Changes for the Better

MITSUBISHI ELECTRIC

Mitsubishi Inverter

FREQROL-S500

## S500 Series-Accomplishing further advances

# EVOLUTION

### Make operations simple

### with the setting dial!


Mitsubishi Electric Corporation Nagoya Works is a factory certified for ISO14001 (standards for environmental management systems) and ISO9001 (standards for quality assurance management systems).

ISO 14001 JACO — UKAS ENVIRONMENTAL MANAGEMENT 051

Certified ISO 9001 by BVQI — UKAS QUALITY MANAGEMENT 008

# Powerful Evolution

## Compact & simple inverter

## Communication function is a standard feature

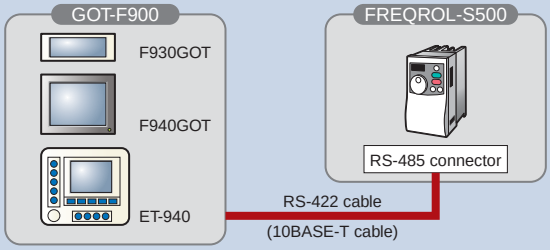
### 1 Connectable to computer or GOT !

New Function

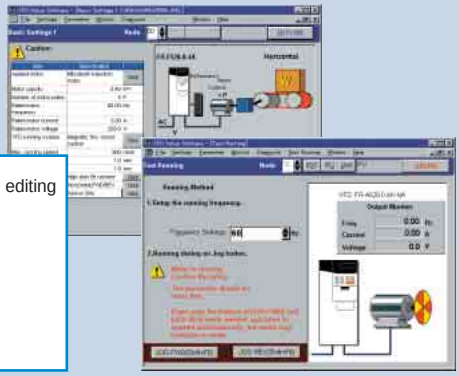
- RS-485 communication is provided as a standard function.
- Setup software (optional: available soon.) serves as a useful tool for everything from inverter startup to maintenance.
- A parameter unit (optional FR-PU04) enables control and monitoring from the panel. Ten-key type direct input is also possible, and an LCD offers displays in 8 languages (Japanese, English, German, French, Spanish, Italian, Swedish, and Finnish).
- Operation using GOT is possible by connecting to a MELSEC-GOT GOT-F900 Series Mitsubishi graphic operation system (F930GOT, F930GOT-K, F940-GOT, F940WGOT, F940 Handy GOT, ET-900).

Note: Please refer to the GOT Manual for details regarding connection to the MELSEC-GOT GOT-F900 Series.


■Connection to MELSEC-GOT F900 Series




▼Easy parameter setting screen



**Functions**

①Parameter setting & editing
②Monitor
③Test run
④Diagnosis
⑤System settings
⑥File
⑦Window
⑧Help

▲Example of Test Run screen

*Windows is a registered trademark of the Microsoft Corporation.

### 2 Setting dial for quick and easy setting

- The frequency and parameters etc. can be set with a few simple steps.
- Easily set values: turn quickly to greatly change the value, and turn slowly to finely adjust the value.
- Accurate settings can be made with the new notch-type “clicking” feel.
- As the default, the parameters that can be set have been grouped into the minimum required twelve parameters. Thus, parameters can be managed easily.
- The modes can be changed between the PU and external operation modes just by pressing the PU/EXT (operation mode changeover) key. The current operation mode can be confirmed with the status display LED.


Example of parameter change


Example of PU operation mode

# FREQROL S500

## CONTENTS



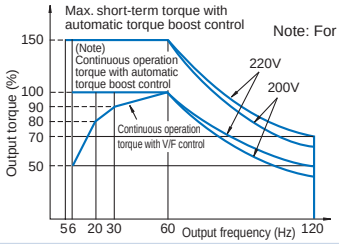
## 3 Compact Design

- The foot print is the same as the Mitsubishi FREQROL-E520. (400V class installation area has been unified to 108mm × 128mm.)
- The height dimensions for all capacities have been unified to 128mm, making panel layout easier.


## 4 Powerful Starting Torque

- The need for torque boost setting can be eliminated and the current during no load can be controlled.
- Featuring Mitsubishi's original "automatic torque boost control", for powerful starting and operation torques.
  - Max. torque of 150% possible at 5Hz.
  - Even with a standard motor, a 100% continuous operation torque can be obtained. Note: For 0.1K to 1.5K.

Frequency and torque characteristics during automatic torque boost control and V/F control
(when SF-JR 4P motor and inverter of equal capacities are combined in a system with a rated power supply)




## 5 Powerful Regenerative Braking Torque

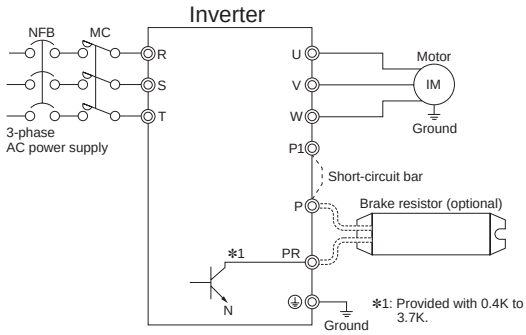
New Function

- Equipped with a regenerative brake transistor, permitting connection to a brake resistor. This allows the regenerative braking torque from conveyor equipment (travel, traverse), etc., deceleration to be applied to a required application.

Note: Provided with FR-S520E 0.4K to 3.7K.

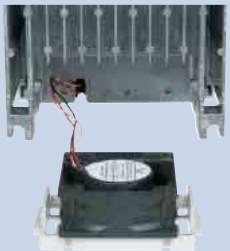
| Connectable Brake Resistors | Permissible Brake Rate | Regenerative Braking Torque (with brake resistor connected) |
|---|---|---|
| FR-ABR-0.4K to 3.7K | 10% | 0.4K to 1.5K : 150%<br>2.2K, 3.7K : 100% |
| MRS type (Note 1) | 3% | |
| MYS type (Note 2) | 6% | |

(Note 1) Applicable motor capacity: 0.4kW to 3.7kW
(Note 2) Applicable motor capacity: 3.7kW




## 6 Easy Maintenance

- The cooling fan can be replaced easily due to a simple cassette design. By setting the fan "ON-OFF control", operation with an extended life can be realized. (The ON-OFF control is set as the default.)
- Wiring space is secured and the wiring work efficiency is enhanced by incorporating an expanded front cover and comb-type wiring cover.
- Maintenance timer function New Function
  This function can be used as a warning signal for the main circuit capacitor life (expected life). By assigning the maintenance timer to an output terminal and specifying (by parameter setting) the replacement schedule for the capacitor or cooling fan, etc., a warning output occurs when the inverter operation time reaches the setting value, simplifying maintenance.



## 7 Environment Awareness

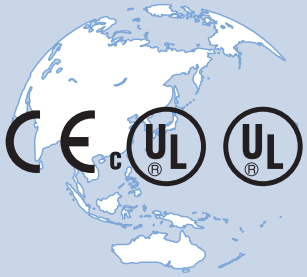
- The popular Soft-PWM control is incorporated as standard. An increase in motor acoustic noise can be reduced, and RFI noise can be suppressed to a minimum.
- Low acoustic noise operation is also possible.
  Low acoustic noise operation is possible by increasing the carrier frequency.
- An optional EMC filter support to comply with European EMC directives.
- Reactor connection to aid harmonic suppression.
  The compact and lightweight DC reactor (FR-BEL-(H)) can be connected. Connect an AC reactor (FR-BAL) when using the single-phase 100V class.

## 8 Wide variety

●Compatible with global specifications.
Compatible with UL, cUL and EN (CE Mark).
IP40 construction is also available.

●Power supply specifications
Compliance with 240V power supplies and 480V power supplies as standard.

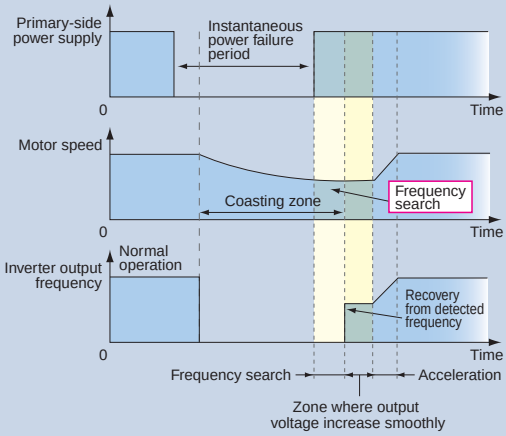
●Single-phase power supply supported.
Single-phase 100V, 200V power supplies are also supported (output is 3-phase 200V).



## 9 Other Handy Functions

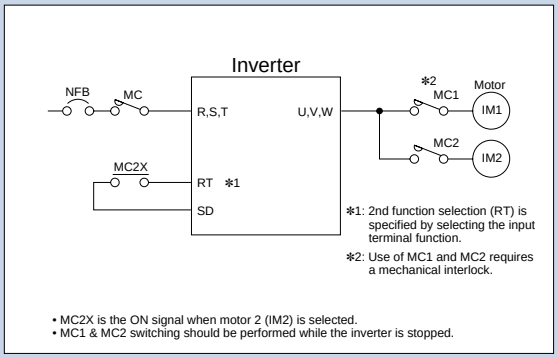
●Restart after instantaneous power failure by frequency search function (New Function)
Even if the motor speed drops due to the machine load, etc., during an instantaneous power failure, the motor speed is detected when power is restored, permitting the motor to be restarted without stopping.
By specifying “frequency detection at each start”, the motor speed is detected each time the START command is received, and at each retry, thus ensuring smooth motor starts.

■When frequency search is enabled




(Refer to the “Restart Function” (Pr.57, Pr.58) for the parameter explanation.)

●Second electronic thermal function (New Function)
When operation includes switching between 2 motors with differing characteristics, the characteristics of each motor can be specified by parameter setting, ensuring that a suitable electronic thermal is selected for the motor being operated. (Selection of the electronic thermal or the second electronic thermal is performed by the “2nd function selection (RT)” signal.)




●Terminal function (15 of speeds, error reset, output stop, etc.) can be selected

●PID control

●4 to 20mA input

●In-rush current suppression circuit is standard for all capacities

●Varied operations are possible.
(Frequency jumps (3 points), JOG operation, etc.)

●Input/output terminal logic (sink/source) switching.
(Supported by a switching connector in the inverter)

## ■Main Function Comparison

○: With Function ×: Without Function

| Functions | FREQROL-S500 Evolution | | | | FREQROL-S500 previous models | | | |
|---|---|---|---|---|---|---|---|---|
| | FR-S520E | FR-S540E | FR-S520SE | FR-S510WE | FR-S520 | FR-S540 | FR-S520S | FR-S510W |
| RS-485 communication function | ○ | | | | Only available at models with RS-485 function | | | |
| Automatic torque boost control function | 5Hz Max. torque of 150% | | | | 6Hz Max. torque of 150% | | | |
| Maintenance timer function | ○ | | | | × | | | |
| Restart after instantaneous power failure by frequency search function | ○ | | | | × | | | |
| Second electronic thermal function | ○ | | | | × | | | |
| Current average value monitor | ○ | | | | × | | | |
| Regenerative brake transistor circuit | ○ (Note 1) | × | | | × | | | |
| Brake transistor error | ○ (Note 1) | × | | | × | | | |
| Brake resistor overheat protection | ○ (Note 1) | × | | | × | | | |
| n6 (communication check interval) default setting status | Communication enabled (Note 2) | Communication enabled | | | Communication disabled | | | |
| Long wiring mode (Pr.70) (Note 3) | Not required | ○ | Not required | | Not required | × | Not required | |

Note 1: Provided with 0.4K to 3.7K capacity types. Note 2: Available on models produced from August, 2004.
Note 3: When set to the “long wiring” mode, 400V Class models offers surge voltage suppression regardless of the wiring length.

# Model Configuration

■Type **FR — S520E — 0.1K —** ☐

| Symbol | Voltage, No. of power supply phases, etc. |
|---|---|
| S510WE | 100V class single-phase input (doubled voltage output) |
| S520E | 200V class 3-phase input |
| S520SE | 200V class single-phase input |
| S540E | 400V class 3-phase input |

| Symbol | Inverter capacity |
|---|---|
| 0.1K to 3.7K | Indicates capacity (kW) |

| Symbol | Construction |
|---|---|
| None | Enclosed type (IP20) |
| C | Totally enclosed structure (IP40) |

## ■Model Configuration

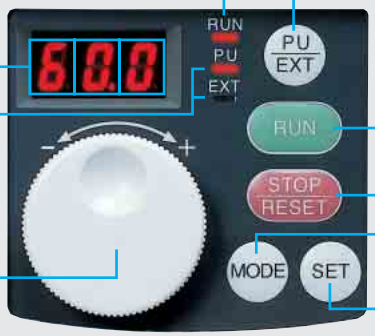
| Power specifications | Inverter type (The inverter capacity is shown in the box.) | Inverter capacity 0.1K | 0.2K | 0.4K | 0.75K | 1.5K | 2.2K | 3.7K |
|---|---|---|---|---|---|---|---|---|
| 3-phase 200V | FR-S520E-☐K | ● | ● | ● | ● | ● | ● | ● |
| | FR-S520E-☐K-C | | | | | | | |
| 3-phase 400V | FR-S540E-☐K | — | — | ● | ● | ● | ● | ● |
| Single-phase 200V (Note) | FR-S520SE-☐K | ● | ● | ● | ● | ● | — | — |
| Single-phase 100V (Note) | FR-S510WE-☐K | ● | ● | ● | ● | — | — | — |

(Note) The output is 3-phase 200V.

● : Available model — : Not available

# Control Panel Explanation

## Control panel




**RUN display**
Shows the operation state.

**3-digit LED monitor**
Shows the parameter number and setting value.

**PU display/EXT display**
Shows operation mode.

**Setting dial**
Sets the frequency, and changes the parameter setting.

**PU/EXT key:** Changes the operation mode.
PU=Control panel operation mode
EXT=External operation mode

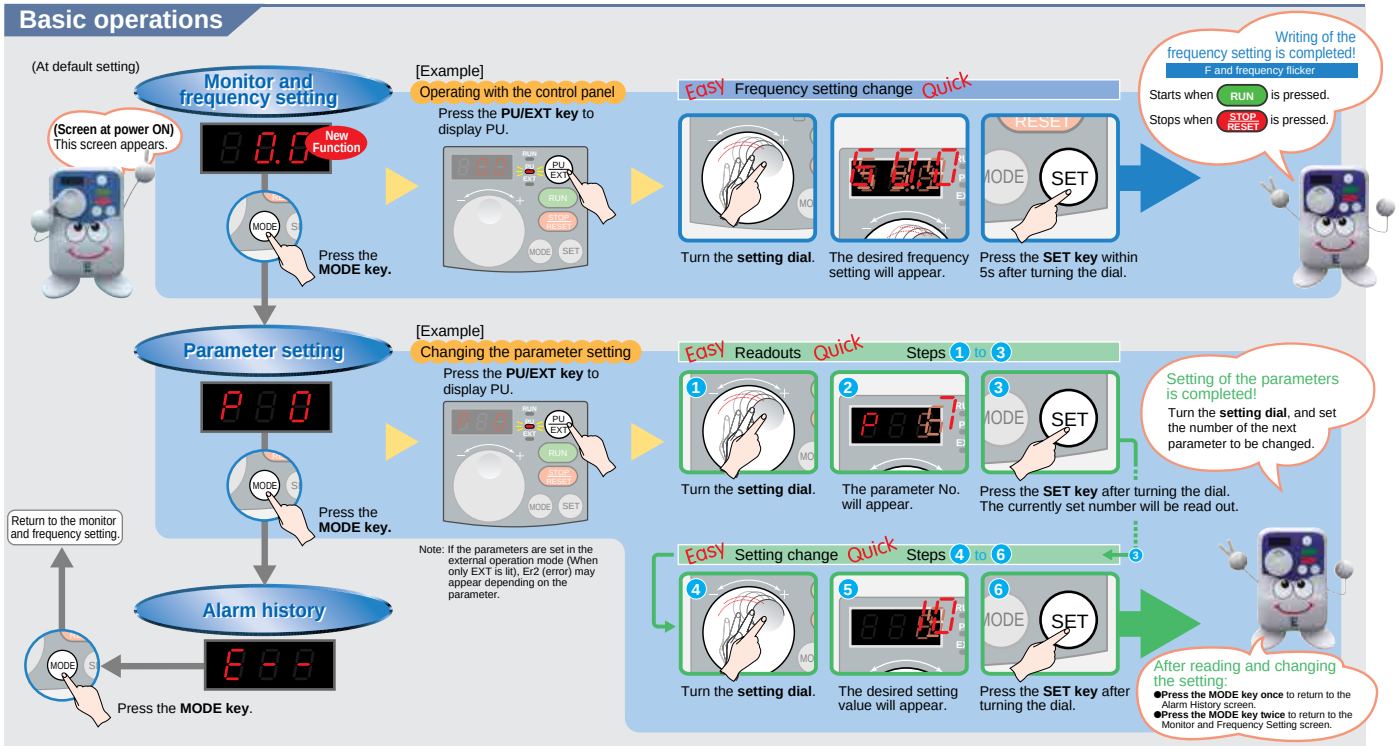
**RUN key:**
Forward run (Can be changed to reverse run with parameter settings.)

