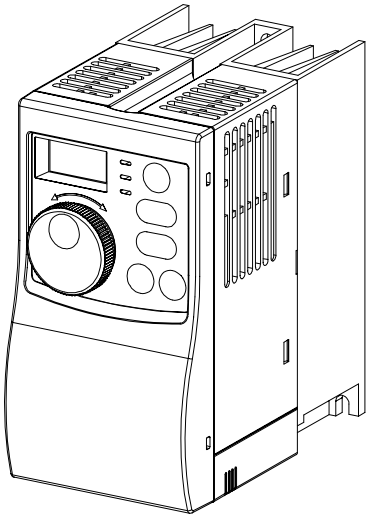
MITSUBISHI

TRANSISTORIZED INVERTER

FR-S500

INSTRUCTION MANUAL (Detailed)



Thank you for choosing this Mitsubishi Transistorized inverter.
This instruction manual (detailed) provides instructions for advanced use of the FR-S500 series inverters.
Incorrect handling might cause an unexpected fault. Before using the inverter, always read this instruction manual and the instruction manual (basic) [IB-0600026] packed with the product carefully to use the equipment to its optimum.
This instruction manual uses the International System of Units (SI). The measuring units in the yard and pound system are indicated in parentheses as reference values.

This section is specifically about safety matters

Do not attempt to install, operate, maintain or inspect the inverter until you have read through the instruction manual (basic) and appended documents carefully and can use the equipment correctly. Do not use the inverter until you have a full knowledge of the equipment, safety information and instructions.
In this instruction manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

WARNING	Assumes that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
CAUTION	Assumes that incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause physical damage only.

Note that even the CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personnel safety.

1. Electric Shock Prevention

WARNING

- While power is on or when the inverter is running, do not open the front cover. You may get an electric shock.
- Do not run the inverter with the front cover removed. Otherwise, you may access the exposed high-voltage terminals or the charging part of the circuitry and get an electric shock.
- If power is off, do not remove the front cover except for wiring or periodic inspection. You may access the charged inverter circuits and get an electric shock.
- Before starting wiring or inspection, check for residual voltages with a meter etc. more than 10 minutes after power-off.
- Earth the inverter.
- Any person who is involved in wiring or inspection of this equipment should be fully competent to do the work.
- Always install the inverter before wiring. Otherwise, you may get an electric shock or be injured.
- Perform setting dial and key operations with dry hands to prevent an electric shock.
- Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Otherwise, you may get an electric shock.
- Do not change the cooling fan while power is on.
  It is dangerous to change the cooling fan while power is on.
- When you have removed the front cover, do not touch the connector above the 3-digit monitor LED display. You will get an electric shock.

2. Fire Prevention

⚠ CAUTION

- Mount the inverter to incombustible material. Mounting it to or near combustible material can cause a fire.
- If the inverter has become faulty, switch off the inverter power. A continuous flow of large current could cause a fire.
- Do not connect a resistor directly to the DC terminals P(+), N(–). This could cause a fire.

3. Injury Prevention

⚠ CAUTION

- Apply only the voltage specified in the instruction manual to each terminal to prevent damage etc.
- Ensure that the cables are connected to the correct terminals. Otherwise, damage etc. may occur.
- Always make sure that polarity is correct to prevent damage etc.
- While power is on and for some time after power-off, do not touch the inverter or brake resistor as they are hot and you may get burnt.

4. Additional instructions

Also note the following points to prevent an accidental failure, injury, electric shock, etc.

(1) Transportation and installation

⚠ CAUTION

- When carrying products, use correct lifting gear to prevent injury.
- Do not stack the inverter boxes higher than the number recommended.
- Ensure that installation position and material can withstand the weight of the inverter. Install according to the information in the Instruction Manual.
- Do not operate if the inverter is damaged or has parts missing.
- When carrying the inverter, do not hold it by the front cover or setting dial; it may fall off or fail.
- Do not stand or rest heavy objects on the inverter.
- Check the inverter mounting orientation is correct.
- Prevent screws, wire fragments, other conductive bodies, oil or other flammable substances from entering the inverter.
- Do not drop the inverter, or subject it to impact.
- Use the inverter under the following environmental conditions:

Environment	Ambient temperature	-10°C to +50°C (14°F to 122°F) (non-freezing)
	Ambient humidity	90%RH or less (non-condensing)
	Storage temperature	-20°C to +65°C * (-4°F to 149°F)
	Ambience	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
	Altitude, vibration	Maximum 1000m (3280.80feet) above sea level for standard operation. After that derate by 3% for every extra 500m (1640.40feet) up to 2500m (8202.00feet) (91%). 5.9m/s^2 or less (conforming to JIS C 0040)

*Temperatures applicable for a short time, e.g. in transit.

(2) Wiring

⚠ CAUTION

- Do not fit capacitive equipment such as power factor correction capacitor, radio noise filter or surge suppressor to the output of the inverter.
- The connection orientation of the output cables U, V, W to the motor will affect the direction of rotation of the motor.

(3) Trial run

⚠ CAUTION

- Check all parameters, and ensure that the machine will not be damaged by a sudden start-up.
- When the load GD^2 is small (at the motor GD^2 or smaller) for 400V from 1.5K to 3.7K, the output current may vary when the output frequency is in the 20Hz to 30Hz range.
  If this is a problem, set the Pr. 72 "PWM frecuency selection" to 6kHz or higher.
  When setting the PWM to a higher frequency, check for noise or leakage current problem and take countermeasures against it.

(4) Operation

⚠ WARNING

- When you have chosen the retry function, stay away from the equipment as it will restart suddenly after an alarm stop.
- The [STOP] key is valid only when the appropriate function setting has been made. Prepare an emergency stop switch separately.
- Make sure that the start signal is off before resetting the inverter alarm. A failure to do so may restart the motor suddenly.
- The load used should be a three-phase induction motor only. Connection of any other electrical equipment to the inverter output may damage the equipment.
- Do not modify the equipment.

⚠ CAUTION

- The electronic overcurrent protection does not guarantee protection of the motor from overheating.
- Do not use a magnetic contactor on the inverter input for frequent starting/stopping of the inverter.
- Use a noise filter to reduce the effect of electromagnetic interference. Otherwise nearby electronic equipment may be affected.
- Take measures to suppress harmonics. Otherwise power harmonics from the inverter may heat/damage the power capacitor and generator.
- When a 400V class motor is inverter-driven, it should be insulation-enhanced or surge voltages suppressed. Surge voltages attributable to the wiring constants may occur at the motor terminals, deteriorating the insulation of the motor.
- When parameter clear or all clear is performed, each parameter returns to the factory setting. Re-set the required parameters before starting operation.
- The inverter can be easily set for high-speed operation. Before changing its setting, fully examine the performances of the motor and machine.
- In addition to the inverter's holding function, install a holding device to ensure safety.
- Before running an inverter which had been stored for a long period, always perform inspection and test operation.

(6) Maintenance, inspection and parts replacement

⚠ CAUTION
● Do not carry out a megger (insulation resistance) test on the control circuit of the inverter.

(7) Disposing of the inverter

⚠ CAUTION
● Treat as industrial waste.

(8) General instructions

Many of the diagrams and drawings in this instruction manual show the inverter without a cover, or partially open. Never operate the inverter like this. Always replace the cover and follow this instruction manual when operating the inverter.

CONTENTS

1. WIRING

This chapter explains the basic "wiring" for use of this product. Always read the instructions before use.
For description of "installation", refer to the instruction manual (basic).

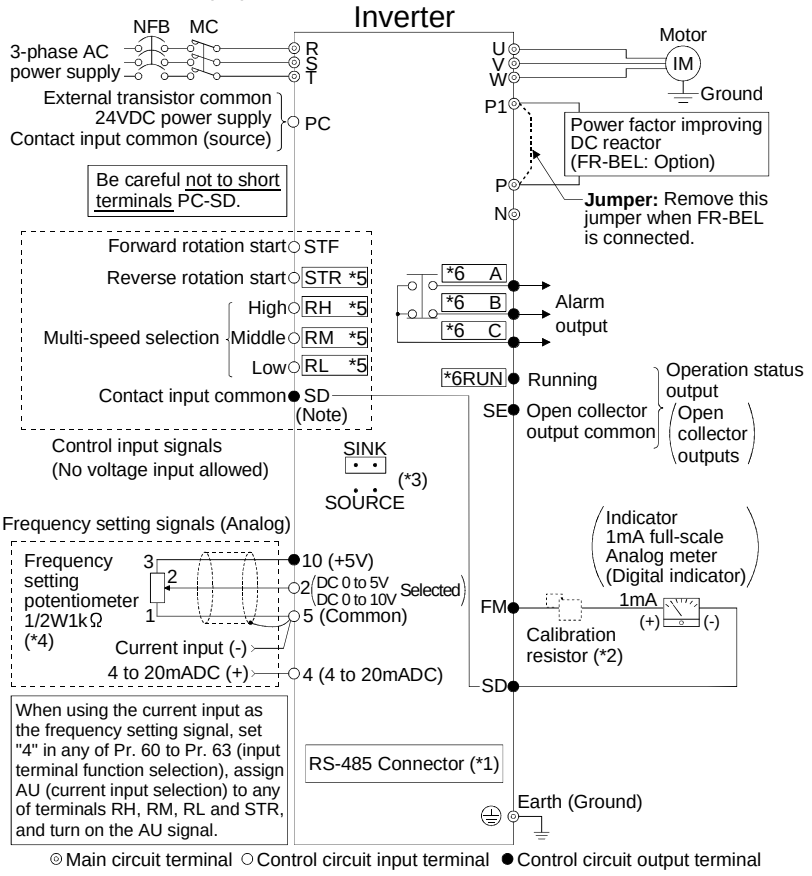
<Abbreviations>

- PU
  Control panel and parameter unit (FR-PU04)
- Inverter
  Mitsubishi transistorized inverter FR-S500 series
- FR-S500
  Mitsubishi transistorized inverter FR-S500 series
- Pr.
  Parameter number

1.1 Japanese Version

1.1.1 Terminal connection diagram

- FR-S520-0.1K to 3.7K (-R) (-C)
- FR-S540-0.4K to 3.7K (-R)



REMARKS

*1 Only the type with RS-485 communication function.

*2 Not needed when the setting dial is used for calibration. This resistor is used when calibration must be made near the frequency meter for such a reason as a remote frequency meter. Note that the needle of the frequency meter may not deflect to full-scale when the calibration resistor is connected. In this case, use both the resistor and setting dial for calibration.

*3 You can switch between the sink and source logic positions. Refer to page 25.

*4 When the setting potentiometer is used frequently, use a 2W1kΩ potentiometer.

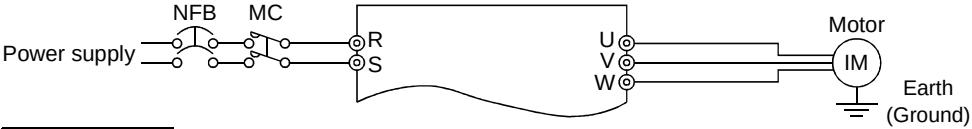
*5 The terminal functions change with input terminal function selection (Pr. 60 to Pr. 63). (Refer to page 38, 88) (RES, RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, X14, X16, (STR) signal selection)

*6 The terminal functions change with output terminal function selection (Pr. 64, Pr. 65). (Refer to page 90) (RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, ABC signal selection)

CAUTION

To prevent a malfunction due to noise, keep the signal cables more than 10cm (3.94inches) away from the power cables.

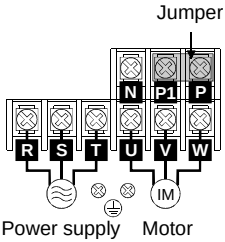
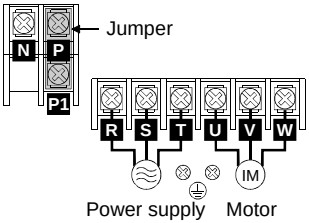
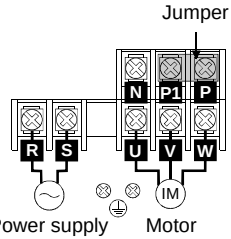
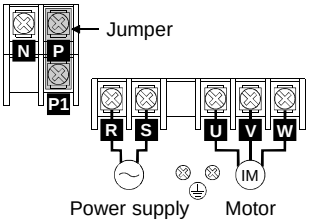
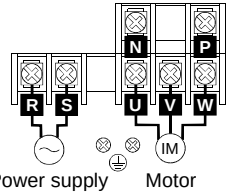
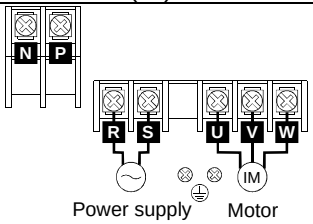
- FR-S520S-0.1K to 1.5K (-R) (-C)
- FR-S510W-0.1K to 0.75K (-R)



REMARKS

- To ensure safety, connect the power input to the inverter via a magnetic contactor and earth leakage circuit breaker or no-fuse breaker, and use the magnetic contactor to switch power on-off.
- The output is three-phase 200V.

1.1.2 Layout and wiring of main circuit terminals

FR-S520-0.1K, 0.2K, 0.4K, 0.75K (-R) (-C)	FR-S520-1.5K, 2.2K, 3.7K (-R) (-C) FR-S540-0.4K, 0.75K, 1.5K, 2.2K, 3.7K (-R)
	
FR-S520S-0.1K, 0.2K, 0.4K, 0.75K (-R)	FR-S520S-1.5K (-R)
	
FR-S510W-0.1K, 0.2K, 0.4K (-R)	FR-S510W-0.75K (-R)
	

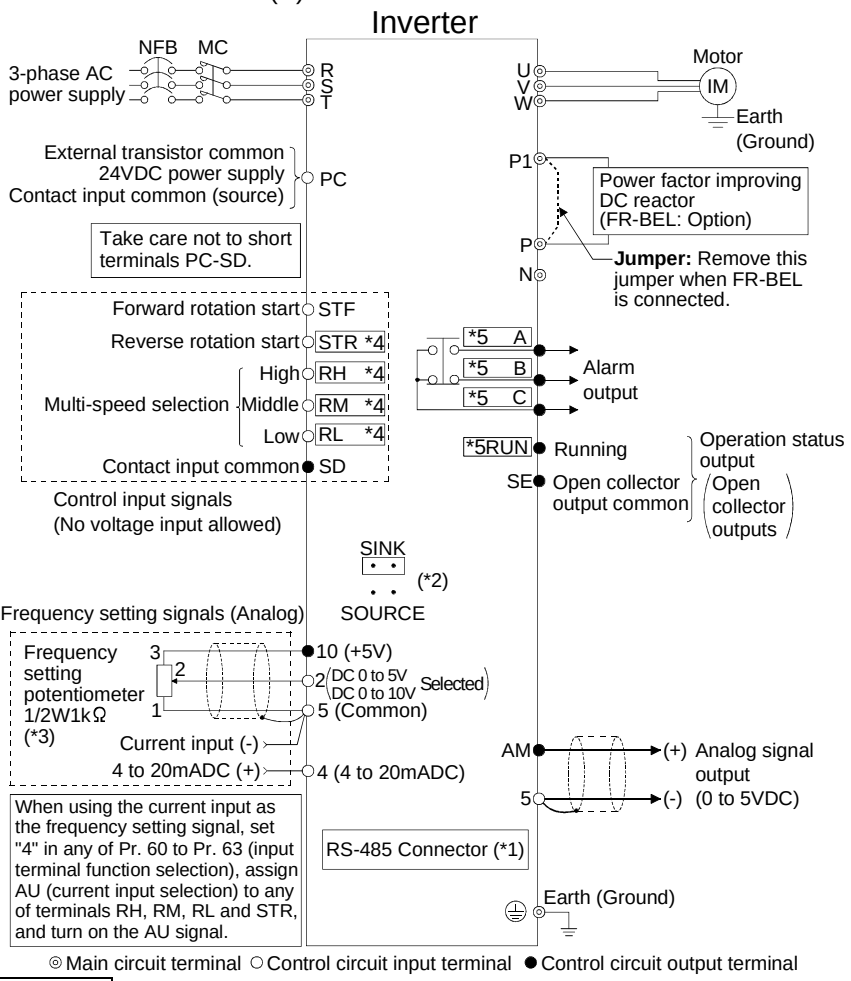
CAUTION

- The power supply cables must be connected to R, S, T. If they are connected to U, V, W, the inverter will be damaged. (Phase sequence need not be matched.)
  (For use with a single-phase power supply, the power supply cables must be connected to R and S.)
- Connect the motor to U, V, W.
  Turning on the forward rotation switch (signal) at this time rotates the motor counterclockwise when viewed from the load shaft.

1.2 North America Version

1.2.1 Terminal connection diagram

- FR-S520-0.1K to 3.7K-NA
- FR-S540-0.4K to 3.7K-NA (R)



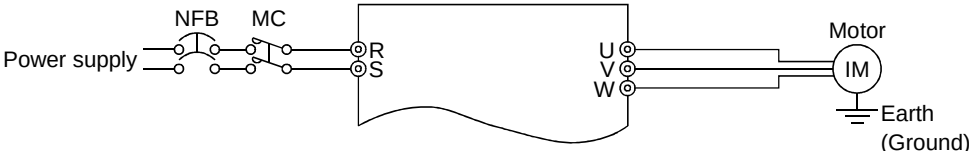
REMARKS

*1 Only the type with RS-485 communication function.
*2 You can switch between the sink and source logic positions. Refer to page 25.
*3 When the setting potentiometer is used frequently, use a 2W 1kΩ potentiometer.
*4 The terminal functions change with input terminal function selection (Pr. 60 to Pr. 63). (Refer to page 38, 88) (RES, RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, X14, X16, (STR) signal selection)
*5 The terminal functions change with output terminal function selection (Pr. 64, Pr. 65). (Refer to page 90) (RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, ABC signal selection)

NOTE

To prevent a malfunction due to noise, keep the signal cables more than 10cm (3.94inches) away from the power cables.

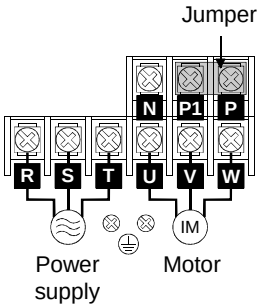
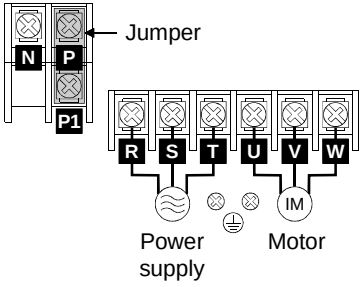
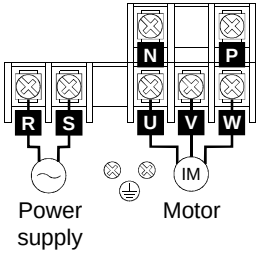
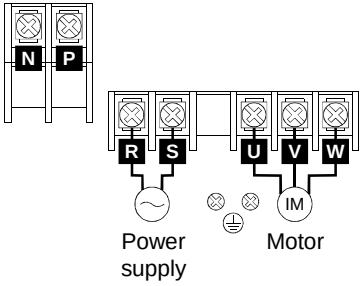
● FR-S510W-0.1K to 0.75K-NA



REMARKS

- To ensure safety, connect the power input to the inverter via a magnetic contactor and earth leakage circuit breaker or no-fuse breaker, and use the magnetic contactor to switch power on-off.
- The output is three-phase 200V.

1.2.2 Layout and wiring of main circuit terminals

FR-S520-0.1K, 0.2K, 0.4K, 0.75K-NA	FR-S520-1.5K, 2.2K, 3.7K-NA FR-S540-0.4K, 0.75K, 1.5K, 2.2K, 3.7K-NA (R)
	
FR-S510W-0.1K, 0.2K, 0.4K-NA	**FR-S510W-0.75K-NA**
	

CAUTION

- The power supply cables must be connected to R, S, T. If they are connected to U, V, W, the inverter will be damaged. (Phase sequence need not be matched.)
- Connect the motor to U, V, W.
  Turning on the forward rotation switch (signal) at this time rotates the motor counterclockwise when viewed from the load shaft.

<When single-phase power input is provided for three-phase power input inverter (NA version only)>

● Reduce the output current.

FR-S520-□K-NA inverter	0.1	0.2	0.4	0.75	1.5	2.2	3.7
Rated output current (A)	0.4	0.8	1.5	2.5	4.0	5.0	7.0
Power supply capacity (kVA)	0.4	0.8	1.5	2.5	4.5	5.5	9.0
AC input current (A)	1.1	2.4	4.5	6.4	11.2	12.9	17.4

● Set m9 (Pr. 637) "current detection filter".

Setting "801" in the manufacturer setting parameter C8 enables you to set the m9 parameter.

CAUTION

Parameters other than m9 can also be made to be displayed, but never alter these since they are manufacturer setting parameters.

m9 Setting	**Description**
0	Single-phase power input
- - - (Factory setting)	Three-phase power input

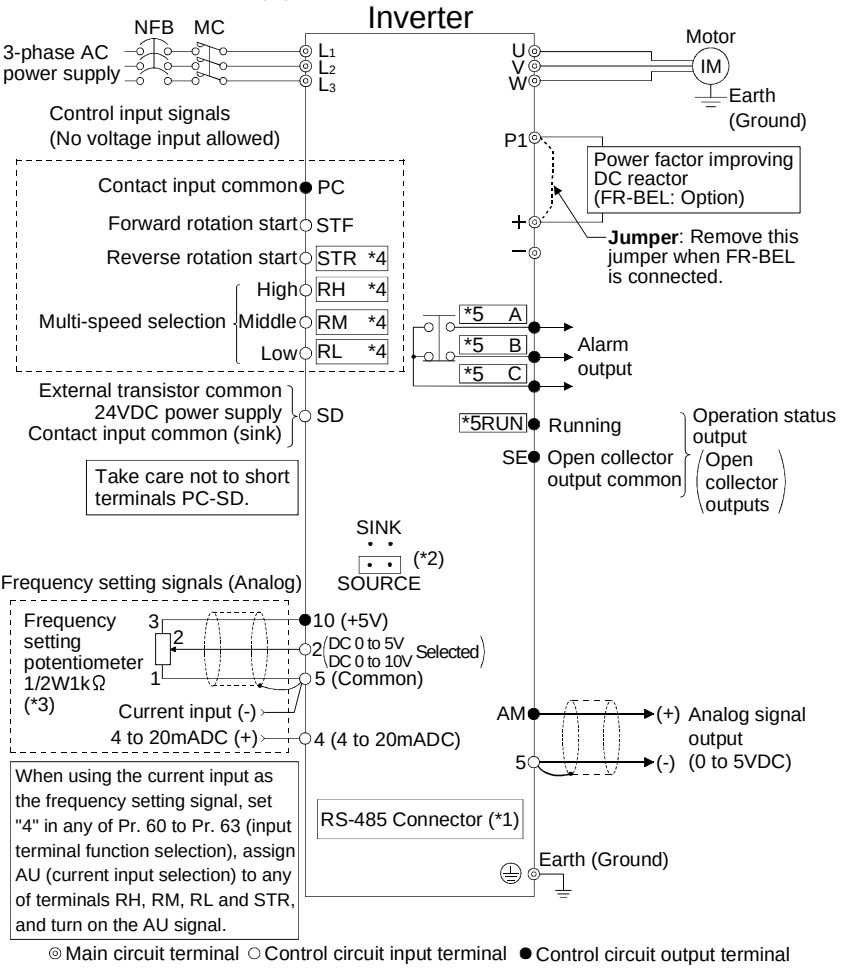
CAUTION

Always return the C8 parameter to 0 (factory setting) after you have finished the setting of m9.

1.3 European Version

1.3.1 Terminal connection diagram

● FR-S540-0.4K to 3.7K-EC(R)

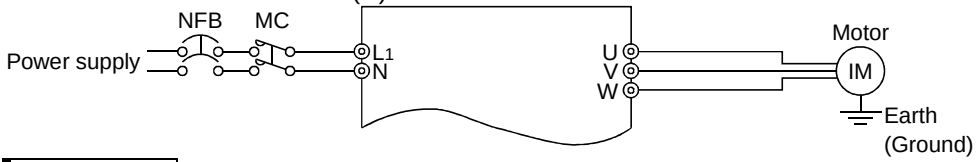


◎ Main circuit terminal ○ Control circuit input terminal ● Control circuit output terminal

REMARKS

*1 Only the type with RS-485 communication function.
*2 You can switch between the sink and source logic positions. Refer to page 25.
*3 When the setting potentiometer is used frequently, use a 2W 1kΩ potentiometer.
*4 The terminal functions change with input terminal function selection (Pr. 60 to Pr. 63). (Refer to page 38, 88) (RES, RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, X14, X16, (STR) signal selection)
*5 The terminal functions change with output terminal function selection (Pr. 64, Pr. 65). (Refer to page 90) (RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, ABC signal selection)

● FR-S520S-0.2K to 1.5K-EC (R)



REMARKS

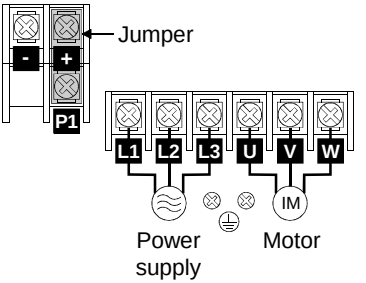
- To ensure safety, connect the power input to the inverter via a magnetic contactor and earth leakage circuit breaker or no-fuse breaker, and use the magnetic contactor to switch power on-off.
- The output is three-phase 200V.

NOTE

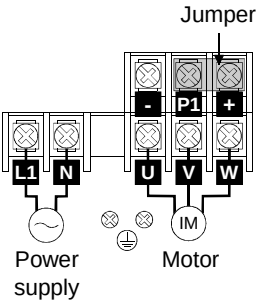
- To prevent a malfunction due to noise, keep the signal cables more than 10cm (3.94inches) away from the power cables.

1.3.2 Layout and wiring of main circuit terminals

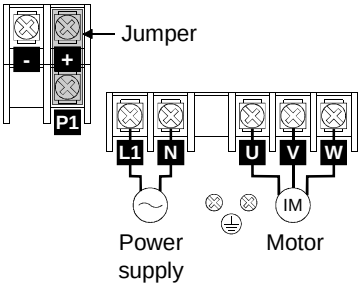
FR-S540-0.4K, 0.75K, 1.5K, 2.2K, 3.7K-EC (R)



FR-S520S-0.2K, 0.4K, 0.75K-EC (R)



FR-S520S-1.5K-EC (R)



CAUTION

- Connect the motor to U, V, W.
  Turning on the forward rotation switch (signal) at this time rotates the motor counterclockwise when viewed from the load shaft.
- For power input wiring, connect L_1 to R/L_1 of the terminal block and N to S/L_2 of the terminal block.
- Do not connect the power supply to U, V and W.

1.4 Description of I/O Terminal Specifications

1.4.1 Main circuit

Symbol	Terminal Name	Description
R, S, T * <L_1, L_2, L_3>	**AC power input**	Connect to the commercial power supply.
U, V, W	**Inverter output**	Connect a three-phase squirrel-cage motor.
N<->	**DC voltage common**	DC voltage common terminal. Not isolated from the power supply and inverter output.
P<+>, P1	**Power factor improving DC reactor connection**	Disconnect the jumper from terminals P<+>-P1 and connect the optional power factor improving DC reactor (FR-BEL). (The single-phase 100V power input model cannot be connected.)
⏚	**Earth (Ground)**	For grounding the inverter chassis. Must be earthed.

* R, S <L_1, N> terminals for single-phase power input.

CAUTION

< >Terminal names in parentheses are those of the EC version.

1.4.2 Control circuit

Symbol			Terminal Name	Description		
Input signals	Contact input	**STF**	**Forward rotation start**	Turn on the STF signal to start forward rotation and turn it off to stop.	When the STF and STR signals are turned on simultaneously, the stop command is given.	Input terminal function selection (Pr. 60 to Pr. 63) changes the terminal functions. (*4)
		STR	**Reverse rotation start**	Turn on the STR signal to start reverse rotation and turn it off to stop.		
		RH RM RL	**Multi-speed selection**	Turn on the RH, RM and RL signals in appropriate combinations to select multiple speeds. The priorities of the speed commands are in order of jog, multi-speed setting (RH, RM, RL, REX) and AU.		
	SD (*1)		**Contact input common (sink)**	Common terminal for contact inputs (terminals STF, STR, RH, RM, RL) and indicator connection (terminal FM). Isolated from terminals 5 and SE.		
	PC (*1)		**External transistor common 24VDC power supply Contact input common (source)**	When connecting the transistor output (open collector output), such as a programmable controller (PLC), connect the positive external power supply for transistor output to this terminal to prevent a malfunction caused by undesirable current. This terminal can be used as a 24V 0.1A DC power output across terminals PC-SD. When source logic is selected, this terminal serves as a contact input signal common.		
	10		**Frequency setting power supply**	5VDC. Permissible load current 10mA.		
	Frequency setting	**2**	**Frequency setting (Voltage signal)**	By entering 0 to 5VDC (0 to 10VDC), the maximum output frequency is reached at 5V (10V) and I/O are proportional. Use Pr. 73 "0-5V/0-10V selection" to switch between 5V and 10V. Input resistance 10kΩ. Maximum permissible voltage 20V.		
		4	**Frequency setting (Current signal)**	Enter 4-20mADC. This signal is factory-adjusted to reach 0Hz at 4mA and 60Hz at 20mA. Maximum permissible input current 30mA. Input resistance approximately 250Ω. For current input, turn on the signal AU. Set the AU signal in any of Pr. 60 to Pr. 63 (input terminal function selection).		

Symbol				Terminal Name	Description	
Input signals	5			Frequency setting input common	Common terminal for the frequency setting signals (terminals 2, 4) and indicator connection (terminal AM). Isolated from terminals SD and SE. Do not earth.	
Output signals	A B C			Alarm output	Change-over contact output indicating that the output has been stopped by the inverter's protective function activated. 230V 0.3A AC, 30V 0.3A DC. Alarm: discontinuity across B-C (continuity across A-C), normal: continuity across B-C (discontinuity across A-C). (*6)	Output terminal function selection (Pr. 64, Pr. 65) changes the terminal functions. (*5)
	Open collector	RUN		Inverter running	Switched low when the inverter output frequency is equal to or higher than the starting frequency (factory set to 0.5Hz, variable). Switched high during stop or DC injection brake operation. (*2) Permissible load 24VDC 0.1A DC.	
	SE			Open collector output common	Common terminal for inverter running terminal RUN. Isolated from terminals 5 and SD.	
	Indicator	Pulse	FM <Japanese>	For meter	One selected from output frequency and motor current is output. The output signal is proportional to the magnitude of each monitoring item.	Factory setting of output item: Frequency Permissible load current 1mA 1440 pulses/s at 60Hz
		Analog	AM <NA, EC>	Analog signal output		Factory setting of output item: Frequency Output signal 0 to 5VDC Permissible load current 1mA
Communication	—			RS-485 connector (*3)	Using the parameter unit connection cable (FR-CB201 to 205), the parameter unit (FR-PU04) is connectable. Communication operation can be performed through RS-485.	

*1. Do not connect terminals SD and PC each other or to the earth.
For sink logic, terminal SD acts as the common terminal of contact input. For source logic, terminal PC acts as the common terminal of contact input. (Refer to page 25 for the way to switch between them.)

*2. Low indicates that the open collector outputting transistor is on (conducts). High indicates that the transistor is off (does not conduct).

*3. Compatible with only the type having RS-485 communication function. (Refer to page 41.)

*4. RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, RES, X14, X16, (STR) signal selection (Refer to page 88.)

*5. RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, ABC signal selection (Refer to page 90.)

*6. To be compatible with the European Directive (Low Voltage Directive), the operating capacity of relay outputs (A, B, C) should be 30V 0.3A DC.

1.5 How to Use the Main Circuit Terminals

1.5.1 Cables, wiring lengths, crimping terminals, etc.

The following selection example assumes the wiring length of 20m (65.62feet).

1) FR-S520-0.1K to 3.7K (-R) (-C)
FR-S520-0.1K to 3.7K-NA

Applicable Inverter Model	Terminal Screw Size	Tightening Torque N•m	Crimping Terminals		Cables				PVC Insulated Cables	
					mm^2		AWG		mm^2	
			R, S, T	U, V, W	R, S, T	U, V, W	R, S, T	U, V, W	R, S, T	U, V, W
FR-S520-0.1K to 0.75K	M3.5	1.2	2-3.5	2-3.5	2	2	14	14	2.5	2.5
FR-S520-1.5K, 2.2K	M4	1.5	2-4	2-4	2	2	14	14	2.5	2.5
FR-S520-3.7K	M4	1.5	5.5-4	5.5-4	3.5	3.5	12	12	4	2.5

2) FR-S540-0.4K to 3.7K (-R)
FR-S540-0.4K to 3.7K-NA (R)
FR-S540-0.4K to 3.7K-EC (R)

Applicable Inverter Model	Terminal Screw Size	Tightening Torque N•m	Crimping Terminals		Cables				PVC Insulated Cables	
					mm^2		AWG		mm^2	
			R, S, T <L_1, L_2, L_3>	U, V, W	R, S, T <L_1, L_2, L_3>	U, V, W	R, S, T <L_1, L_2, L_3>	U, V, W	R, S, T <L_1, L_2, L_3>	U, V, W
FR-S540-0.4K to 3.7K	M4	1.5	2-4	2-4	2	2	14	14	2.5	2.5

3) FR-S520S-0.1K to 1.5K (-R)
FR-S520S-0.2K to 1.5K-EC (R)

Applicable Inverter Model	Terminal Screw Size	Tightening Torque N•m	Crimping Terminals		Cables				PVC Insulated Cables	
					mm^2		AWG		mm^2	
			R, S <L_1, N>	U, V, W	R, S <L_1, N>	U, V, W	R, S <L_1, N>	U, V, W	R, S <L_1, N>	U, V, W
FR-S520S-0.1K to 0.75K	M3.5	1.2	2-3.5	2-3.5	2	2	14	14	2.5	2.5
FR-S520S-1.5K	M4	1.5	2-4	2-4	2	2	14	14	2.5	2.5

4) FR-S510W-0.1K to 0.75K (-R)
FR-S510W-0.1K to 0.75K-NA

Applicable Inverter Model	Terminal Screw Size	Tightening Torque N•m	Crimping Terminals		Cables				PVC Insulated Cables	
					mm^2		AWG		mm^2	
			R, S	U, V, W	R, S	U, V, W	R, S	U, V, W	R, S <L_1, N>	U, V, W
FR-S510W-0.1K to 0.4K	M3.5	1.2	2-3.5	2-3.5	2	2	14	14	2.5	2.5
FR-S510W-0.75K	M4	1.5	5.5-4	2-4	3.5	2	12	14	4	2.5

● Wiring length
100m (328.08feet) maximum. (50m (164.04feet) maximum for the FR-S540-0.4K.)

CAUTION

- When the wiring length of the 0.1K or 0.2K is 30m (98.43feet) or more, use the carrier frequency to 1kHz.
- Use the carrier frequency of 1kHz when the wiring length of the FR-S540-0.4K, 0.75K is 30m (98.43feet) or more.
- The wiring length should be 30m (98.43feet) maximum when automatic torque boost is selected in Pr. 98 "automatic torque boost selection (motor capacity)". (Refer to page 109)

1.5.2 Wiring instructions

1) Use insulation-sleeved crimping terminals for the power supply and motor cables.

2) Application of power to the output terminals (U, V, W) of the inverter will damage the inverter. Never perform such wiring.

3) After wiring, wire off-cuts must not be left in the inverter.
Wire off-cuts can cause an alarm, failure or malfunction. Always keep the inverter clean.
When drilling a control box etc., take care not to let wire off-cuts enter the inverter.

4) Use cables of the recommended size to make a voltage drop 2% maximum.
If the wiring distance is long between the inverter and motor, a main circuit cable voltage drop will cause the motor torque to decrease especially at the output of a low frequency.

5) For long distance wiring, the fast-response current limit function may be reduced or the devices connected to the secondary side may malfunction or become faulty under the influence of a charging current due to the stray capacity of wiring. Therefore, note the maximum overall wiring length.

6) Electromagnetic wave interference
The input/output (main circuit) of the inverter includes harmonic components, which may interfere with the communication devices (such as AM radios) used near the inverter. In this case, install the optional FR-BIF radio noise filter (for use in the input side only) or FR-BSF01 or FR-BLF line noise filter to minimize interference.

7) Do not install a power capacitor, surge suppressor or radio noise filter (FR-BIF option) in the output side of the inverter.
This will cause the inverter to trip or the capacitor and surge suppressor to be damaged. If any of the above devices are connected, remove them. (When using the FR-BIF radio noise filter with a single-phase power supply, connect it to the input side of the inverter after isolating the T <L_3> phase securely.)

8) Before starting rewiring or other work after performing operation once, check the voltage with a meter etc. more than 10 minutes after power-off. For some time after power-off, there is a dangerous voltage in the capacitor.

1.5.3 Peripheral devices

(1) Selection of peripheral devices

Check the capacity of the motor applicable to the inverter you purchased. Appropriate peripheral devices must be selected according to the capacity.
Refer to the following list and prepare appropriate peripheral devices:

1) FR-S520-0.1K to 3.7K (-R) (-C)
FR-S520-0.1K to 3.7K-NA

Motor Output (kW (HP))	Inverter Model	Rated current of Circuit Breaker (Refer to page 15) (*1)	Magnetic Contactor (MC) (Refer to page 17)	Power Factor Improving AC Reactor (Refer to page 18)	Power Factor Improving DC Reactor (Refer to page 18)	Cables (mm^2) (*2)	
						R, S, T	U, V, W
0.1 (1/8)	FR-S520-0.1K	30AF/5A	S-N10	FR-BAL-0.4K (*3)	FR-BEL-0.4K (*3)	2	2
0.2 (1/4)	FR-S520-0.2K	30AF/5A	S-N10	FR-BAL-0.4K (*3)	FR-BEL-0.4K (*3)	2	2
0.4 (1/2)	FR-S520-0.4K	30AF/5A	S-N10	FR-BAL-0.4K	FR-BEL-0.4K	2	2
0.75 (1)	FR-S520-0.75K	30AF/10A	S-N10	FR-BAL-0.75K	FR-BEL-0.75K	2	2
1.5 (2)	FR-S520-1.5K	30AF/15A	S-N10	FR-BAL-1.5K	FR-BEL-1.5K	2	2
2.2 (3)	FR-S520-2.2K	30AF/20A	S-N11, S-N12	FR-BAL-2.2K	FR-BEL-2.2K	2	2
3.7 (5)	FR-S520-3.7K	30AF/30A	S-N20	FR-BAL-3.7K	FR-BAL-3.7K	3.5	3.5

2) FR-S540-0.4K to 3.7K (-R)
FR-S540-0.4K to 3.7K-NA (R)
FR-S540-0.4K to 3.7K-EC (R)

Motor Output (kW (HP))	Inverter Model	Rated current of Circuit Breaker (Refer to page 15) (*1)	Magnetic Contactor (MC) (Refer to page 17)	Power Factor Improving AC Reactor (Refer to page 18)	Power Factor Improving DC Reactor (Refer to page 18)	Cables (mm^2) (*2)	
						R, S, T <L_1, L_2, L_3>	U, V, W
0.4 (1/2)	FR-S540-0.4K	30AF/5A	S-N10	FR-BAL-H0.4K	FR-BEL-H0.4K	2	2
0.75 (1)	FR-S540-0.75K	30AF/5A	S-N10	FR-BAL-H0.75K	FR-BEL-H0.75K	2	2
1.5 (2)	FR-S540-1.5K	30AF/10A	S-N10	FR-BAL-H1.5K	FR-BEL-H1.5K	2	2
2.2 (3)	FR-S540-2.2K	30AF/15A	S-N20	FR-BAL-H2.2K	FR-BEL-H2.2K	2	2
3.7 (5)	FR-S540-3.7K	30AF/20A	S-N20	FR-BAL-H3.7K	FR-BAL-H3.7K	2	2

3) FR-S520S-0.1K to 1.5K (-R)
FR-S520S-0.2K to 1.5K-EC (R)

Motor Output (kW (HP))	Inverter Model	Rated current of Circuit Breaker (Refer to page 15) (*1)	Magnetic Contactor (MC) (Refer to page 17)	Power Factor Improving AC Reactor (Refer to page 18) (*3)	Power Factor Improving DC Reactor (Refer to page 18) (*3)	Cables (mm^2) (*2)	
						R, S <L_1, N>	U, V, W
0.1 (1/8)	FR-S520S-0.1K	30AF/5A	S-N10	FR-BAL-0.4K	FR-BEL-0.4K	2	2
0.2 (1/4)	FR-S520S-0.2K	30AF/10A	S-N10	FR-BAL-0.4K	FR-BEL-0.4K	2	2
0.4 (1/2)	FR-S520S-0.4K	30AF/10A	S-N20	FR-BAL-0.75K	FR-BEL-0.75K	2	2
0.75 (1)	FR-S520S-0.75K	30AF/15A	S-N20	FR-BAL-1.5K	FR-BEL-1.5K	2	2
1.5 (2)	FR-S520S-1.5K	30AF/20A	S-N21	FR-BAL-2.2K	FR-BEL-2.2K	2	2

4) FR-S510W-0.1K to 0.75K (-R)
FR-S510W-0.1K to 0.75K-NA

Motor Output (kW (HP))	Inverter Model	Rated current of Circuit Breaker (Refer to page 15) (*1)	Magnetic Contactor (MC) (Refer to page 17)	Power Factor Improving AC Reactor (Refer to page 18) (*3)	Power Factor Improving DC Reactor (Refer to page 18) (*4)	Cables (mm^2) (*2)	
						R, S <L_1, N>	U, V, W
0.1 (1/8)	FR-S510W-0.1K	30AF/10A	S-N10	FR-BAL-0.75K	—	2	2
0.2 (1/4)	FR-S510W-0.2K	30AF/15A	S-N10	FR-BAL-1.5K	—	2	2
0.4 (1/2)	FR-S510W-0.4K	30AF/20A	S-N20	FR-BAL-2.2K	—	2	2
0.75 (1)	FR-S510W-0.75K	30AF/30A	S-N20	FR-BAL-3.7K	—	3.5	2

*1 For installations in the United States or Canada, the circuit breaker must be inverse time or instantaneous trip type.
*2 The size of the cables assume that the wiring length is 20m (65.62feet).
*3 The power factor may be slightly less.
*4 The single-phase 100V power input model does not allow the power factor improving DC reactor to be fitted.

1.5.4 Leakage current and installation of earth leakage circuit breaker

Due to static capacitances existing in the inverter I/O wiring and motor, leakage currents flow through them. Since their values depend on the static capacitances, carrier frequency, etc., take the following counter measures.

(1) To-ground leakage currents

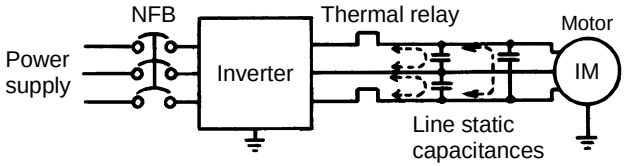
Leakage currents may flow not only into the inverter's own line but also into the other line through the ground cable, etc.
These leakage currents may operate earth leakage circuit breakers and earth leakage relays unnecessarily.

● Counter measures

- If the carrier frequency setting is high, decrease the carrier frequency (Pr. 72) of the inverter.
  Note that motor noise increases. Selection of Soft-PWM control (Pr. 70) will make it unoffending. (Factory setting)
- By using earth leakage circuit breakers designed for harmonic and surge suppression (e.g. Mitsubishi's Progressive Super Series) in the inverter's own line and other line, operation can be performed with the carrier frequency kept high (with low noise).

(2) Line-to-line leakage currents

Harmonics of leakage currents flowing in static capacities between the inverter output cables may operate the external thermal relay unnecessarily.



Line-to-Line Leakage Current Path

● Counter measures

- Use the electronic overcurrent protection of the inverter.
- Decrease the carrier frequency. Note that motor noise increases. Selection of Soft-PWM (Pr. 70) makes it unoffending.
  To ensure that the motor is protected against line-to-line leakage currents, it is recommended to use a temperature sensor to directly detect motor temperature.

● Installation and selection of no-fuse breaker

On the power receiving side, install a no-fuse breaker (NFB) to protect the primary wiring of the inverter. Which NFB to choose depends on the power supply side power factor (which changes with the power supply voltage, output frequency and load) of the inverter. Especially as the completely electromagnetic type NFB changes in operational characteristic with harmonic currents, you need to choose the one of a little larger capacity. (Check the data of the corresponding breaker.)
For the earth leakage circuit breaker, use our product designed for harmonic and surge suppression (Progressive Super Series). (Refer to page 13 for the recommended models.)

CAUTION

Choose the NFB type according to the power supply capacity.

(3) Selecting the rated sensitivity current for the earth leakage circuit breaker

When using the earth leakage circuit breaker with the inverter circuit, select its rated sensitivity current as follows, independently of the PWM carrier frequency:

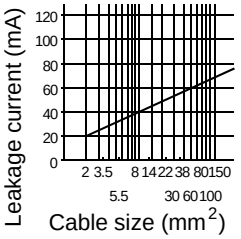
- Progressive Super Series (Type SP, CF, SF, CP)
  Rated sensitivity current:
  $I\Delta n \geq 10 \times (Ig1+Ign+Ig2+Igm)$
- Conventional NV series (Type CA, CS, SS produced prior to '91)
  Rated sensitivity current:
  $I\Delta n \geq 10 \times \{Ig1+Ign+3 \times (Ig2+Igm)\}$

  Ig1, Ig2 : Leakage currents of cable path during commercial power supply operation

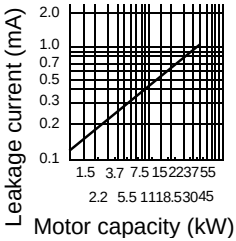
  Ign* : Leakage current of noise filter on inverter input side

  Igm : Leakage current of motor during commercial power supply operation

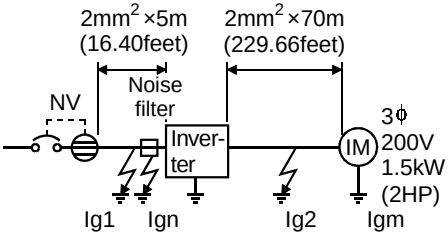
Example of leakage current per 1km in cable path during commercial power supply operation when the CV cable is routed in metal conduit (200V 60Hz)



Leakage current example of 3-phase induction motor during commercial power supply operation (200V 60Hz)



<Example>



CAUTION

- The earth leakage circuit breaker should be installed to the primary (power supply) side of the inverter.
- In the 人 connection neutral point grounded system, the sensitivity current becomes worse for ground faults in the inverter secondary side. Hence, the protective grounding of the load equipment should be 10Ω or less.
- When the breaker is installed in the secondary side of the inverter, it may be unnecessarily operated by harmonics if the effective value is less than the rating. In this case, do not install the breaker since the eddy current and hysteresis loss increase and the temperature rises.

