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富士电机
Fuji Electric

13916183699

021-60510862

USER'S MANUAL

FRENIC MEGA SERIES

富士电机
Fuji Electric

13916183699

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MEH278a

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	MEH642	Product scope, features, specifications, external drawings, and options of the product
Instruction Manual	INR-SI47-1183-E INR-SI47-1223-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 **Note:** The RS-485 Communication User's Manual is as of September 2005. Although it does not specifically refer to the FRENIC-MEGA, all descriptions are intended for all types of inverters.

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

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

Our three-phase, 200 V class series inverters of 3.7 kW or less (FRENIC-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 (INR-SI47-1183-E, INR-SI47-1223-E) 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, HD/LD 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 12 groups 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 (MEH448) 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 () is displayed or not, and then proceed to the troubleshooting items.

Appendices

Glossary

Index

Icons

The following icons are used throughout this manual.

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.

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

This icon indicates a reference to more detailed information.

CONTENTS

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

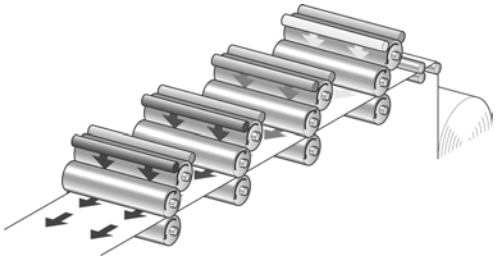
Speed control range: 1:1500

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 (available soon)

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

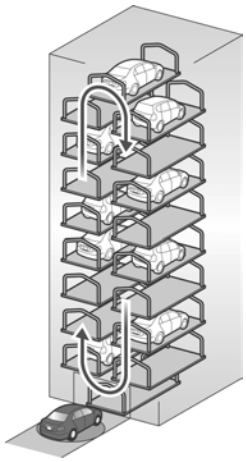
Speed control range: 1:200

Speed response: 20 Hz

Speed control accuracy: ±0.5%

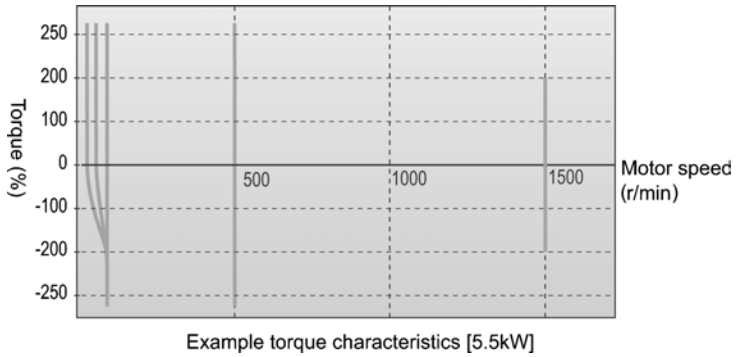
Current response: 500 Hz

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.

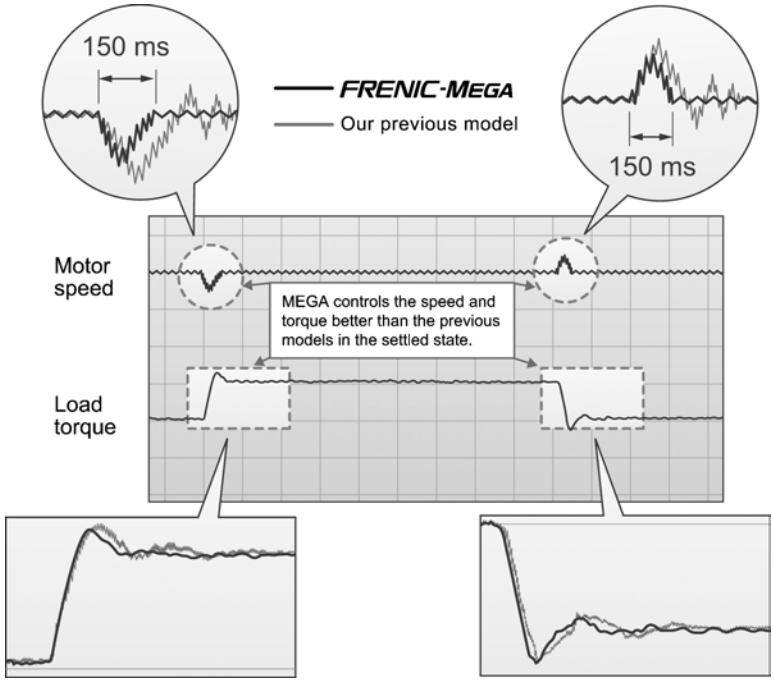


Example torque characteristics [5.5kW]

■ 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: 200% for 3 seconds and 150% for 1 minute.

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

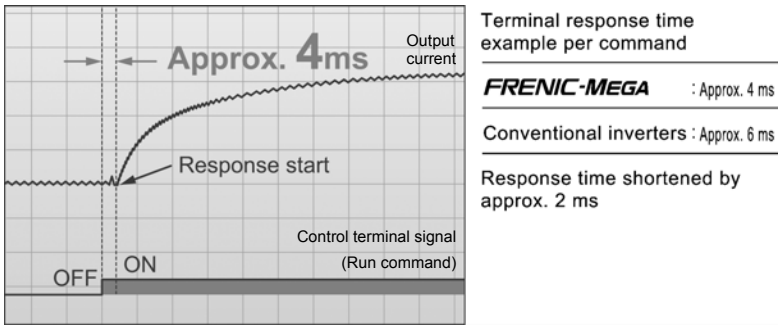
Drive mode	Current overload durability	Major application
HD (High duty) mode	200% for 3 sec, 150% for 1 min	Operation under heavy load
LD (Low duty) mode	120% for 1 min	Operation under light load

■ Quicker response to the operation commands

The terminal response to the operation 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 with a capacity of 22 kW or less as standard. These inverters are applicable to vertical carrier machines and others that run with a certain regenerative load. (Inverters with a capacity of 7.5 kW or less also integrate a braking resistor.)

The brake switching circuit built-in type of inverters with a capacity of 30 to 55 kW in 200 V class series and 30 to 110 kW in 400 V class series is available on request.

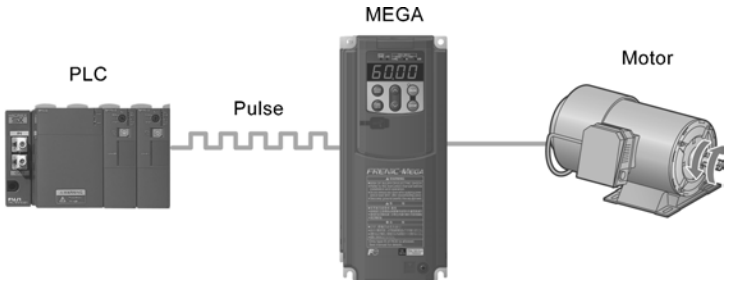
Accommodating various applications

■ Convenient functions for operations at the specified speed

Pulse train input speed command supported as standard

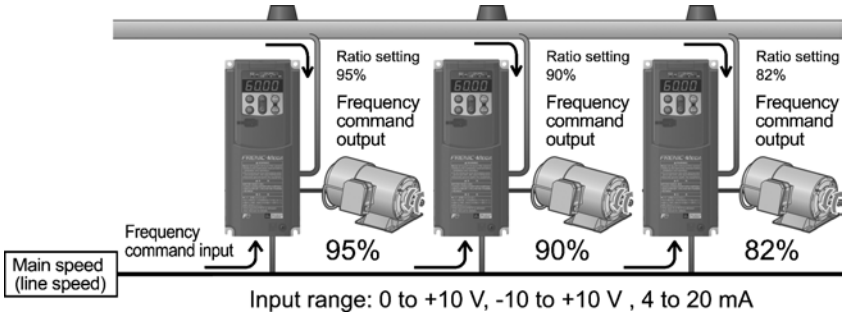
The FRENIC-MEGA can issue a speed command with the pulse train input (single-phase pulse train with sign).

