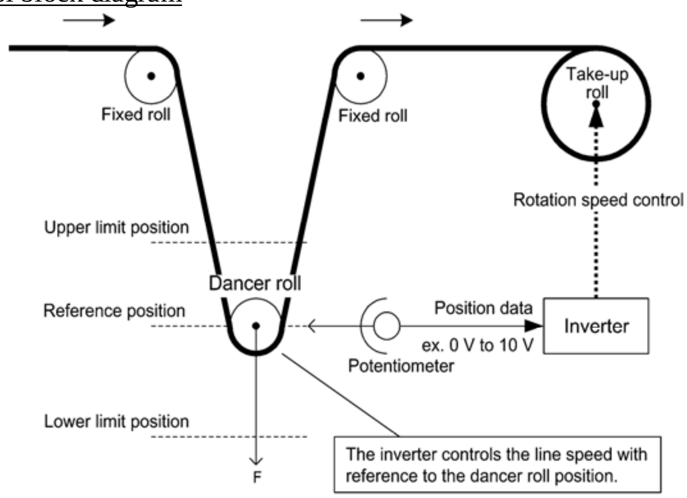
J01 selects the PID control mode.

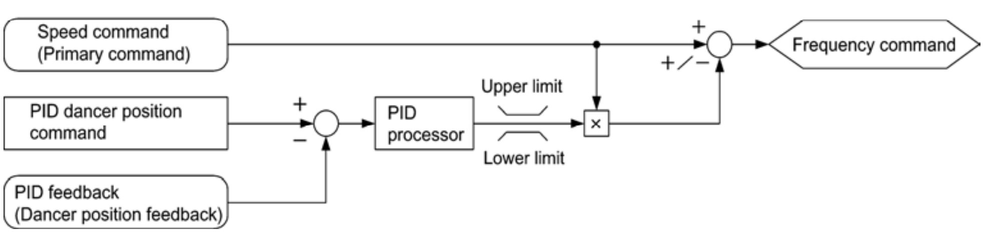
Data for J01	Function
0	Disable
1	Enable (Process control, normal operation)
2	Enable (Process control, inverse operation)
3	Enable (Dancer control)

PID process control block diagram



PID dancer control block diagram





Using J01 enables switching between normal and inverse operations against the PID process control output, so you can specify an increase/decrease of the motor rotating speed to the difference (error component) between the commanded (input) and feedback amounts, making it possible to apply the inverter to air conditioners. The terminal command ***IVS*** can also switch operation between normal and inverse.

📖 For details about the switching of normal/inverse operation, refer to the description of Switch normal/inverse operation ***IVS*** (E01 to E07, data = 21).

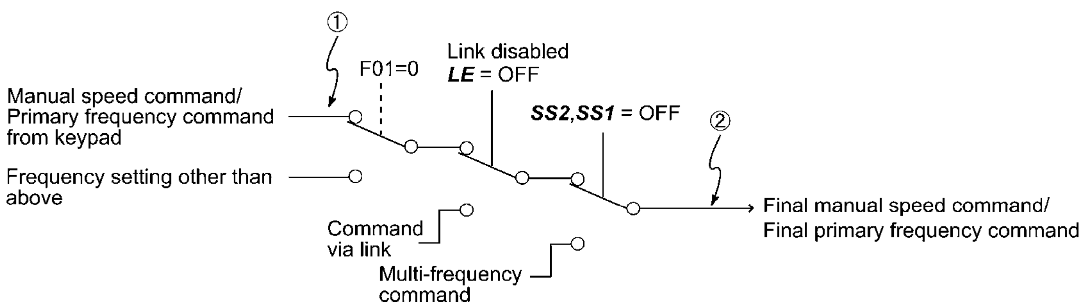
■ Configuring the manual speed command/primary frequency command with the ⌃ and ⌄ keys under PID control

When function code F01 is set at "0" (⌃ / ⌄ keys on keypad) and frequency command 1 is selected as a manual speed command or primary frequency command (Frequency setting via communications link: Disabled; Multi-frequency setting: Disabled; PID control: Disabled), defining the LED monitor as a speed monitor in Running mode enables modification of the manual speed command or primary frequency command using the ⌃ and ⌄ keys.

In Programming or Alarm mode, the manual speed command or primary frequency command cannot be modified with the ⌃ and ⌄ keys, so switch to Running mode beforehand.

The figure below illustrates how the manual speed command or primary frequency command ① entered via the keypad is translated to the final manual speed command/final primary frequency command ②.

The configuration procedure is the same as that for usual frequency setting.



J02 PID Control (Remote command *SV*)

J02 sets a command source that specifies the command value (***SV***) under PID control.

Data for J02	Function	Refer to:
0	∧ / ∨ keys on keypad Specify the PID command using the ∧ / ∨ keys on the keypad.	[1]
1	PID command 1 (Analog input: Terminals [12], [C1] and [V2]) Voltage input to the terminal [12] (0 to ±10 VDC, 100% PID command/ ±10 VDC) Current input to the terminal [C1] (4 to 20 mA DC, 100% PID command/ 20 mA DC Voltage input to the terminal [V2] (0 to ±10 VDC, 100% PID command/ ±10 VDC)	[2]
3	Terminal command ***UP***/***DOWN*** Using the ***UP*** or ***DOWN*** command in conjunction with PID display coefficients (specified by E40 and E41) with which the command value is converted into a physical quantity, etc., you can specify 0 to 100% of the PID command (± 100% for PID dancer control).	[3]
4	Command via communications link Use function code S13 that specifies the communications-linked PID command. The transmission data of 20000 (decimal) is equal to 100% (maximum frequency) of the PID command.	[4]

[1] PID command with the ∧ / ∨ keys on the keypad (J02 = 0, factory default)

Configuring the PID command (PID process command or PID dancer position command) with the ∧ and ∨ keys

(1) To enable PID process control, set function code J01 at "1" or "2."
To enable PID dancer control, set function code J01 at "3."

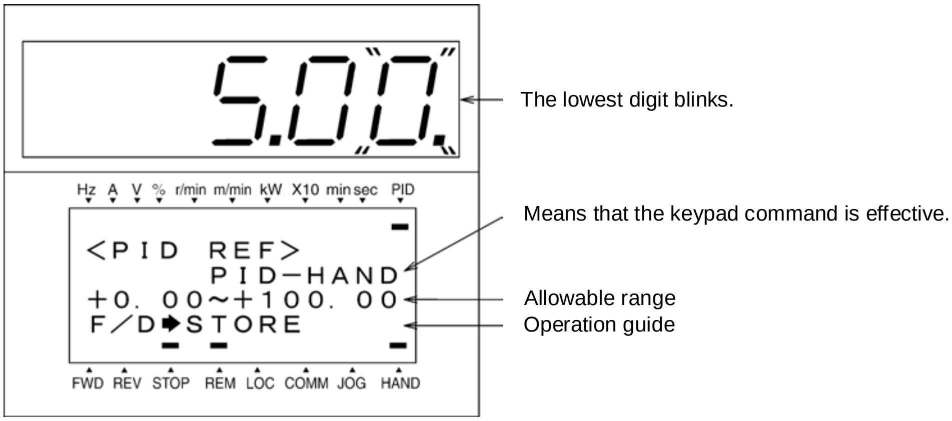
(2) Set function code J02 at "0" (∧ / ∨ keys on keypad).

(3) Set the LED monitor to something other than the speed monitor (E43 = 0) when the inverter is in Running mode.

In Programming or Alarm mode, the PID command cannot be modified with the ∧ and ∨ keys, so switch to Running mode beforehand.

(4) Press the ∧ or ∨ key.

The 7-segment LED monitor displays the PID command and the LCD monitor displays the related information including the operation guide, as shown below.



Example of PID Command Configuration Screen

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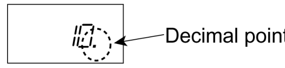
Tip: On the LED monitor, the decimal point of the lowest digit is used to characterize what is displayed. The decimal point of the lowest digit blinks when a PID command is displayed; the decimal point lights when a PID feedback amount is displayed.

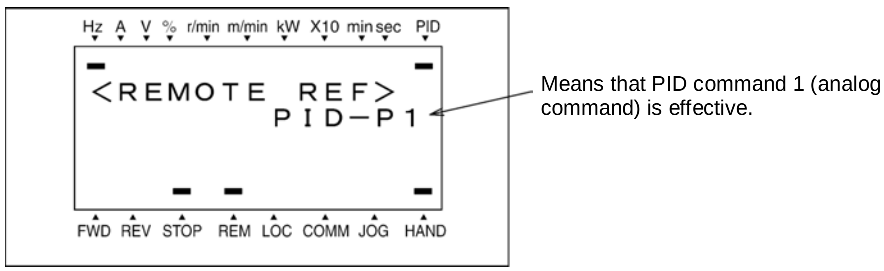


(5) To change the PID command, press the ∧ or ∨ key again. To save the new setting into the inverter's memory, press the FUNC/DATA key (when E64 = 1 (factory default)). When the power is turned ON next time, the new setting will be used as an initial reference frequency.

In addition to saving with the FUNC/DATA key described above, "Automatic saving when the main power is turned OFF" is also possible (when E64 = 0).

Tip:

- Using the ∧ / ∨ keys on the keypad in conjunction with PID display coefficients (specified by E40 and E41), you can specify 0 to 100% of the PID process command (±100% of the PID dancer position command) in an easy-to-understand converted command format.
- Even if multi-frequency is selected as a PID command (***SS4*** or ***SS8*** = ON), setting the PID command with the keypad is possible.
- When function code J02 is set to any value other than "0," pressing the ∧ or ∨ key displays, on the LED monitor, the PID command currently selected, but cannot change the setting. The LCD monitor displays the following.



PID Command Manually Specified with ∧ and ∨ Keys and Requirements

PID control (Mode selection) J01	PID control (Remote command SV) J02	LED monitor E43	Multi-frequency ***SS4***, ***SS8***	Display during ∧ / ∨ key operation
1 or 2	0	Other than 0	ON or OFF	PID process command <u>by keypad</u>
	Other than 0			PID process command <u>currently selected</u>
3	0			PID dancer position command <u>by keypad</u>
	Other than 0			PID dancer position command <u>currently selected</u>

[2] PID command by analog inputs (J02 = 1)

When any analog input (voltage input to terminals [12] and [V2], or current input to terminal [C1]) for PID command 1 (J02 = 1) is used, it is possible to arbitrary specify the PID command by multiplying the gain and adding the bias. The polarity can be selected and the filter time constant and offset can be adjusted. In addition to J02 setting, it is necessary to select PID command 1 for analog input (specified by any of E61 to E63, function code data = 3). For details, refer to the descriptions of E61 to E63.

Adjustable elements of PID command

Input terminal	Input range	Bias		Gain		Polarity	Filter time constant	Offset
		Bias	Base point	Gain	Base point			
[12]	0 to +10 V, -10 to +10V			C32	C34	C35	C33	C31
[C1]	4 to 20 mA	C51	C52	C37	C39	-	C38	C36
[V2]	0 to +10 V, -10 to +10 V			C42	C44	C45	C43	C41

■ Offset (C31, C36, C41)

C31, C36 or C41 configures an offset for an analog voltage/current input. The offset also applies to signals sent from the external equipment.

■ Filter time constant (C33, C38, C43)

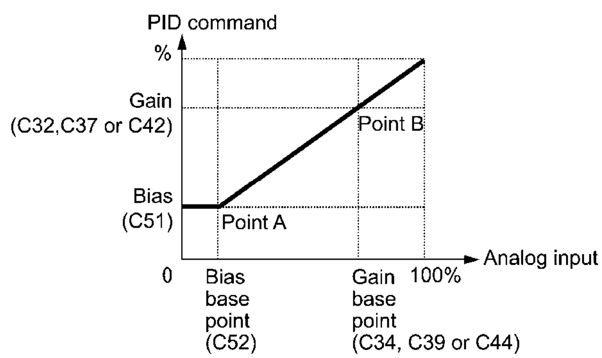
C33, C38, and C43 provide the filter time constants for the voltage and current of the analog input. Choose appropriate values for the time constants considering the response speed of the machinery system, as large time constants slow down the response. If the input voltage fluctuates because of noise, specify large time constants.

■ Polarity (C35, C45)

C35 and C45 specify the input range for analog input voltage.

Data for C35 and C45	Terminal input specifications
0	-10 to +10 V
1	0 to +10 V (negative value of voltage is regarded as 0 V)

■ Gain and bias



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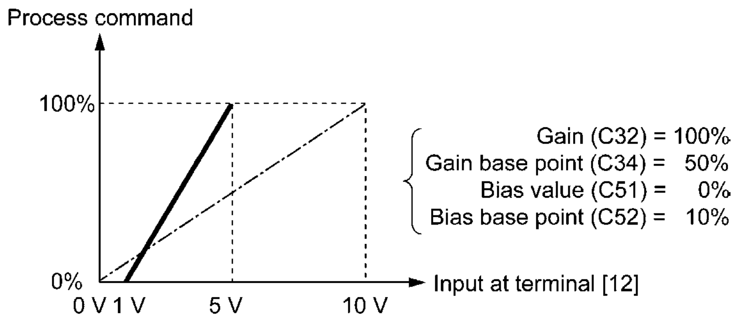
(Example) Mapping the range of 1 through 5 V at terminal [12] to 0 through 100%



[3] PID command with ***UP/DOWN*** control (J02 = 3)

When the ***UP/DOWN*** control is selected as a PID command, turning the terminal command ***UP*** or ***DOWN*** ON causes the PID command to change within the range from 0 to 100%.

The PID command can be specified in mnemonic physical quantities (such as temperature or pressure) with the PID display coefficients (E40, E41).

To select the ***UP/DOWN*** control as a PID command, the ***UP*** and ***DOWN*** should be assigned to the digital input terminals [X1] to [X7]. (📖 E01 to E07, data = 17, 18)

UP	***DOWN***	Function
Data = 17	Data = 18	
OFF	OFF	Retain PID command value.
ON	OFF	Increase PID command value at a rate between 0.1%/0.1 s and 1%/0.1 s.
OFF	ON	Decrease PID command value at a rate between 0.1%/0.1 s and 1%/0.1 s.
ON	ON	Retain PID command value.

Note: The inverter internally holds the PID command value set by ***UP***/***DOWN*** control and applies the held value at the next restart (including powering ON).

[4] PID command via communications link (J02＝4)

Use function code S13 that specifies the communications-linked PID command. The transmission data of 20000 (decimal) is equal to 100% (maximum frequency) of the PID command. For details of the communications format, refer to the RS-485 Communication User's Manual.

Note:
- Other than the remote command selection by J02, the multi-frequency 4, 8 or 12 (specified by C08, C12 or C16, respectively) specified by terminal commands ***SS4*** and ***SS8*** can also be selected as a preset value for the PID command.

  Calculate the setting data of the PID command using the expression below.

$$\textbf{PID command data (\%)} = \frac{\textbf{Preset multi-frequency}}{\textbf{Maximum frequency}} \times \textbf{100}$$

- In dancer control (J01 = 3), the setting from the keypad interlocks with data of J57 (PID control: Dancer reference position), and is saved as function code data.

Selecting Feedback Terminals

For feedback control, determine the connection terminal according to the type of the sensor output.

- If the sensor is a current output type, use the current input terminal [C1] of the inverter.
- If the sensor is a voltage output type, use the voltage input terminal [12] of the inverter, or switch over the terminal [V2] to the voltage input terminal and use it.

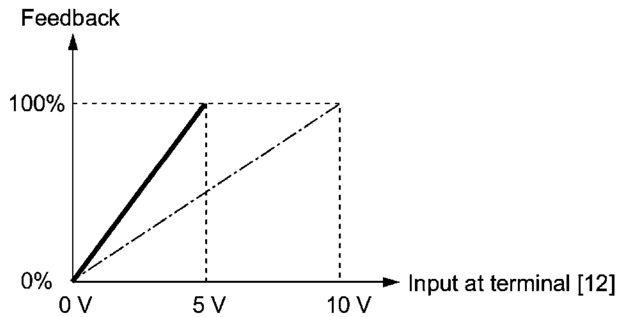
For details, refer to the descriptions of E61 through E63.

Application example: Process control (for air conditioners, fans and pumps)

The operating range for PID process control is internally controlled as 0% through 100%. For the given feedback input, determine the operating range to be controlled by means of gain adjustment.

(Example) When the output level of the external sensor is within the range of 1 to 5 V:

- Use terminal [12] designed for voltage input.
- Set the gain (C32 for analog input adjustment) at 200% in order to make the maximum value (5 V) of the external sensor's output correspond to 100%. Note that the input specification for terminal [12] is 0 to 10 V corresponding to 0 to 100%; thus, a gain factor of 200% (= 10 V ÷ 5 V × 100) should be specified. Note also that any bias setting does not apply to feedback control.



Application examples: Dancer control (for winders)

(Example 1) When the output level of the external sensor is ±7 VDC:

- Use terminal [12] since the voltage input is of bipolar.
- When the external sensor's output is of bipolar, the inverter controls the speed within the range of ±100%. To convert the output ±7 VDC to ±100%, set the gain (C32 for analog input adjustment) at 143% as calculated below.

$$\frac{10\text{ V}}{7\text{ V}} \approx 143\%$$

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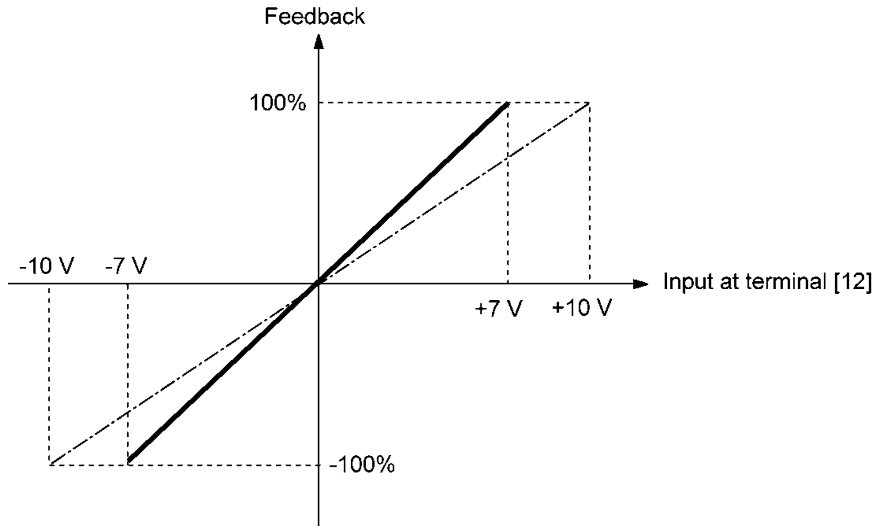
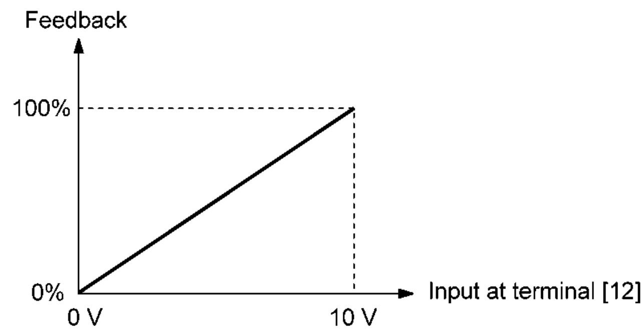


(Example 2) When the output level of the external sensor is 0 to 10 VDC:

- Use terminal [12] designed for voltage input.
- When the external sensor's output is of unipolar, the inverter controls the speed within the range of 0 to 100%.



In this example, it is recommended that the dancer reference position be set around the +5 V (50%) point.

PID Display Coefficient and Monitoring

To monitor the PID command and its feedback value, set the display coefficient to convert the values into easy-to-understand physical quantities such as temperature.

Refer to function codes E40 and E41 for details on display coefficients, and to E43 for details on monitoring.

J03 to J06	PID Control (P (Gain), I (Integral time), D (Differential time), Feedback filter)

■ P gain (J03)

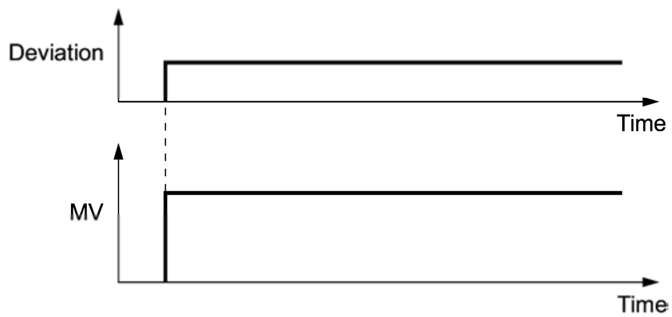
J03 specifies the gain for the PID processor.

- Data setting range: 0.000 to 30.000 (times)

P (Proportional) action

An operation in which the MV (manipulated value: output frequency) is proportional to the deviation is called P action, which outputs the MV in proportion to deviation. However, the P action alone cannot eliminate deviation.

Gain is data that determines the system response level against the deviation in P action. An increase in gain speeds up response, but an excessive gain may oscillate the inverter output. A decrease in gain delays response, but it stabilizes the inverter output.



■ I integral time (J04)

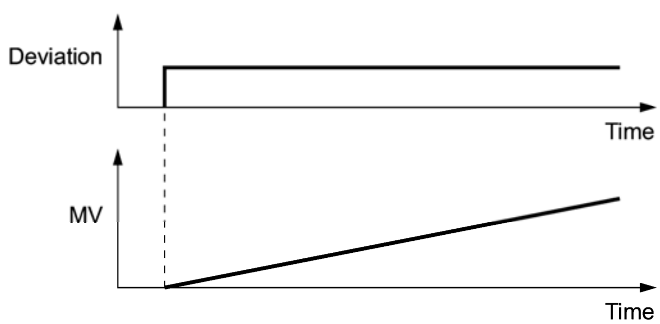
J04 specifies the integral time for the PID processor.

- Data setting range: 0.0 to 3600.0 (s)
  0.0 means that the integral component is ineffective.

I (Integral) action

An operation in which the change rate of the MV (manipulated value: output frequency) is proportional to the integral value of deviation is called I action, which outputs the MV that integrates the deviation. Therefore, I action is effective in bringing the feedback amount close to the commanded value. For the system whose deviation rapidly changes, however, this action cannot make it react quickly.

The effectiveness of I action is expressed by integral time as parameter, that is J04 data. The longer the integral time, the slower the response. The reaction to the external disturbance also becomes slow. The shorter the integral time, the faster the response. Setting too short integral time, however, makes the inverter output tend to oscillate against the external disturbance.



■ D differential time (J05)

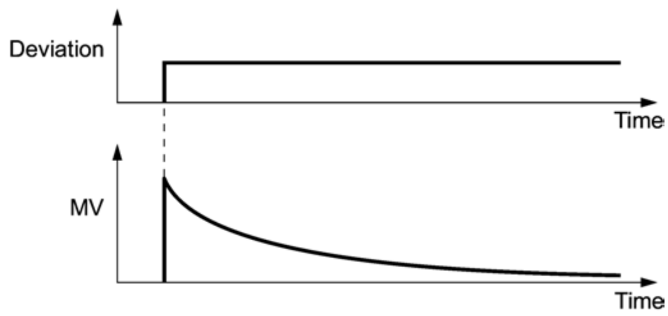
J05 specifies the differential time for the PID processor.

- Data setting range: 0.00 to 600.00 (s)
  0.00 means that the differential component is ineffective.

D (Differential) action

An operation in which the MV (manipulated value: output frequency) is proportional to the differential value of the deviation is called D action, which outputs the MV that differentiates the deviation. D action makes the inverter quickly react to a rapid change of deviation.

The effectiveness of D action is expressed by differential time as parameter, that is J05 data. Setting a long differential time will quickly suppress oscillation caused by P action when a deviation occurs. Too long differential time makes the inverter output oscillation more. Setting short differential time weakens the suppression effect when the deviation occurs.



The combined uses of P, I, and D actions are described below.

(1) PI control

PI control, which is a combination of P and I actions, is generally used to minimize the remaining deviation caused by P action. PI control always acts to minimize the deviation even if a commanded value changes or external disturbance steadily occurs. However, the longer the integral time, the slower the system response to quick-changed control.

P action can be used alone for loads with very large part of integral components.

(2) PD control

Under PD control, the moment that a deviation occurs, the control rapidly generates greater MV (manipulated value) than that generated by D action alone, to suppress the deviation increase. When the deviation becomes small, the behavior of P action becomes small.

A load including the integral component in the controlled system may oscillate due to the action of the integral component if P action alone is applied. In such a case, use PD control to reduce the oscillation caused by P action, for keeping the system stable. That is, PD control is applied to a system that does not contain any damping actions in its process.

(3) PID control

PID control is implemented by combining P action with the deviation suppression of I action and the oscillation suppression of D action. PID control features minimal control deviation, high precision and high stability.

In particular, PID control is effective to a system that has a long response time to the occurrence of deviation.

Follow the procedure below to set data to PID control function codes.

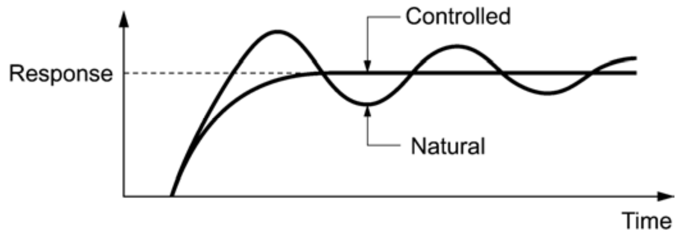
It is highly recommended that you adjust the PID control value while monitoring the system response waveform with an oscilloscope or equivalent. Repeat the following procedure to determine the optimal solution for each system.

- Increase the data of J03 (PID control P (Gain)) within the range where the feedback signal does not oscillate.
- Decrease the data of J04 (PID control I (Integral time)) within the range where the feedback signal does not oscillate.
- Increase the data of J05 (PID control D (Differential time)) within the range where the feedback signal does not oscillate.

Refining the system response waveforms is shown below.

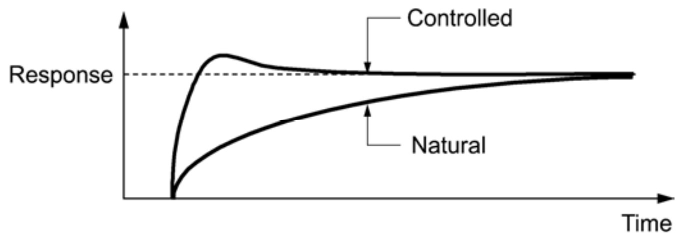
1) Suppressing overshoot

Increase the data of J04 (Integral time) and decrease that of J05 (Differential time.)



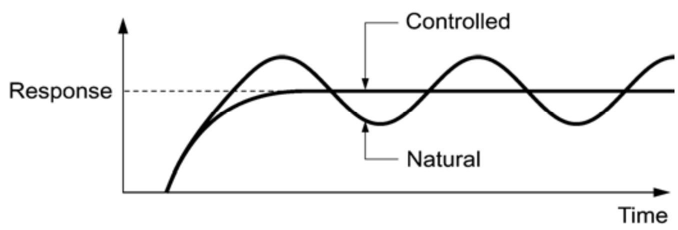
2) Quick stabilizing (moderate overshoot allowable)

Decrease the data of J03 (Gain) and increase that of J05 (Differential time).



3) Suppressing oscillation whose period is longer than the integral time specified by J04

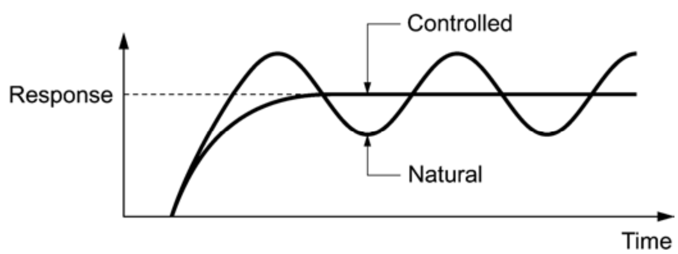
Increase the data of J04 (Integral time).



4) Suppressing oscillation whose period is approximately the same as the time specified by J05 (Differential time)

Decrease the data of J05 (Differential time).

Decrease the data of J03 (Gain), if the oscillation cannot be suppressed even though the differential time is set at 0 sec.



■ Feedback filter (J06)

J06 specifies the time constant of the filter for feedback signals under PID control.

- Data setting range: 0.0 to 900.0 (s)
- This setting is used to stabilize the PID control loop. Setting too long a time constant makes the system response slow.

Note: To specify the filter time constant for feedback signals finely under PID dancer control, apply filter time constants for analog input (C33, C38 and C43).

J08, J09	PID Control (Pressurization starting frequency, pressurizing time) J15 (PID Control, Stop frequency for slow flowrate) J16 (PID Control, Slow flowrate level stop latency) J17 (PID Control, Starting frequency)

Slow flowrate stopping function (J15 to J17)

J15 to J17 configure the slow flowrate stopping function in pump control, a function that stops the inverter when the discharge pressure rises, causing the volume of water to decrease.

When the discharge pressure has increased, decreasing the reference frequency (output of the PID processor) below the stop frequency for slow flowrate level (J15) for the period of slow flowrate level stop latency (J16), the inverter decelerates to stop, while PID control itself continues to operate. When the discharge pressure decreases, increasing the reference frequency (output of the PID processor) above the starting frequency (J17), the inverter resumes operation.

■ PID control (Stop frequency for slow flowrate) (J15)

J15 specifies the frequency which triggers slow flowrate stop of inverter.

■ PID control (Slow flowrate level stop latency) (J16)

J16 specifies the period from when the PID output drops below the frequency specified by J15 until the inverter starts deceleration to stop.

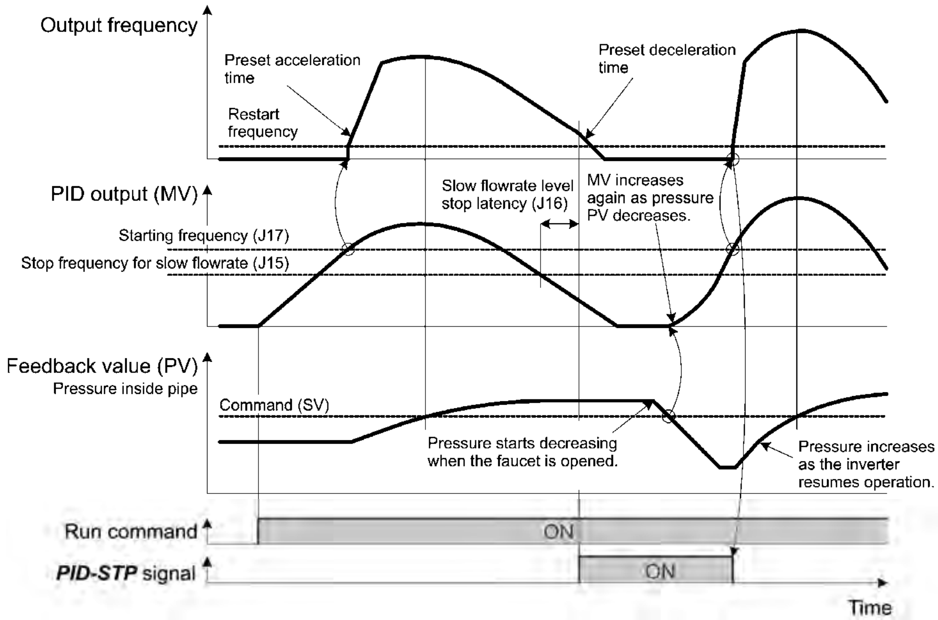
■ PID control (Starting frequency) (J17)

J17 specifies the starting frequency. Set J17 to a frequency higher than the stop frequency for slow flowrate (J15). If the specified starting frequency is lower than the stop frequency for slow flowrate, the latter stop frequency is ignored; the slow flowrate stopping function is triggered when the output of the PID processor drops below the specified starting frequency.

■ Assignment of ***PID-STP*** ("Motor stopped due to slow flowrate under PID control") (E20 to E24 and E27, data = 44)

Assigning the digital output signal ***PID-STP*** to any of the programmable, output terminals with any of E20 through E24 and E27 (data = 44) enables the signal to output when the inverter stops due to the slow flowrate stopping function under PID control.

For the slow flowrate stopping function, see the chart below.



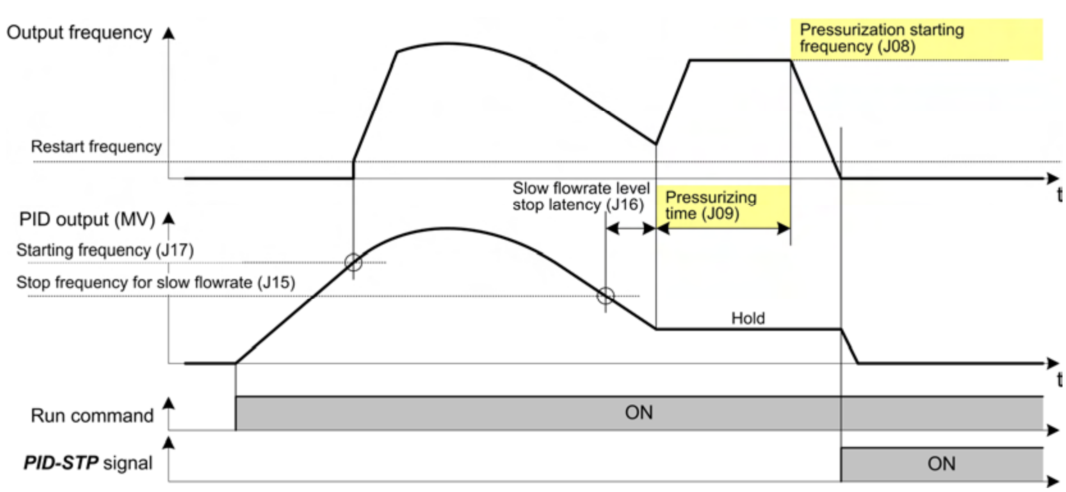
Pressurization before slow flowrate stopping (J08 and J09)

Specifying J08 (Pressurization starting frequency) and J09 (Pressurizing time) enables pressurization control when the frequency drops below the level specified by J15 (Stop frequency for slow flowrate) for the period specified by J16. During the pressurization, PID control is in the hold state.

This function prolongs the stopping time of equipment with a bladder tank by pressurizing immediately before the frequency drops below the level at which the inverter stops the motor, thus enabling energy saving operation.

Because the pressurization starting frequency (J08) can be specified with a parameter, pressurization setting suitable for the equipment is possible.

For pressurization control, see the chart below.



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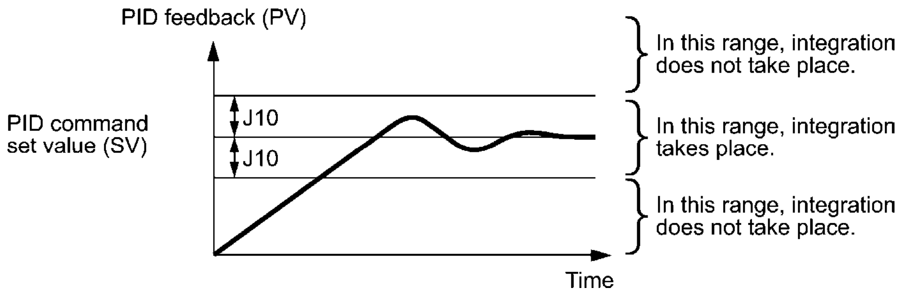
y codes

J10	PID Control (Anti reset windup)

J10 suppresses overshoot under control using a PID processor. As long as the deviation between the PID command and its feedback is out of the preset range, the integrator holds its value and does not perform integration operation.

- Data setting range: 0 to 200 (%)



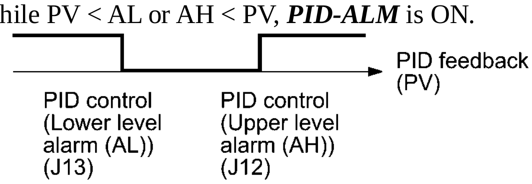
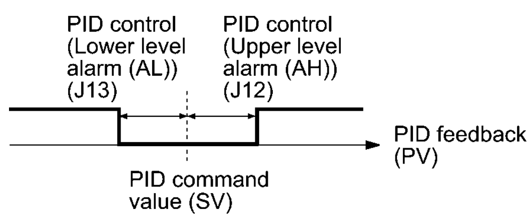
J11 to J13	PID Control (Select alarm output, Upper level alarm (AH) and Lower level alarm (AL))

The inverter can output two types of alarm signals (absolute-value and deviation alarms) associated with PID control if the digital output signal ***PID-ALM*** is assigned to any of the programmable, output terminals with any of E20 through E24 and E27 (data = 42).

J11 specifies the alarm output types. J12 and J13 specify the upper and lower limits for alarms, respectively.

■ Select alarm output (J11)

J11 specifies one of the following alarms available.

Data for J11	Alarm	Description
0	Absolute-value alarm	While PV < AL or AH < PV, ***PID-ALM*** is ON. 
1	Absolute-value alarm (with Hold)	Same as above (with Hold)
2	Absolute-value alarm (with Latch)	Same as above (with Latch)
3	Absolute-value alarm (with Hold and Latch)	Same as above (with Hold and Latch)
4	Deviation alarm	While PV < SV - AL or SV + AH < PV, ***PID-ALM*** is ON. 
5	Deviation alarm (with Hold)	Same as above (with Hold)
6	Deviation alarm (with Latch)	Same as above (with Latch)
7	Deviation alarm (with Hold and Latch)	Same as above (with Hold and Latch)

Hold: During the power-on sequence, the alarm output is kept OFF (disabled) even when the monitored quantity is within the alarm range. Once it goes out of the alarm range, and comes into the alarm range again, the alarm is enabled.

Latch: Once the monitored quantity comes into the alarm range and the alarm is turned ON, the alarm will remain ON even if it goes out of the alarm range. To release the latch, perform a reset by using the RESET key or turning the terminal command ***RST*** ON. Resetting can be done by the same way as resetting an alarm.

■ Upper level alarm (AH) (J12)

J12 specifies the upper limit of the alarm (AH) in percentage (%) of the feedback amount.

■ Lower level alarm (AL) (J13)

J13 specifies the lower limit of the alarm (AL) in percentage (%) of the feedback amount.

Note: The value displayed (%) is the ratio of the upper/lower limit to the full scale (10 V or 20 mA) of the feedback amount (in the case of a gain of 100%).

Upper level alarm (AH) and lower level alarm (AL) also apply to the following alarms.

<table>
<tr><th rowspan="2">Alarm</th><th rowspan="2">Description</th><th colspan="2">How to handle the alarm:</th></tr>
<tr><th>Select alarm output (J11)</th><th>Parameter setting</th></tr>
<tr><td>Upper limit (absolute)</td><td>ON when AH < PV</td><td rowspan="2">Absolute-value alarm</td><td>J13 (AL) = 0</td></tr>
<tr><td>Lower limit (absolute)</td><td>ON when PV < AL</td><td>J12 (AH) = 100%</td></tr>
<tr><td>Upper limit (deviation)</td><td>ON when SV + AH < PV</td><td rowspan="3">Deviation alarm</td><td>J13 (AL) = 100%</td></tr>
<tr><td>Lower limit (deviation)</td><td>ON when PV < SV - AL</td><td>J12 (AH) = 100%</td></tr>
<tr><td>Upper/lower limit (deviation)</td><td>ON when |SV - PV| > AL</td><td>J13 (AL) = J12 (AH)</td></tr>
<tr><td>Upper/lower range limit (deviation)</td><td>ON when SV - AL < PV < SV + AL</td><td>Deviation alarm</td><td rowspan="3">A negative logic signal should be assigned to PID-ALM.</td></tr>
<tr><td>Upper/lower range limit (absolute)</td><td>ON when AL < PV < AH</td><td>Absolute-value alarm</td></tr>
<tr><td>Upper/lower range limit (deviation)</td><td>ON when SV - AL < PV < SV + AH</td><td>Deviation alarm</td></tr>
</table>

J15 to J17 — PID Control (Stop frequency for slow flowrate, Slow flowrate level stop latency and Starting frequency)

(Refer to J08.)

Refer to the description of J08.

J18, J19	**PID Control (Upper limit of PID process output, Lower limit of PID process output)**

The upper and lower limiters can be specified to the PID output, exclusively used for PID control. The settings are ignored when PID cancel is enabled and the inverter is operated at the reference frequency previously specified.

(📖 E01 to E07, data = 20)

■ PID Control (Upper limit of PID process output) (J18)

J18 specifies the upper limit of the PID processor output limiter in %. If you specify "999," the setting of the frequency limiter (High) (F15) serves as the upper limit.

■ PID Control (Lower limit of PID process output) (J19)

J19 specifies the lower limit of the PID processor output limiter in %. If you specify "999," the setting of the frequency limiter (Low) (F16) serves as the lower limit.

J21	**Dew Condensation Prevention (Duty)**

When the inverter is stopped, dew condensation on the motor can be prevented, by feeding DC power to the motor at regular intervals to keep the temperature of the motor above a certain level.

■ Enabling Dew Condensation Prevention

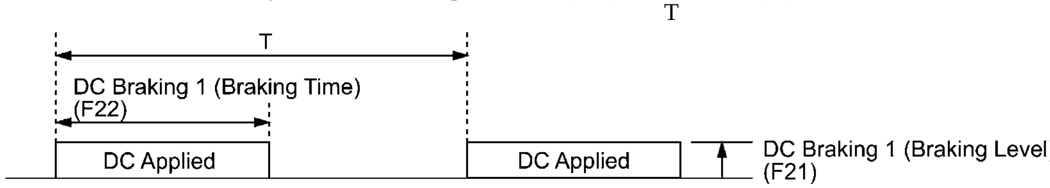
To utilize this feature, you need to assign the terminal command ***DWP*** ("Protect motor from dew condensation") to one of the general-purpose digital input terminals.

(📖 E01 to E07, data = 39)

■ Dew Condensation Prevention (Duty) (J21)

The magnitude of the DC power applied to the motor is the same as the setting of F21 (DC braking 1, Braking level) and its duration of each interval is the same as the setting of F22 (DC braking 1, Braking time). Interval T is determined so that the ratio of the duration of the DC power to T is the value (Duty) set for J21.

$$\text{Duty for condensation prevention (J21)} = \frac{F22}{T} \times 100\ (\%)$$



Condensation Prevention Cycle

J22	**Commercial Power Switching Sequence** (Refer to E01 through E07.)

Refer to the description of ***ISW50*** and ***ISW60*** (Enable integrated sequence to switch to commercial power) in E01 through E07.

J56	PID Control (Speed command filter)

Not used.

J57	PID Control (Dancer reference position)

J57 specifies the dancer reference position in the range of -100% to +100% for dancer control. This function code is enabled when J02 = 0 (Keypad).

The PID command can also be modified with the ⌃ / ⌄ keys and the modified command value is saved as J75 data.

For the setting procedure of the PID command, refer to Chapter 7, Section 7.3.3 "Configuring frequency and PID commands."

J58, J59 to J61	PID Control (Detection width of dancer position deviation) PID Control (P (Gain) 2, I (Integral time) 2 and D (Differential time) 2)

The moment the feedback value of the dancer roll position comes into the range of "Dancer reference position ± Detection width of dancer position deviation (J58)," the inverter switches PID constants from the combination of J03, J04 and J05 to that of J59, J60 and J61, respectively in its PID processor. Giving a boost to the system response by raising the P gain may improve the system performance in the dancer roll positioning accuracy.

■ Detection width of dancer position deviation (J58)

J58 specifies the bandwidth in the range of 1 to 100%. Specifying "0" does not switch PID constants.

■ P (Gain) 2 (J59)

■ I (Integral time) 2 (J60)

■ D (Differential time) 2 (J61)

Descriptions for J59, J60, and J61 are the same as those of PID control P (Gain) (J03), I (Integral time) (J04), and D (Differential time) (J05), respectively.

J62	PID Control (PID control block selection)

J62 is used to select either adding or subtracting the PID processor output to/from the primary speed command under dancer control, as well as selecting either the ratio (%) or the absolute value (Hz) to compensate the PID processor output against the primary speed command.

Data for J62			Control function	
Decimal	Bit 1	Bit 0	Control value type	Operation for the primary speed command
0	0	0	Ratio (%)	Addition
1	0	1	Ratio (%)	Subtraction
2	1	0	Absolute value (Hz)	Addition
3	1	1	Absolute value (Hz)	Subtraction

J68 to J70 J71, J72 J95, J96	**Brake Signal (Brake-OFF current, Brake-OFF frequency/speed and Brake-OFF timer)** **Brake Signal (Brake-ON frequency/speed and Brake-ON timer)** **Brake Signal (Brake-OFF torque and Speed condition selection)**

These function codes are for the brake releasing/activating signals of vertical carrier machines.

It is possible to set the conditions of the brake releasing/activating signals (current, frequency or torque) so that a hoisted load does not fall down at the start or stop of the operation, or so that the load applied to the brake is reduced.

■ Brake signal -- ***BRKS*** (E20 to E24 and E27, data = 57)

This signal outputs a brake control command that releases or activates the brake.

Releasing the Brake

When any of the inverter output current, output frequency, or torque command value exceeds the specified level of the brake signal (J68/J69/J95) for the period specified by J70 (Brake signal (Brake-OFF timer)), the inverter judges that required motor torque is generated and turns the signal ***BRKS*** ON for releasing the brake.

This prevents a hoisted load from falling down due to an insufficient torque when the brake is released.

Function code	Name	Data setting range	Remarks
J68	Brake-OFF current	0 to 300%: Set it assuming the inverter rated current as 100%.	See Note below.
J69	Brake-OFF frequency/speed	0.0 to 25.0 Hz	Available only under V/f control.
J70	Brake-OFF timer	0.0 to 5.0 s	
J95	Brake-OFF torque	0 to 300%	Available only under vector control.
J96	Speed condition selection (Braking conditions)	Response for brake-OFF current (Bit 2) 0: Slow response (default) 1: Quick response	Specifies the response type for brake-OFF current detection. Selecting slow response inserts a detection filter into the current detection circuit so that the brake-OFF timing will be slightly behind the rising edge of the actual current. If the delay is not negligible with adjustments, select quick response.

Note The inverter rated current differs depending upon the drive mode selected (LD, MD, or HD).

Turning the Brake ON

When the run command is OFF and the output frequency drops below the level specified by J71 (Brake signal (Brake-ON frequency/speed)) and stays below the level for the period specified by J72 (Brake signal (Brake-ON timer)), the inverter judges that the motor rotation is below a certain level and turns the signal ***BRKS*** OFF for activating the brake.

Under vector control, when the reference speed or the detected one drops below the level of the brake-ON frequency (specified by bit 3 of J96) and stays below the level for the period specified by J72 (Brake signal (Brake-ON timer)), the inverter judges that the motor rotation is below a certain level and turns the signal ***BRKS*** OFF for activating the brake.

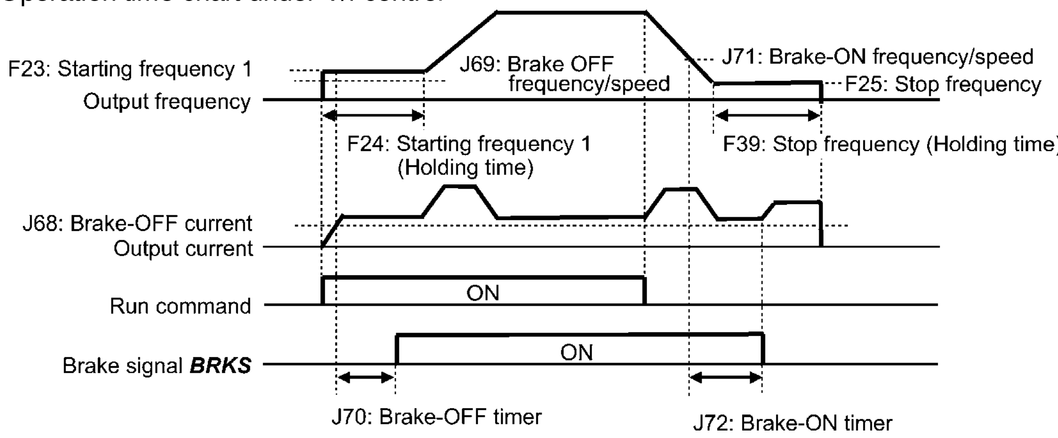
This operation reduces the load applied to the brake, extending lifetime of the brake.

Function code	Name	Data setting range	Remarks
J71	Brake-ON frequency/speed	0.0 to 25.0 Hz	
J72	Brake-ON timer	0.0 to 5.0 s	
J96	Speed condition selection (Braking conditions) Available when using vector control with/without speed sensor.	Criteria of speed condition for brake-ON (Bit 0) 0: Detected speed 1: Reference speed	Specifies the criteria of speed to be used for brake-ON condition. When "Vector control without speed sensor" is selected, specify "Reference speed" (Bit 0 = 1).
		Criteria of frequency for brake-ON (Bit 3) 0: Stop frequency (F25) 1: Brake-ON frequency (J71)	Specifies the criteria of frequency to be used for brake-ON timing. If "Detected speed" and "Stop frequency" are selected (Bit 0 = 0 and Bit 3 = 0) to determine brake-ON timing, the brake may be applied after running at the stop frequency (F25) due to a speed error. If it is required that brake is applied during running at the stop frequency, select "Brake-ON frequency" (Bit 3 = 1) as criteria of frequency. When jogging or inching the motor for vertical conveyance, use J71 as brake-ON frequency.
		Turn-on condition of brake signal (Bit 4) 0: Independent of a run command ON/OFF 1: Only when a run command is OFF	Specifies whether to turn on a brake signal independent of a run command ON/OFF or only when a run command is OFF. When normal and reverse operations are switched, brake-ON conditions may be met in the vicinity of zero speed. For such a case, select "Only when a run command is OFF" (Bit 4 = 1).

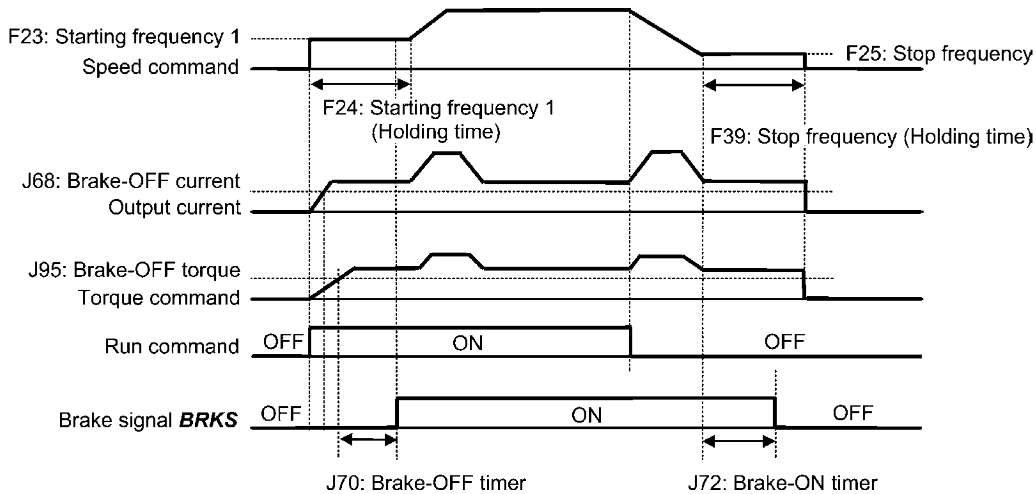
Note

- The brake signal control is only applicable to the 1st motor. If the motor switching function selects any of the 2nd to 4th motors, the brake signal remains ON.
- If the inverter is shut down due to an occurrence of alarm state or by the terminal command ***BX*** ("Coast to a stop"), the brake signal is immediately turned ON.
- Bit 1 of J96 is reserved (fixed at "0").

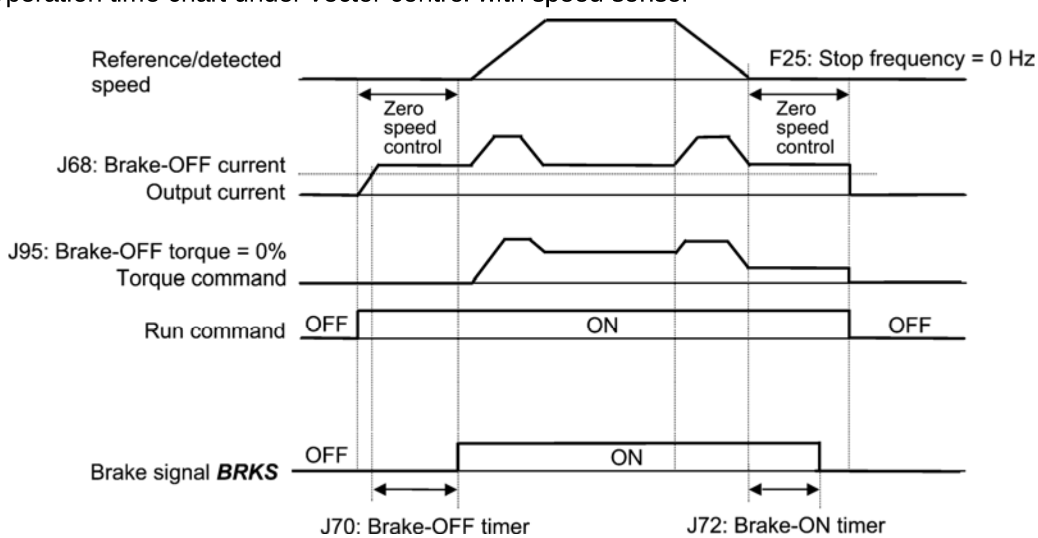
Operation time chart under V/f control



Operation time chart under vector control without speed sensor



Operation time chart under vector control with speed sensor



Note

- If zero speed control is enabled under vector control with speed sensor, set J95 (Brake-OFF torque) at 0%.
- After releasing the brake (***BRKS*** ON), operating for a while, and then activating the brake (***BRKS*** OFF) to stop the motor, if you want to release the brake (***BRKS*** ON), turn the inverter's run command OFF and then ON.

J97 to J99 Servo-lock (Gain, Completion timer, Completion range)

Servo-lock

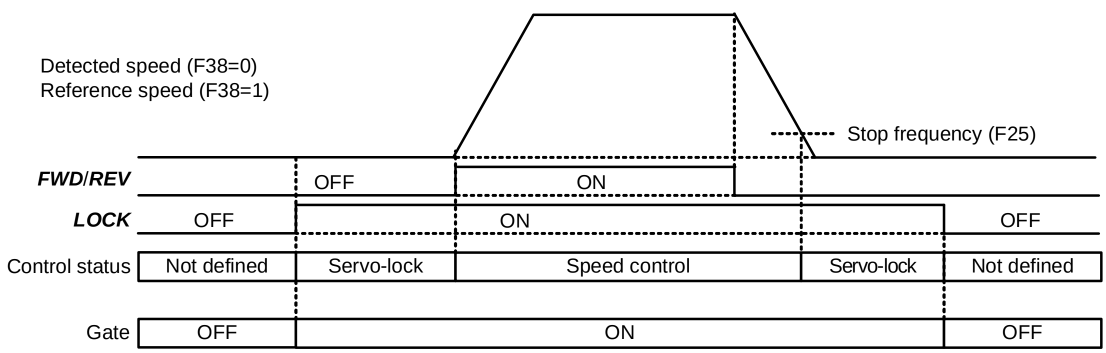
This function servo-locks the inverter to hold the motor within the positioning completion range specified by J99 for the period specified by J98 even if an external force applies to the load.

Note: When the inverter is servo-locked, it keeps the output frequency low; therefore, use the inverter under the following specified thermal restriction: Output current within the range of 150% of the rated current for 3 seconds and 80% for continuous operation. (Note that under the restriction, the inverter automatically limits the carrier frequency under 5 kHz.)

Servo-lock starting conditions

	Servo-lock control starts when the following conditions are met:	
	F38 = 0 (Use detected speed as a decision criteria)	F38 = 1 (Use reference speed as a decision criteria)
1	Run command OFF, or Reference frequency < Stop frequency (F25)	
2	***LOCK*** ("Servo-lock command") ON (Assignment of ***LOCK*** (Function code data = 47))	
3	The detected speed is less than the stop frequency (F25).	The reference speed is less than the stop frequency (F25).

Operation examples



Typical Control Sequence of Servo-lock

⚠WARNING

When the servo-lock command is ON, the inverter keeps on outputting voltage on output terminals [U], [V] and [W] even if a run command is OFF and the motor seems to stop.

An electric shock may occur.

Specifying servo-lock control

■ Positioning completion signal -- ***PSET*** (Function code data = 82), Servo-lock (Completion timer) (J98), and Servo-lock (Completion range) (J99)

This output signal comes ON when the inverter has been servo-locked so that the motor is held within the positioning completion range specified by J99 for the period specified by J98.

■ Servo-lock (Gain) (J97)

J97 specifies the gain of the servo-lock positioning device to adjust the stop behavior and shaft holding torque.

J97	Small	↔	Large
Stop behavior	Response slow, but smooth	↔	Response quick, but hunting large
Shaft holding torque	Small	↔	Large

Monitor for servo-lock control

Monitor item	LCD monitor	Function code	Remarks
Current position	Menu #3 "3: OPR MNTR," Page 8, "P4"	Current position pulse Upper digit: Z90 Lower digit: Z91	Only when the positioning device is in operation (positioning control is active), the LED monitor displays these data. When it is not in operation, the monitor is zero-cleared.
Positioning error	Menu #3 "3: OPR MNTR," Page 8, "dP4"	Positioning error pulse Upper digit: Z94 Lower digit: Z95	

The values on the LED monitor appear based on PG pulses 4-multiplied. Under servo-lock, no current positioning pulses or positioning error pulses are displayed on the LED monitor.

Notes for using servo-lock

(1) Positioning control error Ero

If a positioning error exceeds the value equivalent to four rotations of the motor shaft when the inverter is servo-locked, the inverter issues a positioning control error signal Ero.

(2) Stop frequency (F25) under servo-lock

Since servo-lock starts when the output frequency is below the stop frequency (F25), it is necessary to specify such F25 data that does not trigger Ero (that is, specify the value equivalent to less than 4 rotations of the motor shaft).

Stop frequency (F25) < (4 × Gain (J97) × Maximum frequency)

(Example) When Gain (J97) = 0.01 and Maximum frequency (F03) = 60 Hz,
specify F25 data < 2.4 Hz.

(3) Enabling servo-lock control disables the following:

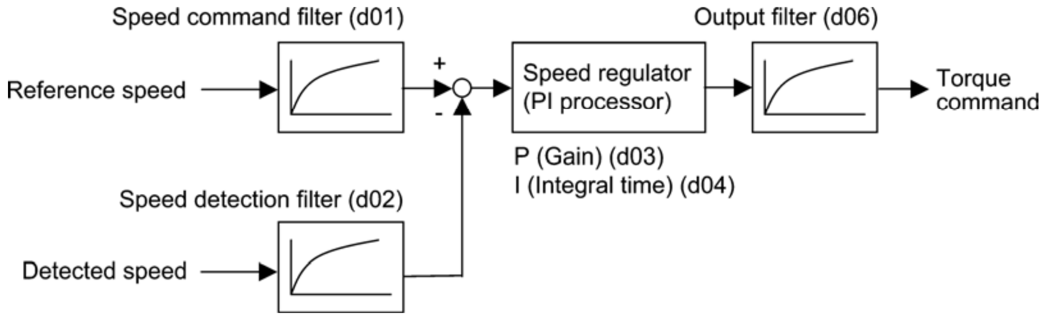
- Operation controlled with a stop frequency
- Rotation direction limitation

5.4.8 d codes (Application functions 2)

d01 to d04 d06	Speed Control 1 (Speed command filter, Speed detection filter, P (Gain) and I (Integral time)) Speed Control 1 (Output filter)

These function codes control the speed control sequence for normal operations.

Block diagram of the speed control sequence



■ Speed command filter (d01)

d01 specifies a time constant determining the first order delay of the speed command filter.

- Data setting range: 0.000 to 5.000 (s)

Modify this data when an excessive overshoot occurs against the change of the reference speed.

Increasing the filter time constant stabilizes the reference speed and reduces overshoot against the change of the reference speed, but it slows the response speed of the inverter.

■ Speed detection filter (d02)

d02 specifies a time constant determining the first order delay of the speed detection filter.

- Data setting range: 0.000 to 0.100 (s)

Modify this data when the control target (machinery) is oscillatory due to deflection of a drive belt or other causes so that ripples (oscillatory components) are superimposed on the detected speed, causing hunting (undesirable oscillation of the system) and blocking the PI processor gain from increasing (resulting in a slow response speed of the inverter). In addition, if the lower encoder (PG) resolution makes the system oscillatory, try to modify this data.

Increasing the time constant stabilizes the detected speed and raises the PI processor gain even with ripples superimposed on the detected speed. However, speed detection itself delays, resulting in a slower speed response, larger overshoot, or hunting.

■ P gain (d03), I integral time (d04)

d03 and d04 specify the gain and integral time of the speed regulator (PI processor), respectively.

- Data setting range: (d03) 0.1 to 200.0 (times)
  (d04) 0.001 to 9.999 (s)

P gain

Definition of "P gain = 1.0" is that the torque command is 100% (100% torque output of each inverter capacity) when the speed deviation (reference speed – detected speed) is 100% (equivalent to the maximum speed).

Determine the P gain according to moment of inertia of machinery loaded to the motor output shaft. Larger moment of inertia needs larger P gain to keep the flat response in whole operations.

Specifying a larger P gain improves the quickness of control response, but may cause a motor speed overshooting or hunting (undesirable oscillation of the system). Moreover, mechanical resonance or vibration sound on the machine or motor could occur due to excessively amplified noises. If it happens, decreasing P gain will reduce the amplitude of the resonance/vibration. A too small P gain results in a slow inverter response and a speed fluctuation in low frequency, which may prolong the time required for stabilizing the motor speed.

Integral time

Specifying a shorter integral time shortens the time needed to compensate the speed deviation, resulting in quick response in speed. Specify a short integral time if quick arrival to the target speed is necessary and a slight overshooting in the control is allowed; specify a long time if any overshooting is not allowed and taking longer time is allowed.

If a mechanical resonance occurs and the motor or gears sound abnormally, setting a longer integral time can transfer the resonance point to the low frequency zone and suppress the resonance in the high frequency zone.

■ Output Filter (d06)

d06 specifies the time constant for the first order delay of the speed controller output filter.

- Data setting range: 0.000 to 0.100 (s)

Use d06 when even adjusting the P gain or integral time cannot suppress mechanical resonance such as hunting or vibration. Generally, setting a larger value to the time constant of the output filter decreases the amplitude of resonance; however, a too large time constant may make the system unstable.

d07	**Speed Control 1 (Notch filter resonance frequency)** **A49, b49, r49 (Speed control 2 to 4, Notch filter resonance frequency)**
d08	**Speed Control 1 (Notch filter attenuation level)** **A50, b50, r50 (Speed control 2 to 4, Notch filter attenuation level)**

These function codes specify speed control using notch filters. The notch filters make it possible to decrease the speed loop gain only in the vicinity of the predetermined resonance points, suppressing the mechanical resonance.

The notch filters are available only under "vector control with speed sensor."

Setting the speed loop gain at a high level in order to obtain quicker speed response may cause mechanical resonance. If it happens, decreasing the speed loop gain is required to slow the speed response as a whole. In such a case, using the notch filters makes it possible to decrease the speed loop gain only in the vicinity of the predetermined resonance points and set the speed loop gain at a high level in other resonance points, enabling a quicker speed response as a whole.

The following four types of notch filters can be specified.

	Function code	Name	Data setting range	Unit	Default setting
Notch filter 1	d07	Speed control 1 (Notch filter resonance frequency)	1 to 200	Hz	200
	d08	Speed control 1 (Notch filter attenuation level)	0 to 20	dB	0 (Disable)
Notch filter 2	A49	Speed control 2 (Notch filter resonance frequency)	1 to 200	Hz	200
	A50	Speed control 2 (Notch filter attenuation level)	0 to 20	dB	0 (Disable)
Notch filter 3	b49	Speed control 3 (Notch filter resonance frequency)	1 to 200	Hz	200
	b50	Speed control 3 (Notch filter attenuation level)	0 to 20	dB	0 (Disable)
Notch filter 4	r49	Speed control 4 (Notch filter resonance frequency)	1 to 200	Hz	200
	r50	Speed control 4 (Notch filter attenuation level)	0 to 20	dB	0 (Disable)

Setting the notch filter attenuation level to "0" (dB) disables the corresponding notch filter.

It is possible to apply all of the four notch filters to the 1st motor or apply each notch filter to each of the 1st to 4th motors.

Requisite for use of notch filters	Notch filter 1	Notch filter 2	Notch filter 3	Notch filter 4
	d07 and d08	A49 and A50	b49 and b50	r49 and r50
M2, ***M3***, and ***M4*** ("Select motor 2, 3, and 4") are not in use. (E01 to E07, E98, E99 ≠ 12, 36, 37)	All of the four notch filters apply to the 1st motor.			
All of the three "Motor/Parameter Switching" items are set to "Parameter." (A42, b42, r42 = 1)	All of the four notch filters apply to the 1st motor.			
Other than the above	To the 1st motor	To the 2nd motor	To the 3rd motor	To the 4th motor

d09, d10 d11 to d13 — Speed Control (Jogging) (Speed command filter and Speed detection filter) (P (Gain), I (Integral time) and Output filter)

(Refer to d01.)

These function codes control the speed control sequence for jogging operations.

The block diagrams and function codes related to jogging operations are the same as for normal operations.

Since this speed control sequence is exclusive to jogging operations, specify these function codes to obtain higher speed response than that of normal operations for smooth jogging operations.

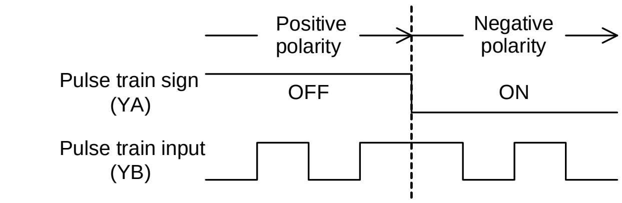
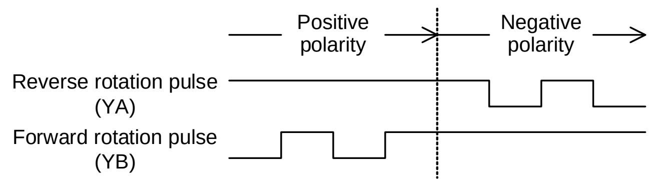
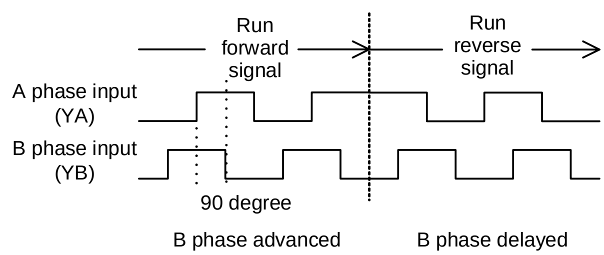
For details, refer to the corresponding descriptions (d01 to d04 and d06) about the speed control sequence for normal operations.

d14 to d17	**Feedback Input (Pulse input format, Encoder pulse resolution, Pulse count factor 1 and Pulse count factor 2)**

These function codes specify the speed feedback input under vector control with speed sensor.

