MITSUBISHI ELECTRIC

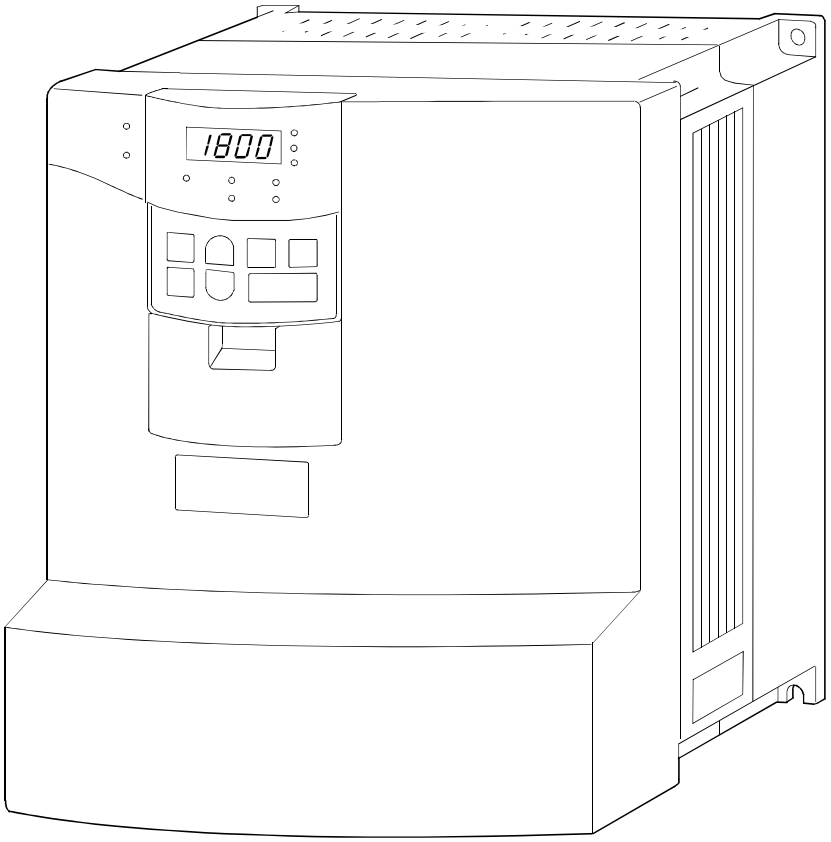
VECTOR INVERTER

FR-V560

INSTRUCTION MANUAL (Detailed)

HIGH PRECISION & HIGH RESPONSE VECTOR INVERTER

FR-V560-2.2K to 55K-NA



Thank you for choosing this Mitsubishi vector inverter. This Instruction Manual (detailed) provides instructions for advanced use of the FR-V500 series inverters. Incorrect handling might cause an unexpected fault. Before using the inverter, always read this Instruction Manual and the Instruction Manual (basic) [IB-0600134E] packed with the product carefully to use the equipment to its optimum performance.
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.
- Even 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, switch power off, wait for more than at least 10 minutes and check for the presence of any residual voltage with a meter etc.
- This inverter must be grounded. Grounding must conform to the requirements of national and local safety regulations and electrical codes. (JIS, NEC section 250, IEC 536 class 1 and other applicable standards).
- 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.

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.
- When a brake resistor is used, use an alarm signal to switch power off. Otherwise, the brake resistor will overheat abnormally due to a brake transistor or other fault, resulting in 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.
- 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)

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

2) Wiring

⚠CAUTION

- Do not fit capacitive equipment such as power factor correction capacitor, surge suppressor or radio noise filter to the inverter output side.
- The connection orientation of the output cables (terminals 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.

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 thermal relay function 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 from the inverter may heat/damage the power capacitor and generator.
- When a 575V 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. In addition to the inverter's holding function, install a holding device to ensure safety.

5) Emergency stop

⚠CAUTION

- Provide a safety backup such as an emergency brake which will prevent the machine and equipment from hazardous conditions if the inverter fails.
- When the breaker on the inverter primary side trips, check for the wiring fault (short circuit), damage of the inner parts of the inverter, etc. Identify the cause of the trip, then remove the cause and power on the breaker.
- When any protective function is activated, take the appropriate corrective action, then reset the inverter, and resume 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 in this manner. Always replace the cover and follow this Instruction Manual when operating the inverter.

CONTENTS

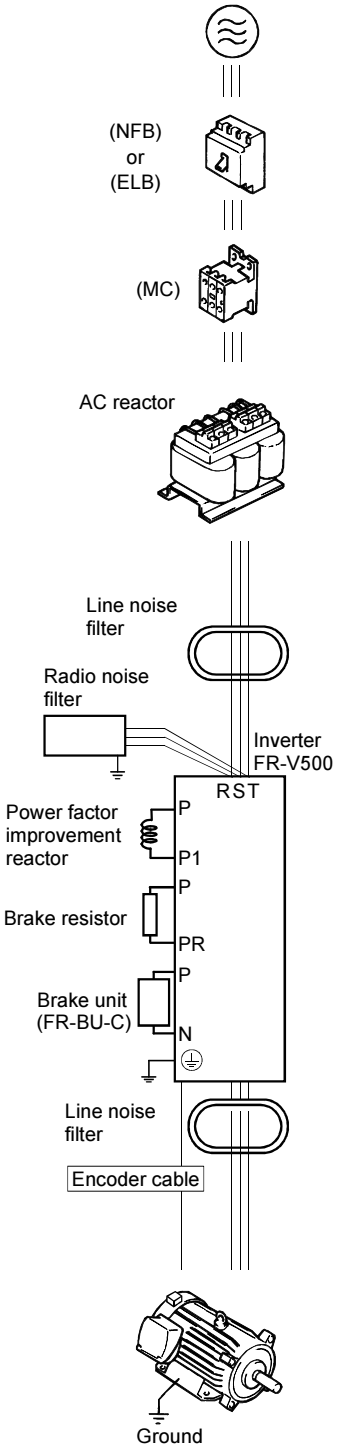
1 WIRING

This chapter describes the basic "wiring" for use of this product.
Always read the instructions and other information before using the equipment.

<Abbreviations>
·DU : Operation panel (FR-DU04-1)
·PU : Operation panel (FR-DU04-1) and parameter unit (FR-PU04V)
·Inverter : Mitsubishi vector inverter FR-V500 series
·Pr. : Parameter number
·PU operation : Operation using the PU (FR-DU04-1/FR-PU04V)
·External operation : Operation using the control circuit signals
·Combined operation : Operation using both the PU (FR-DU04-1/FR-PU04V) and external operation

1.1 Basic configuration and connection of peripheral devices

1.1.1 Basic configuration



Power supply
Use within the permissible power supply specifications of the inverter. (Refer to page 220.)

No-fuse breaker (NFB) or earth leakage circuit breaker (ELB)
The breaker must be selected carefully since an in-rush current flows in the inverter at power-on. (Refer to page 3.)

Magnetic contactor
Install the magnetic contactor to ensure safety. (For details, refer to page 21.)
Do not use this magnetic contactor to start and stop the inverter. Doing so will cause the inverter life to be shorten. (Refer to page 3.)

Power factor improvement reactor
The reactors must be used when the power factor is to be improved or the inverter is installed near a large power supply system (1000kVA or more and wiring distance within 10m (32.81feet)). The inverter may be damaged if you do not use reactors.
Make selection carefully.
- DC reactor, AC reactor

(Caution) Remove the jumpers across terminals P-P1 to connect to the DC reactor.

Noise filter
Install a noise filter to reduce the magnetic noise generated from the inverter.
- Line noise filter
  Effective in the range from about 1MHz to 10MHz. When more wires are passed through, a more effective result can be obtained. (Note that the number of wires run through is limited when fitting to the output side.)
- Radio noise filter
  Effective in reducing the noises in the AM radio frequency band. Dedicated filter for the input side.

Inverter

The life of the inverter is influenced by ambient temperature. The ambient temperature should be as low as possible within the permissible range. This must be noted especially when the inverter is installed in an enclosure. (Refer to the Instruction Manual (basic).)
Wrong wiring might lead to damage of the inverter. The control signal lines must be kept fully away from the main circuit to protect them from noise. (Refer to page 4.)

Brake resistor
(Caution) For the 7.5K or less inverter, remove the jumpers across terminals PR-PX to connect to the inverter.

Brake unit
(Caution) For the 7.5K or less inverter, remove the jumpers across terminals PR-PX to connect to the inverter.

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Motor with encoder
Perform offline auto tuning when exercising vector control with encoder. (Refer to page 132.)

Devices connected to the output
Do not install a power factor correction capacitor, surge suppressor or radio noise filter on the output side of the inverter.
When installing a no fuse breaker on the output side of the inverter, contact each manufacturer for selection of the no fuse breaker.

Ground
To prevent an electric shock, always ground the motor and inverter. For reduction of induction noise from the power line of the inverter, it is recommended to wire the ground cable by returning it to the ground terminal of the inverter.
(For details of noise reduction techniques, refer to page 19.)

CAUTION

- **Do not fit capacitive equipment such as power factor correction capacitor, radio noise filter or surge suppressor to the output side of the inverter. This will cause the inverter to trip or power factor correction capacitor and surge suppressor to be damaged. If any of the above devices are connected, immediately remove them. (If the radio noise filter is connected, switching power off during motor operation may result in "E.UVT". In this case, connect the radio noise filter on the primary side of the magnetic contactor.)**
- **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 radio noise filter (for use on the input side only) or line noise filter to minimize interference.
- **For details of peripheral devices, refer to manuals of each peripheral devices.**

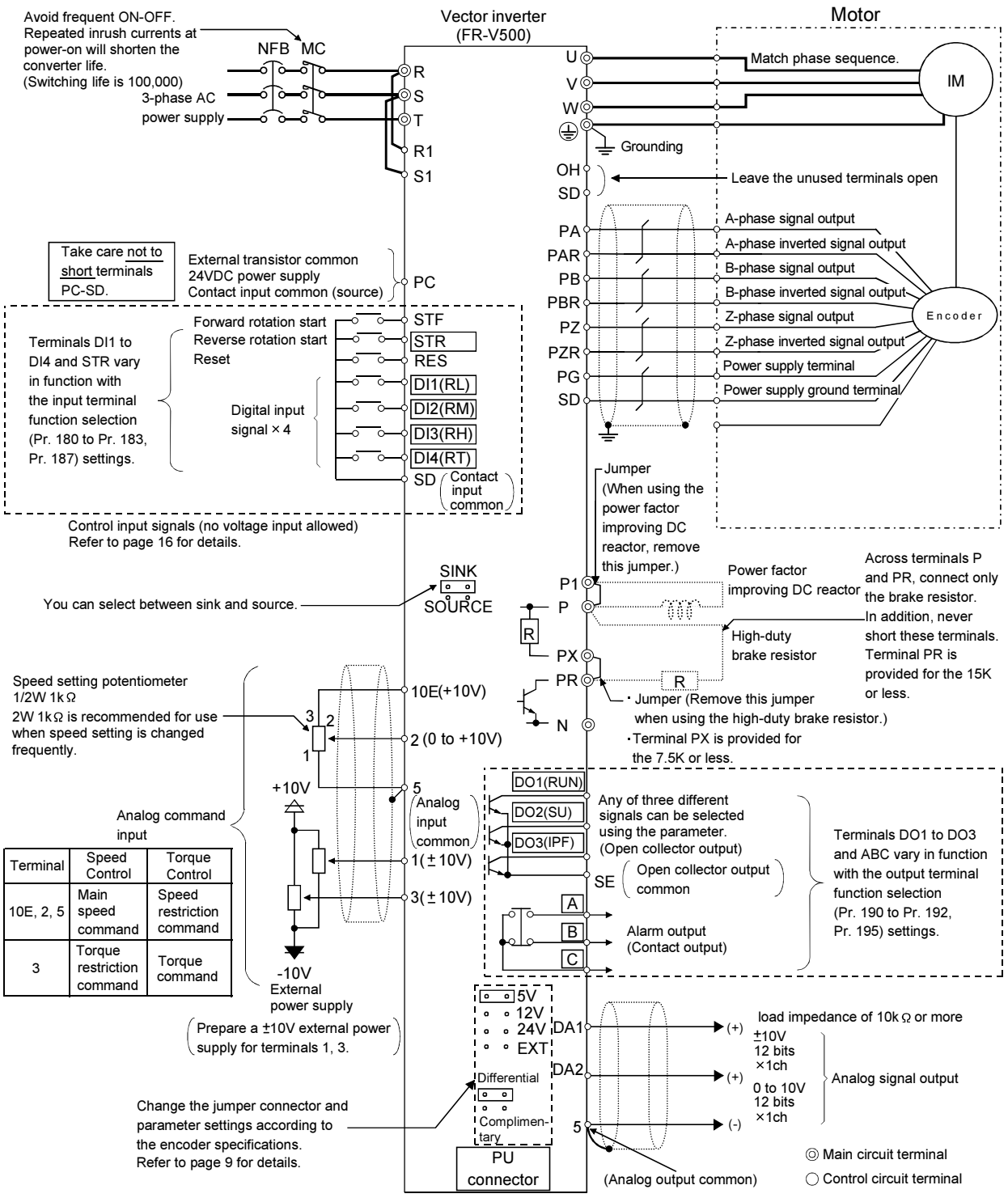
1.1.2 Selection of peripheral devices

Check the motor applicable to the inverter you purchased. Appropriate peripheral devices need to be selected according to the motor capacity. Refer to the list below and prepare appropriate peripheral devices.

Motor Output (kW (HP))	Applicable Inverter Type	No-fuse Breaker (NFB) or Earth Leakage Circuit Breaker (ELB) *		Fuse	Magnetic Contactor (AC3)
		Standard	With power factor improving reactor		
2.2 (3)	FR-V560-2.2K-NA	15A	10A	K5-15A	7A
3.7 (5)	FR-V560-3.7K-NA	20A	15A	K5-20A	10A
7.5 (10)	FR-V560-7.5K-NA	30A	30A	K5-40A	21A
15 (20)	FR-V560-15K-NA	60A	50A	K5-80A	42A
22 (30)	FR-V560-22K-NA	90A	75A	K5-110A	59A
37 (50)	FR-V560-37K-NA	150A	125A	K5-200A	94A
55 (75)	FR-V560-55K-NA	200A	175A	K5-300A	137A

* • Select the NFB type according to the power supply capacity.
• Install the NFB according to the inverter capacity.
• When the breaker on the inverter primary side trips, check for the wiring fault (short circuit), damage of the inner parts of the inverter, etc. Identify the cause of the trip, then remove the cause and power on the breaker.
• For installation in the United States and Canada, select circuit breakers authorized by UL and cUL.

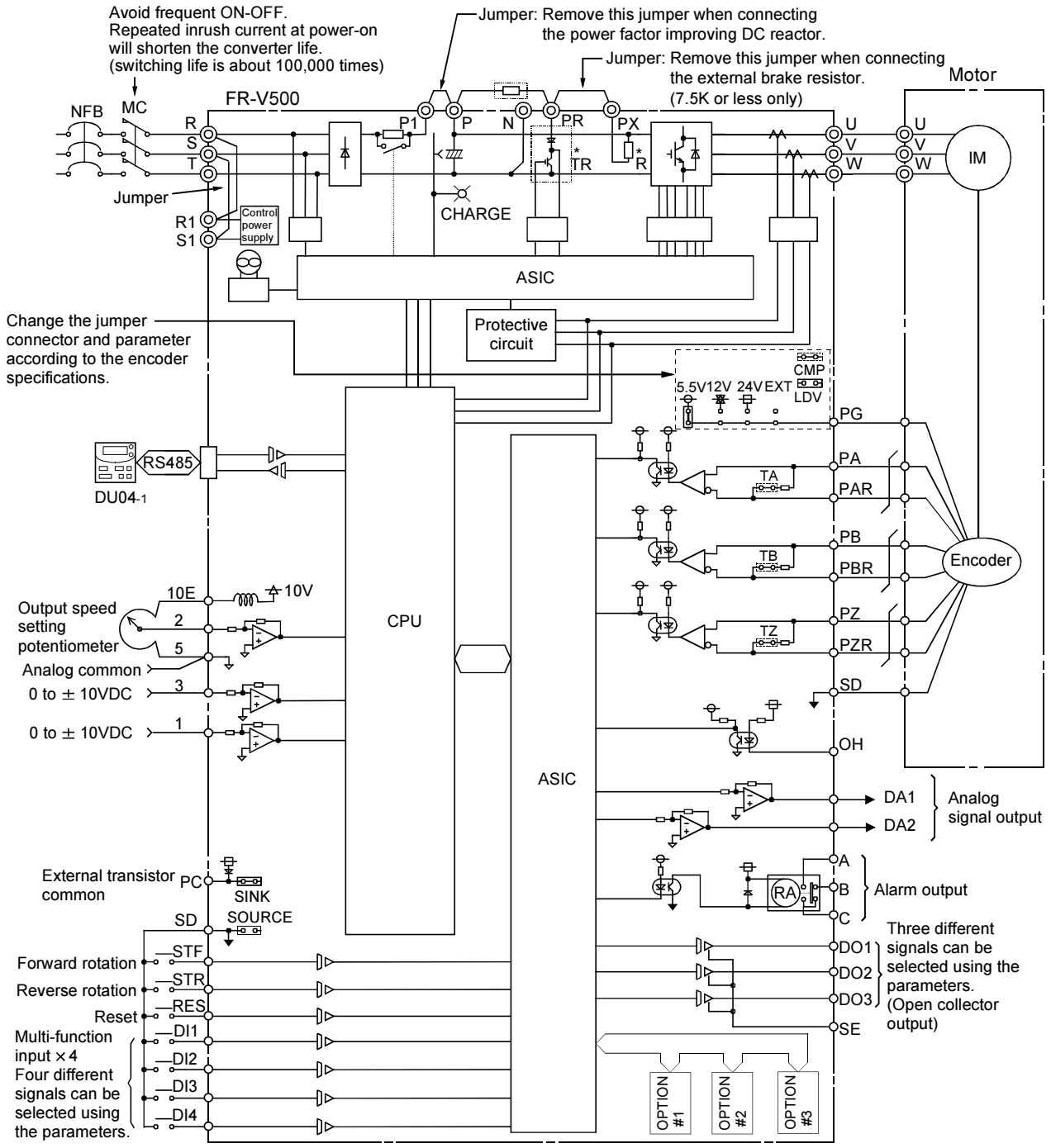
1.2 Connection diagram



CAUTION

- **To prevent a malfunction caused by noise, separate the signal cables more than 10cm (3.94 inches) from the power cables.**
- **During wiring, do not leave wire off-cuts in the inverter.**
  Wire off-cuts will cause an alarm, failure or malfunction. Always keep the inverter clean. When drilling mounting holes in a control box etc., take care not to allow chips and other foreign matter to enter the inverter.

1.3 Internal block diagram



CAUTION

1. **The 22K or more is not equipped with the built-in brake resistor and brake transistor marked *. The brake transistor is provided for the 15K or less and the built-in brake resistor for the 7.5K or less.**
2. **Always ground the inverter and motor.**

1.4 Main circuit terminal specifications

1.4.1 Specification of main circuit terminal

Terminal Symbol	Terminal Name	Description
R, S, T	AC power input	Connect to the commercial power supply.
U, V, W	Inverter output	Connect a three-phase squirrel-cage motor.
R1, S1	Power supply for control circuit	Connected to the AC power supply terminals R and S. To retain the alarm display and alarm output, remove the jumpers from terminals R-R1 and S-S1 and apply external power to these terminals. Do not turn off the power supply for control circuit (R1, S1) with the main circuit power (R, S, T) on. Doing so may damage the inverter. The circuit should be configured so that the main circuit power (R, S, T) is also turned off when the power supply for control circuit (R1, S1) is off. 15K or less: 60VA, 22K to 55K: 80VA
P, PR	Brake resistor connection	Disconnect the jumper from terminals PR-PX (7.5K or less) and connect the brake resistor across terminals P-PR. For the 15K or less, connecting the resistor further provides regenerative braking power.
P, N	Brake unit connection	Connect the optional FR-BU-C brake unit.
P, P1	Power factor improving DC reactor connection	Disconnect the jumper from terminals P-P1 and connect the power factor improving reactor.
PR, PX	Built-in brake circuit connection	When the jumper is connected across terminals PX-PR (factory setting), the built-in brake circuit is valid. (Provided for the 7.5K or less.)
⏚	Ground	For grounding the inverter chassis. Must be grounded.

CAUTION

- **The inverter will be damaged if power is applied to the inverter output terminals (U, V, W). Never perform such wiring.**
- **When connecting the external brake resistor, remove jumpers across terminals PR-PX (7.5K or less). Refer to page 105.**
- **When connecting the brake unit (FR-BU-C), remove jumpers across terminals PR-PX (7.5K or less). Refer to page 12.**

1.4.2 Cables and wiring length

Select the recommended cable size to ensure that a voltage drop will be 2% max.
If the wiring distance between the inverter and motor is long, the motor torque will decrease due to the voltage drop of the main circuit cable especially at high-frequency output. The encoder signal will also be affected by the voltage drop.
The following selection example assumes the wiring length of 20m (65.62 feet).

Applicable Inverter Type	Terminal Screw Size	Tightening Torque N·m	Crimping Terminals		HIV Cables			
					mm^2		AWG	
			R, S, T	U, V, W	R, S, T	U, V, W	R, S, T	U, V, W
FR-V560-2.2K, 3.7K-NA	M4	1	2-4	2-4	2	2	14	14
FR-V560-7.5K-NA	M4	1	5.5-4	2-4	3.5	2	12	14
FR-V560-15K-NA	M6	4	5.5-6	5.5-6	5.5	5.5	10	10
FR-V560-22K-NA	M6	4	14-6	14-6	14	14	6	6
FR-V560-37K-NA	M8	7	22-8	22-8	22	22	4	4
FR-V560-55K-NA	M8	7	38-8	38-8	38	38	2	2

The line voltage drop can be calculated by the following expression:

$$\text{Line voltage drop [V]} = \frac{\sqrt{3} \times \text{cable resistance}[m\Omega/m] \times \text{wiring distance[m]} \times \text{current[A]}}{1000}$$

Use a larger diameter cable when the wiring distance is long or when it is desired to decrease the voltage drop (torque reduction) in the low speed range.

CAUTION

- **Tighten the terminal screw to the specified torque.**
  A screw that has been tighten too loosely can cause a short circuit or malfunction.
  A screw that has been tighten too tightly can cause a short circuit or malfunction due to the unit breakage.
- **The crimping terminals recommended for use to wire the power supply and motor are those provided with insulation sleeves.**

1.5 Motor

POINT

Perform offline auto tuning (rotation mode) with the motor alone before connecting a load. If higher torque accuracy is required, perform online auto tuning next.

? Offline auto tuning

☞ The inverter measures necessary motor circuit constant and stores it to improve low speed torque. (Refer to page 132)

? Online auto tuning

☞ High torque accuracy corresponding to the motor temperature variation is available. (Refer to page 139)

This inverter is factory-set to connect the encoder for 5V and differential line driver connector. Please check encoder specifications before operating the inverter.

(1) List for setting the motor with encoder

Item	Parameter, Jumper Connector, Terminal	Refer to
Motor setting	Pr. 71 "applied motor"	123
Offline tuning	Pr. 96 "auto tuning setting/status"	132
Capacity setting	Pr. 80 "motor capacity"	132
Number of encoder pulses	Pr. 851 "number of encoder pulses"	10
Encoder rotation direction	Pr. 852 "encoder rotation direction"	10
Encoder power supply specification	Encoder power supply jumper connector on the back of the control terminal	9
Encoder output type		
Electronic thermal relay function	Pr. 9 "electronic thermal O/L relay"	93
Thermal protector input	Across OH-SD	93
	Pr. 876 "thermal relay protector input"	

(2) List for setting the motor without encoder

Item	Parameter, Jumper Connector, Terminal	Refer to
Motor setting	Pr. 71 "applied motor"	123
Offline tuning	Pr. 96 "auto tuning setting/status"	132
Online auto tuning	Pr.95 "online auto tuning selection"	139
Capacity setting	Pr. 80 "motor capacity"	132
Electronic thermal relay function	Pr. 9 "electronic thermal O/L relay"	93
Thermal protector input	Across OH-SD	93
	Pr. 876 "thermal relay protector input"	

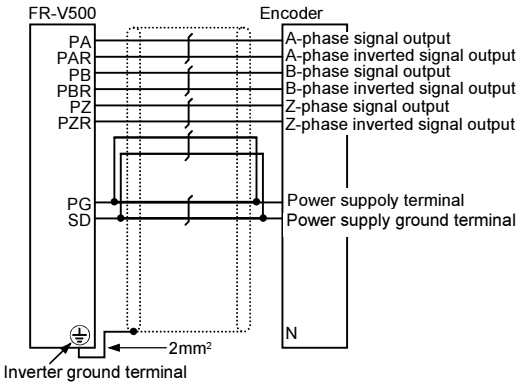
1.5.1 Encoder cable and encoder setting

(1) Encoder specification check items

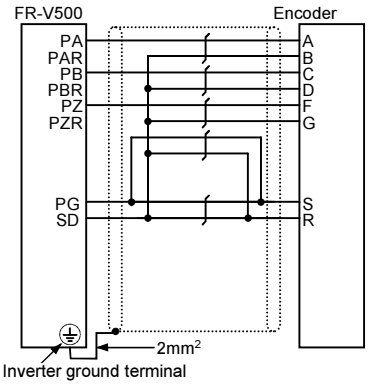
Item	Specification	Setting	Refer to
Resolution	1000 to 4096 Pulse/Rev	Setting by Pr. 851 "number of encoder pulses"	10
Power supply voltage	5V, 12V, 24VDC	Switching the position of the jumper connector on the back surface of the control circuit terminal block	9
Output signal form	A, B phases (90° phase) Z phase (1 Pulse/Rev)	—	14
Output circuit	Differential line driver, Complimentary	Switching the position of the jumper connector on the back surface of the control circuit terminal block	9

(2) Wiring example

1) Differential line driver



2) Complimentary



(3) Encoder cable gauge (Cable fabrication specification)

Wiring Distance	Wiring 0.2mm^2 Cables	Using larger gauge cable	
		mm^2	AWG
0 to 10m (0 to 32.81feet)	2 parallels or more	0.4mm^2	26 or more
10 to 20m (32.81 to 65.62feet)	4 parallels or more	0.75mm^2	21 or more
20 to 100m (65.62 to 328.08feet)	6 parallels or more	1.25mm^2	16 or more

(4) Cable stresses

(1) The way of clamping the cable must be fully considered so that flexing stress and cable's own weight stress are not applied to the cable connection.
(2) In any application where the motor moves, do not subject the cable to excessive stress.
(3) Avoid any probability that the cable sheath might be cut by sharp chips, rubbed by a machine corner or trampled over by workers or vehicles.
(4) When mounting the encoder on a machine where the motor will move, the flexing radius should be as large as possible.

CAUTION

Please contact the cable manufacturer for the number of cable flexes and cable stress due to the flexing radius.

(5) Setting the power supply specification of the encoder and pulse output type

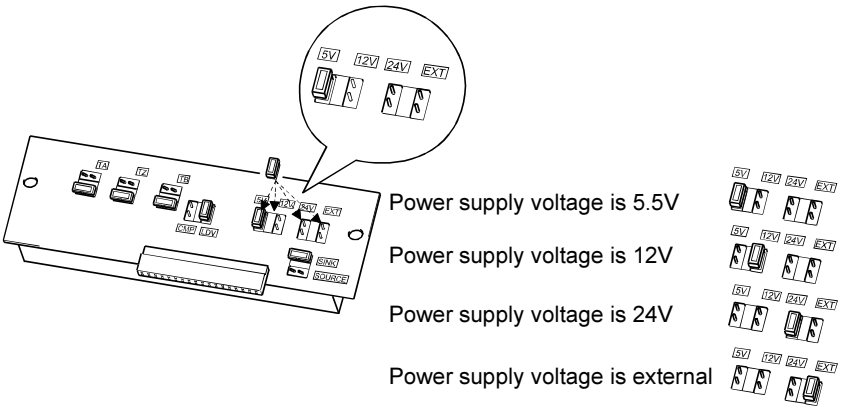
CAUTION

Make setting correctly.
Fitting the jumper connector to the position exceeding the power specification results in an encoder failure. Fitting the jumper connector to the position below the power specification results in an encoder malfunction.

Switch the position of the jumper connector on the back surface of the control circuit terminal block according to the encoder specification. (Refer to page 16 for removal and installation of the control circuit terminal block.)

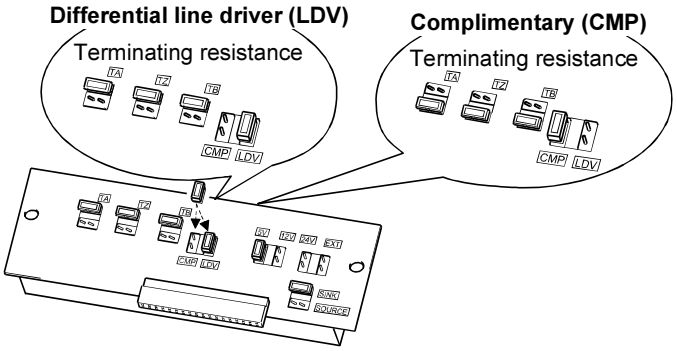
CAUTION

- **Jumper connector for the encoder power supply**
  The jumper connector is fitted to 5V when shipped from the factory. Switch its position according to power supply specification.



- **Jumper connector encoder output circuit**

The jumper connector is fitted to differential line driver (LDV) when shipped from the factory. Switch its position according to output circuit.

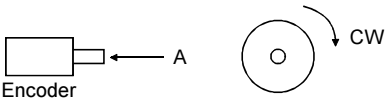
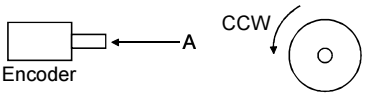


(6) Setting the number of encoder pulses and encoder rotation direction

Set the following parameters according to the encoder specification.

Parameter	Name	Factory Setting	Setting Range	Remarks
851	Number of encoder pulses	1024	0 to 4096	These are extended mode parameters. Set "1" in Pr. 160 "extended function selection"
852	Encoder rotation direction	1	0, 1	

- **The rotation direction of the encoder is displayed on the operation status indication (FWD, REV) of the operation panel.**

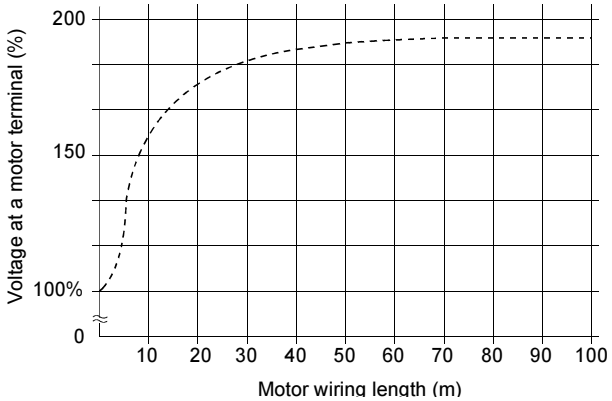
Pr. 852 Setting	Rotation direction of the encoder
0	 Forward rotation is clockwise rotation when viewed from A.
1 (factory setting)	 Forward rotation is counterclockwise rotation when viewed from A.

REMARKS

- The number of encoder pulses should be between 1000 and 4096.

1.5.2 Inverter-driven 575V class motor

In the PWM type inverter, a surge voltage attributable to wiring constants is generated at the motor terminals. Especially for a 575V class motor, the surge voltage may deteriorate the insulation.



Surge voltage at a motor terminal by motor wiring length (reference)

When the 575V class motor is driven by the inverter, consider the following measures:

- **Measures**

(1) Insulation-enhanced motor
Select an insulation-enhanced motor. Many motor manufacturers sell motors with insulation systems designed to withstand the stress imposed by PWM inverters.

(2) AC reactor
For added protection, install an AC reactor on the inverter output.

1.6 Connection of stand-alone option units

The inverter accepts a variety of stand-alone option units as required.
Incorrect connection will cause inverter damage or accident. Connect and operate the option unit carefully in accordance with the corresponding option unit manual.

1.6.1 Connection of the external brake resistor

The built-in brake resistor is connected across terminals P and PR. Fit the external brake resistor when the built-in brake resistor does not have enough thermal capability for high-duty operation. At this time, remove the jumper from across terminals PR-PX and connect the external brake resistor across terminals P-PR.
The external brake resistor should be as listed in the following table. Selected the rated power of the brake resistor according to the brake duty. (The rated power indicated below assumes that the brake resistor duty is 10%)

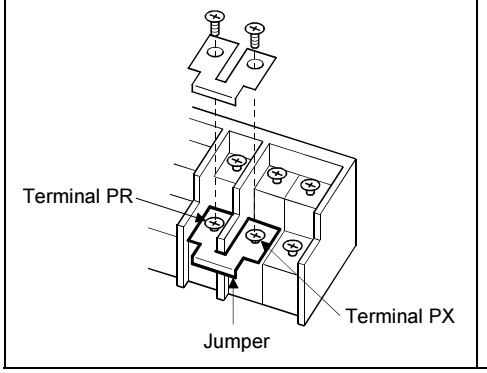
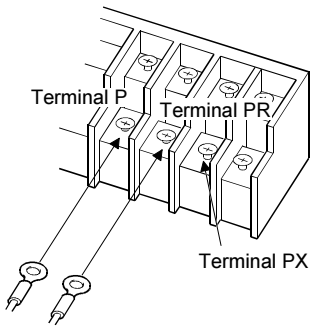
Inverter capacity	Brake resistance specification (wattage at 10% ED)
2.2K	350Ω (500W)
3.7K	200Ω (800W)
7.5K	110Ω (1600W)
15K	55Ω (3200W)

CAUTION

1. **The brake resistor connected should only be the dedicated brake resistor.**
2. **The jumper across terminals PR-PX (7.5K or less) must be disconnected before connecting the external brake resistor. A failure to do so may damage the inverter.**

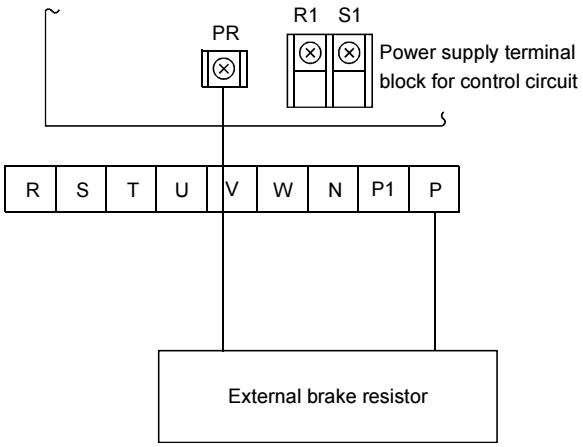
- **Model FR-V560-2.2K, 3.7K, 7.5K-NA**

1)Remove the screws in terminals PR and PX and remove the jumper
2)Connect the brake resistor across terminals P and PR. (The jumper should remain disconnected.)

1) Removal of jumper	2) Connection of brake resistor
	

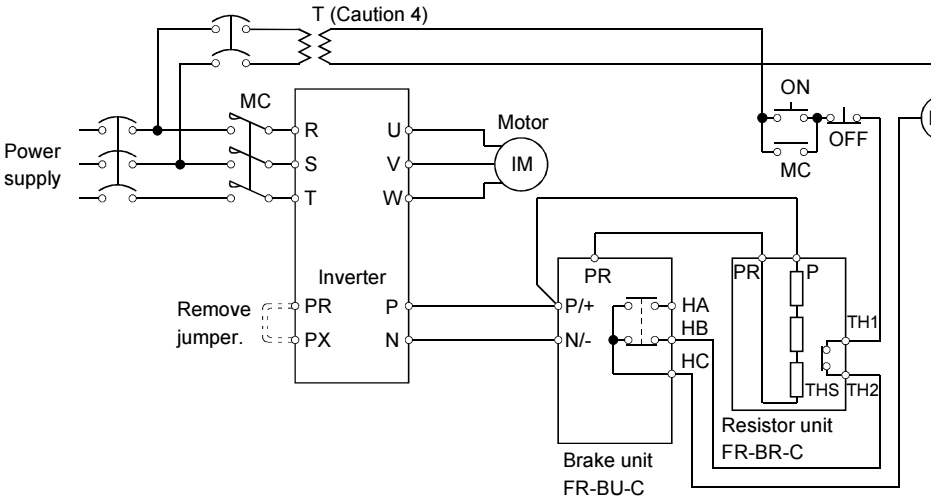
- **Model FR-V560-15K-NA**

1) Connect the brake resistor across terminals P and PR.



1.6.2 Connection of the brake unit (FR-BU-C)

Connect the optional FR-BU-C brake unit as shown below to improve the braking capability during deceleration.

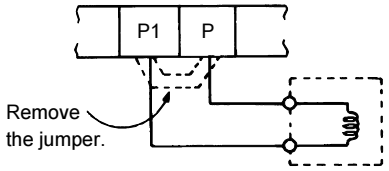


CAUTION

1. **Connect the inverter terminals (P, N) and FR-BU-C brake unit terminals so that their terminal signals match with each other. (Incorrect connection will damage the inverter.) For the 7.5K or less model, the jumper across terminals PR-PX must be removed.**
2. **The wiring distance between the inverter, brake unit and resistor unit should be within 5m (16.40 feet). If twisted wires are used, the distance should be within 10m (32.80 feet).**
3. **If a transistor in the brake unit should become faulty, the resistor can be unusually hot. Therefore, install a magnetic contactor on the inverter's power supply side to shut off a current in case of fault.**
4. **Install a voltage-reducing transformer.**

1.6.3 Connection of the power factor improving DC reactor

When using the power factor improving DC reactor, connect it between terminals P1-P. In this case, the jumper connected across terminals P1-P must be removed. Otherwise, the reactor will not exhibit its function.



CAUTION

1. **The wiring distance should be within 5m (16.40 feet).**
2. **The size of the cables used should be equal to or larger than that of the power supply cables (R, S, T).**

1.7 Control circuit terminal specifications

1.7.1 Specification of control circuit terminal

Type		Terminal Symbol	Terminal Name	Description		Rated Specifications
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 resistance 4.7kΩ Voltage at opening 21 to 27VDC Current at short-circuited 4 to 6mADC Control by open collector output or 0V contact signal
		STR	Reverse rotation start	Turn on the STR signal to start reverse rotation and turn it off to stop. The terminal function varies with the input terminal function selection (Pr. 187) setting. Refer to page 163 for details.		
		DI1 to DI4	Digital input terminals 1 to 4	The terminal functions vary with the input terminal function selection (Pr. 180 to Pr. 183) settings. Refer to page 163 for details.		
		OH	Thermal protector input	Temperature sensor terminal input for motor overheat protection. OHT error occurs when terminals OH and SD are open.		Input resistance 150kΩ Voltage at opening 21 to 27VDC Current at short-circuited 140 to 180mADC Isolate by photocoupler
		RES	Reset	Used to reset the protective circuit activated. Turn on the RES signal for more than 0.1s, then turn it off. Recover about 1s after reset is cancelled.		Input resistance 4.7kΩ Voltage at opening 21 to 27VDC Current at short-circuited 4 to 6mADC Control by open collector output or 0V contact signal.
		SD	Contact input common (sink)	Contact input common terminal. Common output terminal for 24VDC 0.1A power supply (PC terminal). Isolated from terminals 5 and SE.		—
		PC	24VDC power supply and external transistor common, contact input common (source)	When connecting a transistor output (open collector output) such as a programmable controller, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by a sneak current. PC-SD can be used as a 24VDC and 0.1A power supply. Note that a sneak current may not be prevented in this case. When source logic has been selected, this terminal serves as a contact input common.		Voltage range 18 to 26 VDC Permissible load current 0.1A
	Speed setting	10E	Speed setting power supply	Used as power supply when connecting volume for speed setting (torque setting) from outside of the inverter. (terminal 5 is a common terminal)		10VDC±0.4V Permissible load current 10mA
		2	Speed setting (voltage)	By entering 0 to 10VDC, the maximum output speed is reached at 10V and I/O are proportional.		Input resistance 10kΩ±1kΩ Permissible maximum voltage 20VDC
		3	Torque setting terminal	Acts as a torque setting signal for torque control or as a torque restriction signal for speed control or position control. Acts as an input terminal for the external analog-based torque bias function. 0 to ±10VDC input		
		1	Multi-function setting terminal	Since this is a multi-function selection terminal, its function varies with the Pr.868 "No. 1 terminal function assignment" setting. Refer to page 195 for details. 0 to ±10VDC input		
		5	Speed setting common, Analog signal output common	Common terminal for speed setting signal (terminal 2, 1 or 3) or DA1 and DA2. Isolated from terminals SD and SE. Do not ground.		—

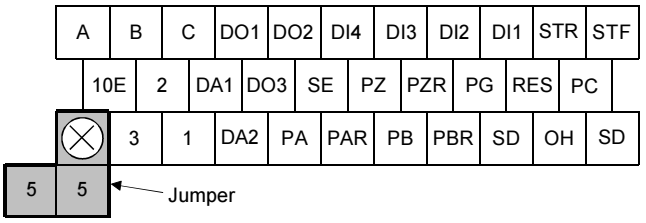
Control circuit terminal specifications

Type		Terminal Symbol	Terminal Name	Description	Rated Specifications
Input signals	Encoder signal	PA	A-phase signal input terminal	A-, B- and Z-phase signals are input from the encoder.	Differential line receiver input (AM26LS32 equivalent) or complimentary input
		PAR	A-phase inverted signal input terminal		Differential line receiver input (AM26LS32 equivalent)
		PB	B-phase signal input terminal		Differential line receiver input (AM26LS32 equivalent) or complimentary input
		PBR	B-phase inverted signal input terminal		Differential line receiver input (AM26LS32 equivalent)
		PZ	Z-phase signal input terminal		Differential line receiver input (AM26LS32 equivalent) or complimentary input
		PZR	Z-phase inverted signal input terminal		Differential line receiver input (AM26LS32 equivalent)
		PG	Encoder power supply terminal (Positive side)	Power supply for encoder. You can switch the power supply between 5, 12 and 24VDC. Can be switched to the external power supply. (Refer to the instruction manual (basic) for the switchover method.)	5.5VDC 350mA 12VDC 150mA 24VDC 80mA
		SD	Contact input common (sink), Power supply ground terminal	Common terminal for contact input or encoder power supply. Isolated from terminals 5 and SE. Do not ground.	Power supply common
Output signals	Contact	A, B, C	Alarm output	Switch-over contact output indicating that the output has been stopped by the inverter protective function. 230VAC 0.3A, 30VDC 0.3A. Alarm: discontinuity across B-C (continuity across A-C), normal: continuity across B-C (discontinuity across A-C). The terminal function varies with the output terminal function selection (Pr. 195) setting. Refer to page 165 for details.	Contact output Permissible contact 230VAC 0.3A 30VDC 0.3A
	Open collector	DO1 to DO3	Digital output terminals 1 to 3	The terminal functions vary with the output terminal function selection (Pr. 190 to Pr. 192) settings. Refer to page 165 for details.	Open collector output Permissible load 24VDC 0.1A
		SE	Open collector output common	Common terminal for terminals DO1, DO2 and DO3. Isolated from terminals SD and 5.	—
	Analog	DA1, DA2	Analog signal output	One selected from monitoring items, such as the speed, is output.* The output signal is proportional to the magnitude of the corresponding monitoring item.	0 to ±10VDC Permissible load current 1mA Resolution 12 bit load impedance 10kΩ or more
		5	Analog signal output common	Common terminal for DA1 and DA2. Isolated from terminals SD and SE. Do not ground.	
Communication	RS-485	—	PU connector	With the PU connector, communication can be made through RS-485. • Conforming standard : EIA Standard RS-485 • Transmission format : Multidrop link system • Communication speed : Maximum. 19200bps • Overall length : 500m	

* Not output during inverter reset.

1.7.2 Control circuit terminal layout

Terminal screw size : M3.5
Tightening torque : 1.2N·m
When connecting three or more control cables to the terminal 5, connect the accessory terminal 5 dedicated L-shaped jumper to the terminal 5.
In this case no cable should be connected to the screw in the ⊗ part.



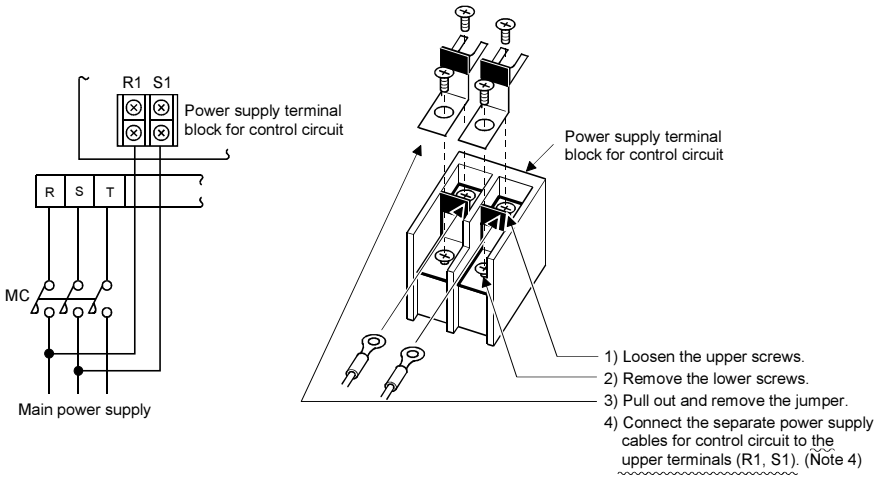
1.7.3 Wiring instructions

1) Terminals 5, SD and SE are common to the I/O signals and isolated from each other. Do not ground these terminals. Avoid connecting the terminal SD and 5 and the terminal SE and 5.
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) Since the control circuit input signals are micro currents, use two or more parallel micro signal contacts or a twin contact to prevent a contact fault.
4) It is recommended to use the cables of 0.75mm^2 gauge for connection to the control circuit terminals. If the cable gauge used is 1.25mm^2 or more, the front cover may be lifted when there are many cables running or the cables are run improperly, resulting in an operation panel or parameter unit contact fault.
5) The maximum wiring length should be 30m (98.43 feet).

1.7.4 Connecting the control circuit to a power supply separately from the main circuit

If the magnetic contactor (MC) in the inverter power supply is opened when the protective circuit is operated, the inverter control circuit power is lost and the alarm output signal cannot be kept on. To keep the alarm signal on terminals R1 and S1 are available. In this case, connect the power supply terminals R1 and S1 of the control circuit to the primary side of the MC.

<Connection procedure>



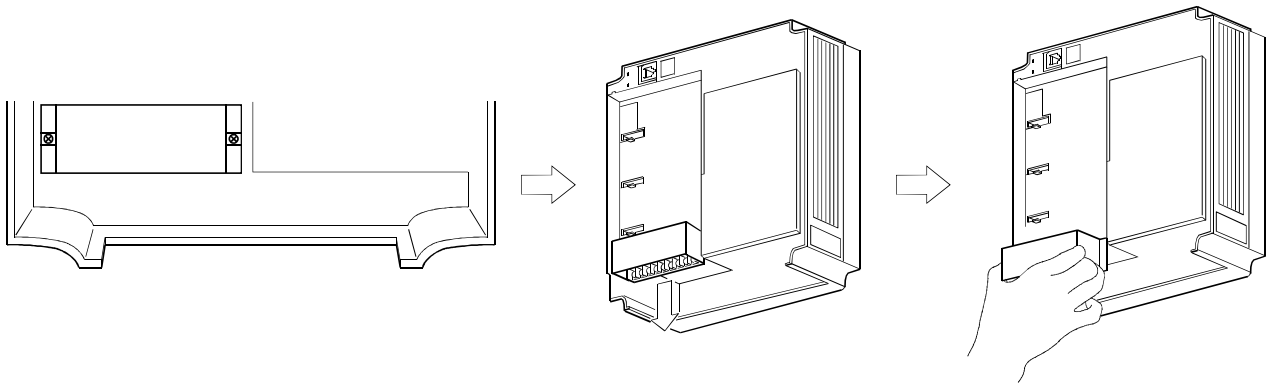
CAUTION

1. **When the main circuit power (R, S, T) is on, do not switch off the control power (terminals R1, S1). Otherwise the inverter may be damaged.**
2. **When using a separate power supply, the jumpers across R-R1 and S-S1 must be removed. Otherwise the inverter may be damaged.**
3. **For a different power supply system which takes the power of the control circuit from other than the primary side of the MC, the voltage should be equal to the main circuit voltage.**
4. **The power supply cables must not be connected to the lower terminals. If connected, the inverter may be damaged.**
5. **Entering the start signal with power supplied to only the R1 and S1 terminals will result in an error display (E.OC1).**

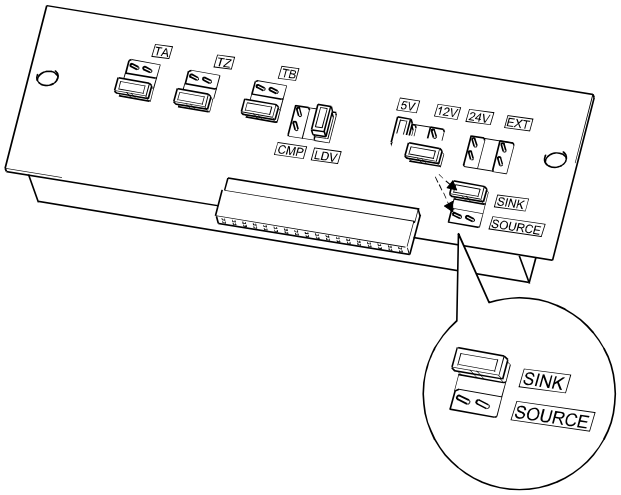
1.7.5 Changing the control logic

The input signals are factory set to sink logic (SINK).
To change the control logic, the jumper connector on the back of the control circuit terminal block must be moved to the other position.
(The output signals may be used in either the sink or source logic independently of the jumper connector position.)

1) Loosen the two mounting screws in both ends of the control circuit terminal block. (The screws cannot be removed.) Pull down the terminal block from the back of the control circuit terminals.



2) Fit the jumper connector from the sink logic (SINK) position on the back surface of the control circuit terminal block to the source logic (SOURCE) position to change to the source logic.



3) Using care not to bend the pins of the inverter's control circuit connector, reinstall the control circuit terminal block and fix it with the mounting screws.

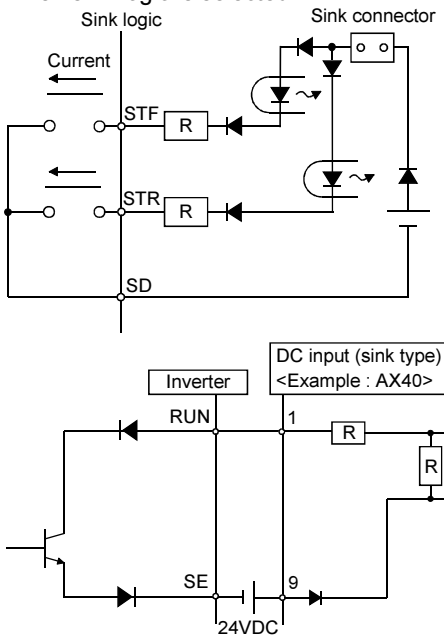
CAUTION

1. **Make sure that the control circuit connector is fitted correctly.**
2. **While power is on, never disconnect the control circuit terminal block.**
3. **The sink-source logic change-over jumper 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.**

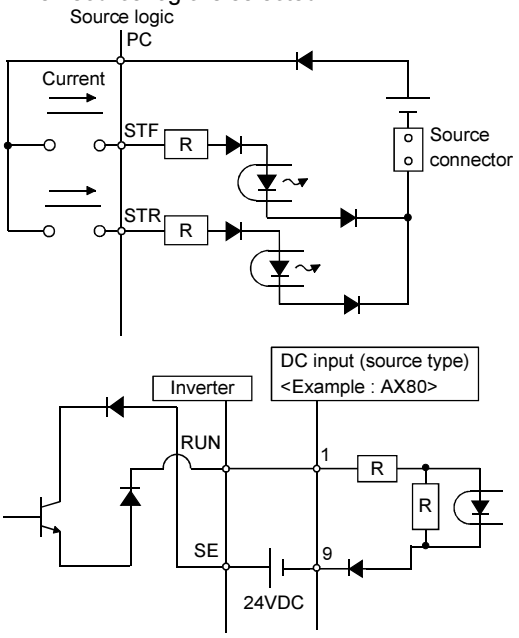
4) Sink logic type and source logic type

- The sink logic type is a logic where a signal turns 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.
- The source logic type is a logic where a signal turns on when a current flows into the corresponding signal input terminal.Terminal PC is common to the contact input signals. Terminal SE is common to the open collector output signals.

● Current flow concerning the RUN signal when sink logic is selected

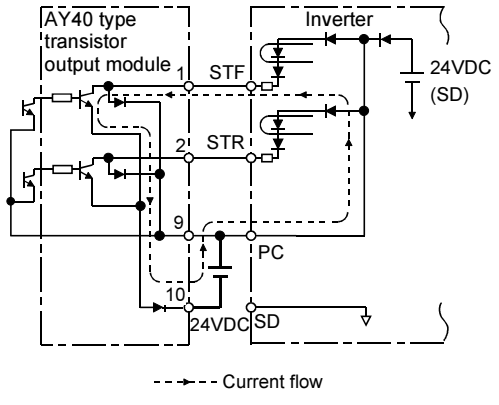


● Current flow concerning the RUN signal when source logic is selected

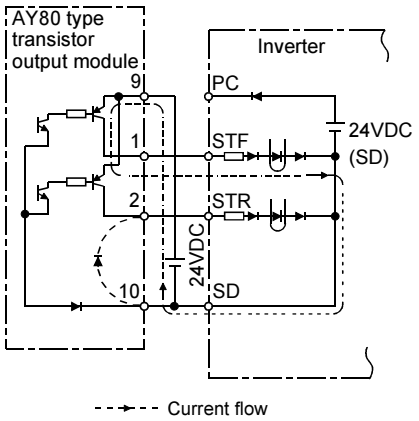


● When using an external power supply for transistor output

- Sink logic type
  Using terminal PC as a common terminal prevents a malfunction caused by 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 a power supply in parallel in the outside of the inverter. Doing so may cause a malfunction due to undesirable current.)



- Source logic type
  Use terminal SD as a common to prevent a malfunction caused by undesirable current.



1.8 Precautions for use of the vector inverter

The FR-V500 series is a highly reliable product, but incorrect peripheral circuit making or operation/handling method may shorten the product life or damage the product.
Before starting operation, always recheck the following items.

(1) Use insulation-sleeved crimping terminals for the power supply and motor cables.
(2) Power must not be applied to the output terminals (U, V, W) of the inverter. Otherwise the inverter will be damaged.
(3) After wiring, wire off-cuts must not be left in the inverter.
Wire off-cuts can cause an alarm, fault or malfunction. Always keep the inverter clean.
When drilling mounting holes in a control box or the like, use care not to allow chips etc. to enter the inverter.
(4) Wire the cables of the recommended size to make a voltage drop 2% or less.
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 high frequency.
Refer to page 7 for the recommended wire sizes.
(5) The overall wiring length should be 100m (328.08 feet) maximum.
Especially for long distance wiring, the high-response current restriction function may be reduced or the equipment connected to the secondary side may malfunction or become faulty under the influence of a charging current due to the stray capacity of the wiring. Therefore, note the 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 radio noise filter (for use on the input side only) or line noise filter to minimize interference.
(7) Do not install a power factor correction capacitor, surge suppressor or radio noise filter on 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 is installed, immediately remove it. (When the radio noise filter is connected, switching power off during motor operation may result in E. UVT. In this case, connect the radio noise filter in the primary side of the magnetic contactor.)
(8) When rewiring after operation, switch power off, wait for more than 10 minutes, and then make sure that the voltage is zero using a tester, etc. For some time after power-off, there is a dangerous voltage in the capacitor.
(9) A short circuit or ground fault in the inverter output side may damage the inverter modules.
- Fully check the insulation resistance of the circuit prior to inverter operation since repeated short circuits caused by peripheral circuit inadequacy or an ground fault caused by wiring inadequacy or reduced motor insulation resistance may damage the inverter modules.
- Fully check the to-ground insulation and inter-phase insulation of the inverter secondary side before power-on. Especially for an old motor or use in hostile atmosphere, securely check the motor insulation resistance etc.

(10) Do not use the inverter power supply side magnetic contactor to start/stop the inverter.
Always use the start signal (turn on/off terminals STF, STR-SD) to start/stop the inverter. (Refer to page 21.)
(11) Across the P and PR terminals, connect only an external regenerative brake discharge resistor.
Do not connect a mechanical brake.
(12) Do not apply a voltage higher than the permissible voltage to the inverter I/O signal circuits.
Application (contact) of a voltage higher than the permissible voltage to the inverter I/O signal circuits or opposite polarity may damage the I/O devices. Especially check the wiring to prevent the speed setting potentiometer from being connected incorrectly to short terminals 10E-5.
(13) Use of single-phase power supply
Do not use single-phase power input.
(14) Connect the encoder to the backlash-free motor shaft.

● Capacity (VA) of separate power supply

The capacity is 60VA or more for 15kW (20HP) or less and 80VA for 22kW (30HP) to 55kW (75HP) when separate power is supplied from R1, S1.

1.9 Others

1.9.1 Leakage currents and countermeasures

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

(1) To-ground leakage currents

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

● Countermeasures

- When the carrier frequency setting is high, decrease the carrier frequency (Pr. 72) of the inverter. Note that motor noise increases. Selection of Soft-PWM (Pr. 240) will make it unoffending.
- Ground leakage breakers designed for harmonics and surges can be used in the inverter's own line and other lines to perform operation with the carrier frequency high (with low noise).

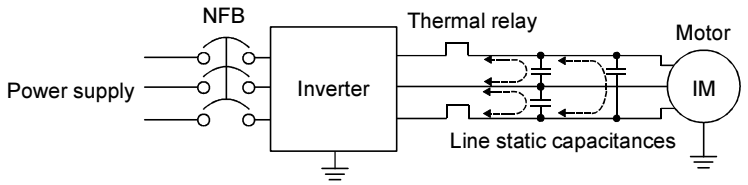
(2) Line-to-line leakage currents

Harmonics of leakage currents flowing in static capacitances between the inverter output cables may operate the external thermal relay unnecessarily. When the wiring length is long (50m (164.04 feet) or more) for the small-capacity model (7.5kW (10HP) or less), the external thermal relay is likely to operate unnecessarily because the ratio of the leakage current to the rated motor current increases.

● Line-to-line leakage current data example

Motor capsity (kW (HP))	Rated Motor Current(A)	Leakage Current (mA)	
		Wiring length 50m (164.04 feet)	Wiring length 100m (328.08 feet)
2.2 (3)	8.1	1200	1770

- Motor SF-JR 4P
- Carrier frequency: 14.5KHz
- Cable :2mm^{2}4-core
- Cab tyre cable



Line-to-Line Leakage Current Path

● Measures

- Use the electronic thermal relay function (Pr. 9) of the inverter.
- Decrease the carrier frequency. Note that motor noise increases. Selection of Soft-PWM (Pr. 240) will make it unoffending.
  Using a temperature sensor to directly detect the motor temperature is recommended to ensure that the motor is protected against line-to-line leakage currents.

● Installation and selection of no-fuse breaker

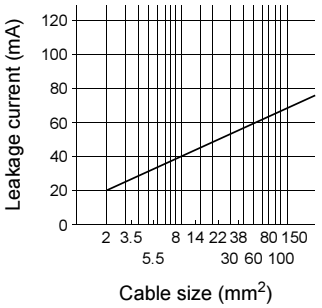
Install a no-fuse breaker (NFB) on the power receiving side to protect the wiring of the inverter primary side. Select the NFB according to the power supply side power factor (which depends on the power supply voltage, output frequency and load). Especially for a completely electromagnetic NFB, one of a slightly large capacity must be selected since its operation characteristic varies with harmonic currents. (Check it in the data of the corresponding breaker.) As a ground leakage breaker, use the Mitsubishi ground leakage breaker designed for harmonics and surges.

(3) Selection of rated sensitivity current of ground leakage breaker

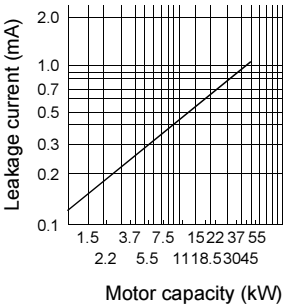
When using the ground leakage breaker with the inverter circuit, select its rated sensitivity current as follows, independently of the PWM carrier frequency.

- Breaker for harmonic and surge
  Rated sensitivity current
  $I\Delta n \geq 10 \times (Ig1 + Ign + Ig2 + Igm)$
- Standard breaker
  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

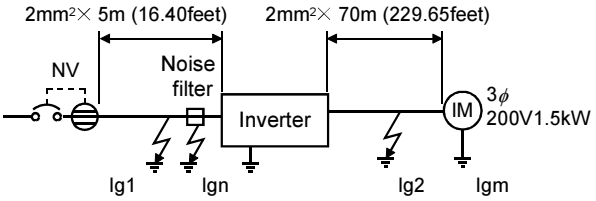
Leakage Current Example of Cable Path per 1km during Commercial Power Supply Operation When CV Cable Is Routed in Metal Conduit (200V 60Hz)



Leakage Current Example of 3-Phase Induction Motor during Commercial Power Supply Operation (200V 60Hz)



<Example>



CAUTION

- **Install the NV on the primary (power supply) side of the inverter.**
- **In the 人 connection neutral point grounding system, the sensitivity current is purified against an ground fault in the inverter secondary side. Grounding must conform to the requirements of national and local safety regulations and electrical codes. (JIS, NEC section 250, IEC 536 class 1 and other applicable standards)**
- **When the breaker is installed on 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 will increase, leading to temperature rise.

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

	Breaker for Harmonic and Surge	Standard Breaker
Leakage current Ig1 (mA)	$20 \times \frac{5m(16.40feet)}{1000m(3280feet)} = 0.10$	
Leakage current Ign (mA)	0 (without noise filter)	
Leakage current Ig2 (mA)	$20 \times \frac{70m(229.65feet)}{1000m(3280feet)} = 1.40$	
Motor leakage current Igm (mA)	0.16	
Total leakage current (mA)	1.66	4.78
Rated sensitivity current (mA) ($\geq Ig \times 10$)	30	100

1.9.2 Power off and magnetic contactor (MC)

(1) Inverter primary side magnetic contactor (MC)

On the inverter primary side, it is recommended to provide an MC for the following purposes.
(Refer to page 3 for selection.)

1) To release the inverter from the power supply when the inverter protective function is activated or the drive becomes faulty (e.g. emergency stop operation)
   When cycle operation or heavy-duty operation is performed with an optional brake resistor connected, overheat and burnout of the electrical-discharge resistor can be prevented if a regenerative brake transistor is damaged due to insufficient heat capacity of the electrical-discharge resistor and excess regenerative brake duty.
2) To prevent any accident due to an automatic restart at restoration of power after an inverter stop made by a power failure
3) To rest the inverter for an extended period of time
   The control power supply for inverter is always running and consumes a little power. When stopping the inverter for an extended period of time, powering off the inverter will save power slightly.
4) To separate the inverter from the power supply to ensure safe maintenance and inspection work
   Since the MC on the inverter primary side is used for the above purposes, they correspond to the standard duties. Therefore, when making an emergency stop during running, select a JEM1038 class AC3 MC for the inverter input side currents.

REMARKS

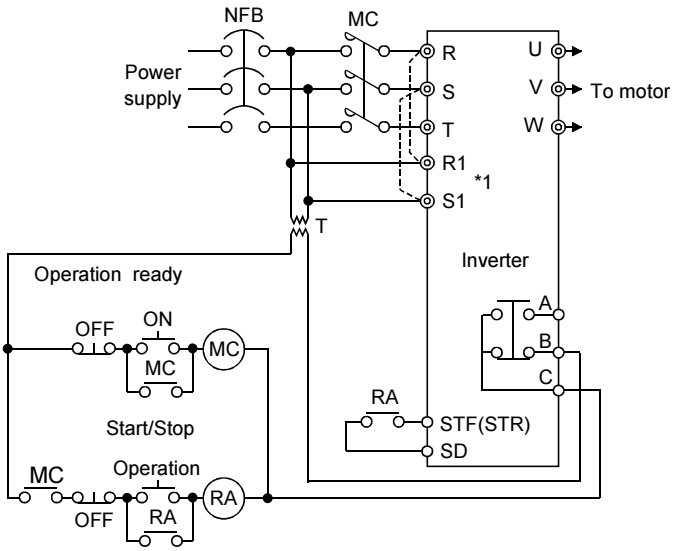
The MC may be switched on/off to start/stop the inverter. However, since repeated inrush currents at power-on will shorten the life of the converter circuit (switching life is about 100,000 times), frequent starts and stops must be avoided. Turn on/off the inverter start controlling terminals (STF, STR) to run/stop the inverter.

(2) 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.

- **Inverter Start/Stop Circuit Example**

As shown on the right, always use the start signal (turn on/off terminals STF, STR-SD) to start/stop the inverter.
(Refer to page 29.)

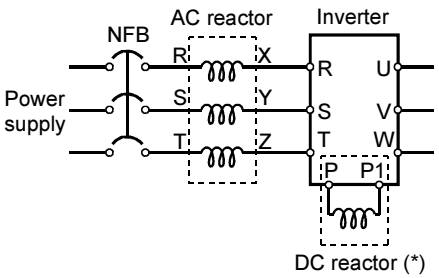


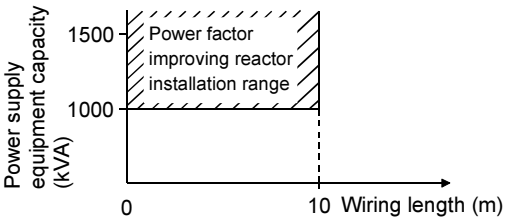
REMARKS

*1. Connect the power supply terminals R1 and S1 to the primary side of the MC to hold an alarm signal when the inverter`s protective circuit is activated. At this time, remove jumpers across terminals R-R1 and S-S1. (For removal of jumpers, refer to page 15)

1.9.3 Installation of power factor improving reactor

When the inverter is connected near a large-capacity power transformer (1000kVA or more and wiring length 10m (32.80 feet) max.) or when a power capacitor is to be switched over, an excessive peak current may flow in the power input circuit, damaging the converter circuit. To prevent this, always install the power factor improving reactor.





REMARKS

* When connecting the DC reactor, remove the jumper across terminals P-P1. The wiring length between the DC reactor and inverter should be 5m (16.4feet) maximum and minimized. Use the same wire size as that of the power supply wire (R, S, T).

1.9.4 Notes on grounding

- Leakage currents flow in the inverter. To prevent an electric shock, the inverter and motor must be grounded. Grounding must conform to the requirements of national and local safety regulations and electrical codes.) (JIS, NEC section 250, IEC 536 class 1 and other applicable standards)
- Use the dedicated ground terminal to ground the inverter. (Do not use the screw in the case, chassis, etc.)
- Use the largest possible gauge for the ground cable. The gauge should be equal to or larger than those indicated in the following table. The grounding point should be as near as possible to the inverter to minimize the ground cable length.