(Maximum pulse input: 100 kHz)



Ratio operation

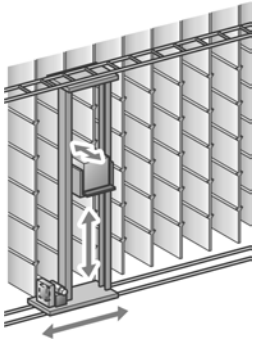
The ratio operation is convenient for synchronous control of two or more carrier machines in a multiline conveyor system. It is possible to specify the ratio of the main speed to other follower motors as a frequency command, so the conveying speed of carrier machines that handle variable loads or loading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



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

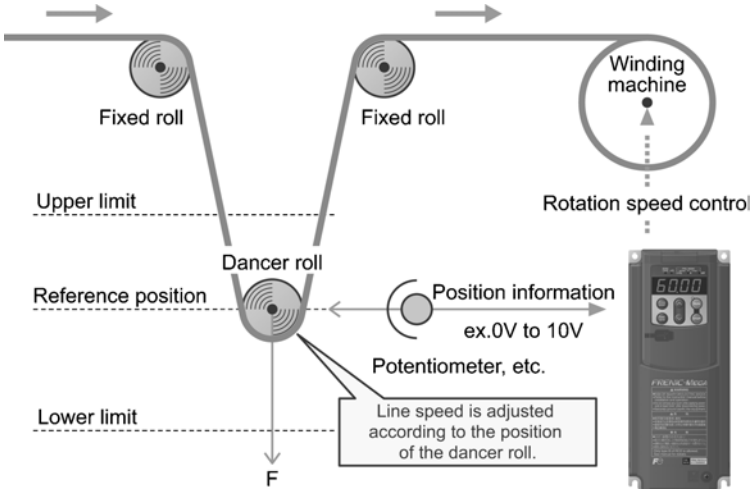
■ Optimum function for preventing an object from slipping down

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.

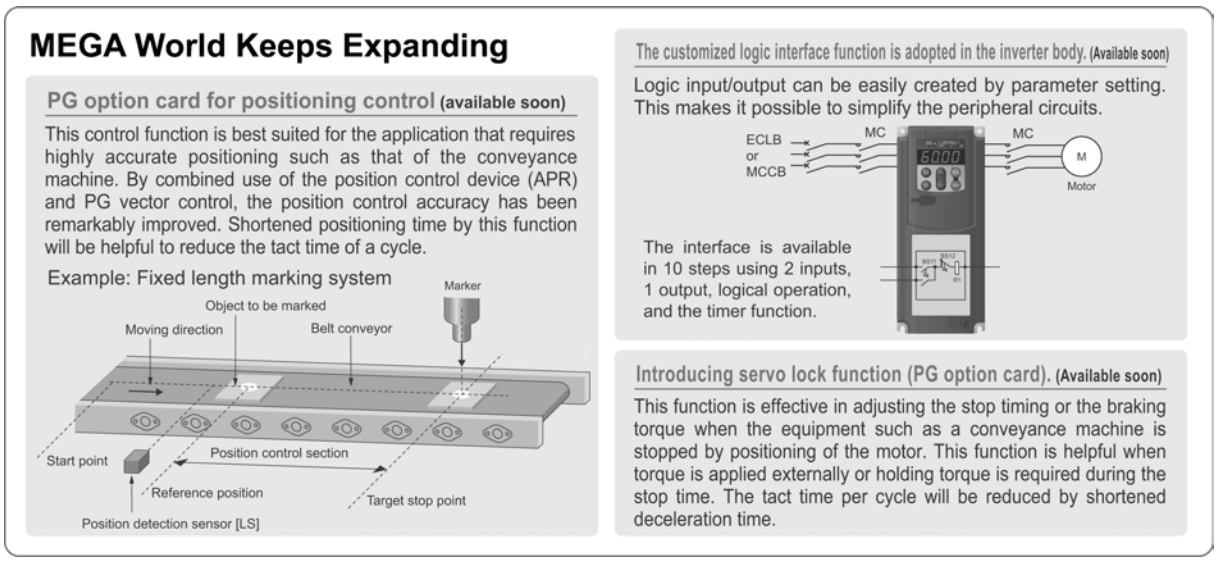


■ Thorough protection of the braking circuit

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



Wide model variation meeting the customer needs

■ Wide model variation

1. Basic type

Suitable for the equipment that uses a peripheral device to suppress noise or harmonics.

2. EMC filter built-in type (available soon)

This type has a built-in EMC filter and is compliant with European EMC Directives.

Objective standard: Category C3 (2nd Env) EN61800-3:2004 compliant

* Use of EMC filter will increase the leakage current.

3. Inverter type designed to the guideline specified by the Ministry of Land, Infrastructure and Transport (available soon)

The inverter employs a DC reactor and complies with "Standard Specifications for Public Building Construction" supervised by the Ministry of Land, Infrastructure and Transport. This inverter suppresses harmonics and noise.

* The inverter incorporates the DC reactor, and the zero-phase reactor is supplied together with the inverter to meet the inverter installation standards stipulated in the Standard Specifications for Public Building Construction (Electric Equipment) 2004 version published under the supervision by Government Buildings Department in Minister/Secretariat of Land, Infrastructure and Transport.

Supports for simple maintenance

■ The built-in USB port allows use of an inverter support loader (FRENIC loader) for easy information control!

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.

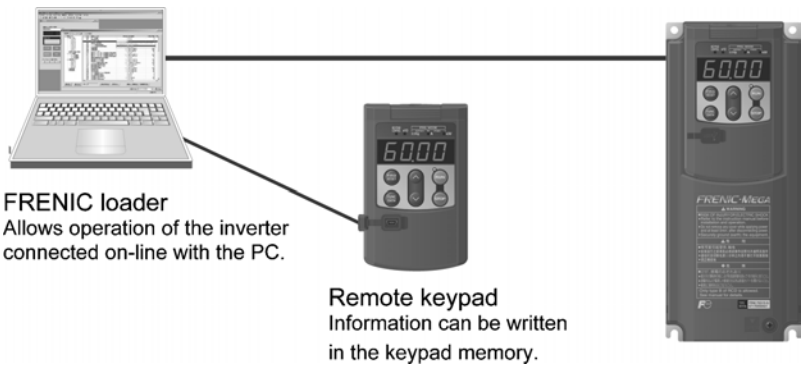
Example of use in the office

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 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) Trouble history (indicating the latest four trouble records)
   (4) Maintenance information
   (5) Historical trace (available soon)

- 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



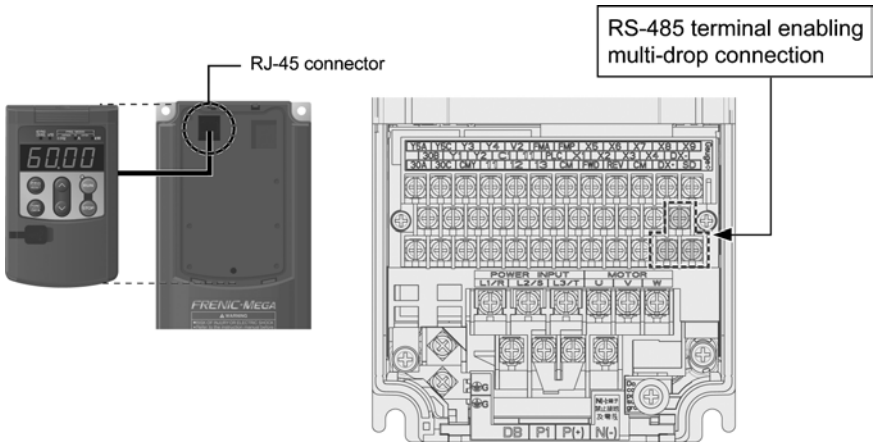
Network connectivity

■ Connectivity to the various FA networks with the following option cards (available soon)

- SX bus interface card
- T-link interface card
- PROFIBUS-DP interface card
- DeviceNet interface card
- CANopen interface card
- CC-Link interface 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

The part life conditions that the inverter is used at:

a surrounding temperature of 40ºC and under the load rate of 100% (HD mode) or 80% (LD 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 MEGA, resistance to the environmental impact has been increased compared with the conventional model (FRENIC5000 G11S/P11S). 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.