■ Feedback Input, Pulse input format (d14)

d14 specifies the speed feedback input format.

Data for d14	Pulse input mode	Remarks
0	Pulse train sign/ Pulse train input	
1	Forward rotation pulse/Reverse rotation pulse	
2	A and B phases with 90 degree phase difference	

■ Feedback Input, Encoder pulse resolution (d15)

d15 specifies the pulse resolution (P/R) of the speed feedback encoder.

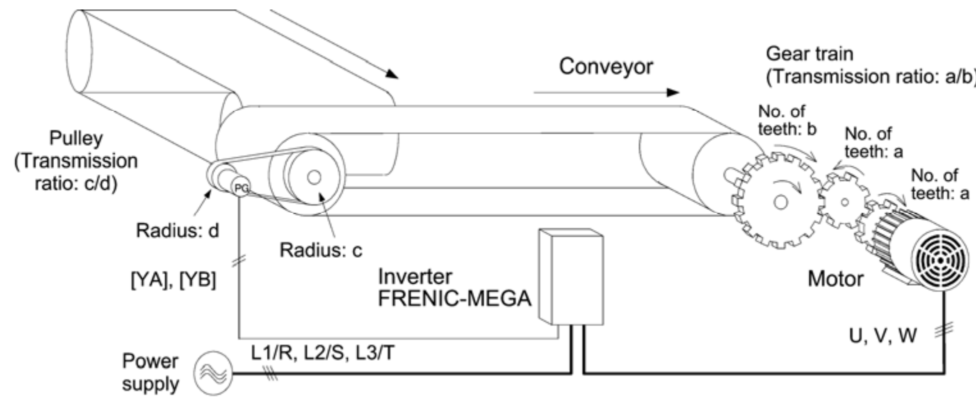
- Data setting range: 20 to 60000 (P/R)

■ Feedback Input, Pulse count factor 1 (d16) and Pulse count factor 2 (d17)

d16 and d17 specify the factors to convert the speed feedback input pulse rate into the motor shaft speed (min^{-1}).

- Data setting range: 1 to 9999

Specify the data according to the transmission ratios of the pulley and gear train as shown below.



An Example of a Closed Loop Speed Control System (Conveyor)

Listed below are expressions for conversion between a speed feedback input pulse rate and motor shaft speed.

$$\text{Motor shaft speed} = \frac{\text{Pulse count factor 2 (d17)}}{\text{Pulse count factor 1 (d16)}} \times \text{Encoder shaft speed}$$

$$\frac{\text{Pulse count factor 2 (d17)}}{\text{Pulse count factor 1 (d16)}} = \frac{b}{a} \times \frac{d}{c}$$

$$\text{Pulse count factor 1 (d16)} = a \times c$$

$$\text{Pulse count factor 2 (d17)} = b \times d$$

Note: When enabling the vector control with speed sensor, mount the sensor encoder on the motor output shaft directly, or on a shaft with the rigidity equivalent to the motor output shaft. A backlash or deflection being on the mounting shaft could interfere with normal control.

d21, d22 d23	Speed Agreement/PG Error (Hysteresis width and Detection timer) PG Error Processing

These function codes specify the detection levels of the speed agreement signal ***DSAG*** and PG error detected signal ***PG-ERR***.

Speed agreement signal *DSAG* (E20 to E24 and E27, data = 71)

■ Speed Agreement/PG Error (Hysteresis width (d21) and Detection timer (d22))

- Data setting range: (d21) 0.0 to 50.0 (%), 100 (%) at the maximum speed
  (d22) 0.00 to 10.00 (s)

If the speed regulator's deviation (between the reference speed and detected one) is within the specified range (d21), the signal ***DSAG*** turns ON. If the deviation is out of the specified range (d21) for the specified period (d22), the signal turns OFF. This signal allows the user to check whether the speed regulator works properly or not.

PG error detected signal *PG-ERR* (E20 to E24 and E27, data = 76)

■ Speed Agreement/PG Error (Hysteresis width (d21), Detection timer (d22) and PG Error Processing (d23))

- Data setting range: (d21) 0.0 to 50.0 (%), 100 (%) at the maximum speed
  (d22) 0.00 to 10.00 (s)
  (d23) 0 to 5

If the speed regulator's deviation (between the reference speed and detected one) is out of the specified range (d21) for the period specified by d22, the inverter judges it as a PG error.

d23 defines the detection condition (and exception), processing after error detection, and hysteresis width as listed below.

Data for d23	Function	Detection condition (and exception)	Processing after error detection	Hysteresis width for error detection
0	Continue to run 1	When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.	The inverter outputs the PG error detected signal ***PG-ERR*** and continues to run.	Detection width = d21, which is constant, even if the speed command is above the base frequency (F04).
1	Stop running with alarm 1		The inverter initiates a motor coast to stop, with the Er-E alarm. It also outputs the PG error detected signal ***PG-ERR***.	
2	Stop running with alarm 2	No exception.		
3	Continue to run 2	When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.	The inverter outputs the PG error detected signal ***PG-ERR*** and continues to run.	If the speed command is below the base frequency (F04), detection width = d21, which is constant. If it is above the base frequency, detection width = d21*Speed command*Maximum frequency/Base frequency (F04).
4	Stop running with alarm 3		The inverter initiates a motor coast to stop, with the Er-E alarm. It also outputs the PG error detected signal ***PG-ERR***.	
5	Stop running with alarm 4	No exception.		

Note: Enabling an operation limiting function such as the torque limit and droop control will increase the deviation caused by a huge gap between the reference speed and detected one. In this case, the inverter may trip interpreting this situation as a PG error, depending on the running state. To avoid this incident, set the d23 data to "0" (Continue to run) to prevent the inverter from tripping even if any of those limiting functions is activated.

d24 Zero Speed Control (Refer to F23.)

Refer to the description of F23.

d25 ASR Switching Time (Refer to A42.)

Refer to the description of A42.

d32, d33 Torque control (Speed limits 1 and 2)

If a regenerative load (which is not generated usually) is generated under droop control or function codes are incorrectly configured, then the motor may rotate at an unintended high speed. To protect the machinery, it is possible to specify the overspeed level with d32 and d33 as follows.

- Forward overspeed level = Maximum frequency 1 (F03) × Speed limit 1 (d32) × 120 (%)
- Reverse overspeed level = Maximum frequency 1 (F03) × Speed limit 2 (d33) × 120 (%)

d41 Application-Defined Control

d41 selects/deselects constant peripheral speed control or synchronous control (simultaneous or standby synchronization).

Constant peripheral speed control suppresses an increase in peripheral speed (line speed) resulting from the increasing radius of the take-up roll in a winder system.

Synchronous control drives two or more shafts of a conveyer while keeping their positions in synchronization. For details about synchronous control, refer to the PG Interface Card instruction manual.

■ Application-Defined Control (d41)

Data for d41	Function
0	Disable (Ordinary control)
1	Enable (Constant peripheral speed control) **Note:** This control is valid only when "V/f control with speed sensor" or "Dynamic torque vector control with speed sensor" is selected with F42, A14, b14, or r14 (data = 3 or 4).
2	Enable (Simultaneous synchronization, without Z phase)
3	Enable (Standby synchronization)
4	Enable (Simultaneous synchronization, with Z phase)

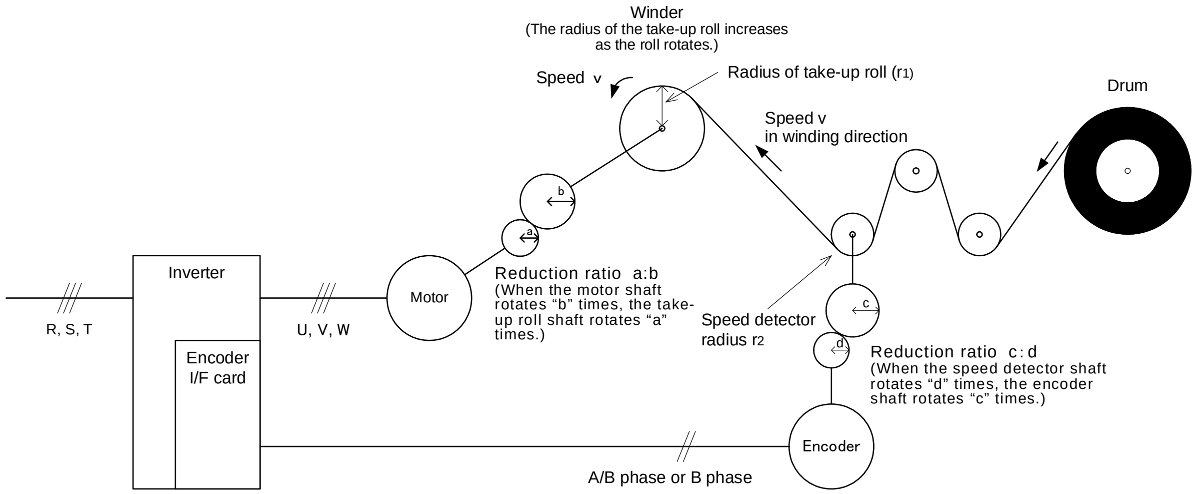
[1] Constant Peripheral Speed Control

In a winder system (e.g., roving frames, wiredrawing machines), if the inverter continues to run the motor at a constant speed, the take-up roll gets bigger with materials (roving, wire, etc.) and its radius increases so that the winding speed of the take-up roll increases.

To keep the peripheral speed (winding speed) constant, the inverter detects the winding speed using an encoder and controls the motor rotation according to the encoder feedback.

Machinery configuration of winder system and function code settings

Shown below is a machinery configuration of a winder system for which it is necessary to configure the function codes as listed below.



- Speed reduction ratio between motor shaft and take-up roll shaft a : b
- Speed reduction ratio between speed detector shaft and encoder shaft c : d
- Radius of take-up roll before winding r_1
- Radius of speed detector r_2

Setting the Reduction Ratio

Function code	Name	Settings
d15	Encoder pulse resolution	Encoder pulse resolution (P/R)
d16	Pulse count factor 1	Speed reduction ratio of the whole machinery (load) $\frac{K_2}{K_1} = \frac{r_2}{r_1} \times \frac{b}{a} \times \frac{d}{c} = \text{d17/d16}$ d16: Denominator factor for the speed reduction ratio (K1 = r1 × a × c) d17: Numerator factor for the speed reduction ratio (K2 = r2 × b × d)
d17	Pulse count factor 2	

■ Peripheral speed (line speed) command

Under constant peripheral speed control, speed commands should be given as peripheral speed (line speed) commands.

Setting with digital inputs

To digitally specify a peripheral speed (line speed) in m/min, make the following settings.

Function code	Name	Settings
E48	LED monitor	5: Line speed
E50	Coefficient for speed indication	$K_s = \frac{240\pi \times a \times r_1}{p \times b}$ Ks: Coefficient for speed indication (E50) p: Number of motor poles a, b: Components of speed reduction ratio between motor shaft and take-up roll shaft (When the motor shaft rotates "b" times, the take-up roll shaft rotates "a" times.) r1: Radius of take-up roll before winding (initial value) in m

Setting with analog inputs

To specify a peripheral speed (line speed) using analog inputs, set an analog input (0 to 100%) based on the following equation.

$$\text{Analog input (\%)} = \frac{p \times b \times 100}{240\pi \times r1 \times a \times fmax} \times V$$

Where
V: Peripheral speed (Line speed) in m/min
f_{max}: Maximum frequency 1 (F03)

■ Adjustment

Like usual speed controls, it is necessary to adjust the speed command filter, speed detection filter, P gain, and integral time in the speed control sequence that controls the peripheral speed at a constant level.

Function code	Name	Key points
d01	Speed control (Speed command filter)	If an excessive overshoot occurs for a speed command change, increase the filter constant.
d02	Speed control (Speed detection filter)	If ripples are superimposed on the speed detection signal so that the speed control gain cannot be increased, increase the filter constant to obtain a larger gain.
d03	Speed control P (Gain)	If hunting is caused in the motor speed control, decrease the gain. If the motor response is slow, increase the gain.
d04	Speed control I (Integral time)	If the motor response is slow, decrease the integral time.

■ Cancel constant peripheral speed control -- ***Hz/LSC***
(Function code E01 to E07, data = 70)

Turning ON ***Hz/LSC*** cancels constant peripheral speed control. This disables the frequency compensation of PI operation, resulting in no compensation for a take-up roll getting bigger and an increase in the winding speed.

Use this signal to temporarily interrupt the control for repairing a thread break, for example.

Hz/LSC	Function
OFF	Enable constant peripheral speed control (depending on d41 setting)
ON	Cancel constant peripheral speed control (V/f control, without compensation for a take-up roll getting bigger)

■ Hold the constant peripheral speed control frequency in the memory -- ***LSC-HLD*** (Function code E01 to E07, data = 71)

If ***LSC/HLD*** is ON under constant peripheral speed control, stopping the inverter (including an occurrence of an alarm and a coast-to-stop command) or turning OFF ***Hz/LSC*** saves the current frequency command compensating for a take-up roll getting bigger, in the memory. At the time of restart, the saved frequency command applies and the inverter keeps the peripheral speed constant.

LSC-HLD	Function
OFF	Disable (No saving operation)
ON	Enable (Saving the frequency command compensating for a take-up roll getting bigger)

Note: Shutting down the inverter power during an operation stop loses the frequency compensation data saved in the memory. At the time of restart, therefore, the inverter runs at the frequency without compensation so that a large overshoot may occur.

d51 to d55 d68, d69, d99 — Reserved for particular manufacturers

Function codes d51 to d55, d68, d69 and d99 appear on the LED monitor, but they are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

d59, d61 d62, d63 — Command (Pulse Rate Input) (Pulse input format, Filter time constant, Pulse count factor 1 and Pulse count factor 2)

(Refer to F01.)

Refer to the description of F01.

d60, d71 to d78 — Command (Pulse Rate Input) (Encoder pulse resolution) Synchronous Operation

These function codes specify various parameters required for synchronous operation. For details, refer to the PG Interface Card instruction manual.

d70 — Speed Control Limiter

d70 specifies a limiter for the PI value output calculated in speed control sequence under "V/f control with speed sensor" or "dynamic torque vector control with speed sensor."

A PI value output is within the "slip frequency × maximum torque (%)" in a normally controlled state.

If an abnormal state such as a temporary overload arises, the PI value output greatly fluctuates and it may take a long time for the PI value output to return to the normal level. Limiting the PI value output with d70 suppresses such abnormal operation.

Data setting range: 0 to 100 (%) (assuming the maximum frequency as 100%)

5.4.9 U codes (Application functions 3)

U00	**Customizable Logic (Mode selection)**
U01 to U50	**Customizable Logic: Step 1 to 10 (Setting)**
U71 to U75	**Customizable Logic Output Signal 1 to 5 (Output selection)**
U81 to U85	**Customizable Logic Output Signal 1 to 5 (Function selection)**
U91	**Customizable Logic Timer Monitor (Step selection)**

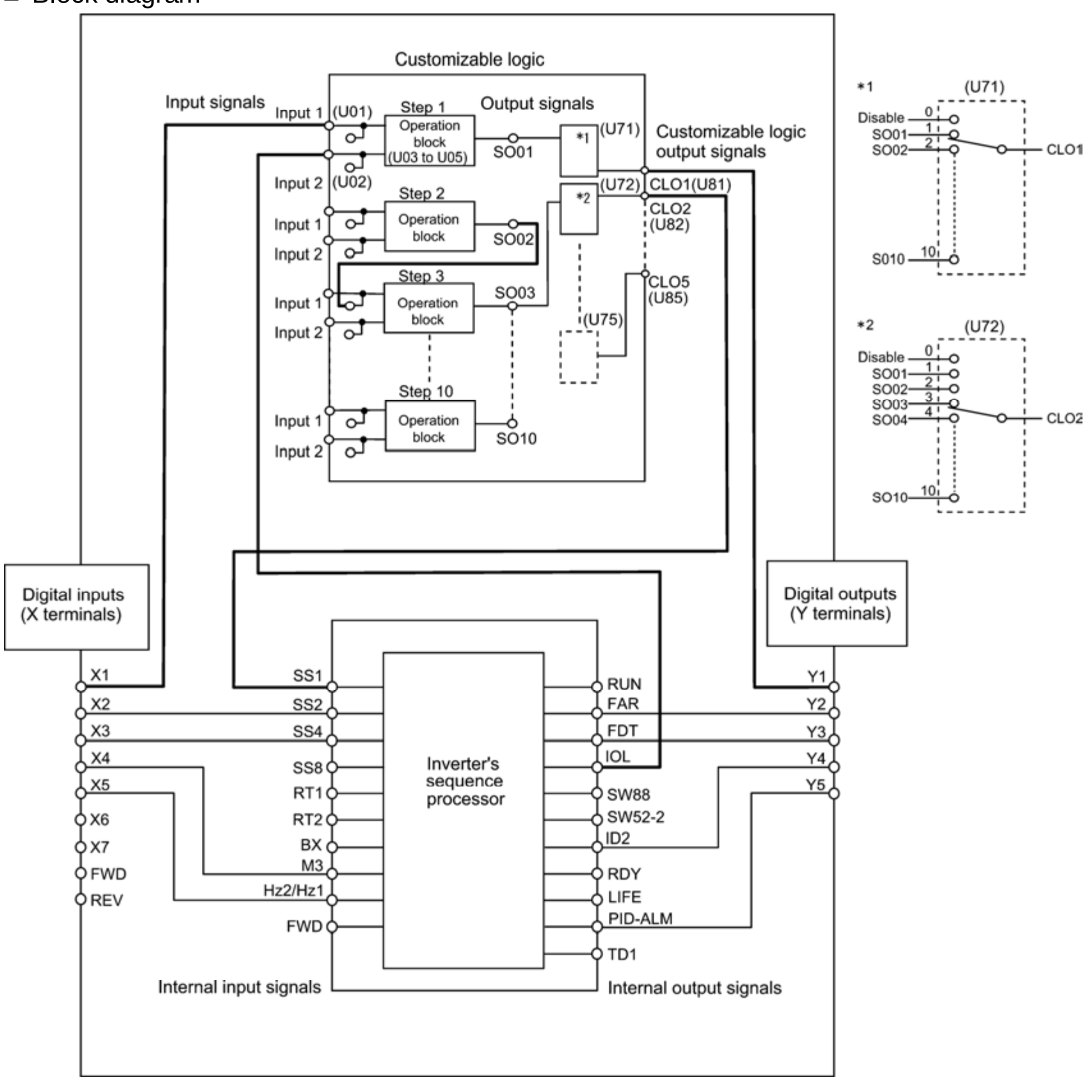
The customizable logic function allows the user to form a logic circuit for digital input/output signals, customize those signals arbitrarily, and configure a simple relay sequence inside the inverter.

In a customizable logic, one step (component) is composed of "2 inputs and 1 output + logical operation (including timer)" and a total of ten steps can be used to configure a sequence.

■ Specifications

Item	Specifications
Input signal	2 inputs
Operation block	Logical operation, counter, etc.: 13 types Timer: 5 types
Output signal	1 output
Number of steps	10 steps
Customizable logic output signal	5 outputs
Customizable logic processing time	2 ms

■ Block diagram



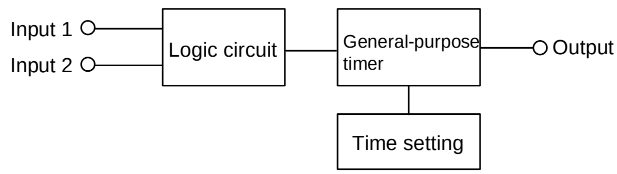
■ Customizable Logic (Mode selection) (U00)

U00 specifies whether to enable the sequence configured with the customizable logic function or disable it to run the inverter only via its input terminals and others.

Data for U00	Function
0	Disable
1	Enable (Customizable logic operation)

■ Customizable Logic (Setting) (U01 to U50)

In a customizable logic, one step is composed of the components shown in the following block diagram.



Configuration of function codes for each step

Step No.	Input 1	Input 2	Logic circuit	General-purpose timer	Time setting	Output (Note)
Step 1	U01	U02	U03	U04	U05	***SO01***
Step 2	U06	U07	U08	U09	U10	***SO02***
Step 3	U11	U12	U13	U14	U15	***SO03***
Step 4	U16	U17	U18	U19	U20	***SO04***
Step 5	U21	U22	U23	U24	U25	***SO05***
Step 6	U26	U27	U28	U29	U30	***SO06***
Step 7	U31	U32	U33	U34	U35	***SO07***
Step 8	U36	U37	U38	U39	U40	***SO08***
Step 9	U41	U42	U43	U44	U45	***SO09***
Step 10	U46	U47	U48	U49	U50	***SO10***

(Note) These items shown in this column are output signals, not function codes.

■ Inputs 1 and 2 (U01, U02, etc.)

The following signals are available as input signals.

Data	Selectable Signals	
0000 (1000) | 0105 (1105)	General-purpose output signals Same as the ones specified by E20, e.g., ***RUN*** (Inverter running), ***FAR*** (Frequency (speed) arrival signal), ***FDT*** (Frequency (speed) detected), ***LU*** (Undervoltage detected (Inverter stopped)), ***B/D*** (Torque polarity detected) **Note:** 27 (Universal DO) is not available.	
2001 (3001)	Output of step 1	***SO01***
2002 (3002)	Output of step 2	***SO02***
2003 (3003)	Output of step 3	***SO03***
2004 (3004)	Output of step 4	***SO04***
2005 (3005)	Output of step 5	***SO05***
2006 (3006)	Output of step 6	***SO06***
2007 (3007)	Output of step 7	***SO07***
2008 (3008)	Output of step 8	***SO08***

Data	Selectable Signals	
2009 (3009)	Output of step 9	***SO09***
2010 (3010)	Output of step 10	***SO10***
4001 (5001)	Terminal [X1] input signal	***X1***
4002 (5002)	Terminal [X2] input signal	***X2***
4003 (5003)	Terminal [X3] input signal	***X3***
4004 (5004)	Terminal [X4] input signal	***X4***
4005 (5005)	Terminal [X5] input signal	***X5***
4006 (5006)	Terminal [X6] input signal	***X6***
4007 (5007)	Terminal [X7] input signal	***X7***
4010 (5010)	Terminal [FWD] input signal	***FWD***
4011 (5011)	Terminal [REV] input signal	***REV***
6000 (7000)	Final run command (ON when "frequency command ≠ 0" and a run command is given)	***FL_RUN***
6001 (7001)	Final FWD run command (ON when "frequency command ≠ 0" and a run forward command is given)	***FL_FWD***
6002 (7002)	Final REV run command (ON when "frequency command ≠ 0" and a run reverse command is given)	***FL_REV***
6003 (7003)	During acceleration (ON during acceleration)	***DACC***
6004 (7004)	During deceleration (ON during deceleration)	***DDEC***
6005 (7005)	Under anti-regenerative control (ON under anti-regenerative control)	***REGA***
6006 (7006)	Within dancer reference position (ON when the dancer roll position is within the reference range)	***DR_REF***
6007 (7007)	Alarm factor presence (ON when there is no alarm factor)	***ALM_ACT***

■ Logic circuit (U03, etc.)

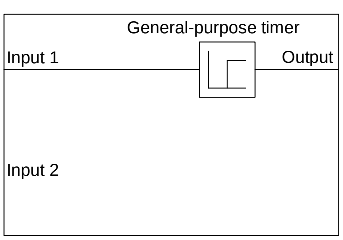
Any of the following functions is selectable as a logic circuit (with general-purpose timer).

Data	Function	Description
0	No function assigned	Output is always OFF.
1	Through output + General-purpose timer	Only a general-purpose timer. No logic circuit exists.
2	ANDing + General-purpose timer	AND circuit with 2 inputs and 1 output, plus general-purpose timer.
3	ORing + General-purpose timer	OR circuit with 2 inputs and 1 output, plus general-purpose timer.
4	XORing + General-purpose timer	XOR circuit with 2 inputs and 1 output, plus general-purpose timer.
5	Set priority flip-flop + General-purpose timer	Set priority flip-flop with 2 inputs and 1 output, plus general-purpose timer.
6	Reset priority flip-flop + General-purpose timer	Reset priority flip-flop with 2 inputs and 1 output, plus general-purpose timer.
7	Rising edge detector + General-purpose timer	Rising edge detector with 1 input and 1 output, plus general-purpose timer. This detects the rising edge of an input signal and outputs the ON signal for 2 ms.

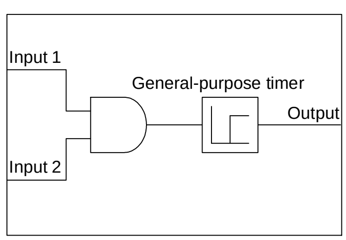
Data	Function	Description
8	Falling edge detector + General-purpose timer	Falling edge detector with 1 input and 1 output, plus general-purpose timer. This detects the falling edge of an input signal and outputs the ON signal for 2 ms.
9	Rising & falling edges detector + General-purpose timer	Rising and falling edges detector with 1 input and 1 output, plus general-purpose timer. This detects both the falling and rising edges of an input signal and outputs the ON signal for 2 ms.
10	Hold + General-purpose timer	Hold function of previous values of 2 inputs and 1 output, plus general-purpose timer. If the hold control signal is OFF, the logic circuit outputs input signals; if it is ON, the logic circuit retains the previous values of input signals.
11	Increment counter	Increment counter with reset input. By the rising edge of an input signal, the logic circuit increments the counter value by one. When the counter value reaches the target one, the output signal turns ON. Turning the reset signal ON resets the counter to zero.
12	Decrement counter	Decrement counter with reset input. By the rising edge of an input signal, the logic circuit decrements the counter value by one. When the counter value reaches zero, the output signal turns ON. Turning the reset signal ON resets the counter to the initial value.
13	Timer with reset input	Timer output with reset input. If an input signal turns ON, the output signal turns ON and the timer starts. When the period specified by the timer has elapsed, the output signal turns OFF, regardless of the input signal state. Turning the reset signal ON resets the current timer value to zero and turns the output OFF.

The block diagrams for individual functions are given below.

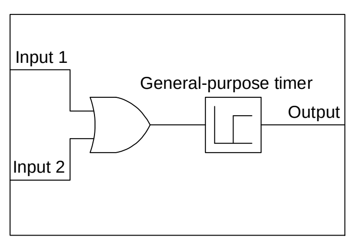
(1) Through output



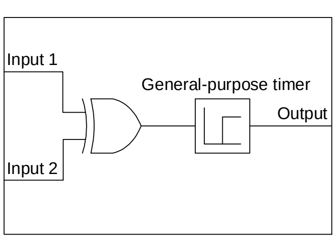
(2) AND



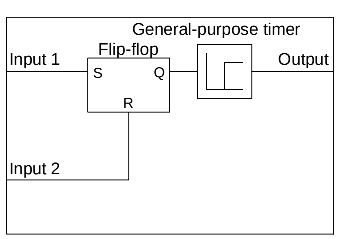
(3) OR



(4) XOR

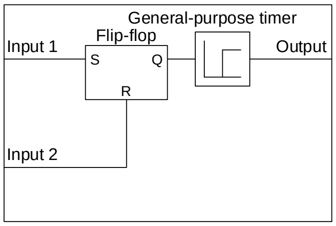


(5) Set priority flip-flop



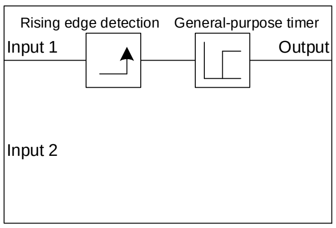
Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
	ON	—	OFF	
ON	—	—	ON	Set priority

(6) Reset priority flip-flop

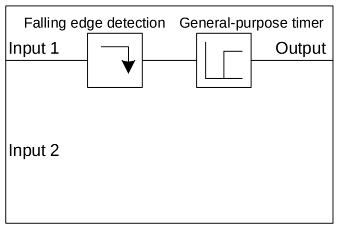


Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
–	ON	–	OFF	Reset priority
ON	OFF	–	ON	

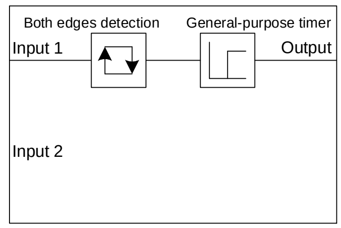
(7) Rising edge detector



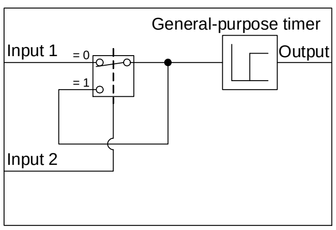
(8) Falling edge detector



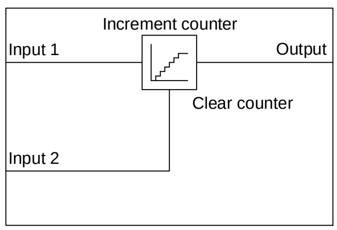
(9) Rising & falling edges detector



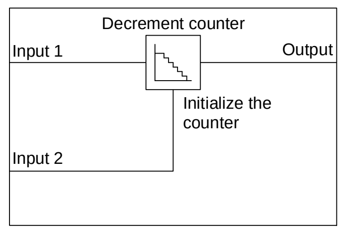
(10) Hold



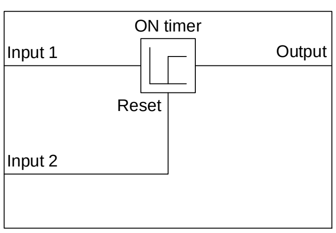
(11) Increment counter

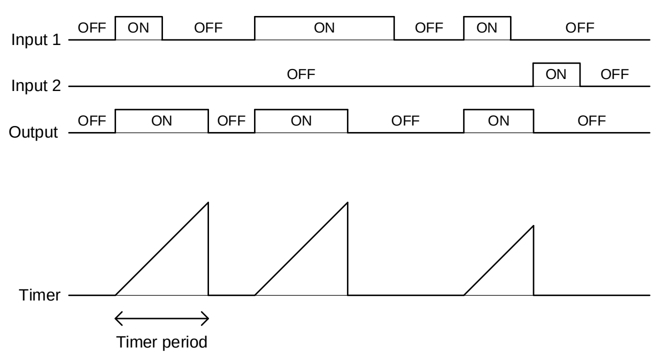


(12) Decrement counter



(13) Timer with reset input





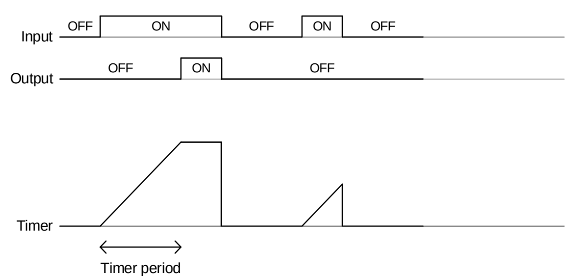
■ General-purpose timer (U04, etc.)

The table below lists the general-purpose timers available.

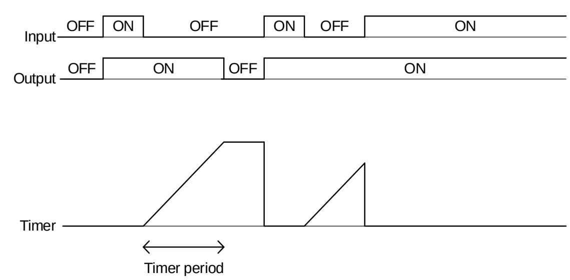
Data	Function	Description
0	No timer	
1	On-delay timer	Turning an input signal ON starts the on-delay timer. When the period specified by the timer has elapsed, an output signal turns ON. Turning the input signal OFF turns the output signal OFF.
2	Off-delay timer	Turning an input signal ON turns an output signal ON. Turning the input signal OFF starts the off-delay timer. When the period specified by the timer has elapsed, the output signal turns OFF.
3	One-shot pulse output	Turning an input signal ON issues a one-shot pulse whose length is specified by the timer.
4	Retriggerable timer	Turning an input signal ON issues a one-shot pulse whose length is specified by the timer. If an input signal is turned ON again during the preceding one-shot pulse length, however, the logic circuit issues another one-shot pulse.
5	Pulse train output	If an input signal turns ON, the logic circuit issues ON and OFF pulses (whose lengths are specified by the timer) alternately and repeatedly. This function is used to flash a luminescent device.

The operation schemes for individual timers are shown below.

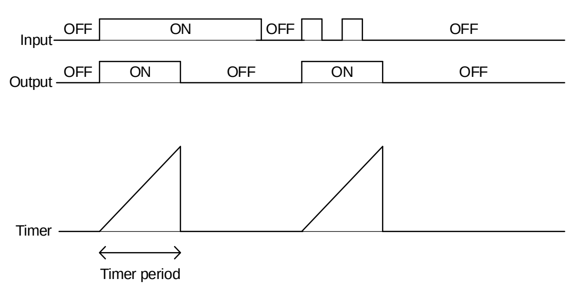
(1) On-delay timer



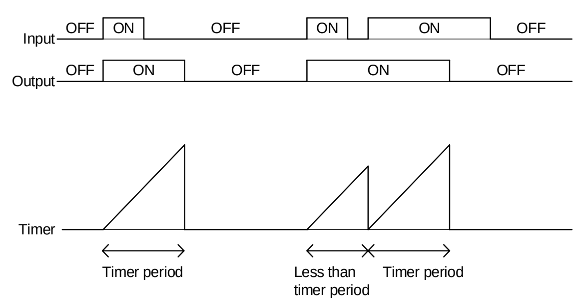
(2) Off-delay timer



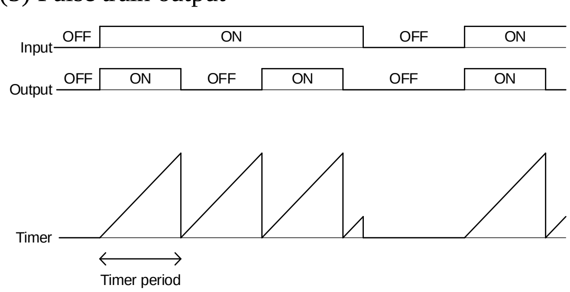
(3) One-shot pulse output



(4) Retriggerable timer



(5) Pulse train output



■ Time setting (U05, etc.)

U05 and other related function codes specify the general-purpose timer period or the increment/decrement counter value.

Data	Function	Description
0.00 to 600.00	Timer period	The period is specified by seconds.
	Counter value	The specified value is multiplied by 100 times. (If 0.01 is specified, it is converted to 1.)

■ Output signals

In a customizable logic, outputs from steps 1 to 10 are issued to SO01 to SO10, respectively.

SO01 to SO10 differ in configuration depending upon the connection destination, as listed below. (To relay those outputs to any function other than the customizable logic, route them via customizable logic outputs CLO1 to CLO5.)

If the connection destination is:	Configuration	Function codes
Customizable logic input	Select one of the internal step output signals ***SO01*** to ***SO10*** in customizable logic input setting.	U01, U02, etc.
Input to the inverter's sequence processor (e.g., "Select multi-frequency" ***SS1***, "Run forward" ***FWD***)	Select one of the internal step output signals ***SO01*** to ***SO10*** to be connected to customizable logic output signals 1 to 5 (***CLO1*** to ***CLO5***).	U71 to U75
	Select an inverter's sequence processor input function to which one of the customizable logic output signals 1 to 5 (***CLO1*** to ***CLO5***) is to be connected. (Same as in E01)	U81 to U85
General-purpose digital output (Y terminals)	Select one of the internal step output signals ***SO01*** to ***SO10*** to be connected to customizable logic output signals 1 to 5 (***CLO1*** to ***CLO5***).	U71 to U75
	To specify a general-purpose digital output function (on Y terminals) to which one of the customizable logic output signals 1 to 5 (***CLO1*** to ***CLO5***) is to be connected, select one of ***CLO1*** to ***CLO5*** by specifying the general-purpose digital output function on any Y terminal.	E20 to E24, E27

Note General-purpose digital outputs (on Y terminals) are updated every 5 ms. To securely output a customizable logic signal via Y terminals, include on- or off-delay timers in the customizable logic. Otherwise, short ON or OFF signals may not be reflected on those terminals.

Function code	Name	Data setting range	Default setting
U71	Customizable logic output signal 1 (Output selection)	0: Disable 1: Output of step 1, ***SO01*** 2: Output of step 2, ***SO02*** 3: Output of step 3, ***SO03*** 4: Output of step 4, ***SO04*** 5: Output of step 5, ***SO05*** 6: Output of step 6, ***SO06*** 7: Output of step 7, ***SO07*** 8: Output of step 8, ***SO08*** 9: Output of step 9, ***SO09*** 10: Output of step 10, ***SO10***	0
U72	Customizable logic output signal 2 (Output selection)		0
U73	Customizable logic output signal 3 (Output selection)		0
U74	Customizable logic output signal 4 (Output selection)		0
U75	Customizable logic output signal 5 (Output selection)		0

Function code	Name	Data setting range	Default setting
U81	Customizable logic output signal 1 (Function selection)	0 to 100, 1000 to 1081 Same as data of E98/E99, except the following. 19 (1019): Enable data change with keypad (data can be modified) 80 (1080): Cancel customizable logic	100
U82	Customizable logic output signal 2 (Function selection)		100
U83	Customizable logic output signal 3 (Function selection)		100
U84	Customizable logic output signal 4 (Function selection)		100
U85	Customizable logic output signal 5 (Function selection)		100

■ Notes for using a customizable logic

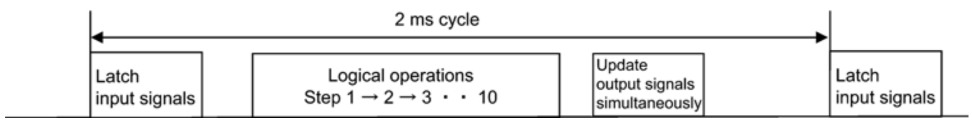
A customizable logic performs processing every 2 ms in the following sequence.

(1) At the start of processing, the customizable logic latches all of the external input signals entered to steps 1 to 10 to ensure simultaneity.

(2) Logical operations are performed in the order of steps 1 to 10.

(3) If an output of a particular step applies to an input at the next step, the output of the step having processing priority can be used in the same processing.

(4) The customizable logic updates all of the five output signals at the same time.



When configuring a logic circuit, take into account the processing order of the customizable logic. Otherwise, a delay in processing of logical operation leads to a signal delay problem, resulting in no expected output, slow processing, or a hazard signal issued.

⚠CAUTION

Ensure safety before modifying customizable logic related function code settings (U codes and related function codes) or turning ON the "Cancel customizable logic" terminal command ***CLC***. Depending upon the settings, such modification or cancellation of the customizable logic may change the operation sequence to cause a sudden motor start or an unexpected motor operation.

An accident or injuries could occur.

■ Customizable logic timer monitor (Step selection) (U91)

The contents of the timer in a customizable logic can be monitored using the monitor-related function code or the keypad.

Selecting a timer to be monitored

Function code	Function	Remarks
U91	1 to 10 U91 specifies the step number whose timer or counter is to be monitored	

Monitoring

Monitored by:	Related function code and LED monitor display	Monitored item
Communications link	X90 Customizable logic (Timer monitor)	Timer or counter value specified by U91 (dedicated to monitoring)

■ Cancel customizable logic -- ***CLC*** (E01 to E07, data = 80)

This terminal command disables the customizable logic temporarily. Use it to run the inverter without using the customizable logic circuit or timers for maintenance or other purposes.

CLC	Function
OFF	Enable customizable logic (Depends on the U00 setting)
ON	Disable customizable logic

Note Before changing the setting of ***CLC***, ensure safety. Turning ***CLC*** ON disables the sequence of the customizable logic, causing a sudden motor start depending upon the settings.

■ Clear all customizable logic timers -- ***CLTC*** (E01 to E07, data = 81)

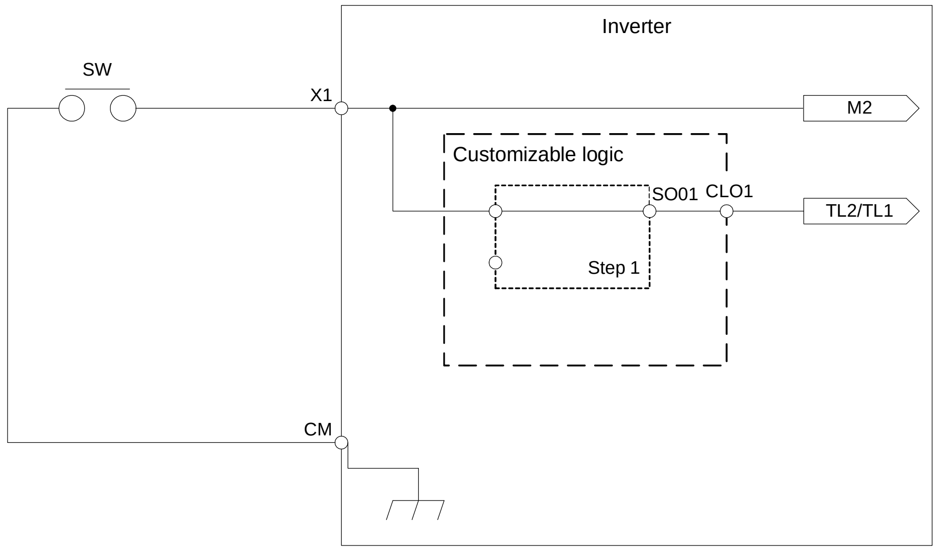
Assigning ***CLTC*** to any of the general-purpose digital input terminals and turning it ON resets all of the general-purpose timers and counters in the customizable logic. Use this command when the timings between the external sequence and the internal customizable logic do not match due to a momentary power failure or other reasons so that resetting and restarting the system is required.

CLTC	Function
OFF	Ordinary operation
ON	Reset all of the general-purpose timers and counters in the customizable logic. (To operate the timers and counters again, revert ***CLTC*** to OFF.)

■ Customizable logic configuration samples

Configuration sample 1: Switch two or more signals using a single switch

When switching between ***M2*** (Select motor 2) and ***TL2/TL1*** (Select torque limiter level 2/1) with a single switch, using a customizable logic instead of a conventional external circuit reduces the number of the required general-purpose input terminals to one as shown below.

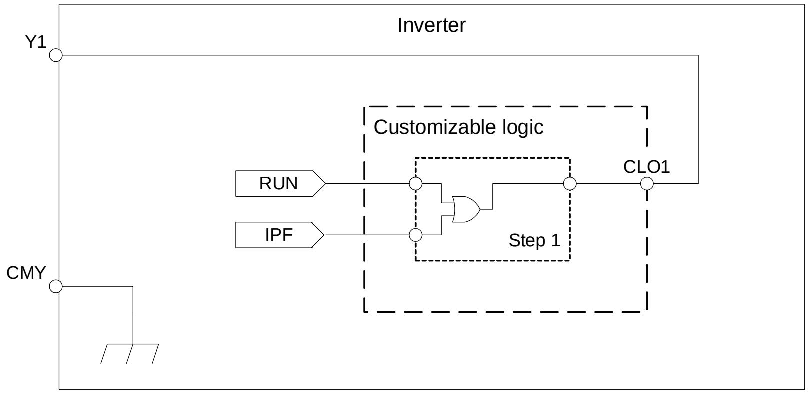


To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E01	Terminal [X1] Function		12	Select motor 2, ***M2***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	4001	Terminal [X1] input signal, ***X1***	
U03		(Logic circuit)	1	Through output + General-purpose timer	Operation selection
U71	Customizable Logic Output Signal 1	(Output selection)	1	Output of step 1, ***SO01***	
U81		(Function selection)	14	Select torque limiter level 2/1, ***TL2/TL1***	

Configuration sample 2: Put two or more output signals into one

When putting two or more output signals into one, using a customizable logic instead of a conventional external circuit reduces the number of the required general-purpose output terminals and eliminates external relays as shown below.

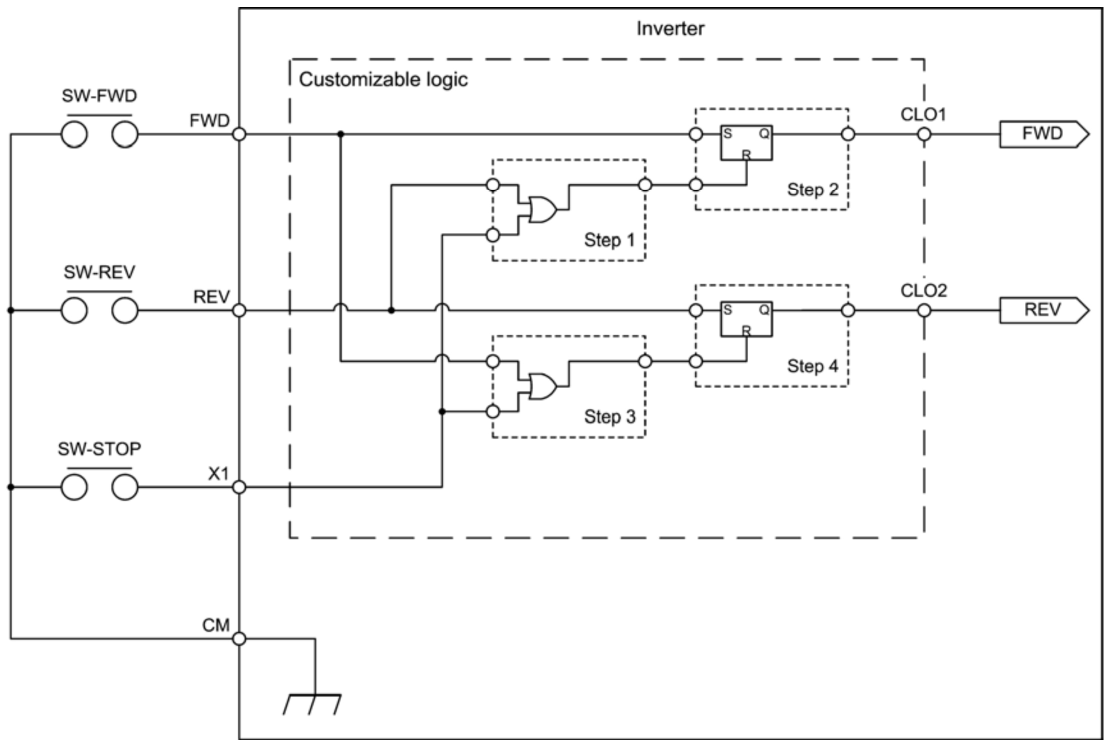


To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E20	Terminal [Y1] Function		111	Customizable logic output signal 1, ***CLO1***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	0	Inverter running, ***RUN***	
U02		(Input 2)	6	Auto-restarting after momentary power failure, ***IPF***	
U03		(Logic circuit)	3	ORing + General-purpose timer	Operation selection
U71	Customizable Logic Output Signal 1	(Output selection)	1	Output of step 1, ***SO01***	
U81		(Function selection)	100	No function assigned, ***NONE***	

Configuration sample 3: One-shot operation

When starting the inverter by short-circuiting the SW-FWD or SW-REV switch and stopping it by short-circuiting the SW-STOP switch (which are functionally equivalent to depression of the RUN and STOP keys on the keypad, respectively), using a customizable logic instead of a conventional external circuit simplifies the external circuit as shown below.



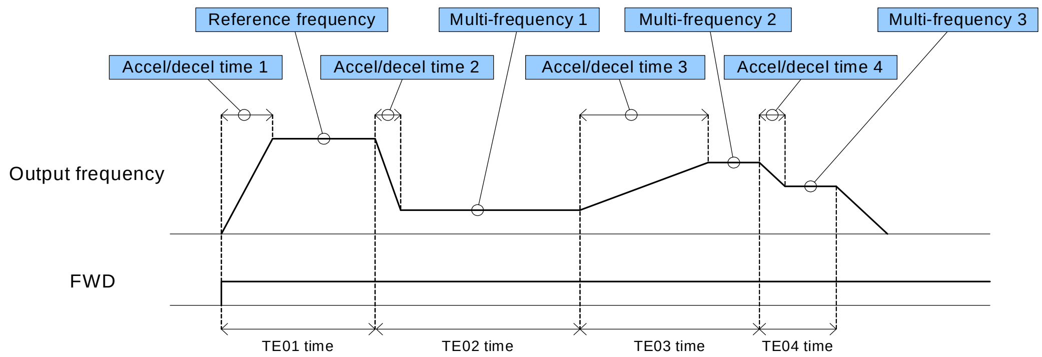
To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E01	Terminal [X1] Function		100	No function assigned, ***NONE***	
E98	Terminal [FWD] Function		100	No function assigned, ***NONE***	
E99	Terminal [REV] Function		100	No function assigned, ***NONE***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	4011	Terminal [REV] input signal, ***REV***	
U02		(Input 2)	4001	Terminal [X1] input signal, ***X1***	
U03		(Logic circuit)	3	ORing + General-purpose timer	Operation selection
U06	Customizable Logic: Step 2	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U07		(Input 2)	2001	Output of step 1, ***SO01***	
U08		(Logic circuit)	6	Reset priority flip-flop + General-purpose timer	Operation selection

Function Code			Setting Data	Function	Remarks
U11	Customizable Logic: Step 3	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U12		(Input 2)	4001	Terminal [X1] input signal, ***X1***	
U13		(Logic circuit)	3	ORing + General-purpose timer	Operation selection
U16	Customizable Logic: Step 4	(Input 1)	4011	Terminal [REV] input signal, ***REV***	
U17		(Input 2)	2003	Output of step 3, ***SO03***	
U18		(Logic circuit)	6	Reset priority flip-flop + General-purpose timer	Operation selection
U71	Customizable Logic Output Signal 1	(Output selection)	2	Output of step 2, ***SO02***	FWD command
U72	Customizable Logic Output Signal 2		4	Output of step 4, ***SO04***	REV command
U81	Customizable Logic Output Signal 1	(Function selection)	98	Run forward, ***FWD***	
U82	Customizable Logic Output Signal 2		99	Run reverse, ***REV***	

Configuration sample 4: Pattern operation

Driving the motor while switching the reference frequency and acceleration/deceleration time at specified time intervals is called "Pattern operation." Given below is a pattern operation sample chart.

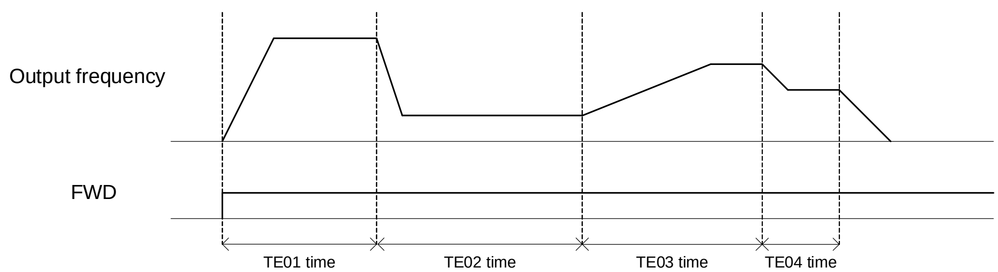


Pattern Operation Setting for Each Stage

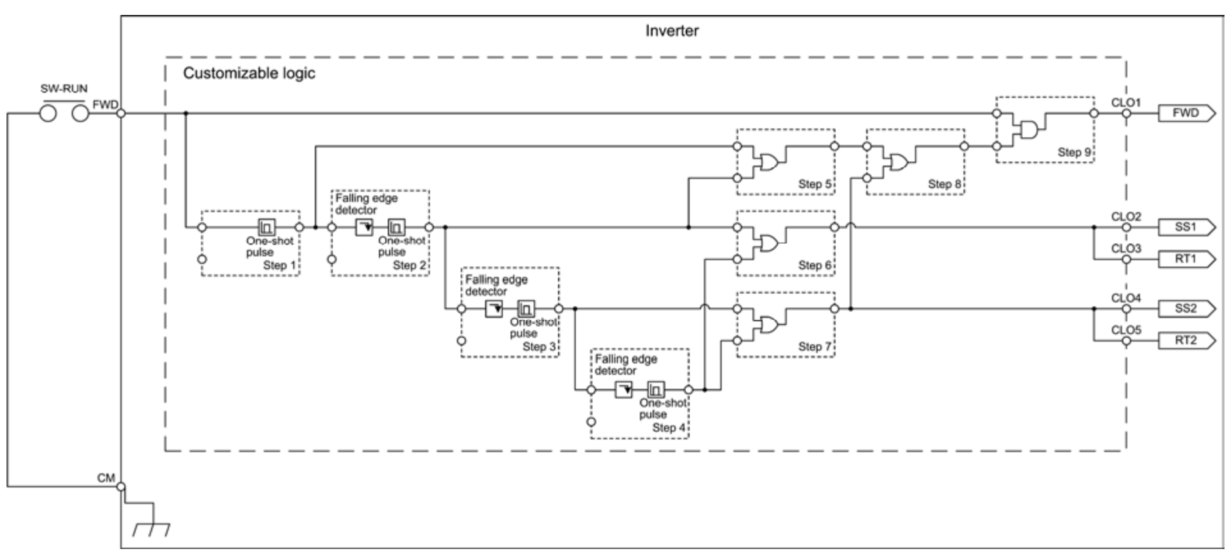
Customizable logic configuration samples for enabling pattern operations are described below.

(1) A single cycle of pattern operation and stop

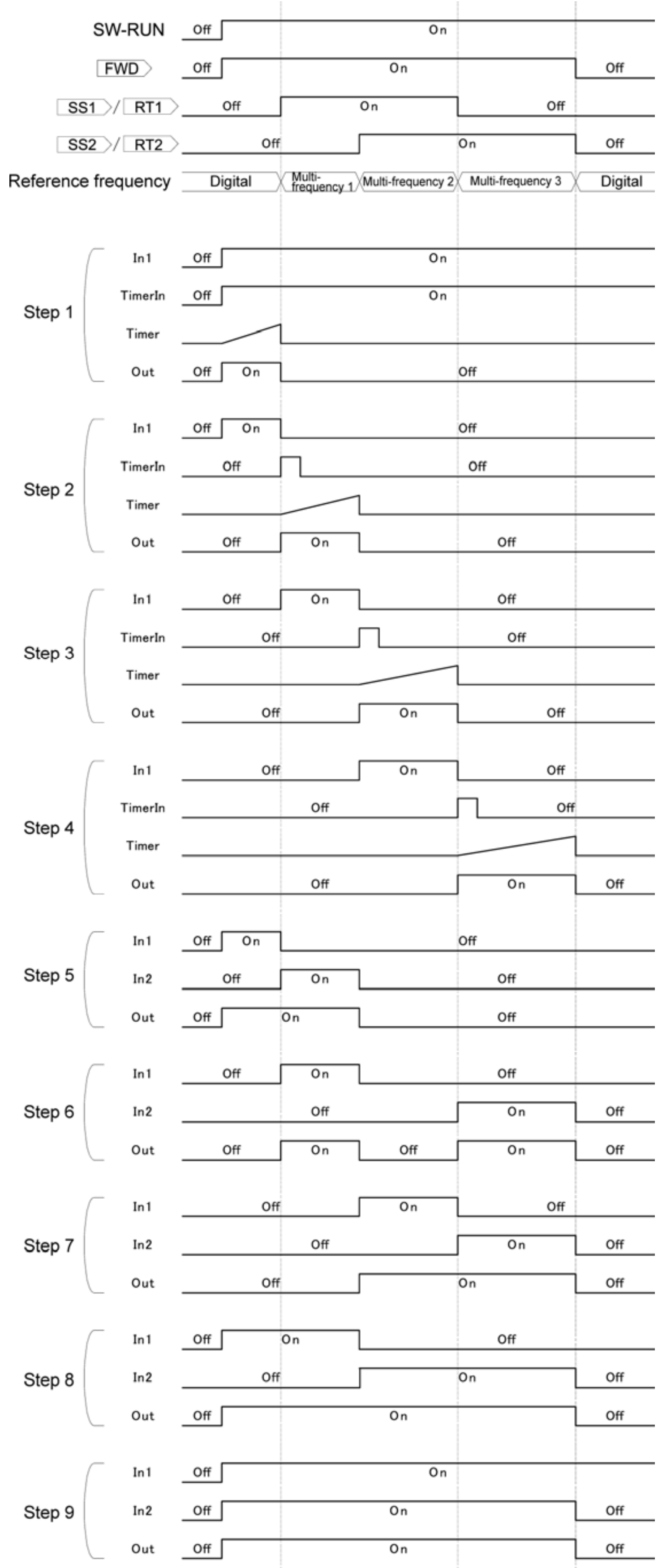
This sample carries out a cycle of the specified pattern operation and stops the inverter output.



Timing Chart of "A Single Cycle of Pattern Operation and Stop"



Customizable Logic Configuration for "A Single Cycle of Pattern Operation and Stop"



Operation Chart of
Customizable Logic Steps 1 to 9 for "A Single Cycle of Pattern Operation and Stop"

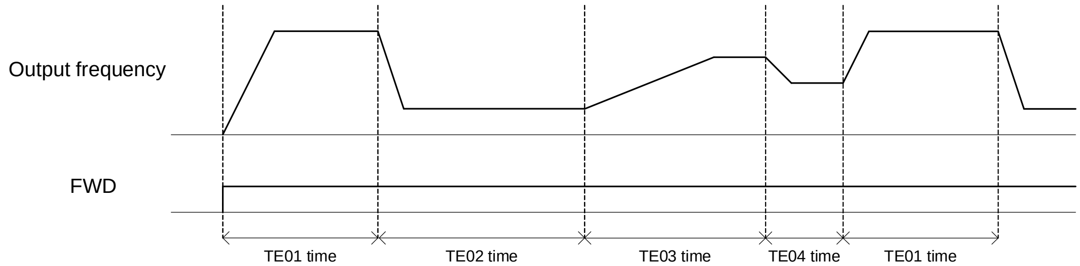
To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E98	Terminal [FWD] Function		100	No function assigned, ***NONE***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U03		(Logic circuit)	1	Through output + General-purpose timer	Operation selection
U04		(Type of timer)	3	One-shot pulse output	
U05		(Time setting)	arbitrary	Stage 1 run time	
U06	Customizable Logic: Step 2	(Input 1)	2001	Output of step 1, ***SO01***	
U08		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U09		(Type of timer)	3	One-shot pulse output	
U10		(Time setting)	arbitrary	Stage 2 run time	
U11	Customizable Logic: Step 3	(Input 1)	2002	Output of step 2, ***SO02***	
U13		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U14		(Type of timer)	3	One-shot pulse output	
U15		(Time setting)	arbitrary	Stage 3 run time	
U16	Customizable Logic: Step 4	(Input 1)	2003	Output of step 3, ***SO03***	
U18		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U19		(Type of timer)	3	One-shot pulse output	
U20		(Time setting)	arbitrary	Stage 4 run time	
U21	Customizable Logic: Step 5	(Input 1)	2001	Output of step 1, ***SO01***	
U22		(Input 2)	2002	Output of step 2, ***SO02***	
U23		(Logic circuit)	3	ORing + General-purpose timer	
U26	Customizable Logic: Step 6	(Input 1)	2002	Output of step 2, ***SO02***	
U27		(Input 2)	2004	Output of step 4, ***SO04***	
U28		(Logic circuit)	3	ORing + General-purpose timer	
U31	Customizable Logic: Step 7	(Input 1)	2003	Output of step 3, ***SO03***	
U32		(Input 2)	2004	Output of step 4, ***SO04***	
U33		(Logic circuit)	3	ORing + General-purpose timer	
U36	Customizable Logic: Step 8	(Input 1)	2005	Output of step 5, ***SO05***	
U37		(Input 2)	2007	Output of step 7, ***SO07***	
U38		(Logic circuit)	3	ORing + General-purpose timer	

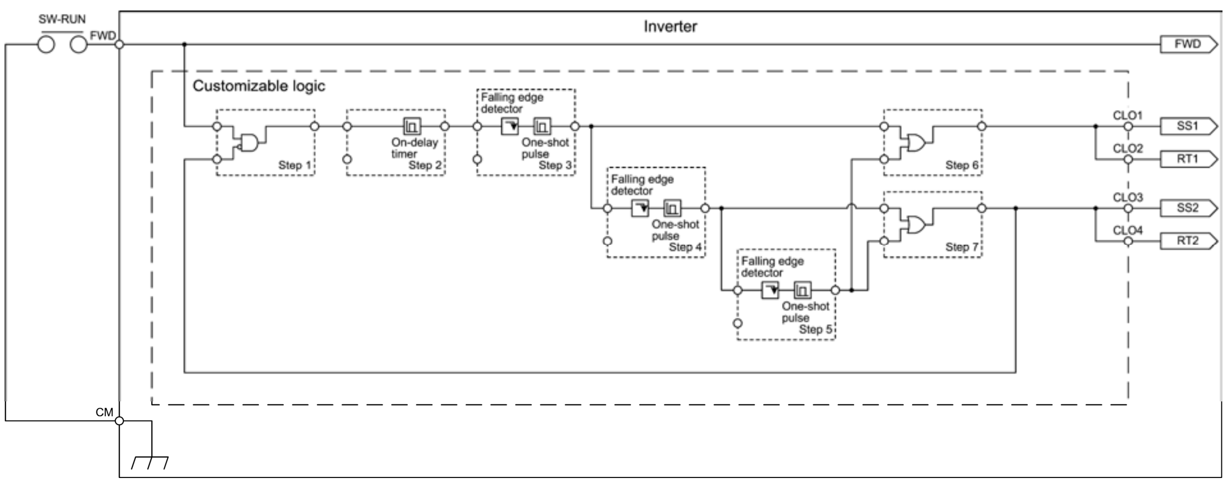
Function Code			Setting Data	Function	Remarks
U41	Customizable Logic: Step 9	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U42		(Input 2)	2008	Output of step 8, ***SO08***	
U43		(Logic circuit)	2	ANDing + General-purpose timer	
U71	Customizable Logic Output Signal 1	(Output selection)	9	Output of step 9, ***SO09***	FWD command
U72	Customizable Logic Output Signal 2		6	Output of step 6, ***SO06***	SS1 command
U73	Customizable Logic Output Signal 3		6	Output of step 6, ***SO06***	RT1 command
U74	Customizable Logic Output Signal 4		7	Output of step 7, ***SO07***	SS2 command
U75	Customizable Logic Output Signal 5		7	Output of step 7, ***SO07***	RT2 command
U81	Customizable Logic Output Signal 1	(Function selection)	98	Run forward, ***FWD***	
U82	Customizable Logic Output Signal 2		0	Select multi-frequency (0 to 1 step), ***SS1***	
U83	Customizable Logic Output Signal 3		4	Select ACC/DEC time (2 steps), ***RT1***	
U84	Customizable Logic Output Signal 4		1	Select multi-frequency (0 to 3 steps), ***SS2***	
U85	Customizable Logic Output Signal 5		5	Select ACC/DEC time (4 steps), ***RT2***	

(2) Repeating of pattern operation

This sample carries out the specified pattern operation repeatedly and stops the inverter output upon receipt of a stop command.



Timing Chart of "Repeating of Pattern Operation"



Customizable Logic Configuration for "Repeating of Pattern Operation"

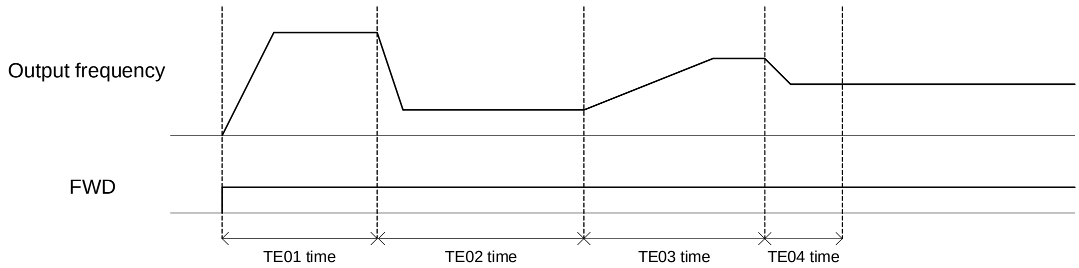
To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E98	Terminal [FWD] Function		98	Run forward, ***FWD***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U02		(Input 2)	3007	Output of step 7 (negative logic), ***SO07***	
U03		(Logic circuit)	2	ANDing + General-purpose timer	
U06	Customizable Logic: Step 2	(Input 1)	2001	Output of step 1, ***SO01***	
U08		(Logic circuit)	1	Through output + General-purpose timer	Operation selection
U09		(Type of timer)	1	On-delay timer	
U10		(Time setting)	arbitrary	Stage 1 run time	
U11	Customizable Logic: Step 3	(Input 1)	3002	Output of step 2 (negative logic), ***SO02***	
U13		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U14		(Type of timer)	3	One-shot pulse output	
U15		(Time setting)	arbitrary	Stage 2 run time	
U16	Customizable Logic: Step 4	(Input 1)	2003	Output of step 3, ***SO03***	
U18		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U19		(Type of timer)	3	One-shot pulse output	
U20		(Time setting)	arbitrary	Stage 3 run time	
U21	Customizable Logic: Step 5	(Input 1)	2004	Output of step 4, ***SO04***	
U23		(Logic circuit)	8	Falling edge detector + General-purpose timer	
U24		(Type of timer)	3	One-shot pulse output	
U25		(Time setting)	arbitrary	Stage 4 run time	
U26	Customizable Logic: Step 6	(Input 1)	2003	Output of step 3, ***SO03***	
U27		(Input 2)	2005	Output of step 5, ***SO05***	
U28		(Logic circuit)	3	ORing + General-purpose timer	

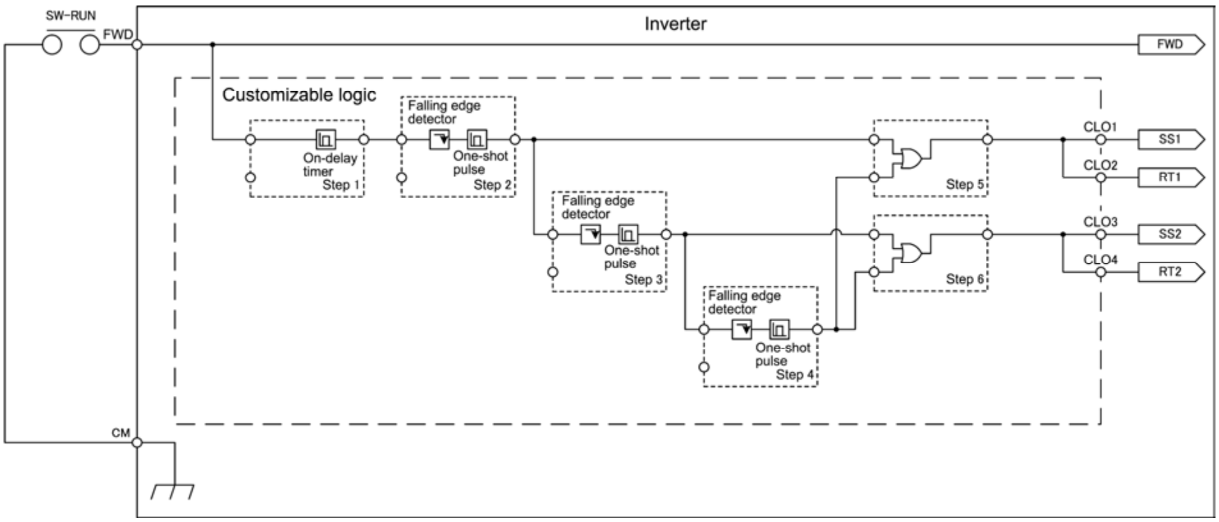
Function Code			Setting Data	Function	Remarks
U31	Customizable Logic: Step 7	(Input 1)	2004	Output of step 4, ***SO04***	
U32		(Input 2)	2005	Output of step 5, ***SO05***	
U33		(Logic circuit)	3	ORing + General-purpose timer	
U71	Customizable Logic Output Signal 1	(Output selection)	6	Output of step 6, ***SO06***	SS1 command
U72	Customizable Logic Output Signal 2		6	Output of step 6, ***SO06***	RT1 command
U73	Customizable Logic Output Signal 3		7	Output of step 7, ***SO07***	SS2 command
U74	Customizable Logic Output Signal 4		7	Output of step 7, ***SO07***	RT2 command
U81	Customizable Logic Output Signal 1	(Function selection)	0	Select multi-frequency (0 to 1 step), ***SS1***	
U82	Customizable Logic Output Signal 2		4	Select ACC/DEC time (2 steps), ***RT1***	
U83	Customizable Logic Output Signal 3		1	Select multi-frequency (0 to 3 steps), ***SS2***	
U84	Customizable Logic Output Signal 4		5	Select ACC/DEC time (4 steps), ***RT2***	

(3) A single cycle of pattern operation and continuation of running

This sample carries out a cycle of the specified pattern operation and continues to run.