* Note the leakage current value of the noise filter installed on the inverter input side.

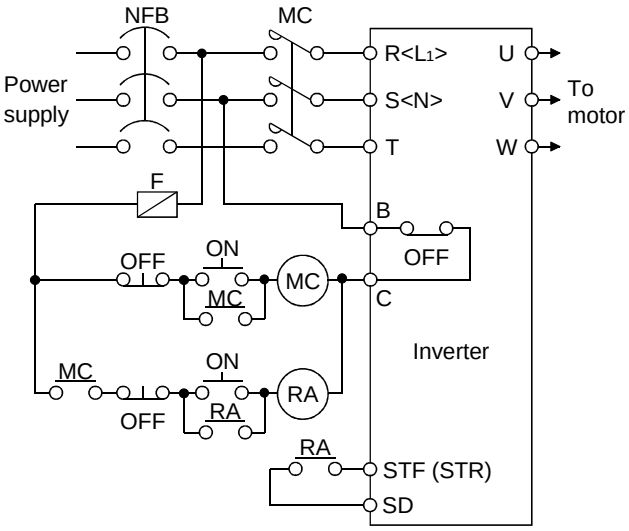
	Progressive Super Series (Type SP, CF, SF,CP)	**Conventional NV (Type CA, CS, SS)**
Leakage current (Ig1) (mA)	$20 \times \frac{\text{5m (16.40feet)}}{\text{1000m (3280.80feet)}} = 0.10$	
Leakage current (Ign) (mA)	0 (without noise filter)	
Leakage current (Ig2) (mA)	$20 \times \frac{\text{70m (229.66feet)}}{\text{1000m (3280.80feet)}} = 1.40$	
Motor leakage current (Igm) (mA)	0.14	
Total leakage current (mA)	1.66	4.78
Rated sensitivity current (mA) (≥ Ig × 10)	30	100

1.5.5 Power-off and magnetic contactor (MC)

CAUTION

Do not use the inverter power supply side magnetic contactor to start or stop the inverter.

As shown on the right, always use the start signal (ON or OFF across terminals STF or STR-SD) to make a start or stop. (Refer to page 28)



Inverter Start/Stop Circuit Example

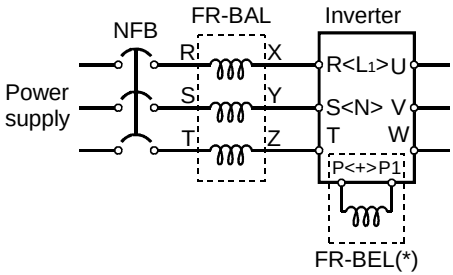
(1) Inverter's primary side magnetic contactor (MC)

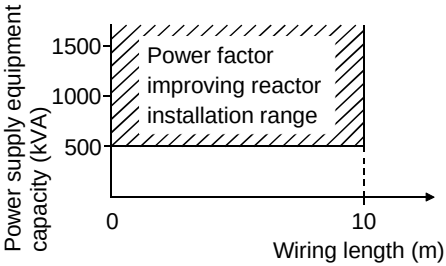
On the inverter's primary side, it is recommended to provide an MC for the following purposes (Refer to page 13 for selection.):

1) To release the inverter from the power supply when the inverter's protective function is activated or when the drive is not functioning (e.g. emergency stop operation).
2) To prevent an accident caused by an automatic restart made at power restoration after an inverter stop due to a power failure.
3) To rest the inverter for a long time.
   The control power supply for inverter is always running and consumes a little power. When stopping the inverter for a long time, switching inverter power off saves power slightly.
4) To separate the inverter from the power supply to ensure safety of maintenance/inspection work.
   As the inverter's primary MC is used for the above purposes, it is equivalent to the standard duty and select the one of class JEM1038-AC3 for the inverter input side current.

1.5.6 Regarding the installation of the power factor improving reactor

When the inverter is installed near a large-capacity power transformer (500kVA or more at the wiring length of 10m (32.81feet) or less) or the power capacitor is to be switched, an excessive peak current will flow in the power supply input circuit, damaging the converter circuit. In such a case, always install the power factor improving reactor (FR-BEL or FR-BAL).





REMARKS

* When connecting the FR-BEL, remove the jumper across terminals P<+>-P1. The wiring length between FR-BEL and inverter should be 5m (16.40feet) maximum and as short as possible.
  Use the cables which are equal in size to those of the main circuit. (Refer to page 11)

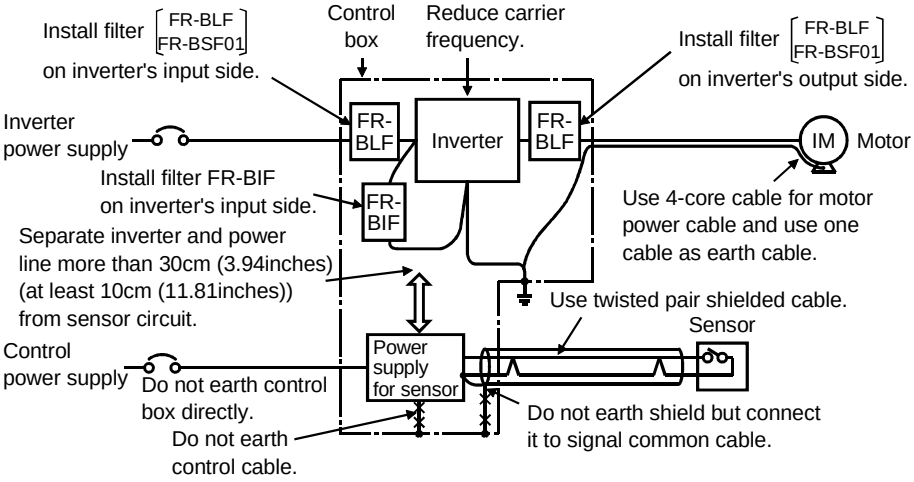
1.5.7 Regarding noise and the installation of a noise filter

Some noise enters the inverter causing it to malfunction and others are generated by the inverter causing the malfunction of peripheral devices. Though the inverter is designed to be insusceptible to noise, it handles low-level signals, so it requires the following general counter measures to be taken.

● General counter measures

- Do not run the power cables (I/O cables) and signal cables of the inverter in parallel with each other and do not bundle them.
- Use twisted shield cables for the detector connecting and control signal cables and connect the sheathes of the shield cables to terminal SD.
- Ground the inverter, motor, etc. at one point.
- Capacitances exist between the inverter's I/O wiring, other cables, earth and motor, through which leakage currents flow to cause the earth leakage circuit breaker, earth leakage relay and external thermal relay to operate unnecessarily. To prevent this, take appropriate measures, e.g. set the carrier frequency in Pr. 72 to a low value, use an earth leakage circuit breaker designed for suppression of harmonics and surges, and use the electronic overcurrent protection built in the inverter.

● Noise reduction examples



1.5.8 Grounding precautions

● Leakage currents flow in the inverter. To prevent an electric shock, the inverter and motor must be grounded.

● Use the dedicated ground terminal to ground the inverter. (Do not use the screw in the casing, chassis, etc.)
Use a tinned* crimping terminal to connect the earth cable. When tightening the screw, be careful not to break the threads.
*Plating should not include zinc.

● Use the thickest possible ground cable. Use the cable whose size is equal to or greater than that indicated in the following table, and minimize the cable length. The grounding point should be as near as possible to the inverter.

(Unit: mm^2)

Motor Capacity	Ground Cable Size	
	200V, 100V class	400V class
2.2kW (3HP) or less	2 (2.5)	2 (2.5)
3.7kW (5HP)	3.5 (4)	2 (4)

For use as a product compliant with the Low Voltage Directive, use PVC cable whose size is indicated within parentheses.

● Ground the motor on the inverter side using one cable of the 4-core cable.

1.5.9 Regarding power harmonics

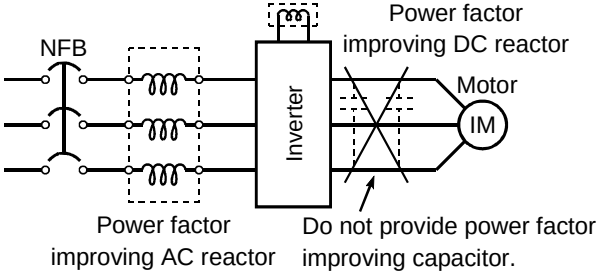
The inverter may generate power harmonics from its converter circuit to affect the power generator, power capacitor etc. Power harmonics are different from noise and leakage currents in source, frequency band and transmission path. Take the following counter measure suppression techniques.

● The following table indicates differences between harmonics and noise:

Item	Harmonics	Noise
Frequency	Normally 40th to 50th degrees or less (up to 3kHz or less)	High frequency (several 10kHz to MHz order)
Environment	To-electric channel, power impedance	To-space, distance, wiring path
Quantitative understanding	Theoretical calculation possible	Random occurrence, quantitative grasping difficult
Generated amount	Nearly proportional to load capacity	Change with current variation ratio (larger as switching speed increases)
Affected equipment immunity	Specified in standard per equipment	Different depending on maker's equipment specifications
Suppression example	Provide reactor.	Increase distance.

● Suppression technique

Harmonic currents produced on the power supply side by the inverter change with such conditions as whether there are wiring impedances and a power factor improving reactor and the magnitudes of output frequency and output current on the load side.



For the output frequency and output current, we understand that they should be calculated in the conditions under the rated load at the maximum operating frequency.

CAUTION

The power factor improving capacitor and surge suppressor on the inverter output side may be overheated or damaged by the harmonic components of the inverter output. Also, since an excessive current flows in the inverter to activate overcurrent protection, do not provide a capacitor and surge suppressor on the inverter output side when the motor is driven by the inverter. To improve the power factor, insert a power factor improving reactor in the inverter's primary side or DC circuit. For full information, refer to page 18.

1.5.10 Japanese power harmonic suppression guideline

Harmonic currents flow from the inverter to a power receiving point via a power transformer. The harmonic suppression guideline was established to protect other consumers from these outgoing harmonics.

1) [Harmonic suppression guideline for household appliances and general-purpose products]

The "harmonic suppression guideline for household appliances and general-purpose products" issued by ex-Ministry of International Trade and Industry (present Ministry of Economy, Trade and Industry) in September, 1994 applies to the FR-S500 series other than the three-phase 400V class. By installing the FR-BEL or FR-BAL power factor improving reactor, this product complies with the "harmonic suppression techniques for transistorized inverters (input current 20A or less)" established by the Japan Electrical Manufacturers' Association.

2) "Harmonic suppression guideline for specific consumers"

This guideline sets forth the maximum values of harmonic currents outgoing from a high-voltage or specially high-voltage consumer who will install, add or renew harmonic generating equipment. If any of the maximum values is exceeded, this guideline requires that consumer to take certain suppression measures.

Table 1 Maximum Values of Outgoing Harmonic Currents per 1kW Contract Power

Received Power Voltage	5th	7th	11th	13th	17th	19th	23rd	Over 23rd
6.6kV	3.5	2.5	1.6	1.3	1.0	0.9	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36
33 kV	1.2	0.86	0.55	0.46	0.35	0.32	0.26	0.24

(1) Application of the harmonic suppression guideline for specific consumers

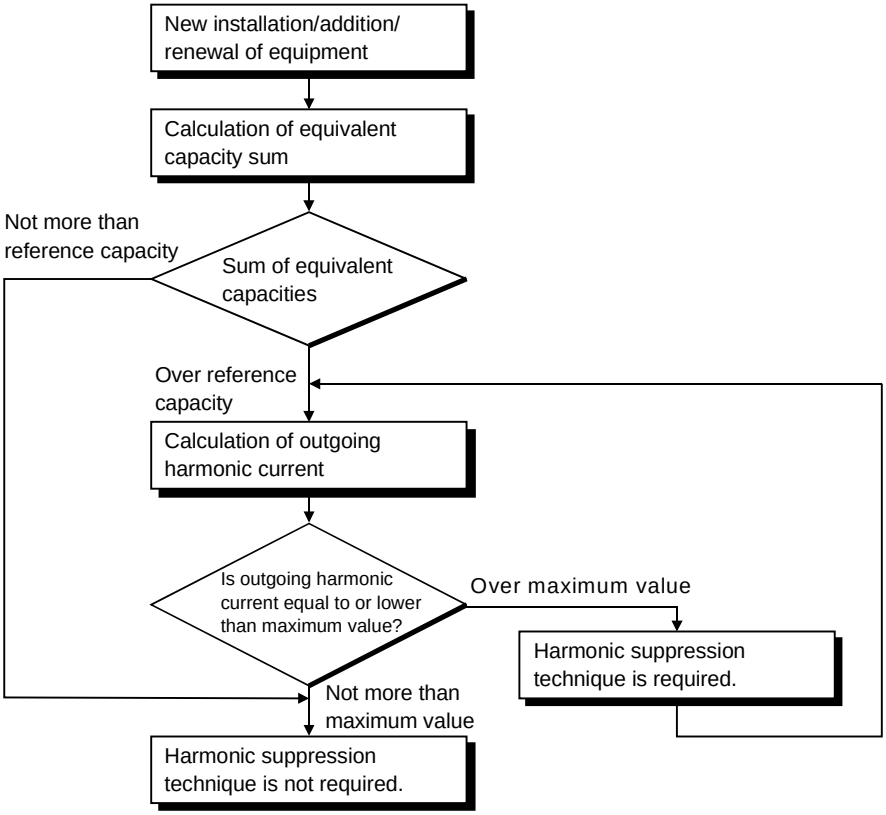


Table 2 Conversion Factors for FR-S500 Series

Class	Circuit Type		Conversion Factor (Ki)
3	3-phase bridge (Capacitor-smoothed)	Without reactor	K31 = 3.4
		With reactor (AC side)	K32 = 1.8
		With reactor (DC side)	K33 = 1.8
		With reactors (AC, DC sides)	K34 = 1.4

Table 3 Equivalent Capacity Limits

Received Power Voltage	Reference Capacity
6.6kV	50 kVA
22/33 kV	300 kVA
66kV or more	2000 kVA

Table 4 Harmonic Contents (Values at the fundamental current of 100%)

Reactor	5th	7th	11th	13th	17th	19th	23rd	25th
Not used	65	41	8.5	7.7	4.3	3.1	2.6	1.8
Used (AC side)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
Used (DC side)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
Used (AC, DC sides)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

1) Calculation of equivalent capacity (P0) of harmonic generating equipment

The "equivalent capacity" is the capacity of a 6-pulse converter converted from the capacity of consumer's harmonic generating equipment and is calculated with the following equation. If the sum of equivalent capacities is higher than the limit in Table 3, harmonics must be calculated with the following procedure:

$P0=\Sigma (Ki \times Pi)$ [kVA]

Ki: Conversion factor (refer to Table 2)

Pi: Rated capacity of harmonic generating equipment* [kVA]

i: Number indicating the conversion circuit type

*Rated capacity: Determined by the capacity of the applied motor and found in Table 5. It should be noted that the rated capacity used here is used to calculate a generated harmonic amount and is different from the power supply capacity required for actual inverter drive.

2) Calculation of outgoing harmonic current

Outgoing harmonic current = fundamental wave current (value converterd from received power voltage) × operation ratio × harmonic content

- Operation ratio: Operation ratio = actual load factor × operation time ratio during 30 minutes
- Harmonic content: Found in Table 4.

Table 5 Rated Capacities and Outgoing Harmonic Currents for Inverter Drive

Applied Motor (kW)	Rated Current [A]	6.6kV Equivalent of Fundamental	Rated Capacity	Fundamental Wave Current Converted from 6.6kV (No reactor, 100% operation ratio)							
	400V	Wave Current (mA)	(kVA)	5th	7th	11th	13th	17th	19th	23rd	25th
0.4	0.81	49	0.57	31.85	20.09	4.165	3.773	2.107	1.519	1.274	0.882
0.75	1.37	83	0.97	53.95	34.03	7.055	6.391	3.569	2.573	2.158	1.494
1.5	2.75	167	1.95	108.6	68.47	14.20	12.86	7.181	5.177	4.342	3.006
2.2	3.96	240	2.81	156.0	98.40	20.40	18.48	10.32	7.440	6.240	4.320
3.7	6.50	394	4.61	257.1	161.5	33.49	30.34	16.94	12.21	10.24	7.092

3) Harmonic suppression technique requirement

If the outgoing harmonic current is higher than; maximum value per 1kW (contract power) × contract power, a harmonic suppression technique is required.

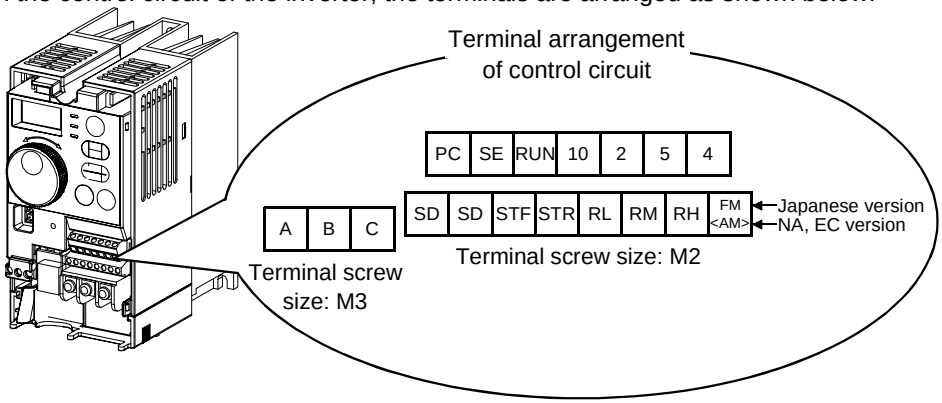
4) Harmonic suppression techniques

No.	Item	Description
1	Reactor installation (ACL, DCL)	Install a reactor (ACL) in the AC side of the inverter or a reactor (DCL) in its DC side or both to suppress outgoing harmonic currents.
2	Installation of power factor improving capacitor	When used with a series reactor, the power factor improving capacitor has an effect of absorbing harmonic currents.
3	Transformer multi-phase operation	Use two transformers with a phase angle difference of 30° as in 人-Δ, Δ-Δ combination to provide an effect corresponding to 12 pulses, reducing low-degree harmonic currents.
4	AC filter	A capacitor and a reactor are used together to reduce impedances at specific frequencies, producing a great effect of absorbing harmonic currents.
5	Passive filter (Active filter)	This filter detects the current of a circuit generating a harmonic current and generates a harmonic current equivalent to a difference between that current and a fundamental wave current to suppress a harmonic current at a detection point, providing a great effect of absorbing harmonic currents.

1.6 How to Use the Control Circuit Terminals

1.6.1 Terminal block layout

In the control circuit of the inverter, the terminals are arranged as shown below:



REMARKS

For the cable size, wiring length, etc., refer to the instruction manual (basic).

1.6.2 Wiring instructions

1) Terminals SD, SE and 5 are common to the I/O signals. These common terminals must not be earthed.
2) Use shielded or twisted cables for connection to the control circuit terminals and run them away from the main and power circuits (including the 200V relay sequence circuit).
3) The input signals to the control circuit are micro currents. When contacts are required, use two or more parallel micro signal contacts or a twin contact to prevent a contact fault.

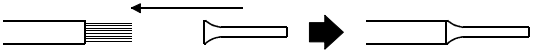
*Information on bar terminals
Introduced products (as of June, 2000): Phoenix Contact Co.,Ltd.

Terminal Screw Size	Bar Terminal Model (With Insulation Sleeve)	Bar Terminal Model (Without Insulation Sleeve)	Wire Size (mm^2)
M3 (A, B, C terminals)	Al 0.5-6WH	A 0.5-6	0.3 to 0.5
	Al 0.75-6GY	A 0.75-6	0.5 to 0.75
M2 (Other than the above)	Al 0.5-6WH	A 0.5-6	0.3 to 0.5

☞ Bar terminal crimping terminal: CRIMPFOX ZA3 (Phoenix Contact Co., Ltd.)

CAUTION

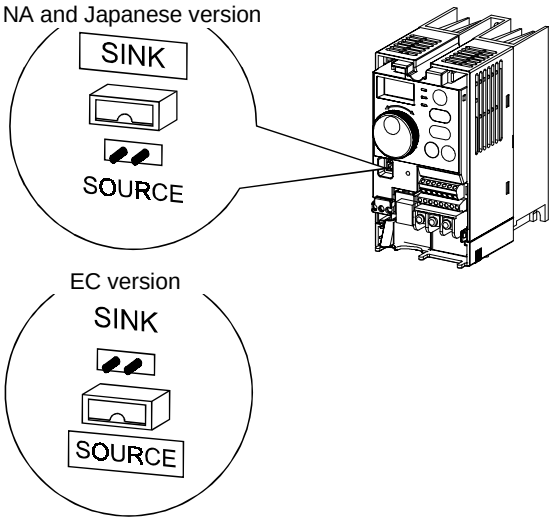
When using the bar terminal (without insulation sleeve), use care so that the twisted wires do not come out.



1.6.3 Changing the control logic

The input signals are set to sink logic for the Japanese and NA version, and to source logic for the EC version.
To change the control logic, the connector under the setting dial must be moved to the other position.

- Change the connector position using tweezers, a pair of long-nose pliers etc.
  Change the connector position before switching power on.

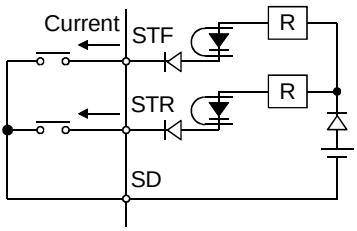


CAUTION

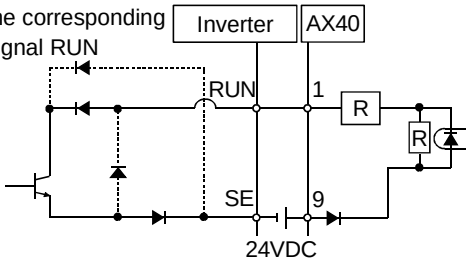
- Make sure that the front cover is installed securely.
- The front cover is fitted with the capacity plate and the inverter unit with the rating plate. Since these plates have the same serial numbers, always replace the removed cover onto the original inverter.
- The sink-source logic change-over connector must be fitted in only one of those positions. If it is fitted in both positions at the same time, the inverter may be damaged.

1) Sink logic type

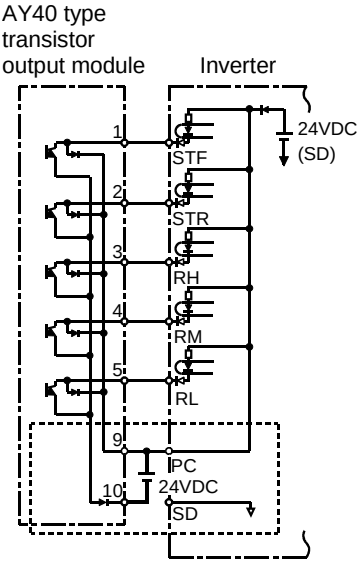
- In this logic, a signal switches on when a current flows out of the corresponding signal input terminal.
  Terminal SD is common to the contact input signals. Terminal SE is common to the open collector output signals.



• A current flows out of the corresponding signal RUN

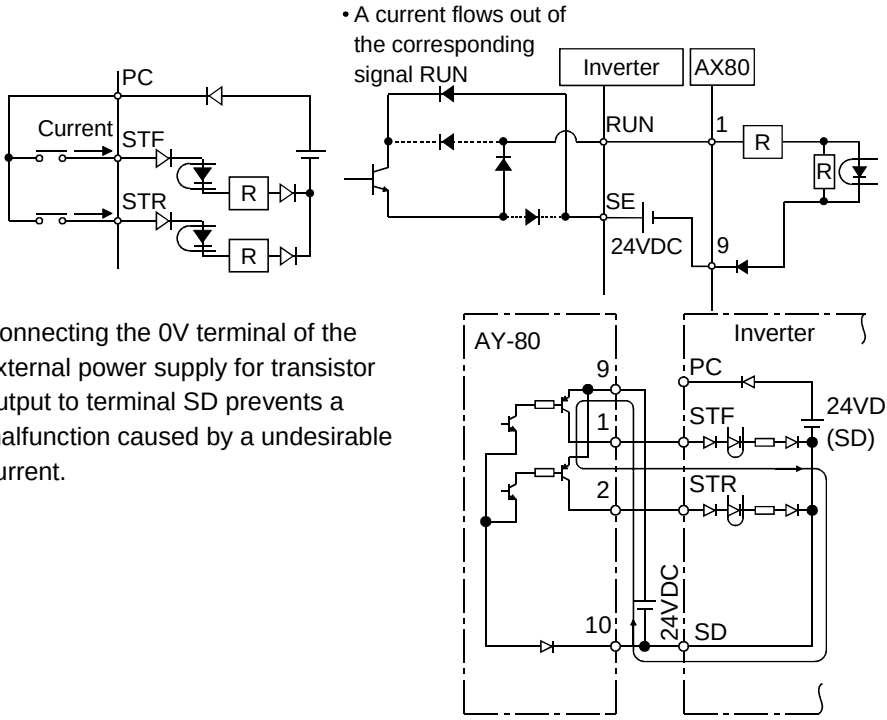


- Connecting a positive external power supply for transistor output to terminal PC prevents a malfunction caused by a undesirable current. (Do not connect terminal SD of the inverter with terminal 0V of the external power supply. When using terminals PC-SD as a 24VDC power supply, do not install an external power supply in parallel with the inverter. Doing so may cause a malfunction in the inverter due to a undesirable current.)



2) Source logic type

• In this logic, a signal switches on when a current flows into the corresponding signal input terminal.
Terminal PC is common to the contact input signals. For the open collector output signals, terminal SE is a positive external power supply terminal.



• Connecting the 0V terminal of the external power supply for transistor output to terminal SD prevents a malfunction caused by a undesirable current.

1

1.7 Input Terminals

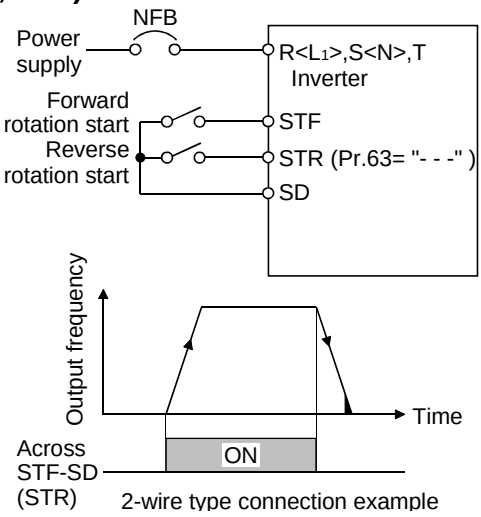
1.7.1 Run (start) and stop (STF, STR, STOP)

To start and stop the motor, first switch on the input power supply of the inverter (switch on the magnetic contactor, if any, in the input circuit during preparation for operation), then start the motor with the forward or reverse rotation start signal.

(1) Two-wire type connection (STF, STR)

A two-wire type connection is shown on the right.

1) The forward/reverse rotation signal is used as both the start and stop signals. Switch on either of the forward and reverse rotation signals to start the motor in the corresponding direction. Switch on both or switch off the start signal during operation to decelerate the inverter to a stop.
2) The frequency setting signal may either be given by entering 0 to 5VDC (or 0 to 10VDC) across frequency setting input terminal 2-5 or by setting the required values in Pr. 4 to Pr. 6 "multi-speed setting" (high, middle, low speeds). (For multi-speed operation, refer to page 32.)



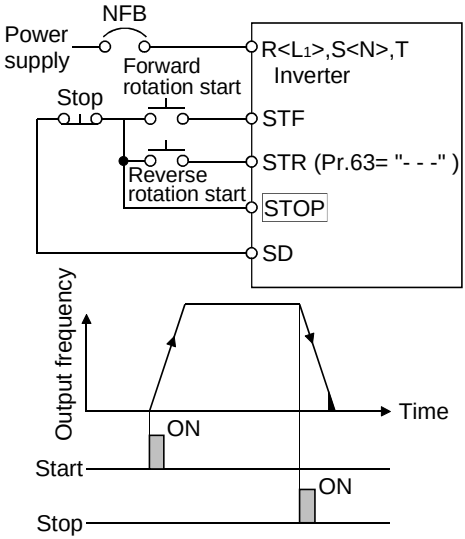
2-wire type connection example

3) After the start signal has been input, the inverter starts operating when the frequency setting signal reaches or exceeds the "starting frequency" set in Pr. 13 (factory-set to 0.5Hz).
   If the motor load torque is large or the "torque boost" set in Pr. 0 is small, operation may not be started due to insufficient torque until the inverter output frequency reaches about 3 to 6Hz.
   If the "minimum frequency" set in Pr. 2 (factory setting = 0Hz) is 6Hz, for example, merely entering the start signal causes the running frequency to reach the minimum frequency of 6Hz according to the "acceleration time" set in Pr. 7.
4) To stop the motor, operate the DC injection brake for the period of "DC injection brake operation time" set in Pr. 11 (factory setting = 0.5s) at not more than the DC injection brake operation frequency or at not more than 0.5Hz.
   To disable the DC injection brake function, set 0 in either of Pr. 11 "DC injection brake operation time" and Pr. 12 "DC injection brake voltage".
   In this case, the motor is coasted to a stop at not more than the frequency set in Pr. 10 "DC injection brake operation frequency" (0 to 120Hz variable) or at not more than 0.5Hz (when the DC dynamic brake is not operated).
5) If the reverse rotation signal is input during forward rotation or the forward rotation signal is input during reverse rotation, the inverter is decelerated and then switched to the opposite output without going through the stop mode.

(2) Three-wire type connection (STF, STR, STOP)

A three-wire type connection is shown on the right. Assign the start self-holding signal (STOP) to any of the input terminals. To make a reverse rotation start, set Pr. 63 to "- - -" (factory setting).

1) Short the signal STOP-SD to enable the start self-holding function. In this case, the forward/reverse rotation signal functions only as a start signal.
   (Note) Assign the stop signal to any of Pr. 60 to Pr. 62 (input terminal function selection).
2) If the start signal terminal STF (STR)-SD are shorted once, then opened, the start signal is kept on and starts the inverter. To change the rotation direction, short the start signal STR (STF)-SD once, then open it.
   (Note) Assign the stop signal to any of Pr. 60 to Pr. 62 (input terminal function selection).
3) The inverter is decelerated to a stop by opening the signal STOP-SD once. For the frequency setting signal and the operation of DC dynamic brake at a stop time, refer to paragraphs 2) to 4) in (1) Two-wire type connection. The right diagram shows 3-wire type connection.



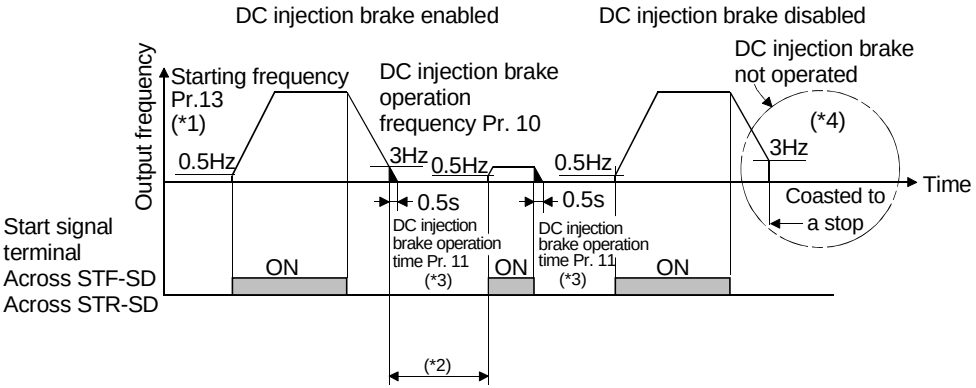
3-wire type connection example

4) When the signal JOG-SD is shorted, the STOP signal is invalid and the JOG signal has precedence.
5) If the output stop signal MRS-SD is shorted, the self-holding function is not deactivated.

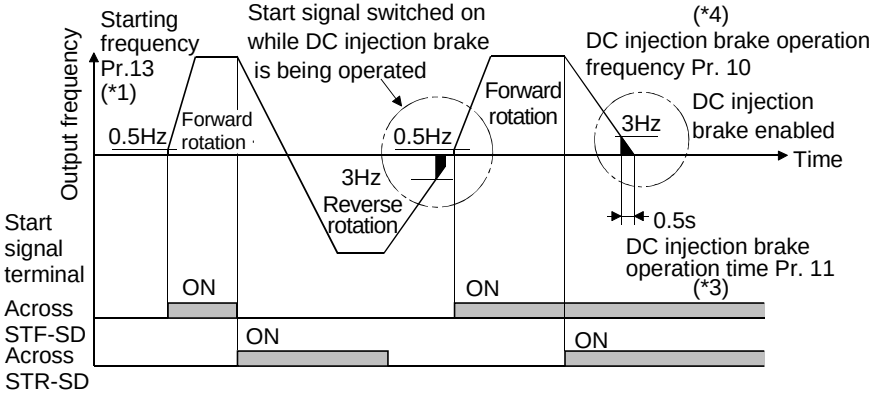
DC Injection Brake and Coasting to Stop functionality

Operation Mode / DC Injection Brake	External Operation or Combined Operation Pr. 79 = "0", "2", "3"		PU Operation or Combined Operation Pr. 79 = "0", "1", "4"	
	Terminals STF (STR)-SD disconnected (*1)	Set frequency changed to 0Hz	Stop key	Set frequency changed to 0Hz
DC injection brake enabled	DC injection brake operated at not more than "DC injection brake operation frequency" set in Pr. 10	DC injection brake operated at 0.5Hz or less.	DC injection brake operated at not more than "DC injection brake operation frequency" set in Pr. 10	DC injection brake operated at 0.5Hz or less.
DC injection brake disabled	Coasted to a stop at not more than "DC injection brake operation frequency" set in Pr. 10	Coasted to a stop at 0.5Hz or less.	Coasted to a stop at not more than "DC injection brake operation frequency" set in Pr. 10	Coasted to a stop at 0.5Hz or less.

*1: Also stopped by the STOP RESET key. Refer to page 94.



Start/Stop Timing Chart (for two-wire type)



Forward-Reverse Rotation Switch-Over Timing Chart

REMARKS

*1 The "starting frequency" in Pr. 13 (factory-set to 0.5Hz) may be set between 0 and 60Hz.

*2. If the next start signal is given during DC injection brake operation, the DC injection brake is disabled and restart is made.

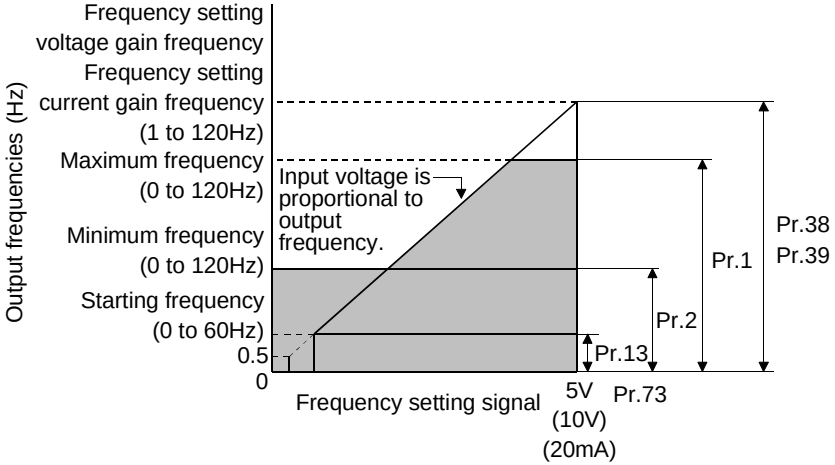
*3. The "DC injection brake operation time" in Pr. 11 (factory-set to 0.5s) may be set between 0 and 10s.

*4. The frequency at which the motor is coasted to a stop is not more than the "DC injection brake operation frequency" set in Pr. 10 (factory setting = 3Hz; may be set between 0 and 120Hz) or not more than 0.5Hz.

*5. The "starting frequency" in Pr. 13, "DC injection brake operation time" in Pr. 11 and "DC injection brake operation frequency" in Pr. 10 are the factory-set values.

1.7.2 Connection of frequency setting potentiometer and output frequency meter (10, 2, 5, 4, AU)

The analog frequency setting input signals that may be entered are voltage and current signals.
For the relationships between the frequency setting input voltages (currents) and output frequencies, refer to the following diagram. The frequency setting input signals are proportional to the output frequencies. Note that when the input signal is less than the starting frequency, the output frequency of the inverter is 0Hz.
If the input signal of 5VDC (or 10V, 20mA) or higher is entered, the output frequency does not exceed the maximum output frequency.



Relationships between Frequency Setting Inputs and Output Frequencies

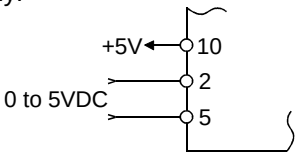
REMARKS

For the way to calibrate the output frequency meter, refer to the instruction manual (basic).

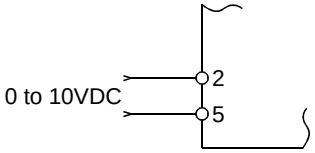
(1) Voltage input (10, 2, 5)

Enter the frequency setting input signal of 0 to 5VDC (or 0 to 10VDC) across the frequency setting input terminals 2-5. The maximum output frequency is reached when 5V (10V) is input across terminals 2-5.
The power supply used may either be the inverter's built-in power supply or an external power supply. For the built-in power supply, terminals 10-5 provide 5VDC output.

- For operation at 0 to 5VDC, set "0" in Pr. 73 to the 0 to 5VDC input. Use terminal 10 for the built-in power supply.



- For operation at 0 to 10VDC, set "1" in Pr. 73 to the 0 to 10VDC input.

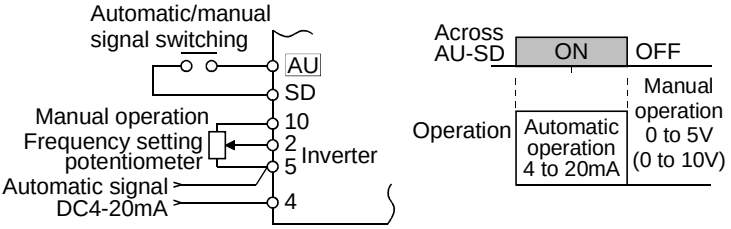


(2) Current input (4, 5, AU)

To automatically perform operation under constant pressure or temperature control using a fan, pump etc., enter the controller output signal of 4 to 20mADC across terminals 4-5.

Terminals AU-SD must be shorted to use the 4 to 20mADC signal for operation. (Assign the signal AU using any of Pr. 60 to Pr. 63.)

When the multi-speed signal is input, the current input is ignored.



Manual-Automatic Switching

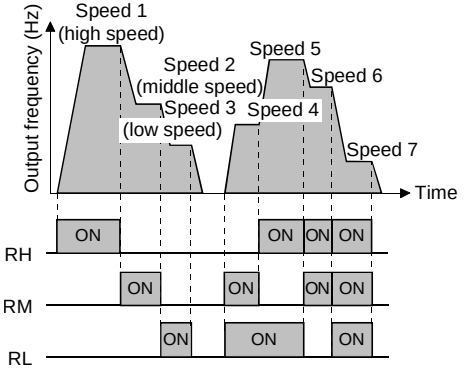
1.7.3 External frequency selection (REX, RH, RM, RL)

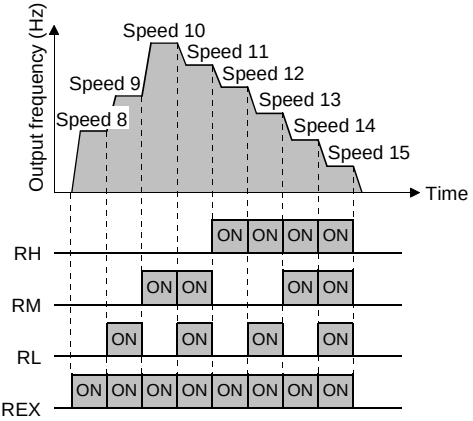
Up to 15 speeds (*) may be selected for an external command forward rotation start or up to 7 speeds for an external command reverse rotation start according to the combination of connecting the multi-speed select terminals REX, RH, RM and RL-SD, and multi-speed operation can be performed as shown below by shorting the start signal terminal STF (STR)-SD.

Speeds (frequencies) may be specified as desired from the operation panel or parameter unit as listed below.

CAUTION

- * Change the setting of Pr. 63 "STR terminal function selection" to "8", and assign and use the 15-speed select signal (REX).
- Has precedence over the main speed setting signal (0 to 5V, 0 to 10V, 4 to 20mA DC).

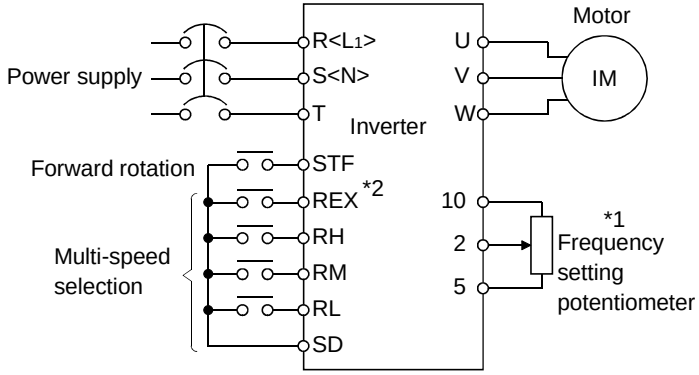




Multi-Speed Setting

Speed	Terminal Input				Parameter	Set Frequency Range	Remarks
	REX-SD*	RH-SD	RM-SD	RL-SD			
Speed 1 (high speed)	OFF	ON	OFF	OFF	Pr. 4	0 to 120Hz	————
Speed 2 (middle speed)	OFF	OFF	ON	OFF	Pr. 5	0 to 120Hz	————
Speed 3 (low speed)	OFF	OFF	OFF	ON	Pr. 6	0 to 120Hz	————
Speed 4	OFF	OFF	ON	ON	Pr. 24	0 to 120Hz, - - -	Pr. 6 setting when Pr. 24="- - -"
Speed 5	OFF	ON	OFF	ON	Pr. 25	0 to 120Hz, - - -	Pr. 6 setting when Pr. 25="- - -"
Speed 6	OFF	ON	ON	OFF	Pr. 26	0 to 120Hz, - - -	Pr. 5 setting when Pr. 26="- - -"
Speed 7	OFF	ON	ON	ON	Pr. 27	0 to 120Hz, - - -	Pr. 6 setting when Pr. 27="- - -"
Speed 8	ON	OFF	OFF	OFF	Pr. 80	0 to 120Hz, - - -	0Hz when Pr. 80="- - -"
Speed 9	ON	OFF	OFF	ON	Pr. 81	0 to 120Hz, - - -	Pr. 6 setting when Pr. 81="- - -"
Speed 10	ON	OFF	ON	OFF	Pr. 82	0 to 120Hz, - - -	Pr. 5 setting when Pr. 82="- - -"
Speed 11	ON	OFF	ON	ON	Pr. 83	0 to 120Hz, - - -	Pr. 6 setting when Pr. 83="- - -"
Speed 12	ON	ON	OFF	OFF	Pr. 84	0 to 120Hz, - - -	Pr. 4 setting when Pr. 84="- - -"
Speed 13	ON	ON	OFF	ON	Pr. 85	0 to 120Hz, - - -	Pr. 6 setting when Pr. 85="- - -"
Speed 14	ON	ON	ON	OFF	Pr. 86	0 to 120Hz, - - -	Pr. 5 setting when Pr. 86="- - -"
Speed 15	ON	ON	ON	ON	Pr. 87	0 to 120Hz, - - -	Pr. 6 setting when Pr. 87="- - -"
External setting	OFF	OFF	OFF	OFF	Frequency setting potentiometer	0 to max. setting	————

*When using the REX signal, a reverse rotation start cannot be made by the external command.



Multi-Speed Operation Connection Example

REMARKS

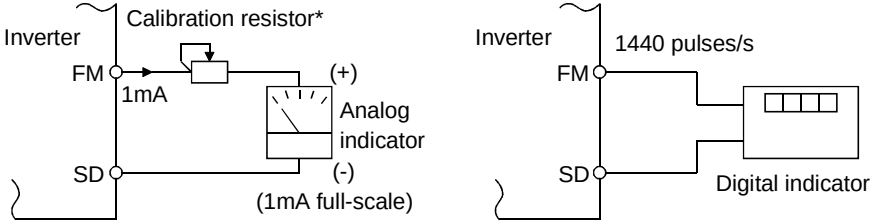
*1: When the frequency setting potentiometer is connected, the input signal of the frequency setting potentiometer is ignored if the multi-speed select signal is switched on. (This also applies to the 4 to 20mA input signal.)

*2: For a reverse rotation start, set Pr. 63 to "- - -" (factory setting).

1.7.4 Indicator connection and adjustment

(1) Japanese version (FM)

The output frequency, etc. of the inverter can be indicated by a DC ammeter of 1mA full-scale deflection and maximum 300Ω internal resistance or a commercially available digital indicator which is connected across terminals FM-SD.
The indicator can be calibrated from the operation panel or parameter unit. Note that the reading varies according to the wiring distance if the indicator is placed away from the inverter. In this case, connect a calibration resistor in series with the indicator as shown below and adjust until the reading matches the operation panel or parameter unit indication (indicator monitoring mode).
Install the indicator within 200m (656.16feet) (50m (164.04feet) for the digital indicator) of the inverter and connect them by at least 0.3mm^2 twisted or shielded cables.



Types of Indicators Connected

REMARKS

* Not needed when calibration is made using the calibration parameter C1 "FM terminal calibration". This resistor is used when calibration must be made near the frequency meter for such a reason as a remote frequency meter. Note that the needle of the frequency meter may not deflect to full-scale when the calibration resistor is connected. In this case, use both the resistor and calibration parameter "C1".

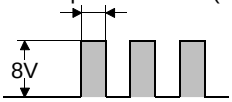
CAUTION

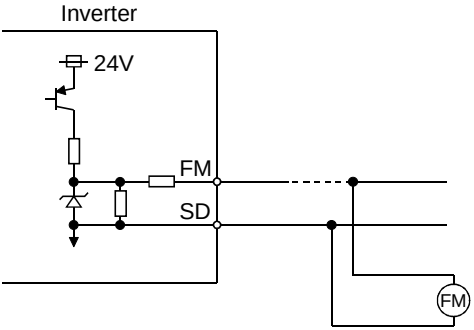
- Refer to page 111 for the procedure of indicator adjustment.

Output waveform of terminal FM

The output signal of terminal FM has a pulse waveform as shown in the table below and the number of its pulses is proportional to the inverter output frequency.
The output voltage (average voltage) is also proportional to the output frequency.