■ Protection against micro surge (optional)

Surge suppression unit SSU (optional)

If the motor drive cable is long, a very thin surge voltage (micro surge) is generated at the motor connection ends. This surge voltage causes deterioration of the motor, dielectric breakdown, or increase in noise. Using the surge suppression unit suppresses this surge voltage.

(1) The surge suppression unit significantly suppresses the surge voltage when simply connected with the motor.

(2) Since no additional work is required, it can be easily mounted on the existing equipment.

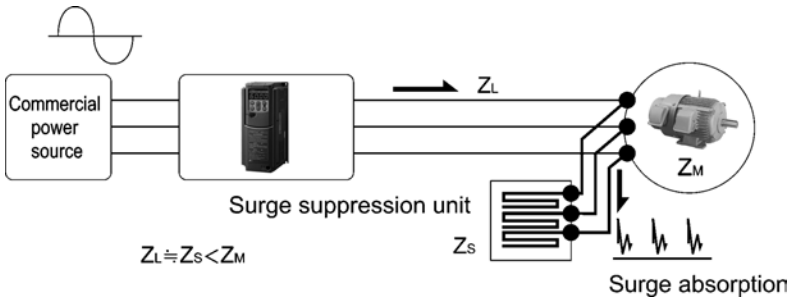
(3) The unit is applicable to the motors regardless of their capacity. (However, consult us for application to the motor with a capacity of 75 kW or over.)

(4) The unit requires no power source and no maintenance.

(5) Two types are available; One for 50m motor cable and the other for 100m motor cable.

(6) Compliant with environmental standard and safety standard (Compliant with RoHS Directives, and application to UL standard pending).

Surge suppression unit structure



■ 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

■ Application to global standards pending

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

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.")

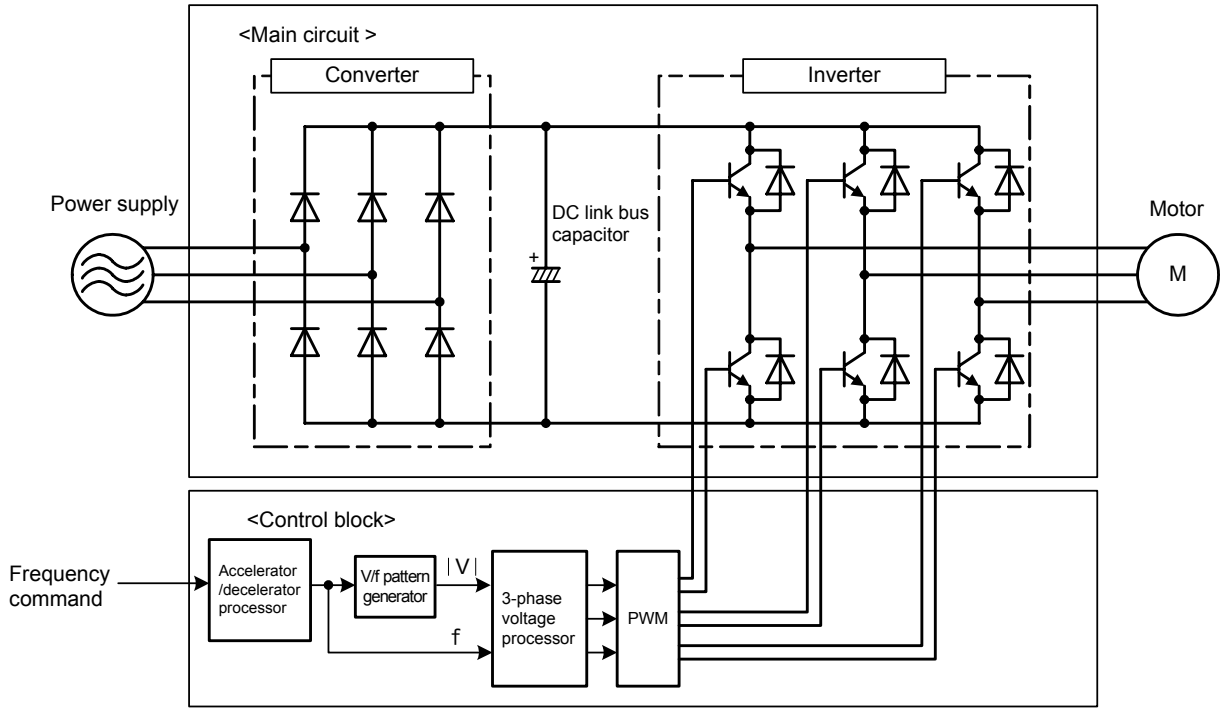


Figure 1.1 Schematic Overview of Theory of Inverter

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.

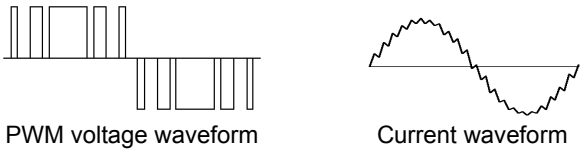


Figure 1.2 Output Voltage and Current Waveform of the Inverter

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	Speed control
V/f control with slip compensation inactive	V/f control	Disable	Frequency control
Dynamic torque vector control			Frequency control with slip compensation active
V/f control with slip compensation active			
Vector control with speed sensor*	Vector control	Enable	Speed control with automatic speed regulator (ASR)

Additionally, the FRENIC-MEGA reserves motor drive controls shown below for future support options.

- V/f control with speed sensor*
- Dynamic torque vector control with speed sensor*
- Vector control without speed sensor