Timing Chart of "A Single Cycle of Pattern Operation and Continuation of Running"



Customizable Logic Configuration for "A Single Cycle of Pattern Operation and Continuation of Running"

To configure the above customizable logic, set function codes as listed below. The "Type of timer" and "Time setting" require no modification unless otherwise specified.

Function Code			Setting Data	Function	Remarks
E98	Terminal [FWD] Function		98	Run forward, ***FWD***	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable Logic: Step 1	(Input 1)	4010	Terminal [FWD] input signal, ***FWD***	
U03		(Logic circuit)	1	Through output + General-purpose timer	Operation selection
U04		(Type of timer)	1	On-delay timer	
U05		(Time setting)	arbitrary	Stage 1 run time	
U06	Customizable Logic: Step 2	(Input 1)	3001	Output of step 1 (negative logic), ***SO01***	
U08		(Logic circuit)	8	Falling edge detector + General-purpose timer	Operation selection
U09		(Type of timer)	3	One-shot pulse output	
U10		(Time setting)	arbitrary	Stage 2 run time	
U11	Customizable Logic: Step 3	(Input 1)	2002	Output of step 2, ***SO02***	
U13		(Logic circuit)	8	Falling edge detector + General-purpose timer	Operation selection
U14		(Type of timer)	3	One-shot pulse output	
U15		(Time setting)	arbitrary	Stage 3 run time	
U16	Customizable Logic: Step 4	(Input 1)	2003	Output of step 3, ***SO03***	
U18		(Logic circuit)	8	Falling edge detector + General-purpose timer	Operation selection
U19		(Type of timer)	3	One-shot pulse output	
U20		(Time setting)	arbitrary	Stage 4 run time	
U21	Customizable Logic: Step 5	(Input 1)	2002	Output of step 2, ***SO02***	
U22		(Input 2)	2004	Output of step 4, ***SO04***	
U23		(Logic circuit)	3	ORing + General-purpose timer	Operation selection
U26	Customizable Logic: Step 6	(Input 1)	2003	Output of step 3, ***SO03***	
U27		(Input 2)	2004	Output of step 4, ***SO04***	
U28		(Logic circuit)	3	ORing + General-purpose timer	Operation selection
U71	Customizable Logic Output Signal 1	(Output selection)	5	Output of step 5, ***SO05***	SS1 command
U72	Customizable Logic Output Signal 2		5	Output of step 5, ***SO05***	RT1 command
U73	Customizable Logic Output Signal 3		6	Output of step 6, ***SO06***	SS2 command
U74	Customizable Logic Output Signal 4		6	Output of step 6, ***SO06***	RT2 command
U81	Customizable Logic Output Signal 1	(Function selection)	0	Select multi-frequency (0 to 1 step), ***SS1***	
U82	Customizable Logic Output Signal 2		4	Select ACC/DEC time (2 steps), ***RT1***	
U83	Customizable Logic Output Signal 3		1	Select multi-frequency (0 to 3 steps), ***SS2***	
U84	Customizable Logic Output Signal 4		5	Select ACC/DEC time (4 steps), ***RT2***	

5.4.10 y codes (Link functions)

y01 to y20 | **RS-485 Communication 1 and 2**

Up to two RS-485 communications ports are available as listed below.

Port	Route	Function code	Applicable equipment
Port 1	RS-485 communications link (via the RJ-45 connector prepared for keypad connection)	y01 through y10	Keypad FRENIC Loader Host equipment
Port 2	RS-485 communications link (via terminals DX+, DX- and SD on the control PCB)	y11 through y20	Host equipment

To connect any of the applicable devices, follow the procedures shown below.

(1) Keypad

The keypad allows you to run and monitor the inverter.
It can be used independent of the y code setting.

(2) FRENIC Loader

Connecting your computer running FRENIC Loader to the inverter via the RS-485 communications link (port 1), you can monitor the inverter's running status information, edit function codes, and test-run the inverters.

For the setting of y codes, refer to the descriptions of y01 to y10.

Note: A remote keypad equipped with a USB port is optionally available. To use the FRENIC Loader via the USB port, simply set the station address (y01) to "1" (factory default).

(3) Host equipment

The inverter can be managed and monitored by connecting host equipment such as a PC and PLC to the inverter. Modbus RTU* and Fuji general-purpose inverter protocol are available for communications protocols.

*Modbus RTU is a protocol established by Modicon, Inc.

For details, refer to the RS-485 Communication User's Manual.

■ Station address (y01 for port 1 and y11 for port 2)

y01 or y11 specifies the station address for the RS-485 communications link. The table below lists the protocols and the station address setting ranges.

Protocol	Station address	Broadcast address
Modbus RTU protocol	1 to 247	0
FRENIC Loader protocol	1 to 255	None
FUJI general-purpose inverter protocol	1 to 31	99

- If any wrong address beyond the above range is specified, no response is returned since the inverter will be unable to receive any enquiries except the broadcast message.
- To use FRENIC Loader via the RS-485 communications link (port 1), set the station address that matches the connected computer.

■ Communications error processing (y02 for port 1 and y12 for port 2)

y02 or y12 specifies the error processing to be performed if an RS-485 communications error occurs.

RS-485 communications errors include logical errors (e.g., address error, parity error, framing error), transmission protocol error, and physical errors (e.g., no-response error specified by y08 and y18). The inverter can recognize such an error only when it is configured with a run or frequency command sourced through the RS-485 communications link and it is running.

If none of run and frequency commands is sourced through the RS-485 communications link or the inverter is not running, the inverter does not recognize any error occurrence.

Data for y02, y12	Function
0	Immediately trip, displaying an RS-485 communications error (Er-8 for y02 and Er-P for y12). (The inverter stops with alarm issue.)
1	Run during the period specified by the error processing timer (y03, y13), display an RS-485 communications error (Er-8 for y02 and Er-P for y12), and then stop operation. (The inverter stops with alarm issue.)
2	Retry communication during the period specified by the error processing timer (y03, y13). If a communications link is recovered, continue operation. Otherwise, display an RS-485 communications error (Er-8 for y02 and Er-P for y12) and stop operation. (The inverter stops with alarm issue.)
3	Continue to run even when a communications error occurs.

For details, refer to the RS-485 Communication User's Manual.

■ Timer (y03 for port 1 and y13 for port 2)

y03 or y13 specifies an error processing timer.

If the specified timer count has elapsed due to no response from the other end when a query has been issued, the inverter interprets it as an error occurrence. See the "No-response error detection time (y08, y18)" given on the next page.

- Data setting range: 0.0 to 60.0 (s)

■ Baud rate (y04 for port 1 and y14 for port 2)

y04 or y14 specifies the transmission speed for RS-485 communication.

For FRENIC Loader (via the RS-485 communications link), specify the transmission speed that matches the connected computer.

Data for y04 and y14	Transmission speed (bps)
0	2400
1	4800
2	9600
3	19200
4	38400

■ Data length (y05 for port 1 and y15 for port 2)

y05 or y15 specifies the character length for RS-485 communication.

For FRENIC Loader (via the RS-485 communications link), no setting is required since Loader automatically sets 8 bits. (The same applies to the Modbus RTU protocol.)

Data for y05 and y15	Data length
0	8 bits
1	7 bits

■ Parity check (y06 for port 1 and y16 for port 2)

y06 or y16 specifies the property of the parity bit.

For FRENIC Loader, no setting is required since Loader automatically sets the even parity.

Data for y06 and y16	Parity
0	None (2 stop bits for Modbus RTU)
1	Even parity (1 stop bit for Modbus RTU)
2	Odd parity (1 stop bit for Modbus RTU)
3	None (1 stop bit for Modbus RTU)

■ Stop bits (y07 for port 1 and y17 for port 2)

y07 or y17 specifies the number of stop bits.

For FRENIC Loader, no setting is required since Loader automatically sets 1 bit.

For the Modbus RTU protocol, no setting is required since the stop bits are automatically determined associated with the property of parity bits.

Data for y07 and y17	Stop bit(s)
0	2 bits
1	1 bit

■ No-response error detection time (y08 for port 1 and y18 for port 2)

y08 or y18 specifies the timeout period for receiving a response from the host equipment (such as a computer or PLC) in RS-485 communication, in order to detect network breaks. This applies to the machinery that accesses the host equipment at the predetermined intervals.

If a response timeout occurs, the inverter starts communications error processing.

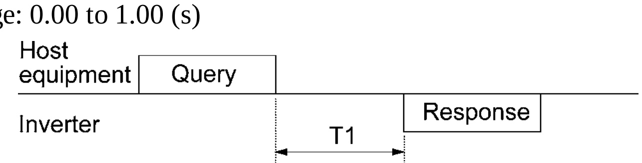
For communications error processing, refer to y02 and y12.

Data for y08 and y18	No-response error detection
0	No detection
1 to 60	1 to 60 s

■ Response interval (y09 for port 1 and y19 for port 2)

y09 or y19 specifies the latency time after the end of receiving a query sent from the host equipment (such as a computer or PLC) until the start of sending the response. This enables the inverter to control the response timing to match the host equipment that is slow in processing.

- Data setting range: 0.00 to 1.00 (s)



T1 = Response interval + α

where α is the processing time inside the inverter. α may vary depending on the processing status and the command processed in the inverter.

For details, refer to the RS-485 Communication User's Manual.

Note: When configuring the inverter with FRENIC Loader via the RS-485 communications link, pay sufficient attention to the performance and configuration of the PC and protocol converter such as USB–RS-485 converter. Some protocol converters monitor the communications status and switch between sending and receiving of transmission data with a timer.

■ Protocol selection (y10 for port 1)

y10 specifies the communications protocol for port 1.

For FRENIC Loader (via the RS-485 communications link), only y10 can be used for protocol selection. Set the y10 data at "1."

Data for y10	Protocol
0	Modbus RTU protocol
1	FRENIC Loader protocol
2	Fuji general-purpose inverter protocol

■ Protocol selection (y20 for port 2)

y20 specifies the communications protocol for port 2.

Data for y20	Protocol
0	Modbus RTU protocol
2	Fuji general-purpose inverter protocol

y97 Communication Data Storage Selection

A nonvolatile storage in the inverter has a limited number of rewritable times (100,000 to 1,000,000 times). Saving data into the storage so many times unnecessarily will no longer allow the storage to save data, causing memory errors.

For frequent data writing via the communications link, therefore, a temporary storage is provided instead of the nonvolatile storage. To use the temporary storage, set the y97 data at "1." Using the temporary storage reduces the number of data writing times into the nonvolatile storage, preventing memory errors.

Setting the y97 data at "2" saves all data written in the temporary storage into the nonvolatile one.

Changing the y97 data requires simultaneous keying of STOP and ∧ / ∨ keys.

Data for y97	Function
0	Save into nonvolatile storage (Rewritable times limited)
1	Write into temporary storage (Rewritable times unlimited)
2	Save all data from temporary storage to nonvolatile one (After saving data, the data automatically returns to "1.")

y98 Bus Link Function (Mode selection) (Refer to H30.)

Refer to the description of H30.

y99	Loader Link Function (Mode selection)

This is a link switching function for FRENIC Loader. Rewriting the data of y99 to enable RS-485 communications from Loader helps Loader send the inverter the frequency and/or run commands. Since the data to be set in the function code of the inverter is automatically set by Loader, no keypad operation is required.

With Loader being selected as a run command source, if the computer runs out of control and cannot be stopped by a stop command sent from Loader, disconnect the RS-485 communications cable from the port 1 (or disconnect the USB cable in the case of a remote keypad equipped with a USB port), connect a keypad instead, and reset the y99 data to "0." The setting of "0" in y99 means that the run and frequency command source specified by H30 takes place instead of FRENIC Loader.

Note that the inverter cannot save the setting of y99. When the power is turned off, the data in y99 is lost (y99 is reset to "0").

Data for y99	Function	
	Frequency command	Run command
0	Follow H30 and y98 data	Follow H30 and y98 data
1	Via RS-485 link (FRENIC Loader)	Follow H30 and y98 data
2	Follow H30 and y98 data	Via RS-485 link (FRENIC Loader)
3	Via RS-485 link (FRENIC Loader)	Via RS-485 link (FRENIC Loader)

Chapter 6

BLOCK DIAGRAMS FOR CONTROL LOGIC

This chapter provides the main block diagrams for the control logic of the FRENIC-MEGA series of inverters.

Contents

FRENIC-MEGA series of inverters is equipped with a number of function codes to match a variety of motor operations required in your system. Refer to Chapter 5 "FUNCTION CODES" for details of the function codes.

The function codes have functional relationship each other. Several special function codes also work with execution priority each other depending on their functions or data settings.

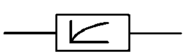
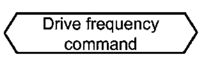
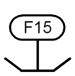
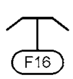
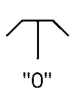
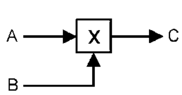
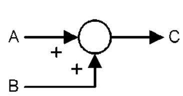
This chapter explains the main block diagrams for control logic in the inverter. You are requested to fully understand the inverter's control logic together with the function codes in order to set the function code data correctly.

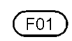
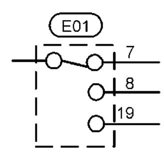
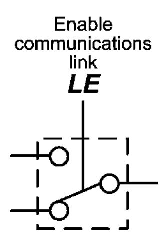
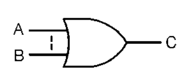
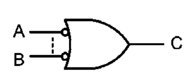
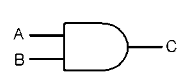
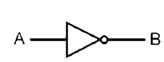
The block diagrams contained in this chapter show only function codes having mutual relationship. For the function codes that work independently and for detailed explanation of each function code, refer to Chapter 5 "FUNCTION CODES."

6.1 Symbols Used in Block Diagrams and their Meanings

Table 6.1 lists symbols commonly used in block diagrams and their meanings with some examples.

Table 6.1 Symbols and Meanings

Symbol	Meaning
[FWD], [Y1] etc.	Programmable, digital inputs/outputs to/from the inverter's control circuit terminal block.
FWD, ***REV*** etc.	Control signals (input) or status signals (output), assigned to control circuit terminals.
	Low-pass filter: Features appropriate characteristics by changing the time constant through the function code data.
	Internal control signal for inverter logic.
	High limiter: Limits the upper value by a constant or data set to a function code.
	Low limiter: Limits the lower value by a constant or data set to a function code.
	Zero limiter: Prevents data from dropping to a negative value.
	Gain multiplier for reference frequencies given by current and/or voltage input or for analog output signals. C = A × B
	Adder for 2 signals or values. C = A + B If B is negative then C = A – B (acting as a subtracter).

Symbol	Meaning
	Function code.
	Switch controlled by a function code. Numbers assigned to the terminals express the function code data.
	Switch controlled by a terminal command. In the example shown on the left, the enable communications link command ***LE*** assigned to one of the digital input terminals from [X1] to [X7] controls the switch.
	OR logic: In normal logic, if any input is ON, then C = ON. Only if all inputs are OFF, then C = OFF.
	NOR (Not-OR) logic: In normal logic, if any input is OFF, then C = ON. If all inputs are ON, C = OFF.
	AND logic: In normal logic, only if A = ON and B = ON, then C = ON. Otherwise, C = OFF.
	NOT logic: In normal logic, if A = ON, then B = OFF, and vice versa.

6.2 Drive Frequency Command Block

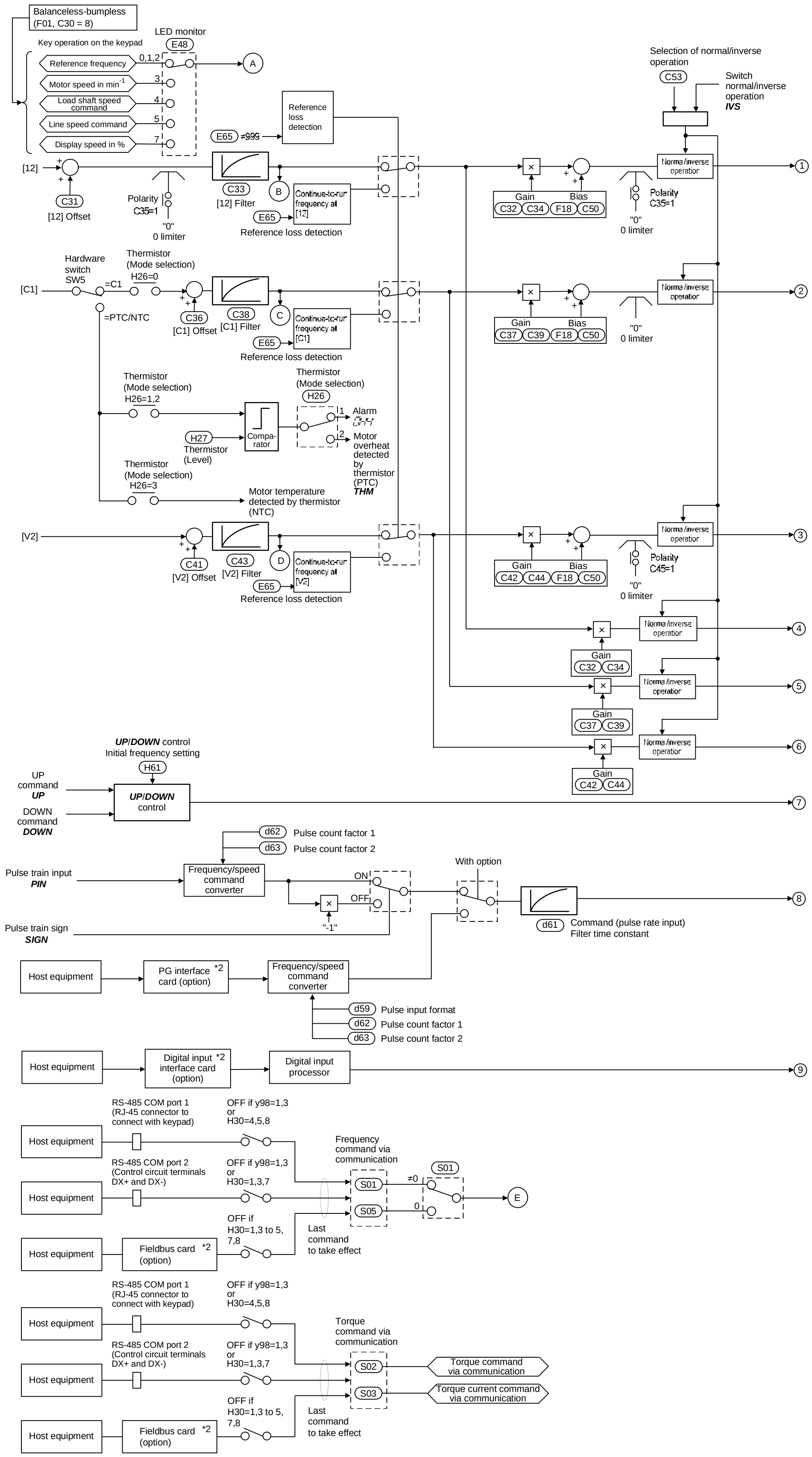
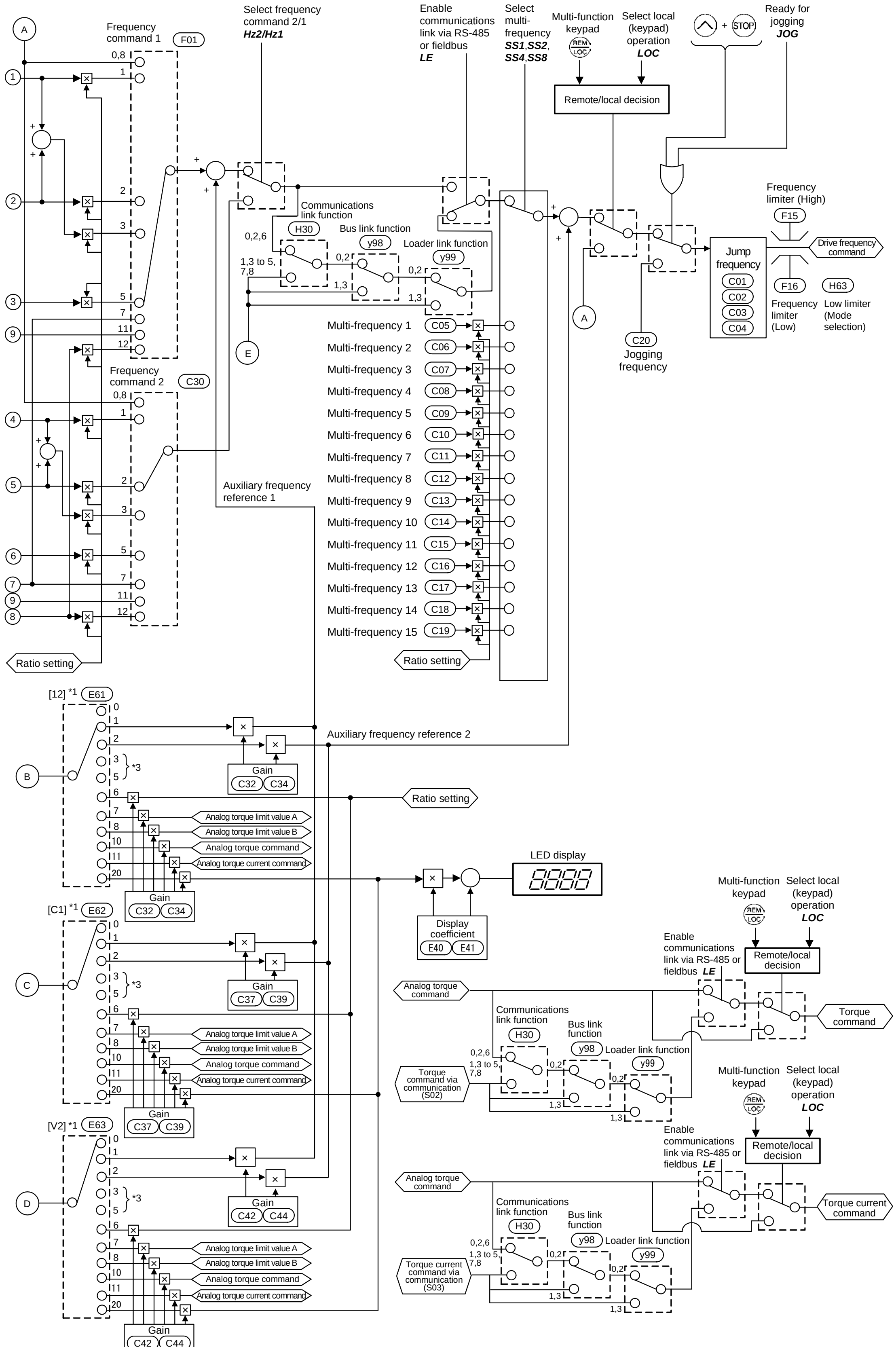


Figure 6.1 (1) Drive Frequency Command Block



Notes:
- When PID control is enabled, the control logic differs from this block diagram.
- S codes are communication-related function codes. Refer to the RS-485 Communication User's Manual for details.

*1 Takes priority when the same function has been assigned by E61, E62 and E63: Terminal [12] > Terminal [C1] > Terminal [V2]
*2 For details of the options, refer to the instruction manual for each option.
*3 Refer to block diagrams of PID control block for details.

Figure 6.1 (2) Drive Frequency Command Block

6.3 Drive Command Block

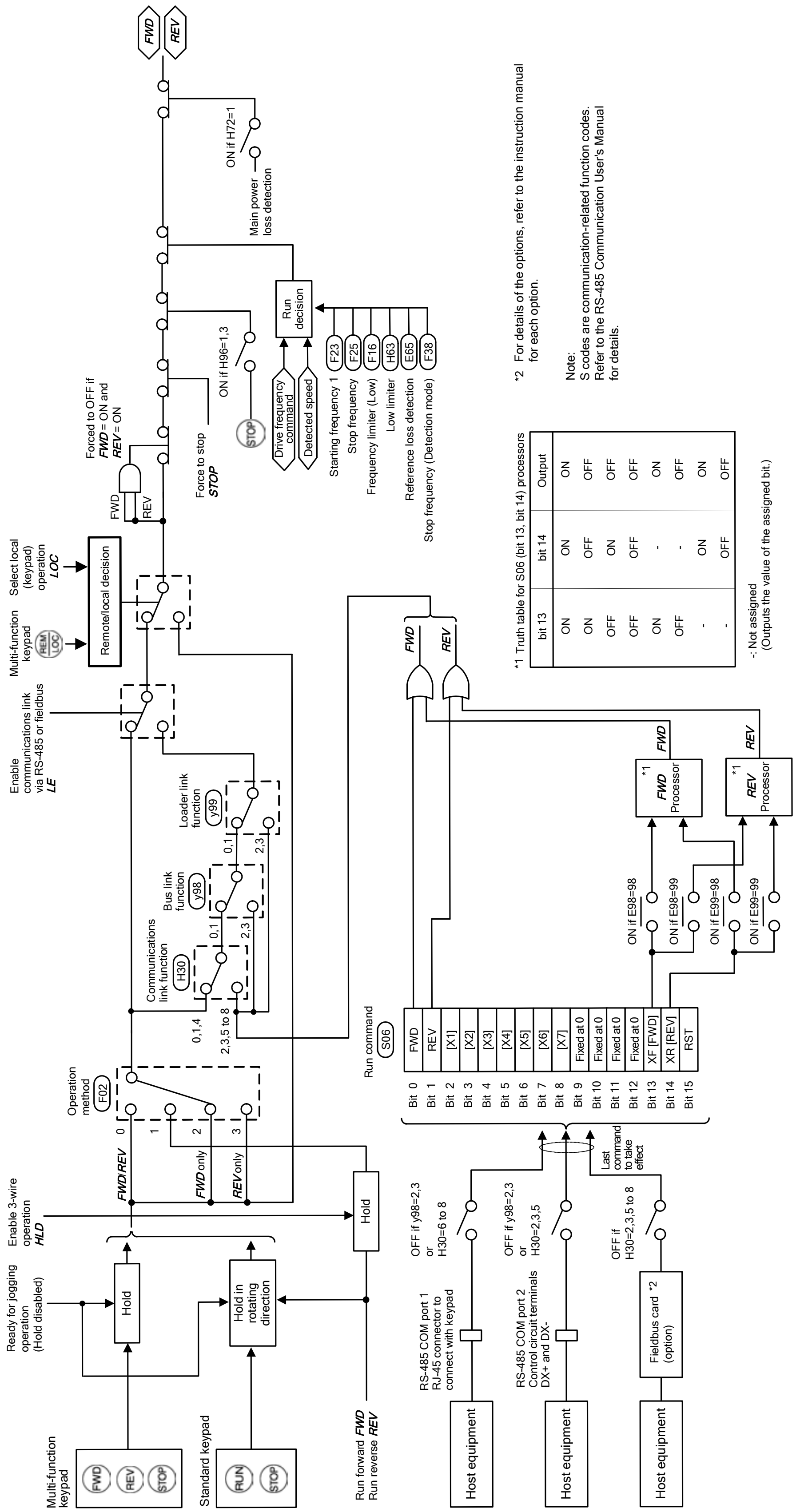


Figure 6.2 Drive Command Block

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6.4 Control Block

6.4.1 V/f control

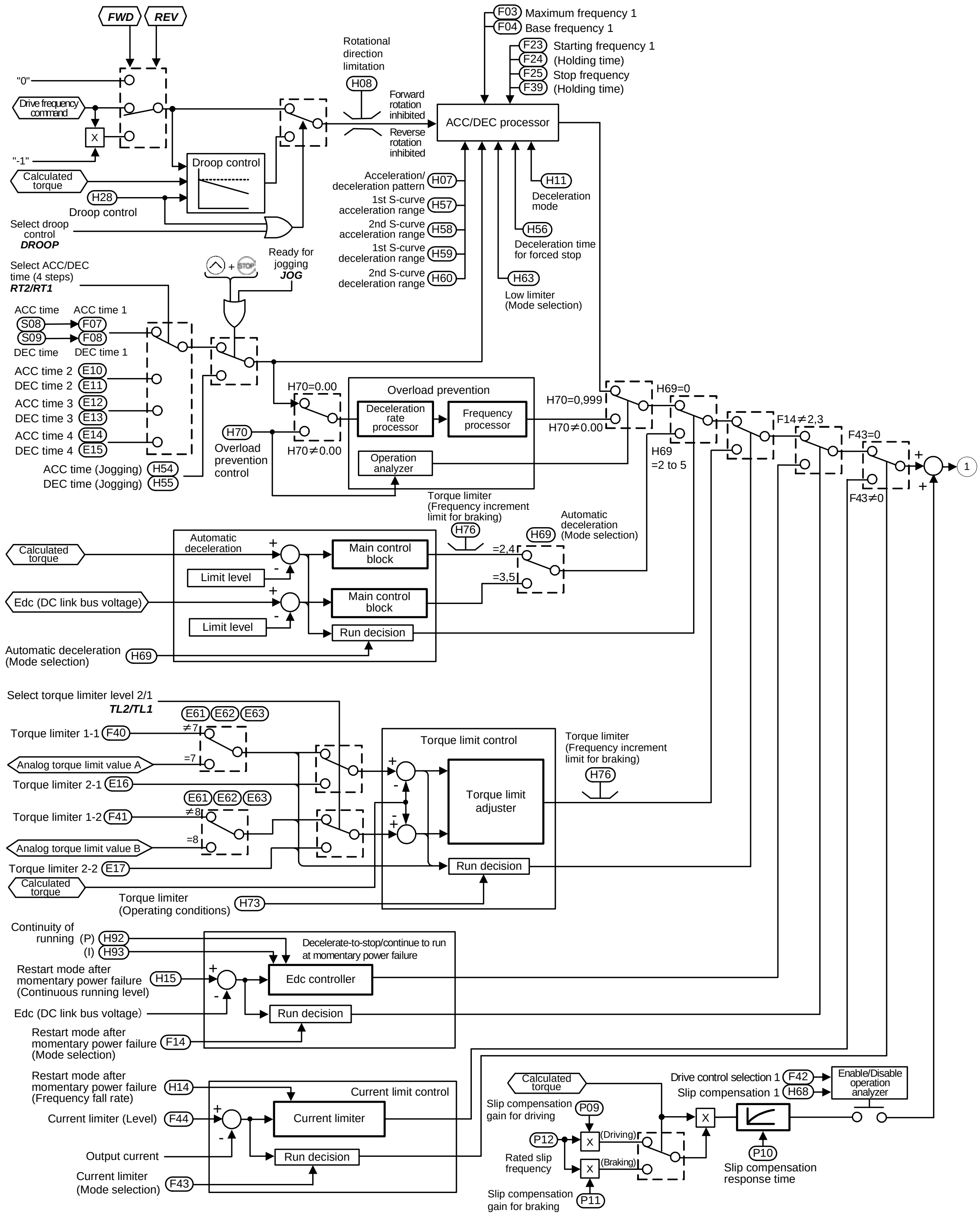


Figure 6.3 (1) V/f Control Block

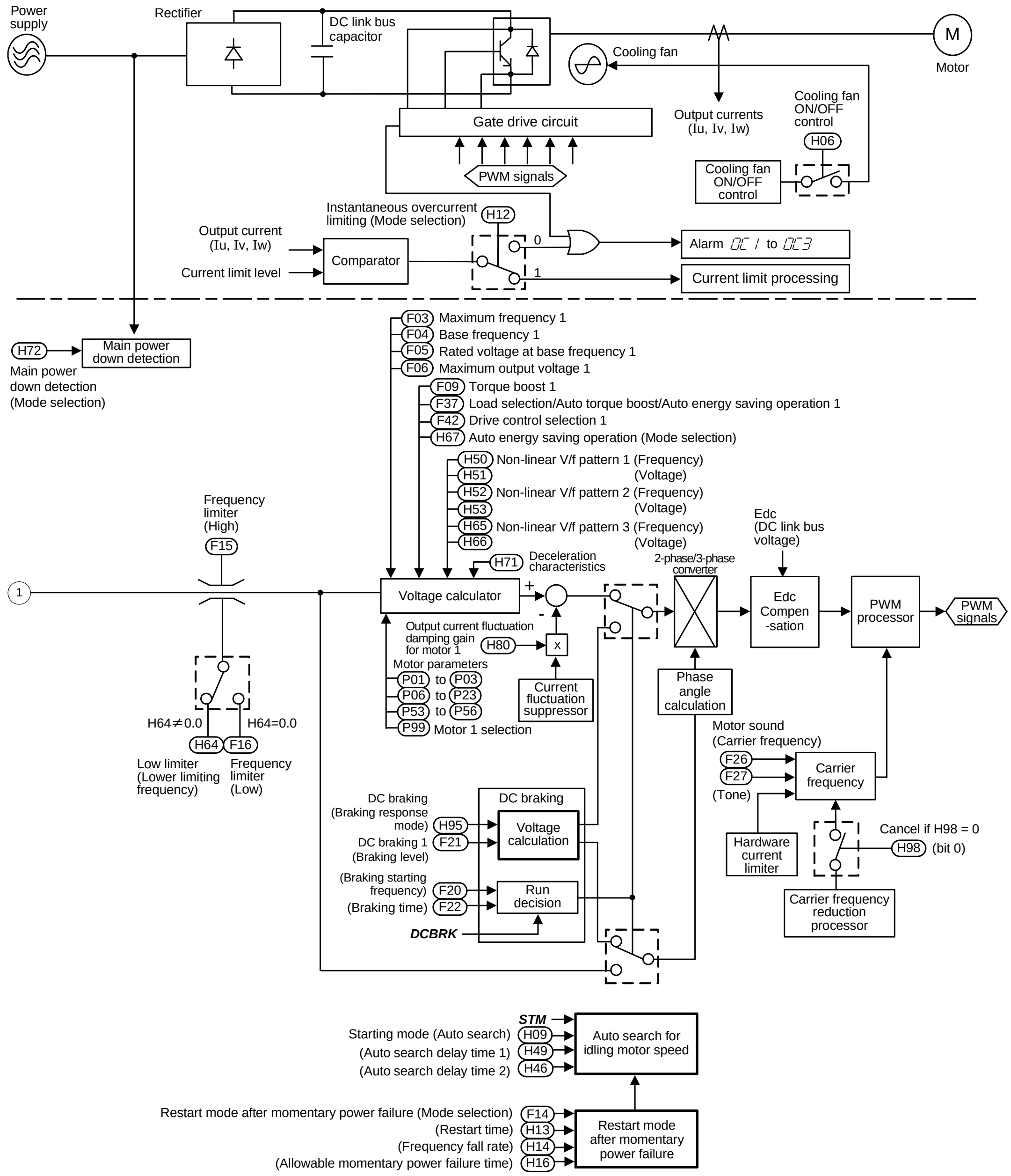


Figure 6.3 (2) V/f Control Block

6.4.2 V/f control with speed sensor

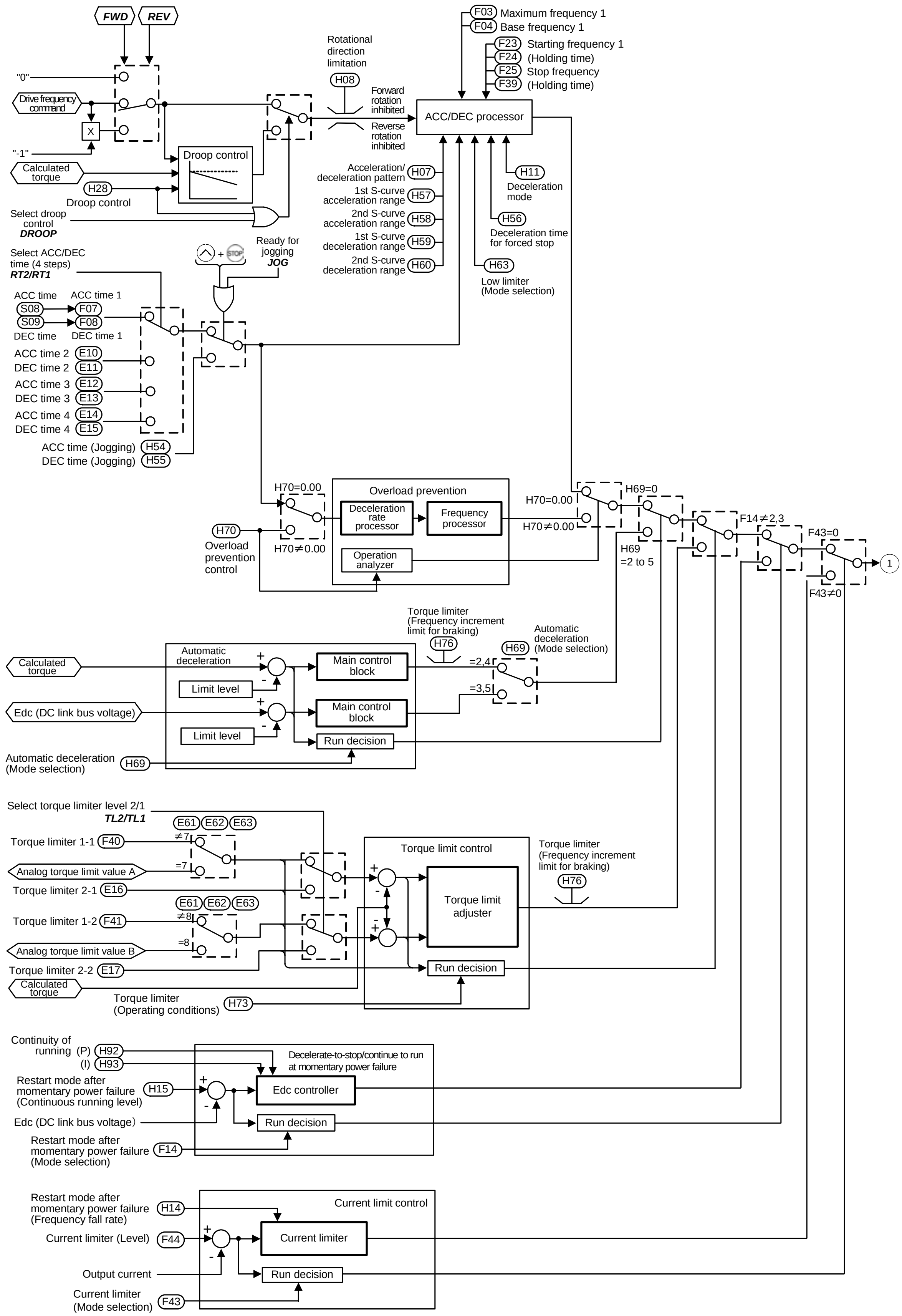


Figure 6.4 (1) Block of V/f Control with Speed Sensor

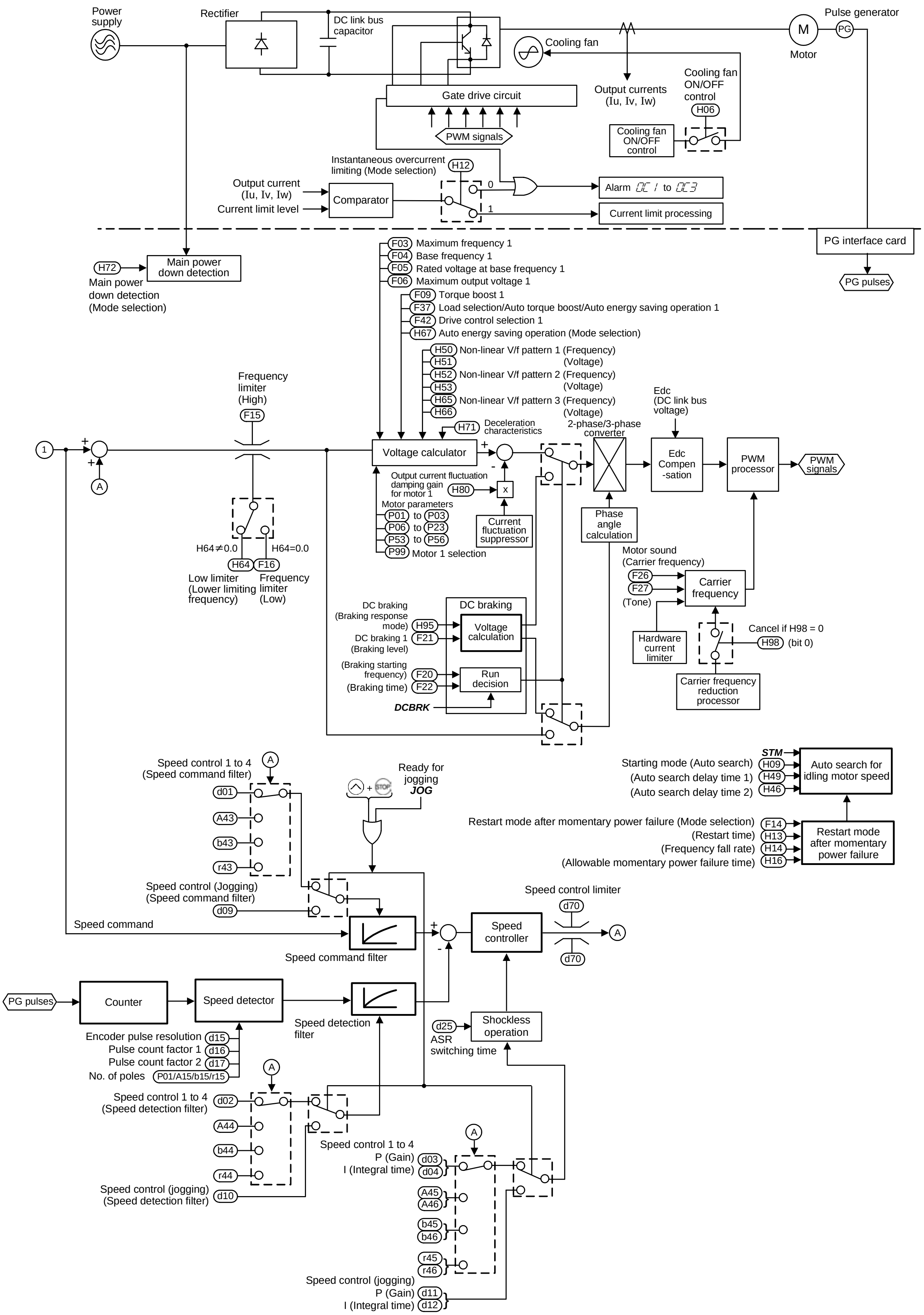


Figure 6.4 (2) Block of V/f Control with Speed Sensor

6.4.3 Vector control with/without speed sensor

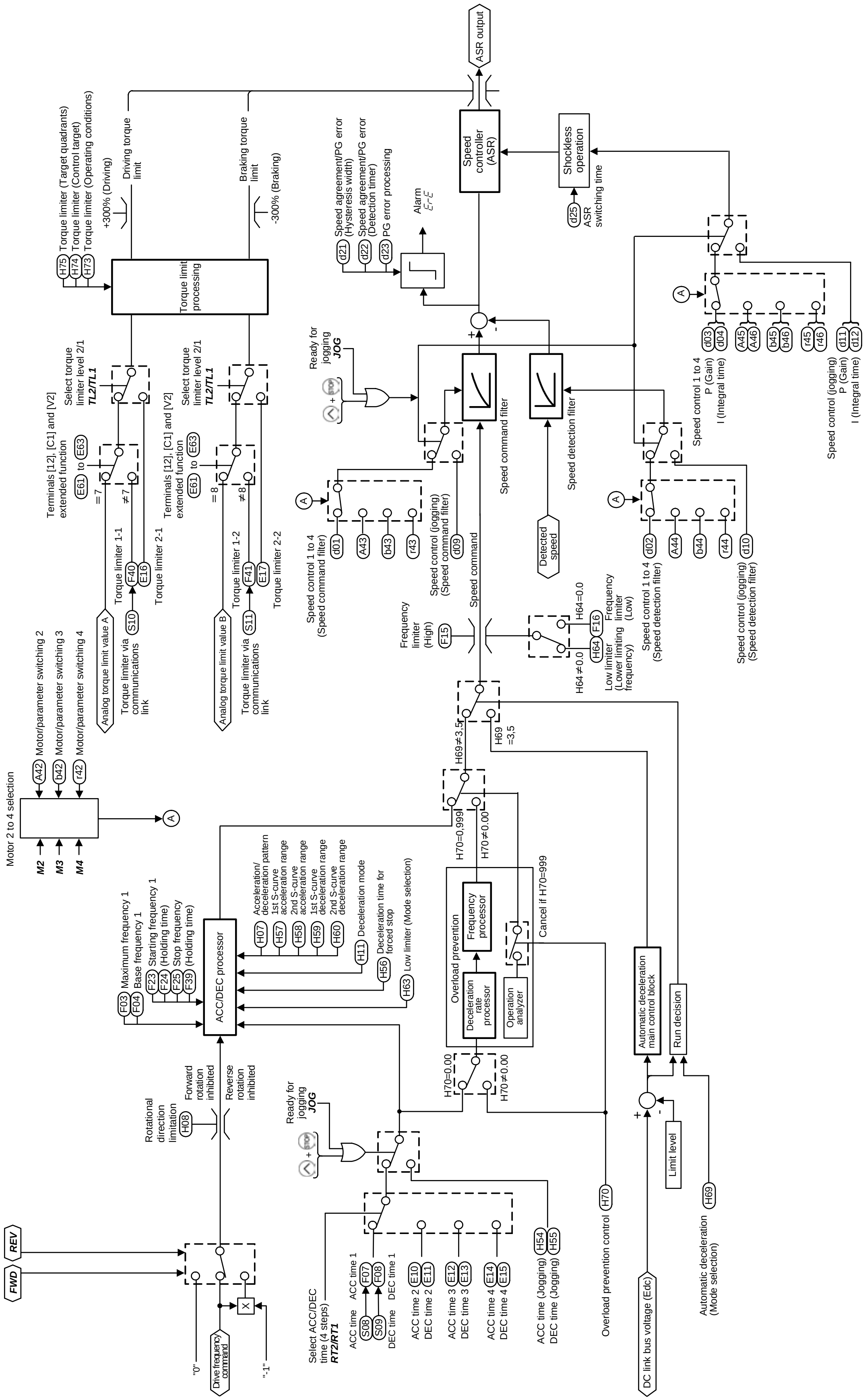


Figure 6.5 (1) Block of Vector Control with/without Speed Sensor

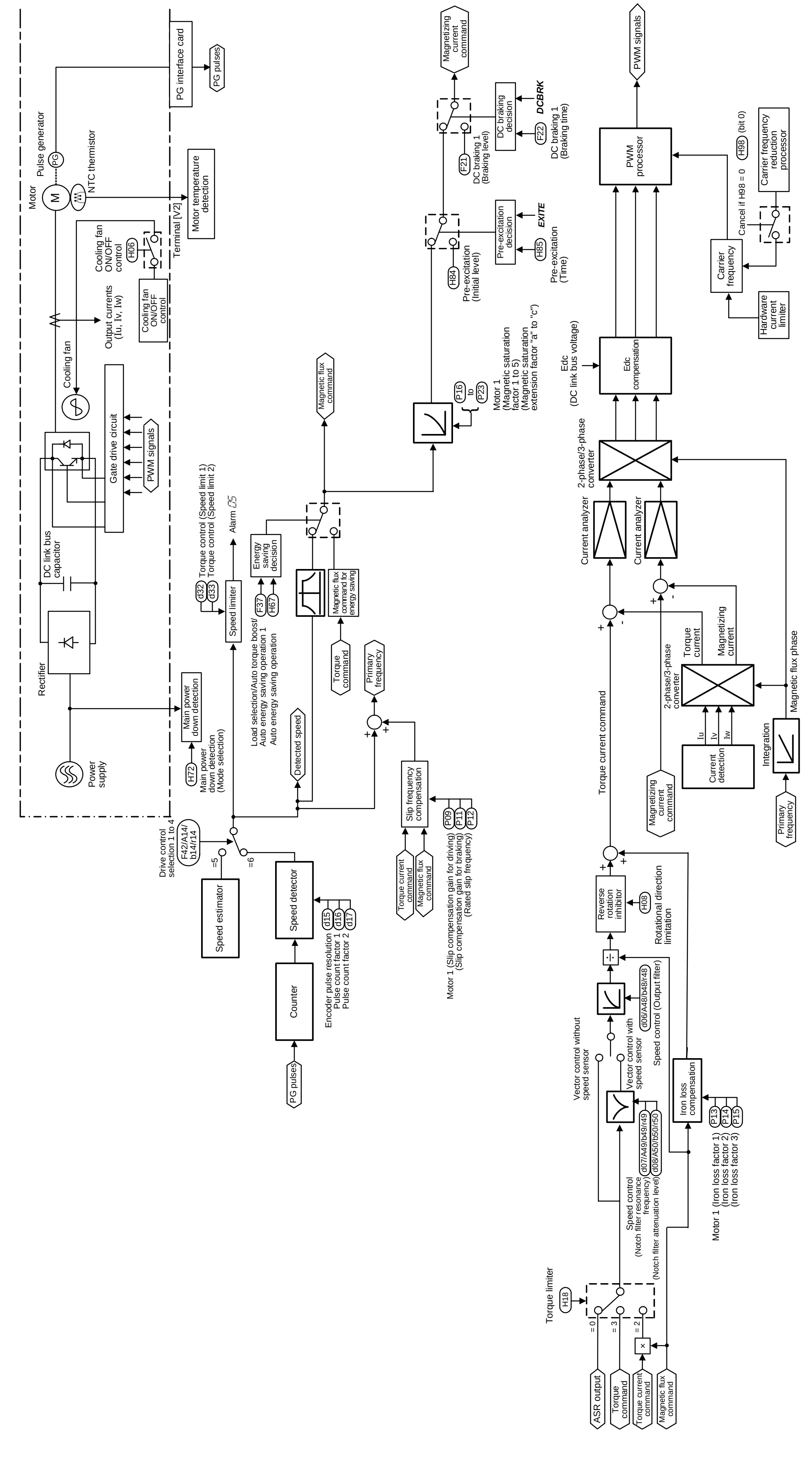


Figure 6.5 (2) Block of Vector Control with/without Speed Sensor

6.5 PID Process Control Block

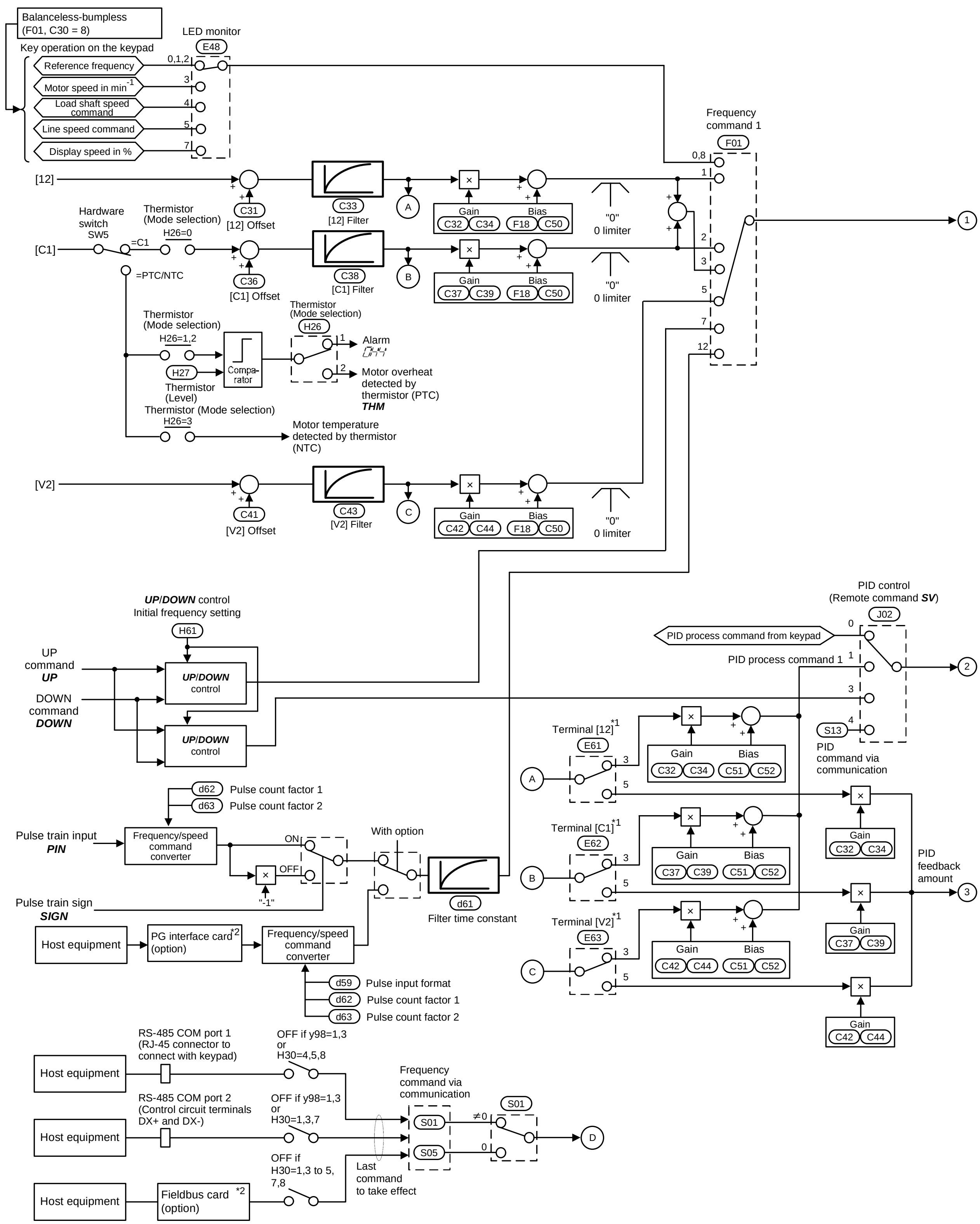
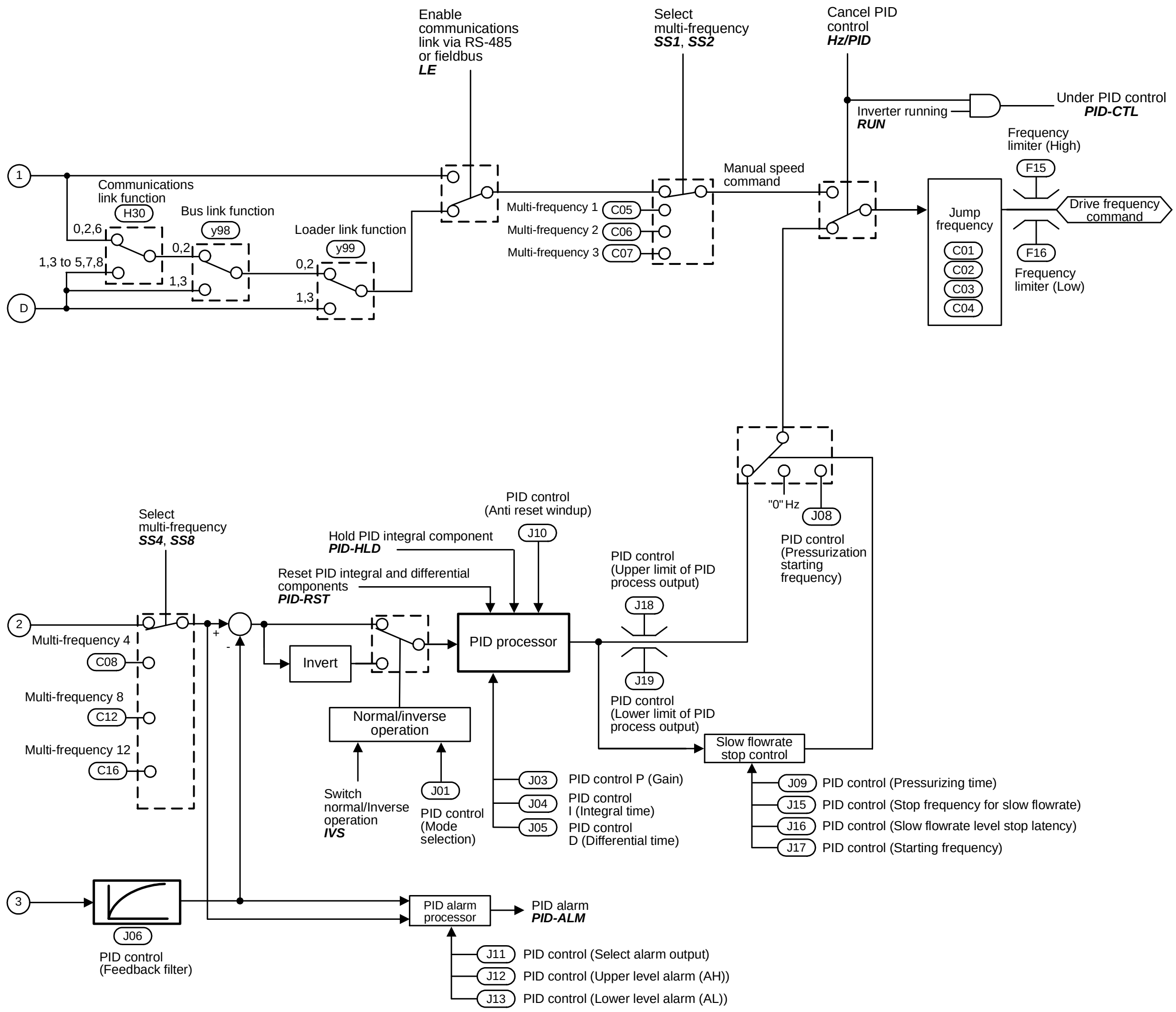


Figure 6.6 (1) PID Process Control Block



*1 Takes priority when the same function has been assigned by E61, E62 and E63:
Terminal [12] > Terminal [C1] > Terminal [V2]

*2 For details of the options, refer to the instruction manual for each option.

Note:
S codes are communication-related function codes. Refer to the RS-485 Communication User's Manual for details.

Figure 6.6 (2) PID Process Control Block

6.6 PID Dancer Control Block

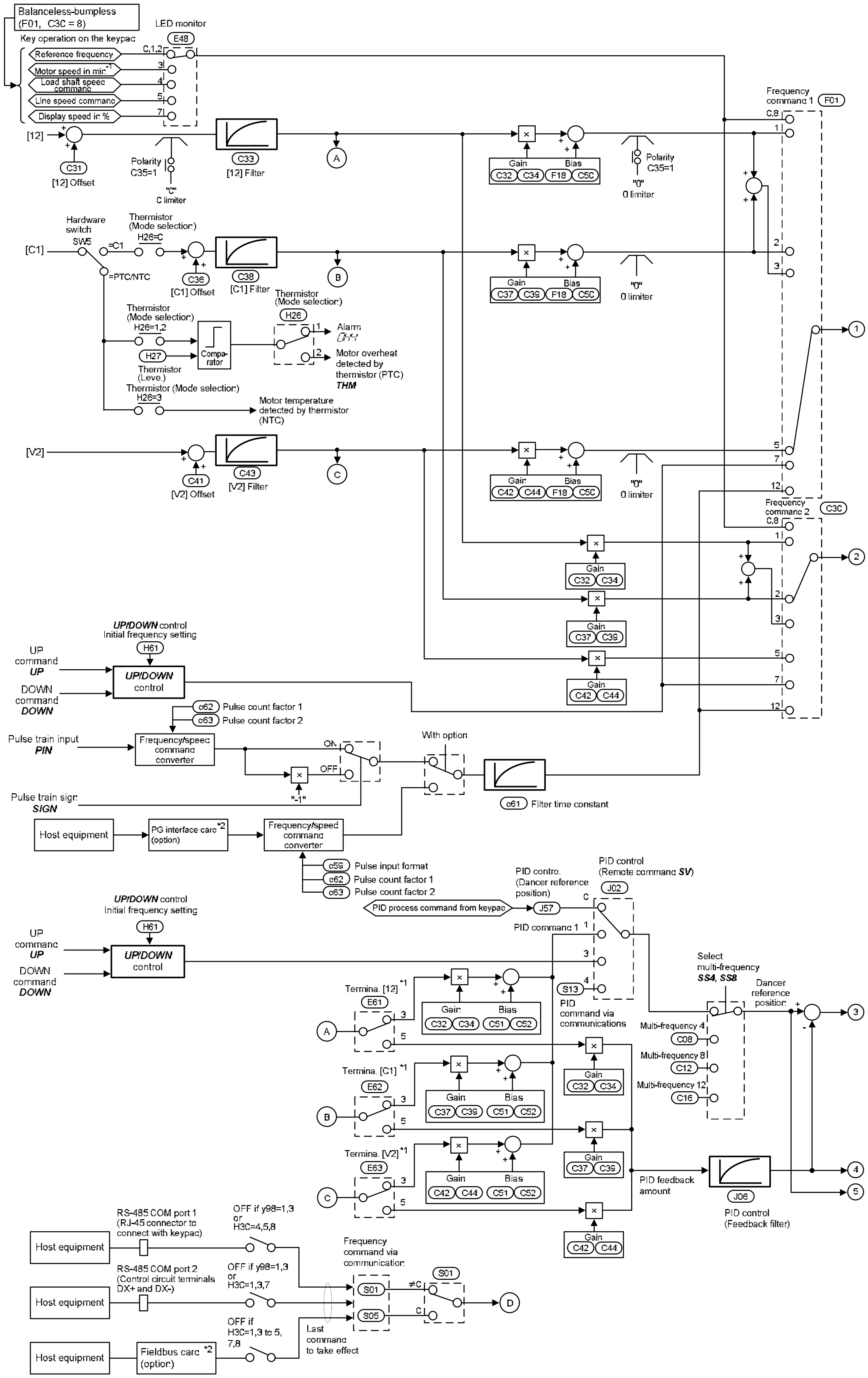
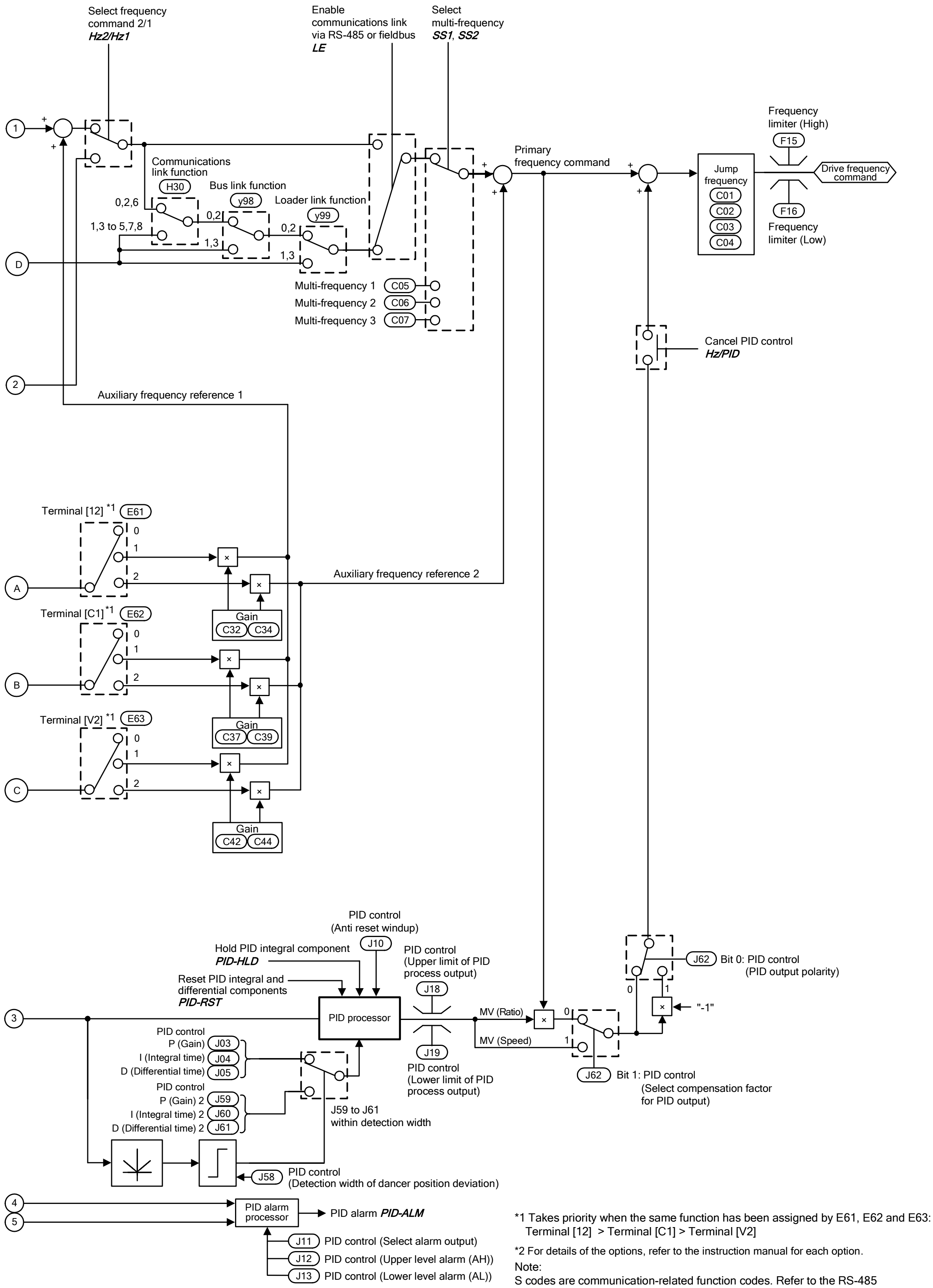


Figure 6.7 (1) PID Dancer Control Block



*1 Takes priority when the same function has been assigned by E61, E62 and E63: Terminal [12] > Terminal [C1] > Terminal [V2]

*2 For details of the options, refer to the instruction manual for each option.

Note:
S codes are communication-related function codes. Refer to the RS-485 Communication User's Manual for details.