**STOP/RESET key:**
Stop/reset (at alarm)

**MODE key:** Changes the setting mode.

**SET key:**
Sets the frequency setting and parameter setting.

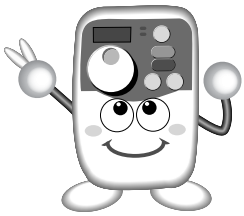
## Basic operations



# General Specifications

| Specifications | | 3-phase 200V | | | | | | | 3-phase 400V | | | | | Single-phase 200V | | | | | Single-phase 100V | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FR-S520E-□□ | | | | | | | FR-S540E-□□ | | | | | FR-S520SE-□□ | | | | | FR-S510WE-□□ | | | |
| Type | | 0.1K | 0.2K | 0.4K | 0.75K | 1.5K | 2.2K | 3.7K | 0.4K | 0.75K | 1.5K | 2.2K | 3.7K | 0.1K | 0.2K | 0.4K | 0.75K | 1.5K | 0.1K | 0.2K | 0.4K | 0.75K |
| Applicable motor capacity (kW) (Note 1) | | 0.1 | 0.2 | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 0.1 | 0.2 | 0.4 | 0.75 | 1.5 | 0.1 | 0.2 | 0.4 | 0.75 |
| Output | Rated capacity (kVA) (Note 2) | 0.3 | 0.5 | 1.0 | 1.6 | 2.8 | 4.0 | 6.6 | 0.9 | 1.6 | 2.7 | 3.7 | 5.9 | 0.3 | 0.5 | 1.0 | 1.6 | 2.8 | 0.3 | 0.5 | 1.0 | 1.6 |
| | Rated current (A) | 0.8 | 1.4 | 2.5 | 4.1 | 7.0 | 10.0 | 16.5 | 1.1 | 2.1 | 3.5 | 4.8 | 7.7 | 0.8 | 1.4 | 2.5 | 4.1 | 7.0 | 0.8 | 1.4 | 2.5 | 4.1 |
| | Overload current rating (Note 3) | 150%60s, 200%0.5s (Inverse time characteristics) | | | | | | | | | | | | | | | | | | | | |
| | Voltage (Note 4) (Note 6) | 3-phase 200 to 240V 50/60Hz | | | | | | | 3-phase 380 to 480V 50/60Hz | | | | | 3-phase 200 to 240V 50/60Hz | | | | | 3-phase 200 to 230V 50/60Hz | | | |
| Power supply | Rated input AC voltage/frequency | 3-phase 200 to 240V 50/60Hz | | | | | | | 3-phase 380 to 480V 50/60Hz | | | | | Single-phase 200 to 240V 50/60Hz | | | | | Single-phase 100 to 115V 50/60Hz | | | |
| | Tolerable AC voltage fluctuation | 170 to 264V 50/60Hz | | | | | | | 325 to 528V 50/60Hz | | | | | 170 to 264V 50/60Hz | | | | | 90 to 132V 50/60Hz | | | |
| | Tolerable frequency fluctuation | Within ±5% | | | | | | | | | | | | | | | | | | | | |
| | Power facility capacity (kVA) (Note 5) | 0.4 | 0.7 | 1.2 | 2.1 | 4.0 | 5.5 | 9 | 1.5 | 2.5 | 4.5 | 5.5 | 9.5 | 0.5 | 0.9 | 1.5 | 2.5 | 4.4 | 0.5 | 0.9 | 1.5 | 2.5 |
| Protective structure (JEM1030) | | Enclosed type (IP20) (Fully enclosed structure series is IP40) | | | | | | | Enclosed type (IP20) | | | | | | | | | | | | | |
| Cooling method | | Self-cooling | | | Forced cooling | | | | Self-cooling | Forced cooling | | | | Self-cooling | | | | Forced cooling | Self-cooling | | | |
| Approximately mass (kg) | | 0.5 | 0.5 | 0.8 | 0.9 | 1.5 | 1.5 | 2.1 | 1.5 | 1.5 | 1.5 | 1.6 | 1.7 | 0.5 | 0.6 | 0.8 | 1.0 | 1.5 | 0.6 | 0.7 | 0.9 | 1.6 |

Notes: 1. The applicable motor indicates the maximum applicable capacity when using a Mitsubishi standard 4-pole motor.
2. The rated output capacity is 230V for the 3-phase 200V output voltage, and 440V for the 3-phase 400V output voltage.
3. The overload current rating percentage indicates the percentage in respect to the inverter's rated output current. When used repeatedly, it is necessary to wait for the inverter motor to return to a temperature less than the temperature for the 100% load.
4. The maximum output voltage will not exceed the power supply voltage for the 3-phase 200V/400V power input specification product and the single-phase 200V power input specification product. The single-phase 100V power input specification product cannot output more than twice the power voltage. The maximum output voltage can be adjusted within the permissible setting range.
However, the peak value of the inverter output's voltage waveform must be approximately $\sqrt{2}$ times the power supply voltage.
5. The power capacity will change according to the power side impedance (including the input reactor or wire) values.
6. For the single-phase 100V power input specification product, when a load is applied on the motor, the output voltage will drop by approx. 10 to 15%.
When using a general-purpose motor, the load must be reduced before use.



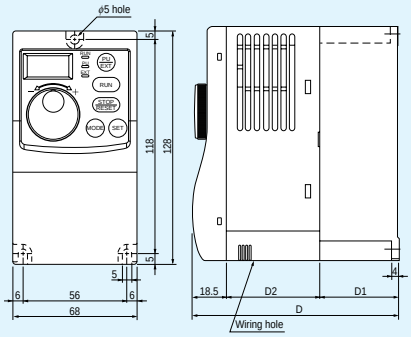
# Common Specifications

| | | | |
|---|---|---|---|
| Control specifications | Control method | | Select from V/F control and automatic torque boost control (Soft-PWM control/high carrier frequency PWM control selective). |
| | Output frequency range | | 0.5 to 120Hz (starting frequency can be varied between 0 to 60Hz) |
| | Frequency setting resolution | | 5VDC input: 1/500 of maximum setting frequency, 10VDC, DC4 to 20mA input: 1/1000 of maximum setting frequency<br>Digital input: 0.1Hz (less than 100Hz), 1Hz (100Hz or more) |
| | Frequency precision | | Analog input: Within ±1% of maximum output frequency (25°C±10°C)<br>Digital input: Within ±0.5% of set output frequency (when setting dial is used) |
| | Starting torque | | 150% (at 5Hz) during automatic torque boost control |
| | Acceleration/deceleration time setting | | 0, 0.1 to 999s (acceleration/deceleration can be set individually), linear or S-pattern acceleration/deceleration mode can be selected |
| | Braking torque | Regenerative (Note 1) | 0.1K, 0.2K··150%, 0.4K, 0.75K··100%, 1.5K··50%, 2.2K 3.7K··20% |
| | | DC braking | Operation frequency (0 to 120Hz), operation time (0 to 10 s), operation voltage (0 to 15%) |
| | Input signals | | Frequency setting signal (0 to 5 (10)VDC), 4 to 20mA, digital setting with setting dial, start signal, error reset (RES), multi-speed selection (RL, RM, RH, REX), 2nd function selection (RT), output stop (MRS), current input selection (AU), external thermal input (OH), start self-hold selection (STOP), JOG mode selection (JOG), PID action selection (X14), PU operation/external operation changeover (X16) |
| | Operation functions | | Upper/lower limit frequency setting, frequency jump operation, external thermal input selection, restart after instantaneous power failure, forward/reverse run prevention, slip compensation, operation mode selection, PID control, computer link operation (RS-485) |
| | Output signals | Operation functions | One type of open collector output can be selected from inverter running (RUN), frequency reached (SU), frequency detection (FU), overload warning (OL), zero current detection (Y13), output current detection (Y12), PID upper limit (FUP), PID lower limit (FDN), PID forward/reverse run (RL), READY (RY), minor failure (LF), Current average value monitor signal (Y93), maintenance timer (Y95), and error (A, B, C). One type can be selected for the contact output (1 contact, 230VAC 0.3A, 30VDC 0.3A). |
| | | For meter | One type can be selected from output frequency or motor current. Pulse train output (1440 pulse/s 1mA full scale). |
| Protection and warning functions | | | Overcurrent (during acceleration, deceleration, and constant speed), regenerative overvoltage (during acceleration, deceleration, and constant speed), overload (electronic thermal relay), fin overheating, fan trouble (Note 4), stall prevention, output side ground fault protection at starting (Note 6), external thermal input (Note 5), PU disconnection, No. of retries exceeded, communication error, CPU error, undervoltage (Note 2), brake transistor error (Note 7), brake resistor overheat protection (Note 7). |
| Environment | Ambient temperature and humidity | | -10°C to +50°C (non freezing), (-10°C to +40°C for fully enclosed structure specifications), 90%RH or less (non condensing) |
| | Storage temperature (Note 3) | | -20°C to +65°C |
| | Atmosphere | | Indoors with no corrosive gases, flammable gases, oil mist or dust |
| | Altitude and vibration | | 1000m or less above sea level, 5.9m/s$^2$ or less (JIS 60068-2-6 compliant) |

Notes: 1. The indicated braking toque is the short-term average torque (which changes with motor loss) when the motor alone is decelerated from 60Hz. It is not the continuous regenerative torque.
Deceleration from frequencies exceeding the base frequency will have a lower average deceleration torque value. Although 3-phase 200V Class inverters (FR-S520E-0.4K to 3.7K) are equipped with a built-in brake transistor, they have no brake resistor. The optional brake resistor should therefore be used in applications where the regenerative energy is large. (Brake resistor cannot be used at the 0.1K, 0.2K types.) A brake unit (BU type) can also be used.
2. If an undervotlage occurs, an error will not be output, but the output will be cutoff. Operation can be resumed after restoring the power, but depending on the operation state (size of load, etc.), the overcurrent protection or regenerative overvoltage protection may function when the power is restored.
3. This is the temperature to which units can be exposed for a short time, such as during transportation.
4. This corresponds only to the products with built-in cooling fan.
5. This functions only when the external thermal input (OH) is selected with Pr.60 to Pr.63 (input terminal function selection).
6. This functions only when Pr.40 (start-time ground fault detection selection) is set to 1.
7. This applies only to 3-phase 200V Class 0.4K to 3.7K types.

# External Dimension Drawings (Unit: mm)

■FR-S520E-0.1K, 0.2K, 0.4K, 0.75K
■FR-S520SE-0.1K, 0.2K, 0.4K, 0.75K
■FR-S510WE-0.1K, 0.2K, 0.4K




3-phase 200V power supply

| Capacity | D | D1 | D2 |
|---|---|---|---|
| 0.1/0.2K | 80.5 | 10 | 52 |
| 0.4K | 112.5 | 42 | 52 |
| 0.75K | 132.5 | 62 | 52 |

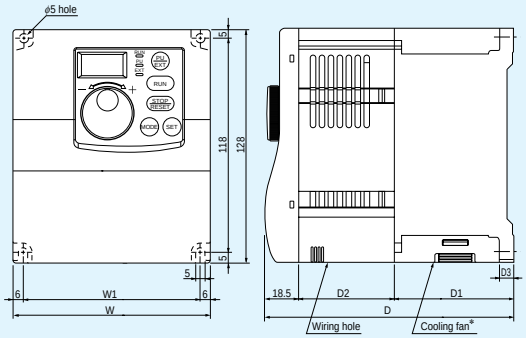
Single-phase 200V power supply

| Capacity | D | D1 | D2 |
|---|---|---|---|
| 0.1/0.2K | 80.5 | 10 | 52 |
| 0.4K | 142.5 | 42 | 82 |
| 0.75K | 162.5 | 62 | 82 |

Single-phase 100V power supply

| Capacity | D | D1 | D2 |
|---|---|---|---|
| 0.1K | 80.5 | 10 | 52 |
| 0.2K | 110.5 | 10 | 82 |
| 0.4K | 142.5 | 42 | 82 |

■FR-S520E-1.5K, 2.2K, 3.7K
■FR-S540E-0.4K, 0.75K, 1.5K, 2.2K, 3.7K
■FR-S520SE-1.5K
■FR-S510WE-0.75K




3-phase 200V power supply

| Capacity | W | W1 | D | D1 | D2 | D3 |
|---|---|---|---|---|---|---|
| 1.5/2.2K | 108 | 96 | 135.5 | 65 | 52 | 8 |
| 3.7K | 170 | 158 | 142.5 | 72 | 52 | 5 |

3-phase 400V power supply

| Capacity | W | W1 | D | D1 | D2 | D3 |
|---|---|---|---|---|---|---|
| 0.4/0.75K | 108 | 96 | 129.5 | 59 | 52 | 5 |
| 1.5K | 108 | 96 | 135.5 | 65 | 52 | 8 |
| 2.2K | 108 | 96 | 155.5 | 65 | 72 | 8 |
| 3.7K | 108 | 96 | 165.5 | 65 | 82 | 8 |

Single-phase 200V power supply

| Capacity | W | W1 | D | D1 | D2 | D3 |
|---|---|---|---|---|---|---|
| 1.5K | 108 | 96 | 155.5 | 65 | 72 | 8 |

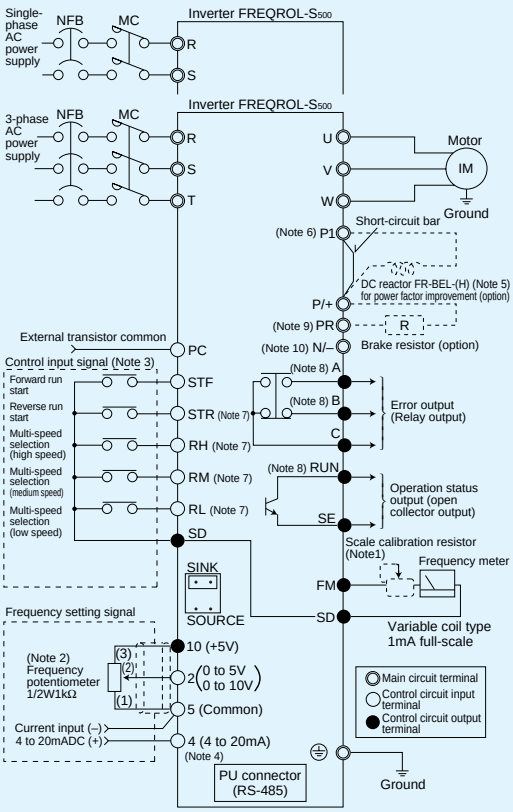
Single-phase 100V power supply

| Capacity | W | W1 | D | D1 | D2 | D3 |
|---|---|---|---|---|---|---|
| 0.75K | 108 | 96 | 149.5 | 59 | 72 | 5 |

*The FR-S510WE-0.75K, FR-S540E-0.4K, 0.75K does not have a cooling fan.

*Outer dimensions are the same as previous FREQROL-S500 Series.

# Terminal Connection Diagram




Notes:
1. This is not required when calibrating with the setting dial. Use this when calibrating the frequency meter manually because the frequency meter is at a remote location etc. Note that when the scale calibration resistor is connected, the needle on the frequency meter may not adjust to the full scale. In this case, calibrate with the setting dial.
2. If the setting unit is used frequently, use the 2W1kΩ potentiometer.
3. Connection example when control circuit logic is sink (default setting).
4. When using the current input for the frequency setting signal, set one of the parameters between Pr. 60 and Pr. 63 (terminal function selection) to 4, and assign one of the terminals RH, RM, RL or STR to AU (current input selection).
5. This cannot be mounted on the single-phase 100V power input specification product.
6. The single-phase 100V power input specification product does not have terminals.
7. The RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, RES, X14 and X16 signals can be selected with the input terminal function selection (Pr. 60 to 63).
8. The RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, Y93, Y95 and A, B, C signals can be selected with the output terminal function selection (Pr. 64, 65).
9. Provided with 3-phase 200V Class (FR-S520E) 0.4K to 3.7K capacity types.
10. Not provided with 3-phase 200V Class (FR-S520E) 0.1 to 0.75 types.

# Explanation of Terminals

| Terminal symbol | | Terminal name | Detailed explanation |
|---|---|---|---|
| Main circuit | R, S, T | Power supply input | Connect to the commercial power supply. |
| | U, V, W | Inverter output | Connect to the 3-phase squirrel cage motor. |
| | N/– | DC voltage common (Note 2) | This is the DC voltage common terminal. It is not insulated from the power supply and inverter output. |
| | P/+, PR | Brake resistor connection (Note 1) | Connect to the optional dedicated brake resistor. |
| | P/+, P1 | Power factor improvement DC reactor connection | Remove the short-circuit bar between terminals P and P1 and connect the optional power factor improvement DC reactor (FR-BEL). (This cannot be connected with the FR-S510WE-□□K) |
| | ⏚ | Grounding | This is for grounding the inverter chassis. Always ground the inverter. |
| Control circuit (input signal) | STF | Forward run start | This functions as the forward run command when the STF signal is ON, and the stop command when the signal is OFF. |
| | STR | Reverse run start | This functions as the reverse run command when the STR signal is ON, and the stop command when the signal is OFF. / If the STF and STR signals turn ON simultaneously, these will function as the stop command. The terminal function will change according to the input terminal selection (Pr. 60 to Pr. 63). Refer to the input signals in the common specifications on page 4 for details on the terminal functions that can be changed. |
| | RH, RM, RL | Multi-speed selection | The multi-speed type can be selected by combining the terminal RH, RM and RL signal short circuits. |
| | SD | Contact input common (sink) | This is the common terminal for the contact input (terminals STF, STR, RH, RM, RL) and meter connection (terminal FM). Terminal 5 and terminal SE are insulated. |
| | PC | External transistor common 24VDC power supply contact input common (source) | When connecting a transistor output (open collector output) such as a programmable controller (PLC), malfunctioning caused by the undesirable current can be prevented by connecting the external power supply (DC24V) common for the transistor output to this terminal. This can be used as the 24VDC 0.1A power supply between terminals PC and SD. When the source logic is selected, this will be the common terminal for the contact input signal. |
| | 10 | Frequency setting power supply | 5VDC. Tolerable load current 10mA. |
| | 2 | Frequency setting (voltage signal) | When 0 to 5VDC (0 to 10V) is input, the maximum output frequency will be reached at 5V (10V), and the input/output will be proportional. Change between 5V and 10V with Pr. 73. The input resistance is 10kΩ, and the maximum tolerable input voltage is 20V. |
| | 5 | Frequency setting input common | This is the common terminal for the frequency setting signal (terminal 2, 4). This is insulated from terminal SD and terminal SE. Do not ground this common. |
| | 4 | Frequency setting (current signal) | Input 4 to 20mA DC. The default setting is adjusted to 0Hz at 4mA and 60Hz at 20mA. The maximum tolerable input current is 30mA, and the input resistance is approximately 250Ω. |
| Control circuit (output signal) | A, B, C, | Error output (relay output) | 1 relay output which indicates that the inverter protective function has activated and the output has stopped. 230VAC 0.3A 30VDC 0.3A. When there is an error, there is non-continuity between B-C (continuity between A-C), and during normal operation, there is continuity between B-C (non-continuity between A-C). / The terminal function will change according to the output terminal function selection (Pr.64, 65). Refer to the output signals in the common specifications on page 4 for details on the terminal functions that can be changed. |
| | RUN | Inverter running | The L level is output when the inverter output frequency is higher than the starting frequency (0.5Hz default can be changed). The H level is output when stopped or during DC braking (Note 3). The tolerable load is 24VDC 0.1A. (Max. voltage drop of 3.4V when ON.) |
| | SE | Open collector common | This is the common terminal for the terminal RUN. This is insulated from terminal 5 and terminal SD. |
| | FM | Display connection | The inverter is set so that the terminals FM to SD will output approximately 1mA at 60Hz (default value). The output frequency is proportional. The output voltage is a pulse waveform, so a digital display can be connected. Pulse specifications: 1440 pulses/s at 60Hz. |
| Communication | – | RS-485 connector | Communication with RS-485 is possible. • Standard compliance: EIA Standards RS-485 • Transmission format: Multidrop link method • Communication speed: Max. 19200 bps • Total length: 500m The parameter unit FR-PU04 can be connected using the parameter unit connection cable FR-CB201 to 205. |

Notes:
1. Provided with 3-phase 200V Class (FR-S520E) 0.4K to 3.7K capacity types.
2. Not provided with 3-phase 200V Class (FR-S520E) 0.1 to 0.75 types.
3. The L level refers to when the open collector output transistor is ON (conducts). The H level refers to when the transistor is OFF (does not conduct).