The 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

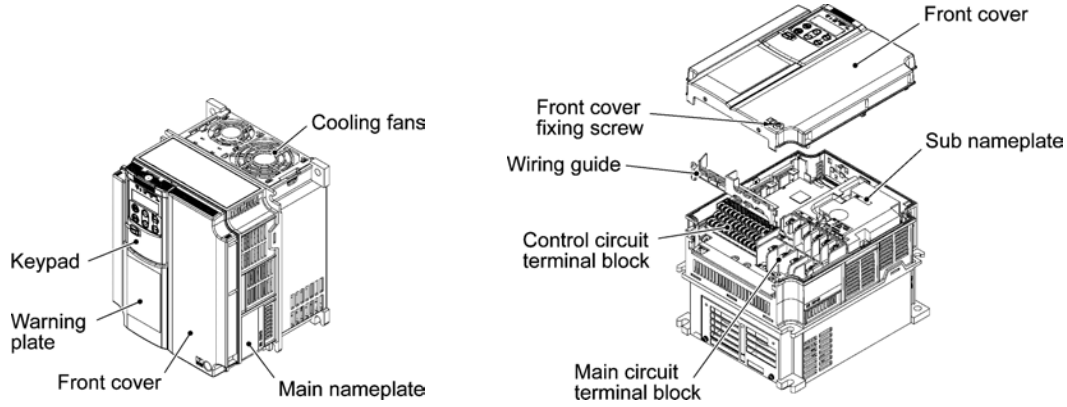


Figure 1.3 FRN11G1S-2☐

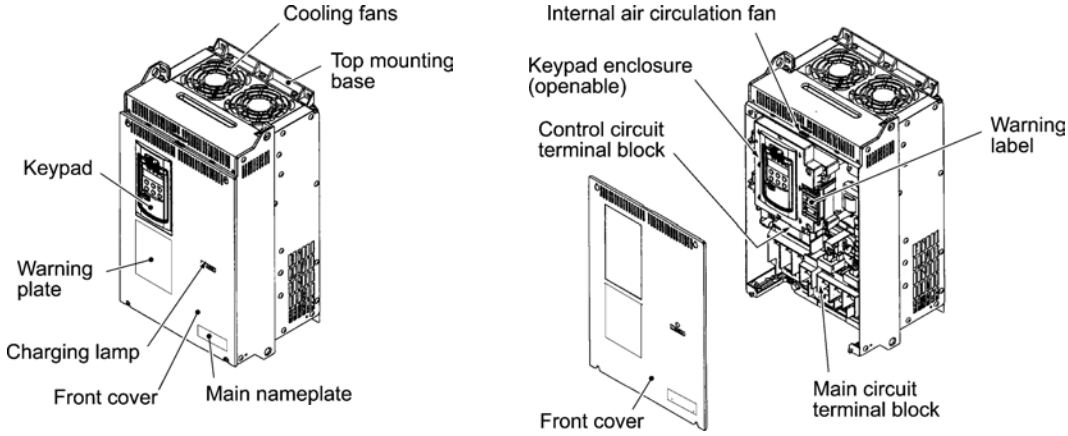
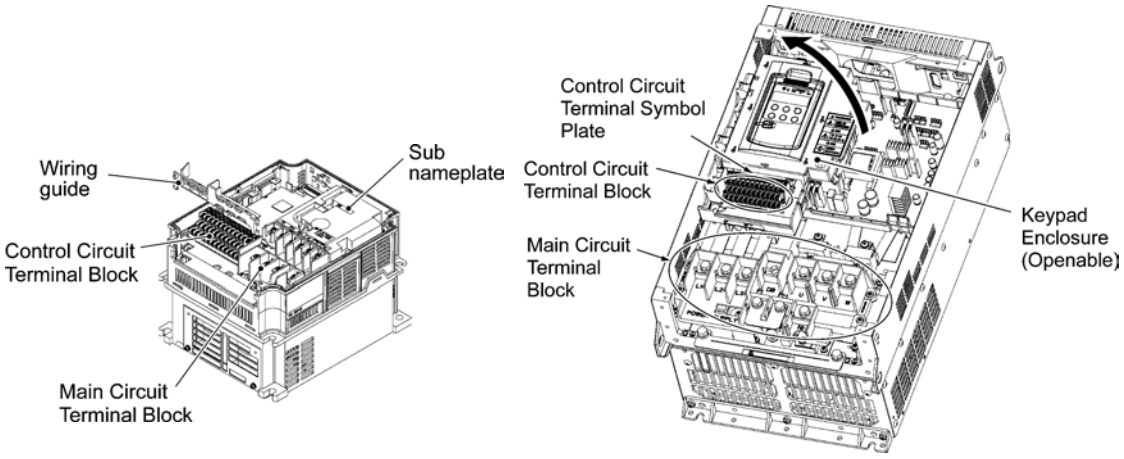


Figure 1.4 FRN30G1S-4☐

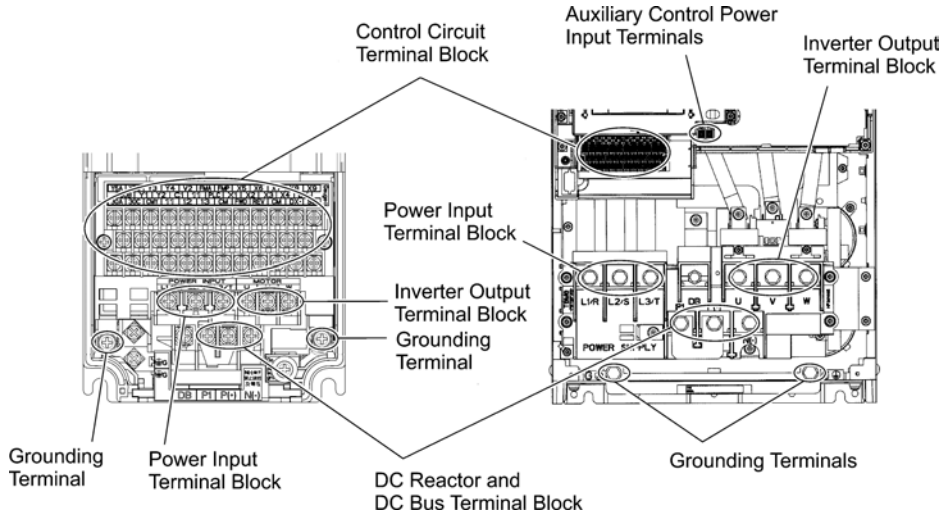
Note: A box (☐) in the above model names replaces A, E, J, or T depending on the shipping destination.

(2) Terminal block location



(a) FRN11G1S-2☐ (b) FRN30G1S-2☐

Figure 1.5 Terminal Blocks and Keypad Enclosure Location



(a) FRN0.75G1S-2☐ (b) FRN30G1S-2☐

Figure 1.6 Enlarged View of the Terminal Blocks

Note: A box (☐) in the above model names replaces A, E, J, or T depending on the shipping destination.

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.