Figure 6.7 (2) PID Dancer Control Block

6.7 FM1/FM2 Output Selector

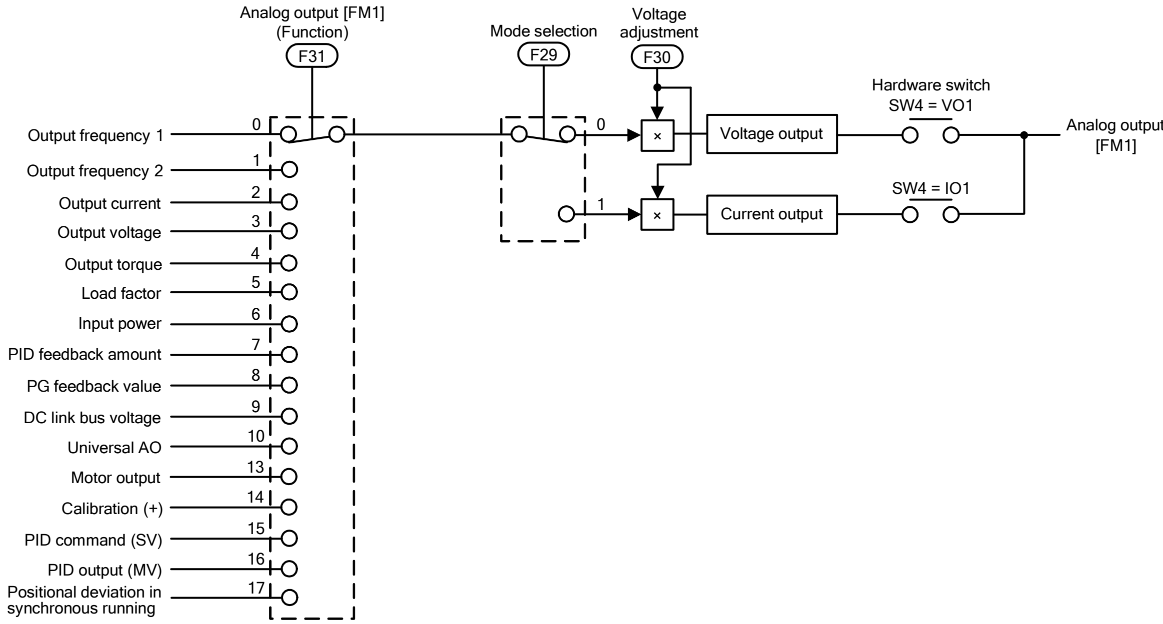


Figure 6.8 Terminal [FM1] Output Selector

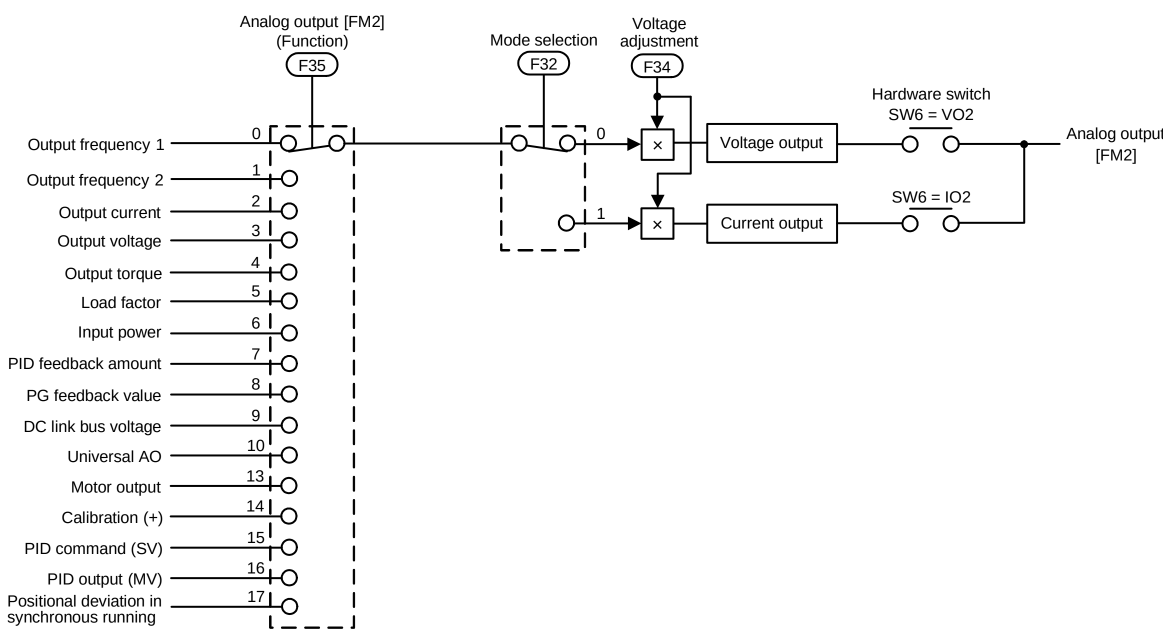


Figure 6.9 Terminal [FM2] Output Selector

Chapter 7

KEYPAD FUNCTIONS
(OPERATING WITH THE KEYPAD)

This chapter describes the names and functions of the keypad and inverter operation using the keypad. The inverter features three operation modes (Running, Programming and Alarm modes) which enable you to run and stop the motor, monitor running status, set function code data, display running information required for maintenance, and display alarm data.

Contents

7.1 LED Monitor, LCD Monitor, and Keys

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

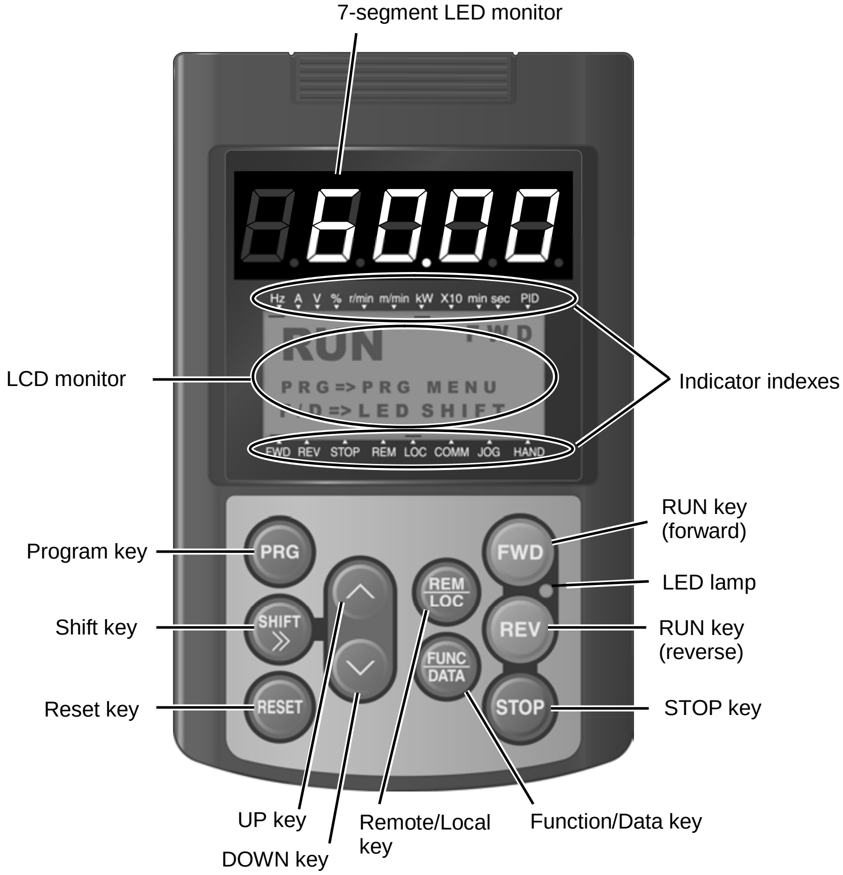


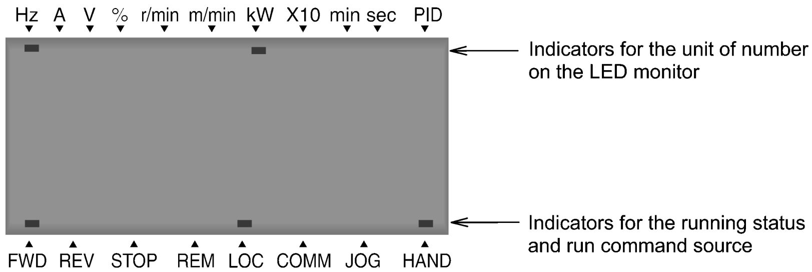
Table 7.1 Overview of Keypad Functions

Item	Monitors and Keys	Functions
Monitors		Five-digit, 7-segment LED monitor which displays the following according to the operation modes: ■ In Running mode: Running status information (e.g., output frequency, current, and voltage) ■ In Programming mode: Same as above. ■ In Alarm mode: Alarm code, which identifies the alarm when the protective function is activated.
		LCD monitor which displays the following according to the operation modes: ■ In Running mode: Running status information ■ In Programming mode: Menus, function codes and their data ■ In Alarm mode: Alarm code, which identifies the alarm when the protective function is activated.
	Indicator indexes	In Running mode, these indexes show the unit of the number displayed on the 7-segment LED monitor and the running status information on the LCD monitor. For details, see the next page.

Table 7.1 Overview of Keypad Functions (Continued)

Item	Monitors and Keys	Functions
Program-ming keys	PRG	Switches the operation modes of the inverter.
	SHIFT »	Shifts the cursor to the right for entry of a numerical value.
	RESET	Pressing this key after removing the cause of an alarm switches the inverter to Running mode. This key is used to reset settings or screen transition.
	∧ and ∨	UP and DOWN keys, which are used to select the setting items or change the function code data.
	FUNC DATA	Function/Data key, which switches the operation mode as follows: ■ In Running mode: Pressing this key switches the information to be displayed concerning the status of the inverter (output frequency (Hz), output current (A), output voltage (V), etc.). ■ In Programming mode: Pressing this key displays the function code and establishes the newly entered data. ■ In Alarm mode: Pressing this key displays the details of the problem indicated by the alarm code that has come up on the LED monitor.
Operation keys	FWD	Starts running the motor in the forward rotation.
	REV	Starts running the motor in the reverse rotation.
	STOP	Stops the motor.
	REM LOC	Holding down this key for more than 1 second toggles between local and remote modes.
LED lamp	FWD LED REV	Lights while a run command is supplied to the inverter.

Details of Indicator Indexes



Type	Item	Description (information, condition, and status)
Unit of number on LED monitor	Hz	Output frequency and reference frequency
	A	Output current
	V	Output voltage
	%	Calculated torque, load factor, and speed
	r/min	Preset and actual motor speeds and preset and actual load shaft speeds
	m/min	Preset and actual line speeds
	kW	Input power and motor output
	X10	Data exceeding 99,999
	min	Preset and actual constant feeding rate times
	sec	Timer
	PID	PID process value
Running status	FWD	Running in the forward rotation
	REV	Running in the reverse rotation
	STOP	No output frequency
Run command source	REM	Remote mode
	LOC	Local mode
	COMM	Via communications link (RS-485 (standard, optional), fieldbus option)
	JOG	Jogging mode
	HAND	Via keypad (This item lights also in local mode.)

7.2 Overview of Operation Modes

The FRENIC-MEGA features the following three operation modes.

Table 7.2 Operation Modes

Mode	Description
Running Mode	This mode allows you to specify run/stop commands in regular operation. It is also possible to monitor the running status in real time. If a light alarm occurs, the L-AL* appears on the LED monitor.
Programming Mode	This mode allows you to configure function code data and check a variety of information relating to the inverter status and maintenance.
Alarm Mode	If an alarm condition arises, the inverter automatically enters the Alarm mode in which you can view the corresponding alarm code* and its related information on the LED and LCD monitors. *Alarm code that represents the cause(s) of the alarm(s) that has been triggered by the protective function. For details, refer to the "Protective Functions" in Chapter 9, Section 9.1.

Figure 7.1 shows the status transition of the inverter between these three operation modes.

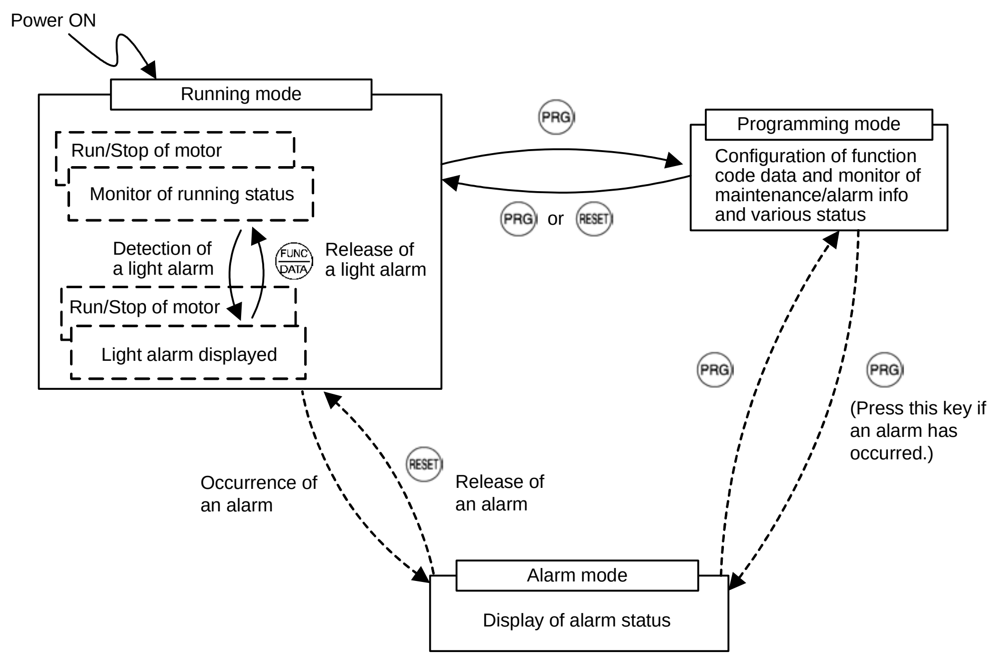


Figure 7.1 Status Transition between Operation Modes

7.3 Running Mode

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

(1) Monitor the running status (e.g., output frequency and output current) on the LED monitor

(2) Monitor light alarms

(3) Configure frequency and PID commands

(4) Run or stop the motor

(5) Jog (inch) the motor

(6) Switch between remote and local modes

7.3.1 Monitoring the running status on the LED monitor

The items listed below can be monitored on the 7-segment LED monitor. Immediately after the power is turned ON, the monitor item specified by function code E43 is displayed.

Pressing the FUNC/DATA key in Running mode switches between monitor items in the sequence shown in Table 7.3. The "Monitor page #" column shows the monitor page of the items supported.

Table 7.3 Items Monitored

Monitored Items on the LED Monitor	Example	Unit	Meaning of Displayed Value	Function code E43	Monitor page #
Speed Monitor	Function code E48 specifies what to be displayed.			0	0
Output frequency 1 (before slip compensation)	50.00	Hz	Frequency actually being output (Hz)	(E48 = 0)	
Output frequency 2 (after slip compensation)	50.00	Hz	Frequency actually being output (Hz)	(E48 = 1)	
Reference frequency	50.00	Hz	Frequency actually being specified (Hz)	(E48 = 2)	
Motor speed	1500	r/min	$\text{Output frequency (Hz)} \times \frac{120}{\text{P01}}$	(E48 = 3)	
Load shaft speed	300.0	r/min	Output frequency (Hz) x E50	(E48 = 4)	
Line speed	300.0	m/min	Output frequency (Hz) x E50	(E48 = 5)	
Display speed (%)	50.0	%	$\frac{\text{Output frequency (Hz)}}{\text{Maximum frequency (Hz)}} \times 100$	(E48 = 7)	

Table 7.3 Items Monitored (Continued)

Monitored Items on the LED Monitor	Example	Unit	Meaning of Displayed Value	Function code E43	Monitor page #
Output current	12.34	A	Current output from the inverter in RMS	3	8
Input power	10.25	kW	Input power to the inverter	9	9
Calculated torque	50	%	Motor output torque in % (Calculated value)	8	10
Output voltage	200	V	Voltage output from the inverter in RMS	4	11
Motor output	9.85	kW	Motor output in kW	16	12
Load factor	50	%	Load factor of the motor in % as the rated output being at 100%	15	13
PID command (Note 1)	10.00.	–	PID command/feedback amount transformed to that of physical value of the object to be controlled (e.g., temperature) Refer to function codes E40 and E41 for details.	10	14
PID feedback amount (Note 1)	9.00.	–		12	15
PID output (Note 1)	100.0.	%	PID output in % as the maximum frequency being at 100%	14	16
Analog input (Note 2)	82.00	–	Analog input to the inverter in a format suitable for a desired scale Refer to function codes E40 and E41 for details.	17	18
Torque current (Note 3)	48	%	Torque current command value or calculated torque current	23	21
Magnetic flux command (Note 3)	50	%	Magnetic flux command value (Available only under vector control)	24	22
Input watt-hour	100.0	kWh	$\frac{\text{Input watt - hour (kWh)}}{100}$	25	23

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

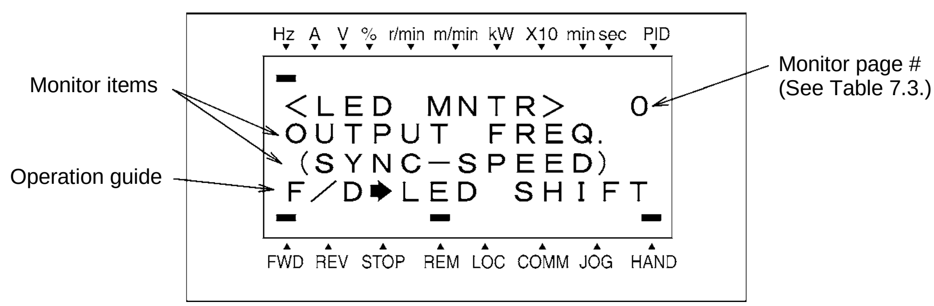


Figure 7.2 LCD Monitor Sample Detailed for the LED Monitor Item

(Note 1) These PID related items appear only under PID control specified by function code J01 (= 1, 2 or 3). When a PID command or PID output is displayed, the dot at the lowest digit on the LED monitor blinks; when a PID feedback amount is displayed, it is lit.

(Note 2) The analog input monitor appears only when the analog input monitor is enabled by any of function codes E61 to E63 (Select terminal function).

(Note 3) Under V/f control, a zero (0) is displayed.

7.3.2 Monitoring light alarms

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

Which abnormal states are categorized as a light alarm ("Light alarm" object) should be defined with function codes H81 and H82 beforehand.

Assigning the ***LALM*** signal to any one of the digital output terminals with any of function codes E20 to E24 and E27 (data = 98) enables the inverter to output the ***LALM*** signal on that terminal upon occurrence of a light alarm.

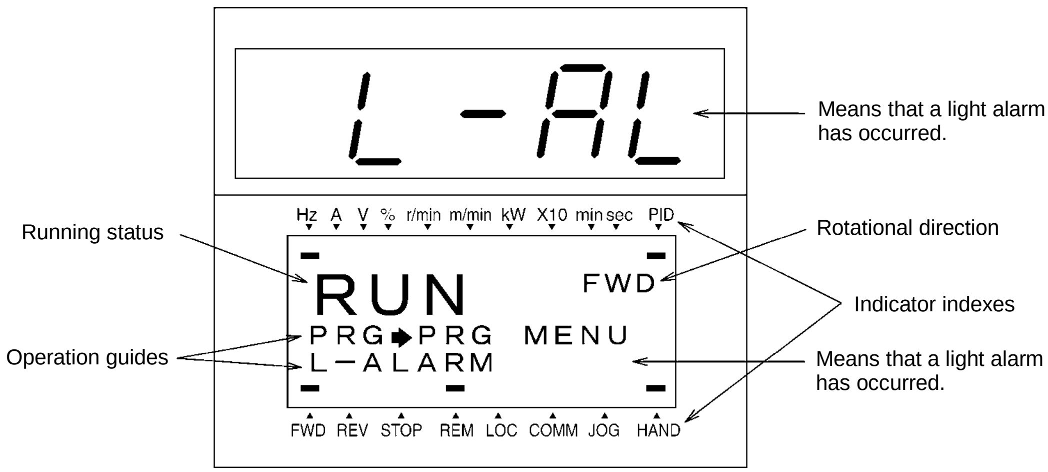


Figure 7.3 Display of Light Alarm

For details of the light alarms, refer to Chapter 9 "TROUBLESHOOTING."

■ How to check a light alarm

If a light alarm occurs, the L -AL appears on the LED monitor. To check the current light alarm, enter Programming mode by pressing the PRG key and select LALM1 on Menu #5 "Maintenance Information."

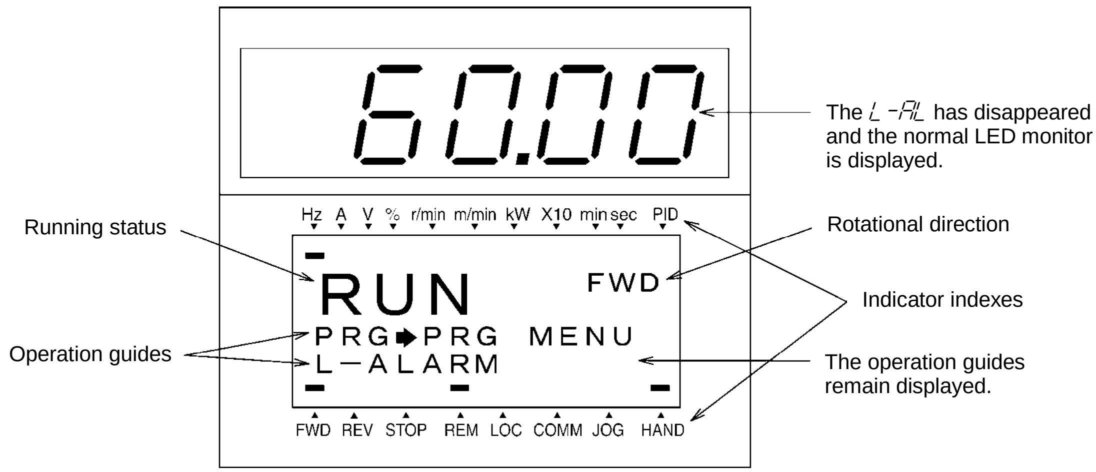
It is also possible to check the last three light alarms by selecting LALM2 (last) to LALM4 (3rd last).

For details of the menu transition of the maintenance information, refer to Section 7.4.6 "Reading maintenance information."

■ **How to remove the current light alarm**

After checking the current light alarm, to switch the LED monitor from the L-AL indication back to the running status display (e.g., output frequency), press the FUNC/DATA key in Running mode.

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



7.3.3 Configuring frequency and PID commands

You can set up the desired frequency and PID commands by using ∧ and ∨ keys on the keypad. It is also possible to set up the frequency command as load shaft speed, motor speed or speed (%) by setting function code E48.

■ Setting up a frequency command

Using the keypad (F01 = 0 (factory default) or 8)

(1) Set function code F01 to "0" or "8" (∧ / ∨ keys on keypad). This can be done only when the inverter is in Running mode.

(2) Press the ∧ / ∨ key to display the current reference frequency. The lowest digit will blink.

(3) To change the reference frequency, press the ∧ / ∨ key again. The new setting can be saved into the inverter's internal memory.

Tip

- The reference frequency will be saved either automatically by turning the main power OFF or only by pressing the FUNC/DATA key. You can choose either way using function code E64.
- If you have set function code F01 to "0" or "8" (∧ / ∨ keys on keypad) but have selected a frequency command source other than frequency command 1 (i.e., frequency command 2, frequency command via communication, or multi-frequency command), then the ∧ and ∨ keys are disabled to change the current frequency command even in Running mode. Pressing either of these keys just displays the current reference frequency.
- When you start specifying the reference frequency or any other parameter with the ∧ / ∨ key, the least significant digit on the display blinks; that is, the cursor lies in the least significant digit. Holding down the ∧ / ∨ key changes data in the least significant digit and generates a carry, while the cursor remains in the least significant digit.
- The standard keypad has SHIFT key. But the optional remote keypad has not, so when you start specifying the reference frequency or any other parameter with the ∧ / ∨ key, after the least significant digit blinks by pressing the ∧ / ∨ key, holding down the PRG/RESET key for more than 1 second moves the cursor from the least significant digit to the most significant digit. Further holding it down moves the cursor to the next lower digit. This cursor movement allows you to easily move the cursor to the desired digit and change the data in higher digits.
- Setting F01 data to "8" (∧ / ∨ keys on keypad) enables the balanceless-bumpless switching. When the frequency command source is switched to the keypad from any other source, the inverter inherits the current frequency that has applied before switching, providing smooth switching and shockless running.

Using analog input (F01 = 1 to 3, or 5)

- Applying the gain and bias to analog inputs (voltage inputs to terminals [12] and [V2], and current input to terminal [C1]) enables the frequency to be set within an arbitrary range (frequency vs. analog input level).

  (Refer to the description of F18.)
- Noise reduction filters are applicable to these analog inputs.

  (Refer to the descriptions of C33, C38 and C43.)
- The normal/inverse operation for the frequency command 1 setting (F01) can be selected with function code C53 and be switched between them with the terminal command IVS assigned to any of the digital input terminals.

  (Refer to the descriptions of E01 through E07.)

Note

- To input bipolar analog voltage (0 to ±10 VDC) to terminals [12] and [V2], set C35 and C45 data to "0." Setting C35 and C45 data to "1" enables the voltage range from 0 to +10 VDC and interprets the negative polarity input from 0 to -10 VDC as 0 V.
- A reference frequency can be specified not only with the frequency (Hz) but also with other menu items, depending on the setting of function code E48 (= 3 to 5, or 7).

■ Settings under PID process control

To enable the PID process control, you need to set the J01 data to "1" or "2."

Under the PID control, the items that can be specified or checked with ∧ and ∨ keys are different from those under regular frequency control, depending upon the current LED monitor setting. If the LED monitor is set to the speed monitor (E43 = 0), you can access manual speed commands (frequency command) with ∧ and ∨ keys; if it is set to any other, you can access the PID process command with those keys.

Setting the PID process command with ∧ and ∨ keys

(1) Set function code J02 to "0" (∧ / ∨ keys on keypad).

(2) Set the LED monitor to something other than the speed monitor (E43=0) when the inverter is in Running mode. When the keypad is in Programming or Alarm mode, you cannot modify the PID process command with the ∧ / ∨ key. To enable the PID process command to be modified with the ∧ / ∨ key, first switch to Running mode.

(3) Press the ∧ / ∨ key to display the PID process command. The lowest digit and its decimal point blink on the LED monitor.

(4) To change the PID process command, press the ∧ / ∨ key again. The new setting can be saved into the inverter's internal memory.

Tip

- The PID process command will be saved either automatically by turning the main power OFF or only by pressing the FUNC/DATA key. You can choose either way using function code E64.
- Even if multi-frequency is selected as a PID command (***SS4*** or ***SS8*** = ON), it is possible to set a PID command using the keypad.
- When function code J02 is set to any value other than "0," pressing the ∧ / ∨ key displays, on the LED monitor, the PID command currently selected, while you cannot change the setting.
- On the LED monitor, the decimal point of the lowest digit is used to discriminate the PID related data from the reference command. The decimal point blinks or lights when a PID command or PID feedback amount is displayed, respectively.

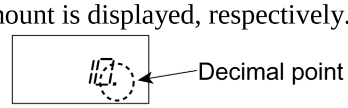


Table 7.4 PID Process Command Manually Set with ∧ / ∨ Key and Requirements

PID control (Mode selection) J01	PID control (Remote command SV) J02	LED monitor E43	Multi- frequency ***SS4***, ***SS8***	With ∧ / ∨ key
1 or 2	0	Other than 0	ON or OFF	PID process command <u>by keypad</u>
	Other than 0			PID process command <u>currently selected</u>

<u>Setting up the frequency command with ∧ and ∨ keys under PID process control</u>

When function code F01 is set to "0" (∧ / ∨ keys on keypad) and frequency command 1 is selected as a manual speed command (when disabling the frequency setting command via communications link, multi-frequency command, and PID control), switching the LED monitor to the speed monitor in Running mode enables you to modify the frequency command with the ∧ / ∨ keys.

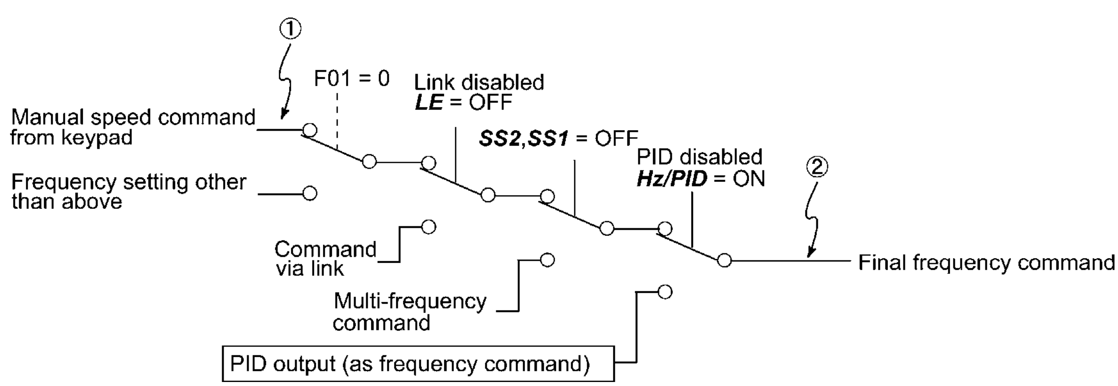
In Programming or Alarm mode, the ∧ / ∨ keys are disabled to modify the frequency command. You need to switch to Running mode.

Table 7.5 lists the combinations of the commands and the figure illustrates how the manual speed command ① entered via the keypad is translated to the final frequency command ②.

The setting procedure is the same as that for setting of a usual frequency command.

Table 7.5 Manual Speed (Frequency) Command Specified with ∧ / ∨ Keys and Requirements

PID control (Mode selection) J01	LED monitor E43	Frequency command 1 F01	Multi-frequency ***SS2***	Multi-frequency ***SS1***	Communi-cations link operation ***LE***	Cancel PID control ***Hz/PID***	Pressing ∧ / ∨ keys controls:
1 or 2	0	0	OFF	OFF	OFF	OFF (PID enabled)	PID output (as final frequency command)
						ON (PID disabled)	Manual speed (frequency) command set by keypad
		Other than the above				OFF (PID enabled)	PID output (as final frequency command)
						ON (PID disabled)	Manual speed (frequency) command currently selected



■ Settings under PID dancer control

To enable the PID dancer control, you need to set the J01 data to "3."

Under the PID control, the items that can be specified or checked with ∧ and ∨ keys are different from those under the regular frequency control, depending upon the current LED monitor setting. If the LED monitor is set to the speed monitor (E43 = 0), the item accessible is the primary frequency command; if it is set to any other data, it is the PID dancer position command.

Setting the PID dancer position command with the ∧ and ∨ keys

(1) Set the J02 data to "0" (∧ / ∨ keys on keypad).

(2) Set the LED monitor to something other than the speed monitor (E43=0) when the inverter is in Running mode. When the keypad is in Programming or Alarm mode, you cannot modify the PID command with the ∧ / ∨ key. To enable the PID dancer position command to be modified with the ∧ / ∨ key, first switch to Running mode.

(3) Press the ∧ / ∨ key to display the PID dancer position command. The lowest digit blinks on the LED monitor.

(4) To change the PID dancer position command, press the ∧ / ∨ key again. The command you have specified will be automatically saved into the inverter's internal memory as function code J57 data. It is retained even if you temporarily switch to another PID command source and then go back to the via-keypad PID command. Furthermore, you can directly configure the command with function code J57.

Tip

- Even if multi-frequency is selected as a PID command (***SS4*** or ***SS8*** = ON), it is possible to set a PID command using the keypad.
- When the J02 data is set to any value other than "0," pressing the ∧ / ∨ key displays, on the LED monitor, the PID command currently selected, while you cannot change the setting.
- On the LED monitor, the decimal point of the lowest digit is used to discriminate the PID related data from the reference command. The decimal point blinks or lights when a PID command or PID feedback amount is displayed, respectively.

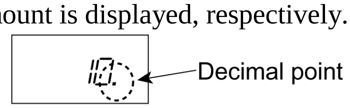


Table 7.6 PID Command Manually Set with ∧ / ∨ Key and Requirements

PID control (Mode selection) J01	PID control (Remote command SV) J02	LED monitor E43	Multi- frequency ***SS4***, ***SS8***	With ∧ / ∨ key
3	0	Other than 0	ON or OFF	PID command by keypad
	Other than 0			PID command currently selected

Setting up the primary frequency command with ∧ and ∨ keys under PID dancer control

When function code F01 is set to "0" (∧ / ∨ keys on keypad) and frequency command 1 is selected as a primary frequency command (when disabling the frequency setting command via communications link, multi-frequency command, and PID control), switching the LED monitor to the speed monitor in Running mode enables you to modify the frequency command with the ∧ / ∨ keys.

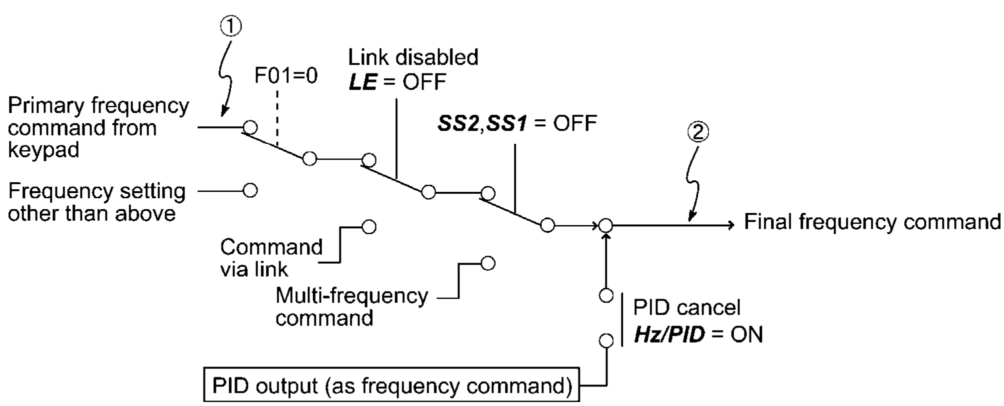
In Programming or Alarm mode, the ∧ / ∨ keys are disabled to modify the frequency command. You need to switch to Running mode.

Table 7.7 lists the combinations of the commands and the figure illustrates how the primary frequency command ① entered via the keypad is translated to the final frequency command ②.

The setting procedure is the same as that for setting of a usual frequency command.

Table 7.7 Primary Frequency Command Specified with ∧ / ∨ Keys and Requirements

PID control (Mode selection) J01	LED monitor E43	Frequency command 1 F01	Multi-frequency ***SS2***	Multi-frequency ***SS1***	Communi-cations link operation ***LE***	Cancel PID control ***Hz/PID***	Pressing ∧ / ∨ keys controls:
3	0	0	OFF	OFF	OFF	OFF (PID enabled)	Final frequency command modified by PID output
						ON (PID disabled)	Keypad primary command (Frequency)
		Other than the above				OFF (PID enabled)	Final frequency command modified by PID output
						ON (PID disabled)	Current primary command (Frequency)



7.3.4 Running or stopping the motor

By factory default, pressing the FWD key starts running the motor in the forward direction and pressing the STOP key decelerates the motor to a stop. The REV key is disabled. Running or stopping the motor with the keypad is enabled only in Running and Programming modes.

To run the motor in reverse direction or run the motor in reversible mode, change the setting of function code F02.

For details of function code F02, refer to Chapter 5 "FUNCTION CODES."

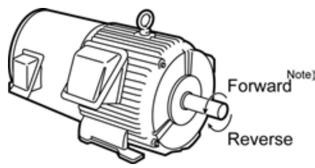


Figure 7.4 Rotational Direction of Motor

Note) The rotational direction of an IEC-compliant motor is opposite to the one shown above.

■ **Displaying the running status on the LCD monitor**

(1) <u>When function code E45 (LCD monitor item selection) is set at "0"</u>

The LCD monitor displays the running status, the rotational direction, and the operation guide.

(The upper indicators show the unit of values displayed on the LED monitor as detailed in Section 7.3.1. The lower ones show the running status and run command source.)

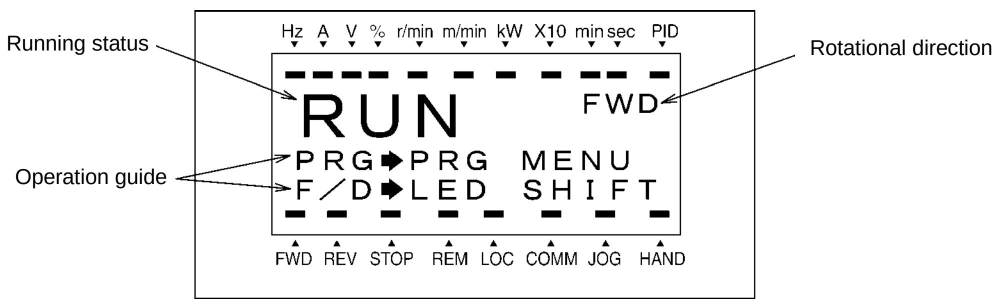


Figure 7.5 Display of Running Status

The running status and the rotational direction are displayed as shown in Table 7.8.

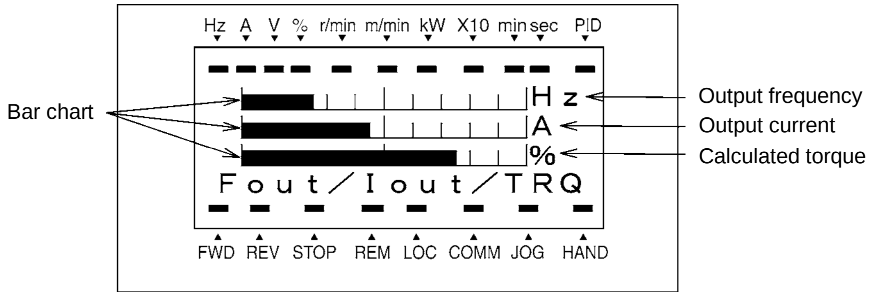
Table 7.8 Running Status and Rotational Direction

Status/Direction	Display	Meaning
Running status	RUN STOP	A run command is given or the inverter is running the motor. A run command is not given and the inverter is stopped.
Rotational direction	FWD REV Blank	Running in the forward rotation Running in the reverse rotation Stopped

(2) When function code E45 (LCD monitor item selection) is set at "1"

The LCD monitor displays the output frequency, output current, and calculated torque in a bar chart.

(The upper indicators show the unit of values displayed on the LED monitor as detailed in Section 7.3.2. The lower ones show the running status and run command source.)



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

Output frequency:	Maximum frequency
Output current:	200% of inverter's rated current
Calculated torque:	200% of rated torque generated by motor

Figure 7.6 Bar Chart

7.3.5 Jogging (inching) the motor

To start jogging operation, perform the following procedure.

(1) Making the inverter ready for jogging

1) Switch the inverter to Running mode (see Section 7.2).

2) Press the "STOP + ∧ keys" simultaneously (when the run command source is "Keypad" (F02 = 0, , or 3). The lower indicator above the "JOG" index comes ON on the LCD monitor.

Note

- Function code C20 specifies the jogging frequency. H54 and H55 specify the acceleration and deceleration times for jogging, respectively. These three function codes are exclusive to jogging operation. Specify each function code data, if needed.
- Using the input terminal command ***JOG*** ("Ready for jogging") switches between the normal operation state and ready-to-jog state.
- Switching between the normal operation state and ready-to-jog state is possible only when the inverter is stopped.

(2) Starting jogging

Hold down the FWD or REV key to continue jogging the motor. Release the key to decelerate the motor to a stop.

(3) Exiting the inverter from the ready-to-jog state and returning to the normal operation state.

Press the "STOP + ∧ keys" simultaneously. The lower indicator above the "JOG" index goes OFF on the LCD monitor.

7.3.6 Switching between remote and local modes

The inverter is switchable between remote and local modes. In remote mode that applies to ordinary operation, the inverter is driven under the control of the data settings held in it, whereas in local mode that applies to maintenance operation, it is separated from the control system and is driven manually under the control of the keypad.

- Remote mode: The run and speed command sources are determined by source switching signals including function codes, run command 2/1 switching signal, and communications link operation signal. The keypad cannot be used as a command source.
- Local mode: The keypad is enabled as a run and speed command source, regardless of the settings specified by function codes. The keypad takes precedence over run command 2/1 switching signal, communications link operation signal or other command sources.

The table below lists the run command sources using the keypad in local mode.

Data for F02	Run command source	Description
0	Keypad	Enables the FWD, REV, and STOP keys to run the motor in the forward and reverse directions, and stop the motor.
1	Terminal command ***FWD*** or ***REV***	
2	Keypad (Forward direction)	Enables the FWD and STOP keys to run the motor in the forward direction and stop it. Running the motor in the reverse direction is not possible.
3	Keypad (Reverse direction)	Enables the REV and STOP keys to run the motor in the reverse direction and stop it. Running the motor in the forward direction is not possible.

Holding down the REM/LOC key for at least one second switches between the remote and local modes.

The mode can be switched also by an external digital input signal. To enable the switching, you need to assign ***LOC*** to one of the digital input terminals, which means that the commands from the keypad are given precedence (one of function codes E01 to E07, E98, or E99 must be set to "35").

You can confirm the current mode on the indicators (REM: Remote mode; LOC: Local mode).

When the mode is switched from remote to local, the frequency settings in the remote mode are automatically inherited. Further, if the inverter is in Running mode at the time of the switching from remote to local, the run command is automatically turned ON so that all the necessary data settings will be carried over. If, however, there is a discrepancy between the settings on the keypad and those in the inverter itself (e.g., switching from reverse rotation in the remote mode to forward rotation in the local mode using the keypad that is for forward rotation only), the inverter automatically stops.

The paths of transition between remote and local modes depend on the current mode and the value (ON/OFF) of ***LOC***, the signal giving precedence to the commands from the keypad, as shown in the state transition diagram shown in Figure 7.7.

📖 For further details on how to set run commands and frequency commands in remote and local modes, refer to the drive command related section in the Chapter 6, "BLOCK DIAGRAMS FOR CONTROL LOGIC."

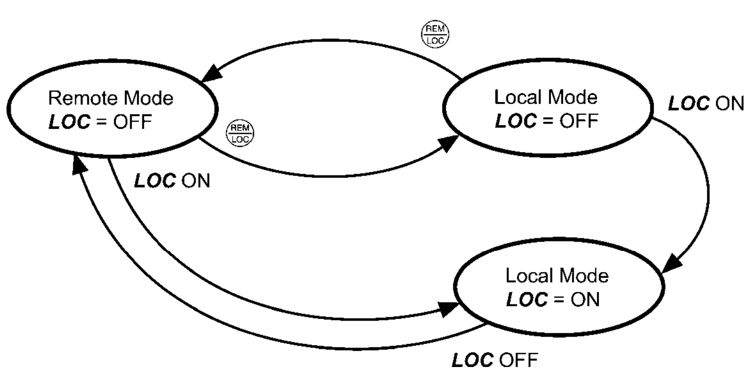


Figure 7.7 Transition between Remote and Local Modes

7.3.7 External run/frequency command

By factory default, run and frequency commands are sourced from the keypad. This section provides other external command source samples--an external frequency command potentiometer (variable resistor) as a frequency command source and external run switches as run forward/reverse command sources.

Set up those external sources using the following procedure.

(1) Configure the function codes as listed below.

Function code	Name	Data	Factory default
F 01	Frequency command 1	1: Analog voltage input to terminal [12]	0
F 02	Operation method	1: External digital input signal	0
E 98	Terminal [FWD] function	98: Run forward command ***FWD***	98
E 99	Terminal [REV] function	99: Run reverse command ***REV***	99

Note: If terminal [FWD] and [REV] are ON, the F02 data cannot be changed. First turn those terminals OFF and then change the F02 data.

(2) Wire the external frequency command potentiometer to terminals across [13], [12], and [11].

(3) Connect the run forward switch between terminals [FWD] and [CM] and the run reverse switch between [REV] and [CM].

(4) To start running the inverter, rotate the potentiometer to give a voltage to terminal [12] and then turn the run forward or reverse switch ON (short-circuit).

For precautions in wiring, refer to the FRENIC-MEGA Instruction Manual, Chapter 2, Section 2.3.

7.4 Programming Mode

Programming mode provides you with these functions--setting and checking function code data, monitoring maintenance information and checking input/output (I/O) signal status. These functions can be easily selected with a menu-driven system. Table 7.9 lists menus available in Programming mode.

When the inverter enters Programming mode from the second time on, the menu selected last in Programming mode will be displayed.

Table 7.9 Menus Available in Programming Mode

Menu #	Menu	Used to:	Refer to Section:
0	Quick Setup	Display only basic function codes previously selected.	7.4.1
1	Data Setting	Display and change the data of the function code selected. (Note)	7.4.2
2	Data Checking	Display the function code selected and its data on the same screen. Also this menu is used to change the function code data or check whether the data has been changed from the factory default.	7.4.3
3	Drive Monitoring	Display the running information required for maintenance or test running.	7.4.4
4	I/O Checking	Display external interface information.	7.4.5
5	Maintenance Information	Display maintenance information including cumulative run time.	7.4.6
6	Alarm Information	Display the recent four alarm codes. Also this menu is used to view the information on the running status at the time the alarm occurred.	7.4.7
7	Alarm Cause	Display the cause of the alarm.	7.4.8
8	Data Copying	Read or write function code data, as well as verifying it.	7.4.9
9	Load Factor Measurement	Measure the maximum output current, average output current, and average braking power.	7.4.10
10	User Setting	Add or delete function codes covered by Quick Setup.	7.4.11
11	Communication Debugging	Confirm the data of function codes exclusively designed for communication (S, M, W, X, and Z codes).	7.4.12

(Note) The o codes are displayed only when the corresponding option is mounted on the inverter. For details, refer to the instruction manual of the corresponding option.

Figure 7.8 shows the transitions between menus in Programming mode.

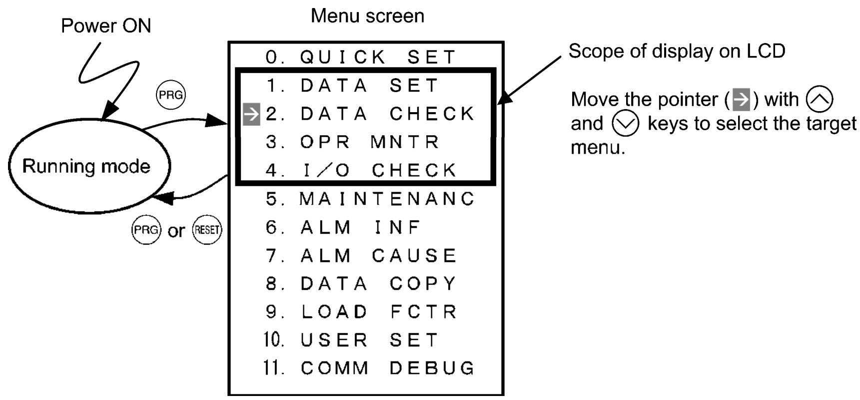


Figure 7.8 Menu Transition in Programming Mode

If no key is pressed for approx. 5 minutes, the inverter automatically goes back to Running mode and turns the backlight OFF.

7.4.1 Setting up function codes quickly using Quick Setup

-- Menu #0 "Quick Setup" --

Menu #0 "Quick Setup" in Programming mode quickly displays and sets up a basic set of function codes specified beforehand.

Using Menu #10 "User Setting" adds or deletes function codes to/from the set of function codes registered for Quick Setup by default. The set of function codes registered for Quick Setup is held in the inverter memory (not the keypad). If the keypad on a particular inverter is mounted on any other inverter, therefore, the set of function codes held in the latter inverter is subject to Quick Setup.

The set of function codes subject to Quick Setup can be copied with the copy function (Menu #8 "Data Copying").

Performing data initialization (function code H03) resets the set of function codes subject to Quick Setup to the factory default.

For the list of function codes subject to Quick Setup by factory default, refer to Chapter 5 "FUNCTION CODES."

The menu transition in Menu #0 is just like that in Menu #1 "Data Setting" given in the next section.

Basic key operation

Same as the basic key operation for Menu #1 "Data Setting."

7.4.2 Setting up function codes -- Menu #1 "Data Setting" --

Menu #1 "Data Setting" in Programming mode allows you to set up all function codes for making the inverter functions match your needs.

Table 7.10 Function Code List

Function Code Group	Function	Description
F codes	Fundamental functions	Functions concerning basic motor running
E codes	Extension terminal functions	Functions concerning the assignment of control circuit terminals Functions concerning the display of the LED monitor
C codes	Control functions	Functions associated with frequency settings
P codes	Motor 1 parameters	Functions for setting up characteristics parameters (such as capacity) of the 1st motor
H codes	High performance functions	Highly added-value functions Functions for sophisticated control
A codes	Motor 2 parameters	Functions for setting up characteristics parameters (such as capacity) of the 2nd motor
b codes	Motor 3 parameters	Functions for setting up characteristics parameters (such as capacity) of the 3rd motor
r codes	Motor 4 parameters	Functions for setting up characteristics parameters (such as capacity) of the 4th motor
J codes	Application functions 1	Functions for applications such as PID control
d codes	Application functions 2	Functions for applications such as speed control
U codes	Application functions 3	Functions for applications such as customizable logic
y codes	Link functions	Functions for controlling communication
o codes	Option functions	Functions for options (Note)

(Note) The o codes are displayed only when the corresponding option is mounted on the inverter. For details, refer to the instruction manual of the corresponding option.

■ Function codes requiring simultaneous keying

To modify the data of function code F00 (data protection), H03 (data initialization), or H97 (clear alarm data), simultaneous keying of "STOP + ∧ keys" or "STOP + ∨ keys" is required.

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

Some function codes can be modified when the inverter is running. The modification may or may not take effect immediately. For details, refer to the "Change when running" column in Chapter 5, Section 5.2 "Function Code Tables."

Basic configuration of screens

Figure 7.9 shows the LCD screen transition for Menu #1 "Data Setting."

A hierarchy exists among those screens that are shifted in the order of "menu screen," "list of function codes," and "function code data modification screens."

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

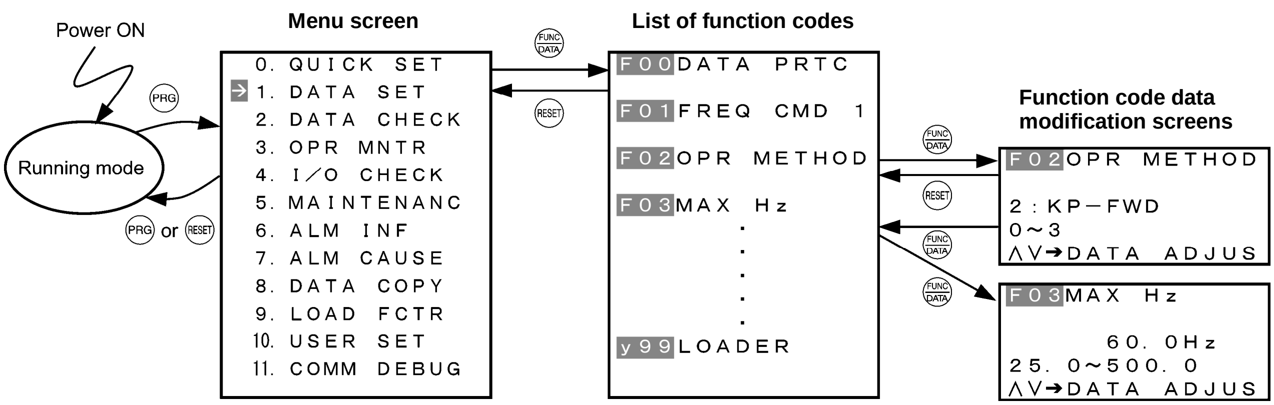
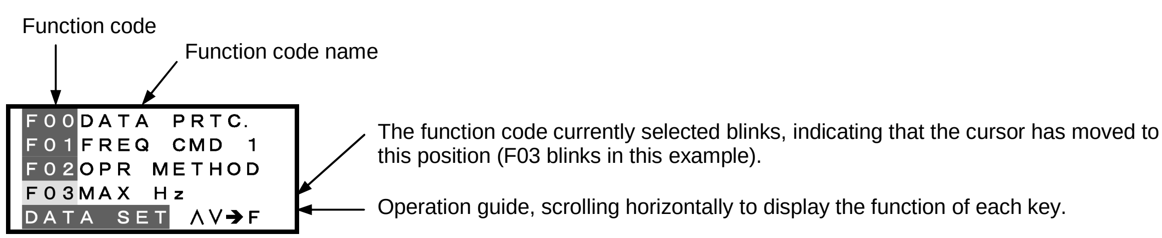


Figure 7.9 Configuration of Screens for "DATA SET"

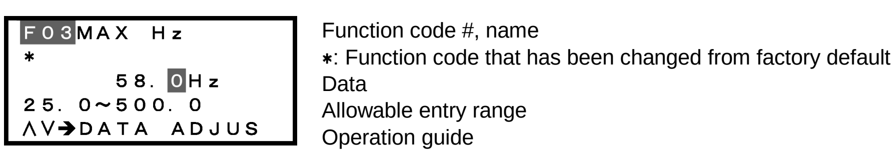
Screen samples for changing function code data

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



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

<Before change>



<Changing data>

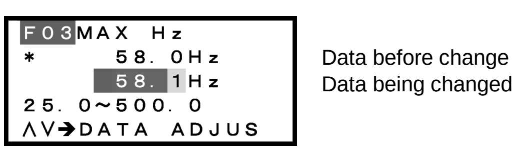


Figure 7.10 Screen Samples for Changing Function Code Data

Basic key operation

This section gives a description of the basic key operation, following the example of the data changing flow shown below. This example shows how to change F03 data (maximum frequency) from 58.0 Hz to 58.1 Hz.

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "1. DATA SET" with the ∧ and ∨ keys, then press the FUNC/DATA key to proceed to a list of function codes.

(3) Select the desired function code (F03 in this example) with the ∧ and ∨ keys, then press the FUNC/DATA key to display the corresponding function code data screen.

(4) Change the function code data with the ∧ and ∨ keys.

Pressing the SHIFT key causes the blinking digit place to shift (cursor shifting) (The blinking digit can be changed).

(5) Press the FUNC/DATA key to establish the function code data.

The data will be saved in the inverter's memory. The display returns to a list of function codes and the cursor moves to the next function code (F04 in this example).

Pressing the RESET key instead of the FUNC/DATA key cancels the new function code data, reverts to the previous data, returns to a list of function codes, and returns the cursor to the previous function code (F03 in this example).

(6) Press the RESET key to go back to the menu screen.

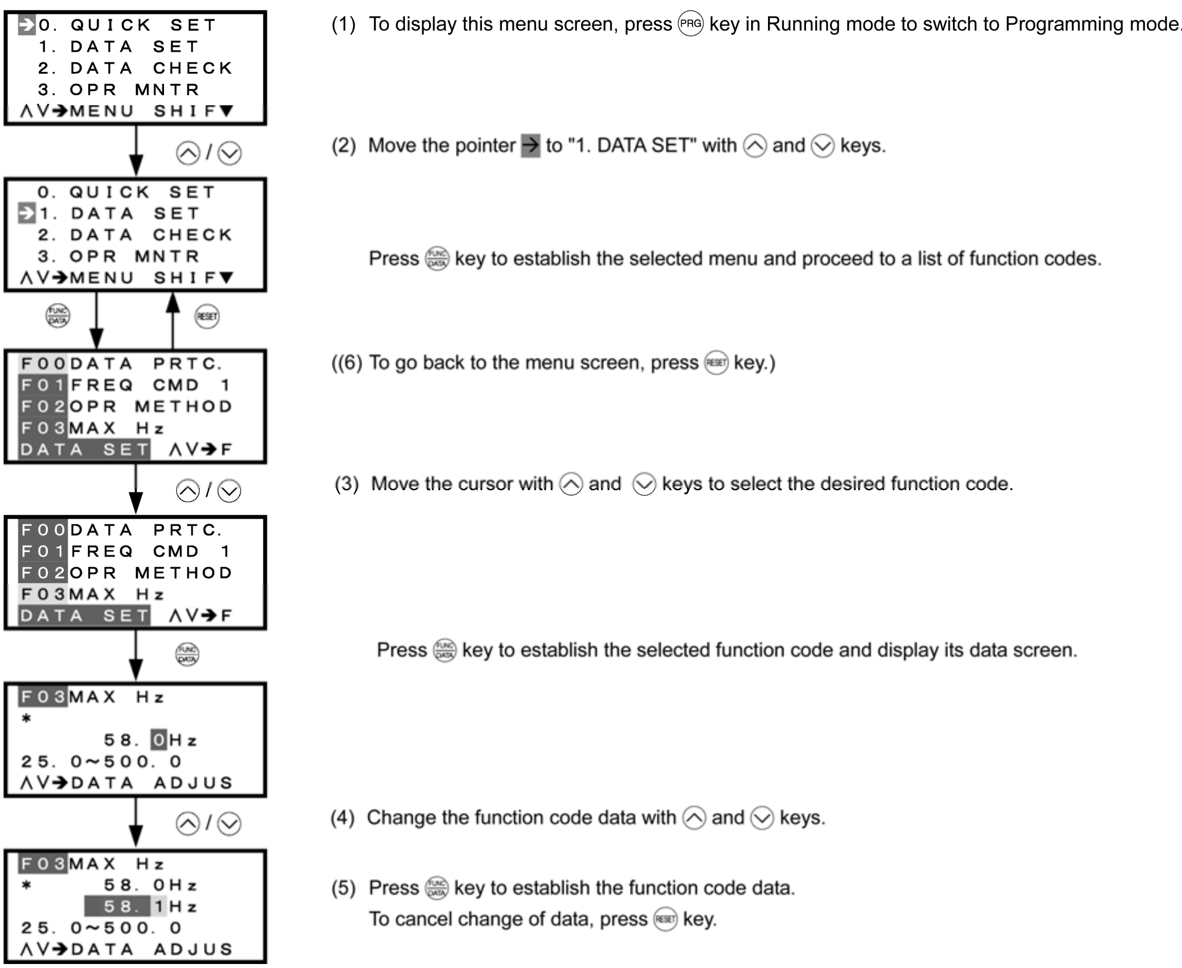


Figure 7.11 Screen Transition for "Data Checking"

7.4.3 Checking changed function codes -- Menu #2 "Data Checking" --

Menu #2 "Data Checking" in Programming mode allows you to check function codes and their data that has been changed. The function codes whose data has been changed from the factory defaults are marked with an asterisk (∗). Select a function code and press the FUNC/DATA key to view or change its data.

The LCD screen transition from Menu #2 is the same as that from Menu #1 "Data Setting," except a list of function codes as shown below.

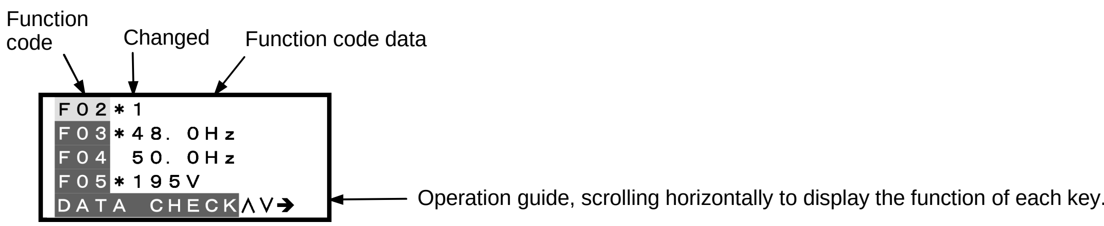


Figure 7.12 List of Function Codes

<u>Basic key operation</u>

Same as the basic key operation for Menu #1 "Data Setting."

7.4.4 Monitoring the running status -- Menu #3 "Drive Monitoring" --

Menu #3 "Drive Monitoring" in Programming mode allows you to monitor the running status during maintenance and test running.

Table 7.11 Drive Monitoring Items

Page # in operation guide	Item	Symbol	Description
1	Output frequency	Fot1	Output frequency (before slip compensation)
	Output frequency	Fot2	Output frequency (after slip compensation)
	Output current	Iout	Output current
	Output voltage	Vout	Output voltage
2	Calculated torque	TRQ	Calculated output torque generated by motor
	Reference frequency	Fref	Frequency specified by a frequency command
	Running direction	FWD REV (Blank)	Forward Reverse Stopped
	Current limit	IL	Current limiting
	Undervoltage Voltage limit	LU VL	Undervoltage detected Voltage limiting
	Torque limit	TL	Torque limiting
	Speed limit	SL	Speed limiting
	Motor selected	M1-M4	Motor 1 to 4
	Drive control	VF DTV VF-SC VF-PG VC-SL VC-PG	V/f control without slip compensation Dynamic torque vector control V/f control with slip compensation Dynamic torque vector control with speed sensor Vector control without speed sensor Vector control with speed sensor
3	Motor speed	SYN	(Output frequency Hz) $\times \frac{120}{P01}$
	Load shaft speed	LOD	Output frequency (Hz) × Function code E50
	Line speed	LIN	Output frequency (Hz) × Function code E50
	Constant peripheral speed control monitor	LSC	Actual peripheral speed under constant peripheral speed control
4	PID command value	SV	The PID command value and PID feedback amount are displayed after conversion to the virtual physical values (e.g., temperature or pressure) of the object to be controlled using function code E40 and E41 data (PID display coefficients A and B). Display value = (PID command value or feedback amount) × (Coefficient A - B) + B
	PID feedback amount	PV	
	PID output value	MV	PID output value, displayed in % (assuming the maximum frequency (F03) as 100%).

Table 7.11 Drive Monitoring Items (Continued)

Page # in operation guide	Item	Symbol	Description
5	Torque limit value A	TLA	Driving torque limit value A (based on motor rated torque)
	Torque limit value B	TLB	Driving torque limit value B (based on motor rated torque)
	Reference torque bias	TRQB	Reserved.
6	Current position pulse	P	Current position pulse for positioning control
	Stop position target pulse	E	Stop position target pulse for positioning control
	Position deviation pulse	dP	Position deviation pulse for positioning control
	Positioning control status	MODE	Positioning control status
7	Motor temperature	NTC	Temperature detected by the NTC thermistor built in the motor
	Ratio setting	Rati	When this setting is 100%, the LED monitor shows 1.00 time of the value to be displayed.
	Magnetic flux command value	FLUX	Flux command value in %.
	Deviation in SY synchronous operation	SY-d	Deviation in SY synchronous operation
8	Current position pulse, 4-multiplied	P4	Current position pulse for positioning control
	Stop position target pulse, 4-multiplied	E4	Stop position target pulse for positioning control
	Position deviation pulse, 4-multiplied	dP4	Position deviation pulse for positioning control
	Positioning control status	MODE	Reserved.

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

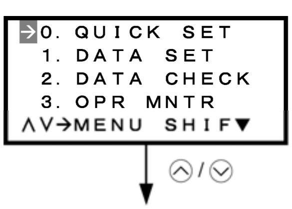
(2) Move the pointer → to "3. OPR MNTR" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to a list of monitoring items (consisting of several pages).

(4) Use the ∧ and ∨ keys to select the page on which the desired monitoring item is shown, then check the running status information of that item.

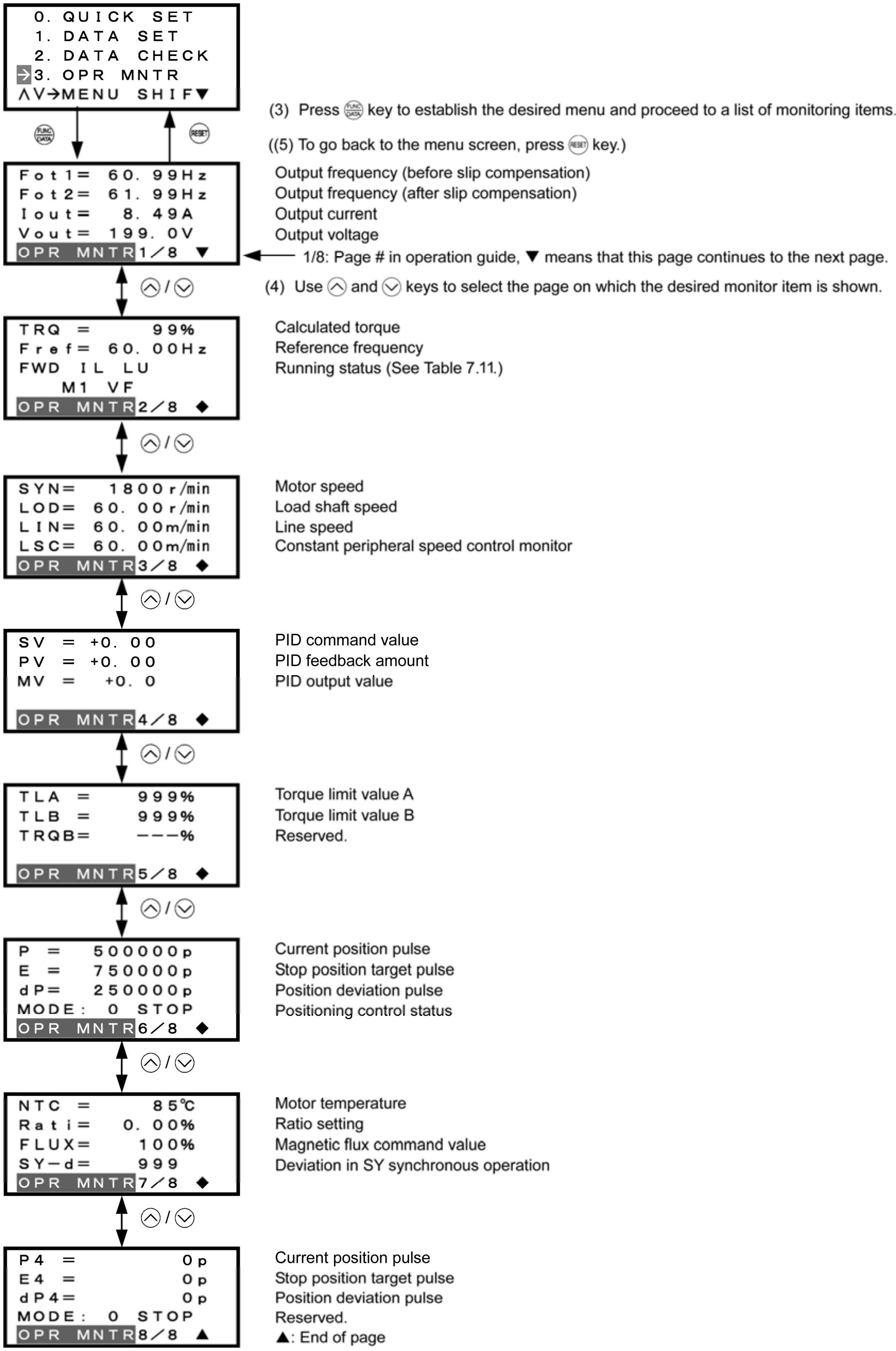
(5) Press the RESET key to go back to the menu screen.

Figure 7.13 shows an example of the LCD screen transition starting from Menu #3 "Drive Monitoring."



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

(2) Move the pointer → to "3. OPR MNTR" with ∧ and ∨ keys.



Common operation items

To access the target data, switch to the desired page using the ⌃ and ⌄ keys.