# List of Parameters

## ■Basic functions <default state>

| Function | Parameter | Name | Setting range | Minimum setting unit | Default setting | Reference page |
|---|---|---|---|---|---|---|
| Basic functions | 0 | Torque boost | 0 to 15% | 0.1% | 6%/5%/4% (Note 3) | 8 |
| | 1 | Maximum frequency | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 2 | Minimum frequency | 0 to 120Hz | 0.1Hz | 0Hz | |
| | 3 | Base frequency | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 4 | Multi-speed (high speed) | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 5 | Multi-speed (medium speed) | 0 to 120Hz | 0.1Hz | 30Hz | |
| | 6 | Multi-speed (low speed) | 0 to 120Hz | 0.1Hz | 10Hz | |
| | 7 | Acceleration time | 0 to 999s | 0.1s | 5s | |
| | 8 | Deceleration time | 0 to 999s | 0.1s | 5s | |
| | 9 | Electronic thermal O/L relay | 0 to 50A | 0.1A | Rated output current (Note 2) | |
| | 30 | Extended function display selection | 0, 1 | 1 | 0 | 9 |
| | 79 | Operation mode selection | 0 to 4, 7, 8 | 1 | 0 | 12 |

By setting parameter 30 to 1, the following function parameters can be set.

## ■Extended functions

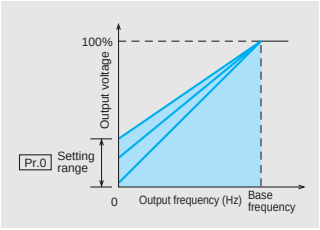
| Function | Parameter | Name | Setting range | Minimum setting unit | Default setting | Reference page |
|---|---|---|---|---|---|---|
| Standard operation functions | 10 | DC injection brake operation frequency | 0 to 120Hz | 0.1Hz | 3Hz | 8 |
| | 11 | DC injection brake operation time | 0 to 10s | 0.1s | 0.5s | |
| | 12 | DC injection brake voltage | 0 to 15% | 0.1% | 6% | |
| | 13 | Starting frequency | 0 to 60Hz | 0.1Hz | 0.5Hz | |
| | 14 | Load pattern selection | 0, 1, 2, 3 | 1 | 0 | |
| | 15 | JOG frequency | 0 to 120Hz | 0.1Hz | 5Hz | 9 |
| | 16 | JOG acceleration/deceleration time | 0 to 999s | 0.1s | 0.5s | |
| | 17 | RUN key rotation direction | 0, 1 | 1 | 0 | |
| | 19 | Base frequency voltage | 0 to 800V, 888, – – – | 1V | – – – | |
| | 20 | Acceleration/deceleration reference frequency | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 21 | Stall prevention function selection | 0 to 31, 100 | 1 | 0 | |
| | 22 | Stall prevention operation level | 0 to 200% | 1% | 150% | |
| | 23 | Stall prevention operation level compensation factor at double speed | 0 to 200%, – – – | 1% | – – – | |
| | 24 to 27 | Multi-speed setting (4-speed) to (7-speed) | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 28 | Stall prevention operation reduction starting frequency | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 29 | Acceleration/deceleration pattern | 0, 1, 2 | 1 | 0 | |
| | 31 | Frequency jump 1A | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 32 | Frequency jump 1B | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 33 | Frequency jump 2A | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 34 | Frequency jump 2B | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 35 | Frequency jump 3A | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 36 | Frequency jump 3B | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| | 37 | Speed display | 0, 0.1 to 999 | 0.1 | 0 | |
| | 38 | Frequency setting voltage gain frequency | 1 to 120Hz | 0.1Hz | 60Hz | |
| | 39 | Frequency setting current gain frequency | 1 to 120Hz | 0.1Hz | 60Hz | |
| | 40 | Start-time ground fault detection selection | 0, 1 | 1 | 0 | |
| Output terminal functions | 41 | Up-to-frequency sensitivity | 0 to 100% | 1% | 10% | 10 |
| | 42 | Output frequency detection | 0 to 120Hz | 0.1Hz | 6Hz | |
| | 43 | Output frequency detection at reverse rotation | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| 2nd functions | 44 | 2nd acceleration/deceleration time | 0 to 999s | 0.1s | 5s | |
| | 45 | 2nd deceleration time | 0 to 999s, – – – | 0.1s | – – – | |
| | 46 | 2nd torque boost | 0 to 15%, – – – | 0.1% | – – – | |
| | 47 | 2nd V/F (base frequency) | 0 to 120Hz, – – – | 0.1Hz | – – – | |
| Current detection | 48 | Output current detection level | 0 to 200% | 1% | 150% | |
| | 49 | Output current detection signal delay time | 0 to 10s | 0.1s | 0s | |
| | 50 | Zero current detection level | 0 to 200% | 1% | 5% | |
| | 51 | Zero current detection time | 0.05 to 1s | 0.01s | 0.5s | |
| Display functions | 52 | Control panel display data selection | 0, 1, 100 | 1 | 0 | |
| | 53 | Frequency setting operation selection | 0, 1 | 1 | 0 | |
| | 54 | FM terminal function selection | 0, 1 | 1 | 0 | |
| | 55 | Frequency monitor reference | 0 to 120Hz | 0.1Hz | 60Hz | |
| | 56 | Current monitor reference | 0 to 50A | 0.1A | Rated output current | |
| Restart | 57 | Restart coasting time | 0 to 5s, – – – | 0.1s | – – – | |
| | 58 | Restart cushion time | 0 to 60s | 0.1s | 1s | |
| Remote setting | 59 | Remote setting function selection | 0, 1, 2 | 1 | 0 | 11 |
| Terminal function selection | 60 | RL terminal function selection | 0 to 10, 14, 16, – – – | 1 | 0 | |
| | 61 | RM terminal function selection | | 1 | 1 | |
| | 62 | RH terminal function selection | | 1 | 2 | |
| | 63 | STR terminal function selection | | 1 | – – – | |
| | 64 | RUN terminal function selection | 0, 1, 3, 4, 11 to 16, 93, 95, 98, 99 | 1 | 0 | |
| | 65 | A, B and C terminal function selection | | 1 | 99 | |

| Function | Parameter | Name | Setting range | Minimum setting unit | Default setting | Reference page |
|---|---|---|---|---|---|---|
| Operation selection functions | 66 | Retry selection | 0, 1, 2, 3 | 1 | 0 | 11 |
| | 67 | Number of retries at alarm occurrence | 0 to 10, 101 to 110 | 1 | 0 | |
| | 68 | Retry waiting time | 0.1 to 360s | 0.1s | 1s | |
| | 69 | Retry count display erase | 0 | 1 | 0 | |
| | 70 | Soft-PWM setting | 0, 1, 10, 11 | 1 | 1 | |
| | 71 | Applicable motor | 0, 1 | 1 | 0 | |
| | 72 | PWM frequency selection | 0 to 15 | 1 | 1 | |
| | 73 | 0 to 5V/0 to 10V selection | 0, 1 | 1 | 0 | |
| | 74 | Input filter time constant | 0 to 8 | 1 | 1 | |
| | 75 | Reset selection/PU stop selection | 0, 1, 14, 15 | 1 | 14 | 12 |
| | 76 | Cooling fan operation selection | 0, 1 | 1 | 1 | |
| | 77 | Parameter write disable selection | 0, 1, 2 | 1 | 0 | |
| | 78 | Reverse rotation prevention selection | 0, 1, 2 | 1 | 0 | |
| Multi-speed operation functions | 80 to 87 | Multi-speed setting (speed 8) to (speed 15) | 0 to 120Hz, ––– | 0.1Hz | ––– | |
| PID control | 88 | PID operation selection | 20, 21 | 1 | 20 | |
| | 89 | PID proportional band | 0.1 to 999%, ––– | 0.1% | 100% | |
| | 90 | PID integral time | 0.1 to 999s, ––– | 0.1s | 1s | |
| | 91 | PID upper limit | 0 to 100%, ––– | 0.1% | ––– | |
| | 92 | PID lower limit | 0 to 100%, ––– | 0.1% | ––– | |
| | 93 | PID control set point during PU operation | 0 to 100%, ––– | 0.01% | 0% | |
| | 94 | PID differential time | 0.01 to 10s, ––– | 0.01s | ––– | |
| Slip compensation | 95 | Motor rated slip | 0 to 50%, ––– | 0.01% | ––– | |
| | 96 | Slip compensation time constant | 0.01 to 10s, ––– | 0.01s | 0.5s | |
| | 97 | Constant power output area slip compensation selection | 0, ––– | 1 | ––– | |
| Automatic torque boost | 98 | Automatic torque boost selection (motor capacity) | 0.1 to 3.7kW/0.2 to 3.7kW, ––– (Note 4) | 0.01kW | ––– | |
| | 99 | Motor primary resistance | 0 to 50Ω, ––– | 0.01Ω | ––– | |
| Communication/ PU function | n1 | Communication station number | 0 to 31 | 1 | 0 | |
| | n2 | Communication speed | 48, 96, 192 | 1 | 192 | |
| | n3 | Stop bit length | 0, 1: (data length 8 bits)<br>10, 11: (data length 7 bits) | 1 | 1 | |
| | n4 | Parity check presence/absence | 0, 1, 2 | 1 | 2 | |
| | n5 | Number of communication retries | 0 to 10, ––– | 1 | 1 | |
| | n6 | Communication check time interval | 0 to 999s, ––– | 0.1s | ––– | |
| | n7 | Wait time setting | 0 to 150ms, ––– | 1 | ––– | 13 |
| | n8 | Operation command write | 0, 1 | 1 | 0 | — |
| | n9 | Speed command write | 0, 1 | 1 | 0 | — |
| | n10 | Link start mode selection | 0, 1 | 1 | 0 | — |
| | n11 | CR/LF selection | 0, 1, 2 | 1 | 1 | 13 |
| | n12 | $E^2$PROM write selection | 0, 1 | 1 | 0 | |
| | n13 | PU display language | 0 to 7 | 1 | 0 | |
| | n14 | PU buzzer sound control | 0, 1 | 1 | 1 | |
| | n15 | PU contrast adjustment | 0 to 63 | 1 | 58 | |
| | n16 | PU main display screen data selection | 0, 100 | 1 | 0 | |
| | n17 | PU disconnection detection/PU operation lock | 0, 1, 10 | 1 | 0 | |
| Maintenance functions | H1 | Maintenance timer | 0 to 999 | 1 (1000h) | 0 | |
| | H2 | Maintenance timer output setting time (Note 5) | 0 to 999, ––– | 1 (1000h) | 36 (36000h) | |
| | H3 | Current average time | 0.1 to 1s | 0.1s | 1s | |
| | H4 | Data output mask time | 0 to 20s | 0.1s | 0s | |
| | H5 | Current average value monitor signal output's reference current | 0.1 to 999A | 0.1A | 1A | |
| Extended functions | H6 | Restart after instantaneous power failure | 0, 1, 10 | 1 | 1 | |
| | H7 | 2nd. electronic thermal | 0 to 50A, ––– | 0.1A | ––– | |
| Regenerative brake (Note 7) | b1 | Regenerative function selection | 0, 1 | 1 | 0 | |
| | b2 | Special regenerative brake duty | 0 to 30% | 0.1% | 0% | |
| Calibration functions | C1 | FM terminal calibration | — | — | — | |
| | C2 | Frequency setting voltage bias frequency | 0 to 60Hz | 0.1Hz | 0Hz | |
| | C3 | Frequency setting voltage bias | 0 to 300% | 0.1% | 0% (Note 6) | |
| | C4 | Frequency setting voltage gain | 0 to 300% | 0.1% | 96% (Note 6) | |
| | C5 | Frequency setting current bias frequency | 0 to 60Hz | 0.1Hz | 0Hz | |
| | C6 | Frequency setting current bias | 0 to 300% | 0.1% | 20% (Note 6) | |
| | C7 | Frequency setting current gain | 0 to 300% | 0.1% | 100% (Note 6) | |
| | C8 | Parameter for manufacturer setting.<br>Do not set. | — | — | — | — |
| Auxiliary functions | CLr | Parameter clear | 0, 1, 10 | 1 | 0 | — |
| | ECL | Alarm history clear | 0, 1 | 1 | 0 | — |

Notes: 1. The shaded parameters can be changed even during operation.
2. This will be 85% of the rated output current for 0.75K or less.
3. 5% for FR-S540E-1.5K, 2.2K types, and 4% for FR-S540E-3.7K type.
4. 0.1 to 3.7kW, ---, for 200V Class, and 0.2 to 3.7kW, ---, for 400V Class.
5. The maintenance timer alarm output time setting (H2) is specified in 1000h units.
6. Setting values may vary for calibration parameters.
7. Provided with FR-S520E-0.4K to 3.7K types.

## Pr.0 Torque boost

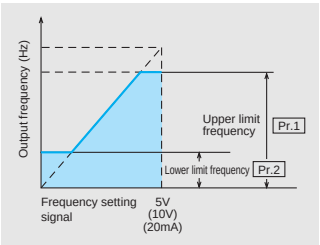
●The motor torque in the low frequency area can be adjusted according to the load.




Notes: 1. When using the dedicated inverter motor (constant torque motor), the settings should be changed as follows.
FR-S520E-0.1K to 0.75K
FR-S540E-0.4K, 0.75K
FR-S520SE-0.1K to 0.75K
FR-S510WE-0.1K to 0.75K } 6%
FR-S520E-1.5K to 3.7K
FR-S540E-1.5K
FR-S520SE-1.5k } 4%
FR-S520E-2.2K, 3.7K : 3%
If Pr.71 is changed to a "constant torque motor" setting with Pr.0 default settings unchanged, the Pr.0 setting switches to the above value.
2. If automatic torque boost control is selected by Pr.98, the Pr.0 setting is ignored.

## Pr.1 to 2 Maximum/Minimum frequency

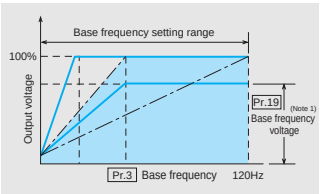
●The output frequency upper and lower limits can be clamped.




Note: If the potentiometer (frequency setting device) connected across terminals 2 & 5 is to be used to specify operation exceeding 60Hz, the Pr.1 and Pr.38 (or Pr.39, if used across terminals 4 & 5) settings must be changed.

## Pr.3 Pr.19 Base frequency

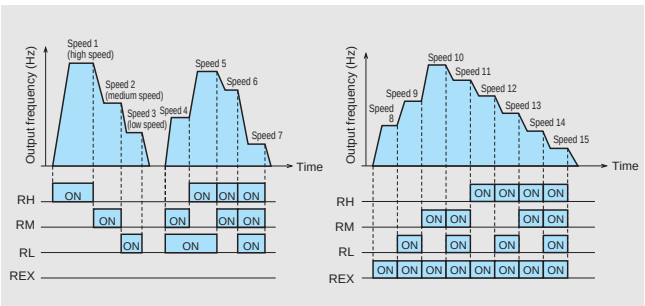
●Set the base frequency (reference frequency for motor rated torque) between 0 and 120Hz according to the motor.




Note: 1. When Pr.19 is set as "888", the max. output voltage will be 95% of the power supply voltage. If Pr.19 is set as "---" (default setting), the max. output voltage will equal to the power supply voltage. At the FR-S510WE-□K model, however, the maximum output voltage will be double the power supply voltage.

## Pr.4 to 6 Pr.24 to 27 Pr.80 to 87 Multi-speed

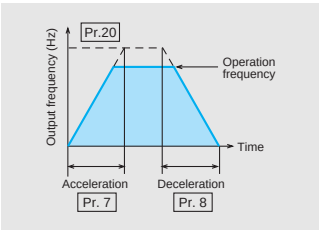
●Speed selection is possible simply by external setting signal switching.
●Speeds (frequencies) can be set as desired within a 0 to 120Hz range during inverter operation.
●Upper frequency limit (Pr.1) and lower frequency limit (Pr.2) settings can be combined for up to 17 speed settings.




Notes: 1. When Pr.24 to 27, and 80 to 87 are set as "---" (default setting), the 4 to 15 speeds (operation) cannot be selected. Moreover, if 2 or more speeds are selected simultaneously, the low-speed terminal's setting frequency is adopted.
2. The multi-speed settings have priority over the main speed (across terminals 2-5 and 4-5, Setting dial). Moreover, when both multi-speed and Setting dial settings are specified while in the joint operation mode (Pr.79=3), the multi-speed setting has priority.
3. Multi-speed setting is possible during both PU operation and external operation.
4. When used jointly with the JOG signal, JOG has priority.
5. The terminals used for REX signal inputs are assigned by the Pr.60 to 63 (terminal function selection) settings.