Terminal FM Output Voltage

	Specifications
Output waveform	Calibration parameter C1 (Pr. 900) 
Number of output pulses (pulses/second)	Max. 2400 pulses/s Set a full-scale value which achieves 1440 pulses/s. Pr. 55: frequency monitoring reference Pr. 56: current monitoring reference
Output voltage	0 to 8VDC max. (*1) (Approx. 5V at 1440 pulses/s)



Example of Inverter and Frequency Meter

*1. 0.5V or less when a DC ammeter of 300Ω or less internal resistance is connected to measure the output voltage.

Adjustment

- **Analog meter**

  To adjust the reading of an analog indicator (ammeter), turn the calibration resistor to change the current.
  When using the operation panel or parameter unit for adjustment, change the pulse width of the output waveform (calibration parameter "C1") (adjust the current through the adjustment of the output voltage) to adjust the reading. (For details, refer to page 111.)

REMARKS

It is not recommended to use a voltage type indicator because it is easily affected by a voltage drop, induction noise, etc. and may not provide correct reading if the wiring distance is long.

• **Digital indicator**

Since the digital indicator counts and displays the number of pulses, adjust it from the operation panel or parameter unit.

The inverter output, at which the reference pulses of 1440 pulses/s are output, can be set in Pr. 55 when frequency monitoring is used as reference, or in Pr. 56 when current monitoring is used as reference.

[Example] 1. To set the output across FM-SD to 1440 pulses/s at the inverter output frequency of 120Hz, set "120" (Hz) in Pr. 55. (Factory setting: 60Hz)

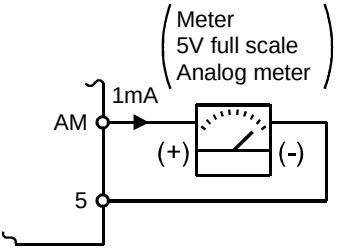
2. To set the output across FM-SD to 1440 pulses/s at the inverter output current of 15A, set "15" (A) in Pr. 56. (Factory setting: rated inverter current)

(2) NA and EC version (AM)

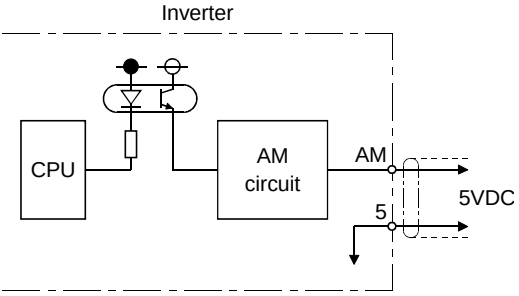
A full-scale 5VDC analog signal can be output from across terminals AM-5.

The analog output level can be calibrated by the operation panel or parameter unit (FR-PU04). Terminal AM function selection can be set in Pr. 54 "AM terminal function selection".

Terminal AM is isolated from the control circuit of the inverter. The cable length should not exceed 30m (98.44feet).



The output signal from terminal AM delays about several 100ms in output and therefore cannot be used as a signal for control which requires fast response.



Terminal AM Output Circuit

Adjustment

Set the reference output value of the inverter which outputs the full-scale voltage 5VDC.

Set it in Pr. 55 for frequency monitoring reference, or in Pr. 56 for current monitoring reference.

Use the terminal AM output calibration parameter C1 to adjust the output voltage.

[Example] 1. To set the output across AM-5 to 5VDC at the inverter output frequency of 90Hz, set 90Hz in Pr. 55. (Factory setting: 50Hz)

2. To set the output across AM-5 to 5VDC at the inverter output current of 20A, set 20A in Pr. 56. (Factory setting: rated inverter current)

CAUTION

• Refer to page 113 for the procedure of indicator adjustment.

1.7.5 Control circuit common terminals (SD, 5, SE)

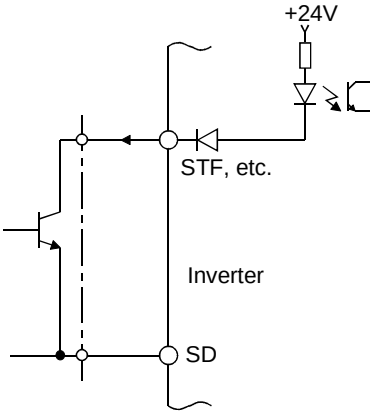
Terminals SD, 5, and SE are all common terminals (0V) for I/O signals and are isolated from each other.
Terminal SD is a common terminal for the contact input terminals (STF, STR, RH, RM, RL) and frequency output signal (FM).
Terminal 5 is a common terminal for the frequency setting analog input signals and indicator terminal "AM". It should be protected from external noise using a shielded or twisted cable.
Terminal SE is a common terminal for the open collector output terminal (RUN).

REMARKS

Terminal FM is provided for the FR-S520-0.1K to 3.7K (-R) (-C), FR-S520S-0.1K to 1.5K (-R) and FR-S510W-0.1K to 0.75 (-R), and terminal AM is provided for the FR-S520-0.1K to 3.7K-NA, FR-S520S-0.2K to 1.5K-EC (R) and FR-S510W-0.1K to 0.75K-NA.

1.7.6 Signal inputs by contactless switches

If a transistor is used instead of a contacted switch as shown on the right, the input signals of the inverter can control terminals STF, STR, RH, RM, RL.



External signal input using transistor

REMARKS

1. When using an external transistor connected with the external power supply, use terminal PC to prevent a malfunction from occurring due to a leakage current. (Refer to page 25.)
2. Note that an SSR (solid-state relay) has a relatively large leakage current at OFF time and it may be accidentally input to the inverter.

1.8 How to Use the Input Signals (Assigned Terminals RL, RM, RH, STR)

These terminals can be changed in function by setting Pr. 60 to Pr. 63.

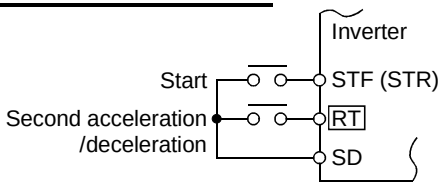
Pr. 60 "RL terminal function selection"	Page 88
Pr. 61 "RM terminal function selection"	
Pr. 62 "RH terminal function selection"	
Pr. 63 "STR terminal function selection"	

1.8.1 Multi-speed setting (RL, RM, RH, REX signals): Setting "0, 1, 2, 8" Remote setting (RL, RM, RH signals): Setting "0, 1, 2"

- By entering frequency commands into the RL, RM, RH and REX signals and turning on/off the corresponding signals, you can perform multi-speed operation (15 speeds). (For details, refer to page 32.)
- If the operation panel is away from the control box, you can perform continuous variable-speed operation with signal contacts, without using analog signals. (For details, refer to page 86.)

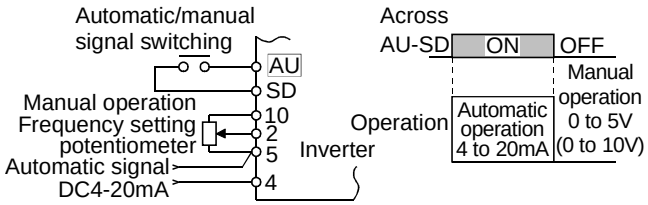
1.8.2 Second function selection (RT signal): Setting "3"

Pr. 44 "second acceleration/deceleration time"
Pr. 45 "second deceleration time"
Pr. 46 "second torque boost"
Pr. 47 "second V/F (base frequency)"
To set any of the above functions, turn on this "RT signal".



1.8.3 Current input selection "AU signal": Setting "4"

When a fan, pump etc. is used to perform operation of constant- pressure/ temperature control, automatic operation can be performed by entering the 4-20mADC output signal of a regulator into across terminals 4-5.



When the 4-20mADC signal is used to perform operation, always short the AU signal.

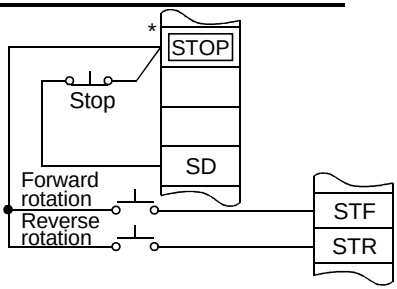
REMARKS

The current input is ignored if the multi-speed signal is input.

1.8.4 Start self-holding selection (STOP signal): Setting "5"

This connection example is used when you want to self-hold the start signal (forward rotation, reverse rotation).

* Connected to the STOP signal to avoid forward or reverse rotation if forward or reverse rotation and stop are turned on simultaneously.



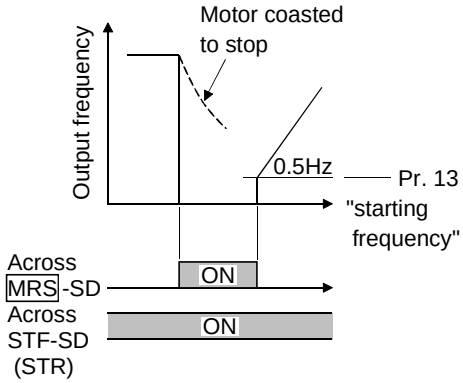
(Wiring example for sink logic)

1.8.5 Output shut-off (MRS signal): Setting "6"

Short the output stop terminal MRS-SD during inverter output to cause the inverter to immediately stop the output. Open terminals MRS-SD to resume operation in about 10ms. Terminal MRS may be used as described below:

(1) To stop the motor by mechanical brake (e.g. electromagnetic brake)
Terminals MRS-SD must be shorted when the mechanical brake is operated and be opened before motor restart.

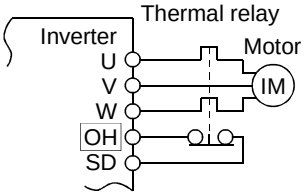
(2) To provide interlock to disable operation by the inverter
After MRS-SD have been shorted, the inverter cannot be operated if the start signal is given to the inverter.



(3) To coast the motor to stop
The motor is decelerated according to the preset deceleration time and is stopped by operating the DC injection brake at 3Hz or less. By using terminal MRS, the motor is coasted to a stop.

1.8.6 External thermal relay input: Setting "7"

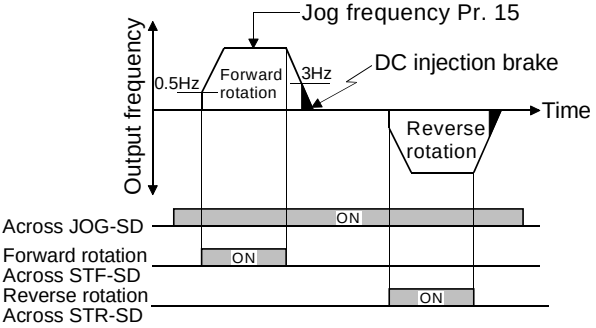
When the external thermal relay or thermal relay built in the motor is actuated, the inverter output is shut off and an alarm signal is given to keep the motor stopped to protect the motor from overheat. If the thermal relay contact is reset, the motor is not restarted unless the reset terminal RES-SD is shorted for more than 0.1s and then opened or power-on reset is performed.
The function may therefore be used as an external emergency stop signal input.



1.8.7 Jog operation (JOG signal): Setting "9"

(1) Jog operation using external signals

Jog operation can be started/stopped by shorting the jog mode select terminal JOG-SD and shorting/opening the start signal terminal STF or STR-SD. The jog frequency and jog acceleration/deceleration time are set in Pr. 15 (factory setting 5Hz, variable between 0 and 120Hz) and Pr. 16 (factory setting 0.5s, variable between 0 and 999s), respectively,



and their settings can be changed from the operation panel or parameter unit (type with RS-485 communication function).

The JOG signal has precedence over the multi-speed signal. (External)

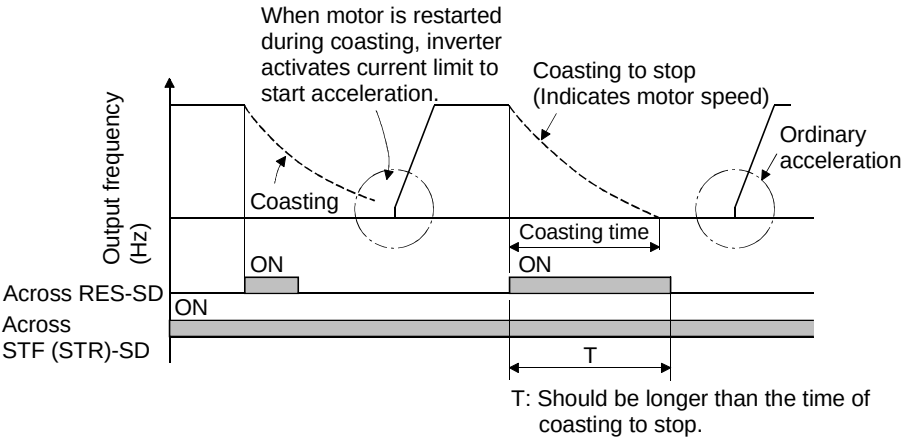
1.8.8 Reset signal: Setting "10"

Used to reset the alarm stop state established when the inverter's protective function is activated. The reset signal immediately sets the control circuit to the initial (cold) status, e.g. initializes the electronic overcurrent protection circuit. It shuts off the inverter output at the same time. During reset, the inverter output is kept shut off. To give this reset input, short terminals RES-SD for more than 0.1 second. When the shorting time is long, the operation panel or parameter unit displays the initial screen, which is not a fault. Operation is enabled after terminals RES-SD are opened.

The reset terminal is used to reset the inverter alarm stop state. If the reset terminal is shorted, then opened while the inverter is running, the motor may be restarted during coasting (refer to the timing chart below) and the output may be shut off due to overcurrent or overvoltage.

Setting either of "1" and "15" in reset selection Pr. 75 allows the accidental input of the reset signal during operation to be unaccepted.

(For details, refer to page 94.)



T: Should be longer than the time of coasting to stop.

CAUTION

Frequent resetting will make electronic overcurrent protection invalid.

1.8.9 PID control valid terminal: Setting "14"

To exercise PID control, turn on the X14 signal. When this signal is off, ordinary inverter operation is performed. For more information, refer to page 101.

♦Related parameters♦

Pr. 88 "PID action selection", Pr. 89 "PID proportional band", Pr. 90 "PID integral time", Pr. 91 "PID upper limit", Pr. 92 "PID lower limit", Pr. 93 "PID control set point for PU operation", Pr. 94 "PID differential time" (Refer to page 101)

1.8.10 PU operation/external operation switching: Setting "16"

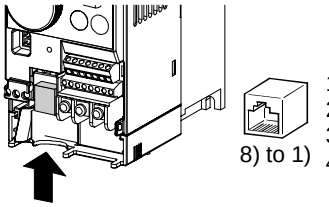
You can change the operation mode.
With "8" set in Pr. 79 "operation mode selection", turning on the X16 signal shifts the operation mode to the external operation mode and turning off the X16 signal shifts it to the PU operation mode. For details, refer to page 98.

♦Related parameters♦

Pr. 79 "operation mode selection" (Refer to page 98)

1.9 Handling of the RS-485 Connector (Type with RS-485 Communication Function)

<RS-485 connector pin layout>
View A of the inverter (receptacle side)



CAUTION

1. Do not plug the connector to a computer LAN board, fax modem socket, telephone modular connector etc. as they are different in electrical specifications, the inverter may be damaged.
2. Pins 2 and 8 (P5S) are provided for the parameter unit power supply. Do not use them for any other purpose or when making parallel connection by RS-485 communication.

(1) When connecting the parameter unit

Use the optional FR-CB2☐.

(2) RS-485 communication

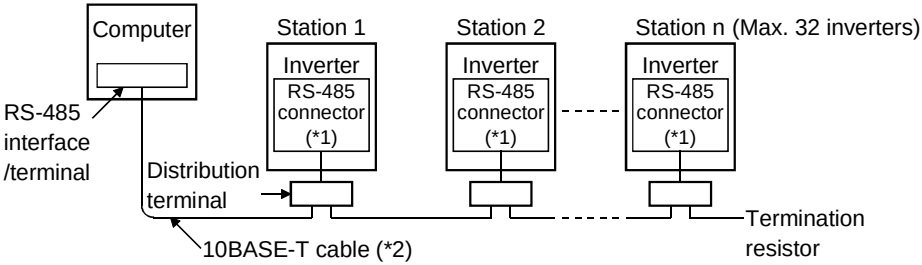
Use the RS-485 connector to perform communication operation from a personal computer etc.

By connecting the RS-485 connector to a computer such as a personal computer, Factory Automation unit (HMI etc.) or other computer, by the communication cable, you can operate/monitor the inverter and read/write the parameter values using user programs. For parameter setting, refer to page 116.

- Conforming standard: EIA Standard RS-485
- Transmission format: Multidrop link system
- Communication speed: Max. 19200bps
- Overall extension: 500m (1640.42feet)

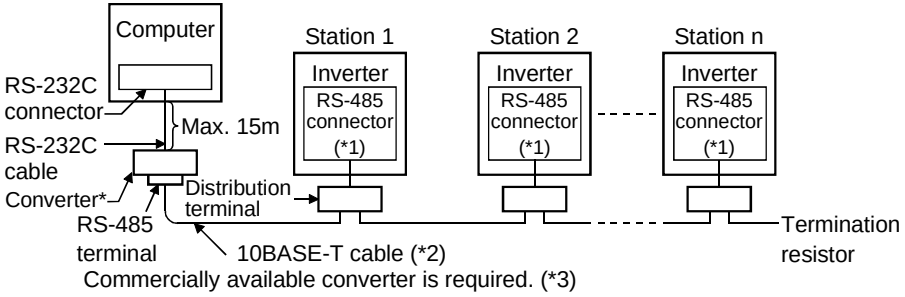
<System configuration examples>

1) When a computer having a RS-485 interface is used with several inverters



Use the connectors and cables which are available on the market.
Introduced products (as of June, 2000)
*1. Connector :RJ45 connector
Example: 5-554720-3, Tyco Electronics Corporation
*2. Cable :Cable conforming to EIA568 (such as 10BASE-T cable)
Example: SGLPEV 0.5mm × 4P (Twisted pair cable, 4 pairs),
Mitsubishi Cable Industries, Ltd.
(Do not use pins No. 2 and 8 (P5S)).

2) When a computer having a RS-232C interface is used with inverters



Use the connectors, cables and converter which are available on the market.
Introduced products (as of June, 2000)

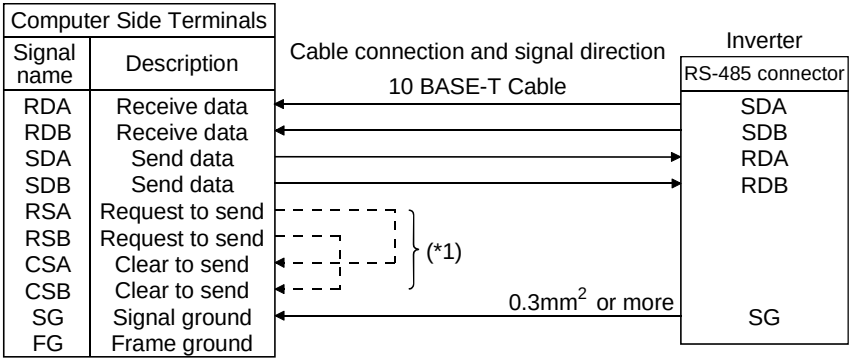
*1. Connector: RJ45 connector
Example: 5-554720-3, Tyco Electronics Corporation

*2. Cable : Cable conforming to EIA568 (such as 10BASE-T cable)
Example: SGLPEV 0.5mm × 4P (Twisted pair cable, 4 pairs),
Mitsubishi Cable Industries, Ltd.
(Do not use pins No. 2 and 8 (P5S)).

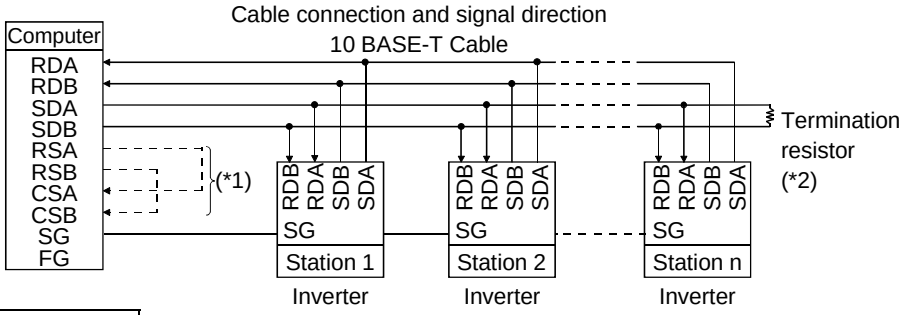
*3. Commercially available converter examples
Model: FA-T-RS40 Converter (One with connector and cable is also available)
Mitsubishi Electric Engineering Co., Ltd.

<Wiring methods>

1) Wiring of one RS-485 computer and one inverter



2) Wiring of one RS-485 computer and "n" inverters (several inverters)



REMARKS

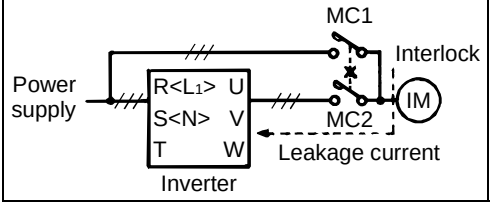
*1. Make connection in accordance with the instruction manual of the computer to be used with. Fully check the terminal numbers of the computer since they change with the model.

*2. The inverters may be affected by reflection depending on the transmission speed or transmission distance. If this reflection hinders communication, provide a termination resistor. When the RS-485 connector is used for connection, a termination resistor cannot be fitted, so use a distributor. Connect the termination resistor to only the inverter remotest from the computer. (Termination resistor: 100Ω)

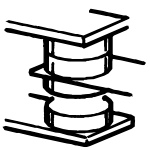
1.10 Design Information

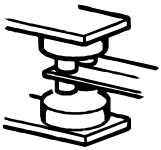
1) Provide electrical and mechanical interlocks for MC1 and MC2 which are used for commercial power supply-inverter switch-over.
   When there is a commercial power supply-inverter switch-over circuit as shown below, the inverter will be damaged by leakage current from the power supply due to arcs generated at the time of switch-over or chattering caused by a sequence error.
2) If the machine must not be restarted when power is restored after a power failure, provide a magnetic contactor in the inverter's primary circuit and also make up a sequence which will not switch on the start signal.
   If the start signal (start switch) remains on after a power failure, the inverter will automatically restart as soon as the power is restored.
3) Since the input signals to the control circuit are on a low level, use two or more parallel micro signal contacts or a twin contact for contact inputs to prevent a contact fault.
4) Do not apply a large voltage to the contact input terminals (e.g. STF) of the control circuit.
5) Always apply a voltage to the alarm output terminals (A, B, C) via a relay coil, lamp etc.
6) Make sure that the specifications and rating match the system requirements.

1) Commercial power supply-inverter switch-over



3) Low-level signal contacts


Low-level signal contacts


Twin contact

2. FUNCTIONS

This chapter explains the "functions" for use of this product. For simple variable-speed operation of the inverter, the factory settings of the parameters may be used as they are. Set the necessary parameters to meet the load and operational specifications. Refer to the instruction manual (basic) for the operation procedures. Always read the instructions before using the functions.

CAUTION

As the contact input terminals RL, RM, RH, STR, open collector output terminal RUN and contact output terminals A, B, C can be changed in functions by parameter setting, their signal names used for the corresponding functions are used in this chapter (with the exception of the wiring examples). Note that they are not terminal names.

REMARKS

Parameter copy
Use of the parameter unit (FR-PU04) with the type having the RS-485 communication function allows the parameter values to be copied to another inverter (only the FR-S500 series).
After batch-reading the parameters of the copy source inverter, you can connect the parameter unit to the copy destination inverter and batch-write the parameters.
For the operation procedure, refer to the instruction manual of the parameter unit (FR-PU04).

2.1 Function (Parameter) List

Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting <EC version>	Refer To:	Customer Setting
0	P 0	Torque boost	0 to 15%	0.1%	6%/5%/ 4% (Note 1)	58	
1	P 1	Maximum frequency	0 to 120Hz	0.1Hz	60Hz <50Hz>	59	
2	P 2	Minimum frequency	0 to 120Hz	0.1Hz	0Hz	59	
3	P 3	Base frequency	0 to 120Hz	0.1Hz	60Hz <50Hz>	59	
4 *	P 4	Multi-speed setting (high speed)	0 to 120Hz	0.1Hz	60Hz <50Hz>	61	
5 *	P 5	Multi-speed setting (middle speed)	0 to 120Hz	0.1Hz	30Hz	61	
6 *	P 6	Multi-speed setting (low speed)	0 to 120Hz	0.1Hz	10Hz	61	
7	P 7	Acceleration time	0 to 999s	0.1s	5s	62	
8	P 8	Deceleration time	0 to 999s	0.1s	5s	62	
9	P 9	Electronic thermal O/L relay	0 to 50A	0.1A	Rated output current	64	
30 *	P30	Extended function display selection	0, 1	1	0	72	
79	P79	Operation mode selection	0 to 4, 7, 8	1	0	98	

Note 1: The factory setting varies with the inverter capacity: 5% for FR-S540-1.5K and 2.2K, 4% for FR-S540-3.7K.

The extended function parameters are made valid by setting "1" in Pr. 30 "extended function display selection". (For full information on the way to set Pr. 30, refer to the instruction manual (basic).)

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Standard operation functions	10	P 10	DC injection brake operation frequency	0 to 120Hz	0.1Hz	3Hz	64	
	11	P 11	DC injection brake operation time	0 to 10s	0.1s	0.5s	64	
	12	P 12	DC injection brake voltage	0 to 15%	0.1%	6%	64	
	13	P 13	Starting frequency	0 to 60Hz	0.1Hz	0.5Hz	65	
	14	P 14	Load pattern selection	0: For constant-torque loads, 1: For variable-torque loads, 2: For vertical lift loads, 3: For vertical lift loads	1	0	66	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting <EC version>	Refer To:	Customer Setting
Standard operation functions	15	P15	Jog frequency	0 to 120Hz	0.1Hz	5Hz	67	
	16	P16	Jog acceleration/ deceleration time	0 to 999s	0.1s	0.5s	67	
	17	P17	RUN key rotation direction selection	0: Forward rotation, 1: Reverse rotation	1	0	67	
	19	P19	Base frequency voltage	0 to 500V, 888, - - - (0 to 800V, 888, - - - for the 400V class.)	1V	- - - <888>	59	
	20	P20	Acceleration/ deceleration reference frequency	1 to 120Hz	0.1Hz	60Hz <50Hz>	62	
	21	P21	Stall prevention function selection	0 to 31, 100	1	0	68	
	22 *	P22	Stall prevention operation level	0 to 200%	1%	150%	69	
	23	P23	Stall prevention operation level compensation factor at double speed	0 to 200%, - - -	1%	- - -	69	
	24 *	P24	Multi-speed setting (speed 4)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	25 *	P25	Multi-speed setting (speed 5)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	26 *	P26	Multi-speed setting (speed 6)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	27 *	P27	Multi-speed setting (speed 7)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	28	P28	Stall prevention operation reduction starting frequency	0 to 120Hz	0.1Hz	60Hz <50Hz>	69	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting <EC version>	Refer To:	Customer Setting
Standard operation functions	29	P29	Acceleration/ deceleration pattern	0: Linear acceleration/ deceleration, 1: S-pattern acceleration/ deceleration A, 2: S-pattern acceleration/ deceleration B	1	0	71	
	31	P31	Frequency jump 1A	0 to 120Hz, - - -	0.1Hz	- - -	72	
	32	P32	Frequency jump 1B	0 to 120Hz, - - -	0.1Hz	- - -	72	
	33	P33	Frequency jump 2A	0 to 120Hz, - - -	0.1Hz	- - -	72	
	34	P34	Frequency jump 2B	0 to 120Hz, - - -	0.1Hz	- - -	72	
	35	P35	Frequency jump 3A	0 to 120Hz, - - -	0.1Hz	- - -	72	
	36	P36	Frequency jump 3B	0 to 120Hz, - - -	0.1Hz	- - -	72	
	37	P37	Speed display	0, 0.1 to 999	0.1	0	73	
	38	P38	Frequency setting voltage gain frequency	1 to 120Hz	0.1Hz	60Hz <50Hz>	74	
	39	P39	Frequency setting current gain frequency	1 to 120Hz	0.1Hz	60Hz <50Hz>	74	
	40	P40	Start-time ground fault detection selection	0: Not detected 1: Detected	1	0 <1>	78	
Output terminal functions	41	P41	Up-to-frequency sensitivity	0 to 100%	1%	10%	78	
	42	P42	Output frequency detection	0 to 120Hz	0.1Hz	6Hz	79	
	43	P43	Output frequency detection for reverse rotation	0 to 120Hz, - - -	0.1Hz	- - -	79	
Second functions	44	P44	Second acceleration/ deceleration time	0 to 999s	0.1s	5s	62	
	45	P45	Second deceleration time	0 to 999s, - - -	0.1s	- - -	62	
	46	P46	Second torque boost	0 to 15%, - - -	0.1%	- - -	58	
	47	P47	Second V/F (base frequency)	0 to 120Hz, - - -	0.1Hz	- - -	59	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting <EC version>	Refer To:	Customer Setting
Current detection	48	P48	Output current detection level	0 to 200%	1%	150%	80	
	49	P49	Output current detection signal delay time	0 to 10s	0.1s	0s	80	
	50	P50	Zero current detection level	0 to 200%	1%	5%	81	
	51	P51	Zero current detection time	0.05 to 1s	0.01s	0.5s	81	
Display functions	52 *	P52	Control panel display data selection	0: Output frequency, 1: Output current, 100: Set frequency during stop/output frequency during operation	1	0	82	
	53 *	P53	Frequency setting operation selection	0: Setting dial frequency setting mode 1: Setting dial potentiometer mode	1	0	83	
	54 *	P54	FM (AM) terminal function selection	0: Output frequency monitor 1: Output current monitor	1	0	82	
	55 *	P55	Frequency monitoring reference	0 to 120Hz	0.1Hz	60Hz <50Hz>	84	
	56 *	P56	Current monitoring reference	0 to 50A	0.1A	Rated output current	84	
Automatic restart functions	57	P57	Restart coasting time	0 to 5s, - - -	0.1s	- - -	84	
	58	P58	Restart cushion time	0 to 60s	0.1s	1s	84	
Additional function	59	P59	Remote setting function selection	0: Without remote setting function 1: With remote setting function With frequency setting storage function 2: With remote setting function Without frequency setting storage function	1	0	86	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Terminal function selection	60	P60	RL terminal function selection	0: RL, 1: RM, 2: RH, 3: RT, 4: AU, 5: STOP, 6: MRS, 7: OH, 8: REX, 9: JOG, 10: RES, 14: X14, 16: X16, - - -: STR (May be assigned to the STR terminal only)	1	0	88	
	61	P61	RM terminal function selection		1	1	88	
	62	P62	RH terminal function selection		1	2	88	
	63	P63	STR terminal function selection		1	- - -	88	
	64	P64	RUN terminal function selection	0: RUN, 1: SU, 3: OL, 4: FU, 11: RY, 12: Y12, 13: Y13, 14: FDN, 15: FUP, 16: RL, 98: LF, 99: ABC	1	0	90	
	65	P65	A, B, C terminal function selection		1	99	90	
	66	P66	Retry selection	0: OC1 to 3, OV1 to 3, THM, THT, GF, OHT, OLT, PE, OPT 1: OC1 to 3, 2: OV1 to 3, 3: OC1 to 3, OV1 to 3	1	0	91	
	67	P67	Number of retries at alarm occurrence	0: No retry 1 to 10: Without alarm output during retry operation 101 to 110: With alarm output during retry operation	1	0	91	
	68	P68	Retry waiting time	0.1 to 360s	0.1s	1s	91	
	69	P69	Retry count display erase	0: Cumulative count erase	1	0	91	
	70 *	P70	Soft-PWM setting	0: Soft-PWM invalid, 1: Soft-PWM valid	1	1	92	
	71	P71	Applied motor	0: Thermal characteristic for standard motor 1: Thermal characteristic for Mitsubishi constant-torque motor	1	0	93	
	72 *	P72	PWM frequency selection	0 to 15	1	1	92	
	73	P73	0-5V/0-10V selection	0: For 0 to 5VDC input 1: For 0 to 10VDC input	1	0	93	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Operation selection functions	74	P74	Input filter time constant	0: 2-step moving average processing 1 to 8: Exponential average value of 2n at the setting of n	1	1	94	
	75 *	P75	Reset selection/PU stop selection	0: Reset normally enabled/PU stop key disabled 1: Enabled at alarm occurrence only/PU stop key disabled 14: Reset normally enabled/normally decelerated to stop 15: Enabled at alarm occurrence only/normally decelerated to stop	1	14	94	
	76	P76	Cooling fan operation selection	0: Operation started at power-on 1: Cooling fan ON/OFF control	1	1	96	
	77 *	P77	Parameter write disable selection	0: Write is enabled only during a stop 1: Write disabled (except some parameters) 2: Write during operation enabled	1	0	97	
	78	P78	Reverse rotation prevention selection	0: Both forward rotation and reverse rotation enabled, 1: Reverse rotation disabled, 2: Forward rotation disabled	1	0	98	
Multi-speed operation function	80 *	P80	Multi-speed setting (speed 8)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	81 *	P81	Multi-speed setting (speed 9)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	82 *	P82	Multi-speed setting (speed 10)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	83 *	P83	Multi-speed setting (speed 11)	0 to 120Hz, - - -	0.1Hz	- - -	61	

Function	Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Multi-speed operation function	84 *	P84	Multi-speed setting (speed 12)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	85 *	P85	Multi-speed setting (speed 13)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	86 *	P86	Multi-speed setting (speed 14)	0 to 120Hz, - - -	0.1Hz	- - -	61	
	87 *	P87	Multi-speed setting (speed 15)	0 to 120Hz, - - -	0.1Hz	- - -	61	
PID control	88	P88	PID action selection	20: PID reverse action, 21: PID forward action	1	20	101	
	89 *	P89	PID proportional band	0.1 to 999%, - - -	0.1%	100%	101	
	90 *	P90	PID integral time	0.1 to 999s, - - -	0.1s	1s	101	
	91	P91	PID upper limit	0 to 100%, - - -	0.1%	- - -	101	
	92	P92	PID lower limit	0 to 100%, - - -	0.1%	- - -	101	
	93 *	P93	PID action set point for PU operation	0 to 100%	0.01%	0%	101	
	94 *	P94	PID differential time	0.01 to 10s, - - -	0.01s	- - -	101	
Slip compensation	95	P95	Rated motor slip	0 to 50%, - - -	0.01%	- - -	109	
	96	P96	Slip compensation time constant	0.01 to 10s	0.01s	0.5s	109	
	97	P97	Constant-output region slip compensation selection	0, - - -	1	- - -	109	
Automatic torque boost	98	P98	Automatic torque boost selection (Motor capacity)	0.1 to 3.7kW, - - - (0.2 to 3.7kW, - - - for the 400V class.)	0.01kW	- - -	109	
	99	P99	Motor primary resistance	0 to 50Ω, - - -	0.01Ω	- - -	111	

Function	Calibration parameters	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Calibration parameters	C1 <Japanese> 900 / <NA, EC> 901	C 1	FM terminal calibration / AM terminal calibration	———	———	———	111	
	C2 (902)	C 2	Frequency setting voltage bias frequency	0 to 60Hz	0.1Hz	0Hz	74	
	C3 (902)	C 3	Frequency setting voltage bias	0 to 300%	0.1%	0% (Note 2)	74	
	C4 (903)	C 4	Frequency setting voltage gain	0 to 300%	0.1%	96% (Note 2)	74	
	C5 (904)	C 5	Frequency setting current bias frequency	0 to 60Hz	0.1Hz	0Hz	74	
	C6 (904)	C 6	Frequency setting current bias	0 to 300%	0.1%	20% (Note 2)	74	
	C7 (905)	C 7	Frequency setting current gain	0 to 300%	0.1%	100% (Note 2)	74	
	C8 (269)	C 8	Parameter set by manufacturer. Do not set.					
Clear parameters	CLr	CLr	Parameter clear	0: Not executed 1: parameter clear 2: all clear	1	0	115	
	ECL *	ECL	Alarm history clear	0: Not cleared, 1: Alarm history clear	1	0	115	

Note 2: Settings may differ because of calibration parameters.

● Parameters only for the type having the RS-485 communication function (When the parameter unit (FR-PU04) is used, operation from the operation panel is not accepted.)

Function	Communication Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Communication Parameters	n1 (331)	n 1	Communication station number	0 to 31: Specify the station number of the inverter.	1	0	118	
	n2 (332)	n 2	Communication speed	48: 4800bps, 96: 9600bps, 192: 19200bps	1	192	118	
	n3 (333)	n 3	Stop bit length	0, 1: (Data length 8), 10, 11: (Data length 7)	1	1	118	
	n4 (334)	n 4	Parity check presence/ absence	0: Absent, 1: With odd parity check, 2: With even parity check	1	2	118	

Function	Communication Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting <NA, EC version>	Refer To:	Customer Setting
Communication Parameters	n5 (335)	n 5	Number of communication retries	0 to 10, - - -	1	1	118	
	n6 (336)	n 6	Communication check time interval	0 to 999s, - - -	0.1s	0s <- - ->	118	
	n7 (337)	n 7	Wait time setting	0 to 150ms, - - -	1	- - -	118	
	n8 (338)	n 8	Operation command write	0: Command write from computer, 1: Command write from external terminal	1	0	130	
	n9 (339)	n 9	Speed command write	0: Command write from computer, 1: Command write from external terminal	1	0	130	
	n10 (340)	n 10	Link start mode selection	0: As set in Pr. 79. 1: Started in computer link operation mode.	1	0	131	
	n11 (341)	n 11	CR/LF selection	0: Without CR/LF, 1: With CR, without LF 2: With CR/LF	1	1	118	
	n12 (342)	n 12	E^2PROM write selection	0: Write to RAM and E^2PROM 1: Write to RAM only	1	0	132	
	n13 (145)	n 13	PU display language	0: Japanese, 1: English, 2: German, 3: French, 4: Spanish, 5: Italian, 6: Swedish, 7: Finish	1	0 <1>	133	
	n14 (990) *	n 14	PU buzzer sound control	0: Without sound, 1: With sound	1	1	133	
	n15 (991) *	n 15	PU contrast adjustment	 0 (bright) 63 (dark)	1	58	134	

Function	Communication Parameter	Indication	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To:	Customer Setting
Communication Parameters	n16 (992) *	n 16	PU main display screen data selection	0: Selectable between output frequency and output current 100: (during stop): Set frequency, output current (during operation): Output frequency, output current	1	0	134	
	n17 (993)	n 17	PU disconnection detection/PU setting lock	0: Without PU disconnection error, 1: Error at PU disconnection, 10: Without PU disconnection error (PU operation disable)	1	0	135	

For details of the program, refer to page 118 onwards.

REMARKS

1. The parameter numbers within parentheses are those for use of the parameter unit (FR-PU04).
2. Set "9999" when setting a value "- - -" using the parameter unit (FR-PU04).
3. The decimal places of a value 100 or more (3 digits or more) cannot be displayed.
4. The parameters marked * can be changed in setting during operation if "0" (factory setting) is set in Pr. 77 "parameter write disable selection". (Note that Pr. 53, Pr. 70 and Pr. 72 may be changed only during PU operation.)

2.2 List of Parameters Classified by Purpose of Use

Set the parameters according to the operating conditions. The following list indicates purpose of use and corresponding parameters.

Purpose of Use		Parameter Numbers Parameter numbers which must be set
Related to operation	Use of extended function parameters	Pr. 30
	Operation mode selection	Pr. 53, Pr. 79 (Communication parameters n10, n17)
	Acceleration/deceleration time/pattern adjustment	Pr. 7, Pr. 8, Pr. 16, Pr. 20, Pr. 29, Pr. 44, Pr. 45
	Selection of output characteristics optimum for load characteristics	Pr. 3, Pr. 14, Pr. 19
	Output frequency restriction (limit)	Pr. 1, Pr. 2
	Operation over 60Hz <50Hz>	Pr. 1, Pr. 38, Pr. 39, Calibration parameter C4, C7
	Adjustment of frequency setting signals and outputs	Pr. 38, Pr. 39, Pr. 73, Calibration parameter C2 to C7
	Motor output torque adjustment	Pr. 0, Pr. 98
	Brake operation adjustment	Pr. 10, Pr. 11, Pr. 12
	Multi-speed operation	Pr. 1, Pr. 2, Pr. 4, Pr. 5, Pr. 6, Pr. 24, Pr. 25, Pr. 26, Pr. 27, Pr. 80, Pr. 81, Pr. 82, Pr. 83, Pr. 84, Pr. 85, Pr. 86, Pr. 87
	Jog operation	Pr. 15, Pr. 16
	Frequency jump operation	Pr. 31, Pr. 32, Pr. 33, Pr. 34, Pr. 35, Pr. 36
	Automatic restart operation after instantneous power failure	Pr. 57, Pr. 58
	Slip compensation setting	Pr. 95 to Pr. 97
	Setting of output characteristics matching the motor	Pr. 3, Pr. 19, Pr. 71
Related to appication operation	Electromagnetic brake operation timing	Pr. 42, Pr. 64, Pr. 65
	Sub-motor operation	Pr. 0, Pr. 3, Pr. 7, Pr. 8, Pr. 44, Pr. 45, Pr. 46, Pr. 47
	Operation in communication with perasonal computer	Communication parameters n1 to n12
	Operation under PID control	Pr. 60 to Pr. 65, Pr. 73, Pr. 79, Pr. 88 to Pr. 94
	Noise reduction	Pr. 70, Pr. 72

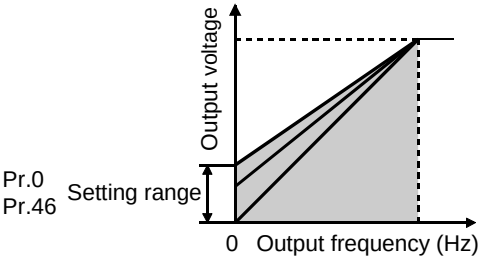
Purpose of Use		Parameter Numbers Parameter numbers which must be set
Related to monitoring	Frequency meter calibration	Pr. 54, Pr. 55, Pr. 56, Calibration parameter C1
	Display of monitor on control panel or parameter unit (FR-PU04)	Pr. 52, Communication parameter n16
	Display of speed, etc	Pr. 37, Pr. 52
Related to incorrect operationprevention	Function write prevention	Pr. 77
	Reverse rotation prevention	(Pr. 17), Pr. 78
	Current detection	Pr. 48 to Pr. 51, Pr. 64, Pr. 65
	Motor stall prevention	Pr. 21, Pr. 22, Pr. 23, Pr. 28
Others	Input terminal function assignment	Pr. 60 to Pr. 63
	Output terminal function assignment	Pr. 64, Pr. 65
	Increased cooling fan life	Pr. 76
	Motor protection from overheat	Pr. 9, Pr. 71
	Automatic restart operation at alarm stop	Pr. 66 to Pr. 69
	Setting of ground fault overcurrent protection	Pr. 40
	Inverter reset selection	Pr. 75

2.3 Explanation of Functions (Parameters)

2.3.1 Torque boost P 0 P46

Increase this value for use when the inverter-to-motor distance is long or motor torque is insufficient in the low speed range (stall prevention is activated).

- Motor torque in the low-frequency range can be adjusted to the load to increase the starting motor torque.



Parameter	Name	Factory Setting	Setting Range	Remarks
0	Torque boost	6%/5%/4% (Note)	0 to 15%	(Note) FR-S520 (S)-0.1K to 3.7K: 6% FR-S540-0.4K, 0.75K: 6% FR-S510W-0.1K to 0.75K: 6% FR-S540-1.5K, 2.2K: 5% FR-S540-3.7K: 4%
46	Second torque boost	- - -	0 to 15%, - - -	- - -: Function invalid. Setting is enabled when Pr. 30 = "1".

<Setting>

- Assuming that the base frequency voltage is 100%, set the 0Hz voltage in %.
- Use the RT signal to switch between two different torque boosts. (Turn on the RT signal to make Pr. 46 valid(*).)

REMARKS

* The RT signal acts as the second function selection signal and makes the other second functions valid.

- When using an inverter-dedicated motor (constant-torque motor), make setting as indicated below.
  - FR-S520-0.1K to 0.75K ..... 6%, FR-S520-1.5K to 3.7K 4%
  - FR-S540-0.4K, 0.75K ..... 6%, FR-S540-1.5K ..... 4%, FR-S540-2.2K, 3.7K 3%
  - FR-S520S-0.1K to 0.75K ..... 6%, FR-S520S-1.5K 4%
  - FR-S510W-0.1K to 0.75K 6%

  If you leave the factory setting as it is and change the Pr. 71 value to the setting for use of the constant-torque motor, the Pr. 0 setting changes to the above value.

CAUTION

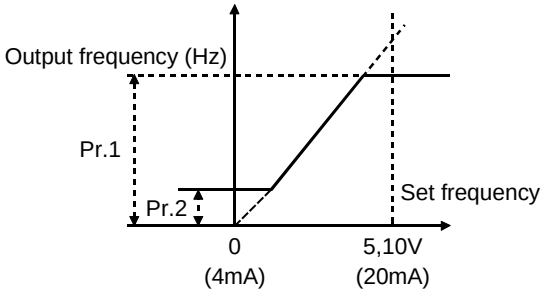
- Selecting automatic torque boost control makes this parameter setting invalid.
- A too large setting may cause the motor to overheat or result in an overcurrent trip. The guideline is about 10% at the greatest.

♦Related parameters♦

- RT signal (second function "Pr. 46") setting⇒ Pr. 60 to Pr. 63 "input terminal function selection" (refer to page 88)
- Constant-torque motor setting ⇒ Pr. 71 "applied motor" (refer to page 93)
- Automatic torque boost control selection ⇒ Pr. 98 "automatic torque boost selection (motor capacity)" (refer to page 109)

2.3.2 Maximum and minimum frequency P 1 P 2

You can clamp the upper and lower limits of the output frequency.



Parameter	Name	Factory Setting <EC version>	Setting Range
1	Maximum frequency	60Hz <50Hz>	0 to 120Hz
2	Minimum frequency	0Hz	0 to 120Hz

<Setting>

- Use Pr. 1 to set the upper limit of the output frequency. If the frequency of the frequency command entered is higher than the setting, the output frequency is clamped at the maximum frequency.
- Use Pr. 2 to set the lower limit of the output frequency.

REMARKS

When using the potentiometer (frequency setting potentiometer) connected across terminals 2-5 to perform operation above 60Hz <50Hz>, change the Pr. 1 and Pr. 38 (Pr. 39 when using the potentiometer across terminals 4-5) values.

⚠ CAUTION

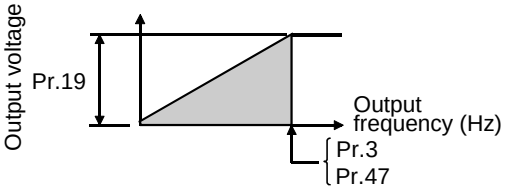
⚠ When the Pr. 2 setting is higher than the Pr. 13 "starting frequency" value, note that the motor will run at the set frequency by merely switching the start signal on, without entering the command frequency.