▼: This page continues to the next page.

◆: This page is continued from the previous page and continues to the next page.

▲: This page is continued from the previous page.

Figure 7.13 Screen Transition for "Drive Monitoring"

7.4.5 Checking I/O signal status -- Menu #4 "I/O Checking" --

Menu #4 "I/O Checking" in Programming mode allows you to check the I/O states of digital and analog signals. It is used to check the running status during maintenance or test running.

Table 7.12 I/O Check Items

Page # in operation guide	Item	Symbol	Description
1	Input signals on the control circuit terminals	FWD, REV, X1 - X7, EN	ON/OFF state of input signals on the control circuit terminal block. (Highlighted when short-circuited; normal when open)
2	Input signals via communications link	FWD, REV, X1 - X7, XF, XR, RST	Input information for function code S06 (communication) (Highlighted when 1; normal when 0)
3	Output signals	Y1 - Y4, Y5, 30ABC	Output signal information
4	I/O signals (hexadecimal)	Di	Input signals on the control circuit terminal block (in hexadecimal)
		Do	Output signals (in hexadecimal)
		LNK	Input signal entered via communications link (in hexadecimal)
5	Analog input signals	12	Input voltage on terminal [12]
		C1	Input current on terminal [C1]
		V2	Input voltage on terminal [V2]
6	Analog output signals	FM1 FM1 FM2 FM2	Output voltage on terminal [FM1] * Output current on terminal [FM1] Output voltage on terminal [FM2] Output current on terminal [FM2]
7	Input signals on the digital input interface card (option)	Di-o	Input signals on the option card in hexadecimal
	Output signals on the digital output interface card (option)	Do-o	Output signals on the option card in hexadecimal
	Pulse train input	X7	Pulse count signals of pulse train input on terminal [X7]
8	PG pulse rate	P1	Pulse rate (kp/s) of the A/B phase signal fed back from the reference PG
		Z1	Pulse rate (p/s) of the Z phase signal fed back from the reference PG
		P2	Pulse rate (kp/s) of the A/B phase signal fed back from the slave PG
		Z2	Pulse rate (p/s) of the Z phase signal fed back from the slave PG
9	I/O signals of analog input/output interface card (option)	32	Input voltage on terminal [32] (option)
		C2	Input current on terminal [C2] (option)
		A0	Output voltage on terminal [A0] (option)
		CS	Output current on terminal [CS] (option)

* Some screens differ depending upon the specifications even on the same inverter models.

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

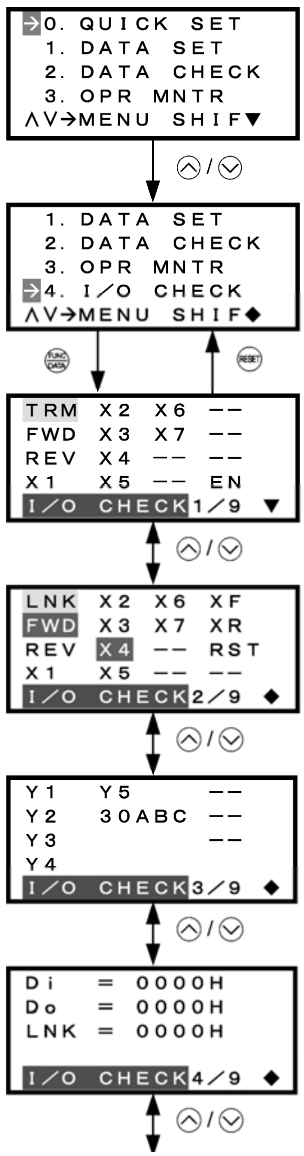
(2) Move the pointer → to "4. I/O CHECK" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to a list of I/O check items (consisting of several pages).

(4) Use the ∧ and ∨ keys to select the page on which the desired item is shown, then check the running status information of that item.

(5) Press the RESET key to go back to the menu screen.

Figure 7.14 shows an example of the LCD screen transition starting from Menu #4 "I/O Checking."



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

(2) Move the pointer → to "4. I/O CHECK" with ∧ and ∨ keys.

(3) Press FUNC/DATA key to establish the selected menu and proceed to a list of I/O check items.
((5) To go back to the menu screen, press RESET key.)

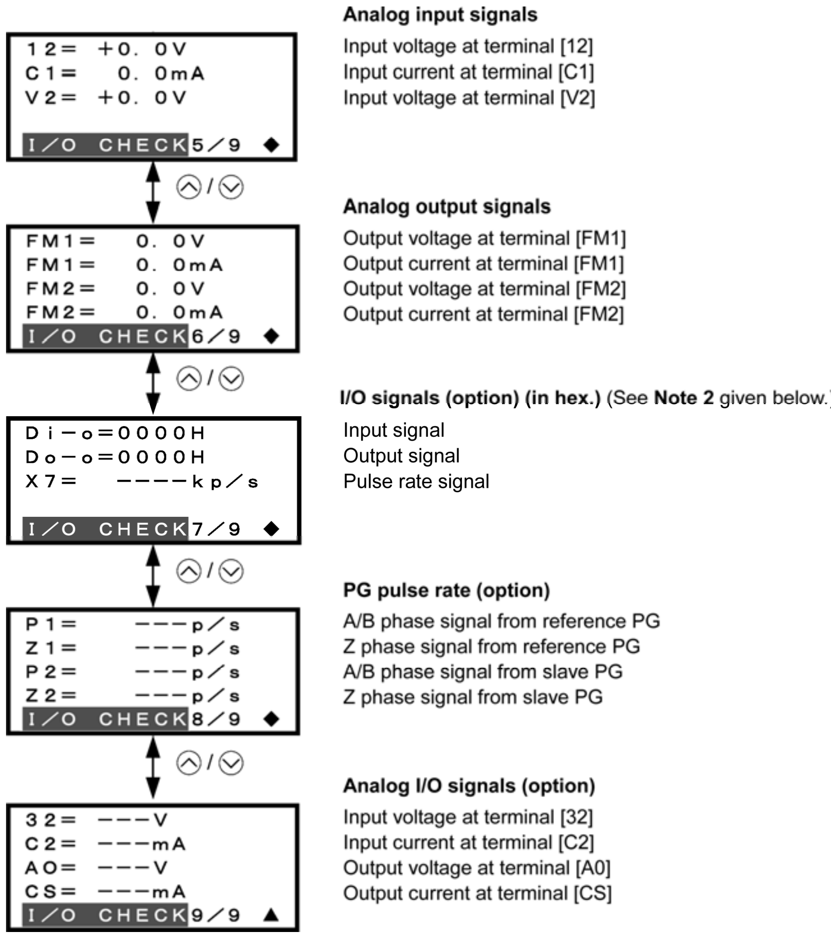
Input signals at the control circuit terminal block
Highlighted when short-circuited
Normal when open

(4) Use ∧ and ∨ keys to select the page of the desired item.

Input signals via communications link (See **Note 1** on the next page.)
Highlighted when 1
Normal when 0

Output signals
Highlighted when ON
Normal when OFF

I/O signals (hexadecimal) (See **Note 2** on the next page.)
Input signals at the control circuit terminal block
Output signal
Input signals via communications link (See **Note 1** on the next page.)



Common operation items

To access the target data, switch to the desired page using the ⌃ and ⌄ keys.

▼: This page continues to the next page.

◆: This page is continued from the previous page and continues to the next page.

▲: This page is continued from the previous page.

Figure 7.14 Screen Transition for "I/O Checking"

Note 1 Input signal status on terminals via communications link

Input commands sent via the RS-485 communications link or other communications options can be displayed in two ways depending on setting of the function code S06: "Display with ON/OFF of the LED segment" or "In hexadecimal format." The content to be displayed is basically the same as that for the control I/O signal terminal status display; however, (XF), (XR), and (RST) are added as inputs. Note that under communications control, I/O display is in normal logic (Active-ON) (using the original signals that are not inverted).

Note 2 I/O signal status in hexadecimal

Each I/O terminal is assigned to one of the 16 binary bits (bit 0 through bit 15). An unassigned bit is interpreted as "0." The I/O status is thus collectively expressed as a four-digit, hexadecimal number (0 through F) as shown in Table 7.13.

Digital input terminals [FWD] and [REV] are assigned to bits 0 and 1, [X1] through [X7] to bits 2 through 10, and [EN] to bit 11, respectively. Each bit assumes a value of "1" when the corresponding signal is ON and a value of "0" when it is OFF. For example, when signals [FWD] and [X1] are ON while all the other signals are OFF, the status is expressed as "0005H."

Digital output terminals [Y1] through [Y4] are assigned to bits 0 through 3. Each is given a value of "1" when it is short-circuited to [CMY], or a value of "0" when its circuit to [CMY] is open. The status of relay output terminal [Y5A/C] is assigned to bit 4, which assumes a value of "1" when the contact between [Y5A] and [Y5C] is closed. The status of relay output terminal [30A/B/C] is assigned to bit 8, which assumes a value of "1" when the contact between [30A] and [30C] is closed or "0" when the contact between [30B] and [30C] is closed. For example, when terminal [Y1] is ON, terminals [Y2] through [Y4]] are OFF, the contact between [Y5A] and [Y5C] is opened, and the link between 30A and 30C is closed, the status is expressed as "0101H."

As in the control I/O signal terminal status display, the ON/OFF status of each input/output terminal signal of a digital input and output interface cards (option) is expressed in hexadecimal notation.

Digital input terminals [I1] through [I16] on a digital input interface card (option) are assigned to 16 binary bits (bit 0 through bit 15). Each bit assumes a value of "1" when the corresponding signal is ON and a value of "0" when it is OFF. Digital output terminals [O1] through [O8] on a digital output interface card (option) are assigned to eight binary bits (bit 0 through bit 7).

Table 7.13 Hexadecimal Notation

Data Displayed		Highest digit												Lowest digit			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Input signal		(RST)*	(XR)*	(XF)*	-	[EN]	-	-	[X7]	[X6]	[X5]	[X4]	[X3]	[X2]	[X1]	[REV]	[FWD]
Output signal		-	-	-	-	-	-	-	[30A/B/C]	-	-	-	[Y5A/C]	[Y4]	[Y3]	[Y2]	[Y1]
Option	DI	[I16]	[I15]	[I14]	[I13]	[I12]	[I11]	[I10]	[I9]	[I8]	[I7]	[I6]	[I5]	[I4]	[I3]	[I2]	[I1]
	DO	-	-	-	-	-	-	-	-	[O8]	[O7]	[O6]	[O5]	[O4]	[O3]	[O2]	[O1]
Example (input)	Binary	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
	Hex.	0005H															

-: Not assigned

* (XF), (XR), (RST) are for communications.
Refer to "Note 1 Input status on terminals via communications link" given on the previous page.

7.4.6 Reading maintenance information

-- Menu #5 "Maintenance Information" --

Menu #5 "Maintenance Information" in Programming mode shows information necessary for performing maintenance on the inverter.

Table 7.14 Maintenance Information Items

Page # in operation guide	Item	Symbol	Description
1	Cumulative run time	TIME	Shows the content of the cumulative power-ON time counter of the inverter. When the count exceeds 65,535 hours, the counter will be reset to "0" and start over again.
	DC link bus voltage	EDC	Shows the DC link bus voltage of the inverter main circuit.
	Max. temperature inside the inverter	TMPI	Shows the maximum temperature inside the inverter for every hour.
	Max. temperature of heat sink	TMPF	Shows the maximum temperature of the heat sink for every hour.
2	Max. effective current	Imax	Shows the maximum current in RMS for every hour.
	Capacitance of the DC link bus capacitor	CAP	Shows the current capacitance of the DC link bus capacitor in %, based on the capacitance when shipping as 100%. Refer to FRENIC-MEGA Instruction Manual (INR-SI47-1457-E), Chapter 7 "MAINTENANCE AND INSPECTION" for details.
	Cumulative motor run time	MTIM	Shows the cumulative run time of the motor. When the count exceeds 99,990 hours, the counter will be reset to "0" and start over again.
	Remaining time before the next maintenance for motor 1 Note 1)	REMT1	Shows the time remaining before the next maintenance, which is estimated by subtracting the cumulative run time of motor 1 from the maintenance interval specified by H78.
3	Cumulative run time of electrolytic capacitors on the printed circuit boards	TCAP	Shows the content of the cumulative time counter of the voltage application to the electrolytic capacitors on the printed circuit boards, which is calculated by multiplying the cumulative time count by the coefficient based on the surrounding temperature condition. The value in parentheses ( ) denotes the service life of the capacitors, which should be used as a guide for replacement timing. Refer to FRENIC-MEGA Instruction Manual (INR-SI47-1457-E), Chapter 7 "MAINTENANCE AND INSPECTION" for details.
	Cumulative run time of the cooling fan	TFAN	Shows the content of the cumulative run time counter of the cooling fan. This counter does not work when the cooling fan ON/OFF control (function code H06) is enabled and the fan stops. The value in parentheses ( ) denotes the service life of the fan, which should be used as a guide for replacement timing. Refer to FRENIC-MEGA Instruction Manual (INR-SI47-1457-E), Chapter 7 "MAINTENANCE AND INSPECTION" for details.

Table 7.14 Maintenance Information Items (Continued)

Page # in operation guide	Item	Symbol	Description
4	Number of startups Note 1)	NST	Shows the content of the motor 1 startup counter (i.e., the number of run commands issued). When the count exceeds 65,530 hours, the counter will be reset to "0" and start over again.
	Input watt-hour Note 2)	Wh	Shows the input watt-hours of the inverter. When the count exceeds 999,900 kWh, the counter will be reset to "0."
	Input watt-hour data Note 2)	PD	Shows the value expressed by "input watt-hour data (kWh) x function code E51." (The display range is from 0.001 to 9,999. Values exceeding 9,999 are expressed as 9,999.)
	Remaining startup times before the next maintenance for motor 1 Note 1)	REMN1	Shows the startup times remaining before the next maintenance, which is estimated by subtracting the number of startups from the preset startup count for maintenance specified by H79.
5	Number of RS-485 communications errors (COM port 1) Note 3)	NRR1	Shows the total number of errors that have occurred in RS-485 communication (COM port 1) after the power was turned ON.
	Error code of RS-485 communications error (COM port 1) Note 3), Note 4)		Shows the content of the latest error that has occurred in RS-485 communication (COM port 1) as an error code.
	Number of RS-485 communications errors (COM port 2) Note 3)	NRR2	Shows the total number of errors that have occurred in RS-485 communication (COM port 2) after the power was turned ON.
	Error code of RS-485 communications error (COM port 2) Note 3), Note 4)		Shows the content of the latest error that has occurred in RS-485 communication (COM port 2) as an error code.
	Count of option errors	NRO	Reserved.
	Option error code		Reserved.
6	ROM version of the inverter	MAIN	Shows the ROM version of the inverter as a 4-digit code.
	ROM version of the keypad	KP	Shows the ROM version of the keypad as a 4-digit code.
7	ROM version of option 1	OP1	Shows the ROM version of the option connected to the A-port as a 4-digit code.
	ROM version of option 2	OP2	Shows the ROM version of the option connected to the B-port as a 4-digit code.
	ROM version of option 3	OP3	Shows the ROM version of the option connected to the C-port as a 4-digit code.

Chap. 7 KEYPAD FUNCTIONS

Table 7.14 Maintenance Information Items (Continued)

Page # in operation guide	Item	Symbol	Description
8	Temperature inside the inverter (real-time value)	TMPIM	Shows the current temperature inside the inverter.
	Temperature of heat sink (real-time value)	TMPFM	Shows the current temperature of the heat sink inside the inverter.
	Lifetime of DC link bus capacitor (elapsed hours)	CAPEH	Shows the cumulative time during which a voltage is applied to the DC link bus capacitor. When the main power is shut down, the inverter automatically measures the discharging time of the DC link bus capacitor and corrects the elapsed time. The display method is the same as that for TCAP above.
	Lifetime of DC link bus capacitor (remaining hours)	CAPRH	Shows the remaining lifetime of the DC link bus capacitor, which is estimated by subtracting the elapsed time from the lifetime (10 years). The display method is the same as that for TCAP above.
9	Cumulative run time of motor 1	MTIM1	Shows the content of the cumulative power-ON time counter of the 1st motor. When the count exceeds 99,990, the counter will be reset to "0" and start over again.
	Cumulative run time of motor 2	MTIM2	Shows the content of the cumulative power-ON time counter of the 2nd motor. The display method is the same as that for MTIM1 above.
	Cumulative run time of motor 3	MTIM3	Shows the content of the cumulative power-ON time counter of the 3rd motor. The display method is the same as that for MTIM1 above.
	Cumulative run time of motor 4	MTIM4	Shows the content of the cumulative power-ON time counter of the 4th motor. The display method is the same as that for MTIM1 above.
10	Number of startups	NST1	Shows the content of the 1st motor startup counter (i.e., the number of run commands issued). Counter range: 0 to 65,530 times When the count exceeds 65,530, the counter will be reset to "0" and start over again.
	Number of startups 2	NST2	Shows the content of the 2nd motor startup counter (i.e., the number of run commands issued). The display method is the same as for NST1 above.
	Number of startups 3	NST3	Shows the content of the 3rd motor startup counter (i.e., the number of run commands issued). The display method is the same as for NST1 above.
	Number of startups 4	NST4	Shows the content of the 4th motor startup counter (i.e., the number of run commands issued). The display method is the same as for NST1 above.

Table 7.14 Maintenance Information Items (Continued)

Page # in operation guide	Item	Symbol	Description
11	Light alarm (Latest)	LALM1	Shows the factor of the latest light alarm as an alarm code. For details, refer to Chapter 9, Section 9.1 "Protective Functions."
	Light alarm (Last)	LALM2	Shows the factor of the last light alarm as an alarm code. For details, refer to Chapter 9, Section 9.1 "Protective Functions."
	Light alarm (2nd last)	LALM3	Shows the factor of the 2nd last light alarm as an alarm code. For details, refer to Chapter 9, Section 9.1 "Protective Functions."
	Light alarm (3rd last)	LALM4	Shows the factor of the 3rd last light alarm as an alarm code. For details, refer to Chapter 9, Section 9.1 "Protective Functions."
12	Number of option errors 1	NROA	Shows the total number of errors that have occurred in the option connected to the A-port.
	Option error factor 1		Shows the factor of the error that has occurred in the option connected to the A-port.
	Number of option errors 2	NROB	Shows the total number of errors that have occurred in the option connected to the B-port.
	Option error factor 2		Shows the factor of the error that has occurred in the option connected to the B-port.
	Number of option errors 3	NROC	Shows the total number of errors that have occurred in the option connected to the C-port.
	Option error factor 3		Shows the factor of the error that has occurred in the option connected to the C-port.

Note 1) Available for the 1st motor only even if the inverter has the motor switching function.

Note 2) To reset the input watt-hour and input watt-hour data to 0, set function code E51 to "0.000."

Note 3) "COM port 1" refers to the RJ-45 connector on the inverter; "COM port 2" is on the terminal block.

Note 4) For details of error codes, refer to the RS-485 Communication User's Manual.

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the (PRG) key to switch to Programming mode and display the menu screen.

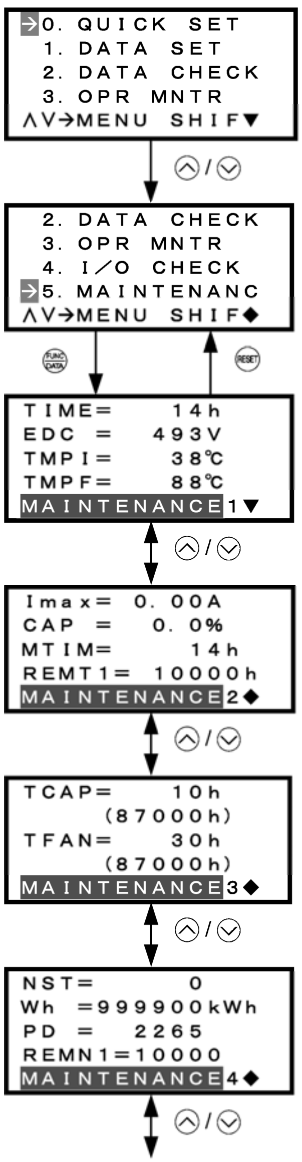
(2) Move the pointer → to "5. MAINTENANC" with the (∧) and (∨) keys.

(3) Press the (FUNC/DATA) key to establish the selected menu and proceed to a list of maintenance items (consisting of several pages).

(4) Use the (∧) and (∨) keys to select the page on which the desired item is shown, then check the maintenance data of that item.

(5) Press the (RESET) key to go back to the menu screen.

Figure 7.15 shows an example of the LCD screen transition starting from Menu #5 "Maintenance Information."



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

(2) Move the pointer → to "5. MAINTENANC" with (∧) and (∨) keys.

(3) Press (FUNC/DATA) key to establish the selected menu and proceed to a list of maintenance items.
((5) To go back to the menu screen, press (RESET) key.)

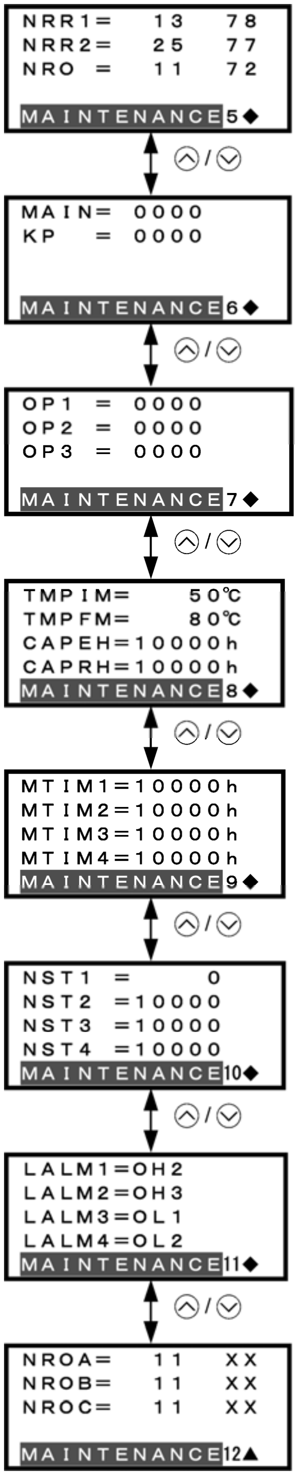
Cumulative run time
DC link bus voltage
Max. temperature inside the inverter
Max. temperature of heat sink

(4) Use (∧) and (∨) keys to select the page of the desired item.

Max. effective current
Capacitance of the DC link bus capacitor
Cumulative motor run time
Remaining time before the next maintenance for motor 1

Cumulative run time of electrolytic capacitors on the printed circuit boards
(Service life as a guide for replacement timing)
Cumulative run time of the cooling fan
(Service life as a guide for replacement timing)

Number of startups
Input watt-hour
Input watt-hour data
Remaining startup times before the next maintenance for motor 1



Number of RS-485 communications errors and the
Number of RS-485 communications errors and the
Reserved.

ROM version

ROM version of the inverter
ROM version of the keypad

ROM version (option)

ROM version of option 1 (A-port)
ROM version of option 2 (B-port)
ROM version of option 3 (C-port)

Temperature inside the inverter
Temperature of heat sink
Lifetime of DC link bus capacitor (elapsed hours)
Life time of DC link bus capacitor (remaining hours)

Cumulative run time of motor 1
Cumulative run time of motor 2
Cumulative run time of motor 3
Cumulative run time of motor 4

Number of startups
Number of startups 2
Number of startups 3
Number of startups 4

Light alarm (Latest)
Light alarm (Last)
Light alarm (2nd last)
Light alarm (3rd last)

Number of errors & error factor

Option 1 (A-port)
Option 2 (B-port)
Option 3 (C-port)

Common operation items

To access the target data, switch to the desired page using the ⌃ and ⌄ keys.

▼: This page continues to the next page.

◆: This page is continued from the previous page and continues to the next page.

▲: This page is continued from the previous page.

Figure 7.15 Screen Transition for "Maintenance Information"

7.4.7 Reading alarm information -- Menu #6 "Alarm Information" --

Menu #6 "Alarm Information" in Programming mode shows the causes of the past four alarms that triggered protective functions, as an alarm code. It is also possible to display the related alarm information on the current inverter conditions detected when the alarm occurred.

Basic configuration of screens

Figure 7.16 shows the LCD screen transition for Menu #6 "Alarm Information."

A hierarchy exists among those screens that are shifted in the order of "menu screen," "list of alarms," and "detailed alarm info screens."

On the "list of alarms," you can view the current alarm and alarm history, and on the "detailed alarm info screens," the information on the inverter running status at the time the alarm occurred.

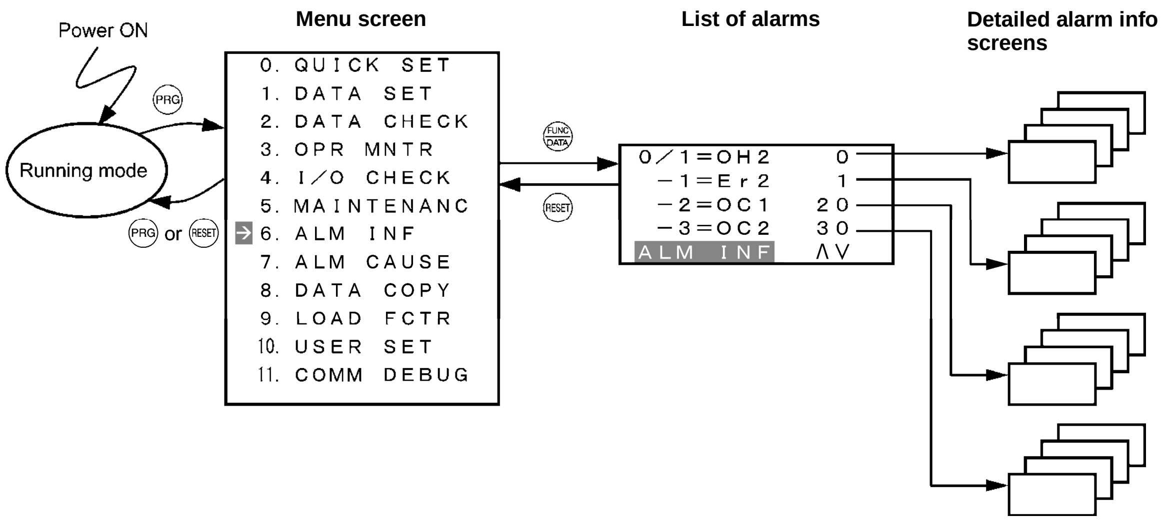
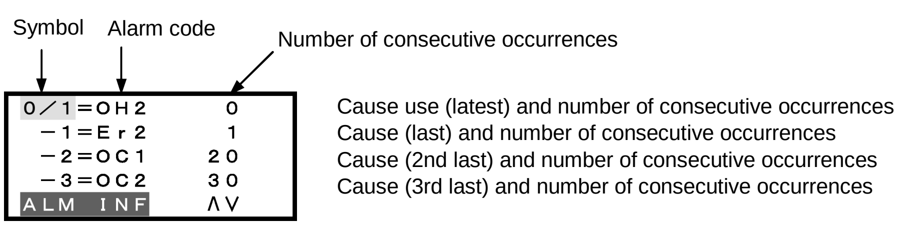


Figure 7.16 Configuration of Screens for "Alarm Information"

Screen samples for viewing alarm info

The list of alarms shows the current alarm and alarm history.



Page # in operation guide	Item	Symbol	Description
—	Alarm history (latest)	0/1	Alarm code and the number of consecutive occurrences
	Alarm history (last)	-1	Alarm code and the number of consecutive occurrences
	Alarm history (2nd last)	-2	Alarm code and the number of consecutive occurrences
	Alarm history (3rd last)	-3	Alarm code and the number of consecutive occurrences

On the "detailed alarm info screens," you can view the information on the inverter running status at the time an alarm occurred. Table 7.15 lists the alarm information displayed on the LCD monitor.

Table 7.15 Alarm Information Items

Page # in operation guide	Item	Symbol	Description
1	Output frequency	Fot1	Output frequency (before slip compensation)
	Output current	Iout	Output current
	Output voltage	Vout	Output voltage
	Calculated torque	TRQ	Calculated motor output torque
2	Reference frequency	Fref	Frequency specified by frequency command
	Rotational direction	FWD REV (Blank)	Forward Reverse Stopped
	Current limit	IL	Current limiting
	Undervoltage Voltage limit	LU VL	Undervoltage detected Voltage limiting
	Torque limit	TL	Torque limiting
	Cumulative run time	TIME	Shows the content of the cumulative power-ON time counter of the inverter. When the count exceeds 65,535 hours, the counter will be reset to "0" and start over again.
	Speed limit	SL	Speed limiting
	Motor being selected	M1-M4	Motor 1 to 4
	Drive control	VF DTV VF-SC VF-PG VF-SL VC-PG	V/f control without slip compensation Dynamic torque vector control V/f control with slip compensation Dynamic torque vector control with speed sensor Vector control without speed sensor Vector control with speed sensor
3	Number of startups	NST	Shows the content of the motor startup counter (i.e., the number of run commands issued). When the count exceeds 65,530, the counter will be reset to "0" and start over again.
	DC link bus voltage	EDC	Shows the DC link bus voltage of the inverter main circuit.
	Temperature inside the inverter	TMPI	Shows the temperature inside the inverter.
	Max. temperature of heat sink	TMPF	Shows the temperature of the heat sink.
4	Input signals on the control circuit terminal block	TRM	Shows the ON/OFF state of input signals on terminals [FWD], [REV], [X1] to [X7], and [EN] (Highlighted when short-circuited; normal when open)
5	Input signals via communications link	LNK	Shows the input signal state of function code S06 (Communication). [FWD], [REV], [X1] to [X7], (XF), (XR), (RST) (Highlighted when 1; normal when 0)
6	Output signals	-	Shows the output signal state on terminals [Y1] to [Y4], [Y5A/C], [30A/B/C].

Table 7.15 Alarm Information Items (Continued)

Page # in operation guide	Item	Symbol	Description
7	Multiple alarm 1	3	Simultaneously occurring alarm codes (1) ("----" is displayed if no alarm has occurred.)
	Multiple alarm 2	2	Simultaneously occurring alarm codes (2) ("----" is displayed if no alarm has occurred.)
	Error sub-code	SUB	Secondary error code for alarms.
	Detected speed	SPEED	Detected speed value

Note: The information of the first alarm is saved as "Alarm history (last)" (Symbol: -1), and that of the latest alarm is retained as "Alarm history (latest)" (Symbol: 0/1).

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "6. ALM INF" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to a list of alarms that displays alarm history on the past four alarms (alarm code and the number of occurrences for each alarm).

(4) Use the ∧ and ∨ keys to select the desired alarm and display its detailed information.

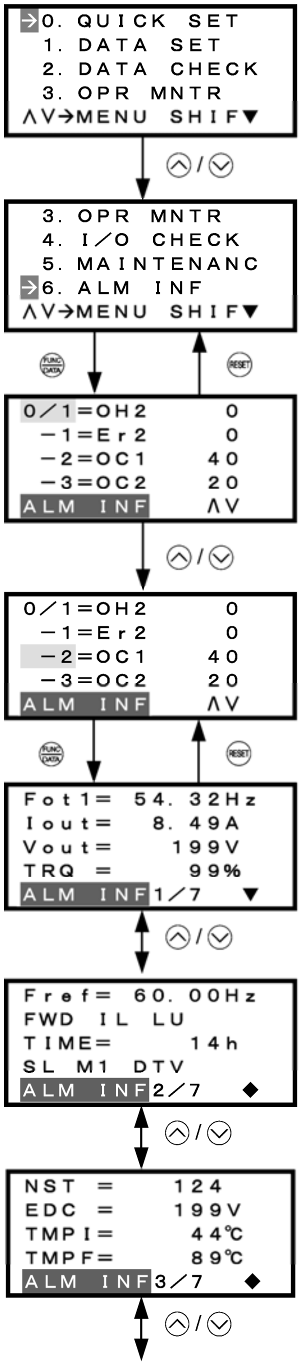
(5) Press the FUNC/DATA key to display the alarm code on the LED monitor and the detailed alarm information (consisting of several pages) on the current inverter conditions detected when the alarm occurred on the LCD monitor.

(6) Use the ∧ and ∨ keys to select the page on which the desired item is shown, then check the detailed data of that item.

(7) Press the RESET key to go back to a list of alarms.

(8) Press the RESET key again to go back to the menu screen.

Figure 7.17 shows an example of the LCD screen transition starting from Menu #6 "Alarm Information."



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

(2) Move the pointer → to "6. ALM INF" with ∧ and ∨ keys.

(3) Press FUNC/DATA key to establish the selected menu and proceed to a list of alarms.
((8) To go back to the menu screen, press RESET key.)

Alarm cause (latest) and no. of occurrences
Alarm cause (last) and no. of occurrences
Alarm cause (2nd last) and no. of occurrences
Alarm cause (3rd last) and no. of occurrences
Press RESET key to go back to Menu.

(4) Use ∧ and ∨ keys to select the desired alarm.

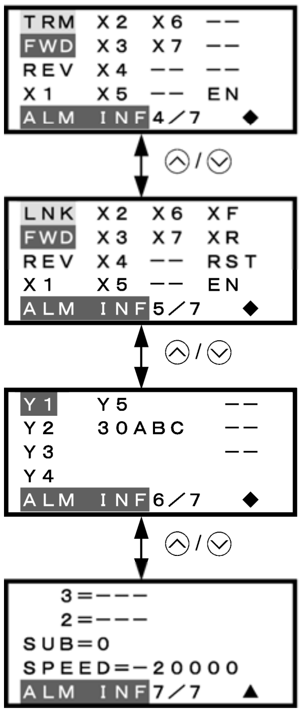
(5) Press FUNC/DATA key to display the detailed alarm information on the current inverter conditions detected when the alarm occurred.
((7) To go back to a list of alarms, press RESET key.)

Output frequency
Output current
Output voltage
Calculated torque

(6) Use ∧ and ∨ keys to select the page on which the desired item is shown.

Reference frequency
Rotational direction and other running states (See Table 7.15.)
Cumulative run time
Running states (See Table 7.15.)

Number of startups
DC link bus voltage
Temperature inside the inverter
Max. temperature of heat sink



Input signals on the control circuit terminal block

Highlighted when short-circuited;
Normal when opened

Input signals via communications link

Highlighted when 1;
Normal when 0

Output signals

Highlighted when 1;
Normal when 0

Multiple alarm 1
Multiple alarm 2
Error sub-code
Detected speed

Common operation items

To access the target data, switch to the desired page using the ⌃ and ⌄ keys.

▼: This page continues to the next page.

◆: This page is continued from the previous page and continues to the next page.

▲: This page is continued from the previous page.

Figure 7.17 Screen Transition for "Alarm Information"

7.4.8 Viewing causes of alarm -- Menu #7 "Alarm Cause" --

Menu #7 "Alarm Cause" in Programming mode shows the causes of the past four alarms that triggered protective functions, as an alarm code. It also shows the cause of each alarm.

Basic configuration of screens

Figure 7.18 shows the LCD screen transition for Menu #7 "Alarm Cause."

A hierarchy exists among those screens that are shifted in the order of "menu screen," "list of alarms," and "alarm cause screens."

On the "alarm cause screen" of the desired alarm code, you can view the cause of the alarm.

The list of alarms is the same as that for Menu #6 "Alarm Information."

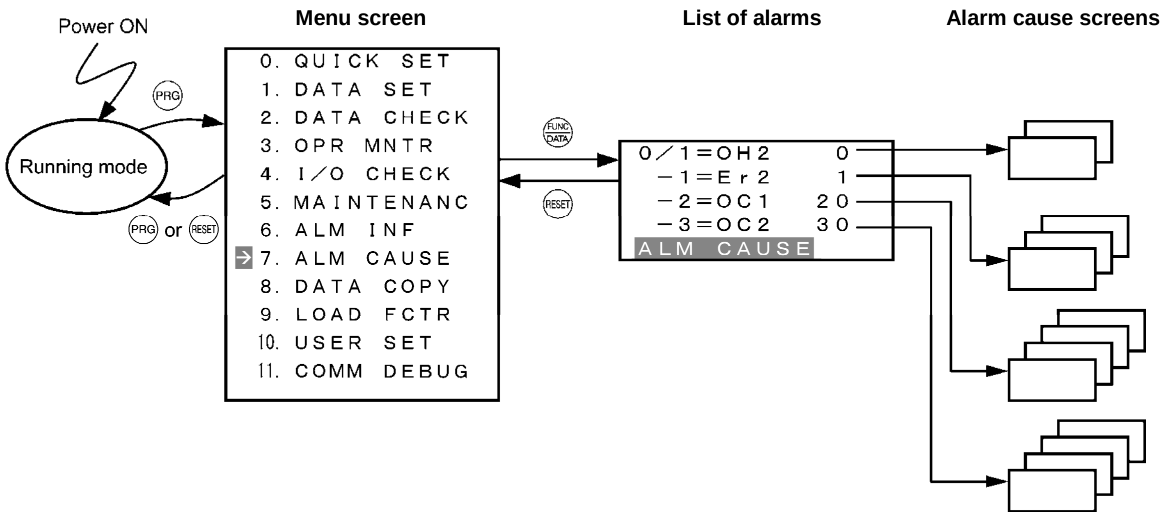


Figure 7.18 Configuration of Screens for "Alarm Cause"

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "7. ALM CAUSE" with the ⌃ and ⌄ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to a list of alarms that displays alarm history on the past four alarms (alarm code and the number of occurrences for each alarm).

(4) Use the ⌃ and ⌄ keys to select the desired alarm and display its detailed information.

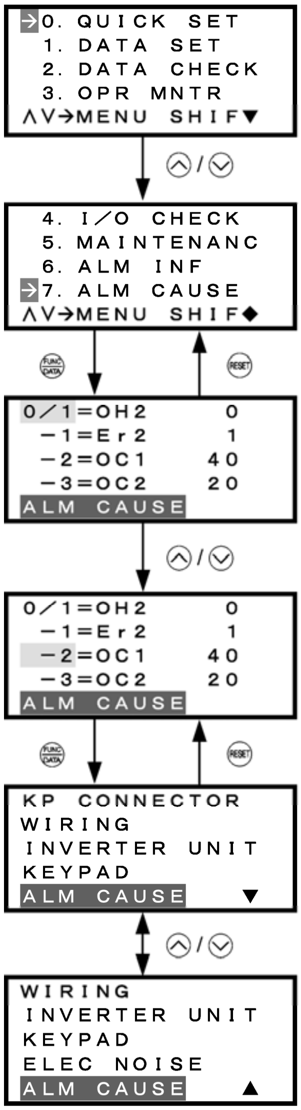
(5) Press the FUNC/DATA key to display the alarm code on the LED monitor and the alarm cause screen (consisting of two pages) on the LCD monitor.

(6) Use the ⌃ and ⌄ keys to show the previous or next page.

(7) Press the RESET key to go back to a list of alarms.

(8) Press the RESET key again to go back to the menu screen.

Figure 7.19 shows an example of the LCD screen transition starting from Menu #7 "Alarm Cause."



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

(2) Move the pointer → to "7. ALM CAUSE" with ∧ and ∨ keys.

(3) Press (FUNC/DATA) key to establish the selected menu and proceed to a list of alarms.
((8) To go back to the menu screen, press (RESET) key.)

Alarm cause (latest) and no. of occurrences
Alarm cause (last) and no. of occurrences
Alarm cause (2nd last) and no. of occurrences
Alarm cause (3rd last) and no. of occurrences

(4) Use ∧ and ∨ keys to select the desired alarm and display its detailed information.

(5) Press (FUNC/DATA) key to display the alarm cause screen (consisting of two pages).
((7) To go back to the alarm cause screen, press (RESET) key.)

Alarm cause (1st page)

(6) Use ∧ and ∨ keys to show the previous or next page.

Alarm cause (2nd page)

Common operation items

To access the target data, switch to the desired page using the ∧ and ∨ keys.
▼: This page continues to the next page.
◆: This page is continued from the previous page and continues to the next page.
▲: This page is continued from the previous page.

Figure 7.19 Screen Transition for "Alarm Cause"

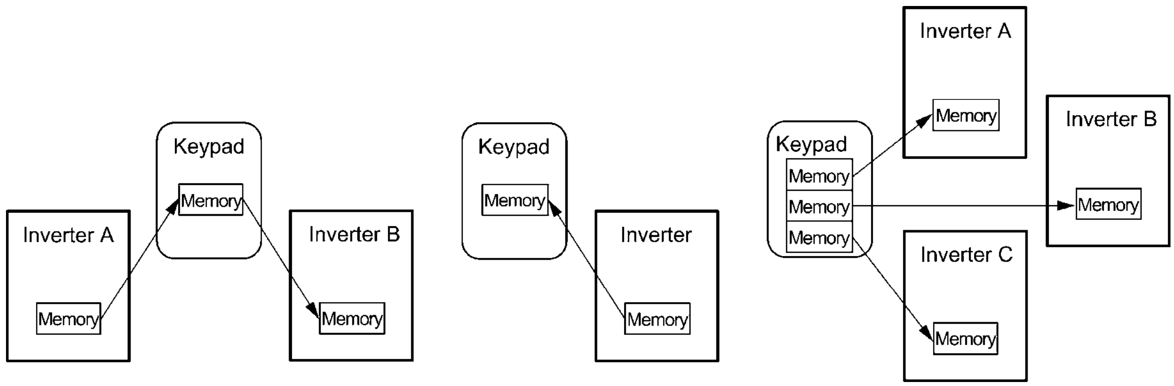
7.4.9 **Data copying** -- Menu #8 "Data Copying" --

Menu #8 "Data Copying" in Programming mode provides "Read," "Write," and "Verify," "Check," and "Protect" functions, enabling the following applications. The keypad can hold three sets of function code data in its internal memory to use for three different inverters.

(a) Reading function code data already configured in an inverter and then writing that function code data altogether into another inverter.

(b) Copying the function code data saved in the inverter memory into the keypad memory for backup.

(c) Saving function code data in the keypad as master data for data management; that is, saving more than one set of function code data in the keypad and writing a set of data suited to the machinery into the target inverter.



(a) Copy (b) Backup (c) Data management

Table 7.16 details the data copying functions.

Table 7.16 List of Data Copying Functions

Functions	Description
Read	Reads out function code data from the inverter memory and stores it into the keypad memory.
Write	Writes the data held in the selected area of the keypad memory into the target inverter memory.
Verify	Verifies the data held in the keypad memory against that in the inverter memory.
Check	Displays the inverter type and its function code data held in each of the three areas of the keypad memory.
Protect	Protects the function code data held in the keypad memory from being overwritten with the data held in the inverter memory.

Target items that can be copied by this function are:

- Function code data
- Function code items subject to Quick Setup, and
- Digital frequency commands and PID commands.

Basic configuration of screens

Figure 7.20 shows the LCD screen transition for Menu #8 "Data Copying."

A hierarchy exists among those screens that are shifted in the order of "menu screen," "list of copy functions," and "memory area selection screen."

On the "memory area selection screen," you can select the target area (1, 2, or 3) of the keypad memory and proceed to the subsequent screens.

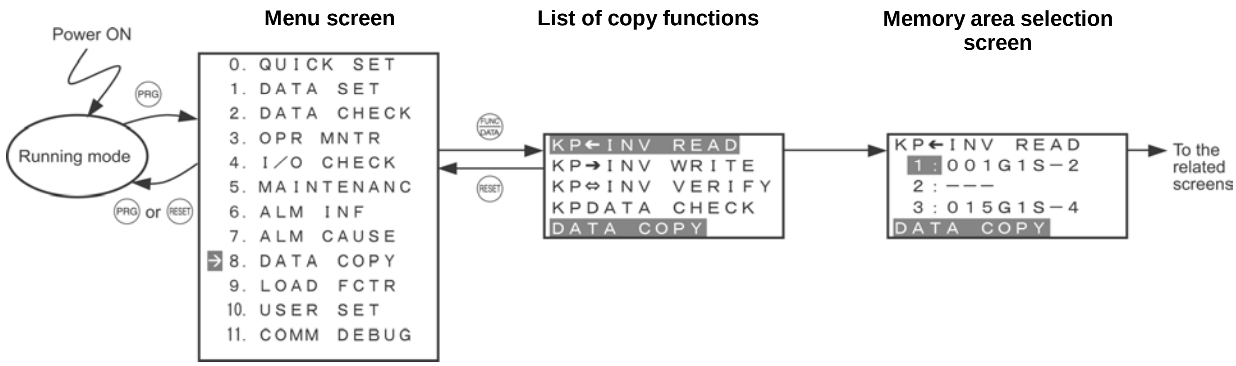
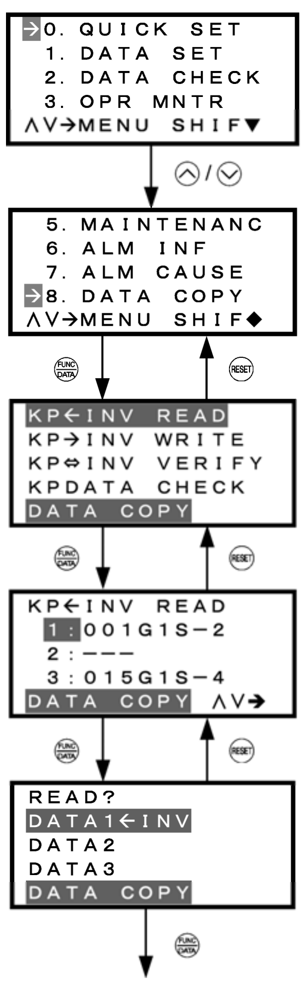


Figure 7.20 Configuration of Screens for "Data Copying"

(1) Read



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

Move the pointer → to the "8. DATA COPY" with (∧) and (∨) keys.

Press (FUNC/DATA) key to establish the selected menu and proceed to a list of copy functions.

List of copy functions
Use (∧) and (∨) keys to select READ.

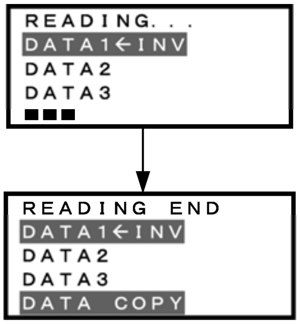
Press (FUNC/DATA) key to establish the selected function.

Memory area selection screen
Use (∧) and (∨) keys to select the target area (1, 2, or 3) of the keypad memory to save data read out from the inverter memory into that area.
To go back to a list of copy functions, press (RESET) key.

Press (FUNC/DATA) key to establish the target area.

Confirmation screen
This screen is to confirm whether to overwrite the data currently held in this area of the keypad memory with data read out from the inverter memory.
To go back to the data selection screen, press (RESET) key.

If OK, press (FUNC/DATA) key to start reading data from the inverter memory.

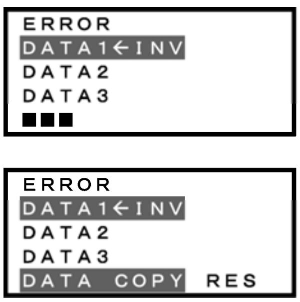


"In progress" screen
A bar indicating progress appears in the bottom.

Upon completion of reading, the completion screen automatically appears.

Completion screen
This screen shows that reading has completed successfully.
To go back to a list of copy functions, press (RESET) key.

Figure 7.21 Screen Transition for "Reading"



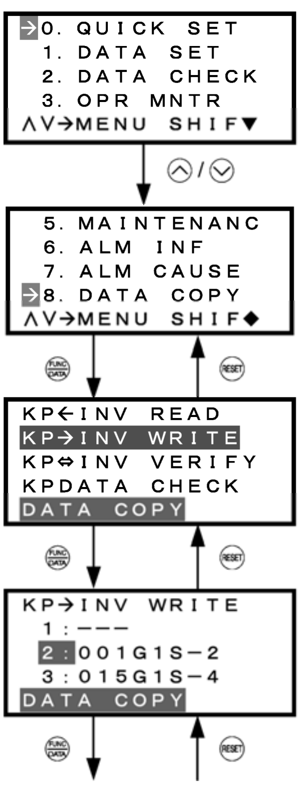
Pressing (PRG) or (RESET) key when reading is in progress cancels the operation and shows this ERROR screen. (See Note below.) It deletes all data held in the keypad memory.

If a communications error occurs between the keypad and the inverter when reading is in progress, this ERROR screen appears.

Figure 7.22 Error Screens for "Reading"

Note If an ERROR screen or an ERROR Ver. screen appears, press the (RESET) key to reset the error condition. The screen returns to a list of copy functions.

(2) Write



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

Move the pointer → to "8. DATA COPY" with (∧) and (∨) keys.

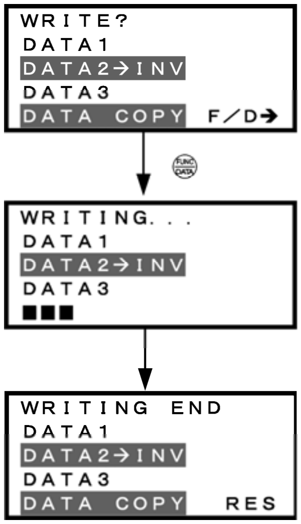
Press (FUNC/DATA) key to establish the selected menu and proceed to a list of copy functions.

List of copy functions
Use (∧) and (∨) keys to select WRITE.

Press (FUNC/DATA) key to establish the selected function.

Memory area selection screen
Use (∧) and (∨) keys to select the target area (1, 2, or 3) of the keypad memory to write data held in that area into the inverter memory.
To go back to a list of copy functions, press (RESET) key.

Press (FUNC/DATA) key to establish the target area.



Confirmation screen
This screen is to confirm whether to overwrite the data held in the inverter with data read out from the keypad.
To go back to the data selection screen, press (RESET) key.

If OK, press (FUNC/DATA) key to start writing data into the inverter memory.

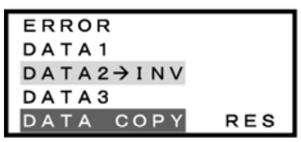
"In progress" screen
A bar indicating progress appears in the bottom.

Upon completion of writing, the completion screen automatically appears.

Completion screen
This screen shows that writing has completed successfully.
To go back to a list of copy functions, press (RESET) key.

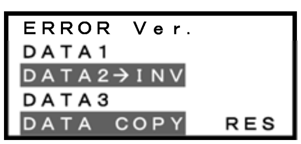
Figure 7.23 Screen Transition for "Writing"

Pressing (PRG) or (RESET) key when writing is in progress cancels the operation and shows this ERROR screen. (See Note below.)
The function code data in the inverter memory is *incompletely* modified, so do not run the inverter as is. Be sure to perform data writing or initialization again.



In any of the following conditions, the inverter causes an error for safety.

- No valid data is found in the keypad memory. (No data reading has been performed since factory shipment or data reading in progress has been cancelled.)
- Data held in the keypad memory contains any error.
- There is a mismatch in inverter types.
- Data writing has been performed when the inverter is running.
- The inverter is data-protected.
- The terminal command ***WE-KP*** ("Enable data change with keypad") is OFF.
- The data to be written is out of the range. (The data setting range has been changed depending upon the applied inverter capacity or the updated version of the software.)

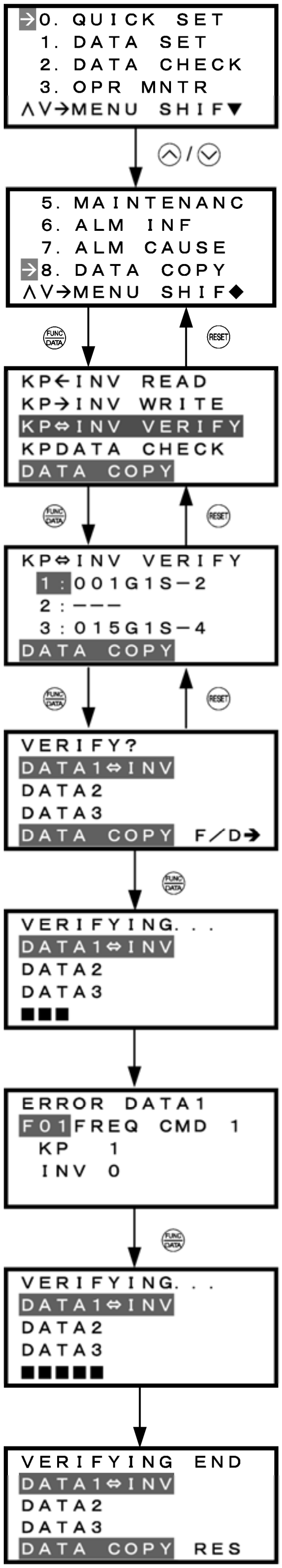


There is no compatibility between the function code data held in the keypad memory and that in the inverter memory. (Either data may be non-standard or updating performed results in no compatibility. Contact your Fuji Electric representative.)

Figure 7.24 Error Screens for "Writing"

Note: If an ERROR screen or an ERROR Ver. screen appears, press the (RESET) key to reset the error condition. The screen returns to a list of copy functions.

(3) Verify



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

Move the pointer → to "8. DATA COPY" with ∧ and ∨ keys.

Press (FUNC/DATA) key to establish the selected menu and proceed to a list of copy functions.

List of copy functions
Use ∧ and ∨ keys to select VERIFY.

Press (FUNC/DATA) key to establish the selected function.

Memory area selection screen
Use ∧ and ∨ keys to select the target area (1, 2, or 3) of the keypad memory for verification.
To go back to a list of copy functions, press (RESET) key.

Press (FUNC/DATA) key to establish the target area.

Confirmation screen
This screen is to confirm whether to proceed to verification.
To go back to the data selection screen, press (RESET) key.

If OK, press (FUNC/DATA) key to start verification.

"In progress" screen
A bar indicating progress appears in the bottom.

When a mismatch is found, verification is halted with the function code and its data displayed on the LCD monitor. To resume verification from the next function code, press (FUNC/DATA) key again.

To resume verification, press (FUNC/DATA) key.

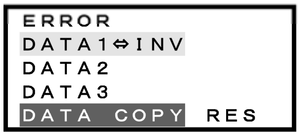
"In progress" screen
A bar indicating progress appears in the bottom.

Upon completion of verification, the completion screen automatically appears.

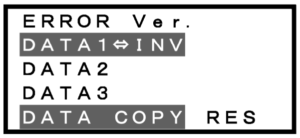
Completion screen
This screen shows that verification has completed successfully.
To go back to a list of copy functions, press (RESET) key.

Figure 7.25 Screen Transition for "Verify"

Pressing (PRG) or (RESET) key when verification is in progress cancels the operation and shows this ERROR screen. (See Note below.) The verification is forcedly terminated.



If no valid data is stored in the keypad memory, this ERROR screen appears. (See Note below.)

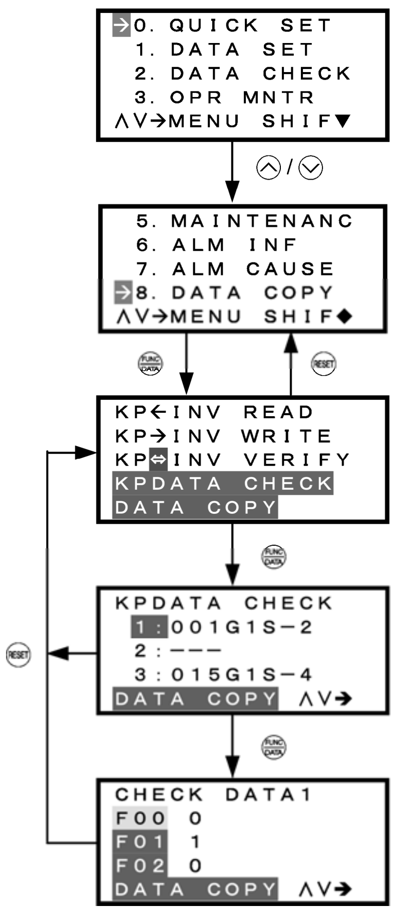


There is no compatibility between the function code data held in the keypad memory and that in the inverter memory. (Either data may be non-standard or updating performed results in no compatibility. Contact your Fuji Electric representative.)

Figure 7.26 Error Screen for "Verify"

Note: If an ERROR screen or an ERROR Ver. screen appears, press the (RESET) key to reset the error condition. The screen returns to a list of copy functions.

(4) Check



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

Move the pointer → to "8. DATA COPY" with (∧) and (∨) keys.

Press (FUNC/DATA) key to establish the selected menu and proceed to a list of copy functions.

List of copy functions
Use (∧) and (∨) keys to select CHECK.

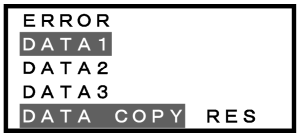
Press (FUNC/DATA) key to establish the selected function.

Memory area selection screen
Use (∧) and (∨) keys to select the target area (1, 2, or 3) of the keypad memory to check data held in that area.
To go back to a list of copy functions, press (RESET) key.

Press (FUNC/DATA) key to establish the target area.

Data checking screen
This screen displays function codes and their data.
To check other function codes, press (∧) and (∨) keys.
To go back to a list of copy functions, press (RESET) key.

Figure 7.27 Screen Transition for "Data Checking"



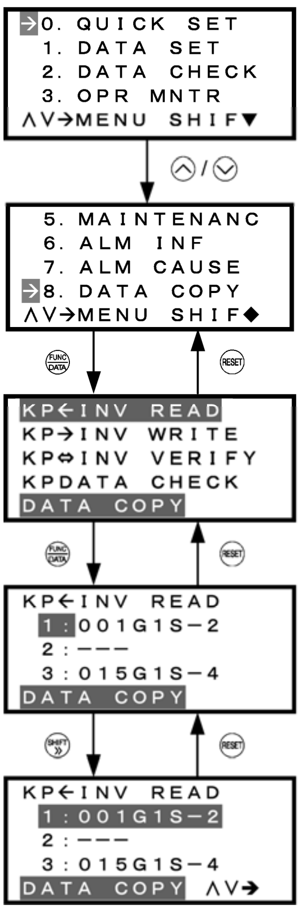
If no valid data is stored in the keypad memory, this ERROR screen appears. (See Note below.)

Figure 7.28 Error Screen for "Data Checking"

Note If an ERROR screen appears, press the RESET key to reset the error condition. The screen returns to a list of copy functions.

(5) Protect

Function code data can be protected from unexpected modifications. Enable the data protection on the "Reading" screen.



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

Move the pointer → to "8. DATA COPY" with ∧ and ∨ keys.

Press FUNC/DATA key to establish the selected menu and proceed to a list of copy functions.

List of copy functions
Use ∧ and ∨ keys to select READ.

Press FUNC/DATA key to establish the selected function.

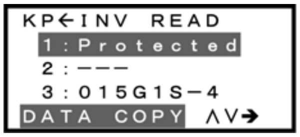
Memory area selection screen
Use ∧ and ∨ keys to select the target area (1, 2, or 3) of the keypad memory to protect data held in that area.
To go back to a list of copy functions, press RESET key.

Hold down SHIFT key for at least five seconds.

Completion screen
The memory area number and the inverter type are highlighted, indicating that the corresponding data is protected.
To go back to a list of copy functions, press RESET key.

(Note) To disable the data protection, press the SHIFT key for at least five seconds in the same procedure shown above. The screen returns to the normal state (not highlighted), indicating that the selected data is not protected.

Figure 7.29 Screen Transition for "Data Protection"



In the process of reading, selecting protected data and pressing the FUNC/DATA key displays the "Protected" (indicating that the data cannot be copied) as shown at left and returns to the normal display.

Figure 7.30 Warning Against Selecting Protected Data

7.4.10 Measuring load factor -- Menu #9 "Load Factor Measurement" --

Menu #9 "Load Factor Management" in Programming mode is used to measure the maximum output current, the average output current, and the average braking power. Two types of measurement modes are available as listed below.

Table 7.17 Measurement Modes

Measurement Mode	Description
Limited duration measurement mode	Measuring load factors for a limited duration (hours).
Start-to-stop measurement mode*	Measuring load factors from the start to stop of running.

* Once the inverter enters the start-to-stop measurement mode when it is running, measurement continues until the stop of the inverter. Once it enters the mode when it is stopped, measurement starts at the next start of the inverter and continues until the stop of the inverter.

(1) Limited duration measurement mode

<u>Basic key operation</u>

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "9. LOAD FCTR" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to the measurement mode selection screen.

(4) Select HOURS SET (Limited duration measurement mode) with the ∧ and ∨ keys.

(5) Press the FUNC/DATA key to establish the selected measurement mode.

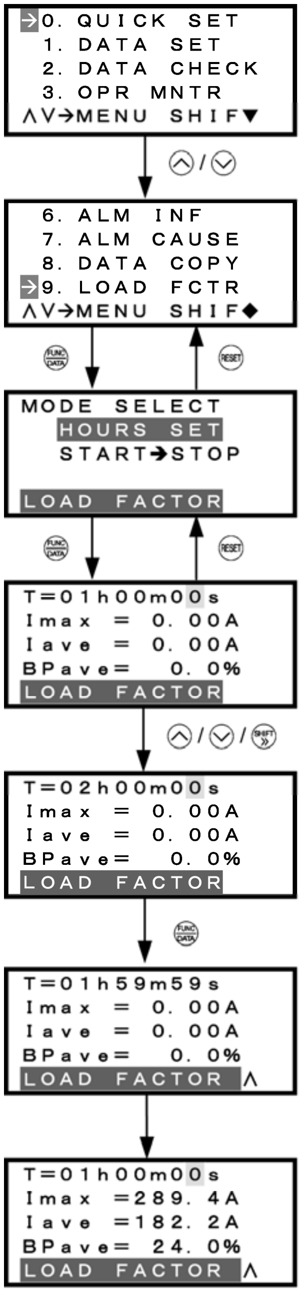
(6) Specify the measurement duration (default: 1 hour) with the ∧, ∨, and SHIFT keys. For details, refer to the screen transition in Figure 7.31.

(7) Press the FUNC/DATA key to establish the specified duration and start measurement.

(8) Press the RESET key to go back to the mode selection screen.

(9) Press the RESET key again to go back to the menu screen.

Figure 7.31 shows an example of the LCD screen transition starting from Menu #9 "Load Factor Measurement."



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

(2) Move the pointer → to "9. LOAD FCTR" with (∧) and (∨) keys.

(3) Press (FUNC/DATA) key to establish the selected menu and proceed to the measurement mode selection screen.
((9) To go back to the menu screen, press (RESET) key.)

Mode selection screen

(4) Select HOUR SET with (∧) and (∨) keys.

(5) Press (FUNC/DATA) key to establish the selected measurement mode.
((8) To go back to the mode selection screen, press (RESET) key.)

Measurement duration specification (Default: 1 hour)

(6) Specify the measurement duration with (∧), (∨), and (SHIFT) keys.

(7) Press (FUNC/DATA) key to establish the specified duration and start measurement.

Measurement in progress (remaining time displayed)
When measurement is in progress, the remaining time is displayed and counting down.
Pressing (FUNC/DATA) key during measurement forcibly terminates the measurement.

When the measurement duration has elapsed, the measurement stops with the results displayed.

Measurement completed (The preset measurement duration reverts to the default.)
Maximum output current
Average output current
Average braking power

Figure 7.31 Screen Transition for "Load Factor Measurement" (Limited duration measurement mode)

(2) Start-to-stop measurement mode

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "9. LOAD FCTR" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to the measurement mode selection screen.

(4) Select START→STOP (Start-to-stop measurement mode) with the ∧ and ∨ keys.

(5) Press the FUNC/DATA key to establish the selected measurement mode.

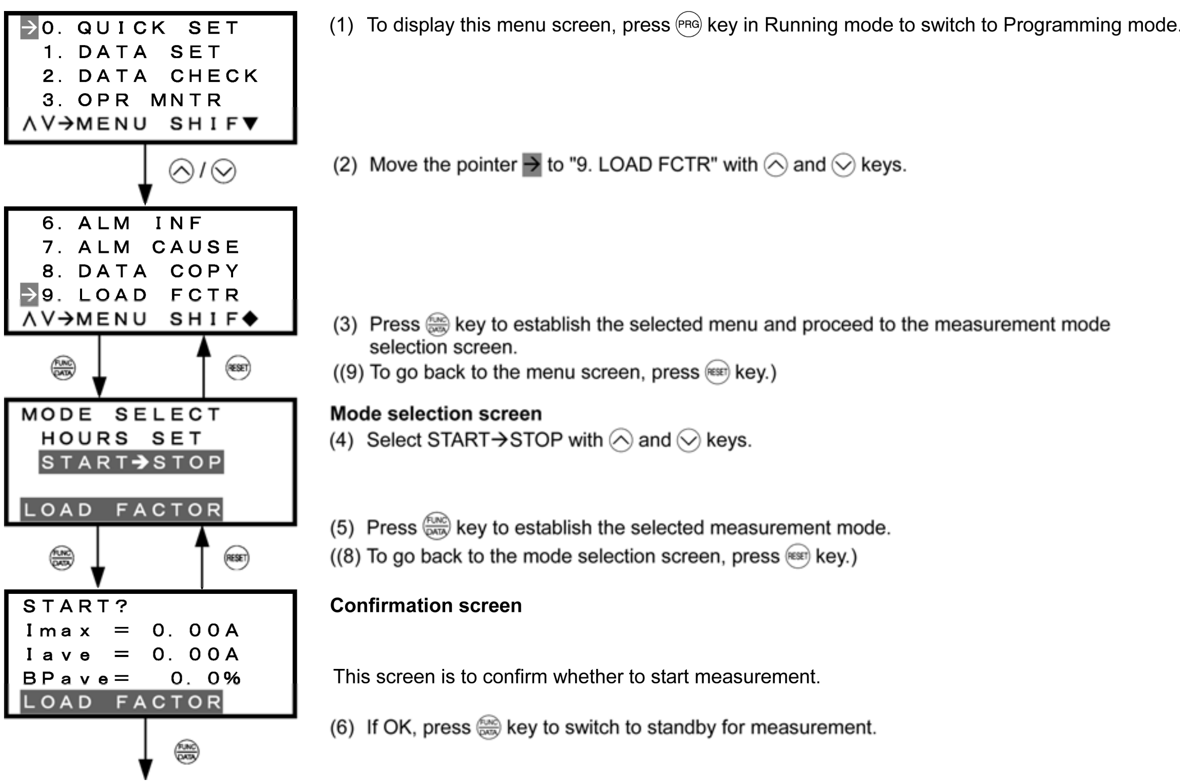
(6) On the confirmation screen, press the FUNC/DATA key to switch to standby for measurement.

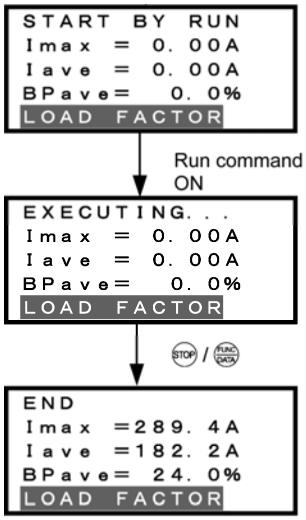
(7) Wait for a run command to enter. For details, refer to the screen transition in Figure 7.32. Upon receipt of a run command, measurement starts.

(8) Press the RESET key to go back to the mode selection screen.

(9) Press the RESET key again to go back to the menu screen.

Figure 7.32 shows an example of the LCD screen transition starting from Menu #9 "Load Factor Measurement."





Waiting for run command (On standby for measurement)

(7) Wait for a run command to enter.
Upon reception of a run command, the measurement starts.
If a run command has already been received, this screen will be skipped.