## Pr.7 to 8 Pr.20 Acceleration/deceleration time

●For the acceleration time Pr. 7, set the time to reach the acceleration/deceleration reference frequency Pr. 20 (default value: 60Hz) from 0Hz, and for the deceleration time Pr. 8, set the time to reach 0Hz from Pr. 20 (default value: 60Hz).



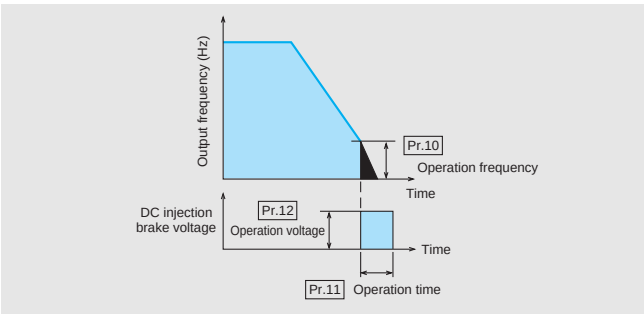

Notes: 1. This is the time required to reach the base frequency (Pr.3) (see Pr.29), when using "S-pattern acceleration/deceleration A".
2. The output frequency that corresponds to frequency setting signal (analog) is specified by Pr.38 or Pr.39.

## Pr.9 Electronic thermal O/L relay

●The setting value to protect the motor from overheating can be set as a current value. Normally, the motor rated current at 50Hz is set. Optimal protection characteristics, including protection for a reduced motor cooling capacity during low-speed operation, can be obtained.
●When 0A is set, the motor protective function will not activate. (The inverter output transistor's protective function will activate.)
●The default setting is the "inverter's rated output current". For 0.1K to 0.75K types, however, the setting is 85% of the inverter's rated output current.
●When connecting multiple motors, set an external thermal relay for each motor.

## Pr.10 to 12 DC braking

●The stopping precision for positioning or similar operations can be adjusted to the load by setting time for which the DC brake torque (voltage) is activated during stopping and the frequency at which the operation is started.



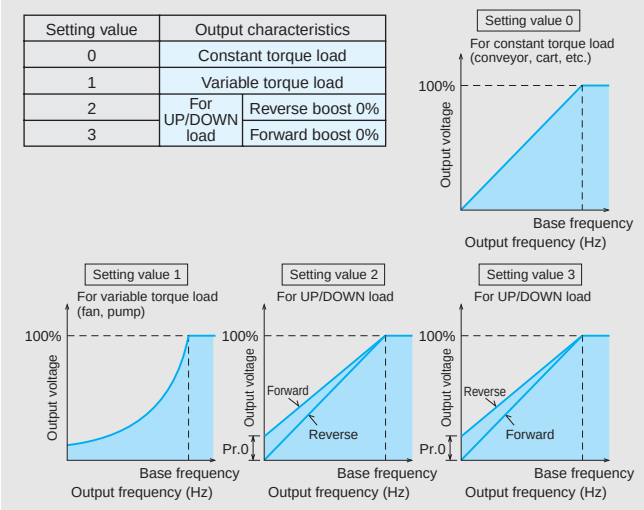

## Pr.13 Starting frequency

●The starting frequency can be set within a 0 to 60Hz range.

## Pr.14 Load pattern selection

●The optimal output characteristics (V/F characteristics) can be selected for the application load conditions in question.

| Setting value | Output characteristics | |
|---|---|---|
| 0 | Constant torque load | |
| 1 | Variable torque load | |
| 2 | For UP/DOWN load | Reverse boost 0% |
| 3 | | Forward boost 0% |



## Pr.15 to 16 JOG operation

●When performing external operation, JOG operation is executed by the JOG and START signals (STF, STR) after selecting the input terminal and JOG functions.
●JOG operation is also executed by selecting the JOG mode at the parameter unit (FR-PU04), and then using the [FWD] and [REV] control panel keys.

(Refer to the Instruction Manual for details.)

## Pr.17 RUN key rotation direction

●Select the rotation direction when using the [RUN] key at the control panel.

| Setting value | Details |
|---|---|
| 0 | Forward |
| 1 | Reverse |

## Pr.19 → Refer to the Pr.3 explanation

## Pr.20 → Refer to the Pr.7 explanation

## Pr.21 Stall prevention function and current limit function

●Selects the operation is enabled or disabled of the stall prevention & high response current limit functions.

| Setting value | Stall prevention, high-response current limit operation |
|---|---|
| 0 | Operation enabled (default setting) |
| 100 | Disabled during regenerative operation |

Note: Additional settings other than those shown above are also available. Refer to the Instruction Manual for details.

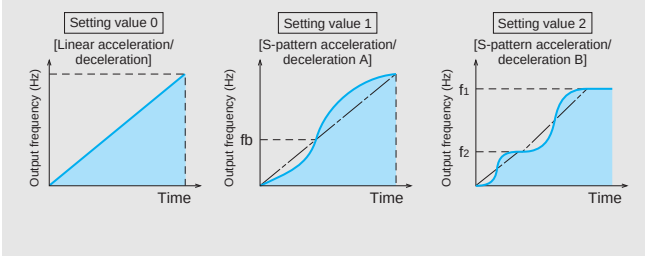
## Pr.22 to 23 Pr.28 Stall prevention operation level setting

●The stall prevention operation level is specified by Pr.22. The standard setting is 150% (default setting).
●At high-speed operations exceeding 60Hz, acceleration may not be possible because the motor current does not increase. In this case, the high-frequency zone's stall prevention operation level can be reduced. The standard setting for Pr.28 is 60Hz, with Pr.23 set to 100%.
●If Pr.23 is set to "---" (default setting), the stall prevention operation level is constant up to 120Hz (Pr.22 setting).

## Pr.24 to 27 → Refer to the Pr.4 explanation

## Pr.29 Acceleration/deceleration pattern selection

●An acceleration/deceleration pattern that is suitable for the application in question can be selected.
● A setting value "0" (linear acceleration/deceleration) is the general acceleration/deceleration pattern, and this is the setting that is normally used.
● A setting value "1" (S-pattern acceleration/deceleration A) is used when momentary acceleration up to the high-speed zone (exceeding the base frequency) is required. "fb" (base frequency) becomes the S-pattern inflection point, and an acceleration/deceleration time can be specified that is suitable for the motor torque reduction in the constant output operation zone exceeding the base frequency. This setting is well suited to machine tool spindle applications.
● A setting value "2" (S-pattern acceleration/deceleration B) results in constant S-pattern acceleration/deceleration from "f2" (current frequency) to "f1" (target frequency), thereby minimizing acceleration/deceleration shocks. This setting is therefore effective for load collapse prevention.




## Pr.30 Extended function display selection

●Set this parameter to display and set the extended function parameters.

| Setting value | Details |
|---|---|
| 0 | Display only basic functions |
| 1 | Display all parameters |

## Pr.31 to 36 Frequency jump

●A resonance frequency jump can be performed to avoid resonance caused by the machine system's inherent vibration. There are 3 jump areas, with jump frequency settings possible at either the top point or bottom point of each jump area.

Notes: 1. A setting of "---" (default setting) disables the frequency jump function.
2. During acceleration/deceleration, the setting range operation frequency is transited.

## Pr.37 Speed display

●The machine operation speed (conveyor speed, etc.) can be displayed as is. The control panel and parameter unit (FR-PU04) monitor's operation speed display units can be specified as appropriate for the speed specifications of the machine in question.
●Set the machine speed that corresponds to a 60Hz operation.

| Setting value | Display content |
|---|---|
| 0 | Output frequency (default setting) is displayed. |
| 0.1 to 999 | • The machine speed at 60Hz operation is displayed. [Ex] If the setting is "950 (m/min)", "950" (no system-of-units displayed) displays at a 60Hz output.<br>• The operation speed units is converted from Hz and displayed. |

Notes: 1.This set units applies only to the PU monitor display and the operation speed setting. Other speed related parameters (Pr.1, etc.) should be set in frequency units.
2.The displayed speed is an output frequency conversion, and does not match exactly with the actual speed.

## Pr.38 Frequency setting voltage gain frequency

●Set the output frequency at the external frequency setting signal is 5VDC (or 10VDC).

Note: A 5VDC (or 10VDC) input across terminals 2 and 5 is not required.

## Pr.39 Frequency setting current gain frequency

●Set the output frequency at the external frequency setting signal is 20mADC.

Note: A 20mA current input across terminals 4 and 5 is not required.

## Pr.40 Start-time ground fault detection selection

●This setting determines whether or not ground fault detection activates at start. Ground fault detection is performed immediately after the inverter's START signal input.

| Setting value | Details |
|---|---|
| 0 | Ground fault detection disabled (default setting) |
| 1 | Ground fault detection enabled<br>Because detection activates at starts, there is an output delay of 20ms after each start. |

Notes: 1. When ground fault detection is performed with Pr.40 set to "1", an error output (GF) is detected, and the output is cut off.
2. The ground fault detection does not activate when ground fault occur during operation.
3. Ground fault protection may not be possible for motors with capacities of less than 0.1kW.

## Pr.41 Up-to-frequency sensitivity

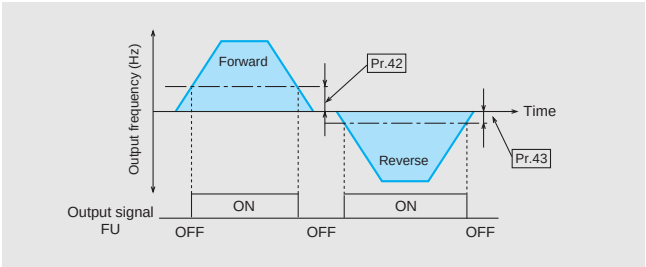
●The operation range of the up-to-frequency signal (SU) that is output when the output frequency reaches the operation frequency, can be adjusted within a 0 to ±100% range relative to the operation frequency.

Note: The terminals used for the up-to-frequency signal (SU) are assigned by Pr.64 and Pr.65 (output terminal function selection).

## Pr.42 to 43 Output frequency detection

●When the output frequency exceeds the value set to the output frequency detection Pr.42, output frequency detection signal (FU) turns to L-level. If the output frequency is less than the Pr.42 setting value, the output is H-level. This signal can be used as the magnetic brake's ON/OFF signal, etc.
●A Pr.43 setting enables dedicated frequency detection for reverse operation. (In this case, the Pr.42 setting value applies only to forward operation.) This is an effective way to change the magnetic brake's operation timing in UP/DOWN operations where forward is UP, and reverse is DOWN. The default setting of "---" specifies the Pr.42 setting value for both forward and reverse operations.

Note: The terminals used for output of the output frequency detection signal (FU) are assigned by the Pr.64 and Pr.65 (output terminal function selection).




## Pr.44 to 47 H7 2nd control functions

●The acceleration/deceleration time and the boost setting, etc., can be changed in a single operation by an external contact signal (across terminals RT-SD).
●This is an effective way to switch between 2 motors with different parameter settings in travel and traverse operations, etc.

| Setting function | | Signal across RT-SD terminals | |
|---|---|---|---|
| | Parameter No. | OFF | ON |
| Acceleration time | Pr.7 | ○ | |
| | Pr.44 | | ○ |
| Deceleration time | Pr.8 | ○ | |
| | Pr.45 | | ○ |
| Torque boost | Pr.0 | ○ | |
| | Pr.46 | | ○ |
| Base frequency | Pr.3 | ○ | |
| | Pr.47 | | ○ |
| Electronic thermal | Pr.9 | ○ | |
| | H7 (Note 1) | | ○ |

Notes: 1. The H7 electronic thermal is selected when the 2nd function is selected.
2. When the Pr.45 setting is "---" (default setting), the Pr.44 setting is adopted for both the 2nd acceleration and deceleration times.
3. In the same manner as for Pr.7 and Pr.8, the Pr.44 and Pr.45 2nd acceleration/deceleration times is the times to or from the Pr.20 setting value (acceleration/deceleration reference frequency).
4. The terminals used for input of the 2nd function selection signal (RT) are assigned by the Pr.60 to Pr.63 (terminal function selection).

## Pr.48 to 49 Output current detection signal

●The output current detection signal (Y12) switches ON when the output current exceeds the level specified by Pr.48 (output current detection level) for a period specified by Pr.49 (output current detection time). Once the output signal switches ON, this status is maintained for a minimum of 100ms.

Note: The terminals used for output of the output current detection signal (Y12) are assigned by the Pr.64 and Pr.65 (output terminal function selection).

## Pr.50 to 51 Zero current detection signal

●The zero current detection signal (Y13) switches ON when the output current falls below the level specified by Pr.50 (zero current detection level) for a period specified by Pr.51 (zero current detection time). Once the output signal switches ON, this status is maintained for a minimum of 100ms even if the output conditions are no longer satisfied.

Note: The terminals used for output of the zero current detection signal (Y13) are assigned by the Pr.64 and Pr.65 (output terminal function selection).

## Pr.52 Pr.54 Monitor display selection

●Selection between 2 signal types is possible by setting the numbers shown in the following table for the monitor and output signals.

| Signal type | Units | Parameter setting value | |
|---|---|---|---|
| | | Pr.52 | Pr.54 |
| | | Control panel monitor display | FM terminal function selection |
| Output frequency | Hz | 0/100 | 0 |
| Output current | A | 1 | 1 |

●If Pr.52 is set as "100", the values displayed when stopped are different from those that display when running.

| | 0 | 100 | |
|---|---|---|---|
| | Running/Stopped | Stopped | Running |
| Output frequency | Output frequency | Setting frequency | Output frequency |

Notes: 1. The control panel's units display is "A" only.
2. For details regarding the parameter unit (FR-PU04) monitor display selection, refer to the "n16" communication parameter item "PU main display screen data selection".

## Pr.53 Frequency setting operation selection

●Operation is possible by turning the Setting dial like a potentiometer.
●When set as "1", frequency setting is possible when running and when stopped, simply by turning the Setting dial.

| Setting value | Details |
|---|---|
| 0 | Setting dial frequency setting mode |
| 1 | Setting dial potentiometer mode |

## Pr.55 Pr.56 Monitor reference

●When Pr.54 is set as "0" (output frequency), Pr.55 specifies a 1440 pulse/s output frequency (1440 pulse/s pulse train output across terminals FM-SD).
●When Pr.54 is set as "1" (output current), Pr.56 specifies a 1440 pulse/s output current (1440 pulse/s pulse train output across terminals FM-SD).

Note: 1. The maximum pulse train for terminal FM is 2400 pulse/s.

## Pr.57 Pr.58 H6 Restart after instantaneous power failure

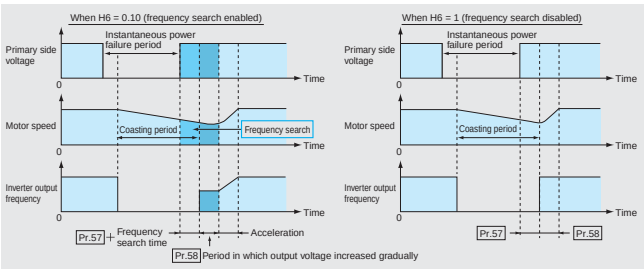
●When power is recovered following an instantaneous power failure, the inverter can be started without stopping the motor (coasting status is maintained).
●Restart coasting time Pr.57

| Setting value | Restart operation enabled/disabled |
|---|---|
| --- (default setting) | Disabled |
| 0, 0.1 to 5 (Note) | Enabled |

The "coasting time" refers to the period following power recovery during which the inverter waits for restart.
Note: When Pr.57 is set as "0", the standard coasting time shown below is adopted.
Generally speaking, operation is possible with this setting, but the time can be adjusted within a 0 to 5s range in accordance with the load's moment of inertia ($GD^2$) and the amount of torque.
0.1K to 1.5K…0.5s 2.2K, 3.7K…1.0s

●Restarting time Pr.58
Normally, operation is possible with the default setting, but the output voltage cushion time can be adjusted in accordance with the load specifications (moment of inertia, amount of torque).
●Instantaneous power failure restart selection H6

| Setting value | Details |
|---|---|
| 0 | Frequency search ENABLED<br>Motor coasting speed detection activats after power failure is detected. |
| 1 | Frequency search DISABLED (default setting)<br>The frequency that existed prior to the instantaneous power failure is output regardless of the motor's coasting speed, with the output voltage being increased gradually in a reduced voltage start format. |
| 10 | Frequency search ENABLED at each start<br>The motor coasting speed is detected after a power failure detection. Also, it is detected at every start. |

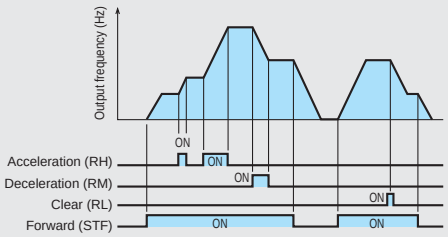



Notes: 1. A frequency search cannot be performed properly when multiple motors are connected to a single inverter. In such configurations, the frequency search function should be disabled (H6=1).
2. If the "restart after instantaneous power failure" continues for 0.2s or longer with the frequency search function disabled (H6=1), the status (output frequency, rotation direction) that existed prior to the instantaneous power failure cannot be retained in memory, and the inverter is therefore started from the Pr.13 starting frequency.
3. If the frequency search is enabled (H6=0.10), and if the frequency search result is less than 10Hz, the inverter is started from the Pr.13 starting frequency.
4. If a special motor is being used, making it impossible to perform a frequency search even though the frequency search is enabled (H6=0.10), the inverter may be started from the Pr.13 starting frequency.

## Pr.59 Remote setting function selection

●"1" or "2" can be specified for Pr.59 to change the input functions of terminals RH, PM, and RL to the "acceleration", "deceleration", and "setting clear" functions (same as the remote setting box (FR-FK) functions).