♦Related parameters♦

- Starting frequency setting ⇒ Pr. 13 "starting frequency" (refer to page 65)
- Maximum frequency setting using external potentiometer
  ⇒ Pr. 30 "extended function display selection" (refer to page 72), Pr. 38 "frequency setting voltage gain frequency", Pr. 39 "frequency setting current gain frequency" (refer to page 74)

2.3.3 Base frequency, Base frequency voltage P 3 P 19 P 47

Used to adjust the inverter outputs (voltage, frequency) to the motor rating.



Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks
3	Base frequency	60Hz <50Hz>	0 to 120Hz	——
19	Base frequency voltage	- - - <888>	0 to 500V, 888, - - -*1	888: 95% of power supply voltage*2 - - -: Same as power supply voltage*3 Setting is enabled when Pr. 30 = "1".
47	Second V/F (base frequency)	- - -	0 to 120Hz, - - -	- - -: Function invalid Setting is enabled when Pr. 30 = "1".

*1 0 to 800V, 888, - - - for FR-S540-0.4K to 3.7K.
*2 1.9 times greater than the power supply voltage for the FR-S510W-0.1K to 0.75K.
*3 Twice greater than the power supply voltage for the FR-S510W-0.1K to 0.75K.

<Setting>

• In Pr. 3 and Pr. 47, set the base frequency (motor's rated frequency).
Use the RT signal to switch between these two different base frequencies.
(Turn on the RT signal to make Pr. 47 valid.) (*)

When running the standard motor, generally set the "base frequency" to the rated frequency of the motor. When running the motor using commercial power supply-inverter switch-over operation, set the base frequency to the same value as the power supply frequency.

When the frequency given on the motor's rating plate is only "50Hz", always set the "base frequency" to "50Hz". Leaving the base frequency unchanged from "60Hz" may make the voltage too low and the torque insufficient, resulting in an overload trip. Special care must be taken when "1" is set in Pr. 14 "load pattern selection".

• Set the base voltage (e.g. rated voltage of motor) in Pr. 19.

CAUTION

1. Set 60Hz in Pr. 3 "base frequency" when using a Mitsubishi constant-torque motor.
2. When automatic torque boost is selected, Pr. 47 is invalid. When automatic torque boost is selected, setting "- - -" or "888" in Pr. 19 uses the rated output voltage.

REMARKS

* The RT signal serves as the second function selection signal and makes the other second functions valid.

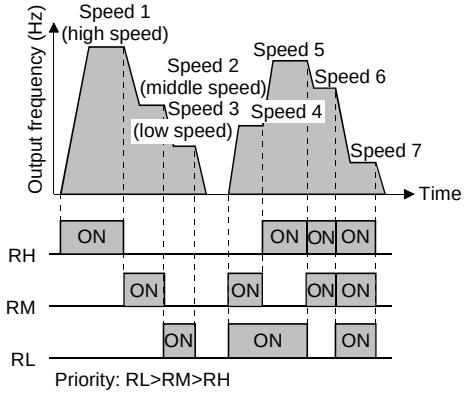
♦Related parameters♦

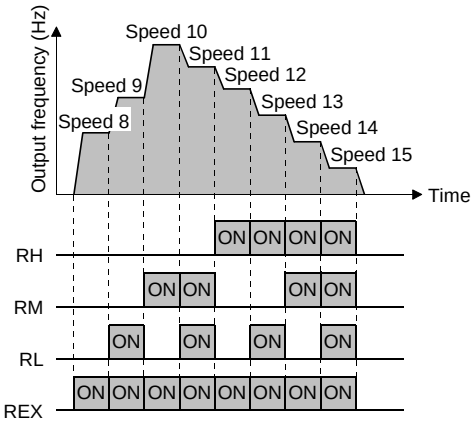
• When rated motor frequency is "50Hz" ⇒ Pr. 14 "load pattern selection" (refer to page 66)
• RT signal (second function "Pr. 47") setting ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)
• Motor setting ⇒ Pr. 71 "applied motor" (refer to page 93)
• Automatic torque boost selection ⇒ Pr. 98 "automatic torque boost selection (motor capacity)" (refer to page 109)

2.3.4 Multi-speed operation P 4 P 5 P 6 P24 to P27 P80 to P87

Used to switch between the predetermined running speeds.

- Any speed can be selected by merely switching on/off the corresponding contact signals (RH, RM, RL, REX signals).
- By using these functions with Pr. 1 "maximum frequency" and Pr. 2 "minimum frequency", up to 17 speeds can be set.
- This function is valid in the external operation mode or in the combined operation mode which is available when Pr. 79 = "3" or "4".





Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks
4	Multi-speed setting (high speed)	60Hz <50Hz>	0 to 120Hz	——
5	Multi-speed setting (middle speed)	30Hz	0 to 120Hz	——
6	Multi-speed setting (low speed)	10Hz	0 to 120Hz	——
24 to 27	Multi-speed setting (speeds 4 to 7)	- - -	0 to 120Hz, - - -	"- - -" = no setting. Setting enabled when Pr. 30 = "1".
80 to 87	Multi-speed setting (speeds 8 to 15)	- - -	0 to 120Hz, - - -	"- - -" = no setting. Setting enabled when Pr. 30 = "1".

<Setting>

- Set the running frequencies in the corresponding parameters.
  Each speed (frequency) can be set as desired between 0 and 120Hz during inverter operation.

  When the parameter of any multi-speed setting is read, turn the setting dial to change the setting.

  In this case, press the SET key (WRITE key) to store the frequency. (This is also enabled in the external mode.)

  The setting is reflected by pressing the SET key (WRITE key).
- Assign the terminals used for signals RH, RM, RL and REX using Pr. 60 to Pr. 63.(*)

CAUTION

1. The multi-speed settings override the main speeds (across terminals 2-5, 4-5, setting dial). When the multi-speed settings and setting dial are used in the combined operation mode (Pr. 79=3), the multi-speed settings have precedence.
2. The multi-speeds can also be set in the PU or external operation mode.
3. For 3-speed setting, if two or three speeds are simultaneously selected, priority is given to the frequency setting of the lower signal.
4. Pr. 24 to Pr. 27 and Pr. 80 to Pr. 87 settings have no priority between them.
5. The parameter values can be changed during operation.
6. When using this function with the jog signal, the jog signal has precedence.

REMARKS

* When terminal assignment is changed using Pr. 60 to Pr. 63, the other functions may be affected. Check the functions of the corresponding terminals before making setting.

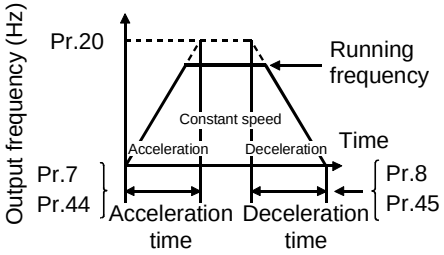
The frequency-set external terminals have the following priority:
Jog > multi-speed operation > AU (terminal 4) > terminal 2

♦Related parameters♦

- Maximum, minimum frequency setting ⇒ Pr. 1 "maximum frequency", Pr. 2 "minimum frequency" (refer to page 59)
- Assignment of signals RH, RM, RL, REX to terminals ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)
- External operation mode setting ⇒ Pr. 79 "operation mode selection" (refer to page 98)
- Computer link mode ⇒ Pr. 79 "operation mode selection" (refer to page 98), communication parameter n10 "link start mode selection" (refer to page 131)
- Speed command write ⇒ Communication parameter n9 "speed command write" (refer to page 130)

2.3.5 Acceleration/deceleration time P7 P8 P20 P44 P45

Used to set motor acceleration/ deceleration time.
Set a larger value for a slower speed increase/decrease or a smaller value for a faster speed increase/decrease.



Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks	
7	Acceleration time	5s	0 to 999s	——	
8	Deceleration time	5s	0 to 999s	——	
20	Acceleration/ deceleration reference frequency	60Hz <50Hz>	1 to 120Hz	Setting is enabled when Pr. 30 = "1".	
44	Second acceleration/ deceleration time	5s	0 to 999s	Setting is enabled when Pr. 30 = "1".	
45	Second deceleration time	- - -	0 to 999s, - - -	- - -: acceleration time = deceleration time.	Setting is enabled when Pr. 30 = "1".

<Setting>

- Use Pr. 7 and Pr. 44 to set the acceleration time required to reach the frequency set in Pr. 20 from 0Hz.
- Use Pr. 8 and Pr. 45 to set the deceleration time required to reach 0Hz from the frequency set in Pr. 20.
- Pr. 44 and Pr. 45 are valid when the RT signal is on. (*)
- Set "- - -" in Pr. 45 to make the deceleration time equal to the acceleration time (Pr. 44).

CAUTION

1. In S-shaped acceleration/deceleration pattern A (refer to page 71), the set time is the period required to reach the base frequency set in Pr. 3.
   - Acceleration/deceleration time calculation expression when the set frequency is the base frequency or higher

$$t = \frac{4}{9} \times \frac{T}{(Pr.\ 3)^2} \times f^2 + \frac{5}{9} T$$

   T: Acceleration/deceleration time setting (s)

   f : Set frequency (Hz)

   - Guideline for acceleration/deceleration time at the base frequency of 60Hz (0Hz to set frequency)

Frequency setting (Hz) / Acceleration/ deceleration time (s)	60	120
5	5	12
15	15	35

2. If the Pr. 20 setting is changed, the settings of calibration functions Pr. 38 and Pr. 39 (frequency setting signal gains) remain unchanged. To adjust the gains, adjust calibration functions Pr. 38 and Pr. 39.
3. When the setting of Pr. 7, Pr. 8, Pr. 44 or Pr. 45 is "0", the acceleration/ deceleration time is 0.04 seconds.
4. If the acceleration/deceleration time is set to the shortest value, the actual motor acceleration/deceleration time cannot be made shorter than the shortest acceleration/deceleration time which is determined by the mechanical system's J (inertia moment) and motor torque.

* When the RT signal is on, the other second functions (Pr. 44, Pr. 45, Pr. 46, Pr. 47) are also selected.

♦Related parameters♦

- Base frequency setting ⇒ Pr. 3 "base frequency" (refer to page 59)
- Acceleration/deceleration pattern, S-pattern acceleration/deceleration A ⇒ Pr. 29 "acceleration/deceleration pattern" (refer to page 71)
- Calibration function ⇒ Pr. 38 "frequency setting voltage gain frequency", Pr. 39 "frequency setting current gain frequency" (refer to page 74)
- RT signal setting ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)
- Jog acceleration/deceleration time ⇒ Pr. 16 "jog acceleration/deceleration time" (refer to page 67)

2.3.6 Electronic overcurrent protection P 9

Set the current of the electronic overcurrent protection to protect the motor from overheat. This feature provides the optimum protective characteristics, including reduced motor cooling capability, at low speed.

Parameter	Name	Factory Setting	Setting Range
9	Electronic thermal O/L relay	Rated output current *	0 to 50A

* 0.1K to 0.75K are set to 85% of the rated inverter current.

<Setting>

- Set the rated current [A] of the motor.
  (Normally set the rated current at 50Hz if the motor has both 50Hz and 60Hz rated current.)
- Setting "0" in Pr. 9 disables electronic thermal O/L relay (motor protective function).
  (The protective function of the inverter is activated.)
- When using a Mitsubishi constant-torque motor, first set "1" in Pr. 71 "applied motor" to choose the 100% continuous torque characteristic in the low-speed range. Then, set the rated motor current in Pr. 9 "electronic thermal O/L relay".

CAUTION

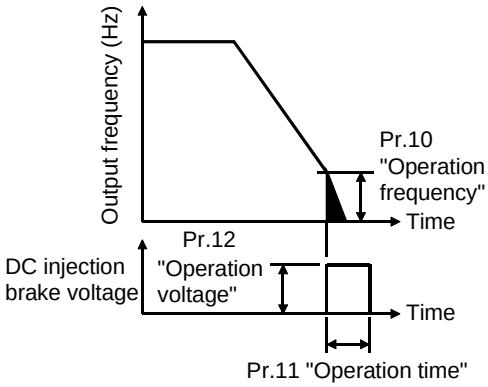
- When two or more motors are connected to the inverter, they cannot be protected by the electronic overcurrent protection. Install an external thermal relay to each motor.
- When the difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic overcurrent protection will be deteriorated. In this case, use an external thermal relay.
- A special motor cannot be protected by the electronic overcurrent protection. Use an external thermal relay.

♦Related parameters♦

• When constant-torque motor is used ⇒ Pr. 71 "applied motor" (refer to page 93)

2.3.7 DC injection brake P 10 P 11 P 12

By setting the DC injection brake voltage (torque), operation time and operation starting frequency, the stopping accuracy of positioning operation, etc. or the timing of operating the DC injection brake to stop the motor can be adjusted according to the load.



Parameter	Name	Factory Setting	Setting Range	Remarks
10	DC injection brake operation frequency	3Hz	0 to 120Hz	Setting is enabled when Pr. 30 = "1".
11	DC injection brake operation time	0.5s	0 to 10s	
12	DC injection brake voltage	6%	0 to 15%	

(When Pr. 11 is set to "0s" or Pr. 12 is set to "0%", DC injection brake is not operated.)

<Setting>

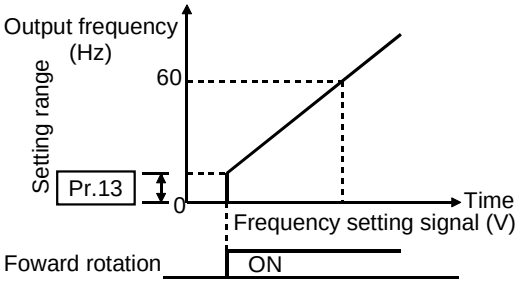
- Use Pr. 10 to set the frequency at which the DC injection brake operation is started.
- Use Pr. 11 to set the period during when the brake is operated.
- Use Pr. 12 to set the percentage of the power supply voltage.
  Change the Pr. 12. setting to 4% when using the inverter-dedicated (constant-torque motor).
  If the Pr. 12 value remains unchanged from the factory setting and Pr. 71 is changed to the setting for use of the constant-torque motor, the Pr. 12 setting is automatically changed to 4%.

⚠ CAUTION

⚠ Install a mechanical brake. No holding torque is provided.

2.3.8 Starting frequency P13

The starting frequency at which the start signal is turned on can be set in the range 0 to 60Hz.



Parameter	Name	Factory Setting	Setting Range	Remarks
13	Starting frequency	0.5Hz	0 to 60Hz	Setting is enabled when Pr. 30 = "1".

CAUTION

The inverter will not start if the frequency setting signal is less than the value set in Pr. 13 "starting frequency".
For example, when 5Hz is set in Pr. 13, the motor will not start running until the frequency setting signal reaches 5Hz.

⚠ CAUTION

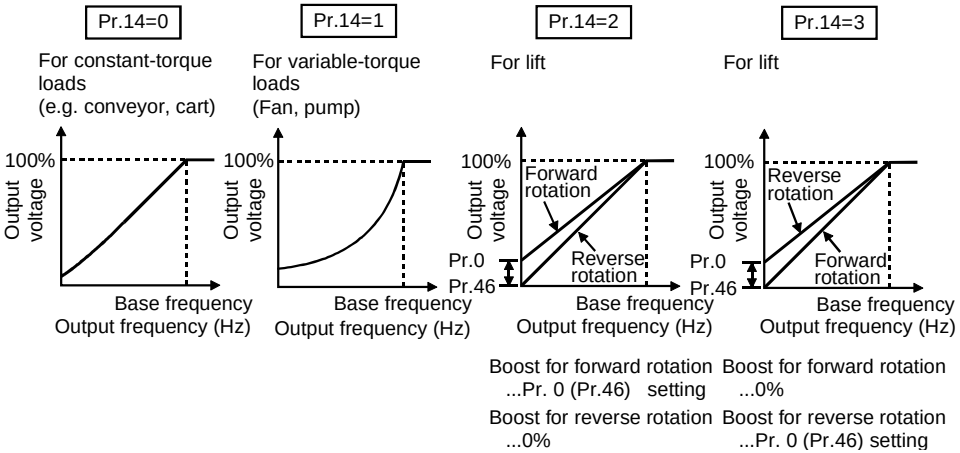
⚠ Note that when Pr. 13 is set to any value lower than Pr. 2 "minimum frequency", simply turning on the start signal will run the motor at the preset frequency if the command frequency is not input.

♦Related parameters♦

• Minimum frequency setting ⇒ Pr. 2 "minimum frequency" (refer to page 59)

2.3.9 Load pattern selection P14

You can select the optimum output characteristic (V/F characteristic) for the application and load characteristics.



Parameter	Name	Factory Setting	Setting Range	Remarks	
14	Load pattern selection	0	0, 1, 2, 3	0: For constant-torque loads 1: For variable-torque loads 2: For vertical lift loads 3: For vertical lift loads	Setting is enabled when Pr. 30 = "1".

CAUTION

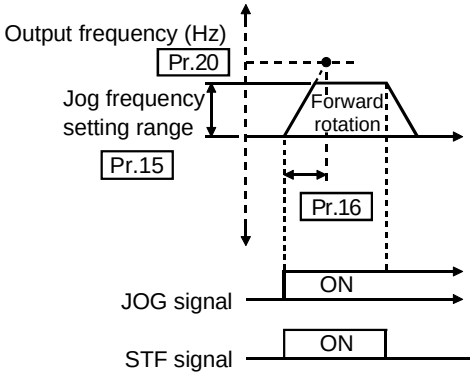
1. When automatic torque boost control is selected, this parameter setting is ignored.
2. Pr. 46 "second torque boost" is made valid when the RT signal turns on.
   The RT signal acts as the second function selection signal and makes the other second functions valid.

♦Related parameters♦

- Automatic torque boost ⇒ Pr. 98 "automatic torque boost selection (motor capacity)" (refer to page 109)
- Boost setting ⇒ Pr. 0 "torque boost", Pr. 46 "second torque boost" (refer to page 58)
- Assignment of RT signal to terminal when second torque boost is used
  ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)

2.3.10 Jog frequency P15 P16

To perform jog operation in the external operation mode, choose the jog operation function in input terminal function selection, turn on the jog signal, and use the start signal (STF, STR) to make a start or stop.
For the type having the RS-485 communication function, you can choose the jog operation mode from the parameter unit (FR-PU04) and perform jog operation using the FWD or REV key.
(Can be read as the basic parameters when the FR-PU04 is connected.)



● Set the frequency and acceleration/deceleration time for jog operation.

Parameter	Name	Factory Setting	Setting Range	Remarks
15	Jog frequency	5Hz	0 to 120Hz	Setting is enabled when Pr. 30 = "1".
16	Jog acceleration/ deceleration time	0.5s	0 to 999s	

CAUTION

- In S-shaped acceleration/deceleration pattern A, the acceleration/deceleration time is the period of time required to reach Pr. 3 "base frequency", not Pr. 20 "acceleration/deceleration reference frequency".
- The acceleration time and deceleration time cannot be set separately for jog operation.
- The value set in Pr. 15 "jog frequency" should be equal to or greater than the Pr. 13 "starting frequency" setting.
- Assign the jog signal using any of Pr. 60 to Pr. 63 (input terminal function selection).

♦Related parameters♦

• Assignment of jog signal to terminal ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)
• Acceleration/deceleration pattern S-shaped acceleration/deceleration A
⇒ Pr. 29 "acceleration/deceleration pattern" (refer to page 71)

2.3.11 RUN key rotation direction selection P17

Used to choose the direction of rotation by operating the RUN key of the operation panel.

Parameter	Name	Factory Setting	Setting Range	Remarks	
17	RUN key rotation direction selection	0	0, 1	0: Forward rotation 1: Reverse rotation	Setting is enabled when Pr. 30 = "1".

P19 ➡ Refer to P 3 (page 59)
P20 ➡ Refer to P 7, P 8 (page 62)

2.3.12 Stall prevention function and current limit function P21

You can make settings to disable stall prevention caused by overcurrent and to disable the fast-response current limit (which limits the current to prevent the inverter from resulting in an overcurrent trip if an excessive current occurs due to sudden load variation or ON-OFF, etc. in the output side of the running inverter).

- Stall prevention
  If the current exceeds the limit value, the output frequency of the inverter is automatically varied to reduce the current.
- Fast-response Current limit
  If the current exceeds the limit value, the output of the inverter is shut off to prevent an overcurrent.

Parameter	Name	Factory Setting	Setting Range	Remarks
21	Stall prevention function selection	0	0 to 31, 100	Setting is enabled when Pr. 30 = "1".

Pr. 21 Setting	Fast-Response Current Limit ○ : Activated ● : Not activated	Stall Prevention Operation Selection ○ : Activated ● : Not activated			OL Signal Output ○ : Operation continued ● : Operation not continued (*)
		Acceleration	Constant speed	Deceleration	
0	○	○	○	○	○
1	●	○	○	○	○
2	○	●	○	○	○
3	●	●	○	○	○
4	○	○	●	○	○
5	●	○	●	○	○
6	○	●	●	○	○
7	●	●	●	○	○
8	○	○	○	●	○
9	●	○	○	●	○
10	○	●	○	●	○
11	●	●	○	●	○
12	○	○	●	●	○
13	●	○	●	●	○
14	○	●	●	●	○
15	●	●	●	●	○

Pr. 21 Setting		Fast-Response Current Limit ○ : Activated ● : Not activated	Stall Prevention Operation Selection ○ : Activated ● : Not activated			OL Signal Output ○ : Operation continued ● : Operation not continued (*)
			Acceleration	Constant speed	Deceleration	
16		○	○	○	○	●
17		●	○	○	○	●
18		○	●	○	○	●
19		●	●	○	○	●
20		○	○	●	○	●
21		●	○	●	○	●
22		○	●	●	○	●
23		●	●	●	○	●
24		○	○	○	●	●
25		●	○	○	●	●
26		○	●	○	●	●
27		●	●	○	●	●
28		○	○	●	●	●
29		●	○	●	●	●
30		○	●	●	●	●
31		●	●	●	●	●
100	Driving	○	○	○	○	○
	Regenerative	●	●	●	●	○

CAUTION

- * When "Operation not continued for OL signal output" is selected, the "OLT" alarm code (stopped by stall prevention) is displayed and operation stopped. (Alarm stop display "OLT")
- If the load is heavy, the lift is predetermined, or the acceleration/deceleration time is short, the stall prevention may be activated and the motor not stopped in the preset acceleration/deceleration time. Therefore, set optimum values to the Pr. 21 and stall prevention operation level.
- When the fast-response current limit has been set in Pr. 21 (factory setting), torque will not be provided at the Pr. 22 setting of 170% or higher. At this time, make setting so that the fast-response current limit is not activated.
- In vertical lift applications, make setting so that the fast-response current limit is not activated. Torque may not be produced, causing a gravity drop.

⚠ CAUTION

⚠ Always perform test operation.

Stall prevention operation performed during acceleration may increase the acceleration time.

Stall prevention operation performed during constant speed may cause sudden speed changes.

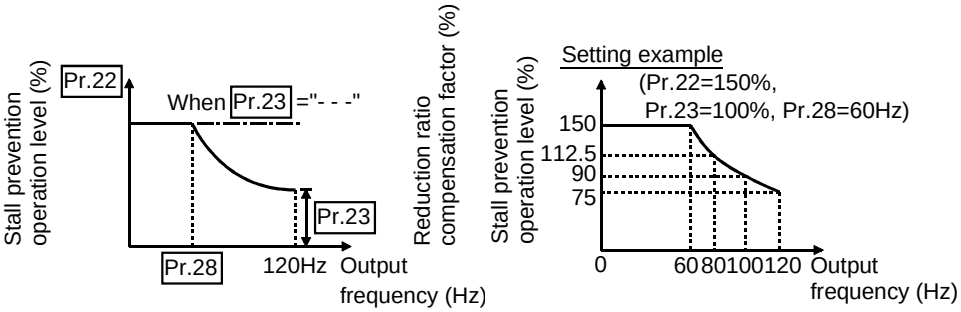
Stall prevention operation performed during deceleration may increase the deceleration time, increasing the deceleration distance.

2.3.13 Stall prevention P22 P23 P28

Set the output current level at which the output frequency will be adjusted to prevent the inverter from stopping due to overcurrent etc.

● During high-speed operation above the rated motor frequency, acceleration may not be made because the motor current does not increase. To improve the operating characteristics of the motor in this case, the stall prevention level can be reduced in the high frequency region. This function is effective for performing operation up to the high speed range on a centrifugal separator etc. Normally, set 60Hz <50Hz> in Pr. 28 "stall prevention operation reduction starting frequency" and 100% in Pr. 23.

Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks	
22	Stall prevention operation level	150%	0 to 200%	——	Setting is enabled when Pr. 30 = "1".
23	Stall prevention operation level compensation factor at double speed	- - -	0 to 200%, - - -	- - -: Pr. 22 equally	
28	Stall prevention operation reduction starting frequency	60Hz <50Hz>	0 to 120Hz	——	



<Setting>

- Generally, set 150% (factory setting) in Pr. 22 "stall prevention operation level". Setting "0" in Pr. 22 disables stall prevention operation.
- To reduce the stall prevention operation level in the high frequency range, set the reduction starting frequency in Pr. 28 "stall prevention operation reduction starting frequency" and the reduction ratio compensation factor in Pr. 23.
  Calculation expression for stall prevention operation level

$$\text{Stall prevention operation level (\%)} = A + B \times \left[\frac{\text{Pr. 22 - A}}{\text{Pr. 22-B}} \right] \times \left[\frac{\text{Pr. 23 - 100}}{100} \right]$$

$$\text{where, } A = \frac{\text{Pr. 28 (Hz)} \times \text{Pr. 22 (\%)}}{\text{output frequency (Hz)}} \text{ , } B = \frac{\text{Pr. 28 (Hz)} \times \text{Pr. 22 (\%)}}{120\text{Hz}}$$

- By setting "- - -" (factory setting) in Pr. 23, the stall prevention operation level is constant at the Pr. 22 setting up to 120Hz.

REMARKS

When the fast-response current limit is set in Pr. 21 "stall prevention function selection" (factory setting), do not set any value above 170% in Pr. 22. The torque will not be developed by doing so.
If the Pr. 22 value is set to higher than 170%, make setting in Pr. 21 to disable the fast-response current limit.
In vertical lift applications, make setting so the fast-response current limit is not cativated. Torque may not be produced, causing a gravity drop.

⚠ CAUTION

⚠ Do not set a small value as the stall prevention operation current.
Otherwise, torque generated will reduce.

⚠ Test operation must be performed.
Stall prevention operation during acceleration may increase the acceleration time.
Stall prevention operation during constant speed may change the speed suddenly.
Stall prevention operation during deceleration may increase the deceleration time, increasing the deceleration distance.

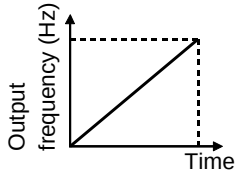
Pr.24 to Pr.27 ➡ Refer to Pr. 4 to Pr. 6 (page 61)

2.3.14 Acceleration/deceleration pattern P29

Set the acceleration/deceleration pattern.

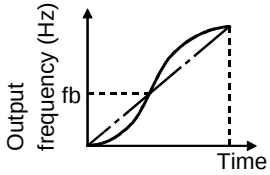
Set value 0

[Linear acceleration/deceleration]



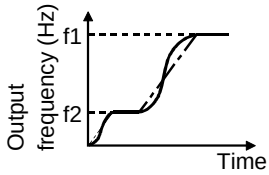
Set value 1

[S-shaped acceleration/deceleration A]



Set value 2

[S-shaped acceleration/deceleration B]



Parameter	Name	Factory Setting	Setting Range	Remarks
29	Acceleration/ deceleration pattern	0	0, 1, 2	Setting is enabled when Pr. 30 = "1".

<Setting>

Pr. 29 Setting	Function	Description
0	Linear acceleration/ deceleration	Acceleration is made to the set frequency linearly. (Factory setting)
1	S-shaped acceleration/ deceleration A (*)	For machine tool spindle applications, etc. Used when acceleration/deceleration must be made in a short time to a high-speed region of not lower than the base frequency. Acceleration/deceleration is made in a pattern where fb (base frequency) acts as the inflection point of an S shape, and you can set the acceleration/deceleration time which matches the motor torque reduction in the constant-output operation region of not lower than the base frequency.
2	S-shaped acceleration/ deceleration B	For conveyor and other load collapse prevention applications, etc. Since acceleration/deceleration is always made in an S shape from f2 (current frequency) to f1 (target frequency), this function eases shock produced at acceleration/deceleration and is effective for load collapse prevention, etc.

CAUTION

* As the acceleration/deceleration time, set the time taken to reach the Pr. 3 "base frequency" value, not the Pr. 20 "acceleration/deceleration reference frequency" value. For details, refer to page 59.

♦Related parameters♦

- Base frequency (acceleration/deceleration time setting) setting ⇒ Pr. 3 "base frequency" (refer to page 59)
- For setting of "1" (S-shaped acceleration/deceleration A)
  ⇒ Pr. 44 "second acceleration/deceleration time", Pr. 45 "second deceleration time" (refer to page 62)

2.3.15 Extended function display selection P30

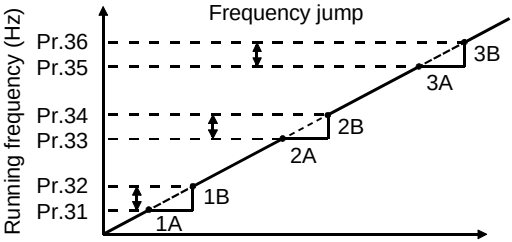
Used to display the extended function parameters.

- Refer to page 46 for the extended function parameter list.
- Refer to the instruction manual (basic) for the parameter setting method.

Parameter	Name	Factory Setting	Setting Range	Remarks
30	Extended function display selection	0	0, 1	0: Without display, 1: With display

2.3.16 Frequency jump P31 to P36

When it is desired to avoid resonance attributable to the natural frequency of a mechanical system, these parameters allow resonant frequencies to be jumped. Up to three areas may be set, with the jump frequencies set to either the top or bottom point of each area.

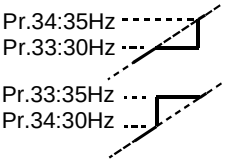


The value set to 1A, 2A or 3A is a jump point and operation is performed at this frequency.

Parameter	Name	Factory Setting	Setting Range	Remarks
31	Frequency jump 1A	- - -	0 to 120Hz, - - -	• - - -: Function invalid • Setting is enabled when Pr. 30 = "1"
32	Frequency jump 1B	- - -	0 to 120Hz, - - -	
33	Frequency jump 2A	- - -	0 to 120Hz, - - -	
34	Frequency jump 2B	- - -	0 to 120Hz, - - -	
35	Frequency jump 3A	- - -	0 to 120Hz, - - -	
36	Frequency jump 3B	- - -	0 to 120Hz, - - -	

<Setting>

- To fix the frequency at 30Hz between Pr. 33 and Pr. 34 (30Hz and 35Hz), set 30Hz in Pr. 33 and 35Hz in Pr. 34.
- To jump to 35Hz between 30 and 35Hz, set 35Hz in Pr. 33 and 30Hz in Pr. 34.



CAUTION

During acceleration/deceleration, the running frequency within the set area is valid.

REMARKS

Write inhibit error "Er 1" occurs if the frequency jump setting ranges overlap.

2.3.17 Speed display P37

You can change the output frequency indication of the operation panel and parameter unit (FR-PU04) to the motor speed or machine speed.

Parameter	Name	Factory Setting	Setting Range	Remarks	
37	Speed display	0	0, 0.1 to 999	0: Output frequency	Setting is enabled when Pr. 30 = "1".

<Setting>

• To display the machine speed, set in Pr. 37 the machine speed for 60Hz operation.

CAUTION

- The motor speed is converted from the output frequency and does not match the actual speed.
- When you want to change the monitor (PU main display) of the operation panel, refer to Pr. 52 "operation panel display data selection" and communication parameter n16 "PU main display screen data selection".
- Since the operation panel indication is 3 digits, make a setting so that the monitor value does not exceed "999". If the Pr. 1 value is higher than 60Hz and Pr. 1 value × Pr. 37 value > 60Hz × 999 Er2 (write error) occurs when Pr. 1 or Pr. 37 is written.

REMARKS

When you set the speed in Pr. 37, the speed is monitored in the monitor frequency setting mode.
At this time, setting can be made in the minimum setting increments of 0.01r/min.
Due to the restrictions on the resolution of the set frequency, the indication in the second decimal place may differ from the setting.

⚠ CAUTION

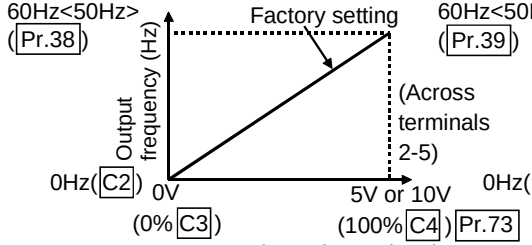
⚠ Make sure that the running speed setting is correct.
Otherwise, the motor might run at extremely high speed, damaging the machine.

♦Related parameters♦

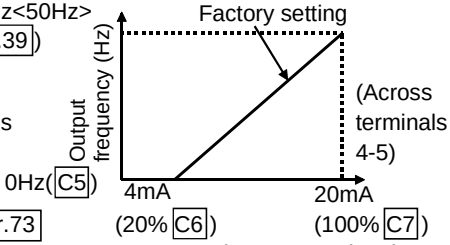
• To choose running speed monitor display ⇒ Pr. 52 "operation panel display data selection" (refer to page 82)
• FR-PU04 display switching ⇒ Communication parameter n16 "PU main display screen data selection" (refer to page 134)

2.3.18 Biases and gains of the frequency setting voltage (current) P38 P39 C2 to C7

You can set the magnitude (slope) of the output frequency as desired in relation to the external frequency setting signal (0 to 5V, 0 to 10V or 4 to 20mA DC). The "bias" and "gain" functions are used to adjust the relationship between the input signal entered from outside the inverter to set the output frequency, e.g. 0 to 5VDC, 0 to 10VDC or 4 to 20mADC, and the output frequency.



Frequency setting voltage signal



Frequency setting current signal

Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks
38	Frequency setting voltage gain frequency	60Hz <50Hz>	1 to 120Hz	Setting is enabled when Pr. 30 = "1".
39	Frequency setting current gain frequency	60Hz <50Hz>	1 to 120Hz	
C2 (902)	Frequency setting voltage bias frequency	0Hz	0 to 60Hz	
C3 (902)	Frequency setting voltage bias	0% *	0 to 300%	
C4 (903)	Frequency setting voltage gain	96% *	0 to 300%	
C5 (904)	Frequency setting current bias frequency	0Hz	0 to 60Hz	
C6 (904)	Frequency setting current bias	20% *	0 to 300%	
C7 (905)	Frequency setting current gain	100% *	0 to 300%	

* Settings may differ because of calibration parameters.
The parameter numbers within parentheses are those for use of the parameter unit (FR-PU04).
When the parameter unit (FR-PU04) is used, operation from the operation panel is not accepted.

POINT

- Bias setting for 0-5VDC (0-10VDC) input ➡ Use calibration parameters C2, C3 for setting.
- Gain setting for 0-5VDC (0-10VDC) input ➡ Use Pr. 38, calibration parameter C4 for setting.
- Bias setting for 4-20mADC input ➡ Use calibration parameters C5, C6 for setting.
- Gain setting for 4-20mADC input ➡ Use Pr. 39, calibration parameter C7 for setting.

(For 4 to 20mADC input, set "4" in any of Pr. 60 to Pr. 63 (input terminal function selection) and assign AU (current input selection) to any of terminals RH, RM, RL and STR, and turn on the AU signal.)

<Setting>

(1) How to change the highest frequency

(2) Adjusting the deviation of the highest frequency from the Pr. 38 (Pr. 39) setting.

(2)-1) Make adjustment with a voltage applied directly across terminals 2-5 (with a current flowing across terminals 4-5)

(2)-2) Make adjustment at any point without a voltage applied across terminals 2-5 (without a current flowing across terminals 4-5)

Changing example When you want to use the 0 to 5VDC input frequency setting potentiometer to change the 5V frequency from 60Hz to 50Hz

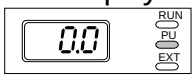
POINT

- Pr. 38 is an extended function parameter. Pr. 30 must be set to "1".
- Change Pr. 38 "frequency setting voltage gain frequency" to 50Hz.

(1) How to change the highest frequency

Operation — Display

1. Confirm the RUN indication and operation mode indication.
   - The inverter must be at a stop.
   - The inverter must be in the PU operation mode. (Press the PU/EXT key.)



2. Press the MODE key to choose the parameter setting mode.

3. Turn the setting dial until the parameter number 38 "frequency setting voltage gain frequency" appears.
   - Pr. 30 must be set to "1". (For the Pr. 30 setting method, refer to the instruction manual (basic).)

4. Pressing the SET key shows the currently set value. (60Hz)

5. Turn the setting dial to change the set value to "50.0". (50Hz)

6. Press the SET key to set the value.

Flicker ... Parameter setting complete!!

- By turning the setting dial , you can read another parameter.
- Press the SET key to show the setting again.
- Press the SET key twice to show the next parameter.

? The monitor/frequency setting indication cannot be changed to just 50Hz ... Why?

☞ The calibration parameter C4 "frequency setting voltage gain" value must be set. (Refer to next page (2))

REMARKS

To change the value to more than 60Hz <50Hz>, Pr. 1 "maximum frequency" must be set to more than 60Hz <50Hz>.

Changing example | Changing the calibration parameter C4 "frequency setting voltage gain" value

POINT

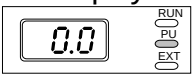
The calibration parameter C4 is an extended function parameter. Pr. 30 must be set to "1".

(2) Adjusting a deviation of the highest frequency from the Pr. 38 (Pr. 39) setting.

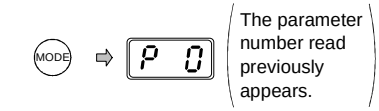
(2)-1) Making adjustment with a voltage applied directly across terminals 2-5 (with a current flowing across terminals 4-5)

Operation — Display

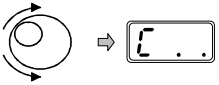
1. Confirm the RUN indication and operation mode indication.
   - The inverter must be at a stop.
   - The inverter must be in the PU operation mode. (Press the PU/EXT key)



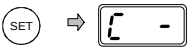
2. Press the MODE key to choose the parameter setting mode.



3. Turn the setting dial to show "C . .".
   - Pr. 30 must be set to "1". (For the Pr. 30 setting method, refer to the instruction manual (basic).)

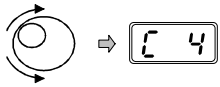


4. Press the SET key to show "C -".

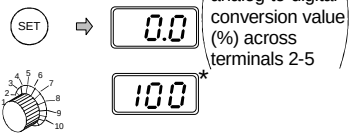


When adjusting Pr. 38

5. Turn the setting dial until the calibration parameter C4 "frequency setting voltage gain" appears.



6. Press the SET key to show the analog voltage analog-to-digital conversion value (%).



7. Apply a 5V voltage. (Turn the external potentiometer connected to across terminals 2-5 to the maximum (any position).)

*The value is nearly 100 (%) in the maximum position of the potentiometer.

CAUTION

After performing operation in step 7, do not touch the setting dial until completion of calibration.

8. Press the SET key to set the value.

Flicker ... Parameter setting complete!!
(Adjustment complete)

*The value is nearly 100 (%) in the maximum position of the potentiometer.

- By turning the setting dial, you can read another parameter.
- Press the SET key to return to the C - indication (step 4).
- Press the SET key twice to show the next parameter (CLr).

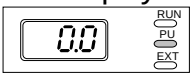
? The frequency meter (indicator) connected to across terminals FM-SD (AM-5)does not indicate just 50Hz ... Why?
☞ The calibration parameter C1 "FM (AM) terminal calibration" value must be set. (For the setting method, refer to the instruction manual (basic).)

? When write is performed, an error (Er3) is displayed.
☞ The gain and bias frequency settings are too close.

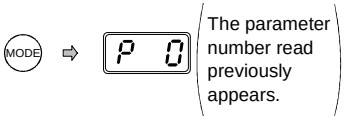
(2)-2) Making adjustment at any point with a voltage not applied across terminals 2-5 (with a current not flowing across terminals 4-5)

Operation — Display

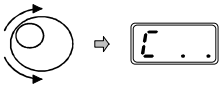
1. Confirm the RUN indication and operation mode indication.
   - The inverter must be at a stop.
   - The inverter must be in the PU operation mode. (Press the PU/EXT key)



2. Press the MODE key to choose the parameter setting mode.



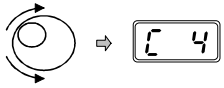
3. Turn the setting dial to show "C . .".
   - Pr. 30 must be set to "1". (For the Pr. 30 setting method, refer to the instruction manual (basic).)



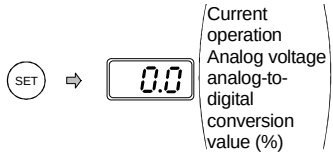
4. Press the SET key to show "C -".

When adjusting Pr. 38

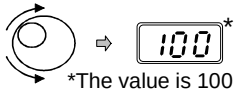
5. Turn the setting dial until the calibration parameter C4 "frequency setting voltage gain" appears.



6. Press the SET key to show the analog voltage analog-to-digital conversion value (%). (The maximum value can be displayed by merely turning the setting dial clockwise or counterclockwise in this status by one pulse's worth of turns (there is tactile feedback because of the notch type).)



7. Turn the setting dial to the maximum value (100%) or any point.



*The value is 100 (%) in the maximum position of the potentiometer.

8. Press the SET key to set the value.

Flicker ... Parameter setting complete!!
*The value is 100 (%) in the maximum position of the potentiometer.

- Turn the setting dial to read another parameter.
- Press the SET key to return to the C - indication (step 4).
- Press the SET key twice to show the next parameter (CLr).

REMARKS

For the way to change the output frequency setting of the frequency setting potentiometer, refer to the instruction manual (basic).

2.3.19 Start-time ground fault detection selection P40

You can choose whether to make ground fault detection valid or invalid at a start. Ground fault detection is executed only right after the start signal is input to the inverter.

Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks	
40	Start-time ground fault detection selection	0 <1>	0, 1	0: Ground fault detection for protection is not executed. 1: Ground fault detection for protection is executed.	Setting is enabled when Pr. 30 = "1".

CAUTION

1. If a ground fault is detected with "1" set in Pr. 40, alarm output "GF" is detected and the output is shut off.
2. If the motor capacity is less than 0.1kW, ground fault protection may not be provided.

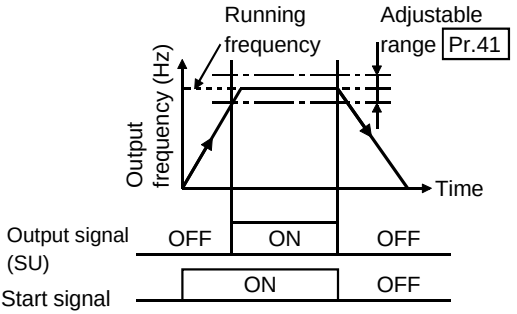
REMARK

When a ground fault is detected with "1" set in Pr. 40, an approximate 20ms delay occurs at every start.

2.4 Output Terminal Function Parameters

2.4.1 Up-to-frequency sensitivity P41

The ON range of the up-to-frequency signal (SU) output when the output frequency reaches the running frequency can be adjusted between 0 and ±100% of the running frequency. This parameter can be used to ensure that the running frequency has been reached to provide the operation start signal etc. for related equipment.



Parameter	Name	Factory Setting	Setting Range	Remarks
41	Up-to-frequency sensitivity	10%	0 to 100%	Setting is enabled when Pr. 30 = "1".

REMARKS

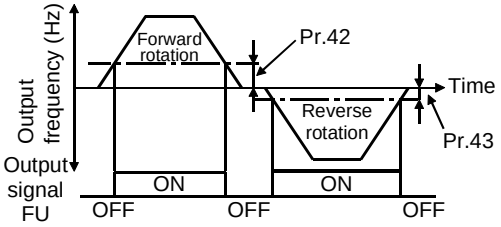
Using Pr. 64 or Pr. 65 to change terminal assignment may affect the other functions. Make setting after confirming the function of each terminal. (Refer to page 90.)

♦Related parameters♦

• Assignment of SU signal to terminal ⇒ Pr. 64 "RUN terminal function selection", Pr. 65 "A, B, C terminal function selection" (refer to page 90)

2.4.2 Output frequency detection P42 P43

The output frequency detection signal (FU) is output when the output frequency reaches or exceeds the setting. This function can be used for electromagnetic brake operation, open signal, etc. You can also set the detection of the frequency used exclusively for reverse rotation.



This function is effective for switching the timing of electromagnetic brake operation between forward rotation (rise) and reverse rotation (fall) during vertical lift operation, etc.

Parameter	Name	Factory Setting	Setting Range	Remarks	
42	Output frequency detection	6Hz	0 to 120Hz	——	Setting is enabled when Pr. 30 = "1".
43	Output frequency detection for reverse rotation	- - -	0 to 120Hz, - - -	- - -: Same as Pr. 42 setting	

<Setting>

Refer to the above chart and set the corresponding parameters.

- When Pr. 43 "output frequency detection for reverse rotation" ≠ "- - -", the Pr.42 setting applies to forward rotation and the Pr.43 setting applies to reverse rotation.
- Use Pr. 64 or Pr. 65 (output terminal function selection) to assign the terminal used for FU signal output.

CAUTION

Using Pr. 64 or Pr. 65 to change terminal assignment may affect the other functions. Make setting after confirming the function of each terminal.

♦Related parameters♦

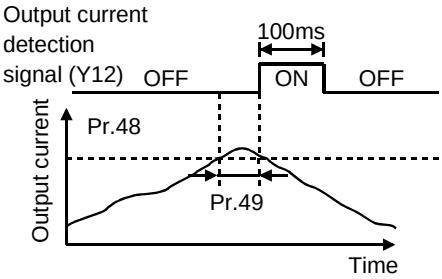
- Assignment of FU signal to terminal ⇒ Pr. 64 "RUN terminal function selection", Pr. 65 "A, B, C terminal function selection" (refer to page 90)

P44, P45 ➡ Refer to P 7, P 8 (page 62).
P46 ➡ Refer to P 0 (page 58).
P47 ➡ Refer to P 3 (page 59).

2.5 Current Detection Function Parameters

2.5.1 Output current detection functions P48 P49

If the output remains higher than the Pr. 48 setting during inverter operation for longer than the time set in Pr. 49, the output current detection signal (Y12) is output from the inverter's open collector output terminal.