Measurement starts upon reception of a run command.

Measurement in progress
Measurement continues until the stop of the inverter.

Pressing [STOP] / [FUNC/DATA] key terminates the measurement.

Measurement completed (When measurement completes, the results appear.)
Maximum output current
Average output current
Average braking power

To go back to Mode selection, press [RESET] key.

Figure 7.32 Screen Transition for "Load Factor Measurement" (Start-to-stop measurement mode)

Tip

Going back to Running mode

When measurement of the load factor is in progress, pressing the [PRG] key switches the inverter to Running mode, and pressing. the [RESET] key, to the mode selection screen. This switching does not interrupt measurement.

Selecting the "9: LOAD FCTR" menu on the menu screen again allows you to confirm whether or not measurement is in progress.

After measurement has completed, pressing the [FUNC/DATA] key on the mode selection screen displays the measurement results.

Screen when measurement is in progress

Note

Turning the inverter OFF clears the measurement result.

7.4.11 Changing function codes covered by Quick Setup

-- Menu #10 "User Setting" --

Menu #10 "User Setting" in Programming mode is used to add or delete function code to/from the set of function codes registered for Quick Setup.

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the PRG key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "10. USER SET" with the ∧ and ∨ keys.

(3) Press the FUNC/DATA key to establish the selected menu and proceed to a list of function codes.

(4) Select a function code to be added, using the ∧ and ∨ keys.
Function codes whose names are not highlighted are not registered for Quick Setup. For addition, select a function code whose name is not highlighted.

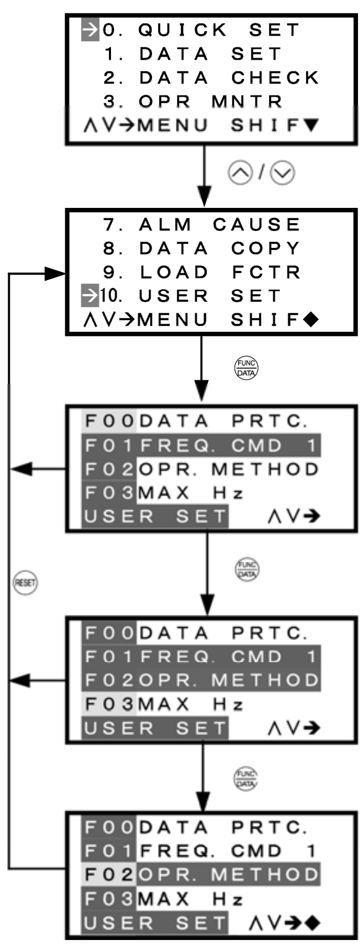
(5) Press the FUNC/DATA key to add the selected function code.

(6) Select a function code to be deleted, using the ∧ and ∨ keys.
Function codes whose names are highlighted are registered for Quick Setup. For deletion, select a function code whose name is highlighted.

(7) Press the FUNC/DATA key to delete the selected function code.

(8) Press the RESET key to go back to the menu screen.

Figure 7.33 shows the LCD screen transition starting from Menu #10 "User Setting.".



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

(2) Move the pointer → to "10. USER SET" with ∧ and ∨ keys.

(3) Press FUNC/DATA key to establish the selected menu and proceed to a list of function codes.

List of function codes

This screen lists the function codes and their names.

(4) To add a particular function code (whose name is not highlighted), select the code (F02 in this example) with ∧ and ∨ keys.

(To go back to the menu screen, press RESET key.)

(5) Press FUNC/DATA key to add the selected function code to Quick Setup.

(6) To delete a particular function code (whose name is highlighted), select the code (F01 in this example) with ∧ and ∨ keys.

(To go back to the menu screen, press RESET key.)

(7) Press FUNC/DATA key to delete the selected function code from Quick Setup.

(8) To go back to the menu screen, press RESET key.

Figure 7.33 Screen Transition for Changing Function Codes Covered by Quick Setup

7.4.12 Helping debugging for communication
-- Menu #11 "Communication Debugging" --

Menu #11 "Communication Debugging" in Programming mode is used to monitor the data of communication-related function codes (S, M, W, X, and Z codes) to help debug programs for communication with host equipment.

Basic key operation

(1) Turn the inverter ON. It automatically enters Running mode. In that mode, press the (PRG) key to switch to Programming mode and display the menu screen.

(2) Move the pointer → to "11. COMM DEBUG" with the ∧ and ∨ keys.

(3) Press the (FUNC/DATA) key to establish the selected menu and proceed to a list of communication-related function codes.

(4) Select the desired function code with the ∧ and ∨ keys.

(5) Press the (FUNC/DATA) key to display the data of the selected function code.

(6) Change the data of the S codes if necessary, using the ∧ and ∨ keys. Other communication-related function codes cannot be changed.

(7) Press the (RESET) key to go back to the menu screen.

Figure 7.34 shows the LCD screen transition starting from Menu #11 "Communication Debugging."

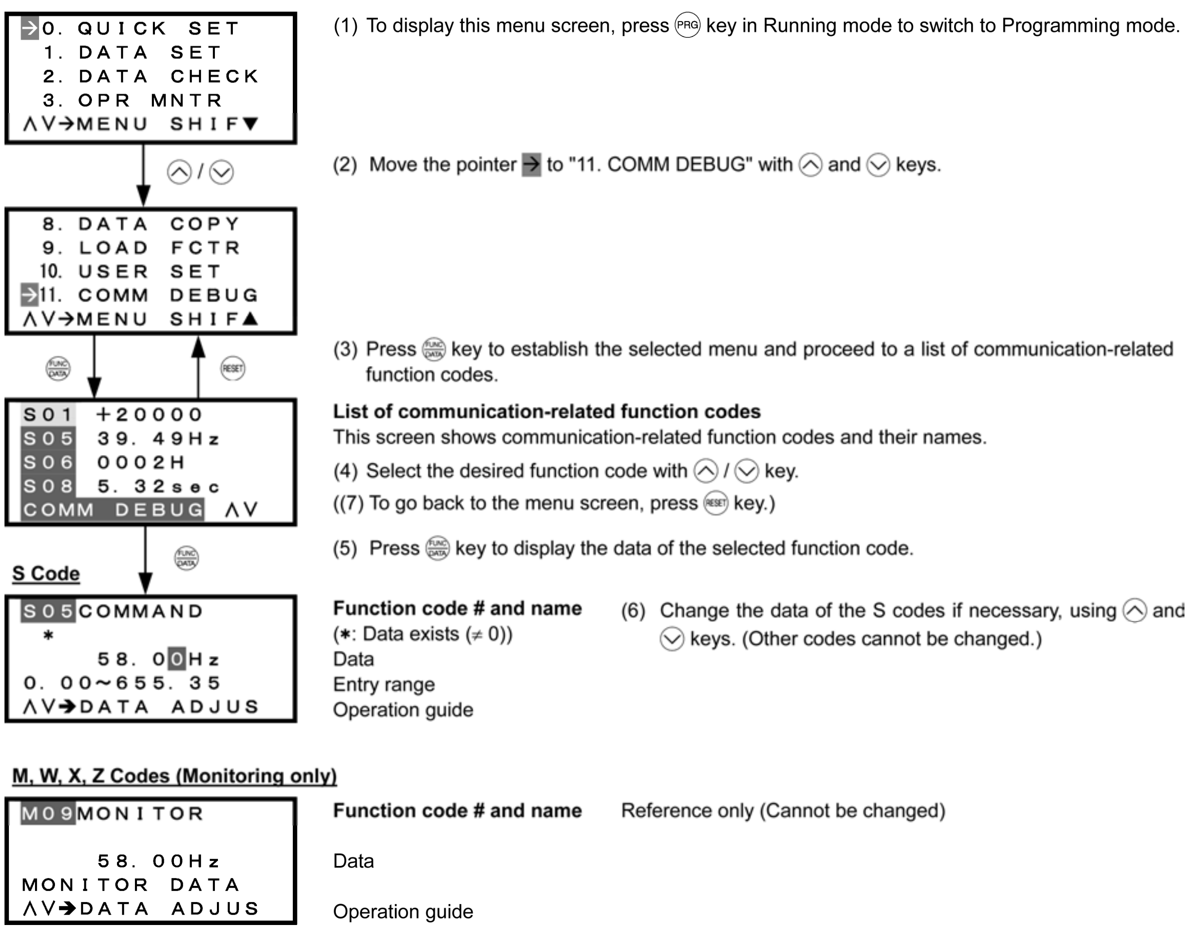


Figure 7.34 Screen Transition for "Communication Debugging"

7.5 Alarm Mode

If an abnormal condition arises so that the protective function is invoked and issues an alarm, then the inverter automatically switches to Alarm mode, displaying the alarm code on the LED monitor and the alarm information on the LCD monitor as shown below.

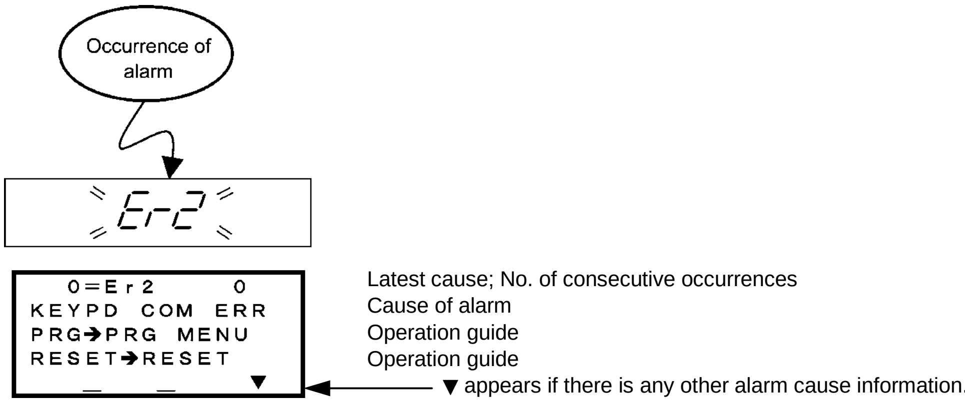
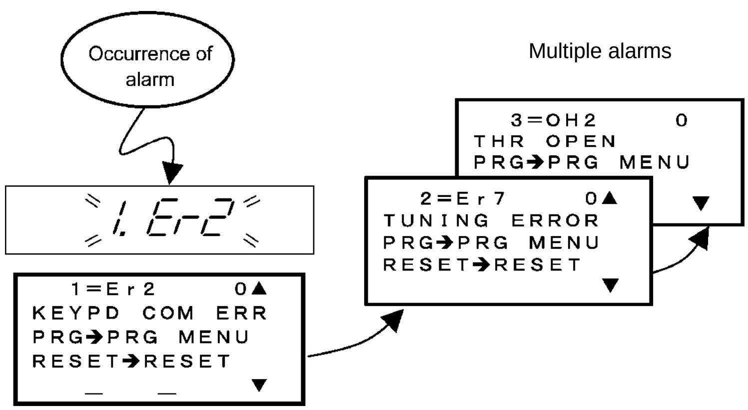


Figure 7.35 Without Multiple Alarms

If more than one alarm (multiple alarms) occurs, the display appears as shown below, allowing you to check the multiple alarms.



If multiple alarms occur, the latest cause appears as "1 = alarm code," not as "0 = alarm code."

Figure 7.36 With Multiple Alarms

It is also possible to view the alarm history.

In addition to the latest (current) alarm, you can view past three alarms and multiple alarms (if any) using the ∧ and ∨ keys when the latest (current) one is displayed.

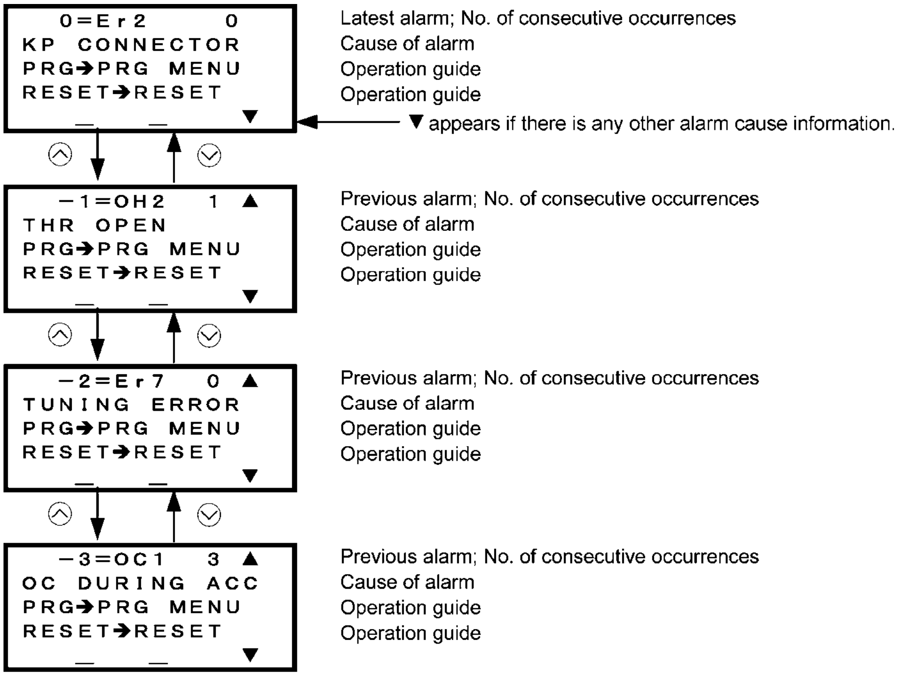


Figure 7.37 Switching of Display of Overlapping Alarm History

■ Display of running status information at the time of alarm (Note 1 in Figure 7.38)

By pressing the FUNC/DATA key while an alarm code is displayed, you can view the output frequency, output current, and other data concerning the running status. The data you can view is the same as with "6. ALM INF." Use the ∧ and ∨ keys for scrolling pages within the menu.

Also, while a past alarm code is displayed, you can view the inverter running status at the occurrence of the displayed alarm.

Pressing the PRG key or RESET key with the running status information being displayed will switch back to the display of the alarm code.

■ Transition to Programming mode (Note 2 in Figure 7.38)

To change function code data for investigating or removing alarm causes, press the PRG key while alarm information is displayed. Then the inverter enters the Programming mode, in which you can use a variety of features including function code data change.

■ Resetting alarm (Note 3 in Figure 7.38)

When you remove the cause of the alarm and press the RESET key, the alarm condition will be reset, and the inverter will go back to the Running mode.

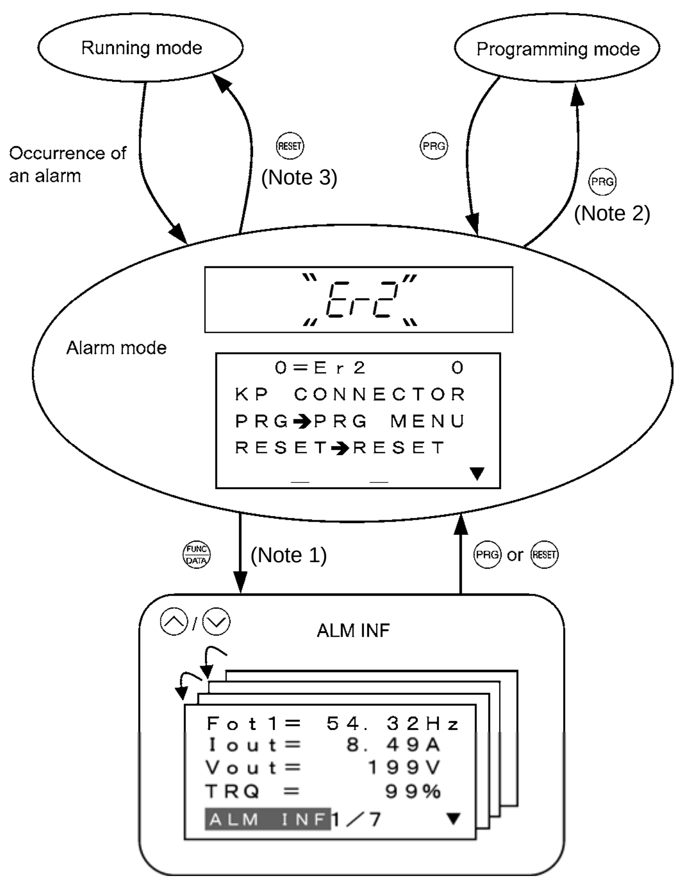


Figure 7.38 Screen Transition in/from Alarm Mode

Chapter 8

RUNNING THROUGH RS-485 COMMUNICATION

This chapter describes an overview of inverter operation through the RS-485 communications facility. Refer to the RS-485 Communication User's Manual for details.

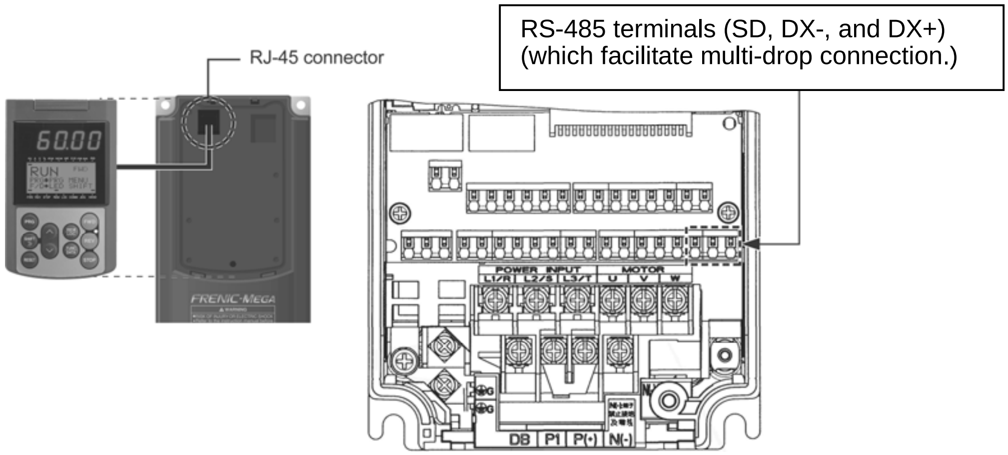
Contents

8.1 Overview on RS-485 Communication

The FRENIC-MEGA has two RS-485 communications ports at the locations shown below.

(1) Communications port 1: RJ-45 connector for the keypad

(2) Communications port 2: RS-485 terminals (Control circuit terminals SD, DX-, and DX+)



Using the RS-485 communications ports shown above enables the extended functions listed below.

■ Remote operation from a keypad at the remote location (COM port 1)

Using an extension cable to connect the standard keypad to the RJ-45 port allows you to mount the keypad on a panel located far from the inverter, enabling remote operation. The maximum length of the extension cable is 66 ft (20 m).

■ Operation by FRENIC Loader (COM port 1)

A Windows-based PC can be connected to the RJ-45 connector (RS-485 communication) or the USB port on the optional remote keypad. Through the interface, you can run FRENIC Loader (see Section 8.2) on the PC to edit the function code data and monitor the running status of the inverter.

■ Control via host equipment (COM ports 1 and 2)

Connecting the inverter to a PC, PLC, or other host equipment enables you to control the inverter as a subordinate device from the host.

Besides the communications port (RJ-45 connector) shared with the keypad, the FRENIC-MEGA has RS-485 terminals as standard. The connection via terminals facilitates multi-drop connection.

Protocols for managing a network including inverters include the Modbus RTU protocol (compliant to the protocol established by Modicon Inc.) that is widely used in FA markets and the Fuji general-purpose inverter protocol that supports the FRENIC-MEGA and conventional series of inverters.

Note

- Connecting the keypad to the COM port 1 automatically switches to the keypad protocol; there is no need to modify the function code setting.
- When using FRENIC Loader, which requires a special protocol for handling Loader commands, you need to set up some communication function codes accordingly.
  For details, refer to the FRENIC Loader Instruction Manual.
- The COM port 2 supports only controls from host equipment, and not from the keypad or FRENIC Loader.

For details of RS-485 communication, refer to the RS-485 Communication User's Manual.

8.1.1 RS-485 common specifications

Items	Specifications		
Protocol	FGI-BUS	Modbus RTU	Loader commands (supported only on the standard version)
Compliance	Fuji general-purpose inverter protocol	Modicon Modbus RTU-compliant (only in RTU mode)	Dedicated protocol (Not disclosed)
No. of supporting stations	Host device: 1 Inverters: Up to 31		
Electrical specifications	EIA RS-485		
Connection to RS-485	RJ-45 connector or terminal block		
Synchronization	Asynchronous start-stop system		
Transmission mode	Half-duplex		
Transmission speed	2400, 4800, 9600 19200 or 38400 bps		
Max. transmission cable length	1640 ft (500 m)		
No. of logical station addresses available	1 to 31	1 to 247	1 to 255
Message frame format	FGI-BUS	Modbus RTU	FRENIC Loader
Frame synchronization	SOH (Start Of Header) character detection	Detection of no-data transmission time for 3-byte period	Start code 96H detection
Frame length	Normal transmission: 16 bytes (fixed) High-speed transmission: 8 or 12 bytes	Variable length	Variable length
Max. transfer data	Write: 1 word Read: 1 word	Write: 50 words Read: 50 words	Write: 41 words Read: 41 words
Messaging system	Polling/Selecting/Broadcast		Command message
Transmission character format	ASCII	Binary	Binary
Character length	8 or 7 bits (selectable by the function code)	8 bits (fixed)	8 bits (fixed)
Parity	Even, Odd, or None (selectable by the function code)		Even (fixed)
Stop bit length	1 or 2 bits (selectable by the function code)	No parity: 2 bits/1 bit Even or Odd parity: 1 bit Select by parity setting.	1 bit (fixed)
Error checking	Sum-check	CRC-16	Sum-check

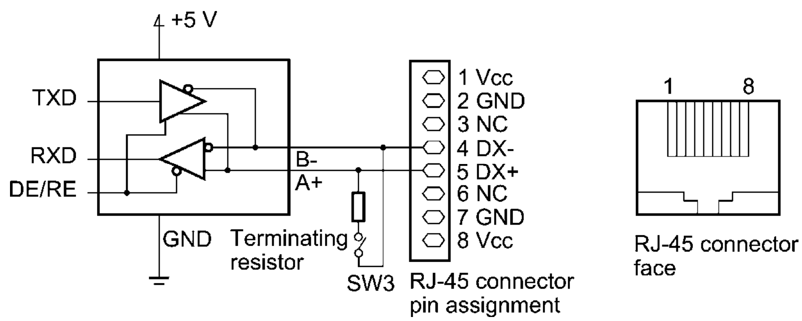
8.1.2 Terminal specifications for RS-485 communications

[1] RS-485 communications port 1 (for connecting the keypad)

The port designed for a standard keypad uses an RJ-45 connector having the following pin assignment:

Pin	Signal name	Function	Remarks
1 and 8	Vcc	Power source for the keypad	5 V power lines
2 and 7	GND	Reference potential	Grounding pins
3 and 6	NC	Not used.	No connection
4	DX-	RS-485 data (-)	Built-in terminating resistor: 112Ω Open/close by SW3*
5	DX+	RS-485 data (+)	

* For details about SW3, refer to Chapter 2, Section 2.4.2 "Setting up the slide switches."



Note: Pins 1, 2, 7, and 8 on the RJ-45 connector are exclusively assigned to power supply and grounding for keypads. When connecting other devices to the RJ-45 connector, take care not to use those pins. Failure to do so may cause a short-circuit hazard. Use the pins 4 and 5 only.

[2] RS-485 communications port 2 (control circuit terminals)

The FRENIC-MEGA has terminals for RS-485 communications on the control circuit terminal block. The details of each terminal are shown below.

Signal name	Function	Remarks
SD	Shield terminal	
DX－	RS-485 data (-)	Built-in terminating resistor: 112Ω Open/close by SW2*
DX＋	RS-485 data (+)	

* For details about SW2, refer to Chapter 2, Section 2.4.2 "Setting up the slide switches."

8.1.3 Connection method

- Up to 31 inverters can be connected to one host equipment.
- The protocol is commonly used in the FRENIC series of general-purpose inverters, so programs for similar host equipment can run/stop the inverter.
  (The parameters specifications may differ depending on the equipment.)
- Fixed-length transmission frames facilitate developing communication control programs for hosts.

For details of RS-485 communication, refer to the RS-485 Communication User's Manual.

Multi-drop connection using the RS-485 communications port 1 (for connecting the keypad)

For connecting inverters in multi-drop connection, use the branch adapters for multi-drop connection as shown below.

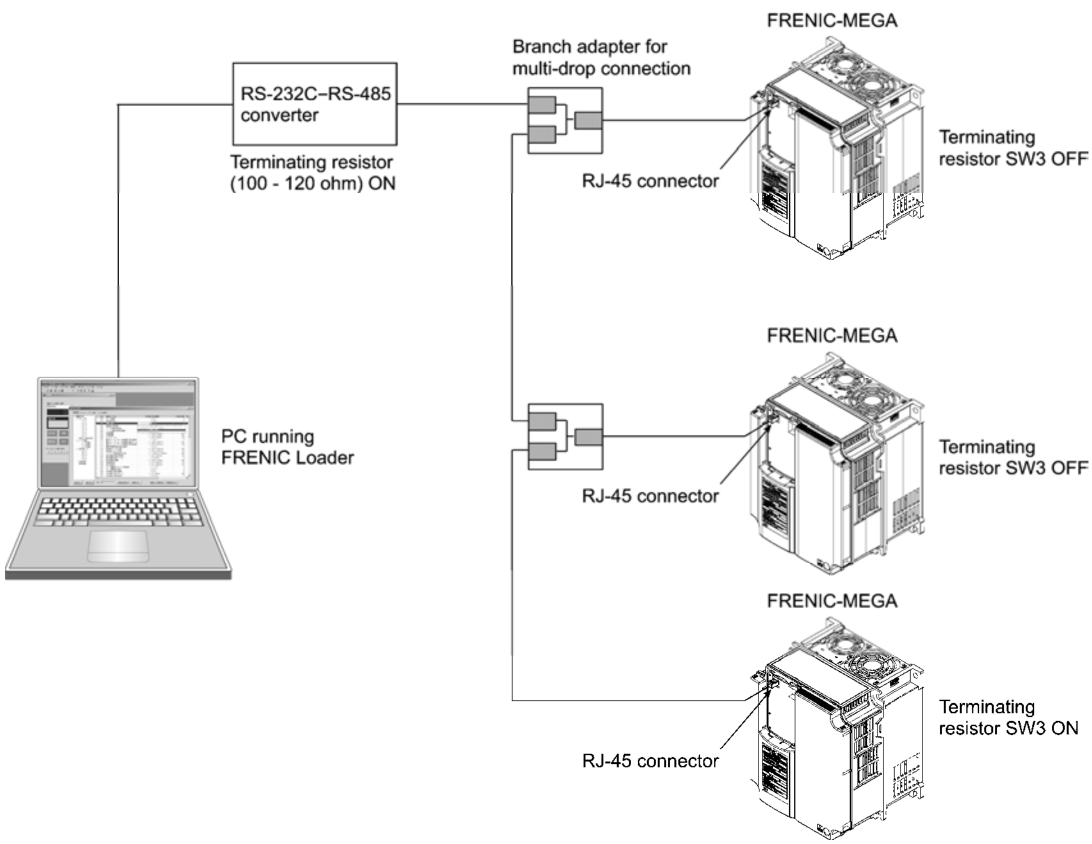


Figure 8.1 Multi-drop Connection (Using the RJ-45 connector)

Note

- Pins 1, 2, 7, and 8 on the RJ-45 connector are exclusively assigned to power supply and grounding for keypads. When connecting other devices to the RJ-45 connector, take care not to use those pins. Failure to do so may cause a short-circuit hazard. Use the pins 4 and 5 only. (For details, refer to Section 8.1.2 "Terminal specifications for RS-485 communications.")
- When selecting additional devices to prevent the damage or malfunction of the control PCB caused by external noises or eliminate the influence of common mode noises, be sure to see section 8.1.4 "Communications support devices."
- The maximum wiring length must be 1640 ft (500 m).
- Use cables and converters meeting the specifications for proper connection. (Refer to [2] "Requirements for the cable (COM port 1: for RJ-45 connector)" in Section 8.1.4 "Communications support devices."

Multi-drop connection using the RS-485 communications port 2 (on the terminal block)

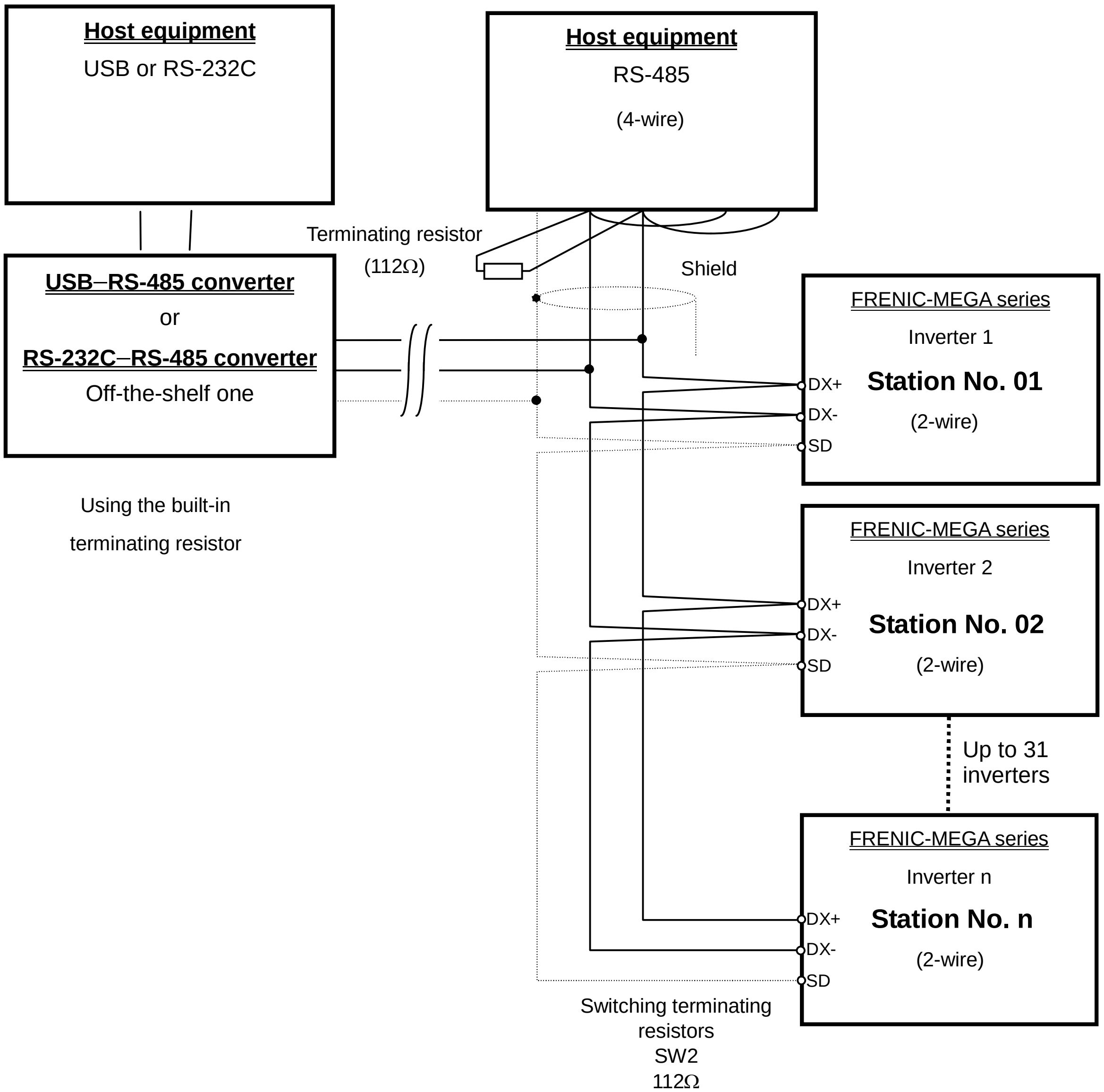


Figure 8.2 Multi-drop Connection Diagram (Connecting to the Terminal Block)

Note: Use cables and converters meeting the specifications for proper connection. (Refer to [3] "Requirements for the cable (COM port 2: for RS-485 connector)" in Section 8.1.4 "Communications support devices."

8.1.4 Communications support devices

This section describes the devices required for connecting the inverter to a PC having no RS-485 interface or for connecting two or more inverters in multi-drop network.

[1] Communications level converters

Usually PCs are not equipped with an RS-485 communications port but with an RS-232C port. To connect inverters to a PC, therefore, you need an RS-232C–RS-485 converter or a USB–RS-485 converter*. To run Loader correctly, use a converter satisfying the requirements given below.

* The USB–RS-485 converter should be a product that is compatible with the conventional COM port by emulation of a virtual COM port device driver.

Requirements for recommended communications level converters

Send/receive switching:	Auto-switching by monitoring of send/receive data status at the PC (RS-232C)
Electric isolation:	Electrically isolated from the RS-485 port
Fail-safe:	Fail-safe facility*
Other requirements:	Superior noise immunity

* The fail-safe facility refers to a feature that ensures the RS-485 receiver's output at "High" (logical value = 0) even if the RS-485 receiver's input is opened or short-circuited or all the RS-485 drivers are inactive. Refer to Figure 8.3.

Recommended converters

System Sacom Sales Corporation (Japan) : KS-485PTI (RS-232C–RS-485 converter)
: USB-485I RJ45-T4P (USB–RS-485 converter)

Send/receive switching system

The RS-485 communications system of the inverter acts in half-duplex mode (2-wire) so the converter must feature a send/receive switching circuitry. Generally, the switching system may be either one of the following.

(1) Auto-switching by monitoring of send/receive data

(2) Switching by RS-232C control signal of RTS or DTR (hardware flow control system)

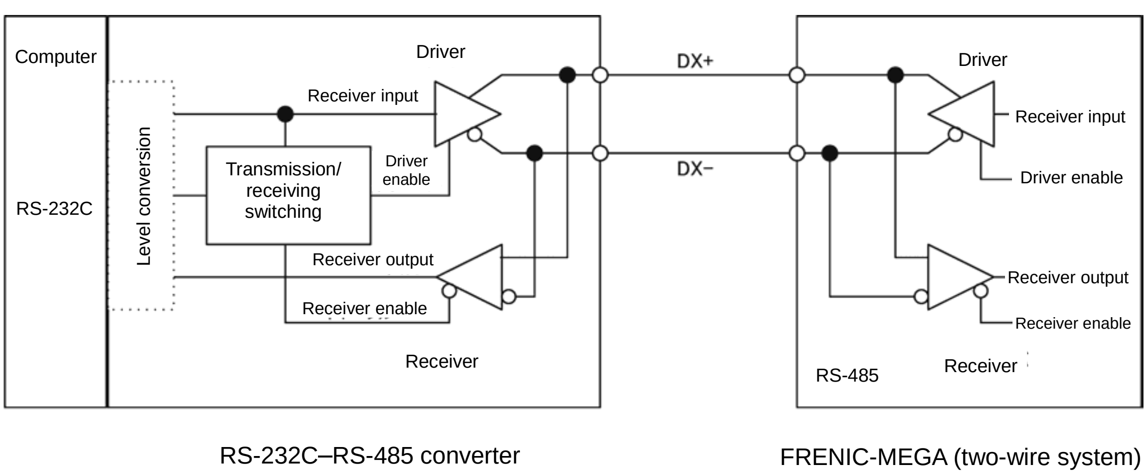


Figure 8.3 Communications Level Conversion

[2] Requirements for the cable (COM port 1: for RJ-45 connector)

Use a standard 10BASE-T/100BASE-TX LAN cable (US ANSI/TIA/EIA-568A category 5 compliant, straight type).

Note: The RJ-45 connector (COM port 1) has power source pins (pins 1, 2, 7 and 8) exclusively assigned to keypads. When connecting other devices to the RJ-45 connector, take care not to use those pins. Using them will cause a short-circuit hazard. Use pins 4 and 5 only.

[3] Requirements for the cable (COM port 2: for RS-485 connector)

To ensure the reliability of connection, use twisted pair shield cables for long distance transmission AWG 16 to 26.

Recommended LAN cable

Manufacturer: FURUKAWA Electric Co., LTD

AWM2789 Cable for long distance connection

Type (Product code): DC23225-2PB

[4] Branch adapter for multi-drop

An RS-485 communications network for inverters utilizes 2-wire 10BASE-T LAN cables fitted with an RJ-45 connector at both ends. To connect those inverters to the network in multi-drop mode, use branch adapters for multi-drop.

Recommended branch adapter

SK Koki (Japan): MS8-BA-JJJ

8.1.5 Noise suppression

Depending on the operating environment, instruments may malfunction due to the noise generated by the inverter. Possible measures to prevent such malfunction are: separating the wiring, use of shielded cable, isolating the power supply, and adding an inductance component. Shown below is an example of adding an inductance component.

📖 Refer to the RS-485 Communication User's Manual, Chapter 2, Section 2.2.4 "Noise suppression" for details.

Adding inductance components

To suppress or eliminate noise for keeping the network in high noise immunity level, insert inductance components such as choke coils in series in the signal circuit, or pass the RS-485 communications cable through a ferrite core ring or wind it around by 2 or 3 turns as shown below to keep the impedance of the signal lines high.

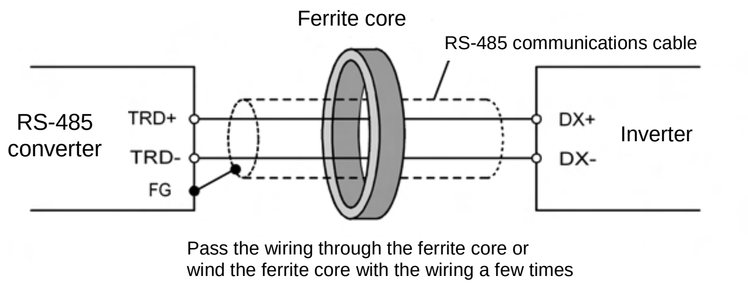


Figure 8.4 Adding an Inductance Component

8.2 Overview of FRENIC Loader

FRENIC Loader is a software tool that supports the operation of the inverter via an RS-485 communications link. It allows you to remotely run or stop the inverter, edit, set, or manage the function codes, monitor key parameters and values during operation, as well as monitor the running status (including alarm information) of the inverters on the RS-485 communications network.

Note With special order-made inverters, FRENIC Loader may not be able to display some function codes normally.

For details, refer to the FRENIC Loader Instruction Manual.

8.2.1 Specifications

Item		Specifications (White on black indicates factory default)	Remarks
Name of software		FRENIC Loader	
Supported inverter		FRENIC-MEGA/Multi/Eco/Mini	(Note 1)
No. of supported inverters		When connected to RS-485 communications ports: Up to 31 When connected to USB port on the optional remote keypad: 1	
Recommended cable		10BASE-T cable or higher class cable	For the RS-485 interface
Operating environment	CPU	Intel Pentium III 600 MHz or later	(Note 2)
	OS	Microsoft Windows 2000 Microsoft Windows XP Microsoft Windows Vista (32-bit) Microsoft Windows 7 (32-bit)	
	Memory	32 MB or more RAM	512 MB or more recommended
	Hard disk	14 MB or more free space	
	COM port	RS-232C (conversion to RS-485 communication required to connect inverters) or USB (optional remote keypad required)	
	Monitor resolution	800 x 600 or higher	XGA (1024 x 768), 32-bit color or higher is recommended
Transmission requirements	COM port	COM1 to COM255	PC COM ports assigned to Loader
	Transmission rate	When connected to RS-485 communications ports: 38400, 19200, 9600, 4800, 2400 (bps) When connected to USB port on the optional remote keypad: Between loader and keypad = fixed at 12 (Mbps) Between keypad and inverter = fixed at 19200 (bps)	19200 bps or more is recommended. (Note 3)
	Character length	8 bits	Prefixed
	Stop bit length	1 bit	Prefixed
	Parity	Even	Prefixed
	No. of retries	None or 1 to 10	No. of retry times before detecting communications error
	Timeout setting	(100 ms, 300 ms, 500 ms), (1.0 to 1.5 to 1.9 s), (2.0 to 9.0 s) or (10.0 to 60.0 s)	This setting should be longer than the response interval time set by function code y09 of the inverter.

(Note 1) FRENIC Loader cannot be used with inverters that do not support SX protocol (protocol for handling Loader commands).

(Note 2) Use a PC with as high a performance as possible, since some slow PCs may not properly refresh the operation status monitor and Test-run windows.

(Note 3) To use FRENIC Loader on a network where a FRENIC-Mini inverter is also configured, choose 19200 bps or below.

8.2.2 Connection

By connecting a number of inverters to one PC, you can control one inverter at a time or a number of inverters simultaneously. You can also simultaneously monitor a number of inverters on the multi monitor.

For how to connect a PC to one or more inverters, refer to the RS-485 Communication User's Manual.

8.2.3 Function overview

8.2.3.1 Setting of function code

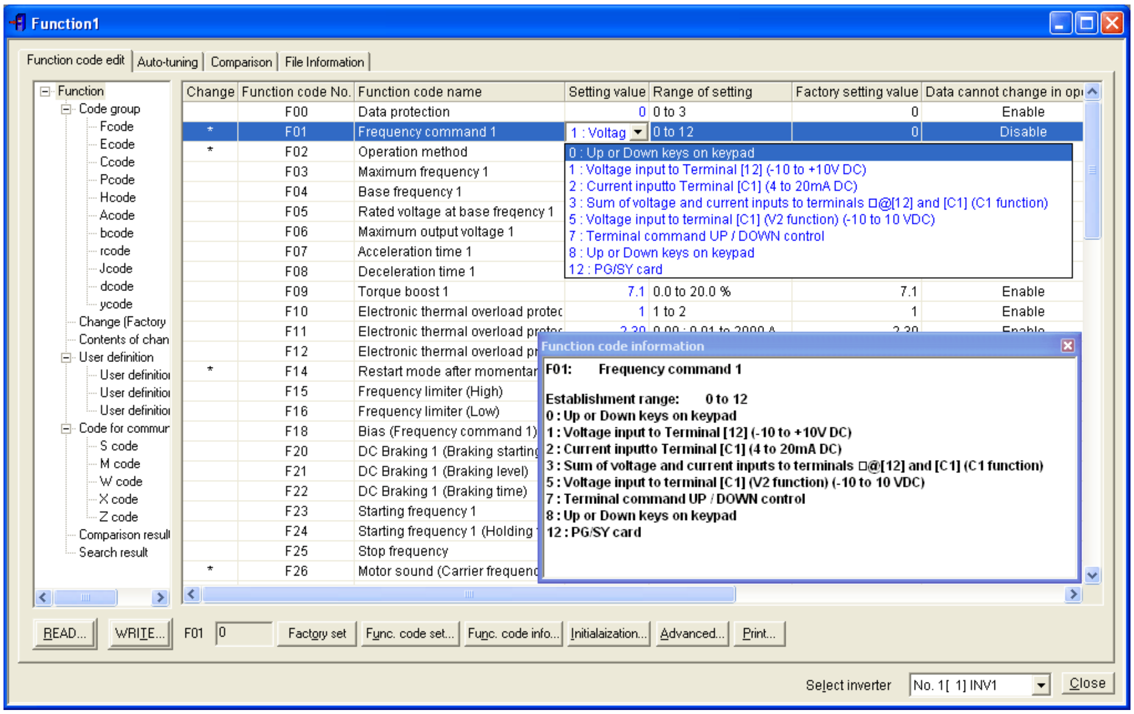
You can set, edit, and check the setting of the inverter's function code data.

List and Edit

In List and edit, you can list and edit function codes with function code No., name, set value, set range, and factory default.

You can also list function codes by any of the following groups according to your needs:

• Function code group
• Function codes that have been modified from their factory defaults
• Result of comparison with the settings of the inverter
• Result of search by function code name
• User-specified function code set



Comparison

You can compare the function code data currently being edited with that saved in a file or stored in the inverter.

To perform a comparison and review the result displayed, click the **Comparison** tab and then click the **Compared with inverter** tab or click the **Compared with file** tab, and specify the file name.

The result of the comparison will be displayed also in the Comparison Result column of the list.

File information

Clicking the **File information** tab displays the property and comments for identifying the function code editing file.

(1) Property

Shows file name, inverter model, inverter's capacity, date of readout, etc.

(2) Comments

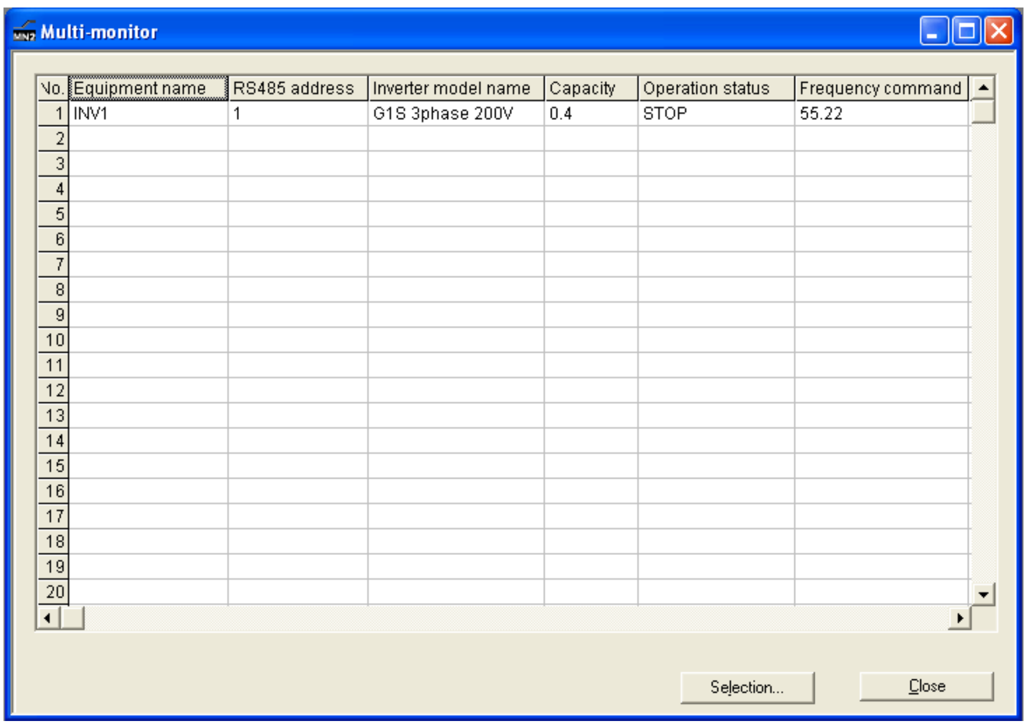
Displays the comments you have entered. You can write any comments necessary for identifying the file.

8.2.3.2 Multi-monitor

This feature lists the status of all the inverters that are marked "connected" in the configuration table.

Multi-monitor

Allows you to monitor the status of more than one inverter in a list format.

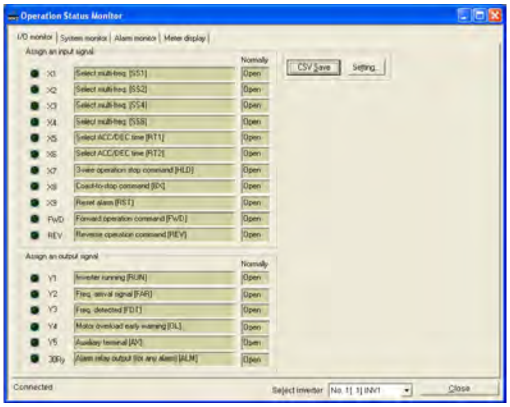


8.2.3.3 Running status monitor

The running status monitor offers four monitor functions: I/O monitor, System monitor, Alarm monitor, and Meter display. You can choose an appropriate monitoring format according to the purpose and situation.

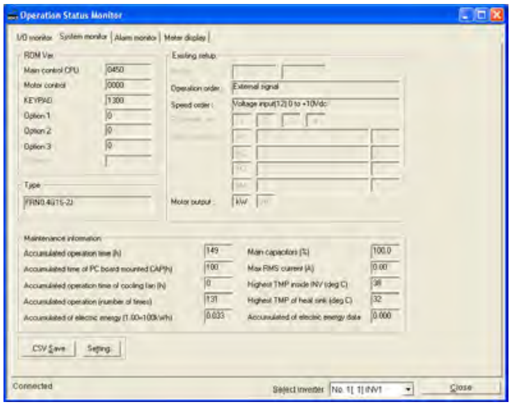
<u>I/O monitor</u>

Allows you to monitor the ON/OFF states of the digital input signals to the inverter and the transistor output signals.



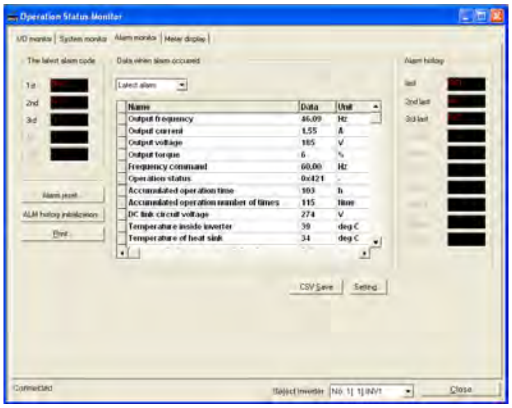
<u>System monitor</u>

Allows you to check the inverter's system information (version, model, maintenance information, etc.).



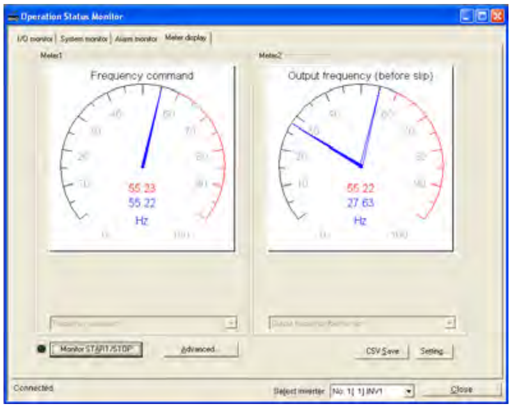
<u>Alarm monitor</u>

The alarm monitor shows the alarm status of the selected inverter. In this window, you can check the details of the alarm that currently occurs and the related information.



<u>Meter display</u>

Displays analog readouts of the selected inverter (such as output frequency) on analog meters. The example on the right displays the reference frequency and the output frequency.



8.2.3.4 Test-running

The Test-running feature allows you to test-run the motor in the forward or reverse direction while monitoring the running status of the selected inverter.

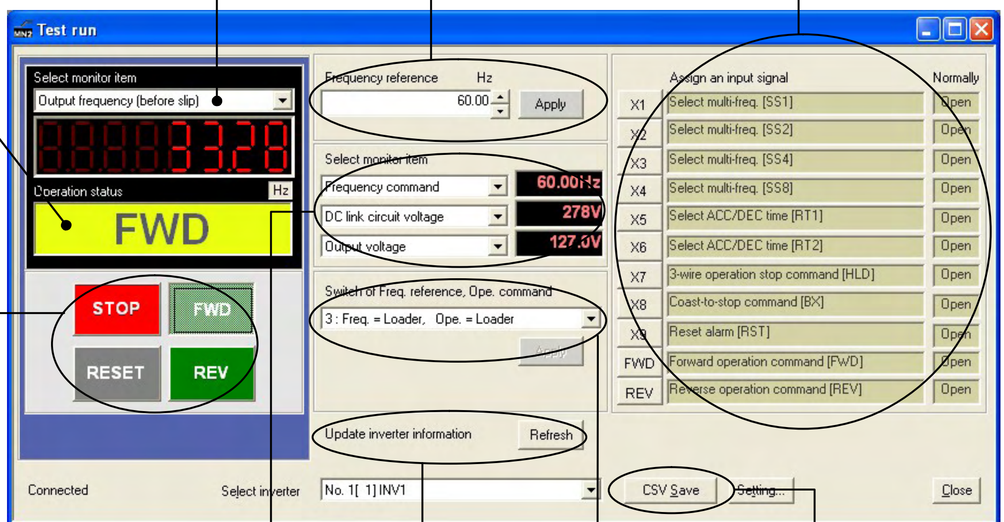
<u>Select monitor item</u>
Select what is to be displayed (e.g., output frequency or current) here using the pull-down menu.

<u>Frequency reference</u>
Enter or select the frequency command to write it into the inverter. Click **Apply** to make it effective.

<u>I/O terminal status</u>
Shows the status of the programmable, digital I/O terminals of the inverter.

<u>Operation status</u>
Shows FWD, REV, STOP and alarm codes.

<u>Operation buttons</u>
(See the table below.)*



<u>Select monitor item</u>
Select the operation status information to be monitored in real-time.

<u>Update inverter information</u>
Click the **Refresh** button to refresh the contents of this window to show the latest inverter status.

<u>Switching of frequency and run command sources</u>
Select the frequency and run command sources and click **Apply**.

<u>CSV Save</u>
Use these buttons to save the displayed data in CSV format.

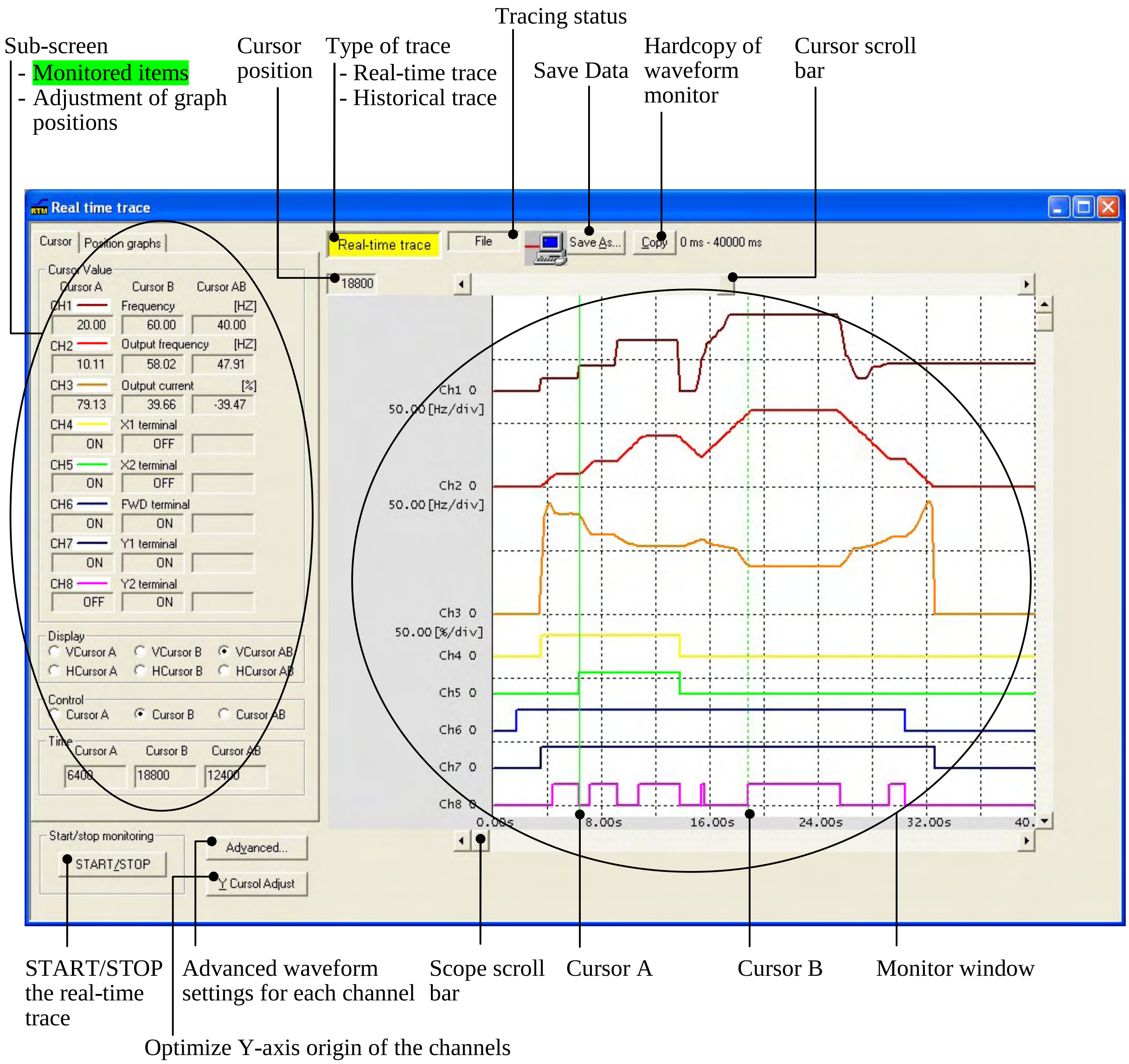
* The details of the operation buttons are described in the table below.

Button	Use to
STOP	Stop the motor.
FWD	Run the motor forward. (The indented appearance of the button indicates that the button is active and the motor is running.)
REV	Run the motor reverse. (The indented appearance of the button indicates that the button is active and the motor is running.)
RESET	Reset all alarm information saved in the selected inverter.

8.2.3.5 Real-time trace

The real-time trace monitors up to 4 analog readouts and up to 8 digital ON/OFF signals to display the running status of a selected inverter in real-time waveforms.

- Sampling interval: Fixed at 200 ms
- Max. 4 channels for analog data and max. 8 channels for digital data (max. 8 channels in total)
- Waveform capturing capability: Max. 15360 samples/channel



Note During the real-time trace in progress you cannot:

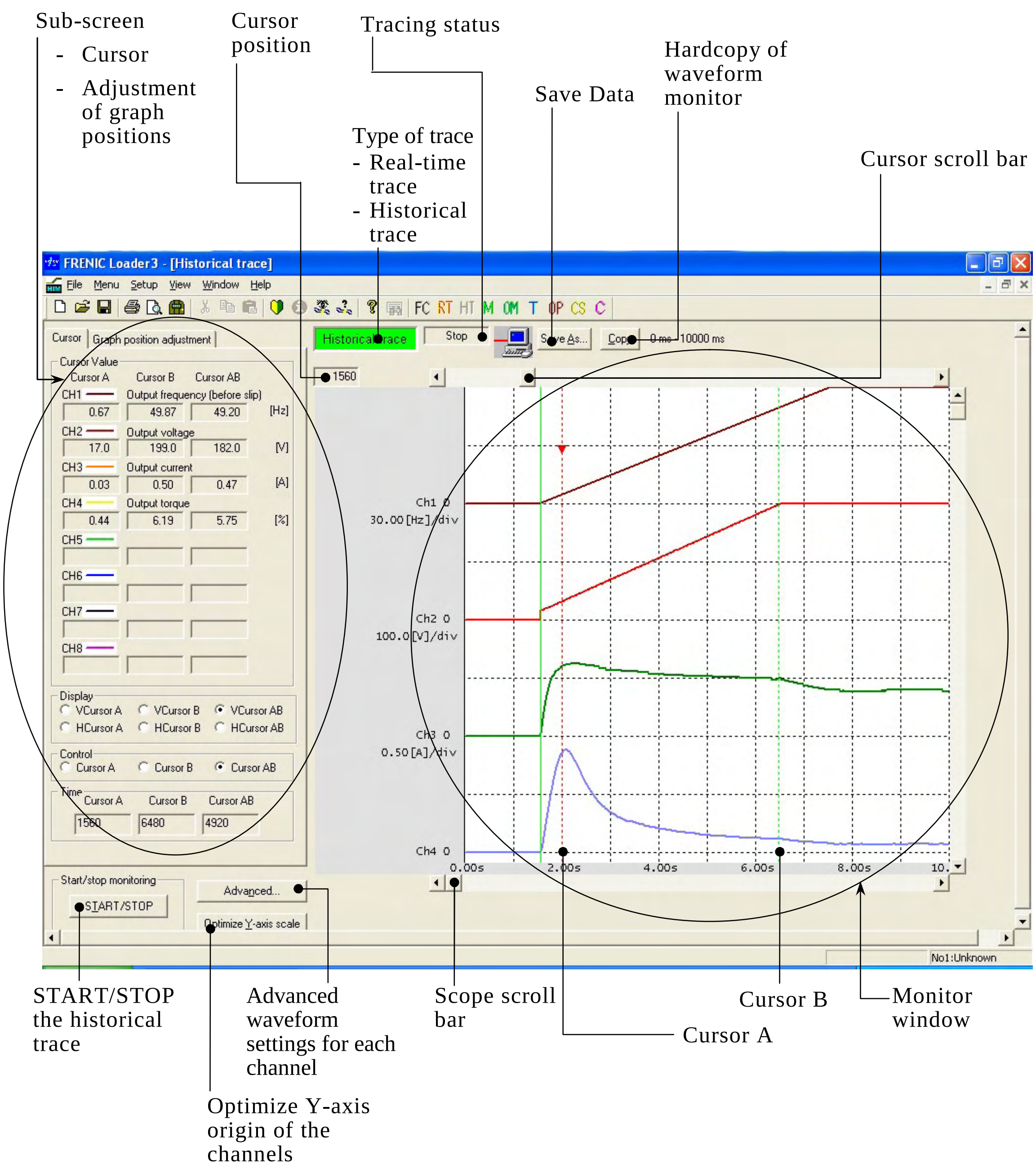
- Change the RS-485 station address,
- Change the advanced waveform settings, or
- Scroll the real-time trace screen or move the cursor.

Resizing the real-time trace window automatically changes the monitor window size.

8.2.3.6 Historical trace

The historical trace monitors the running status of a selected inverter in greater detail with more contiguous waveforms than in the real-time trace.

- Sampling interval: 1 to 200 ms
- Size of data saved: 2 kilobytes
- Max. 4 channels for analog data and max. 8 channels for digital data (max. 8 channels in total)
- Waveform capturing capability: Max. 500 samples/channel



Note During the real-time trace in progress you cannot:
- Change the RS-485 station address, or
- Change the advanced waveform settings.

Resizing the historical trace window automatically changes the monitor window size.

8.2.3.7 USB port on the optional remote keypad

The USB port on the optional remote keypad allows you to connect a computer supporting USB connection and use the FRENIC Loader. As described below, various information of the inverter saved in the keypad memory can be monitored and controlled on the computer.

Improved working efficiency in the manufacturing site

- A variety of data about the inverter body can be saved in the keypad memory, allowing you to check the information in any place.

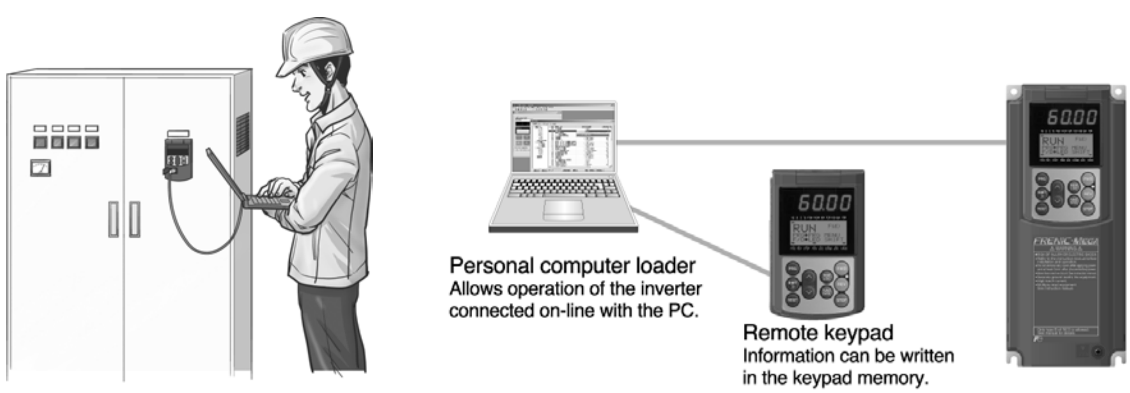
  <Example of use in the office>

  Features

  1. The keypad can be directly connected to the computer through a commercial USB cable (mini B) without using a converter. The computer can be connected on-line with the inverter.
  2. With the personal computer loader, the inverter can support the following functions (1) to (5).
     (1) Editing, comparing, and copying the function code data
     (2) Real-time operation monitor
     (3) Trouble history (indicating the latest four troubles)
     (4) Maintenance information
     (5) Historical trace

- Data can be transferred from the USB port of the remote keypad directly to the computer (personal computer loader) in the manufacturing site.
- Periodical collection of life information can be carried out efficiently.
- The real-time tracing function permits the operator to check the equipment for abnormality.

<Example of use in the manufacturing site>



Chapter 9

TROUBLESHOOTING

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

Contents

9.1 Protective Functions

The FRENIC-MEGA series of inverters has various protective functions as listed below to prevent the system from going down and reduce system downtime. The protective functions marked with an asterisk (*) in the table are disabled by default. Enable them according to your needs.

The protective functions include, for example, the "alarm" detection function which, upon detection of an abnormal state, displays the alarm code on the LED monitor and causes the inverter to trip, the "light alarm" detection function which displays the alarm code but lets the inverter continue the current operation, and other warning signal output functions.

If any problem arises, understand the protective functions listed below and follow the procedures given in Sections 9.2 and onwards for troubleshooting.