Note: 1. If an open status continues for approximately 1 minute or longer across terminals RH-SD and RM-SD, or if the start signal switches OFF, the operation frequency at that point is saved in memory. If "1" is set at Pr.59, operation is resumed in accordance with this setting value even if the power is switched OFF and back ON again.




## Pr.60 to 63 Input terminal function selection

●The Pr.60 to Pr.63 settings can specified as 0 to 10, 14, 16, ---, to assign desired functions to the input terminals.

| Pr.No. | Name | Terminal name |
|---|---|---|
| 60 | RL terminal function selection | RL |
| 61 | RM terminal function selection | RM |
| 62 | RH terminal function selection | RH |
| 63 | STR terminal function selection | STR |

| Setting value | Signal Name | Terminal function description | | | |
|---|---|---|---|---|---|
| 0 | RL | Pr.59 =0 | Low-speed operation command | Pr.59 =1, 2 | Remote setting (Setting clear) |
| 1 | RM | | Medium-speed operation command | | Remote setting (Deceleration) |
| 2 | RH | | High-speed operation command | | Remote setting (Acceleration) |
| 3 | RT | 2nd function selection | | | |
| 4 | AU | Current input selection | | | |
| 5 | STOP | Start self-hold selection | | | |
| 6 | MRS | Output cutoff stop | | | |
| 7 | OH | External thermal input (Note 1) | | | |
| 8 | REX | 15 speed selection (combinations of the RL, RM, RH signals) (Note 2) | | | |
| 9 | JOG | JOG operation selection | | | |
| 10 | RES | Reset | | | |
| 14 | X14 | PID control enable/disable selection | | | |
| 16 | X16 | PU/external operation switching | | | |
| --- | STR | Reverse start (Note 3) | | | |

Notes: 1. Operation occurs at relay contact (open).
2. When the REX signal is used, a reverse start by external command is not possible.
3. Assignable only by Pr.63.

## Pr.64 Pr.65 Output terminal functions selection

●The Pr.64 and Pr.65 settings can specified as 0 to 99, to assign desired functions to the output terminals (including relays).

| Pr.No. | Name | Terminal name |
|---|---|---|
| 64 | RUN terminal function selection | RUN |
| 65 | A, B, C terminal function selection | A, B, C |

| Setting value | Signal name | Terminal function description |
|---|---|---|
| 0 | RUN | Inverter running |
| 1 | SU | Frequency reached |
| 3 | OL | Overload warning |
| 4 | FU | Output frequency detection |
| 11 | RY | Inverter ready |
| 12 | Y12 | Output current detection |
| 13 | Y13 | Zero current detection |
| 14 | FDN | PID lower limit |
| 15 | FUP | PID upper limit |
| 16 | RL | PID forward/reverse output |
| 93 | Y93 | Current average value monitor signal (Note 1) |
| 95 | Y95 | Maintenance timer warning |
| 98 | LF | Minor fault output |
| 99 | ABC | Alarm output |

Note: 1. Setting is possible only by Pr.64.

## Pr.66 to 69 Retry function

●When an inverter alarm occurs, the retry function allows the inverter to automatically reset the alarm and restart, thereby resuming operation.
●The alarms for which retries occur can be selected by Pr.66.

| Setting value | Alarms for which retries are performed |
|---|---|
| 0 | Retries occur for all alarms except the following: Fin overheat (FIN), PU disconnected (PUE), Retry count exceeded (RET), CPU error (CPU). |
| 1 | Overcurrent cutoff (OC1 to 3) |
| 2 | Regenerative overvoltage cutoff (OV1 to 3) |
| 3 | Overcurrent cutoff (OC1 to 3), regenerative overvoltage cutoff (OV1 to 3) |

●The Pr.67 setting specifies the number of retry attempts (retry count) when an alarm occurs.

| Setting value | Retry count | Alarm error signal output |
|---|---|---|
| 0(default setting) | No retry is performed | ---------- |
| 1 to 10 | 1 to 10 times | Output when the retry count is exceeded. |
| 101 to 110 | 1 to 10 times | Output each time. |

●The Pr.68 setting specifies the waiting period (0.1 to 360s) from an inverter alarm until the retry is performed.
●A Pr.69 readout can be performed to obtain the cumulative retry count until the restart succeeded. This cumulative count is cleared by entering a setting of "0".

Notes: 1. Because the inverter is automatically started after the retry waiting period specified by Pr.68 has expired, the operator should exercise care when using this function in order to avoid injury.
2. The reset which accompanies a restart by the retry function does not clear electronic thermal data, etc., that has been stored. (Differs from a power-on reset.)

## Pr.70 Pr.72 Motor noise change

●The Pr.70 setting can be used to change the motor noise tone by enabling/disabling the Soft-PWM control function. Soft-PWM control changes the motor noise from a metallic tone to a complex tone that is more pleasant to the ear.
●When the long wiring mode is specified at 400V Class inverters, the surge voltage can be suppressed regardless of the wiring length.

| Pr.70 setting | Description | | |
|---|---|---|---|
| | Soft-PWM | Long wiring mode | Remarks |
| 0 | Disabled | Disabled | – |
| 1 | Enabled When Pr.72 = 0 to 5 | Disabled | – |
| 10 | Disabled | Enabled | • When Pr.72=0 or 1, the PWM carrier frequency remains constant at 0.7Hz. • When Pr.72=2 or more, the PWM carrier frequency remains constant at 1kHz. |
| 11 | Enabled | Enabled | |

●The PWM carrier frequency can be specified by the Pr.72 setting. A lower PWM carrier frequency increases the motor noise, but reduces the RFI noise and current leakage from the inverter.
●The Pr.72 setting range is 0 to 15. A setting of "0" specifies a "0.7kHz" frequency, and a setting of "15" specifies a "14.5kHz" frequency. All other setting values correspond directly to the resulting kHz frequencies.

## Pr.71 Applicable motor selection

●When using a Mitsubishi constant-torque motor, Pr.71 should be set to "1" for both V/F control and automatic torque boost control.
The electronic thermal is set in accordance with the constant-torque motor's thermal characteristics.

| Setting value | Electronic thermal's thermal characteristics | Motor | |
|---|---|---|---|
| | | Standard | Constant torque |
| 0, 100 | Thermal characteristics conform to standard motor | ○ | |
| 1, 101 | Thermal characteristics conform to Mitsubishi's constant-torque motor | | ○ |

Note: 1. When set to 100 or 101, the electronic thermal conforms to thermal characteristics of Mitsubishi's constant torque motor when the RT signal switches ON.

## Pr.73 Frequency command voltage range selection

●The input (terminal 2) specifications can be switched to conform to the frequency setting voltage signal. Be sure to specify this setting when using 0 to 10VDC inputs.
Pr.73=0: 0 to 5V DC input (default setting)
Pr.73=1: 0 to 10V DC input

## Pr.74 Input filter time constant

●This setting specifies the time constant setting for the internal filter at the external voltage or current frequency setting signal input. This setting is effective in eliminating frequency setting circuit noise.
●When stable operation is not possible due to noise, increase the filter time constant setting. A higher setting value results in a slower response.

## Pr.75 Reset selection/PU stop selection

●A reset function or PU (control panel) stop key function can be selected.
●Reset selection: The reset function input (RES signal) timing can be selected.
●PU stop selection: Regardless of the operation mode, the motor can be decelerated to a stop by pressing the control panel's [Stop] key.

| Setting value | Reset selection | PU stop selection |
|---|---|---|
| 0 | Input always enabled | PU's [Stop] key is disabled.<br>A [Stop] key is enabled, however, in the PU operation mode or combined mode (Pr.79=4). |
| 1 | Input enabled only when protective function is operating | |
| 14 | Input always enabled | By pressing the [stop] key, the motor can be decelerated to a stop in any of the operation modes (PU, External, Communication). |
| 15 | Input enabled only when protective function is operating | |

Notes: 1. If the reset input (RES) occurs during operation, the inverter stops all outputs while being reset, the electronic thermal's internal thermal count value, and the retry count value, etc., are also reset, and a motor coasting stop occurs.
2. The control panel's [Reset] key is enabled only when the protective function is operating, regardless of the Pr.75 setting.

## Pr.76 Cooling fan operation selection

●Operation of the inverter's internal cooling fan can be controlled. (The presence or absence of a cooling fan depends on the unit's capacity.)

| Setting value | Fan operation |
|---|---|
| 0 | Operates when power is ON. (Default setting) |
| 1 | ON/OFF control is performed.<br>(Fan is always ON when the inverter is running. When the inverter is stopped, the fan switches ON/OFF according to the temperature.) |

## Pr.77 Parameter writing disable selection

●Parameter writing can be enabled/disabled in order to prevent parameter settings from accidentally being rewritten.

| Setting value | Function |
|---|---|
| 0 | Writing permitted only when stopped in the PU operation mode. |
| 1 | Parameter writing disabled (Note 1). |
| 2 | Writing permitted even during operation (Note 2). |

Notes: 1. Pr.22, Pr.30, Pr.75, Pr.77, Pr.79 writing permitted.
2. Even if Pr.79=2, writing to the following parameters is disabled during operation: Pr.17, Pr.23, Pr.28, Pr.60 to Pr.65, Pr.71, Pr.79, Pr.98, Pr.99, CLr.

## Pr.78 Reverse rotation prevention selection

●Prevents problems caused by reverse operation when an erroneous start input occurs.

| Setting value | Details |
|---|---|
| 0 | Both forward and reverse are enabled (default setting) |
| 1 | Reverse disabled |
| 2 | Forward disabled |

## Pr.79 Operation mode selection

●The inverter operation modes include operation with external signal and operation with the PU (setting dial, touch keys). The mode can be fixed to one mode, or two modes can be used together.
(Refer to the Instruction Manual for details.)

| Setting value | Details | |
|---|---|---|
| 0 | PU (setting dial, touch key) operation or external operation can be changed by pressing PU/EXT key on the control panel. | |
| 1 | Operation is possible only with PU (setting dial, touch key). | |
| 2 | Only external operation is possible. | |
| 3 | Operation frequency | Starting signal |
| | • Setting with setting dial<br>• Multi-speed selection<br>• 4 to 20mADC input | External terminal (STF/STR) |
| 4 | Operation frequency | Starting signal |
| | External terminal signal (Multi-speed, 0 to 5VDC, etc.) | RUN key |
| 7 | PU operation interlock | |
| 8 | Operation mode external signal changeover<br>Select operation mode by turning PU operation/external operation mode changeover (X16) signal ON and OFF. | |

## Pr.80 to 87 → Refer to the Pr.4 explanation

## Pr.88 to 94 PID control

●Processes involving flow rates, airflow volumes, and pressures, etc., can be controlled. This is accomplished by using the voltage input signal or digital setting value as the target value, with a 4 to 20mA current input signal providing PID control as a feedback amount.
(Refer to the Instruction Manual for details.)

## Pr.95 to 97 Slip compensation

●The motor's slip is estimated based on the inverter's output current and the motor speed is maintained constant.

| Parameter | Function name | Function explanation | Default setting |
|---|---|---|---|
| 95 | Motor rated slip | Sets the motor rated slip. | ––– |
| 96 | Slip compensation response time | Sets the slip compensation response time. (Note 1) | 0.5s |

$$\text{Rated slip} = \frac{\text{synchronous speed at base frequency} - \text{rated rotation speed}}{\text{synchronous speed at base frequency}} \times 100\ [\%]$$

●The Pr.97 setting determines whether or not slip compensation is applied to the constant power output range (frequency range that exceeds the frequency specified by Pr.3).

| Setting value | Function |
|---|---|
| 0 | No slip compensation in constant power output range. |
| ––– | Slip compensation applied in constant power output range. (Default setting) |

Notes: 1. Although a smaller setting value results in faster responsiveness, the larger the load inertia, the more likely that a regenerative overvoltage (OVT) alarm will occur.
2. Slip compensation is disabled by a Pr.95 setting of "---" or "0".

## Pr.98 Automatic torque boost selection

●Automatic torque boost control can be selected.

| Setting value | Details |
|---|---|
| ––– | Usual V/F control and torque boost (Pr.0, Pr.46) enabled |
| 0.1 to 3.7K | Automatic torque boost control enabled<br>(specify the applicable motor capacity) |

Note: The following restrictions apply when using automatic torque boost control.
1. The motor capacity must either be the same as the inverter capacity, or 1 rank below the inverter capacity.
2. The motor polarity must be a 2-pole, 4-pole, or 6-pole type.
3. The motor must operate singly (1 motor per inverter).
4. The wiring distance from the inverter to the motor must not exceed 30m.
Acceptable operation characteristics may not be obtained if the above conditions are not met.

## Pr.99 Motor primary resistance

●The motor primary resistance constant can be set manually.
(Refer to the Instruction Manual for details.)
●Normally, this setting is not required.

| Setting value | Details |
|---|---|
| ––– | The standard motor constant (including constant-torque motors) for the motor capacity specified by Pr.98 is adopted. |
| 0 to 50Ω | The motor primary resistance value is specified. |

## n1 to 7 n11 n12 RS-485 communication

●An RS-485 communication operation is possible.
The following parameter settings are required in order to perform an RS-485 communication operation.
(Refer to the Instruction Manual for details.)

| Parameter | Name | Setting value | Details |
|---|---|---|---|
| n1 | Communication station No. | 0 to 32 | Sets the inverter's station No. |
| n2 | Communication rate | 48, 96, 192 | 48:4800bps, 96:9600bps, 192:19200bps |
| n3 | Stop bit length | 0 | Stop bit length: 1 bit, data length: 8 bits |
| | | 1 | Stop bit length: 2 bit, data length: 8 bits |
| | | 10 | Stop bit length: 1 bit, data length: 7 bits |
| | | 11 | Stop bit length: 2 bit, data length: 7 bits |
| n4 | Parity check enabled/disabled | 0, 1, 2 | 0: Parity check disabled, 1: Odd parity, 2: Even parity |
| n5 | Number of communication retries | 0 to 10 | Sets the permissible number of retries when a communication error occurs. |
| | | ––– | Communication error detection disabled. |
| n6 | Communication check time interval | 0 | Communication disabled |
| | | 0.1 to 999 | Sets the communication time interval. (Units: s) |
| | | ––– | Stop communication check |

| Parameter | Name | Setting value | Details |
|---|---|---|---|
| n7 | Waiting time setting | 0 to 150 | Specifies the waiting time from transmission to the inverter until the reply. (Units: ms) |
| | | ––– | Specifies the waiting time from transmission to the inverter until the reply by the communication setting. |
| n11 | CR-LF enabled/ disabled selection | 0, 1, 2 | 0: CR, LF disabled, 1: CR enabled, 2: CR and LF enabled |
| n12 | $E^2$PROM write selection | 0 | Writing to RAM and $E^2$PROM. |
| | | 1 | Writing to RAM only. No writing to $E^2$PROM. |

## n13 PU display language

●The parameter unit (FR-PU04) display language can be selected as follows:
0: Japanese, 1: English, 2: German, 3: French, 4: Spanish, 5: Italian, 6: Swedish, 7: Finnish.
These settings are enabled when using the optional FR-PU04 unit.

## n14 PU buzzer sound control

●This setting determines whether or not a buzzer sounds when a key input occurs at the optional parameter unit (FR-PU04).

| Setting value | Details |
|---|---|
| 0 | Buzzer disabled |
| 1 | Buzzer enabled (default setting) |

## n15 PU contrast adjustment

●The LCD contrast can be adjusted at the optional parameter unit (FR-PU04).

| Setting value | Details |
|---|---|
| 0 | Light |
| to | to |
| 63 | Dark |

## n16 PU main display screen data selection

●This setting selects the data that displays at the optional parameter unit (FR-PU04) main display screen.
●A setting of "0" or "100" is possible.
●When set to "100", the values displayed when stopped are different from those that display when running.

| | 0 | 100 | |
|---|---|---|---|
| | Running/running | Stopped | Running |
| Output frequency | Output frequency | Setting frequency | Output frequency |
| Output current | Output current | | |
| Alarm display | Alarm display | | |

Notes:1. When an alarm status exists, the alarm output frequency display appears.
2. An "MRS in progress" status is handled in the same manner as a "Stopped" status.

## n17 PU disconnection detection/PU operation lock

●The parameter unit (FR-PU04) connector disconnection detection function and the parameter unit (FR-PU04) operation lock can be selected.

| Setting value | PU disconnection detection | PU operation lock |
|---|---|---|
| 0 | Operation continues even if PU is disconnected (PU disconnection detection disabled) | PU operation enabled |
| 1 | Inverter outputs are stopped when PU is disconnected (PU disconnection detection enabled) | |
| 10 | Operation continues even if PU is disconnected (PU disconnection detection disabled) | PU operation disabled |

## H1 H2 Maintenance timer function

●The maintenance timer warning signal (Y95) output occurs when the inverter's cumulative power ON time (H1 maintenance timer) reaches the time value specified by the maintenance warning output setting time (H2).
●This signal can be used as a main circuit smoothing capacitor life warning (expected life), etc.

Note: 1. The terminals used for the maintenance timer warning signal (Y95) are assigned by the Pr.64 and Pr.65 settings (output terminal function selection).

## H3 to 5 Current average value monitor signal

●The output current average value during constant speed operation and the maintenance timer value (H1) are output as pulse outputs at the current average value monitor signal (Y93).
●If input to a programmable controller's I/O unit, etc., the pulse width can be measured to detect output current increases caused by peripheral device wear or stretched belts, etc., and can be used as a maintenance schedule guideline for peripheral equipment.

Note: 1. The terminals used for the current average value monitor signal (Y93) are assigned by the Pr.64 and Pr.65 settings (output terminal function selection).