(Unit: mm^2)

Motor Capacity	Ground Cable Gauge
3.7kW (5HP) or less	3.5
7.5kW (10HP)	5.5
15kW (20HP)	14
22kW, 37kW (30HP, 50HP)	22
55kW (75HP)	38

- Ground the motor on the inverter side using one wire of the 4-core cable.
- Always ground the motor and inverter.

(1)Purpose of grounding

Generally, an electrical apparatus has an ground terminal, which must be connected to the ground before use. An electrical circuit is usually insulated by an insulating material and encased. However, it is impossible to manufacture an insulating material that can shut off a leakage current completely, and actually, a slight current flow into the case. The purpose of grounding the case of an electrical apparatus is to prevent operator from getting an electric shock from this leakage current when touching it.

To avoid the influence of external noises, this grounding is important to audio equipment, sensors, computers and other apparatuses that handle low-level signals or operate very fast.

(2)Grounding methods and grounding work

As described previously, grounding is roughly classified into an electrical shock prevention type and a noise-affected malfunction prevention type. Therefore, these two types should be discriminated clearly, and the following work must be done to prevent the leakage current having the inverter's high frequency components from entering the malfunction prevention type grounding:

(a) Where possible, use independent grounding for the inverter.
If independent grounding (I) is impossible, use joint grounding (II) where the inverter is connected with the other equipment at an grounding point. Joint grounding as in (III) must be avoided as the inverter is connected with the other equipment by a common ground cable.
Also a leakage current including many high frequency components flows in the ground cables of the inverter and inverter-driven motor. Therefore, they must use the independent grounding method and be separated from the grounding of equipment sensitive to the aforementioned noises.
In a tall building, it will be a good policy to use the noise malfunction prevention type grounding with steel frames and carry out electric shock prevention type grounding in the independent grounding method.

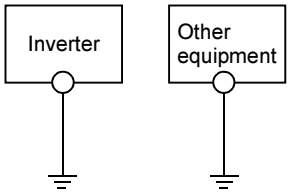
(b) This inverter must be grounded. Grounding must conform to the requirements of national and local safety regulations and electrical codes. (JIS, NEC section 250, IEC 536 class 1 and other applicable standards).

(c) Use the thickest possible ground cable. The ground cable should be of not less than the size indicated in the above table.

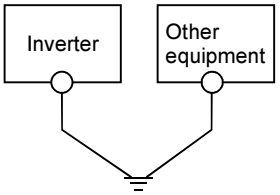
(d) The grounding point should be as near as possible to the inverter to minimize the ground cable length.

(e) Run the ground cable as far away as possible from the I/O wiring of equipment sensitive to noises and run them in parallel in the minimum distance.

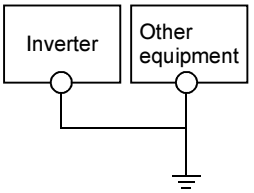
(f) Use one wire in a 4-core cable with the ground terminal of the motor and ground it on the inverter side.



(I) Independent grounding ... Best



(II) Joint grounding ... Good

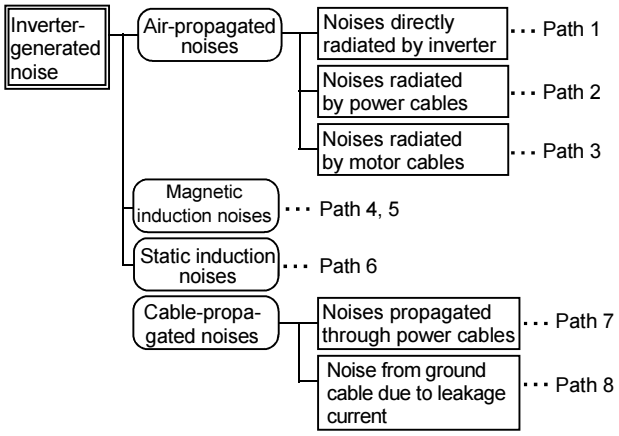


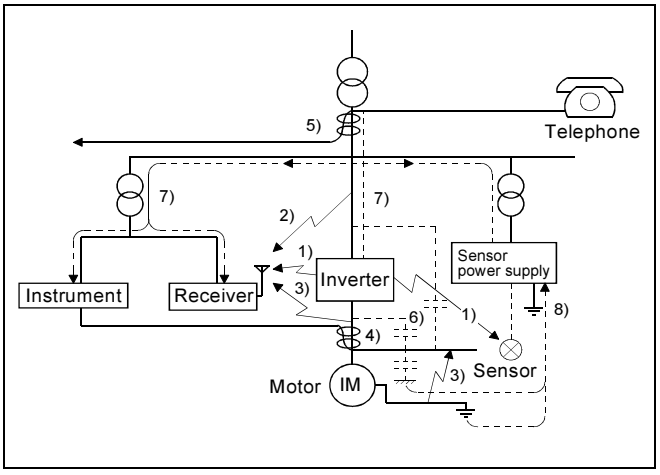
(III) Joint grounding ... Not allowed

1.9.5 Inverter-generated noises and their reduction techniques

Some noises enter the inverter to malfunction it and others are radiated by the inverter to malfunction peripheral devices. Though the inverter is designed to be insusceptible to noises, it handles low-level signals, so it requires the following basic techniques. Also, since the inverter chops outputs at high carrier frequency, that could generate noises. If these noises cause peripheral devices to malfunction, measures should be taken to suppress noises. These techniques differ slightly depending on noise propagation paths.

1) Basic techniques
   - 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 pair shielded cables for the detector connection and control signal cables, and connect the sheathes of the shield cables to terminal SD.
   - Ground the inverter, motor, etc. at one point.
2) Techniques to reduce noises that enter and malfunction the inverter
   When devices that generate many noises (which use magnetic contactors, magnetic brakes, many relays, for example) are installed near the inverter and the inverter may be malfunctioned by noises, the following measures must be taken:
   •Provide surge suppressors for devices that generate many noises to suppress noises.
   •Fit data line filters (page 24) to signal cables.
   •Ground the shields of the detector connection and control signal cables with cable clamp metal.
3) Techniques to reduce noises that are radiated by the inverter to malfunction peripheral devices
   Inverter-generated noises are largely classified into those radiated by the cables connected to the inverter and inverter main circuits (I/O), those electromagnetically and electrostatically induced to the signal cables of the peripheral devices close to the main circuit power supply, and those transmitted through the power supply cables.





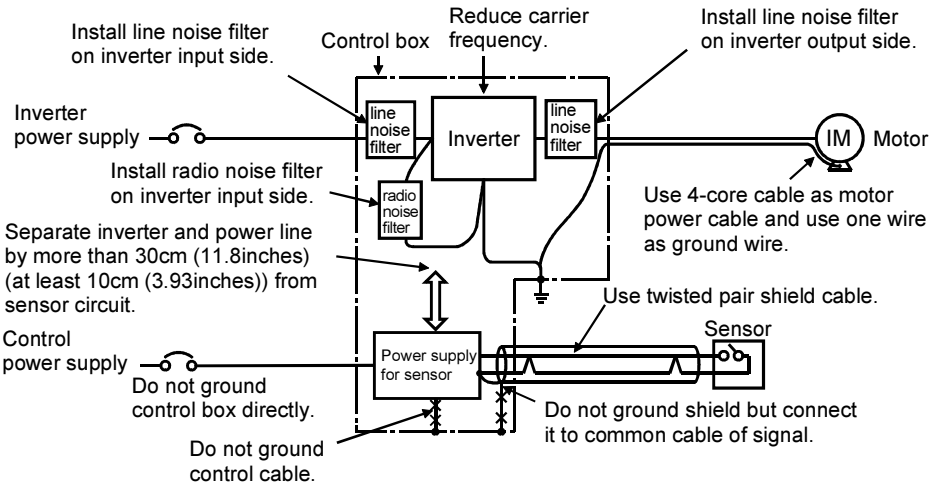
- By decreasing the carrier frequency, the mains terminal interface voltage* can be reduced. When motor noise does not pose a problem, set the carrier frequency to a low value using Pr. 72.
  (*Mains terminal interface voltage represents the magnitude of noise propagated from the inverter to the power supply side.)
- Using shield cables as signal cables, induction noise can be reduced greatly (to 1/10 - 1/100). Induction noise can also be reduced by separating the signal cables from the inverter output cables. (Separation of 30cm (11.8 inches) reduces noise to 1/2-1/3.)
  By fitting the line noise filter on the inverter output side, induction noise to the signal cables can be reduced.

Noise Propagation Path	Measures
1), 2), 3)	When devices that handle low-level signals and are liable to malfunction due to noises, e.g. instruments, receivers and sensors, are contained in the enclosure that contains the inverter or when their signal cables are run near the inverter, the devices may be malfunctioned by air-propagated noises. The following measures must be taken: (1) Install easily affected devices as far away as possible from the inverter. (2) Run easily affected signal cables as far away as possible from the inverter and its I/O cables. (3) Do not run the signal cables and power cables (inverter I/O cables) in parallel with each other and do not bundle them. (4) Insert line noise filters into I/O and radio noise filters into input to suppress cable-radiated noises. (5) Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
4), 5), 6)	When the signal cables are run in parallel with or bundled with the power cables, magnetic and static induction noises may be propagated to the signal cables to malfunction the devices and the following measures must be taken: (1) Install easily affected devices as far away as possible from the inverter. (2) Run easily affected signal cables as far away as possible from the I/O cables of the inverter. (3) Do not run the signal cables and power cables (inverter I/O cables) in parallel with each other and do not bundle them. (4) Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
7)	When the power supplies of the peripheral devices are connected to the power supply of the inverter in the same line, inverter-generated noises may flow back through the power supply cables to malfunction the devices and the following measures must be taken: (1) Install the radio noise filter to the power cables (input cables) of the inverter. (2) Install the line noise filter to the power cables (I/O cables) of the inverter.
8)	When a closed loop circuit is formed by connecting the peripheral device wiring to the inverter, leakage currents may flow through the ground cable of the inverter to malfunction the device. In such a case, disconnection of the ground cable of the device may cause the device to operate properly.

● Data line filters

Noise entry can be prevented by providing a data line filter for the detector cable etc.

● Example of noise reduction techniques



1.9.6 Power supply harmonics

Power supply harmonics may be generated from the converter section of the inverter, affecting the power supply equipment, power capacitors, etc. Power supply harmonics are different in generation source, frequency and transmission path from radio frequency (RF) noise and leakage currents. Take the following measures.

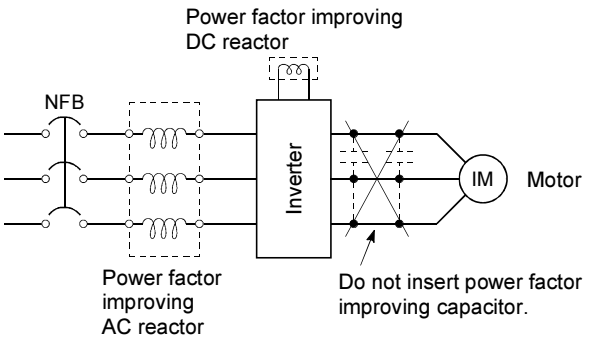
● The differences between harmonics and RF noises are indicated below:

Item	Harmonics	RF Noise
Frequency	Normally 40 to 50th degrees (3kHz or less)	High frequency (several 10kHz to 1GHz order)
Environment	To wire paths, power impedance	Across spaces, distance, laying paths
Quantitative understanding	Logical computation is possible	Occurs randomly, quantitative understanding is difficult.
Generated amount	Approximately proportional to load capacity	According to current fluctuation rate (larger with faster switching)
Immunity of affected device	Specified in standards for each device.	Differs according to maker's device specifications.
Examples of safeguard	Install a reactor.	Increase the distance.

● Safeguard

The harmonic current generated from the inverter to the power supply differs according to various conditions such as the wiring impedance, whether a power factor improving reactor is used or not, and output frequency and output current on the load side.

For the output frequency and output current, the adequate method is to obtain them under rated load at the maximum operating frequency.



CAUTION

A power factor improving capacitor or surge suppressor on the inverter's output side may overheat or be damaged due to the harmonics of the inverter output. Also, when an overcurrent flows in the inverter, the overcurrent protection is activated. Hence, when the motor is driven by the inverter, do not install a capacitor or surge suppressor on the inverter's output side. To improve the power factor, insert a power factor improving reactor on the inverter's primary side or in the DC circuit.

1.9.7 Using the PU connector for computer link

(1) When connecting the operation panel or parameter unit using a connection cable

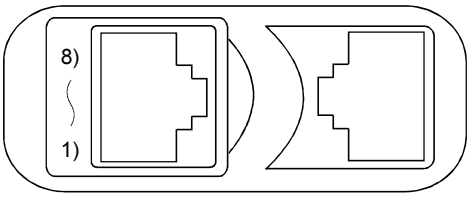
Refer to the Instruction Manual (basic).

(2) For RS-485 communication

The PU connector can be used to perform communication operation from a personal computer etc.
By connecting the PU connector to computers such as a personal computer and Factory Automation computer with a communication cable, you can monitor the inverter operation and read and write parameters using a user program.

<PU connector pin-outs>

Viewed from the inverter (receptacle side) front



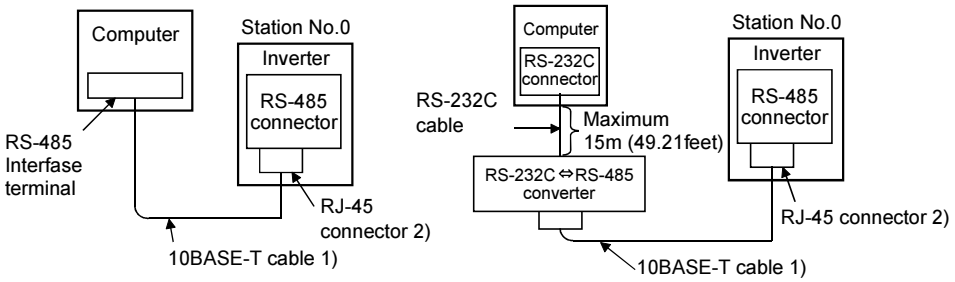
1) SG 5) SDA
2) P5S 6) RDB
3) RDA 7) SG
4) SDB 8) P5S

CAUTION

1. **Do not connect the PU connector to the computer's LAN board, FAX modem socket or telephone modular connector. Otherwise, the product may be damaged due to electrical specification differences.**
2. **Pins No. 2 and 8 (P5S) provide power to the operation panel or parameter unit. Do not use these pins for RS-485 communication.**

<System configuration example>

(1) Connection of a computer to the inverter (one-to-one connection)



●Computer - inverter connection cable

For a connection cable between the computer having RS-232C and the inverter (RS-232C⇔RS-485 converter), refer to the table below.
Examples of commercially available products (as of July, '02)

Type	Maker
FA-T-RS40 □*	Mitsubishi Electric Engineering Co., Ltd

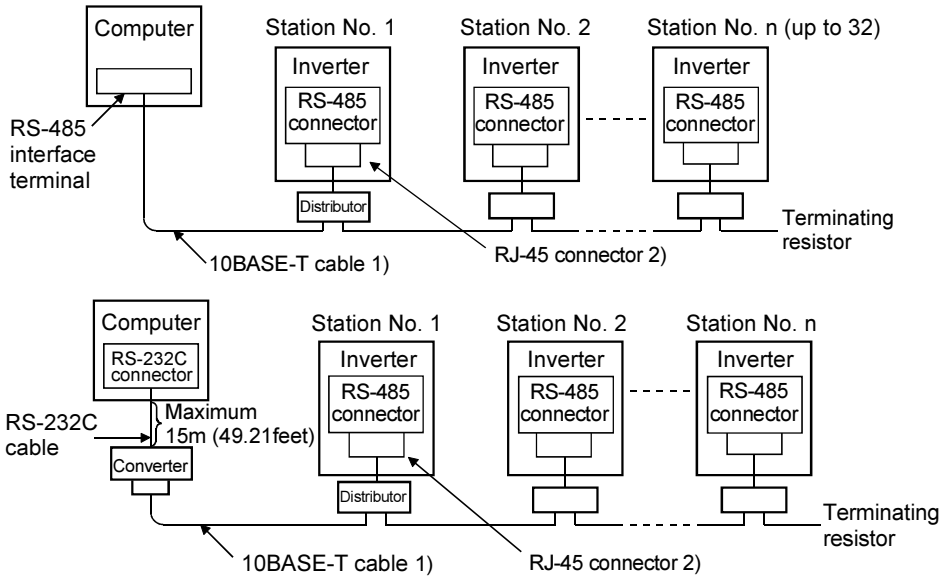
* You can not connect multiple inverters with a converter cable (a computer and an inverter are one-to-one connection). As the RS-232C cable and the RS-485 cable (10BASE-T+RJ-45 connector) are provided with a product, no need to prepare a cable and a connector separately. Contact a maker for details of the product.

REMARKS

When fabricating the cable on the user side, see below.
Examples of commercially available products (as of July, '02)

	Product	Type	Maker
1)	10BASE-T cable	SGLPEV-T 0.5mm × 4P * Do not use No. 2 and No. 8 pin (P5S).	Mitsubishi Cable Industries, Ltd.
2)	RJ-45 connector	5-554720-3	Tyco Electronics Corporation

(2) Connection of a computer to multiple inverters (one-to-n connection)



REMARKS

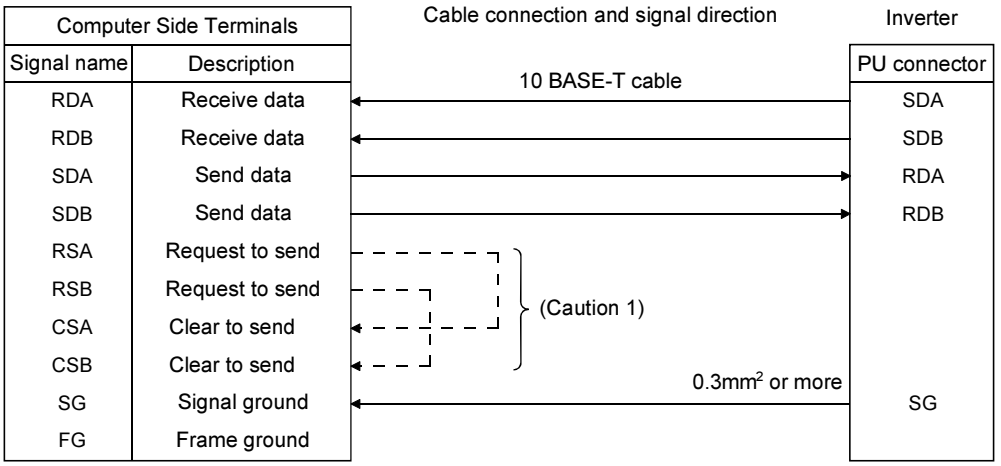
When fabricating the cable on the user side, see below.
Examples of commercially available products (as of July, '02)

	Product	Type	Maker
1)	10BASE-T cable	SGLPEV-T 0.5mm × 4P *	Mitsubishi Cable Industries, Ltd.
2)	RJ-45 connector	5-554720-3	Tyco Electronics Corporation

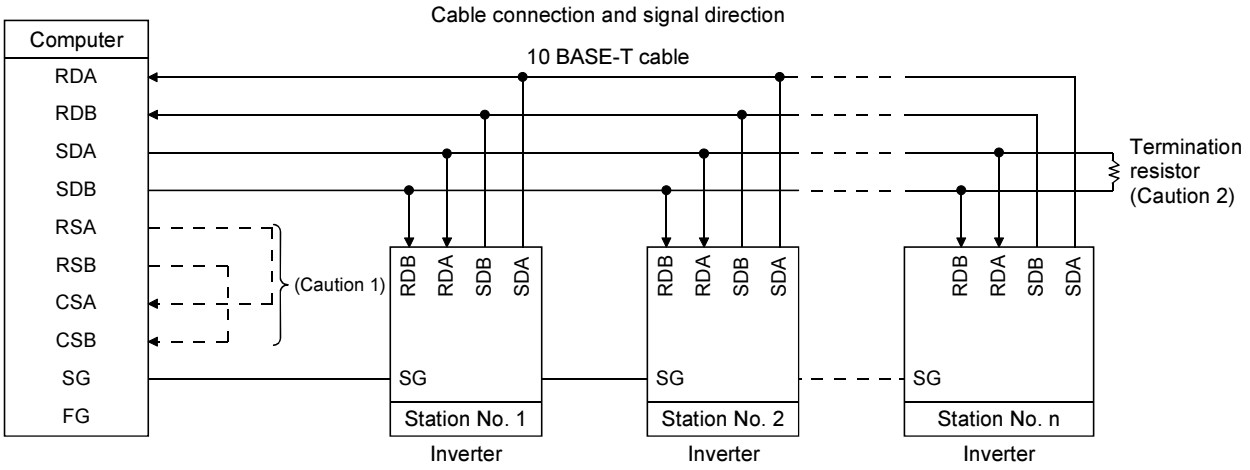
* Do not use No. 2 and No. 8 pin (P5S) of the 10 BASE-T cable.

<Wiring method>

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



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



CAUTION

1. **Make connections in accordance with the manual of the computer used.**
   Fully check the terminal numbers of the computer since they vary with the model.
2. **There may be the influence of reflection depending on the transmission speed and/or transmission distance. If this reflection hinders communication, provide a termination resistor. If the PU connector is used to make a connection, use a distributor since a terminal resistor cannot be fitted.**
   Connect the termination resistor to only the inverter remotest from the computer.
   (Termination resistor: 100Ω)

1.10 Input terminals

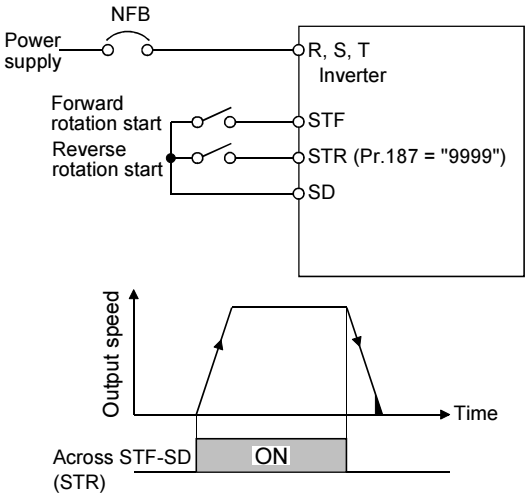
1.10.1 Run (start) and stop (STF, STR, STOP)

To start and stop the motor, first switch on the input power of the inverter (when there is a magnetic contactor on the input side, use the operation-ready switch to turn on the magnetic contactor), then start the motor with the forward or reverse rotation start signal.

(1) Two-wire type (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. Turn on either of the forward and reverse rotation signals to start the motor in the corresponding direction. Turn on both or turn off the start signal during operation to decelerate the inverter to a stop.
2) The speed setting signal may either be given by entering 0 to 10VDC across the speed setting input terminal 2-5 or by setting the required values in Pr. 4 to Pr. 6 "three-speed setting" (high, middle, low speeds). (Refer to page 90 for three-speed operation.)



Two-Wire Type Connection Example

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

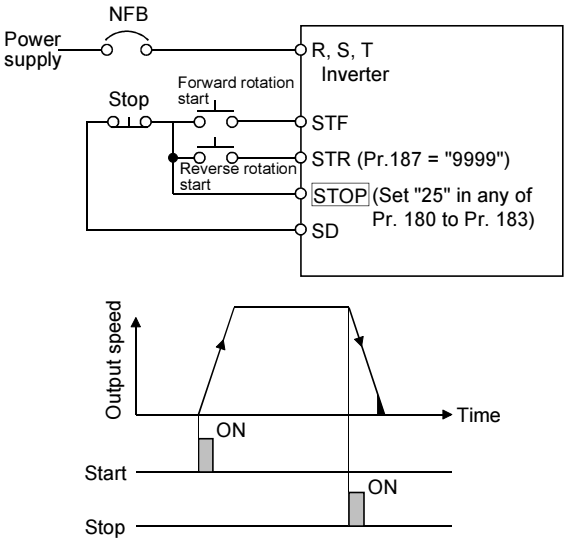
A three-wire type connection is shown on the right. Assign the start self-holding signal (STOP) to any of the input terminals.

1) Short signals STOP-SD to enable the start self-holding function. In this case, the forward/reverse rotation signal functions only as a start signal.

REMARKS

Assign the STOP signal to any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection).

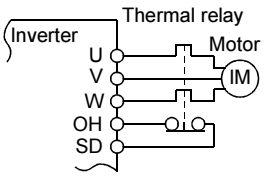
2) If the start signal terminals STF (STR)-SD are once shorted, then opened, the start signal is kept on and starts the inverter. To change the rotation direction, short the start signal STR (STF)-SD once, then open it.
3) The inverter is decelerated to a stop by opening terminals STOP-SD once. The three-wire connection is shown on the right.
4) When terminals JOG-SD are shorted, the STOP signal is invalid and jog signal has precedence.
5) If the output stop terminals MRS-SD are shorted, the self-holding function is not deactivated.



Three-Wire Type Connection Example

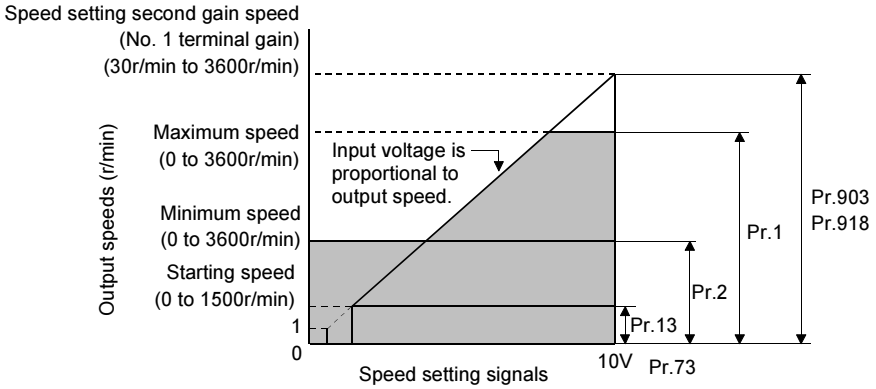
1.10.2 External thermal relay input (OH)

When the external thermal relay or the built-in thermal relay of the motor (thermal protector) is actuated to protect the motor from overheat, the inverter output can be shut off and the corresponding alarm signal can be provided to hold a stop status. If the thermal relay contact resets, the motor cannot be restarted unless the reset terminal RES-SD are shorted for more than 0.1 seconds and then opened or a power-on reset is made.
Therefore, this function can be used as an external emergency stop signal input.



1.10.3 Speed setting potentiometer connection (10E, 2 (1), 5)

As an analog speed setting input signal, a voltage signal can be input.
The relationships between the speed setting input voltages and output speeds are as shown below. The speed setting input signals are proportional to the output speeds. Note that when the input signal is less than the starting speed, the output speed of the inverter is 0r/min.
If the input signal of 10VDC or higher is entered, it cannot exceed Pr. 1 "maximum speed".



Relationships between Speed Setting Inputs and Output Speeds

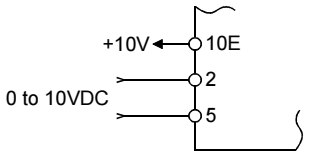
Related parameters

Maximum speed setting Pr. 1 "maximum speed" (Refer to page 89.)

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

Enter the speed setting input signal of 0 to 10VDC across the speed setting input terminals 2-5. The maximum output speed is reached when 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 10E-5 provide 10VDC output.

- Use terminal 10E for the built-in power supply.

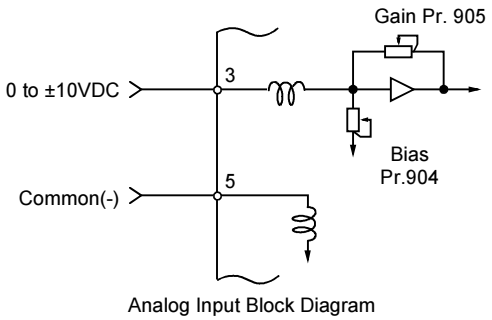


(2) Multi-function input (1, 5)

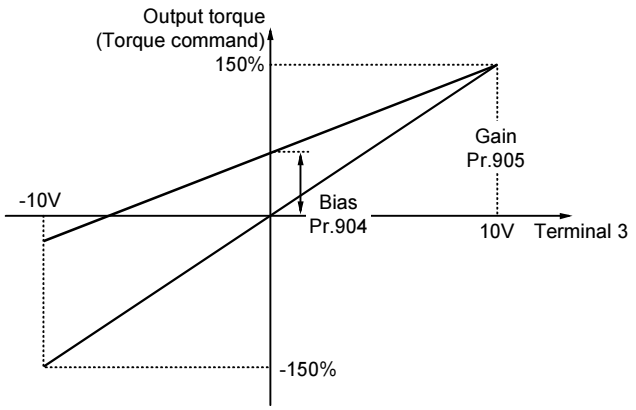
The analog input function can be multi-functioned, e.g. compensation signal may be entered across the main speed setting terminals 2-5 for synchronous operation.
Across auxiliary input terminals 1-5 ... 0 to ±10VDC
The function of terminal 1 depends on the setting of Pr. 868 "No. 1 terminal function assignment". Refer to page 195 for details of Pr 868.

1.10.4 Torque setting input signal and motor-generated torque (terminals 3, 5)

Refer to the diagrams shown at below right for the relationship between the torque setting input signal and output voltage. The torque setting input signal is in proportion to the output torque. However, motor-generated torque varies with the motor temperature.



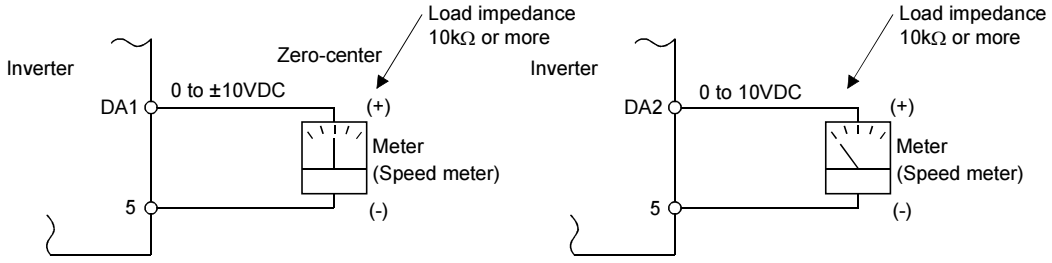
Analog Input Block Diagram



Torque Setting Input vs. Output Torque

1.10.5 Meter connection method and adjustment (DA1, DA2)

The output speed etc. of the inverter can be displayed by connecting a meter (speed meter) across terminals DA1 (DA2)-5.
The meter can be calibrated from the operation panel or parameter unit. However, if the meter is away from the inverter, the display value will vary with the wiring distance.
The terminals DA1, DA2 are non-isolated from the control circuit of the inverter. Using a shield cable of within 30m (98.42feet) for wiring.



Types of Connected Meters

REMARKS

Using Pr. 867 "DA1 output filter", you can function the primary delay filter. (Refer to page 195.)

CAUTION

Refer to page 200 for the meter adjustment procedure.

[Example] To provide a 10V DA1-5 (DA2-5) output of 10V at the inverter output speed of 3000r/min, set "3000" (r/min) in Pr. 55.(factory setting : 1800r/min)

Parameter No.	Name	Factory Setting	Setting Range
55	Speed monitoring reference	1800r/min	0 to 3600r/min

CAUTION

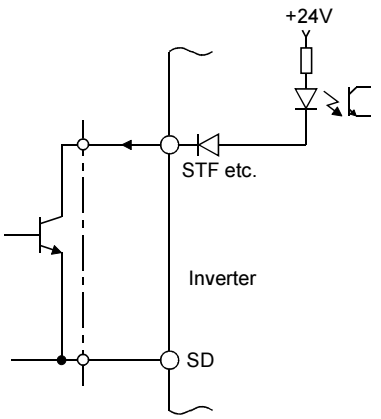
Note that when wiring is long, a voltage type meter is susceptible to a voltage drop, induction noise, etc. and may not read correctly.

1.10.6 Common terminals (SD, 5, SE)

Terminals SD, 5 and SE are all common terminals (0V) for I/O terminals and the other common terminals are isolated from each other.
Terminal SD is a common terminal for the contact input terminals (STF, STR, OH, RES, DI1, DI2, DI3 and DI4) and the encoder output signals. When using the terminal SD as a common terminal for the encoder output signals, use a shielded or twisted cable to protect it from external noise.
Terminal 5 is a common terminal for the speed setting analog input signals and analog output signals. Use a shielded or twisted cable to protect it from external noise.
Terminal SE is a common terminal for the open collector output terminals (DO1, DO2, DO3).

1.10.7 Signal inputs by contact-less switches

If a transistor is used instead of a contacted switch as shown on the right, the input signals of the inverter can control the STF, STR, OH, RES, DI1, DI2, DI3 and DI4 terminals.
Input resistance : 4.7kΩ
Voltage when contacts are open : 21 to 27VDC
When contacts are short-circuited : 4 to 6mADC



External Signal Input by Transistor

REMARKS

- When using an external transistor connected to the external power supply, use terminal PC to prevent a malfunction due to a sneak current.
  (Refer to page 17 for details.)
- Note that when off, an SSR (solid-state relay) has a relatively large leakage current and it may be accidentally input to the inverter.

1.11 How to use the input signals (assigned terminals DI1 to DI4, STR) (Pr. 180 to Pr. 183, Pr. 187)

These terminals vary in functions with the settings of Pr. 180 to Pr. 183 and Pr. 187.

Parameter	Factory-Set Value	Factory-Set Signal	Setting Range	
Pr. 180 "DI1 terminal function selection"	0	RL	0 to 3, 5, 8 to 16, 20, 22 to 28, 42 to 44, 9999 (9999 is valid for Pr. 187 only)	Page 163
Pr. 181 "DI2 terminal function selection"	1	RM		
Pr. 182 "DI3 terminal function selection"	2	RH		
Pr. 183 "DI4 terminal function selection"	3	RT		
Pr. 187 "STR terminal function selection"	9999	STR		

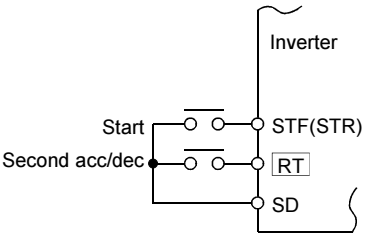
The priorities of the speed commands are in order of jog, multi-speed setting (RH, RM, RL, REX) and PID (X14).

1.11.1 Multi-speed setting (RL, RM, RH, REX signals): Pr. 180 to Pr. 183, Pr. 187 setting "0, 1, 2, 8"
Remote setting (RL, RM, RH signals): Pr. 180 to Pr. 183, Pr. 187 setting "0, 1, 2"

- When Pr. 59 = 0, turning on/off the RL, RM, RH and REX signals input as the speed commands enables multi-speed operation (15 speeds). (Refer to page 90 for details. Pr. 59 = 0)
- When Pr. 59 ≠ "0", you can use contact signals to perform continuous variable-speed operation without using analog signals even if the operation panel is away from the control box. (Refer to page 116 for details.)

1.11.2 Second function selection/second motor switchover (RT signal) : Pr. 180 to Pr. 183, Pr. 187 setting "3"

Pr. 44 "second acceleration/deceleration time"
Pr. 45 "second deceleration time"
Pr. 450 "second applied motor"
Pr. 451 "second motor control method selection"
Pr. 452 "second electronic thermal O/L relay"
Pr. 453 "second motor capacity"
Pr. 454 "number of second motor poles"
Pr. 830 "speed control P gain 2"
Pr. 831 "speed control integral time 2"
Pr. 832 "speed setting filter 2
Pr. 833 "speed detection filter 2"
Pr. 834 "torque control P gain 2"
Pr. 835 "torque control integral time 2"
Pr. 836 "torque setting filter 2"
Pr. 837 "torque detection filter 2"

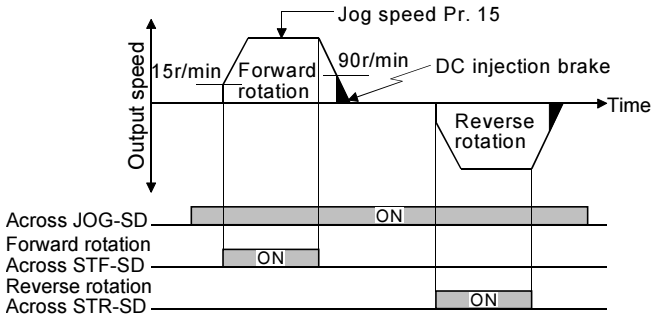


Entering the RT signal enables the second functions (above parameters). However, when Pr. 450 = 9999, it is judged that the second motor functions are not selected, and parameters Pr. 451 and Pr. 453, Pr. 454 are invalid. The second functions other than the above are enabled with the first motor.

1.11.3 Jog operation (jog signal): Pr. 180 to Pr. 183, Pr. 187 setting "5"

(1) Jog operation using external signals

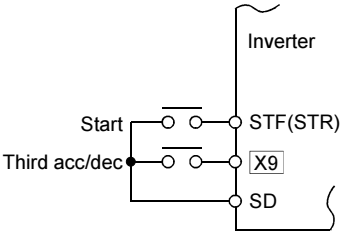
Jog operation can be started/stopped by shorting the jog mode select terminal JOG-SD and shorting/opening the start signal terminal STF or STR-SD. The jog speed and jog acceleration/deceleration time are set in Pr. 15 (factory setting 150r/min, variable between 0 and 1500r/min) and Pr. 16 (factory setting 0.5s, variable between 0 and 3600s (when Pr. 21 = 0)/0 to 360s (when Pr. 21 = 1)), respectively, and their settings can be changed from the operation panel or parameter unit.
The jog signal has higher priority than the multi-speed signals. (external)



1.11.4 Third function selection (X9 signal): Pr. 180 to Pr. 183, Pr. 187 setting "9"

Turn on this "X9 signal" to set:
Pr. 110 "third acceleration/deceleration time"
Pr. 111 "third deceleration time"
Select either the first motor or the second motor according to the RT signal input.

X9 signal	RT signal	Applied Motor	Other Function
OFF	OFF	First motor	First function
OFF	ON	Second motor	Second function
ON	OFF	First motor	Third function
ON	ON	Second motor	Third function



1.11.5 PU operation external interlock signal (X12 signal): Pr. 180 to Pr. 183, Pr. 187 setting "12"

This function prevents the inverter from being inoperative during operation using an external command if the mode is accidentally left unswitched from the PU operation mode. (Refer to page 127.)
X12 signal on ..... Shift to PU operation mode enabled (output stop during external operation)
X12 signal off ..... Shift to PU operation mode disabled (output stop during external operation)

1.11.6 PID control enable terminal: Pr. 180 to Pr. 183, Pr. 187 setting "14"

Turn the X14 signal on to exercise PID control. When this signal is off, normal inverter operation is performed. Refer to page 152 for details.

Related parameters

Pr. 128 "PID action selection", Pr. 129 "PID proportional band", Pr. 130 "PID integral time", Pr. 131 "upper limit", Pr. 132 "lower limit", Pr. 133 "PID action set point for PU operation", Pr. 134 "PID differential time" (Refer to page 152.)

1.11.7 Brake sequence opening signal (BRI signal): Pr. 180 to Pr. 183, Pr. 187 setting "15"

Used when the method of inputting the mechanical brake opening completion signal to the inverter is used for the brake sequence functions. (Refer to page 118.)

Related parameters

Pr. 60 "intelligent mode selection", Pr. 278 "brake opening speed", Pr. 279 "brake opening current", Pr. 280 "brake opening current detection time", Pr. 281 "brake operation time at start", Pr. 282 "brake operation speed", Pr. 283 "brake operation time at stop", Pr. 284 "deceleration detection function selection", Pr. 285 "overspeed detection speed" (Refer to page 118.)

1.11.8 PU operation/external operation switchover: Pr. 180 to Pr. 183, Pr. 187 setting "16"

You can change the operation mode.
When Pr. 79 "operation mode selection" = "8", turning the X16 signal on shifts the current operation mode to the external operation mode and turning that signal off shifts to the PU operation mode. Refer to page 129 for details.

Related parameters

Pr. 79 "operation mode selection" (Refer to page 129)

1.11.9 S-pattern acceleration/deceleration C switchover terminal (X20 signal) : Pr. 180 to Pr. 183, Pr. 187 setting "20"

When Pr. 29 = "4", you can use the S-pattern acceleration/deceleration C switchover terminal to set the acceleration of S-pattern acceleration/deceleration in the parameter. (Refer to page 102.)

Related parameters

Pr. 29 "acceleration/deceleration pattern", Pr. 380 "acceleration S pattern 1", Pr. 381 "deceleration S pattern 1", Pr. 382 "acceleration S pattern 2", Pr. 383 "deceleration S pattern 2" (Refer to page 102.)

1.11.10 Orientation command (X22 signal): Pr. 180 to Pr. 183, Pr. 187 setting "22"

With the position detector (encoder) fitted to the motor end, you can perform position stop (orientation) control of the rotation shaft. Refer to page 172 for details.

Related parameters

Pr. 350 "stop position command selection", Pr. 351 "orientation switchover speed", Pr. 356 "Internal stop position command", Pr. 357 "orientation in-position zone", Pr. 360 "external position command selection", Pr. 361 "position shift", Pr. 362 "orientation position loop gain", Pr. 393 "orientation selection", Pr. 396 "orientation speed gain (P term)", Pr. 397 "orientation speed integral time", Pr. 398 "orientation speed gain (D term)", Pr. 399 "orientation deceleration ratio" (Refer to page 172.)

1.11.11 Pre-excitation/servo on (LX signal): Pr. 180 to Pr. 183, Pr. 187 setting "23"

● Pre-excitation

When the start signal (STF, STR) is not input to the inverter (during a stop), turning on the pre-excitation terminal LX enables 0 speed control or servo lock. (Refer to page 95 for details.)

● Servo on

Use the LX signal to exercise position control.

Turning on the LX signal switches the servo on and cancels the base circuit shut-off, resulting in a servo lock status. (Refer to page 57 for details.)

Related parameters

Pre-excitation ⇒ Pr. 802 "pre-excitation selection" (Refer to page 95.)

Servo-on ⇒ Pr. 419 "position command right selection", Pr. 420 "command pulse scaling factor numerator", Pr. 421 "command pulse scaling factor denominator", Pr. 422 "position loop gain", Pr. 423 "position feed forward gain", Pr. 424 "position command acceleration/deceleration time constant", Pr. 425 "position feed forward command filter", Pr. 426 "in-position width", Pr. 427 "excessive level error", Pr. 430 "pulse monitor selection", Pr. 464 "digital position control sudden stop deceleration time", Pr. 465 to Pr. 494 (position feed amount) (Refer to page 57.)

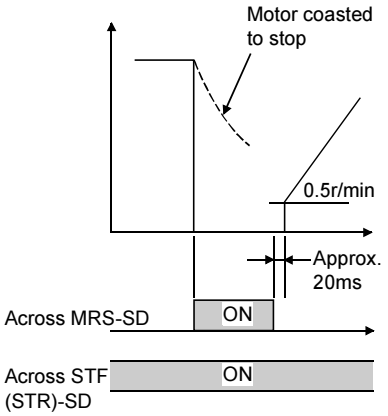
1.11.12 Output stop (MRS signal): Pr. 180 to Pr. 183, Pr. 187 setting "24"

Short the output stop terminals MRS-SD during inverter output to cause the inverter to stop the output immediately.
This function is valid in any mode independently of the control mode.
Open terminals MRS-SD to resume operation in about 20ms.
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 the motor that has stopped restarts.

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

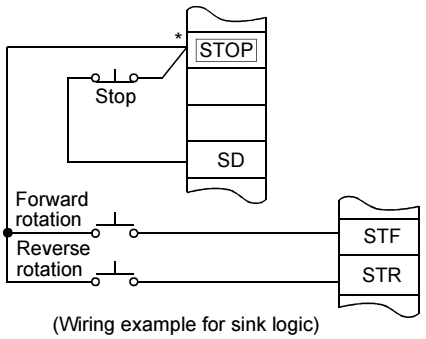
(3) To coast the motor to stop
The motor is decelerated according to the preset deceleration time and is stopped by operating the DC injection brake at the DC injection brake operation speed or less. Using terminal MRS, the motor is coasted to a stop.



1.11.13 Start self-holding selection (STOP signal): Pr. 180 to Pr. 183, Pr. 187 setting "25"

The connection example given here is used to self-hold the start signal (forward rotation, reverse rotation).

* Connected to the STOP signal to disable forward or reverse rotation if forward or reverse rotation and stop are turned on at the same time.



(Wiring example for sink logic)

1.11.14 Control mode changing (MC signal): Pr. 180 to Pr. 183, Pr. 187 setting "26"

By setting Pr. 800 "control system selection", change the control mode between speed, torque and position. Refer to page 182 for details.

1.11.15 Torque restriction selection (TL signal): Pr. 180 to Pr. 183, Pr. 187 setting "27"

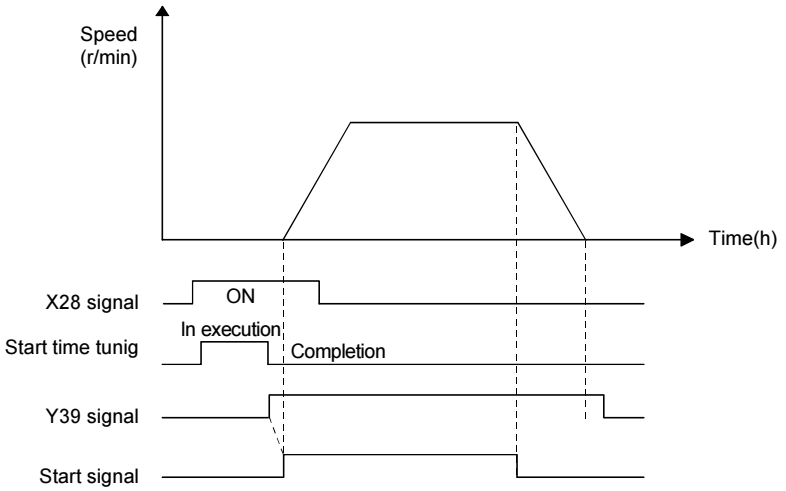
By setting Pr. 815 "torque restriction level 2", you can change the torque restriction value. Refer to the Instruction Manual (basic) for details.

1.11.16 Start time tuning (X28 signal): Pr. 180 to Pr. 183, Pr. 187 setting "28"

You can perform online tuning before turning on (during stop) the start signals (STF, STR) to prevent a start time delay due to tuning.

POINT

- Perform offline auto tuning (page 132) and set "1" in Pr. 95 (start time tuning).
- You can perform start time tuning by X28 signal when the Y39 signal is off.
- It takes 500ms maximum for start time tuning to complete.



REMARKS

- Start time tuning is also performed with the LX signal on and a start signal by the speed command less than the starting speed (e.g. zero speed command) on.
- The Y39 signal is kept on while the second magnetic flux remains after a motor stop.
- The X28 signal is not made valid while the Y39 signal is on.
- The STF, STR and LX signals are made valid after completion of start time tuning.
- During tuning, only the output signals below are valid IPF, THP, PU, Y12, RY, ER, LF, MT, DA1, DA2, ABC.
- Invalid during V/F control.

1.11.17 Torque bias selection 1 (X42 signal): Pr. 180 to Pr. 183, Pr. 187 setting "42"
Torque bias selection 2 (X43 signal): Pr. 180 to Pr. 183, Pr. 187 setting "43"

When using the torque bias function, you can combine the on/off of the X42 and X43 signals to select the torque bias amount. Refer to page 189 for details.

Related parameters

Pr. 840 "torque bias selection", Pr. 841 "torque bias 1", Pr. 842 "torque bias 2", Pr. 843 "torque bias 3", Pr. 844 "torque bias filter", Pr. 845 "torque bias operation time", Pr. 846 "torque bias balance compensation", Pr. 847 "fall-time torque bias No. 3 bias", Pr. 848 "fall-time torque bias No. 3 gain" (Refer to page 189.)

1.11.18 P control selection (P/PI control switchover) (X44 signal):

Pr. 180 to Pr. 183, Pr. 187 setting ***"44"***

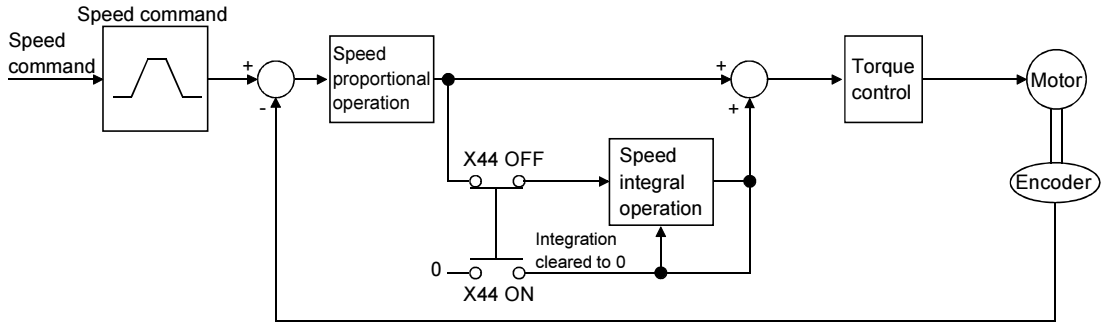
By turning the X44 signal on/off during speed control operation under vector control, you can select whether to add integral time (I) or not when performing gain adjustment with P gain and integral time using the X44 signal.
When the X44 signal is off: PI control

When the X44 signal is on: P control

Since speed deviation occurs according to the load, you can use the machine-coupled device to suppress the hunting of the control system.

Related parameters

Pr. 820 "speed control P(proportional) gain 1"
Pr. 821 "speed control integral time 1"
Pr. 830 "speed control P(proportional) gain 2"
Pr. 831 "speed control integral time 2"
Refer to page 48 for details.



1.12 How to use the output signals (assigned terminals DO1 to DO3, ABC) (Pr. 190 to Pr. 192, Pr. 195)

The output terminals DO1, DO2, DO3, ABC vary in functions with the Pr. 190 to Pr. 192 and Pr. 195 settings.

Parameter	Name	Terminal Symbol	Factory Setting	Factory-Set Terminal Function	Setting Range	Remarks
190	DO1 terminal function selection	RUN	0	Inverter running	0 to 8, 10 to 16, 20, 25 to 27, 30 to 37, 39, 40 to 44, 96 to 99, 100 to 108, 110 to 116, 120, 125 to 127, 130 to 137, 139, 140 to 144, 196 to 199, 9999	Extended mode
191	DO2 terminal function selection	SU	1	Up to speed		
192	DO3 terminal function selection	IPF	2	Instantaneous power failure, undervoltage		
195	ABC terminal function selection	A, B, C	99	Alarm output		

<Setting>

Refer to the following table for the settings of Pr. 190 to Pr. 192 and Pr. 195.

Setting		Signal Name	Function	Operation
Positive logic	Negative logic			
0	100	RUN	Inverter running	Output when the start command is input. For V/F control, this signal is output during operation when the inverter output speed rises to or above the starting speed. During DC injection brake, 0 speed control or servo lock, this signal is not output.
1	101	SU	Up to speed	Refer to Pr. 41 "up-to-speed sensitivity" (page 108).
2	102	IPF	Instantaneous power failure or undervoltage	Output at occurrence of an instantaneous power failure or undervoltage.
3	103	OL	Overload alarm	Output when torque or speed restriction is activated. For V/F control, this signal is output while the stall prevention function is activated.
4	104	FU	Output speed detection	Refer to Pr. 42, Pr. 43 (speed detection) (page 108).
5	105	FU2	Second output speed detection	Refer to Pr. 50 "second speed detection" (page 108).
6	106	FU3	Third output speed detection	Refer to Pr. 116 "third speed detection" (page 108).
7	107	RBP	Regenerative brake prealarm	Output when 85% of the regenerative brake duty set in Pr. 70 is reached.
8	108	THP	Electronic thermal relay function prealarm	Output when the electronic thermal relay function cumulative value reaches 85% of the preset level.
10	110	PU	PU operation mode	Output when the PU operation mode is selected.
11	111	RY	Inverter operation ready	Output when the inverter can be started by switching the start signal on or while it is running.
12	112	Y12	Output current detection	Refer to Pr. 150 and 151 (output current detection) (page 159).
13	113	Y13	Zero current detection	Refer to Pr. 152 and 153 (zero current detection) (page 160).
14	114	FDN	PID lower limit	Refer to Pr. 128 to 134 (PID control) (page 152).
15	115	FUP	PID upper limit	
16	116	RL	PID forward-reverse rotation output	
20	120	BOF	Brake opening request	Refer to Pr. 278 to Pr. 285 (brake sequence function) (page 118).
25	125	FAN	Fan fault output	Output at the time of a fan fault.
26	126	FIN	Fin overheat prealarm	Output when the heatsink temperature reaches about 85% of the fin overheat protection activating temperature.
27	127	ORA	Orientation in-position	When orientation is valid
30	130	Y30	Forward rotation output	For vector control
31	131	Y31	Reverse rotation output	

Setting		Signal Name	Function	Operation
Positive logic	Negative logic			
32	132	Y32	Regenerative status output	For vector control
33	133	RY2	Operation ready 2	Output on completion of pre-excitation. Turned on at an output start when pre-excitation is not made.
34	134	LS	Low speed output	Output when the speed falls to or below any preset low speed.
35	135	TU	Torque detection	Output when the motor torque rises above the predetermined value (Pr.864). (Refer to page 194.)
36	136	Y36	In-position	Acts as an in-position signal.
37	137	MT	Maintenance timer output	Refer to Pr. 890 to Pr. 892 (maintenance output function) (page 199).
39	139	Y39	Start time tuning completion	Output on completion of start time tuning
40	140	Y40	Trace status	Acts as a trace completion signal.
41	141	FB	Speed detection	Output when the motor output speed (feed back value) exceeds the preset speed. Perform in the same way as FU, FU2 and FU3 under V/F control.
42	142	FB2	Second speed detection	
43	143	FB3	Third speed detection	
44	144	RUN2	Inverter running 2	• Output during forward operation or the reverse signal is ON. • Output at deceleration even during forward rotation or the reverse signal is OFF. (Does not output during pre-excitation LX is ON.) • Output during the orientation command signal (X22) is ON. • Switched ON when the servo is ON (LX-ON) under position cotrol. (Switched OFF when the servo is OFF. (LX-OFF)
96	196	REM	Remote output	Refer to Pr. 495 to Pr.497 (page 181).
97	197	ER	Minor fault output 2	At occurrence of a major fault, the base circuit is shut off immediately. At occurrence of a minor fault, the base circuit is shut off after deceleration to a stop.
98	198	LF	Minor fault output	Output when a minor fault (fan fault or communication error alarm) occurs.
99	199	ABC	Alarm output	Output when the inverter's protective function is activated to stop the output (major fault).
9999		——	No function	—

0 to 99: Positive logic, 100 to 199: Negative logic

1.13 Design information to be checked

1) When performing commercial power supply-inverter switchover operation for the motor other than the vector control dedicated motor, securely provide electrical and mechanical interlocks for the MC1 and MC2 used for commercial power supply-inverter switchover.
When the wiring is wrong or there is a commercial power supply-inverter switchover circuit as shown below, the inverter will be damaged by a sneak current from the power supply due to arcs generated at the time of switchover 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 that will not turn 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) When the power supply used with the control circuit is different from the one used with the main circuit, make up a circuit which will switch off the main circuit power supply terminals R, S, T when the control circuit power supply terminals R1, S1 are switched off.

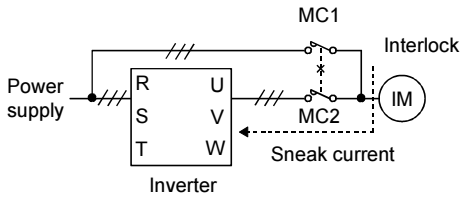
4) Since the input signals to the control circuit are on a low level, use two parallel low-level signal contacts or a twin contact for contact inputs to prevent poor contact.

5) Do not apply a voltage to the contact input terminals (e.g. STF) of the control circuit.

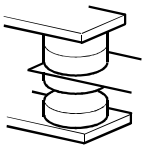
6) Do not apply a voltage directly to the alarm output terminals (A, B, C). Always apply a voltage to these terminals via a relay coil, lamp, etc.

7) Fully make sure that the specifications and rating match the system requirements.

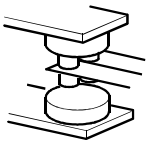
Commercial power supply-inverter switchover (other than the vector control dedicated motor)



Low-level signal contacts



Low-level signal contacts



Twin contact

1.14 Using the second motor

1.14.1 Wiring diagram (second motor)

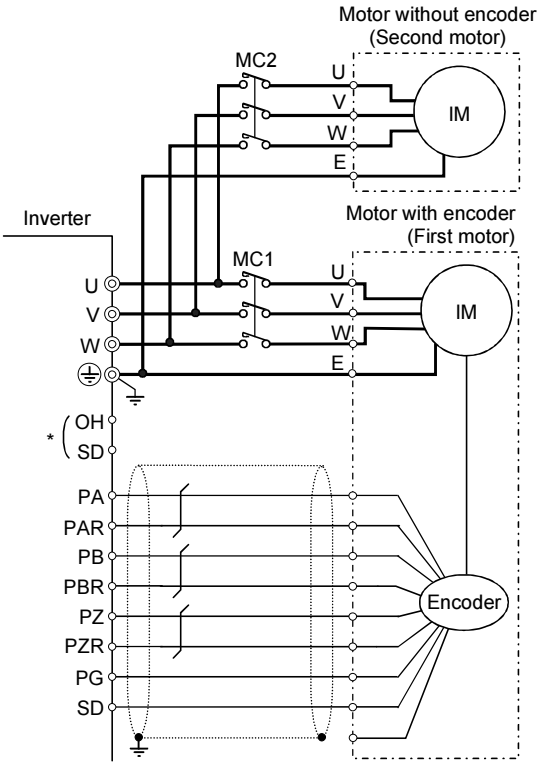
Vector control with encoder is not enabled with the second motor.

CAUTION

1. **Provide interlocks to prevent the MC1 and MC2 from being turned on simultaneously.**
2. **For the second motor (motor without encoder), use Pr. 452 "second electronic thermal O/L relay" or provide an external thermal relay.**
3. ***: Give one external thermal relay signal to across OH-SD.**

Related parameters

Second electronic thermal relay function setting ⇒ (Pr. 452 "second electronic thermal O/L relay" (Refer to page 93.))



1.14.2 Second motor setting parameters

Parameter	Name	Factory Setting	Setting Range			
450	Second applied motor	9999	0	Standard motor	Inverter internal constant	Refer to page 123.
			3 to 8		Offline auto tuning	
			10	Constant torque motor	Inverter internal constant	
			13 to 18		Offline auto tuning	
			20	SF-JR (4P)-1.5kW (2HP) or less (under vector control)	Inverter internal constant	
			23, 24		Offline auto tuning	
			30	Vector control dedicated motor	Inverter internal constant	
			33, 34		Offline auto tuning	
			9999	Function invalid		
451	Second motor control method selection	9999	10	vector control without encoder	Speed control	
			11		Torque control	
			12		Speed control-torque control switchover	
			20	V/F control	Speed control	
			9999	Function invalid		
452	Second electronic thermal O/L relay	9999	Set the rated motor current. 0 to 500A (Refer to page 93.)			
			9999	Function invalid		

Parameter	Name	Factory Setting	Setting Range	
453	Second motor capacity	Inverter capacity	Set the motor capacity. 0.4 to 55kW (0.5 to 75HP)	Setting can be made when Pr. 450 ≠ "9999"
454	Number of second motor poles	4	Set the number of motor poles. 2, 4, 6P	
456	Rated second motor voltage	575V	Set the rated voltage 0 to 100V	
457	Rated second motor frequency	60Hz	Set the rated frequency 20 to 200Hz	
463	Second auto tuning setting/status	0	0 : Without auto tuning 1 : Tuning without running the motor 101 : Tuning with running the motor	

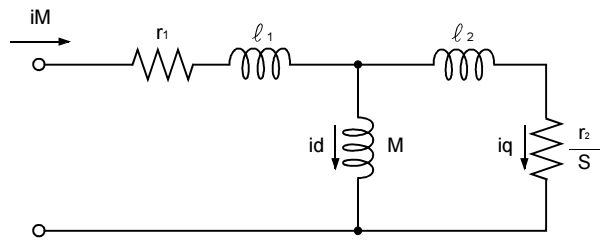
- Turn on/off the RT signal to switch between the first and second motors using contacts information of the magnetic contactor (MC).
  (Use the RT signal after setting it to any of the DI1 to DI4 signals using Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection).
- By setting values other than "9999" in Pr. 451 when Pr. 450="9999" (factory setting), the control system of the first motor can be changed by switching the RT terminal on and off.
  (In this case, turning the RT signal on makes the second function of Pr. 44, Pr. 45, Pr. 452, Pr. 456, Pr. 457, Pr. 463, and Pr. 830 to Pr. 837 valid.

2 VECTOR CONTROL WITH ENCODER

This chapter explains the basic "adjustment for vector control with encoder" for use of this product.
Always read the instructions and other information before using the equipment.

2.1 What is vector control?

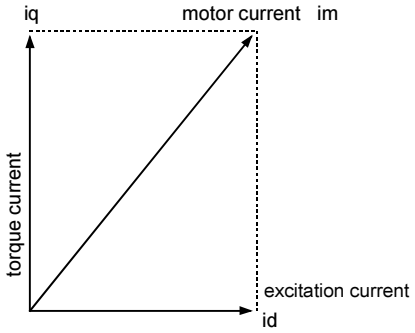
Vector control is one of the control techniques for driving an induction motor. To help explain vector control, the fundamental equivalent circuit of an induction motor is shown below:



r1 : Primary resistance
r2 : Secondary resistance
ℓ_1 : Primary leakage inductance
ℓ_2 : Secondary leakage inductance
M : Mutual inductance
S : Slip
id : Excitation current
iq : Torque current
im : Motor current

In the above diagram, currents flowing in the induction motor can be classified into a current id (excitation current) for making a magnetic flux in the motor and a current iq (torque current) for causing the motor to develop a torque.

.



In vector control, the voltage and output frequency are calculated to control the motor so that the excitation current and torque current (as shown in the left figure) flow to the optimum as described below:

(1) The excitation current is controlled to place the internal magnetic flux of the motor in the optimum status.

(2) Derive the torque command value so that the difference between the motor speed command and the actual speed obtained from the encoder connected to the motor shaft is zero.

Motor-generated torque (TM), slip angular velocity (ωs) and the motor's secondary magnetic flux ($\phi 2$) can be found by the following calculation:

$$T_M \propto \phi_2 \cdot iq$$

$$\phi_2 = M \cdot id$$

$$\omega s = \frac{r2}{L2} \cdot \frac{iq}{id}$$

where, L2 = secondary inductance

$L2 = \ell_2 + M$

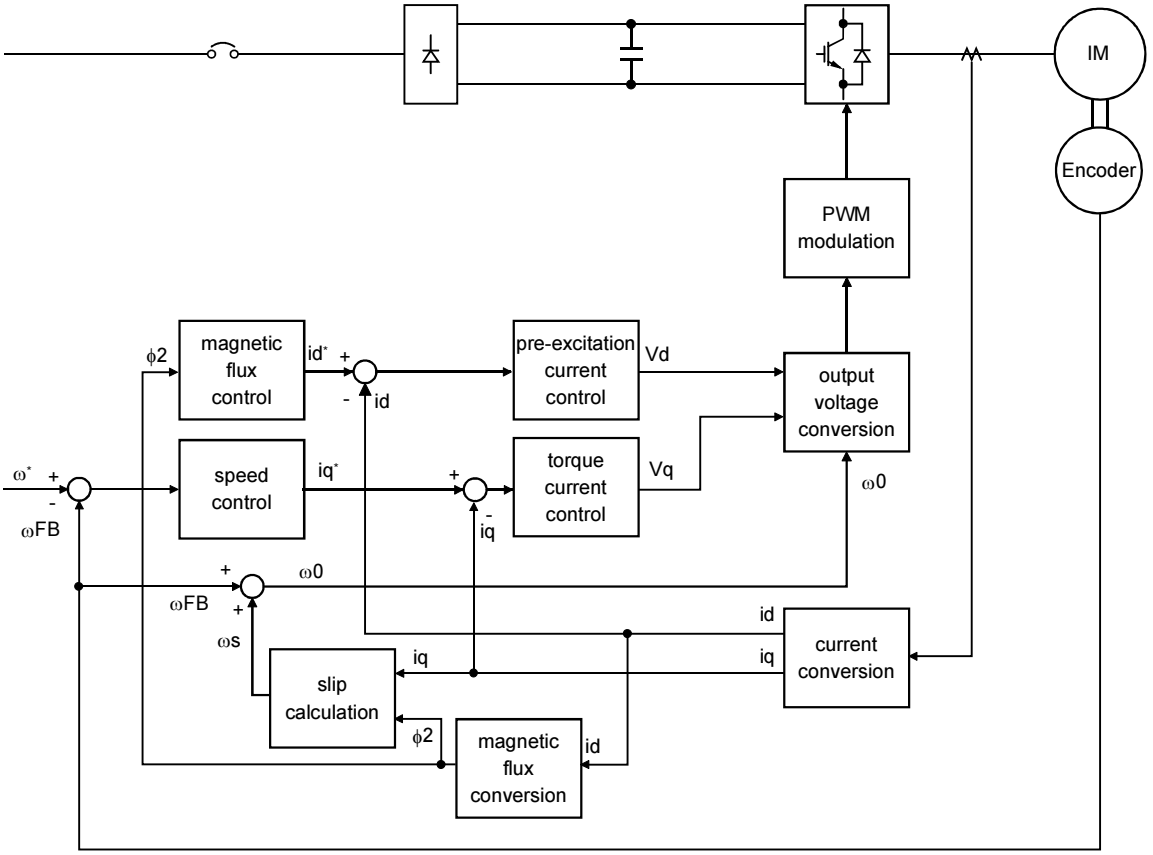
Vector control provides the following advantages:

(1) Excellent control characteristics when compared to V/F control and other control techniques, achieving the control characteristics equal to those of DC machines.

(2) Applicable to high-response applications with which induction motors were previously regarded as difficult to use. Applications requiring a wide variable-speed range from extremely low speed to high speed, frequent acceleration/deceleration operations, continuous four-quadrant operations etc.

(3) Allows torque control.

(4) Allows servo-lock torque control which generates a torque at zero speed (i.e. status of motor shaft = stopped).



(1) Speed control
Speed control operation is performed to zero the difference between the speed command (ω*) and actual rotation detection value (ω_{FB}). At this time, the motor load is found and its result is transferred to the torque current controller as a torque current command (i_q*).

(2) Torque current control
A voltage (Vq) is calculated to start a current (i_q*) which is identical to the torque current command (iq) found by the speed controller.

(3) Magnetic flux control
The magnetic flux (ϕ_2) of the motor is derived from the excitation current (id). The excitation current command (id*) is calculated to use that motor magnetic flux (ϕ_2) as a predetermined magnetic flux.

(4) Excitation current control
A voltage (Vd) is calculated to start a current (id) which is identical to the excitation current command (id*) found by magnetic flux control.

(5) Output frequency calculation
Motor slip (ω_s) is calculated on the basis of the torque current value (iq) and magnetic flux (ϕ_2). The output frequency (w_0) is found by adding that slip (ω_s) to the feedback (ω_{FB}) found by a feedback from the encoder.