Parameter	Name	Factory Setting	Setting Range	Remarks
48	Output current detection level	150%	0 to 200%	Setting is enabled when Pr. 30 = "1"
49	Output current detection signal delay time	0s	0 to 10s	

<Setting>

Parameter Number	Description
48	Set the output current detection level. 100% is the rated inverter current.
49	Set the output current detection time. Set the time from when the output current has risen above the Pr. 48 setting until the output current detection signal (Y12) is output.

CAUTION

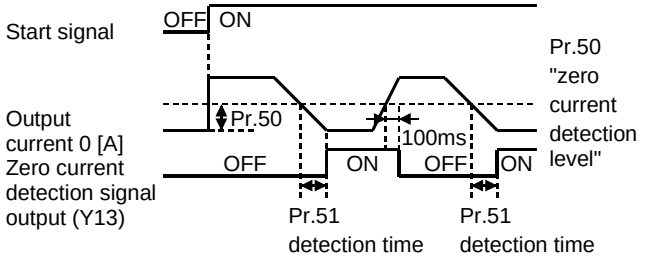
- Once turned on because the current has risen above the preset detection level, the output current detection signal is held on for at least 100ms (approximately).
- Using Pr. 64 or Pr. 65 to change terminal assignment may affect the other functions. Make setting after confirming the function of each terminal.

♦Related parameters♦

• Assignment of Y12 signal to terminal ⇒ Pr. 64 "RUN terminal function selection", Pr. 65 "A, B, C terminal function selection" (refer to page 90)

2.5.2 Zero current detection P50 P51

When the inverter's output current falls to "0", torque will not be generated. This may cause a gravity drop when the inverter is used in vertical lift application.



To prevent this, the output current "zero" signal can be output from the inverter to close the mechanical brake when the output current has fallen to "zero".

Parameter	Name	Factory Setting	Setting Range	Remarks
50	Zero current detection level	5%	0 to 200%	Setting is enabled when Pr. 30 = "1"
51	Zero current detection time	0.5s	0.05 to 1s	

POINT

If the output is lower than the Pr.50 setting for longer than the time set in Pr. 51 during inverter operation, the zero current detection (Y13) signal is output from the inverter's open collector output terminal.

<Setting>

Parameter	Description
50	Set the zero current detection level. Set the level of zero current detection in terms of the percentage of the rated inverter current from the output current value of 0 [A].
51	Set the zero current detection time. Set a period of time from when the output current falls to or below the Pr. 50 setting to when the zero current detection signal (Y13) is output.

CAUTION

- If the current falls below the preset detection level but the timing condition is not satisfied, the zero current detection signal is held on for about 100ms.
- When the terminal functions are changed using Pr. 64, Pr. 65, the other functions may be affected. Confirm the functions of the corresponding terminals before making settings.
- When one inverter is used to run (connect) multiple motors sequentially, the zero current detection signal (Y13) may be output. Set 13% or more for the 0.1K, and 8% or more for the 0.2K. (If the sum of motor capacities is less than the zero current detection level current or if the motor capacity per motor is less than the zero current detection level current)

♦Related parameters♦

• Assignment of Y13 signal to terminal ⇒ Pr. 64 "RUN terminal function selection", Pr. 65 "A, B, C terminal function selection" (refer to page90)

2.6 Display Function Parameters

2.6.1 Monitor display Pr.52 Pr.54

You can choose the display of the operation panel "monitor/frequency setting screen".

● For the Pr. 54 function, the Japanese version has the FM terminal feature, and the NA and EC versions have the AM terminal feature.

Parameter	Name	Factory Setting	Setting Range	Remarks
52	Operation panel display data selection	0	0, 1, 100	Setting is enabled when Pr. 30 = "1"
54	FM (AM) terminal function selection	0	0, 1	

POINT

- You can also use the (SET) key to change the display. (Refer to the instruction manual (basic) for the operation procedure.)
- The pulse train output terminal FM (analog voltage output terminal AM) is available for signal output. (Make selection using the Pr. 54 "FM (AM) terminal function selection" value.)

<Setting>

Signal Type	Unit	Parameter Setting		Full-Scale Value of FM (AM) Level Meter
		Pr. 52	Pr. 54	
		Operation panel LED	FM (AM) terminal	
Output frequency	Hz	0/100	0	Pr. 55 "frequency monitoring reference"
Output current	A	1	1	Pr. 56 "current monitoring reference"

When "100" is set in Pr. 52, the monitor value changes depending on whether the inverter is during stop or running.

	Pr. 52		
	0	100	
	During running/stop	During stop	During running
Output frequency	Output frequency	Set frequency	Output frequency

REMARKS

- During an error, its definition appears.
- During reset, the values displayed are the same as during a stop.
- For selection of the parameter unit (FR-PU04) monitor display, refer to the communication parameter n16 "PU main display screen data selection". (Page 134)

CAUTION

The unit displayed on the operation panel is only A and other units are not displayed.

♦Related parameters♦

- Speed display ⇒ Pr. 37 "speed display" (refer to page 73)
- Adjustment of FM (AM) level meter full-scale value ⇒ Calibration parameter C1 "FM (AM) terminal calibration" (refer to page 111)
- Monitoring reference ⇒ Pr. 55 "frequency monitoring reference", Pr. 56 "current monitoring reference" (refer to page 84)

2.6.2 Setting dial function selection P53

You can use the dial like a potentiometer to perform operation.

Parameter	Name	Factory Setting	Setting Range	Remarks	
53	Frequency setting operation selection	0	0, 1	0: Setting dial frequency setting mode 1: Setting dial potentiometer mode	Setting is enabled when Pr. 30 = "1"

Using the setting dial like a potentiometer to perform operation

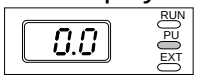
POINT

- Set "1" (extended function parameter valid) in Pr. 30 "extended function display selection".
- Set "1" (setting dial potentiometer mode) in Pr. 53 "frequency setting operation selection".

Operation example Changing the frequency from 0Hz to 60Hz during operation

Operation — Display

1. Mode/monitor check
   - Choose monitor/frequency monitor. (MODE key)
   - The inverter must be in the PU operation mode. (Press the PU/EXT key.)
   - Pr. 30 must be set to "1".
   - Pr. 53 must be set to "1".



2. Press the RUN key to start the inverter.

3. Turn the setting dial clockwise until "60.0" appears. The flickering frequency is the set frequency.
   You need not press the SET key.

Flickers for 3s.

REMARKS

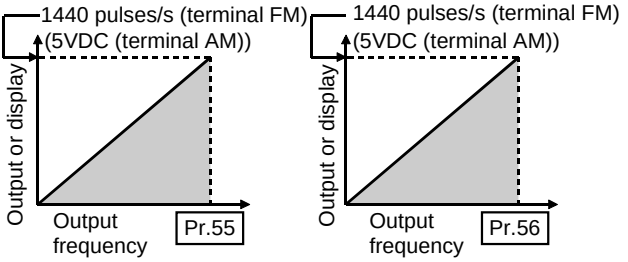
- If flickering "60.0" turns to "0.0", the Pr. 53 "frequency setting operation selection" setting may not be "1".
- Independently of whether the inverter is running or at a stop, the frequency can be set by merely turning the dial.
- When the frequency is changed, it will be stored as the set frequency often 10 seconds.

P54 ➡ Refer to P52 (page 82).

2.6.3 Monitoring reference P55 P56

Set the frequency or current which is referenced when the output frequency or output current is selected for the FM (AM) terminal.

- The Japanese version has the FM terminal feature, and the NA and EC versions have the AM terminal feature.



Parameter	Name	Factory Setting <EC version>	Setting Range	Remarks
55	Frequency monitoring reference	60Hz <50Hz>	0 to 120Hz	Setting is enabled when Pr. 30 = "1"
56	Current monitoring reference	Rated output current	0 to 50A	

<Setting>

Refer to the above diagrams and set the frequency monitoring reference value in Pr. 55 and the current monitoring reference value in Pr. 56.
Pr. 55 is set when Pr. 54 "FM (AM) terminal function selection" = "0" and Pr. 56 is set when Pr. 54 = "1".
Set the Pr. 55 and Pr. 56 values so that the output pulse train output of terminal FM is 1440 pulses/s (the output voltage of terminal AM is 5V).

CAUTION

- The maximum pulse train output of terminal FM is 2400pulses/s. If Pr. 55 is not adjusted, the output of terminal FM will be filled to capacity. Therefore, adjust Pr. 55.
- The maximum output voltage of terminal AM is 5VDC.

2.7 Restart Operation Parameters

2.7.1 Restart setting P57 P58

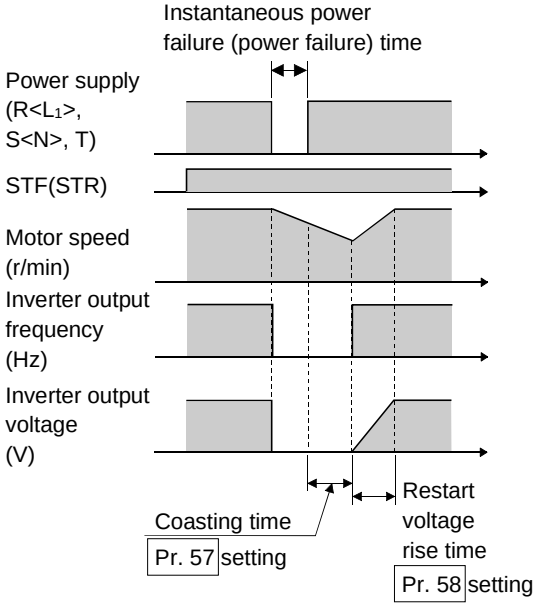
At power restoration after an instantaneous power failure, you can restart the inverter without stopping the motor (with the motor coasting).

Parameter	Name	Factory Setting	Setting Range	Remarks
57	Restart coasting time	- - -	0 to 5s, - - -	Setting is enabled when Pr. 30 = "1"
58	Restart cushion time	1s	0 to 60s	

<Setting>

Refer to the following table and set the parameters:

Parameter	Setting		Description	
57	0	0.1K to 1.5K	Coasting time of 0.5s	Generally, this setting will pose no problems.
		2.2K, 3.7K	Coasting time of 1.0s	
	0.1 to 5s		Waiting time for inverter-triggered restart after power is restored from an instantaneous power failure. (Set this time between 0.1 and 5s according to the inertia moment (J) and torque of the load.)	
	- - -		No restart	
58	0 to 60s		Normally the motor may be run with the factory settings. These values are adjustable to the load (inertia moment, torque).	



CAUTION

- Automatic restart operation after instantaneous power failure is a reduced voltage starting system in which the output voltage is risen gradually at the preset frequency independently of the coasting speed of the motor.
  It is a system which outputs the output frequency before an instantaneous power failure, unlike the motor coasting speed detection system (speed search system) used by the FR-E500 series Mitsubishi transistorized inverters. Hence, if the instantaneous power failure time is 0.2s or longer, the frequency before an instantaneous power failure cannot be stored in memory and the inverter restarts at 0Hz.
- The SU and FU signals are not output during a restart. They are output after the restart cushion time has elapsed.

⚠ CAUTION

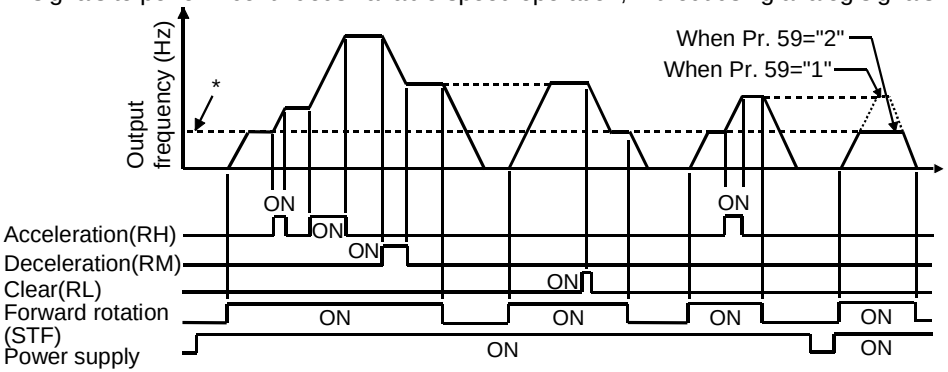
⚠ When automatic restart after instantaneous power failure has been selected, the motor and machine will start suddenly (after the restart coasting time has elapsed) after occurrence of an instantaneous power failure. Stay away from the motor and machine.
When you have selected automatic restart after instantaneous power failure, apply in easily visible places the CAUTION seals supplied to the instruction manual (basic).

⚠ The motor is coasted to a stop as soon as you turn off the start signal or press the STOP RESET key during the restart cushion time after instantaneous power failure.

2.8 Additional Function Parameters

2.8.1 Remote setting function selection P59

If the operator panel is located away from the control box, you can use contact signals to perform continuous variable-speed operation, without using analog signals.



* External operation frequency or PU operation frequency other than at multiple speeds

Parameter	Name	Factory Setting	Setting Range	Remarks
59	Remote setting function selection	0	0, 1, 2	Setting is enabled when Pr. 30 = "1"

REMARKS

- When the remote function is used, the output frequency of the inverter can be compensated for as follows:

  External operation mode — Frequency set by RH/RM operation plus external analog frequency command

  PU operation mode — Frequency set by RH/RM operation plus setting dial or PU digital preset frequency

<Operation panel operation procedure>

Monitor, frequency setting mode (MODE) ⇨ Turn setting dial to make correction. ⇨ Press (SET) key to complete setting.*

* When you have set "1" in Pr. 53 "frequency setting operation selection", you need not press the (SET) key.

<Setting>

Pr. 59 Setting	Operation	
	Remote setting function	Frequency setting storage function (E^2PROM)
0	No	——
1	Yes	Yes
2	Yes	No

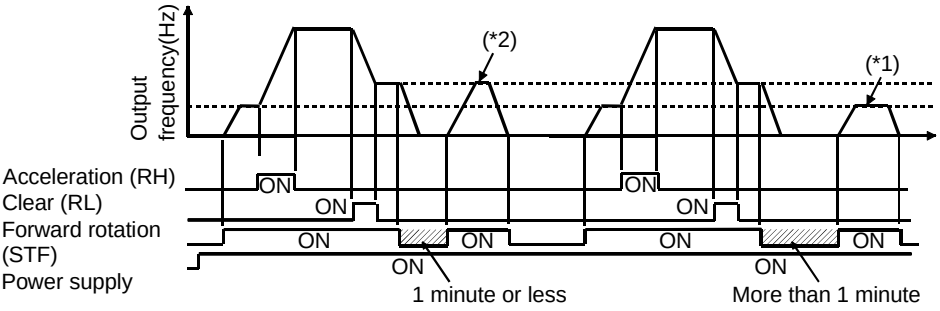
- Use Pr. 59 to select whether the remote setting function is used or not and whether the frequency setting storage function* in the remote setting mode is used or not. When "remote setting function - yes" is selected, the functions of terminals RH, RM and RL are changed to acceleration (RH), deceleration (RM) and clear (RL).
  Use Pr. 60 to Pr. 62 (input terminal function selection) to set the signals RH, RM, RL.
  * Frequency setting storage function
    The remote setting frequency (frequency set by RH/RM operation) is stored in memory.
    When power is switched off once and then on again, the inverter resumes running at this setting of output frequency. (Pr. 59="1")

<Frequency setting storage conditions>

- Frequency as soon as the start signal (STF or STR) turns off.
- Frequency when the RH (acceleration) or RM (deceleration) signal has remained off for longer than 1 minute.

REMARKS

A restart (STF signal ON) after ON-OFF of the clear signal (RL) should be made after more than 1 minute has elapsed. The output frequency provided when a restart is made within 1 minute is the output frequency given after the clear signal (RL) is turned off (multi-speed frequency).



(*1) External operation frequency or PU operation frequency except multi-speed
(*2) Multi-speed frequency

CAUTION

- The frequency can be varied by RH (acceleration) and RM (deceleration) between 0 and the maximum frequency (Pr. 1 setting).
- When the acceleration or deceleration signal switches on, the set frequency varies according to the slope set in Pr. 44 "second acceleration/deceleration time" or Pr. 45 "second deceleration time". The output frequency acceleration and deceleration times are as set in Pr. 7 "acceleration time" and Pr. 8 "deceleration time", respectively. Therefore, the longer preset times are used to vary the actual output frequency.
- If the start signal (STF or STR) is off, turning on the acceleration (RH) or deceleration (RM) signal varies the preset frequency.

⚠ CAUTION

⚠ When selecting this function, re-set the maximum frequency according to the machine.

♦Related parameters♦

• Maximum frequency setting ⇒ Pr. 1 "maximum frequency" (refer to page 59)
• Output frequency acceleration/deceleration time ⇒ Pr. 7 "acceleration time", Pr. 8 "deceleration time" (refer to page 62)
• Time setting for acceleration/deceleration ⇒ Pr. 44 "second acceleration/deceleration time", Pr. 45 "second deceleration time" (refer to page 62)

2.9 Terminal Function Selection Parameters

2.9.1 Input terminal function selection P60 P61 P62 P63

Use these parameters to select/change the input terminal functions.

Parameter	Name	Factory Setting	Setting Range	Remarks
60	RL terminal function selection	0	0 to 10, 14, 16	Setting is enabled when Pr. 30 = "1"
61	RM terminal function selection	1		
62	RH terminal function selection	2		
63	STR terminal function selection	- - -	0 to 10, 14, 16, - - -	

<Setting>

Refer to the following table and set the parameters:

Setting	Signal Name	Functions		Related Parameters
0	RL	Pr. 59 = "0"	Low-speed operation command	Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 80 to Pr. 87
		Pr. 59 = "1", "2" (*1)	Remote setting (setting clear)	Pr. 59
1	RM	Pr. 59 = "0"	Middle-speed operation command	Pr. 4 to Pr. 6, Pr.24 to Pr. 27, Pr.80 to Pr. 87
		Pr. 59 = "1", "2" (*1)	Remote setting (deceleration)	Pr. 59
2	RH	Pr. 59 = "0"	High-speed operation command	Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 80 to Pr. 87
		Pr. 59 = "1", "2" (*1)	Remote setting (acceleration)	Pr. 59
3	RT	Second function selection		Pr. 44 to Pr. 47
4	AU	Current input selection		——
5	STOP	Start self-holding selection		——
6	MRS	Output shut-off stop		——
7	OH	External thermal relay input (*2) The inverter stops when the externally provided overheat protection thermal relay, motor's embedded temperature relay etc. is actuated.		Refer to page 140.
8	REX	15-speed selection (combination with 3 speeds RL, RM, RH) (*3)		Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 80 to Pr. 87
9	JOG	Jog operation selection		Pr. 15, Pr. 16
10	RES	Reset		Pr. 75
14	X14	PID control presence/absence selection		Pr. 88 to Pr. 94
16	X16	PU-external operation switch-over		Pr. 79 (setting: 8)
- - -	STR	Reverse rotation start		(can be assigned to STR terminal (Pr. 63) only)

*1 When Pr. 59 = "1 or 2", the functions of the RL, RM and RH signals change as listed above.

*2 Actuated when the relay contact "opens".

*3 When using the REX signal, an external command cannot be used to make a reverse rotation start.

REMARKS

- One function can be assigned to two or more terminals. In this case, the function is activated when one of the multiple terminals used for assignment turns on.
- The speed command priorities are higher in order of jog, multi-speed setting (RH, RM, RL, REX) and AU.
- Use common terminals to assign multi-speeds (7 speeds) and remote setting. They cannot be set individually.
  (Common terminals are used since these functions are designed for speed setting and need not be set at the same time.)

2.9.2 Output terminal function selection P64 P65

You can change the functions of the open collector and contact output terminals.

Parameter	Name	Factory Setting	Setting Range	Remarks
64	RUN terminal function selection	0	0, 1, 3, 4, 11 to 16, 98, 99	Setting is enabled when Pr. 30 = "1"
65	A, B, C terminal function selection	99		

<Setting>

Setting	Signal Name	Function	Operation	Parameters Referred to
0	RUN	Inverter running	Output during operation when the inverter output frequency rises to or above the starting frequency.	Pr. 2, Pr.13
1	SU	Up to frequency	Output when the output frequency is reached.	Pr. 41
3	OL	Overload alarm	Output while stall prevention function is activated.	Pr. 21, Pr. 22, Pr. 23, Pr. 28
4	FU	Output frequency detection	Output when the output frequency rises to or above the setting.	Pr. 42, Pr. 43
11	RY	Inverter operation ready	Output when the inverter is ready to be started by switching the start signal on.	—
12	Y12	Output current detection	Output when the output current rises to or above the setting.	Pr. 48, Pr. 49
13	Y13	Zero current detection	Output when the output current reaches 0.	Pr. 50, Pr. 51
14	FDN	PID lower limit	Outputs the detection signal under PID control.	Pr. 88 to Pr. 94
15	FUP	PID upper limit		
16	RL	PID forward-reverse rotation output		
98	LF	Minor fault output	Output when a minor fault (fan failure or communication error warning) occurs.	Pr. 76, Pr. n5
99	ABC	Alarm output	Output when the inverter's protective function is activated to stop the output (major fault).	—

REMARKS

The same function may be set to more than one terminal.

2.10 Operation Selection Function Parameters

2.10.1 Retry function P66 P67 P68 P69

When any protective function (major fault) is activated and the inverter stops its output, the inverter itself resets automatically and performs retries. You can select whether retry is made or not, alarms reset for retry, number of retries made, and waiting time.

Parameter	Name	Factory Setting	Setting Range	Remarks
66	Retry selection	0	0 to 3	Setting is enabled when Pr. 30 = "1"
67	Number of retries at alarm occurrence	0	0, 1 to 10, 101 to 110	
68	Retry waiting time	1s	0.1 to 360s	
69	Retry count display erase	0	0	

<Setting>

• Use Pr. 66 to choose the protective functions (major failures) for retries.

Pr. 66 Setting	Protective Functions (Major Failures) for Retries												
	OCT	OVT	THM	THT	FIN	GF	OHT	OLT	PE	PUE	RET	CPU	OPT
0	●	●	●	●		●	●	●	●				●
1	●												
2		●											
3	●	●											

* ● Indicates the retry items selected. (OCT denotes any of OC1 to OC3 and OVT any of OV1 to OV3.)

• Use Pr. 67 to set the number of retries at alarm occurrence.

Pr. 67 Setting	Number of Retries	Alarm Signal Output
0	Retry is not made.	———
1 to 10	1 to 10 times	Not output every time *
101 to 110	1 to 10 times	Output every time

* If the retry count is exceeded, " rET " (retry count excess) is displayed.

• Use Pr. 68 to set the waiting time from when an inverter alarm occurs until a restart in the range 0.1 to 360s.

• Reading the Pr. 69 value provides the cumulative number of successful restart times made by retry. The setting of "0" erases the cumulative number of times.

CAUTION

- The cumulative number in Pr. 69 is incremented by "1" when retry operation is regarded as successful, i.e. when normal operation is continued without the protective function (major fault) activated during a period four times longer than the time set in Pr. 68.
- If the protective function (major fault) is activated consecutively within a period four times longer than the above waiting time, the control panel may show data different from the most recent data or the parameter unit (FR-PU04) may show data different from the first retry data. The data stored as the error reset for retry is only that of the protective function (major fault) which was activated the first time.
- When an inverter alarm is reset by the retry function at the retry time, the stored data of the electronic overcurrent protection, etc. are not cleared. (Different from the power-on reset.)

⚠ CAUTION

⚠ When you have selected the retry function, stay away from the motor and machine unless required. They will start suddenly (after the reset time has elapsed) after occurrence of an alarm.
When you have selected the retry function, apply in easily visible places the CAUTION seals supplied to the instruction manual (basic).

2.10.2 PWM carrier frequency P70 P72

You can change the motor sound.

Parameter	Name	Factory Setting	Setting Range	Remarks
70	Soft-PWM setting	1	0, 1	Setting is enabled when Pr. 30 = "1"
72	PWM frequency selection	1	0 to 15	

REMARKS

- By parameter setting, you can select Soft-PWM control which changes the motor tone.
- Soft-PWM control changes motor noise from a metallic tone into an unoffending complex tone.

<Setting>

Parameter Number	Setting	Description
70	0	Soft-PWM invalid
	1	When any of "0 to 5" is set in Pr. 72, Soft-PWM is made valid.
72	0 to 15	PWM carrier frequency can be changed. The setting displayed is in [kHz]. Note that 0 indicates 0.7kHz and 15 indicates 14.5kHz.

REMARKS

- An increased PWM frequency will decrease motor noise but noise and leakage current will increase. Take proper action (Refer to pages 18).
- Metallic sound may be generated from the motor at sudden deceleration but it is not a fault.

2.10.3 Applied motor Pr. 71

Set the motor used.

POINT

- When using the Mitsubishi constant-torque motor, set "1" in Pr. 71 for either V/F control or automatic torque boost control.
  The electronic overcurrent protection is set to the thermal characteristic of the constant-torque motor.
- When you selected the Mitsubishi constant-torque motor, the values of the following parameters are automatically changed. (For factory settings only)
  Pr. 0 "torque boost", Pr. 12 "DC injection brake voltage", Pr. 46 "second torque boost"

Parameter	Name	Factory Setting	Setting Range	Remarks
71	Applied motor	0	0, 1	Setting is enabled when Pr. 30 = "1"

<Setting>

Refer to the following list and set this parameter according to the motor used.

Pr. 71 Setting	Electronic Overcurrent Protection Thermal Characteristic
0	Thermal characteristics matching a standard motor
1	Thermal characteristics matching the Mitsubishi constant-torque motor

⚠ CAUTION

⚠ Set this parameter correctly according to the motor used.
Incorrect setting may cause the motor to overheat and burn.

2.10.4 Voltage input selection Pr. 73

You can change the input (terminal 2) specifications in response to the frequency setting voltage signal. When entering 0 to 10VDC, always make this setting.

Parameter	Name	Factory Setting	Setting Range	Remarks	
73	0-5V/0-10V selection	0	0, 1	Terminal 2 input voltage 0: 0-5VDC input 1: 0-10VDC input	Setting is enabled when Pr. 30 = "1"

CAUTION

- The acceleration/deceleration time, which is a slope up/down to the acceleration/deceleration reference frequency, is not affected by the change in Pr. 73 setting.
- When connecting a frequency setting potentiometer across terminals 10-2-5 for operation, always set "0" in this parameter.

2.10.5 Input filter time constant P74

You can set the input section's built-in filter constant for an external voltage or current frequency setting signal.

● Effective for eliminating noise in the frequency setting circuit.

Parameter	Name	Factory Setting	Setting Range	Remarks
74	Input filter time constant	1	0 to 8	Setting is enabled when Pr. 30 = "1"

REMARKS

Increase the filter time constant if steady operation cannot be performed due to noise. A larger setting results in slower response. (The time constant can be set between approximately 1ms to 1s with the setting of 0 to 8. A larger setting results in a larger filter time constant.)

2.10.6 Reset selection/PU stop selection P75

You can make reset input acceptance selection and choose the stop function from the operation panel (PU).

● Reset selection : You can choose the reset function input (RES signal) timing.

● PU stop selection: When an alarm etc. occurs in any operation mode, you can make a stop from the operation panel by pressing the (STOP RESET) key.

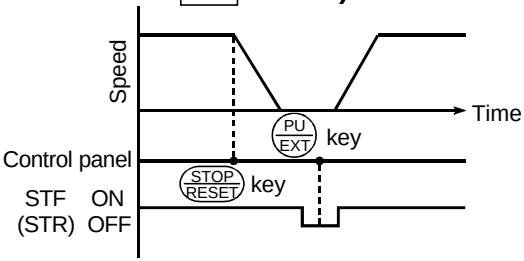
Parameter	Name	Factory Setting	Setting Range	Remarks
75	Reset selection/ PU stop selection	14	0, 1, 14, 15	Setting is enabled when Pr. 30 = "1"

<Setting>

Pr. 75 Setting	Reset Selection	PU Stop Selection
0	Reset input normally enabled.	The PU stop key is invalid. Note that the (STOP RESET) key is valid only in the PU operation mode or combined operation mode (Pr. 79 = "4").
1	Enabled only when the protective function is activated.	
14	Reset input normally enabled.	Pressing the (STOP RESET) key decelerates the inverter to a stop in any of the PU, external and communication operation modes.
15	Enabled only when the protective function is activated.	

(1) How to make a restart after a stop by the STOP/RESET key input from the operation panel (Restarting method with PS shown)

1) After completion of deceleration to a stop, switch off the STF or STR signal.
2) Press the PU/EXT key to show PU. ..... (PS canceled)
3) Press the PU/EXT key to return to EXT.
4) Switch on the STF or STR signal.



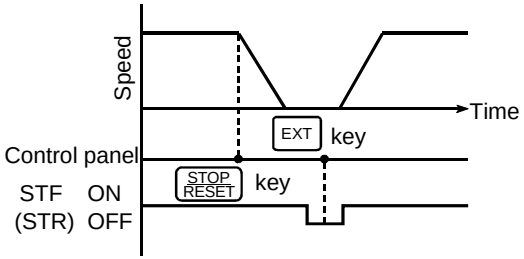
Stop and restart example for external operation

REMARKS

- By entering the reset signal (RES) during operation, the inverter shuts off its output while it is reset, the internal thermal summation value of the electronic overcurrent protection and the number of retries are reset, and the motor coasts.
- The Pr. 75 value can be set any time. Also, if parameter (all) clear is executed, this setting will not return to the initial value.
- When the inverter is stopped by the PU stop function, the display alternates between PS and 0.0. An alarm is not output.

(2) How to make a restart when a stop is made by the STOP/RESET key input from the PU

1) After completion of deceleration to a stop, switch off the STF or STR signal.
2) Press the EXT key . ..... (PS canceled)
3) Switch on the STF or STR signal.



Stop and restart example for external operation

Besides the above operations, a restart can be made by performing a power-on reset or resetting the inverter with the inverter's reset terminal.

REMARKS

- By entering the reset signal (RES) during operation, the inverter shuts off output while it is reset, the data of the electronic overcurrent protection and regenerative brake duty are reset, and the motor coasts.
- To resume operation, reset the inverter after confirming that the PU is connected securely.
- The Pr. 75 value can be set any time. Also, if parameter (all) clear is executed, this setting will not return to the initial value.
- When the inverter is stopped by the PU stop function, PS is displayed but an alarm is not output.

⚠ CAUTION

Do not reset the inverter with the start signal on.
Otherwise, the motor will start instantly after resetting, leading to potentially hazardous conditions.

2.10.7 Cooling fan operation selection P76

You can control the operation of the cooling fan built in the inverter (whether there is a cooling fan or not depends on the model.).

Parameter	Name	Factory Setting	Setting Range	Remarks	
76	Cooling fan operation selection	1	0, 1	0: Operation is performed with power on. 1: Cooling fan ON/OFF control	Setting is enabled when Pr. 30 = "1"

<Setting>

Setting	Description
0	Operated at power on (independent of whether the inverter is running or at a stop).
1	Cooling fan ON/OFF control valid ● Always on during inverter operation ● During stop (reset or error), the inverter status is monitored and the fan is switched on/off according to the temperature. • Heat sink temperature is less than 40ºC (104ºF) .....Cooling fan off • Heat sink temperature is not less than 40ºC (104ºF) .....Cooling fan on

REMARKS

In either of the following cases, fan operation is regarded as faulty, Fn is shown on the control panel, and the minor fault (LF) signal is output. Use any of Pr. 64, Pr. 65 (output terminal function selection) to allocate the terminal used to output the LF signal.

- Pr. 76 = "0"
  When the fan comes to a stop with power on.
- Pr. 76 = "1"
  When the inverter is running and the fan stops during fan ON command or the fan starts during fan OFF command.

CAUTION

When the terminal assignment is changed using Pr. 64, Pr. 65, the other functions may be affected. Confirm the functions of the corresponding terminals before making settings.

2.10.8 Parameter write inhibit selection P77

You can select between write-enable and disable for parameters. This function is used to prevent parameter values from being rewritten by incorrect operation.

Parameter	Name	Factory Setting	Setting Range	Remarks
77	Parameter write disable selection	0	0, 1, 2	Setting is enabled when Pr. 30 = "1"

<Setting>

Pr. 77 Setting	Function
0	Parameter values may only be written during a stop in the PU operation mode. (*)
1	Write disabled. Values of Pr. 22, Pr. 30, Pr. 75, Pr. 77 and Pr. 79 can be written.
2	Write can be performed during operation. Write can be performed independently of the operation mode.

CAUTION

- * The parameters * screened in the parameter list can be set at any time. Note that the Pr. 70 and Pr. 72 values may be changed during PU operation only.
- If Pr. 77 = 2, the values of Pr. 17, Pr. 23, Pr. 28, Pr. 60 to Pr. 63, Pr. 71, Pr. 79, Pr. 98, Pr. 99, CLr cannot be written during operation. Stop operation when changing their parameter settings.
- By setting "1" in Pr. 77, the following clear operations can be inhibited:
  - Parameter clear
  - All clear

2.10.9 Reverse rotation prevention selection P78

This function can prevent any reverse rotation fault resulting from the incorrect input of the start signal.

POINT

Used for a machine which runs only in one direction, e.g. fan, pump.
(The setting of this function is valid for the combined, PU, external and communication operations.)

Parameter	Name	Factory Setting	Setting Range	Remarks
78	Reverse rotation prevention selection	0	0, 1, 2	Setting is enabled when Pr. 30 = "1"

<Setting>

Pr. 78 Setting	Function
0	Both forward and reverse rotations allowed
1	Reverse rotation disallowed
2	Forward rotation disallowed

2.10.10 Operation mode selection P79

Used to select the operation mode of the inverter.
The inverter can be run from the control panel or parameter unit (PU operation), with external signals (external operation), or by combination of PU operation and external operation (external/PU combined operation).
The inverter is placed in the external operation mode at power-on (factory setting).

Parameter	Name	Factory Setting	Setting Range
79	Operation mode selection	0	0 to 4, 7, 8

<Setting>

In the following table, operation using the control panel or parameter unit is abbreviated to PU operation.

<table>
<tr><th rowspan="2">Pr. 79 Setting</th><th rowspan="2">Function</th><th colspan="3">LED Indication * RUN / PU / EXT</th></tr>
<tr><th>RUN</th><th>PU</th><th>EXT</th></tr>
<tr><td>0</td><td colspan="2">At power-on, the inverter is put in the external operation mode. The operation mode can be changed between the PU and external operation modes from the operation panel (PU/EXT key) or parameter unit (PU / EXT key). For each mode, refer to the columns of settings 1 and 2.</td><td rowspan="6">Off: Stop without start command
Forward rotation: On
Reverse rotation: Slow flickering
With start command / Without frequency setting: Fast flickering</td><td colspan="2">Refer to settings "1" and "2".</td></tr>
<tr><td>1</td><td>PU operation mode</td><td>Setting from operation panel or FR-PU04 (RUN key)</td><td>On (Off)</td><td>Off</td></tr>
<tr><td>2</td><td>External operation mode</td><td>External signal input (across terminals 2(4)-5, multi-speed selection, jog)</td><td>Off</td><td>On</td></tr>
<tr><td>3</td><td>External/ PU combined operation mode 1</td><td>Dial of operation panel, digital setting by parameter unit key operation, or external signal input (multi-speed setting, across terminals 4-5 (valid when AU signal is on))</td><td>On</td><td>On</td></tr>
<tr><td>4</td><td>External/ PU combined operation mode 2</td><td>External signal input (across terminals 2(4)-5, multi-speed selection, jog)</td><td colspan="2">(RUN key)</td></tr>
<tr><td>7</td><td colspan="2">External operation mode (PU operation interlock)
MRS signal ON ... Able to be switched to PU operation mode (output stop during external operation)
MRS signal OFF .. Switching to PU operation mode inhibited</td><td colspan="2" rowspan="2">Refer to settings "1" and "2".</td></tr>
<tr><td>8</td><td colspan="2">Operation mode change using external signal (disallowed during operation)
X16 signal ON ..... Switched to external operation mode
X16 signal OFF.... Switched to PU operation mode</td><td></td></tr>
</table>

REMARKS

Either "3" or "4" may be set to select the PU/external combined operation. These settings differ in starting method.

In case of the type having the RS-485 communication function, refer to page 116 for the computer link operation mode.

*1. When the FR-PU04 is connected, the LED indication (PU, EXT) is not lit.

*2. The LED indication (PU, EXT) flickers in the computer link operation mode.

*3. Lit when the operation panel is used. Extinguished when the FR-PU04 is used.

(1) PU operation interlock

PU operation interlock forces the operation mode to be changed to the external operation mode when the MRS signal switches off. This function prevents the inverter from being inoperative by the external command if the mode is accidentally left unswitched from the PU operation mode.

1) Preparation

- Set "7" in Pr. 79 (operation mode selection).
- Set the terminal used for MRS signal input with any of Pr. 60 to Pr. 63 (input terminal function selection).
  Refer to page 88 for Pr. 60 to Pr. 63 (input terminal function selection).

REMARKS

When terminal assignment is changed using Pr. 60 to Pr. 63, the other functions may be affected.
Check the functions of the corresponding terminals before making settings.

2) Function

MRS Signal	Function/Operation
ON	Output stopped during external operation. Operation mode can be switched to PU operation mode. Parameter values can be rewritten in PU operation mode. PU operation allowed.
OFF	Forcibly switched to external operation mode. External operation allowed. Switching to PU operation mode inhibited.

<Function/operation changed by switching on-off the MRS signal>

Operating Condition		MRS Signal	Operation Mode (*2)	Operating Status	Parameter Write	Switching to PU Operation Mode
Operation mode	Status					
PU	During stop	ON → OFF (*1)	PU → External	During stop	Allowed → disallowed	Disallowed
	During operation	ON → OFF (*1)		If external operation frequency setting and start signal are entered, operation is performed in that status.	Allowed → disallowed	Disallowed
External	During stop	OFF → ON	External	During stop	Disallowed → disallowed	Allowed
		ON → OFF			Disallowed → disallowed	Disallowed
	During operation	OFF → ON		During operation → output stop	Disallowed → disallowed	Disallowed
		ON → OFF		Output stop → operation	Disallowed → disallowed	Disallowed

REMARKS

- If the MRS signal is on, the operation mode cannot be switched to the PU operation mode when the start signal (STF, STR) is on.

*1. The operation mode switches to the external operation mode independently of whether the start signal (STF, STR) is on or off.
Therefore, the motor is run in the external operation mode when the MRS signal is switched off with either of STF and STR on.

*2. Switching the MRS signal on and rewriting the Pr. 79 value to other than "7" in the PU operation mode causes the MRS signal to act as the ordinary MRS function (output stop). Also as soon as "7" is set in Pr. 79, the signal acts as the PU interlock signal.

(2) Operation mode switching by external signal

1) Preparation
Set "8" (switching to other than external operation mode) in Pr. 79.
Use any of Pr. 60 to Pr. 63 (input terminal function selection) to set the terminal used for X16 signal input.

REMARKS

When terminal assignment is changed using Pr. 60 to Pr. 63, the other functions may be affected.
Check the functions of the corresponding terminals before making settings.
For details refer to page 88.

2) Function
This switching is enabled during an inverter stop only and cannot be achieved during operation.

X16 Signal	Operation Mode
ON	External operation mode (cannot be changed to the PU operation mode)
OFF	PU operation mode (cannot be changed to the external operation mode)

P80 to P87 ➡ Refer to P 4 to P 6 (page 61).

2.10.11 PID control P88 to P94

The inverter can be used to exercise process control, e.g. flow rate, air volume or pressure.

- The voltage input signal (0 to +5V or 0 to +10V) or Pr. 93 setting is used as a set point and the 4 to 20mA DC current input signal used as a feedback value to constitute a feedback system for PID control.

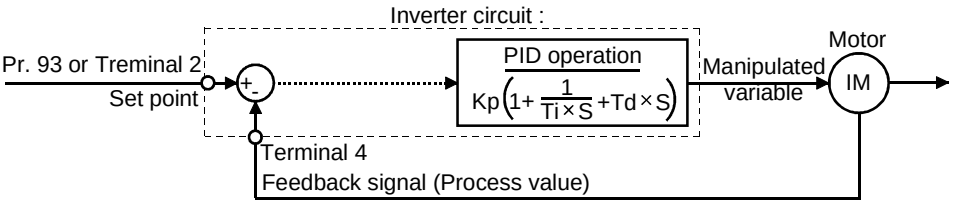
POINT

Made valid by turning on the X14 signal. Use Pr. 60 to Pr. 63 (input terminal function selection) to make assignment.

Parameter	Name	Factory Setting	Setting Range	Remarks
88	PID action selection	20	20, 21	Setting is enabled when Pr. 30 = "1"
89	PID proportional band	100%	0.1 to 999 %, - - -	
90	PID integral time	1s	0.1 to 999s, - - -	
91	PID upper limit	- - -	0 to 100%, - - -	
92	PID lower limit	- - -	0 to 100%, - - -	
93	PID action set point for PU operation	0%	0 to 100%	
94	PID differential time	- - -	0.01 to 10s, - - -	

<Setting>

(1) Basic PID control configuration



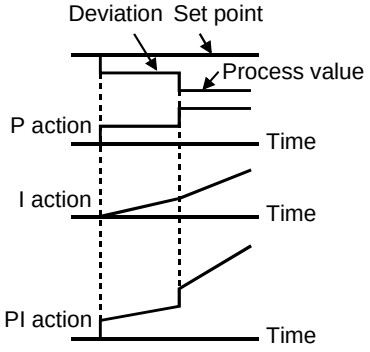
Kp: Proportion constant Ti: Integral time S: Operator Td: Differential time

(2) PID action overview

1) PI action

A combination of proportional control action (P) and integral control action (I) for providing a manipulated variable in response to deviation and changes with time.

[Operation example for stepped changes of process value]



REMARKS

PI action is the sum of P and I actions.

2) PD action

A combination of proportional control action (P) and differential control action (D) for providing a manipulated variable in response to deviation speed to improve the transient characteristic.

REMARKS

PD action is the sum of P and D actions.

3) PID action

The PI action and PD action are combined to utilize the advantages of both actions for control.

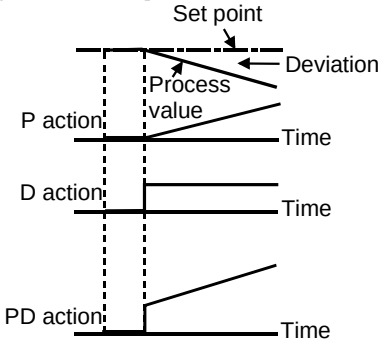
REMARKS

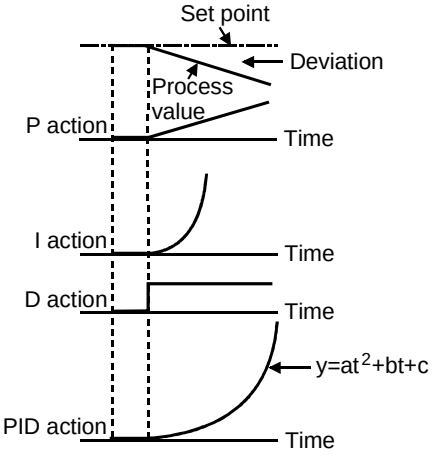
The PID action is the sum of P, I and D actions.

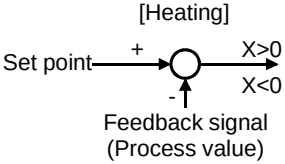
4) Reverse action

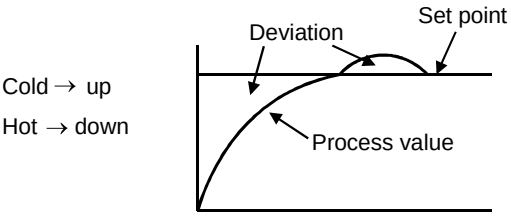
Increases the manipulated variable (output frequency) if deviation X = (set point - process value) is positive, and decreases the manipulated variable if deviation is negative.

[Operation example for proportional changes of process value]



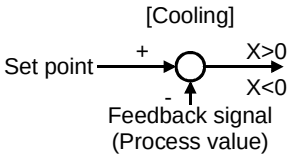






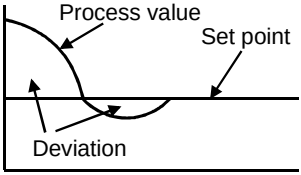
5) Forward action

Increases the manipulated variable (output frequency) if deviation X = (set point - process value) is negative, and decreases the manipulated variable if deviation is positive.



Too cold → down

Hot → up

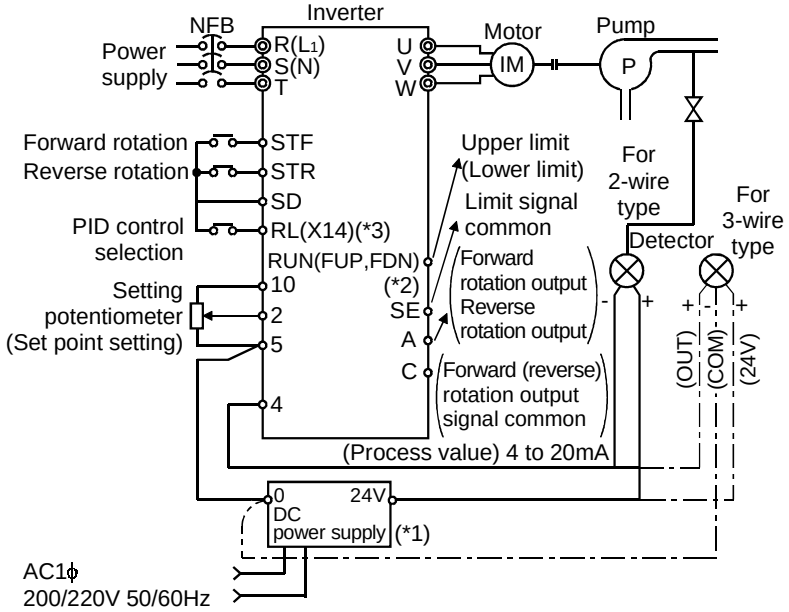


Relationships between deviation and manipulated variable (output frequency)

	Deviation	
	Positive	**Negative**
Reverse action	↗	↘
Forward action	↘	↗

(3) Wiring example

- Pr. 60 = 14
- Pr. 64 = 15
- Pr. 65 = 16
- Pr. 88 = 20



CAUTION

*1. The power supply must be selected in accordance with the power specifications of the detector used.
*2. The output signal terminals used depends on the Pr. 64, Pr. 65 settings.
*3. The input signal terminal used depends on the setting of Pr. 60 to Pr. 63.
• The contact input signal (AU Signal) need not be turned on.

(4) I/O signals

Signal		Terminal Used	Function	Description
Input	X14	Depending on Pr. 60 to Pr. 63	PID control selection	Turn on X14 to exercise PID control.
	2	2	Set point input	Enter the set point for PID control.
	4	4	Process value input	Enter the 4 to 20mADC process value signal from the detector.
Output	FUP	Depending on Pr. 64, Pr. 65	Upper limit output	Output to indicate that the process value signal exceeded the upper limit value.
	FDN		Lower limit output	Output to indicate that the process value signal exceeded the lower limit value.
	RL		Forward (reverse) rotation direction output	"Hi" is output to indicate that the output indication of the parameter unit is forward rotation (FWD) or "Low" to indicate that it is reverse rotation (REV) or stop (STOP).