## H6 → Refer to the Pr.57 explanation

## H7 → Refer to the Pr.44 explanation

## b1 b2 Regenerative braking duty

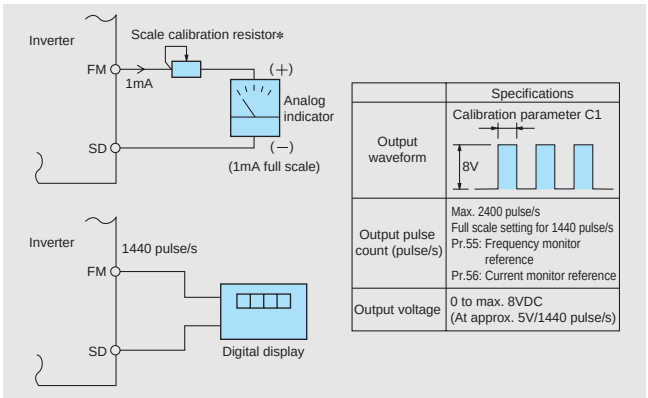
●When frequent starts and stops occur at inverters with capacities of 0.4kW or more, an optional brake resistor can be used to increase the duty of regenerative braking.

| Parameter | Name | Setting range | Details |
|---|---|---|---|
| b1 | Regenerative function selection | 0 | Brake resistor (MRS type)<br>Brake unit (BU type)<br>High power factor converter (FR-HC)<br>Power regeneration common converter (FR-CV) |
| | | 1 | High duty brake resistor (FR-ABR)<br>Brake resistor (MYS type) |
| b2 | Special regenerative brake duty | 0 to 30% | Sets the %ED for the built-in brake transistor operation. |

Notes:1. Provided on FR-S520E-0.4K to 3.7K types.
2. When set as b1=0, b2 is disabled.
3. When an MRS type brake resistor is used, the rate of regenerative braking use is 3%.
4. When a high duty brake resistor is used, b1=1 and b2=10% settings should be specified.
5. When an MYS type brake resistor is used, b1=1 and b2=6% settings should be specified. In this case, only the 3.7K type can be used.
6. Brake resistors cannot be connected to 0.1K and 0.2K types.

## C1 Terminal FM output calibration

●The meter connected to the FM terminal can be calibrated from the control panel. This calibration applies to all monitoring selected at Pr.54.
●Although the FM terminal output is a pulse output as shown below, the C1 setting permits scale calibration of the meter connected to the inverter to be performed from the control panel, without requiring a scale calibration resistor. (Refer to the Instruction Manual for calibration details.)
●Monitoring by digital display
The FM terminal pulse train output can be used for a digital display by the digital counter. With the full scale value explained at the Pr.54, the output is 1440 pulse/s. For operation frequency monitoring, this FM terminal's output frequency percentage can be specified by Pr.55.



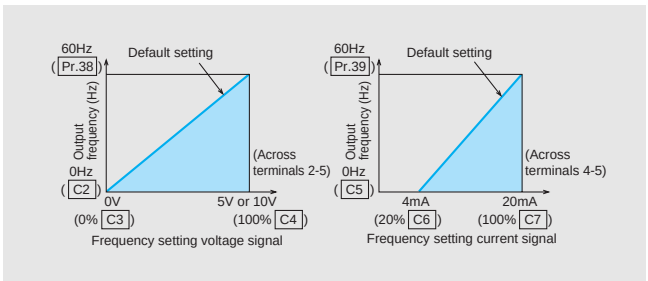

Note: The default setting for 60Hz is full scale at 1mA, with an FM output frequency of 1440 pulse/s.

## C2 to 7 Frequency setting signal gain and bias adjustment

●The output frequency level (slope) can be specified as desired relative to the external frequency setting signal (0 to 5V, 0 to 10V, or 4 to 20mA).
●Gain and bias adjustment points

| Item | Item to be adjusted | Adjustment parameter No. |
|---|---|---|
| 1 | 0 to 5VDC (0 to 10VDC) input bias adjustment | C2, C3 |
| 2 | 0 to 5VDC (0 to 10VDC) input gain adjustment | Pr.38, C4 |
| 3 | 4 to 20mADC input bias adjustment | C5, C6 |
| 4 | 4 to 20mADC input gain adjustment | Pr.39, C7 |

Notes: 1. For 4 to 20mADC inputs, assign the AU signal (current input selection) at one of the Pr.60 to Pr.63 parameters (input terminal function selection), then turn the AU signal ON.
2. Er3 will occur at the parameter writing if the analog input gain and bias calibration values are too close.



## Protective Functions

Although the protective functions shown below are designed to protect the inverter itself (excluding the motor electronic thermal), these functions may also be activated if an inverter failure occurs.

| Protective function name | | Description | | Display |
|---|---|---|---|---|
| Overcurrent | | If the inverter's output current exceeds approximately 200% of the rated current during acceleration/deceleration and constant-speed operation, a protective circuit is activated, and the inverter outputs are stopped. | Accelerating | OC1 (OC1) |
| | | | Constant speed | OC2 (OC2) |
| | | | Decelerating | OC3 (OC3) |
| Regenerative overvoltage | | If the inverter's internal main circuit DC voltage exceeds the prescribed level due to regenerative energy during braking, a protective circuit is activated, and inverter outputs are stopped. The protective circuit may also be activated by surge voltage in the power supply system. | Accelerating | Ou1 (OV1) |
| | | | Constant speed | Ou2 (OV2) |
| | | | Decelerating | Ou3 (OV3) |
| Overload (electronic thermal overcurrent protection) (Note 1) | Motor | The inverter's internal electronic thermal detects motor overheating caused by overloads or by reduced cooling capacity during low-speed operation, and inverter outputs are stopped. When using multi-pole motors or when running multiple motors, be sure to install a thermal relay at the inverter's output side. | | THM (THM) |
| | Inverter | If a current equivalent to 150% of the rated output current occurs, but is not high enough to trigger an overcurrent cutoff (200% or less), the electronic thermal operates with inverse-time characteristics to protect the output transistor, and inverter outputs are stopped. | | THT (THT) |
| Heatsink overheat | | If the heatsink overheats, a temperature sensor is activated, and inverter outputs are stopped. | | FIn (FIN) |
| Fan trouble (Note 5) | | When the inverter's internal fan fails (stops), "FN" displays at the control panel, but inverter outputs are not stopped. | | Fn (FN) |
| Ground fault overcurrent protection at starts | | If a ground fault occurs (with ground fault overcurrent) at the inverter output side (load side) when the inverter is started, the inverter outputs are stopped. This protection is enabled when Pr.40 (start-time ground fault detection selection) is set to "1". | | GF (GF) |
| External thermal relay (Note 2) | | When a motor's external overheat protection thermal relay or internal thermal relay is activated (contact open), the inverter outputs are stopped. Even if a relay contact auto-recovery occurs, the inverter will not restart until a reset is performed. | | OHT (OHT) |
| Brake transistor error detection (Note 3) | | If a brake transistor error is detected, the inverter outputs are stopped. In this case, the inverter's power supply should be turned OFF immediately. | | bE (BE) |
| Parameter error | | Indicates an error in the saved parameter data (e.g. $E^2$PROM failure, etc.). | | PE (PE) |
| PU disconnected | | If the PU is disconnected from the inverter (no communication) when the "n17" communication parameter (PU dislocation detection) is set to "1", the inverter outputs are stopped. | | PUE (PUE) |
| Retry count excess | | If normal operation is not resumed within the specified retry count, the inverter outputs are stopped. | | rET (RET) |
| CPU error | | If the internal CPU's calculations are not completed within a specified period, the inverter outputs are stopped. | | CPU (CPU) |
| Current limiting stall prevention | Accelerating | If a current equivalent to 150% (Note 4) of the inverter's rated current flows to the motor, the frequency increase is stopped until the load current is reduced in order to prevent an overcurrent cutoff. When the current drops below 150%, the frequency increase resumes. | | Alternating OL and monitor display |
| | Constant speed | If a current equivalent to 150% or more (Note 4) of the inverter's rated current flows to the motor, the frequency is reduced until the load current is reduced in order to prevent an overcurrent cutoff. When the current drops below 150%, the setting frequency is restored. | | Alternating OL and monitor display<br>When outputs are stopped:<br>OLT (OLT) |
| | Deceleration | If an excessive motor regenerative energy exceeds the braking capacity, the frequency reduction is stopped in order to prevent an over-voltage cutoff. When the regenerative energy is reduced, the deceleration is resumed.<br>If a current equivalent to 150% (Note 4) of the inverter's rated current flows to the motor, the frequency reduction is stopped until the load current is reduced in order to prevent an overcurrent cutoff. When the current drops below 150%, the frequency decrease resumes. | | Alternating OL and monitor display |
| Communication error | | If there is a setting error or connection (connector) problem when using the RS-485 communication function, the inverter outputs are stopped. | | OPT (OPT) |

Notes: 1. The electronic thermal's internal thermal data clears when the inverter is reset.
2. Enabled only when "0H" is specified at Pr.60 to Pr.63 (input terminal function selection)
3. Functions only when an optional regenerative braking resistor is connected to a 3-phase 200V class inverte.
4. The stall prevention operation current can be set as desired. The default setting is 150%.
5. Output cutoff does not occur, even when protective function is activated. A "minor failure" signal output is possible by parameter setting.
6. Refer to the Instruction Manual for details concerning the PS, Uv, Er1, Er2, Er3, Err displays, etc.

●Alarm output signal HOLD···If the magnetic contactor (MC) at the inverter's power supply side is opened when a protective function is activated, the inverter's control power is cut off, and an alarm output signal will not be held.

●Alarm display···When a protective function is activated, the alarm codes shown above automatically display at the control panel.

●Resetting method···Because an inverter "outputs stopped" status is maintained when a protective function is activated, operation cannot be resumed until a reset is performed. To perform a reset, turn the power OFF, then back ON again, or, short-circuit the RES-SD reset terminals for 0.1s, then release (assigne RES by Pr.60 to Pr.63). If the short across the RES-SD reset terminals is prolonged, "Err" displays (flickers), indicating that the inverter is being reset.

# ■Selecting peripheral devices

| Power voltage | Motor output (kW) | Applicable inverter type | Circuit breaker (MCCB) Earth leakage breaker | Magnetic contactor (MC) | Wire (mm²) | | AC reactor for power factor improvement (FR-BAL) | DC reactor for power factor improvement (FR-BEL) |
|---|---|---|---|---|---|---|---|---|
| | | | | | R, S, T | U, V, W | | |
| 3-phase 200V | 0.1 | FR-S520E-0.1K(-C) | 30AF 5A | S-N10 | 2 | 2 | 0.4K | 0.4K |
| | 0.2 | FR-S520E-0.2K(-C) | 30AF 5A | S-N10 | 2 | 2 | 0.4K | 0.4K |
| | 0.4 | FR-S520E-0.4K(-C) | 30AF 5A | S-N10 | 2 | 2 | 0.4K | 0.4K |
| | 0.75 | FR-S520E-0.75K(-C) | 30AF 10A | S-N10 | 2 | 2 | 0.75K | 0.75K |
| | 1.5 | FR-S520E-1.5K(-C) | 30AF 15A | S-N10 | 2 | 2 | 1.5K | 1.5K |
| | 2.2 | FR-S520E-2.2K(-C) | 30AF 20A | S-N10 | 2 | 2 | 2.2K | 2.2K |
| | 3.7 | FR-S520E-3.7K(-C) | 30AF 30A | S-N20/N21 | 3.5 | 3.5 | 3.7K | 3.7K |
| 3-phase 400V | 0.4 | FR-S540E-0.4K | 30AF 5A | S-N10 | 2 | 2 | H0.4K | H0.4K |
| | 0.75 | FR-S540E-0.75K | 30AF 5A | S-N10 | 2 | 2 | H0.75K | H0.75K |
| | 1.5 | FR-S540E-1.5K | 30AF 10A | S-N10 | 2 | 2 | H1.5K | H1.5K |
| | 2.2 | FR-S540E-2.2K | 30AF 15A | S-N10 | 2 | 2 | H2.2K | H2.2K |
| | 3.7 | FR-S540E-3.7K | 30AF 20A | S-N20/N21 | 2 | 2 | H3.7K | H3.7K |
| Single-phase 200V | 0.1 | FR-S520SE-0.1K | 30AF 5A | S-N10 | 2 | 2 | 0.4K | 0.4K |
| | 0.2 | FR-S520SE-0.2K | 30AF 10A | S-N10 | 2 | 2 | 0.4K | 0.4K |
| | 0.4 | FR-S520SE-0.4K | 30AF 10A | S-N20/N21 | 2 | 2 | 0.75K | 0.75K |
| | 0.75 | FR-S520SE-0.75K | 30AF 15A | S-N20/N21 | 2 | 2 | 1.5K | 1.5K |
| | 1.5 | FR-S520SE-1.5K | 30AF 20A | S-N20/N21 | 2 | 2 | 2.2K | 2.2K |
| Single-phase 100V | 0.1 | FR-S510WE-0.1K | 30AF 10A | S-N10 | 2 | 2 | 0.75K | — |
| | 0.2 | FR-S510WE-0.2K | 30AF 15A | S-N10 | 2 | 2 | 1.5K | — |
| | 0.4 | FR-S510WE-0.4K | 30AF 20A | S-N20/N21 | 2 | 2 | 2.2K | — |
| | 0.75 | FR-S510WE-0.75K | 30AF 30A | S-N20/N21 | 3.5 | 2 | 3.7K | — |

Notes: 1. The MCCB must select to the inverter power supply capacity, with 1 MCCB being installed for each inverter.
2. The indicated cable sizes apply when the wiring length is 20m.
3. In combinations where the inverter capacity is greater than the motor capacity, the breaker and magnetic contactor should be selected according to the inverter's capacity, and the cable and power factor improving reactor should be selected according to the motor capacity.
For inverters with single-phase 200V input specs. and single-phase 100V input specs., however, the recommended items shown in the table should be selected.
4. A breaker trip at the inverter's primary side could be caused by a miss wiring (short, etc.), or by the failure of an inverter component. Identify the cause of the breaker trip, correct the problem, then turn the breaker ON again.

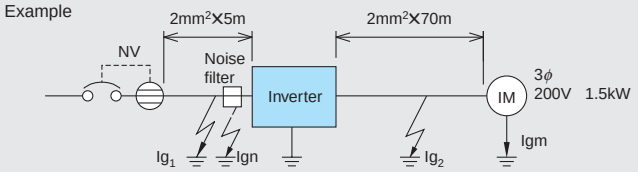
# ■Selecting the earth leakage current breaker's rated sensitivity current

When using the earth leakage current breaker with the inverter circuit, the rated sensitivity current should be selected as shown below, regardless of the carrier frequency.

- For high-frequency surge suppression models:
  Rated current sensitivity current
  $Iga=Ig_1+Ign+Ig_2+Igm$
  $I\triangle n \geq 10 \times Iga$
- For general type models:
  Rated current sensitivity current
  $Igb=Ig_1+Ign+3\times(Ig_2+Igm)$
  $I\triangle n \geq 10 \times Igb$

$Ig_1$, $Ig_2$ : Electric line's leakage current at commercial power supply operation
Ign* : Inverter input side's noise filter leakage current
Igm : Motor leakage current at commercial power supply operation

Example

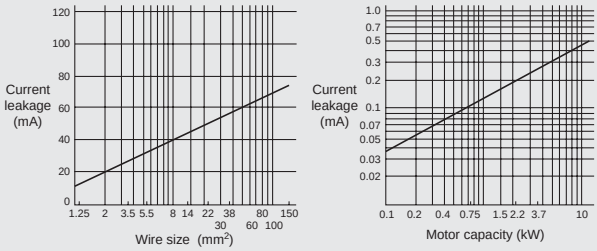



✻Pay special attention to leakage current from the noise filter installed at the inverter's input side.

Notes: 1. The earth leakage current braker should be installed at the inverter's primary side (power supply side).
2. In a ⅄ connection neutral grounding system, the sensitivity current is dulled relative to the inverter's secondary side ground fault, and a Class C ground (10Ω or less) should therefore be provided for the load device's protective ground.
3. Installing the breaker at the inverter's secondary side could result in unnecessary operation due to harmonics, even if the effective value is below the rating. Because this could cause eddy currents and increased hysteresis loss and elevated temperatures, do not install the breaker at the secondary side.
4. Mitsubishi general models include the following: BV-C1 type, BC-V type, NVB type, NV-L type, NV-G2N type, NV-G3NA type, NV-2F type, earth leakage relay (excluding NV-ZHA), NV with Type 3 neutral line open phase protection.
Mitsubishi high-frequency surge suppression models include the following: NV-C, NV-S, MN Series, NV30-FA, NV50-FA, BV-C2, earth leakage alarm breaker (NF-Z), NV-ZHA, NV-H.

●The following example shows the earth leakage per 1km of electric line in a commercial power supply operation, when the CV cable is routed through a metallic conduit. (200V 60Hz)

●The following example shows the earth leakage for a 3-phase induction motor in a commercial power supply operation. (200V 60Hz)




●Selection example (for conditions (3-phase, 3-wire, ⅄ connection) shown in the figure at left)

[Units: mA]

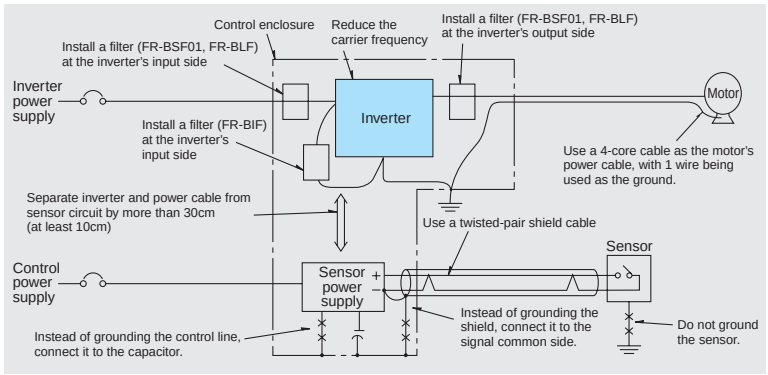
| | For high-frequency surge resistant models | For general models |
|---|---|---|
| Leakage current $Ig_1$ | $20 \times \frac{5m}{1000m} = 0.10$ | |
| Leakage current Ign | 0 (without noise filter) | |
| Leakage current $Ig_2$ | $20 \times \frac{70m}{1000m} = 1.4$ | |
| Motor leakage current Igm | 0.16 | |
| Total leakage current (mA) | 1.66 ( = Iga) | 4.78 ( = Igb) |
| Rated sensitivity current (mA) (I△n ≥ 10 x total leakage current) | 30 ≥ 16.6 | 100 ≥ 47.8 |

# ■Noise

When carrying out low-noise operation with the carrier frequency increased, the electromagnetic noise will tend to increase. Refer to the following countermeasures, and act accordingly. Depending on the installation, the effect of noise may be apparent even during non-low noise operation (default state).