The above results are used to make PWM modulation and run the motor.

This inverter can control a motor under speed, torque or position control. (As required, set "1" (extended function parameters valid) in Pr. 160 "extended function selection".)
Refer to page 163 for details of Pr. 160 "extended function selection". (Since the factory setting of Pr. 77 is "0", perform parameter write in the PU mode or during a stop.)

2.2 Speed control

2.2.1 Outline of speed control

The basics of speed control are explained in the Instruction Manual (basic).

Set any of "0 (speed control), 2 (speed-torque switchover), 4 (speed-position switchover)" in Pr. 800 "control system selection" to make speed control valid.
Pr. 800 is factory-set to 0 (speed control) (Refer to page 182.)

↓

Set the motor. (Refer to page 8)

↓

Set the operation command. (Refer to page 129.)

↓

Test run

As required

1) Gain adjustment
Perform easy gain tuning. (Refer to the Instruction Manual (basic).)

↓ To achieve faster responsiveness to the speed command change (when faster responsiveness is desired)

Perform model adaptive control/speed feed forward control. (Refer to page 51.)

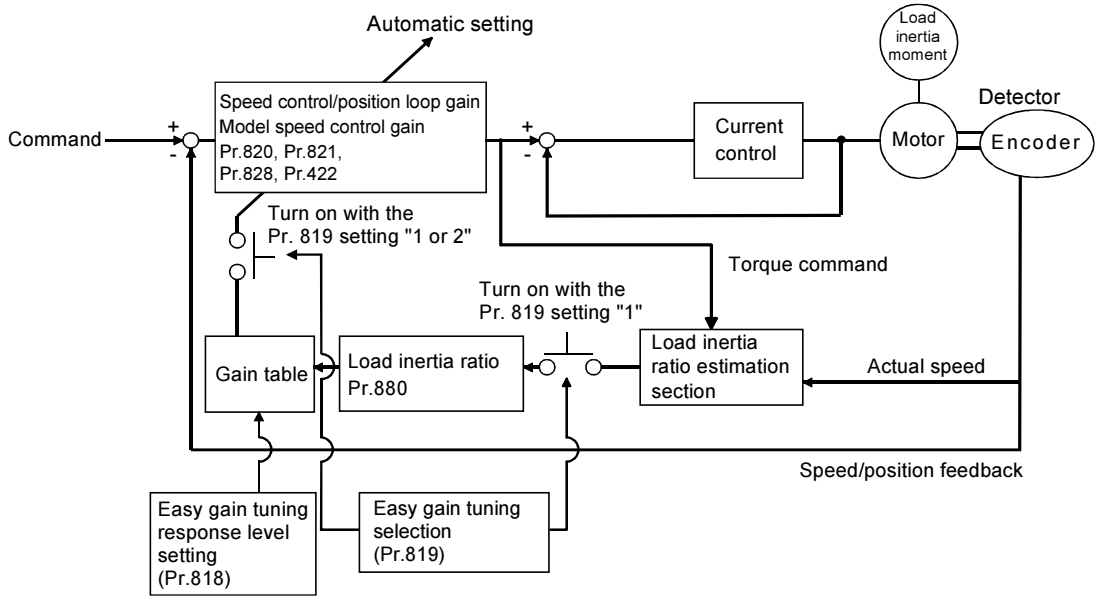
↓ For further fine adjustment of gains

Perform manual input gain adjustment. (Refer to page 48.)

2) Set the torque restriction value.

Refer to the Instruction Manual (basic) for the connection diagram, test run and easy gain tuning.

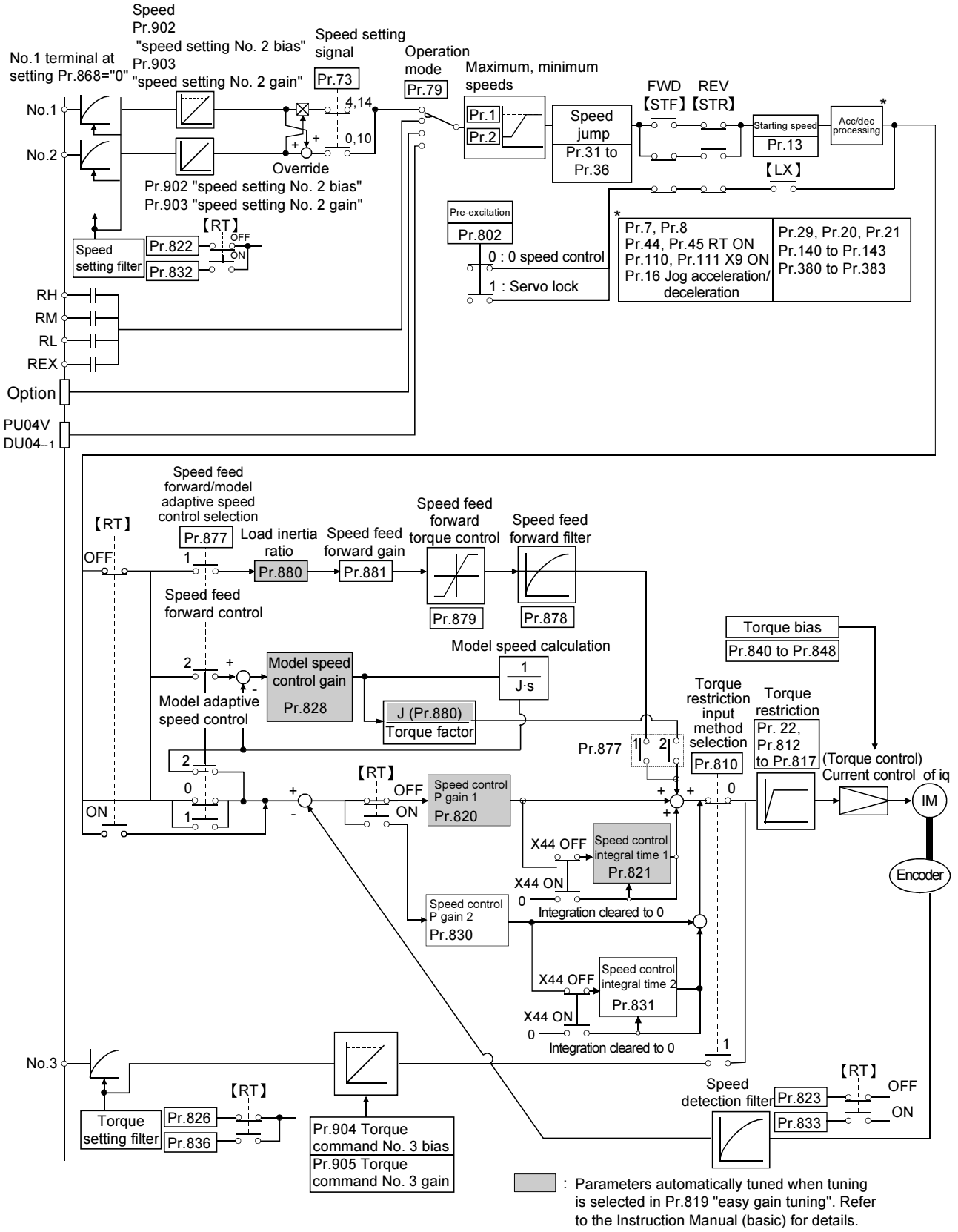
2.2.2 Easy gain tuning function block diagram



2.3 Fine adjustment of gains for speed control

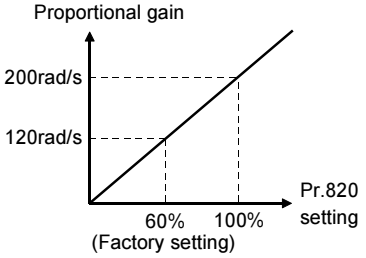
If easy gain tuning does not provide high accuracy, refer to the next page and make adjustment.
Make adjustment when vibration, noise or any other unfavorable phenomenon occurs due to large load inertia or gear backlash, for example, or when you want to exhibit the best performance that matches the machine.

2.3.1 Control block diagram

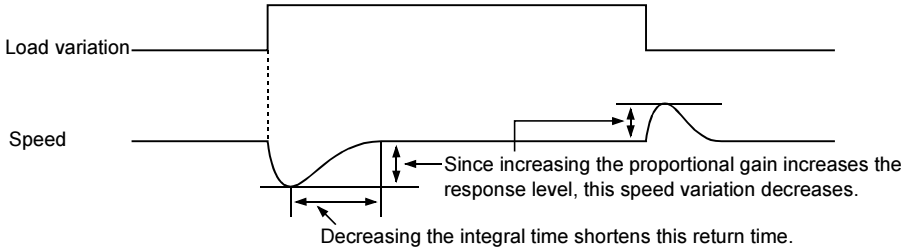


2.3.2 Concept of adjustment of manual input speed control gains

1) Speed control P gain 1
   - Pr. 820 = 60% is equivalent to 120rad/s (speed responce of the motor alone). (factory setting)
   - Increasing the proportional gain increases the response level. However, a too high gain will produce vibration and/or unusual noise.
2) Speed control integral time
   - Pr. 821 = 0.333s (factory setting)
   - Decreasing the integral time shortens the return time taken at a speed change. However, a too short time will generate an overshoot.



When there is load inertia, the actual speed gain is as given below.



Also, when there is load inertia, the actual speed gain decreases as indicated below.

$$\text{Actual speed gain} = \text{speed gain of motor without load} \times \frac{J_M}{J_M+J}$$

J_M : Inertia of motor
J_L : Motor shaft-equivalent load inertia

2.3.3 Speed control gain adjustment procedure (Pr. 820, Pr. 821)

- Set "0" in Pr. 819 "easy gain tuning". (Easy gain tuning is not performed.)
  Refer to the Instruction Manual (basic) for easy gain tuning.
- Refer to the following for manually input gain adjustment.

● Manuall input gain adjustment

- Pr. 820 "speed control P (proportional) gain 1", Pr. 830 "speed control P (proportional) gain 2"
- Pr. 821 "speed control integral time 1", Pr. 831 "speed control integral time 2"

Make adjustment when any of such phenomena as unusual machine vibration/noise, low response level and over-shoot has occurred.

1) First check the conditions and simultaneously change Pr. 820 "speed control P gain 1" value.
2) If you cannot make proper adjustment, change Pr. 821 "speed control integral time 1" value and repeat step (1).

CAUTION

Pr. 830 "speed control P(proportional) gain 2" and Pr. 831 "speed control integral time 2" are made valid when the RT terminal is switched on. Make adjustments in the same way as Pr. 820 and Pr. 821.

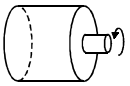
No.	Phenomenon/Condition	Adjustment Method	
1	Large load inertia	Set the Pr. 820 and Pr. 821 values a little higher.	
		Pr. 820	When a speed rise is slow, increase the value 10% by 10% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.
		Pr. 821	If an overshoot occurs, double the value until an overshoot does not occur, and set about 0.8 to 0.9 of that value.
2	Vibration/noise generated from mechanical system	Set the Pr. 820 value a little lower and the Pr. 821 value a little higher.	
		Pr. 820	Decrease the value 10% by 10% until just before vibration/noise is not produced, and set about 0.8 to 0.9 of that value.
		Pr. 821	If an overshoot occurs, double the value until an overshoot does not occur, and set about 0.8 to 0.9 of that value.
3	Slow response	Set the Pr. 820 value a little higher.	
		Pr. 820	When a speed rise is slow, increase the value 5% by 5% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.

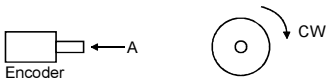
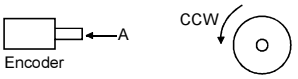
No.	Phenomenon/Condition	Adjustment Method
4	Long return time (response time)	Set the Pr. 821 value a little lower.
		Decrease the value by half until just before an overshoot or the unstable phenomenon does not occur, and set about 0.8 to 0.9 of that value.
5	Overshoot or unstable phenomenon occurs.	Set the Pr. 821 value a little higher.
		Double the value until just before an overshoot or the unstable phenomenon does not occur, and set about 0.8 to 0.9 of that value.

REMARKS

You can switch between PI control and P control under speed control using the X44 signal. (Refer to page 37.)

2.3.4 Troubleshooting

	Phenomenon	Cause	Corrective Action
1	Motor does not rotate.	(1) The motor or encoder wiring is wrong.	(1) Check the wiring. * Choose V/F control (Pr. 800 = 20) and check the rotation direction of the motor and the speed monitor output from the DA1 output terminal.  When the forward rotation signal is input, the motor running in the counterclockwise direction as viewed from the motor shaft is normal. (If it runs in the clockwise direction, the phase sequence of the inverter secondary side wiring is incorrect.)
		(2) The encoder specifications (jumper connector setting) are wrong.	(2) Check the encoder specifications. Check the positions of the 5V/12V/24V/External and differential/complimentary jumper connectors.
		(3) The encoder wiring is wrong.	(3) Check that FWD is displayed when running the motor in the counter-clockwise direction from outside during a stop of the inverter. If REV is displayed, the encoder phase sequence is wrong. Perform the correct wiring or match the Pr. 852 "encoder rotation direction" setting.
		(4) The Pr. 851 "number of encoder pulses" setting and the number of encoder used are different.	(4) The motor will not run if the parameter setting is smaller than the number of encoder pulses used. Set Pr. 851 "number of encoder pulses" correctly.
2	Motor does not run at correct speed. (Speed command does not match actual speed)	(1) The speed command from the command device is incorrect. The speed command is compounded with noise.	(1) Check that a correct speed command comes from the command device. Decrease the PWM carrier frequency in Pr. 72.
		(2) The speed command value does not match the inverter-recognized value.	(2) Readjust the speed command bias and gain in Pr. 902, Pr. 903, Pr. 917, and Pr. 918.
		(3) The number of encoder pulses setting is incorrect.	(3) Check the setting of the number of encoder pulses in Pr. 851.

Pr. 852 Setting	Relationship between the motor and encoder
0	 Forward rotation is clockwise rotation when viewed from A.
1 (factory setting)	 Forward rotation is counterclockwise rotation when viewed from A.

Fine adjustment of gains for speed control

	Phenomenon	Cause	Corrective Action
3	Speed does not rise to the speed command.	(1) Insufficient torque. Torque restriction is actuated.	(1)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(1)-2 Insufficient capacity
		(2) Only P (proportional) control is selected.	(2) When the load is heavy, speed deviation will occur under P (proportional) control. Select PI control.
4	Motor speed is unstable.	(1) The speed command varies.	(1)-1 Check that a correct speed command comes from the command device. (Take measures against noises.)
			(1)-2 Decrease the PWM carrier frequency in Pr. 72.
			(1)-3 Increase the speed setting filter in Pr. 822.
		(2) Insufficient torque.	(2)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(2)-2 Return the excitation ratio in Pr. 854 to the factory setting (100%).
		(3) The speed control gains do not match the machine. (machine resonance)	(3)-1 Perform easy gain tuning.
			(3)-2 Adjust Pr. 820 and Pr. 821. (Refer to gain adjustment.)
			(3)-3 Perform speed feed forward control and model adaptive speed control.
5	Motor or machine hunts (vibration/noise is produced).	(1)The speed control gain is high.	(1)-1 Perform easy gain tuning.
			(1)-2 Decrease Pr. 820 and increase Pr. 821.
			(1)-3 Perform speed feed forward control and model adaptive speed control.
		(2) High torque control gain.	(2) Decrease Pr. 824. (Refer to page 55.)
		(3) Motor wiring and encoder wiring are not correct.	(3) Check wiring. Check Pr. 852 setting for the encoder rotation direction.
6	Acceleration/ deceleration time does not match the setting.	(1) Insufficient torque.	(1)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(1)-2 Return the excitation ratio in Pr. 854 to the factory setting.
			(1)-3 Perform speed feed forward control.
		(2) Large load inertia.	(2) Set the acceleration/deceleration time that meets the load.
7	Machine operation is unstable	(1) The speed control gains do not match the machine.	(1)-1 Perform easy gain tuning.
			(1)-2 Adjust Pr. 820 and Pr. 821. (Refer to page 48.)
			(1)-3 Perform speed feed forward control and model adaptive speed control.
		(2) Slow response because of improper acceleration/ deceleration time of the inverter.	(2) Change the acceleration/deceleration time to an optimum value.
8	Speed fluctuates at low speed.	(1) Adverse effect of high carrier frequency.	(1) Decrease the PWM carrier frequency in Pr. 72.
		(2) Adverse effect of weak excitation.	(2) Return the excitation ratio in Pr. 854 to the factory setting.
		(3) Low speed control gain.	(3) Increase Pr. 820 "speed control P gain".

Related parameter reference pages

- Pr. 71 "applied motor" (Refer to page 123.)
- Pr. 72 "PWM frequency selection" (Refer to page 124.)
- Pr. 800 "control system selection" (Refer to page 182.)
- Pr. 820 "speed control P gain 1" (Refer to page 187.)
- Pr. 821 "speed control integral time 1" (Refer to page 187.)
- Pr. 822 "speed setting filter 1" (Refer to page 187.)
- Pr. 851 "number of encoder pulses" (Refer to page 10.)
- Pr. 854 "excitation ratio" (Refer to page 193.)
- Pr. 902 "speed setting No. 2 bias" (Refer to page 202.)
- Pr. 903 "speed setting No. 2 gain" (Refer to page 202.)
- Pr. 917 "No. 1 terminal bias (speed)" (Refer to page 202.)
- Pr. 918 "No. 1 terminal gain (speed)" (Refer to page 202.)

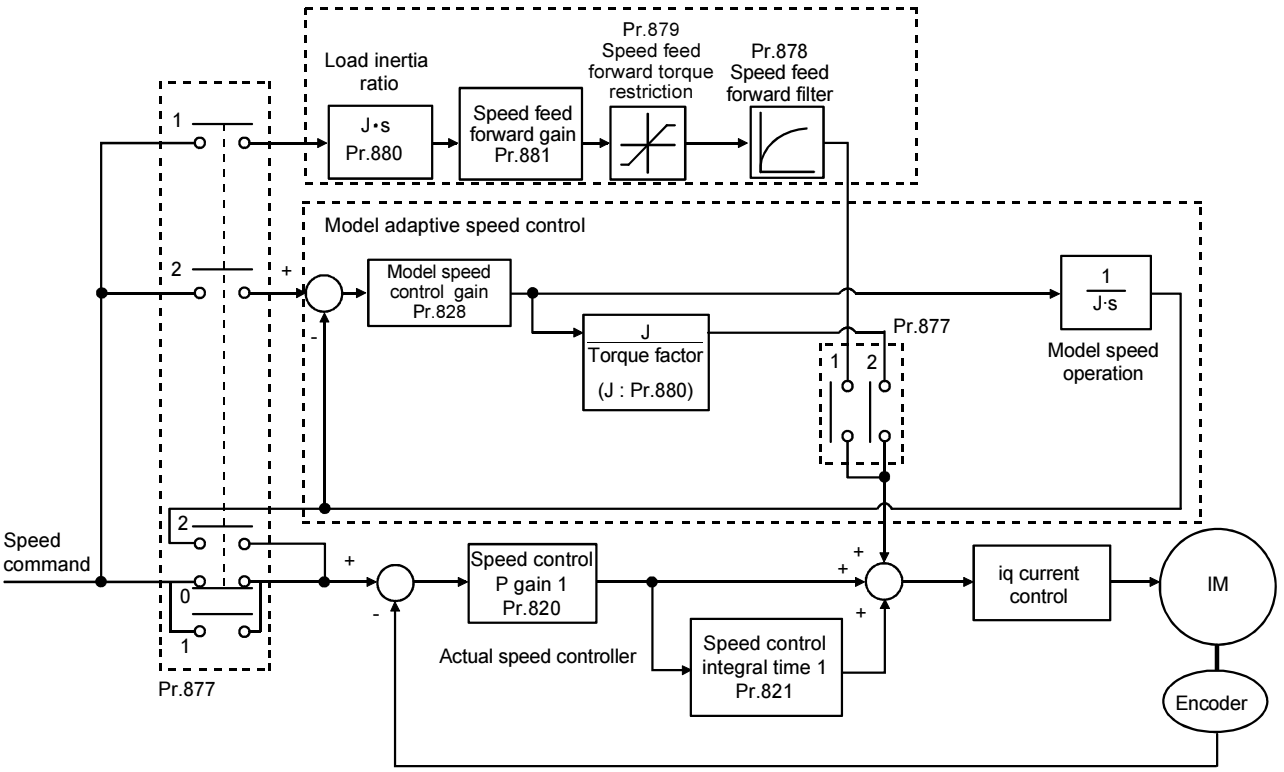
2.3.5 Speed feed forward control, model adaptive speed control (Pr. 877 to Pr. 881)

By making parameter setting, select the speed feed forward control or model adaptive speed control.
The speed feed forward control enhances the trackability of the motor in response to a speed command change.
The model adaptive speed control enables individual adjustment of speed trackability and motor disturbance torque response.

Parameter	Name	Factory Setting	Setting Range
828	Model speed control gain	60%	0 to 1000%
877	Speed feed forward control/model adaptive speed control selection	0	0,1,2
878	Speed feed forward filter	0s	0 to 1s
879	Speed feed forward torque restriction	150%	0 to 400%
880	Load inertia ratio	7	0,1 to 200 times
881	Speed feed forward gain	0%	0 to 1000%

POINT

When model adaptive speed gain is selected, the data obtained from easy gain tuning is used for Pr. 828 "model speed control proportional gain". Perform easy gain tuning also (simultaneously). (Refer to the Instruction Manual (basic).)



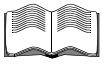
Pr. 877 Setting	Description
0	Normal speed control is exercised.
1	Speed feed forward control is exercised. ① Calculate required torque in responce to the acceleration/deceleration command for the inertia ratio set in Pr. 880 and generate torque immediately. ② When inertia ratio estimation has been made by easy gain tuning, the inertia ratio estimation result is used as the Pr. 880 setting, from which the speed feed forward is calculated. ③ When the speed feed forward gain is 100%, the calculation result of the speed feed forward in 1) is reflected as-is. ④ If the speed command changes suddenly, large torque is generated due to the speed feed forward calculation. The maximum value of the speed feed forward is restricted using Pr. 879. ⑤ Using Pr. 878, the speed feed forward result can be dulled by the primary delay filter.
2	Model adaptive speed control is enabled. ・At this time, the motor's model speed is calculated to feed back the model side speed controller. This model speed is also used as the actual speed controller command. ・The inertia ratio in Pr. 880 is used for calculation of the torque current command value given by the model side speed controller. When inertia ratio estimation has been made by easy gain tuning, Pr. 880 is overwritten by the inertia ratio estimation result, and that value is used to calculate the torque current command value. ・The torque current command value of the model side speed controller is added to the output of the actual speed controller, and the result is used as the iq current control input. Pr. 828 is used for model side speed control (P control), and the first gain in Pr. 820 is used for the actual speed controller. The model adaptive speed control is valid for the first motor only. ・When Pr. 877 = 2, switching to the second motor handles the second motor as Pr. 877 = 0.

CAUTION

The adequate gain value for the model and actual loop parts are set according to the responce setting of easygain tuning under model adaptive speed control. To increase the responce level, Pr. 818 "responce setting"needs to be changed (increased).

The following table indicates the relationships between the speed feed forward control and easy gain tuning function.

	Easy Gain Tuning Selection (Pr. 819) Setting		
	0	1	2
Load inertia ratio (Pr. 880)	Manual input	Inertia ratio estimation value found by easy gain tuning is displayed. Manual input enabled only during a stop.	Manual input
Model speed control gain (Pr. 828)	Manual input	Tuning results are displayed. Write disabled.	Tuning results are displayed. Write disabled.
Speed feed forward gain (Pr. 881)	Manual input	Manual input	Manual input

 For details of easy gain tuning, refer to the Instruction Manual (basic) for details.

Related parameters

- Pr. 820 "speed control P gain 1" (Refer to page 187.)
- Pr. 821 "speed control integral time 1" (Refer to page 187.)
- Pr. 830 "speed control P gain 2" (Refer to page 187.)
- Pr. 831 "speed control integral time 2" (Refer to page 187.)

2.4 Torque control

2.4.1 Outline of torque control

The basics of torque control are explained in the Instruction Manual (basic).

Set any of "1 (torque control), 2 (speed-torque switchover), 5 (position-torque switchover)" in Pr. 800 "control system selection" to make torque control valid.
(The parameter is factory-set to enable speed control. Set "1" in Pr. 800 to make torque control valid.) (Refer to page182.)

↓

Set the motor. (Refer to page 8.)

↓

Set the torque command. (terminal 3)
When using the parameter or communication to input the torque command, refer to Pr. 804 "torque command right" (page 184).
When giving the torque command from the option (FR-A5NC, FR-V5AH, FR-A5AX, FR-V5AP), refer to the instruction manual of the corresponding option.

↓

Set the speed restriction value.(Refer to the Instruction Manual (basic)

↓

Test run

↓

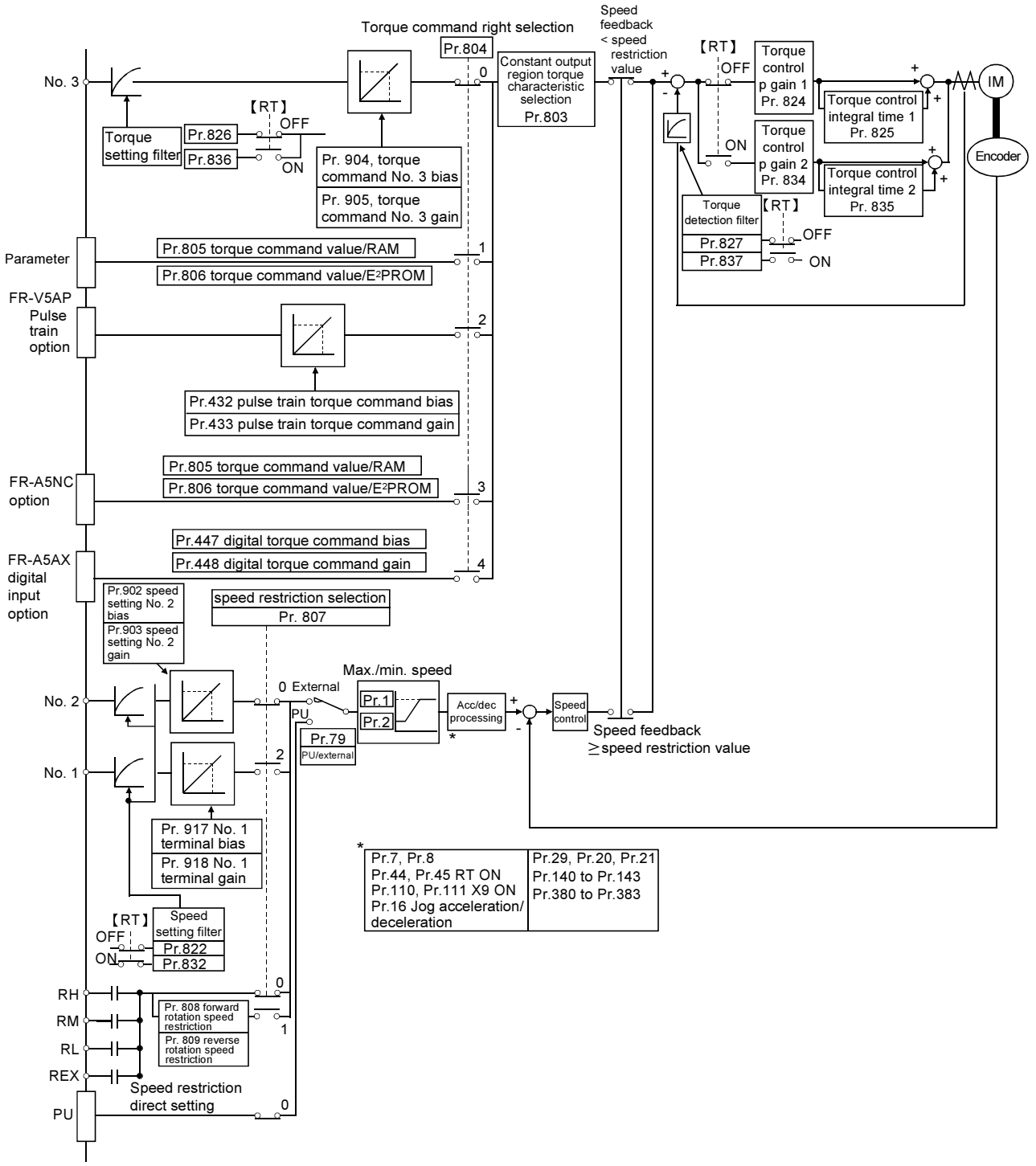
Set online auto tuning (adaptive magnetic flux observer) as required.

Refer to the Instruction Manual (basic) for the details of connection diagram, test run, and online auto tuning.

2.5 Fine adjustment for torque control

Current loop gain parameter for adjusting torque control operation state is available with the FR-V500 series. Stable operation is possible with the factory-set parameter.
Refer to the next page and adjust the parameters when torque pulsation or any other unfavorable phenomenon occurs depending on the machine and operating conditions or when you want to exhibit the best performance that matches the machine.

2.5.1 Control block diagram



2.6 Gain adjustment for torque control

When exercising torque control, do not perform easy gain tuning. Easy gain tuning produces no effects.
If torque accuracy is necessary, perform online auto tuning. (Refer to the Instruction Manual (basic).)

2.6.1 Concept of torque control gains

(1) Torque control P gain 1
2000rad/s when Pr. 824 = 100% (factory setting).
(2) Torque control integral time 1
Pr. 825 = 5ms (factory setting)

2.6.2 Gain adjustment procedure

Refer to the following table for manual input gain adjustment.

CAUTION

Normally, the current loop gains in Pr. 824 and Pr. 825 need not be changed. Fully note that unnecessarily changing the settings of the current loop gains will result in unstable phenomena and/or reduced response level.

- **Manual input gain adjustment**

Pr. 824 "torque control P gain 1", Pr. 834 "torque control P gain 2"
Pr. 825 "torque control integral time 1", Pr. 835 "torque control integral time 2"

Make adjustment when any of such phenomena as unusual machine vibration/noise and overcurrent has occurred.
(1) First check the conditions and simultaneously change Pr. 824 "torque control P gain 1" value.
(2) If you cannot make proper adjustment, change Pr. 825 "torque control integral time 1" value and repeat step (1).

CAUTION

Pr. 834 "torque control P gain 2" and Pr. 835 "toruque control integral time 2" are made valid when the RT terminal is switched on. Make adjustments in the same way as Pr. 824 and Pr. 825.

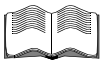
No.	Phenomenon/Condition	Adjustment Method	
1	• Unusual noise generated from motor • Unusual current flowing	Set Pr. 824 a little lower and Pr. 825 a little higher. First lower Pr. 824 and check the motor for unusual vibration/noise and overcurrent. If the problem still persists, increase Pr. 825.	
		Pr. 824	Decrease the value 10% by 10% until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value. Note that a too low value will produce current ripples, causing the motor to generate synchronous sound.
		Pr. 825	Double the value until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value. Note that a too high value will produce current ripples, causing the motor to generate synchronous sound.
2	Overcurrent occurs.	Set Pr. 824 a little lower and Pr. 825 a little higher. First lower Pr. 824 and check the motor for unusual vibration/noise and overcurrent. If the problem still persists, increase Pr. 825.	
		Pr. 824	Decrease the value 10% by 10% until just before an overcurrent does not occur, and set about 0.8 to 0.9 of that value.
		Pr. 825	Double the value until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value.

2.6.3 Troubleshooting

	Phenomenon	Cause	Corrective Action
1	Torque control is not exercised normally.	(1) The phase sequence of the motor or encoder wiring is wrong.	(1) Check the wiring. (Refer to page 4.)
		(2) The control mode selection, Pr. 800, setting is improper.	(2) Check the Pr. 800 setting. (The factory setting is speed control)
		(3) The speed restriction value is not input.	(3) Set the speed restriction value. (If the speed restriction value is not input, the motor will not rotate since the speed restriction value is regarded as 0r/min.)
		(4) The torque command varies.	(4) Check that the command device gives a correct torque command. ・Decrease the PWM carrier frequency in Pr. 72. ・Increase the torque setting filter in Pr. 826.
		(5) Torque variation due to the change in the motor temperature.	(5) Set the adaptive magnetic flux observer in Pr. 95.
		(6) The torque command does not match the inverter-recognized value.	(6) Recalibrate the torque command bias and gain in Pr. 904 and Pr. 905.
2	When the torque command is small, the motor rotates in the direction opposite to the start signal.	The offset calibration of the torque command does not match.	Recalibrate the torque command bias in Pr. 904.
3	Normal torque control cannot be exercised during acceleration/ deceleration. The motor vibrates.	Since the speed restriction value changes with the setting of the acceleration/deceleration time in Pr. 7, Pr. 8, the speed restriction may be activated. (When the speed restriction is activated, torque control cannot be exercised.)	Reduce the acceleration/deceleration time. Alternatively, set the acceleration/deceleration time to 0. (Speed restriction during acceleration/deceleration is speed restriction during constant speed)
4	Output torque is not linear in response to the torque command.	Insufficient torque.	Return the excitation ratio to the factory setting.

Related parameter reference pages

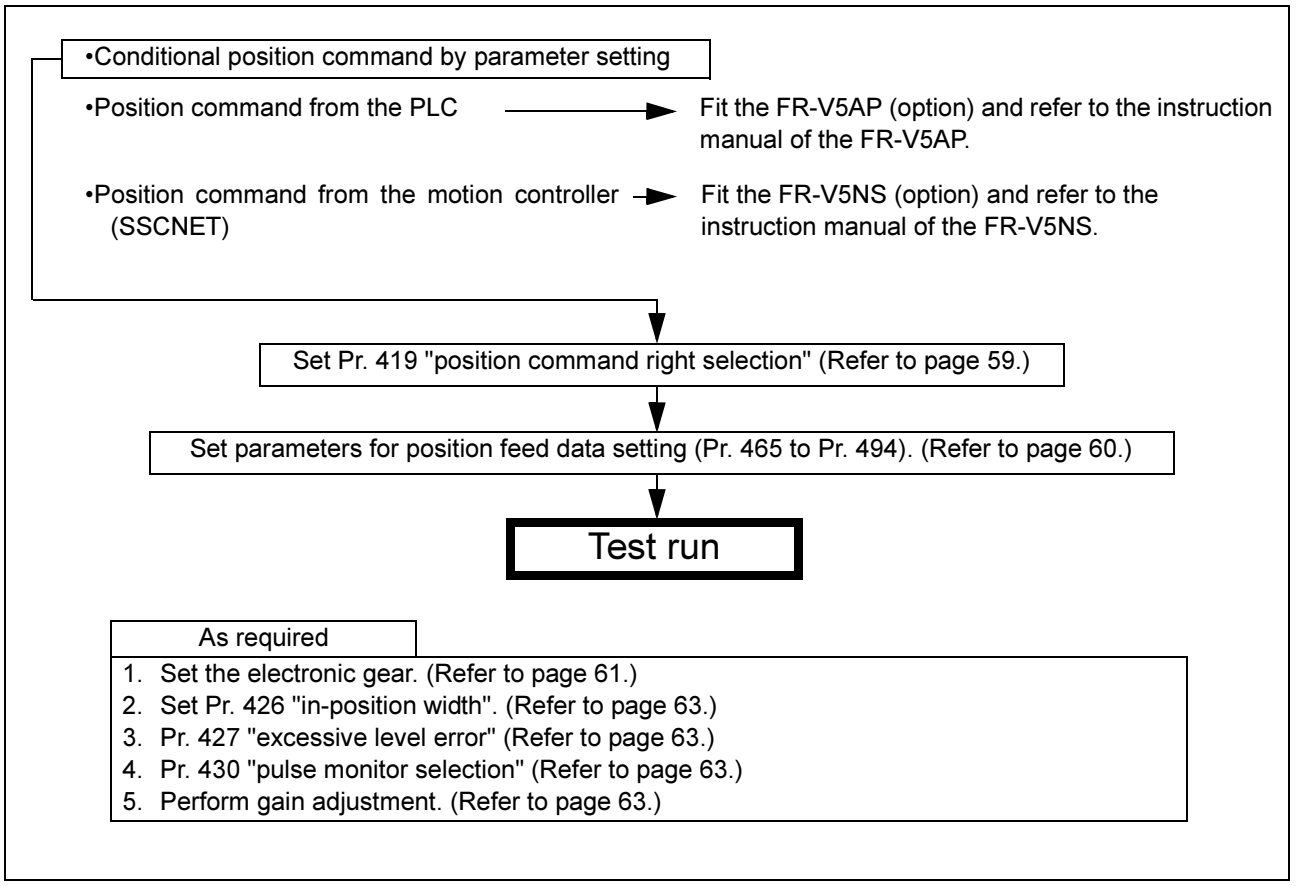
- Pr. 7 "acceleration time" (Refer to page 91.)
- Pr. 8 "deceleration time" (Refer to page 91.)
- Pr. 800 "control system selection" (Refer to page 182.)
- Pr. 802 "pre-excitation selection" (Refer to page 95.)
- Pr. 810 "torque restriction input method selection" (Refer to page 100.)
- Pr. 826 "torque setting filter 1" (Refer to page 188.)
- Pr. 904 "torque command No. 3 bias" (Refer to page 202.)
- Pr. 905 "torque command No. 3 gain" (Refer to page 202.)

 For online auto tuning, refer to the Instruction Manual (basic)

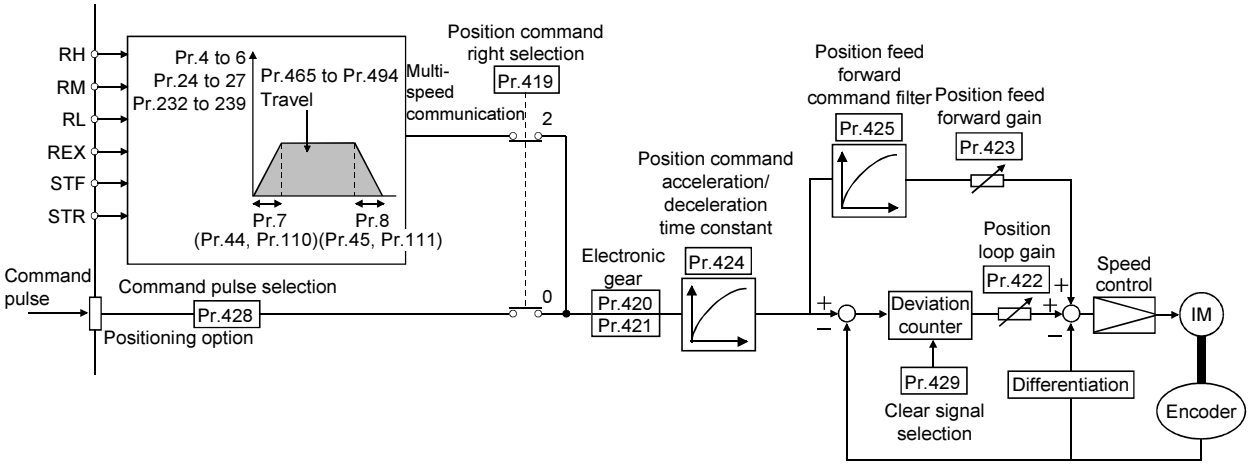
2.7 Position control (Pr. 419 to Pr. 430, Pr. 464 to Pr. 494)

This inverter is allowed to perform position control by setting conditional position feed by contact input or the position control option (FR-V5AP, FR-V5NS). And the position loop gain that adjusts this position control status is provided for the inverter. It is not used independently but is used with the speed loop parameter to determine the value. Therefore, first adjust the speed loop gain and then adjust the position loop gain parameter.

2.7.1 Position control step



2.7.2 Control block diagram



2.7.3 Parameter

Set the following parameters when exercising position control with the inverter.

Parameter	Name	Factory Setting	Setting Range	Description
419	Position command right selection	0	0, 1	Set position command input.
420	Command pulse scaling factor numerator	1	0 to 32767	Set the electronic gear.
421	Command pulse scaling factor denominator	1	0 to 32767	
422	Position loop gain	25	0 to 150s^{-1}	Set the gain of the position loop.
423	Position feed forward gain	0%	0 to 100%	Function to cancel a delay caused by the droop pulses of the deviation counter.
424	Position command acceleration/ deceleration time constant	0s	0 to 50s	
425	Position feed forward command filter	0s	0 to 5s	Enter the primary delay filter in response to the feed forward command.
426	In-position width	100 pulses	0 to 32767 pulses	The in-position signal turns on when the droop pulses become less than the setting.
427	Excessive level error	40K	0 to 400K, 9999	An error becomes excessive when the droop pulses exceed the setting.
430	Pulse monitor selection	9999	0 to 5, 9999	Display the number of pulses.
464	Digital position control sudden stop deceleration time	0	0 to 360.0s	

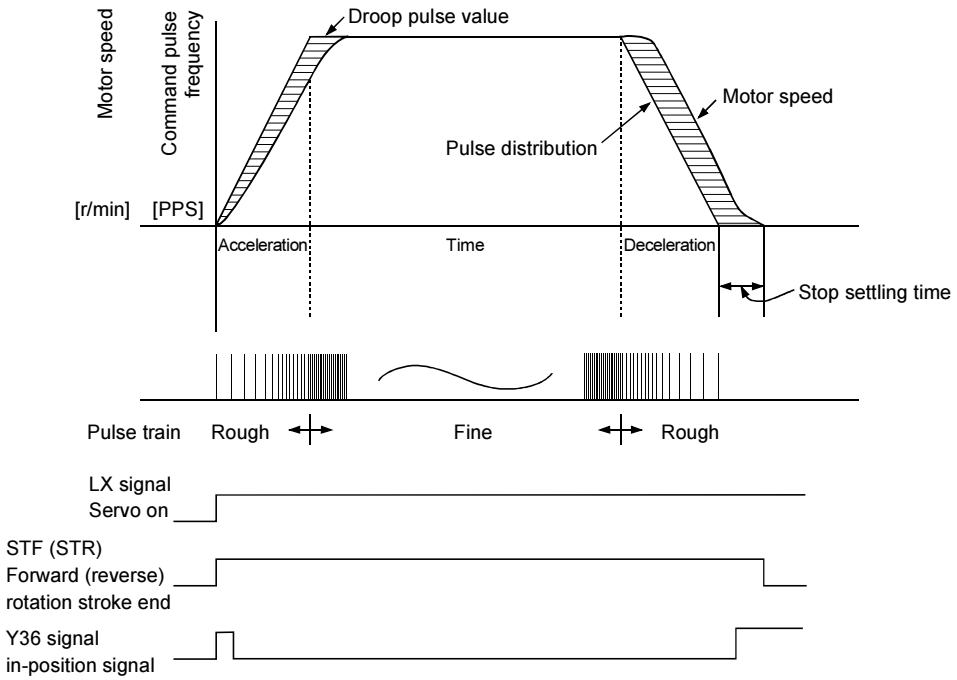
(1) Position command right selection (Pr. 419)

Pr. 419 Setting	Description
0 (factory setting)	Conditional position control function by contact input. (using parameters)
1	Position command by pulse train input (when the FR-V5AP is fitted). (Refer to the instruction manual of the option for details.)

(2) Operation

The speed command given to rotate the motor is calculated to zero the difference between the number of internal command pulse train pulses (when Pr. 419=0, the number of pulses set by parameter (Pr. 465 to Pr. 494) is changed to the command pulses in the inverter) and the number of pulses fed back from the motor end encoder.

1) When a pulse train is input, pulses are accumulated in the deviation counter and these droop pulses act as position control pulses to give the speed command.
2) As soon as the motor starts running under the speed command of the inverter, the encoder generates feed back pulses and the droop of the deviation counter is counted down. The deviation counter maintains a given droop pulse value to keep the motor running.
3) When the command pulse input stops, the droop pulses of the deviation counter decrease, reducing the speed. The motor stops when there are no droop pulses.
4) When the number of droop pulses has fallen below the value set in Pr.426 (in-position width), it is regarded as completion of positioning and the in-position signal (Y36) turns on.



- For conditional position control function by contact input, the STF and STR terminals provide the forward (reverse) command signal. The motor can run only in the direction where the forward (reverse) signal is on.
- Opening STF-SD disables the forward rotation, and opening STR-SD disables the reverse rotation.
- The pulse train is rough during acceleration and fine at the maximum speed.
  During deceleration the pulse train is rough and at last there are no pulses.
  The motor stops shortly after the command pulses stop. This time lag is necessary for maintaining the stop accuracy and called stop setting time.

Related parameters

- Servo on (LX) signal ⇒ Set "23" in any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection). (Refer to page 163.)
- In-position signal (Y36) ⇒ Set "36" in any of Pr.190 to Pr.192 and Pr.195 (output terminal function selection). (Refer to page 165.)

2.7.4 Conditional position feed function by contact input (Pr. 419=0)

Inputting the number of pulses (positions) in the parameters and setting multi-speed and forward (reverse) commands enable position control during servo operation. This position feed function does not return to the home position.

(1) Setting position command using parameters

Set position command using any two of Pr. 465 to Pr. 494 (position feed amount).
Resolution of encoder × speed × 4

↓

To stop the motor after 100 rotations when the encoder resolution is 2048 (pulse/rev)
2048 (pulse/rev) × 100 (speed) × 4 = 819200 (feed amount)

Setting the first amount 819200

Pr. 466 (upper digits)= □ □ □ □ Pr. 465 (lower digits)= □ □ □ □ (decimal numeration)

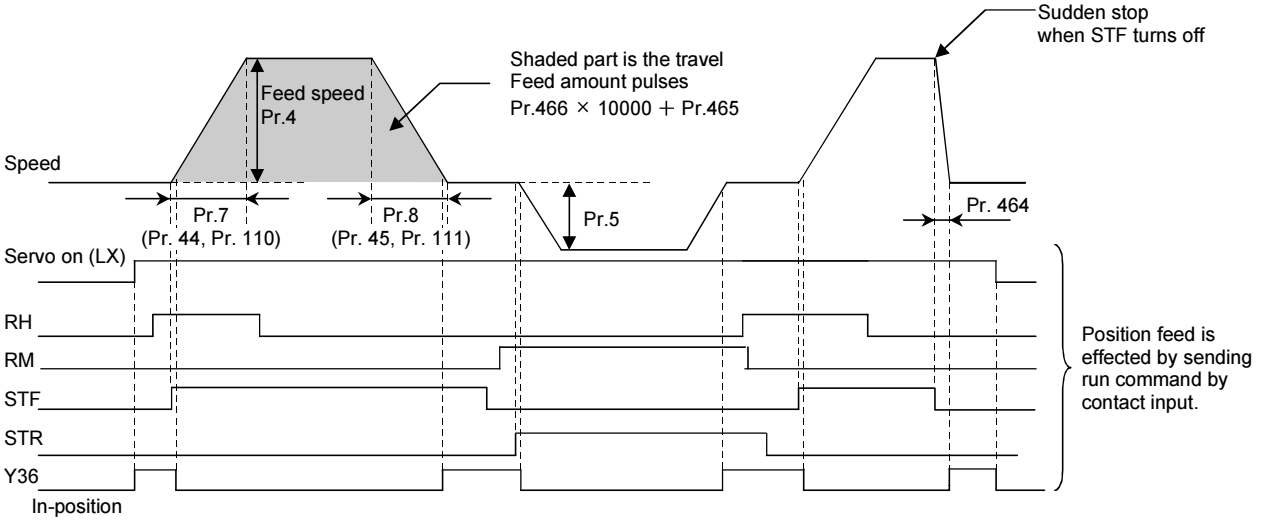
0 0 8 1 9 2 0 0

<Position feed data setting parameters>

- Factory setting : 0
- Setting range : 0 to 9999
- Minimum setting range : 1

Parameter	Name		Selection Method				Position Feed Speed
			REX	RH	RM	RL	
465	First position feed amount	(lower digits)	OFF	ON	OFF	OFF	High speed, Pr. 4
466		(upper digits)					
467	Second position feed amount	(lower digits)	OFF	OFF	ON	OFF	Middle speed, Pr. 5
468		(upper digits)					
469	Third position feed amount	(lower digits)	OFF	OFF	OFF	ON	Low speed, Pr. 6
470		(upper digits)					
471	Fourth position feed amount	(lower digits)	OFF	OFF	ON	ON	Speed 4, Pr. 24
472		(upper digits)					
473	Fifth position feed amount	(lower digits)	OFF	ON	OFF	ON	Speed 5, Pr. 25
474		(upper digits)					
475	Sixth position feed amount	(lower digits)	OFF	ON	ON	OFF	Speed 6, Pr. 26
476		(upper digits)					
477	Seventh position feed amount	(lower digits)	OFF	ON	ON	ON	Speed 7, Pr. 27
478		(upper digits)					
479	Eighth position feed amount	(lower digits)	ON	OFF	OFF	OFF	Speed 8, Pr. 232
480		(upper digits)					
481	Ninth position feed amount	(lower digits)	ON	OFF	OFF	ON	Speed 9, Pr. 233
482		(upper digits)					
483	Tenth position feed amount	(lower digits)	ON	OFF	ON	OFF	Speed 10, Pr. 234
484		(upper digits)					
485	Eleventh position feed amount	(lower digits)	ON	OFF	ON	ON	Speed 11, Pr. 235
486		(upper digits)					
487	Twelfth position feed amount	(lower digits)	ON	ON	OFF	OFF	Speed 12, Pr. 236
488		(upper digits)					
489	Thirteenth position feed amount	(lower digits)	ON	ON	OFF	ON	Speed 13, Pr. 237
490		(upper digits)					
491	Fourteenth position feed amount	(lower digits)	ON	ON	ON	OFF	Speed 14, Pr. 238
492		(upper digits)					
493	Fifteenth position feed amount	(lower digits)	ON	ON	ON	ON	Speed 15, Pr. 239
494		(upper digits)					

(2) Operation by position command using parameters



- Acceleration/deceleration time is 0.1s minimum and 360s maximum.
- Acceleration/deceleration reference speed (Pr. 20) is clamped at a minimum of 500r/min.
- Deceleration time can be set in Pr. 464 "digital position control sudden stop deceleration time".
- At this time, the acceleration/deceleration patterns are all linear acceleration and the setting of Pr. 29 "acceleration/deceleration pattern" is invalid. (Refer to page 102 for Pr. 29.)

CAUTION

Information on multi-speed command (position command) is determined at rising of the forward (reverse) command to perform position control.
Therefore, set forward (reverse) command after multi-speed command (position command).
Position feed is invalid if the multi-speed command is given after forward (reverse) command.

2.7.5 Setting the electronic gear

Adjust the ratio of the machine side gear and the motor side gear.

The position resolution (travel per pulse $\Delta\ell$ [mm]) is determined by the travel per motor revolution Δ s [mm] and the feedback pulses Pf [pulse/rev] of the detector, and is represented by the following expression.

$$\Delta\ell = \frac{\Delta s}{Pf}$$

$\Delta\ell$:Travel per pulse [mm]
Δs :Travel per motor revolution [mm]
Pf :Number of feedback pulses [pulse/rev]
(the number of pulses after multiplying the number of encoder pulses by 4)

Using the parameters, the travel per command pulse can be set separately to set the travel per command pulse without a fraction.

$$\Delta\ell = \frac{\Delta s}{Pf} \times \frac{\text{Pr. 420}}{\text{Pr. 421}}$$

The relationship between the motor speed and internal command pulse frequency is as follows.

$$fo \times \frac{\text{Pr. 420}}{\text{Pr. 421}} = Pf \times \frac{No}{60}$$

fo: Internal command pulse frequency [pps]
No:Motor speed [r/min]

CAUTION

Set the electronic gear in the range of 1/50 to 20.

"Setting example 1"

The travel per pulse is $\Delta\ell$ = 0.01 (mm) in a drive system where the ballscrew pitch PB = 10 (mm) and the reduction ratio 1/n = 1 and the electronic gear ratio is Δs = 10 (mm) when the number of feedback pulses Pf = 4000 (pulse/rev). According to the following expression,

$$\Delta\ell = \frac{\Delta s}{Pf} \times \frac{Pr.\ 420}{Pr.\ 421}$$

$$\frac{Pr.\ 420}{Pr.\ 421} = \Delta\ell \times \frac{Pf}{\Delta s}$$

$$= 0.01 \times \frac{4000}{10} = \frac{4}{1}$$

Therefore, set "4" in Pr. 420 and "1" in Pr. 421.

"Setting example 2"

Find the internal command pulse frequency of the SF-V5R rated speed.
Note that the command pulse scaling factor Pr. 420/Pr. 421 = 1.

Assuming that the number of encoder pulses is 2048 (pulses/rev) (feedback pulse Pf = 2048 × 4),

$$fo = 2048 \times \frac{No}{60} \times \frac{Pr.\ 421}{Pr.\ 420} \times 4$$

$$= 204800$$

Therefore, the internal command pulse frequency is 204800 (pps).

<Relationship between position resolution $\Delta\ell$ and overall accuracy>

Since overall accuracy (positioning accuracy of machine) is the sum of electrical error and mechanical error, normally take measures to prevent the electrical system error from affecting the overall error. As a guideline, refer to the following relationship.

$$\Delta\ell < \left(\frac{1}{5} \text{ to } \frac{1}{10}\right) \times \Delta\varepsilon$$

$\Delta\varepsilon$: Positioning accuracy

<Stopping characteristic of motor>

When parameters are used to run the motor, the command pulse frequency and motor speed have the relationship as shown in the chart on page 59, and as the motor speed decreases, pulses are accumulated in the deviation counter of the inverter. These pulses are called droop pulses (ε) and the relationship between command frequency (fo) and position loop gain (Kp: Pr. 422) is as represented by the following expression.

$$\varepsilon = \frac{fo}{Kp} \text{ [pulse]} \qquad \varepsilon = \frac{204800}{25} \text{ [pulse]} \quad \text{(motor rated speed)}$$

When the factory setting of Kp is $25s^{-1}$, the droop pulses (ε) are 8192 pulses.

Since the inverter has droop pulses during running, a stop settling time (ts) is needed from when the command has zeroed until the motor stops. Set the operation pattern in consideration of the stop settling time.

$$ts = 3 \times \frac{1}{Kp} \text{ [s]}$$

When the factory setting of Kp is $25s^{-1}$, the stop settling time (ts) is 0.12s.

The positioning accuracy $\Delta\varepsilon$ is (5 to 10) × $\Delta\ell$ = $\Delta\varepsilon$ [mm]

● Position command acceleration/deceleration time constant (Pr. 424)

1) When the electronic gear ratio is large (about 10 or more times) and the speed is low, rotation will not be smooth, resulting in pulse-wise rotation. At such a time, set this parameter to smooth the rotation.
2) When acceleration/deceleration time cannot be provided for the command pulses, a sudden change in command pulse frequency may cause an overshoot or error excess alarm. At such a time, set this parameter to provide acceleration/deceleration time.
   Normally set 0.

2.7.6 In-position width (Pr. 426)

The Y36 terminal signal acts as an in-position signal. The in-position signal turns on when the number of droop pulses becomes less than the setting.

2.7.7 Excessive level error (Pr. 427)

A position error becomes excessive when the droop pulses exceed the Pr. 427 setting. Error (E.OD) is displayed and the motor stops.
When you decreased the position loop gain (Pr. 422) setting, increase the error excessive level setting.
Also decrease the setting when you want to detect an error slightly earlier under large load.
When Pr. 472="9999", an excessive position error (E.OD) is not output regardless of the droop pulses.

Parameter	Name	Factory Setting	Setting Range	Remarks
427	Excessive level error	40	0 to 400, 9999	9999: function invalid

2.7.8 Pulse monitor selection (Pr. 430)

The states of various pulses during operation are displayed in terms of the number of pulses.
Set "6" in Pr. 52 "DU/PU main display data selection" to display output frequency monitor.

Pr. 430	Description	Display Range (FR-DU04-1)	Display Range (FR-PU04V)
0	The cumulative command pulse value is displayed.	Lower 4 digits	Lower 5 digits
1		Upper 4 digits	Upper 5 digits
2	The cumulative feedback pulse value is displayed.	Lower 4 digits	Lower 5 digits
3		Upper 4 digits	Upper 5 digits
4	The droop pulses are monitored.	Lower 4 digits	Lower 5 digits
5		Upper 4 digits	Upper 5 digits
9999	The frequency monitor is displayed. (factory setting)		

REMARKS

- Count the number of pulses when the servo is on.
- The cumulative pulse value is cleared when the base is shut off or the clear signal is turned on.

Related parameters

Pr. 52 "DU/PU main display data selection" (Refer to page 110.)

2.7.9 Concept of position control gains

Easy gain tuning is available as an easy tuning method. For easy gain tuning, refer to the Instruction Manual (basic). If it does not produce any effect, make fine adjustment by using the following parameters. Set "0" in Pr. 819 "easy gain tuning" before setting the parameters below.

(1) Pr. 422 "position loop gain" (factory setting 25s^{-1})

Make adjustment when any of such phenomena as unusual vibration, noise and overcurrent of the motor/ machine occurs.
Increasing the setting improves trackability for the position command and also improves servo rigidity at a stop, but oppositely makes an overshoot and vibration more liable to occur. Normally set this parameter within the range about 5 to 50.

No.	Phenomenon/Condition	Adjustment Method	
1	Slow response	Increase the Pr. 422 value.	
		Pr. 422	Increase the value 3s^{-1} by 3s^{-1} until just before an overshoot, stop-time vibration or other instable phenomenon occurs, and set about 0.8 to 0.9 of that value.
2	Overshoot, stop-time vibration or other instable phenomenon occurs.	Decrease the Pr. 422 value.	
		Pr. 824	Decrease the value 3s^{-1} by 3s^{-1} until just before an overshoot, stop-time vibration or other instable phenomenon occurs, and set about 0.8 to 0.9 of that value.

(2) Pr. 423 "position feed forward gain" (factory setting 0)

This function is designed to cancel a delay caused by the droop pulses of the deviation counter.
When a tracking delay for command pulses poses a problem, increase the setting gradually and use this parameter within the range where an overshoot or vibration will not occur.
This function has no effects on servo rigidity at a stop.
Normally set this parameter to 0.

2.7.10 Troubleshooting

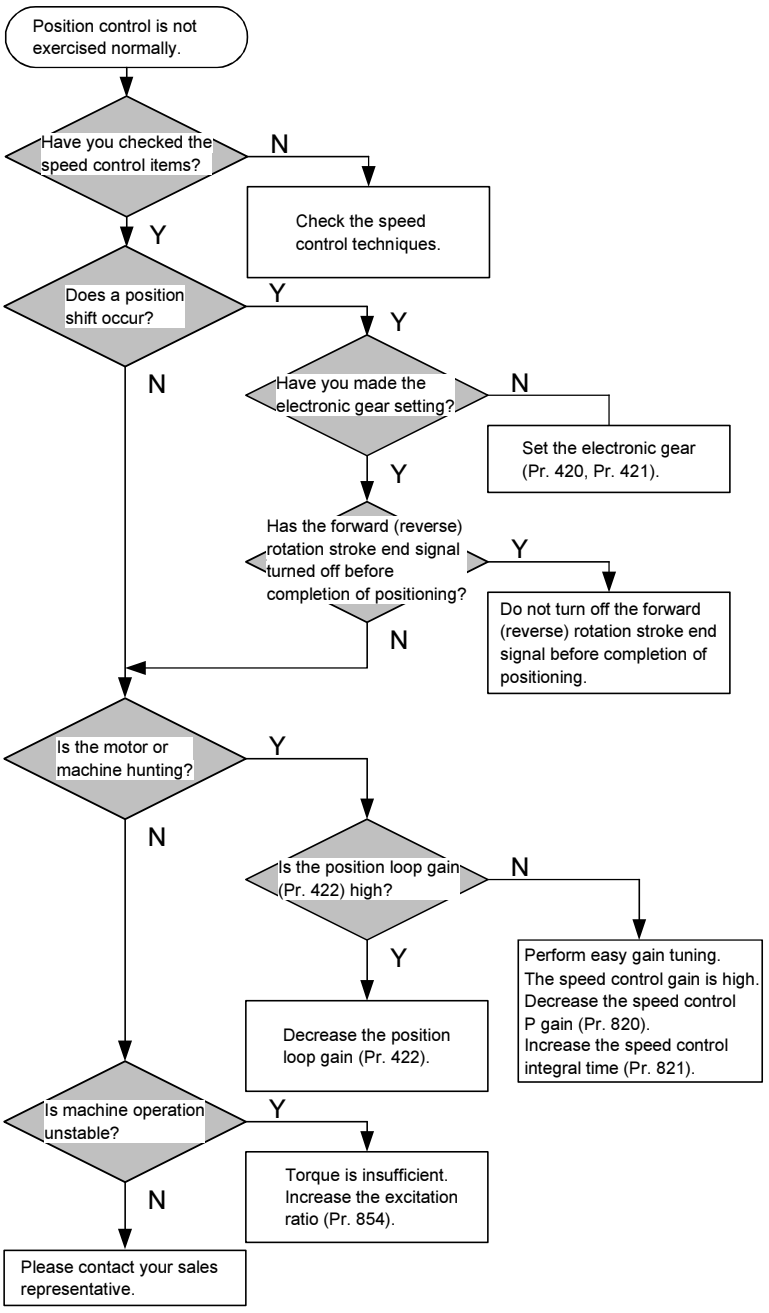
	Phenomenon	Cause	Corrective Action
1	Motor does not rotate.	(1) The phase sequence of the motor or encoder wiring is wrong.	(1) Check the wiring. (Refer to page 4)
		(2) The control mode selection, Pr. 800, setting is improper.	(2) Check the Pr. 800 setting. (Factory setting is speed control)
		(3) The servo on signal or start signal (STF, STR) is not input.	(3) Check that the signals are input normally.
		(4) The command pulses are not input correctly. (FR-V5AP)	(4)-1 Check that the command pulses are input normally. (Check the cumulative command pulse value in Pr. 430.) (4)-2 Check the command pulse form and command pulse selection, Pr. 428, setting.
		(5) The position command right selection, Pr. 419, setting is not correct.	(5) Check the position command right selection in Pr. 419.
		(6) When the position command right selection, Pr. 419, setting is 0, the position feed amount, Pr. 465 to Pr. 494, settings are not correct.	(6) Check the position feed amounts in Pr. 465 to Pr. 494.
2	Position shift occurs.	(1) The command pulses are not input correctly.	(1)-1 Check the command pulse form and command pulse selection, Pr. 428, setting. (1)-2 Check that the command pulses are input normally. (Check the cumulative command pulse value in Pr. 430.)
		(2) The command is affected by noise or the encoder feedback is compounded with noise.	(2)-1 Decrease the PWM carrier frequency in Pr. 72. (2)-2 Change the shielded cable grounding place or raise the cable.
3	Motor or machine hunts.	(1) The position loop gain is high.	(1) Decrease Pr. 422.
		(2) The speed loop gain is high.	(2)-1 Perform easy gain tuning. (2)-2 Decrease Pr. 820 and increase Pr. 821.
4	Machine operation is unstable.	(1) The acceleration/deceleration time setting has adverse effect.	(1) Decrease Pr. 7 and Pr. 8.

Related parameter reference pages

- Pr. 800 "control system selection" (Refer to page 182.)
- Pr. 802 "pre-excitation selection" (Refer to page 95.)
- Pr. 820 "speed control P gain 1" (Refer to page 187.)
- Pr. 7 "acceleration time" (Refer to page 91.)
- Pr. 8 "deceleration time" (Refer to page 91.)
- Pr. 72 "PWM frequency selection" (Refer to page 124.)
- Pr. 821 "speed control integral time 1" (Refer to page 187.)

2.7.11 Position control is not exercised normally

(1) Position control



REMARKS

The speed command of position control relates to speed control. Refer to the Instruction Manual (basic) for details.

MEMO

3 VECTOR CONTROL WITHOUT ENCODER

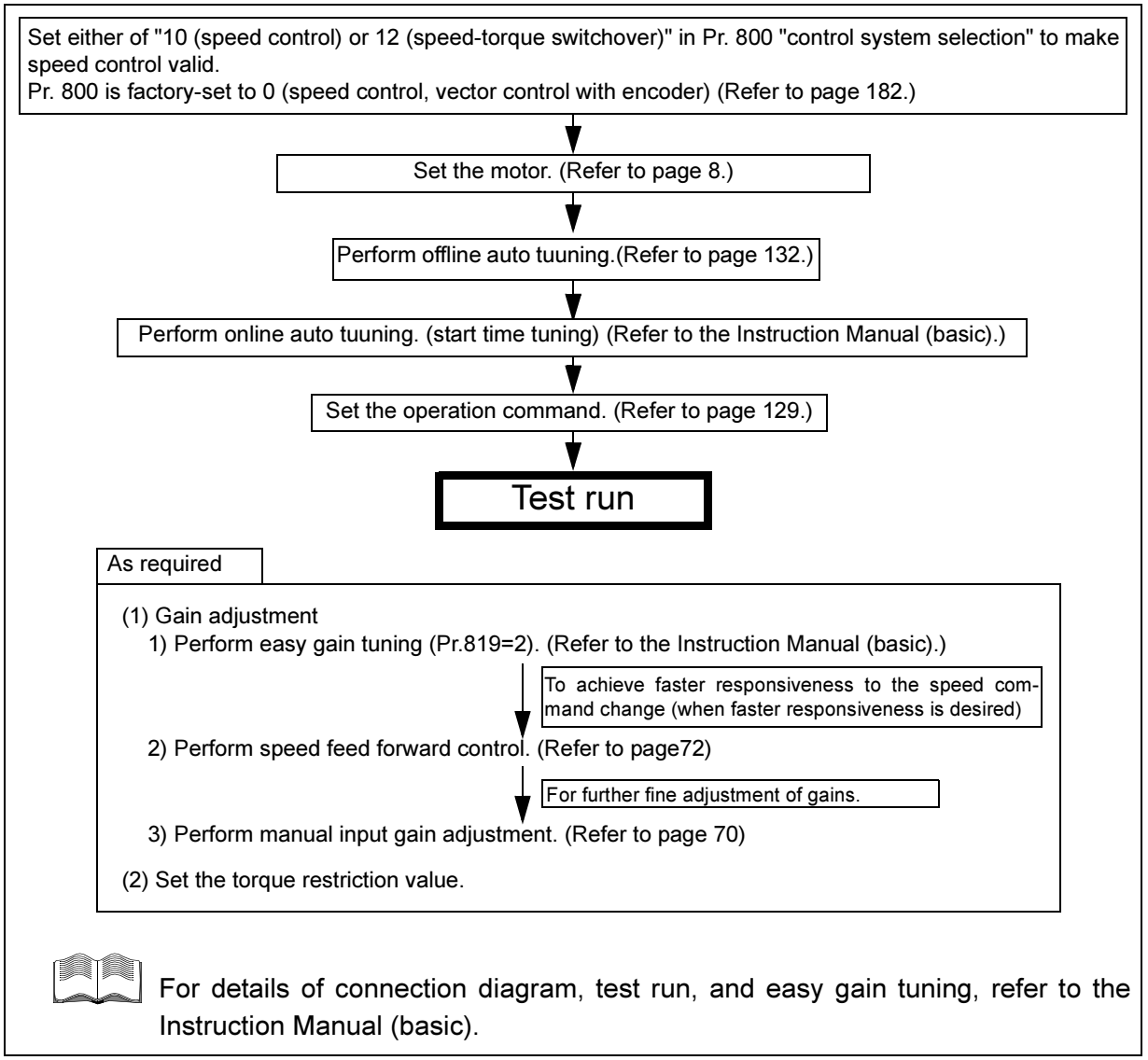
This chapter explains the basic "adjustment for vector control" for use of this product.
Always read the instructions and other information before using the equipment.