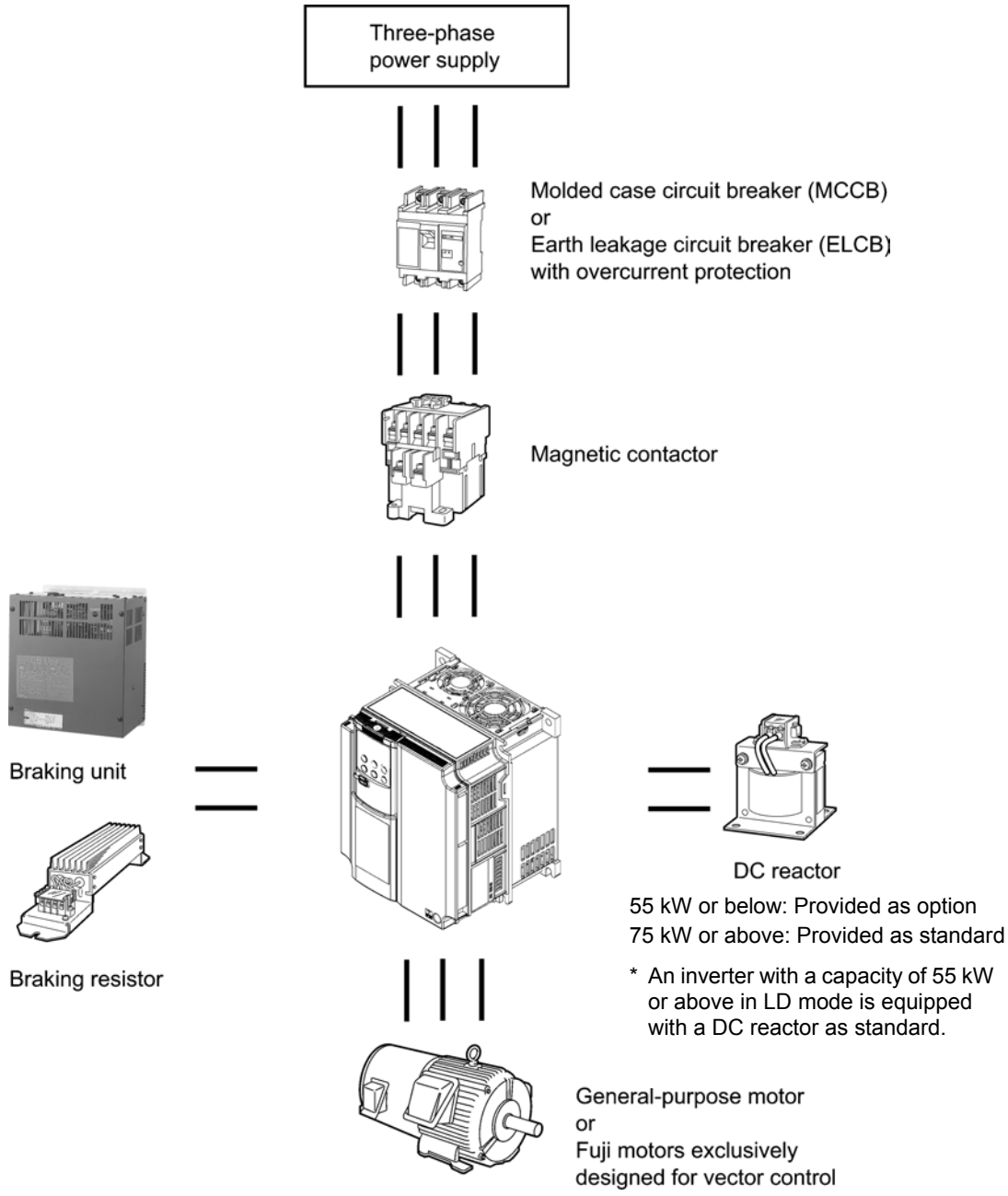


Figure 1.7 Recommended Configuration Diagram

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, product warranty, precautions for using inverters, external dimensions, examples of basic connection diagrams, and details of the protective functions.

Contents

2.1 Standard Models

2.1.1 Three-phase 200 V class series (HD- and LD-mode inverters)

Item			Specifications														
Type (FRN_ _ _G1S-2□)			0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55
Nominal applied motor (kW) *1		HD	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55
		LD	–	–	–	–	–	7.5	11	15	18.5	22	30	37	45	55	75
Output ratings	Rated capacity (kVA) *2	HD	1.1	1.9	3.0	4.2	6.8	10	14	18	24	28	34	45	55	68	81
		LD	–	–	–	–	–	11	16	20	25	30	43	55	68	81	107
	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	HD	3	5	8	11	18	27	37	49	63	76	90	119	146	180	215
		LD	–	–	–	–	–	31.8 (29)	46.2 (42)	59.4 (55)	74.8 (68)	88 (80)	115 (107)	146	180	215	283
	Overload capability	HD	150%-1 min, 200%-3.0 s														
		LD	–					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%														
	Required capacity (with DCR) (kVA) *6	HD	0.6	1.2	2.2	3.1	5.2	7.4	10	15	20	25	30	40	48	58	71
		LD	–	–	–	–	–	10	15	20	25	30	40	48	58	71	98
Braking	Torque (%) *7	HD	150			100				20				10 to 15			
		LD	–					70		15				7 to 12			
	Braking transistor		Built-in											–			
	Built-in braking resistor: Braking time (s)	HD	5							–							
		LD	–					3.7	3.4	–							
	Built-in braking resistor: Duty cycle (%ED)	HD	5	3	5	3	2	3	2	–							
		LD	–					2.2	1.4	–							
DC reactor (DCR)			Option														*8
Applicable safety standards			UL508C, C22.2No.14, EN61800-5-1:2003 (applied)														
Enclosure (IEC60529)			IP20, UL open type											IP00, UL open type			
Cooling method			Natural cooling			Fan cooling											
Weight / Mass (kg)			1.8	2.0	2.8	3.0	3.2	6.5	7.0	7.0	9.5	9.5	10	25	32	42	43

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 220 V for 200 V class series and 440 V for 400 V class 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 or higher, manage the load so that the current comes to be within the rated ones enclosed in parentheses ( ) in continuous running.

*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max voltage (V) - Min voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC61800-3)}$$

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. (It varies with the efficiency of the motor.)

*8 For inverters with a capacity of 55 kW, a DCR is provided as standard or option for LD or HD mode, respectively.

Note: A box (□) in the above table replaces A, E, J, or T depending on the shipping destination.

2.1.2 Three-phase 400 V class series (HD- and LD-mode inverters)

Item			Specifications															
Type (FRN_ _ _G1S-4□)			0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75
Nominal applied motor (kW) *1		HD	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75
		LD	–	–	–	–	–	7.5	11	15	18.5	22	30	37	45	55	75	90
Output ratings	Rated capacity (kVA) *2	HD	1.1	1.9	2.8	4.1	6.8	10	14	18	24	29	34	45	57	69	85	114
		LD	–	–	–	–	–	12	17	22	28	33	45	57	69	85	114	134
	Rated voltage (V) *3		Three-phase 380 to 480 V (with AVR function)															
	Rated current (A)	HD	1.5	2.5	4.0	5.5	9.0	13.5	18.5	24.5	32	39	45	60	75	91	112	150
		LD	–	–	–	–	–	16.5	23	30.5	37	45	60	75	91	112	150	176
	Overload capability	HD	150%-1 min, 200%-3.0 s															
		LD	–					120%-1 min										
Input power	Voltage, frequency		380 to 480 V, 50/60 Hz															*8
	Allowable voltage/frequency		Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) *5, Frequency: +5 to -5%															
	Required capacity (with DCR) (kVA) *6	HD	0.6	1.2	2.1	3.2	5.2	7.4	10	15	20	25	30	40	48	58	71	96
		LD	–	–	–	–	–	10	15	20	25	30	40	48	58	71	96	114
Braking	Torque (%) *7	HD	150			100				20				10 to 15				
		LD	–					70		15				7 to 12				
	Braking transistor		Built-in											–				
	Built-in braking resistor: Braking time (s)	HD	5							–								
		LD	–					3.7	3.4	–								
	Built-in braking resistor: Duty cycle (%ED)	HD	5	3	5	3	2	3	2	–								
		LD	–					2.2	1.4	–								
DC reactor (DCR)			Option														*9	Stan-dard
Applicable safety standards			UL508C, C22.2No.14, EN61800-5-1:2003 (Applied)															
Enclosure (IEC60529)			IP20, UL open type											IP00, UL open type				
Cooling method			Natural cooling			Fan cooling												
Weight / Mass (kg)			1.8	2.0	2.8	3.0	3.2	6.5	7.0	7.0	9.5	9.5	10	25	26	31	33	42

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 220 V for 200 V class series and 440 V for 400 V class series.

*3 Output voltage cannot exceed the power supply voltage.

*5 $$\text{Voltage unbalance (\%)} = \frac{\text{Max voltage (V) - Min voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \text{ (IEC61800-3)}$$

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

*6 Required when a DC reactor (DCR) is used. A DCR is provided as standard for LD-mode inverters with a capacity of 55 kW and inverters with a capacity of 75 kW or above.

*7 Average braking torque for the motor running alone. (It varies with the efficiency of the motor.)

*8 380 to 440 V, 50 Hz; 380 to 480 V, 60 Hz

*9 For inverters with a capacity of 55 kW, a DCR is provided as standard or option for LD or HD mode, respectively.

Note: A box (□) in the above table replaces A, E, J, or T depending on the shipping destination.