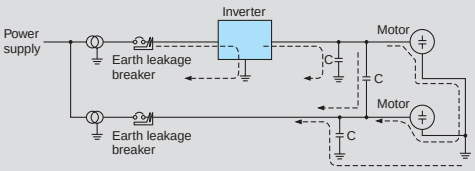
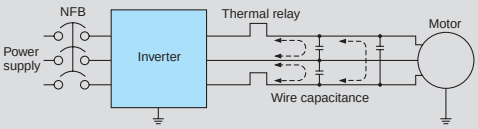
- ●The noise level can be reduced by specifying a smaller setting value at Pr.72 (carrier frequency).
- ●The radio noise filter FR-BIF is effective against static noise heard in AM radio broadcasts.
- ●A line noise filter (FR-BSF01, FR-BLF) is effective countermeasure for sensor operation malfunctions.
- ●As a countermeasure against induction noise from the inverter power cable, keep the sensor circuits 30cm (minimum of 10cm) away from the inverter and power cable, and use a twisted-pair shield wire at signal lines. Without grounding the shield, connect it (one-point connection) to the signal common side.

Example of noise countermeasures




# ■Leakage current

A capacitance exists between the inverter's input/output wiring and other wiring, and between the inverter and the ground, as well as at the motor, providing a route for leakage current. Because the amount of leakage is determined by the electrostatic capacity and the carrier frequency, etc., the amount of leakage increases when the inverter's carrier frequency is set high for low-noise operation. The following measures can be taken to counter this problem. The selection of an appropriate earth leakage breaker should be determined as shown on page 15, regardless of the carrier frequency setting.

| Type | Effect & countermeasure | Circular routing |
|---|---|---|
| Current leakage between inverter and ground | ●This refers to the leakage current that leaks between the inverter's input/output lines and the ground. Leakage also occurs from other places, such as the ground wire, etc.<br>●Unnecessary earth leakage breaker or leakage relay operation may occur.<br>Countermeasures<br>●Lower the inverter's carrier frequency setting (Pr.72). Motor noise will increase somewhat, but this can be mitigated by selecting the Soft-PWM control to soften the motor noise tone.<br>●The use of high-frequency and surge suppression products at the earth leakage breakers of the inverter system and other systems can alow low-noise operation (high carrier frequency setting). |  |
| Current leakage between wires | ●Electric current leakage occurs between the inverter's output wiring, by way of the capacitance.<br>●The leakage current's high-frequency component can cause unnecessary operation of the externally connected thermal relay.<br>Countermeasures<br>●Equip the inverter with an internal electronic thermal.<br>●Lower the inverter's carrier frequency (Pr.72). Motor noise will increase somewhat, but this can be mitigated by selecting the Soft-PWM control to soften the motor noise tone. |  |

# ■Harmonic suppression guidelines

The harmonic current produced from the inverter flows to the power receiving point by way of the power supply transformer. As this harmonic outflow can affect other power users, harmonic suppression guidelines have been established. Previous 3-phase 200V specification models of 3.7kW or less, single-phase 200V specification models of 2.2kW or less, and single-phase 100V specification models of 0.75kW or less, conformed to the " Harmonic Suppression Guidelines For Consumer Electronics & General Purpose Products" and to the "Harmonics Suppression Guidelines For High-Voltage Or Special Voltage Power Users". Beginning from January of 2004, however, the general-purpose inverter was removed from the scope of the "Harmonic Suppression Guidelines For Consumer Electronics & General Purpose Products", being subject only to the "Harmonic Suppression Guidelines For High-Voltage Or Special Voltage Power Users".

- "Harmonic Suppression Guidelines For High-Voltage Or Special Voltage Power Users"
  These guidelines set forth the upper limit of permissible harmonic current outflow when a high-voltage or special high-voltage power user installs new harmonic generating equipment or expands existing equipment, and if that limit is exceeded, measures to reduce the outflow must be taken.

Users not subject to the above guidelines do not require to suppress the Harmonic but JEMA request to the users to connect DC and AC reactors in the same manner as before.

Conformance with the "Harmonic Suppression Guidelines For High-Voltage Or Special Voltage Power Users"

| Input power supply | Applicable capacity | Countermeasure |
|---|---|---|
| Single-phase 100V | All capacities | Evaluate the system conditions based on the "Harmonic Suppression Guidelines For High-Voltage Or Special Voltage Power Users" released in September of 1994 by the Ministry of International Trade and Industry, and take appropriate countermeasures if necessary. For details concerning calculation methods for power supply harmonics, refer to the following reference materials.<br>Reference materials<br>• "Harmonic Suppression Measures For General-Purpose Inverters" January, 2004 JEMA: Japan Electrical Manufacturers Association<br>• "Inverter Harmonic Current Calculation Methods For Special Users" JEM-TR201 (December, 2003 Revised Edition): Japan Electrical Manufacturers Association |
| Single-phase 200V | | |
| 3-phase 200V | | |
| 3-phase 400V | | |

Conformance with the "Harmonic Suppression Guide For General-Purpose Inverters (Input Current of 20A Or Less) Not Classified As Special Users"

| Input power supply | Applicable capacity | Countermeasure |
|---|---|---|
| Single-phase 100V | 0.75kW or less | An AC or DC reactor should be connected in accordance with the catalog and Instruction Manual recommendations.<br>Reference material<br>• "Harmonic Suppression Guide For General-Purpose Inverters (Input Current of 20A Or Less) Not Classified As Special Users" JEM-TR226 (December, 2003): Japan Electrical Manufacturers Association |
| Single-phase 200V | 2.2kW or less | |
| 3-phase 400V | 3.7kW or less | |

●Harmonic current loss calculation

Harmonic current loss = fundamental wave current (value converted from received power voltage) × operation rate × harmonic content

- Operation rate: Operation rate = actual load rate × 30 minutes continuous operation rate
- Harmonic content: Obtained from Table 1.

Table 1 3-phase bridge (capacitor smoothing) harmonic content (when fundamental wave current is 100%)

| Reactor | 5th order | 7th order | 11th order | 13th order | 17th order | 19th order | 23th order | 25th order |
|---|---|---|---|---|---|---|---|---|
| None | 65 | 41 | 8.5 | 7.7 | 4.3 | 3.1 | 2.6 | 1.8 |
| With (AC side) | 38 | 14.5 | 7.4 | 3.4 | 3.2 | 1.9 | 1.7 | 1.3 |
| With (DC side) | 30 | 13 | 8.4 | 5.0 | 4.7 | 3.2 | 3.0 | 2.2 |
| With (AC and DC sides) | 28 | 9.1 | 7.2 | 4.1 | 3.2 | 2.4 | 1.6 | 1.4 |

Table 2 Rated capacity and harmonic current during 3-phase inverter drive

| Applicable motor (kW) | Rated current (A) | | Fundamental wave current 6.6kV conversion value (mA) | Rated capacity (kVA) | Harmonic current 6.6kV conversion value (mA) (without reactor, and with 100% operation rate) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 200V | 400V | | | 5th order | 7th order | 11th order | 13th order | 17th order | 19th order | 23th order | 25th order |
| 0.4 | 1.61 | 0.81 | 49 | 0.57 | 31.85 | 20.09 | 4.165 | 3.773 | 2.107 | 1.519 | 1.274 | 0.882 |
| 0.75 | 2.74 | 1.37 | 83 | 0.97 | 53.95 | 34.03 | 7.055 | 6.391 | 3.569 | 2.573 | 2.158 | 1.494 |
| 1.5 | 5.50 | 2.75 | 167 | 1.95 | 108.6 | 68.47 | 14.20 | 12.86 | 7.181 | 5.177 | 4.342 | 3.006 |
| 2.2 | 7.93 | 3.96 | 240 | 2.81 | 156.0 | 98.40 | 20.40 | 18.48 | 10.32 | 7.440 | 6.240 | 4.320 |
| 3.7 | 13.0 | 6.50 | 394 | 4.61 | 256.1 | 161.5 | 33.49 | 30.34 | 16.94 | 12.21 | 10.24 | 7.092 |

# List of Options

| | Name | Type | Application and specifications, etc. | | | Applicable inverter |
|---|---|---|---|---|---|---|
| Stand alone type | Parameter unit (8 languages) | FR-PU04 | Interactive parameter unit with LCD display | | | |
| | Cable for connecting parameter unit | FR-CB201 (1m)<br>FR-CB203 (3m)<br>FR-CB205 (5m) | Cable for connecting parameter unit and inverter | | | |
| | Power factor improvement AC reactor | FR-BAL- (H) □□ (Note 2) (Note 6) | For power factor improvement (power factor approx. 90%) | Connect to input side | | Compatible with 0.1K to 3.7K capacities |
| | Power factor improvement DC reactor | FR-BEL- (H)□□(Note 2) (Note 5) (Note 6) | For power factor improvement (power factor approx. 95%) | | | |
| | Radio noise filter | FR-BIF- (H) (Note 6) | Reduces radio noise | Connect to input side | | Common for all models |
| | Line noise filter | FR-BSF01 | Reduces line noise | | | |
| | Surge voltage suppression filter | FR-ASF-H□□ (Note 2) | For micro-surge voltage suppression | | | FR-S540E-0.4K to 3.7K |
| | Brake resistor | MRS type, MYS type | Improved regenerative braking capacity (tolerable usage rate is 3% ED) | | | FR-S520E-0.4K to 3.7K |
| | High frequency brake resistor | FR-ABR-0.4K | Improved regenerative braking capacity (tolerable usage rate is 10% ED) | | | FR-S520E-0.4K |
| | | FR-ABR-0.75K | | | | FR-S520E-0.75K |
| | | FR-ABR-2.2K | | | | FR-S520E-1.5K, 2.2K |
| | | FR-ABR-3.7K | | | | FR-S520E-3.7K |
| | BU type brake unit | BU- (H)□□ (Note 2) (Note 6) | Greatly increases regenerative braking performance | | | FR-S520E-1.5K to 3.7K<br>FR-S540E-2.2K to 3.7K |
| | Discharging resistor | GZG GRZG type | Discharging resistor for BU type brake unit | | | FR-S520SE-0.1K to 1.5K |
| | High power factor converter | FR-HC- (H)7.5K (Note 3) (Note 6) | For suppressing harmonics current | | | FR-S520E-1.5K to 3.7K<br>FR-S540E-0.4K to 3.7K |
| | Power regeneration common converter | FR-CV- (H)□ (-AT) (Note 2) (Note 6) (Note 7) | Common converter type power regeneration brake unit | | | FR-S520E-1.5K to 3.7K |
| | Dedicated standalone reactor for FR-CU | FR-CVL- (H)□ (Note 2) (Note 6) | Reactor for power regeneration common converter | | | FR-S540E-0.4K to 3.7K |
| | EMC directive compatible noise filter (EU directive) | SF1306 | Leakage current reference values (mA) | 10 | EMC directive (EN50081-2) compatible noise filter<br>✻Measures must be taken to prevent malfunction of peripheral devices (earth leakage breaker), etc., and electric shocks caused by leakage currents. | FR-S520E-0.1K to 1.5K |
| | | SF1309 | | 15 | | FR-S520E-2.2K, 3.7K (Note 4) |
| | | FR-S5NFSA-0.75K | | 4.5 | | FR-S520SE-0.1K to 0.75K<br>FR-S510WE-0.1K to 0.4K |
| | | FR-S5NFSA-1.5K | | 9.5 | | FR-S520SE-1.5K<br>FR-S510WE-0.75K |
| | | FR-E5NF-H0.75K | | 22.6 | | FR-S540E-0.4K, 0.75K |
| | | FR-E5NF-H3.7K | | 44.5 | | FR-S540E-1.5K to 3.7K |
| | EMC filter installation attachment | FR-E5T | Attachment for installing EMC directive compatible noise filter (SF1309) onto inverter | | | FR-S520E-2.2K/3.7K |
| | DIN rail installation attachment | FR-UDA01 | DIN rail installation | | | FR-S520(E)(SE)-0.1K to 0.75K, FR-S510WE-0.1K to 0.4K |
| | | FR-UDA02 | | | | FR-S520E-1.5K, 2.2K, FR-S540E-0.4K to 3.7K<br>FR-S520SE-1.5K, FR-S510WE-0.75K |
| | | FR-UDA03 | | | | FR-S520E-3.7K |
| FR series controllers and setters (Note1) | Operation box with frequency meter | FR-AX | For operation with frequency meter, frequency setting potentiometer and start switch | | | Common for all models |
| | DC tach. follower | FR-AL | For parallel operation (1VA) with external signals (0 to 5VDC, 0 to 10VDC) | | | |
| | 3-speed setting operation box | FR-AT | For operation changing between high, medium and low speed (1.5VA) | | | |
| | Remote operation box | FR-FK | For remote operation; operation from several places is possible (5VA) | | | |
| | Ratio setting box | FR-FH | For ratio operation; ratios for up to five inverters can be set (3VA). | | | |
| | PG follower | FR-FP | For speed syncronous operation using the signal of a pilot generator (PG). (2VA) | | | |
| | Master controller | FR-FG | Main speed setting unit for parallel operation of several inverters (up to 35 units). (5V) | | | |
| | Soft start control box | FR-FC | For soft starting/stopping; parallel operation acceleration/deceleration is possible (3VA) | | | |
| | Deviation detector | FR-FD | For continuous speed control operation. Used with deviation sensor and synchro. (5VA) | | | |
| | Pre-amplifier box | FR-FA | Can be used as A/V converter or operation amplifier (3VA) | | | |
| Others | Pilot generator | QVAH-10 | 70/35VAC 500Hz for tracking operation (at 2500r/min) | | | |
| | Deviation sensor | YVGC-500W-NS | For continuous speed control operation (mechanical deviation detection). Output 90VAC/90° | | | |

Notes: 1. FR Series controllers and setting box power supply specifications are 200VAC 50Hz, 200/220V 60Hz, 115VAC 60Hz.
2. The values given in □□ indicate the capacity.
3. One 3.7K inverter must be connected. (When using without the 3.7K inverter connected, use as a common converter or regenerative converter is possible, but the power higher harmonic suppression effect will drop.)
4. The EMC filter installation attachment (FR-E5T) must be used when installing SF filter on the FR-S520E-2.2K/3.7K.
5. This cannot be connect to the single-phase 100V power input specification product.
6. The 3-phase 400V input specification product is indicated with an "H" in the type.
7. -AT indicates the type installed in the panel. If -AT is not added, this is a type to mount the heatsink through the back of enclosure.

# Product Introduction (As Of August, 2004)

| Name | | Type | Manufacturer | Application, etc. | Tel. No. (Note 1) |
|---|---|---|---|---|---|
| RS232C ⇔ 485 converter | Commercially available examples | FA-T-RS40 Series | Mitsubishi Electric Engineering Corp. | Communication converter Provided with inverter-side or personal computer-side cable | 03-3288-1743 |
| | | DAFXIH-CAB Series<br>DINV-485CAB | Diatrend Corp. | Cable with built-in interface (personal computer-side cable) + connector converter cable (inverter-side) | 06-4705-2100 |
| | | DINV-CABV | | Dedicated inverter cable with built-in interface | |
| Communication connector | | 5-554720-3 | Tyco Electronics AMP K.K. | RJ45 connector | 044-844-8013 |
| Communication cable | | SGLPEV-T0.5mm ✕ 4P | Mitsubishi Cable Industries, LTD. | EIA568 compliant cable (10base-T cable) | 03-3216-1566 |
| RS-485 distributor | Commercially available example | BMJ-8 | Hakko Electric Machine Works Co., LTD. | Cable kit for connecting multiple inverters when RS-485 communication uses the inverter's PU connector. | 03-5614-7585 |

✻Please contact the relevant manufacturer for information concerning the delivery schedules, prices, and specifications, etc., of the introduced products.
(Note1) The listed telephone numbers may be changed without prior notice.

## ⚠ For Maximum Safety

- Always read the instruction manual before use to use the equipment properly and safely.
- This product is not designed or manufactured to be used in equipment or systems in situations that can affect or endanger human life.
- When considering this product for operation in special applications such as equipment or systems used in passenger transportation, medical, aerospace, nuclear energy, electric power, or submarine relay applications, please contact your nearest Mitsubishi sales office.
- Although this product was manufactured under strict quality control conditions, it is strongly advised to install safety devices to forestall serious accidents when used in facilities where a breakdown of the product is likely to cause a serious accident.
- Please do not use for loads other than 3-phase induction motors.

## Product Selection Precautions

### ■Inverter Capacity Selection

- When operating a special motor or multiple motors in parallel with the inverter, select an inverter capacity that is greater than 1.1 times of the total rated current of the motors.

### ■Motor Starting Torque

- The starting and acceleration characteristics of the motor that drives the inverter are restricted by the inverter's overload current rating. The torque characteristics are therefore lower than when started in a general type commercial power supply system. In cases where a large starting torque is required, the automatic torque boost control can be selected (motor capacity is set at Pr.98), or, the torque boost value can be adjusted. When the torque boost control selection and adjustment are still insufficient, an inverter with a higher capacity (1 step up) should be selected, or higher capacities should be selected for both the motor and inverter.

### ■Acceleration/Deceleration Times

- The motor's acceleration/deceleration times are determined by the motor's generated torque, the load, and by the load's moment of inertia (J).
- Acceleration/deceleration times should be set somewhat long because more time may be required if the current limiting function and stall prevention function are operating during acceleration/deceleration.
- The acceleration/deceleration times can be shortened by the following methods:
  - By increasing the torque boost value (if increased too much, the stall prevention function may be activated at starts, making the acceleration time even longer).
  - By using automatic torque boost control.
  - By using a higher capacity inverter and motor.