This inverter can control a motor under speed or torque control. (As required, set "1" (extended function parameters valid) in Pr. 160 "extended function selection".)
Refer to page 163 for details of Pr. 160 "extended function selection". (Since the factory setting of Pr. 77 is "0", perform parameter write in the PU mode or during a stop.)

3.1 Speed control (without encoder)

3.1.1 Outline of speed control

The basics of speed control are explained in the Instruction Manual (basic).

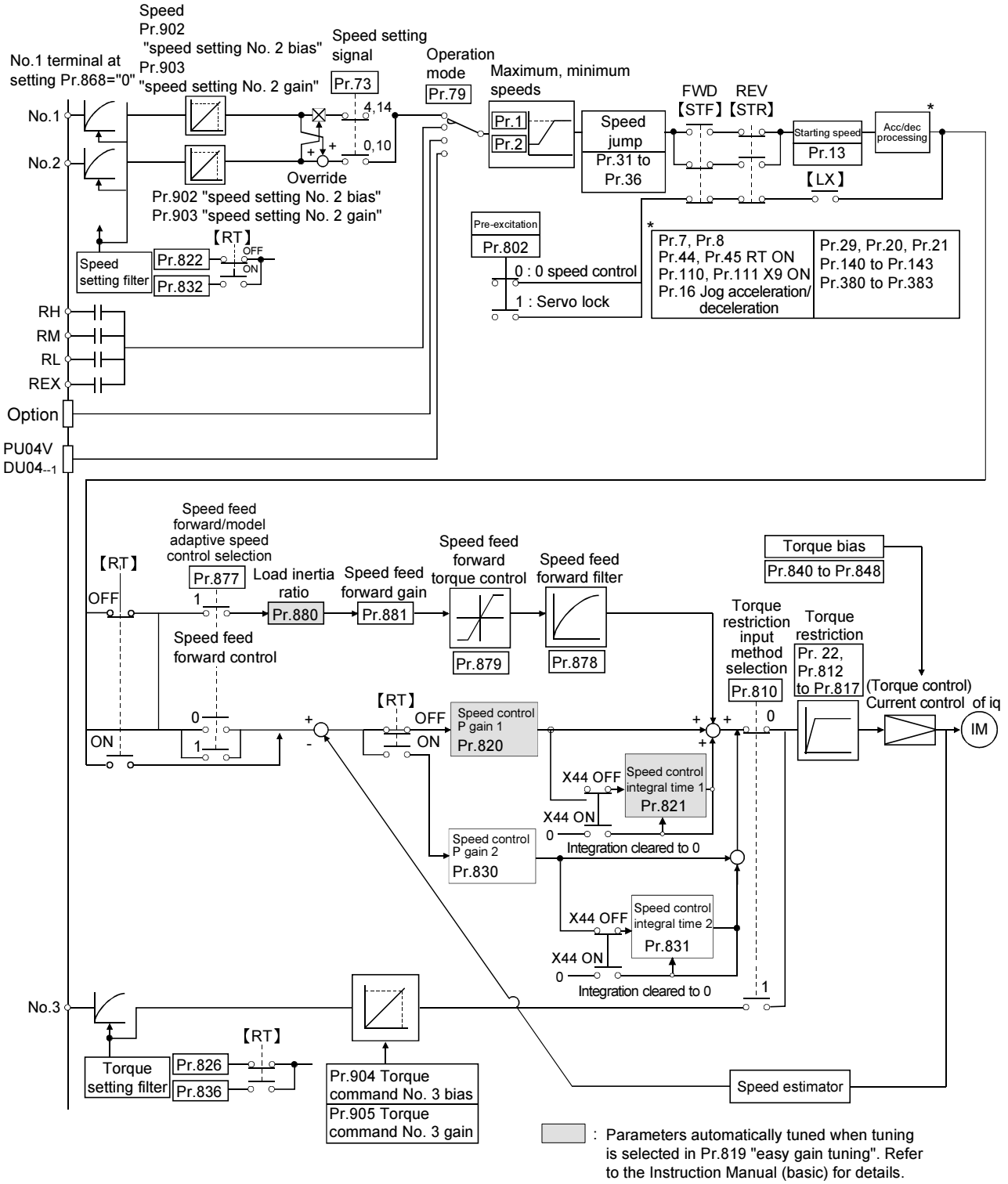


For details of connection diagram, test run, and easy gain tuning, refer to the Instruction Manual (basic).

3.2 Fine adjustment of gains for speed control (without encoder)

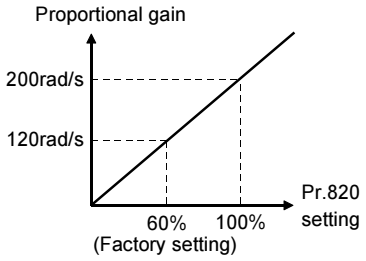
Make adjustment when vibration, noise or any other unfavorable phenomenon occurs due to large load inertia or gear backlash, for example, or when you want to exhibit the best performance that matches the machine.

3.2.1 Control block diagram

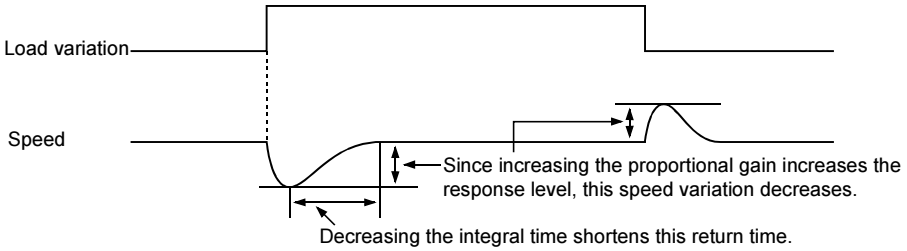


3.2.2 Concept of adjustment of manual input speed control gains

1) Speed control P gain 1
   - Pr. 820 = 60% is equivalent to 120rad/s (speed responce of the motor alone). (factory setting)
   - Increasing the proportional gain increases the response level. However, a too high gain will produce vibration and/or unusual noise.
2) Speed control integral time
   - Pr. 821 = 0.333s (factory setting)
   - Decreasing the integral time shortens the return time taken at a speed change. However, a too short time will generate an overshoot.



When there is load inertia, the actual speed gain is as given below.



Also, when there is load inertia, the actual speed gain decreases as indicated below.

$$\text{Actual speed gain} = \text{speed gain of motor without load} \times \frac{J_M}{J_M + J}$$

J_M : Inertia of motor
J_L : Motor shaft-equivalent load inertia

3.2.3 Speed control gain adjustment procedure (Pr. 820, Pr. 821)

- Set "0" in Pr. 819 "easy gain tuning". (Easy gain tuning is not performed.)

  Refer to the Instruction Manual (basic) for easy gain tuning.
- Refer to the following for manually input gain adjustment.

● Manual input gain adjustment

- Pr. 820 "speed control P (proportional) gain 1", Pr. 830 "speed control P (proportional) gain 2"
- Pr. 821 "speed control integral time 1", Pr. 831 "speed control integral time 2"

Make adjustment when any of such phenomena as unusual machine vibration/noise, low response level and overshoot has occurred.

1) First check the conditions and simultaneously change Pr. 820 "speed control P gain 1" value.
2) If you cannot make proper adjustment, change Pr. 821 "speed control integral time 1" value and repeat step (1).

CAUTION

Pr. 830 "speed control P(proportional) gain 2" and Pr. 831 "speed control integral time 2" are made valid when the RT terminal is switched on. Make adjustments in the same way as Pr. 820 and Pr. 821.

No.	Phenomenon/Condition	Adjustment Method	
1	Large load inertia	Set the Pr. 820 and Pr. 821 values a little higher.	
		Pr. 820	When a speed rise is slow, increase the value 10% by 10% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.
		Pr. 821	If an overshoot occurs, double the value until an overshoot does not occur, and set about 0.8 to 0.9 of that value.
2	Vibration/noise generated from mechanical system	Set the Pr. 820 value a little lower and the Pr. 821 value a little higher.	
		Pr. 820	Decrease the value 10% by 10% until just before vibration/noise is not produced, and set about 0.8 to 0.9 of that value.
		Pr. 821	If an overshoot occurs, double the value until an overshoot does not occur, and set about 0.8 to 0.9 of that value.
3	Slow response	Set the Pr. 820 value a little higher.	
		Pr. 820	When a speed rise is slow, increase the value 5% by 5% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.
4	Long return time (response time)	Set the Pr. 821 value a little lower.	
		Decrease the value by half until just before an overshoot or the unstable phenomenon does not occur, and set about 0.8 to 0.9 of that value.	
5	Overshoot or unstable phenomenon occurs.	Set the Pr. 821 value a little higher.	
		Double the value until just before an overshoot or the unstable phenomenon does not occur, and set about 0.8 to 0.9 of that value.	

3.2.4 Troubleshooting

	Phenomenon	Cause	Corrective Action
1	Motor does not run at correct speed. (Speed command does not match actual speed)	(1) The speed command from the command device is incorrect. The speed command is compounded with noise.	(1) Check that a correct speed command comes from the command device. Decrease the PWM carrier frequency in Pr. 72.
		(2) The speed command value does not match the inverter-recognized value.	(2) Readjust the speed command bias and gain in Pr. 902, Pr. 903, Pr. 917, and Pr. 918.
2	Speed does not rise to the speed command.	(1) Insufficient torque. Torque restriction is actuated.	(1)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(1)-2 Insufficient capacity
		(2) Only P (proportional) control is selected.	(2) When the load is heavy, speed deviation will occur under P (proportional) control. Select PI control.
3	Motor speed is unstable.	(1) The speed command varies.	(1)-1 Check that a correct speed command comes from the command device. (Take measures against noises.)
			(1)-2 Decrease the PWM carrier frequency in Pr. 72.
			(1)-3 Increase the speed setting filter in Pr. 822.
		(2) Insufficient torque.	(2)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(2)-2 Return the excitation ratio in Pr. 854 to the factory setting (100%).
		(3) The speed control gains do not match the machine. (machine resonance)	(3)-1 Adjust Pr. 820 and Pr. 821. (Refer to page 48.)
			(3)-2 Perform speed feed forward control.
4	Motor or machine hunts (vibration/noise is produced).	(1)The speed control gain is high.	(1)-1 Decrease Pr. 820 and increase Pr. 821.
			(1)-2 Perform speed feed forward control.
		(2) High torque control gain.	(2) Decrease Pr. 824. (Refer to page 55.)
5	Acceleration/ deceleration time does not match the setting.	(1) Insufficient torque.	(1)-1 Increase the torque restriction value. (📖 Refer to the torque restriction of speed control in the Instruction Manual (basic).)
			(1)-2 Return the excitation ratio in Pr. 854 to the factory setting.
			(1)-3 Perform speed feed forward control.
		(2) Large load inertia.	(2) Set the acceleration/deceleration time that meets the load.
6	Machine operation is unstable	(1) The speed control gains do not match the machine.	(1)-1 Adjust Pr. 820 and Pr. 821. (Refer to page 70.)
			(1)-2 Perform speed feed forward control.
		(2) Slow response because of improper acceleration/ deceleration time of the inverter.	(2) Change the acceleration/deceleration time to an optimum value.
7	Speed fluctuates at low speed.	(1) Adverse effect of high carrier frequency.	(1) Decrease the PWM carrier frequency in Pr. 72.
		(2) Adverse effect of weak excitation.	(2) Return the excitation ratio in Pr. 854 to the factory setting.
		(3) Low speed control gain.	(3) Increase Pr. 820 "speed control P gain".
8	Motor does not decelerate	The error between R1 of the motor and R1 of the inverter is excessive. (E.11 error)	Perform offline auto tuning again and perform start time tuning.

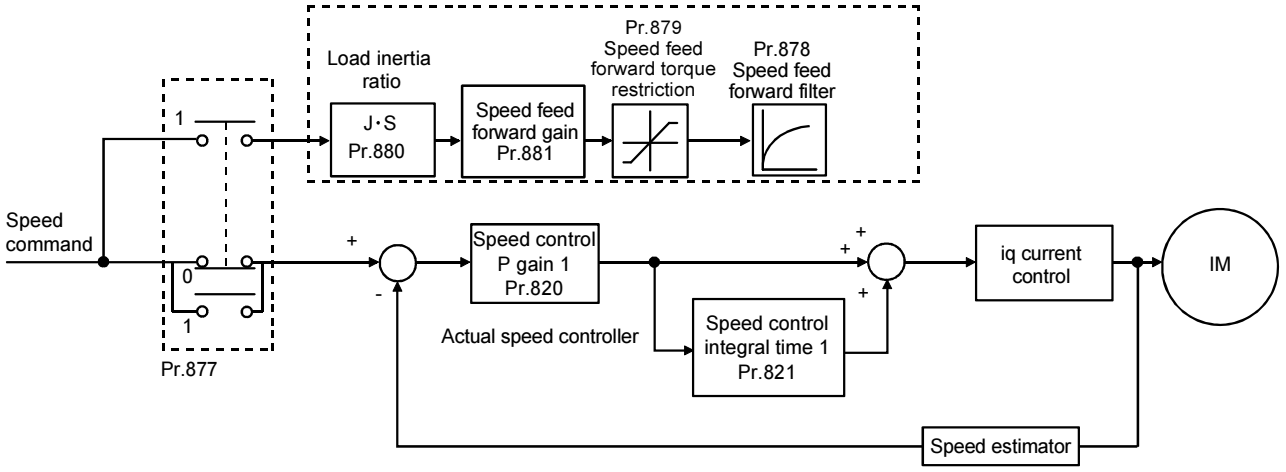
Related parameter reference pages

- Pr. 71 "applied motor" (Refer to page 123.)
- Pr. 72 "PWM frequency selection" (Refer to page 124.)
- Pr. 800 "control system selection" (Refer to page 182.)
- Pr. 820 "speed control P gain 1" (Refer to page 187.)
- Pr. 821 "speed control integral time 1" (Refer to page 187.)
- Pr. 822 "speed setting filter 1" (Refer to page 187.)
- Pr. 851 "number of encoder pulses" (Refer to page 10.)
- Pr. 854 "excitation ratio" (Refer to page 193.)
- Pr. 902 "speed setting No. 2 bias" (Refer to page 202.)
- Pr. 903 "speed setting No. 2 gain" (Refer to page 202.)
- Pr. 917 "No. 1 terminal bias (speed)" (Refer to page 202.)
- Pr. 918 "No. 1 terminal gain (speed)" (Refer to page 202.)

3.2.5 Speed feed forward control (Pr. 877 to Pr. 881)

By making parameter setting, select the speed feed forward control.
The speed feed forward control enhances the trackability of the motor in response to a speed command change.

Parameter	Name	Factory Setting	Setting Range
877	Speed feed forward control/model adaptive speed control selection	0	0,1,2
878	Speed feed forward filter	0s	0 to 1s
879	Speed feed forward torque restriction	150%	0 to 400%
880	Load inertia ratio	7	0,1 to 200 times
881	Speed feed forward gain	0%	0 to 1000%



Pr. 877 Setting	Description
0	Normal speed control is exercised.
1	Speed feed forward control is exercised. ① Calculate required torque in responce to the acceleration/deceleration command for the inertia ratio set in Pr. 880 and generate torque immediately. ② When inertia ratio estimation has been made by easy gain tuning, the inertia ratio estimation result is used as the Pr. 880 setting, from which the speed feed forward is calculated. ③ When the speed feed forward gain is 100%, the calculation result of the speed feed forward in 1) is reflected as-is. ④ If the speed command changes suddenly, large torque is generated due to the speed feed forward calculation. The maximum value of the speed feed forward is restricted using Pr. 879. ⑤ Using Pr. 878, the speed feed forward result can be dulled by the primary delay filter.
2	Function is invalid.

For details of easy gain tuning, refer to the Instruction Manual (basic) for details.

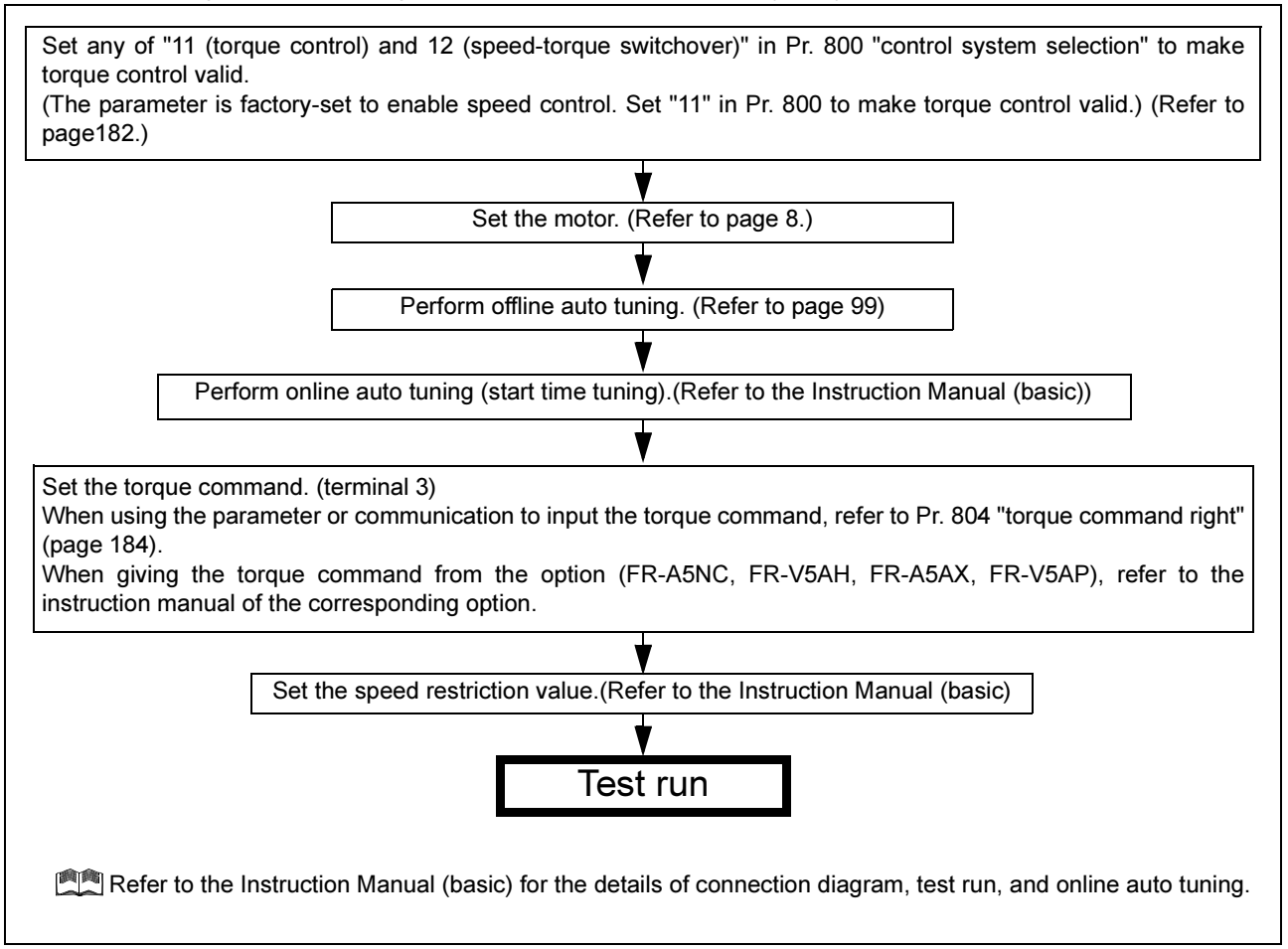
Related parameters

- Pr. 820 "speed control P gain 1" (Refer to page 187.)
- Pr. 821 "speed control integral time 1" (Refer to page 187.)
- Pr. 830 "speed control P gain 2" (Refer to page 187.)
- Pr. 831 "speed control integral time 2" (Refer to page 187.)

3.3 Torque control (without encoder)

3.3.1 Outline of torque control

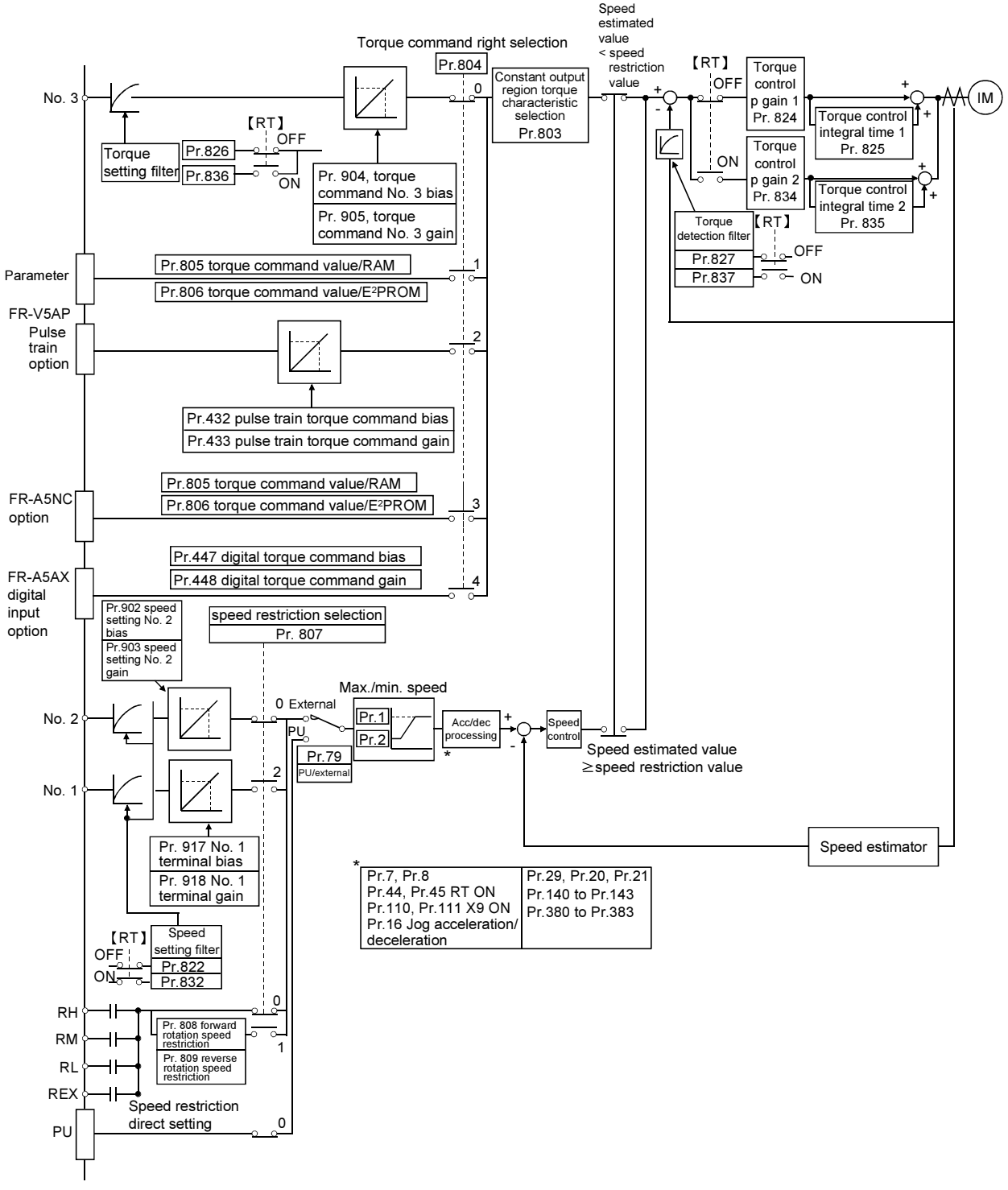
The basics of torque control are explained in the Instruction Manual (basic).



3.4 Fine adjustment for torque control (without encoder)

Current loop gain parameter for adjusting torque control operation state is available with the FR-V500 series. Stable operation is possible with the factory-set parameter.
Refer to the next page and adjust the parameters when torque pulsation or any other unfavorable phenomenon occurs depending on the machine and operating conditions or when you want to exhibit the best performance that matches the machine.

3.4.1 Control block diagram



3.5 Gain adjustment for torque control (without encoder)

When exercising torque control, perform online auto tuning (start time tuning "Pr. 95 = 1").
(Refer to the Instruction Manual (basic).)

3.5.1 Concept of torque control gains

(1) Torque control P gain 1
2000rad/s when Pr. 824 = 100% (factory setting).
(2) Torque control integral time 1
Pr. 825 = 5ms (factory setting)

3.5.2 Gain adjustment procedure

Refer to the following table for manual input gain adjustment.

CAUTION

Normally, the current loop gains in Pr. 824 and Pr. 825 need not be changed. Fully note that unnecessarily changing the settings of the current loop gains will result in unstable phenomena and/or reduced response level.

- **Manual input gain adjustment**

Pr. 824 "torque control P gain 1", Pr. 834 "torque control P gain 2"
Pr. 825 "torque control integral time 1", Pr. 835 "torque control integral time 2"

Make adjustment when any of such phenomena as unusual machine vibration/noise and overcurrent has occurred.
(1) First check the conditions and simultaneously change Pr. 824 "torque control P gain 1" value.
(2) If you cannot make proper adjustment, change Pr. 825 "torque control integral time 1" value and repeat step (1).

CAUTION

Pr. 834 "torque control P gain 2" and Pr. 835 "torque control integral time 2" are made valid when the RT terminal is switched on. Make adjustments in the same way as Pr. 824 and Pr. 825.

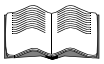
No.	Phenomenon/Condition	Adjustment Method	
1	• Unusual noise generated from motor • Unusual current flowing	Set Pr. 824 a little lower and Pr. 825 a little higher. First lower Pr. 824 and check the motor for unusual vibration/noise and overcurrent. If the problem still persists, increase Pr. 825.	
		Pr. 824	Decrease the value 10% by 10% until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value. Note that a too low value will produce current ripples, causing the motor to generate synchronous sound.
		Pr. 825	Double the value until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value. Note that a too high value will produce current ripples, causing the motor to generate synchronous sound.
2	Overcurrent occurs.	Set Pr. 824 a little lower and Pr. 825 a little higher. First lower Pr. 824 and check the motor for unusual vibration/noise and overcurrent. If the problem still persists, increase Pr. 825.	
		Pr. 824	Decrease the value 10% by 10% until just before an overcurrent does not occur, and set about 0.8 to 0.9 of that value.
		Pr. 825	Double the value until just before the phenomenon on the left is improved, and set about 0.8 to 0.9 of that value.

3.5.3 Troubleshooting

	Phenomenon	Cause	Corrective Action
1	Torque control is not exercised normally.	(1) The phase sequence of the motor or encoder wiring is wrong.	(1) Check the wiring. (Refer to page 4.)
		(2) The control mode selection, Pr. 800, setting is improper.	(2) Check the Pr. 800 setting. (The factory setting is speed control)
		(3) The speed restriction value is not input.	(3) Set the speed restriction value. (If the speed restriction value is not input, the motor will not rotate since the speed restriction value is regarded as 0r/min.)
		(4) The torque command varies.	(4) Check that the command device gives a correct torque command. ・Decrease the PWM carrier frequency in Pr. 72. ・Increase the torque setting filter in Pr. 826.
		(5) Torque variation due to the change in the motor temperature.	(5) Set start time tuning of Pr. 95.
		(6) The torque command does not match the inverter-recognized value.	(6) Recalibrate the torque command bias and gain in Pr. 904 and Pr. 905.
2	When the torque command is small, the motor rotates in the direction opposite to the start signal.	The offset calibration of the torque command does not match.	Recalibrate the torque command bias in Pr. 904.
3	Normal torque control cannot be exercised during acceleration/ deceleration. The motor vibrates.	Since the speed restriction value changes with the setting of the acceleration/deceleration time in Pr. 7, Pr. 8, the speed restriction may be activated. (When the speed restriction is activated, torque control cannot be exercised.)	Reduce the acceleration/deceleration time. Alternatively, set the acceleration/deceleration time to 0. (Speed restriction during acceleration/deceleration is speed restriction during constant speed)
4	Output torque is not linear in response to the torque command.	Insufficient torque.	Return the excitation ratio to the factory setting.

Related parameter reference pages

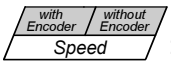
- Pr. 7 "acceleration time" (Refer to page 91.)
- Pr. 8 "deceleration time" (Refer to page 91.)
- Pr. 800 "control system selection" (Refer to page 182.)
- Pr. 802 "pre-excitation selection" (Refer to page 95.)
- Pr. 810 "torque restriction input method selection" (Refer to page 100.)
- Pr. 826 "torque setting filter 1" (Refer to page 188.)
- Pr. 904 "torque command No. 3 bias" (Refer to page 202.)
- Pr. 905 "torque command No. 3 gain" (Refer to page 202.)

 For online auto tuning, refer to the Instruction Manual (basic)

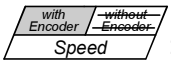
4 PARAMETERS

This chapter explains the "parameters" for use of this product.
Always read the instructions and other information before using the equipment.

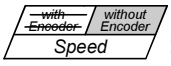
The following marks indicate availability of parameters under each control.



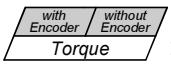
: Available under speed control in the vector control with encoder system and vector control without encoder system



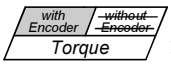
: Available under speed control in the vector control with encoder



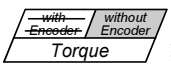
: Available under speed control in the vector control without encoder



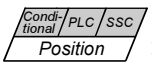
: Available under torque control in the vector control with encoder system and vector control without encoder system



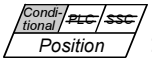
: Available under torque control in the vector control with encoder



: Available under torque control in the vector control without encoder



: Available under position control
Conditional . . . Conditional positioning control by parameter setting
PLC . . . . . Positioning control from the PLC
SSC . . . . . Positioning control from the motion controller (SSCNET)



: Available under position control by parameter settings

4.1 Parameter lists

The inverter is factory-set to display only the simple mode parameters.
Set Pr. 160 "extended function selection" as required.

Parameter	Name	Factory Setting	Setting Range	Remarks
160	Extended function selection	0	0	Accessible to only the simple mode parameters.
			1	Accessible to all parameters.

CAUTION

- **The blacked out parameters in the table below indicate simple mode parameters.**
- **The shaded parameters in the table allow its setting to be changed during operation even if "0" (factory setting) is set in Pr. 77 (parameter write disable selection).**
- ***: Accessible when Pr. 77 = 801.**

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Basic functions	0	Torque boost (manual)	0 to 30%	0.1%	3%/2%/1% (2.2K/ 3.7K, 7.5K/ 15K or more)	89	
	1	Maximum speed	0 to 3600r/min	1r/min	1800r/min	89	
	2	Minimum speed	0 to 3600r/min	1r/min	0r/min	89	
	3	Base frequency	20 to 200Hz	0.01Hz	60Hz	90	
	4	Multi-speed setting (high speed)	0 to 3600r/min	1r/min	1800r/min	90	
	5	Multi-speed setting (middle speed)	0 to 3600r/min	1r/min	750r/min	90	
	6	Multi-speed setting (low speed)	0 to 3600r/min	1r/min	150r/min	90	
	7	Acceleration time	0 to 3600s/0 to 360s	0.1s/0.01s	5s/15s (3.7K or less /7.5K or less)	91	
	8	Deceleration time	0 to 3600s/0 to 360s	0.1s/0.01s	5s/15s (3.7K or less /7.5K or less)	91	
	9	Electronic thermal O/L relay	0 to 500A	0.01A	Rated inverter output current	93	
Standard operation functions	10	DC injection brake operation speed	0 to 1500r/min, 9999	0.1r/min	15r/min	95	
	11	DC injection brake operation time	0 to 0.5s	0.1s	0.5s	95	
	12	DC injection brake voltage	0 to 30%	0.1%	1%	95	
	13	Starting speed	0 to 1500r/min	0.1r/min	15r/min	97	
	15	Jog speed setting	0 to 1500r/min	0.1r/min	150r/min	98	
	16	Jog acceleration/deceleration time	0 to 3600s/0 to 360s	0.1s/0.01s	0.5s	98	
Operation selection functions	17	MRS input selection	0, 2	1	0	98	
	19	Base frequency voltage	0 to 1000V, 8888, 9999	0.1V	9999	90	
	20	Acceleration/deceleration reference speed	1 to 3600r/min	1r/min	1800r/min	91	
	21	Acceleration/deceleration time increments	0, 1	1	0	91	
	22	Torque restriction level	0 to 400%	0.1%	150%	100	
	24	Multi-speed setting (speed 4)	0 to 3600r/min, 9999	1r/min	9999	90	
	25	Multi-speed setting (speed 5)	0 to 3600r/min, 9999	1r/min	9999	90	
	26	Multi-speed setting (speed 6)	0 to 3600r/min, 9999	1r/min	9999	90	
	27	Multi-speed setting (speed 7)	0 to 3600r/min, 9999	1r/min	9999	90	
	28	Multi-speed input compensation	0, 1	1	0	101	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Operation selection functions	29	Acceleration/deceleration pattern	0, 1, 2, 3, 4	1	0	102	
	30	Regenerative function selection	0, 1, 2	1	0	105	
	31	Speed jump 1A	0 to 3600r/min, 9999	1r/min	9999	106	
	32	Speed jump 1B	0 to 3600r/min, 9999	1r/min	9999	106	
	33	Speed jump 2A	0 to 3600r/min, 9999	1r/min	9999	106	
	34	Speed jump 2B	0 to 3600r/min, 9999	1r/min	9999	106	
	35	Speed jump 3A	0 to 3600r/min, 9999	1r/min	9999	106	
	36	Speed jump 3B	0 to 3600r/min, 9999	1r/min	9999	106	
	37	Speed display	0, 1 to 9998	1	0	106	
Output terminal functions	41	Up-to-speed sensitivity	0 to 100%	0.1%	10%	108	
	42	Speed detection	0 to 3600r/min	1r/min	300r/min	108	
	43	Speed detection for reverse rotation	0 to 3600r/min, 9999	1r/min	9999	108	
Second functions	44	Second acceleration/deceleration time	0 to 3600s/0 to 360s	0.1s/0.01s	5s	101	
	45	Second deceleration time	0 to 3600s/0 to 360s, 9999	0.1s/0.01s	9999	101	
Output terminal function	50	Second speed detection	0 to 3600r/min	1r/min	750r/min	108	
Display functions	52	DU/PU main display data selection	0, 5 to 12, 17 to 20, 23, 24, 32 to 35, 38, 100	1	0	110	
	53	PU level display data selection	0 to 3, 5 to 12, 17, 18	1	1	110	
	54	DA1 terminal function selection	1 to 3, 5 to 12, 17, 18, 21, 32 to 34, 36	1	1	110	
	55	Speed monitoring reference	0 to 3600r/min	1r/min	1800r/min	113	
	56	Current monitoring reference	0 to 500A	0.01A	Inverter rated output current	113	
Automatic restart	57	Restart coasting time	0, 0.1 to 5s, 9999	0.1s	9999	114	
	58	Restart cushion time	0 to 60s	0.1s	1.0s	114	
Additional function	59	Remote setting function selection	0, 1, 2, 3	1	0	116	
Operation selection functions	60	Intelligent mode selection	0, 7, 8	1	0	118	
	65	Retry selection	0 to 5	1	0	121	
	67	Number of retries at alarm occurrence	0 to 10, 101 to 110	1	0	121	
	68	Retry waiting time	0 to 10s	0.1s	1s	121	
	69	Retry count display erasure	0	1	0	121	
	70	Special regenerative brake duty	0 to 15%/0 to 30%/0%	0.1%	0%	105	
	71	Applied motor	0, 3 to 8, 10, 13 to 18, 30, 33, 34	1	30	123	
	72	PWM frequency selection	1 to 6	1	1	124	
	73	Speed setting signal	0, 4, 10, 14	1	0	125	
	75	Reset selection/disconnected PU detection/PU stop selection	0 to 3, 14 to 17	1	14	127	
	77	Parameter write disable selection	0, 1, 2	1	0	128	
	78	Reverse rotation prevention selection	0, 1, 2	1	0	129	
	79	Operation mode selection	0 to 4, 6 to 8	1	0	129	
Motor constants	80	Motor capacity	0.4 to 55kW	0.01kW	Inverter capacity	132	
	81	Number of motor poles	2, 4, 6	1	4	132	
	82	Motor excitation current (no load current) *	0 to , 9999		9999	136	
	83	Rated motor voltage	0 to 1000V	0.1V	575V	132	
	84	Rated motor frequency	20 to 200Hz	0.01Hz	60Hz	132	
	90	Motor constant R1 *	0 to , 9999		9999	136	
	91	Motor constant R2 *	0 to , 9999		9999	136	
	92	Motor constant L1 *	0 to , 9999		9999	136	
	93	Motor constant L2 *	0 to , 9999		9999	136	
	94	Motor constant X *	0 to , 9999		9999	136	
Motor constants	95	Online auto tuning selection	0, 1, 2	1	0	139	
	96	Auto tuning setting/status	0, 1, 101	1	0	132	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Third functions	110	Third acceleration/deceleration time	0 to 3600/0 to 360s	0.1s/0.01s	5s	91	
	111	Third deceleration time	0 to 3600/0 to 360s, 9999	0.1s/0.01s	9999	91	
Output terminal function	116	Third speed detection	0 to 3600r/min	1r/min	1800r/min	108	
Communication functions	117	Communication station number	0 to 31	1	0	141	
	118	Communication speed	48, 96, 192	1	192	141	
	119	Stop bit length/data length	0, 1, 10, 11	1	1	141	
	120	Parity check presence/absence	0, 1, 2	1	2	141	
	121	Number of communication retries	0 to 10, 9999	1	1	141	
	122	Communication check time interval	0 to 999.8s, 9999	0.1s	9999	141	
	123	Waiting time setting	0 to 150ms, 9999	1ms	9999	141	
	124	CR, LF presence/absence selection	0, 1, 2	1	1	141	
PID control	128	PID action selection	10, 11, 30, 31	1	10	152	
	129	PID proportional band	0.1 to 1000%, 9999	0.1%	100%	152	
	130	PID integral time	0.1 to 3600s, 9999	0.1s	1s	152	
	131	Upper limit	0 to 100%, 9999	0.1%	9999	152	
	132	Lower limit	0 to 100%, 9999	0.1%	9999	152	
	133	PID action set point for PU operation	0 to 100%	0.01%	0%	152	
	134	PID differential time	0.01 to 10s, 9999	0.01s	9999	152	
Backlash	140	Backlash acceleration stopping speed	0 to 3600r/min	1r/min	30r/min	102	
	141	Backlash acceleration stopping time	0 to 360s	0.1s	0.5s	102	
	142	Backlash deceleration stopping speed	0 to 3600r/min	1r/min	30r/min	102	
	143	Backlash deceleration stopping time	0 to 360s	0.1s	0.5s	102	
Display functions	144	Speed setting switchover	0, 2, 4, 6, 8, 10	1	0	106	
	145	Parameter for the option (FR-PU04V).					
Current detection	150	Output current detection level	0 to 200%	0.1%	150%	159	
	151	Output current detection period	0 to 10s	0.1s	0	159	
	152	Zero current detection level	0 to 200.0%	0.1%	5.0%	160	
	153	Zero current detection period	0 to 1s	0.01s	0.5s	160	
Sub functions	156	Stall prevention operation selection	0 to 31, 100, 101	1	1	161	
	157	OL signal output timer	0 to 25s, 9999	0.1s	0	162	
Display functions	158	DA2 terminal function selection	1 to 3, 5 to 12, 17, 18, 21, 32 to 34, 36	1	1	110	
	160	Extended function selection	0, 1	1	0	163	
Automatic restart after instantaneous power failure	162	Automatic restart after instantaneous power failure selection	0, 1, 10	1	0	114	
	163	First cushion time for restart	0 to 20s	0.1s	0s	114	
	164	First cushion voltage for restart	0 to 100%	0.1%	0%	114	
	165	Restart current restriction level	0 to 200%	0.1%	150%	114	
Maintenance functions	168	Maker setting parameters. Do not make setting.					
	169						
Initial monitor	171	Actual operation hour meter clear	0	1	0	163	
Terminal assignment functions	180	DI1 terminal function selection	0 to 3, 5, 8 to 12, 14 to 16, 20, 22 to 28, 42 to 44, 9999	1	0	163	
	181	DI2 terminal function selection		1	1		
	182	DI3 terminal function selection		1	2		
	183	DI4 terminal function selection		1	3		
	187	STR terminal function selection		1	9999		
	190	DO1 terminal function selection	0 to 8, 10 to 16, 20, 25 to 27, 30 to 37, 39, 40 to 44, 96 to 99, 100 to 108, 110 to 116, 120,125 to 127, 130 to 137, 139, 140 to 144, 196 to 199, 9999	1	0	165	
	191	DO2 terminal function selection		1	1		
	192	DO3 terminal function selection		1	2		
	195	ABC terminal function selection		1	99		
Multi-speed operation	232	Multi-speed setting (speed 8)	0 to 3600r/min, 9999	1r/min	9999	90	
	233	Multi-speed setting (speed 9)	0 to 3600r/min, 9999	1r/min	9999	90	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Multi-speed operation	234	Multi-speed setting (speed 10)	0 to 3600r/min, 9999	1r/min	9999	90	
	235	Multi-speed setting (speed 11)	0 to 3600r/min, 9999	1r/min	9999	90	
	236	Multi-speed setting (speed 12)	0 to 3600r/min, 9999	1r/min	9999	90	
	237	Multi-speed setting (speed 13)	0 to 3600r/min, 9999	1r/min	9999	90	
	238	Multi-speed setting (speed 14)	0 to 3600r/min, 9999	1r/min	9999	90	
	239	Multi-speed setting (speed 15)	0 to 3600r/min, 9999	1r/min	9999	90	
Sub functions	240	Soft-PWM setting	0, 1	1	0	124	
	244	Cooling fan operation selection	0, 1	1	0	167	
Stop selection function	250	Stop selection	0 to 100s, 9999	0.1s	9999	167	
Operation selection function	251	Output phase failure protection selection	0, 1	1	1	168	
Additional functions	252	Override bias	0 to 200%	0.1%	50%	169	
	253	Override gain	0 to 200%	0.1%	150%	169	
Power failure stop functions	261	Power failure stop selection	0, 1	1	0	169	
	262	Subtracted speed at deceleration start	0 to 600r/min	1r/min	90r/min	169	
	263	Subtraction starting speed	0 to 3600r/min, 9999	1r/min	1800r/min	169	
	264	Power-failure deceleration time 1	0 to 3600/0 to 360s	0.1s/0.01s	5s	169	
	265	Power-failure deceleration time 2	0 to 3600/0 to 360s, 9999	0.1s/0.01s	9999	169	
	266	Power-failure deceleration time switchover speed	0 to 3600r/min	1r/min	1800r/min	169	
Brake sequence	278	Brake opening speed	0 to 900r/min	1r/min	20r/min	118	
	279	Brake opening current	0 to 200%	0.1%	130%	118	
	280	Brake opening current detection time	0 to 2s	0.1s	0.3s	118	
	281	Brake operation time at start	0 to 5s	0.1s	0.3s	118	
	282	Brake operation speed	0 to 900r/min	1r/min	25r/min	118	
	283	Brake operation time at stop	0 to 5s	0.1s	0.3s	118	
	284	Deceleration detection function selection	0, 1	1	0	118	
	285	Overspeed detection speed	0 to 900r/min, 9999	1r/min	9999	118	
Droop	286	Droop gain	0 to 100.0%	0.01%	0%	171	
	287	Droop filter constant	0.00 to 1.00s	0.01s	0.3s	171	
	288	Droop function activation selection	0, 1, 2	1	0	171	
Additional function	342	E^2PROM write selection	0, 1	1	0	141	
Orientation	350	Stop position command selection	0, 1, 2, 9999	1	9999	172	
	351	Orientation switchover speed	0 to 1000r/min	1r/min	200r/min	172	
	356	Internal stop position command	0 to 16383	1	0	172	
	357	Orientation in-position zone	0 to 8192	1	11	172	
	360	External position command selection	0, 1, 2 to 127	1	0	172	
	361	Position shift	0 to 16383	1	0	172	
	362	Orientation position loop gain	0.1 to 100	0.1	10	172	
Control system function	374	Overspeed detection level	0 to 4200r/min	1r/min	4200r/min	179	
S-pattern C	380	Acceleration S pattern 1	0 to 50%	1%	0%	102	
	381	Deceleration S pattern 1	0 to 50%	1%	0%	102	
	382	Acceleration S pattern 2	0 to 50%	1%	0%	102	
	383	Deceleration S pattern 2	0 to 50%	1%	0%	102	
Orientation	393	Orientation selection	1, 2, 10, 11, 12	1	0	172	
	396	Orientation speed gain (P term)	0 to 1000%	1	60%	172	
	397	Orientation speed integral time	0 to 20.0s	0.001	0.333s	172	
	398	Orientation speed gain (D term)	0 to 100.0%	0.1	1%	172	
	399	Orientation deceleration ratio	0 to 1000	1	20	172	
Position control	419	Position command right selection	0, 1	1	0	58	
	420	Command pulse scaling factor numerator	0 to 32767	1	1	58	

Parameter lists

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Position control	421	Command pulse scaling factor denominator	0 to 32767	1	1	58	
	422	Position loop gain	0 to 150s^{-1}	1s^{-1}	25s^{-1}	58	
	423	Position feed forward gain	0 to 100%	1%	0%	58	
	424	Position command acceleration/ deceleration time constant	0 to 50s	0.001s	0s	58	
	425	Position feed forward command filter	0 to 5s	0.001s	0s	58	
	426	In-position width	0 to 32767 pulses	1 pulse	100 pulses	58	
	427	Excessive level error	0 to 400K, 9999	1K	40K	58	
	430	Pulse monitor selection	0 to 5, 9999	1	9999	58	
Motor constants	450	Second applied motor	0, 3 to 8,10, 13 to 18, 20, 23, 24, 30, 33, 34, 9999	1	9999	41	
	451	Second motor control method selection	10, 11, 12, 20, 9999	1	9999	41	
	452	Second electronic thermal O/L relay	0 to 500A, 9999	0.01A	9999	93	
	453	Second motor capacity	0.4 to 55kW (0.5 to 75HP)	0.01kW (0.01HP)	Inverter capacity	41	
	454	Number of second motor poles	2, 4, 6	1	4	41	
	455	Second exciting current	0 to , 9999		9999	41	
	456	Rated second motor voltage	0 to 1000V	0.1V	575V	41	
	457	Rated second motor frequency	20 to 200Hz	0.01Hz	60Hz	41	
	458	Second motor constant (R1)	0 to , 9999		9999	135	
	459	Second motor constant (R2)	0 to , 9999		9999	135	
	460	Second motor constant (L1)	0 to , 9999		9999	135	
	461	Second motor constant (L2)	0 to , 9999		9999	135	
	462	Second motor constant (X)	0 to , 9999		9999	135	
	463	Second auto tuning setting/status	0, 1, 2		0	132	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Position control	464	Digital position control sudden stop deceleration time	0 to 360.0s	0.1s	0	58	
	465	First position feed amount lower 4 digits	0 to 9999	1	0	60	
	466	First position feed amount upper 4 digits	0 to 9999	1	0	60	
	467	Second position feed amount lower 4 digits	0 to 9999	1	0	60	
	468	Second position feed amount upper 4 digits	0 to 9999	1	0	60	
	469	Third position feed amount lower 4 digits	0 to 9999	1	0	60	
	470	Third position feed amount upper 4 digits	0 to 9999	1	0	60	
	471	Fourth position feed amount lower 4 digits	0 to 9999	1	0	60	
	472	Fourth position feed amount upper 4 digits	0 to 9999	1	0	60	
	473	Fifth position feed amount lower 4 digits	0 to 9999	1	0	60	
	474	Fifth position feed amount upper 4 digits	0 to 9999	1	0	60	
	475	Sixth position feed amount lower 4 digits	0 to 9999	1	0	60	
	476	Sixth position feed amount upper 4 digits	0 to 9999	1	0	60	
	477	Seventh position feed amount lower 4 digits	0 to 9999	1	0	60	
	478	Seventh position feed amount upper 4 digits	0 to 9999	1	0	60	
	479	Eighth position feed amount lower 4 digits	0 to 9999	1	0	60	
	480	Eighth position feed amount upper 4 digits	0 to 9999	1	0	60	
	481	Ninth position feed amount lower 4 digits	0 to 9999	1	0	60	
	482	Ninth position feed amount upper 4 digits	0 to 9999	1	0	60	
	483	Tenth position feed amount lower 4 digits	0 to 9999	1	0	60	
	484	Tenth position feed amount upper 4 digits	0 to 9999	1	0	60	
	485	Eleventh position feed amount lower 4 digits	0 to 9999	1	0	60	
	486	Eleventh position feed amount upper 4 digits	0 to 9999	1	0	60	
	487	Twelfth position feed amount lower 4 digits	0 to 9999	1	0	60	
	488	Twelfth position feed amount upper 4 digits	0 to 9999	1	0	60	
	489	Thirteenth position feed amount lower 4 digits	0 to 9999	1	0	60	
	490	Thirteenth position feed amount upper 4 digits	0 to 9999	1	0	60	
	491	Fourteenth position feed amount lower 4 digits	0 to 9999	1	0	60	
	492	Fourteenth position feed amount upper 4 digits	0 to 9999	1	0	60	
	493	Fifteenth position feed amount lower 4 digits	0 to 9999	1	0	60	
	494	Fifteenth position feed amount upper 4 digits	0 to 9999	1	0	60	
Remote output	495	Remote output selection	0, 1	1	0	181	
	496	Remote output data 1	0 to 4095	1	0	181	
	497	Remote output data 2	0 to 4095	1	0	181	
Operation selection functions	800	Control system selection	0 to 5, 20	1	0	182	
	801	Torque characteristic selection	0, 1	1	1	182	
	802	Pre-excitation selection	0, 1	1	0	95	
	803	Constant output region torque characteristic selection	0, 1	1	0	100	
	804	Torque command right selection	0 to 4	1	0	184	
	805	Torque command value (RAM)	600 to 1400%	1%	1000%	184	
	806	Torque command value (RAM, E^2PROM)	600 to 1400%	1%	1000%	184	
	807	Speed restriction selection	0, 1, 2	1	0	185	
	808	Forward rotation speed restriction	0 to 3600r/min	1r/min	1800r/min	185	
	809	Reverse rotation speed restriction	0 to 3600r/min, 9999	1r/min	9999	185	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Control system functions	810	Torque restriction input method selection	0, 1	1	0	100	
	812	Torque restriction level (regeneration)	0 to 400%, 9999	0.1%	9999	100	
	813	Torque restriction level (3rd quadrant)	0 to 400%, 9999	0.1%	9999	100	
	814	Torque restriction level (4th quadrant)	0 to 400%, 9999	0.1%	9999	100	
	815	Torque restriction level 2	0 to 400%, 9999	0.1%	9999	100	
	816	Acceleration torque restriction level	0 to 400%, 9999	0.1%	9999	100	
	817	Deceleration torque restriction level	0 to 400%, 9999	0.1%	9999	100	
	818	Easy gain tuning response level setting	1 to 15	1	2	187	
	819	Easy gain tuning selection	0, 1, 2	1	0	187	
	820	Speed control P gain 1	0 to 1000%	1%	60%	187	
	821	Speed control integral time 1	0 to 20s	0.001s	0.333s	187	
	822	Speed setting filter 1	0 to 5s+	0.001s	0s	187	
	823	Speed detection filter 1	0 to 0.1s	0.001s	0.001s	188	
	824	Torque control P gain 1	0 to 200%	1%	100%	188	
	825	Torque control integral time 1	0 to 500ms	0.1ms	5ms	188	
	826	Torque setting filter 1	0 to 5s	0.001s	0s	188	
	827	Torque detection filter 1	0 to 0.1s	0.001s	0s	189	
	828	Model speed control gain	0 to 1000%	1%	60%	51	
	830	Speed control P gain 2	0 to 1000%, 9999	1%	9999	187	
	831	Speed control integral time 2	0 to 20s, 9999	0.001s	9999	187	
	832	Speed setting filter 2	0 to 5s, 9999	0.001s	9999	187	
	833	Speed detection filter 2	0 to 0.1s, 9999	0.001s	9999	188	
	834	Torque control P gain 2	0 to 200%, 9999	1%	9999	188	
	835	Torque control integral time 2	0 to 500ms, 9999	0.1ms	9999	188	
	836	Torque setting filter 2	0 to 5s, 9999	0.001s	9999	188	
	837	Torque detection filter 2	0 to 0.1s, 9999	0.001s	9999	189	
Torque biases	840	Torque bias selection	0 to 3, 9999	1	9999	189	
	841	Torque bias 1	600 to 1400%, 9999	1%	9999	189	
	842	Torque bias 2	600 to 1400%, 9999	1%	9999	189	
	843	Torque bias 3	600 to 1400%, 9999	1%	9999	189	
	844	Torque bias filter	0 to 5s, 9999	0.001s	9999	189	
	845	Torque bias operation time	0 to 5s, 9999	0.01s	9999	189	
	846	Torque bias balance compensation	0 to 10V, 9999	0.1V	9999	189	
	847	Fall-time torque bias No. 3 bias	0 to 400%, 9999	1%	9999	189	
	848	Fall-time torque bias No. 3 gain	0 to 400%, 9999	1%	9999	189	
Additional functions	849	Analog input offset adjustment *	0 to 200%	0.1%	100%	205	
	850	Brake operation selection for vector control without encoder	0, 1	1	0	95	
	851	Number of encoder pulses	0 to 4096	1	1024	10	
	852	Encoder rotation direction	0, 1	1	1	10	
	854	Excitation ratio	0 to 100%	1%	100%	193	
	859	Torque current *	0 to , 9999	1	9999	136	
	860	Second torque current	0 to , 9999	1	9999	132	
	862	Notch filter frequency	0 to 31	1	0	193	
	863	Notch filter depth	0 to 3	1	0	193	
	864	Torque detection	0 to 400%	0.1%	150%	194	
	865	Low speed detection	0 to 3600r/min	1r/min	45r/min	194	
Display functions	866	Torque monitoring reference	0 to 400%	0.1%	150%	113	
	867	DA1 output filter	0 to 5s	0.001s	0.05s	195	
Terminal assignment function	868	No. 1 terminal function assignment	0, 1, 2, 5, 9999	1	0	195	
Protective functions	870	Speed deviation level	0 to 1500r/min, 9999	1r/min	9999	196	
	871	Speed deviation time	0 to 100s	0.1s	12s	196	
	873	Speed restriction	0 to 3600r/min	1r/min	600r/min	197	
	874	OLT level setting	0 to 200%	0.1%	150%	197	
Operation selection functions	875	Fault definition	0, 1	1	0	198	
	876	Thermal relay protector input	0, 1	1	0	93	

Function	Parameter No.	Name	Setting Range	Minimum Setting Increments	Factory Setting	Refer To	Customer Setting
Control system functions	877	Speed feed forward control/model adaptive speed control selection	0, 1, 2	1	0	51	
	878	Speed feed forward filter	0 to 1s	0.01s	0s	51	
	879	Speed feed forward torque restriction	0 to 400%	0.1%	150%	51	
	880	Load inertia ratio	0, 1 to 200 times	0.1	7	51	
	881	Speed feed forward gain	0 to 1000%	1%	0%	51	
Maintenance functions	890	Maintenance output setting time	0 to 9998, 9999	10hr	9999	199	
	891	Maintenance output timer	0 to 9998	10hr	0	199	
	892	Maintenance output signal clear	0	1	0	199	
Calibration functions	900	DA1 terminal calibration				200	
	901	DA2 terminal calibration				200	
	902	Speed setting No. 2 bias	0 to 10V, 0 to 3600r/min	0.1r/min	0V, 0r/min	202	
	903	Speed setting No. 2 gain	0 to 10V, 0 to 3600r/min	1r/min	10V, 1800r/min	202	
	904	Torque command No. 3 bias	0 to 10V, 0 to 400%	0.1%	0V, 0%	202	
	905	Torque command No. 3 gain	0 to 10V, 0 to 400%	0.1%	10V, 150%	202	
	917	No. 1 terminal bias (speed)	0 to 10V, 0 to 3600r/min	0.1r/min	0V, 0r/min	202	
	918	No. 1 terminal gain (speed)	0 to 10V, 0 to 3600r/min	1r/min	10V, 1800r/min	202	
	919	No. 1 terminal bias (torque/magnetic flux)	0 to 10V, 0 to 400%	0.1%	0V, 0%	202	
	920	No. 1 terminal gain (torque/magnetic flux)	0 to 10V, 0 to 400%	0.1%	10V, 150%	202	
Additional functions	990	PU buzzer control	0, 1	1	1	205	
	991	Parameter for the option (FR-PU04V).					

4.2 At-a-glance guide to functions

○....Usable function, × ..... Unusable function

Category	Function	Pr. number	Terminal	Vector with encoder: Speed	Vector with encoder: Torque	Vector with encoder: Position	Vector without encoder: Speed	Vector without encoder: Torque
	Control			Vector with encoder			Vector without encoder	
	Applicable Motor			"Motor with encoder (standard, constant torque)" *: This function can be usable under position control by parameter setting.			Vector control dedicated motor	
Control	Speed restriction	Pr. 807 to Pr. 809, Pr.873, Pr. 902, Pr. 903, Pr. 917, Pr. 918	terminal 2 (1), multi-speed	×	○	×	×	○
	Torque restriction	Pr. 22, Pr. 803, Pr. 810 to Pr. 817, Pr. 904, Pr. 905, Pr.919, Pr.920	terminal 3 (1)	○	×	○	○	×
	Offline auto tuning	Pr. 9, Pr. 71, Pr. 80 to Pr. 84, Pr. 90 to Pr. 94, Pr. 96, Pr. 859		○	○	×	○	○
	Online auto tuning (start time) Pr.95=1	Pr. 95		○	○	×	○	○
	Online auto tuning (adaptive magnetic flux observer) Pr.95=2	Pr. 95		○	○	○	×	×
	Easy gain tuning (with load estimation) Pr.819=1	Pr. 818, Pr. 819		○	×	○	×	×
	Easy gain tuning (load manual input (Pr.880)) Pr.819=2	Pr. 818, Pr. 819, Pr. 880		○	×	○	○	×
	Gain adjustment	Pr. 820 to Pr. 827, Pr. 830 to Pr. 837		○	○	○	○	○
	Machine analyzer (notch filter)	Pr. 862, Pr. 863		○	×	○	×	×
	0 speed control	Pr. 802		○	×	○	○	×
	Servo lock	Pr. 802		○	×	○	×	×
	Variable excitation	Pr. 854		○	○	○	○	○
	Speed feed-forward, model adaptive speed control	Pr. 877 to Pr. 881, Pr. 820, Pr. 821, Pr. 828		○	×	○	○	×
	P/PI switchover	Pr. 180 to Pr. 183, Pr. 187	X44 signal	○	○	○	○	○
	Speed feedback filter	Pr. 823, Pr. 833		○	○	○	×	×
Basic functions	Extended function display	Pr. 160		○	○	○	○	○
	Maximum speed	Pr. 1		○	○	○	○	○
	Minimum speed	Pr. 2		○	○	×	○	○
	Acceleration time	Pr. 7, Pr. 8, Pr. 20, Pr. 21, Pr. 44, Pr. 45, Pr. 110, Pr. 111		○	○	×*	○	○
	Acceleration/deceleration pattern	Pr. 29, Pr. 140 to Pr. 143, Pr. 380 to Pr. 383		○	○	×	○	○
	Jog operation mode	Pr. 15, Pr. 16		○	○	×	○	○
	PWM frequency selection	Pr. 72, Pr. 240		○	○	○	○	○
	Operation mode (PU/external/combined)	Pr. 79		○	○	×	○	○
	Switchover mode	Pr. 79		○	○	×	○	○
	PU operation interlock mode	Pr. 79, Pr. 180 to Pr. 183, Pr. 187	X12	○	○	○	○	○
	Operation mode external signal switchover mode	Pr. 79, Pr. 180 to Pr.183, Pr. 187	X16	○	○	○	○	○
	Start command (2-wire, 3-wire)	Pr. 180 to Pr. 183, Pr. 187	STOP	○	○	○	○	○
	Parameter write disable selection	Pr. 77		○	○	○	○	○
Application functions	Starting speed	Pr. 13		○	○	×	○	○
	DC injection brake	Pr. 10, Pr. 11, Pr. 12		○	○	×	○	○
	Second, third functions	Pr. 180 to Pr. 183, Pr. 187	RT, X9	○	○	○	○	○
	Multi-speed setting	Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 28, Pr. 232 to Pr. 239		○	○	×*	○	○
	Remote setting	Pr. 59		○	○	×	○	○
	Speed jump	Pr. 31 to Pr. 36		○	○	×	○	○
	PID control	Pr. 128 to Pr. 134, Pr. 180 to Pr. 183, Pr. 187	X14	○	×	×	○	×
	Stop selection	Pr. 250		○	○	×	○	○
	Power failure stop	Pr. 261 to Pr. 266		○	○	×	○	○
	PU stop	Pr. 75		○	○	○	○	○
	Reset selection	Pr. 75		○	○	○	○	○
	Forward/reverse rotation prevention	Pr. 78		○	○	○	○	○
	Automatic restart after instantaneous power failure	Pr. 57, Pr. 58		○	○	×	○	○
	Cooling fan on/off control	Pr. 244		○	○	○	○	○
	Retry function	Pr. 65, Pr. 67, Pr. 68, Pr. 69		○	○	×	○	○
	Inverter RS485 communication	Pr. 117 to Pr. 124		○	○	○	○	○
	Droop control (with zero limit) Pr. 288=0, 1	Pr. 286 to Pr. 288		○	×	×	○	×
	Droop control (without zero limit) Pr. 288=2	Pr. 286 to Pr. 288		○	×	×	×	×

Category	Function	Pr. number	Terminal	Vector with encoder: Speed	Vector with encoder: Torque	Vector with encoder: Position	Vector without encoder: Speed	Vector without encoder: Torque
	Control			Vector with encoder			Vector without encoder	
	Applicable Motor			"Motor with encoder (standard, constant torque)" *: This function can be usable under position control by parameter setting.			Vector control dedicated motor	
Application functions	Brake sequence	Pr. 60, Pr. 278 to Pr. 285		○	×	×	○	×
	Torque bias	Pr. 180 to Pr. 183, Pr. 187, Pr. 840 to Pr. 848, Pr. 904, Pr. 905	X42, X43	○	×	×	×	×
	Regenerative function selection	Pr. 30, Pr. 70		○	○	○	○	○
	Soft-PWM	Pr. 240		○	○	○	○	○
	Torque characteristic selection	Pr. 801		○	○	○	○	○
	Encoder rotation direction	Pr. 852		○	○	○	×	×
	Number of encoder pulses	Pr. 851		○	○	○	×	×
	Conditional position control by contact input	Pr. 465 to Pr. 494		×	×	○	×	×
	Direct display and direct setting of motor constants	Pr. 71, Pr. 82, Pr. 90 to Pr. 94, Pr. 859		○	○	○	○	○
	Speed setting/display unit switchover	Pr. 37, Pr. 144, Pr. 81, Pr. 454		○	○	○	○	○
	Electronic gear	Pr. 420, Pr. 421		×	×	○	×	×
Input functions	Multi-function input terminal assignment	Pr. 180 to Pr. 183, Pr. 187		○	○	○	○	○
	Analog input assignment/calibration	Pr. 868 / Pr. 902 to Pr. 920	terminals 1, 2, 3	○	○	○	○	○
	Analog command filter time constant	Pr. 822, Pr. 826, Pr. 832, Pr. 836		○	○	○	○	○
	Override, polarity reversible	Pr. 73, Pr. 252, Pr. 253		○	○	×	○	○
	Output stop	Pr. 17, Pr. 180 to Pr. 183, Pr. 187	MRS	○	○	○	○	○
Output functions	Multi-function output terminal assignment	Pr. 190 to Pr. 192, Pr. 195		○	○	○	○	○
	Speed restriction output	Pr. 190 to Pr. 192, Pr. 195	SL	×	○	×	×	○
	Inverter running signal	Pr. 13, Pr.190 to Pr. 192, Pr. 195	RUN	○	○	○	○	○
	Up-to-speed signal	Pr. 41,Pr. 190 to Pr. 192, Pr. 195	SU	○	×	×	○	×
	Overload alarm signal	Pr. 190 to Pr. 192, Pr. 195	OL					
	Speed detection signal	Pr. 42, Pr. 43, Pr. 50, Pr. 116, Pr.190 to Pr. 192, Pr. 195	FU, FU2, FU3	○	×	×	○	×
			FB, FB2, FB3	○	○	○	○	○
	Regenerative brake prealarm signal	Pr. 190 to Pr. 192, Pr. 195	RBP	○	○	○	○	○
	Electronic thermal relay function prealarm signal	Pr. 190 to Pr. 192, Pr. 195	THP	○	○	○	○	○
	PU operation mode signal	Pr. 190 to Pr. 192, Pr. 195	PU	○	○	○	○	○
	Operation ready signal	Pr. 190 to Pr. 192, Pr. 195	RY	○	○	○	○	○
	Output current detection signal, zero current detection signal	Pr. 150, Pr. 151, Pr. 152, Pr. 153, Pr. 190 to Pr. 192, Pr. 195	Y12, Y13	○	○	○	○	○
	Fan fault output signal	Pr. 190 to Pr. 192, Pr. 195	FAN	○	○	○	○	○
	Fin overheat prealarm signal	Pr. 190 to Pr. 192, Pr. 195	FIN	○	○	○	○	○
	Forward, reverse rotation output signal	Pr. 190 to Pr. 192, Pr. 195	Y30, Y31	○	○	○	○	○
	Regenerative status output signal	Pr. 190 to Pr. 192, Pr. 195	Y32	○	○	○	○	○
	Operation ready 2 signal	Pr. 190 to Pr. 192, Pr. 195	RY2	○	○	○	○	○
	Low speed detection signal	Pr. 190 to Pr. 192, Pr. 195, Pr. 865	LS	○	○	○	○	○
	Torque detection signal	Pr. 190 to Pr. 192, Pr. 195, Pr. 864	TU	○	○	○	○	○
	Maintenance output	Pr. 190 to Pr. 192, Pr. 195, Pr. 890 to Pr. 892	MT	○	○	○	○	○
	Remote output	Pr. 190 to Pr.192, Pr. 195, Pr. 495 to Pr. 497	REM	○	○	○	○	○
	Instantaneous power failure (undervoltage) signal	Pr. 190 to Pr. 192, Pr. 195	IPF	○	○	○	○	○
	Fault definition	Pr. 190 to Pr. 192, Pr. 195, Pr. 875	ER	○	○	×	○	○
	Minor fault output signal	Pr. 190 to Pr. 192, Pr. 195	LF	○	○	○	○	○
	Alarm output signal	Pr. 190 to Pr. 192, Pr. 195	ABC	○	○	○	○	○
Monitor functions	DU/PU display data selection	Pr. 52, Pr. 53		○	○	○	×	×
	DA1, DA2 output/calibration	Pr. 54 to Pr. 56, Pr. 866, Pr. 158, Pr. 900, Pr. 901	DA1, DA2	○	○	○	○	○
	DA1 output filter	Pr. 867	DA1	○	○	○	○	○
	Speed monitor	Pr. 52 to Pr. 55, Pr.158		○	○	○	○	○
	Output current monitor/output current peak value monitor	Pr. 52 to Pr. 54, Pr. 56, Pr. 158		○	○	○	○	○
	Output voltage monitor	Pr. 52 to Pr. 54, Pr. 158		○	○	○	○	○
	Preset speed monitor	Pr. 52 to Pr. 55, Pr. 158		○	○	○	○	○
	Output frequency monitor	Pr. 52 to Pr. 55, Pr. 158		○	○	○	○	○
	Motor torque monitor	Pr. 52 to Pr. 54, Pr. 158, Pr. 866		○	○	○	○	○
	Converter output voltage monitor, converter output voltage peak value monitor	Pr. 52 to Pr. 54, Pr. 158		○	○	○	○	○

Category	Function	Pr. number	Terminal	Vector with encoder: Speed	Vector with encoder: Torque	Vector with encoder: Position	Vector without encoder: Speed	Vector without encoder: Torque
	Control			"Motor with encoder (standard, constant torque)" *: This function can be usable under position control by parameter setting.			Vector control dedicated motor	
	Applicable Motor							
Monitor functions	Input terminal monitor, output terminal monitor	—		○	○	○	○	○
	Load meter monitor	Pr. 52 to Pr. 54, Pr. 158, Pr. 866		○	○	○	○	○
	Motor excitation current monitor	Pr. 52 to Pr. 54, Pr. 158, Pr. 56		○	○	○	○	○
	Cumulative operation time monitor	Pr. 52		○	○	○	○	○
	Actual operation time monitor	Pr. 52, Pr. 171		○	○	○	○	○
	Motor load factor	Pr. 52		○	○	○	○	○
	Orientation status	Pr. 52		○	×	×	○	○
	Option fitting status monitor	—		○	○	○	○	×
	Terminal assignment status monitor	—		○	○	○	○	○
	Motor output monitor	Pr. 52		○	○	○	○	○
	Feedback pulse monitor	Pr. 52		○	○	○	○	○
	Torque command/torque current command	Pr. 52, Pr. 54, Pr. 158, Pr. 866		○	○	○	×	×
Protective functions	Overcurrent protection	—		○	○	○	○	○
	Overvoltage protection	—		○	○	○	○	○
	Electronic thermal O/L relay	Pr. 9		○	○	○	○	○
	Fin overheat	—		○	○	○	○	○
	Brake transistor alarm	Pr. 30, Pr. 70		○	○	○	○	○
	Ground fault overcurrent protection	—		○	○	○	○	○
	External thermal relay <OHT>	Pr. 876	OH	○	○	○	○	○
	Motor overload (OLT)	Pr. 865, Pr. 874		○	○	○	○	○
	Option alarm	—		○	○	○	○	○
	Parameter error	—		○	○	○	○	○
	Disconnected PU detection	Pr. 75		○	○	○	○	○
	Output phase failure protection	Pr. 251		○	○	○	○	○
	CPU error	—		○	○	○	○	○
	12/24VDC power supply short circuit protection	—		○	○	○	○	○
	Operation panel power supply short circuit protection	—		○	○	○	○	○
	Overspeed occurrence	Pr. 374		○	○	○	○	○
	Speed deviation large	Pr. 870, Pr. 871		○	○	○	×	×
	Encoder no-signal	—		○	○	○	×	×
	Encoder A no-signal	—		○	×	×	×	×
	Position error large	Pr. 427		×	×	○	×	×
	Output short circuit protection	—		○	○	○	×	×
	Encoder phase error (E. EP)	—		○	○	○	○	○
PU	PU language changing	Pr. 145		○	○	○	×	×
	PU buzzer control	Pr. 990		○	○	○	○	○
	PU contrast adjustment	Pr. 991		○	○	○	○	○
Options	12-bit digital input "A5AX"	Pr. 300 to Pr. 305, Pr. 329		○	○	×	○	○
	Digital setting of torque command "A5AX"	Pr. 447, Pr. 448, Pr. 804		×	○	×	○	○
	Machine end orientation "V5AM"	Pr. 350 to Pr. 369, Pr. 390 to Pr. 396		○	×	×	×	○
	Pulse position control "V5AP"	Pr. 419 to Pr. 431		×	×	○	×	×
	Encoder output "V5AY"	Pr. 410 to Pr. 413		○	○	○	×	×
	Thermistor secondary resistance compensation "V5AX"	Pr. 407, Pr. 925		○	○	○	×	×
	Extension analog input "V5AX"	Pr. 406		○	○	○	×	×
	Extension contact input "V5AX"	Pr. 400 to Pr. 405		○	○	○	○	○
	Digital output "A5AY, V5AY"	Pr. 313 to Pr. 319 / Pr. 410 to Pr. 413		○	○	○	○	○
	Extension analog output "A5AY"	Pr. 306 to Pr. 312		○	○	○	○	○
	Relay output "A5AR"	Pr. 320 to Pr. 322, Pr. 330		○	○	○	○	○
	Pulse train input "A5AP"	Pr. 384 to Pr. 386		○	○	×	○	○
	SSCNET "V5NS"	Pr. 79=9, Pr. 117, Pr. 338 to Pr. 342, Pr. 499		○	×	○	○	○
	Ethernet "V5NE"	Pr. 434 to Pr. 438		○	○	○	×	×
	RS485 communication "A5NR"	Pr. 331 to Pr. 342		○	○	○	○	○
	CC-Link "A5NC"	Pr. 338 to Pr. 342		○	○	○	○	○
	Profibus DP "A5NPA"	Pr. 338 to Pr. 342		○	○	○	○	○
	DeviceNet "A5ND"	Pr. 338 to Pr. 342, Pr. 345 to Pr. 348		○	○	○	○	○
	16-bit digital input "V5AH"	Pr. 300 to Pr. 305, Pr. 329		○	○	×	○	○
	Trace (plug-in option)	Pr. 520 to Pr. 536		○	○	○	○	○

4.3 Basic functions (Pr. 0 to Pr. 9)

4.3.1 Torque boost (Pr. 0)

Use this parameter for V/F control only.