2.2 Common Specifications

Item			Explanation		Remarks
Output frequency	Setting range	Maximum frequency	• 25 to 500 Hz (HD mode, V/f control *1, *2, *3) • 25 to 200 Hz (HD mode, V/f control with PG/vector control with PG *4, *5, *7) • 25 to 120 Hz (HD mode, vector control without speed sensor *6 LD mode, various controls *1 to *7)		
		Base frequency	25 to 500 Hz variable (120 Hz in LD mode)		
		Starting frequency	0.1 to 60.0 Hz variable (Vector control without speed sensor *6 / Vector control with PG, 0.0 Hz *7)		
		Carrier frequency	• 0.75 to 16 kHz variable setting (HD mode: 0.4 to 55 kW, LD mode: 5.5 to 18.5 kW) • 0.75 to 10 kHz variable setting (HD mode: 75 to 400 kW, LD mode: 22 to 55 kW) • 0.75 to 6 kHz variable setting (HD mode: 500 to 630 kW, LD mode: 75 to 500 kW) • 0.75 to 4 kHz variable setting (LD mode: 630 kW) Note: Frequency drops automatically to protect the inverter depending on environmental temperature and output current. (This auto drop function can be canceled.)		
	Output frequency accuracy (Stability)		• Analog setting: ±0.2% of maximum frequency (at 25±10°C) *1 • Keypad setting: ±0.01% of maximum frequency (at -10 to +50°C)		
	Setting resolution		• Analog setting: 1/3000 of maximum frequency (1/1500 with V2 input) The resolution can be set in the function code. (0.01 to 500 Hz) • Keypad setting: 0.01 Hz (99.99 Hz or less), 0.1 Hz (100.0 to 500 Hz) • Link setting: 1/20000 of maximum frequency or 0.01 Hz (fixed)		*8
	Speed control range		• Minimum speed : Base speed 1:1500 (4P 1 r/min to 1500 r/min) *7 • Minimum speed : Base speed 1:200 (4P 7.5 r/min to 1500 r/min) *6 • Minimum speed : Base speed 1:100 1:200 (4P 15 r/min to 1500 r/min, 1024 p/r) *4,*5 • Constant torque range : Constant output range 1:4 *7 • Constant torque range : Constant output range 1:2 *4, *5, *6		*8 *8 *8
	Speed control accuracy		• Analog setting: ±0.2% of maximum frequency (at 25 ±10°C) *4, *5, *7 • Digital setting: ±0.01% of maximum frequency (at -10 to +50°C)		*8
			• Analog setting: ±0.5% of base speed (at 25 ±10°C) *6 • Digital setting: ±0.5% of base speed (at -10 to +50°C)		
Control	Control method		• V/f control *1 • Dynamic torque vector control *2 • V/f control with slip compensation active *3 • V/f control with speed sensor (PG option) *4 • Dynamic torque vector control with speed sensor (PG option) *5 • Vector control without speed sensor *6 • Vector control with speed sensor (PG option) *7		 *8 *8 *8
	Voltage/frequency characteristic	200 V class 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		
		400 V class 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 240 V) and frequency (0 to 500 Hz) can be set. *1, *4		

*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)
*8 Not available in the initial version of inverters.

	Item	Explanation	Remarks
Control	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, *4 • Select application load with the function code. (Variable torque load or constant torque load) *1, *4	
	Starting torque (HD mode)	• 22 kW or below: 200% or higher, 30 kW or above: 180% or higher/reference frequency: 0.3 Hz *6 • 22 kW or below: 200% or higher, 30 kW or above: 180% or higher/reference frequency: 0.3 Hz, Base frequency 50 Hz *2 • Auto torque boost operation *1 to*4	
	Start/stop operation	Keypad: Start and stop with RUN and STOP keys (Standard keypad) Start and stop with FWD / REV and STOP keys (Optional multi-function keypad)	
		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 field bus (option) communications	
		Switching operation command: Remote/local switching, link switching	
	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	
	Acceleration/ deceleration time	Setting range: Between 0.00 and 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***.	
		Auto-tuning by shortest acceleration/deceleration mode and optimal acceleration/ deceleration mode	*8

*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.
*8 Not available in the initial version of inverters.

	Item	Explanation	Remarks
Control	Frequency limiter (Upper limit and lower limit frequencies)	• Specifies the high and low limits in Hz. • It is possible to choose the operation done when the set frequency drops below the lower limit from between continuous operation at lower limit frequency and operation stop.	
	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% • Off-set : Set in the range from -5.0 to +5.0% • Filter : Set in the range from 0.00s 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 RUN key (standard keypad), FWD or REV key (multi-function keypad), or digital contact input ***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. *1 to *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	*8
	Software current limiter	Automatically reduces the frequency so that the output current becomes lower than the preset operation level. *1 to *5	
	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 electric constant needs tuning: Offline tuning) *1 to * 3 and *6	

*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)
*8 Not available in the initial version of inverters.

	Item	Explanation	Remarks
Control	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. *1, *4	
	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.)	*8
	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.	
	Auto-tuning (online)	Tuning for compensating the temperature change in motor parameters.	*8
	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.	*8
	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.	
	Overload stop function	When the torque or the current exceeds the specified level, the inverter decelerates the motor to a stop or allows the motor to coast to a stop. When the motor is interrupted by a mechanical stop, the inverter controls the current to secure the holding torque. *1 to *5	
	Speed control	• Notch filter for vibration control, vibration suppressing observer. *7 • Estimates the GD2 value applied to the motor shaft from the load, and automatically controls the ASR system constant. *6 and *7	*8
	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	*8
	Torque control *6, *7	• Analog torque command input • Speed limit function is provided to prevent the motor from becoming out of control.	*8
	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	*8

*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)
*8 Not available in the initial version of inverters.

Item		Explanation	Remarks
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, Load rate: inverter rated current 100% (LD mode: 80%)	
	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. (200 V 22 kW, 400V 22 kW 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. (200 V 30 kW, 400 V 30 kW or above)	EF
	Overvoltage protection	An excessive voltage (200 V class series: 400 VDC, 400 V class 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 (200 V class series: 200 VDC, 400 V class 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
	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. (200 V 45 kW, 400 V 75 kW 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. (200 V 75 kW, 400 V 90 kW or above)	FUS
	Charge circuit fault	Stop the inverter output detecting the charge circuit abnormality in the inverter. (200 V 37 kW, 400 V 75 kW or above)	PbF

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

	Item		Explanation	Remarks
Protection	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.)	OL 1 to OL 4
		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.	Er 1
	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 operation 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.	
	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

*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)

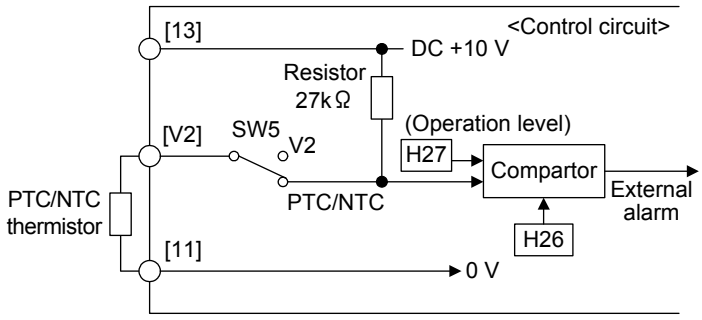
	Item	Explanation	Remarks
Protection	Alarm relay output (for any fault)	• The relay signal is output when the inverter stops upon an alarm. • PRG/RESET key or digital input signal ***RST*** is used to reset the alarm stop state.	
	Light-alarm (warning)	The "light-alarm" display is indicated when alarm 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), Motor protection (OH4), Braking resistor overheat (dbH), Overload of motor (OL1 to OL4), Keypad communications error (Er-3), Option communications error (Er-4), Option error (Er-5), RS-485 communications error (port 1) (Er-8), Speed mismatch or excessive speed deviation (Er-E), RS-485 communications error (port 2) (Er-P), DC fan locked, Motor overload early warning, Heat sink overheat early warning, Lifetime alarm (DC link bus capacitor, electrolytic capacitors on printed circuit boards or cooling fans), PTC thermistor activated (PTC), Inverter life (Cumulative run time), Inverter life (number of startups)	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).	
	Momentary power failure protection	• A protective function (inverter stoppage) is activated upon a momentary power failure for 15 ms or longer. • If restart upon momentary power failure is selected, the inverter restarts upon recovery of the voltage within the set time.	
Environment	Installation location	Shall be free from corrosive gases, flammable gases, oil mist, dusts, and direct sunlight. (Pollution degree 2 (IEC60664-1)). Indoor use only.	
	Surrounding temperature	-10 to +50°C (-10 to +40°C when installed side-by-side without clearance (22 kW or below))	
	Relative humidity	5 to 95% RH (without condensation)	
	Altitude	Lower than 1,000 m	
	Vibration	200 V 55 kW, 400 V 75 kW or below 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	
	Storage temperature	-25 to +65°C	
	Storage humidity	5 to 95% RH (without condensation)	