Protective function	Description	Related function code
"Alarm" detection	This function detects an abnormal state, displays the corresponding alarm code, and causes the inverter to trip. The "alarm" codes are check-marked in the "Alarm" object column in Table 9.1. For details of each alarm code, see the corresponding item in the troubleshooting. The inverter retains the last four alarm codes and their factors together with their running information applied when the alarm occurred, so it can display them.	H98
"Light alarm" detection*	This function detects an abnormal state categorized as a "light alarm," displays L-AL and lets the inverter continue the current operation without tripping. It is possible to define which abnormal states should be categorized as a "light alarm" using function codes H81 and H82. The "light alarm" codes are check-marked in the "Light alarm" object column in Table 9.1. For details on how to check and release light alarms, see Section 9.5 "If the "Light Alarm" Indication (L-AL) Appears on the LED Monitor."	H81 H82
Stall prevention	When the output current exceeds the current limiter level (F44) during acceleration/ deceleration or constant speed running, this function decreases the output frequency to avoid an overcurrent trip.	F44
Overload prevention control*	Before the inverter trips due to a heat sink overheat (OH1) or inverter overload (OLU), this function decreases the output frequency to reduce the load.	H70
Automatic deceleration* (Anti-regenerative control)	If regenerative energy returned exceeds the inverter's braking capability, this function automatically increases the deceleration time or controls the output frequency to avoid an overvoltage trip.	H69
Deceleration characteristics* (Excessive regenerative energy proof braking capability)	During deceleration, this function increases the motor energy loss and decreases the regenerative energy returned to avoid an overvoltage trip (OU).	H71
Reference loss detection*	This function detects a reference frequency loss (due to a broken wire, etc.), continues the inverter operation at the specified frequency, and issues the "Command loss detected" signal ***REF OFF***.	E65
Automatic lowering of carrier frequency	Before the inverter trips due to an abnormal surrounding temperature or output current, this function automatically lowers the carrier frequency to avoid a trip.	H98
Dew condensation prevention*	Even when the inverter is in stopped state, this function feeds DC current across the motor at certain intervals to raise the motor temperature for preventing dew condensation.	J21
Motor overload early warning*	When the inverter output current has exceeded the specified level, this function issues the "Motor overload early warning" signal ***OL*** before the thermal overload protection function causes the inverter to trip for motor protection. This function exclusively applies to the 1st motor.	E34 E35
Auto-reset*	When the inverter has stopped because of a trip, this function allows the inverter to automatically reset and restart itself. (The number of retries and the latency between stop and reset can be specified.)	H04 H05

Protective function	Description	Related function code
Forced stop*	Upon receipt of the "Force to stop" terminal command ***STOP***, this function interrupts the run and other commands currently applied in order to forcedly decelerate the inverter to a stop.	H56
Surge protection	This function protects the inverter from a surge voltage invaded between main circuit power lines and the ground.	--

Table 9.1 Abnormal States Detectable ("Alarm" and "Light Alarm" Objects)

Code	Name	"Alarm" objects	"Light alarm" objects	Remarks	Ref. page
OC1, OC2, OC3	Instantaneous overcurrent	√	--		9-13
EF	Ground fault	√	--	50 HP or above	9-14
OU1, OU2, OU3	Overvoltage	√	--		9-14
LU	Undervoltage	√	--		9-15
Lin	Input phase loss	√	--		9-15
OPL	Output phase loss	√	--		9-16
OH1	Heat sink overheat	√	√		9-16
OH2	External alarm	√	√		9-17
OH3	Inverter internal overheat	√	√		9-17
OH4	Motor protection (PTC/NTC thermistor)	√	--		9-17
dbH	Braking resistor overheat	√	√	40 HP or below	9-18
FUS	Fuse blown	√	--	125 HP or above for 230 V series 150 HP or above for 460 V series	9-18
PbF	Charger circuit fault	√	--	60 HP or above for 230 V series 125 HP or above for 460 V series	9-19
OL1 to OL4	Overload of motor 1 through 4	√	√		9-19
OLU	Inverter overload	√	--		9-20
OS	Overspeed	√	--		9-20
PG	PG wire break	√	--		9-21
Er1	Memory error	√	--		9-21
Er2	Keypad communications error	√	--		9-22
Er3	CPU error	√	--		9-22
Er4	Option communications error	√	√		9-22
Er5	Option error	√	√		9-22
Er6	Operation protection	√	--		9-23
Er7	Tuning error	√	--		9-23
Er8 ErP	RS-485 communications error (COM port 1) RS-485 communications error (COM port 2)	√	√		9-24
ErF	Data saving error during undervoltage	√	--		9-24
ErH	Hardware error	√	--	60 HP or above for 230 V series 75 HP or above for 460 V series	9-25
ErE	Speed mismatch or excessive speed deviation	√	√		9-25
nrb	NTC wire break error	√	--		9-26
Err	Mock alarm	√	--		9-26
CoF	PID feedback wire break	√	√		9-26

Table 9.1 Abnormal States Detectable ("Alarm" and "Light Alarm" Objects) (Continued)

Code	Name		"Alarm" objects	"Light alarm" objects	Remarks	Ref. page
dbA	Braking transistor broken		√	--		9-27
Ero	Positioning control error	(Servo-lock)	√	--		9-27
		(Synchronous control)	√	√		9-27
ECF	Enable circuit failure		√	--		9-27
L-AL	Light alarm		--	--		--
FAL	DC fan locked		--	√	75 HP or above for 230 V series 125 HP or above for 460 V series	--
OL	Motor overload early warning		--	√		--
OH	Heat sink overheat early warning		--	√		--
LiF	Lifetime alarm		--	√		--
rEF	Reference command loss detected		--	√		--
Pid	PID alarm		--	√		--
UTL	Low torque output		--	√		--
PTC	PTC thermistor activated		--	√		--
rTE	Inverter life (Motor cumulative run time)		--	√		--
CnT	Inverter life (Number of startups)		--	√		--

9.2 Before Proceeding with Troubleshooting

⚠WARNING⚠

If any of the protective functions has been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.

Injury may occur.

- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
- **Turn OFF the power and wait at least five minutes for inverters of 40 HP or below, or at least ten minutes for inverters of 50 HP or above.** Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped to the safe level (+25 VDC or below).

Electric shock may occur.

Follow the procedure below to solve problems.

(1) First, check that the inverter is correctly wired, referring to Chapter 2, Section 2.8 "Connection Diagrams."

(2) Check whether an alarm code or the "light alarm" indication (L-AL) is displayed on the LED monitor.

- If neither an alarm code nor "light alarm" indication (L-AL) appears on the LED monitor
  - Abnormal motor operation → Go to Section 9.3.1.
    - [1] The motor does not rotate.
    - [2] The motor rotates, but the speed does not increase.
    - [3] The motor runs in the opposite direction to the command.
    - [4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.
    - [5] Grating sound is heard from the motor or the motor sound fluctuates.
    - [6] The motor does not accelerate or decelerate within the specified time.
    - [7] The motor does not restart even after the power recovers from a momentary power failure.
    - [8] The motor abnormally heats up.
    - [9] The motor does not run as expected.
  - Problems with inverter settings → Go to Section 9.3.2.
    - [1] Nothing appears on the LED monitor.
    - [2] The desired menu is not displayed.
    - [3] Data of function codes cannot be changed.
- If an alarm code appears on the LED monitor → Go to Section 9.4.
- If the "light alarm" indication (L-AL) appears on the LED monitor → Go to Section 9.5.
- If an abnormal pattern appears on the LED monitor while neither an alarm code nor "light alarm" indication (L-AL) is displayed → Go to Section 9.6.

■ For problems that could be caused by running the inverter on single-phase power → Go to Section 9.7.

If any problems persist after the above recovery procedure, contact your Fuji Electric representative.

9.3 If Neither an Alarm Code Nor "Light Alarm" Indication (L-AL) Appears on the LED Monitor

This section describes the troubleshooting procedure based on function codes dedicated to motor 1 which are marked with an asterisk (*). For motors 2 to 4, replace those asterisked function codes with respective motor dedicated ones (refer to Chapter 5, Section 5.4.6, Table 5.5).

For the function codes dedicated to motors 2 to 4, see Chapter 5 "FUNCTION CODES."

9.3.1 Abnormal motor operation

[1] The motor does not rotate.

Possible Causes	What to Check and Suggested Measures
(1) No power supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary. ➔ If only the auxiliary control power input is supplied, also supply the main power to the inverter.
(2) No run forward/reverse command was inputted, or both the commands were inputted simultaneously (external signal operation).	Check the input status of the forward/reverse command with Menu #4 "I/O Checking" using the keypad. ➔ Input a run command. ➔ Set either the forward or reverse run command off if both commands are being entered. ➔ Correct the run command source. (Set F02 data to "1.") ➔ Correct the assignment of commands ***FWD*** and ***REV*** with function codes E98 and E99. ➔ Connect the external circuit wires to control circuit terminals [FWD] and [REV] correctly. ➔ Make sure that the sink/source slide switch (SW1) on the control printed circuit board (control PCB) is properly configured.
(3) No Enable input	Check the input status of terminal [EN] with Menu #4 "I/O Checking" using the keypad. ➔ Correct the external circuit wiring to control circuit terminal [EN].
(4) The inverter could not accept any run commands from the keypad since it was in Programming mode.	Check which operation mode the inverter is in, using the keypad. ➔ Shift the operation mode to Running mode and enter a run command.
(5) A run command with higher priority than the one attempted was active, and the run command was stopped.	Referring to the block diagram of the frequency command block (given in Chapter 6), check the higher priority run command with Menu #2 "Data Checking" and Menu #4 "I/O Checking" using the keypad. ➔ Correct any incorrect function code data settings (in H30, y98, etc.) or cancel the higher priority run command.

Possible Causes	What to Check and Suggested Measures
(6) No analog frequency command input.	Check whether the analog frequency command (reference frequency) is correctly inputted, using Menu #4 "I/O Checking" on the keypad. ➔ Connect the external circuit wires to terminals [13], [12], [11], [C1], and [V2] correctly. ➔ When terminal [C1] is used, check the slider position of terminal [C1] property switch (SW5) and the setting of the thermistor mode selection (H26).
(7) The reference frequency was below the starting or stop frequency.	Check that a reference frequency has been entered correctly, using Menu #4 "I/O Checking" on the keypad. ➔ Set the reference frequency at the same or higher than that of the starting and stop frequencies (F23* and F25). ➔ Reconsider the starting and stop frequencies (F23* and F25), and if necessary, change them to the lower values. ➔ Inspect the external frequency command potentiometers, signal converters, switches, and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [C1], and [V2] correctly.
(8) A frequency command with higher priority than the one attempted was active.	Check the higher priority run command with Menu #2 "Data Checking" and Menu #4 "I/O Checking" using the keypad, referring to the block diagram of the frequency command block (refer to Chapter 6). ➔ Correct any incorrect function code data (e.g. cancel the higher priority run command).
(9) The upper and lower frequencies for the frequency limiters were set incorrectly.	Check the data of function codes F15 (Frequency limiter (High)) and F16 (Frequency limiter (Low)). ➔ Change the settings of F15 and F16 to the correct ones.
(10) The coast-to-stop command was effective.	Check the data of function codes E01 through E07, E98, and E99 and the input signal status, using Menu #4 "I/O Checking" on the keypad. ➔ Release the coast-to-stop command setting.
(11) Broken wires, incorrect connection or poor contact with the motor.	Check the wiring (Measure the output current). ➔ Repair the wires to the motor, or replace them.
(12) Overload	Measure the output current. ➔ Reduce the load (In winter, the load tends to increase.)
	Check whether any mechanical brake is activated. ➔ Release the mechanical brake, if any.
(13) Torque generated by the motor was insufficient.	Check that the motor starts running if the value of torque boost (F09*) is increased. ➔ Increase the value of torque boost (F09*) and try to run the motor.
	Check the data of function codes F04*, F05*, H50, H51, H52, H53, H65, and H66. ➔ Change the V/f pattern to match the motor's characteristics.
	Check that the motor switching signal (selecting motor 1, 2, 3 or 4) is correct and the data of function codes matches each motor. ➔ Correct the motor switching signal. ➔ Modify the function code data to match the connected motor.
	Check whether the reference frequency is below the slip-compensated frequency of the motor. ➔ Change the reference frequency so that it becomes higher than the slip-compensated frequency of the motor.

Possible Causes	What to Check and Suggested Measures
(14) Wrong connection or poor contact of DC reactor (DCR)	Check the wiring. Inverters of 100 HP or above require a DCR to be connected. Without a DCR, these inverters cannot run. ➔ Connect the DCR correctly. Repair or replace DCR wires.

[2] The motor rotates, but the speed does not increase.

Possible Causes	What to Check and Suggested Measures
(1) The maximum frequency currently specified was too low.	Check the data of function code F03* (Maximum frequency). ➔ Correct the F03* data.
(2) The data of frequency limiter (High) currently specified was too low.	Check the data of function code F15 (Frequency limiter (High)). ➔ Correct the F15 data.
(3) The reference frequency currently specified was too low.	Check that the reference frequency has been entered correctly, using Menu #4 "I/O Checking" on the keypad. ➔ Increase the reference frequency. ➔ Inspect the external frequency command potentiometers, signal converters, switches, and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [C1], and [V2] correctly.
(4) A frequency command (e.g., multi-frequency or via communications) with higher priority than the one attempted was active and its reference frequency was too low.	Check the data of the relevant function codes and what frequency commands are being received, through Menu #1 "Data Setting," Menu #2 "Data Checking" and Menu #4 "I/O Checking," on the keypad by referring to the block diagram of the frequency command (refer to Chapter 6). ➔ Correct any incorrect data of function codes (e.g. cancel the higher priority frequency command).
(5) The acceleration time was too long or too short.	Check the data of function codes F07, E10, E12, and E14 (Acceleration time). ➔ Change the acceleration time to match the load.
(6) Overload.	Measure the output current. ➔ Reduce the load.
	Check whether any mechanical brake is activated. ➔ Release the mechanical brake.
(7) Function code settings do not agree with the motor characteristics.	If auto-torque boost or auto-energy saving operation is specified, check whether the data of P02*, P03*, P06*, P07*, and P08* agree with the parameters of the motor. ➔ Perform auto-tuning of the inverter for the motor to be used.
(8) The output frequency does not increase due to the current limiter operation.	Make sure that F43 (Current limiter (Mode selection)) is set to "2" and check the data of F44 (Current limiter (Level)). ➔ Correct the F44 data. Or, if the current limiter operation is not needed, set F43 to "0" (disabled).
	Decrease the value of torque boost (F09*), then run the motor again and check if the speed increases. ➔ Adjust the value of the torque boost (F09*).
	Check the data of function codes F04*, F05*, H50, H51, H52, H53, H65, and H66 to ensure that the V/f pattern setting is right. ➔ Match the V/f pattern setting with the motor ratings.

Possible Causes	What to Check and Suggested Measures
(9) The output frequency does not increase due to the torque limiter operation.	Check whether data of torque limiter related function codes (F40, F41, E16 and E17) is correctly configured and the "Select torque limiter level" terminal command ***TL2***/***TL1*** is correct. ➔ Correct data of F40, F41, E16 and E17 or reset them to the factory defaults (disable). ➔ Set the ***TL2***/***TL1*** correctly.
(10)Bias and gain incorrectly specified.	Check the data of function codes F18, C50, C32, C34, C37, C39, C42, and C44. ➔ Readjust the bias and gain to appropriate values.

[3] The motor runs in the opposite direction to the command.

Possible Causes	What to Check and Suggested Measures
(1) Wiring to the motor is incorrect.	Check the wiring to the motor. ➔ Connect terminals U, V, and W of the inverter to the U, V, and W terminals of the motor, respectively.
(2) Incorrect connection and settings for run commands and rotation direction commands ***FWD*** and ***REV***.	Check the data of function codes E98 and E99 and the connection to terminals [FWD] and [REV]. ➔ Correct the data of the function codes and the connection.
(3) The rotation direction specification of the motor is opposite to that of the inverter.	The rotation direction of IEC-compliant motors is opposite to that of incompliant motors. ➔ Switch the ***FWD***/***REV*** signal setting.

[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.

Possible Causes	What to Check and Suggested Measures
(1) The frequency command fluctuates.	Check the signals for the frequency command with Menu #4 "I/O Checking" using the keypad. ➔ Increase the filter constants (C33, C38, and C43) for the frequency command.
(2) An external potentiometer is used for frequency setting.	Check that there is no noise in the control signal wires from external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals.
	Check whether the external frequency command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 2.)
(3) Frequency switching or multi-frequency command was enabled.	Check whether the relay signal for switching the frequency command is chattering. ➔ If the relay contact is defective, replace the relay.
(4) The wiring length between the inverter and the motor is too long.	Check whether auto-torque boost, auto-energy saving operation, or dynamic torque vector control is enabled. ➔ Perform auto-tuning of the inverter for every motor to be used. ➔ Disable the automatic control systems by setting F37* to "1" (Constant torque load) and F42* to "0" (V/f control with slip compensation active), then check that the motor vibration stops. ➔ Make the output wires as short as possible.

Possible Causes	What to Check and Suggested Measures
(5) The machinery is hunting due to vibration caused by low rigidity of the load. Or the current is irregularly oscillating due to special motor parameters.	Once disable all the automatic control systems such as auto torque boost, auto energy saving operation, overload prevention control, current limiter, torque limiter, automatic deceleration (anti-regenerative control), auto search for idling motor speed, slip compensation, dynamic torque vector control, droop control, overload stop function, speed control, tuning, notch filter, observer, and then check that the motor vibration comes to a stop. ➔ Disable the functions causing the vibration. ➔ Readjust the output current fluctuation damping gain (H80*). ➔ Readjust the speed control systems. (d01* through d06*)
	Check that the motor vibration is suppressed if you decrease the level of F26 (Motor sound (Carrier frequency)) or set F27 (Motor sound (Tone)) to "0." ➔ Decrease the carrier frequency (F26) or set the tone to "0" (F27 = 0).

[5] Grating sound is heard from the motor or the motor sound fluctuates.

Possible Causes	What to Check and Suggested Measures
(1) The specified carrier frequency is too low.	Check the data of function codes F26 (Motor sound (Carrier frequency)) and F27 (Motor sound (Tone)). ➔ Increase the carrier frequency (F26). ➔ Change the setting of F27 to appropriate value.
(2) The surrounding temperature of the inverter was too high (when automatic lowering of the carrier frequency was enabled by H98).	Measure the temperature inside the panel where the inverter is mounted. ➔ If it is over 40°C (104°F), lower it by improving the ventilation. ➔ Lower the temperature of the inverter by reducing the load. (For fans or pumps, decrease the frequency limiter value (F15).) **Note:** If you disable H98, an OH1, OH3, or OLU alarm may occur.
(3) Resonance with the load.	Check the machinery mounting accuracy or check whether there is resonance with the mounting base. ➔ Disconnect the motor from the machinery and run it alone, then find where the resonance comes from. Upon locating the cause, improve the characteristics of the source of the resonance. ➔ Adjust the settings of C01 (Jump frequency 1) to C04 (Jump frequency (Hysteresis width)) so as to avoid continuous running in the frequency range causing resonance. ➔ Enable the speed control (notch filter) (d07*, d08*) and the observer (d18 to d20) to suppress vibration. (Depending on the characteristics of the load, this may take no effect.)

[6] The motor does not accelerate or decelerate within the specified time.

Possible Causes	What to Check and Suggested Measures
(1) The inverter runs the motor with S-curve or curvilinear pattern.	Check the data of function code H07 (Acceleration/deceleration pattern). ➔ Select the linear pattern (H07 = 0). ➔ Shorten the acceleration/deceleration time (F07, F08, E10 through E15).
(2) The current limiting operation prevented the output frequency from increasing (during acceleration).	Make sure that F43 (Current limiter (Mode selection)) is set to "2: Enable during acceleration and at constant speed," then check that the setting of F44 (Current limiter (Level)) is reasonable. ➔ Readjust the setting of F44 to appropriate value, or disable the function of current limiter with F43. ➔ Increase the acceleration/deceleration time (F07, F08, E10 through E15).
(3) The automatic deceleration (Anti-regenerative control) is enabled during deceleration.	Check the data of function code H69 (Automatic deceleration (Mode selection)). ➔ Increase the deceleration time (F08, E11, E13, and E15).

Possible Causes	What to Check and Suggested Measures
(4) Overload.	Measure the output current. ➔ Reduce the load (For fans or pumps, decrease the frequency limiter value (F15).) (In winter, the load tends to increase.)
(5) Torque generated by the motor was insufficient.	Check that the motor starts running if the value of the torque boost (F09*) is increased. ➔ Increase the value of the torque boost (F09*).
(6) An external potentiometer is used for frequency setting.	Check that there is no noise in the control signal wires from external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals. ➔ Connect a capacitor to the output terminal of the external frequency command potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 2.)
(7) The output frequency is limited by the torque limiter.	Check whether data of torque limiter related function codes (F40, F41, E16 and E17) is correctly configured and the ***TL2***/***TL1*** terminal command ("Select torque limiter level 2/1") is correct. ➔ Correct the data of F40, F41, E16 and E17 or reset them to the factory defaults. ➔ Set the ***TL2***/***TL1*** correctly. ➔ Increase the acceleration/deceleration time (F07, F08, E10 through E15).
(8) The specified acceleration or deceleration time was incorrect.	Check the terminal commands ***RT1*** and ***RT2*** for acceleration/deceleration times. ➔ Correct the ***RT1*** and ***RT2*** settings.

[7] The motor does not restart even after the power recovers from a momentary power failure.

Possible Causes	What to Check and Suggested Measures
(1) The data of function code F14 is either "0," "1," or "2."	Check if an undervoltage trip (LU) occurs. ➔ Change the data of function code F14 (Restart mode after momentary power failure (Mode selection)) to "3," "4," or "5."
(2) The run command remains OFF even after the power has been restored.	Check the input signal with Menu #4 "I/O Checking" using the keypad. ➔ Check the power recovery sequence with an external circuit. If necessary, consider the use of a relay that can keep the run command ON.
	In 3-wire operation, the power to the control printed circuit board (control PCB) has been shut down once because of a long momentary power failure time, or the "Enable 3-wire operation" signal ***HOLD*** has been turned OFF once. ➔ Change the design or the setting so that a run command can be issued again within 2 seconds after the power has been restored.

[8] The motor abnormally heats up.

Possible Causes	What to Check and Suggested Measures
(1) Excessive torque boost specified.	Check whether decreasing the torque boost (F09*) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (F09*).
(2) Continuous running in extremely slow speed.	Check the running speed of the inverter. ➔ Change the speed setting or replace the motor with a motor exclusively designed for inverters.
(3) Overload.	Measure the inverter output current. ➔ Reduce the load (For fans or pumps, decrease the frequency limiter value (F15).) (In winter, the load tends to increase.)

[9] The motor does not run as expected.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check that function codes are correctly configured and no unnecessary configuration has been done. ➔ Configure all the function codes correctly.
	Make a note of function code data currently configured and then initialize all function code data using H03. ➔ After the above process, reconfigure function codes one by one, checking the running status of the motor.
(2) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power," [3].

9.3.2 Problems with inverter settings

[1] Nothing appears on the LED monitor.

Possible Causes	What to Check and Suggested Measures
(1) No power (neither main power nor auxiliary control power) supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts and fix them if necessary.
(2) The power for the control PCB did not reach a sufficiently high level.	Check if the jumper bar has been removed between terminals P1 and P(+) or if there is a poor contact between the jumper bar and those terminals. ➔ Mount a jumper bar or a DC reactor between terminals P1 and P(+). For poor contact, tighten up the screws.
(3) The keypad was not properly connected to the inverter.	Check whether the keypad is properly connected to the inverter. ➔ Remove the keypad, put it back, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem recurs.
	When running the inverter remotely, ensure that the extension cable is securely connected both to the keypad and to the inverter. ➔ Disconnect the cable, reconnect it, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem per recurs.

[2] Data of function codes cannot be changed.

Possible Causes	What to Check and Suggested Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with Menu #3 "Drive Monitoring" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running by referring to the function code tables. ➔ Stop the motor then change the data of the function codes.
(2) The data of the function codes is protected.	Check the data of function code F00 (Data Protection). ➔ Change the F00 data from "Enable data protection" (1 or 3) to "Disable data protection" (0 or 2).
(3) The ***WE-KP*** terminal command ("Enable data change with keypad") is not entered, though it has been assigned to a digital input terminal.	Check the data of function codes E01 through E07, E98 and E99 and the input signal status with Menu #4 "I/O Checking" using the keypad. ➔ Input a ***WE-KP*** command through a digital input terminal.
(4) The FUNC/DATA key was not pressed.	Check whether you have pressed the FUNC/DATA key after changing the function code data. ➔ Press the FUNC/DATA key after changing the function code data. ➔ Check that SAVE is displayed on the LED monitor.
(5) The data of function codes F02, E01 through E07, E98, and E99 cannot be changed.	Either one of the ***FWD*** and ***REV*** terminal commands is turned ON. ➔ Turn OFF both ***FWD*** and ***REV***.
(6) The target function code(s) does not appear.	When "0. QUICK SET" is selected, only the particular function code(s) appears. ➔ Select "10. USER SET" and add the target function code(s) to the set of function codes registered for Quick Setup. After that, select the target function code(s) and change its data. For details, refer to Chapter 7, Table 7.9 "Menus Available in Programming Mode."

9.4 If an Alarm Code Appears on the LED Monitor

[1] OCn Instantaneous overcurrent

Problem The inverter momentary output current exceeded the overcurrent level.

OC1 Overcurrent occurred during acceleration.
OC2 Overcurrent occurred during deceleration.
OC3 Overcurrent occurred during running at a constant speed.

Possible Causes	What to Check and Suggested Measures
(1) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals ([U], [V] and [W]) and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited part (including replacement of the wires, relay terminals and motor).
(2) Ground faults have occurred at the inverter output lines.	Disconnect the wiring from the output terminals ([U], [V] and [W]) and perform a Megger test. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).
(3) Overload.	Measure the motor current with a measuring device to trace the current trend. Then, use this data to judge if the trend is over the calculated load value for your system design. ➔If the load is too heavy, reduce it or increase the inverter capacity.
	Trace the current trend and check if there are any sudden changes in the current. ➔ If there are any sudden changes, make the load fluctuation smaller or increase the inverter capacity. ➔ Enable instantaneous overcurrent limiting (H12 = 1).
(4) Excessive torque boost specified. (when F37* = 0, 1, 3, or 4)	Check whether decreasing the torque boost (F09*) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (F09*).
(5) The acceleration/ deceleration time was too short.	Check that the motor generates enough torque required during acceleration/deceleration. That torque is calculated from the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, F08, E10 through E15, and H56). ➔ Enable the current limiter (F43) and torque limiter (F40, F41, E16, and E17). ➔ Increase the inverter capacity.
(6) Malfunction caused by noise.	Check if noise control measures are appropriate (e.g., correct grounding and routing of control and main circuit wires). ➔ Implement noise control measures. For details, refer to Appendix A. ➔ Enable the Auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.

[2] EF Ground fault

Problem A ground fault current flew from the output terminal of the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output terminal(s) grounded (ground fault).	Disconnect the wiring from the output terminals ([U], [V], and [W]) and perform a Megger test. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).

[3] OUn Overvoltage

Problem The DC link bus voltage was over the detection level of overvoltage.

OU1 Overvoltage occurred during acceleration.
OU2 Overvoltage occurred during deceleration.
OU3 Overvoltage occurred during running at constant speed.

Possible Causes	What to Check and Suggested Measures
(1) The power supply voltage exceeded the inverter's specification range.	Measure the input voltage. ➔ Decrease the voltage to within the specified range.
(2) A surge current entered the input power supply.	In the same power line, if a phase-advancing capacitor is turned ON/OFF or a thyristor converter is activated, a surge (momentary large increase in the voltage or current) may be caused in the input power. ➔ Install a DC reactor.
(3) The deceleration time was too short for the moment of inertia for load.	Recalculate the deceleration torque based on the moment of inertia for the load and the deceleration time. ➔ Increase the deceleration time (F08, E11, E13, E15, and H56). ➔ Enable the automatic deceleration (anti-regenerative control) (H69), or deceleration characteristics (H71). ➔ Enable torque limiter (F40, F41, E16, E17, and H73). ➔ Set the rated voltage (at base frequency) (F05*) to "0" to improve the braking capability. ➔ Consider the use of a braking resistor.
(4) The acceleration time was too short.	Check if the overvoltage alarm occurs after rapid acceleration. ➔ Increase the acceleration time (F07, E10, E12, and E14). ➔ Select the S-curve pattern (H07). ➔ Consider the use of a braking resistor.
(5) Braking load was too heavy.	Compare the braking torque of the load with that of the inverter. ➔ Set the rated voltage (at base frequency) (F05*) to "0" to improve the braking capability. ➔ Consider the use of a braking resistor.
(6) Malfunction caused by noise.	Check if the DC link bus voltage was below the protective level when the overvoltage alarm occurred. ➔ Implement noise control measures. For details, refer to Appendix A. ➔ Enable the auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.

[4] LU Undervoltage

Problem DC link bus voltage has dropped below the undervoltage detection level.

Possible Causes	What to Check and Suggested Measures
(1) A momentary power failure occurred.	➔ Release the alarm. ➔ If you want to restart running the motor without treating this condition as an alarm, set F14 to "3," "4," or "5," depending on the load type.
(2) The power to the inverter was switched back to ON too soon (when F14 = 1).	Check if the power to the inverter was switched back to ON while the control power was still alive. (Check whether the LEDs on the keypad light.) ➔ Turn the power ON again after all LEDs on the keypad go off.
(3) The power supply voltage did not reach the inverter's specification range.	Measure the input voltage. ➔ Increase the voltage to within the specified range.
(4) Peripheral equipment for the power circuit malfunctioned, or the connection was incorrect.	Measure the input voltage to find which peripheral equipment malfunctioned or which connection is incorrect. ➔ Replace any faulty peripheral equipment, or correct any incorrect connections.
(5) Any other loads connected to the same power supply has required a large starting current, causing a temporary voltage drop.	Measure the input voltage and check the voltage fluctuation. ➔ Reconsider the power supply system configuration.
(6) Inverter's inrush current caused the power voltage drop because the power supply transformer capacity was insufficient.	Check if the alarm occurs when a molded case circuit breaker (MCCB), residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or magnetic contactor (MC) is turned ON. ➔ Reconsider the capacity of the power supply transformer.

[5] Lin Input phase loss

Problem Input phase loss occurred, or interphase voltage unbalance rate was large.

Possible Causes	What to Check and Suggested Measures
(1) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).
(2) The screws on the main power input terminals are loosely tightened.	Check if the screws on the main power input terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(3) Interphase voltage unbalance between three phases was too large.	Measure the input voltage. ➔ Connect an AC reactor (ACR) to lower the voltage unbalance between input phases. ➔ Increase the inverter capacity.
(4) Overload cyclically occurred.	Measure the ripple wave of the DC link bus voltage. ➔ If the ripple is large, increase the inverter capacity.
(5) Single-phase voltage was input to the three-phase input inverter.	Check the inverter settings and service condition. ➔ Correct them for single-phase use, referring to FRENIC-MEGA Instruction Manual, Chapter 1, Section 1.3.4 " Precautions for use on single-phase power.
(6) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power," [5].

Note The input phase loss protection can be disabled with the function code H98 (Protection/Maintenance Function).

[6] OPL Output phase loss

Problem Output phase loss occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output wires are broken.	Measure the output current. ➔ Replace the output wires.
(2) The motor winding is broken.	Measure the output current. ➔ Replace the motor.
(3) The terminal screws for inverter output were not tight enough.	Check if any screws on the inverter output terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(4) A single-phase motor has been connected.	➔ Single-phase motors cannot be used. Note that the FRENIC-MEGA only drives three-phase induction motors.

[7] OH1 Heat sink overheat

Problem Temperature around heat sink has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) Temperature around the inverter exceeded the inverter's specification range.	Measure the temperature around the inverter. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Ventilation path is blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the heat sink is not clogged. ➔ Clean the heat sink.
(3) Cooling fan's airflow volume decreased due to the service life expired or failure.	Check the cumulative run time of the cooling fan. Refer to Chapter 7, Section 7.4.6 "Reading maintenance information – Menu #5 "Maintenance Information"." ➔ Replace the cooling fan.
	Visually check whether the cooling fan rotates normally. ➔ Replace the cooling fan.
	Inverters of 60 HP or above for three-phase 230 V series and those of 125 HP or above for three-phase 460 V series are equipped with not only a cooling fan for heat sink but also an internal air circulation fan. Check the following. ➔ Check the connection of the fan power switching connectors "CN R" and "CN W." ➔ Correct the connection. (Refer to "⑥ Switching connectors" in FRENIC-MEGA Instruction Manual, Chapter 2, Section 2.3.4 "Wiring of main circuit terminals and grounding terminals".
(4) Overload.	Measure the output current. ➔ Reduce the load (e.g. Use the heat sink overheat early warning (E01 through E07) or the overload early warning (E34) and reduce the load before the overload protection is activated.). ➔ Decrease the motor sound (carrier frequency) (F26). ➔ Enable the overload prevention control (H70).
(5) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power, [1] and [6].

[8] OH2 External alarm

Problem External alarm was inputted (***THR***).
(when the "Enable external alarm trip" ***THR*** has been assigned to any of digital input terminals)

Possible Causes	What to Check and Suggested Measures
(1) An alarm function of external equipment was activated.	Check the operation of external equipment. ➔ Remove the cause of the alarm that occurred.
(2) Wrong connection or poor contact in external alarm signal wiring.	Check if the external alarm signal wiring is correctly connected to the terminal to which the "Enable external alarm trip" terminal command ***THR*** has been assigned (Any of E01 through E07, E98, and E99 should be set to "9."). ➔ Connect the external alarm signal wire correctly.
(3) Incorrect setting of function code data.	Check whether the "Enable external alarm trip" terminal command ***THR*** has been assigned to an unavailable terminal (with E01 through E07, E98, or E99). ➔ Correct the assignment.
	Check whether the normal/negative logic of the external signal matches that of the ***THR*** command specified by any of E01 through E07, E98, and E99. ➔ Ensure the matching of the normal/negative logic.

[9] OH3 Inverter internal overheat

Problem Temperature inside the inverter has exceeded the allowable limit.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the inverter's specification limit.	Measure the surrounding temperature. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power," [6].

[10] OH4 Motor protection (PTC/NTC thermistor)

Problem Temperature of the motor has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) The temperature around the motor exceeded the motor's specification range.	Measure the temperature around the motor. ➔ Lower the temperature.
(2) Cooling system for the motor defective.	Check if the cooling system of the motor is operating normally. ➔ Repair or replace the cooling system of the motor.
(3) Overload.	Measure the output current. ➔ Reduce the load (e.g. Use the heat sink overheat early warning (E01 through E07) or the overload early warning (E34) and reduce the load before the overload protection is activated.). (In winter, the load tends to increase.) ➔ Lower the temperature around the motor. ➔ Increase the motor sound (Carrier frequency) (F26).
(4) The activation level (H27) of the PTC thermistor for motor overheat protection was set inadequately.	Check the PTC thermistor specifications and recalculate the detection voltage. ➔ Modify the data of function code H27.
(5) Settings for the PTC/NTC thermistor are improper.	Check the setting of the thermistor mode selection (H26) and the slider position of terminal [C1] property switch SW5. ➔ Change the H26 data in accordance with the thermistor used and set the SW5 to the PTC/NTC position.

Possible Causes	What to Check and Suggested Measures
(6) Excessive torque boost specified. (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.
(7) The V/f pattern did not match the motor.	Check if the base frequency (F04*) and the rated voltage at base frequency (F05*) match the values on the motor's nameplate. ➔ Match the function code data with the values on the motor's nameplate.
(8) Incorrect setting of function code data.	Although no PTC/NTC thermistor is used, the thermistor mode is enabled (H26). ➔ Set the H26 data to "0" (Disable).

[11] dbH Braking resistor overheated

Problem The electronic thermal protection for the braking resistor has been activated.

Possible Causes	What to Check and Suggested Measures
(1) Braking load is too heavy.	Reconsider the relationship between the braking load estimated and the real load. ➔ Lower the real braking load. ➔ Review the selection of the braking resistor and increase the braking capability (Modification of related function code data (F50, F51, and F52) is also required.)
(2) Specified deceleration time is too short.	Recalculate the deceleration torque and time needed for the load currently applied, based on a moment of inertia for the load and the deceleration time. ➔ Increase the deceleration time (F08, E11, E13, E15, and H56). ➔ Review the selection of the braking resistor and increase the braking capability. (Modification of related function code data (F50, F51, and F52) is also required.)
(3) Incorrect setting of function code data F50, F51, and F52.	Recheck the specifications of the braking resistor. ➔ Review data of function codes F50, F51, and F52, then modify them.

Note: The inverter issues an overheat alarm of the braking resistor by monitoring the magnitude of the braking load, not by measuring its surface temperature.

When the braking resistor is frequently used so as to exceed the settings made by function codes F50, F51, and F52, therefore, the inverter issues an overheat alarm even if the surface temperature of the braking resistor does not rise. To squeeze out full performance of the braking resistor, configure function codes F50, F51, and F52 while actually measuring the surface temperature of the braking resistor.

[12] FUS Fuse blown

Problem The fuse inside the inverter blew.

Possible Causes	What to Check and Suggested Measures
(1) The fuse blew due to short-circuiting inside the inverter.	Check whether there has been any excess surge or noise coming from outside. ➔ Take measures against surges and noise. ➔ Have the inverter repaired.

[13] PbF Charger circuit fault

Problem The magnetic contactor for short-circuiting the charging resistor failed to work.

Possible Causes	What to Check and Suggested Measures
(1) The control power was not supplied to the magnetic contactor intended for short-circuiting the charging resistor.	Check that, in normal connection of the main circuit (not a connection via the DC link bus), the connector (CN R) on the power printed circuit board (power PCB) is not inserted to NC. ➔ Insert the connector (CN R) to FAN.
	Check whether you quickly turned the circuit breaker ON and OFF to confirm safety after cabling/wiring. ➔ Wait until the DC link bus voltage has dropped to a sufficiently low level and then release the current alarm. After that, turn ON the power again. (Do not turn the circuit breaker ON and OFF quickly.) (Turning ON the circuit breaker supplies power to the control circuit to the operation level (lighting the LEDs on the keypad) in a short period. Immediately turning it OFF even retains the control circuit power for a time, while it shuts down the power to the magnetic contactor intended for short-circuiting the charging resistor since the contactor is directly powered from the main power. Under such conditions, the control circuit can issue a turn-on command to the magnetic contactor, but the contactor not powered can produce nothing. This state is regarded as abnormal, causing an alarm.)
(2) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power," [4].

[14] OLn Overload of motor 1 through 4

Problem Electronic thermal protection for motor 1, 2, 3, or 4 activated.

OL1 Motor 1 overload
OL2 Motor 2 overload
OL3 Motor 3 overload
OL4 Motor 4 overload

Possible Causes	What to Check and Suggested Measures
(1) The electronic thermal characteristics do not match the motor overload characteristics.	Check the motor characteristics. ➔ Reconsider the data of function codes (P99*, F10* and F12*). ➔ Use an external thermal relay.
(2) Activation level for the electronic thermal protection was inadequate.	Check the continuous allowable current of the motor. ➔ Reconsider and change the data of function code F11*.
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/ deceleration time (F07, F08, E10 through E15, and H56).
(4) Overload.	Measure the output current. ➔ Reduce the load (e.g. Use the overload early warning (E34) and reduce the load before the overload protection is activated.). (In winter, the load tends to increase.)
(5) Excessive torque boost specified (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.

[15] OLU Inverter overload

Problem Temperature inside inverter has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) Temperature around the inverter exceeded the inverter's specification range.	Measure the temperature around the inverter. ➔ Lower the temperature (e.g., ventilate the panel where the inverter is mounted).
(2) Excessive torque boost specified (F09*)	Check whether decreasing the torque boost (F09*) does not stall the motor. ➔ If no stall occurs, decrease the F09* data.
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, F08, E10 through E15, and H56).
(4) Overload.	Measure the output current. ➔ Reduce the load (e.g., Use the overload early warning (E34) and reduce the load before the overload protection is activated.). (In winter, the load tends to increase.). ➔ Decrease the motor sound (Carrier frequency) (F26). ➔ Enable overload prevention control (H70).
(5) Ventilation paths are blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the heat sink is not clogged. ➔ Clean the heat sink.
(6) Cooling fan's airflow volume decreased due to the service life expired or failure.	Check the cumulative run time of the cooling fan. Refer to Chapter 7, Section 7.4.6 "Reading maintenance information – Menu #5 "Maintenance Information"." ➔ Replace the cooling fan.
	Visually check that the cooling fan rotates normally. ➔ Replace the cooling fan.
(7) The wires to the motor are too long, causing a large leakage current from them.	Measure the leakage current. ➔ Insert an output circuit filter (OFL).
(8) Running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power," [1] and [6].

[16] OS Overspeed

Problem The motor rotates in an excessive speed (Motor speed ≥ (F03 data) × (d32 data, d33 data) × 1.2)

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check the motor parameter "Number of poles" (P01*). ➔ Specify the P01* data in accordance with the motor to be used.
	Check the maximum frequency setting (F03*). ➔ Specify the F03* data in accordance with the output frequency.
	Check the setting of speed limit function (d32 and d33). ➔ Disable the speed limit function (d32 and d33).
(2) Insufficient gain of the speed controller.	Check whether the actual speed overshoots the commanded one in higher speed operation. ➔ Increase the speed controller gain (d03*.) (Depending on the situations, reconsider the setting of the filter constant or the integral time.)

Possible Causes	What to Check and Suggested Measures
(3) Noises superimposed on the PG wire.	Check whether appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires and main circuit wires). ➔ Implement noise control measures. For details, refer to Appendix A.

[17] PG PG wire break

Problem The pulse generator (PG) wire has been broken somewhere in the circuit.

Possible Causes	What to Check and Suggested Measures
(1) The wire between the pulse generator (PG) and the option card has been broken.	Check whether the pulse generator (PG) is correctly connected to the option card or any wire is broken. ➔ Check whether the PG is connected correctly. Or, tighten up the related terminal screws. ➔ Check whether any joint or connecting part bites the wire sheath. ➔ Replace the wire.
(2) PG related circuit affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires, communication cables, and main circuit wires). ➔ Implement noise control measures. ➔ Separate the signal wires from the main power wires as far as possible.

[18] Er1 Memory error

Problem Error occurred in writing the data to the memory in the inverter.

Possible Causes	What to Check and Suggested Measures
(1) When writing data (especially initializing or copying data), the inverter was shut down so that the voltage to the control PCB has dropped.	Initialize the function code data with H03 (= 1). After initialization, check if pressing the RESET key releases the alarm. ➔ Revert the initialized function code data to their previous settings, then restart the operation.
(2) Inverter affected by strong electrical noise when writing data (especially initializing or copying data).	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (1) above. ➔ Implement noise control measures. Revert the initialized function code data to their previous settings, then restart the operation.
(3) The control PCB failed.	Initialize the function code data by setting H03 to "1," then reset the alarm by pressing the RESET key and check that the alarm goes on. ➔ The control PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.

[19] Er-2 Keypad communications error

Problem A communications error occurred between the remote keypad or the multi-function keypad and the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Broken communications cable or poor contact.	Check continuity of the cable, contacts and connections. ➔ Re-insert the connector firmly. ➔ Replace the cable.
(2) Connecting many control wires hinders the front cover from being mounted, lifting the keypad.	Check the mounting condition of the front cover. ➔ Use wires of the recommended size AWG 19 or 18 (0.65 to 0.82 mm^2) for wiring. ➔ Change the wiring layout inside the unit so that the front cover can be mounted firmly.
(3) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communication cables and main circuit wires). ➔ Implement noise control measures. For details, refer to Appendix A.
(4) A keypad failure occurred.	Replace the keypad with another one and check whether a keypad communications error (Er-2) occurs. ➔ Replace the keypad.

[20] Er-3 CPU error

Problem A CPU error (e.g. erratic CPU operation) occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.

[21] Er-4 Option communications error

Problem A communications error occurred between the option card and the inverter.

Possible Causes	What to Check and Suggested Measures
(1) There was a problem with the connection between the option card and the inverter.	Check whether the connector on the option card is properly engaged with that of the inverter. ➔ Reload the option card into the inverter.
(2) Strong electrical noise.	Check whether appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.

[22] Er-5 Option error

An error detected by the option card. Refer to the instruction manual of the option card for details.

[23] Er-6 Operation protection

Problem An incorrect operation was attempted.

Possible Causes	What to Check and Suggested Measures
(1) The STOP key was pressed when H96 = 1 or 3.	Check that the STOP key was pressed when a run command had been entered from the input terminal or through the communications port. ➔ If this was not intended, check the setting of H96.
(2) The start check function was activated when H96 = 2 or 3.	Check that any of the following operations has been performed with a run command being entered. - Turning the power ON - Releasing the alarm - Switching the enable communications link ***LE*** operation ➔ Review the running sequence to avoid input of a Run command when this error occurs. If this was not intended, check the setting of H96. (Turn the run command OFF before releasing the alarm.)
(3) The forced stop digital input STOP was turned OFF.	Check that turning the ***STOP*** OFF decelerated the inverter to stop. ➔ If this was not intended, check the settings of E01 through E07 for terminals [X1] through [X7].

[24] Er 7 Tuning error

Problem Auto-tuning failed.

Possible Causes	What to Check and Suggested Measures
(1) A phase was missing (There was a phase loss) in the connection between the inverter and the motor.	➔ Properly connect the motor to the inverter.
(2) V/f or the rated current of the motor was not properly set.	Check whether the data of function codes (F04*, F05*, H50 through H53, H65, H66, P02*, and P03*) matches the motor specifications.
(3) The wiring length between the inverter and the motor was too long.	Check whether the wiring length between the inverter and the motor exceeds 164 ft (50 m). (Small capacity inverters are greatly affected by the wiring length.) ➔ Review, and if necessary, change the layout of the inverter and the motor to shorten the connection wire. Alternatively, minimize the wiring length without changing the layout. ➔ Disable both auto-tuning and auto-torque boost (set data of F37* to "1").
(4) The rated capacity of the motor was significantly different from that of the inverter.	Check whether the rated capacity of the motor is three or more ranks lower, or two or more ranks higher than that of the inverter. ➔ Replace the inverter with one with an appropriate capacity. ➔ Manually specify the values for the motor parameters P06*, P07*, and P08*. ➔ Disable both auto-tuning and auto-torque boost (set data of F37* to "1").
(5) The motor was a special type such as a high-speed motor.	➔ Disable both auto-tuning and auto-torque boost (set data of F37* to "1").
(6) A tuning operation involving motor rotation (P04* = 2 or 3) was attempted while the brake was applied to the motor.	➔ Specify the tuning that does not involve the motor rotation (P04* = 1). ➔ Release the brake before tuning that involves the motor rotation (P04* = 2 or 3).

📖 For details of tuning errors, refer to FRENIC-MEGA Instruction Manual, Chapter 4, Section 4.1.7 "Function code basic settings and tuning < 2 >, ■ Tuning errors."

[25] Er-8 RS-485 communications error (COM port 1)
Er-P RS-485 communications error (COM port 2)

Problem A communications error occurred during RS-485 communications.

Possible Causes	What to Check and Suggested Measures
(1) Communications conditions of the inverter do not match that of the host equipment.	Compare the settings of the y codes (y01 to y10, y11 to y20) with those of the host equipment. ➔ Correct any settings that differ.
(2) Even though no-response error detection time (y08, y18) has been set, communications is not performed within the specified cycle.	Check the host equipment. ➔ Change the settings of host equipment software or disable the no-response error detection (y08, y18 = 0).
(3) The host equipment did not operate due to defective software, settings, or defective hardware.	Check the host equipment (e.g., PLCs and computers). ➔ Remove the cause of the equipment error.
(4) The RS-485 converter did not operate due to incorrect connections and settings, or defective hardware.	Check the RS-485 converter (e.g., check for poor contact). ➔ Change the various RS-485 converter settings, reconnect the wires, or replace hardware with recommended devices as appropriate.
(5) Broken communications cable or poor contact.	Check the continuity of the cables, contacts and connections. ➔ Replace the cable.
(6) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communications cables and main circuit wires). ➔ Implement noise control measures. ➔ Implement noise reduction measures on the host side. ➔ Replace the RS-485 converter with a recommended insulated one.
(7) Terminating resistor not properly configured.	Check that the inverter serves as a terminating device in the network. ➔ Configure the terminating resistor switch(es) (SW2/SW3) for RS-485 communication correctly. (That is, turn the switch(es) to ON.)

[26] Er-F Data saving error during undervoltage

Problem The inverter failed to save data such as the frequency commands and PID commands (which are specified through the keypad), or the output frequencies modified by the ***UP***/***DOWN*** terminal commands when the power was turned OFF.

Possible Causes	What to Check and Suggested Measures
(1) During data saving performed when the power was turned OFF, the voltage fed to the control PCB dropped in an abnormally short period due to the rapid discharge of the DC link bus.	Check how long it takes for the DC link bus voltage to drop to the preset voltage when the power is turned OFF. ➔ Remove whatever is causing the rapid discharge of the DC link bus voltage. After pressing the (RESET) key and releasing the alarm, return the data of the relevant function codes (such as the frequency commands and PID commands (specified through the keypad) or the output frequencies modified by the ***UP***/***DOWN*** terminal commands) back to the original values and then restart the operation.

Possible Causes	What to Check and Suggested Measures
(2) Inverter operation affected by strong electrical noise when the power was turned OFF.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). ➔ Implement noise control measures. After pressing the RESET key and releasing the alarm, return the data of the relevant function codes (such as the frequency commands and PID commands (specified through the keypad) or the output frequencies modified by the ***UP/DOWN*** terminal commands) back to the original values and then restart the operation.
(3) The control circuit failed.	Check if Er-F occurs each time the power is turned ON. ➔ The control PCB (on which the CPU is mounted) is defective. Contact your Fuji Electric representative.

[27] Er-H Hardware error

Problem The LSI on the power printed circuit board malfunctions.

Possible Causes	What to Check and Suggested Measures
(1) The inverter capacity setting on the control printed circuit board is wrong.	It is necessary to set the inverter capacity correctly. ➔ Contact your Fuji Electric representative.
(2) Data stored in the power printed circuit board memory is corrupted.	It is necessary to replace the power printed circuit board. ➔ Contact your Fuji Electric representative.
(3) The control printed circuit board is misconnected to the power printed circuit board.	It is necessary to replace the power or control printed circuit board. ➔ Contact your Fuji Electric representative.

[28] Er-E Speed mismatch or excessive speed deviation

Problem An excessive deviation appears between the speed command and the detected speed.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check the following function code data; P01* (Motor (No. of poles)), d15 (Feedback encoder pulse count/rev), and d16 and d17 (Feedback pulse correction factor 1 and 2). ➔ Specify data of function codes P01*, d15, d16, and d17 in accordance with the motor and PG.
(2) Overload.	Measure the inverter output current. ➔ Reduce the load.
	Check whether any mechanical brake is working. ➔ Release the mechanical brake.
(3) The motor speed does not rise due to the current limiter operation.	Check the data of function code F44 (Current limiter (Level)). ➔ Change the F44 data correctly. Or, set the F43 data to "0" (Disable) if the current limiter operation is not needed.
	Check the data of function codes F04*, F05*, and P01* through P12* to ensure that the V/f pattern setting is right. ➔ Match the V/f pattern setting with the motor ratings. ➔ Change the function code data in accordance with the motor parameters.
(4) Function code settings do not match the motor characteristics.	Check whether the data of P01*, P02*, P03*, P06*, P07*, P08*, P09*, P10* and P12* match the parameters of the motor. ➔ Perform auto-tuning of the inverter, using the function code P04*.

Possible Causes	What to Check and Suggested Measures
(5) Wrong wiring between the pulse generator (PG) and the inverter.	Check the wiring between the PG and the inverter. ➔ Correct the wiring.
	Check that the relationships between the PG feedback signal and the run command are as follows: • For the FWD command: the B phase pulse is in the High level at rising edge of the A phase pulse • For the REV command: the B phase pulse is in the Low level at rising edge of the A phase pulse ➔ If the relationship is wrong, interchange the A and B phase wires.
(6) Wiring to the motor is incorrect.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.
(7) The motor speed does not rise due to the torque limiter operation.	Check the data of F40 (Torque limiter 1-1). ➔ Correct the F40 data. Or, set the F40 data to "999" (Disable) if the torque limiter operation is not needed.

[29] nrb NTC wire break error

Problem A wire break is found in the NTC thermistor detection circuit.

Possible Causes	What to Check and Suggested Measures
(1) The NTC thermistor cable is broken.	Check whether the motor cable is broken. ➔ Replace the motor cable.
(2) The temperature around the motor is extremely low (lower than -30°C (-22°F)).	Measure the temperature around the motor. ➔ Reconsider the use environment of the motor.
(3) The NTC thermistor is broken.	Measure the resistance of the NTC thermistor. ➔ Replace the motor.

[30] Err Mock alarm

Problem The LED displays the alarm Err.

Possible Causes	What to Check and Suggested Measures
(1) The STOP + FUNC/DATA keys were held down for more than 5 seconds.	➔ To escape from this alarm state, press the FUNC/DATA key.

[31] CoF PID feedback wire break

Problem The PID feedback wire is broken.

Possible Causes	What to Check and Suggested Measures
(1) The PID feedback signal wire is broken.	Check whether the PID feedback signal wires are connected correctly. ➔ Check whether the PID feedback signal wires are connected correctly. Or, tighten up the related terminal screws. ➔ Check whether any contact part bites the wire sheath.
(2) PID feedback related circuit affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires, communication cables, and main circuit wires). ➔ Implement noise control measures. ➔ Separate the signal wires from the main power wires as far as possible.

[32] dbA Braking transistor error

Problem A braking transistor error is detected.

Possible Causes	What to Check and Suggested Measures
(1) The braking transistor is broken.	Check whether resistance of the braking resistor is correct or there is a misconnection of the resistor. ➔ Consult your Fuji Electric representative for repair.

[33] Ero Positioning control error (Servo-lock)

Problem An excessive positioning deviation has occurred when the servo-lock function was activated.

Possible Causes	What to Check and Suggested Measures
(1) Insufficient gain in positioning control system.	Readjust the settings of J97 (Servo-lock (Gain)) and d03 (Speed control 1 P (Gain)).
(2) Incorrect control completion width.	Check whether the setting of J99 (Servo-lock (Completion width)) is correct. ➔ Correct the setting of J99.

[34] Ero Positioning control error (Synchronous control)

Problem An excessive positioning deviation has occurred when the synchronous control function was activated.

For details, refer to the instruction manual of the PG interface card.

Possible Causes	What to Check and Suggested Measures
(1) Insufficient gain in positioning control system.	Readjust the settings of d72 (Synchronous Control Parameters (APR P gain)) and d03 (Speed control 1 P (Gain)).
(2) Incorrect control completion width.	Check whether the setting of d78 (Synchronous Control Parameters (Over-deviation detection width)) is correct. ➔ Correct the setting of d78.

[35] ECF Enable circuit failure

Problem The circuit that detects the status of the enable circuit is broken.

Possible Causes	What to Check and Suggested Measures
(1) Circuit related to the Enable circuit affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires, communication cables, and main circuit wires). ➔ Implement noise control measures. ➔ Separate the signal wires from the main power wires as far as possible.

Note The "Reset alarm" terminal command ***RST*** cannot reset this alarm ECF. If even a power-off reset cannot restore the inverter state, the inverter needs to be repaired.

9.5 If the "Light Alarm" Indication (L -AL) Appears on the LED Monitor

If the inverter detects a minor abnormal state "light alarm," it can continue the current operation without tripping while displaying the "light alarm" indication L -AL on the LED monitor. In addition to the indication L -AL, the inverter displays the "L-ALARM" (blinking) on the LCD monitor and outputs the "light alarm" signal ***L-ALM*** to a digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the ***L-ALM***, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E20 through E24 and E27 to "98.")

Function codes H81 and H82 specify which alarms should be categorized as "light alarm." The available "light alarm" codes are check-marked in the "Light alarm" object column in Table 9.1.

To display the "light alarm" and escape from the light alarm state, follow the instructions below.

■ Displaying the light alarm

1) Press the (PRG) key to enter Programming mode.
2) Shift to Menu #5 "5: MAINTENANC," scroll to Page 11, and check the "LALM1" (Light alarm (Latest)). The light alarm is displayed in alarm codes. For details about those codes, see Table 9.1 "Abnormal States Detectable ("Alarm" and "Light Alarm" Objects)."

   For details about the menu transition in Menu #5 "Maintenance Information", see Chapter 7, Section 7.4.6 "Reading maintenance information – Menu #5 "Maintenance Information." It is also possible to display the factors of other three light alarms--"LALM2" (Light alarm (Last)) to "LALM4" (Light alarm (3rd)).

■ Switching the LED monitor from the light alarm to normal display

If it is necessary to return the LED monitor to the normal display state (showing the running status such as reference frequency) before the light alarm is removed (e.g., when it takes a long time to remove the light alarm), follow the steps below.

1) Press the (RESET) key to return the LED monitor to the light alarm indication (L -AL).
2) With L -AL being displayed, press the (FUNC/DATA) key. The LED monitor returns to the normal display state, but the "L-ALARM" on the LCD monitor continues blinking.

■ Releasing the light alarm

1) First remove the "LALM1" (Light alarm (Latest)) under Menu #5, in accordance with the troubleshooting procedure. The reference page for the troubleshooting corresponding to each light alarm is shown in "Ref. page" column in Table 9.1.
2) To return the LED monitor from the L -AL display to the normal display state (showing the running status such as reference frequency), press the (FUNC/DATA) key in Running mode.

   If the light alarm(s) has been successfully removed in step 1) above, the "L-ALARM" blinking on the LCD monitor disappears and the digital output ***L-ALM*** also goes OFF. (If any light alarm persists, e.g., detecting a DC fan lock, the "L-ALARM" continues blinking and the ***L-ALM*** remains ON.)

9.6 If an Abnormal Pattern Appears on the LED Monitor except Alarm Codes and "Light Alarm" Indication (L-AL)

[1] – – – – (center bar) appears

Problem A center bar (– – – –) appeared on the LED monitor.

Possible Causes	What to Check and Suggested Measures
(1) When PID control had been disabled (J01 = 0), you changed E43 (LED Monitor (Item selection)) to 10 or 12. With the PID being enabled (J01 = 1, 2, or 3), you disabled PID control (J01 = 0) when the LED monitor had been set to display the PID command or PID feedback amount by pressing the FUNC/DATA key.	Make sure that when you wish to view other monitor items, E43 is not set to "10: PID command" or "12: PID feedback amount." ➔ Set E43 to a value other than "10" or "12." Make sure that when you wish to view a PID command or a PID feedback amount, J01 (PID control) is not set to "0: Disable." ➔ Set J01 to "1: Enable (Process control normal operation)," "2: Enable (Process control inverse operation)," or "3: Enable (Dancer control)."
(2) The keypad was poorly connected.	Prior to proceed, check that pressing the FUNC/DATA key does not change the display on the LED monitor. Check continuity of the extension cable for the keypad used in remote operation. ➔ Replace the cable.

[2] _ _ _ _ (under bar) appears

Problem Although you pressed the FWD / REV key or entered a run forward command ***FWD*** or a run reverse command ***REV***, the motor did not start and an under bar (_ _ _ _) appeared on the LED monitor.

Possible Causes	What to Check and Suggested Measures
(1) The voltage of the DC link bus was low.	Select 5_01 under Menu #5 "Maintenance Information" in Programming mode on the keypad, then check the DC link bus voltage which should be 200 VDC or below for three-phase 230 V series, and 400 VDC or below for three-phase 460 V series. ➔ Connect the inverter to a power supply that meets its input specifications.
(2) The main power is not ON, while the auxiliary input power to the control circuit is supplied.	Check whether the main power is turned ON. ➔ Turn the main power ON.
(3) Although power is supplied not via the commercial power line but via the DC link bus, the main power down detection is enabled (H72 = 1).	Check the connection to the main power and check if the H72 data is set to "1" (factory default). ➔ Correct the H72 data.
(4) Inverter running on single-phase power	➔ Refer to Section 9.7 "If the Inverter is Running on Single-Phase Power, " [2].

[3] [ ] appears

Problem Parentheses ([ ]) appeared on the LED monitor during speed monitoring on the keypad.

Possible Causes	What to Check and Suggested Measures
(1) The display data overflows the LED monitor.	Check whether the output frequency multiplied by the display coefficient (E50) is 1,000,000 or more. ➔ Correct the E50 data.

9.7 If the Inverter is Running on Single-Phase Power

[1] The AC fan(s) does not work. (230 V series with 60 HP or above or 460 V series with 125 HP or above)

Possible Causes	Suggested Measures
The power supply is connected to the main circuit power input terminal L2.	Connect the power supply to L1 and L3.

[2] _ _ _ _ (under bar) appears

Possible Causes	Suggested Measures
The power supply is connected to the main circuit power input terminal L2 and the main power down detection is activated.	Connect the power supply to L1 and L3.

[3] The motor does not run as expected.

Possible Causes	Suggested Measures
Large voltage ripple inside the inverter due to single-phase power	When the inverter runs on single-phase power, the voltage ripple becomes larger than that on three-phase power so that an operation error span becomes wider, causing lower performance than expected. To improve the accuracy in operation, use the inverter on three-phase power.

[4] PbF Charger circuit fault (230 V series with 60 HP or above or 460 V series with 125 HP or above)

Possible Causes	Suggested Measures
The power supply is connected to the main circuit power input terminal L2.	Connect the power supply to L1 and L3.

[5] Lin Input phase loss

Possible Causes	Suggested Measures
The input phase loss protection is activated.	Disable the input phase loss protection by switching Bit 1 of H98 to "0." When switching from the factory default of H98, modify the H98 data from 82 to 81 in decimal.

[6] OH1 Heat sink overheat, OH3 Inverter internal overheat, or OLU Inverter overload

Possible Causes	Suggested Measures
The inverter was running with load exceeding the single-phase rating.	To run the inverter on single-phase power, it is necessary to derate the output to the lower level than that on three-phase power. Review the load conditions to run the inverter within the single-phase rating, or increase the inverter capacity.

Appendices

Contents

App. A Advantageous Use of Inverters (Notes on electrical noise)

- Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (April 1994). It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

A.1 Effect of inverters on other devices

Inverters have been and are rapidly expanding its application fields. This paper describes the effect that inverters have on electronic devices already installed or on devices installed in the same system as inverters, as well as introducing noise prevention measures. (Refer to Section A.3 [3], "Noise prevention examples" for details.)

[1] Effect on AM radios

Phenomenon	If an inverter operates, AM radios may pick up noise radiated from the inverter. (An inverter has almost no effect on FM radios or television sets.)
Probable cause	Radios may receive noise radiated from the inverter.
Measures	Inserting a noise filter on the power supply side of the inverter is effective.

[2] Effect on telephones

Phenomenon	If an inverter operates, nearby telephones may pick up noise radiated from the inverter in conversation so that it may be difficult to hear.
Probable cause	A high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables, causing noise.
Measures	It is effective to commonly connect the grounding terminals of the motors and return the common grounding line to the grounding terminal of the inverter.

[3] Effect on proximity switches

Phenomenon	If an inverter operates, proximity switches (capacitance-type) may malfunction.
Probable cause	The capacitance-type proximity switches may provide inferior noise immunity.
Measures	It is effective to connect a filter to the input terminals of the inverter or change the power supply treatment of the proximity switches. The proximity switches can be replaced with superior noise immunity types such as magnetic types.

[4] Effect on pressure sensors

Phenomenon	If an inverter operates, pressure sensors may malfunction.
Probable cause	Noise may penetrate through a grounding wire into the signal line.
Measures	It is effective to install a noise filter on the power supply side of the inverter or to change the wiring.

[5] Effect on position detectors (pulse encoders)

Phenomenon	If an inverter operates, pulse encoders may produce erroneous pulses that shift the stop position of a machine.
Probable cause	Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
Measure	The influence of induction noise and radiation noise can be reduced by separating the PG signal lines and power lines. Providing noise filters at the input and output terminals is also an effective measure.

A.2 Noise

This section gives a summary of noises generated in inverters and their effects on devices subject to noise.

[1] Inverter noise

Figure A.1 shows an outline of the inverter configuration. The inverter converts AC to DC (rectification) in a converter unit, and converts DC to AC (inversion) with 3-phase variable voltage and variable frequency. The conversion (inversion) is performed by PWM implemented by switching six transistors (IGBT: Insulated Gate Bipolar Transistor, etc), and is used for variable speed motor control.

Switching noise is generated by high-speed on/off switching of the six transistors. 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 is expressed as follows:

$$i = C \cdot dv/dt$$

It is related to the stray capacitance (C) and dv/dt (switching speed of the transistors). Further, this noise current is related to the carrier frequency since the noise current flows each time the transistors are switched on or off.

In addition to the main circuit of the inverter, the DC-to-DC switching power regulator (DC/DC converter), which is the power source for the control circuit of the inverter, may be a noise source in the same principles as stated above.

The frequency band of this noise is less than approximately 30 to 40 MHz. Therefore, the noise will affect devices such as AM radios using low frequency band, but will not virtually affect FM radios and television sets using higher frequency than this frequency band.

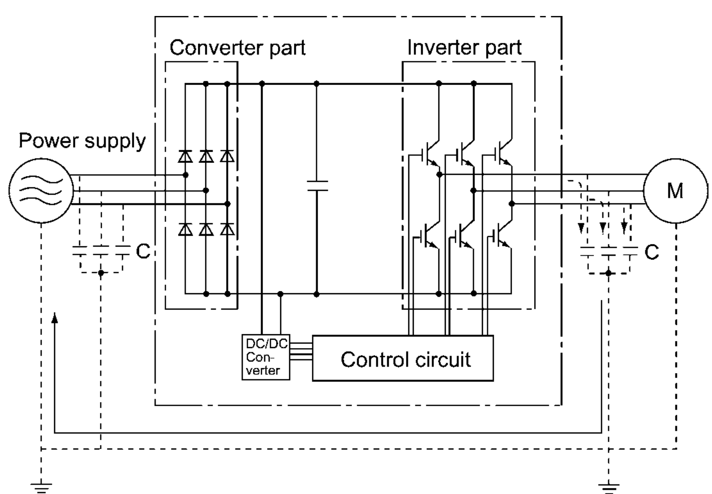


Figure A.1 Outline of Inverter Configuration

[2] Types of noise

Noise generated in an inverter is propagated through the main circuit wiring to the power supply and the motor so as to affect a wide range of applications from the power supply transformer to the motor. The various propagation routes are shown in Figure A.2. According to those routes, noises are roughly classified into three types--conduction noise, induction noise, and radiation noise.

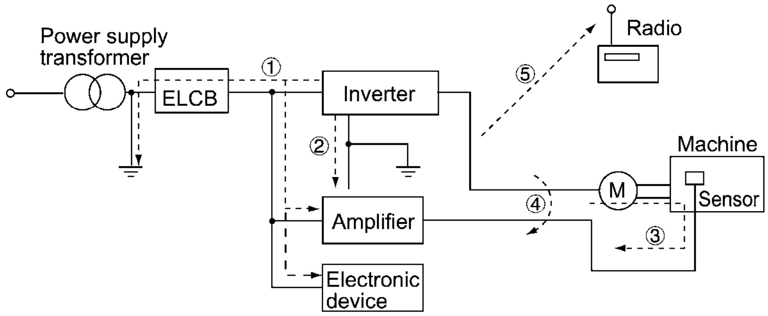


Figure A.2 Noise Propagation Routes

(1) Conduction noise

Noise generated in an inverter may propagate through the conductor and power supply so as to affect peripheral devices of the inverter (Figure A.3). This noise is called "conduction noise." Some conduction noises will propagate through the main circuit ①. If the ground wires are connected to a common ground, conduction noise will propagate through route ②. As shown in route ③, some conduction noises will propagate through signal lines or shielded wires.

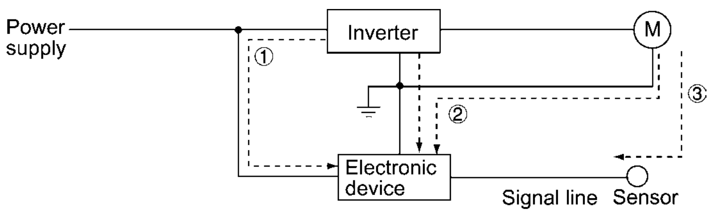


Figure A.3 Conduction Noise

(2) Induction noise

When wires or signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter through which noise current is flowing, noise will be induced into those wires and signal lines of the devices by electromagnetic induction (Figure A.4) or electrostatic induction (Figure A.5). This is called "induction noise" ④.

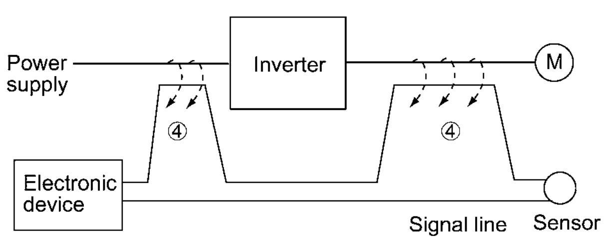


Figure A.4 Electromagnetic Induced Noise

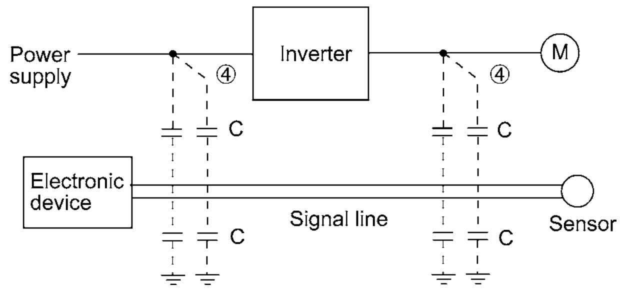


Figure A.5 Electrostatic Induced Noise

(3) Radiation noise

Noise generated in an inverter may be radiated through the air from wires (that act as antennas) at the input and output sides of the inverter so as to affect peripheral devices. This noise is called "radiation noise" ⑤ as shown below. Not only wires but motor frames or control system panels containing inverters may also act as antennas.