- Motor torque in the low speed region can be adjusted according to the load to increase the starting motor torque.

Parameter	Name	Factory Setting	Setting Range	Remarks
0	Torque boost (manual)	3%/2%/1% (2.2K/3.7K, 7.5K/15K or more)	0 to 30%	Extended mode

<Setting>

- Increase the setting when the distance between the inverter and motor is long or when the motor torque in the low speed region is insufficient (when the stall prevention protective function is activated), for example.
- Assuming that the base frequency voltage is 100%, set the 0Hz voltage in %.

CAUTION

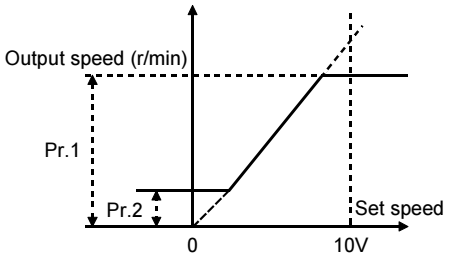
If the setting is too large, the motor may result in overheat or overcurrent trip. The guideline for maximum value is about 10%.

4.3.2 Maximum and minimum speed settings

(Pr. 1 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque; Conditional / PLC / SSC: Position *, Pr. 2* with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque *)*

You can limit the maximum (minimum) speed.

- Speed control
  The maximum setting is placed on the running speed.
  The minimum setting is placed on the preset speed.
- Torque control
  The maximum and minimum settings are made on the speed restriction commands. (Restriction is not placed on the running speed.)
- Position control
  The maximum setting is valid for the speed command obtained from the droop pulses. The minimum setting is invalid.



Parameter	Name	Factory Setting	Setting Range	Remarks
1	Maximum speed	1800r/min	0 to 3600r/min	Simple mode
2	Minimum speed	0r/min	0 to 3600r/min	Simple mode

<Setting>

● Speed control

- When the upper limit of the output speed is set in Pr. 1, the output speed is clamped at the maximum speed even if the speed command entered is higher than the speed set in Pr.1. (This also applies to the minimum speed setting.)

⚠CAUTION

⚠ When the Pr. 2 setting is higher than Pr. 13 "starting speed" value, note that the motor will run at the preset speed by merely turning the start signal on, even if the command speed has not been entered.

Related parameters

- Starting speed setting ⇒ Pr. 13 "starting speed" (Refer to page 97.)
- Speed restriction command selection for torque control ⇒ Pr. 807 "speed restriction selection" (Refer to page 185.)
- External (example: terminal 2-5 connection) speed setting potentiometer adjustment ⇒ Pr. 902 "speed setting No. 2 bias" (Refer to page 202.),
  Pr. 903 "speed setting No. 2 gain" (Refer to page 202.)

4.3.3 Base frequency, base frequency voltage (Pr. 3, Pr. 19)

Use this parameter for V/F control only.
This parameter matches the inverter outputs (voltage, frequency) to the motor rating.

Parameter	Name	Factory Setting	Setting Range	Remarks
3	Base frequency	60Hz	20 to 200Hz	Extended mode
19	Base frequency voltage	9999	0 to 1000V, 8888, 9999	Extended mode 8888: 95% of power supply voltage 9999: Same as power supply voltage

<Setting>

- Use Pr. 3 to set the base frequency (rated motor frequency).
- Use Pr. 19 to set the base voltage (e.g. rated motor voltage).
  The motor whose rated voltage is lower than the power supply voltage of the inverter can be used optimally.

REMARKS

If vector control is disabled due to an encoder fault, setting "20" in Pr. 800 "control system selection" enables operation under V/F control. (Refer to page 182.)

Related parameters

Motor setting ⇒ Pr. 71 "applied motor", Pr. 450 "second applied motor" (Refer to page 123.)

4.3.4 Multi-speed operation (Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 232 to Pr. 239)

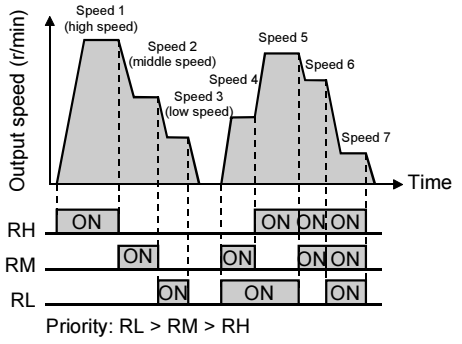
with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / ~~PLC~~ / ~~SSC~~ — Position

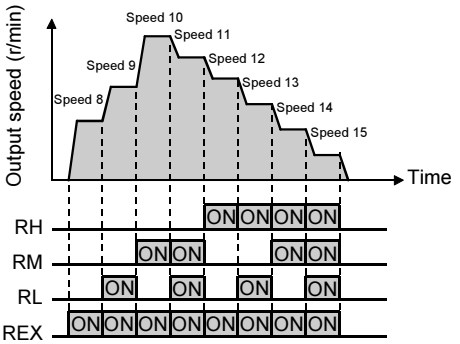
Can be used to change between the predetermined running speeds by switching from one terminal to another.

- Any speed can be selected by merely turning on-off the contact signals (RH, RM, RL, REX signals).
- Using these parameters with Pr. 1 "maximum speed" and Pr. 2 "minimum speed" allows the setting of up to 17 speeds.

POINT

- Valid in the external operation mode or in the combined operation mode that is made available by setting "3 or 4" in Pr. 79.
- Valid when "0" is set in Pr. 59.





Parameter	Name	Factory Setting	Setting Range	Remarks
4	Multi-speed setting (high speed)	1800r/min	0 to 3600r/min	Simple mode
5	Multi-speed setting (middle speed)	750r/min	0 to 3600r/min	Simple mode
6	Multi-speed setting (low speed)	150r/min	0 to 3600r/min	Simple mode
24 to 27	Multi-speed setting (speeds 4 to 7)	9999	0 to 3600r/min, 9999	"9999" No setting
232 to 239	Multi-speed setting (speeds 8 to 15)	9999	0 to 3600r/min, 9999	"9999" No setting

<Setting>

- Set the running speeds in the corresponding parameters.
  Each speed can be set as desired in the range 0 to 3600r/min during inverter operation.

  With any multi-speed setting parameter being read, press ▲/▼ to change the setting.

  In this case, press SET to store the preset speed. (This is also enabled in the external mode.)

  Pressing SET reflects the preset speed.

REMARKS

- Press WRITE when the FR-PU04V (option) is used.
- Use Pr. 180 to Pr. 183 and Pr. 187 to assign the terminals used for signals RH, RM, RL, and REX. (*)
  *Changing terminal assignment using Pr. 180 to Pr. 183, Pr. 187 may affect the other functions. Check the functions of the corresponding terminals before making setting.
- The priorities of the external terminals for speed commands are as follows.
  Jog > pulse train input (option FR-A5AP) > digital setting (option FR-A5AX) > multi-speed operation > PID > terminal 2

CAUTION

1. **The multi-speed settings override the main speed (across terminals 2-5).**
2. **The multi-speeds can also be set in the PU or external operation mode.**
3. **For 3-speed setting, if two or more speeds are simultaneously selected, priority is given to the preset speed of the lower signal. (RL > RM > RH)**
4. **Pr. 24 to Pr. 27 and Pr. 232 to Pr. 239 settings have no priority between them.**
5. **The settings can also be changed during operation.**
6. **When the jog signal is used with multi-speed signals, the jog signal has priority.**

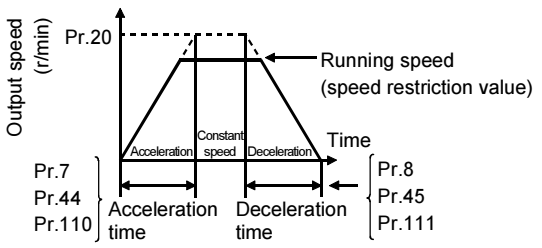
Related parameters

- Maximum, minimum speed setting⇒ Pr. 1 "maximum speed", Pr. 2 "minimum speed" (Refer to page 89.)
- Signal RH, RM, RL, REX terminal assignment⇒ Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)
- External operation mode setting⇒ Pr. 79 "operation mode selection" (Refer to page 129.)
- Extended mode/simple mode setting⇒ Pr. 160 "extended function selection" (Refer to page 163.)

4.3.5 Acceleration and deceleration times

(Pr. 7, Pr. 8, Pr. 20, Pr. 21, Pr. 44, Pr. 45, Pr. 110, Pr. 111 with Encoder / without Encoder Speed; with Encoder / without Encoder Torque; Conditional / ~~PLC~~ / ~~SSC~~ Position)

Set the acceleration/deceleration time of the motor during speed control and position control by parameter setting.
Set a larger value for a slower speed increase/ decrease or a smaller value for a faster speed increase/decrease.
Under torque control, the speed restriction value varies with the acceleration/deceleration time.



Parameter	Name	Factory Setting	Setting Range	Remarks	
7	Acceleration time	5s/15s (3.7K or less/7.5K or more)	0 to 3600s	Simple mode	
			0 to 360s		
8	Deceleration time	5s/15s (3.7K or less/7.5K or more)	0 to 3600s	Simple mode	
			0 to 360s		
20	Acceleration/ deceleration reference speed	1800r/min	1 to 3600 r/min	Extended mode	
21	Acceleration/ deceleration time increments	0	0, 1	0: 0 to 3600s 1: 0 to 360s	Extended mode
44	Second acceleration/ deceleration time	5s	0 to 3600s	Pr. 21 = 0	Extended mode
			0 to 360s	Pr. 21 = 1	
45	Second deceleration time	9999	0 to 3600s	Pr. 21 = 0	Extended mode
			0 to 360s	Pr. 21 = 1	
			9999	Acceleration time = deceleration time	
110	Third acceleration/ deceleration time	5s	0 to 3600s	Pr. 21 = 0	Extended mode
			0 to 360s	Pr. 21 = 1	
111	Third deceleration time	9999	0 to 3600s	Pr. 21 = 0	Extended mode
			0 to 360s	Pr. 21 = 1	
			9999	Acceleration time = deceleration time	

<Setting>

- Use Pr. 21 to set the acceleration/deceleration time and minimum setting range.
  Value "0" (factory setting) 0 to 3600s (minimum setting increments: 0.1s)
  Value "1" 0 to 360s (minimum setting increments: 0.01s)
  Changing the Pr. 21 value changes the setting of Pr. 7, Pr. 8, Pr. 44, Pr. 45, Pr. 110 and Pr. 111.

CAUTION

Changing the Pr. 21 setting changes the acceleration/deceleration setting (Pr. 7, Pr. 8, Pr. 16, Pr. 44, Pr. 45, Pr. 110, Pr. 111)
<Example>
When Pr. 21 = "0", setting "5.0" s in Pr. 7 and "1" in Pr. 21 changes the Pr. 7 setting to "0.5" s.

- Use Pr. 7, Pr. 44 and Pr. 110 to set the acceleration time taken to reach the speed set in Pr. 20 from 0r/min.
- Use Pr. 8, Pr. 45 and Pr. 111 to set the deceleration time taken to reach 0r/min from the speed set in Pr. 20.
- Use Pr. 180 to Pr. 183 and Pr. 187 to assign the terminals used to input the RT and X9 signals.

CAUTION

- **Pr. 44 and Pr. 45 are valid when the RT signal is on.**
  When the RT signal is on, the other second functions (Pr. 450 to Pr. 463, Pr. 815, Pr. 830 to Pr. 837) are also valid.
- **Pr. 110 and Pr. 111 are valid when the X9 signal is on.**
  When the X9 signal is on, Pr. 820 to Pr. 827 are also valid.
- **When both RT and X9 are on, Pr. 110 and Pr. 111 are valid.**
- **Switching the RT and X9 signals during operation does not change the acceleration/deceleration time imediately when position control is exercised with the conditional position control function (Pr. 419 = "0") by the contact input.**

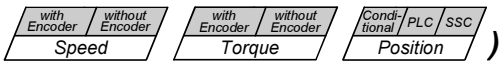
REMARKS

- Changing the Pr. 20 "acceleration/deceleration reference speed" setting does not adjust the speed gain setting signal. To adjust the gain, adjust the calibration function (Pr. 903).
- When the setting of Pr. 7, Pr. 8, Pr. 44, Pr. 45, Pr. 110 or Pr. 111 is "0" under V/F control, the acceleration/deceleration time is 0.04s.
- However short the acceleration/deceleration time setting is, the actual motor acceleration/deceleration time cannot be made shorter than the shortest acceleration/deceleration time that is determined by the mechanical system J (inertia moment) and the motor torque.

Related parameters

- Jog acceleration/deceleration time ⇒ Pr. 16 "jog acceleration/deceleration time" (Refer to page 98.)
- RT signal, X9 signal setting ⇒ Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)

4.3.6 Motor overheat protection (Pr. 9, Pr. 452, Pr. 876)



When an external thermal relay is not used, protect the motor from overheat by integration processing of the inverter output current. This feature provides the optimum protective characteristics, including reduced motor cooling capability, at low speed.

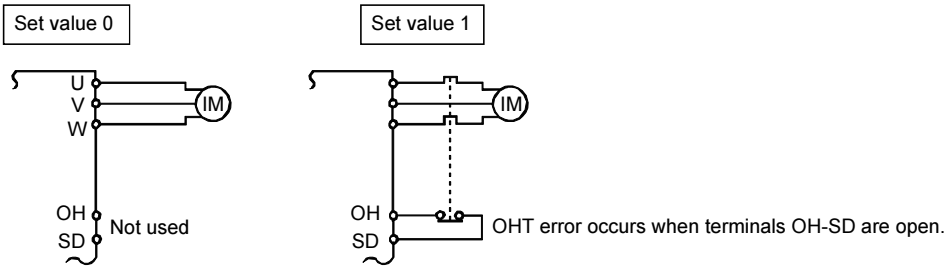
Parameter	Name	Factory Setting	Setting Range	Remarks
9	Electronic thermal O/L relay	Rated inverter output current	0 to 500A	Simple mode
452	Second electronic thermal O/L relay	9999	0 to 500A, 9999	Extended mode 9999: Without second electronic thermal relay function
876	Thermal relay protector input	0	0, 1	Extended mode

<Setting>

- When not using an external thermal relay, set the rated current value [A] of the motor in Pr. 9 (Pr. 452) to make the electronic thermal relay function valid.
- Setting "0" in Pr. 9 (Pr. 452) deactivates the electronic thermal relay function (motor protective function). (The inverter's output transistor protective function is activated.)
- When using the Mitsubishi constant-torque motor
  Set "10" in Pr. 71 "applied motor" to select the 100% continuous torque characteristic in the low speed range.
  Set the rated current of the motor in Pr. 9 "electronic thermal O/L relay".
- The electronic thermal relay function of the second motor (Pr. 452 "second electronic thermal O/L relay" is made valid by:
  Turning on the RT signal; and
  Setting other than 9999 in Pr. 450.
  (The value set in Pr. 9 is valid when Pr. 452 = 9999.)

● Selection for whether to use an external thermal relay or not (Pr. 876 "thermal relay protector input")

Pr. 876 Setting	Motor with encoder (e.g. SF-JR)
0	When thermal relay etc. is not used (thermal relay protector input invalid)
1 (factory setting)	When thermal relay etc. is used (thermal relay protector input valid)



CAUTION

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

REMARKS

- When running two motors with one inverter, you can set the electronic thermal relay function of each inverter.

Pr. 450 "second applied motor"	Pr. 9 "electronic thermal O/L relay"	Pr. 452 "second electronic thermal O/L relay"	First Motor Electronic Thermal Relay Function		Second Motor Electronic Thermal Relay Function	
			RT = OFF	RT = ON	RT = OFF	RT = ON
9999	0	9999	×	×	×	×
		0	×	×	×	×
		0.01 to 500	×	×	△	○
9999	Other than 0	9999	○	○	×	×
		0	○	△	×	×
		0.01 to 500	○	△	△	○
Other than 9999	0	9999	×	×	×	×
		0	×	×	×	×
		0.01 to 500	×	×	△	○
Other than 9999	Other than 0	9999	○	△	△	○
		0	○	△	×	×
		0.01 to 500	○	△	△	○

○... Output current value is used to perform integration processing.

△... Output current is assumed as 0A to perform integration processing. (cooling processing)

×... Electronic thermal relay function is not activated.

- It is valid for controlling one motor with one inverter in two different control systems.
- It is valid for controlling the first motor with an external thermal relay and the second motor with an electronic thermal relay function.

Related parameters

- When constant-torque motor is used ⇒ Pr. 71 "applied motor", Pr. 450 "second applied motor" (Refer to page 123.)
- Use of second motor ⇒ Pr. 450 "second applied motor" (Refer to page 123.)
- RT signal setting ⇒ Set "3" in any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection). (Refer to page 163.)

4.4 Standard operation functions (Pr. 10 to Pr. 16)

4.4.1 DC injection brake operation (Pr. 10, Pr.11 with Encoder / without Encoder: Speed, with Encoder / without Encoder: Torque, Pr. 12 ~~with Encoder~~ / without Encoder: Speed, ~~with Encoder~~ / without Encoder: Torque, Pr.802 with Encoder / without Encoder: Speed, Conditional / PLC / SSC: Position, Pr. 850 ~~with Encoder~~ / without Encoder: Speed)

By setting the DC injection brake voltage (torque) at a stop, operation time and operation starting speed, the stopping accuracy of positioning operation, etc. or the timing of applying the DC injection brake to stop the motor is adjusted according to the load.

Parameter	Name	Factory Setting	Setting Range	Remarks	
10	DC injection brake operation speed	15r/min	0 to 1500 r/min, 9999	9999: Operated at or below Pr. 13 value.	Extended mode
11	DC injection brake operation time	0.5s	0 to 0.5s		
12	DC injection brake voltage	1%	0 to 30%	Use during V/F control and vector control without encoder.	
802	Pre-excitation selection	0	0, 1	Use during speed control under vector control with encoder.	
850	Brake operation selection for vector control without encoder	0	0, 1	Use during speed control under vector control without encoder	

<Setting>

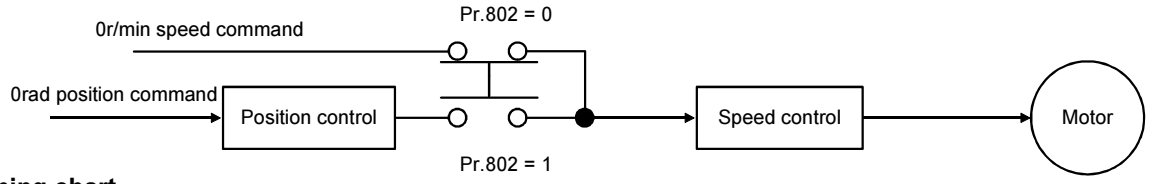
- Use Pr. 10 to set the speed at which the DC injection brake application is started.
  By setting "9999", the brake is operated at or below the speed set in Pr. 13.
- When stopping the motor by using a STOP key or turning the STF/STR off, the DC injection brake application is started at the speed set in Pr.10. When stopping the motor by setting speed to 0r/min (with PU or Volume), the DC injection brake application is started at the speed set in Pr.13.
- Use Pr. 11 to set the duration period the brake is applied. During this period, DC injection brake operation is exercised.
  When this period has elapsed, the motor is coasted to a stop.
- Use Pr. 12 to set the percentage to the power supply voltage. (Use this parameter only during V/F control.)

1) Vector control with encoder

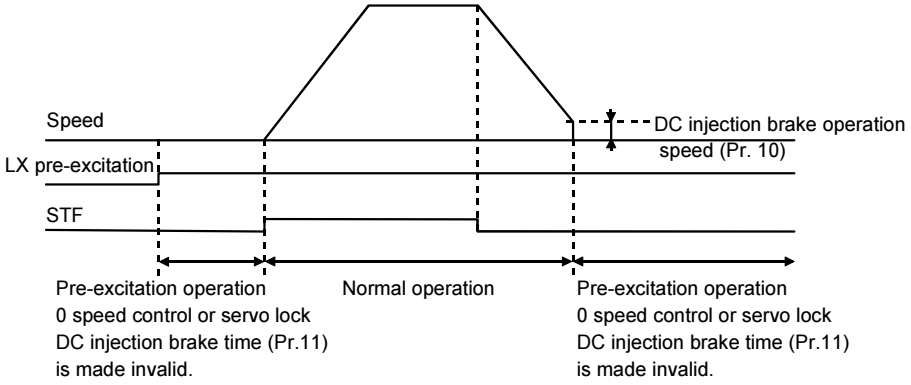
Select either 0 speed control or servo lock control for brake operation when pre-excitation is performed with the LX signal using Pr.802.
Turning on the LX signal enables the pre-excitation operation. (valid only during speed control)

Parameter	Name	Description
802	Pre-excitation selection	0: 0 speed control (factory setting) Even under load, an attempt is made to maintain 0r/min to keep the motor shaft stopped. Note that if the shaft is overcome and turned by external force, it does not return to the original position. Position control is not exercised and only speed control is carried out to perform operation.
		1: Servo lock Even under load, an attempt is made to maintain the motor shaft position. Note that if the shaft is turned by external force, it returns to the original position after the external force has gone away. Since position control is exercised, you can adjust this position loop gain using Pr. 422 "position loop gain".

● **The control block diagram during pre-excitation**



● **Timing chart**



* When the LX (pre-excitation) terminal is off, the pre-excitation operation functions for the time set in the DC injection brake operation time (Pr. 11).

CAUTION

The DC injection brake functions during speed restriction under speed control or torque control. (It does not function under position control.)

2) Vector control without encoder

For brake operation during deceleration to a stop at the speed less than Pr.10 "DC injection brake operation speed", select either zero speed control for vector control with encoder or DC brake operation for magnetic flux vector control.

CAUTION

This setting is made invalid when the start signal is turned on with the set speed less than Pr. 13 "starting speed" and brake operation under 0 speed control is performed.

Parameter	Name	Description
850	Brake operation selection for vector control without encoder	0: DC injection brake with current control (factory setting) When the speed has reached the DC injection brake operation speed (Pr. 10), brake operation is performed by applying the voltage set in Pr. 12 "DC injection brake voltage" against input voltage for the period set in Pr. 11 "DC injection brake voltage". 1: 0 speed control Same control as for vector control with encoder. (servo lock is not enabled)

● **Relationship between DC injection brake operation and pre-excitation operation in each control mode**

Control Mode	Operation			
	LX terminal OFF (Deceleration to stop)		LX terminal ON	
	Pre-excitation selection Pr. 802 = 0	Pre-excitation selection Pr. 802 = 1	Pre-excitation selection Pr. 802 = 0	Pre-excitation selection Pr. 802 = 1
V/F control	DC injection brake	DC injection brake	No operation	No operation
Speed control (vector control with encoder)	0 speed control	Servo lock	0 speed control	Servo lock
Speed control (vector control without encoder)	0 speed control	0 speed control	0 speed control	0 speed control
Position control (vector control with encoder)	No operation	No operation	Servo lock	Servo lock

⚠CAUTION

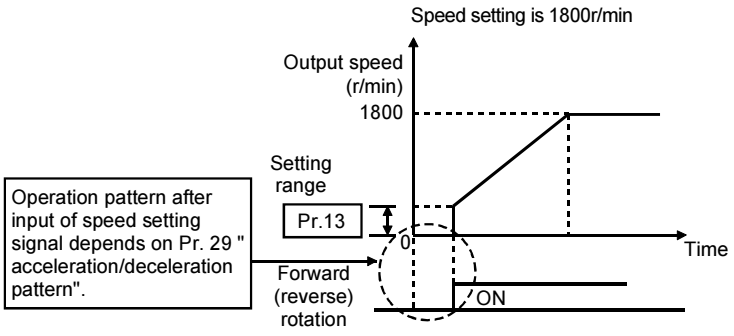
⚠ **Install a mechanical brake.**
After the machine stops fully and the mechanical brake is applied, switch the LX signal (pre-excitation) off.

Related parameters

- DC injection brake operation speed when Pr. 10 = 9999 ⇒ Pr. 13 "starting speed" (Refer to page 97.)
- Motor setting when using constant-torque motor ⇒ Pr. 71 "applied motor", Pr. 450 "second applied motor"(Refer to page 123.)
- Setting control mode ⇒ Pr. 800 "control system selection" (Refer to page 182.)
- LX signal terminal assignment ⇒ Set "23" in any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection). (Refer to page 163.)

4.4.2 Starting speed (Pr. 13 with Encoder / without Encoder Speed with Encoder / without Encoder Torque)

You can set the starting speed at which the start signal is turned on.



Parameter	Name	Factory Setting	Setting Range	Remarks
13	Starting speed	15r/min	0 to 1500r/min	Extended mode

CAUTION

- **If the speed setting signal is less than the value set in Pr. 13 "starting speed", the operation is either 0 speed or servo lock.**
  For example, when 150r/min is set in Pr. 13, the motor will start running when the speed setting signal reaches 150r/min.
- **When the analog voltage command (example: across 2-5) is used as speed for operation, too low of a setting of the rotation speed at a start may start the motor running by merely entering the start signal although the voltage command is zero. In this case, adjustment can be made using the calibration function, Pr. 902.**

⚠CAUTION

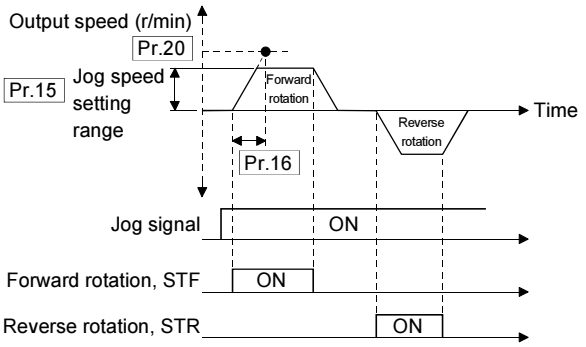
⚠ **When the Pr. 13 setting is equal to or less than Pr. 2 "minimum speed" value, note that the motor will start running at the preset speed by merely turning the start signal on, even if the command speed has not been entered.**

Related parameters

- Minimum speed setting ⇒ Pr. 2 "minimum speed" (Refer to page 89.)
- Acceleration/deceleration pattern setting ⇒ Pr. 29 "acceleration/deceleration pattern" (Refer to page 102.)
- Adjustment for analog voltage command ⇒ Pr. 902 "speed setting No. 2 bias" (Refer to page 202.)

4.4.3 Jog operation (Pr. 15, Pr. 16 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque *)*

To start/stop jog operation in the external operation mode, choose the jog operation function in input terminal function selection, turn on the jog signal, and turn on/off the start signal (STF, STR).
When using the parameter unit (FR-PU04V), choose the jog operation mode and use FWD or REV to perform jog operation.
(When the FR-PU04V is connected, these parameters can be read as the basic parameters.)
Perform PU JOG operation using PU (FR-DU04-1, FR-PU04V) in the PU-JOG operation mode.



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

Parameter	Name	Factory Setting	Setting Range	Remarks	
15	Jog speed setting	150r/min	0 to 1500r/min	————	Extended mode
16	Jog acceleration/ deceleration time	0.5s	0 to 3600s	When Pr. 21=0	
			0 to 360s	When Pr. 21=1	

REMARKS

For the operation method from the operation panel (FR-DU04-1), refer to the Instruction Manual (basic).

CAUTION

- **The acceleration time and deceleration time cannot be set separately for jog operation.**
- **Pr. 15 "jog speed setting" value should be equal to or higher than Pr. 13 "starting speed" setting.**
- **Assign the jog signal to any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection).**
- **The priorities of the external terminals for speed commands are: Jog > multi-speed operation > No. 2 terminal**
- **During jog operation, the RT and X9 signals cannot be used to switch to the second and third acceleration/deceleration time.**
- **Under torque control, the jog speed acts as the speed restriction value by turning on the jog signal.**
- **Jog operation is invalid under position control.**

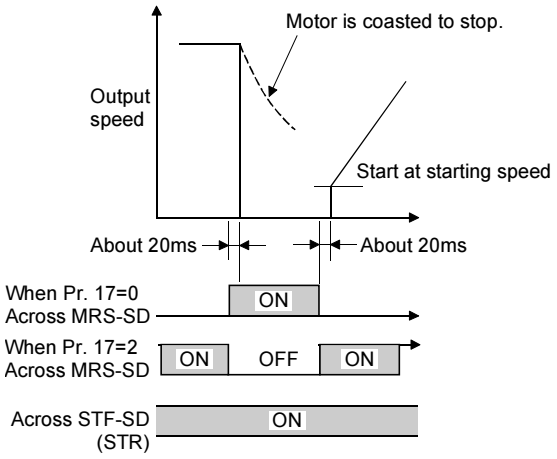
Related parameters

- Jog signal terminal assignment ⇒ Set "5" in any of Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)
- S-shaped acceleration/deceleration pattern A ⇒ Pr. 29 "acceleration/deceleration pattern" (Refer to page 102.)
- Pr. 16 setting range, minimum setting increments condition setting ⇒ Pr. 21 "acceleration/deceleration time increments" (Refer to page 91.)

4.5 Operation selection functions 1 (Pr. 17 to Pr. 37)

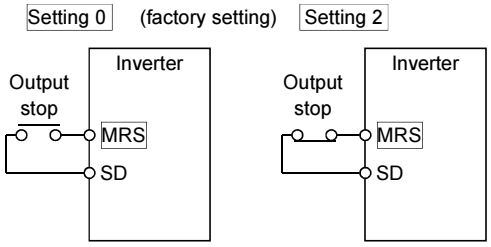
4.5.1 Inverter output stop (MRS) (Pr. 17 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque; Conditional / PLC / SSC: Position *)*

The setting of this parameter needs to be changed to:
- Stop the motor with a mechanical brake (e.g. electromagnetic brake);
- Provide interlocks to prevent the inverter from running if the start signal is input to the inverter; or
- Coast the motor to a stop.



Parameter	Name	Factory Setting	Setting Range	MRS Signal Specifications	Remarks
17	MRS input selection	0	0	Output stops when MRS signal turns on.	Extended mode
			2	Output stops when MRS signal turns off. (b contact input specifications)	

<Wiring example> For sink logic



REMARKS

- Set the MRS signal using the input terminal function selection (Pr. 180 to Pr. 183, Pr. 187).
- The setting cannot be changed during operation.
- Refer to page 218 for inverter reset.

CAUTION

- **When the operation mode is the NET mode and Pr. 338 = 0, the MRS signal is used as both the external terminal and communication-based signals, and the output stops when either signal turns on. At the Pr. 17 setting of 2, the output stops when either signal turns off. (Oppositely, at the Pr. 17 setting of 2, both the external terminal and communication-based signals should turn on to make a start.)**

Related parameters

- Starting speed setting ⇒ Pr. 13 "starting speed" (Refer to page 97.)
- MRS signal terminal assignment ⇒ Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)

Pr. 19 ➡ Refer to Pr. 3 (page 90)

Pr. 20, Pr. 21 ➡ Refer to Pr. 7, Pr. 8 (page 91)

4.5.2 Torque restriction (Pr. 22 [with Encoder / without Encoder: Speed] [Conditional / PLC / SSC: Position], Pr. 803 [with Encoder / without Encoder: Speed] [with Encoder / without Encoder: Torque] [Conditional / PLC / SSC: Position], Pr. 810 [with Encoder / without Encoder: Speed] [Conditional / PLC / SSC: Position], Pr. 812 to Pr. 817 [with Encoder / without Encoder: Speed] [Conditional / PLC / SSC: Position])

Used to restrict the output torque to the predetermined value during speed control.
For details of the setting method, refer to the torque restriction of the Instruction Manual (basic).

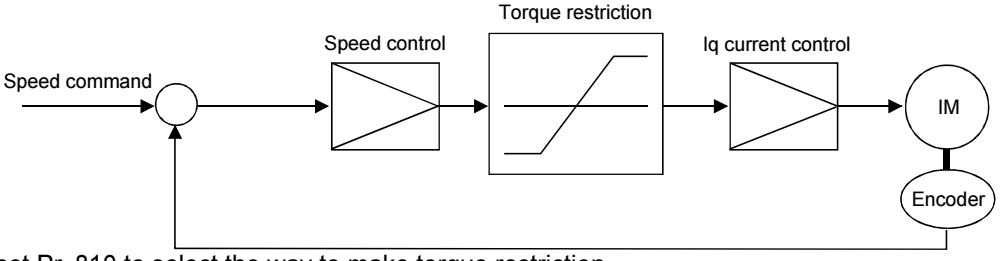
Parameter	Name	Factory Setting	Setting Range	Remarks	
22	Torque restriction level (*1)	150%	0 to 400%	When Pr. 810 = 0, 1 quadrant Pr. 22 2 quadrant Pr. 812 3 quadrant Pr. 813 4 quadrant Pr. 814	Extended mode
803	Constant output region torque characteristic selection	0	0	Constant output restriction (torpue current restricyion and control)	
			1	Constant torque restriction (torpue restricyion and control(*3))	
810	Torque restriction input method selection	0	0	Internal torque restriction Parameter-set torque restriction operation is performed.	
			1	External torque restriction Speed restriction based on the analog voltage from the terminal 3	
812	Torque restriction level (regeneration)	9999	0 to 400%, 9999	Valid in the regeneration mode when Pr. 810 = 0. 9999: Pr. 22 value is used for restriction.	
813	Torque restriction level (3rd quadrant)	9999	0 to 400%, 9999	Valid in the reverse rotation driving mode when Pr. 810 = 0. 9999: Pr. 22 value is used for restriction.	
814	Torque restriction level (4th quadrant)	9999	0 to 400%, 9999	Valid in the regeneration mode when Pr. 810 = 0. 9999: Pr. 22 value is used for restriction.	
815	Torque restriction level 2	9999	0 to 400%, 9999	When the torque restriction selection (TL) signal is on, Pr. 815 is used as the torque restriction value regardless of Pr. 810. Valid when torque restriction selection (TL) terminal input is provided. 9999: Depending on Pr. 22 setting	
816	Acceleration torque restriction level (*2)	9999	0 to 400%, 9999	Set the torque restriction value during acceleration. 9999: Same torque restriction as at constant speed	
817	Deceleration torque restriction level (*2)	9999	0 to 400%, 9999	Set the torque restriction value during deceleration. 9999: Same torque restriction as at constant speed	

CAUTION

***1.Output current level (stall prevention function) is activated to prevent the inverter from alarm stop due to overcurrent etc. during V/F control. When "0" is set in Pr. 22, stall prevention function is invalid.**
***2.Pr. 816 "acceleration torque restriction level" and Pr. 817 "deceleration torque restriction level" are invalid during position control.**
***3.For torque restriction and torque control, torque is restricted and controled not by magnetic flux.**

<Details>

Torque restriction is activated so that the output torque does not exceed the predetermined value during speed control. The block diagram is shown below. The output of speed control is suppressed within the torque restriction value.



At this time, set Pr. 810 to select the way to make torque restriction.

<Setting>

Pr. 810 Setting	Torque Restriction Input Method	Operation
0	Internal torque restriction	Parameter-set torque restriction operation is performed. Changing the torque restriction parameter value by communication enables torque restriction to be adjusted by communication.
1	External torque restriction	Torque restriction using the analog voltage from the terminal 3 is made valid.

REMARKS

Refer to the Instruction Manual (basic) for details of the other parameters.

CAUTION

Whether the torque restriction in the constant output range is set to constant torque restriction or constant output restriction in the torque restriction setting depends on the setting of Pr. 803 "constant output range torque characteristic selection".

Related parameters

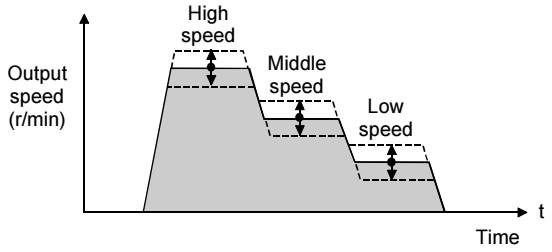
- Torque command bias adjustment ⇒ Pr. 904 "torque command No. 3 bias" (Refer to page 202.)
- Torque command gain adjustment ⇒ Pr. 905 "torque command No. 3 gain" (Refer to page 202.)

Pr. 24 to Pr. 27 ➡ Refer to Pr. 4 to Pr. 6 (page 90)

4.5.3 RH, RM, RL signal input compensation (Pr. 28 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque)

By entering 0 to ±10V into terminal 1 (speed setting auxiliary terminal), the speeds of the RH, RM and RL signals (command speeds for multi-speed operation) can be compensated for.

Parameter	Name	Factory Setting	Setting Range	Description	Remarks
28	Multi-speed input compensation	0	0	Without compensation	Extended mode
			1	With compensation	



CAUTION

- **When "4 or 14" is set in Pr. 73, the compensation signal is input from terminal 2, not from terminal 1. (Override function)**
- **Since terminal 1 is a multi-function selection terminal, its function varies with the Pr. 868 setting. Set "0" in Pr. 868. Refer to Pr. 902 and Pr. 903 for calibration of the terminal 1.**

Related parameters

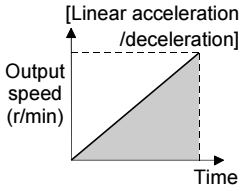
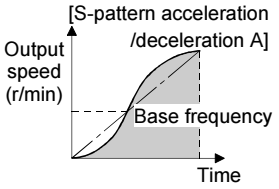
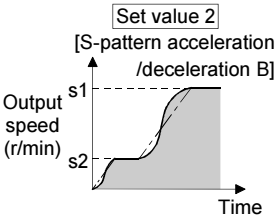
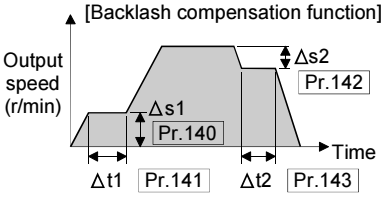
- Multi-speed setting ⇒ Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 232 to Pr. 239 (multi-speed setting) (Refer to page 90.)
- RH, RM, RL signals⇒ Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)
- Speed compensation using terminal 2 ⇒ Pr. 73 "speed setting signal" (Refer to page 125.)
- Function assignment to terminal 1 ⇒ Set "0" in Pr. 868 "No. 1 terminal function assignment" (Refer to page 195.)
- Pr. 59 "remote setting function selection" ⇒ Refer to page 116.
- Calibration of terminal 1 ⇒ Pr. 902 "speed setting No. 2 bias", Pr. 903 "speed setting No. 2 gain" (Refer to page 202)

4.5.4 S-pattern acceleration/deceleration curve (Pr. 29, Pr. 140 to Pr. 143, Pr. 380 to Pr. 383)

When you have changed the preset speed during start, acceleration, deceleration, stop, or operation, you can change the running speed by acceleration/deceleration to make adjustment to reach the preset speed. Set the acceleration/deceleration pattern in Pr. 29 "acceleration/deceleration pattern".

Parameter	Name	Factory Setting	Setting Range	Remarks	
29	Acceleration/ deceleration pattern	0	0	Linear acceleration/deceleration	Extended mode
			1	S-pattern acceleration/deceleration A	
			2	S-pattern acceleration/deceleration B	
			3	Backlash compensation acceleration/ deceleration	
			4	S-pattern acceleration/deceleration C	
140	Backlash acceleration stopping speed	30r/min	0 to 3600r/min	Accessible when Pr. 29 = 3	
141	Backlash acceleration stopping time	0.5s	0 to 360s		
142	Backlash deceleration stopping speed	30r/min	0 to 3600r/min		
143	Backlash deceleration stopping time	0.5s	0 to 360s		
380	Acceleration S pattern 1	0%	0 to 50%	Accessible when Pr. 29 = 4	
381	Deceleration S pattern 1	0%	0 to 50%		
382	Acceleration S pattern 2	0%	0 to 50%		
383	Deceleration S pattern 2	0%	0 to 50%		

<Setting>

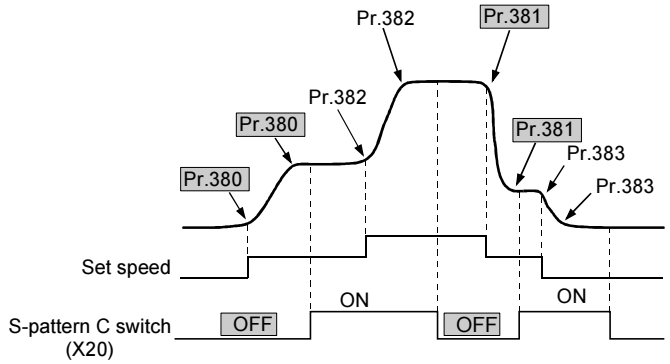
Pr. 29 Setting	Function	Description	Operation
0	Linear acceleration/ deceleration (factory setting)	Acceleration/deceleration is made linearly up/down to the preset speed .	
1	S-pattern acceleration/ deceleration A (torque variation technique)	The motor torque is utilized effectively to make fast acceleration/deceleration in a large motor-generated torque area and smooth acceleration/deceleration in a small motor-generated torque area. In this acceleration/deceleration pattern, the base frequency is the inflection point of an S shape, and you can set the acceleration/deceleration time according to the reduction in motor torque in the constant-output operation range at higher than the rated speed. This function is valid for V/F control only. For other than V/F control, linear acceleration/deceleration is made. **CAUTION** **As the acceleration/deceleration time, set the time taken to reach Pr. 3 "base frequency", not Pr. 20 "acceleration/deceleration reference speed".**	
2	S-pattern acceleration/ deceleration B (shock absorption)	Prevention of cargo collapse on conveyor, etc. This setting always provides S-pattern acceleration/ deceleration from s2 (current speed) to s1 (preset speed), easing an acceleration/deceleration shock and producing an effect on the prevention of cargo collapse, etc.	
3	Backlash compensation acceleration/ deceleration	Backlash compensation for reduction gear, etc. This function stops a speed change temporarily during acceleration/deceleration, reducing a shock generated when a reduction gear backlash is eliminated suddenly. Use Pr. 140 to Pr. 143 to set the stopping times and stopping speed in accordance with the chart on the right. The acceleration/deceleration time is increased by the stopping time. **REMARKS** Output speed is retained for the time for the starting speed (Pr. 13) and ∆s1 (Pr. 140) time at a start and accelerate again after ∆t1 time has elapsed. Speed reaches or below ∆s2 (Pr. 142) is retained for ∆t2 (Pr. 143) time at a start of deceleration and decelerate again after ∆t2 time has elapsed.	
4	S-pattern acceleration/ deceleration C	See next page.	See next page.

REMARKS

For the acceleration/deceleration time, turning on the RT signal makes Pr. 44 "second acceleration/deceleration time" and Pr. 45 "second deceleration time" valid (turning on the X9 signal makes Pr. 110 and Pr. 111 valid). Refer to page 91.

Pr. 29 = 4 (S-pattern acceleration/deceleration C)

The S-pattern acceleration/deceleration C switch signal (X20) changes an acceleration/deceleration curve.



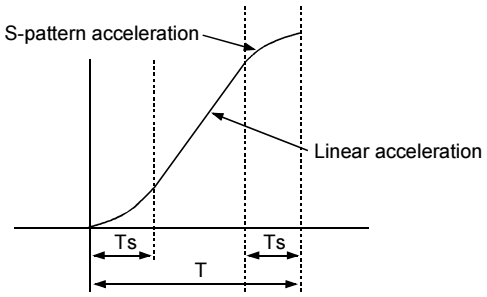
CAUTION

Change the S pattern acceleration/ deceleration C switch (X20) after the speed becomes constant. S pattern operation before switching continues even if the X20 is changed during acceleration or deceleration.

Operation / X20 Signal	During Acceleration	During Deceleration
OFF	Pr. 380 "acceleration S pattern 1"	Pr. 381 "deceleration S pattern 1"
ON	Pr. 382 "acceleration S pattern 2"	Pr. 383 "deceleration S pattern 2"

As the acceleration/deceleration time during acceleration/deceleration, set the percentage to the acceleration/ deceleration time T in Pr. 380 to Pr. 383.

Parameter setting (%) = Ts / T ×100%



REMARKS

- At a start, the motor starts at Pr. 13 "starting speed" when the start signal turns on.
- If there is a difference between the speed command and speed at a start of deceleration due to torque restriction operation etc., the speed command is matched with the speed to make deceleration.

Related parameters

- Base frequency setting (acceleration/deceleration time setting) ⇒ Pr. 3 "base frequency" (Refer to page 90.)
- X20 signal setting when Pr. 29 = 4 (S-pattern acceleration/deceleration switch) ⇒ Pr. 180 to Pr. 187 (input terminal function selection) (Refer to page 163.)
- Starting speed setting ⇒ Pr. 13 "starting speed" (Refer to page 97.)
- Pr. 20 "acceleration/deceleration reference speed" ⇒ Refer to page 91.

4.5.5 Regenerative brake duty (Pr. 30, Pr. 70 with Encoder / without Encoder Speed; with Encoder / without Encoder Torque; Conditional / PLC / SSC Position)

- When making frequent starts/stops in a 15K or less inverter, use the external high-duty brake resistor to increase the regenerative brake duty.

Parameter	Name	Factory Setting	Setting Range	Remarks	
30	Regenerative function selection	0	0	When using built-in brake resistor or brake unit (FR-BU-C)	Extended mode
			1	When using the high-duty brake resistor	
			2	Maker setting value. Do not make setting.	
70	Special regenerative brake duty	0%	0 to 15%	1.5K	
			0 to 30%	2.2K or more	

<Setting>

1) When using the built-in brake resistor, brake unit or power regeneration converter

Set "0" in Pr. 30. The Pr. 70 setting is made invalid.

At this time, the regenerative brake duty is as follows.

- •FR-V560-7.5K or less 2%
- •FR-V560-15K or more..... 0%

2) When using the high-duty brake resistor

- Set "1" in Pr. 30.
- Set Pr.70 "special regenerative brake duty" as follows:

  7.5K or less 10%

  11K or more . . .6%

⚠WARNING

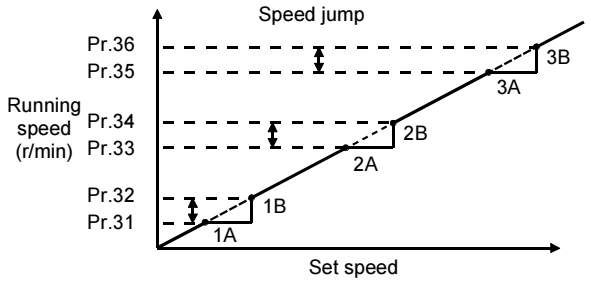
⚠ **The value set in Pr. 70 must not exceed the setting of the brake resistor used. Otherwise, the resistor can overheat.**

REMARKS

1. The Pr. 70 setting is invalid for the inverter of 22K or more.
2. Pr. 70 "regenerative brake duty" indicates the %ED of the built-in brake transistor operation.

4.5.6 Speed jump (Pr. 31 to Pr. 36 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque *)*

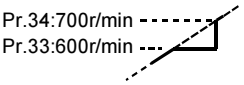
When it is desired to avoid resonance attributable to the natural frequency of a mechanical system, these parameters allow resonance occurrence speeds to be jumped. Up to three areas may be set, with the jump speeds set to either the top or bottom point of each area.
The value set to 1A, 2A or 3A is a jump point and operation is performed at this speed.



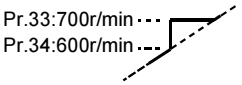
Parameter	Name	Factory Setting	Setting Range	Remarks
31	Speed jump 1A	9999	0 to 3600r/min, 9999	• 9999: Function invalid • Extended mode
32	Speed jump 1B	9999	0 to 3600r/min, 9999	
33	Speed jump 2A	9999	0 to 3600r/min, 9999	
34	Speed jump 2B	9999	0 to 3600r/min, 9999	
35	Speed jump 3A	9999	0 to 3600r/min, 9999	
36	Speed jump 3B	9999	0 to 3600r/min, 9999	

<Setting>

- To fix the speed at 600r/min between Pr. 33 and Pr. 34 (600r/min and 700r/min), set 600r/min in Pr. 33 and 700r/min in Pr. 34.



- To jump to 700r/min between 600r/min and 700r/min, set 700r/min in Pr. 33 and 600r/min in Pr. 34.



CAUTION

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

REMARKS

If the speed jump setting ranges overlap, a write disable error " Err " appears.

4.5.7 Speed display (Pr. 37, Pr. 144 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque; Conditional / PLC / SSC: Position *)*

The units of the running speed monitor display of the PU (FR-DU04-1/FR-PU04V), the running speed/ frequency setting in the PU operation mode, and the parameter setting unit used for frequency setting can be changed from the frequency to the motor speed or machine speed.

Parameter	Name	Factory Setting	Setting Range	Remarks	
37	Speed display	0	0	Output speed	Extended mode
			1 to 9998		
144	Speed setting switchover	0	0, 2, 4, 6, 8, 10	Number of motor poles	

<Setting>

- To display the machine speed, set in Pr. 37 the machine speed for 1800r/min operation.
- To display the motor frequency, set the number of motor poles (2, 4, 6, 8, 10) in Pr. 144.
- When the running speed monitoring has been selected, the parameter setting unit and the running speed setting in the PU operation mode depend on the combination of the Pr. 37 and Pr. 144 settings as indicated below:

Pr. 37	Pr. 144	Running Speed Monitor	Preset Speed Monitor	Output Frequency Monitor	Running Speed Setting/Pr. Setting
0	0	r/min	r/min	Hz Pr. 81, Pr. 454	r/min
	2 to 10	Hz Pr. 144	Hz Pr. 144	Hz Pr. 144	Hz Pr. 144
1 to 9998	0	Machine speed Pr. 37	Machine speed Pr. 37	Hz Pr. 81, Pr. 454	r/min
	2 to 10	Machine speed Pr. 37	Machine speed Pr. 37	Hz Pr. 81, Pr. 454	Machine speed Pr. 37

CAUTION

1. **When Pr. 37 and Pr. 144 are combined to select the Hz setting, the number of poles set in Pr. 144 is used to calculate the frequency, independently of the number of motor poles (Pr. 81, Pr. 454) used for control.**
   Note this when the number of motor poles (Pr. 81, Pr. 454) differs from Pr. 144.
2. **When the speed setting has been selected, operation is performed at the synchronous speed.**
   When 4 poles and 60Hz are set, operation is performed at 1800r/min. For V/F control, the output frequency is 60Hz.
3. **To change the PU main monitor (PU main display) or PU level meter (PU level display), refer to Pr. 52 and Pr. 53.**
4. **As the operation panel display is 4 digits, "– – – –" is displayed when the monitored value exceeds "9999".**

⚠CAUTION

⚠ **Make sure that the settings of the running speed and number of motor poles are correct.**
Otherwise, the motor might run at extremely high speed, damaging the machine.

Related parameters

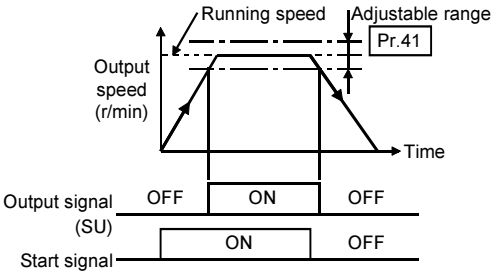
- PU main monitor changing ⇒ Pr. 52 "DU/PU main display data selection" (Refer to page 110.)
- PU level meter changing ⇒ Pr. 53 "PU level display data selection" (Refer to page 110.)
- Setting of number of motor poles ⇒ Pr. 81 "number of motor poles", Pr. 454 "number of second motor poles" (Refer to page 132.)

4.6 Output terminal functions (Pr. 41 to Pr. 50)

4.6.1 Up-to-speed sensitivity (Pr. 41 with Encoder / without Encoder Speed)

You can adjust the ON range of the up-to-speed signal (SU) output when the output speed reaches the running speed.
This parameter can be used to confirm that the running speed has been reached and used as the operation start signal etc. for related equipment.

- Under vector control with encoder: Actual motor speed (feedback value) is adjusted.
- Under vector control without encoder: Speed estimated valued is adjusted.



Parameter	Name	Factory Setting	Setting Range	Remarks
41	Up-to-speed sensitivity	10%	0 to 100%	Extended parameter

REMARKS

- Assign functions to the terminals DO1 to DO3 and ABC to use the SU signal. The SU signal is assigned to the terminal DO2 when shipped from the factory. Use any of Pr. 190 to Pr. 192 and Pr. 195 to change the terminal functions. Changing the terminal assignment with any of Pr. 190 to Pr. 192 and Pr. 195 may affect the other functions. Check the functions of the corresponding terminals before making setting. (Refer to page 165.)
- For V/F control, the motor runs at the speed converted from the output frequency.

Related parameters

- SU signal terminal assignment ⇒ Set "1" in any of Pr. 190 to Pr. 192 and Pr. 195 (output terminal function selection) (Refer to page 165.)

4.6.2 Speed detection (Pr. 42, Pr. 43, Pr. 50, Pr. 116 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque, Conditional / PLC / SSC Position)

When the speed reaches or exceeds the setting, the output speed detection signal (FU, FU2, FU3 signal) or speed detection signal (FB, FB2, FB3 signal) is output.

- This function can be used for electromagnetic brake operation, open signal, etc.
- You can also set speed detection used exclusively for reverse rotation.
- This function is effective for changing the timing of electromagnetic brake operation between forward rotation (rise) and reverse rotation (fall) during vertical lift operation, etc.
  - ●The FU signal is output when the speed has reached the output speed.
  - ●The FB signal is output when the speed has reached the detected actual motor speed (feedback value). (the estimated speed of the actual motor speed for vector control without encoder)

Parameter	Name	Factory Setting	Setting Range	Remarks	
42	Speed detection	300r/min	0 to 3600r/min	————	Extended parameters
43	Speed detection for reverse rotation	9999	0 to 3600r/min, 9999	9999: Same as Pr. 42 setting	
50	Second speed detection	750r/min	0 to 3600r/min	————	
116	Third speed detection	1800r/min	0 to 3600r/min	————	

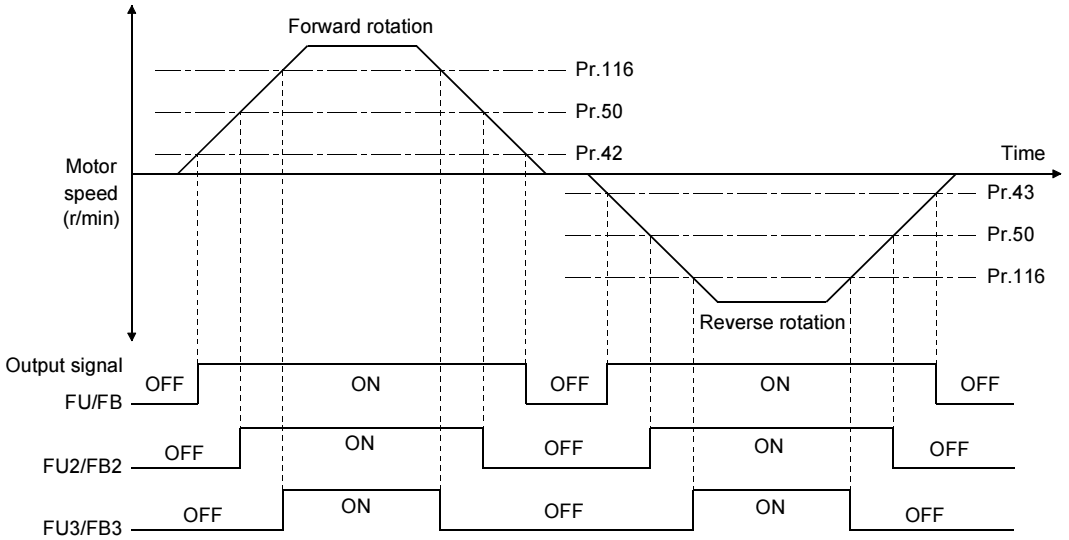
(1) Signal operation

The FU, FU2 and FU3 signals function under speed/V/F control. They do not function under torque/position control.

	FU	FB
Compared signals	**Speed command value**	**Actual motor speed**
FU/FB signal	Forward rotation: On when speed is equal to or higher than in Pr. 42 Reverse rotation: On when speed is equal to or higher than in Pr. 43	
FU2/FB2 signal	On when speed is equal to or higher than in Pr. 50 (both forward and reverse) Off when speed is lower than in Pr. 50 (both forward and reverse)	
FU3/FB3 signal	On when speed is equal to or higher than in Pr. 116 (both forward and reverse) Off when speed is lower than in Pr. 116 (both forward and reverse)	

REMARKS

For V/F control, on/off control is exercised at the speed converted from the output frequency. (The detection actions of the FU and FB signals are the same.)



REMARKS

The speed command value indicates the last speed command value given after acceleration/deceleration processing.

CAUTION

- **Assign functions to the terminals DO1 to DO3 and ABC to use the FU, FU2, FU3 and FB, FB2, FB3 signals. Use any of Pr. 190 to Pr. 192 and Pr. 195 to change the terminal functions. Changing the terminal assignment with Pr. 190 to Pr. 192 and Pr. 195 may affect the other functions. Check the functions of the corresponding terminals before making setting.**
- **The speed detection signal turns off when an inverter alarm occurs or when the reset terminal (MRS, RES signal) turns on.**
- **When any parameter setting is "0", the corresponding signal turns on as soon as the start signal turns on.**

Related parameters

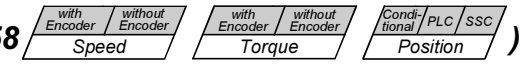
- FB, FB2, FB3, FU, FU2, FU3 signal terminal assignment ⇒ Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection) (Refer to page 165.)

Pr. 44, Pr. 45 ➡ Refer to Pr. 7, Pr. 8 (page 91)

Pr. 50 ➡ Refer to Pr. 42, Pr. 43 (page 108)

4.7 Display functions 1 (Pr. 52 to Pr. 56)

4.7.1 Monitor display/DA1, DA2 terminal function selection (Pr. 52 to Pr. 54, Pr. 158)



During operation, you can select the signals shown on the operation panel (FR-DU04-1)/parameter unit (FR-PU04V) main display screen and on the parameter unit (FR-PU04V) level meter and the signals output to the DA1 and DA2 terminals.

- There are two analog output DA1 and DA2 terminals. Select the signals using Pr. 54 and Pr. 158.

Parameter	Name	Factory Setting	Setting Range	Remarks
52	DU/PU main display data selection	0	0, 5 to 12, 17 to 20, 23, 24, 32 to 35, 38, 100 (5 to 12 are invalid for FR-PU04V)	Extended mode
53	PU level display data selection	1	0 to 3, 5 to 12, 17, 18	
54	DA1 terminal function selection	1	1 to 3, 5 to 12, 17, 18, 21, 32 to 34, 36	
158	DA2 terminal function selection	1	1 to 3, 5 to 12, 17, 18, 21, 32 to 34, 36	

<Setting>

Any of the following signals can be monitored by parameter setting.
The signals marked × cannot be selected for monitoring.

Signal Type	Display Unit	Parameter Settings					± Output	Full-Scale Value of the Level Meter Connected to DA1 and DA2	Description
		Pr. 52		Pr. 53	Pr. 54	Pr. 158			
		DU LED	PU main monitor	PU level meter	DA1 terminal 12 bits (±10V)	DA2 terminal 12 bits (+10V)			
No display	——	×	×	0	×			——	When "0" is set in Pr. 53, the level meter of the parameter unit is not displayed.
Speed	0.1 r/min	0/100	0/100	1	1		○	Pr. 55	**Vector control with encoder**: Speed feedback value from encoder **Vector control without encoder**: Speed estimation value **V/F control**: Speed calculated from output frequency
Output current	0.01A	0/100	0/100	2	2		×	Pr. 56	The output current is displayed as effective value.
Output voltage	0.1V	0/100	0/100	3	3		×	1000V	The output voltage is displayed as effective value.
Alarm display	——	0/100	0/100	×	×		×	——	————
Set speed	0.1 r/min	5	*2	5	5		×	Pr. 55	Under speed control, the current speed setting is displayed. 0r/min under position control.
Output frequency	0.01 Hz	6	*2	6	6		○	The frequency converted from Pr. 55	The output frequency is displayed.

Signal Type	Display Unit	Parameter Settings					± Output	Full-Scale Value of the Level Meter Connected to DA1 and DA2	Description
		Pr. 52		Pr. 53	Pr. 54	Pr. 158			
		DU LED	PU main monitor	PU level meter	DA1 terminal 12 bits (±10V)	DA2 terminal 12 bits (+10V)			
Motor torque	0.1%	7	*2	7	7		○	Pr. 866	The output torque is displayed. The ratio to the rated torque is displayed. When the DA1 output monitor is used, a positive voltage is output during forward driving and reverse regeneration and a negative voltage is output during reverse driving and forward regeneration.
Converter output voltage	0.1V	8	*2	8	8		×	1000V	DC bus voltage is displayed.
Regenerative brake duty	0.1%	9	*2	9	9		×	Pr. 70	The brake resistor duty is displayed.
Electronic overcurrent protection load factor	0.1%	10	*2	10	10		×	Thermal relay operation level	The thermal relay load factor is displayed.
Output current peak value	0.01A	11	*2	11	11		×	Pr. 56	The peak value of the output voltage is displayed as effective value.
Converter output voltage peak value	0.1V	12	*2	12	12		×	1000V	The peak value of DC bus voltage is displayed.
Input terminal status	——	×	*2	×	×		×	——	————
Output terminal status	——	×	*2	×	×		×	——	————
Load meter *1	0.1%	17	17	17	17		○	Pr. 866	The load meter is output.
Motor excitation current	0.01A	18	18	18	18		×	Pr. 56	Pre-excitation current is displayed.
Position pulse	——	19	19	×	×		×	——	The position of the motor output shaft is monitored.
Cumulative operation time	1h	20	20	×	×		×	——	Cumulative operation time since the inverter shipment (power on time) is displayed. (Minimum increment is Hr)
Reference voltage output	——	×	×	×	21		×	——	The voltage of DA1 and DA2 at full-scale is output
Actual operation time	1h	23	23	×	×		×	——	The inverter running time is accumulated. (The time during a stop is not accumulated.) It is cleared using Pr. 171 "actual operation hour meter clear".
Motor load factor	0.1%	24	24	×	×		×	——	The load factor to the rated motor capacity is displayed.
Torque command*1	0.1%	32	32	×	32		○	Pr. 866	The torque command value is displayed.
Torque current command*1	0.1%	33	33	×	33		○	Pr. 866	The torque current command value is displayed.
Motor output *1	0.01 kW (0.01 HP)	34	34	×	34		○	Rated motor current	The machine output of the motor shaft end is displayed.