2.3 Terminal Specifications

2.3.1 Terminal functions

Main circuit and analog input terminals

Classification	Symbol	Name	Functions
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connect the three-phase input power lines.
	U, V, W	Inverter outputs	Connect a three-phase motor.
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect AC power lines same as that of the main power input.
	P1, P(+)	DC reactor connection	Connect a DC reactor (DCR) for correcting power factor. • HD-mode inverters: A DCR is provided as option for 0.4 to 55 kW, and as standard for 75 kW or above. • LD-mode inverters: A DCR is provided as option for 5.5 to 45 kW, and as standard for 55 kW or above.
	P(+), DB	Braking resistor	Connect the braking resistor (option).
	P(+), N(-)	DC link bus	Connect a DC link bus of other inverter(s). A high power-factor, regenerative PWM converter is also connectable to these terminals.
	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 (RHC series).
	⏚ 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 frequency command potentiometer (Potentiometer: 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 analog 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."

Classification	Symbol	Name	Functions
Analog input	[C1]	Analog setting current input (C1 function)	(1) The frequency is commanded according to the external analog 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.
	[V2]	Analog setting voltage input (V2 function)	(1) The frequency is commanded according to the external analog 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."
		PTC/NTC thermistor input (PTC/NTC function)	(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 (refer to "Setting up the slide switches" on page 2-20). The figure shown at the right illustrates the internal circuit diagram where SW5 (switching the input of terminal [V2] between V2 and PTC/NTC) is turned to the PTC/NTC position. For details on SW5, refer to "Setting up the slide switches" on page 2-20. In this case, you must change data of the function code H26.  Figure 2.1 Internal Circuit Diagram (SW5 Selecting PTC/NTC)
	[11]	Analog common	Common for analog input/output signals ([13], [12], [C1], [V2] and [FMA]). Isolated from terminals [CM]s and [CMY].

Classification	Symbol	Name	Functions	Related function codes
Analog input	Note		- Since low level analog signals are handled, these signals are especially susceptible to the external noise effects. Route the wiring as short as possible (within 20 m) and use shielded wires. In principle, ground the shielded sheath of wires; if effects of external inductive noises are considerable, connection to terminal [11] may be effective. As shown in 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]. - 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.	

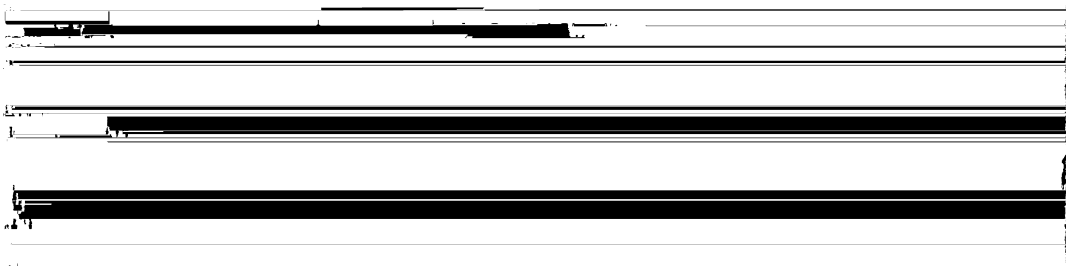


Figure 2.2 Connection of Shielded Wire

Figure 2.3 Example of Electric Noise Reduction

Digital Input Terminals

Classification	Symbol	Name	Functions
Digital input	[X1]	Digital input 1	(1) Various signals such as "Coast to a stop," "Enable external alarm trip," and "Select multi-frequency" can be assigned to terminals [X1] to [X9], [FWD] and [REV] by setting function codes E01 to E09, E98, and E99. For details, refer to Chapter 5 "FUNCTION CODES." (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to "Setting up the slide switches" on page 2-20.) (3) Switches the logic value (1/0) for ON/OFF of the terminals [X1] to [X9], [FWD], or [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 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 2-15.) 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)
	[X2]	Digital input 2	
	[X3]	Digital input 3	
	[X4]	Digital input 4	
	[X5]	Digital input 5	
	[X6]	Digital input 6	
	[X7]	Digital input 7	
	[X8]	Digital input 8	
	[X9]	Digital input 9	
	[FWD]	Run forward command	
	[REV]	Run reverse command	

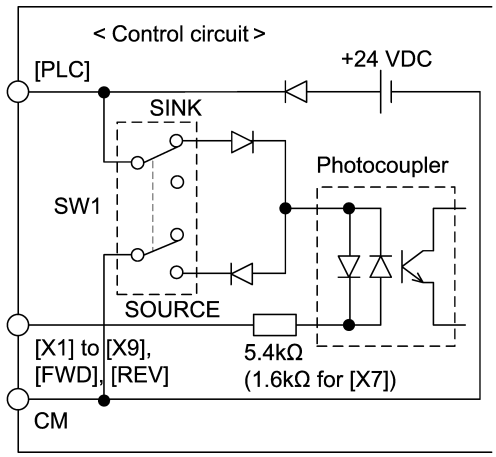
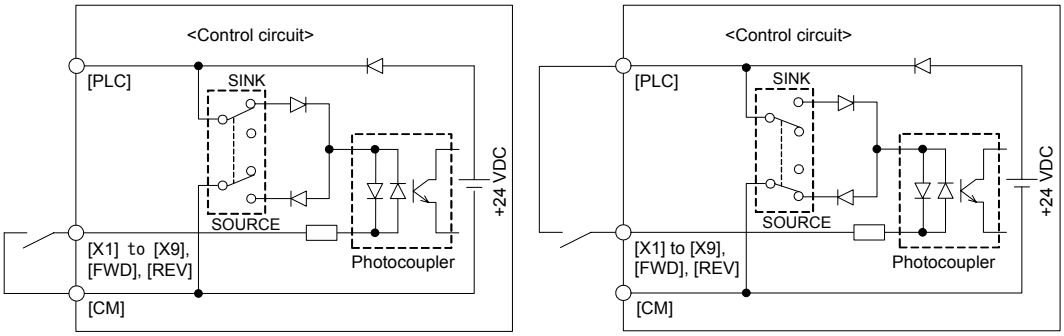


Figure 2.4 Digital Input Circuit

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

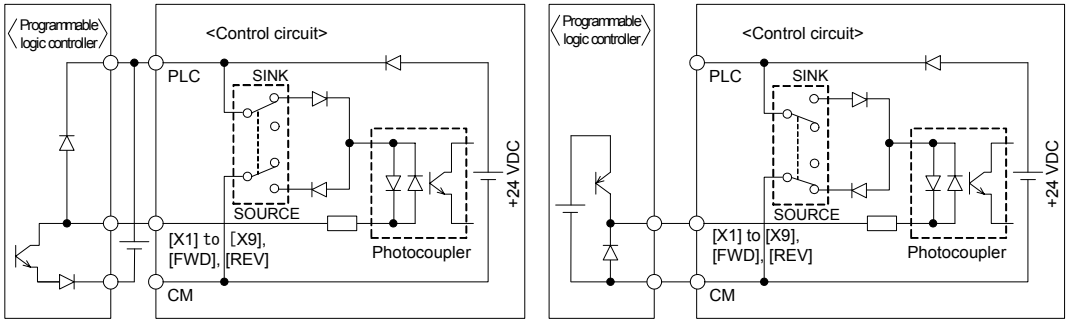
Classification	Symbol	Name	Functions
Digital input	[PLC]	PLC signal power	(1) Connects to PLC output signal power supply. Rated voltage: +24 VDC (Allowable range: +22 to +27 VDC), Maximum 100 mA DC (2) This terminal also supplies a power to the load connected to the transistor output terminals [Y1] and [Y2]. Refer to "Transistor output" described later in this table for more.
	[CM]	Digital input common	Two common terminals for digital input signals These terminals are electrically isolated from the terminals [11]s and [CMY].
	Tip		■ Using a relay contact to turn [X1] to [X9], [FWD], or [REV] ON or OFF Figure 2.5 shows two examples of a circuit that uses a relay contact to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch SW1 has been turned to SINK, whereas in circuit (b) it has been turned to SOURCE. **Note:** To configure this kind of circuit, use a highly reliable relay. (Recommended product: Fuji control relay Model HH54PW.)