- Enter the set point across inverter terminals 2-5 or in Pr. 93 and enter the process value signal across inverter terminals 4-5.
- To exercise PID control, turn on the X14 signal. When this signal is off, PID control is not exercised.

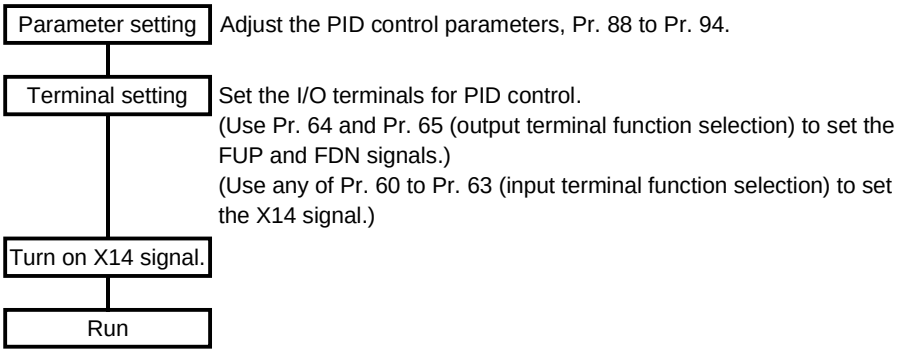
Item	Entry	Description	
Set point	Across terminals 2-5	Set 0V as 0% and 5V as 100%.	When "0" is set in Pr. 73 (5V selected for terminal 2).
		Set 0V as 0% and 10V as 100%.	When "1" is set in Pr. 73 (10V selected for terminal 2).
	Pr. 93	Set the set point (%) in Pr. 93.	
Process value	Across terminals 4-5	4mA DC is equivalent to 0% and 20mA DC to 100%.	

(5) Parameter setting

Parameter Number	Name	Setting	Description	
88	PID action selection	20	For heating, pressure control, etc.	PID reverse action
		21	For cooling, etc.	PID forward action
89	PID proportional band	0.1 to 999%	If the proportional band is narrow (parameter setting is small), the manipulated variable varies greatly with a slight change of the process value. Hence, as the proportional band narrows, the response sensitivity (gain) improves but the stability deteriorates, e.g. hunting occurs. Gain K = 1/proportional band	
		- - -	No proportional control	

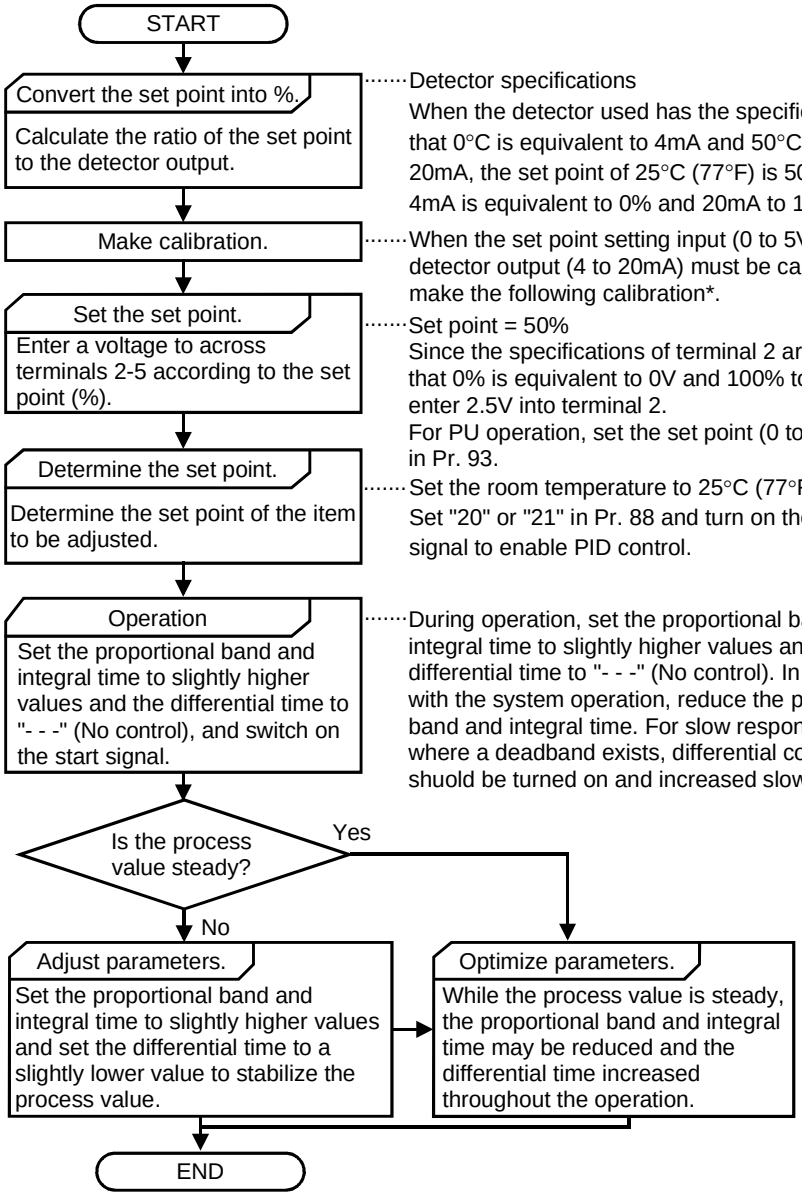
Parameter Number	Name	Setting	Description
90	PID integral time	0.1 to 999s	Time required for the integral (I) action to provide the same manipulated variable as that for the proportional (P) action. As the integral time decreases, the set point is reached earlier but hunting occurs more easily.
		- - -	No integral control.
91	PID upper limit	0 to 100%	Set the upper limit. If the feedback value exceeds the setting, the FUP signal is output. (Process value of 4mA is equivalent to 0% and 20mA to 100%.)
		- - -	No function
92	PID lower limit	0 to 100%	Set the lower limit. (If the feedback value falls below the setting, the FDN signal is output. In this case, the process value of 4mA is equivalent to 0% and 20mA to 100%.)
		- - -	No function
93	PID action set point for PU operation	0 to 100%	Valid only when Pr. 79 = "3" (n9 = 0 for computer link operation) under the PU command in the PU operation or PU/external combined mode. (When the computer has the speed command write in the computer link operation mode (NET)) For external operation, the voltage across 2-5 is the set point. (C3 value is equivalent to 0% and C4 value to 100%.)
94	PID differential time	0.01 to 10s	Time required for the differential (D) action to provide the same process value as that for the proportional (P) action. As the differential time increases, greater response is made to a deviation change.
		- - -	No differential control.

(6) Adjustment procedure



(7) Calibration example

(A detector of 4mA at 0°C (32°F) and 20mA at 50°C (122°F) is used to adjust the room temperature to 25°C (77°F) under PID control. The set point is given to across inverter terminals 2-5 (0-5V).)



*When calibration is required → Use Pr. 38 and calibration parameters C2 to C4 (terminal 2) and Pr. 39 and calibration parameters C5 to C7 (terminal 4) to calibrate the detector output and set point setting input. Make calibration in the PU mode when the inverter is at a stop.

<Set point input calibration>

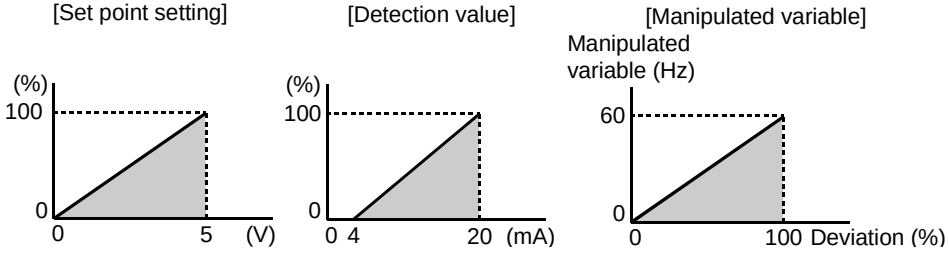
1. Apply the input voltage of 0% set point setting (e.g. 0V) across terminals 2-5.
2. Make calibration using the calibration parameters C2, C3. At this time, enter in C2 the frequency which should be output by the inverter at the deviation of 0% (e.g. 0Hz). (When using the FR-PU04, make calibration with Pr. 902.)
3. Apply the voltage of 100% set point (e.g. 5V) to across terminals 2-5.
4. Make calibration using Pr. 38 and calibration parameter C4. At this time, enter in Pr. 38 the frequency which should be output by the inverter at the deviation of 100% (e.g. 60Hz). (When using the FR-PU04, make calibration with Pr. 903.)

<Detector output calibration>

1. Apply the output current of 0% detector setting (e.g. 4mA) across terminals 4-5.
2. Make calibration using the calibration parameter C6. (When using the FR-PU04, make calibration with Pr. 904.)
3. Apply the output current of 100% detector setting (e.g. 20mA) across terminals 4-5.
4. Make calibration using the calibration parameter C7. (When using the FR-PU04, make calibration with Pr. 905.)

Note: The frequencies set in the calibration parameter C5 and Pr. 39 should be equal to those set in the calibration parameter C2 and Pr. 38, respectively.

The results of the above calibration are as shown below:



REMARKS

- If the multi-speed (RH, RM, RL) signal or jog operation (jog) signal is entered, PID control is stopped and multi-speed or jog operation is started.
- When the terminal functions are changed using Pr. 60 to Pr. 65, the other functions may be affected. Confirm the functions of the corresponding terminals before making settings.
- When PID control is selected, the minimum frequency is the frequency set in the calibration parameter C2 and the maximum frequency is the frequency set in Pr. 38. (The Pr. 1 "maximum frequency" and Pr. 2 "minimum frequency" settings are also valid.)

♦Related parameters♦

X14 signal assignment ⇒ Pr. 60 to Pr. 63 (input terminal function selection) (refer to page 88)
FUP, FDN and RL signal assignment ⇒ Pr. 64 "RUN terminal function selection", Pr. 65 "A, B, C terminal function selection" (refer to page 90)
Voltage input selection (0 to ±5V, 0 to ±10V) ⇒ Pr. 73 "0-5V/0-10V selection" (refer to page 93)
Operation mode selection ⇒ Pr. 79 "operation mode selection" (refer to page 98)
Making terminal calibration ⇒ Pr. 38, Pr. 39, C2 to C7 (calibration parameters) (refer to page 74)

2.11 Auxiliary Function Parameters

2.11.1 Slip compensation P95 P96 P97

The inverter output current may be used to assume motor slip to keep the motor speed constant.

Parameter	Name	Factory Setting	Setting Range	Remarks
95	Rated motor slip	- - -	0 to 50%, - - -	Setting is enabled when Pr. 30 = "1"
96	Slip compensation time constant	0.5s	0.01 to 10s	
97	Constant-output region slip compensation selection	- - -	0, - - -	

<Setting>

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

Parameter	Setting	Function
95	0.01 to 50%	Used to set the rated motor slip.
	0, - - -	Slip compensation is not made.
96	0.01 to 10s	Used to set the slip compensation response time. (*)
97	0	Slip compensation is not made in the constant output range (frequency range above the frequency set in Pr. 3).
	- - -	Slip compensation is made in the constant output range.

* When this value is made smaller, response will be faster.
However, as load inertia is greater, a regenerative overvoltage (OVT) error is more liable to occur.

REMARKS

When making slip compensation at 60Hz<50Hz>, set the maximum frequency to slightly higher than 60Hz<50Hz>.
In the factory setting status, it is clamped at 60Hz<50Hz>.

2.11.2 Automatic torque boost selection P98

You can choose automatic torque boost control.

● Automatic torque boost control
Not only gives the motor the optimum excitation but also provides high torque even in a low speed range.

Parameter	Name	Factory Setting	Setting Range	Remarks
98	Automatic torque boost selection (motor capacity)	- - -	0.1 to 3.7kW, - - -	Setting is enabled when Pr. 30 = "1"

<Operating conditions>

- The number of motor poles should be any of 2, 4 and 6 poles.
- Single-motor operation (One motor for one inverter)
- The wiring length from inverter to motor should be within 30m (98.42feet).

<Setting>

Parameter	Setting	Description
98	- - -	Ordinary V/F control and torque boost (Pr. 0, Pr. 46) are valid.
	0.1 to 3.7kW (*)	Automatic torque boost control valid (Set the applied motor capacity or one rank lower motor capacity.)

* The setting range changes with the inverter: 0.2kW to 3.7kW, - - - for the 400V class.

- Also when the Pr. 98 setting is other than "- - -", Pr. 3 "base frequency" and Pr. 19 "base frequency voltage" are valid.
- When "- - -" or "888" is set in Pr. 19, the rated output voltage is selected.

CAUTION

* During operation using automatic torque boost, write to Pr. 3 and Pr. 19 is disabled if "2" is set in Pr. 77.

♦Related parameters♦

- Torque boost ⇒ Pr. 0 "torque boost", Pr. 46 "second torque boost" (refer to page 58)
- Base frequency ⇒ Pr. 3 "base frequency", Pr. 19 "base frequency voltage" (refer to page 59)
- Applied motor setting ⇒ Pr. 71 "applied motor" (refer to page 93)
- Motor primary resistance ⇒ Pr. 99 "motor primary resistance" (refer to page 111)

2.11.3 Motor primary resistance P99

Generally this parameter need not be set. At the factory setting of "- - -", the standard motor constant of the motor capacity set in Pr. 98 (including that of the constant-torque motor) is used.

Parameter	Name	Factory Setting	Setting Range	Remarks
99	Motor primary resistance	- - -	0 to 50Ω, - - -	Setting is enabled when Pr. 30 = "1"

♦Related parameters♦

• Applied motor setting ⇒ Pr. 71 "applied motor" (refer to page 93)
• Automatic torque boost selection ⇒ Pr. 98 "automatic torque boost selection (motor capacity)" (refer to page 109)

2.12 Calibration Parameters

2.12.1 Meter (frequency meter) calibration C1 (Japanese version)

- By using the control panel or parameter unit, you can calibrate a analog meter connected to terminal FM to full scale deflection.
- Terminal FM provides the pulse output. By setting the calibration parameter C1, you can use the parameter to calibrate the analog meter connected to the inverter without providing a calibration resistor.

Parameter	Name	Factory Setting	Setting Range	Remarks
C1 (900)	FM terminal calibration	———	———	Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses applies to when the parameter unit (FR-PU04) is used.

Changing example Deflecting the meter (analog indicator) to full-scale (1mA) at the preset frequency of 60Hz (for frequency setting, refer to the instruction manual (basic).)

POINT

- The calibration parameters "C1" can be made to be ready by setting "1" (extended function parameter valid) in Pr. 30 "extended function display selection".
- Set the value of the calibration parameter C1 "FM terminal calibration".

Operation — Display

In PU operation mode

1. Press the MODE key to choose the parameter setting mode.

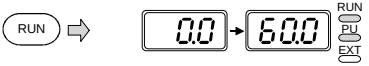
2. Turn the setting dial to show "C . . ".
   - Pr. 30 must be set to "1". (For details, refer to the instruction manual (basic).)

3. Press the SET key to show "C - ".

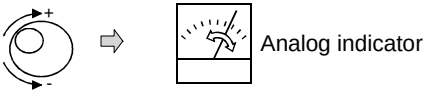
4. Turn the setting dial until the calibration parameter C1 "FM terminal calibration" appears.

5. Press the SET key to enable setting.

6. If the inverter is at a stop, press the RUN key to start it. (The motor need not be connected.)



7. Turn the setting dial to adjust the indicator needle to the desired position.



8. Press the SET key. Setting is complete.

Flicker ... Parameter setting complete!!

- By turning the setting dial, you can read another parameter.
- Press the SET key to return to the C - indication (step 3).
- Press the SET key twice to show the next parameter (CLr).

REMARKS

- Depending on the set value, it may take some for the needle to move.
- If "1" is set in Pr. 30 "extended function display selection", the calibration parameter C1 "FM terminal calibration" can also be set in the external operation mode.
- C1 is factory-set to 1mA full-scale or 1440 pulses/s FM output frequency at 60Hz. The maximum pulse train output of terminal FM is 2400 pulses/s.
- When a frequency meter is connected across terminals FM-SD to monitor the running frequency, the FM terminal output is filled to capacity at the factory setting if the maximum output frequency reaches or exceeds 100Hz. In this case, the Pr. 55 setting must be changed to the maximum frequency.
- When the FR-PU04 is used, make calibration with Pr. 900.

POINT

By setting the Pr. 54 "FM terminal function selection" value, preset Pr. 55 "frequency monitoring reference" or Pr. 56 "current monitoring reference" to the running frequency or current value at which the output signal is 1440 pulses/s.
At 1440 pulses/s, the meter generally deflects to full-scale.

2.12.2 Meter (frequency meter) calibration C1 (NA and EC version)

The AM terminal is factory-set to provide 5VDC output in the full-scale status of each monitor item. However, calibration parameter C1 can be used to adjust the output voltage ratio (gain) according to the meter scale. Note that the maximum output voltage is 5VDC.

Parameter	Name	Factory Setting	Setting Range	Remarks
C1 (901)	AM terminal calibration	———	———	Setting is enabled when Pr. 30 = "1"

The parameter number within the parentheses applies to when the parameter unit (FR-PU04) is used.

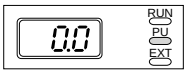
Changing example Deflecting the meter (analog indicator) to full-scale (5V) at the preset frequency of 60Hz (for frequency setting, refer to the instruction manual (basic).)

POINT

- The calibration parameters "C1" can be made to be ready by setting "1" (extended function parameter valid) in Pr. 30 "extended function display selection".
- Set the value of the calibration parameter C1 "AM terminal calibration".

Operation — Display

1. Confirm the RUN indication and operation mode indication.
   ● The inverter must be at a stop.



2. Press the (MODE) key to choose the parameter setting mode.

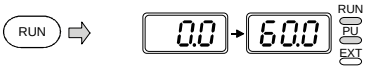
3. Turn the setting dial to show "C . . ".
   ● Pr. 30 must be set to "1".
   (For details, refer to the instruction manual (basic)).

4. Press the (SET) key to show "C -".

5. Turn the setting dial until the calibration parameter C1 "AM terminal calibration" appears.

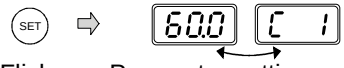
6. Press the (SET) key to enable setting.

7. Press the (RUN) key to start the inverter. (The motor need not be connected.)



8. Turn the setting dial to adjust the indicator needle to the desired position.

9. Press the (SET) key. Setting is complete.



Flicker ... Parameter setting complete!!

- By turning the setting dial, you can read another parameter.
- Press the (SET) key to return to the C - indication (step 4).
- Press the (SET) key twice to show the next parameter (CLr).

REMARKS

- Depending on the set value, it may take some for the needle to move.
- If "1" is set in Pr. 30 "extended function display selection", the calibration parameter C1 "AM terminal calibration" can also be set in the external operation mode.
- When the FR-PU04 is used, make calibration with Pr. 901.

POINT

By setting the Pr. 54 "AM terminal function selection" value, preset Pr. 55 "frequency monitoring reference" or Pr. 56 "current monitoring reference" to the running frequency or current value at which the output signal is 5V.
At 5V, the meter generally deflects to full-scale.

♦Related parameters♦

- Choosing signal to be output to FM (AM) terminal ⇒ Pr. 54 "FM (AM) terminal function selection" (refer to page 82)
- Reference values of frequency and current values ⇒ Pr. 55 "frequency monitoring reference", Pr. 56 "current monitoring reference" (refer to page 84)

C2 to C7 ➡ Refer to P38, P39 (page 74).

2.13 Clear Parameters

2.13.1 Parameter clear CLr

Initializes the parameter values to the factory settings.
Clear the parameters during a stop in the PU operation mode.

Parameter	Name	Factory Setting	Setting Range	Remarks	
CLr	Parameter clear	0	0, 1, 10	0: Clear is not executed. 1: Parameter clear *1 (Calibration parameters C1 to C7 are not cleared) 10: All clear *2 (All settings including those of the calibration parameters C1 to C7 return to factory settings)	Setting is enabled when Pr. 30 = "1"

*1 Parameters are not cleared by setting "1" in Pr. 77 "parameter write disable selection".
Pr. 75 "reset selection/PU stop selection", Pr. 38, Pr. 39, Pr. 53, Pr. 60 to Pr. 65, Pr. 99, calibration parameters C1 to C7 and communication parameters n13, n15 are not cleared.

*2 Pr. 75 "reset selection/PU stop selection" and communication parameter n13 "PU language switching" are not cleared.

REMARKS

For details of the operation procedure, refer to the instruction manual (basic).

2.13.2 Alarm history clear ECL

Erases the alarm history.

Parameter	Name	Factory Setting	Setting Range	Remarks	
ECL	Alarm history clear	0	0, 1	0: Not cleared 1: Alarm history clear	Setting is enabled when Pr. 30 = "1"

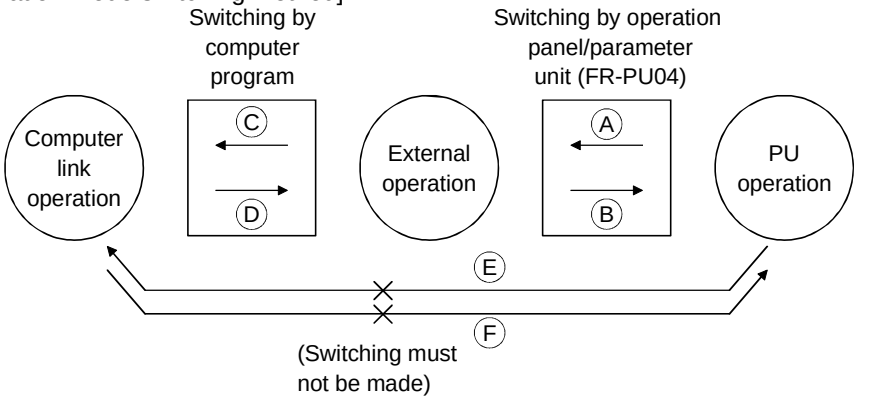
2.14 Communication Parameters (Only for the type having the RS-485 communication function)

You can perform communication operation from the RS-485 connector of the inverter through RS-485.

(1) Operational functions

1) Operation mode switching

[Operation mode switching method]



Symbol	Switching Type	Switching Method		
Ⓐ	PU operation to external operation	Using the PU/EXT key of the operation panel or PU/EXT key of the parameter unit (FR-PU04)		
Ⓑ	External operation to PU operation	Using the PU/EXT key of the operation panel or PU/EXT key of the parameter unit (FR-PU04)		
Ⓒ	External operation to computer link operation	Using the computer program	Read (H7B)/ Write (HFB)	H0000: Communication operation H0001: External operation
Ⓓ	Computer link operation to external operation	Using the computer program		
Ⓔ	PU operation to computer link operation	Switching must not be made (External operation may be selected at Ⓐ and then switched to computer link operation at Ⓒ*)		
Ⓕ	Computer link operation to PU operation	Switching must not be made (External operation may be selected at Ⓓ and then switched to PU operation at Ⓑ*)		

* When "1" is set in the communication parameter n10 "link start mode selection", the inverter is placed in the computer link operation mode at power-on or inverter reset. (Note that it is overridden by the Pr. 79 "operation mode selection" setting.)

REMARKS

Unlike the other inverters, the FR-S500 series is not the type of inverter whose operation panel is removed to make communication.

When the setup software is used to switch to the PU operation mode (Pr. 79 = 1, 3, 4), parameter setting cannot be made. At that time, pressing the RUN key of the operation panel starts the inverter.

2) Operation mode-based functions

Operation Location	Item	Operation Mode		
		PU operation	External operation	Computer link operation
Operation panel or FR-PU04	Run command (start)	Enabled	Enabled (Combined operation mode)	Disabled
	Running frequency setting	Enabled	Enabled (Combined operation mode)	Disabled
	Monitoring	Enabled	Enabled	Enabled
	Parameter write	Enabled (*4)	Disabled	Disabled
	Parameter read	Enabled	Enabled	Enabled
	Inverter reset	Enabled	Enabled	Enabled
	Stop command	Enabled	Enabled (*3)	Enabled (*3)
On-computer user program by RS-485 communication	Run command	Disabled	Disabled	Enabled (*1)
	Running frequency setting (*)	Disabled	Disabled	Enabled (*1)
	Monitoring	Enabled	Enabled	Enabled
	Parameter write	Disabled	Disabled	Enabled (*4)
	Parameter read	Enabled	Enabled	Enabled
	Inverter reset	Disabled	Disabled	Enabled (*2)
	Stop command	Disabled	Disabled	Enabled
Control circuit external terminal	Inverter reset	Enabled	Enabled	Enabled
	Run command	Enabled (Combined operation mode)	Enabled	Enabled (*1)
	Running frequency setting	Enabled (Combined operation mode)	Enabled	Enabled (*1)

*1. As set in the communication parameters n8 "operation command write" and n9 "speed command write". (refer to page 130)
*2. At occurrence of RS-485 communication error, the inverter cannot be reset from the computer.
*3. As set in Pr. 75 "reset selection/PU stop selection".
*4. As set in Pr. 77 "parameter write disable selection".

CAUTION

* When the user program of the computer is used to make the running frequency setting by RS-485 communication, setting can be made in the minimum setting increments of 0.01Hz, but the setting may be written to the inverter in increments of 0.1Hz. (0 is written in the second decimal place.)

POINT

To make RS-485 communication between the inverter and personal computer, the operation mode must be set to the "computer link operation mode".
Pr. 79 "operation mode selection" ≠, "1, 3, 4"
and communication parameter n10 "link start mode selection" = "1"
Reset the inverter after setting the communication parameters n1, n2, n3, n4, n7, n11. The values set are registered once the inverter is reset.

2.14.1 Communication settings n1 to n3, n11

● Communication-related parameters

Parameter	Name	Factory Setting <NA, EC version>	Setting Range	Remarks	Reflection Timing
n1 (331)	Communication station number	0	0 to 31	Setting is enabled when Pr. 30 = "1"	After reset
n2 (332)	Communication speed	192	48, 96, 192		After reset
n3 (333)	Stop bit length	1	0, 1, 10, 11		After reset
n4 (334)	Parity check presence/ absence	2	0, 1, 2		After reset
n5 (335)	Number of communication retries	1	0 to 10, - - -		Immediately
n6 (336)	Communication check time interval (*1)	0s <- - -> (*2)	0, 0.1 to 999s, - - -		Immediately
n7 (337)	Wait time setting	- - -	0 to 150ms, - - -		After reset
n11 (341)	CR/LF selection	1	0, 1, 2		After reset

*1. To make communication, set any value other than 0 in the communication parameter n6 "communication check time interval".

*2. Factory setting of NA and EC versions.

- The parameter numbers within parentheses are those for use of the parameter unit (FR-PU04).
- Refer to page 177 for the instruction codes.

● Communication specifications

Item			Computer
Conforming standard			RS-485 Standard
Number of inverters connected			1:N (max. 32 inverters)
Communication speed			Selected between 19200, 9600 and 4800bps
Control protocol			Asynchronous
Communication method			Half-duplex
Communication specifications	Character system		ASCII (7 bits/8 bits) selectable
	Stop bit length		Selectable between 1 bit and 2 bits.
	Terminator		CR/LF (presence/absence selectable)
	Check system	Parity check	Selectable between presence (even/odd) and absence
		Sumcheck	Presence
Waiting time setting			Selectable between presence and absence

REMARKS

- For computer link operation, set 65520 (HFFF0) as the value "888" and 65535 (HFFFF) as the value "- - -".
- Refer to page 41 for handling the RS-485 connector.
- Refer to the "parameter data code list" (page 177) for the data codes of the parameters.

<Setting>

To make communication between the personal computer and inverter, the communication specifications must be set to the inverter initially. If initial setting is not made or there is a setting fault, data transfer cannot be made.

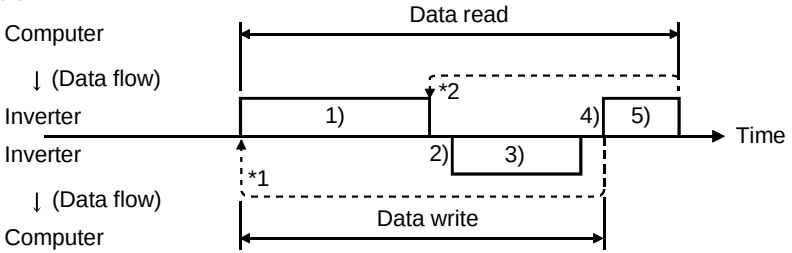
Note: After making the initial setting of the parameters, always reset the inverter. After you have changed the communication-related parameters, communication cannot be made unit the inverter is reset.

Parameter	Description	Setting		Description
n1	Communication station number	0 to 31		Station number specified for communication from the RS-485 connector. Set the inverter station numbers when two or more inverters are connected to one personal computer.
n2	Communication speed	48		4800 bps
		96		9600 bps
		192		19200 bps
n3	Stop bit length	8 bits	0	Stop bit length 1 bit
			1	Stop bit length 2 bits
		7 bits	10	Stop bit length 1 bit
			11	Stop bit length 2 bits
n4	Parity check presence/ absence	0		Absent
		1		Odd parity present
		2		Even parity present
n5	Number of communication retries	0 to 10		Set the permissible number of retries at occurrence of a data receive error. If the number of consecutive errors exceeds the permissible value, the inverter will come to an alarm stop (OPT).
		- - - (65535)		If a communication error occurs, the inverter will not come to an alarm stop. At this time, the inverter can be coasted to a stop by MRS or RES input. During a communication error (H0 to H5), the minor fault signal (LF) is switched on. Allocate the used terminal with any of Pr. 64, Pr. 65 (multi-function outputs).
n6	Communication check time interval	0		No communication
		0.1 to 999		Set the communication check time [s] interval. If a no-communication state persists for longer than the permissible time, the inverter will come to an alarm stop (OPT).
		- - -		Communication check suspension
n7	Wait time setting	0 to 150		Set the waiting time between data transmission to the inverter and response.
		- - -		Set with communication data.
n11	CR • LF selection	0		Without CR • LF
		1		With CR, without LF
		2		With CR • LF

<Computer programming>

(1) Communication protocol

Data communication between the computer and inverter is performed using the following procedure:



REMARKS

*1. If a data error is detected and a retry must be made, execute retry operation with the user program. The inverter comes to an alarm stop if the number of consecutive retries exceeds the parameter setting.

*2. On receipt of a data error occurrence, the inverter returns "reply data 3)" to the computer again. The inverter comes to an alarm stop if the number of consecutive data errors reaches or exceeds the parameter setting.

(2) Communication operation presence/absence and data format types

Communication operation presence/absence and data format types are as follows:

No.	Operation		Run Command	Running Frequency	Parameter Write	Inverter Reset	Monitor-ing	Parame-ter Read
1)	Communication request is sent to the inverter in accordance with the user program in the computer.		A'	A (A'')*1	A (A'')*2	A	B	B
2)	Inverter data processing time		Present	Present	Present	Absent	Present	Present
3)	Reply data from the inverter. (Data 1) is checked for error)	No error* (Request accepted)	C	C	C	Absent	E, E' (E'')*1	E (E'')*2
		With error (request rejected)	D	D	D	Absent	F	F
4)	Computer processing delay time		Absent	Absent	Absent	Absent	Absent	Absent
5)	Answer from computer in response to reply data 3). (Data 3) is checked for error)	No error* (No inverter processing)	Absent	Absent	Absent	Absent	G (Absent)	G (Absent)
		With error. (Inverter outputs 3) again.)	Absent	Absent	Absent	Absent	H	H

* In the communication request data from the computer to the inverter, 10ms or more is also required after "no data error (ACK)". (Refer to page 123.)

REMARKS

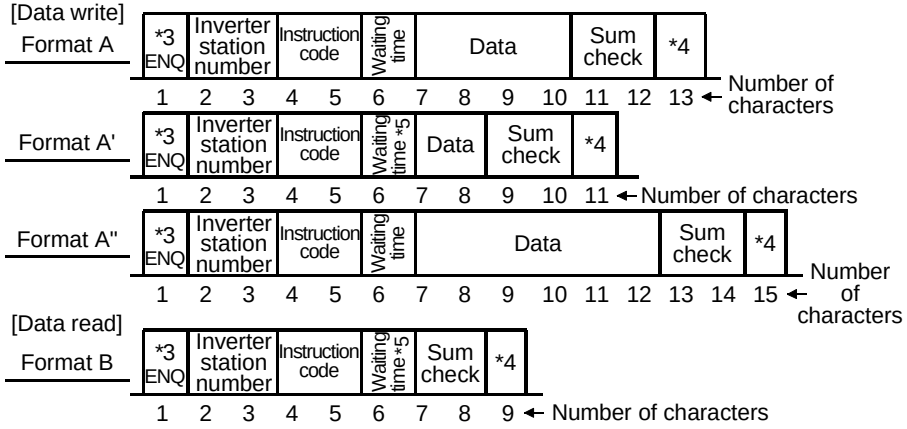
* 1. Setting any of "0.1" to "999" in Pr. 37 "speed display" and "1" in data code "HFF" sets the data format to A" or E" (6-digit data).
Also, the output frequency turns to a speed display, which is valid in 0.01r/min increments. (The third decimal place is invalid.)
If the data code "HFF" is other than "1", the display is in 1r/min increments and a 4-digit data format can be used.
Reply data is given in format E if the requested monitor data has 4 digits, in format E' if the data has 2 digits, or in format E" if the data has 6 digits.
* 2. The data format to read/write Pr. 37 "speed display" is always E"/A" (6-digit data).

(3) Data format

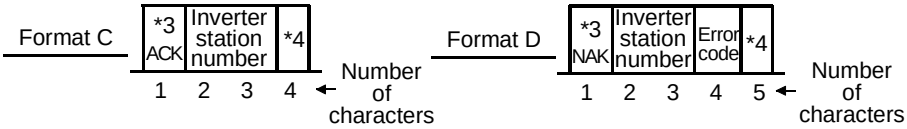
Data used is hexadecimal.
Data is automatically transferred in ASCII between the computer and inverter.

● Data format types

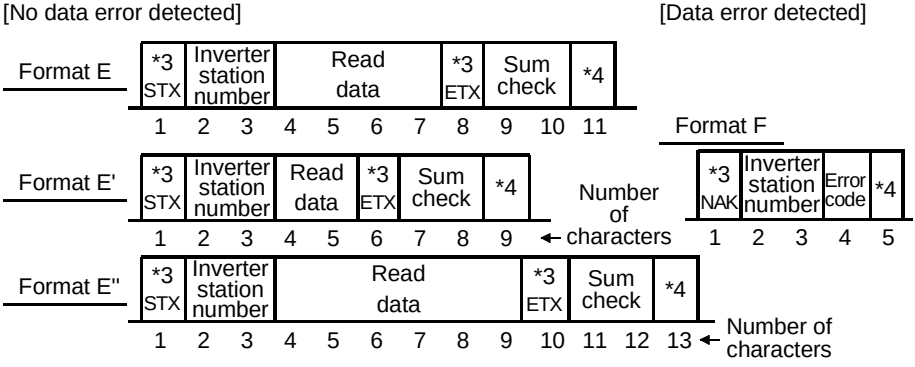
1) Communication request data from computer to inverter



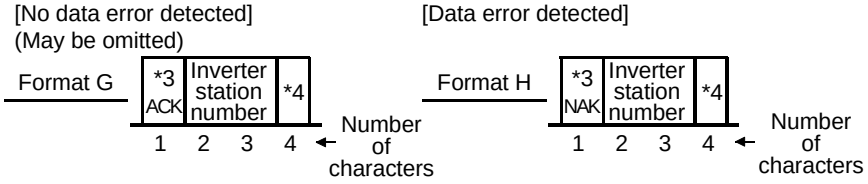
2) Reply data from inverter to computer during data write



3) Reply data from inverter to computer during data read



4) Send data from computer to inverter during data read



REMARKS

- The inverter station numbers may be set between H00 and H1F (stations 0 and 31) in hexadecimal.
- *3 indicates the control code.
- *4 indicates the CR or LF code.
  When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer.
  Also, the presence and absence of the CR and LF codes can be selected using n11.
- At *5, when communication parameter n7 "waiting time setting" ≠ - - -, create the communication request data without "waiting time" in the data format.
  (The number of characters is decremented by 1.)

(4) Data definitions

1) Control codes

Signal	ASCII Code	Description
STX	H02	Start of Text (Start of data)
ETX	H03	End of Text (End of data)
ENQ	H05	Enquiry (Communication request)
ACK	H06	Acknowledge (No data error detected)
LF	H0A	Line Feed
CR	H0D	Carriage Return
NAK	H15	Negative Acknowledge (Data error detected)

2) Inverter station number

Specify the station number of the inverter which communicates with the computer.

3) Instruction code

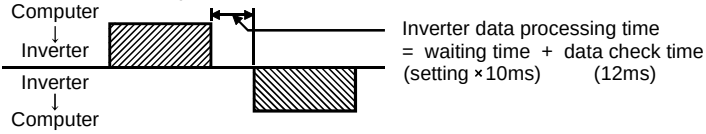
Specify the processing request, e.g. operation, monitoring, given by the computer to the inverter. Hence, the inverter can be run and monitored in various ways by specifying the instruction code as appropriate. (Refer to page 177.)

4) Data

Indicates the data such as frequency and parameters transferred to and from the inverter. The definitions and ranges of set data are determined in accordance with the instruction codes. (Refer to page 177.)

5) Waiting time

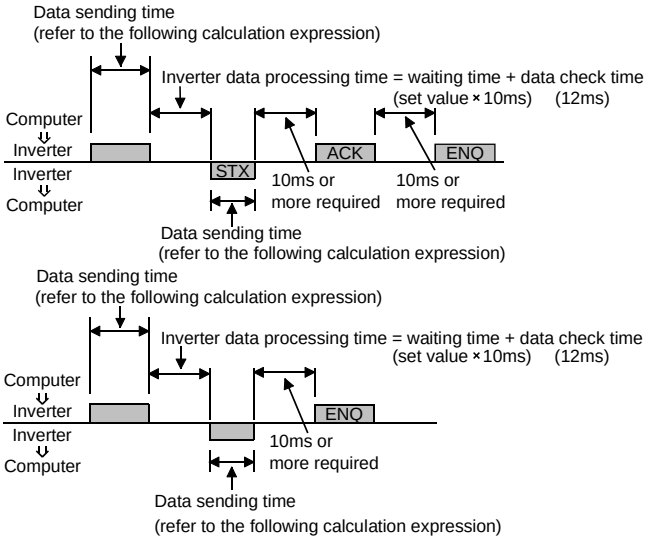
Specify the waiting time between the receipt of data at the inverter from the computer and the transmission of reply data. Set the waiting time in accordance with the response time of the computer between 0 and 150ms in 10ms increments (e.g. 1 = 10ms, 2 = 20ms).



REMARKS

When communication parameter n7 "waiting time setting" ≠, "- - -", create the communication request data without "waiting time" in the data format. (The number of characters is decremented by 1.)

6) Response time



[Data sending time calculation expression]

$$\frac{1}{\text{Communication speed (bps)}} \times \text{Number of data characters (Refer to page 121)} \times \text{Communication specification (Total number of bits) (See below)} = \text{Data sending time (s)}$$

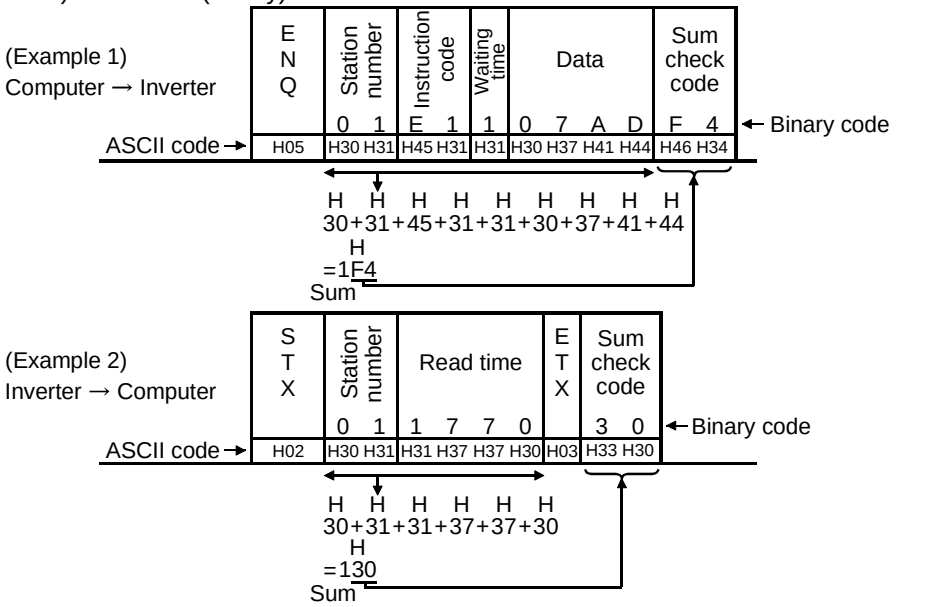
●Communication specification

Name		Number of Bits
Stop bit length		1 bit 2 bits
Data length		7 bits 8 bits
Parity check	Yes	1 bit
	No	0 bits

In addition to the bits in the above table, 1 bit is required for the start bit.
Minimum total number of bits ... 9 bits
Maximum total number of bits ... 12 bits

7) Sum check code

The sum check code is 2-digit ASCII (hexadecimal) representing the lower 1 byte (8 bits) of the sum (binary) derived from the checked ASCII data.



8) Error code

If any error is found in the data received by the inverter, its definition is sent back to the computer together with the NAK code. (Refer to page 128.)

REMARKS

1. When the data from the computer has an error, the inverter will not accept that data.
2. Any data communication, e.g. run command, monitoring, is started when the computer gives a communication request. Without the computer's command, the inverter does not return any data. For monitoring, therefore, design the program to cause the computer to provide a data read request as required.
3. When accessing the parameter settings, data for link parameter expansion setting differs between the parameters as indicated below:

		Instruction Code	Data
Link parameter expansion setting	Read	H7F	H00: Pr. 0 to Pr. 99 can be accessed. H01: Calibration parameters C1 to C7 (Pr. 900 to Pr. 905) and communication parameter n13 (Pr. 145) can be accessed. H03: Communication parameters n1 to n12 (Pr. 331 to Pr. 342) can be accessed. H09: Communication parameters n14 to n17 (Pr. 990 to Pr. 993) can be accessed.
	Write	HFF	

⚠ CAUTION

⚠ When the inverter's permissible communication time interval is not set, interlocks are provided to disable operation to prevent hazardous conditions. Always set the communication check time interval before starting operation.

⚠ Data communication is not started automatically but is made only once when the computer provides a communication request. If communication is disabled during operation due to signal cable breakage etc, the inverter cannot be stopped. When the communication check time interval has elapsed, the inverter will come to an alarm stop (OPT).
The inverter can be coasted to a stop by switching on its RES signal or by switching power off.

⚠ If communication is broken due to signal cable breakage, computer fault etc, the inverter does not detect such a fault. This should be fully noted.

<Setting items and set data>

After completion of parameter settings, set the instruction codes and data then start communication from the computer to allow various types of operation control and monitoring.