Display functions 1 (Pr. 52 to Pr. 56)

Signal Type	Display Unit	Parameter Settings					± Output	Full-Scale Value of the Level Meter Connected to DA1 and DA2	Description
		Pr. 52		Pr. 53	Pr. 54	Pr. 158			
		DU LED	PU main monitor	PU level meter	DA1 terminal 12 bits (±10V)	DA2 terminal 12 bits (+10V)			
Feedback pulse	——	35	35	×	×		×	——	The number of pulses feed back during 1 sampling is displayed. Display range is 0 to 99999 pulses. Sampling time for the following number of encoder pulses are: 1.0s for 1500 pls/rev or less; 0.5s for 1501 to 3200 pls/rev; and 0.25s for 3201 to 4096 pls/rev.
Torque monitor (driving/ regenerative polarity switchover) *1	——	×	×	×	36		○	Pr. 866	The output torque is monitored. When the DA1 output monitor is used, a positive voltage is output during forward and reverse driving and a negative voltage is output during forward and reverse regeneration.
Trace status	——	38	38	×	×		×	——	The trace status is displayed. 0: Stop 1: During pre-trigger 2: Waiting for trigger 3: During trace 4: Trace completion 101: During data output 102: Data output completion

CAUTION

***1 When DA1 (Pr. 54) is selected, high responce output is available.**
When DA2 (Pr. 158) is selected, average value is output.
***2 Select this monitor in "Others" of the FR-PU04V (option).**

When "100" is set in Pr. 52, the monitored values during stop and during operation differ as indicated below. (The LED on the left of r/min flickers during stop, and is lit during operation.)

	Pr.52		
	0	100	
	During operation/ during stop	During stop	During operation
Speed	Speed	Set speed	Speed
Output current	Output current		
Output voltage	Output voltage		
Alarm display	Alarm display		

REMARKS

- During a reset, the values are the same as at a stop.
  During offline auto tuning, the tuning status monitor has priority.
- By setting "0" in Pr. 52, the monitoring of output speed to alarm display can be selected in sequence by the SHIFT key.
- *Speed setting to output terminal status on the PU main monitor are selected by "other monitor selection" of the parameter unit (FR-PU04V).
- When Pr. 52 = any of "17, 18 and 24", the output current monitor changes to the set monitored data.
  When Pr. 52 = any of "19, 20, 23 and 32 to 35, 38", the output voltage monitor changes to the set monitored data.

CAUTION

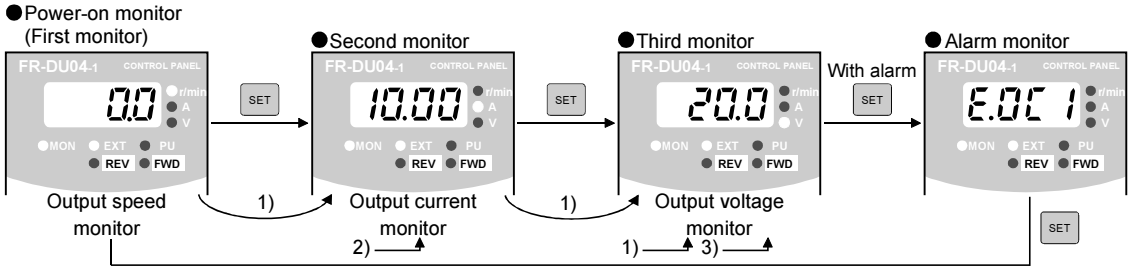
1. **The cumulative operation time and actual operation time are accumulated from 0 to 65535 hours, then cleared, and accumulated again from 0.**
   When the operation panel (FR-DU04-1) is used, more than 9999h is displayed as "– – – –".
   Use the parameter unit (FR-PU04V) to confirm more than 9999h.
2. **The cumulative operation time and actual operation time is not accumulated unless the inverter is run continuously for more than one hour.**
3. **When the operation panel (FR-DU04-1) is used, the display unit is r/min, V or A only.**

REMARKS

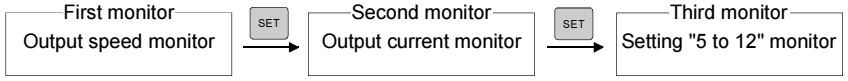
Where to monitor the data set in Pr. 52 varies with the setting.

Factory setting

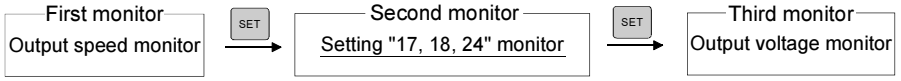
* The monitor displayed at powering on is the first monitor. To set the first monitor, press SET for more than 1.5s.



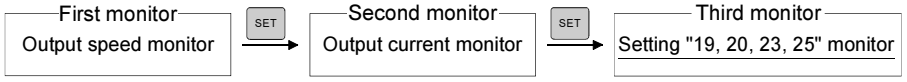
1) Setting is any of "5 to 12" (Displayed in the third monitor position)



2) Setting is any of "17, 18 and 24" (Displayed instead of output current monitor)



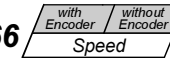
3) Setting is any of "19, 20, 23, 25" (Displayed instead of output voltage monitor)

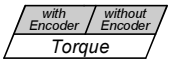


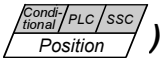
Related parameters

- Speed monitoring reference setting ⇒ Pr. 55 (Refer to page 113.)
- Current monitoring reference setting ⇒ Pr. 56 (Refer to page 113.)
- Torque monitoring reference setting ⇒ Pr. 866 (Refer to page 113.)
- Output filter of terminal DA1 ⇒ Pr. 867 (Refer to page 195.)

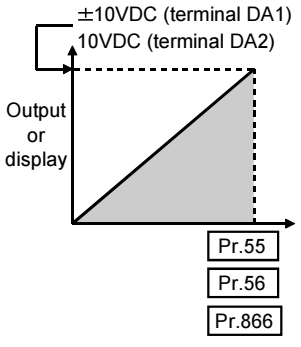
4.7.2 Monitoring reference (Pr. 55, Pr. 56, Pr. 866)







Set the value that is referenced when the output speed or output current is selected for the DA1 and DA2 terminals and PU level meter display.



Parameter	Name	Factory Setting	Setting Range	Remarks
55	Speed monitoring reference	1800r/min	0 to 3600r/min	Extended mode
56	Current monitoring reference	Inverter rated output current	0 to 500A	
866	Torque monitoring reference	150%	0 to 400%	

4.8 Automatic restart (Pr. 57, Pr. 58)

4.8.1 Automatic restart after instantaneous power failure

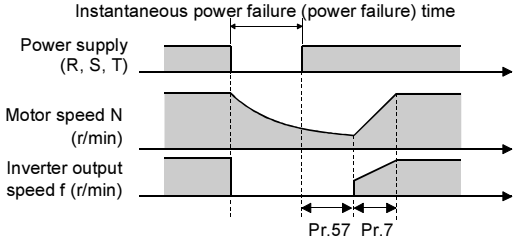
(Pr. 57 [with Encoder / without Encoder] Speed, [with Encoder / without Encoder] Torque , Pr. 58, Pr. 162 to Pr. 165 [~~with Encoder~~ / without Encoder] Speed, [~~with Encoder~~ / without Encoder] Torque)

You can restart the inverter without stopping the motor (with the motor coasting) when power is restored after an instantaneous power failure.

Parameter	Name	Factory Setting	Setting Range	Remarks		
57	Restart coasting time	9999	0	Set to 0.1s.		Extended mode
			0.1 to 5s			
			9999	9999: No restart		
58	Restart cushion time	1.0s	0 to 60s	Valid for V/F control		
162	Automatic restart after instantaneous power failure selection	0	0	0: With speed search	Valid for vector control without encoder and V/F control ("10" is valid for vector control with encoder also)	
			1	1: Without speed search		
			10	10: Speed search initiated per start		
163	First cushion time for restart	0s	0 to 20s	Valid for V/F control		
164	First cushion voltage for restart	0%	0 to 100%			
165	Restart current restriction level	150%	0 to 200%			

<When vector control with encoder is exercised>

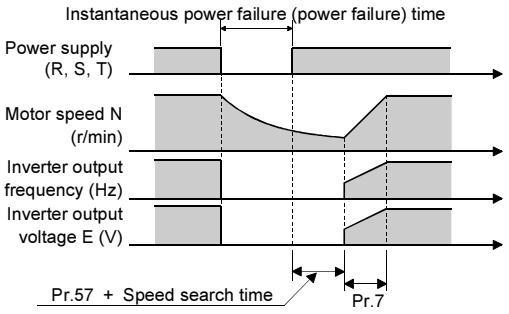
(The Pr. 162 setting "0, 1" is invalid under vector control with encoder.)



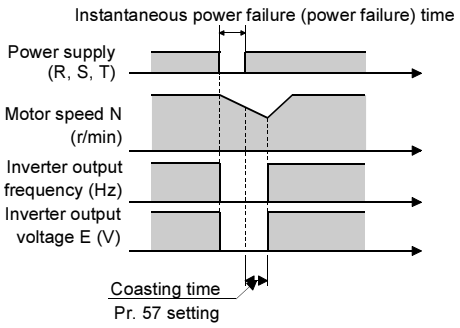
* 0r/min when search speed is 15r/min or less.
Pr.58 is invalid under vector control

<When vector control without encoder is exercised>

Pr. 162 = 0 (with speed search)

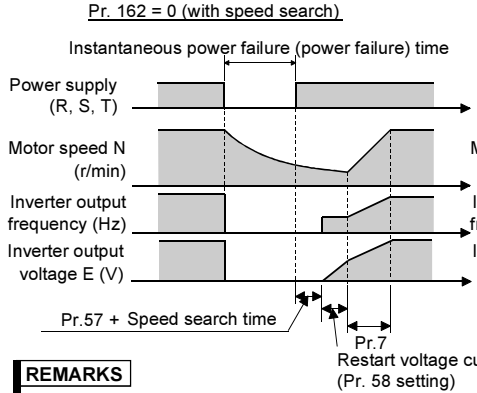


Pr. 162 = 1 (without speed search)

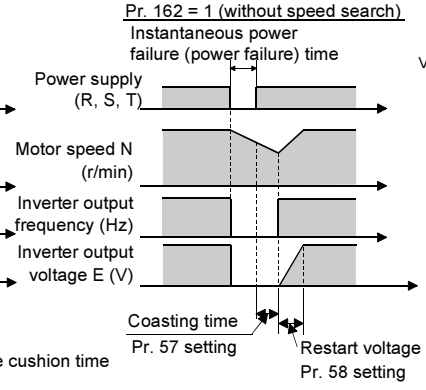


<When V/F control is exercised>

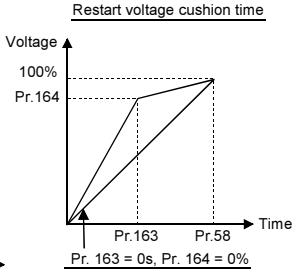
Pr. 162 = 0 (with speed search)



Pr. 162 = 1 (without speed search)



Restart voltage cushion time



REMARKS

When Pr. 162 = "1", the output speed before an instantaneous power failure is stored and output at the time of restart. If the power of the inverter control circuit is lost, the output speed berore an instantaneous power failure cannot be stored and the inverter will start at 0r/min.

<Setting>

Refer to the above figures and following table to set the corresponding parameters.

Parameter Number	Setting	Description
57	0	0.1s coasting time — This setting may be used without problem during vector control.
	0.1 to 5s	Waiting time for inverter-triggered restart after power is restored from an instantaneous power failure. (Set this time between 0.1s and 5s according to the inertia moment (J) and torque magnitude.) **REMARKS** • Recommended settings for Pr. 57 during vector control without encoder and V/F control are 1.0s for 2.2 to 7.5K, 3.0s for 15K or more. • The setting value does not include resetting time of the inverter.
	9999	Without restart
162	0	With speed search Speed search is made after detection of an instantaneous power failure.
	1	Without speed search Independently of the motor coasting speed, the output voltage is gradually increased with the speed kept as preset, i.e. a reduced voltage starting system. **REMARKS** Increase output voltage instantly under vector control without encoder.
	10	Speed search is made on startup. The motor starts running at the speed detected by the encoder under vector control with encoder.
58	0 to 60s	Normally the motor may be run with the factory settings, but restart or voltage cushion time are adjustable according to the load (inertia moment, torque) magnitude using Pr. 58, Pr. 163, or Pr. 164. Also the output frequency is reduced when the current flow exceeds the Pr. 165 setting. Invalid for vector control with encoder.
163	0 to 20s	
164	0 to 100%	
165	0 to 200%	

(1) To make automatic restart after instantaneous power failure valid.
Restart function after instantaneous power failure is made valid by setting a value other than "9999" in Pr. 57 "restart coasting time".
Time set in this Pr. 57 is the control start waiting time from power restoration to automatic restart.

(2) Selection of whether speed search is used or not (Pr. 162 "automatic restart after instantaneous power failure selection")
Smooth start at power restoration is available as required only during vector control without encoder and V/F control.

CAUTION

1. When Pr. 162 = "0" under V/F control, DC injection brake is applied for a moment at speed detection. Therefore speed may decrease if the inertia is small.
2. To start during coasting under vector control without encoder, set "10" (speed search initiated per start) in Pr. 162.

CAUTION

1. With speed search (Pr. 162= "0") under vector control without encoder or V/F control.
•When the inverter capacity is two rank or more larger than the motor capacity when Pr. 162="0" (with speed search), the inverter may not start due to overcurrent (OCT) alarm.
•Searchable speed is 3000r/min or less.
•Speed is regarded as 0r/min when the search speed is 150r/min or less.
2. The restart coasting time in Pr. 57 does not include the speed search time (300ms maximum). There is no delay time due to speed search when speed search is not made or vector control is exercised. (excluding the inverter starting time)
3. If two or more motors are connected to one inverter, the inverter functions abnormally. (The inverter does not start smoothly.)
4. When restart operation is selected, UVT and IPF among the alarm output signals are not output at occurrence of an instantaneous power failure.
5. The SU and FU signals are not output during restart but 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 the supplied CAUTION seals, provided for the Instruction Manual (basic), in easily visible places.
- **The motor coasts to a stop as soon as the start signal is turned off or STOP RESET is pressed during automatic restart cushion time.**

Related parameters

• Setting of alarm output signal for executing automatic restart after instantaneous power failure ⇒ Pr. 65 "retry selection" (Refer to page 121.)

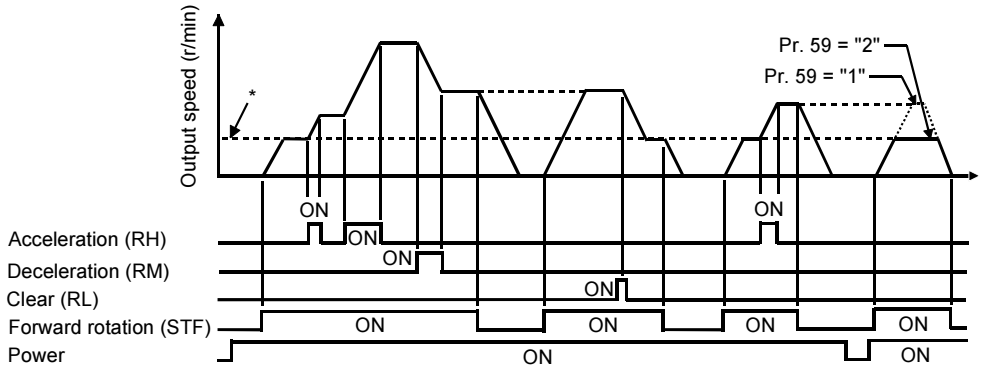
4.9 Additional functions (Pr. 59)

4.9.1 Remote setting function selection (Pr. 59 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque)

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

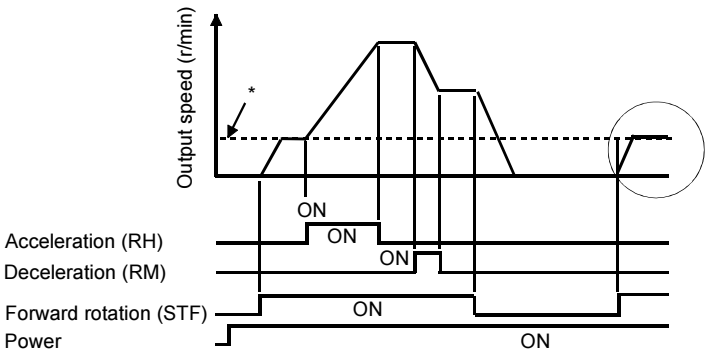
Parameter	Name	Factory Setting	Setting Range	Remarks	
59	Remote setting function selection	0	0	Remote function not activated.	Extended mode
			1	Remote function activated: Stored into E^2PROM.	
			2	Remote function activated: Not stored into E^2PROM.	
			3	Remote function activated: Not stored into E^2PROM. (Turn on STF (STR) to clear remote setting)	

(1) Pr. 59 = "1" or "2"



*External operation speed or PU operation speed other than multi-speed

(2) Pr. 59 = "3"



*External operation speed or PU operation speed other than multi-speed

REMARKS

- When the remote function is used, the output speed of the inverter can be compensated for as follows:
  For external operation, speed set by RH/RM operation plus external analog speed command
  For PU operation mode, speed set by RH/RM operation plus DU/PU digital setting speed
- When any value other than 0 is set in Pr. 59, multi-speed operation is invalid. (Refer to page 90.)
- Speed compensation by terminal 1 is made invalid when speed command by terminal 2 is selected.
  Set "1" in Pr. 28 "multi-speed input compensation" to enable speed compensation of terminal 1 (Pr. 28 = "0").

<Setting>

Use Pr. 59 to select whether the remote setting function is used or not and whether the speed setting storage function* in the remote setting mode is used or not. When "1" or "2" is set in Pr. 59, the functions of signals RH, RM and RL are changed to acceleration (RH), deceleration (RM) and clear (RL), respectively. Use Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection) to set signals RH, RM and RL.

* Speed setting storage function (Pr. 59 = "1")
This function stores the remotely-set speed (speed set by RH/RM operation) into memory. When power is switched off once, then on, operation is resumed with that output speed value.

<Speed setting storage conditions>

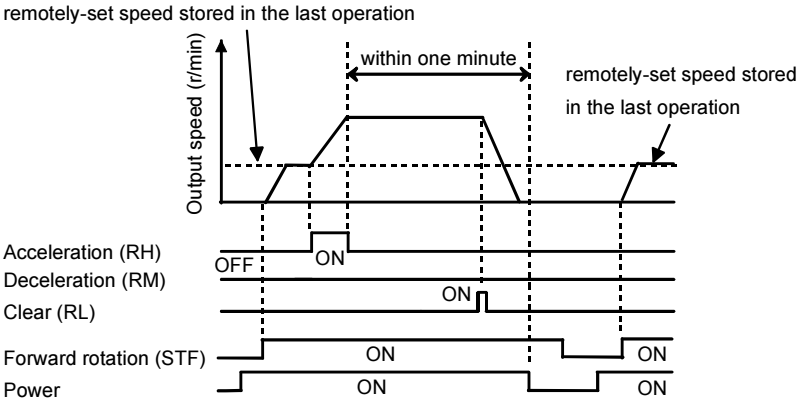
- Speed at which the start signal (STF or STR) turns off
- The remotely-set speed is stored every one minute after one minute has elapsed since turn off (on) of both the RH (acceleration) and RM (deceleration) signals. (The speed is written if the present speed value compared with the past speed value every one minute is different.) (The state of the RL signal dose not affect writing.)

REMARKS

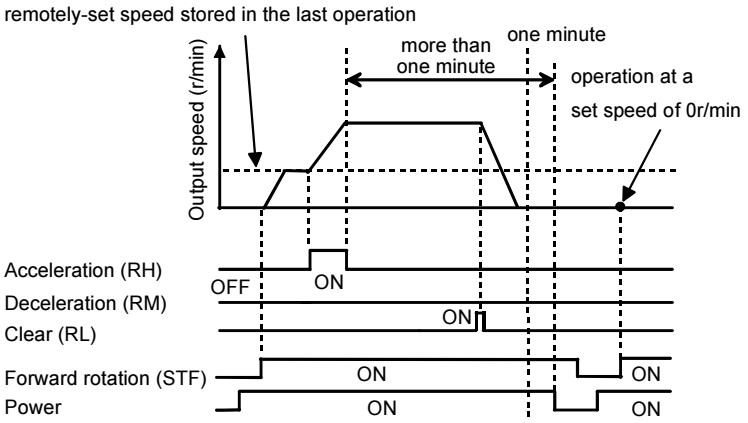
This function is invalid under jog operation and PID control operation.

Setting speed is "0"

Even when the remotely-set speed is cleared by turning on the RL (clear) signal after turn off (on) of both the RH and RM signals, the inverter operates at the remotely-set speed stored in the last operation if power is reapplied before one minute has elapsed since turn off (on) of both the RH and RM signals.



When the remotely-set speed is cleared by turning on the RL (clear) signal after turn off (on) of both the RH and RM signals, the inverter operates at the speed in the remotely-set speed cleared state if power is reapplied after one minute has elapsed since turn off (on) of both the RH and RM signals.



CAUTION

- **The speed can be varied by RH (acceleration) and RM (deceleration) between 0 and the maximum speed (Pr. 1 setting).**
- **When the acceleration or deceleration signal turns on, the set speed varies according to the slope set in Pr. 44 "second acceleration/deceleration time" or Pr. 45 "second deceleration time". The output speed acceleration/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 speed. (Refer to page 30 for the set speed and output speed.)**
- **If the start signal (STF or STR) is off, turning on the RH (acceleration) or RM (deceleration) signal varies the set speed.**

⚠CAUTION

⚠ When selecting this function, re-set Pr. 1 "maximum speed" according to the machine.

Related parameters

- RH, RM, RL signal terminal assignment ⇒ Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)
- Maximum speed setting ⇒ Pr. 1 "maximum speed" (Refer to page 89.)
- Output speed acceleration/deceleration time ⇒ Pr. 7 "acceleration time", Pr. 8 "deceleration time" (Refer to page 91.)
- Time setting for acceleration/deceleration ⇒ Pr. 44 "second acceleration/deceleration time", Pr. 45 "second deceleration time" (Refer to page 91.)
- RH, RM, RL signal compensation ⇒ Pr. 28 "multi-speed input compensation" (Refer to page 101.)

4.10 Brake sequence (Pr. 60, Pr. 278 to Pr. 285)

4.10.1 Brake sequence function (Pr. 60, Pr. 278 to Pr. 285)

with Encoder / without Encoder / Speed

The inverter automatically sets appropriate parameters for operation.
This function is used to output from the inverter the mechanical brake opening completion signal timing signal in vertical lift and other applications.
This function prevents the load from dropping with gravity at a start due to the operation timing error of the mechanical brake or an overcurrent alarm from occurring at a stop, ensuring secure operation.

POINT

Set "7" or "8" in Pr. 60.
Set any of "0, 2, 4, 10, 12" in Pr. 800 "control system selection" under external operation and set speed control. (Refer to page 182)

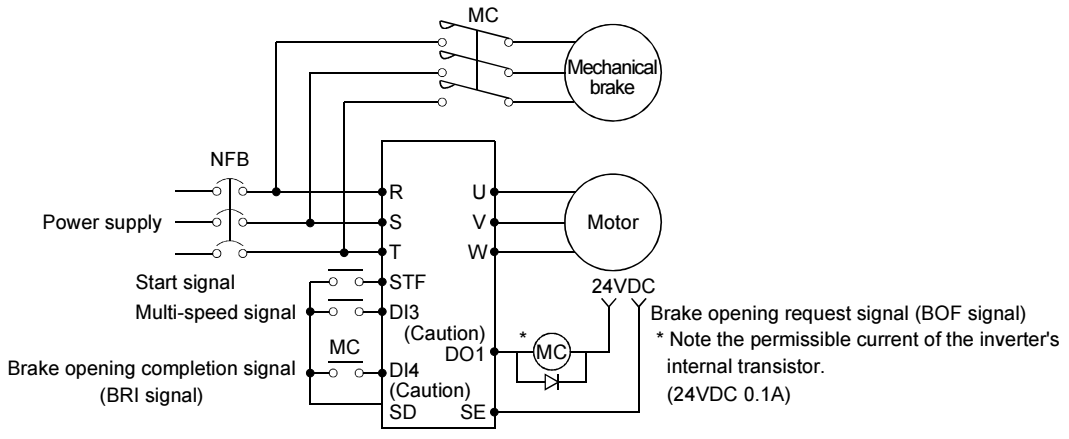
Parameter	Name	Factory Setting	Setting Range	Remarks
60	Intelligent mode selection	0	0, 7, 8	Extended mode
278	Brake opening speed	20r/min	0 to 900r/min	
279	Brake opening current	130%	0 to 200%	
280	Brake opening current detection time	0.3s	0 to 2s	
281	Brake operation time at start	0.3s	0 to 5s	
282	Brake operation speed	25r/min	0 to 900r/min	
283	Brake operation time at stop	0.3s	0 to 5s	
284	Deceleration detection function selection	0	0, 1	
285	Overspeed detection speed	9999	0 to 900r/min, 9999	

CAUTION

When brake sequence mode is selected, automatic restart after instantaneous power failure is invalid.

(1) Wiring example

- Sink logic
- Pr.183=15
- Pr.190=20



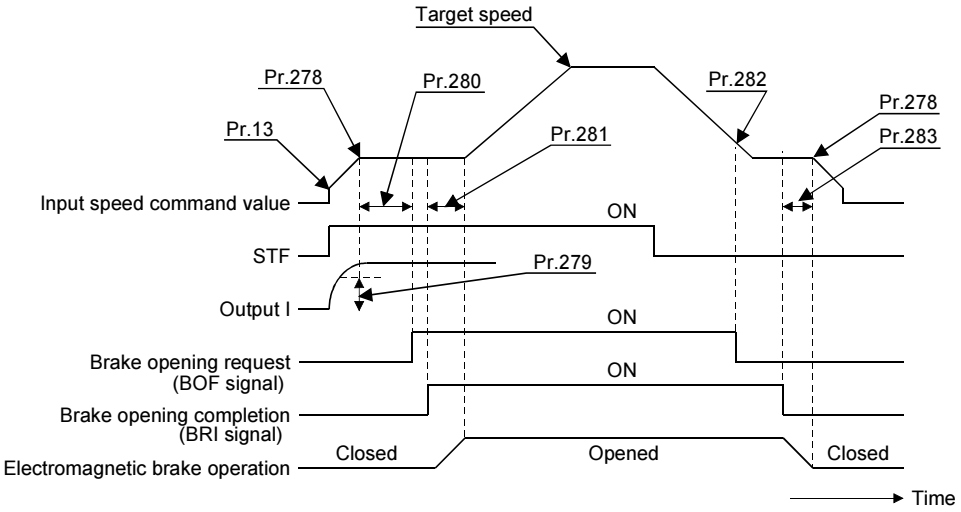
CAUTION

The input signal terminal used differs according to the parameter settings. (Refer to page 120.)

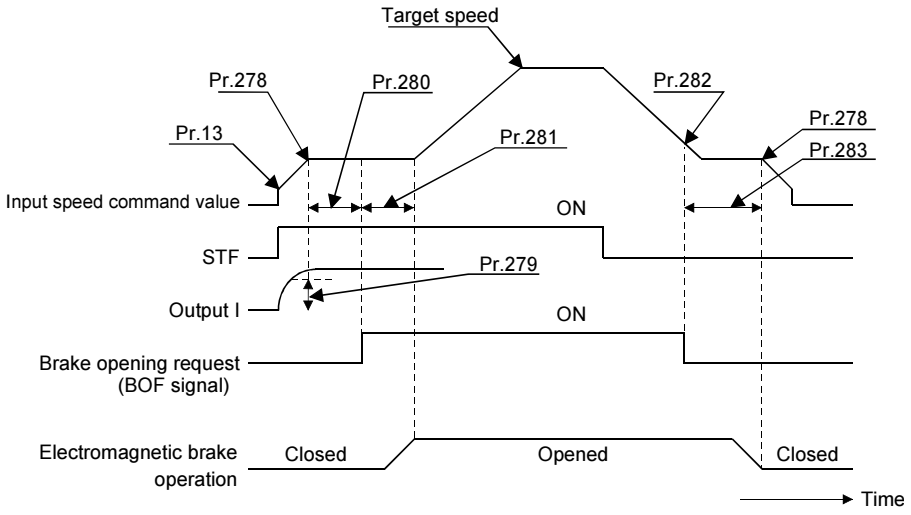
(2) Operation example

- At start: When the start signal is input to the inverter, the inverter starts running. When the internal speed command reaches the value set in Pr. 278 and the output current is not less than the value set in Pr. 279, the inverter outputs the brake opening request signal (BOF) after the time set in Pr. 280 has elapsed.
  When the time set in Pr. 281 has elapsed after the brake opening completion signal (BRI) was input, the inverter increases the internal speed command to the set speed.
- At stop: When the speed has decreased to the speed set in Pr. 282, the brake opening request signal (BOF) is turned off. When the time set in Pr. 283 has elapsed after the brake operation confirmation signal (BRI) was input, the inverter output is switched off.
  *If Pr. 60 = "8" (mechanical brake opening completion signal not input), this time is the time after the brake opening request signal is output.

1. Pr. 60 = "7" (brake opening completion signal input)



2. Pr. 60 = "8" (mechanical brake opening completion signal not input)



(3) Parameter setting

1. Set speed control in Pr.800 "control system selection". (Refer to page 182.)
2. Set "7 or 8" (brake sequence mode) in Pr. 60.
   To ensure more complete sequence control, it is recommended to set "7" (brake opening completion signal input) in Pr. 60.

Pr. 60 Setting	Operation Mode	Description	
0	Normal operation mode	——	
7	Brake sequence mode	With mechanical brake opening completion signal input	This function causes the inverter to output the mechanical brake operation timing signal for elevating application. For the function details and setting method, refer to Pr. 278 to Pr. 285 (brake sequence function).
8		Without mechanical brake opening completion signal input	

REMARKS

Even if the intelligent operation function has been selected, inputting the jog or RT (second function selection) signal during an inverter stop will switch to the normal operation and give priority to jog operation or second function selection.
After intelligent operation has been started, neither the jog signal nor the RT signal is accepted.

3. Refer to the following table and set the parameters.

Parameter	Name	Setting Range	Description
278	Brake opening speed	0 to 900r/min	Set the value higher than the Pr. 13 "starting speed". Setting is enabled only when Pr. 278 ≤ Pr. 282.
279	Brake opening current	0 to 200%	Generally, set this parameter to about 50 to 90%. If the setting is too low, the load is liable to drop with gravity at start. Suppose that the rated inverter current is 100%.
280	Brake opening current detection time	0 to 2s	Generally, set this parameter to about 0.1 to 0.3s.
281	Brake operation time at start	0 to 5s	Pr. 60 = 7: Set the mechanical delay time until the brake is loosened. Pr. 60 = 8: Set the mechanical delay time until the brake is loosened + about 0.1 to 0.2s.
282	Brake operation speed	0 to 900r/min	Generally, set the Pr. 278 setting + 1 to 2r/min to this parameter. Setting is enabled only when Pr. 282 ≥ Pr. 278.
283	Brake operation time at stop	0 to 5s	Pr. 60 = 7: Set the mechanical delay time until the brake is closed + 0.1s. Pr. 60 = 8: Set the mechanical delay time until the brake is closed + about 0.2 to 0.3s.
284	Deceleration detection function selection	0	Deceleration is not detected.
		1	If deceleration is not normal during deceleration operation, the inverter alarm (E.MB2) is provided to shut off the output and turn off the brake opening request signal (BOF).
285	Overspeed detection speed*	0 to 900r/min	If (detected speed) - (output speed) > Pr. 285, the inverter alarm (E.MB1) is provided to shut off the output and turn off the brake opening request signal (BOF).
		9999	Overspeed is not detected.

* This function is valid during vector control with encoder and vector control without encoder.

CAUTION

When using this function, set the acceleration/deceleration time to 1s or longer.

(4) Setting terminals

The terminals must be assigned using Pr. 180 to Pr. 183 and Pr. 187 and Pr. 190 to Pr. 192 and Pr. 195.

Signal	Brake Sequence Mode	
	Pr. 60 = 7 (with mechanical brake opening completion signal)	Pr. 60 = 8 (without mechanical brake opening completion signal)
BOF	Brake opening request	Brake opening request
BRI	Brake opening completion signal	——

CAUTION

1. **The brake opening completion signal (BRI) is a parameter valid when Pr. 60 = 7.**
2. **Changing the terminal function using any of Pr. 180 to Pr. 183, Pr. 187, Pr. 190 to Pr. 192, and Pr. 195 may affect the other functions. Confirm the functions of the corresponding terminals before making setting. (Refer to page 163.)**

(5) Protective functions

If any of the following errors occurs in the brake sequence mode, the inverter results in an alarm, shuts off the output, and turns off the brake opening request signal (BOF terminal).
On the operation panel (FR-DU04-1) LED or parameter unit (FR-PU04V) screen, the following errors are displayed:

Error Display	Description
E.MB1	(Detected speed) - (output speed) > Pr. 285 during vector control. (Overspeed detection function)
E.MB2	Deceleration is not normal during deceleration operation (Use Pr. 284 to select this function.) (Except stall prevention operation)
E.MB3	Brake opening request signal (BOF) turned on though the motor is at a stop. (Gravity drop prevention function)
E.MB4	More than 2s after the run command (forward or reverse rotation) is input, the brake opening request signal (BOF) does not turn on.
E.MB5	More than 2s after the brake opening request signal turned on, the brake opening completion signal (BRI) does not turn on.
E.MB6	Though the inverter had turned on the brake opening request signal (BOF), the brake opening completion signal (BRI) turned off midway.
E.MB7	More than 2s after the brake opening request signal (BOF) turned off at a stop, the brake opening completion signal (BRI) does not turn off.

4.11 Operation selection function 2 (Pr. 65 to Pr. 79)

4.11.1 Retry function (Pr. 65, Pr. 67 to Pr. 69 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque)

When the inverter output is stopped by the protective function (major fault), this function causes the inverter to automatically reset itself to make a retry. You can select whether retry operation is to be performed or not, alarms reset for retry, number of retries made, and waiting time.

Parameter	Name	Factory Setting	Setting Range	Remarks
65	Retry selection	0	0 to 5	Extended mode
67	Number of retries at alarm occurrence	0	0, 1 to 10, 101 to 110	
68	Retry waiting time	1s	0 to 10s	
69	Retry count display erasure	0	0	

<Setting>

- Use Pr. 65 to select the protective functions (major faults) to be activated for retries.

Errors Reset for Retry		Pr. 65						Remarks
Error definition	Abbreviation	0	1	2	3	4	5	
Acceleration overcurrent	E.OC1	●	●		●	●	●	
Constant-speed overcurrent	E.OC2	●	●		●	●		
Deceleration overcurrent	E.OC3	●	●		●	●	●	
Acceleration overvoltage	E.OV1	●		●	●	●		
Constant-speed overvoltage	E.OV2	●		●	●	●		
Deceleration overvoltage	E.OV3	●		●	●	●		
Motor thermal relay	E.THM	●						
Transistor thermal relay	E.THT	●						
Instantaneous power failure	E.IPF	●				●		
Undervoltage	E.UVT	●				●		
Brake transistor	E.BE	●				●		
Ground fault protection	E.GF	●				●		
Output phase failure	E.LF							
External thermal relay	E.OHT	●						
Stall prevention-triggered stop	E.OLT	●				●		
Option alarm	E.OPT	●				●		
Option 1 alarm	E.OP1	●				●		

Errors Reset for Retry		Pr. 65						Remarks
Error definition	Abbreviation	0	1	2	3	4	5	
Option 2 alarm	E.OP2	●				●		
Option 3 alarm	E.OP3	●				●		
Storage device alarm	E.PE	●				●		
PU disconnection	E.PUE							
Retry count excess	E.RET							
CPU error	E.CPU							
Fan stop	E.FAN							
Fin overheat	E.FIN							
Overspeed occurrence	E.OS	●				●		Under vector control with encoder
Speed deviation large	E.OSD	●				●		Under vector control with encoder
Encoder no-signal	E.ECT							Under vector control with encoder
Position error large	E.OD							Under vector control with encoder
Encoder A no-signal	E.ECA							Under vector control with encoder
MB1	E.MB1	●				●		Brake sequence
MB2	E.MB2	●				●		Brake sequence
MB3	E.MB3	●				●		Brake sequence
MB4	E.MB4	●				●		Brake sequence
MB5	E.MB5	●				●		Brake sequence
MB6	E.MB6	●				●		Brake sequence
MB7	E.MB7	●				●		Brake sequence
P24 short circuit	E.P24							
P12 short circuit	E.P12							
Circuit alarm (P5S short circuit)	E.CTE							

* ● indicates the errors selected for retry.

• 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 number of retries to be made is exceeded, "E.rET" (retry count excess) is displayed.

• Use Pr. 68 to set the waiting time from when an inverter alarm occurs until a retry is made in the range 0 to 10s.
• Reading the Pr. 69 value provides the cumulative number of successful restarts made by retries. Writing "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) being 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 operation panel may show data different from the latest data or the parameter unit (FR-PU04V) 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) activated the first time.**
- **When an inverter alarm is reset by the retry function at the retry time, the accumulated data of the electronic thermal relay function, 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 predetermined time has elapsed) after occurrence of an alarm. When you have selected the retry function, apply the CAUTION seals provided for the Instruction Manual (basic) in easily visible places.**

Pr. 70 ➡ Refer to Pr. 30 (page 105)

4.11.2 Applied motor (Pr. 71, Pr. 450 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque, Conditional / PLC / SSC Position)

Set the motor used.
Refer to page 8 for the motor setting, etc.

Parameter	Name	Factory Setting	Setting Range	Remarks
71	Applied motor	30	0, 3 to 8, 10, 13 to 18, 20, 23, 24, 30, 33, 34	
450	Second applied motor	9999	0, 3 to 8, 10, 13 to 18, 20, 23, 24, 30, 33, 34, 9999	9999: Second applied motor invalid

<Setting>

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

Setting	Motor	Control Constants
0	Standard motor	Inverter internal constants
3		Offline auto tuning
4		Offline auto tuning data utilization
5		Star connection direct input
6		Delta connection direct input
7		Star connection direct input + offline auto tuning
8		Delta connection direct input + offline auto tuning
10	Constant-torque motor	Inverter internal constants
13		Offline auto tuning
14		Offline auto tuning data utilization
15		Star connection direct input
16		Delta connection direct input
17		Star connection direct input + offline auto tuning
18		Delta connection direct input + offline auto tuning
20	SF-JR (4P)-1.5kW (2HP) or less (during vector control)	Inverter internal constants
23		Offline auto tuning
24		Offline auto tuning data utilization
30 (factory setting)	Vector control dedicated motor	Inverter internal constants
33		Offline auto tuning
34		Offline auto tuning data utilization

CAUTION

1. **Refer to page 132 for offline auto tuning.**
2. **Refer to page 41 when using the second motor.**

⚠CAUTION

⚠ **Set this parameter correctly according to the motor used.**

REMARKS

- For online auto tuning, refer to the Instruction Manual (basic).

4.11.3 PWM carrier frequency selection (Pr. 72, Pr. 240 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque; Conditional / PLC / SSC: Position)

By parameter setting, you can set to exercise the Soft-PWM control that changes the motor tone .

- Soft-PWM control is a control system that changes the motor noise from a metallic tone into an unoffending complex tone.

Parameter	Name	Factory Setting	Setting Range	Remarks
72	PWM frequency selection	1	1 to 6	Simple mode
240	Soft-PWM setting	0	0, 1	Extended mode

<Setting>

Pr. 72 Setting	Description
1	2.25kHz
2	4.5kHz
3	6.75kHz
4	9kHz
5	11.25kHz
6	13.5kHz

CAUTION

1. An increased PWM carrier frequency will decrease the motor sound but increase noise and leakage currents. Therefore, perform the reduction techniques. (Refer to page 19.)

Pr. 240 Setting	Description
	Soft-PWM
0	Invalid
1	Valid (when Pr. 72 = "1 or 2")

4.11.4 Speed setting signal on/off selection (Pr. 73 with Encoder / without Encoder Speed / with Encoder / without Encoder Torque)

You can select the override function to make main speed setting with the speed setting auxiliary terminal 1. Using Pr. 73, set the input specifications of terminals 1 and 2 and whether to use the override function or not.

POINT

- Set "0" in Pr. 807 "speed restriction selection". (Refer to page 185.)
- Set "0" in Pr. 868 "No. 1 terminal function selection". (Refer to page 195.)
- Refer to Pr. 902 "speed setting No. 2 bias", Pr. 903 "speed setting No. 2 gain" for calibration. (Refer to page 202.)

Parameter	Name	Factory Setting	Setting Range	Remarks
73	Speed setting signal	0	0	Extended mode
			4	
			10	
			14	

Pr. 73 Setting	Control Mode	Function		Terminal 1 (0 to ±10V)	Terminal 2 (0 to 10V)*3
		Override	Polarity reversible		
0	Speed control	×	×	Addition auxiliary *1 Speed command	Main speed setting
4		○*2	×	Main speed setting	Override signal
10		×	○	Addition auxiliary *1 Speed command	Main speed setting
14		○*2	○	Main speed setting	Override signal
0	Torque control	×	×	Addition auxiliary Speed restriction	Speed restriction
4		○*4	×	Speed restriction	Override signal
10		×	×	Addition auxiliary Speed restriction	Speed restriction
14		○*4	×	Speed restriction	Override signal
0, 4, 10, 14	Position control	No function		No function	No function

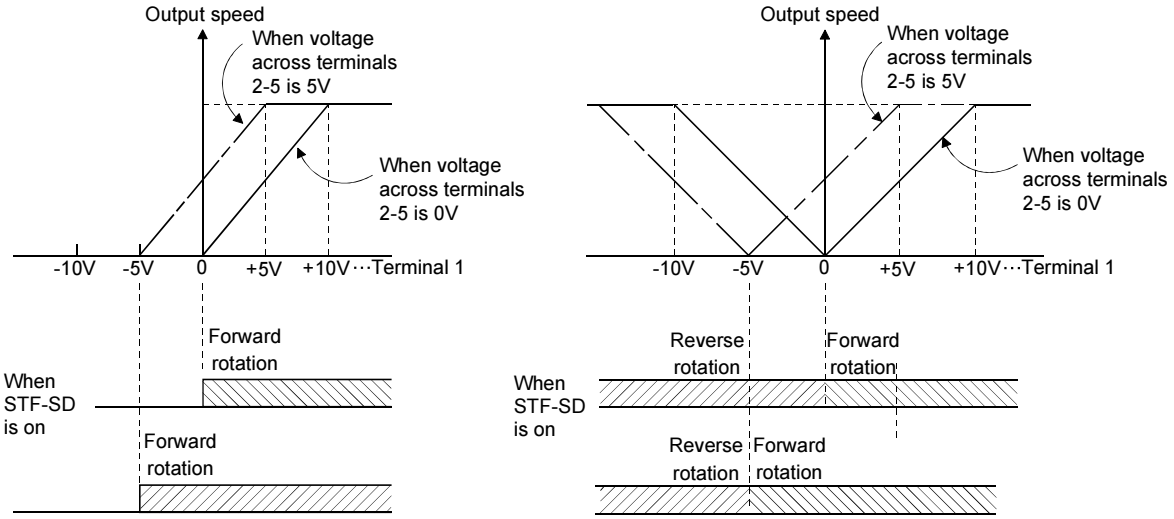
*1:The value of terminal 1 (speed setting auxiliary input) is added to the main speed setting signal of terminal 2.
*2:When override has been selected, terminal 1 is for the main speed setting and terminal 2 for the override signal (50 to 150% at 0 to 10V). (Refer to page 169 for bias/gain adjustment.)
*3:When "30" or "31" is set in Pr. 128, terminal 2 acts as the PID set point function.
*4:When override has been selected, terminal 1 is for speed restriction and terminal 2 is for the override signal.

CAUTION

To change the maximum output speed at the input of the maximum speed command voltage, use the speed setting voltage gain, Pr. 903 (Pr. 905).
At this time, the command voltage need not be input.
Also, the acceleration/deceleration time, which is a slope up/down to the acceleration/deceleration reference speed, is not affected by the change in Pr. 73 setting.

(a) When Pr. 73 "speed setting signal" value is "0"
The voltage across terminals 1-5 is added to the voltage signal (positive) across terminals 2-5. If the result of addition is negative, it is regarded as 0 and the motor comes to a stop.

(b) When Pr. 73 "speed setting signal" value is "10"
The polarity reversible operation function is selected.
The voltage signal across terminals 1-5 is added to the voltage signal (positive) across terminals 2-5. A positive addition result turns the motor in the forward rotation direction (when the STF terminal turns on), or a negative result turns it in the reverse rotation direction (when the STF terminal turns on). The compensation signal of terminal 1 can also be added to the multi-speed setting.



(a) When Pr. 73 setting is 0 (b) When Pr. 73 setting is 10

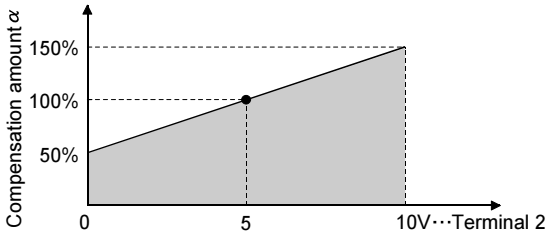
Auxiliary Input Characteristics

1) Multi-speed input compensation
By setting 1 in Pr. 28 "multi-speed input compensation selection" (factory setting 0), the speed from the auxiliary input terminal 1 is added when multi-speed operation is performed. (Refer to page 90.)

Inverter Output According to Start Signal and Auxiliary Input Terminal Polarity

Pr. 73 Setting	Added Command Voltage	Start Signal Input	
		STF-SD	STR-SD
0	+	Forward rotation	Reverse rotation
	−	Stop	Stop
10	+	Forward rotation	Reverse rotation
	−	Reverse rotation	Forward rotation

2) Override
For the above compensation input, the fixed compensation amount is applied to each speed. Using the override function easily varies each speed equally.
By setting either "4 or 14" in Pr. 73, override allows the parameter-set multiple speeds and analog input across terminals 1-5 to be varied equally within the range 50% to 150% (The range can be increased with Pr. 252 and Pr. 253) by the analog signal input across terminals 2-5.

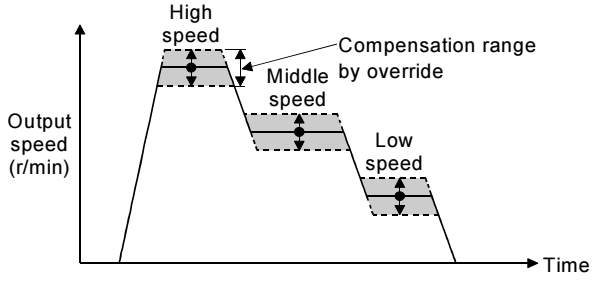


Override Setting Signal vs. Compensation Amount

How to find each speed (N)

$$N = N_{pr.} \times \frac{\alpha}{100} \text{ [r/min]}$$

Npr.: Speed setting [r/min]
[Multiple speeds
Analog input across terminals 1-5]
α : Override compensation amount [%]
(Analog input across terminals 2-5)



Multi-speed Override Operation

4.11.5 Reset selection/disconnected PU detection/PU stop selection

(Pr. 75 with Encoder / without Encoder — Speed; with Encoder / without Encoder — Torque; Conditional / PLC / SSC — Position **)**

You can select the reset input acceptance, PU (FR-DU04-1/FR-PU04V) connector disconnection detection function and PU stop function.

- Reset selection: You can select the reset function input (RES signal) timing.
- Disconnected PU detection: When the disconnection of the PU (FR-DU04-1/FR-PU04V) from the inverter for more than 1s is detected, the inverter outputs an alarm code (E.PUE) and comes to an alarm stop.
- PU stop selection: When an alarm etc. occurs in any operation mode, you can stop the motor from the operation panel by pressing STOP RESET.

Parameter	Name	Factory Setting	Setting Range	Remarks
75	Reset selection/disconnected PU detection/PU stop selection	14	0 to 3, 14 to 17	Extended mode

<Setting>

Pr. 75 Setting	Reset Selection	Disconnected PU Detection	PU Stop Selection
0	Reset input is always enabled.	If the PU is disconnected, operation will be continued as-is.	The PU stop key is invalid. STOP RESET input is valid only in the PU or combined operation mode (Pr. 79 = "4").
1	Reset input is enabled only when the protective function is activated.		
2	Reset input is always enabled.	When the PU is disconnected, the inverter output is shut off.	
3	Reset input is enabled only when the protective function is activated.		
14	Reset input is always enabled.	If the PU is disconnected, operation will be continued as-is.	STOP RESET input decelerates the motor to a stop in any of the PU, external and communication operation modes.
15	Reset input is enabled only when the protective function is activated.		
16	Reset input is always enabled.	When the PU is disconnected, the inverter output is shut off.	
17	Reset input is enabled only when the protective function is activated.		

(1) Restarting method when stop was made by inputting STOP RESET from the operation panel (Method of restarting from PS indication)

1) After the motor has decelerated to a stop, turn off the STF or STR signal.

2) Press MODE twice* to display OPMd.

CAUTION

When Pr. 79 = "3", press MODE three times to display PU. Then press ▼ and proceed to 3).

(*For monitor screen)..... Refer to the Instruction Manual (basic) for details of the monitor display provided by pressing MODE.

3) Press SET.

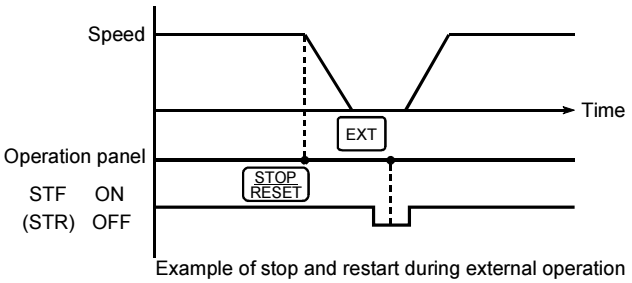
4) Turn on the STF or STR signal.

REMARKS

- When you provide a reset input (RES) during operation, the inverter that is being reset shuts off the output and resets the internal heat integrating value of the electronic thermal relay function and the number of retries, and the motor coasts.
- The Pr. 75 value can be set any time. This value does not return to the initial value even if parameter (all) clear is executed.
- When the motor is stopped from the PU, PS and 0.0 are displayed alternately. An alarm output is not provided.

(2) Restarting method when stop was made by inputting STOP RESET from PU

1) After the motor has decelerated to a stop, turn off the STF or STR signal.
2) Press EXT.
..... (Recovery from PS)
3) Turn on the STF or STR signal.



Example of stop and restart during external operation

Alternatively, you can make a restart by making a power-on reset or resetting the inverter using the reset terminal of the inverter.

REMARKS

- When you provide a reset input (RES) during operation, the inverter that is being reset shuts off the output and resets the data of the electronic thermal relay function, and the motor coasts.
- To make a restart, confirm that the PU is connected and then reset the inverter.
- The Pr. 75 value can be set any time. This value does not return to the initial value even if parameter (all) clear is executed.
- When the motor is stopped from the PU, PS is displayed. An alarm output is not provided.
- Pr. 250 is made invalid.

⚠CAUTION

⚠ **Do not reset the inverter with the start signal input.**
Doing so will start the inverter immediately after it has recovered from the error, causing hazard.

4.11.6 Parameter write disable selection (Pr. 77 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque, Condi-tional / PLC / SSC Position)

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

Parameter	Name	Factory Setting	Setting Range	Remarks
77	Parameter write disable selection	0	0, 1, 2	Simple mode

<Setting>

Pr. 77 Setting	Function
0	Write is enabled only during a stop in the PU operation mode.*
1	Parameter write is disabled.
2	Write is enabled even during operation. Write is enabled independently of the operation mode.

CAUTION

- *** The shaded parameters in the parameter list (refer to page 78) always allow setting.**
- **Even when "2" is set in Pr. 77, the following parameters do not allow writing during operation.**
  Pr. 60, Pr. 71, Pr. 72, Pr. 79, Pr. 80 to Pr. 84, Pr. 90 to Pr. 96, Pr. 180 to Pr. 183, Pr. 187, Pr. 190 to Pr. 192, Pr. 195, Pr. 450, Pr. 451, Pr. 453, Pr. 454, Pr. 800, Pr. 819, Pr. 851, Pr. 852, Pr. 859 and Pr. 868
  Stop operation when changing the values of the above parameters.
- **By setting "1" in Pr. 77, the following clear operations can be inhibited:**
  • Parameter clear
  • Parameter all clear
  Even when "1" is set in Pr. 77, write is allowed for Pr. 22, Pr. 75, Pr. 77 and Pr. 79.

4.11.7 Reverse rotation prevention selection (Pr. 78)

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

POINT

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

Parameter	Name	Factory Setting	Setting Range	Remarks
78	Reverse rotation prevention selection	0	0, 1, 2	Extended mode

<Setting>

Control Method	Pr. 78 Setting	Start Signal		Restriction on Analog Reversible
		STF	STR	
Speed control V/F control	0	Valid	Valid	Negative input starts rotation in the direction opposite to that of start signal
	1 (reverse rotation lock)	Valid	Invalid	Negative input does not start rotation.
	2 (forward rotation lock)	Invalid	Valid	
Torque control	0	Valid	Valid	Negative input starts rotation in the direction opposite to that of start signal
	1 (reverse rotation lock)	Valid	Invalid	Negative analog input results as follows.
	2 (forward rotation lock)	Invalid	Valid	
Position control	0	Functions as a stroke signal and motor does not rotate in the direction where the STF or STR signal does not exist.		Under position control, analog command is irrelevant to the forward/reverse rotation lock function as it does not function in other than torque restriction setting (absolute value used for operation).
	1 (reverse rotation lock)	Motor does not rotate in the reverse rotation direction.		
	2 (forward rotation lock)	Motor does not rotate in the forward rotation direction.		

Speed	Operation
Start speed or less	No rotation
When rotation is in the same direction as that of start signal and speed is higher than starting speed.	Torque in the direction opposite to that of start signal is generated.

4.11.8 Operation mode selection (Pr. 79)

Used to select the operation mode of the inverter.
The inverter can be run from the operation 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 external operation mode is selected at power-on (factory setting).

Parameter	Name	Factory Setting	Setting Range
79	Operation mode selection	0	0 to 4, 6 to 8

<Setting>

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

Pr. 79 Setting	Function		
0	At power-on, the external operation mode is selected. You can change between the PU operation mode and external operation mode from the operation panel (MODE) or parameter unit (PU/EXT). Refer to the fields of settings 1 and 2 for the corresponding modes.		
1	**Operation mode**	**Speed command**	**Start signal**
	PU operation mode	Setting from the operation panel or FR-PU04V	FWD, REV
2	External operation mode	External signal input (across terminals 2(1)-5, multi-speed selection, jog)	External signal input (terminal STF, STR)
3	External/PU combined operation mode 1	Digital setting by PU key operation or external signal input (multi-speed setting)	External signal input (terminal STF, STR)
4	External/PU combined operation mode 2	External signal input (across terminals 2(1)-5, multi-speed selection, jog)	FWD, REV
6	Switchover mode Switchover between PU operation, external operation and computer link operation (when a communication option is used) can be done while running.		
7	External operation mode (PU operation interlock) X12 signal ON..... Can be switched to PU operation mode (output stop during external operation) X12 signal OFF .... Switching to PU operation mode inhibited		
8	Operation mode switchover using external signal (disallowed during operation) X16 signal ON..... Switched to external operation mode X16 signal OFF .... Switched to PU operation mode		

REMARKS

- A stop function(PU stop selection) by STOP RESET of the PU (FR-DU04-1/FR-PU04V) is made valid during the operation other than the PU operation mode. (Refer to page 127)
- Either "3" or "4" may be set to select the PU/external combined operation, and these settings differ in starting method. Refer to page 141 for the computer link operation mode.

(1) Switchover mode

PU operation, external operation and computer link operation (when communication option is used) can be used by switching between them.

Operation Mode Switching	Switching Operation/Operating Status
External operation to PU operation	1) Change the operation mode to the PU operation mode from the operation panel or parameter unit. •Rotation direction is the same as that of external operation. •Set speed is as set by the potentiometer (speed setting potentiometer). (Note that the setting will disappear when power is switched off or the inverter is reset.)
External operation to computer link operation	1) Mode change command to computer link mode is transmitted from the computer. •Rotation direction is the same as that of external operation. •Set speed is as set by the potentiometer (speed setting potentiometer). (Note that the setting will disappear when power is switched off or the inverter is reset.)
PU operation to external operation	1) Press the external operation key of the parameter unit. •Rotation direction is determined by the external operation input signal. •Set speed is determined by the external speed setting signal.
PU operation to computer link operation	1) Mode change command to computer link mode is transmitted from the computer. •Rotation direction and set speed are the same as those of PU operation.
Computer link operation to external operation	1) Command to change to external mode is transmitted from the computer. •Rotation direction is determined by the external operation input signal. •Set speed is determined by the external speed setting signal.
Computer link operation to PU operation	1) Select the PU operation mode with the operation panel or parameter unit. •Rotation direction and set speed are the same as those of computer link operation.

(2) PU operation interlock

The PU operation interlock function is designed to forcibly change the operation mode to the external operation mode when the X12 signal input turns 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" (PU operation interlock) in Pr. 79.
- Using any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection), allocate the terminal used to input the X12 signal. (Refer to page 163)

REMARKS

Changing the terminal assignment with any of Pr. 180 to 183 and Pr. 187 may affect the other functions. Check the functions of the corresponding terminals before making setting.

2) Function

X12 Signal	Function/Operation
ON	Output stop during external operation. Operation mode can be switched to the PU operation mode. PU operation allowed.
OFF	Forcibly switched to the external operation mode. External operation allowed. Switching to the PU operation mode inhibited.

<Function/operation changed by switching on-off the X12 signal>

Operating Condition		X12 Signal	Operation Mode	Operating Status
Operation mode	Status			
PU	During stop	ON→OFF (*)	PU → External	During stop
	During operation	ON→OFF (*)		If external operation speed setting and start signal are entered, operation is performed in that status.
External	During stop	OFF→ON	External	During stop
		ON→OFF		
	During operation	OFF→ON		During operation → output stop
		ON→OFF		Output stop → operation

REMARKS

- If the X12 signal is on, the operation mode cannot be switched to the PU operation mode when the start signal (STF, STR) is on.

* 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 X12 signal is turned off with either of STF and STR on.

- When the X12 signal is off during external operation mode, the operation mode cannot be changed to the PU operation mode. (Change to the PU operation mode after switching the X12 signal on)

(3) Operation mode external signal switching function

1) Preparation

Set "8" (operation mode with signal) in Pr. 79.

Using any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection), allocate the terminal used to input the X16 signal.

REMARKS

Changing the terminal assignment with any of Pr. 180 to 183 and Pr. 187 may affect the other functions. Check the functions of the corresponding terminals before making setting. Refer to page 163 for details.

2) Function

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

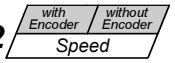
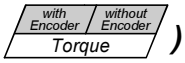
X16 Signal	Operation Mode
ON	External operation mode (cannot be changed to the PU operation mode)
OFF	PU operation mode (cannot be changed to the external operation mode)

Related parameters

Pr. 75 "PU stop selection" (Refer to page 127.)

4.12 Offline auto tuning (Pr. 80 to Pr. 96)

4.12.1 Offline auto tuning function

(Pr. 9, Pr. 80, Pr. 81, Pr. 83, Pr. 84, Pr. 71, Pr. 96, Pr. 450, Pr. 452  )

If any other manufacturer's motor is used, using the offline auto tuning function runs the motor with the optimum operating characteristics.

- By performing offline auto tuning, the inverter measures the necessary motor constants.
- Offline auto tuning can be performed with an inertia load, e.g. coupling, connected. (As the load is lighter, tuning accuracy is higher. Tuning accuracy does not change if the inertia is large.)
- For the offline auto tuning, you can select either the motor non-rotation mode or rotation mode. The rotation mode has higher tuning accuracy than the non-rotation mode. The rotation mode should be selected for the online auto tuning.
- If any other manufacturer's motor is used, perform offline auto tuning (Pr. 96="101") with motor alone to run the motor before performing online auto tuning. (The motor with inertia load can be connected.) (For online auto tuning, refer to the Instruction Manual (basic).)

CAUTION

1. **The motor capacity is equal to or one rank lower than the inverter capacity.**
2. **Special motors such as high-slip motor and high-speed motor cannot be tuned.**
3. **Motor runs at up to about the rated speed of the motor.**
4. **Make sure that the motor is connected. (At a tuning start, the motor should be at a stop.)**
5. **Tune the motor alone without connecting a load (e.g. frictional stationary load) to the motor. (An inertia load such as a coupling may remain connected.)**
6. **Use the encoder that is coupled directly to the motor shaft without looseness.**
7. **Offline auto tuning will not be performed properly if it is performed with a reactor or surge voltage suppression filter connected between the inverter and motor. Remove it before starting tuning.**

REMARKS

- You can copy the tuning data (motor constants) to another inverter with the PU (FR-DU04-1/FR-PU04V).
- The offline auto tuning status can be monitored with the PU (FR-DU04-1/FR-PU04V).

4.12.2 Parameters

Set the following parameters.

(1) Parameters related to tuning of the first motor

Parameter	Name	Setting Range	Factory Setting	Remarks
71	Applied motor	Refer to page 123 and set "3 (standard motor)", "13 (constant-torque motor)" or "33 (vector control dedicated motor)". Electronic thermal characteristics are also changed in accordance with the motor.		
9	Electronic thermal O/L relay	0 to 500A (Set 0 for use of an external thermal relay.)	Rated inverter output curent	Refer to the motor rating plate and set the rated value.
80	Motor capacity	0.4 to 55kW	Inverter capacity	
81	Number of motor poles	2, 4, 6	4	
83	Rated motor voltage	0 to 1000V	575V	
84	Rated motor frequency	20 to 200Hz	60Hz	
96	Auto tuning setting/status	0, 1, 101	0	0 : Auto tuning not performed 1 : Tuning performed without motor running 101 : Tuning performed with motor running
851	Number of encoder pulses	0 to 4096	1024	
852	Encoder rotation direction	0,1	1	
876	Thermal relay protector input	0,1	0	

(2) Parameters related to tuning of the second motor

POINT

Refer to page 41 when using the second motor.

Parameter	Name	Setting Range	Factory Setting	Remarks
450	Second applied motor	Refer to page 123.		
452	Second electronic thermal O/L relay	0 to 500A, 9999	9999	Set the rated value refering to the motor rating plate.
453	Second motor capacity	0.4 to 55kW	Inverter Capacity	
454	Number of second motor poles	2, 4, 6	4	
456	Rated second motor voltage	0 to 1000V	575V	
457	Rated second motor frequency	20 to 200Hz	60Hz	
463	Second auto tuning setting/status	0, 1, 101	0	0: without auto tuning 1: tuning without running the motor 101: tuning with running the motor

REMARKS

Turn the RT signal ON/OFF to switch from the first motor to the second motor.

4.12.3 Execution of offline auto tuning

The following applies to the first motor.

CAUTION

- **Note the following when "101" (offline auto tuning performed with motor running) is set in Pr. 96 (Pr. 463).**
  - **•Ensure safety when the motor starts running.**
  - **•Torque is not enough during tuning.**
  - **•The motor may be run at nearly its rated frequency (Pr. 84 (Pr. 457) setting) without any problem.**
  - **•The brake is open.**
  - **•When over current alarm (E.OC1, OC2, OC3) occurs, set acceleration time longer using Pr. 7.**
  - **•No external force is applied to rotate the motor.**
    If "1" (tuning performed without motor running) is set in Pr. 96 (Pr. 463), the motor may run slightly (However, torque is not enough). Therefore, fix the motor securely with a mechanical brake, or before tuning, make sure that there will be no problem in safety if the motor runs.
    This instruction must be followed especially in vertical lift applications.
    Note that if the motor runs slightly, tuning performance is unaffected.
  - **•During offline auto tuning, only the following I/O signals are valid:**
    Input signals (STOP, OH, MRS, RT, RES, STF, STR)
    Output signals (RUN, OL, IPF, DA1, DA2, A, B, C)
    Take extra precaution when designing a sequence where a mechanical brake is opened by the RUN signal.

(1) Parameter setting

- Select Pr. 851 "number of encoder pulses" and Pr. 852 "encoder rotation direction" (Refer to page 10.) (It is not necessary to select when using the motor without encoder.)
- Select Pr. 80 (Pr. 453) "motor capacity" and Pr. 81 (Pr. 454) "number of motor poles".
- Refer to the parameter details to set the parameters below.
  1) Set "1" or "101" in Pr. 96 (Pr. 463)
     •When the setting is "1" . . . . .tuning performed without motor running
     •When the setting is "101" . . .tuning performed with motor running
  2) Set Pr. 9 (Pr. 452) "electronic thermal O/L relay".
     When using the external thermal, change the Pr. 9 (Pr. 452) setting back to "0" after offline auto tuning. The electronic thermal function is made invalid. Set "0" in Pr. 876 if the external thermal relay is not used.
  3) Set the rated motor voltage (V) in Pr. 83 (Pr. 456).
  4) Set the rated motor frequency (Hz) in Pr. 84 (Pr. 457).
  5) Select the motor in Pr. 71 (Pr. 450).
     Example
     •Standard motor . . . . . Pr. 71 (Pr. 450) = "3"
     •Constant torque motor . . . . . Pr. 71 (Pr. 450) = "13"
     •SF-JR 4 poles (1.5kW (2HP) or less) . . . . . Pr. 71 (Pr. 450) = "23"
     •Vector control dedicated motor . . . . . Pr. 71 (Pr. 450) = "33"

CAUTION

For the setting value, set the motor rating plate value..

(2) Tuning command

After setting the above parameters, press FWD or REV.
(For external operation, turn on the run command (STF, STR).)

REMARKS

- To force tuning to end, use the MRS or RES signal or press STOP RESET. (The start signal may also be turned off to end.)
- Excitation noise is produced during tuning.
- When executing offline auto tuning, input the run command after switching on the main circuit power (R, S, T) of the inverter.