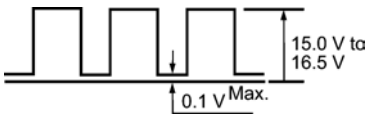
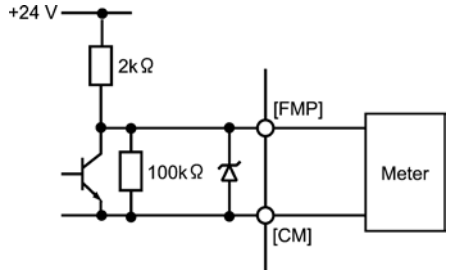
(a) With the switch turned to SINK (b) With the switch turned to SOURCE

Figure 2.5 Circuit Configuration Using a Relay Contact

Tip		■ Using a programmable logic controller (PLC) to turn [X1] to [X9], [FWD], or [REV] ON or OFF Figure 2.6 shows two examples of a circuit that uses a programmable logic controller (PLC) to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch SW1 has been turned to SINK, whereas in circuit (b) it has been turned to SOURCE. In circuit (a) below, short-circuiting or opening the transistor's open collector circuit in the PLC using an external power supply turns ON or OFF control signal [X1] to [X9], [FWD], or [REV]. 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.

Classification	Symbol	Name	Functions
Digital input			 (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 "Setting up the slide switches" on page 2-20.)
	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.

Analog output, pulse output, transistor output, and relay output terminals

Classification	Symbol	Name	Functions
Analog output	[FMA]	Analog monitor (FMA function)	The monitor signal for analog DC voltage (0 to +10 V) or analog DC current (+4 to +20 mA) is output. You can select the output form (VO/IO) by switching the slide switch SW4 on the control PCB and changing data of the function code F29. You can select one of the following signal functions with function code F31. • 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 * 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%
	[11]	Analog common	Two common terminals for analog input and output signals. These terminals are electrically isolated from terminals [CM]s and [CMY].
Pulse output	[FMP]	Pulse monitor (FMP function)	Pulse signal is output. You can also select one of the signal functions listed in the above column for [FMA] using function code F35. * Input impedance of the external device: Min. 5kΩ (While the terminal is outputting 0 to 10 VDC, it is capable of driving up to two analog voltmeters with 10 kΩ impedance.) * Pulse duty: Approx. 50% Pulse rate: 25 to 6000 p/s (at full scale) Voltage waveform • Pulse output waveform  • FMP output circuit 
	[CM]	Digital common	Two common terminals for digital input and [FMP] output signals. These terminals are electrically isolated from other common terminals, [11]s and [CMY]. These are the shared terminals with the digital input terminal [CM]s.

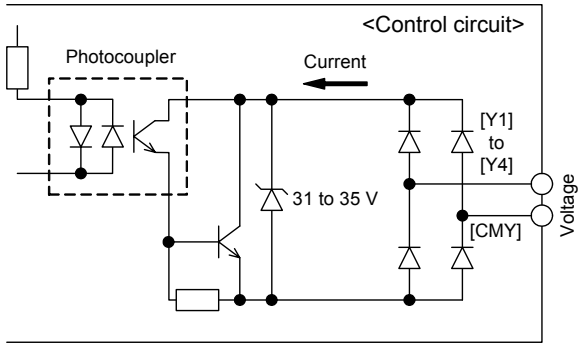
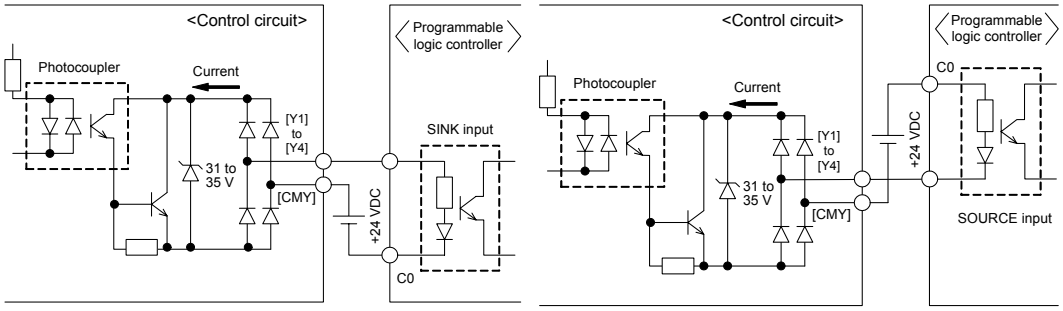
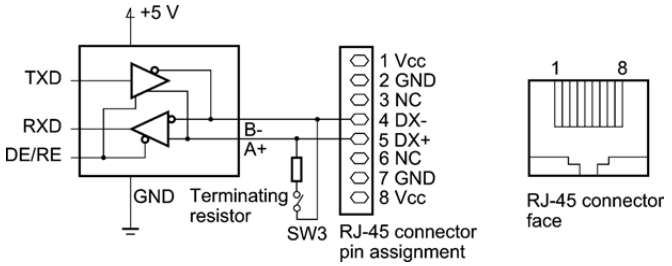
<table>
<tr><th>Classification</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="5">Transistor output</td><td>[Y1]</td><td>Transistor output 1</td><td rowspan="4">(1) Various signals such as inverter running, speed/freq. arrival and overload early warning can be assigned to any terminals, [Y1] to [Y4] by setting function code E20 to E24. Refer to Chapter 5 "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 specifications)
 

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 motor 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>
<tr><td>[CMY]</td><td>Transistor output common</td><td>Common terminal for transistor output signals
This terminal is electrically isolated from terminals [CM]s and [11]s.</td></tr>
</table>

Classification	Symbol	Name	Functions	Related function codes
Transistor output			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	
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.).	
Relay output	[30A/B/C]	Alarm relay output (for any error)	(1) Outputs a contact signal (SPDT) when a protective function has been activated to stop the motor. Contact rating: 250 VAC, 0.3A, cos ϕ = 0.3, 48 VDC, 0.5A (2) 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.).	

RS-485 communications port

Classification	Connector	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 personal computer or other equipment such as a PLC. (For setting of the terminating resistor, refer to "Setting up the slide switches" on page 2-20)
	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 "Setting up the slide switches" on page 2-20.  Figure 2.9 RJ-45 Connector and its Pin Assignment* * Pins 1, 2, 7, and 8 are exclusively assigned to power lines for the standard keypad and multi-function keypad, so do not use those pins for any other equipment.
	USB connector	USB port (On the keypad)	A USB port connector (Mini-B) that connects an inverter to a personal 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. * FRENIC Loader is available as a free download from our website at: http://web1.fujielectric.co.jp/Kiki-Info-EN/User/guestlogin.asp (Fuji Electric FA Components & Systems Co., Ltd. Technical Information site) On the Fuji website shown above, select "Technical Information" | "Drive Control Equipment" | "Inverters" | "Software libraries." Then download the "FRENIC-MEGA Loader (setup version)," "Message Manager for FRENIC-MEGA PC Loader," and "Loader Software for FRENIC-MEGA Instruction Manual." Before downloading, you are requested to register as a member (free of charge).

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).