<table>
<tr><th>No.</th><th colspan="3">Item</th><th>Instruction Code</th><th>Description</th><th>Number of Data Digits (Data code FF = 1)</th></tr>
<tr><td rowspan="2">1</td><td colspan="2" rowspan="2">Operation mode</td><td>Read</td><td>H7B</td><td>H0000: Communication operation
H0001: External operation</td><td rowspan="2">4 digits</td></tr>
<tr><td>Write</td><td>HFB</td><td>H0000: Communication operation
H0001: External operation</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Monitoring</td><td colspan="2">Output frequency [speed]</td><td>H6F</td><td>H0000 to HFFFF:Output frequency (hexadecimal) in 0.01Hz increments
[Speed (hexadecimal) in r/min when Pr. 37 = "0.1 to 999"]</td><td>4 digits
(6 digits)</td></tr>
<tr><td colspan="2">Output current</td><td>H70</td><td>H0000 to HFFFF: Output current (hexadecimal) in 0.01A increments</td><td>4 digits</td></tr>
<tr><td colspan="2">Alarm definition</td><td>H74 to H75</td><td>H0000 to HFFFF: Two most recent alarm definitions
Alarm definition display example (instruction code H74)
b15 b8b7 b0
0 0 1 1 0 0 0 0 1 0 1 0 0 0 0 0
Previous alarm (H30) Most recent alarm (HA0)
Alarm data
<table>
<tr><th>Data</th><th>Description</th><th>Data</th><th>Description</th></tr>
<tr><td>H00</td><td>No alarm</td><td>H40</td><td>FIN</td></tr>
<tr><td>H10</td><td>OC1</td><td>H60</td><td>OLT</td></tr>
<tr><td>H11</td><td>OC2</td><td>H80</td><td>GF</td></tr>
<tr><td>H12</td><td>OC3</td><td>H90</td><td>OHT</td></tr>
<tr><td>H20</td><td>OV1</td><td>HA0</td><td>OPT</td></tr>
<tr><td>H21</td><td>OV2</td><td>HB0</td><td>PE</td></tr>
<tr><td>H22</td><td>OV3</td><td>HB1</td><td>PUE</td></tr>
<tr><td>H30</td><td>THT</td><td>HB2</td><td>RET</td></tr>
<tr><td>H31</td><td>THM</td><td>HC0</td><td>CPU*</td></tr>
</table>
* Error code may not be returned.</td><td>4 digits</td></tr>
<tr><td>3</td><td colspan="3">Run command</td><td>HFA</td><td>b7 b0
0 0 0 0 0 0 1 0
[For example 1]
[Example 1] H02 ... Forward rotation
[Example 2] H00 ... Stop
b0 : ———
b1 : Forward rotation (STF)
b2 : Reverse rotation (STR)*
b3 : Low speed (RL)*
b4 : Middle speed (RM)*
b5 : High speed (RH)*
b6 : ———
b7 : ———
* Function change can be made using Pr. 60 to Pr. 63 (input terminal function selection).</td><td>2 digits</td></tr>
</table>

<table>
<tr><th>No.</th><th>Item</th><th>Instruction Code</th><th>Description</th><th>Number of Data Digits (Data code FF = 1)</th></tr>
<tr><td>4</td><td>Inverter status monitor</td><td>H7A</td><td>b7 b0
0 0 0 0 0 0 1 0
[For example 1]
[Example 1] H02 ... During forward rotation
[Example 2] H80 ... Stop due to alarm
b0: Inverter running (RUN)*
b1: Forward rotation
b2: Reverse rotation
b3: Up to frequency (SU)
b4: Overload (OL)
b5: ————
b6: Frequency detection (FU)
b7: Alarm occurrence*
* Function change can be made using Pr. 64 and Pr. 65 (output terminal function selection).</td><td>2 digits</td></tr>
<tr><td rowspan="4">5</td><td>Set frequency read (E^2PROM)</td><td>H6E</td><td rowspan="2">Reads the set frequency (RAM or E^2PROM).
H0000 to H2EE0: 0.01Hz increments (hexadecimal)</td><td rowspan="2">4 digits (6 digits)</td></tr>
<tr><td>Set frequency read (RAM)</td><td>H6D</td></tr>
<tr><td>Set frequency write (RAM and E^2PROM)</td><td>HEE</td><td rowspan="2">H0000 to H2EE0: 0.01Hz increments (hexadecimal) (0 to 120.00Hz)*
To change the set frequency consecutively, write data to the inverter RAM. (Instruction code: HED)
* The minimum setting increments are 0.01Hz but setting may be made in 0.1Hz increments only.</td><td rowspan="2">4 digits (6 digits)</td></tr>
<tr><td>Set frequency write (RAM only)</td><td>HED</td></tr>
<tr><td>6</td><td>Inverter reset</td><td>HFD</td><td>H9696: Resets the inverter.
As the inverter is reset on start of communication by the computer, the inverter cannot send reply data back to the computer.</td><td>4 digits</td></tr>
<tr><td>7</td><td>Alarm definition batch clear</td><td>HF4</td><td>H9696: Alarm history batch clear</td><td>4 digits</td></tr>
<tr><td>8</td><td>All parameter clear</td><td>HFC</td><td>All parameters return to the factory settings.
Any of four different all clear operations are performed according to the data.
<table>
<tr><th>Pr. / Data</th><th>Communication Pr.</th><th>Calibration Pr.</th><th>Other Pr.*</th><th>HEC HFF</th></tr>
<tr><td>H9696</td><td>○</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>H9966</td><td>○</td><td>○</td><td>○</td><td>○</td></tr>
<tr><td>H5A5A</td><td>×</td><td>×</td><td>○</td><td>○</td></tr>
<tr><td>H55AA</td><td>×</td><td>○</td><td>○</td><td>○</td></tr>
</table>
When all parameter clear is executed for H9696 or H9966, communication-related parameter settings also return to the factory settings. When resuming operation, set the parameters again.
* Pr. 75 is not cleared.</td><td>4 digits</td></tr>
<tr><td>9</td><td>Parameter write</td><td>H80 to HFD</td><td rowspan="2">Refer to the "Data Code List" (page 177) and write and/or read the values as required.</td><td rowspan="2">4 digits</td></tr>
<tr><td>10</td><td>Parameter read</td><td>H00 to H7B</td></tr>
</table>

No.	Item		Instruction Code	Description	Number of Data Digits
11	Link parameter expansion setting	Read	H7F	H00 to H6C and H80 to HEC parameter values are changed. H00: Pr. 0 to Pr. 99 are accessible. H01: Communication parameter n13 (Pr. 145) and calibration parameters C1 to C7 (Pr. 900 to Pr. 905) are accessible. H03: Communication parameters n1 to n12 (Pr. 331 to Pr. 342) are accessible. H09: Communication parameters n14 to n17 (Pr. 990 to Pr. 993) are accessible.	2 digits
		Write	HFF		
12	Second parameter changing (Code HFF = 1)	Read	H6C	When setting the bias/gain (data codes H5E to H61, HDE to HE1) parameters H00: Frequency (*1) H01: Analog H02: Analog value of terminal (*2) *1. The gain frequencies may also be written using Pr. 38 and Pr. 39 (data codes A6 and A7). *2. When a voltage is given to the external terminal to make bias or gain calibration, the data value written is 4 digits.	2 digits
		Write	HEC		

REMARKS

For the instruction codes HFF, HEC, their set values are held once they are written, but changed to 0 when the inverter is reset or all clear is performed.

<Error Code List>

The corresponding error code in the following list is displayed if an error is detected in any communication request data from the computer:

Error Code	Item	Definition	Inverter Operation
H0	Computer NAK error	The number of errors consecutively detected in communication request data from the computer is greater than allowed number of retries.	Brought to an alarm stop (OPT) if error occurs continuously more than the allowable number of retries.
H1	Parity error	The parity check result does not match the specified parity.	
H2	Sum check error	The sum check code in the computer does not match that of the data received by the inverter.	
H3	Protocol error	Data received by the inverter is in wrong protocol, data receive is not completed within given time, or CR and LF are not as set in the parameter.	
H4	Framing error	The stop bit length is not as specified by initialization.	
H5	Overrun error	New data has been sent by the computer before the inverter completes receiving the preceding data.	
H6	———	———	———
H7	Character error	The character received is invalid (other than 0 to 9, A to F, control code).	Does not accept received data but is not brought to alarm stop.
H8	———	———	———
H9	———	———	———
HA	Mode error	Parameter write was attempted in other than the computer link operation mode or during inverter operation.	Does not accept received data but is not brought to alarm stop.
HB	Instruction code error	The specified command does not exist.	
HC	Data range error	Invalid data has been specified for parameter write, frequency setting, etc.	
HD	———	———	———
HE	———	———	———
HF	———	———	———

(5) Operation at alarm occurrence

Fault Location	Description		Operation Mode	
			Communication Operation (RS-485 connector)	External Operation
Inverter fault	Inverter operation		Stop	Stop
	Communication	RS-485 connector	Continued	Continued
Communication error (Communication from RS-485 connector)	Inverter operation		Stop/continued (*3)	Continued
	Communication	RS-485 connector	Stop	Stop

*3: Can be selected using the corresponding parameter (factory-set to stop).

(6) Communication error

Fault Location	Error Message (Operation panel)	Remarks
Communication error (Communication from RS-485 connector)	OPT	Error code is OPT

(7) Program example

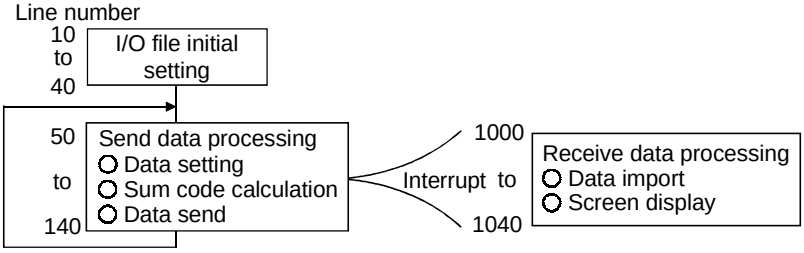
To change the operation mode to computer link operation

Program

```
Line number
  10 OPEN"COM1:9600,E,8,2,HD"AS #1        ☆ Opening the communication file
  20 COMST1,1,1:COMST1,2,1                ☆ ON/OFF setting of circuit control signals (RS, ER)
  30 ON COM(1)GOSUB*REC                   ☆ Interrupt definition for data receive
  40 COM(1)ON                             ☆ Interrupt enable
                                          [Initial setting of I/O file]

  50 D$="01FB10000"                       [Send data setting]
  60 S=0                                  [Sum code calculation]
  70 FOR I=1 TO LEN(D$)
  80 A$=MID$(D$,I,1)
  90 A=ASC(A$)
 100 S=S+A
 110 NEXT I
 120 D$=CHR$(&H5)+D$+RIGHT$(HEX$(S),2)    ☆ Addition of control and sum codes
 130 PRINT#1,D$                           [Data send]
                                          [Interrupt data receive]
 140 GOTO 50
                                          ☆ Interrupt occurrence during data receive
1000 *REC
1010 IF LOC(1)=0 THEN RETURN
1020 PRINT"RECEIVE DATA"
1030 PRINT INPUT$(LOC(1),#1)
1040 RETURN
```

General flowchart



2.14.2 Operation and speed command write n8 n9

Used to make valid the operation and speed commands from the computer or external terminals.

Parameter	Name	Factory Setting	Setting Range	Remarks
n8 (338)	Operation command write	0	0, 1	Setting is enabled when Pr. 30 = "1"
n9 (339)	Speed command write	0	0, 1	

The parameter numbers within parentheses are those for use of the parameter unit (FR-PU04).

<Setting>

In the computer operation mode, commands from the external terminals and sequence program are as listed below.

(Refer to page 88 for Pr. 60 to Pr. 63 (input terminal function selection).)

Operation location selection				n8 (Pr. 338) "operation command write" n9 (Pr. 339) "speed command write"	0: Computer 0: Computer	0: Computer 1: External	1: External 0: Computer	1: External 1: External	Remarks
Fixed function (Terminal-equivalent function)			Forward rotation command (STF)		Computer	Computer	External	External	
			Computer link operation frequency		Computer	—	Computer	—	
			2		—	External	—	External	
			4		—	External	—	External	
Selection function	Pr. 60 to Pr. 63 settings	0	Low-speed operation command (RL)		Computer	External	Computer	External	Pr. 59 = "0"
		1	Middle-speed operation command (RM)		Computer	External	Computer	External	Pr. 59 = "0"
		2	High-speed operation command (RH)		Computer	External	Computer	External	Pr. 59 = "0"
		3	Second function selection (RT)		Computer	Computer	External	External	
		4	Current input selection (AU)		—	Either	—	Either	
		5	Start self-holding selection (STOP)		—	—	External	External	
		6	Output stop (MRS)		Either	Either	External	External	Pr. 79 ≠ "7"
		7	External thermal relay input (OH)		External	External	External	External	
		8	15-speed selection (REX)		Computer	External	Computer	External	Pr. 59 = "0"
		9	Jog operation selection (JOG)		—	—	External	External	
		10	Reset (RES)		Either	Either	Either	Either	
		14	PID control valid terminal (X14)		Computer	External	Computer	External	
		16	PU-external operation switch-over (X16)		External	External	External	External	
		- - -	Reverse rotation command (STR)		Computer	Computer	External	External	

Operation location selection	n8 (Pr. 338) "operation command write" n9 (Pr. 339) "speed command write"	0: Computer 0: Computer	0: Computer 1: External	1: External 0: Computer	1: External 1: External	Remarks
RH, RM, RL, REX selection function	Remote setting (RH, RM, RL)	Computer	External	Computer	External	Pr. 59 = "1", "2"
	15-speed selection (REX)	—	—	—	—	
MRS selection function	PU operation interlock (MRS)	External	External	External	External	Pr. 79 = "7"

[Explanation of table]

External : Operation is valid only from external terminal signal.

Computer : Operation is valid only from sequence program.

Either : Operation is valid from either of external terminal and computer.

— : Operation is invalid from either of external terminal and computer.

CAUTION

When Pr. 79 "operation mode selection" is set to "7" (PU operation interlock function), only the external terminal is made valid independently of the n8 and n9 settings because the MRS terminal is shared.

2.14.3 Link start mode selection n10

You can choose the operation mode established at power-on or at power restoration after instantaneous power failure.

Set "1" in n10 to select the computer link operation mode.

After a link start, parameter write is enabled with a program.

Parameter	Name	Factory Setting	Setting Range	Remarks
n10 (340)	Link start mode selection	0	0, 1	Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses is the one for use of the parameter unit (FR-PU04).

<Setting>

n10 Setting	Operation Mode		Mode at Power-On or at Power Restoration after Instantaneous Power Failure
	Pr. 79		
0 (Factory setting)	0	PU or external operation	Placed in the external operation mode.
	1	PU operation	Placed in the PU operation mode.
	2	External operation	Placed in the external operation mode.
	3	External/PU combined operation mode	The running frequency is given in the PU operation mode and the start signal in the external operation mode.
	4	External/PU combined operation mode	The running frequency is given in the external operation mode and the start signal in the PU operation mode.
	7	External operation mode	MRS signal ON .....Can be switched to PU operation mode. (Output stop during external operation) MRS signal OFF ...Switching to PU operation mode inhibited.
	8	External/PU combined operation mode	X16 signal ON .....Switched to external operation mode. X16 signal OFF .....Switched to PU operation mode.
1	0	Computer link operation	Disabled when PU is selected. Enabled when external is selected.
	1	PU operation only	Disabled
	2	Computer link operation	Enabled
	3	External/PU combined operation	Disabled
	4	External/PU combined operation	Disabled
	7	External operation (PU operation interlock)	Enabled only for external operation when the PU interlock signal (MRS) is ON.
	8	PU or external (signal switching)	Enabled only for external operation (X16: ON).

- n10 can be changed independently of the operation mode of the operation panel.
- Setting of n10 = "1" is made valid when "0" or "2" is set in Pr. 79 "operation mode selection".

n11 ➡ Refer to n1 to n7 (page 118)

2.14.4 E^2PROM write selection n12

You can choose whether the parameters are stored into E^2PROM or not at the parameter setting for computer communication.

Parameter	Name	Factory Setting	Setting Range	Remarks
n12 (342)	E^2PROM write selection	0	0, 1	0: Written to RAM and E^2PROM 1: Written to RAM only Not written to E^2PROM* Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses is the one for use of the parameter unit (FR-PU04).

* When reset is performed, the parameter value will be the value of E^2PROM.

2.15 Parameter Unit (FR-PU04) Setting

When the optional parameter unit (FR-PU04) is connected to the RS-485 connector of the inverter, you can make the environment setting of the parameter unit.

CAUTION

When the parameter unit (FR-PU04) is used, operation from the operation panel is not accepted. (The stop key (STOP RESET key) is valid)

2.15.1 Parameter unit display language switching n13

By setting the communication parameter n13 "PU display language switching", you can switch the display language of the parameter unit to another.

Parameter	Name	Factory Setting <NA, EC version>	Setting Range	Remarks
n13 (145)	PU display language	0 <1>	0 to 7	Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses is the one for use of the parameter unit (FR-PU04).

<Setting>

n13 Setting	Display Language
0	Japanese
1	English
2	German
3	French
4	Spanish
5	Italian
6	Swedish
7	Finish

2.15.2 Buzzer sound control n14

By setting the communication parameter n14 "PU buzzer sound control", you can control "beep" produced when any of the parameter unit (FR-PU04) keys is operated.

Parameter	Name	Factory Setting	Setting Range	Remarks
n14 (990)	PU buzzer sound control	1	0, 1	0: Without sound 1: With sound (factory setting) Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses is the one for use of the parameter unit (FR-PU04).

2.15.3 PU contrast adjustment n15

By setting the communication parameter n15 "PU contrast adjustment", you can adjust the LCD contact of the parameter unit (FR-PU04). When using the FR-PU04, adjust the numerical value to any brightness with the ▲/▼ keys and define that brightness with the WRITE key of the parameter unit.

Parameter	Name	Factory Setting	Setting Range	Remarks
n15 (991)	PU contrast adjustment	58	0 to 63	Setting is enabled when Pr. 30 = "1"

The parameter number in parentheses is the one for use of the parameter unit (FR-PU04).

CAUTION

When using the FR-PU04, you should press the WRITE key to store the LCD contrast setting.

2.15.4 PU main display screen data selection n16

You can choose the main display screen of the parameter unit (FR-PU04).

Parameter	Name	Factory Setting	Setting Range	Remarks
n16 (992)	PU main display screen data selection	0	0, 100	Setting is enabled when Pr. 30 = "1"

<Setting>

When you set 100 in n16, the monitor value changes depending on whether the inverter is at a stop or running.

	n16		
	0	100	
	During operation/stop	During stop	During operation
Output frequency	Output frequency	Set frequency	Output frequency
Output current	Output current		
Alarm display	Alarm display		

REMARKS

- During an error, the output frequency at error occurrence appears.
- During MRS, the values displayed are the same as during a stop.

♦Related parameters♦

• Speed display ⇒ Pr. 37 "speed display" (refer to page 73)

2.15.5 PU disconnection detection/PU setting lock n17

You can choose the connector disconnection detection function of the parameter unit (FR-PU04) and the operation write of the parameter unit (FR-PU04).

● PU disconnection detection : This function detects that the parameter unit (FR-PU04) has been disconnected from the inverter for longer than 1 second and causes the inverter to provide an alarm output (PUE) and come to an alarm stop. When the PU has been disconnected since before power-on, it is not judged as an alarm.

● PU operation : Operation performed to perform running, frequency setting or parameter setting from the parameter unit (FR-PU04).

Parameter	Name	Factory Setting	Setting Range	Remarks
n17 (993)	PU disconnection detection/PU setting lock	0	0, 1, 10	Setting is enabled when Pr. 30 = "1"

<Setting>

n17 Setting	PU Disconnection Detection	PU Setting Lock
0	Operation is continued as-is if the PU is disconnected (without PU disconnection detection)	PU operation valid
1	Inverter output is shut off when the PU is disconnected (with PU disconnection detection)	
10	Operation is continued as-is if the PU is disconnected (without PU disconnection detection)	PU operation invalid*

* The monitor display and STOP RESET key are valid.

REMARKS

When RS-485 communication operation is performed through the RS-485 connector, the reset selection/PU stop selection function is valid but the PU disconnection detection function is invalid.

⚠ CAUTION

⚠ Do not reset the inverter while the start signal is being input.
Doing so will cause the inverter to start immediately after a reset, leading to hazardous conditions.

3. PROTECTIVE FUNCTIONS

This chapter explains the "protective functions" of this product.
Always read the instructions before using the equipment.

3.1 Errors (Alarms)

If any fault has occurred in the inverter, the corresponding protective function is activated to bring the inverter to an alarm stop and automatically give the corresponding error (alarm) indication on the PU display.
If your fault does not correspond to any of the following errors or if you have any other problem, please contact your sales representative.

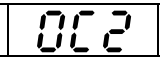
- Retention of alarm output signal.....When the magnetic contactor (MC) provided on the power supply side of the inverter is opened at the activation of the protective function, the inverter's control power will be lost and the alarm output will not be held.
- Alarm indication.....When the protective function is activated, the operation panel display automatically switches to the above indication.
- Resetting method .....When the protective function is activated, the inverter output is kept stopped. Unless reset, therefore, the inverter cannot restart. Switch power off once, then on again; power off once, then on again; or apply RES signal for more than 0.1 second. Kept on, "Err." appears (flickers) to indicate that the inverter is being reset.
- When the protective function is activated, take the corresponding corrective action, then reset the inverter, and resume operation.

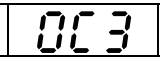
3.1.1 Error (alarm) definitions

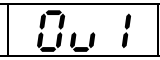
(1) Major failures

When the protective function is activated, the inverter output is shut off and the alarm is output.

Operation Panel Indication	**OC1**		**FR-PU04**	**OC During Acc**
Name	Overcurrent cut-off during acceleration			
Description	When the inverter output current reaches or exceeds approximately 200% of the rated inverter current during acceleration, the protective circuit is activated to stop the inverter output.			
Check point	Check for sudden acceleration. Check for output short-circuit/ground fault.			
Corrective action	Increase the acceleration time.			

Operation Panel Indication	OC2		FR-PU04	Stedy Spd OC
Name	Overcurrent cut-off during constant speed			
Description	When the inverter output current reaches or exceeds approximately 200% of the rated inverter current during constant-speed operation, the protective circuit is activated to stop the inverter output.			
Check point	Check for sudden load change. Check for output short-circuit/ground fault.			
Corrective action	Keep load stable.			

Operation Panel Indication	OC3		FR-PU04	OC During Dec
Name	Overcurrent cut-off during deceleration			
Description	When the inverter output current reaches or exceeds approximately 200% of the rated inverter current during deceleration (other than acceleration or constant speed), the protective circuit is activated to stop the inverter output.			
Check point	Check for sudden speed reduction. Check for output short-circuit/ground fault. Check for too fast operation of motor's mechanical brake.			
Corrective action	Increase the deceleration time. Adjust brake operation.			

Operation Panel Indication	OV1		FR-PU04	OV During Acc
Name	Regenerative overvoltage cut-off during acceleration			
Description	When the main circuit DC voltage in the inverter rises to or above the specified value due to excessive regenerative energy during acceleration, the protective circuit is activated to stop the inverter output. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	Check for too slow acceleration.			
Corrective action	• Decrease the acceleration time. • Install a power factor improving reactor.			

Operation Panel Indication	OV2		FR-PU04	Stedy Spd OV
Name	Regenerative overvoltage cut-off during constant speed			
Description	When the main circuit DC voltage in the inverter rises to or above the specified value due to excessive regenerative energy during constant speed, the protective circuit is activated to stop the inverter output. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	Check for sudden load change.			
Corrective action	• Keep load stable. • Install a power factor improving reactor.			

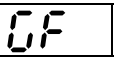
Operation Panel Indication	OV3		FR-PU04	OV During Dec
Name	Regenerative overvoltage cut-off during deceleration or stop			
Description	When the main circuit DC voltage in the inverter rises to or above the specified value due to excessive regenerative energy during deceleration or stop, the protective circuit is activated to stop the inverter output. The circuit may also be activated by a surge voltage produced in the power supply system.			
Check point	Check for sudden speed reduction.			
Corrective action	• Increase the deceleration time. (Set the deceleration time which matches the inertia moment of the load) • Decrease the braking duty. • Install a power factor improving reactor.			

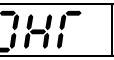
Operation Panel Indication	THM		FR-PU04	Motor Overload
Name	Motor overload cut-off (electronic thermal overcurrent protection) (* 1)			
Description	The electronic overcurrent protection in the inverter detects motor overheat due to overload or reduced cooling capability during low-speed operation to stop the inverter output. When a multi-pole motor or two or more motors are run, provide a thermal relay in the output side of the inverter. Protection from burning due to motor temperature rise			
Check point	Check the motor for use under overload.			
Corrective action	• Reduce the load weight. • For the constant-torque motor, change the Pr. 71 setting to the constant-torque motor setting.			

Operation Panel Indication	THT		FR-PU04	Inv. Overload
Name	Inverter overload cut-off (electronic thermal overcurrent protection) (* 1)			
Description	If a current of more than 150% of the rated output current flows and overcurrent shut-off does not occur (200% or less), inverse-time characteristics cause the electronic overcurrent protection to be activated to stop the inverter output in order to protect the output transistors. Output transistor protection from overheat			
Check point	Check the motor for use under overload.			
Corrective action	Reduce the load weight.			

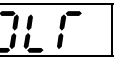
*1. Resetting the inverter initializes the internal heat integrating data of the electronic overcurrent protection.

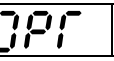
Operation Panel Indication	FIN		FR-PU04	H/Sink O/Temp
Name	Fin overheat			
Description	If the cooling fin overheats, the overheat sensor is actuated to stop the inverter output.			
Check point	• Check for too high ambient temperature. • Check for cooling fin clogging.			
Corrective action	Set the ambient temperature to within the specifications.			

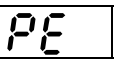
Operation Panel Indication	GF		FR-PU04	Ground Fault
Name	Start-time output side ground fault overcurrent protection			
Description	This function stops the inverter output if a ground fault overcurrent flows due to a ground fault which occurred in the inverter's output (load) side. Made valid when Pr. 40 "start-time ground fault detection selection" = "1".			
Check point	Check for a ground fault in the motor and connection cable.			
Corrective action	Remedy the ground fault portion.			

Operation Panel Indication	OHT		FR-PU04	OH Fault
Name	External thermal relay (*2)			
Description	If the external thermal relay designed for motor overheat protection or the internally mounted temperature relay in the motor switches on (contacts open), the inverter output is stopped. If the relay contacts are reset automatically, the inverter will not restart unless it is reset.			
Check point	• Check for motor overheating. • Check that the value of 7 (OH signal) is set correctly in any of Pr. 60 to Pr. 63 (input terminal function selection).			
Corrective action	Reduce the load and operating duty.			

*2. Functions only when any of Pr. 60 to Pr. 63 (input terminal function selection) is set to OH.

Operation Panel Indication	OLT		FR-PU04	Stll Prev STP
Name	Stall prevention (overload)			
Description	The running frequency has fallen to 0 by stall prevention operation activated. OL appears while stall prevention is being activated.			
Check point	Check the motor for use under overload.			
Corrective action	Reduce the load weight.			

Operation Panel Indication	OPT		FR-PU04	Option Fault
Name	Communication error (*3)			
Description	Stops the inverter output if a setting error or connection (connector) fault occurs during use of the RS-485 communication function.			
Check point	Check that the connector is plugged securely.			
Corrective action	Make connection securely. Please contact your sales representative.			

Operation Panel Indication	PE		FR-PU04	Corrupt Memory
Name	Parameter error			
Description	A fault occurred in parameters stored (example: E^2PROM fault).			
Check point	Check for too many number of parameter write times.			
Corrective action	Please contact your sales representative.			

Operation Panel Indication	PUE	PUE	FR-PU04	PU Leave Out
Name	PU disconnected (*3)			
Description	Stops the inverter output if communication between inverter and PU is suspended, e.g. if the PU is disconnected with "1" set in the communication parameter n17 "PU disconnection detection/PU setting lock".			
Check point	• Check that the FR-PU04 is fitted securely. • Check the setting of the communication parameter n17 "PU disconnection detection".			
Corrective action	Fit the FR-PU04 securely.			

*3. For only the type having the RS-485 communication function.

Operation Panel Indication	RET	rET	FR-PU04	Retry No Over
Name	Retry count			
Description	If operation cannot be resumed properly within the number of retries set, this function stops the inverter output.			
Check point	Find the cause of alarm occurrence.			
Corrective action	Eliminate the cause of the error preceding this error indication.			

Operation Panel Indication	CPU	CPU	FR-PU04	CPU Fault
Name	CPU error			
Description	If the arithmetic operation of the built-in CPU does not end within a predetermined period, the inverter self-determines it as an alarm and stops the output.			
Check point	———			
Corrective action	Please contact your sales representative.			

(2) Minor failures

When the protective function is activated, the output is not shut off. You can make parameter setting to output the light fault signal. (Set "98" in any of Pr. 64, Pr. 65 (output terminal function selection). Refer to page 90)

Operation Panel Indication	FN	Fn	FR-PU04	FN
Name	Fan trouble			
Description	For the inverter which contains a cooling fan, Fn appears on the operation panel when the cooling fan stops due to a fault or operates differently from the setting of Pr. 76 "cooling fan operation selection".			
Check point	Check the cooling fan for a fault.			
Corrective action	Change the fan.			

(3) Warnings

Operation Panel Indication	OL		FR-PU04	OL
Name	Stall prevention (overcurrent)			
Description	During acceleration	If a current of more than 150% (* 4) of the rated inverter current flows in the motor, this function stops the increase in frequency until the overload current reduces to prevent the inverter from resulting in overcurrent shut-off. When the overload current has reduced below 150%, this function increases the frequency again.		
	During constant-speed operation	If a current of more than 150% (* 4) of the rated inverter current flows in the motor, this function lowers the frequency until the overload current reduces to prevent overcurrent shut-off. When the overload current has reduced below 150%, this function increases the frequency up to the set value.		
	During deceleration	If a current of more than 150% (* 4) of the rated inverter current flows in the motor, this function stops the decrease in frequency until the overload current reduces to prevent the inverter from resulting in overcurrent shut-off. When the overload current has reduced below 150%, this function decreases the frequency again.		
Check point	Check the motor for use under overload.			
Corrective action	• The acceleration/deceleration time may change. • Increase the stall prevention operation level with Pr. 22 "stall prevention operation level", or disable stall prevention with Pr. 21 "stall prevention function selection". • Check that the torque boost (Pr. 0) setting is not higher than required.			

*4. The stall prevention operation current can be set as desired. It is factory-set to 150%.

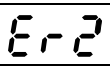
Operation Panel Indication	oL		FR-PU04	oL
Name	Stall prevention (overvoltage)			
Description	During deceleration	If the regenerative energy of the motor increases too much to exceed the brake capability, this function stops the decrease in frequency to prevent overvoltage shut-off. As soon as the regenerative energy has reduced, deceleration resumes.		
Check point	Check for sudden speed reduction.			
Corrective action	The deceleration time may change. Increase the deceleration time using Pr. 8 "deceleration time".			

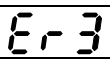
Operation Panel Indication	PS		FR-PU04	PS
Name	PU stop (Stopped with PU STOP key)			
Description	Pr. 75 "reset selection/PU stop selection" had been set and a stop was made by pressing the STOP/RESET key of the operation panel or parameter unit (FR-PU04) during operation in the external operation mode.			
Check point	Check for a stop made by pressing the STOP/RESET key of the operation panel during external operation.			
Corrective action	Refer to page 94.			

Operation Panel Indication	UV	
Name	Undervoltage	
Description	If the power supply voltage of the inverter reduces, the control circuit will not operate properly and will result in decreased motor torque or increased heat generation. To prevent this, if the power supply voltage reduces below about 115VAC (about 230VAC for the three-phase 400V power input series, about 58VAC for the single-phase 100V power input series), this function stops the inverter output.	
Check point	• Check for a start of large-capacity motor. • Check that the power supply capacity is as indicated in the specifications (refer to page 161).	
Corrective action	Check the power supply system equipment such as the power supply.	

(4) Write errors

Operation Panel Indication	Er1		FR-PU04	Control Mode
Name	Write disable error			
Description	• Write was performed with "1" (write disable) set in Pr. 77 "parameter write disable selection". • Frequency jump setting range overlapped. • Parameter write was performed though the operation panel does not have the write precedence. (Only the type having RS-485 communication function)			
Corrective action	• Check the setting of Pr. 77 "parameter write disable selection". (Refer to page 97) • Check the settings of Pr. 31 to 36 (frequency jump). (Refer to page 72) • When the FR-PU04 is fitted and n17 = "0" or "1", the operation of the operation panel is invalid. For RS-485 connector (RS-485) communication, the operation of the operation panel is invalid.			

Operation Panel Indication	Er2		FR-PU04	In PU/EXT Mode OPERATOR ERR
Name	Write-while-running error/mode designation error			
Description	• Write was performed during operation. • An attempt was made to change the Pr. 79 setting to the operation mode where the operation command has been input. • Write was performed in the external operation mode.			
Corrective action	• After stopping operation, make parameter setting. • After setting the operation mode to the "PU operation mode", make parameter setting. (Refer to page 98)			

Operation Panel Indication	Er3		FR-PU04	Incr I/P
Name	Calibration error			
Description	Analog input bias and gain calibration values are too close.			
Corrective action	Check the settings of C3, C4, C6 and C7 (calibration functions). (Refer to page 74)			

3.1.2 To know the operating status at the occurrence of alarm (Only when FR-PU04 is used)

When any alarm has occurred, the display automatically switches to the indication of the corresponding protective function (error). By pressing the (MON) key at this point without resetting the inverter, the display shows the output frequency. In this way, it is possible to know the running frequency at the occurrence of the alarm. It is also possible to know the current in the same manner. After resetting, you can confirm the definitions in "Alarm History". (For details, refer to the instruction manual of the parameter unit (FR-PU04).)

3.1.3 Correspondence between digital and actual characters

There are the following correspondences between the actual alphanumeric characters and the digital characters displayed on the control panel:

Actual	Display
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Actual	Display
A	A
B	b
C	C
D	d
E	E
F	F
G	G
H	H
I	I
J	J
L	L

Actual	Display
M	M
N	n
O	O
o	o
P	P
S	S
T	T
U	U
V	v
r	r
-	-

3.1.4 Resetting the inverter

The inverter can be reset by performing any of the following operations. Note that the electronic overcurrent protection's internal heat calculation value and the number of retries are cleared (erased) by resetting the inverter.

Operation 1:..... Using the control panel, press the (STOP RESET) key to reset the inverter.
(This may only be performed when the inverter protective function (major failure) is activated.)
Operation 2:..... Cut (off) power once, then switch it on again.
Operation 3:..... Switch on the reset signal (RES).
(Assign this signal to any of Pr. 60 to Pr. 63.) (Refer to page 40, 88)

3.2 Troubleshooting

POINTS

Check the corresponding areas. If the cause is still unknown, it is recommended to initialize the parameters (return to factory settings), re-set the required parameter values, and check again.

3.2.1 Motor remains stopped

- 1) Check the main circuit
  - Check that a proper power supply voltage is applied (operation panel display is provided).
  - Check that the motor is connected properly.
  - Check that the connector across P1-P<+> is connected.
- 2) Check the input signals
  - Check that the start signal is input.
  - Check that both the forward and reverse rotation start signals are not input.
  - Check that the frequency setting signal is not zero.
  - Check that the AU signal is on when the frequency setting signal is 4 to 20mA.
  - Check that the output stop signal (MRS) or reset signal (RES) is not on. (Assign signals MRS and RES using Pr. 60 to Pr. 63 (input terminal function selection).)
  - Check that the sink or source connector is fitted securely.
- 3) Check the parameter settings
  - Check that the reverse rotation prevention (Pr. 78) is not selected.
  - Check that the operation mode (Pr. 79) setting is correct.
  - Check that the bias and gain (C2 to C7) settings are correct.
  - Check that the starting frequency (Pr. 13) setting is not greater than the running frequency.
  - Check that various operational functions (such as three-speed operation), especially the maximum frequency (Pr. 1), are not zero.
- 4) Check the load
  - Check that the load is not too heavy.
  - Check that the shaft is not locked.
- 5) Others
  - Check that the operation panel display does not show an error (e.g. OC1).
  - Check that the Pr. 15 "jog frequency" setting is not lower than the Pr. 13 "starting frequency" value.

3.2.2 Motor rotates in opposite direction

- Check that the phase sequence of output terminals U, V and W is correct.
- Check that the start signals (forward rotation, reverse rotation) are connected properly.
- Check the setting of Pr. 17 "RUN key rotation direction selection".

3.2.3 Speed greatly differs from the setting

- Check that the frequency setting signal is correct. (Measure the input signal level.)
- Check that the following parameter settings are correct (Pr. 1, Pr. 2, Pr. 19, Pr. 38, Pr. 39, Pr. 95, C2 to C7).
- Check that the input signal lines are not affected by external noise. (Use shielded cables)
- Check that the load is not too heavy.

3.2.4 Acceleration/deceleration is not smooth

- Check that the acceleration and deceleration time settings are not too short.
- Check that the load is not too heavy.
- Check that the torque boost setting is not too large to activate the stall prevention function.

3.2.5 Motor current is large

- Check that the load is not too heavy.
- Check that the torque boost setting is not too large.

3.2.6 Speed does not increase

- Check that the maximum frequency setting is correct.
- Check that the load is not too heavy. (In agitators, etc., load may become heavier in winter.)
- Check that the torque boost setting is not too large to activate the stall prevention function.

3.2.7 Speed varies during operation

When slip compensation is selected, the output frequency varies with load fluctuation between 0 and 2Hz. This is a normal operation and is not a fault.

1) Inspection of load
   - Check that the load is not varying.

2) Inspection of input signal
   - Check that the frequency setting signal is not varying.
   - Check that the frequency setting signal is not affected by noise.
   - Check for a malfunction due to an undesirable current when the transistor output unit is connected. (Refer to page 25)

3) Others
   - Check that the wiring is within specified length.
   - Check that the inverter is either FR-S540-1.5K, 2.2K or 3.7K and GD^2 load is samll (at the mnitor GD^2 or smaller)
     If so, set the Pr. 72 "PWM frequency selection" to 6kHz or higher. When setting the PWM to a higher frequency, check for noise or leakage current problem and take countermeasures against it.

3.2.8 Operation mode is not changed properly

If the operation mode does not change correctly, check the following:

1. External input signal ..... Check that the STF or STR signal is off.
   When it is on, the operation mode cannot be changed.
2. Parameter setting ..... Check the Pr. 79 setting.
   When the Pr. 79 "operation mode selection" setting is "0", switching input power on places the inverter in the external operation mode. Press the PU/EXT key to switch to the PU operation mode.
   For other settings (1 to 8), the operation mode is limited accordingly.
   (For details of Pr. 79, refer to page 98.)

3.2.9 Operation panel display is not operating

- Make sure that terminals PC-SD are not shorted.
- Make sure that the connector is fitted securely across terminals P<+>-P1.

3.2.10 Parameter write cannot be performed

- Make sure that operation is not being performed (signal STF or STR is not ON).
- Check that the SET key (WRITE key) was pressed.
- Make sure that you are not attempting to set the parameter outside the setting range.
- Make sure that you are not attempting to set the parameter in the external operation mode.
- Check Pr. 77 "parameter write disable selection".

3.2.11 Motor produces annoying sound

- Check the Pr. 72 "PWM frequency selection" setting.
- Make sure that the deceleration time is not too short.

3.3 Precautions for Maintenance and Inspection

The inverter is a static unit mainly consisting of semiconductor devices. Daily inspection must be performed to prevent any fault from occurring due to adverse influence of the operating environment, such as temperature, humidity, dust, dirt and vibration, changes in the parts with time, service life, and other factors.

3.3.1 Precautions for maintenance and inspection

For some short time after the power is switched off, a high voltage remains in the smoothing capacitor. Therefore, when more than 10 minutes have elapsed after power-off, make sure that the voltage across the main circuit terminals P-N of the inverter is 30VDC or less using a meter, etc. Then, access the inverter for inspection.

3.3.2 Check items

(1) Daily inspection

- Check the following:
  1) Motor operation fault
  2) Improper installation environment
  3) Cooling system fault
  4) Unusual vibration and noise
  5) Unusual overheating and discoloration
- During operation, check the inverter input voltages using a meter.

(2) Cleaning

Always run the inverter in a clean state.
When cleaning the inverter, gently wipe dirty areas with a soft cloth immersed in neutral detergent or ethanol.

CAUTION

Do not use solvent, such as acetone, benzene, toluene and alcohol, as they will cause the inverter surface paint to peel off.

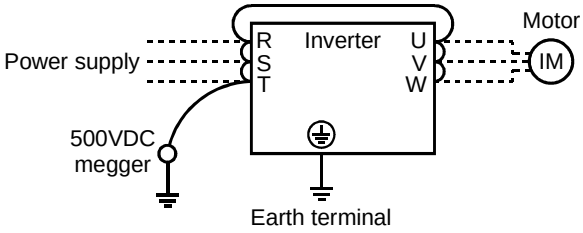
3.3.3 Periodic inspection

Check the areas inaccessible during operation and requiring periodic inspection.

1) Cooling system:.....Clean the air filter, etc.
2) Screws and bolts:.....These parts may become loose due to vibration, temperature changes, etc. Check that they are tightened securely and retighten as necessary.
3) Conductors and insulating materials: Check for corrosion and damage.
4) Insulation resistance: Measure.
5) Cooling fan, smoothing capacitor, relay: Check and change if necessary.

3.3.4 Insulation resistance test using megger

1) Before performing the insulation resistance test using a megger on the external circuit, disconnect the cables from all terminals of the inverter so that the test voltage is not applied to the inverter.
2) For the continuity test of the control circuit, use a meter (high resistance range) and do not use the megger or buzzer.
3) For the inverter, conduct the insulation resistance test on the main circuit only as shown below and do not perform the test on the control circuit. (Use a 500VDC megger.)



3.3.5 Pressure test

Do not conduct a pressure test. The inverter may be deteriorated.

3.3.6 Daily and periodic inspection

Area of Inspection	Inspection Item	Description	Interval			Method	Criterion	Instrument
			Daily	Periodic* 1 year	Periodic* 2 years			
General	Surrounding environment	Check ambient temperature, humidity, dust, dirt, etc.	○			Make measurement 5cm (1.97inches) away from inverter.	Ambient temperature: -10ºC to +50ºC (14ºF to 122ºF), non-freezing. Ambient humidity: 90% or less, non-condensing.	Thermo-meter, hygrometer, recorder
	Overall unit	Check for unusual vibration and noise.	○			Visual and auditory checks.	No fault.	
	Power supply voltage	Check that main circuit voltage is normal.	○			Measure voltage across inverter terminals R-S-T	Within permissible AC (DC) voltage fluctuation (Refer to page 161)	Meter, digital multimeter

Area of Inspection	Inspection Item	Description	Interval			Method	Criterion	Instrument
			Daily	Periodic*				
				1 year	2 years			
General	General	(1) Check with megger (across main circuit terminals and ground terminal). (2) Check for loose screws and bolts. (3) Check for overheat on each part. (4) Clean.		○ ○ ○	○	(1) Disconnect all cables from inverter and measure across terminals R, S, T, U, V, W and ground terminal with megger. (2) Retighten. (3) Visual check.	(1) 5MΩ or more. (2), (3) No fault.	500VDC class megger
Main circuit	Conductors, cables	(1) Check conductors for distortion. (2) Check cable sheaths for breakage.		○ ○		(1), (2) Visual check.	(1), (2) No fault.	
	Terminal block	Check for damage.		○		Visual check	No fault	
	Inverter module Converter module	Check resistance across terminals.			○	Disconnect cables from inverter and measure across terminals R, S, T↔P, N, and across U, V, W↔P, N with a meter with a 100Ω range.	Refer to page 153.	Analog meter
	Smoothing capacitor	(1) Check for liquid leakage. (2) Check for safety valve projection and bulge. (3) Measure electrostatic capacity.	○ ○	 ○		(1), (2) Visual check. (3) Measure with capacity meter.	(1), (2) No fault. (3) 85% or more of rated capacity.	Capacity meter
	Relay	(1) Check for chatter during operation. (2) Check for rough surface on contacts.		○ ○		(1) Auditory check. (2) Visual check.	(1) No fault. (2) No fault.	

Area of Inspection	Inspection Item	Description	Interval			Method	Criterion	Instrument
			Daily	Periodic*				
				1 year	2 years			
Control circuit Protective circuit	Operation check	(1) Check balance of output voltages across phases with inverter operated independently. (2) Perform sequence protective operation test to make sure there is no fault in protective or display circuits.		○ ○		(1) Measure voltage across inverter output terminals U-V-W. (2) Simulate connection of inverter protective circuit output terminals.	(1) Phase-to-phase voltage balance within 4V (8V) for 200V (400V). (2) Fault must occur because of sequence.	Digital multimeter, rectifier type voltmeter
Cooling system	Cooling fan	(1) Check for unusual vibration and noise. (2) Check for loose connection.	○ ○	 ○	○	(1) Turn by hand with power off. (2) Visual check.	No unusual vibration and unusual noise.	
Display	Display	(1) Check for LED lamp blown. (2) Clean.	○	 ○		(1) Lamps indicate indicator lamps on panel. (2) Clean with rag.	(1) Check that lamps are lit.	
	Meter	Check that reading is normal.	○			Check reading of meters on panel.	Must satisfy specified and management values.	Voltmeter, ammeter, etc.
Motor	General	(1) Check for unusual vibration and noise. (2) Check for unusual odor.	○ ○			(1) Auditory, sensory, visual checks. (2) Check for unusual odor due to overheat, damage, etc.	(1), (2) No fault.	
	Insulation resistance	(1) Check with megger (across terminals and ground terminal).			○	(1) Disconnect cables from U, V, W (including motor cables).	5MΩ or more.	500V megger

Note: The value for the 400V class is indicated in the parentheses.

* For periodic inspection, contact you nearest Mitsubishi sales representative.

● Checking the inverter and converter modules

<Preparation>

(1) Disconnect the external power supply cables (R, S, T) and motor cables (U, V, W).
(2) Prepare a meter. (Use 100Ω range.)

<Checking method>

Change the polarity of the meter alternately at the inverter terminals R, S, T, U, V, W, P and N, and check for continuity.

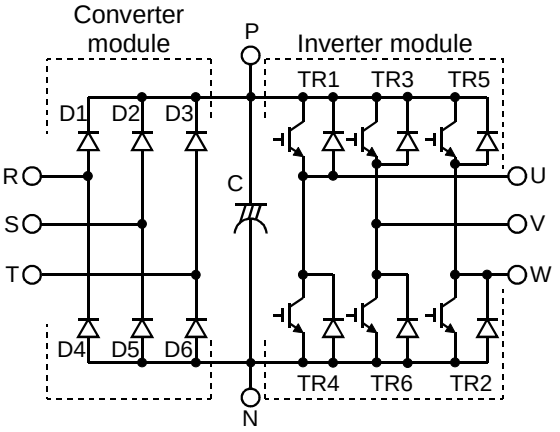
CAUTION

- Before measurement, check that the smoothing capacitor is discharged.
- At the time of continuity, the measured value is several to several ten's-of ohms depending on the number of modules, number of parallel modules, circuit tester type, etc. If all measured values are almost the same, the modules are without fault.

<Module device numbers and terminals to be checked>

		Tester Polarity		Measured Value		Tester Polarity		Measured Value
		⊕	⊖			⊕	⊖	
Converter module	D1	R	P	Discontinuity	D4	R	N	Continuity
		P	R	Continuity		N	R	Discontinuity
	D2	S	P	Discontinuity	D5	S	N	Continuity
		P	S	Continuity		N	S	Discontinuity
	D3	T	P	Discontinuity	D6	T	N	Continuity
		P	T	Continuity		N	T	Discontinuity
Inverter module	TR1	U	P	Discontinuity	TR4	U	N	Continuity
		P	U	Continuity		N	U	Discontinuity
	TR3	V	P	Discontinuity	TR6	V	N	Continuity
		P	V	Continuity		N	V	Discontinuity
	TR5	W	P	Discontinuity	TR2	W	N	Continuity
		P	W	Continuity		N	W	Discontinuity

(Assumes the use of an analog meter.)



REMARKS

The FR-S520S-0.1K to 1.5K and FR-S510W-0.1K to 0.75K do not have T, D3 and D6.

3.3.7 Replacement of parts

The inverter consists of many electronic parts such as semiconductor devices.
The following parts may deteriorate with age because of their structural or physical characteristics, leading to reduced performance and/or failure of the inverter. For preventive maintenance, the parts must be changed periodically.

Part Name	Standard Replacement Interval	Description
Cooling fan	2 to 3 years	Change (as required)
Smoothing capacitor in main circuit	5 years	Change (as required)
Smoothing capacitor on control board	5 years	Change the board (as required).
Relays	———	Change as required

CAUTION

For parts replacement, consult the nearest Mitsubishi FA Center.

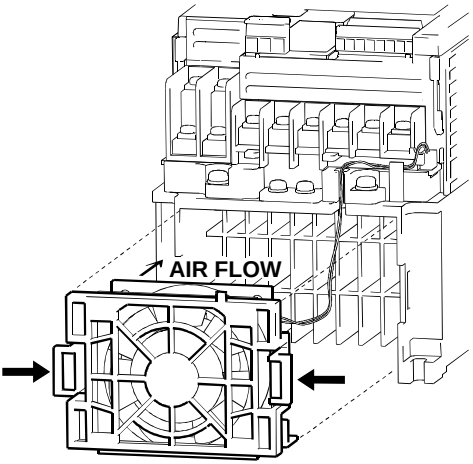
(1) Cooling fan

The cooling fan used to cool heat-generating parts such as the main circuit semiconductors has a bearing whose life is said to be 10,000 to 35,000 hours. Hence, the cooling fan must be changed every 2 to 3 years if the inverter is run continuously. When unusual noise and/or vibration is noticed during inspection, the cooling fan must be changed immediately.