(3) Monitoring during execution

When the parameter unit (FR-PU04V) is used, the Pr. 96 (Pr. 463) value is displayed during tuning on the main monitor as shown on the next page. When the operation panel (FR-DU04-1) is used, the same value as on the PU is only displayed.
When Pr.96=1

- Parameter unit (FR-PU04V) main monitor

	1. Setting	2. Tuning in progress	3. Completion	4. Error-activated end (for inverter trip)
Display	1 --- STOP PU	TUNE 2 STF FWD PU	TUNE 3 COMPLETION STF STOP PU	TUNE 9 ERROR STF STOP PU

- Operation panel (FR-DU04-1) display

	1. Setting	2. Tuning in progress	3. Completion	4. Error-activated end (for inverter trip)
Displayed value	1	2	3	9

REMARKS

- Offline auto tuning time (factory setting)
  1: No-rotation mode: Approx. 25s
  2: Rotation mode: Approx. 40s
  (Offline auto tuning time varies with the acceleration and deceleration time settings as indicated below.
  Offline auto tuning time = acceleration time + deceleration time + approx. 30s)

(4) Ending the offline auto tuning

1) Confirm the Pr. 96 (Pr. 463) value.
   • Normal end: "3" or "103" is displayed.
   • Error end: "9", "91", "92" or "93" is displayed.
   • Forced end: "8" is displayed.
2) When tuning ended normally

   For PU operation, press STOP RESET. For external operation, turn off the start signal (STF or STR) once.
   This operation resets the offline auto tuning and the PU's monitor display returns to the normal indication. (Without this operation, next operation cannot be started.) (Refer to page 218 for inverter reset.)
3) When tuning was ended due to an error
   Offline auto tuning did not end normally. (The motor constants have not been set.) Reset the inverter and start tuning all over again.
4) Error display definitions

Error Display	Error Cause	Remedy
9	Inverter trip	Make setting again.
91	Current limit (stall prevention) function was activated.	Increase acceleration/deceleration time. Set "1" in Pr. 156.
92	Converter output voltage reached 75% of rated value.	Check for fluctuation of power supply voltage.
93	Calculation error	Check the motor wiring and make setting again.

   No connection with motor will also result in "93" error.
5) When tuning was ended forcibly

   Tuning is ended forcibly by pressing STOP RESET or turning off the start signal (STF or STR) during tuning.
   In this case, offline auto tuning has not ended properly.
   (The motor constants have not been set.)
   Perform an inverter reset and restart tuning.

REMARKS

1. The motor constants measured once in the offline auto tuning are stored as parameters and their data are held until the offline auto tuning is performed again.
2. An instantaneous power failure occurring during tuning will result in a tuning error. After power is restored, the inverter goes into the ordinary operation mode. Therefore, when STF (STR) is on, the motor runs in the forward (reverse) rotation.
3. Any alarm occurring during tuning is handled as in the ordinary mode. Note that if an error retry has been set, retry is ignored.
4. The set speed monitor displayed during the offline auto tuning is 0r/min.

⚠CAUTION

⚠ **Note that the motor may start running suddenly.**

⚠ **When the offline auto tuning in the rotation mode is used in vertical lift application, e.g. a lifter, it may drop due to insufficient torque.**

4.12.4 Utilizing or changing offline auto tuning data for use

<Setting the motor constants as desired>

Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) (motor constants) may be set as desired in either of two ways; the data measured in the offline auto tuning are read and utilized or changed, or the motor constants are set without the offline auto tuning data being used.

<Operating procedure>

1. Set the following value in Pr. 71 (Pr. 450):
   - Standard motor ..... Pr. 71 (Pr. 450) = "4"
   - Constant-torque motor ..... Pr. 71 (Pr. 450) = "14"
   - SF-JR (4P) (1.5kW(2HP) or less) ..... Pr. 71 (Pr. 450) = "24"
   - Vector control dedicated motor ..... Pr. 71 (Pr. 450) = "34"
2. Set "801" in Pr. 77.
   (The parameter values of Pr. 82 (Pr. 455) "motor excitation current" and Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) (motor constants) can be displayed. Though the parameter values of other than Pr. 82 (Pr. 455) and Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) can also be displayed, they are parameters for manufacturer setting and their values should not be changed.)
3. In the parameter setting mode, read the following parameters and set desired values.

Parameter Number	Name	Setting Range	Setting Increments	Factory Setting
82 (455)	Motor excitation current (no load current)	0 to ****, 9999	1	9999
90 (458)	Motor constant R1	0 to ****, 9999	1	9999
91 (459)	Motor constant R2	0 to ****, 9999	1	9999
92 (460)	Motor constant L1	0 to ****, 9999	1	9999
93 (461)	Motor constant L2	0 to ****, 9999	1	9999
94 (462)	Motor constant x	0 to ****, 9999	1	9999
859 (860)	Torque current	0 to ****, 9999	1	9999

REMARKS

When "0" (factory setting) is set in Pr. 684 "tuning data increment switchover", the motor constants are set in "internal variable increment". When "1" is set in Pr. 684, the motor constants are set in "mH, Ω, A". (can be set when Pr.77 = "801")

4. Return the Pr. 77 setting to the original value.

REMARKS

1. Set "9999" in Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) to use the standard motor constants (including those for the constant-torque motor).
2. Set "3 (standard motor), "13" (constant-torque motor) or "23" (SF-JR(4P) 1.5kW(2HP) or less) in Pr. 71 to use the constants measured in the offline auto tuning. Set "4, 14 or 24" in Pr. 71 (Pr. 450) and change the motor constants to change the values measured in the offline auto tuning.
3. As the motor constants measured in the offline auto tuning have been converted into internal data (****), refer to the following setting example when making setting:
   Setting example: To slightly increase Pr. 90 (Pr. 458) value (5%)
   When Pr. 90 (Pr. 458) is displayed "2516", set 2642, i.e. 2516 × 1.05=2641.8, in Pr. 90 (Pr. 458). (The value displayed has been converted into a value for internal use. Hence, simple addition of a given value to the displayed value has no significance.)
4. When "1" is set in Pr. 96 (Pr. 463), the last values of Pr. 82, Pr. 92, and Pr. 93 (Pr. 455, Pr. 460, Pr. 461) remain unchanged.

4.12.5 Setting the motor constants directly

Offline auto tuning is not used.
The Pr. 92 and Pr. 93 (Pr. 460, Pr. 461) motor constants may either be entered in [Ω] or in [mH]. Before starting operation, confirm which motor constant unit is used. (Refer to page 132.)

● To enter the Pr. 92 and Pr. 93 (Pr. 460, Pr. 461) motor constants in [Ω]

<Operating procedure>

1. After checking that the input motor constants are those for star connection or delta connection, set the Pr. 71 (Pr. 450) value as indicated below (When direct input is selected and offline auto tuning is performed, set "7, 8, 17 or 18") in Pr. 71 (Pr. 450). (Refer to page 138.).

		Star Connection Motor	Delta Connection Motor
Pr. 71 (Pr. 450) Setting	Standard motor	5	6
	Constant-torque motor	15	16

2. Set "801" in Pr. 77.
   (The parameter values of the motor constants (Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462)) can be displayed. Though the parameter values of other than Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) can also be displayed, they are parameters for manufacturer setting and their values should not be changed.)
3. In the parameter setting mode, read the following parameters and set desired values.

I_q=Torque, I_{100}=Rated current, I_0=No load current

$$I_q = \sqrt{I_{100}^2 - I_0^2}$$

Parameter Number	Name	Setting Range	Setting Increments	Factory Setting
82 (455)	Motor excitation current (no load current)	0 to 500A	0.01A	9999
90 (458)	Motor constant r1	0 to 50Ω, 9999	0.001Ω	9999
91 (459)	Motor constant r2	0 to 50Ω, 9999	0.001Ω	9999
92 (460)	Motor constant x1	0 to 50Ω, 9999	0.001Ω	9999
93 (461)	Motor constant x2	0 to 50Ω, 9999	0.001Ω	9999
94 (462)	Motor constant xm	0 to 500Ω, 9999	0.01Ω	9999
859 (860)	Torque current	0 to 500A	0.01A	9999

4. Return the Pr. 77 setting to the original value.
5. Set Pr. 83 and Pr. 84 (Pr. 456, Pr. 457).

Parameter Number	Name	Setting Range	Setting Increments	Factory Setting
83 (456)	Rated motor voltage	0 to 1000V	0.1V	575V
84 (457)	Rated motor frequency	20 to 200Hz	0.01Hz	60Hz

CAUTION

1. **Set "9999" in Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) to use the standard motor constants (including those for the constant-torque motor).**
2. **If "star connection" is mistaken for "delta connection" or vice versa during setting of Pr. 71 (Pr. 450), control cannot be exercised properly.**

● To enter the Pr. 92 and Pr. 93 (Pr. 460 and Pr. 461) motor constants in [mH]

<Operating procedure>

1. After checking that the input motor constants are those for star connection or delta connection, set the Pr. 71 (Pr. 450) value as indicated below.

Pr. 71 (Pr. 450) Setting	Standard motor	0
	Constant-torque motor	10
	Vector control dedicated motor	30

2. Set "801" in Pr. 77.
   (The parameter values of the motor constants (Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462)) can be displayed. Though the parameter values of other than Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) can also be displayed, they are parameters for manufacturer setting and their values should not be changed.)

3. In the parameter setting mode, read the following parameters and set desired values.

Parameter Number	Name	Setting Range	Setting Increments	Factory Setting
82 (455)	Motor excitation current (no load current)	0 to 500A	0.01A	9999
90 (458)	Motor constant R1	0 to 50Ω, 9999	0.001Ω	9999
91 (459)	Motor constant R2	0 to 50Ω, 9999	0.001Ω	9999
92 (460)	Motor constant L1	0 to 1000mH, 9999	0.1mH	9999
93 (461)	Motor constant L2	0 to 1000mH, 9999	0.1mH	9999
94 (462)	Motor constant x	0 to 100%, 9999	0.1%	9999
859 (860)	Torque current	0 to 500A	0.01A	9999

4. Return the Pr. 77 setting to the original value.
5. Refer to the following table and set Pr. 83 and Pr. 84 (Pr. 456 to Pr. 457).

Parameter Number	Name	Setting Range	Setting Increments	Factory Setting
83 (456)	Rated motor voltage	0 to 1000V	0.1V	575V
84 (457)	Rated motor frequency	20 to 200Hz	0.01Hz	60Hz

CAUTION

Set "9999" in Pr. 90 to Pr. 94 (Pr. 458 to Pr. 462) to use the standard motor constants (including those for the constant-torque motor).

4.12.6 Direct input + offline auto tuning

Perform offline auto tuning after directly inputting the motor constants.
1. Set Pr. 71 (Pr. 450).

Pr. 71 Setting	Description	
7	Star connection direct input + offline auto tuning	General-purpose motor
8	Delta connection direct input + offline auto tuning	
17	Star connection direct input + offline auto tuning	Constant-torque motor
18	Delta connection direct input + offline auto tuning	

2. Set the motor constants (Refer to page 137).
3. Set Pr. 96 (Pr. 463) to perform offline auto tuning (Refer to page 133).

4.13 Online auto tuning (Pr. 95)

Excellent torque accuracy is provided by temperature compensation even if the secondary resistance value of the motor varies with the rise in the motor temperature.
This function is effective or when stable, higher-torque operation is needed at low speed in vector control without encoder.

4.13.1 Online auto tuning selection

(Pr. 95, Pr. 9, Pr. 71, Pr. 80, Pr. 81 with Encoder / without Encoder Speed with Encoder / without Encoder Torque Conditional / PLC / SSC Position *)*

Parameter	Name	Factory Setting	Setting Range	Remarks
95	Online auto tuning selection	0	0, 1, 2	0: Online auto tuning not performed 1: Start time tuning (at start-up) 2: Adaptive magnetic flux observer (normal)
9	Electronic thermal O/L relay	Rated inverter output current	0 to 500A	Used as rated motor current and electronic thermal relay function parameters. (Refer to page 93)
71	Applied motor	30	Refer to page 123 and make setting.	
80	Motor capacity	Inverter capacity	0.4 to 55kW	(Down to one rank lower of the inverter capacity)
81	Number of motor poles	4	2, 4, 6	

(1) Pr. 95="1" (start time tuning)

This function is effective for optimum speed estimation and torque accuracy improvement when using the motor without encoder.
The current at a start is detected to compensate for the secondary resistance of the motor so that excellent characteristics are provided regardless of the change in value of the secondary resistance of the motor with the rise of the motor temperature.

POINT

When exercising vector control without encoder, set "1" in Pr. 95 to perform start time tuning.
Perform offline auto tuning in the rotation mode before performing online auto tuning with start time tuning.
Data needs to be calculated.

CAUTION

1. **For using start time tuning in vertical lift applications, examine the utilization of a brake sequence for the brake opening timing at a start. Though the tuning ends in about a maximum of 500ms after a start, torque is not provided fully during that period. Therefore, note that there may be a possibility of gravity drop.**

REMARKS

To prevent delay at starting, X28 function which executes tuning before start signal input is provided. (Refer to page 36.)

(2) Pr. 95 = "2" (normal tuning)/adaptive magnetic flux observer

This function is effective for torque accuracy improvement when using the motor with encoder.
The current flowing in the motor and the inverter output voltage are used to estimate/observe the magnetic flux in the motor.
The magnetic flux of the motor is always detected with high accuracy so that excellent characteristics are provided regardless of the change in the temperature of the secondary resistance.
Set "2" when exercising vector control wtih encoder.

CAUTION

1. Adaptive magnetic flux observer (Pr. 95 = "2") is invalid under vector control without encoder. Select start time tuning.

REMARKS

1. Online auto tuning of the start time tuning is not enabled when the starting conditions of the inverter are not satisfied, e.g. the MRS is input, the preset speed is less than the starting speed (Pr. 13), during inverter error, etc.
2. Online auto tuning of the start time tuning does not operate during deceleration or at a restart during DC brake operation.
3. Invalid for jog operation.
4. The RUN signal is not output during online auto tuning of the start time tuning. The RUN signal turns on at a start.
5. If the period from an inverter stop to a restart is within 4s, online auto tuning of the start time tuning is performed but the tuning results are not reflected.
6. Automatic restart after instantaneous power failure overrides when automatic restart after instantaneous power failure is selected.
7. Zero current detection and output current detection are valid during online auto tuning.

CAUTION

Refer to the Instruction Manual (basic) for details.

Pr. 96 ➡ Refer to page 132.

Pr. 110, Pr. 111 ➡ Refer to Pr. 7 (page 91).

Pr. 116 ➡ Refer to Pr. 42 (page 108).

4.14 Communication functions (Pr. 117 to Pr. 124)

4.14.1 Computer link operation (RS-485 communication) (Pr. 117 to Pr. 124 with Encoder / without Encoder Speed; with Encoder / without Encoder Torque; Conditional / PLC / SSC Position)

Used to perform required settings for communication between the inverter and personal computer.

- Communication operation can be performed from the PU connector of the inverter by RS-485 communication.

<Communication specifications>

Conforming standard			RS-485 Standard
Number of inverters connected			1: N (max. 32 inverters)
Communication speed			Selected among 19200, 9600 and 4800bps
Control protocol			Asynchronous system
Communication method			Half-duplex system
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
		Sum check	Presence
	Waiting time setting		Selectable between presence and absence

- For the data codes of the parameters, refer to the data code list in Appendices (page 226).

REMARKS

For computer link operation, set 65520 (HFFF0) as "8888" and 65535 (HFFFF) as "9999".

<Setting>

To make communication between the personal computer and inverter, the initial settings of the communication specifications must be made to the inverter. Data communication cannot be made if the initial settings are not made or there is any setting error.

CAUTION

Always reset the inverter after making the initial settings of the parameters. Communication is disabled unless the inverter is reset after the communication-related parameter values have been changed.

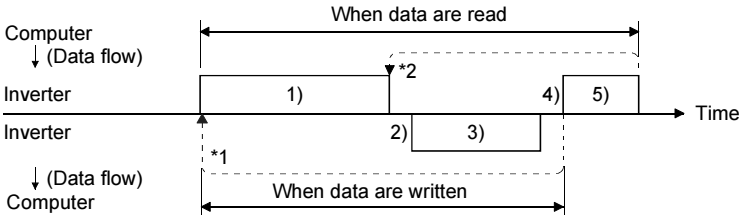
Parameter Number	Name	Factory Setting	Setting		Description
117	Communication station number	0	0 to 31		Station number specified for communication from the PU connector. Set the inverter station numbers when two or more inverters are connected to one personal computer.
118	Communication speed	192	48		4800bps
			96		9600bps
			192		19200bps
119	Stop bit length/ data length	1	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
120	Parity check presence/ absence	2	0		Absent
			1		Odd parity present
			2		Even parity present
121	Number of communication retries	1	0 to 10		Set the permissible number of retries at occurrence of data receive error. If the number of consecutive errors exceeds the permissible value, the inverter will come to an alarm stop (E. PUE).
			9999 (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 RESET input. During a communication error (H0 to H5), the minor fault signal (LF) is given to the open collector output. Allocate the used terminal with any of Pr. 190 to Pr. 192 and Pr. 195 (output terminal function selection).
122*	Communication check time interval	9999	0		No communication
			0.1 to 999.8s		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 (E. PUE).
			9999		Communication check suspension
123	Waiting time setting	9999	0 to 150ms		Set the waiting time between data transmission to the inverter and response.
			9999		Set with communication data.
124	CR/LF instruction presence/ absence	1	0		Without CR/LF
			1		With CR
			2		With CR/LF

* When making communication, set any value other than 0 in Pr. 122 "communication check time interval".

<Computer programming>

(1) Communication procedure

Data communication between the computer and inverter is made in the following procedure.



*1 If a retry must be made at occurrence of a data error, 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 retry 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.

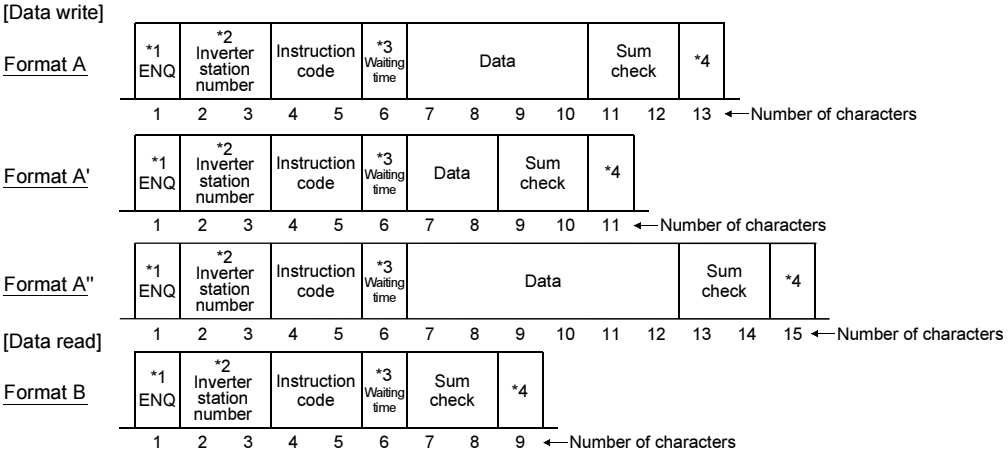
No.	Operation		Run Command	Running Speed	Parameter Write	Inverter Reset	Monitoring	Parameter Read
1)	Communication request is sent to the inverter in accordance with the user program of the computer.		A'	A A"	A	A	B	B
2)	Inverter data processing time		Present	Present	Present	Absent	Present	Present
3)	Reply data from the inverter (Data 1 is checked for error)	No error* (Request accepted)	C	C	C	Absent	E E' E"	E
		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* Inverter performs no processing	Absent	Absent	Absent	Absent	G	G
		With error Inverter re-outputs 3	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 145.)

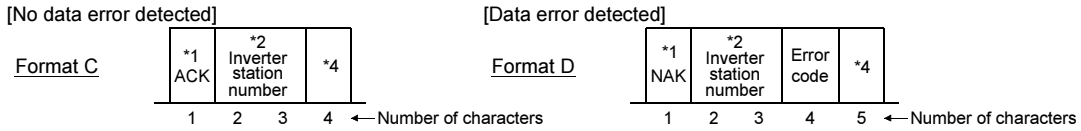
(3) Data format

Data are used in hexadecimal.
Data are automatically converted into ASCII for communication between the computer and inverter.
Data format types

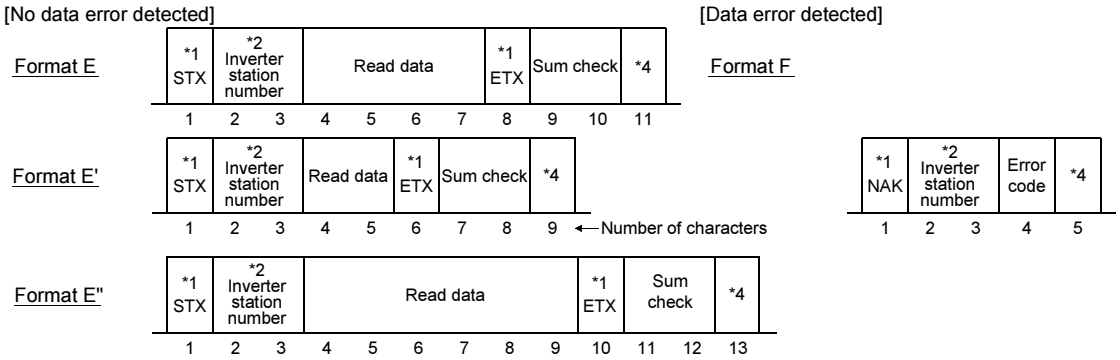
1) Communication request data from the computer to the inverter



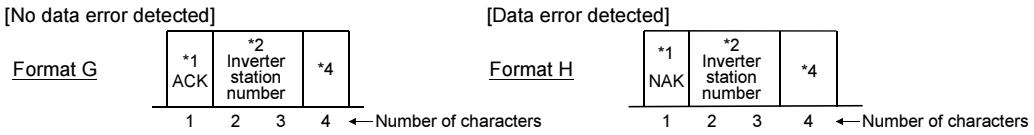
2) Reply data from the inverter to the computer during data write



3) Reply data from the inverter to the computer during data read



4) Send data from the computer to the inverter during data read



CAUTION

1. **Indicates the control code.**
2. **Specify the inverter station numbers between H00 and H1F (stations 0 and 31) in hexadecimal.**
3. **When the Pr. 123 "waiting time setting" setting is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)**
4. **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 from the inverter according to the computer.
   Also, the presence and absence of the CR and LF codes can be selected using Pr. 124.

(4) Data definitions

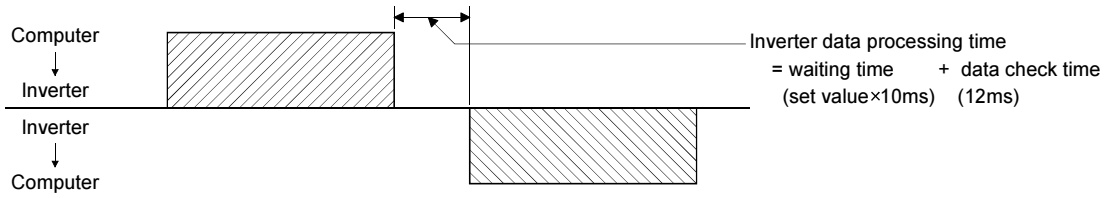
1) Control codes

Signal Name	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 or monitoring, given by the computer to the inverter. Hence, the inverter can be run and monitored in various ways by specifying the instruction codes as appropriate. (Refer to page 226.)
4) Data
   Indicates the data such as speed 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 226.)

5) Waiting time

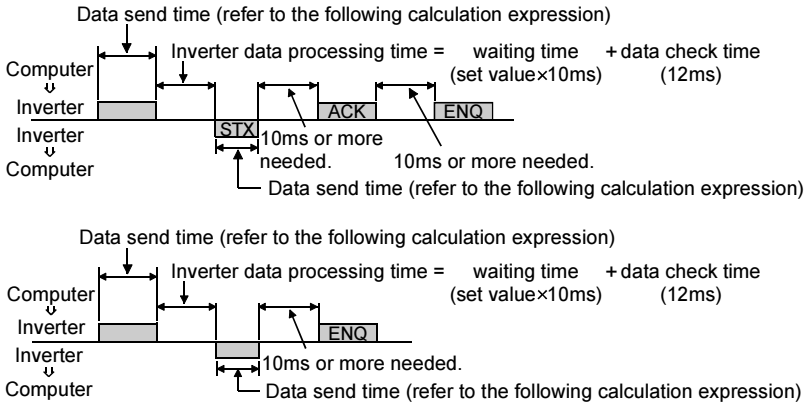
Specify the waiting time between the receipt of data by the inverter from the computer and the transmission of reply data from the inverter. Set the waiting time in accordance with the response time of the computer between 0 and 150ms in 10ms increments. (Example: 1 = 10ms, 2 = 20ms)



CAUTION

When the Pr. 123 "waiting time setting" setting is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

6) Response time



[Data send time calculation expression]

$$\frac{1}{\text{Communication speed (bps)}} \times \text{Number of data characters (Refer to page 143)} \times \text{Communication specifications (Total number of bits) (See below)} = \text{Data send time (s)}$$

- Communication specifications

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

1 start bit is needed in addition to the bits in the left table.
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.

(Example 1)

Computer→Inverter

	ENQ	Station number		Instruction code		* Waiting time	Data				Sum check code		
		0	1	E	1	1	0	7	A	D	F	4	←Binary code
ASCII code→	H05	H30	H31	H45	H31	H31	H30	H37	H41	H44	H46	H34	

$H30 + H31 + H45 + H31 + H31 + H30 + H37 + H41 + H44$

$= 1F4H$

Sum

*: When the Pr. 123 "waiting time setting" setting is other than 9999, create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

(Example 2)

Inverter→Computer

	STX	Station number		Read data				ETX	Sum check code		
		0	1	1	7	7	0		3	0	←Binary code
ASCII code→	H02	H30	H31	H31	H37	H37	H30	H03	H33	H30	

$H30 + H31 + H31 + H37 + H37 + H30$

$= 130H$

Sum

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 150.)

CAUTION

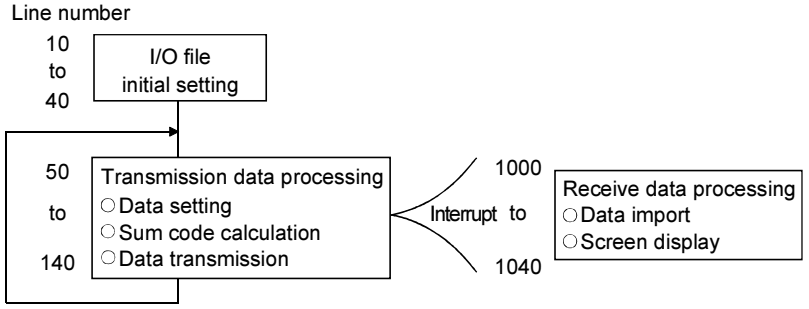
1. **When the data from the computer has an error, the inverter does not accept that data.**
2. **Any data communication, e.g. run command or monitoring, is started when the computer gives a communication request. Without the computer's command, the inverter does not return any data. For monitoring, etc. therefore, design the program to cause the computer to provide a data read request as required.**

(5) Instructions for the program

1) When data from the computer has any error, the inverter does not accept that error. Hence, in the user program, always insert a retry program for data error.
2) Since any data communication, such as operation command or monitoring, is always requested by the computer, the inverter will not return data without the computer's request. Hence, design the program so that the computer gives a data read request for monitoring, etc. as required.
3) Program example
   When the operation mode is switched to communication operation

```
                                                  Initial setting of I/O file
 10 OPEN "COM1:9600,E,8,2,HD" AS #1               : Communication file opening
 20 COMST1,1,1:COMST1,2,1                         : Circuit control signal (RS, ER) ON/OFF setting
 30 ON COM(1)GOSUB*REC                            : Interrupt definition at data receive
 40 COM(1)ON                                      : Interrupt enable
 50 D$= "01FB10002"                               Transmission data setting
 60 S=0
 70 FOR I=1 TO LEN(D$)
 80 A$=MID$(D$,I,1)
 90 A=ASC(A$)                                     Sum code calculation
100 S=S+A
110 NEXTI
120 D$=CHR$(&H5)+D$+RIGHT$(HEX$(S),2)  : Addition of control and sum codes
130 PRINT#1,D$                                    Data transmission
140 GOTO 50
1000 *REC                                         Interrupt data receive
1010 IF LOC(1)=0 THEN RETURN                      : Interrupt occurrence at data receive
1020 PRINT "RECEIVE DATA"
1030 PRINT INPUT$(LOC(1),#1)
1040 RETURN
```

General flowchart



⚠CAUTION

⚠ **When the inverter's communication time interval is not set, interlocks are provided to disable operation to prevent hazard. 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 (E.PUE).**
The inverter can be coasted to a stop by turning 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 setting, set the instruction codes and data and 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</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 option operation
H0001: External operation
H0002: Communication operation (PU connector)</td><td rowspan="2">4 digits</td></tr>
<tr><td>Write</td><td>HFB</td><td>H0000: Communication option operation
H0001: External operation
H0002: Communication operation (PU connector)</td></tr>
<tr><td rowspan="6">2</td><td rowspan="6">Monitoring</td><td colspan="2">Speed</td><td>H6F</td><td>H0000 to HFFFF: Speed (hexadecimal) in 1r/min increments (4 digits)
[In 0.1r/min increments (6 digits) when HFF = 1.]</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">Output voltage</td><td>H71</td><td>H0000 to HFFFF: Output voltage (hexadecimal) in 0.1V increments</td><td>4 digits</td></tr>
<tr><td colspan="2">Special monitor</td><td>H72</td><td>H0000 to HFFFF: Monitor data selected in instruction code HF3</td><td>4 digits</td></tr>
<tr><td rowspan="2">Special monitor selection No.</td><td>Read</td><td>H73</td><td rowspan="2">H01 to H0E: Monitor selection data
*0.1r/min increments when HFF = 1
<Input terminal monitor details>
b15 b0
RES OH DI4 DI3 DI2 DI1 STR STF
<Output terminal monitor details>
b15 b0
ABC DO3 DO2 DO1</td><td rowspan="2">2 digits</td></tr>
<tr><td>Write</td><td>HF3</td></tr>
<tr><td>Alarm definition</td><td colspan="2">H74 to H77</td><td>H0000 to HFFFF: Two latest alarm definitions
Alarm definition display example (instruction code H74)
Read data: [Example] H30A0
(Previous alarm··· THT)
(Latest alarm ····· OPT)
b15 b8b7 b0
0 0 1 1 0 0 0 0 1 0 1 0 0 0 0 0
Previous alarm (H30) Latest alarm (HA0)
Alarm data</td><td>4 digits</td></tr>
</table>

H01 to H0E: Monitor selection data

Data	Description	Increments	Data	Description	Increments
H01	Output frequency	0.01Hz	H10	Output terminal status	—
H02	Output current	0.01A	H11	Load meter	0.1%
H03	Output voltage	0.1V	H12	Motor excitation current	0.01A
H05	Speed setting*	1r/min	H13	Position pulse	—
H06	Running speed*	1r/min	H14	Cumulative operation time	1h
H07	Motor torque	0.1%	H17	Actual operation time	1h
H08	Converter output voltage	0.1V	H18	Motor load factor	0.1%
H09	Regenerative brake	0.1%	H20	Torque command	0.1%
H0A	Electronic overcurrent protection load factor	0.1%	H21	Torque current command	0.1%
H0B	Output current peak value	0.01A	H22	Motor output	0.01kW (0.01HP)
H0C	Converter output voltage peak value	0.1V	H23	Feedback pulse	—
H0F	Input terminal status	—			

Alarm data

Data	Description	Data	Description	Data	Description
H00	No alarm	H81	LF	HD3	OD
H10	0C1	H90	OHT	HD4	ECA
H11	0C2	HA0	OPT	HD5	MB1
H12	0C3	HA1	OP1	HD6	MB2
H20	0V1	HA2	OP2	HD7	MB3
H21	0V2	HA3	OP3	HD8	MB4
H22	0V3	HB0	PE	HD9	MB5
H30	THT	HB1	PUE	HDA	MB6
H31	THM	HB2	RET	HDB	MB7
H40	FIN	HC1	CTE	HDC	EP
H50	IPF	HC2	P24	HF1	E.1
H51	UVT	HC3	P12	HF2	E.2
H60	OLT	HD0	OS	HF3	E.3
H70	BE	HD1	OSD	HF6	E.6
H80	GF	HD2	ECT	HF7	E.7

<table>
<tr><th>No.</th><th>Item</th><th>Instruction Code</th><th>Description</th><th>Number of Data Digits</th></tr>
<tr><td>3</td><td>Alarm definition all clear</td><td>HF4</td><td>H9696: Clears the error history.</td><td>4 digits</td></tr>
<tr><td>4</td><td>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: ——
b4: ——
b5: ——
b6: ——
b7: ——</td><td>2 digits</td></tr>
<tr><td>5</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 occurrence
b0: Inverter running (RUN)
b1: Forward rotation
b2: Reverse rotation
b3: DO1*
b4: DO2*
b5: DO3*
b6: Speed detection (FB)
b7: Alarm occurrence*
* Output data varies with the settings of Pr. 190 to Pr. 192 and Pr. 195.</td><td>2 digits</td></tr>
<tr><td rowspan="2">6</td><td>Set speed write (E^2PROM)</td><td>HEE</td><td rowspan="2">HFF=0
H0000 to H1C20: 1r/min increments (hexadecimal) (4 digits)
HFF=1
H0000 to H11940: 0.1r/min increments (hexadecimal) (6 digits)
To change the running speed consecutively, write data to the inverter RAM.
(Instruction code: HED)</td><td rowspan="2">4 digits
(6 digits)</td></tr>
<tr><td>Set speed write (RAM)</td><td>HED</td></tr>
<tr><td rowspan="2">7</td><td>Set speed (E^2PROM) read</td><td>H6E</td><td rowspan="2">HFF = 0
H0000 to H1C20: 1r/min increments (hexadecimal) (4 digits)
HFF = 1
H0000 to 11940: 0.1r/min increments (hexadecimal) (6 digits)</td><td rowspan="2">4 digits
(6 digits)</td></tr>
<tr><td>Set speed (RAM) read</td><td>H6D</td></tr>
<tr><td>8</td><td>Inverter reset</td><td>HFD</td><td>H9696: Resets the inverter.
As the inverter is reset at start of communication by the computer, the inverter cannot send reply data back to the computer.</td><td>4 digits</td></tr>
<tr><td>9</td><td>Parameter all clear</td><td>HFC</td><td>All parameters return to the factory settings.
Any of four different clear operations is 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 HF3 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 parameter all 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>10</td><td colspan="2">Parameter write</td><td>H80 to HFD</td><td rowspan="2">Refer to the data list (page 226) and write and/or read parameter values as required.</td><td rowspan="2">4 digits</td></tr>
<tr><td>11</td><td colspan="2">Parameter read</td><td>H00 to H7B</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Link parameter expansion setting</td><td>Read</td><td>H7F</td><td rowspan="2">Parameter description is changed according to H00 to H09 setting. Refer to the parameter data code list (page 226) for details of the setting value.
CAUTION
When the instruction code "HFF" was rewritten, increments of the speed monitor, write and read is changed.
HFF = "0" . . . . . .1r/min increments
HFF = "1" . . . . . .0.1r/min increments
HFF = more than "2" . . . .1r/min increments</td><td rowspan="2">2 digits</td></tr>
<tr><td>Write</td><td>HFF</td></tr>
</table>

No.	Item		Instruction Code	Description	Number of Data Digits
13	Second parameter changing (Code FF=1)	Read	H6C	When reading/setting the bias/gain (data code H5E to H61, HDE to HE1) parameters H00: Speed/torque H01: Analog H02: Analog value of terminal (When written, the data value is any 4-digit value.)	2 digits
		Write	HEC		

REMARKS

For the instruction codes HFF, HEC and HF3, their values are held once written but cleared to zero when an inverter 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	Error Item	Error Definition	Inverter Side Operation
H0	Computer NAK error	The number of errors consecutively detected in communication request data from the computer is greater than the allowed number of retry times.	Brought to an alarm stop (E. PUE) if error occurs continuously more than the allowable number of retry times.
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 the wrong protocol, data receive is not completed within the given time, or CR and LF are not as set in the parameter.	
H4	Framing error	The stop bit length differs from the initial setting.	
H5	Overrun	New data has been set 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 receive 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 or receive 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, running frequency write, etc.	
HD	—	—	—
HE	—	—	—
HF	—	—	—

(6) Communication specifications for RS-485 communication

Operation Location	Item	Operation Mode		
		Communication operation from PU connector	External operation	Computer link operation (When plug-in option is used)
On-computer user program from PU connector	Run command (start)	Enable	Disable	Disable
	Running speed setting	Enable	Enable (Combined operation mode)	Disable
	Monitoring	Enable	Enable	Enable
	Parameter write	Enable (*4)	Disable (*4)	Disable (*4)
	Parameter read	Enable	Enable	Enable
	Inverter reset	Enable (*2)	Enable (*2)	Enable (*2)
	Stop command (*3)	Enable	Enable	Enable
On-computer user program from plug-in option	Run command	Disable	Disable	Enable (*1)
	Running speed setting	Disable	Disable	Enable (*1)
	Monitoring	Enable	Enable	Enable
	Parameter write	Disable (*4)	Disable (*4)	Enable (*4)
	Parameter read	Enable	Enable	Enable
	Inverter reset	Disable	Disable	Enable (*2)
	Stop command (*3)	Disable	Disable	Enable
Control circuit terminal	Inverter reset	Enable	Enable	Enable
	Run command	Disable	Enable	Enable (*1)
	Speed setting	Disable	Enable	Enable (*1)

(*1) As set in the Pr.79 external/PU combined mode.
(*2) At occurrence of RS-485 communication error, the inverter cannot be reset from the computer.
(*3) As set in Pr. 75.
(*4) As set in Pr. 77.

(7) Operation at alarm occurrence

Alarm Location	State		Operation Mode		
			Communication operation (PU connector)	External operation	Computer link operation (When plug-in option is used)
Inverter fault	Inverter operation		Stop	Stop	Stop
	Communication	PU connector	Continued	Continued	Continued
		Plug-in option	Continued	Continued	Continued
Communication error (Communication from PU connector)	Inverter operation		Stop/continued (*5)	Continued	Continued
	Communication	PU connector	Stop	Stop	Stop
		Plug-in option	Continued	Continued	Continued

*5: Can be selected using the parameter (factory-set to Continued).

(8) Communication error

Alarm Location	Error Message
Communication error (Error in communication from PU connector)	E.PUE

4.14.2 E^2PROM write selection (Pr. 342)

You can select either E^2PROM or RAM to which parameters to be written during computer link communication operation (RS-485 communication by PU connector) and operation with a communication option. When changing the parameter values frequently, write them to the RAM (Pr. 342 = 1).

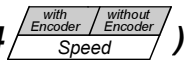
Parameter	Name	Factory Setting	Setting Value	
342	E^2PROM write selection	0	0	Write into E^2PROM
			1	Write into RAM

Pr. 342 Setting	
0 (factory setting)	E^2PROM write Powering off the inverter will not erase the changed parameter values.
1	RAM write Powering off the inverter will erase the changed parameter values. Therefore, the parameter values available when power is switched on again are the values stored in E^2PROM last time.

REMARKS

When the parameter setting is "not written to the E^2PROM" (setting=1), the settings return to the original values (values saved in the E^2PROM) at power-on reset or terminal reset.

4.15 PID control (Pr. 128 to Pr. 134)

4.15.1 PID control (Pr. 128 to Pr. 134 

)

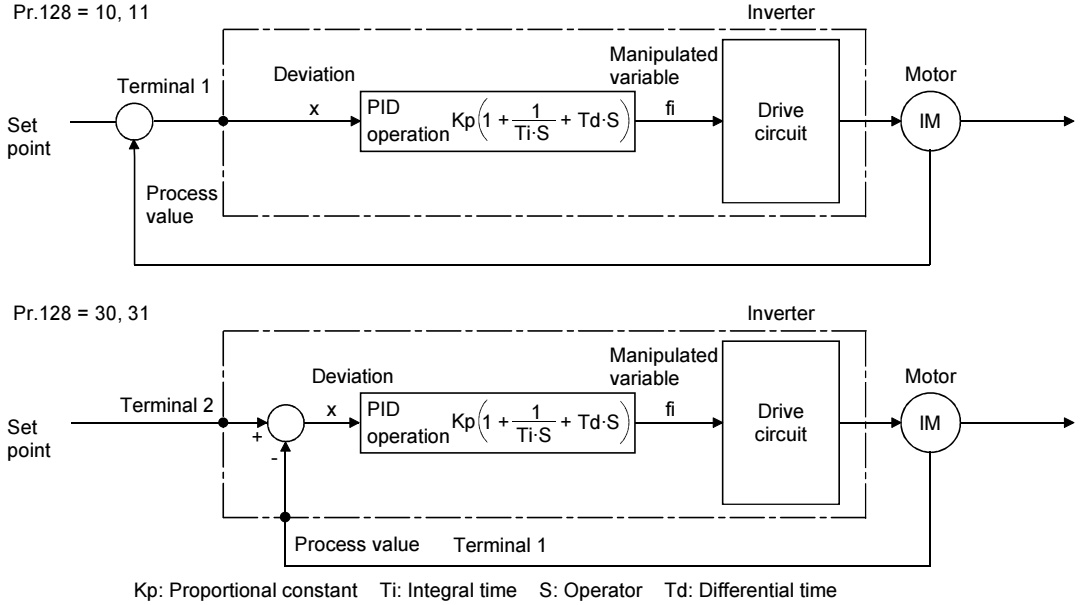
The inverter can be used to exercise process control, e.g. flow rate, air volume or pressure.

- The voltage input signal (0 to ±10V) is used as a feedback value to constitute a feedback system for PID control.

Parameter Number	Name	Factory Setting	Setting Range	Remarks
128	PID action selection	10	10, 11, 30, 31	
129	PID proportional band	100%	0.1 to 1000%, 9999	9999: No proportional control
130	PID integral time	1s	0.1 to 3600s, 9999	9999: No integral control
131	Upper limit	9999	0 to 100%, 9999	9999: Function invalid
132	Lower limit	9999	0 to 100%, 9999	9999: Function invalid
133	PID action set point for PU operation	0%	0 to 100%	
134	PID differential time	9999	0.01 to 10.00s, 9999	9999: No differential control

<Setting>

(1) Basic PID control configuration



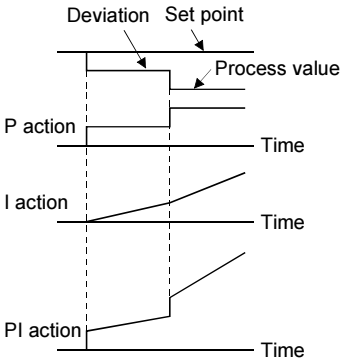
Kp: Proportional constant Ti: Integral time S: Operator Td: Differential time

(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]

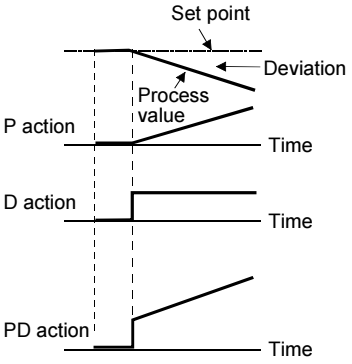
CAUTION
PI action is the sum of P and I actions.



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.

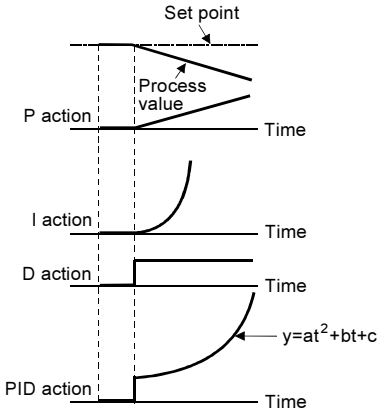
[Operation example for proportional changes of process value]

CAUTION
PD action is the sum of P and D actions.

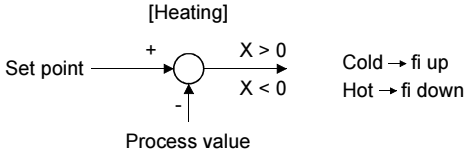


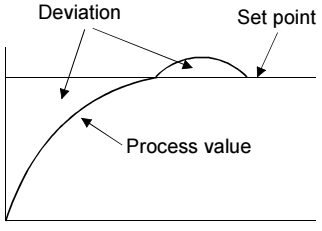
3) PID action
The PI action and PD action are combined to utilize the advantages of both actions for control.

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

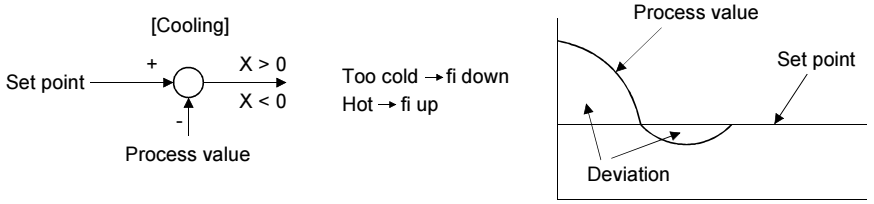


4) Reverse action
Increases the manipulated variable (output speed) if deviation X (set point - process value) is positive, and decreases the manipulated variable if deviation is negative.





5) Forward action
Increases the manipulated variable (output speed) if deviation X (set point - process value) is negative, and decreases the manipulated variable if deviation is positive.

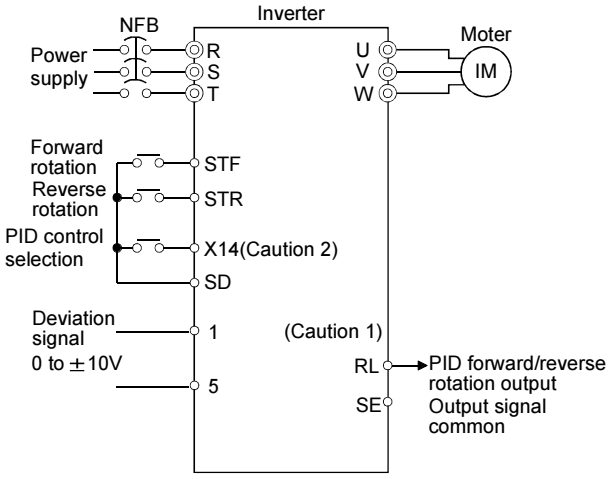


Relationships between deviation and manipulated variable (output speed)

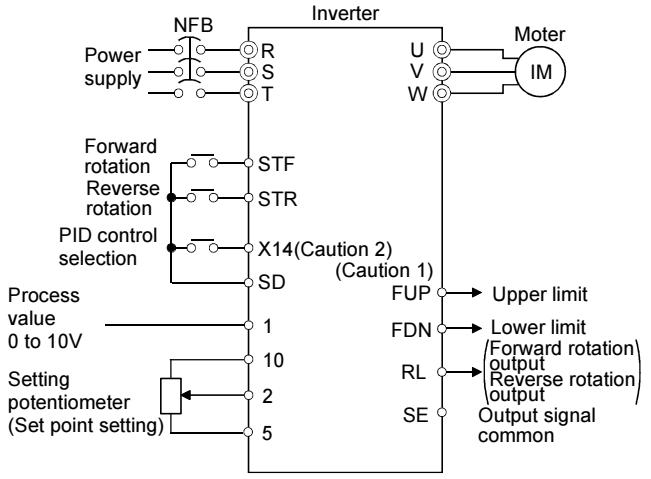
	Deviation	
	Positive	**Negative**
Reverse Action	↗	↘
Forward Action	↘	↗

(3) Wiring example

Pr.128 = 10, 11



Pr.128 = 30, 31



CAUTION

1. Set "16" to the output signal terminal used (Pr. 190 to Pr. 192, Pr. 195). (Refer to page 165.)
2. Set "14" to the input signal terminal used (Pr. 180 to Pr. 183, Pr. 187). (Refer to page 163.)

(4) I/O signals

Signal		Terminal Used	Function	Description	Remarks	
Input	X14	Depending on Pr. 180 to 183, Pr. 187	PID control selection	Turn on X14 to select PID control.	Set any of 10, 11, 30 and 31 in Pr. 128.	
	1	1	Deviation signal input	Enter the deviation signal of the 0 to ±10V signal calculated externally.	When Pr. 128 = 10, 11	Refer to Pr. 917 and Pr. 918 (page 202) for calibration.
			Process value input	Enter the 0 to 10V process value signal from the detector.	When Pr. 128 = 30, 31	
	2	2	Set point input	Enter the set point for PID control.	When Pr. 128 = 30, 31	Refer to Pr. 902 and Pr. 903 (page 202) for calibration.
	5	5	Common terminal to the PID control setting signal (terminal 2, 1)	Isolated from terminals SD and SE. Do not ground.		
Output	RL	Depending on Pr. 190 to 192, Pr. 195	PID forward/ reverse rotation 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).	(When Pr. 128 = 10, 11, 30, 31)	Open collector output
	FUP		Upper limit output	Output to indicate that the process value signal exceeded the upper limit value.	When Pr. 128 = 30, 31	
	FDN		Lower limit output	Output to indicate that the process value signal exceeded the lower limit value.		
	SE	SE	Output terminal common	Common terminal for terminal RL		

- To start PID control, turn on the X14 signal. When this signal is off, normal inverter operation is performed without the PID action being done.
- When entering the externally calculated deviation signal, enter it across terminals 1-5. At this time, set "10" or "11" in Pr. 128.
- Enter the set point across inverter terminals 2-5 or into Pr. 133 and enter the process value signal across inverter terminals 1-5. At this time, set "30" or "31" in Pr. 128.

Item	Entry Method	Description	
Deviation signal	Across terminals 1-5	Set -10V as -100% Set 0V as 0% and +10V as +100%.*	When 10 or 11 is set in Pr. 128, terminal 1 gives the deviation input signal independently of the Pr. 868 setting.
Set point	Across terminals 2-5	Set 0V as 0% and 10V as +100%.*	When 30 or 31 is set in Pr. 128, terminal 1 gives the process value input signal independently of the Pr. 868 setting.
	Pr.133	Set the set point (%) in Pr. 133.	
Process value	Across terminals 1-5	Set 0V as 0% and +10V as +100%.*	

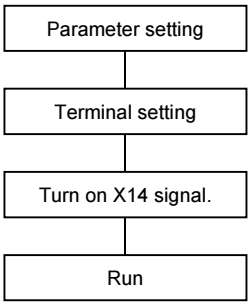
*: The value changes by calibration

(5) Parameter setting

Parameter Number	Setting	Name	Description		
128	10	PID action selection	For heating, pressure control, etc.	Deviation value signal input (terminal 1)	PID reverse action
	11		For cooling, etc.		PID forward action
	30		For heating, pressure control, etc.	Process value input (terminal 1)	PID reverse action
	31		For cooling, etc.		PID forward action
129	0.1 to 1000%	PID proportional band	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 Kp= 1/proportional band		
	9999		No proportional control		
130	0.1 to 3600s	PID integral time	Time required for only 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.		
	9999		No integral control.		
131	0 to 100%	Upper limit	Set the upper limit value. If the feedback value exceeds the setting, the FUP signal is output. (Process value of 0V is equivalent to 0% and 10V to 100%.)*		
	9999		No function		
132	0 to 100%	Lower limit	Set the lower limit value. (If the process value goes out of the setting range, an alarm can be output. In this case, the process value of 0V is equivalent to 0% and 10V to 100%.)*		
	9999		No function		
133	0 to 100%	PID action set point for PU operation	Only valid for the PU command in the PU operation or PU/external combined mode. For external operation, the voltage across terminals 2-5 is the set point. (Pr. 902 value is equivalent to 0% and Pr. 903 value to 100%.)		
134	0.01 to 10.00s	PID differential time	Time required for only the differential (D) action to provide the same manipulated variable as that for the proportional (P) action. As the differential time increases, greater response is made to a deviation change.		
	9999		No differential control.		

*: The value changes by calibration

(6) Adjustment procedure

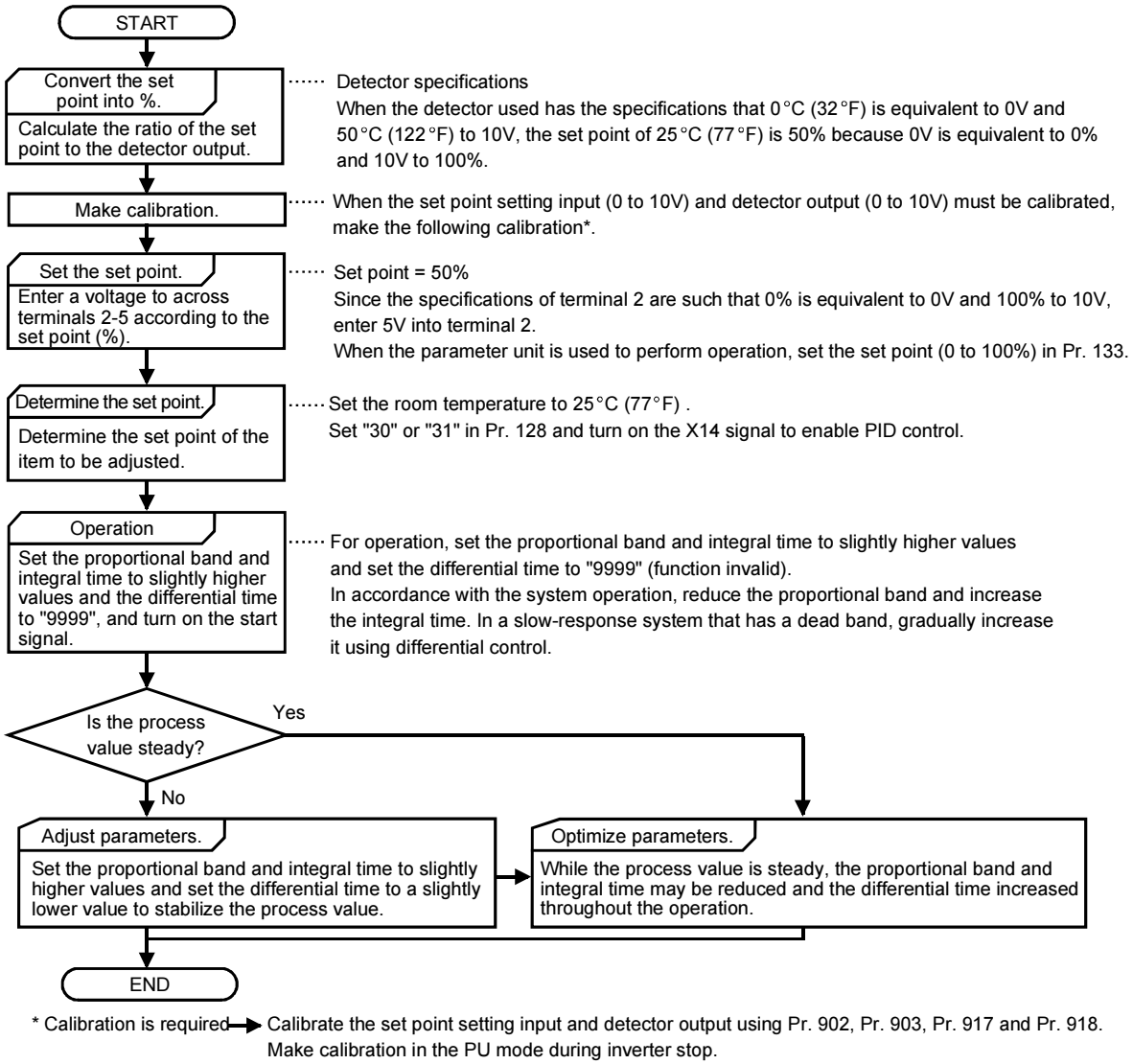


Adjust the PID control parameters, Pr. 128 to Pr. 134.

Set the I/O terminals for PID control
(Pr. 180 to Pr. 183, Pr. 187, Pr. 190 to Pr. 192, Pr. 195).
Pr.128 = 10, 11, 30, 31

(7) Adjustment example

(A detector of 0V at 0°C (32°F) and 10V 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 to 10V).)



* Calibration is required → Calibrate the set point setting input and detector output using Pr. 902, Pr. 903, Pr. 917 and Pr. 918.
Make calibration in the PU mode during inverter stop.

(8) Calibration example

<Set point input calibration>

1. Apply the input voltage of 0% set point setting (e.g. 0V) to across terminals 2-5.
2. Make calibration using Pr. 902. At this time, enter the speed output by the inverter at the deviation of 0% (e.g. 0r/min).
3. Apply the voltage of 100% set point setting (e.g. 10V) to across terminals 2-5.
4. Make calibration using Pr. 903. At this time, enter the speed output by the inverter at the deviation of 100% (e.g. 1800r/min).

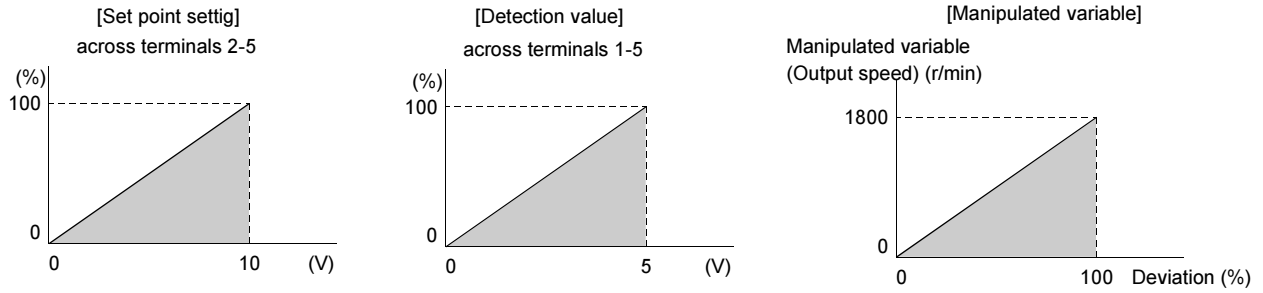
<Detector output calibration>

1. Apply the output current of 0% detector setting (e.g. 0V) to across terminals 1-5.
2. Make calibration using Pr. 917.
3. Apply the output current of 100% detector setting (e.g. 5V) to across terminals 1-5.
4. Make calibration using Pr. 918.

CAUTION

The frequencies set in Pr. 917 and Pr. 918 should be the same as set in Pr. 902 and Pr. 903.

The results of the above calibration are as shown below:



CAUTION

1. **If the multi-speed (RH, RM, RL) signal or jog operation (jog) signal is entered with the X14 signal on, PID control is stopped and multi-speed or jog operation is started.**
2. **When "6" (switchover mode) is selected for Pr. 79, PID is made invalid.**
3. **When "1" (online auto tuning) is selected for Pr. 95, PID control is made invalid.**
4. **Changing the terminal function using any of Pr. 180 to 183 and Pr. 187 and Pr. 190 to 192 and Pr. 195 may affect the other functions. Confirm the functions of the corresponding terminals before making setting.**
5. **When PID control is selected, the minimum speed is as set in Pr. 902 and the maximum speed is as set in Pr. 903.**
   (Pr. 1 "maximum speed" and Pr. 2 "minimum speed" settings are also valid.)

Related parameters

- Pr. 73 "speed setting signal" (Refer to page 125.)
- Pr. 79 "operation mode selection" (Refer to page 129.)
- Pr. 180 to Pr. 183, Pr. 187 (input terminal function selection) (Refer to page 163.)
- Pr. 191 to Pr. 192, Pr. 195 (output terminal function selection) (Refer to page 165.)
- Pr. 902, Pr. 903, Pr. 917, Pr. 918 (Speed setting terminal bias/gain) (Refer to page 202.)

Pr. 140 to Pr. 143 ➡ Refer to Pr. 29 (page 102)

Pr. 144 ➡ Refer to Pr. 37 (page 106)

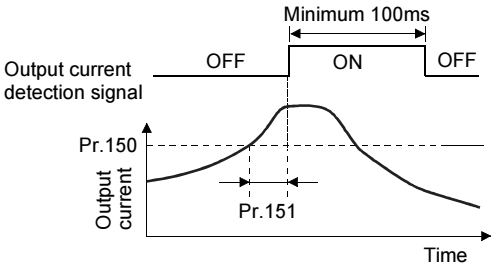
4.16 Current detection (Pr. 150 to Pr. 153)

4.16.1 Output current detection function (Pr. 150, Pr. 151)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

- If the output current remains higher than the Pr. 150 setting during inverter operation for longer than the period set in Pr. 151, the output current detection signal (Y12) is output from the inverter's open collector output terminal.
  (Use any of Pr. 190 to Pr. 192 and Pr. 195 to assign the terminal used for Y12 signal output.)

Parameter	Name	Factory Setting	Setting Range
150	Output current detection level	150%	0 to 200.0%
151	Output current detection period	0	0 to 10s



<Setting>

Refer to the following table and set the parameters.

Parameter	Description
150	Set the output current detection level. 100% is the rated inverter current.
151	Set the output current detection period. Set the period from when the output current has risen above the setting until the output current detection signal (Y12) is output.

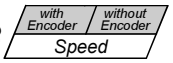
CAUTION

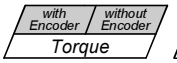
1. **Once turned on, the output current detection signal is held on for at least 100ms.**
2. **This function is also valid during execution of the online or offline auto tuning.**
3. **Changing the terminal function using any of Pr. 190 to 192 and Pr. 195 may affect the other functions. Confirm the functions of the corresponding terminals before making setting.**
4. **When "0" is set in Pr. 151, the output current detection period is about 50ms.**

Related parameters

- Y12 signal terminal assignment ⇒ Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection) (Refer to page 165.)

4.16.2 Zero current detection (Pr. 152, Pr. 153)

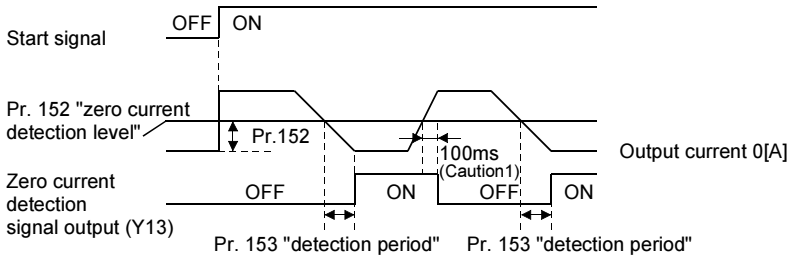




When the inverter's output current falls to "0", torque will not be generated. This may cause a gravity drop to occur when the inverter is used in vertical lift application.
To prevent this, the output current "zero" signal can be output from the inverter to close the mechanical brake when the output current has fallen to "zero".

- If the output current remains lower than the Pr. 152 setting during inverter operation for longer than the period set in Pr. 153, the zero current detection (Y13) signal is output from the inverter's open collector output terminal.
  (Use any of Pr. 190 to Pr. 192 and Pr. 195 to assign the terminal used for Y13 signal output.)

Parameter	Name	Factory Setting	Setting Range
152	Zero current detection level	5.0%	0 to 200.0%
153	Zero current detection period	0.5s	0 to 1s



<Setting>

Refer to the following table and set the parameters.

Parameter	Description
152	Set the zero current detection level. Set this parameter to define the percentage of the rated current at which the zero current will be detected.
153	Set the zero current detection period. Set this parameter to define the period from when the output current drops below the Pr. 152 value until the zero current detection signal (Y13) is output.

CAUTION

1. **If the current rises above the preset detection level and the condition is not satisfied, the zero current detection signal is held on for about 100ms.**
2. **This function is also valid during execution of the online auto tuning.**
3. **Changing the terminal function using any of Pr. 190 to 192 and Pr. 195 may affect the other functions. Confirm the functions of the corresponding terminals before making setting.**
4. **When "0 to 0.04" is set in Pr. 153, the zero current detection period is about 50ms.**

⚠CAUTION

⚠ **The zero current detection level setting should not be too high, and the zero current detection period setting not too long.**
Otherwise, the detection signal may not be output when torque is not generated at a low output current.

⚠ **To prevent the machine and equipment from resulting in hazardous conditions by use of the zero current detection signal, install a safety backup such as an emergency brake.**

Related parameters

- Y13 signal terminal assignment ⇒ Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection) (Refer to page 165.)

4.17 Auxiliary functions (Pr. 156, Pr. 157)

4.17.1 Stall prevention operation selection (Pr. 156)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

Make setting to disable stall prevention activated by overcurrent and/or to prevent the inverter from resulting in an overcurrent trip if an excessive current flows due to sudden load fluctuation or running inverter output side ON-OFF (to disable high-response current restriction that limits the current). An OL signal output delay can be set in Pr. 157.

- Stall prevention (only during V/F control)
  Automatically change the output frequency of the inverter to reduce the amount of current when the current flow exceeds the current restriction value.
- High-response current restriction
  Shut off the output of the inverter to prevent overcurrent when the current flows exceeds the current restriction value.

Parameter	Name	Factory Setting	Setting Range	Remarks
156	Stall prevention operation selection	1	0 to 31, 100, 101	Extended mode

Setting	High-Response Current Restriction ○ : Activated ● : Not activated	Stall Prevention ○ : Activated			OL Signal Output ○ : Operation continued ● : Operation not continued (Caution1)
		Acceleration	Constant speed	Deceleration	
0	○	○	○	○	○
1	●	○	○	○	○
2	○	●	○	○	○
3	●	●	○	○	○
4	○	○	●	○	○
5	●	○	●	○	○
6	○	●	●	○	○
7	●	●	●	○	○
8	○	○	○	●	○
9	●	○	○	●	○
10	○	●	○	●	○
11	●	●	○	●	○
12	○	○	●	●	○
13	●	○	●	●	○
14	○	●	●	●	○
15	●	●	●	●	○
16	○	○	○	○	●
17	●	○	○	○	●
18	○	●	○	○	●
19	●	●	○	○	●
20	○	○	●	○	●
21	●	○	●	○	●
22	○	●	●	○	●
23	●	●	●	○	●

Setting		High-Response Current Restriction ○ : Activated ● : Not activated	Stall Prevention ○ : Activated			OL Signal Output ○ : Operation continued ● : Operation not continued (Caution1)
			Acceleration	Constant speed	Deceleration	
24		○	○	○	●	●
25		●	○	○	●	●
26		○	●	○	●	●
27		●	●	○	●	●
28		○	○	●	●	●
29		●	○	●	●	●
30		○	●	●	●	●
31		●	●	●	●	●
100	Driving	○	○	○	○	○
	Regenerative	●	●	●	●	○
101(Caution 3)	Driving	●	○	○	○	○
	Regenerative	●	●	●	●	○

CAUTION

1. **When "Operation not continued for OL signal output" is selected, the "E. OLT" alarm code (stopped by stall prevention) is displayed and operation stopped. (Alarm stop display "E. OLT")**
2. **For the lift application, make setting to disable high-response current restriction. Otherwise the torque may not be generated, resulting in the lift drop with gravity.**
3. **When the setting value is "101", high-response current restriction at driving is well disabled compared to when "100" is set.**

⚠CAUTION

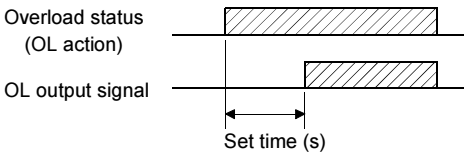
⚠ **Always perform test operation.**
Stall prevention operation performed during acceleration may increase the acceleration time.
Stall prevention operation performed during constant speed may cause sudden speed changes.
Stall prevention operation performed during deceleration may increase the deceleration time, increasing the deceleration distance.