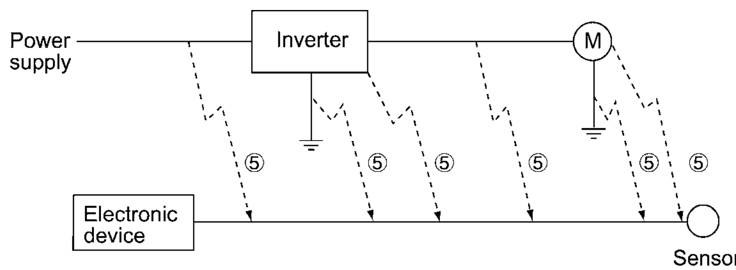


Figure A.6 Radiation Noise

A.3 Noise prevention

The more noise prevention is strengthened, the more effective. However, with the use of appropriate measures, noise problems may be resolved easily. It is necessary to implement economical noise prevention according to the noise level and the equipment conditions.

[1] Noise prevention prior to installation

Before installing an inverter in your control panel or installing an inverter panel, you need to consider noise prevention. Once noise problems occur, it will cost additional materials and time for solving them.

Noise prevention prior to installation includes:

1) Separating the wiring of main circuits and control circuits
2) Putting main circuit wiring into a metal conduit pipe
3) Using shielded wires or twisted shielded wires for control circuits.
4) Implementing appropriate grounding work and grounding wiring.

These noise prevention measures can avoid most noise problems.

[2] Implementation of noise prevention measures

There are two types of noise prevention measures--one for noise propagation routes and the other for noise receiving sides (that are affected by noise).

The basic measures for lessening the effect of noise at the receiving side include:

Separating the main circuit wiring from the control circuit wiring, avoiding noise effect.

The basic measures for lessening the effect of noise at the generating side include:

1) Inserting a noise filter that reduces the noise level.
2) Applying a metal conduit pipe or metal control panel that will confine noise, and
3) Applying an insulated transformer for the power supply that cuts off the noise propagation route.

Table A.1 lists the noise prevention measures, their goals, and propagation routes.

Table A.1 Noise Prevention Measures

Noise prevention method		Goal of noise prevention measures				Conduction route		
		Make it more difficult to receive noise	Cutoff noise conduction	Confine noise	Reduce noise level	Conduction noise	Induction noise	Radiation noise
Wiring and installation	Separate main circuit from control circuit	Y					Y	
	Minimize wiring distance	Y			Y		Y	Y
	Avoid parallel and bundled wiring	Y					Y	
	Use appropriate grounding	Y			Y	Y	Y	
	Use shielded wire and twisted shielded wire	Y					Y	Y
	Use shielded cable in main circuit			Y			Y	Y
	Use metal conduit pipe			Y			Y	Y
Control panel	Appropriate arrangement of devices in panel	Y					Y	Y
	Metal control panel			Y			Y	Y
Anti-noise device	Line filter	Y			Y	Y		Y
	Isolation transformer		Y			Y		Y
Measures at noise receiving sides	Use a passive capacitor for control circuit	Y					Y	Y
	Use ferrite core for control circuit	Y			Y		Y	Y
	Line filter	Y		Y		Y		
Others	Separate power supply systems		Y			Y		
	Lower the carrier frequency				Y*	Y	Y	Y

Y: Effective, Y*: Effective conditionally, Blank: Not effective

What follows is noise prevention measures for the inverter drive configuration.

(1) Wiring and grounding

As shown in Figure A.7, separate the main circuit wiring from control circuit wiring as far as possible regardless of being located inside or outside the system control panel containing an inverter. Use shielded wires and twisted shielded wires that will block out extraneous noises, and minimize the wiring distance. Also avoid bundled wiring of the main circuit and control circuit or parallel wiring.

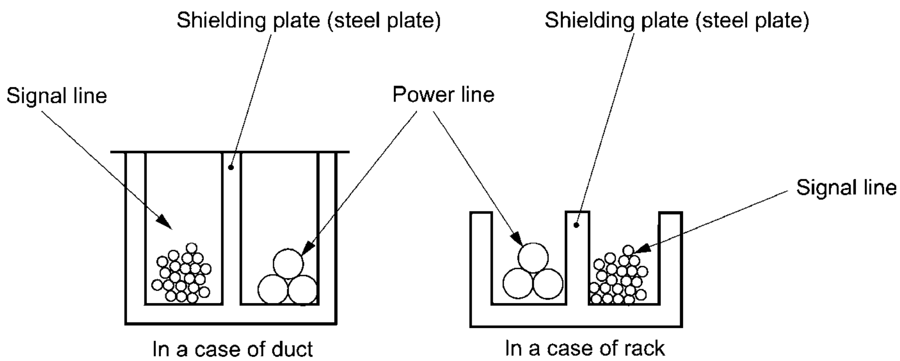


Figure A.7 Separate Wiring

For the main circuit wiring, use a metal conduit pipe and connect its wires to the ground to prevent noise propagation (refer to Figure A.8).

The shield (braided wire) of a shielded wire should be 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 A.9).

The grounding is effective not only to reduce the risk of electrical shocks due to leakage current, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be Class D (300 VAC or less, grounding resistance: 100Ω or less) and Class C (300 to 600 VAC, grounding resistance: 10Ω or less). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

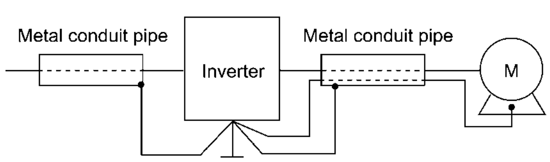


Figure A.8 Grounding of Metal Conduit Pipe

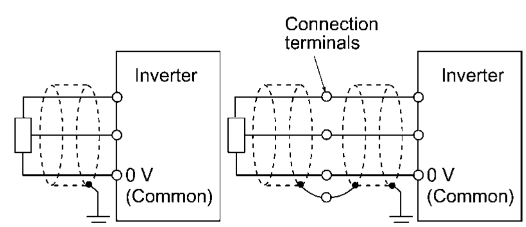


Figure A.9 Treatment of Braided Wire of Shielded Wire

(2) Control panel

The system control panel containing an inverter is generally made of metal, which can shield noise radiated from the inverter itself.

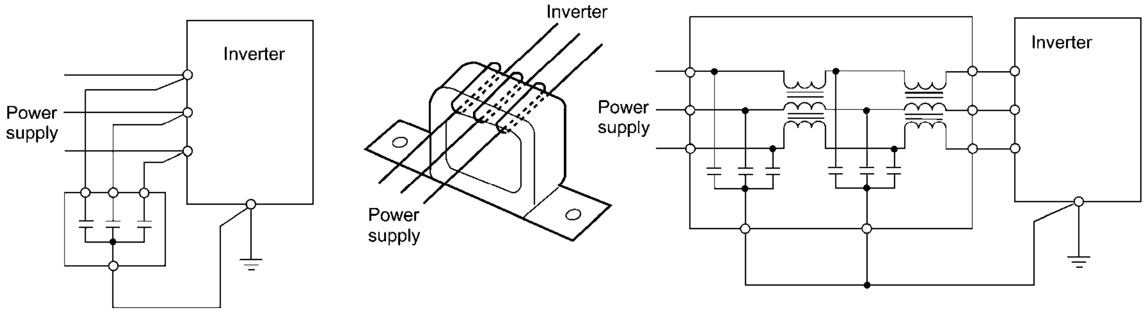
When installing other electronic devices such as a programmable logic controller in the same control panel, be careful with the layout of each device. If necessary, arrange shield plates between the inverter and peripheral devices.

(3) Anti-noise devices

To reduce the noise propagated through the electrical circuits and the noise radiated from the main circuit wiring to the air, a line filter and power supply transformer should be used (refer to Figure A.10).

Line filters are available in these types--the simplified type such as a capacitive filter to be connected in parallel to the power supply line and an inductive filter to be connected in series to the power supply line and the orthodox type such as an LC filter to meet radio noise regulations. Use them according to the targeted effect for reducing noise.

Power supply transformers include common insulated transformers, shielded transformers, and noise-cutting transformers. These transformers have different effectiveness in blocking noise propagation.



(a) Capacitive filter (b) Inductive filter (zero-phase reactor) (c) LC filter

Figure A.10 Various Filters and their Connection

(4) Noise prevention measures at the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter or located near an inverter. Line filters and shielded or twisted shielded wires are used to block the penetration of noise in the signal lines of these devices. The following treatments are also implemented.

1) Lower the circuit impedance by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) Increase the circuit impedance for noise by inserting choke coils in series in the signal circuit or passing signal lines through ferrite core beads. It is also effective to widen the signal base lines (0 V line) or grounding lines.

(5) Other

The level of generating/propagating noise will change with the carrier frequency of the inverter. The higher the carrier frequency, the higher the noise level.

In an inverter whose carrier frequency can be changed, lowering the carrier frequency can reduce the generation of electrical noise and result in a good balance with the audible noise of the motor under driving conditions.

[3] Noise prevention examples

Table A.2 lists examples of the measures to prevent noise generated by a running inverter.

Table A.2 Examples of Noise Prevention Measures

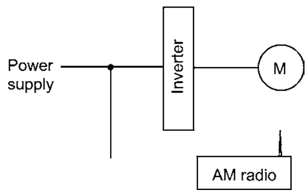
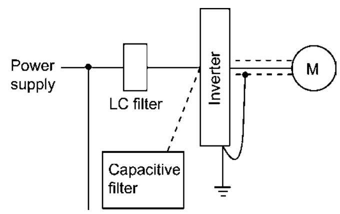
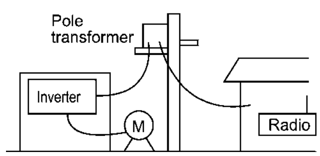
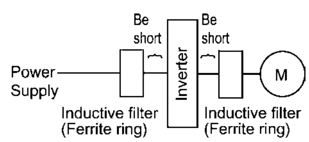
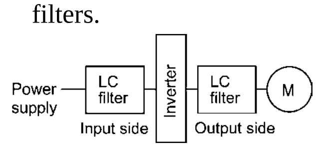
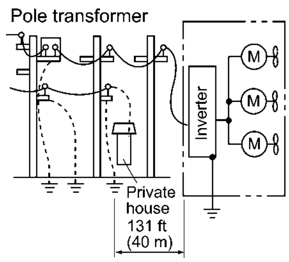
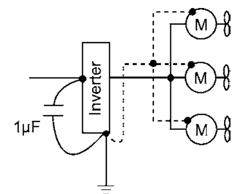
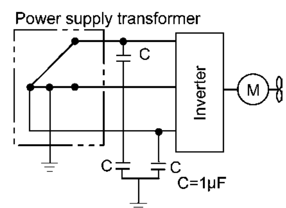
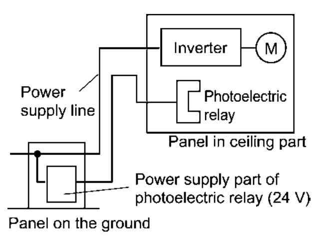
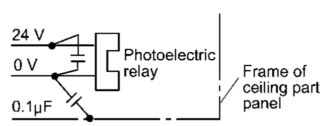
No.	Target device	Phenomena	Noise prevention measures	Notes
1	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive noise radiated from wires at the power supply and output sides of the inverter.	1) Install an LC filter at the power supply side of the inverter. (In some cases, a capacitive filter may be used as a simple method.) 2) Install a metal conduit wiring between the motor and inverter.  Note: Minimize the distance between the LC filter and inverter as short as possible (within 3.3 ft (1 m)).	1) The radiation noise of the wiring can be reduced. 2) The conduction noise to the power supply side can be reduced. Note: Sufficient improvement may not be expected in narrow regions such as between mountains.
2	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive noise radiated from the power line at the power supply side of the inverter.	1) Install inductive filters at the input and output sides of the inverter.  The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. In addition, wiring between the inverter and the zero-phase reactor (or ferrite ring) should be as short as possible. (within 3.3 ft (1 m)) 2) When further improvement is necessary, install LC filters. 	1) The radiation noise of the wiring can be reduced.

Table A.2 Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
3	Telephone (in a common private residence at a distance of 131 ft (40 m))	When driving a ventilation fan with an inverter, noise enters a telephone in a private residence at a distance of 131 ft (40 m).  <Possible cause> A high-frequency leakage current from the inverter and motor flowed to grounded part of the telephone cable shield. During the current's return trip, it flowed through a grounded pole transformer, and noise entered the telephone by electrostatic induction.	1) Connect the ground terminals of the motors in a common connection. Return to the inverter panel, and insert a 1 µF capacitor between the input terminal of the inverter and ground. 	1) The effect of the inductive filter and LC filter may not be expected because of sound frequency component. 2) In the case of a V-connection power supply transformer in a 200V system, it is necessary to connect capacitors as shown in the following figure, because of different potentials to ground. 
4	Photo-electric relay	A photoelectric relay malfunctioned when the inverter runs the motor. [The inverter and motor are installed in the same place (for overhead traveling)]  <Possible cause> It is considered that induction noise entered the photoelectric relay since the inverter's input power supply line and the photoelectric relay's wiring are in parallel separated by approximately 0.98 inch (25 mm) over a distance of 98 to 131 ft (30 to 40 m). Due to conditions of the installation, these lines cannot be separated.	1) As a temporary measure, Insert a 0.1 µF capacitor between the 0 V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and a frame of the overhead panel.  2) As a permanent measure, move the 24 V power supply from the ground to the overhead unit so that signals are sent to the ground side with relay contacts in the ceiling part.	1) The wiring is separated by more than 12 inches (30 cm). 2) When separation is impossible, signals can be received and sent with dry contacts etc. 3) Do not wire low-current signal lines and power lines in parallel.

App.

Table A.2 Continued

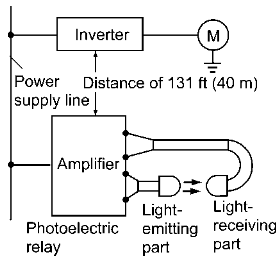
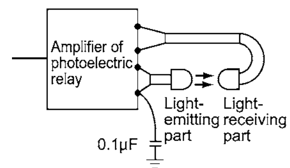
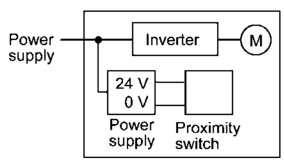
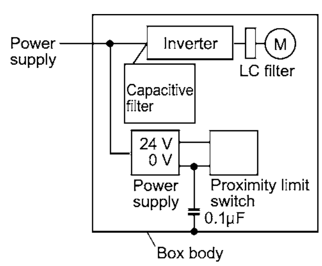
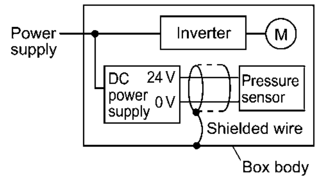
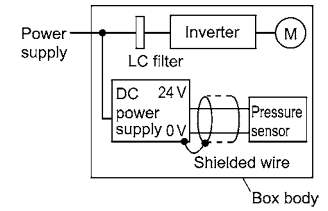
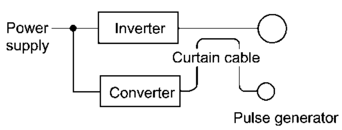
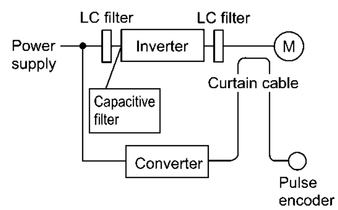
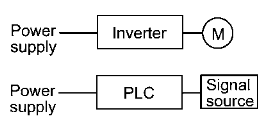
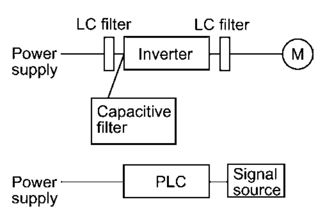
No.	Target device	Phenomena	Noise prevention measures	Notes
5	Photo-electric relay	A photoelectric relay malfunctioned when the inverter was operated.  <Possible cause> Although the inverter and photoelectric relay are separated by a sufficient distance but the power supplies share a common connection, it is considered that conduction noise entered through the power supply line into the photoelectric relay.	1) Insert a 0.1 µF capacitor between the output common terminal of the amplifier of the photoelectric relay and the frame.  	1) If a low-current circuit at the malfunctioning side is observed, the measures may be simple and economical.
6	Prox-imity switch (capaci-tance type)	A proximity switch malfunctioned.  <Possible cause> It is considered that the capacitance type proximity switch is susceptible to conduction and radiation noise because of its low noise immunity.	1) Install an LC filter at the output side of the inverter. 2) Install a capacitive filter at the input side of the inverter. 3) Ground the 0 V (common) line of the DC power supply of the proximity switch through a capacitor to the box body of the machine.  	1) Noise generated in the inverter can be reduced. 2) The switch is superseded by a proximity switch of superior noise immunity (such as a magnetic type).

Table A.2 Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
7	Pressure sensor	A pressure sensor malfunctioned.  <Possible cause> The pressure sensor may malfunction due to noise that came from the box body through the shielded wire.	1) Install an LC filter on the input side of the inverter. 2) Connect the shield of the shielded wire of the pressure sensor to the 0 V line (common) of the pressure sensor, changing the original connection. 	1) The shielded parts of shield wires for sensor signals are connected to a common point in the system. 2) Conduction noise from the inverter can be reduced.
8	Position detector (pulse encoder)	Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.  <Possible cause> Erroneous pulses may be outputted by induction noise since the power line of the motor and the signal line of the PG are bundled together.	1) Install an LC filter and a capacitive filter at the input side of the inverter. 2) Install an LC filter at the output side of the inverter. 	1) This is an example of a measure where the power line and signal line cannot be separated. 2) Induction noise and radiation noise at the output side of the inverter can be reduced.
9	Program mable logic controller (PLC)	The PLC program sometimes malfunctions.  <Possible 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 can be reduced.

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

- Disclaimer: This document provides you with a translated summary of the Guideline of the Ministry of Economy, Trade and Industry. It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Agency of Natural Resource and Energy of Japan published the following two guidelines for suppressing harmonic noise in September 1994.

(1) Guideline for suppressing harmonics in home electric and general-purpose appliances

(2) Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Assuming that electronic devices generating high harmonics will be increasing, these guidelines are to establish regulations for preventing high frequency noise interference on devices sharing the power source. These guidelines should be applied to all devices that are used on the commercial power lines and generate harmonic current. This section gives a description limited to general-purpose inverters.

B.1 Application to general-purpose inverters

[1] Guideline for suppressing harmonics in home electric and general-purpose appliances

Our three-phase, 230 V series inverters of 5 HP or less (FRENIC-MEGA series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

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

We, as before, recommend that you connect a reactor (for suppressing harmonics) to your inverter.

[2] Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Unlike other guidelines, this guideline is not applied to the equipment itself such as a general-purpose inverter, but is applied to each large-scale electric power consumer for total amount of harmonics. The consumer should calculate the harmonics generated from each piece of equipment currently used on the power source transformed and fed from the high or special high voltage source.

(1) Scope of regulation

In principle, the guideline applies to the customers that meet the following two conditions:

- The customer receives high voltage or special high voltage.
- The "equivalent capacity" of the converter load exceeds the standard value for the receiving voltage (50 kVA at a receiving voltage of 6.6 kV).

Appendix B.2 [1] "Calculation of equivalent capacity (Pi)" gives you some supplemental information with regard to estimation for the equivalent capacity of an inverter according to the guideline.

(2) Regulation

The level (calculated value) of the harmonic current that flows from the customer's receiving point out to the system is subjected to the regulation. The regulation value is proportional to the contract demand. The regulation values specified in the guideline are shown in Table B.1.

Appendix B.2 gives you some supplemental information with regard to estimation for the equivalent capacity of the inverter for compliance to "Japanese guideline for suppressing harmonics by customers receiving high voltage or special high voltage."

Table B.1 Upper Limits of Harmonic Outflow Current per kW of Contract Demand (mA/kW)

Receiving voltage	5th	7th	11th	13th	17th	19th	23rd	Over 25th
6.6 kV	3.5	2.5	1.6	1.3	1.0	0.90	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36

(3) When the regulation applied

The guideline has been applied. As the application, the estimation for "Voltage distortion factor" required as the indispensable conditions when entering into the consumer's contract of electric power is already expired.

B.2 Compliance to the harmonic suppression for customers receiving high voltage or special high voltage

When calculating the required matters related to inverters according to the guideline, follow the terms listed below. The following descriptions are based on "Technical document for suppressing harmonics" (JEAG 9702-1995) published by the Japan Electrical Manufacturer's Association (JEMA).

[1] Calculation of equivalent capacity (Pi)

The equivalent capacity (Pi) may be calculated using the equation of (input rated capacity) x (conversion factor). However, catalogs of conventional inverters do not contain input rated capacities, so a description of the input rated capacity is shown below:

(1) "Inverter rated capacity" corresponding to "Pi"

- In the guideline, the conversion factor of a 6-pulse converter is used as reference conversion factor 1. It is, therefore, necessary to express the rated input capacity of inverters in a value including harmonic component current equivalent to conversion factor 1.
- Calculate the input fundamental current I_1 from the kW rating and efficiency of the load motor, as well as the efficiency of the inverter. Then, calculate the input rated capacity as shown below:

$$\text{Input rated capacity} = \sqrt{3} \times (\text{power supply voltage}) \times I_1 \times 1.0228/1000 \ \ (\text{kVA})$$

where 1.0228 is the 6-pulse converter's value of (effective current)/(fundamental current).

- When a general-purpose motor or inverter motor is used, the appropriate value shown in Table B.2 can be used. Select a value based on the kW rating of the motor used, irrespective of the inverter type.

Note: The input rated capacity shown above is for the dedicated use in the equation to calculate capacity of the inverters, following the guideline. Note that the capacity cannot be applied to the reference for selection of the equipment or wires to be used in the inverter input circuits.

For selection of capacity for the peripheral equipment, refer to the catalogs or technical documents issued from their manufacturers.

App.

Table B.2 "Input Rated Capacities" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Pi (kVA)	200 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8
	400 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8

(2) Values of "Ki (conversion factor)"

Depending on whether an optional ACR (AC reactor) or DCR (DC reactor) is used, apply the appropriate conversion factor specified in the appendix to the guideline. The values of the conversion factor are listed in Table B.3.

Table B.3 "Conversion Factors Ki" for General-purpose Inverters Determined by Reactors

Circuit category	Circuit type		Conversion factor Ki	Main applications
3	3-phase bridge (capacitor smoothing)	w/o reactor	K31=3.4	• General-purpose inverters
		w/- reactor (ACR)	K32=1.8	• Elevators
		w/- reactor (DCR)	K33=1.8	• Refrigerators, air conditioning systems
		w/- reactors (ACR and DCR)	K34=1.4	• Other general appliances

Note Some models are equipped with a reactor as a standard accessory.

[2] Calculation of Harmonic Current

(1) Value of "input fundamental current"

- When you calculate the amount of harmonics according to Table 2 in Appendix of the Guideline, you have to previously know the input fundamental current.
- Apply the appropriate value shown in Table B.4 based on the kW rating of the motor, irrespective of the inverter type or whether a reactor is used.

Note If the input voltage is different, calculate the input fundamental current in inverse proportion to the voltage.

Table B.4 "Input Fundamental Currents" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Input fundamental current (A)	200 V	1.62	2.74	5.50	7.92	13.0	19.1	25.6	36.9	49.8	61.4
	400 V	0.81	1.37	2.75	3.96	6.50	9.55	12.8	18.5	24.9	30.7
6.6 kV converted value (mA)		49	83	167	240	394	579	776	1121	1509	1860

(2) Calculation of harmonic current

Usually, calculate the harmonic current according to the Sub-table 3 "Three-phase bridge rectifier with the smoothing capacitor" in Table 2 of the Guideline's Appendix. Table B.5 lists the contents of the Sub-table 3.

Table B.5 Generated Harmonic Current (%), 3-phase Bridge Rectifier (Capacitor Smoothing)

Degree	5th	7th	11th	13th	17th	19th	23rd	25th
w/o a reactor	65	41	8.5	7.7	4.3	3.1	2.6	1.8
w/- a reactor (ACR)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
w/- a reactor (DCR)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
w/- reactors (ACR and DCR)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

- ACR: 3%
- DCR: Accumulated energy equal to 0.08 to 0.15 ms (100% load conversion)
- Smoothing capacitor: Accumulated energy equal to 15 to 30 ms (100% load conversion)
- Load: 100%

Calculate the harmonic current of each degree using the following equation:

$$\text{nth harmonic current (A)} = \text{Fundamental current (A)} \times \frac{\text{Generated nth harmonic current (\%)}}{100}$$

(3) Maximum availability factor

- For a load for elevators, which provides intermittent operation, or a load with a sufficient designed motor rating, reduce the current by multiplying the equation by the "maximum availability factor" of the load.
- The "maximum availability factor of an appliance" means the ratio of the capacity of the harmonic generator in operation at which the availability reaches the maximum, to its total capacity, and the capacity of the generator in operation is an average for 30 minutes.
- In general, the maximum availability factor is calculated according to this definition, but the standard values shown in Table B.6 are recommended for inverters for building equipment.

Table B.6 Availability Factors of Inverters, etc. for Building Equipment (Standard Values)

Equipment type	Inverter capacity category	Single inverter availability
Air conditioning system	200 kW or less	0.55
	Over 200 kW	0.60
Sanitary pump	———	0.30
Elevator	———	0.25
Refrigerator, freezer	50 kW or less	0.60
UPS (6-pulse)	200 kVA	0.60

Correction coefficient according to contract demand level

Since the total availability factor decreases if the scale of a building increases, calculating reduced harmonics with the correction coefficient β defined in Table B.7 is permitted.

Table B.7 Correction Coefficient according to the Building Scale

Contract demand (kW)	Correction coefficient β
300	1.00
500	0.90
1000	0.85
2000	0.80

Note: If the contract demand is between two specified values listed in Table B.7, calculate the value by interpolation.

Note: The correction coefficient β is to be determined as a matter of consultation between the customer and electric power company for the customers receiving the electric power over 2000 kW or from the special high voltage lines.

(4) Degree of harmonics to be calculated

The higher the degree of harmonics, the lower the current flows. This is the property of harmonics generated by inverters so that the inverters are covered by "The case not causing a special hazard" of the term (3) in the above Appendix for the 9th or higher degrees of the harmonics.

Therefore, "It is sufficient that the 5th and 7th harmonic currents should be calculated."

[3] Examples of calculation

(1) Equivalent capacity

Example of loads	Input capacity and No. of inverters	Conversion factor	Equivalent capacity
[Example 1] 400 V, 3.7 kW, 10 units w/- AC reactor and DC reactor	4.61 kVA × 10 units	K32 = 1.4	4.61 × 10 × 1.4 = 64.54 kVA
[Example 2] 400 V, 1.5 kW, 15 units w/- AC reactor	2.93 kVA × 15 units	K34 = 1.8	2.93 × 15 × 1.8 = 79.11 kVA
	Refer to Table B.2.	Refer to Table B.3.	

(2) Harmonic current every degrees

[Example 1] 400 V, 3.7 kW 10 units, w/- AC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 10 = 3940 3940 × 0.55 = 2167	5th (38%)	7th (14.5%)	11th (7.4%)	13th (3.4%)	17th (3.2%)	19th (1.9%)	23rd (1.7%)	25th (1.3%)
	823.5	314.2						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

[Example 2] 400 V, 3.7 kW, 15 units, w/- AC reactor and DC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 15 = 5910 5910 × 0.55 = 3250.5	5th (28%)	7th (9.1%)	11th (7.2%)	13th (4.1%)	17th (3.2%)	19th (2.4%)	23rd (1.6%)	25th (1.4%)
	910.1	295.8						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

App.

App. C Effect on Insulation of General-purpose Motors Driven with 400 V Class Inverters

- Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (March, 1995). It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Preface

When an inverter drives a motor, surge voltages generated by switching the inverter elements are superimposed on the inverter output voltage and applied to the motor terminals. If the surge voltages are too high they may have an effect on the motor insulation and some cases have resulted in damage.

For preventing such cases this document describes the generating mechanism of the surge voltages and countermeasures against them.

Refer to A.2 [1] "Inverter noise" for details of the principle of inverter operation.

C.1 Generating mechanism of surge voltages

As the inverter rectifies a commercial power source voltage and smoothes into a DC voltage, the magnitude E of the DC voltage becomes about $\sqrt{2}$ times that of the source voltage (about 620 V in case of an input voltage of 440 VAC). The peak value of the output voltage is usually close to this DC voltage value.

But, as there exists inductance (L) and stray capacitance (C) in wiring between the inverter and the motor, the voltage variation due to switching the inverter elements causes a surge voltage originating in LC resonance and results in the addition of high voltage to the motor terminals. (Refer to Figure C.1)

This voltage sometimes reaches up to about twice that of the inverter DC voltage (620 V x 2 = approximately 1,200 V) depending on a switching speed of the inverter elements and wiring conditions.

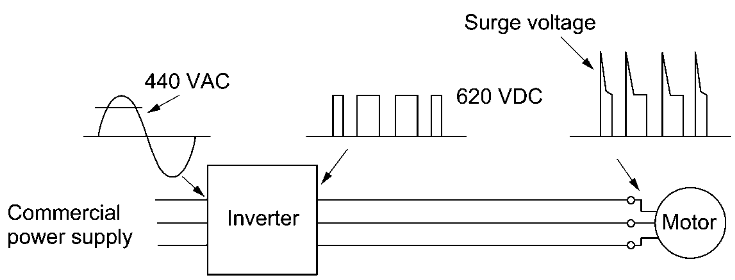
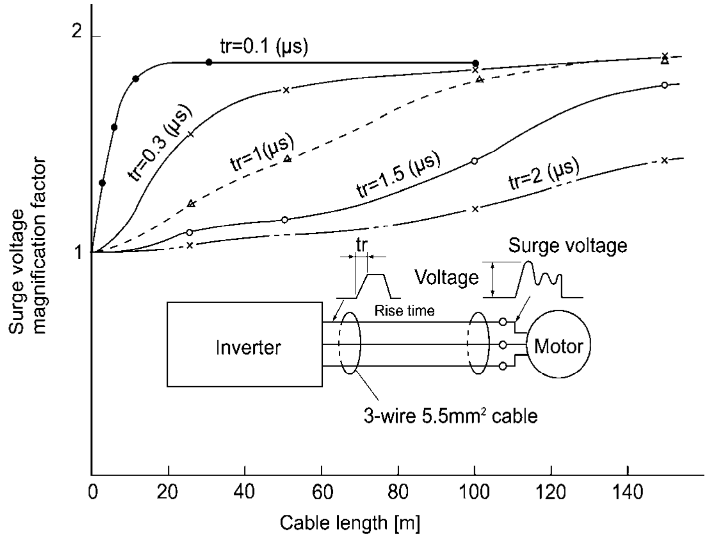


Figure C.1 Voltage Waveform of Individual Portions

A measured example in Figure C.2 illustrates the relation of a peak value of the motor terminal voltage with a wiring length between the inverter and the motor.

From this it can be confirmed that the peak value of the motor terminal voltage ascends as the wiring length increases and becomes saturated at about twice the inverter DC voltage.

The shorter a pulse rise time becomes, the higher the motor terminal voltage rises even in the case of a short wiring length.



IGBT corresponds to
tr = 0.1 to 0.3 μs.

Bipolar transistor corresponds to
tr = 0.3 to 1 μs.

The case when an output reactor and/or a filter are inserted corresponds to
tr > 1 μs.

Surge voltage magnification factor :
Magnification factor against DC voltage E

Excerpt from [J. IEE Japan, Vol. 107, No. 7, 1987]

Figure C.2 Measured Example of Wiring Length and Peak Value of Motor Terminal Voltage

C.2 Effect of surge voltages

The surge voltages originating in LC resonance of wiring may be applied to the motor terminals and depending on their magnitude sometimes cause damage to the motor insulation.

When the motor is driven with a 200 V class inverter, the dielectric strength of the insulation is no problem since the peak value at the motor terminal voltage increases twice due to the surge voltages (the DC voltage is only about 300 V).

But in case of a 400 V class inverter, the DC voltage is approximately 600 V and depending on the wiring length, the surge voltages may greatly increase and sometimes result in damage to the insulation.

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C.3 Countermeasures against surge voltages

When driving a motor with a 400 V class inverter, the following are countermeasures against damage to the motor insulation by the surge voltages.

[1] Suppressing surge voltages

There are two ways for suppressing the surge voltages, one is to reduce the voltage rise time and another is to reduce the voltage peak value.

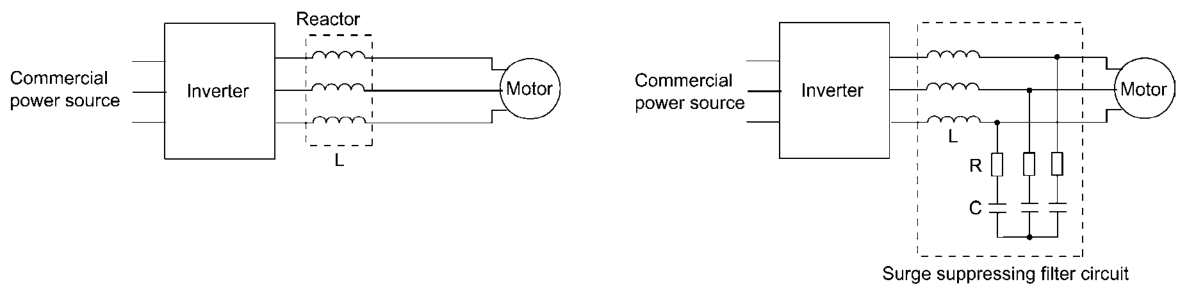
(1) Output reactor

If wiring length is relatively short, the surge voltages can be suppressed by reducing the voltage rise time (dv/dt) with the installation of an AC reactor on the output side of the inverter. (Refer to Figure C.3 (1).)

However, if the wiring length becomes long, suppressing the peak voltage due to surge voltage may be difficult.

(2) Output filter

Installing a filter on the output side of the inverter allows a peak value of the motor terminal voltage to be reduced. (Refer to Figure C.3 (2).)



(1) Output reactor (2) Output filter

Figure C.3 Method to Suppress Surge Voltage

Tip If the wiring length between the inverter and the motor is comparatively long, the crest value of the surge voltage can be suppressed by connecting a surge suppressor unit (SSU) to the motor terminal. For details, refer to Chapter 4, Section 4.4.1.5 "Surge suppression unit (SSU)."

[2] Using motors with enhanced insulation

Enhanced insulation of a motor winding allows its surge withstanding to be improved.

C.4 Regarding existing equipment

[1] In case of a motor being driven with 400 V class inverter

A survey over the last five years on motor insulation damage due to the surge voltages originating from switching of inverter elements shows that the damage incidence is 0.013% under the surge voltage condition of over 1,100 V and most of the damage occurs several months after commissioning the inverter. Therefore there seems to be little probability of occurrence of motor insulation damage after a lapse of several months of commissioning.

[2] In case of an existing motor driven using a newly installed 400 V class inverter

We recommend suppressing the surge voltages with the ways shown in Section C.3.

App. D Inverter Generating Loss

The table below lists the inverter generating loss.

Power supply voltage	Inverter type	Generating loss (W)				
		LD mode		MD mode	HD mode	
		Low carrier frequency	High carrier frequency	Low carrier frequency	Low carrier frequency	High carrier frequency
Three-phase 230 V	FRNF50G1S-2U	35	45	-	35	45
	FRN001G1S-2U	50	60	-	50	60
	FRN002G1S-2U	80	110	-	80	110
	FRN003G1S-2U	110	140	-	110	140
	FRN005G1S-2U	170	210	-	170	210
	FRN007G1■-2U	290	370	-	240	310
	FRN010G1■-2U	290	370	-	240	310
	FRN015G1■-2U	410	550	-	300	415
	FRN020G1■-2U	500	670	-	450	620
	FRN025G1■-2U	630	840	-	540	700
	FRN030G1■-2U	770	970	-	660	860
	FRN040G1■-2U	1120	1250 *1	-	790	1040
	FRN050G1■-2U	1650	1750 *1	-	1300	1450
	FRN060G1■-2U	1650	1850 *1	-	1300	1550
	FRN075G1■-2U	1850	1950 *1	-	1450	1600
	FRN100G1■-2U	2250	2400 *1	-	1750	1900
	FRN125G1S-2U	2700	2800 *2	-	2300	2550 *1
	FRN150G1S-2U	3250	3350 *2	-	2750	3050 *1
Three-phase 460 V	FRNF50G1S-4U	35	60	-	35	60
	FRN001G1S-4U	45	80	-	45	80
	FRN002G1S-4U	60	110	-	60	110
	FRN003G1S-4U	80	140	-	80	140
	FRN005G1S-4U	130	230	-	130	230
	FRN007G1■-4U	210	370	-	170	300
	FRN010G1■-4U	210	370	-	170	300
	FRN015G1■-4U	300	520	-	230	400
	FRN020G1■-4U	360	610	-	300	520
	FRN025G1■-4U	460	770	-	360	610
	FRN030G1■-4U	510	870	-	440	770
	FRN040G1■-4U	710	1310 *1	-	510	900
	FRN050G1■-4U	1000	1250 *1	-	800	1150
	FRN060G1■-4U	1250	1550 *1	-	1000	1450
	FRN075G1■-4U	1350	1700 *1	-	1100	1600
	FRN100G1■-4U	1950	2400 *1	-	1350	1950
	FRN125G1S-4U	2000	2250 *2	-	1600	2150 *1
	FRN150G1S-4U	2250	2550 *2	2250	1900	2600 *1
	FRN200G1S-4U	2700	3050 *2	2700	2300	3050 *1
	FRN250G1S-4U	3050	3400 *2	3050	2500	3300 *1
	FRN300G1S-4U	3900	4350 *2	3900	3100	4000 *1
	FRN350G1S-4U	4250	4750 *2	4250	3850	5000 *1
	FRN450G1S-4U	5600	6200 *2	4850	4350	5600 *1
	FRN500G1S-4U	6500	7300 *2	5850	5300	6900 *1
	FRN600G1S-4U	7500	8350 *2	6650	6000	7800 *1
	FRN700G1S-4U	8100	9100 *2	7250	6450	8450 *1
	FRN800G1S-4U	9200	10350 *2	8250	7350	9650 *1
	FRN900G1S-4U	11550	12950 *2	-	9600	10700 *2
	FRN1000G1S-4U	13500	13800 *3	-	11900	13300 *2

Note: A box (■)in the above table replaces S or H depending on the enclosure.

Low carrier: 2 kHz

High carrier: 40 HP or below: 16 kHz (*1: 10 kHz)
50 HP or above: 15 kHz (*1: 10 kHz, *2: 6 kHz, *3: 4 kHz)

App. E Conversion from SI Units

All expressions given in Chapter 3, "SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES" are based on SI units (International System of Units). This section explains how to convert expressions to other units.

[1] Conversion of units

(1) Force

- 1 (kgf) ≈ 9.8 (N)
- 1 (N) ≈ 0.102 (kgf)

(2) Torque

- 1 (kgf·m) ≈ 9.8 (N·m)
- 1 (N·m) ≈ 0.102 (kgf·m)

(3) Work and energy

- 1 (kgf·m) ≈ 9.8 (N·m) = 9.8 (J) = 9.8 (W·s)

(4) Power

- 1 (kgf·m/s) ≈ 9.8 (N·m/s) = 9.8 (J/s) = 9.8 (W)
- 1 (N·m/s) ≈ 1 (J/s) = 1 (W) ≈ 0.102 (kgf·m/s)

(5) Rotation speed

- $1\,(\text{r/min}) = \frac{2\pi}{60}\,(\text{rad/s}) \approx 0.1047\,(\text{rad/s})$
- $1\,(\text{rad/s}) = \frac{60}{2\pi}\,(\text{r/min}) \approx 9.549\,(\text{r/min})$

(6) Inertia constant

$J\,(kg\cdot m^2)$: moment of inertia

$GD^2\,(kg\cdot m^2)$: flywheel effect

- $GD^2 = 4\,J$
- $J = \frac{GD^2}{4}$

(7) Pressure and stress

- 1 (mmAq) ≈ 9.8 (Pa) ≈ 9.8 (N/m^2)
- 1(Pa) ≈ 1(N/m^2) ≈ 0.102 (mmAq)
- 1 (bar) ≈ 100000 (Pa) ≈ 1.02 ($kg\cdot cm^2$)
- 1 ($kg\cdot cm^2$) ≈ 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

- $P\ (W) \approx \frac{2\pi}{60} \cdot N\ (r/min) \cdot \tau\ (N \cdot m)$
- $P\ (W) \approx 1.026 \cdot N\ (r/min) \cdot T\ (kgf \cdot m)$
- $\tau\ (N \cdot m) \approx 9.55 \cdot \frac{P\ (W)}{N\ (r/min)}$
- $T\ (kgf \cdot m) \approx 0.974 \cdot \frac{P\ (W)}{N\ (r/min)}$

(2) Kinetic energy

- $E\ (J) \approx \frac{1}{182.4} \cdot J\ (kg \cdot m^2) \cdot N^2\ [(r/min)^2]$
- $E\ (J) \approx \frac{1}{730} \cdot GD^2\ (kg \cdot m^2) \cdot N^2\ [(r/min)^2]$

(3) Torque of linear moving load

Driving mode

- $\tau\ (N \cdot m) \approx 0.159 \cdot \frac{V\ (m/min)}{N_M\ (r/min) \cdot \eta_G} \cdot F\ (N)$
- $T\ (kgf \cdot m) \approx 0.159 \cdot \frac{V\ (m/min)}{N_M\ (r/min) \cdot \eta_G} \cdot F\ (kgf)$

Braking mode

- $\tau\ (N \cdot m) \approx 0.159 \cdot \frac{V\ (m/min)}{N_M\ (r/min) / \eta_G} \cdot F\ (N)$
- $T\ (kgf \cdot m) \approx 0.159 \cdot \frac{V\ (m/min)}{N_M\ (r/min) / \eta_G} \cdot F\ (kgf)$

(4) Acceleration torque

Driving mode

- $\tau\ (N \cdot m) \approx \frac{J\ (kg \cdot m^2)}{9.55} \cdot \frac{\Delta N\ (r/min)}{\Delta t\ (s) \cdot \eta_G}$
- $T\ (kgf \cdot m) \approx \frac{GD^2\ (kg \cdot m^2)}{375} \cdot \frac{\Delta N\ (r/min)}{\Delta t\ (s) \cdot \eta_G}$

Braking mode

- $\tau\ (N \cdot m) \approx \frac{J\ (kg \cdot m^2)}{9.55} \cdot \frac{\Delta N\ (r/min) \cdot \eta_G}{\Delta t\ (s)}$
- $T\ (kgf \cdot m) \approx \frac{GD^2\ (kg \cdot m^2)}{375} \cdot \frac{\Delta N\ (r/min) \cdot \eta_G}{\Delta t\ (s)}$

(5) Acceleration time

- $t_{ACC}\ (s) \approx \frac{J_1 + J_2 / \eta_G\ (kg \cdot m^2)}{\tau_M - \tau_L / \eta_G\ (N \cdot m)} \cdot \frac{\Delta N\ (r/min)}{9.55}$
- $t_{ACC}\ (s) \approx \frac{GD_1^{\ 2} + GD_2^{\ 2} / \eta_G\ (kg \cdot m^2)}{T_M - T_L / \eta_G\ (kgf \cdot m)} \cdot \frac{\Delta N\ (r/min)}{375}$

(6) Deceleration time

- $t_{DEC}\ (s) \approx \frac{J_1 + J_2 \cdot \eta_G\ (kg \cdot m^2)}{\tau_M - \tau_L \cdot \eta_G\ (N \cdot m)} \cdot \frac{\Delta N\ (r/min)}{9.55}$
- $t_{DEC}\ (s) \approx \frac{GD_1^{\ 2} + GD_2^{\ 2} \cdot \eta_G\ (kg \cdot m^2)}{T_M - T_L \cdot \eta_G\ (kgf \cdot m)} \cdot \frac{\Delta N\ (r/min)}{375}$

Glossary

This glossary explains the technical terms that are frequently used in this manual.

Acceleration time

A period required for an inverter to increase its output from 0 Hz to the maximum frequency. It should be specified, taking into account the inertia of the machinery (load).

Related function codes: F03, A01, b01, r01, F07, E10, E12, E14 and H54

Alarm output (for any alarm)

A signal issued when any of the protective functions is activated.

Allowable voltage/frequency fluctuation

General-purpose inverters are designed to be supplied with power from commercial power lines. The allowable voltage/frequency fluctuation ranges are specified (see Chapter 2, Section 2.1). Even power supplied by a private power generator should meet the power requirements.

Analog input

An external voltage or current input to give the inverter a frequency command through any of terminals [12], [C1] and [V2]. Assignment of functions to these terminals can be changed using function codes.

Related function codes: E61 to E63

Anti-regenerative control
(Automatic deceleration)

A control mode that prevents the inverter from causing an overvoltage trip due to excessive regenerative energy, by automatically controlling the deceleration time and output frequency, even if no braking resistor is used.

Related function codes: H69

Auto energy saving operation

Energy saving operation that automatically controls the output voltage to the motor in order to minimize the total power loss of the motor and the inverter.

Related function codes: F37, A13, b13 and r13

Auto search

Automatically searching for the rotational speed and direction of the motor idling without power supplied in order for the inverter to smoothly drive the idling motor again.

Related function codes: H09, H46 and H49

Auto-reset function

A function that makes the inverter automatically attempt to reset the tripped state and restart even if any protective function is activated. The number of reset times and interval can be specified with function codes.

Related function codes: H04 and H05

Auto-tuning

Automatically tuning up the inverter itself by detecting the constants of the connected motor and saving the motor parameters in the inverter. Auto-tuning is started by the keypad operation.

Related function codes: P04, A18, b18 and r18

Auxiliary power input for the control circuit

A general-purpose inverter usually supplies its control circuit with power from the DC link bus. In a panel that shuts down the power if the inverter trips, therefore, the panel display disappears with the trip. The auxiliary power input is used to keep the panel display.

AVR (Automatic Voltage Regulator)

Voltage regulator that keeps the inverter output voltage constant regardless of input voltage fluctuations.

Balanceless-bumpless switching

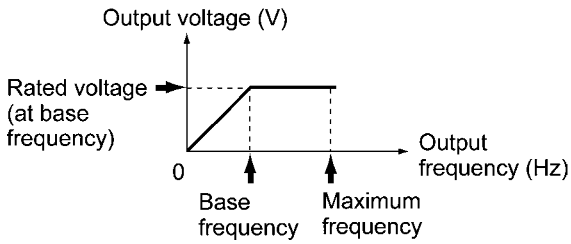
To switch the frequency command source to the keypad from any other source, in which the inverter inherits the current frequency that has applied before switching. This switching provides smooth switching and shockless running

Related function codes: F01 and C30

Base frequency

The minimum frequency at which an inverter's output voltage becomes constant.

Related function codes: F04, A02, b02 and r02



Bias

Bias that is a value to be added to an analog frequency command value (e.g., 0 to 10 VDC) to produce the output frequency. It applies to the frequency control signal voltage from the upper level controller.

Related function codes: F18 and C50 to C52

Braking torque

Generally, a motor acts as a generator during a decelerate-to-stop sequence, where the kinetic energy built up in the machinery (load) is transformed into electric power and returned to the inverter. The inverter consumes the returned power to generate a braking torque.

Carrier frequency

Frequency used to determine the modulation period of a pulse width under the inverter's PWM control. The higher the carrier frequency, the closer to the sinusoidal waveform the inverter output current waveform approaches and the quieter the motor sound becomes. However, noise emitted from the inverter increases.

Related function codes: F26

Coast-to-stop command (***BX***)

A digital terminal command input to one of the control circuit terminals, which forces the inverter to immediately shut down its output, causing the motor to coast to a stop. Used to forcibly stop the motor independent of inverter control.

Related function codes: E01 to E07, E98 and E99

Constant torque load

Machinery (load) that requires a constant torque independent of the inverter's output frequency (motor speed). The power consumption increases in proportion to the motor speed. For such machinery (load), e.g., a material conveyer and a lift, the HD-mode inverters are required.

Control circuit terminals

Terminals mainly used to connect to signal lines from a PLC or control relay circuits. Inverters with any capacity have these terminals in common. These terminals include an analog output terminal for a conventional analog meter and a pulse output terminal.

Cooling fan ON/OFF control

A control that automatically turns the cooling fan ON and OFF depending on the temperature detected inside the inverter, saving unnecessary cooling fan operations.

Related function codes: H06

Current limiter

A control that limits the inverter output current to a specified level by varying the output frequency.

Related function codes: F43 and F44

Current response

A performance index under vector control, which indicates how often the inverter can change the direction of current to the motor. If this index is 100 Hz, it means that the current direction change command is applicable 100 times a second.

Customizable logic function

A function that allows the user to form a logic circuit for digital input/output signals, customize those signals arbitrarily, and configure a simple relay sequence inside the inverter. In a customizable logic, one step (component) is composed of "2 inputs and 1 output + logical operation (including timer)" and a total of ten steps can be used to configure a sequence.

DC braking

DC current braking that flows a DC current through the motor stator windings to generate a magneto electric loss of the rotor. Used to firmly stop the motor when the load has a large moment of inertia and a low friction torque.

Related function codes: F20, A09, b09, r09, F21, A10, b10, r10, F22, A11, b11 and r11

DC link bus voltage

The voltage of the DC link bus that is an inverter input circuit to convert the input AC power to the DC power. It is approx. 1.4 times the input power voltage and is used as a reference voltage in detecting an undervoltage or overvoltage condition. It can be monitored on the keypad.

Deceleration time

A period required for an inverter to decelerate its output from the maximum frequency to 0 Hz.

Related function codes: F03, A01, b01, r01, F08, E11, E13, E15 and H55

Droop control

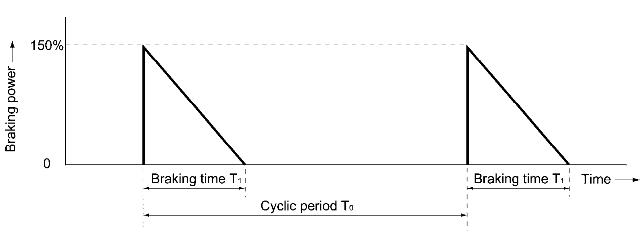
A control that reduces the inverter’s output frequency depending on the motor’s load factor. When the machinery (load) is driven by two or more inverter-driven motors, this control helps the inverters balance their driving forces.

Related function codes: H28

Duty cycle (%ED)

Obtained by dividing the braking time by the cyclic period.

$$\text{Duty cycle \%ED} = \frac{T1}{T0} \times 100\ (\%)$$



Dynamic torque vector control

A high performance control system in which the inverter calculates the flux and torque vectors based on the real-time voltage and current applied to the motor power terminals. Its basic control is V/f control.

Electronic thermal overload protection

A function that protects the motor from overheating with internal electronic calculation, without using a thermistor or any other thermal sensors on the motor.

Related function codes: F10 to F12

EMC (Electromagnetic Compatibility)

Electromagnetic noninterference and immunity that electrical equipment has.

The electromagnetic noninterference means that electrical equipment works without creating a certain level of electromagnetic disturbances (electromagnetic interference EMI) that would interfere with the operation of other equipment or affect human health.

The electromagnetic immunity means that electrical equipment has a certain level of electromagnetic susceptibility EMS so that it is susceptible to interfering electromagnetic waves coming from other electrical equipment in the vicinity to work without suffering EMI.

Enable data change with keypad (***WE-KP***)

A digital terminal command input to one of the control circuit terminals, which protects function code data from accidentally getting changed from the keypad when this command is OFF in order to prevent the motor from unexpectedly running.

Turning this command ON enables data change from the keypad.

Related function codes: E01 to E07, E98 and E99

Encoder (PG: pulse generator)

One type of rotational sensor, directly mounted on the output shaft of a vector motor. It generally outputs A and B phase signals. According to these signals, the inverter can detect the motor rotational direction, speed and amount. Using the encoder requires an optional PG interface card (OPC-G1-PG) on the inverter.

Filter

A filter that smoothens and cleans a signal, eliminating unnecessary frequency band. Applying a filter will produce a desirable effect in some cases:

- Suppressing fluctuation of unstable, hard-to-read display on the keypad (F42).
- Suppressing noise superimposed on analog input for frequency command (C33, C38 and C43).
- Stabilizing analog speed command and feedback signal (d01, d02, d09, d10 and d61).

Frequency accuracy

An index that indicates the accuracy of inverter output frequency relative to the commanded frequency. If the frequency command is given digitally from the keypad, the accuracy will be ±0.01% of the maximum frequency.

Frequency command

Reference frequency whose sources can be specified by function code F01. In addition, it can be given by multi-frequency commands and via an RS-485 communications link or other open networks.

Frequency command resolution

Resolution of a frequency command given in an analog input format such as a voltage input. The resolution of terminal [12] input, for example, is 1/3000 of the maximum frequency.

Frequency limiter

A function that determines the upper and lower limits of the inverter output frequency to protect the motor. Accordingly, it protects the machinery (load) from getting unexpected frequency command.

Related function codes: F15 and F16

HD (High Duty) mode

A mode that applies to the inverter for driving a motor whose capacity is identical to the inverter's one. The HD-mode inverter withstands 150% of the rated current for a minute, and 200% for three seconds.

Related function codes: H80

Interphase (voltage) unbalance

Interphase unbalance of three-phase AC input voltage (supply voltage) that is calculated by the following expression stipulated by the IEC Standard.

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

The IEC Standard requires variable speed drives such as inverters to withstand up to 2% of interphase voltage unbalance.

Inverse operation

Inverting the scale of the inverter's output frequency to its analog frequency command level. Used for applications such as air-conditioners that require switching between cooling and heating.

Related function codes: C53

Jogging operation

Inching the motor for mechanical positioning in the machinery (load). The frequency command, acceleration/deceleration time and dynamic response during the vector control can be separately specified.

Related function codes: C20

Jump frequencies

Jump frequencies that are used to skip inverter operation in the specified jump frequency bands within the driving frequency band in order to avoid resonance caused by the motor speed and natural frequency of the machinery. In the jump frequency bands, the specified acceleration/ deceleration time applies.

Related function codes: C01 to C04

LD (Low Duty) mode

A mode that applies to the inverter for driving a motor whose capacity is one or two ranks higher than the inverter's one. The LD-mode inverter withstands 120% of the rated current for a minute.

Related function codes: H80

Line speed

Traveling speed of a machine (e.g., conveyor) driven by the inverter-driven motor. The unit is meter per minute (m/min). The speed can be displayed on the keypad.

Related function codes: E43 and E50

Link function

A function that starts or stops the inverter through a communications link such as RS-485 interface or other open network, without using the keypad or digital input terminal signals.

Related function codes: H30, y98 and y99

Main circuit terminals

Power input/output terminals mainly used to connect to commercial power lines, braking resistors, DC reactors and motors. The size and other specifications of the terminals differ depending on the inverter capacity.

Maximum frequency

The maximum output frequency of an inverter. It equals to the reference frequency when the +10V input applies on terminal [12] or the 20 mA input applies on terminal [C1] if the gain is set at 100%.

Related function codes: F03, A01, b01 and r01

MD (Medium Duty) mode

A mode that applies to the inverter for driving a motor whose capacity is one rank higher than the inverter's one. The MD-mode inverter withstands 150% of the rated current for a minute.

Related function codes: H80

Mock alarm

Alarm intentionally caused by activating the inverter protective function in order to check whether external sequences function correctly at the time of machine setup.

Simultaneous keying or using the related function code causes a mock alarm. The mock alarm can be reset by the terminal command ***RST***.

Related function codes: H45

Motor selection

A general-purpose inverter can drive more than one motor by switching. A FRENIC-MEGA inverter can drive up to four motors by switching with terminal commands ***M2***, ***M3*** and ***M4***. It is also possible to register four sets of motor drive data, including base frequencies, drive controls and numbers of poles.

Related function codes: E01 to E07

Multi-frequency selection

Selection from 15 steps of reference frequencies that can be switched by digital terminal command input to the control circuit terminals.

Those 15 steps of frequencies should be preset with function codes C05 to C19.

Related function codes: E01 to E07, E98 and E99

Nominal applied motors

Three-phase induction motors (4-pole) that can be normally driven by the inverter. The output ratings are expressed in HP as listed in the specification tables.

Output circuit filter

An output circuit filter that is used to eliminate noise leakages from the inverter main output cable when the cable length between the inverter and the motor is long or when an inverter drives two or more motors so that the total cable length is long.

Overload capability

Index that indicates how much overload conditions the inverter can tolerate. It is expressed in a combination of the output current level (%) and the period, assuming the rated current as 100%. For instance, it is 150% for 1 minute in HD mode, and 120% for 1 minute in LD mode.

Overload current rating

The overload current that the inverter can tolerate, expressed in percentage of the rated output current level and its permissible period.

Overload prevention control

A function that detects inverter's heat sink overheat or overload and lowers the output frequency before the inverter trips, thus preventing the protective function from being activated. Useful for equipment such as pumps in which a decrease in the output frequency leads to a decrease in the load.

Related function codes: H70

PLC signal power (Terminal [PLC])

Name of an external power input terminal that connects to a PLC (programmable logic controller) output signal power supply. Also used to supply power to the load connected to the transistor output terminals.

Positioning control

Positioning control under which the inverter detects the rotational amount of the encoder to control that of the motor shaft. Under the speed control, the inverter controls the rotational speed of the motor shaft using the speed sensor.

The "Positioning control," implies the traveling distance of machinery (load) driven by the motor.

Pulse train input

Pulse train input that the inverter can use as a frequency command or speed command. It is a digital signal, enabling control with less thermal drift.

Related function codes: d59, d62 and d63

Rated capacity

The rating of an inverter output capacity, or the apparent power obtained by multiplying the rated output voltage by the rated output current.

Rated output current

An RMS current that flows through the inverter's output terminals under the rated output conditions (that is, when the output voltage, current, frequency and load factor meet the rated conditions).

The 230 V series of inverters is designed so that the rated output current is higher than that of a 200 V, 6-pole motor; the 460 V series is designed so that it is higher than that of a 380 V, 50 Hz, 4-pole motor.

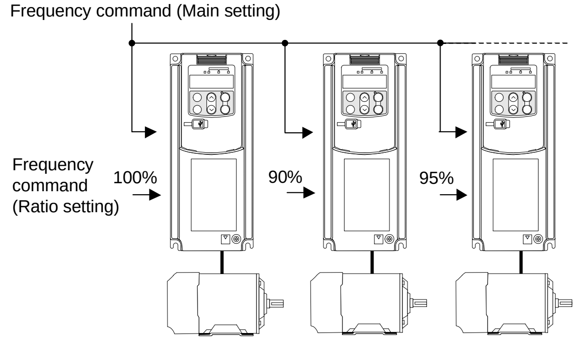
Rated output voltage

An RMS voltage of a fundamental wave that is generated across the inverter's output terminals when the output frequency is equal to the base frequency.

Ratio operation

Ratio operation in which two or more inverters share a same frequency command (main setting) and an individual inverter multiplies the given frequency command by the ratio (%) specified by one of the analog input terminal extended functions so that individual inverters run at different output frequencies.

Related function codes: E61 to E63



$$\text{Frequency command} = \text{Main setting} \times \frac{\text{Ratio setting}}{100\%}$$

Required power supply capacity

The capacity required of a power supply for an inverter. This is calculated by solving either of the following equations and is stated in kVA.

Required power supply capacity (kVA)
$= \sqrt{3} \times 230 \times$ Input RMS current (230 V, 50 Hz)

Required power supply capacity (kVA)
$= \sqrt{3} \times 460 \times$ Input RMS current (460 V, 50 Hz)

Servo-lock

Holding the current position of the motor shaft at the stopped state in servo system under vector control with speed sensor, even if any external force is applied to the motor shaft.

Simultaneous keying

To simultaneously press two keys on the keypad, which is required for enabling some special keypad operations.

SINK or SOURCE

To switch the digital input modes between SINK and SOURCE with the hardware switch.

SINK mode, in which short-circuiting a digital input terminal with the common [CM] terminal transmits an input signal.

SOURCE mode, in which externally applying voltage signal (24 VDC) to a digital input terminal transmits an input signal.

Slip compensation

To compensate for decrease in motor rotation that is caused by slip of an induction motor, by increasing the inverter's output frequency in proportion to the increase of load torque.

Related function codes: P12

Speed control

Motor drive control that applies to a motor equipped with a speed sensor. The inverter controls the motor speed based on the actual speed detected by the speed sensor mounted on the motor shaft. (Ordinarily, an inverter controls the motor speed at a frequency.)

Related function codes: d01 to d04

Speed control accuracy

An index to show the stability of the motor shaft rotational speed relative to a given speed command under speed control. It is expressed in percentage (%) of the maximum frequency or the rated rotational speed (base speed) of the motor.

Speed control range

An index to show the controllable speed range relative to the rated motor speed (base speed). It is expressed by a ratio, for example, 1:1500 that means the inverter is able to control the motor speed to 1/1500 of the rated speed.

Speed response

A performance index in speed control, which shows how many times the inverter can change the motor shaft rotational speed with commands in one second. If this index is 100 Hz, for instance, it means that the inverter can respond to up to 100 speed commands per second.

Standard motor

Fuji standard motors (8-, 6- and 9-series) which the inverter can drive by just configuring function codes P99, A39, b39 and r39.

Starting frequency

The initial frequency at which an inverter starts raising its output frequency.

Related function codes: F23, A12, b12 and r12

Starting torque

Torque that a motor produces when it starts rotating (or the drive torque with which the motor can run a load).

Stop frequency

The output frequency at which an inverter stops its output in decelerate-to-stop operation.

Related function codes: F25

STOP key priority

Giving priority to the STOP key on the keypad, which always enables the STOP key during inverter running.

The STOP key priority can be enabled by function code H96 even if the STOP key is disabled by function code F02 or H30.

Switch to commercial power (***SW50***/***SW60***)

To switch the power source for three-phase induction motors between the inverter output and commercial power line. The switching sequence is integrated in the inverter.

Related function codes: E01 to E07, E98 and E99

Thermal time constant

The time needed to activate the electronic thermal overload protection when the preset level of motor current continuously has flowed.

Related function codes: F12, A08, b08 and r08

Thermistor

A kind of thermal sensors, which is classified into two types: PTC (Positive Temperature Coefficient) thermistors and NTC (Negative Temperature Coefficient) thermistors. As the temperature rises, the internal resistance of the PTC thermistors increases, and that of the NTC thermistors decreases.

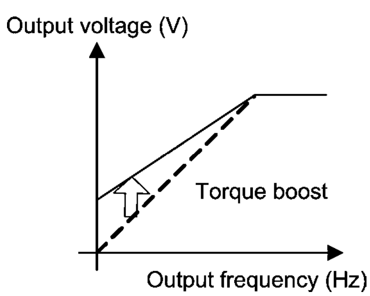
Some regenerative braking resistors, cooling fans and motors have a built-in thermistor.

Torque boost

The compensation process for a voltage drop in a low frequency region when an inverter drives a three-phase induction motor.

In a low frequency range, a voltage drop reduces the motor output torque. To compensate for the decrease, this process raises the output voltage.

Related function codes: F09, A05, b05 and r05



Torque control

Controlling the motor output torque in vector control with speed sensor using the option card, in proportion to the analog input given at terminal [12]. It does not control the speed and amount of the motor rotation.

Transistor output

A solid-state digital output (signals), unlike a mechanical contact output such as a relay contact output. These signals output via terminals [Y1] to [Y4] and the reference potential terminal [CMY]. Function codes E20 to E23 assign functions to those terminals.

Trip

An inverter's output shutdown state in which an inverter goes when the protective function is activated due to an overvoltage, overcurrent, or any other unusual event. The inverter cannot run until the trip state is reset. The trip factor is displayed on the keypad.

Universal DI

To relay a digital signal sent from the peripheral equipment to the upper controller (e.g., PLC) using any of the input terminals (if free) on the inverter. The universal DI signal is independent of the inverter operation.

Related function codes: E01 to E07, E98 and E99

Universal DO

To relay a digital command signal sent the upper controller (e.g., PLC) to the peripheral equipment using any of the output terminals (if free) on the inverter. The universal DO signal is independent of the inverter operation.

Related function codes: E20 to E27

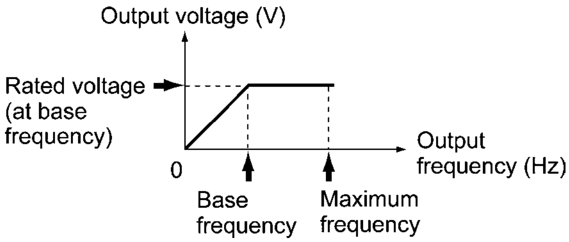
Variable torque load

A load whose torque varies in proportion to the square of the motor shaft rotational speed. Fans and pumps are typical variable torque loads. Using a suitable inverter for them yields energy-saving effect.

V/f characteristics

Characteristics of an inverter output, frequency "f" versus voltage "V." The graph below plots the output frequency along the abscissa, and the output voltage along the ordinate.

Related function codes: F04, F05, A02, A03, b02, b03, r02 and r03



V/f control

The rotational speed of a three-phase induction motor is calculated by the expression given below. A general-purpose inverter controls the motor speed by varying its output frequency (f).

In proportion to the output frequency (f), the V/f control varies the output voltage (V). Select the V/f control to drive more than one motor with a single inverter.

$$N = \frac{120 \times f}{p} \times (1 - s)$$

where,

N: Motor speed (min^{-1})
f: Output frequency (Hz)
p: Number of poles
s: Slip frequency

Vector control without speed sensor

Introduced in response to a strong demand from the market for a control mode using no speed sensor (PG: pulse generator) in environments where it is difficult to structurally mount a PG near the motor shaft or to suppress inductive noises on the PG signal wiring.

This control provides lower response and accuracy than the control with speed sensor.

Vector control with speed sensor

A high-performance, high-response control mode, in which an inverter processes motor data such as the actual motor speed and motor shaft rotational angle detected by the speed sensor (PG: pulse generator) for optimally controlling the motor rotor flux.

To achieve an optimal control performance, this control mode is usually selected when the inverter drives motors exclusively designed for vector control with the rated voltage of 180 VAC (360 VAC).

Vector motor

A generic term for motors applicable to the vector control. Fuji MVK motors driven by the FRENIC5000VG7 series of inverters are available.

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High Performance, Multifunction Inverter

FRENIC-MEGA

User's Manual

First Edition, September 2010

Fuji Electric Systems Co., Ltd.
Fuji Electric Corp. of America

The purpose of this manual is to provide accurate information in the handling, setting up and operating of the FRENIC-MEGA series of inverters. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.