Inverter Model No.	Fan Type
FR-S520-1.5K, 2.2K, 3.7K FR-S520S-1.5K	MMF-06D24DS BKO-C2416H07
FR-S540-1.5K, 2.2K, 3.7K	MMF-06D24ES-FC4 BKO-CA1027H09

● Removal

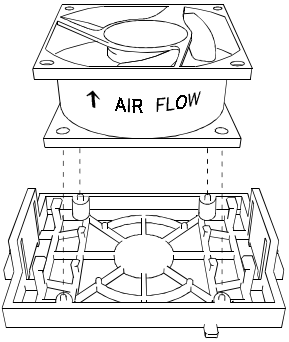
1) Remove the front cover and wiring cover. (Refer to the instruction manual (basic).)
2) Unplug the fan connector.
   The cooling fan is connected with the cooling fan connector on the side of the inverter terminal block. Unplug the connector to disconnect the inverter and cooling fan.
3) Remove the cooling fan cover.
   Remove the cover by disengaging the fixing catches indicated by the arrows.



4) Remove the cooling fan and cooling fan cover.
   The cooling fan is secured by the fixing catches.
   Disengaging the fixing catches removes the cooling fan and cooling fan cover.

● Reinstallation

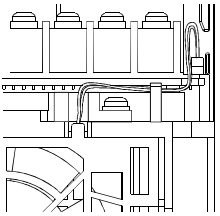
1) After confirming the orientation of the fan, reinstall the fan to the cover so that the arrow on the left of "AIR FLOW" faces in the opposite direction of the fan cover.



CAUTION

If the air flow is set in the wrong direction, the inverter life can be shorter.

2) Reinstall the fan cover to the inverter.
   Run the cable through the wiring groove to prevent it from being caught between the chassis and cover.
3) Reconnect the cable to the connector.
4) Reinstall the wiring cover.



(2) Smoothing capacitors

A large-capacity aluminum electrolytic capacitor is used for smoothing the DC in the main circuit, and an aluminum electrolytic capacitor is also used for stabilizing the control power in the control circuit.

Their characteristics are adversely affected by ripple current, etc. When the inverter is operated in an ordinary, air-conditioned environment, change the capacitors about every 5 years. When 5 years have elapsed, the capacitors will deteriorate more rapidly. Check the capacitors at least every year (less than six months if the life will be expired soon). Check the following:

1) Case (side faces and bottom face for expansion)
2) Sealing plate (for remarkable warp and extreme crack)
3) Appearance, external cracks, discoloration, leakage.

   When the measured capacitance of the capacitor has reduced below 85% of the rating, change the capacitor.

(3) Relays

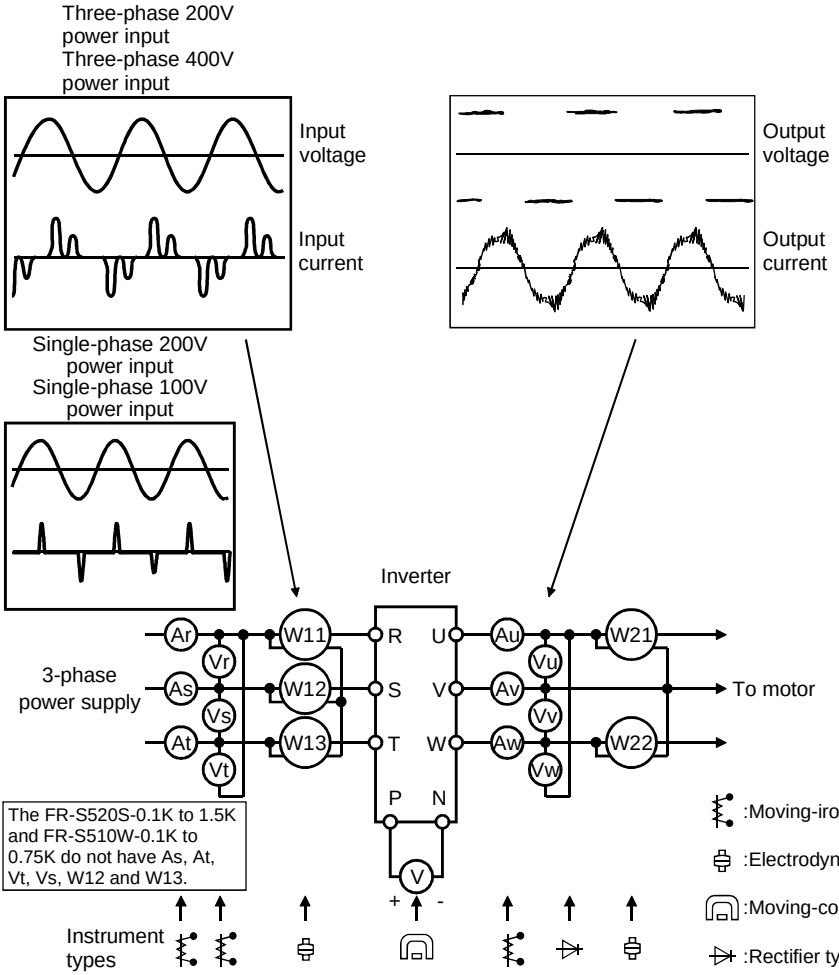
To prevent a contact fault, etc., relays must be changed according to the number of accumulative switching times (switching life).

3.3.8 Measurement of main circuit voltages, currents and powers

● Measurement of voltages and currents

Since the voltages and currents on the inverter power supply and output sides include harmonics, accurate measurement depends on the instruments used and circuits measured.

When instruments for commercial frequency are used for measurement, measure the following circuits using the instruments given on the next page.



Typical Measuring Points and Instruments

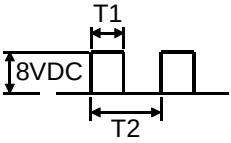
CAUTION

Use FFT (Fast Fourier Transforms) to measure the output voltage accurately.

It cannot be measured accurately with a meter or general instrument.

Measuring Points and Instruments

Item	Measuring Point	Measuring Instrument	Remarks (Reference Measured Value)	
Power supply voltage (V1)	Across R-S, S-T and T-R	Moving-iron type AC voltmeter	Is the commercial power supply within permissible variation of AC voltage (Refer to page 161)	
Power supply side current (I1)	R, S and T line currents	Moving-iron type AC ammeter		
Power supply side power (P1)	At R, S and T, and across R-S, S-T and T-R	Electrodynamic type single-phase wattmeter	P1 = W11 + W12 + W13 (3-wattmeter method)	
Power supply side power factor (Pf1)	Calculate after measuring power supply voltage, power supply side current and power supply side power. [For three-phase power supply] $Pf1=\frac{P1}{\sqrt{3}V1\times I1}\times 100\%$ [For single-phase power supply] $Pf1=\frac{P1}{V1\times I1}\times 100\%$			
Output side voltage (V2)	Across U-V, V-W and W-U	Rectifier type AC voltmeter (Note 1) (Cannot be measured by moving-iron type)	Difference between phases is within ±1% of maximum output voltage.	
Output side current (I2)	U, V and W line currents	Moving-iron type AC ammeter (Note 2)	Current should be equal to or less than rated inverter current. Difference between phases is 10% or lower.	
Output side power (P2)	At U, V and W, and across U-V and V-W	Electrodynamic type single-phase wattmeter	P2 = W21 + W22 2-wattmeter method (or 3-wattmeter method)	
Output side power factor (Pf2)	Calculate in similar manner to power supply side power factor. $Pf2=\frac{P2}{\sqrt{3}V2\times I2}\times 100\%$			
Converter output	Across P-N	Moving-coil type (such as a meter)	Inverter LED display is lit. 1.35 × V1	
Frequency setting signal	Across 2 (+)-5	Moving-coil type (Meter, etc. may be used) (Internal resistance: 50kΩ or larger)	0 to 5V/0 to 10VDC	"5" is common.
	Across 4 (+)-5		4 to 20mADC	

Item	Measuring Point	Measuring Instrument	Remarks (Reference Measured Value)	
Frequency setting power supply	Across 10 (+)-5	Moving-coil type (Meter, etc. may be used) (Internal resistance: 50kΩ or larger)	5VDC	"5" is common.
Frequency meter signal	Across FM (+)-SD		Approximately 5VDC at maximum frequency (without frequency meter)  Pulse width T1: Adjusted with C1 Pulse cycle T2: Set with Pr. 55 (Pr,56)	SD is common.
	Across AM (+)-5		Approximately 5VDC at maximum frequency (without frequency meter)	5 is common.
Start signal Select signal	Across STF, STR, RH, RM, RL, MRS, RES-SD	Moving-coil type (Meter, etc. may be used) (Internal resistance: 50kΩ or larger)	20 to 30VDC when open. ON voltage: 1V or less SD is common.	SD is common.
Alarm signal	Across A-C Across B-C	Moving-coil type (such as a meter)	Continuity check <Normal> <Fault> Across A-C: Discontinuity Continuity Across B-C: Continuity Discontinuity	

CAUTION

1. Use FFT to measure the output voltage accurately. It can not be measured accurately with a meter or general instrumentation.
2. When the carrier frequency exceeds 5kHz, do not use the instrument because overcurrent losses occurring in the metallic parts inside the instrument will increase and may lead to burnout.
   In this case, use an approximate effective value type instrument.

4. SPECIFI-CATIONS

This chapter provides the "specifications" of this product.
Always read the instructions before using the equipment

4.1 Specification List

4.1.1 Ratings

(1) 3-phase 200V power supply

● Japanese version

FR-S520-0.1K to 3.7K (-R) (-C)

● NA version

FR-S520-0.1K to 3.7K-NA

Type FR-S520-□K(-R) (-C)			0.1	0.2	0.4	0.75	1.5	2.2	3.7
Applicable motor capacity (*1)		kW	0.1	0.2	0.4	0.75	1.5	2.2	3.7
		HP	1/8	1/4	1/2	1	2	3	5
Output	Rated capacity (kVA) (*2)		0.3	0.5	1.0	1.6	2.8	4.0	6.6
	Rated current (A)		0.8	1.4	2.5	4.1	7.0	10	16.5
	Overload capacity (*3)		150% 60s 200% 0.5s (Inverse time characteristics)						
	Voltage (*4)		Three phase, 200V to 240V 50Hz/60Hz						
Power supply	Rated input AC (DC) voltage, frequency		Three phase, 200V to 240V 50Hz/60Hz						
	Permissible AC (DC) voltage fluctuation		170 to 264V 50Hz/60Hz						
	Permissible frequency fluctuation		±5%						
	Power supply system capacity (kVA) (*5)		0.4	0.7	1.2	2.1	4.0	5.5	9
Protective structure (JEM1030)			Enclosed type (IP20), IP40 for dirt-protection structure series						
Cooling system			Self-cooling				Forced air cooling		
Approximate weight (kg (lbs))			0.5 (1.1)	0.5 (1.1)	0.8 (1.76)	0.9 (1.98)	1.5 (3.3)	1.5 (3.3)	2.1 (4.62)

*1. The applicable motor capacity indicated is the maximum capacity applicable when a Mitsubishi 4-pole standard motor is used.

*2. The rated output capacity indicated assumes that the output voltage is 230V.

*3. The % value of the overload capacity indicates the ratio of the overload current to the inverter's rated output current.
For repeated duty, allow time for the inverter to return to or below the temperatures under 100% load.

*4. The maximum output voltage cannot exceed the power supply voltage. The maximum output voltage may be set as desired below the power supply voltage. However, the PWM pulse voltage value of the inverter output side voltage remains unchanged at about $\sqrt{2}$ that of the power supply.

*5. The power supply capacity changes with the values of the power supply side inverter impedances (including those of the input reactor and cables).

(2) 3-phase 400V power supply

● Japanese version
FR-S540-0.4K to 3.7K (-R)

● NA version
FR-S540-0.4K to 3.7K-NA (R)

● EC version
FR-S540-0.4K to 3.7K-EC (R)

Type FR-S540-□K(-R)			0.4	0.75	1.5	2.2	3.7
Applicable motor capacity (*1)		kW	0.4	0.75	1.5	2.2	3.7
		HP	1/2	1	2	3	5
Output	Rated capacity (kVA) (*2)		0.9	1.6	2.7	3.7	5.9
	Rated current (A)		1.1	2.1	3.5	4.8	7.7
	Overload capacity (*3)		150% 60s 200% 0.5s (Inverse time characteristics)				
	Voltage (*4)		Three phase, 380V to 480V 50Hz/60Hz				
Power supply	Rated input AC (DC) voltage, frequency		Three phase, 380V to 480V 50Hz/60Hz				
	Permissible AC (DC) voltage fluctuation		325 to 528V 50Hz/60Hz				
	Permissible frequency fluctuation		±5%				
	Power supply system capacity (kVA) (*5)		1.5	2.5	4.5	5.5	9.5
Protective structure (JEM1030)			Enclosed type (IP20)				
Cooling system			Self-cooling		Forced air cooling		
Approximate weight (kg (lbs))			1.5 (3.3)	1.5 (3.3)	1.5 (3.3)	1.6 (3.53)	1.7 (3.75)

*1. The applicable motor capacity indicated is the maximum capacity applicable when a Mitsubishi 4-pole standard motor is used.

*2. The rated output capacity indicated assumes that the output voltage is 440V.

*3. The % value of the overload capacity indicates the ratio of the overload current to the inverter's rated output current.
For repeated duty, allow time for the inverter to return to or below the temperatures under 100% load.

*4. The maximum output voltage cannot exceed the power supply voltage. The maximum output voltage may be set as desired below the power supply voltage. However, the PWM pulse voltage value of the inverter output side voltage remains unchanged at about $\sqrt{2}$ that of the power supply.

*5. The power supply capacity changes with the values of the power supply side inverter impedances (including those of the input reactor and cables).

(3) Single-phase 200V power supply

● Japanese version

FR-S520S-0.1K to 1.5K (-R)

● EC version

FR-S520S-0.2K to 1.5K-EC (R)

Type FR-S520S-□K(-R)			0.1	0.2	0.4	0.75	1.5
Applicable motor capacity (*1)		kW	0.1	0.2	0.4	0.75	1.5
		HP	1/8	1/4	1/2	1	2
Output	Rated capacity (kVA) (*2)		0.3	0.5	1.0	1.6	2.8
	Rated current (A)		0.8	1.4	2.5	4.1	7.0
	Overload capacity (*3)		150% 60s 200% 0.5s (Inverse time characteristics)				
	Voltage (*4)		Three phase, 200V to 240V 50Hz/60Hz				
Power supply	Rated input AC (DC) voltage, frequency		Single-phase, 200V to 240V 50Hz/60Hz				
	Permissible AC (DC) voltage fluctuation		170 to 264V 50Hz/60Hz				
	Permissible frequency fluctuation		±5%				
	Power supply system capacity (kVA) (*5)		0.5	0.9	1.5	2.5	4.4
Protective structure (JEM1030)			Enclosed type (IP20)				
Cooling system			Self-cooling				Forced air cooling
Approximate weight (kg (lbs))			0.5 (1.1)	0.6 (1.32)	0.8 (1.76)	1.0 (2.2)	1.5 (3.3)

*1. The applicable motor capacity indicated is the maximum capacity applicable when a Mitsubishi 4-pole standard motor is used.

*2. The rated output capacity indicated assumes that the output voltage is 230V.

*3. The % value of the overload capacity indicates the ratio of the overload current to the inverter's rated output current.
For repeated duty, allow time for the inverter to return to or below the temperatures under 100% load.

*4. The maximum output voltage cannot exceed the power supply voltage. The maximum output voltage may be set as desired below the power supply voltage. However, the PWM pulse voltage value of the inverter output side voltage remains unchanged at about $\sqrt{2}$ that of the power supply.

*5. The power supply capacity changes with the values of the power supply side inverter impedances (including those of the input reactor and cables).

(4) Single-phase 100V power supply

● Japanese version

FR-S510W-0.1K to 0.75K (-R)

● NA version

FR-S510W-0.1K to 0.75K-NA

Type FR-S510W-□K(-R)			0.1	0.2	0.4	0.75
Applicable motor capacity (*1)		kW	0.1	0.2	0.4	0.75
		HP	1/8	1/4	1/2	1
Output	Rated capacity (kVA) (*2)		0.3	0.5	1.0	1.6
	Rated current (A)		0.8	1.4	2.5	4.1
	Overload capacity (*3)		150% 60s 200% 0.5s (Inverse time characteristics)			
	Voltage		Three phase, 200V to 230V 50Hz/60Hz (*4, 6)			
Power supply	Rated input AC (DC) voltage, frequency		Single-phase, 100V to 115V 50Hz/60Hz			
	Permissible AC (DC) voltage fluctuation		90 to 132V 50Hz/60Hz			
	Permissible frequency fluctuation		±5%			
	Power supply system capacity (kVA) (*5)		0.5	0.9	1.5	2.5
Protective structure (JEM1030)			Enclosed type (IP20)			
Cooling system			Self-cooling			
Approximate weight (kg (lbs))			0.6 (1.32)	0.7 (1.54)	0.9 (1.98)	1.6 (3.52)

*1. The applicable motor capacity indicated is the maximum capacity applicable when a Mitsubishi 4-pole standard motor is used.

*2. The rated output capacity indicated assumes that the output voltage is 230V.

*3. The % value of the overload capacity indicates the ratio of the overload current to the inverter's rated output current.
For repeated duty, allow time for the inverter to return to or below the temperatures under 100% load.

*4. For single-phase 100V power input, the output voltage provided cannot be twice or more than the power supply voltage.

*5. The power supply capacity changes with the values of the power supply side inverter impedances (including those of the input reactor and cables).

*6. For single-phase 100V power input, the application of motor load reduces the output voltage about 10 to 15%. Therefore, the load must be reduced when a general-purpose motor is used.

4.1.2 Common specifications

Control specifications	Control method		Selectable between Soft-PWM control and high carrier frequency PWM control, V/F control or automatic torque boost control selectable.	
	Output frequency range		0.5 to 120Hz (starting frequency variable between 0 and 60Hz)	
	Frequency setting resolution		5VDC input: 1/500 of max. set frequency, 10V, 4 to 20mADC input: 1/1000 of max. set frequency. Digital input: 0.1Hz (less than 100Hz), 1Hz (100Hz or higher)	
	Frequency accuracy		Analog input: Within ±1% of max. output frequency (25ºC±10ºC (77ºF±18ºF)) Digital input: Within ±0.5% of set output frequency (when setting dial is used)	
	Starting torque		150% (at 6Hz) during automatic torque boost control	
	Acceleration/deceleration time setting		0, 0.1 to 999s (may be set individually for acceleration and deceleration), linear or S-pattern acceleration/deceleration mode selectable.	
	Braking torque (*2)	Regenerative	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 10s), operation voltage (0 to 15%)	
	Input signals	Frequency setting signal	Analog input	0 to 5VDC, 0 to 10VDC, 4 to 20mA
			Digital input	Entered from control panel.
		Start signal	STF, STR	Forward and reverse rotation, start signal automatic self-holding input (3-wire input) can be selected.
		Alarm reset		Used to reset alarm output provided when protective function is activated.
		Multi-speed selection		Up to 15 speeds can be selected. (Each speed can be set between 0 and 120Hz, running speed can be changed during operation from the control panel.)
		Second function selection		Used to select second functions (acceleration time, deceleration time, torque boost, base frequency, electronic overcurrent protection).
		Output stop		Instantaneous shut-off of inverter output (frequency, voltage).
		Current input selection		Used to select input of frequency setting signal 4 to 20mADC (terminal 4).
		External thermal relay input		Thermal relay contact input for use when the inverter is stopped by the external thermal relay.
		Jog signal		Jog operation mode selection
		PID control valid		Selection for exercising PID control
		PU operation-external operation switching		Used to switch between PU operation and external operation from outside the inverter.

Use Pr. 60 to Pr. 63 for selection.

Control specifications	Operation functions			Maximum and minimum frequency setting, frequency jump operation, external thermal relay input selection, automatic restart after instantaneous power failure, forward/reverse rotation prevention, slip compensation, operation mode selection, PID control, computer link operation (RS-485) (*3)	
	Output signals	Running status		1 open collector signal can be selected from among inverter running, up-to-frequency, frequency detection, overload warning, zero current detection, output current detection, PID upper limit, PID lower limit, PID forward/reverse rotation, operation ready, minor failure and alarm. 1 contact output (1 contact, 230V 0.3A AC, 30V 0.3A DC) signal can be selected.	Use Pr. 64 to Pr. 65 for selection.
		For meter	Japanese	1 signal can be selected from output frequency and motor current. Pulse train output (1440 pulses/s, 1mA full scale)	
			NA, EC	1 signal can be selected from output frequency and motor current. Analog output (0 to 5VDC, 1mA full scale)	
Protective/alarm functions				Overcurrent shut-off (during acceleration, deceleration, constant speed), regenerative overvoltage shut-off (during acceleration, deceleration, constant speed), overload shut-off (electronic overcurrent protection), fin overheat, fan failure (*4), stall prevention, start-time output side ground fault protection (*5), external thermal relay (*6), PU disconnection (*3), retry count excess, communication error (*3), CPU error, undervoltage (*1)	
Environment	Ambient temperature			-10ºC to +50ºC (14°F to 122°F) (non-freezing) (-10°C to +40°C (14°F to 104°F) for totally enclosed structure feature)	
	Ambient humidity			90%RH maximum. (non-condensing)	
	Storage temperature			-20ºC to +65ºC (-4°F to 149°F)	
	Ambience			Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)	
	Altitude, vibration			Maximum 1000m (3280.80feet) above sea level for standard operation. 5.9m/s^2 or less (conforming to JIS C 0040)	

*1. When undervoltage or instantaneous power failure occurs, no alarm output is provided but the output is shut off. After power restoration, the inverter may be run as it is. Depending on the running status (e.g. load magnitude), however, overcurrent, regenerative overvoltage or other protection may be activated at power restoration. (In external operation mode.)

*2. The braking torque indicated is a short-duration average torque (which varies with motor loss) when the motor alone is decelerated from 60Hz in the shortest time and is not a continuous regenerative torque. When the motor is decelerated from the frequency higher than the base frequency, the average deceleration torque will reduce.

*3. This function is valid for only the type with RS-485 communication function.

*4. Compatible with only the product having the built-in cooling fan.

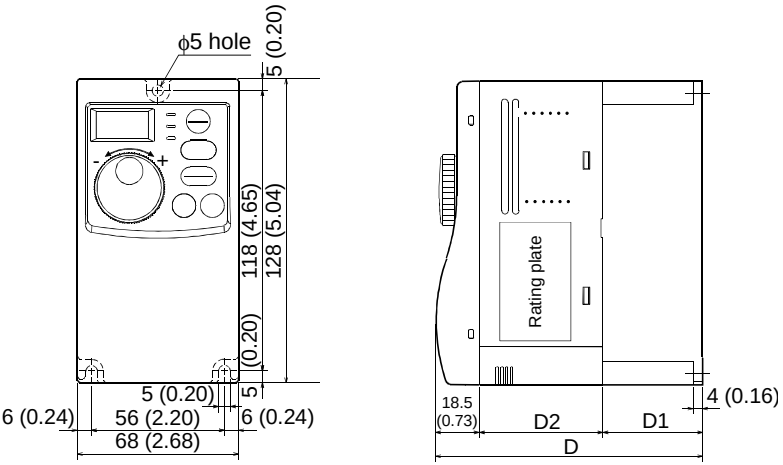
*5. Activated only when "1" is set in Pr. 40 "start-time ground fault detection selection".

*6. Activated only when external thermal relay input (OH) is selected in any of Pr. 60 to Pr. 63 (input terminal function selection).

4.2 Outline Drawings

(Remarks) For the dimensions of the type having RS-485 communication function and the totally enclosed structure type, refer to those of the standard type inverter of the same capacity.

- FR-S520-0.1K, 0.2K, 0.4K, 0.75K(-NA)
- FR-S520S-0.1K
- FR-S520S-0.2K, 0.4K, 0.75K(-EC)
- FR-S510W-0.1K, 0.2K, 0.4K(-NA)



•3-phase 200V power supply

Capacity	D	D1	D2
0.1K, 0.2K	80.5 (3.17)	10 (0.39)	52 (2.05)
0.4K	112.5 (4.43)	42 (1.65)	52 (2.05)
0.75K	132.5 (5.22)	62 (2.44)	52 (2.05)

•Single-phase 200V power supply

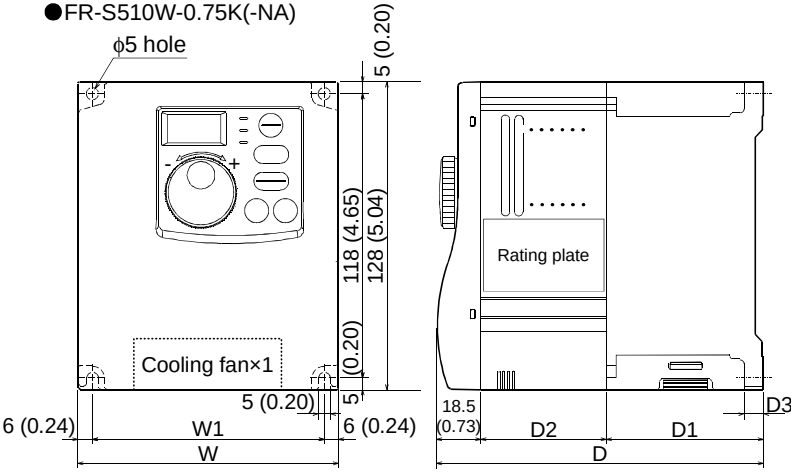
Capacity	D	D1	D2
0.1K, 0.2K	80.5 (3.17)	10 (0.39)	52 (2.05)
0.4K	142.5 (5.61)	42 (1.65)	82 (3.23)
0.75K	162.5 (6.40)	62 (2.44)	82 (3.23)

•Single-phase 100V power supply

Capacity	D	D1	D2
0.1K	80.5 (3.17)	10 (0.39)	52 (2.05)
0.2K	110.5 (4.35)	10 (0.39)	82 (3.23)
0.4K	142.5 (5.61)	42 (1.65)	82 (3.23)

(Unit: mm (inches))

●FR-S520-1.5K, 2.2K, 3.7K(-NA)
●FR-S540-0.4K, 0.75K, 1.5K, 2.2K, 3.7K(-NA)(-EC)
●FR-S520S-1.5K(-EC)
●FR-S510W-0.75K(-NA)



•3-phase 200V power supply

Capacity	W	W1	D	D1	D2	D3
1.5K, 2.2K	108 (4.25)	96 (3.78)	135.5 (5.33)	65 (2.56)	52 (2.05)	8 (0.31)
3.7K	170 (6.69)	158 (6.22)	142.5 (5.61)	72 (2.83)	52 (2.05)	5 (0.20)

•3-phase 400V power supply

Capacity	W	W1	D	D1	D2	D3
0.4K, 0.75K	108 (4.25)	96 (3.78)	129.5 (5.10)	59 (2.32)	52 (2.05)	5 (0.20)
1.5K	108 (4.25)	96 (3.78)	135.5 (5.33)	65 (2.56)	52 (2.05)	8 (0.31)
2.2K	108 (4.25)	96 (3.78)	155.5 (6.12)	65 (2.56)	72 (2.83)	8 (0.31)
3.7K	108 (4.25)	96 (3.78)	165.5 (6.52)	65 (2.56)	82 (3.23)	8 (0.31)

•Single-phase 200V power supply

Capacity	W	W1	D	D1	D2	D3
1.5K	108 (4.25)	96 (3.78)	155.5 (6.12)	65 (2.56)	72 (2.83)	8 (0.31)

•Single-phase 100V power supply

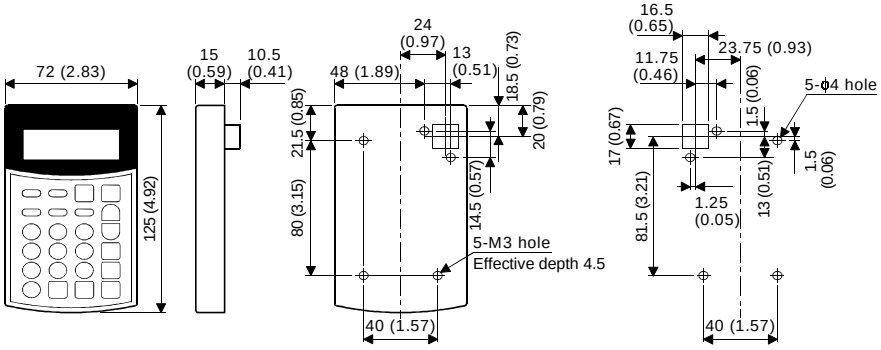
Capacity	W	W1	D	D1	D2	D3
0.75K	108 (4.25)	96 (3.78)	149.5 (5.89)	59 (2.32)	72 (2.83)	5 (0.20)

* The FR-S540-0.4K, 0.75K (-NA) (-EC) and FR-S510W-0.75K (-NA) do not have a cooling fan.

(Unit: mm (inches))

● Parameter unit (FR-PU04)

<Outline drawing> <Panel cut dimension drawing>



(Unit:mm (inches))

Choose the mounting screws whose length will not exceed the effective depth of the mounting threads.

5. INSTRUCTIONS

5.1 Selecting Instructions

(1) Inverter capacity selection

When a special motor is run or multiple motors are run in parallel by one inverter, choose the inverter capacity so that the sum of the rated motor currents (at 50Hz) will be not more than the rated output current of the inverter.

(2) Motor starting torque

The starting and acceleration characteristics of an inverter-driven motor are restricted by the overload capacity of the inverter used. The torque characteristic is generally smaller than at a start made by the commercial power supply. When large starting torque is necessary, choose automatic torque boost control (set the motor capacity in Pr. 98) or adjust the torque boost value. If these selection and adjustment cannot develop enough torque, choose a one rank higher inverter capacity or increase both the motor and inverter capacities.

(3) Acceleration/deceleration time

- The acceleration/deceleration time of the motor is determined by the motor-generated torque, load torque and load's inertia moment (J).
- If the current limit or stall prevention function is activated during acceleration/deceleration, the time may increase, so change the acceleration/deceleration time setting to a little longer value.
- When you want to shorten the acceleration/deceleration time, increase the torque boost value (if you set a too large value, the stall prevention function will be activated at a start, resulting in increased acceleration/deceleration time), use automatic torque boost control, or increase the inverter and motor capacities.

5.2 Peripheral Selecting Instructions

(1) Installation and selection of no-fuse breaker

To protect the inverter's primary side wiring, install a no-fuse breaker (NFB) on the power receiving side. For selection of the NFB, refer to page 13 as it depends on the power supply side power factor (which changes with the power supply voltage, output frequency and load) of the inverter. Especially, a little larger capacity must be chosen for a completely electromagnetic type NFB because its operation characteristic changes with harmonic currents. Also, use the earth leakage circuit breaker of our harmonic/surge suppression product. (Refer to page 15)

(2) Handling of primary side magnetic contactor

- When the external terminal is used (terminal STF or STR is used) for operation, provide a primary side MC to prevent accidents due to an automatic restart at power restoration after a power failure, such as an instantaneous power failure, and to ensure safety in maintenance work. Do not use this MC to make frequent starts and stops. (The switching life of the inverter input circuit is about 100,000 times.)
- For parameter unit operation, an automatic restart after power failure is not made and the MC cannot be used to make a start. Note that the primary side MC may be used to make a stop but the motor will coast to a stop.

(3) Handling of secondary side magnetic contactor

In principle, do not provide a magnetic contactor between the inverter and motor and switch it from off to on during operation. If it is switched on during inverter operation, a large inrush current may flow, stopping the inverter due to overcurrent shut-off. When an MC is provided for switching to the commercial power supply, for example, switch it on/off after the inverter and motor have stopped.

(4) Installation of thermal relay

To protect the motor from overheat, the inverter has the protective functions using electronic overcurrent protection. However, when multiple motors are run by a single inverter or a multi-pole motor is run (for example), provide a thermal relay (OCR) between the inverter and motor. In this case, set the electronic overcurrent protection of the inverter to 0A, and set the thermal relay by adding a line-to-line leakage current (refer to page 16) to 1.0 times the current value at 50Hz given on the motor rating plate or 1.1 times the current value at 60Hz

(5) Disuse of power factor improving capacitor (power capacitor)

The power factor improving capacitor and surge suppressor on the inverter output side may be overheated or damaged by the harmonic contents of the inverter output. In addition, do not provide a capacitor and surge suppressor since excessive currents will flow in the inverter to active overcurrent protection. To improve the power factor, use a power factor improving reactor.

(6) Secondary side measuring instruments

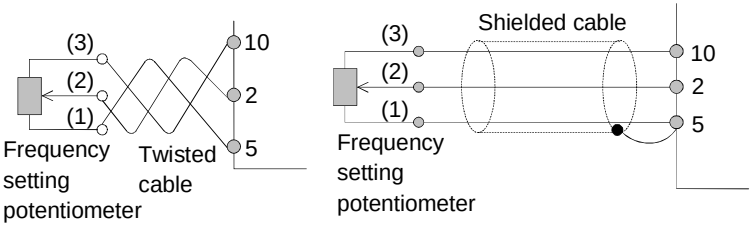
If inverter-to-motor wiring is long, the measuring instruments and CT may generate heat under the influence of line-to-line leakage currents. To prevent this, choose the instruments which have allowances for current ratings.

(7) About electromagnetic wave interference

The inputs/outputs of the inverter's main circuit include harmonic content and may interfere with communications apparatus (AM radios) and sensors used near the inverter. In this case, installing the FR-BIF radio noise filter (for use on input side only) or FR-BSF01 or FR-BLF line noise filter reduces interference.

(8) Cable thickness and wiring distance

- If the inverter-to-motor wiring distance is long, the motor torque will decrease due to a voltage drop in the main circuit cables especially at low frequency output. Use thick cables for wiring to make a voltage drop less than 2%. (A selection example for the wiring distance of 20m (65.62feet) is given on page 11.)
- For remote operation using analog signals, the control cable between operator box or operator signal and inverter should be less than 30m (98.43feet) and wire the cable away from the power circuit to avoid induction from other equipment.
- When using the external potentiometer to set the frequency, use a shielded or twisted cable, and do not earth the shield, but connect it to terminal 5 as shown below.



■Grounding
When the inverter is run in the low acoustic noise mode, high-speed switching will generate more leakage currents than in the non-low acoustic noise mode. Always ground the inverter and motor. In addition, always use the ground terminal of the inverter to ground the inverter.

5.3 Operating Instructions

(1) Operation

- When a magnetic contactor (MC) is provided on the primary side, do not use this MC to make frequent starts/stops. Doing so can cause the inverter to fail.
- When an alarm occurs in the inverter, the protective function is activated to stop the output. However, at this time, the motor cannot be brought to a sudden stop. Hence, provide a mechanical stopping/holding mechanism for the machine/equipment which requires an emergency stop.
- Since the capacitor needs time to discharge, do not start inspection immediately after powering off the inverter. More than 10 minutes after power-off, make sure that there are no residual voltages with a multimeter etc. before stating inspection.

(2) Wiring

- Application of power to the output terminals (U, V, W) of the inverter will damage the inverter circuit. Hence, before power-on, fully check the wiring and sequence for incorrect wiring and so on.
- Terminals P<+> and P1 are designed to connect a dedicated option. Do not connect any equipment other than the dedicated option. In addition, do not short the frequency setting power supply terminal 10 and common terminal 5, and terminals PC-SD.

(3) Installation

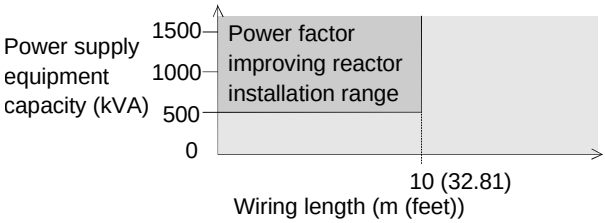
- Avoid hostile environment where oil mist, fluff, dust etc. are floating, and install the inverter in a clean place or put it within an enclosed box where floating bodies will not enter. When placing the inverter inside a box, determine the cooling system and box dimensions so that the ambient temperature of the inverter will fall within the permissible temperature range (refer to page 166 for the specified value).
- The inverter may become hot locally, so do not mount it to combustible material such as wood.
- Mount the inverter to a wall in a vertical direction.

(4) Setting

- By setting the operation panel, the inverter can be run at the speed as high as 120Hz. Therefore, wrong setting will lead to hazardous conditions. Using the maximum frequency setting function, set the upper limit.
  (The maximum frequency in the external operation mode is factory-set to 60Hz.)
- Setting the DC injection brake operation voltage and operation time to values higher than the factory settings can cause the motor to overheat (electronic overcurrent protection trip).

(5) Power supply

- When the inverter is installed near a large-capacity power transformer (500kVA or more at the wiring length of 10m (32.81feet) or less) or the power capacitor is to be switched, an excessive peak current will flow in the power supply input circuit, damaging the inverter. In such a case, always install the FR-BEL or FR-BAL power factor improving reactor.



- If a surge voltage occurs in the power supply system, this surge energy may flow into the inverter, causing the inverter to display OV1, OV2 or OV3 and come to an alarm stop. In such a case, also install the FR-BEL or FR-BAL power factor improving reactor.

5.4 Inverter-driven 400V class motor

In the PWM type inverter, a surge voltage attributable to wiring constants is generated at the motor terminals. Especially for a 400V class motor, the surge voltage may deteriorate the insulation. When the 400V class motor is driven by the inverter, consider the following measures:

- Measures

It is recommended to take either of the following measures:

(1) Rectifying the motor insulation

For the 400V class motor, use an insulation-rectified motor. Specifically

1) Specify the "400V class inverter-driven, insulation-rectified motor".
2) For the dedicated motor such as the constant-torque motor and low-vibration motor, use the "inverter-driven, dedicated motor".

(2) Suppressing the surge voltage on the inverter side

On the secondary side of the inverter, connect the optional surge voltage suppression filter (FR-ASF-H).

APPENDIX

APPENDIX 1 PARAMETER DATA CODE LIST

Function	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Basic functions	0	Torque boost	00	80	0.1%	0
	1	Maximum frequency	01	81	0.01Hz	0
	2	Minimum frequency	02	82	0.01Hz	0
	3	Base frequency	03	83	0.01Hz	0
	4	Multi-speed setting (high speed)	04	84	0.01Hz	0
	5	Multi-speed setting (middle speed)	05	85	0.01Hz	0
	6	Multi-speed setting (low speed)	06	86	0.01Hz	0
	7	Acceleration time	07	87	0.1s	0
	8	Deceleration time	08	88	0.1s	0
	9	Electronic thermal O/L relay	09	89	0.01A	0
	30	Extended function display selection	1E	9E	1	0
	79	Operation mode selection	4F	None	1	0

The extended function parameters are made valid by setting "1" in Pr. 30 "extended function display selection".

Function	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Standard operation functions	10	DC injection brake operation frequency	0A	8A	0.01Hz	0
	11	DC injection brake operation time	0B	8B	0.1s	0
	12	DC injection brake voltage	0C	8C	0.1%	0
	13	Starting frequency	0D	8D	0.01Hz	0
	14	Load pattern selection	0E	8E	1	0
	15	Jog frequency	0F	8F	0.01Hz	0
	16	Jog acceleration/ deceleration time	10	90	0.1s	0
	17	RUN key rotation direction selection	11	91	1	0
	19	Base frequency voltage	13	93	0.1V	0
	20	Acceleration/deceleration reference frequency	14	94	0.01Hz	0
	21	Stall prevention function selection	15	95	1	0
	22	Stall prevention operation level	16	96	0.1%	0

Func-tion	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Standard operation functions	23	Stall prevention operation level compensation factor at double speed	17	97	0.1%	0
	24	Multi-speed setting (speed 4)	18	98	0.01Hz	0
	25	Multi-speed setting (speed 5)	19	99	0.01Hz	0
	26	Multi-speed setting (speed 6)	1A	9A	0.01Hz	0
	27	Multi-speed setting (speed 7)	1B	9B	0.01Hz	0
	28	Stall prevention operation reduction starting frequency	1C	9C	0.01Hz	0
	29	Acceleration/deceleration pattern	1D	9D	1	0
	31	Frequency jump 1A	1F	9F	0.01Hz	0
	32	Frequency jump 1B	20	A0	0.01Hz	0
	33	Frequency jump 2A	21	A1	0.01Hz	0
	34	Frequency jump 2B	22	A2	0.01Hz	0
	35	Frequency jump 3A	23	A3	0.01Hz	0
	36	Frequency jump 3B	24	A4	0.01Hz	0
	37	Speed display	25	A5	0.001	0
	38	Frequency setting voltage gain frequency	26	A6	0.01Hz	0
	39	Frequency setting current gain frequency	27	A7	0.01Hz	0
	40	Start-time ground fault detection selection	28	A8	1	0
Output terminal functions	41	Up-to-frequency sensitivity	29	A9	0.1%	0
	42	Output frequency detection	2A	AA	0.01Hz	0
	43	Output frequency detection for reverse rotation	2B	AB	0.01Hz	0
Second functions	44	Second acceleration/ deceleration time	2C	AC	0.1s	0
	45	Second deceleration time	2D	AD	0.1s	0
	46	Second torque boost	2E	AE	0.1%	0
	47	Second V/F (base frequency)	2F	AF	0.01Hz	0

Func-tion	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Current detection	48	Output current detection level	30	B0	0.1%	0
	49	Output current detection signal delay time	31	B1	0.1s	0
	50	Zero current detection level	32	B2	0.1%	0
	51	Zero current detection time	33	B3	0.01s	0
Display functions	52	Control panel display data selection	34	B4	1	0
	53	Frequency setting operation selection	35	B5	1	0
	54	FM (AM) terminal function selection	36	B6	1	0
	55	Frequency monitoring reference	37	B7	0.01Hz	0
	56	Current monitoring reference	38	B8	0.01A	0
Automatic restart functions	57	Restart coasting time	39	B9	0.1s	0
	58	Restart cushion time	3A	BA	0.1s	0
Additional function	59	Remote setting function selection/Frequency setting storage function selection	3B	BB	1	0
Terminal functions selection	60	RL terminal function selection	3C	BC	1	0
	61	RM terminal function selection	3D	BD	1	0
	62	RH terminal function selection	3E	BE	1	0
	63	STR terminal function selection	3F	BF	1	0
	64	RUN terminal function selection	40	C0	1	0
	65	A, B, C terminal function selection	41	C1	1	0
Operation selection functions	66	Retry selection	42	C2	1	0
	67	Number of retries at alarm occurrence	43	C3	1	0
	68	Retry waiting time	44	C4	0.1s	0
	69	Retry count display erase	45	C5	1	0
	70	Soft-PWM setting	46	C6	1	0
	71	Applied motor	47	C7	1	0

Func-tion	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Operation selection functions	72	PWM frequency selection	48	C8	1	0
	73	0-5V/0-10V selection	49	C9	1	0
	74	Input filter time constant	4A	CA	1	0
	75	Reset selection/PU stop selection	4B	CB	1	0
	76	Cooling fan operation selection	4C	CC	1	0
	77	Parameter write disable selection	4D	None	1	0
	78	Reverse rotation prevention selection	4E	CE	1	0
Multi-speed operation	80	Multi-speed setting (speed 8)	50	D0	0.01Hz	0
	81	Multi-speed setting (speed 9)	51	D1	0.01Hz	0
	82	Multi-speed setting (speed 10)	52	D2	0.01Hz	0
	83	Multi-speed setting (speed 11)	53	D3	0.01Hz	0
	84	Multi-speed setting (speed 12)	54	D4	0.01Hz	0
	85	Multi-speed setting (speed 13)	55	D5	0.01Hz	0
	86	Multi-speed setting (speed 14)	56	D6	0.01Hz	0
	87	Multi-speed setting (speed 15)	57	D7	0.01Hz	0
PID control	88	PID action selection	58	D8	1	0
	89	PID proportional band	59	D9	0.1%	0
	90	PID integral time	5A	DA	0.1s	0
	91	PID upper limit	5B	DB	0.1%	0
	92	PID lower limit	5C	DC	0.1%	0
	93	PID action set point for PU operation	5D	DD	0.01%	0
	94	PID differential time	5E	DE	0.01s	0
Sub functions	95	Rated motor slip	5F	DF	0.01%	0
	96	Slip compensation time constant	60	E0	0.01s	0
	97	Constant-output region slip compensation selection	61	E1	1	0
	98	Automatic torque boost selection (Motor capacity)	62	E2	0.01kW	0
	99	Motor primary resistance	63	E3	0.001Ω	0

Function	Parameter Number	Name	Data Code		Computer Link Data Setting Increments *	Link Parameter Extension Setting (Data Code 7F/FF)
			Read	Write		
Calibration parameters	C1 (900 (901))	FM (AM) terminal calibration	5C	DC	—	1
	C2 (902)	Frequency setting voltage bias frequency	5E	DE	0.01Hz	1 (6C/EC=0)
	C3 (902)	Frequency setting voltage bias	5E	DE	0.1%	1 (6C/EC=1)
	C4 (903)	Frequency setting voltage gain	5F	DF	0.1%	1 (6C/EC=1)
	C5 (904)	Frequency setting current bias frequency	60	E0	0.01Hz	1 (6C/EC=0)
	C6 (904)	Frequency setting current bias	60	E0	0.1%	1 (6C/EC=1)
	C7 (905)	Frequency setting current gain	61	E1	0.1%	1 (6C/EC=1)
	C8 (269)	Parameter set by manufacturer. Do not set.				
Clear parameters	CLr	Parameter clear	—	FC	1	—
	ECL	Alarm history clear	—	F4	1	—
Communication parameters	n1 (331)	Communication station number	1F	9F	1	3
	n2 (332)	Communication speed	20	A0	1	3
	n3 (333)	Stop bit length	21	A1	1	3
	n4 (334)	Parity check presence/absence	22	A2	1	3
	n5 (335)	Number of communication retries	23	A3	1	3
	n6 (336)	Communication check time interval	24	A4	0.1s	3
	n7 (337)	Wait time setting	25	A5	1	3
	n8 (338)	Operation command write	26	A6	1	3
	n9 (339)	Speed command write	27	A7	1	3
	n10 (340)	Link start mode selection	28	A8	1	3
	n11 (341)	CR/LF selection	29	A9	1	3
	n12 (342)	E^2PROM write selection	2A	AA	1	3
	n13 (145)	PU display language	2D	AD	1	1
	n14 (990)	PU buzzer sound control	5A	DA	1	9
	n15 (991)	PU contrast adjustment	5B	DB	1	9
	n16 (992)	PU main display screen data selection	5C	DC	1	9
	n17 (993)	PU disconnection detection/PU setting lock	5D	DD	1	9

The parameter numbers within parentheses are those for use of the parameter unit (FR-PU04).

* Though parameter setting by RS-485 communication can be made in the setting increments indicated in the table, note that the valid setting increments are as indicated in the parameter list (page 46).

REVISIONS

*The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Mar, 2000	IB(NA)-0600027-A	First edition
Jun., 2000	IB(NA)-0600027-B	Addition Single-phase 100V power input specifications
Mar., 2001	IB(NA)-0600027-C	Addition 3-phase 400V power input specifications