  To shorten the deceleration time at 3-phase 200V Class inverters (0.4K and higher types), an optional brake resistor (MRS and FR-ABR) should be installed.

## Precautions When Selecting Peripheral Devices

### ■Selecting And Installing A Circuit Breaker

- The user should install a circuit breaker (MCCB) in order to protect the inverter's primary-side wiring. The MCCB is selected according to the inverter's power factors (power voltage, output frequency, fluctuations according to load). Refer to page 15 for details. Because the operation characteristics of a fully magnetic type MCCB are particularly affected by harmonic current, a somewhat larger capacity type should be selected. Regarding an earth leakage breaker, Mitsubishi's harmonics and surge resistant type should be used. (See page 15.)

### ■Primary-Side Magnetic Contactor Handling

- A magnetic contactor should be installed at the primary side to prevent accidents caused by automatically restarts after a recovery from an instantaneous power failure, etc. when external terminal controlled operation (using STF or STR terminal). This will also ensure safety during maintenance operations. Do not use this magnetic contactor to perform frequent starts and stops. (The inverter input circuit's open/close life is approx. 100,000 times.)
- Automatic restarts following a recovery are not possible in the parameter unit operation mode (PU), and the magnetic contactor cannot be used to perform a start. Although a stop can be performed from the primary side magnetic contactor, it will be a coasting stop without the inverter's regenerative braking.
- The installation of a primary-side magnetic contactor is recommended in systems where a 3-phase 200V class inverter is connected to an optional brake resistor, and is used for cycle and strenuous operations. Due to an insufficient thermal capacity at the brake's discharging resistor, and to an excessive brake usage rate, etc., the regenerative braking transistor can become damaged, resulting in discharging resistor overheating and burn damage. The magnetic contactor prevents this from occurring.

  In the case of the above problem, the inverter alarm output could be used to have the magnetic contactor cut off the inverter.

### ■Secondary-Side Magnetic Contactor Handling

- As a rule, a magnetic contactor should not be installed between the inverter and the motor, with OFF to ON switching during operation. Turning the magnetic contactor ON during inverter operation can cause a large rush current, possibly activating the overcurrent cutoff function. If a magnetic contactor has been installed for the purpose of switching to a commercial power supply, etc., the switching should be performed only after the inverter and motor are stopped.

### ■Thermal Relay Installation

- Although the inverter is equipped with an electronic thermal protective function to protect against motor overheating, a thermal relay (OCR) should be installed between the inverter and motors when a single inverter operates multiple motors, or when operating a multi-pole motor. In such cases, the inverter's electronic thermal should be set to "0A", and the thermal relay should be set to total value of the motor rated current and line-to-line leakage current (see page 15). For low-speed operation where the cooling capability of the motor reduces, it is recommended to use a thermal protector incorporated motor.

### ■Disuse of Power Factor Improving Capacitor (Phase Advancing Capacitor)

- A power factor improving capacitor and surge killer at the inverter's output side could overheat and be damaged by the inverter output's harmonic component. Moreover, the capacitor could create an overcurrent condition that activates the overcurrent protection function. For these reasons, a capacitor and surge killer should not be installed. To improve the power factor, use a power factor improving reactor.

### ■Secondary-Side Measuring Instrument

- In systems with long wiring between the inverter and motor, a instrument or CT could generate heat due to wire current leakage. Therefore, select an instrument with an adequate current rating margin.

### ■Radio Wave Interference

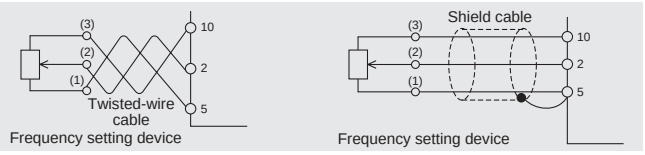
- The inverter main circuit's inputs/outputs include a high order harmonic component that could cause interference in a communication device (AM radio) or sensor. In such cases, an FR-BIF radio noise filter (exclusively for input side) or an FR-BSF01 or FR-BLF line noise filter can be installed to minimize interference.

### ■Wire Thickness And Wiring Distance

- Long wiring between the inverter and motor could reduce the motor torque due to a voltage drop in the main circuit's cable (particularly at low frequency outputs). A thick wire that limits the voltage drop to 2% or less should therefore be used. (Wire selection examples for a wiring distance of 20m are given on page 15.)
- Extremely long wiring can produce a charge current from the wiring's stray capacity, and this could activate the high-response current limiting function. Therefore, the wiring length should not exceed the distances shown in the table below.
- The use of a shield cable for the wiring between the inverter and motor will result in a large current leakage due to a large stray capacity. In order for the inverter to detect the current leakage and the current flowing to the motor, the current monitor value becomes high and the electronic thermal activate earlier than normal. If a shield cable must be used and motor overheating protection is requred, set the Pr.9 (electronic thermal) setting as "0", and consider other measures such as using a motor equipped with a temperature sensor (Klixon, etc.).

| Inverter Capacity | | 0.1K | 0.2K | 0.4K | 0.75K | 1.5K | 2.2K | 3.7K |
|---|---|---|---|---|---|---|---|---|
| For non low acoustic noise operation | 100V Class 200V Class | 100m | 100m | 100m | 100m | 100m | 100m | 100m |
| | 400V Class | — | — | 50m | 100m | 100m | 100m | 100m |
| For low acoustic noise operation | 100V Class 200V Class | 30m | 30m | 100m | 100m | 100m | 100m | 100m |
| | 400V Class | — | — | 30m | 30m | 100m | 100m | 100m |

- The wiring length between the inverter and motor should not exceed 30m when automatic torque boost control is selected.
- For remote control by analog signal, the control line length to the inverter must not exceed 30m, and the wiring should be kept apart from the high-powered circuits.
- If the frequency is set by an external potentiometer, use a shield cable or twisted-wire cable as shown below, and connect the shield to terminal 5 (do not ground the shield).




### ■Grounding

When the inverter is run with low acoustic noise mode, the leakage current will increase because of the high-speed switching compared to the non-low acoustic noise operation. Always ground the inverter and motor. Always use the inverter's grounding terminal to ground the inverter.

For 400V class, make sure to ground the supply neutral.

# Operation Precautions

## ■Operation

- ●When a magnetic contactor (MC) is installed on the primary side, do not start and stop operation frequently with this MC. Failure to observe this could lead to inverter faults.
- ●When a fault occurs in the inverter, the protective function will activate and the output will stop, but the motor will not stop immediately. Thus, if the machine or facility requires emergency stop means, install mechanical stopping and holding mechanism.
- ●Even if the inverter's power supply is cut off, capacitor discharging requires a little time. Therefore, before performing an inspection, wait at least 10 minutes after power OFF, then use a tester to verify the voltage.
- ●In applications where the inverter is frequently started and stopped, the inverter's transistor element temperature rises and falls due to the repeated large current flow, and the resulting thermal fatigue may shorten the transistor life. Because thermal fatigue is related to the level of current, the life can be extended by reducing the locked rotor current and the starting current, etc. Although the inverter life can be extended by reducing the current, a reduced current may result in an insufficient torque and a failure to start. Therefore, the inverter's capacity should be increased to allow a sufficient margin for the current.

## ■Wiring

- ●Inverter damage will occur if the power supply is applied to the inverter's output terminals (U, V, W). Therefore, before turning the power ON, perform a thorough check of the wiring and sequence to verify that the wiring is connected correctly.
- ●The P, PR, P1 and N terminals are used for the connection of dedicated options. Do not connect any other devices to these terminals. Moreover, do not perform a short-circuit across the frequency setting power supply terminal 10 and common terminal 5, or across the PC and SD terminals.

## ■Installation

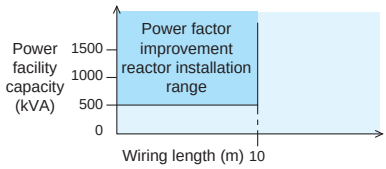
- ●Avoid installation in poor environments where airborne oil-mist, fibers, and dust, etc., are present, or, if installed in such environments, enclose the unit in an airtight cabinet. If enclosed in a cabinet, be sure that the cooling method and cabinet dimensions are adequate to keep the inverter ambient temperature within the permissible range (see page 4 for the specifications value).
- ●Parts of the inverter can become extremely hot, and the inverter should therefore not be mounted on a combustible material.
- ●The inverter should be mounted vertically on a wall.

## ■Setting

- ●As a maximum operation speed of 120Hz can be specified from the control panel, an incorrect setting could result in dangerous conditions. To prevent this, use the upper limit frequency setting function to specify a maximum frequency. (The "maximum frequency" default setting for external input signal operation is 60Hz. 60Hz is also specified for PU mode operation.)
- ●At 3-phase 200V Class inverters, do not set the regenerative braking usage rate (b2) unless the optional brake resistor is being used. Because this function is used for brake resistor overheat protection, take care not to specify a value that exceeds the brake resistor's permissible usage rate.
- ●Specifying a DC braking voltage and operation time that exceed the factory settings can cause the motor to overheat (trips the electronic thermal).

## ■Power Supply

- ●If the unit is installed directly below a large-capacity power supply transformer (500kVA or more, with wiring length of 10m or less), or where the phase advance capacitor switches, an excessive peak current may flow to the power input circuit causing damage to the inverter. In this case, be sure to install the optional FR-BEL-(H) or FR-BAL-(H) power factor improvement reactor.




- ●If surge voltage is generated in the power system, this surge energy could flow into the inverter and cause the inverter to stop with the OV1, OV2 or OV3 alarm displayed. In this case, install the optional power factor improvement reactor FR-BEL-(H) or FR-BAL-(H).

# Standard Motor Application

## ■Motor Loss And Temperature Rise

When a standard motor is being run by the inverter, the motor runs a little hotter than when operating by commercial power supply, and the continuous operation torque is limited. Moreover, the motor's output torque should be lowered at low speeds because cooling efficacy is reduced at low speeds. Refer to the output characteristics shown in the figure below for details regarding the continuous output range. When a 100% continuous torque is required at low speeds, consider using a constant-torque motor (see page 20).

## ■Torque Characteristics

When the inverter is running a standard motor, the motor torque (particularly, the starting torque) is lower than when running off a commercial power supply, and may sometimes be insufficient. Therefore, be sure to verify the load torque characteristics of the corresponding machine.

## ■Vibration

Compared with a commercial power supply drive, the motor vibration level may be somewhat higher when the motor is installed on a machine. Vibration is often caused by the wide range of speed change, though the following are also considerations:

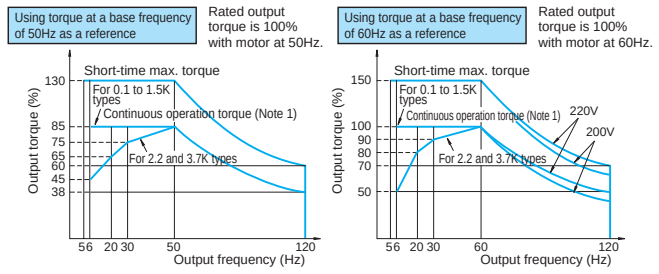
1. The machine's rotating components may be unbalanced, causing vibration.
2. The machine's natural frequency may produce resonance. This is a special concern when variable speed operation is introduced on a machine that has been used at a constant speed. Vibration transmission can be minimized by using a tire coupling, or by installing rubber damping pads beneath the motor's base. Changing the Pr.72 PWM carrier frequency setting is also effective. Note also that an extremely high vibration level may occur when running a 2-pole motor at a high speed of 60Hz or higher.

## ■Output Characteristics

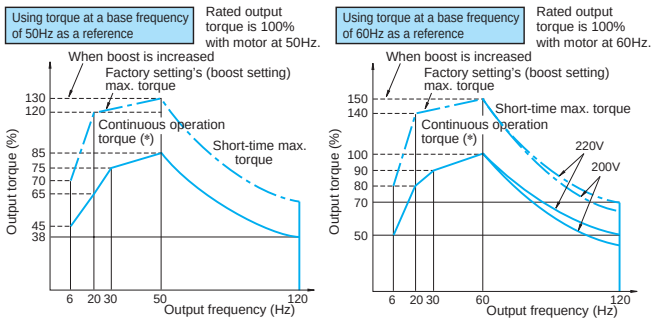
When Mitsubishi's 3-phase squirrel cage motor (SF-JR Model, 4-pole) and an inverter of equal capacity are combined in a system with a rated power supply, the torque characteristics are as shown below.

(Assuming factory settings for all other parameters.)

### With Automatic Torque Boost Control




### With V/F Control




Notes: 1. The continuous operation torque value is not the motor output torque. Rather, it is an indicator of the permissible load torque limit used to ensure that the motor operates within the permissible temperature range. The motor output torque is indicated by the short-time maximum torque value.
The continuous operation torque of a single-phase 100V Class inverter is approximately 90% of the continuous torque shown above.
2. Depending on the motor capacity and number of poles, operation above 60Hz may not be possible. Be sure to verify the motor's maximum permissible operation frequency.

## ■Inverter Driven 400V Class Motor

When using an inverter to drive 400V Class motor, a surge voltage caused by the wiring constant occurs at the motor terminal, and this voltage can degrade the motor's insulation. In such cases, the following countermeasures should be considered.

(1) Strengthen the motor's insulation

①Use a 400V Class insulation-enhanced, inverter driven motor.

Note: Mitsubishi's standard 4-pole motors (SF-JR, SB-JR) conform to the 400V Class insulation-enhanced, inverter driven motor specifications.

②Use a dedicated "inverter motor" such as a constant-torque motor or a low-vibration motor, etc.

(2) Surge voltage suppression method at inverter side

A filter must be connected at the inverter's secondary side to suppress the surge voltage in order to prevent the motor terminal voltage from exceeding 850V. When using a Mitsubishi inverter to drive the motor, the optional surge voltage suppression filter (FR-ASF-H) should be connected at the inverter's secondary side.

# Constant-Torque Motor Application

## ■SF-HRCA Type

●**Continuous operation possible at 100% torque down to low speeds of 3Hz (with slip compensation enabled)**

For 2.2kW or less, constant-torque (100% torque) continuous operation is possible in the 1/20 speed ratio range, without having to reduce the load torque even at low speed.

●**Wide speed control range (with slip compensation enabled)**

Operation is possible through a wide speed range (3 to 120Hz). Speeds exceeding 60Hz feature constant output power characteristics.

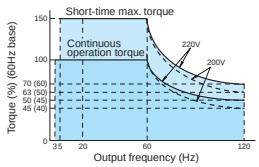
The continuous operation torque with a single-phase 100V input is 90% of the indicated value.

●**Same footprint dimensions as a standard motor**

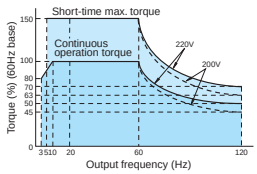
★Note that the operation characteristics shown in the figure at right do not apply when using V/F control.

Continuous rated operation range (with automatic torque boost control and slip compensation, and factory settings for all other parameters)

For 0.2kW to 2.2kW inverter




For 3.7kW inverter




Values shown in parentheses apply to 0.2kW to 0.75kW inverters.

Standard specifications

| Model | Number of poles | Output (kW) | Frequency range |
|---|---|---|---|
| Totally enclosed fan-cooled type SF-HRCA | 4 | 0.2 | 3 to 120Hz (base frequency is 60Hz) |
| | | 0.4 | |
| | | 0.75 | |
| | | 1.5 | |
| | | 2.2 | |
| | | 3.7 | |

Notes:
1. When using Mitsubishi's constant-torque motor, be sure to specify the automatic torque boost control and slip compensation settings. For further details, refer to the Instruction Manual.
2. In applications requiring sudden accelerations/decelerations, select an inverter capacity that is 1 rank higher.
3. When running 2 or more motors in a parallel configuration, motor slippage is less than for a standard motor, making unbalanced torque conditions more likely.

# Special Motor Application

## ■Motor With Brake

Use a brake equipped motor that has an independent power supply for the brake. The brake's power supply should be connected to the inverter's primary side power supply, with the output stop terminal (MRS) being used to turn inverter outputs OFF when braking (motor stop) occurs. Depending on the brake type, a brake lining rattle may be heard at low speeds, but this is normal.

## ■Pole Changing Motor

Because pole changing motors have a different rated current than standard motors, select the inverter with reference to the motor's maximum current. Pole changes should be performed only the motor is stopped. If performed while the motor is running, the regenerative overvoltage protection circuit may be activated, accompanied by an inverter alarm. The motor is then brought to a coasting stop.

## ■Geared Motor

The continuous speed range of geared motors varies according to the lubrication format and the manufacturer. Oil lubricated motors, in particular, are susceptible to gear seizures if operated continuously at low speeds only. Consult with the motor manufacturer when applications require high speeds exceeding 60Hz.

## ■Explosion-Proof Motor

In order to drive a pressure and explosion-proof motor, the motor and inverter combination must have explosion-proof certification. The same applies when driving an explosion-proof motor that is already installed. Mitsubishi's FR-B and FR-B3 Series inverters have received this certification of Japan. For details, contact your Mitsubishi representative. Because the inverter itself is not explosion-proof, it must be installed in a safe location.

## ■Synchronous Motor

Synchronous motors are not suitable for applications with variable loads and large impact shocks because these conditions can easily disrupt the synchronization. The starting current and rated current of these motors are larger than that of standard motors, making them unstable at low speeds. Consult with your Mitsubishi representative before using this type of motor.

## ■Single-Phase Motor

Single-phase motors are unsuitable for variable speed operation with inverter. In capacitor starting motor, a harmonic current flows to the capacitor making it susceptible to damage. Moreover, split-phase starting and repulsion-start motor lack torque at low speeds, and the internal centrifugal switch fails to operate, resulting in burn damage at the starting coil. A single-phase motor should therefore be replaced by a 3-phase motor.

**⚠ Safety Warning**

To ensure proper use of the products listed in this catalog, please be sure to read the instruction manual prior to use.

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