4.17.2 OL signal output timer (Pr. 157 with Encoder / without Encoder — Speed; with Encoder / without Encoder — Torque; Conditional / PLC / SSC — Position *)*

Use this parameter to set whether the overload alarm signal (OL signal) is output immediately or a preset period of time after occurrence of an overload status.

Parameter	Name	Factory Setting	Setting Range	Remarks
157	OL signal output timer	0s	0 to 25s, 9999	9999: No signal output

V/F control ..... On when stall prevention operation level is exceeded.
Speed control .....On when torque restriction is activated.
Torque control ..... On when speed restriction is activated.
Position control ... On when torque restriction is activated.



<Setting>

Refer to the following table and set the parameter.

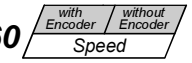
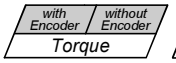
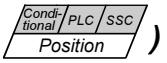
Pr. 157 Setting	Description
0	Output immediately.
0.1 to 25	Output after the set time (s) has elapsed.
9999	Overload alarm signal is not output.

Related parameters

- OL signal terminal assignment ⇒ Set 3 in any of Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection). (Refer to page 165.)

Pr.158 ➡ Refer to Pr. 54 (page 110).

4.18 Display function 3 (Pr. 160)

4.18.1 Extended function display selection (Pr. 160   )

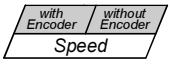
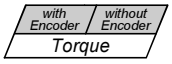
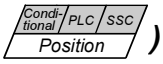
Used to display the extended function parameters.

- Refer to page 78 for the extended function parameter list.

Parameter	Name	Factory Setting	Setting Range	Remarks
160	Extended function selection	0	0	Only the simple mode parameters are accessible.
			1	All parameters are accessible.

Pr. 162 to Pr. 165 ➡ Refer to Pr. 57 (page 114).

4.19 Initial monitor (Pr. 171)

4.19.1 Actual operation hour meter clear (Pr. 171   )

You can clear the actual operation hour of the monitoring function.

Parameter	Name	Factory Setting	Setting Range
171	Actual operation hour meter clear	0	0

<Setting>

Write "0" in the corresponding parameter to clear the actual operation hour.

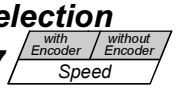
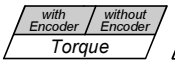
REMARKS

The actual operation time is the value monitored by setting "23" in Pr. 52.

Related parameters

- Pr. 52 "DU/PU main display data selection" (Refer to page 110.)

4.20 Terminal assignment functions (Pr. 180 to Pr. 195)

4.20.1 Input terminal function selection (Pr. 180 to Pr. 183, Pr. 187   )

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

Parameter	Name	Terminal Symbol	Factory-Set Value	Factory-Set Terminal Function	Setting Range	Remarks	
180	DI1 terminal function selection	DI1	0	Low speed operation command (RL)	0 to 3, 5, 8 to 12,14 to 16, 20, 22 to 28, 42 to 44, 9999	9999: No function	Extended mode
181	DI2 terminal function selection	DI2	1	Middle speed operation command (RM)			
182	DI3 terminal function selection	DI3	2	High speed operation command (RH)			
183	DI4 terminal function selection	DI4	3	Second function/ second motor switchover (RT)			
187	STR terminal function selection	STR	9999	Reverse rotation command (STR)		9999: STR	

<Setting>

Refer to the following table and set the parameters.

Setting	Signal Name	Functions		Related Parameters	Response Time
0	RL	Pr. 59 = 0	Low speed operation command	Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 232 to Pr. 239	Within 20ms
		Pr. 59 = 1, 2 *	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. 232 to Pr. 239	
		Pr. 59 = 1, 2, 3 *	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. 232 to Pr. 239	
		Pr. 59 = 1, 2, 3*	Remote setting (acceleration)	Pr.59	
3	RT	Second function selection		Pr. 44 to Pr. 50, Pr. 450 to Pr. 457, Pr. 463	
5	JOG	Jog operation selection		Pr. 15, Pr. 16	
8	REX	15-speed selection (combination with three speeds RL, RM, RH)		Pr. 4 to Pr. 6, Pr. 24 to Pr. 27, Pr. 232 to Pr. 239	
9	X9	Third function		Pr. 110, Pr. 111, Pr. 116	
10	Maker setting value. Do not make setting.				
11	Maker setting value. Do not make setting.				
12	X12	PU operation external interlock signal		Pr. 79	Within 20ms
14	X14	PID control enable terminal		Pr. 128 to Pr. 134	
15	BRI	Brake sequence opening completion signal		Pr. 278 to Pr. 285	
16	X16	PU/external operation switchover		Pr. 79	
20	X20	S-pattern acceleration/deceleration C switchover		Pr. 29, Pr. 380 to Pr. 383	
22	X22	Orientation command (Caution 4)		Pr. 350 to Pr. 369	
23	LX	Pre-excitation/servo on (Caution 5)		Pr. 802	
24	MRS	Output stop		Pr. 17	
25	STOP	Start self-holding selection		—	
26	MC	Control mode changing		—	
27	TL	Torque restriction selection		Pr. 815	
28	X28	Start time tuning			
42	X42	Torque bias selection 1		—	
43	X43	Torque bias selection 2		—	
44	X44	P control selection (P/PI control switchover)		—	
9999	STR	Reverse rotation start		STR terminal (Pr. 187) only (Note) DI1 to DI4 functions are made invalid.	—

* When Pr. 59 = "1, 2, or 3", the functions of the RL, RM, RH and RT signals change as listed above.

CAUTION

1. **One signal can be assigned to two or more terminals. In this case, turning on any one of the terminals make the signal valid.**
2. **The speed command priorities are higher in order of jog, multi-speed setting (RH, RM, RL, REX) and PID (X14).**
3. **Use common terminals to assign multi-speeds (7 speeds) and remote setting. They cannot be set individually.**
4. **The FR-A5AX (12-bit digital input) is needed to externally input a stop position under orientation control.**
5. **Made valid under vector control with encoder.**

4.20.2 Output terminal function selection

(Pr. 190 to Pr. 192, Pr. 195 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque, Conditional / PLC / SSC Position)

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

Parameter	Name	Factory-Set Value	Factory-Set Signal Function	Setting Range	Remarks
190	DO1 terminal function selection	0	RUN (Inverter running)	0 to 8, 10 to 16, 20, 25 to 27, 30 to 37, 39, 40 to 44, 96 to 99, 100 to 108, 110 to 116, 120, 125 to 127, 130 to 137, 139, 140 to 144, 196 to 199, 9999	Extended mode
191	DO2 terminal function selection	1	SU (Up to speed)		
192	DO3 terminal function selection	2	IPF (Instantaneous power failure/ undervoltage)		
195	ABC terminal function selection	99	A, B, C (Alarm output)		

<Setting>

Refer to the following table and set the parameters.

Setting		Signal Name	Function	Operation	Related Parameters	Response Time
Positive logic	Negative logic					
0	100	RUN	Inverter running	This signal is output during operation when the inverter output speed rises to or above the starting speed. During DC injection brake, 0 speed control or servo lock, this signal is not output. However, LX is output as ON under position control.		Within 20ms
1	101	SU	Up to speed	Refer to Pr. 41 "up-to-speed sensitivity" (page 108). (Caution 1)		
2	102	IPF	Instantaneous power failure or undervoltage	Output at occurrence of an instantaneous power failure or undervoltage.	—	—
3	103	OL	Overload alarm	Output when torque or speed restriction is activated. For V/F control, this signal is output while the stall prevention function is activated.	Pr. 22, Pr. 806, Pr. 807, Pr. 812 to Pr. 817	
4	104	FU	Output speed detection	Refer to Pr. 42, Pr. 43, Pr. 50 and Pr. 116 (speed detection) (page 108).		Within 20ms
5	105	FU2	Second output speed detection			
6	106	FU3	Third output speed detection			
7	107	RBP	Regenerative brake prealarm	Output when 85% of the regenerative brake duty set in Pr. 70 is reached.	Pr. 70	—
8	108	THP	Electronic thermal relay function prealarm	Output when the electronic thermal relay function cumulative value reaches 85% of the preset level.	Pr. 9	
10	110	PU	PU operation mode	Output when the PU operation mode is selected.	—	Within 20ms
11	111	RY	Inverter operation ready	Output when the inverter can be started by switching the start signal on or while it is running.		
12	112	Y12	Output current detection	Refer to Pr. 150 and Pr. 151 (output current detection).	Pr. 150, Pr. 151	—
13	113	Y13	Zero current detection	Refer to Pr. 152 and Pr. 153 (zero current detection).	Pr. 152, Pr. 153	
14	114	FDN	PID lower limit	Refer to Pr. 128 to Pr. 134 (PID control).	Pr. 128 to Pr. 134	Within 20ms
15	115	FUP	PID upper limit			
16	116	RL	PID forward-reverse rotation output			
20	120	BOF	Brake opening request	Refer to Pr. 278 to Pr. 285 (brake sequence function).	Pr. 278 to Pr. 285	—

Setting		Signal Name	Function	Operation	Related Parameters	Response Time
Positive logic	Negative logic					
25	125	FAN	Fan fault output	Output at the time of a fan fault.	Pr. 244	—
26	126	FIN	Fin overheat prealarm	Output when the heatsink temperature reaches about 85% of the fin overheat protection activating temperature.	—	
27	127	ORA	Orientation in-position	When orientation is valid (Refer to page 172)		
30	130	Y30	Forward rotation output	On: Forward rotation under vector control without encoder with encoder Off: Other controls		Within 20ms
31	131	Y31	Reverse rotation output	On: Reverse rotation under vector control with encoder Off: Other controls		
32	132	Y32	Regenerative status output	On: Regeneration under vector control with encoder Off: Other controls (include stop, pre-excitation)		—
33	133	RY2	Operation ready 2	Output on completion of pre-excitation. Turned on at an output start when pre-excitation is not made.	Pr. 802	
34	134	LS	Low speed output	Output when the speed falls to or below any preset low speed.	Pr. 865	
35	135	TU	Torque detection	Output when the motor torque rises above the predetermined value.	Pr. 864	
36	136	Y36	In-position	Output when positioning is completed under position control.	—	Within 20ms
37	137	MT	Maintenance timer output	When Pr. 891 ≥ Pr. 890, the MT output signal turns on and the warning indication MT appears.	Pr. 890, Pr. 891	—
39	139	Y39	Start time tuning completion	Output on completion of start time tuning.		
40	140	Y40	Trace status	Refer to the instruction manual of the trace option.	—	
41	141	FB	Speed detection	Output when the inverter output speed rises to or above the preset speed. Refer to Pr. 42, Pr.43, Pr. 50, and Pr. 116 (speed detection) (page 108).		Within 20ms
42	142	FB2	Second speed detection			
43	143	FB3	Third speed detection			
44	144	RUN2	Inverter running 2	• Output during forward operation or the reverse signal is ON. • Output at deceleration even during forward rotation or the reverse signal is OFF. (Does not output during pre-excitation LX is ON.) • Output during the orientation command signal (X22) is ON. • Switched ON when the servo is ON (LX-ON) under position cotrol. (Switched OFF when the servo is OFF. (LX-OFF)	—	—
96	196	REM	Remote output	You can use the on/off of signals instead of the remote output function of the PLC.	Pr. 495, Pr. 496, Pr. 497	
97	197	ER	Minor fault output 2	At occurrence of a major fault, the base circuit is shut off immediately. At occurrence of a minor fault, the base circuit is shut off after deceleration to a stop.	Pr. 875	Within 20ms
98	198	LF	Minor fault output	Output when a minor fault (fan fault or communication error alarm) occurs.	Pr. 121, Pr. 244	
99	199	ABC	Alarm output	Output when the inverter's protective function is activated to stop the output (major fault).	—	
9999		—	No function	—		—

0 to 99: Positive logic
100 to 199: Negative logic

CAUTION

1. **Note that when the speed setting is varied using an analog signal or ▲/▼ of the operation panel, the output of the SU (up to speed) signal may alternate on and off depending on that varying speed and the timing of the varying speed due to acceleration/deceleration time setting.**
   (The output will not alternate on and off when the acceleration/deceleration time setting is "0s".)
2. **The same function may be set to more than one terminal.**
3. **Pr. 190 to Pr. 192 and Pr. 195 do not function if the values set are other than the above.**

Pr.232 to Pr.239 ➡ Refer to Pr. 4 (page 90).

Pr.240 ➡ Refer to Pr. 72 (page 124).

4.21 Auxiliary function (Pr. 244)

4.21.1 Cooling fan operation selection (Pr. 244 with Encoder / without Encoder Speed; with Encoder / without Encoder Torque; Conditional / PLC / SSC Position)

You can control the operation of the cooling fan built in the inverter.

Parameter	Name	Factory Setting	Setting Range	Remarks
244	Cooling fan operation selection	0	0, 1	Extended mode

<Setting>

Setting	Description
0	Operated with power on (independently of whether the inverter is running or at a stop).
1	Cooling fan on-off control valid (The cooling fan is always on while the inverter is running. During a stop, the inverter status is monitored and the fan switches on-off according to temperature.)

REMARKS

In either of the following cases, fan operation is regarded as faulty, [FN] is shown on the operation panel, and the fan fault (FAN) and minor fault (LF) signals are output. Use Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection) to allocate the terminals used to output the FAN and LF signals.

1. Pr. 244 = "0"
   When the fan comes to a stop with power on.
2. Pr. 244 = "1"
   When the fan comes to a stop during the fan ON command while the inverter is running.

CAUTION

Changing the terminal function using any of Pr. 190 to 192 and Pr. 195 may affect the other functions. Confirm the functions of the corresponding terminals before making setting.

4.22 Stop selection function (Pr. 250)

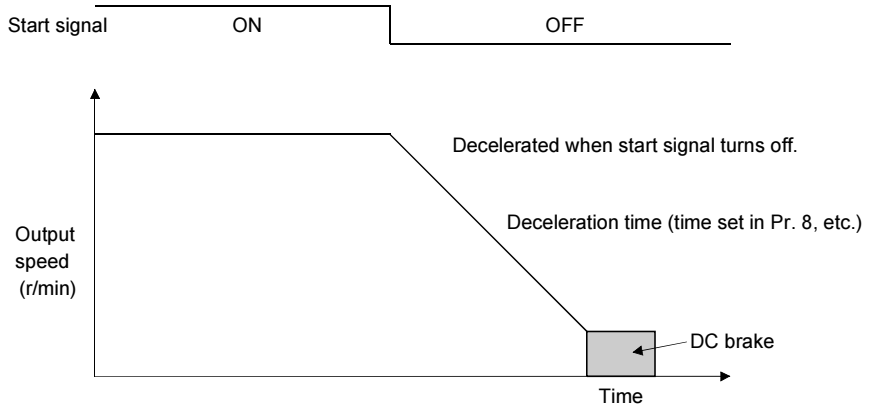
4.22.1 Stop selection (Pr. 250 with Encoder / without Encoder Speed; with Encoder / without Encoder Torque)

Used to select the stopping method (deceleration to a stop or coasting) when the start signal (STF/STR) turns off.

Parameter	Name	Factory Setting	Setting Range	Remarks
250	Stop selection	9999	0 to 100s, 9999	Extended mode

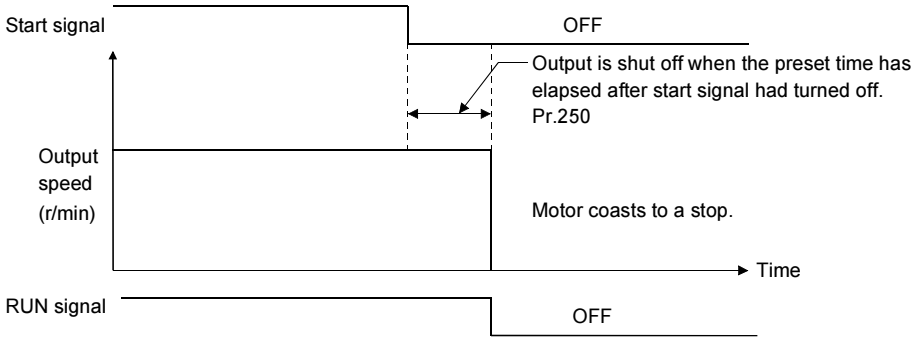
(1) Pr. 250 = "9999"

When the start signal turns off, the motor is decelerated to a stop.



(2) Pr. 250 = other than "9999" (Output is shut off after preset time)

The output is shut off when the time set in Pr. 250 has elapsed after the start signal had turned off. The motor coasts to a stop.



CAUTION

1. **The RUN signal turns off when the output stops.**
2. **When the start signal is turned on again during motor coasting, the motor starts at 0Hz.**
3. **The output speed becomes the speed restriction value during torque control.**

4.23 Operation selection function (Pr. 251)

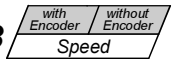
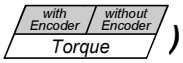
4.23.1 Output phase failure protection selection (Pr. 251)

with Encoder / without Encoder — Speed; with Encoder / without Encoder — Torque; Conditional / PLC / SSC — Position

You can disable the output phase failure protection (E.LF) function that will stop the inverter output if any of the three phases (U, V, W) on the inverter output side (load side) opens.

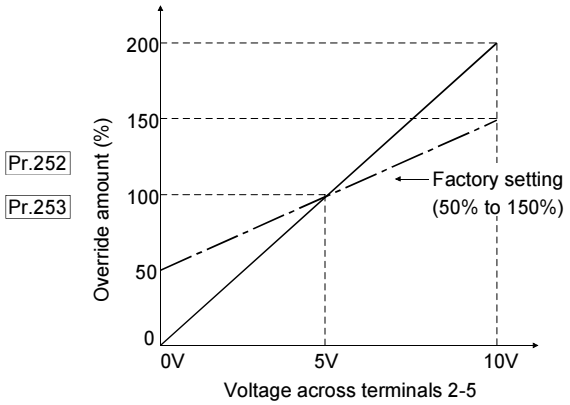
Parameter	Name	Setting Range	Minimum Setting Increments	Factory Setting	Description	Remarks
251	Output phase failure protection selection	0, 1	1	1	0: Without output phase failure protection 1: With output phase failure protection	Extended mode

4.24 Additional function 2 (Pr. 252, Pr. 253)

4.24.1 Override bias, gain (Pr. 252, Pr. 253  )

When override is selected in Pr. 73 "speed setting signal", the override range of 50% to 150% can be increased (to between 0% and 200%) as desired.

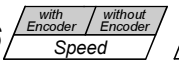
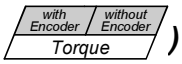
Parameter	Name	Setting Range	Minimum Setting Increments	Factory Setting	Remarks
252	Override bias	0 to 200%	0.1%	50%	Extended mode
253	Override gain	0 to 200%	0.1%	150%	



Related parameters

- ⇒ Pr. 73 "speed setting signal" (Refer to page 125.)

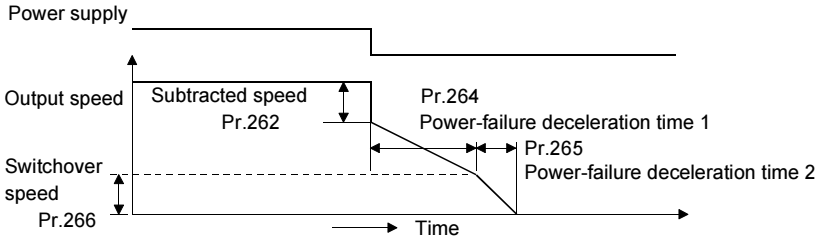
4.25 Power failure stop functions (Pr. 261 to Pr. 266)

4.25.1 Power-failure deceleration stop function (Pr. 261 to Pr. 266  )

When a power failure or undervoltage occurs, the inverter can be decelerated to a stop.

- Remove the jumpers from across terminals R-R1 and S-S1, and connect terminal R1 to terminal P and terminal S1 to terminal N.

Parameter	Name	Factory Setting	Setting Range	Remarks
261	Power failure stop selection	0	0, 1	Extended mode
262	Subtracted speed at deceleration start	90r/min	0 to 600r/min	
263	Subtraction starting speed	1800r/min	0 to 3600r/min, 9999	
264	Power-failure deceleration time 1	5s	0 to 3600/0 to 360s	
265	Power-failure deceleration time 2	9999	0 to 3600/0 to 360s, 9999	
266	Power-failure deceleration time switchover speed	1800r/min	0 to 3600r/min	



<Setting>

Parameter		Setting	Description
261		0	Coasting to stop When undervoltage or power failure occurs, the inverter output is shut off.
		1	When undervoltage or power failure occurs, the inverter is decelerated to a stop.
262		0 to 600r/min	Normally, operation can be performed with the factory setting unchanged, but the speed can be adjusted within the range 0 to 600r/min according to the load specifications (inertia moment, torque).
263		0 to 3600r/min	If the output speed at occurrence of undervoltage or power failure is equal to or greater than the speed set in Pr. 263, deceleration starts at the value found by subtracting the speed set in Pr. 262 from the output speed at that time. If the output speed at occurrence of undervoltage or power failure is less than the speed set in Pr. 263, the inverter is decelerated to a stop, starting at the output speed at that time.
		9999	The inverter is decelerated to a stop, starting at the value found by subtracting the speed set in Pr. 262 from the output speed at occurrence of undervoltage or power failure.
264	Pr. 21 = 0	0 to 3600s	Set a deceleration slope down to the speed set in Pr. 266. Set the slope in terms of time required for deceleration from the speed set in Pr. 20 to 0r/min.
	Pr. 21 = 1	0 to 360s	
265	Pr. 21 = 0	0 to 3600s	Set a deceleration slope below the speed set in Pr. 266. Set the slope in terms of time required for deceleration from the speed set in Pr. 20 to 0r/min.
	Pr. 21 = 1	0 to 360s	
		9999	Same slope as in Pr. 264.
266		0 to 3600r/min	Set the speed at which the deceleration slope is switched from the Pr. 264 setting to the Pr. 265 setting.

CAUTION

1. **This function is invalid when the automatic restart after instantaneous power failure function is activated.**
2. **If the calculation result of the output speed - set speed of Pr. 262 is negative at occurrence of undervoltage or power failure, it is regarded as 0r/min.**
3. **The power failure stop function is not activated if a power failure occurs during a stop or error.**
4. **If power is restored during deceleration, the inverter is kept decelerated to a stop.**
   To restart, turn off the start signal once, then turn it on again.
5. **This function is not activated when the high power factor converter or power regeneration common converter is used (Pr. 30 = 2).**

⚠CAUTION

⚠ **If power-failure deceleration operation is set, some loads may cause the inverter to trip and the motor to coast.**
The motor will coast if enough regenerative energy is given from the motor.

Related parameters

- Pr. 12 "DC injection brake voltage" (Refer to page 95.)
- Pr. 20 "acceleration/deceleration reference speed", Pr. 21 "acceleration/deceleration time increments" (Refer to page 91.)

Pr.278 to Pr.285 ➡ Refer to Pr.60 (page 118).

4.26 Droop (Pr. 286 to Pr. 288)

4.26.1 Droop control (Pr. 286, Pr. 287 [~~with Encoder~~ / without Encoder Speed], Pr. 288 [with Encoder / without Encoder Speed])

This function is designed to balance the load in proportion to the load torque to provide the speed drooping characteristic.
This function is effective for balancing the load when using multiple inverters

- The speed command is varied according to the magnitude of the motor load (load meter of the inverter). The drooping amount at the rated torque is set by the droop gain as a percentage using the rated speed as a reference.

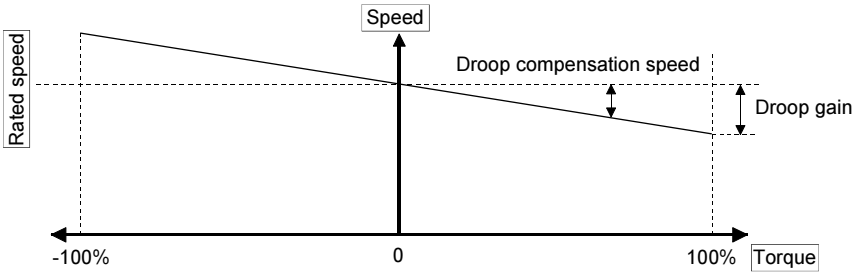
$$\text{Droop compensation speed} = \frac{\text{Amount of torque current after filtering}}{\text{100\% torque amount current}} \times \frac{\text{Rated speed} \times \text{droop gain}}{100}$$

- Droop control is made valid when Pr. 286 is other than "0".

Parameter	Name	Factory Setting	Setting Range	Remarks
286	Droop gain	0%	0 to 100%	The drooping amount at the rated torque is set by the droop gain as a percentage using the rated speed as a reference. When the setting value is "0", the function will be invalid.
287	Droop filter constant	0.3s	0.00 to 1.00s	Set the time constant of the primary delay filter applied to the torque current.
288	Droop function activation selection	0	0	Droop control is not exercised during acceleration/deceleration.
			1	Droop control is always exercised during operation. (with zero limit)
			2	Droop control is always exercised during operation (without zero limit) (valid for vector control with encoder only)

● Speed limitter after droop compensation

Pr. 288 setting	Description
0	Droop control is not excercised during acceleration/deceleration. Note that the speed command after droop is stopped at 0r/min if the speed command after droop is negative.
1	Droop control is always excercised during operation. Note that, during vector control with encoder, the speed command after droop is stopped at 0r/min if the speed command after droop is negative.
2	Droop control is always excercised during operation. Note that the speed command after droop is not stopped at 0r/min even if the speed command after droop is negative. (stop at 0r/min under vector control without encoder)



Pr. 342 ➡ Refer to Pr. 117 (page 141).

4.27 Orientation (Pr. 350 to Pr. 362, Pr. 393 to Pr. 399)

4.27.1 Orientation control (Pr. 350, Pr. 351, Pr. 356, Pr. 357, Pr. 360 to Pr. 362, Pr. 393, Pr. 396 to Pr. 399 with Encoder / ~~without Encoder~~ Speed)

Orientation is a function that stops a motor shaft at a position set by parameter using the motor built-in position detector (encoder). Install the option (FR-V5AM or FR-A5AP) on the inverter to perform stop position command control with a position detector (encoder) fitted to the machine. Refer to the instruction mannual of the option for details.
Pr. 350 "stop position command selection" is factory-set to "9999" to make the orientation control function invalid.

Parameter No.	Name	Setting Range	Factory Setting	Remarks
350	Stop position command selection	0, 1, 2, 3, 9999	9999	Extended mode
351	Orientation switchover speed	0 to 1000r/min	200r/min	
356	Internal stop position command	0 to 16383	0	
357	Orientation in-position zone	0 to 8192	11	
360	External position command selection	0, 1, 2 to 127	0	
361	Position shift	0 to 16383	0	
362	Orientation position loop gain	0.1 to 100	10	
393	Orientation selection	1, 2, 10, 11, 12	0	
396	Orientation speed gain (P term)	0 to 1000%	60%	
397	Orientation speed integral time	0 to 20.0s	0.333s	
398	Orientation speed gain (D term)	0 to 100.0%	1%	
399	Orientation deceleration ratio	0 to 1000	20	

REMARKS

Check the Pr. 851 and Pr. 852 settings. (Refer to page 10.)

<Settings>
If the orientation command signal (X22) is turned on during operation after the various parameters have been set, the speed will decelerate to the "orientation switchover speed". After the "orientation stop distance" is calculated, the speed will further decelerate, and the "orientation state" (servo lock) will be entered. The "orientation complete signal" (ORA) will be output when the "orientation complete width" is entered.

(1) Setting I/O singals

Input	Orientation command	X22 signal	Orientation control is valid with the signal on. Set "22" in any of Pr. 180 to Pr.183 or Pr. 187 (input terminal function selection). (Refer to page 163.)
Output	Orientaiton complete signal	ORA signal	Switched low if the orientation has stopped within the in-position zone while the start and orientation signals are input. Open collector output Permissible load 24VDC, 0.1A Set 27 in any of Pr.190 to Pr. 192 or Pr. 195 (output terminal function selection). (Refer to page 165.)

(2) Selecting stop position command (Pr. 350 "stop position command selection")

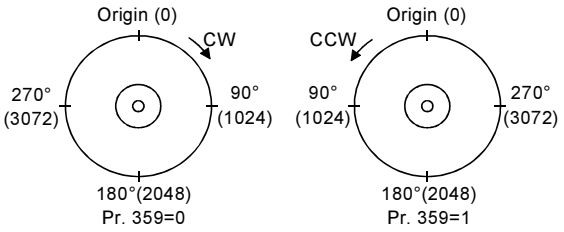
Select either the internal stop position command (Pr. 356) or the external stop position command (6/12/16-bit data).

Pr. 350 Setting	Type of Command
0	Internal stop position command (Pr. 356:0 to 16383)
1	External stop position command (FR-V5AX) 6-bit data
2	External stop position command (FR-A5AX) 12-bit data
3	External stop position command (FR-V5AH) 16-bit data
9999 (factory setting)	Orientation control invalid

(1) Internal stop position command (Pr. 350="0")

The value set in Pr. 356 is the stop position.

When the number of encoder pulses is 1024p/r, one revolution of the encoder (360°) is divided into 4096 positions, i.e. 360°/ 4096 pulses = 0.0879°/pulses per address, as shown on the right. The stop positions (addresses) are indicated in parentheses.



(2)-1 External stop position command (Pr. 350="1")

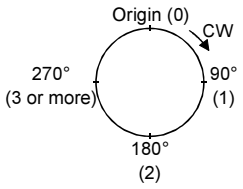
(Pr. 360 "external position command selection" (factory setting: 0))

Mount the option FR-V5AX and set a stop position using 6-bit data (binary input).

- The value set in Pr. 360 "external position command selection" should be the number of stop positions less 1.

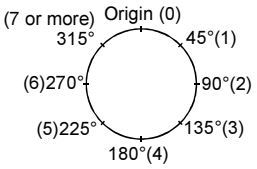
Pr. 360 Setting	Description
0	External position command is made invalid (multi-function input with the FR-V5AX)
1	Set 64 stop positions at regular intervals
2 to 127	Set the stop position command dividing up to 128 stop positions at regular intervals. If the external stop command entered is greater than the setting, the stop positions are the same as those in the maximum external stop command value. Note that the stop command greater than the 64 stop positions can not be entered if the number of stop positions are 65 to 128. <Example> When the number of stop positions is 20 (divided at intervals of 18°), 20 - 1 = 19. Hence, set "19".

[Example 1]
4 stop positions



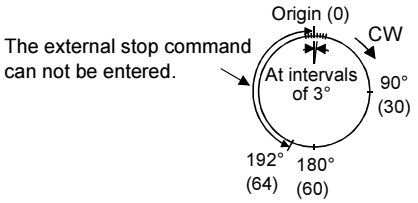
Pr. 360 = "3"

[Example 2]
8 stop positions



Pr. 360 = "7"

[Example 3]
120 stop positions



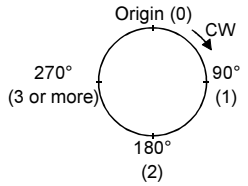
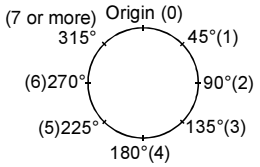
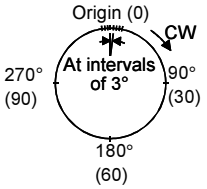
Pr. 360 = "119"

(2)-2 External stop position command (Pr. 350="2")

Mount the option FR-A5AX and set a stop position using 12-bit data (binary input).

- The value set in Pr. 360 "external position command selection" should be the number of stop positions less 1.

Pr. 360 Setting	Description
0	External position command is made invalid (speed command with the FR-A5AX)
1	Set 4096 stop positions at regular intervals
2 to 127	Set the stop position command dividing up to 128 stop positions at regular intervals. If the external stop command entered is greater than the setting, the stop positions are the same as those in the maximum external stop command value. <Example> When the number of stop positions is 90 (divided at intervals of 4°), 90 - 1 = 89. Hence, set "89".

[Example 1] **4 stop positions**	**[Example 2]** **8 stop positions**	**[Example 3]** **120 stop positions**
		
Pr. 360 = "3"	Pr. 360 = "7"	Pr. 360 = "119"

CAUTION

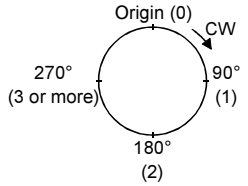
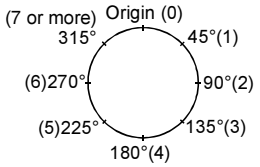
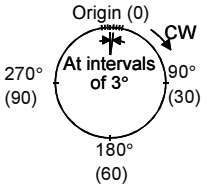
- **Values in parentheses indicate binary data entered from the terminals. If the position pulse monitoring (Pr. 52 "DU/PU main display screen data selection" = 19) is selected, the data monitored is not the number of stop positions but is 0 to 4095 pulses.**
- **When any of "1 to 127" is set in Pr. 360, parameters (Pr. 300 to Pr. 305) of the FR-A5AX are made invalid. (Parameters are valid when Pr. 360="0".)**
- **Terminal DY (Data read timing input signal) is made invalid.**
  (The position data is downloaded at the start of orientation.)
- **When the option is not fitted or Pr. 360="0", the stop position is 0 even if the external stop position command is selected with the Pr. 350 setting.**

(2)-3 External stop position command (Pr. 350="3")

Mount the option FR-V5AH and set a stop position using 16-bit data (binary input).

- The value set in Pr. 360 "external position command selection" should be the number of stop positions less 1.

Pr. 360 Setting	Description
0	External position command is made invalid (speed command or torque command with the FR-V5AH)
1	Set 65536 stop positions at regular intervals
2 to 127	Set the stop position command dividing up to 128 stop positions at regular intervals. If the external stop command entered is greater than the setting, the stop positions are the same as those in the maximum external stop command value. <Example> When the number of stop positions is 90 (divided at intervals of 4°), 90 - 1 = 89. Hence, set "89".

[Example 1] **4 stop positions**	**[Example 2]** **8 stop positions**	**[Example 3]** **120 stop positions**
		
Pr. 360 = "3"	Pr. 360 = "7"	Pr. 360 = "119"

CAUTION

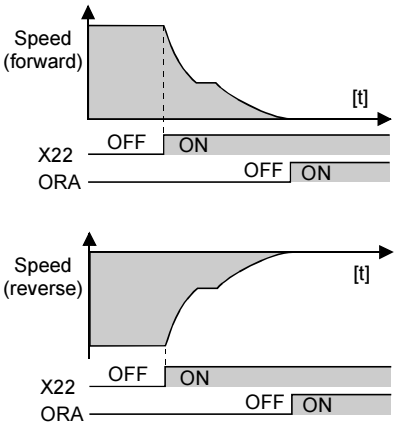
- **Values in parentheses indicate binary data entered from the input terminals. If the position pulse monitoring (Pr. 52 "DU/PU main display screen data selection" = 19) is selected, the data monitored is not the number of stop positions but is 0 to 65535 pulses.**
- **When any of "1 to 127" is set in Pr. 360, parameters (Pr. 300 to Pr. 305) of the FR-V5AH are made invalid. (Parameters are valid when Pr. 360="0".)**
- **Terminal DY (Data read timing input signal) is made invalid.**
  (The position data is downloaded at the start of orientation.)
- **When the option is not fitted or Pr. 360="0", the stop position is 0 even if the external stop position command is selected with the Pr. 350 setting.**

(3) Setting the rotation direction (Pr. 393 "orientation selection")

Pr. 393 setting	Rotation Direction	Type	Remarks
0 (factory setting)	Pre-orientation	Motor end orientation	Orientation is executed from the current rotation direction.
1	Forward rotation orientation		Orientation is executed from the forward rotation direction. (If the motor is running in reverse, orientation is executed from the forward rotation direction after deceleration.)
2	Reverse rotation orientation		Orientation is executed from the reverse rotation direction. (If the motor is running in forward, orientation is executed from the reverse rotation direction after deceleration.)
10	Pre-orientation	Machine end orientation (when the FR-V5AM or FR-A5AP is used)	Refer to the instruction manual of the option for details.
11	Forward rotation orientation		
12	Reverse rotation orientation		

(1) Orientation from the current rotation direction

- When the orientation command (terminal X22) is input, the motor speed will decelerate from the runnig speed to Pr. 351 "orientation switchover speed". At the same time, the orientation stop position command will be read in. (The stop position command is determined by the settings of Pr.350 and Pr.360. Refer to the diagram on the right.)
- When the orientation switchover speed is reached, the encoder Z phase pulse will be confirmed, and the mode will change from speed control to position control (orientation position loop gain parameter (Pr. 362)).
- When the control is changed, the distance to the orientation stop position will be calculated. The motor will decelerate and stop with a set deceleration pattern (Pr. 399), and the orientation (servo lock) state will be entered.
- When entered in the Pr. 357 in-position zone is entered, the orientation complete signal (terminal ORA) will be output.
- The zero point position (origin) can be moved using position shift (Pr. 361).

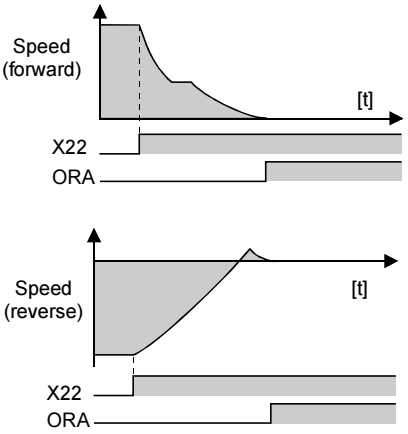


⚠WARNING

⚠ **If the orientation command (terminal X22) is turned off while the start signal is input, the motor will accelerate toward the speed of the current speed command. Thus, to stop, turn the forward rotation (reverse rotation) signal off.**

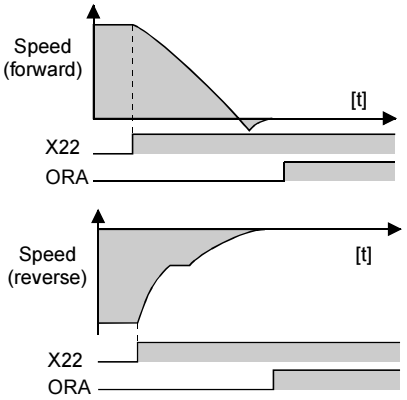
(2) Orientation from the forward rotation direction

This method is used to improve the stopping precision and maintain the mechanical precision when the backlash is large.
If the motor is running in the forward rotation direction, it will orientation stop with the same method as "orientation from the current rotation direction". If the motor is running in reverse, it will decelerate, the rotation direction will be changed to forward run, and then orientation stop will be executed.



(3) Orientation from the reverse rotation direction

If the motor is running in the reverse rotation direction, it will orientation stop with the same method as "orientation from the current rotation direction".
If the motor is running in forward, it will decelerate, the rotation direction will be changed to reverse run, and then orientation stop will be executed.



CAUTION

1. **The encoder should be coupled with the motor shaft or the spindle oriented with a speed ratio of 1 to 1 without any mechanical looseness.**
2. **To ensure correct positioning, the encoder must be set in the proper rotation direction and the A and B phases connected correctly.**
3. **The orientation may not be completed if the pulse signals are not received from the encoder during orientation due to a break in the cable or the like.**
4. **To terminate orientation, the start signal (STF or STR) must be first switched off and the orientation signal (X22) must be switched off. As soon as this orientation signal is switched off, orientation control ends.**
5. **For orientation control, set correct values in Pr. 350 "stop position command selection" and Pr. 360 "external position command selection"**
   If the values set are incorrect, proper orientation control will not be performed.
6. **When orientation control is exercised, PID control is invalid.**

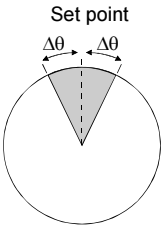
REMARKS

If "E.ECT" (no encoder signal) is displayed causing the inverter to trip when the orient signal (X22) is ON, check for an break in the cable of the Z phase of the encoder.

● Pr. 357 "orientation in-position zone" (factory setting:11)

- The positioning width for orientation stop can be set.
  The factory setting of Pr. 357 is "11". To change the $\Delta\theta$ value, finely adjust with ±10 increments, and make fine adjustment.
- If the position detection value from the encoder enters $\pm\Delta\theta$ during orientation stop, the orientation complete signal (ORA) will be output.

Example of operation



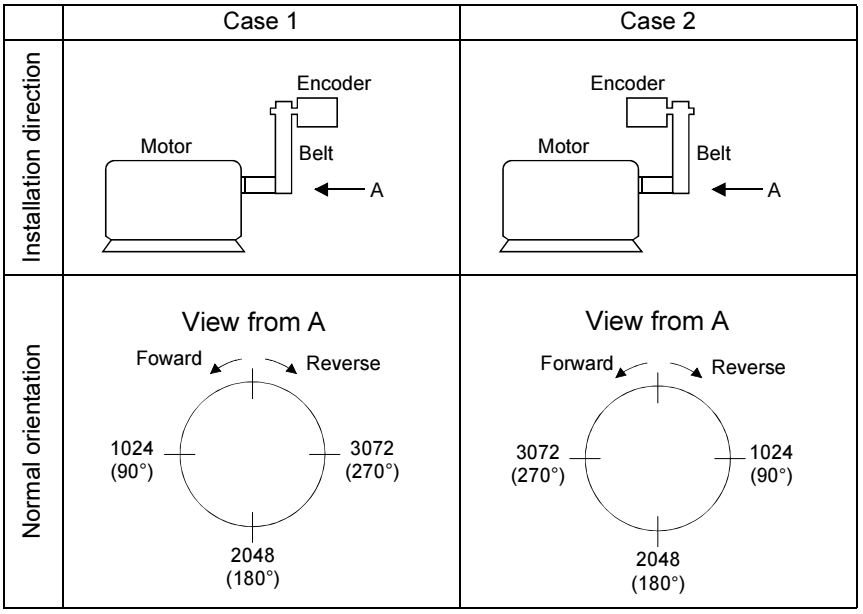
$$\Delta\theta = \frac{360^\circ}{\text{Pr.851 number of encoder pulses} \times 4} \times \text{Pr.357}$$

CAUTION

This setting is used to judge the ON/OFF of the orientation complete signal, and does not determine the orientation stop precision.

(4) Fine adjustment of the orientation stop position (Pr. 361 "position shift" (factory setting: 0))

The orientation stop position will deviate by the value set x 360° / Pr. 851"number of encoder pulses" x4.
Finely adjust the position by changing this setting value in 10 increments.
The orientation stop position will differ according to the direction that the encoder is installed in.
(Refer to the drawings below.)



(5) Adjustment of the servo rigidity

- Pr. 396 "orientation speed gain (P term)" (factory setting: 60)
- Pr. 397 "orientation speed integral time" (factory setting: 0.333)
- Pr. 398 "orientation speed gain (D term)" (factory setting: 1)
- Pr. 362 "orientation position loop gain" (factory setting: 10)

• To increase the servo rigidity*1 during orientation stop in Pr. 396 or Pr. 397, adjust with the following procedures.

1) Increase the Pr. 362 "orientation position loop gain" value to the extent that rocking does not occur during orientation stop.
2) Increase Pr. 396 and Pr. 397 at the same rate.
   Generally adjust Pr. 396 in the range from 10 to 100, and Pr. 397 from 0.1 to 1.0s.
   (Note that these do not need to be set to the same rate.)
   <Example>
   When the Pr. 396 value is multiplied by 1.2, divide the Pr. 397 value by 1.2.
   If vibration occurs during orientation stop, the scale cannot be raised any higher.
3) Pr. 398 is the lag/advance compensation gain.*2
   The limit cycle can be provided by increasing the value, and the running can be stopped stably. However, the torque in regard to the position deviation will drop, and the motor will stop with deviation.

POINT

Application of lag/advance control and PI control
PI control can be applied by setting Pr. 398 to 0. Normally, the lag/advance control is selected. Use PI control in the following cases.
When using a machine with a high spindle stationary friction torque and requires a stopping position precision.

REMARKS

*1.. Servo rigidity: This is the response when a position control loop is configured.
When the servo rigidity is raised, the holding force will increase, the running will stabilize, but vibration will occur easily.
When the servo rigidity is lowered, the holding force will drop, and the setting time will increase.
2.. Limit cycle:This is a phenomenon that generates ± continuous vibration centering on the target position.
*3.. Rocking: Movement in which return occurs if the stopping position is exceeded.

● Pr. 399 "orientation deceleration ratio" (factory setting: 20)

• Make adjustments as shown below according to the orientation status.
(Refer to the Pr. 396 and Pr. 397 details also.)
Generally adjust Pr. 362 in the range from 5 to 20 and Pr. 399 from 5 to 50.

Phenomenon	Adjustment Procedure			
	Pr. 396	Pr. 397	Pr. 362	Pr. 399
Rocking occurs during stopping	3) ↗	3) ↗	2) ↘	1) ↘
The orientation time is long	→	→	2) ↗	1) ↗
Hunting occurs when stopping	2) ↘	2) ↗	1) ↘	→
The servo rigidity during stopping is low	1) ↗	1) ↘	2) ↗	→

REMARKS

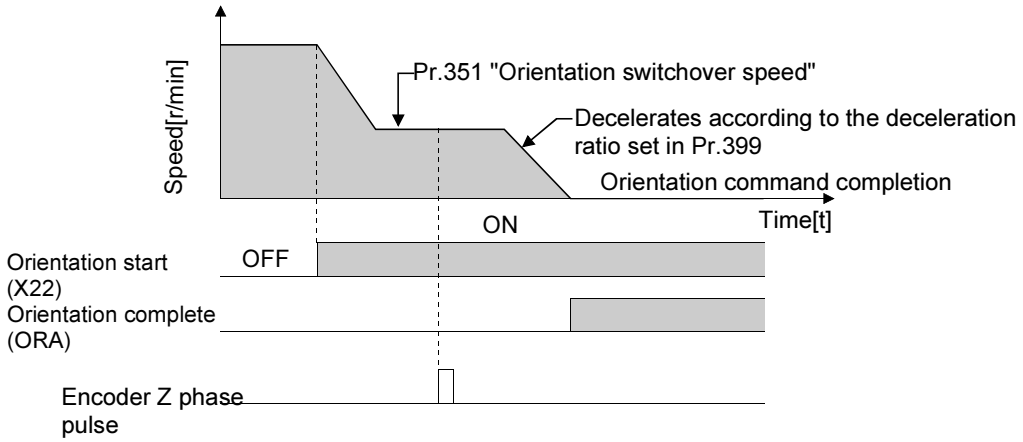
1. ↗ :Increase the parameter setting value.
→ :Do not change the parameter setting value.
↘ :Decrease the parameter setting value.
2. The numbers 1) 2) and 3) in the table show the order of priority for changing the parameters setting value.

CAUTION

If orientation stop is not possible and the excessive position error alarm occurs, or if the motor does forward/reverse reciprocation operation (↻), the parameter setting value for the orientation detector installation direction may be incorrect. Review Pr. 393 "orientation selection" (Refer to page 175.) and Pr. 852 "encoder rotation direction" (Refer to page 10.).

● Pr. 351 "orientation switchover speed" (factory setting: 200)

Set the speed when switching beween the speed control mode and the position control mode under orientation operation. Decreasing the set speed enables stable orientation stop. Note that the orientation time will increase.



REMARKS

When " 19" is set in Pr. 52 "DU/PU main display data selection", position pulse monitor is displayed instead of PU output voltage monitor.

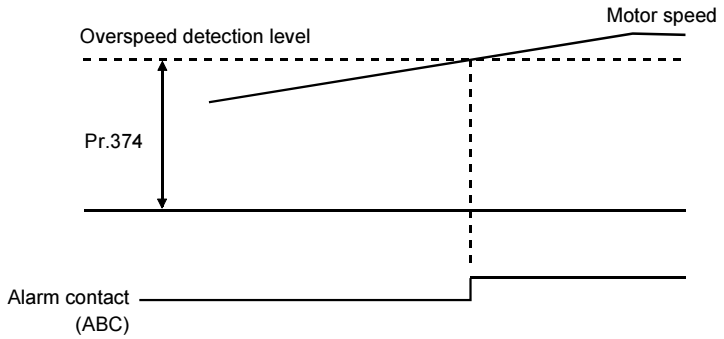
4.28 Control system function (Pr. 374)

4.28.1 Overspeed detection (Pr. 374)

with Encoder / ~~without Encoder~~ — Speed
with Encoder / ~~without Encoder~~ — Torque
Conditional / PLC / SSC — Position

- Excess of the motor speed over the overspeed detection level results in E.OS, stopping the output. This function is enabled only during speed control, torque control or position control under vector control with encoder.

Parameter	Name	Setting Range	Factory Setting	Remarks
374	Overspeed detection level	0 to 4200r/min	4200r/min	Extended mode



Pr. 380 to Pr. 383 ➡ Refer to Pr. 29 (page 102).

Pr. 393, Pr. 396 to Pr. 399 ➡ Refer to Pr. 350 (page 172).

4.29 Position control (Pr. 419 to Pr. 430, Pr. 464 to Pr. 494)

4.29.1 Position control (Pr. 419 to Pr. 430, Pr. 464 to Pr. 494 Conditional / PLC / SSC / Position)

Parameter	Name	Setting Range	Factory Setting
419	Position command right selection	0, 1	0
420	Command pulse scaling factor numerator	0 to 32767	1
421	Command pulse scaling factor denominator	0 to 32767	1
422	Position loop gain	0 to 150s^{-1}	25s^{-1}
423	Position feed forward gain	0 to 100%	0%
424	Position command acceleration/deceleration time constant	0 to 50s	0s
425	Position feed forward command filter	0 to 5s	0s
426	In-position width	0 to 32767 pulses	100 pulses
427	Excessive level error	0 to 400K, 9999	40K
430	Pulse monitor selection	0 to 5, 9999	9999
464	Digital position control sudden stop deceleration time	0 to 360.0s	0

Parameter	Name	Setting Range	Factory Setting	Selection Method				Positioning Speed
				REX	RH	RM	RL	
465	First position feed amount lower 4 digits	0 to 9999	0	OFF	**ON**	OFF	OFF	High speed, Pr. 4
466	First position feed amount upper 4 digits							
467	Second position feed amount lower 4 digits			OFF	OFF	**ON**	OFF	Middle speed, Pr. 5
468	Second position feed amount upper 4 digits							
469	Third position feed amount lower 4 digits			OFF	OFF	OFF	**ON**	Low speed, Pr. 6
470	Third position feed amount upper 4 digits							
471	Fourth position feed amount lower 4 digits			OFF	OFF	**ON**	**ON**	Speed 4, Pr. 24
472	Fourth position feed amount upper 4 digits							
473	Fifth position feed amount lower 4 digits			OFF	**ON**	OFF	**ON**	Speed 5, Pr. 25
474	Fifth position feed amount upper 4 digits							
475	Sixth position feed amount lower 4 digits			OFF	**ON**	**ON**	OFF	Speed 6, Pr. 26
476	Sixth position feed amount upper 4 digits							
477	Seventh position feed amount lower 4 digits			OFF	**ON**	**ON**	**ON**	Speed 7, Pr. 27
478	Seventh position feed amount upper 4 digits							
479	Eighth position feed amount lower 4 digits			**ON**	OFF	OFF	OFF	Speed 8, Pr. 232
480	Eighth position feed amount upper 4 digits							
481	Ninth position feed amount lower 4 digits			**ON**	OFF	OFF	**ON**	Speed 9, Pr. 233
482	Ninth position feed amount upper 4 digits							
483	Tenth position feed amount lower 4 digits			**ON**	OFF	**ON**	OFF	Speed 10, Pr. 234
484	Tenth position feed amount upper 4 digits							
485	Eleventh position feed amount lower 4 digits			**ON**	OFF	**ON**	**ON**	Speed 11, Pr. 235
486	Eleventh position feed amount upper 4 digits							
487	Twelfth position feed amount lower 4 digits			**ON**	**ON**	OFF	OFF	Speed 12, Pr. 236
488	Twelfth position feed amount upper 4 digits							
489	Thirteenth position feed amount lower 4 digits			**ON**	**ON**	OFF	**ON**	Speed 13, Pr. 237
490	Thirteenth position feed amount upper 4 digits							
491	Fourteenth position feed amount lower 4 digits			**ON**	**ON**	**ON**	OFF	Speed 14, Pr. 238
492	Fourteenth position feed amount upper 4 digits							
493	Fifteenth position feed amount lower 4 digits			**ON**	**ON**	**ON**	**ON**	Speed 15, Pr. 239
494	Fifteenth position feed amount upper 4 digits							

Refer to page 57 for details of position control.

Pr. 450 ➡ Refer to Pr. 71 (page 123).

Pr. 451 ➡ Refer to Pr. 800 (page 182).

Pr. 452 ➡ Refer to Pr. 9 (page 93).

Pr. 453, Pr. 454 ➡ Refer to page 41.

Pr. 464 to Pr. 494 ➡ Refer to page 57.

4.30 Remote output (Pr. 495 to Pr.497)

4.30.1 Remote output function (Pr. 495 to Pr.497 with Encoder / without Encoder Speed / with Encoder / without Encoder Torque / Conditional / PLC / SSC Position)

You can utilize the on/off of the inverter's output signals instead of the remote output function of the programmable controller.(Use Pr. 190 to Pr. 192 and Pr. 195 to set the output signals. Refer to page 165.)

Parameter	Name	Factory Setting	Setting Range	Description	Remarks
495	Remote output selection	0	0	Remote output data cleared at power failure	Extended mode
			1	Remote output data held at power failure	
496	Remote output data 1	0	0 to 4095	Refer to the following diagram.	
497	Remote output data 2	0	0 to 4095		

<Remote output data>
Pr. 496

b11											b0
*	DO13 **	DO12 **	DO11 **	*	*	ABC	*	*	DO3	DO2	DO1

*: As desired (always 0 when read)
**DO11 to DO13 are available only when the extension output option (FR-V5AY) is fitted.

Pr. 497

b11											b0
*	RA0 ****	RA3 ***	RA2 ***	RA1 ***	Y6 **	Y5 **	Y4 **	Y3 **	Y2 **	Y1 **	Y0 **

*: As desired (always 0 when read)
**:Y0 to Y6 are available only when the extension output option (FR-A5AY) is fitted.
***:RA1 to RA3 are available only when the extension output option (FR-A5AR) is fitted.
****:RA0 is available only when the extension output option (FR-A5NR) is fitted.

(1) Operation

By setting 1 in the corresponding bit of Pr. 496, the output terminal that has been set to 96 (positive logic) or 196 (negative logic) in any of Pr. 190 to Pr. 192 and Pr. 195 turns on (off for negative logic). By setting 0, the output terminal turns off (on for negative logic).
If a power failure occurs at the Pr. 495 setting of 0, the output data are cleared to zero after power recovery and the output terminals turn on/off in accordance with the positive/negative logic settings of Pr. 190 to Pr. 192 and Pr. 195.
When the Pr. 495 setting is 1, the remote output data at occurrence of a power failure are stored into E^2PROM to make the output data at power recovery the same as those at a power failure, and the on/off states of the output terminals are also made the same as those at a power failure. (They are not stored at an inverter reset.)
If the terminals of remote output and non-remote output are mixed using Pr. 190 to Pr. 192 and Pr. 195, the terminal to which remote output is not assigned will not turn on/off even if 0/1 is set in the corresponding bit of the remote output data (Pr. 496), and that terminal turns on/off with respect to the selected function.

(2) Others

Setting Pr. 496, Pr. 497 with the PU/DU, by computer link through the PU connector, or by communication through the communication option allows the on/off control of the remote output terminals.
Pr. 496, Pr. 497 is always accessible by making access to RAM only. When the inverter is reset, therefore, the Pr. 496, Pr. 497 setting changes to 0. When Pr. 495 = 1, however, that setting is the same as at a power failure.
If you change the Pr. 495 setting of 1 to 0 with the Pr. 496 and Pr. 497 value stored in E^2PROM at occurrence of a power failure, the Pr. 496 and Pr. 497 value stored changes to 0.

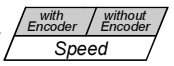
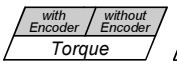
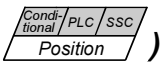
CAUTION

When Pr. 495 = 1, take such a step as to connect R1, S1 and P, N to ensure that control power will be retained to some degree. If you do not take such a step, the output signals provided after power-on are not guaranteed.

Related parameters

- Pr. 190 to Pr. 192, Pr. 195 (output terminal function selection) (Refer to page 165.)

4.31 Operation selection functions 4 (Pr. 800 to Pr. 809)

4.31.1 Control selection (Pr. 800, Pr. 451   )

Used to select the control method.

- Setting Pr. 800 (Pr. 451) control system selection enables the following combination using the MC signal (mode changing).
- Use terminal RT to switch to the second motor, control method selection.
  (Refer to page 41 for details about using the second motor)

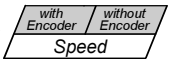
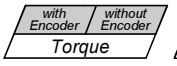
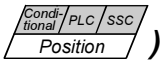
Parameter	Name	Factory Setting	Setting Range
800	Control system selection	0	0 to 5, 10, 11, 12, 20
451	Second motor control method selection	9999	10, 11, 12, 20, 9999

- Select the inverter control system such as speed control, torque control or position control.

Pr. 800 Setting	Control System	Control Method	Remarks
0	Vector control with encoder	Speed control	Factory setting
1		Torque control	—
2		Speed control-torque control switchover	MC ON: Torque control MC OFF: Speed cotrol
3		Position control	—
4		Speed control-position control switchover	MC ON: Position control MC OFF: Speed control
5		Position control-torque control switchover	MC ON: Torque control MC OFF: Position control
10	Vector control without encoder	Speed control	—
11		Torque control	—
12		Speed control-torque control switchover	MC ON: Torque control MC OFF: Speed control
20	V/F control	Speed control	—

Related parameters

MC signal terminal assignment ⇒ Set "26" in any of Pr. 180 to Pr. 183 and Pr. 187 (input terminal function selection). (Refer to page 163.)

4.31.2 Torque characteristic selection (Pr. 801   )

When using the motor with encoder, you can select the torque characteristic.

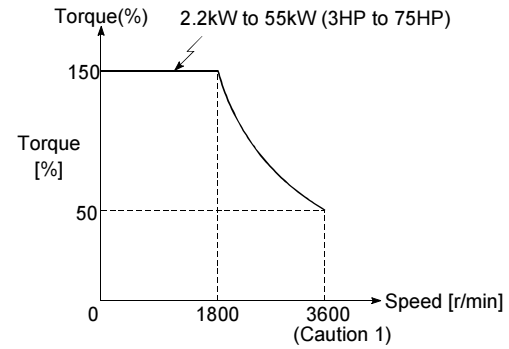
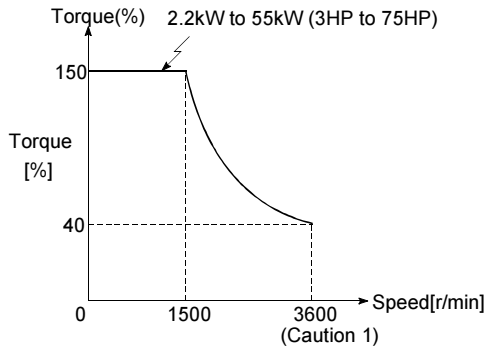
Parameter	Name	Factory Setting	Setting Range	
				Motor with encoder (e.g. SF-JR)
801	Torque characteristic selection	1	0	Cyclic operation mode
			1	Continuous operation mode

CAUTION

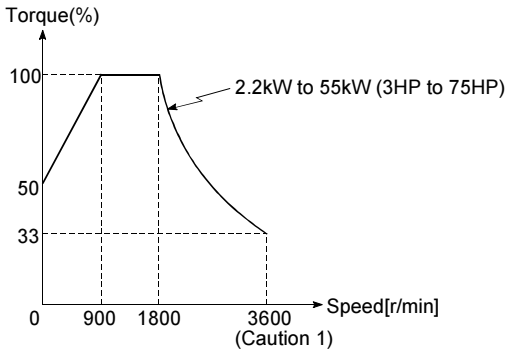
- **Usually, operate in the continuous operation mode (setting value: 1)**
  Torque at a low speed is not sufficient in the cyclic operation mode (setting value: 0).
  Note this when changing the setting.

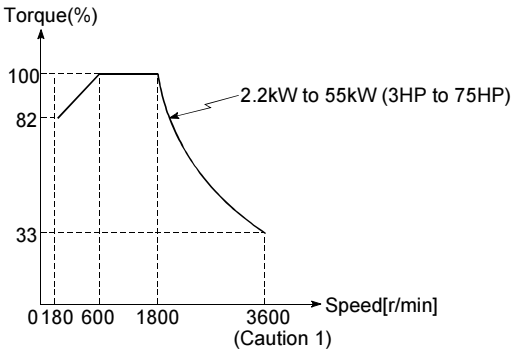
● Torque characteristic of motor with encoder (Example: SF-JR with encoder (4 poles))

Torque characteristic available when the inverter and motor of the same capacity are used and the rated voltage is input

1800r/min (60Hz) torque reference	
Cyclic operation mode setting	**Continuous operation mode setting**
● Short-duration maximum torque <2.2 to 55 (3 to 75)[kW (HP)]>	● Short-duration maximum torque <2.2 to 55 (3 to 75) [kW (HP)]>
	

1800r/min (60Hz) torque reference	
Cyclic operation mode setting	**Continuous operation mode setting**
● 50%ED torque <2.2 to 55 (3 to 75) [kW (HP)]>	● Continuous operation torque <2.2 to 55 (3 to 75) [kW (HP)]>





CAUTION

1. **The maximum speeds are 1) 2.2kW to 7.5kW (3HP to 10HP): 3600r/min, 2) 15kW to 22kW (20HP to 30HP): 3000r/min, and 3) 37kW to 55kW (50HP to 75HP): 1950r/min.**
2. **50%ED continuously repeated operation can be performed at the cycle time of 10 minutes. Note that continuous operation can be performed for a maximum of 5 minutes.**

Pr. 802 ➡ Refer to Pr. 10 to Pr. 12 (page 95).

Pr. 803 ➡ Refer to Pr. 22 (page 100).

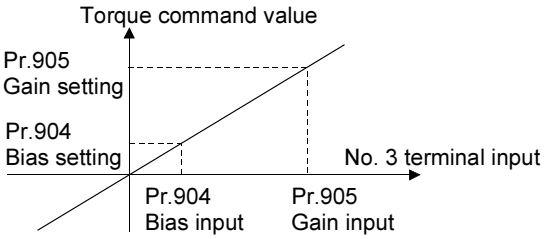
4.31.3 Torque command right selection (Pr. 804 to Pr. 806)

with Encoder / without Encoder — Torque

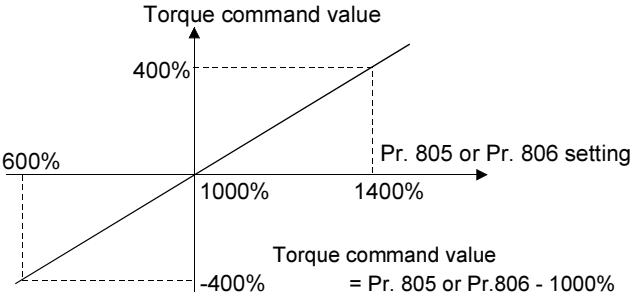
When you selected torque control, you can choose the torque command.

Parameter	Name	Factory Setting	Setting Range	
804	Torque command right selection	0	0	Terminal 3 analog input
			1	Digital input from parameter Pr. 805 or Pr. 806 setting (-400% to 400%)
			2	Torque command using pulse train command (FR-V5AP) Refer to the instruction manual of the option "FR-V5AP" for details.
			3	Torque command by using CC-Link (FR-A5NC) Refer to the instruction manual of the option "FR-A5NC" for details.
			4	Torque command from the option (digital) (FR-V5AH, FR-A5AX) Refer to the instruction manual of the option "FR-V5AH, FR-A5AX" for details.
805	Torque command value (RAM)	1000%	600 to 1400%	
806	Torque command value (RAM, E^2PROM)	1000%	600 to 1400%	

(1) Terminal 3 calibration (Pr. 804 = 0)
The torque command value for the analog input of the terminal 3 varies with Pr. 904 and Pr. 905 as shown on the right.



(2) Digital input from parameter (Pr. 804 = 1)
Digital setting of the torque command can be made by writing the torque command value to Pr. 805 or Pr. 806 by communication. The torque command can also be specified by parameter direct setting. In this case, set the speed restriction value to an appropriate value to prevent acceleration.
The relationship between the Pr. 805 or Pr. 806 setting and actual torque command value at this time is shown on the right. On the assumption that 1000% is 0%, the torque command is indicated by an offset from 1000%.



CAUTION

1. **For the command given by the torque setting command E^2PROM (RYE), the set torque (RWW1) is reflected on the torque command value of the inverter when the torque setting command E^2PROM (RYE) changes from off to on.**
   For the command given by the torque setting command RAM (RYD), the set torque (RWW1) is reflected on the inverter while the torque setting command RAM (RYD) is on.
2. **When writing the torque command value by communication (Pr. 804 = 1, Pr. 804 = 3), there is a restriction on the number of write times to E^2PROM. When the value is changed often, write it to RAM. (When Pr. 804 = 1, set "1" in Pr. 342 "E^2PROM write selection" to select write to RAM.)**

4.31.4 Speed restriction (Pr. 807 to Pr. 809 with Encoder / without Encoder Torque)

When you selected torque control, set the speed restriction value to prevent the load torque from becoming less than the torque command value, resulting in motor overspeed.

Parameter	Name	Factory Setting	Setting Range
807	Speed restriction selection	0	0, 1, 2
808	Forward rotation speed restriction	1800r/min	0 to 3600r/min
809	Reverse rotation speed restriction	9999	0 to 3600r/min, 9999

<Settings>

Set the speed restriction value to prevent the load torque from becoming less than the torque command value, resulting in motor overspeed. Select the speed restriction input method using Pr. 807.

Pr. 807 Setting	Speed Restriction Input Method	Operation
0 (factory setting)	Same method as in speed setting for speed control	• Speed setting from the operation panel • External analog command (terminal 1, 2) • Multi-speed command • Option (FR-V5AX etc.) • For both PU and external operations, speed restriction changes according to the acceleration/deceleration time.
1	Pr. 808 Forward rotation speed restriction Pr. 809 Reverse rotation speed restriction	According to the rotation direction, set the speed restrictions in forward and reverse rotation directions individually. When the reverse rotation speed restriction is 9999, the setting is the same as that of the torque restriction in the forward rotation direction.
2	Forward/reverse rotation speed restriction (analog polarity switchover speed restriction) (Terminal 1 analog input)	The analog voltage of the terminal 1 input is used to make speed restriction. For 0 to 10V input, set the forward rotation speed restriction. (The reverse rotation speed restriction is Pr. 1 "maximum speed" .) For -10 to 0V input, set the reverse rotation speed restriction. (The forward rotation speed restriction is Pr. 1 "maximum speed".) The maximum speed of both the forward and reverse rotation is Pr. 1 "maximum speed". When terminal 1 input is selected, set "5" in Pr. 868 "No. 1 terminal function assignment". (Refer to page 195.)

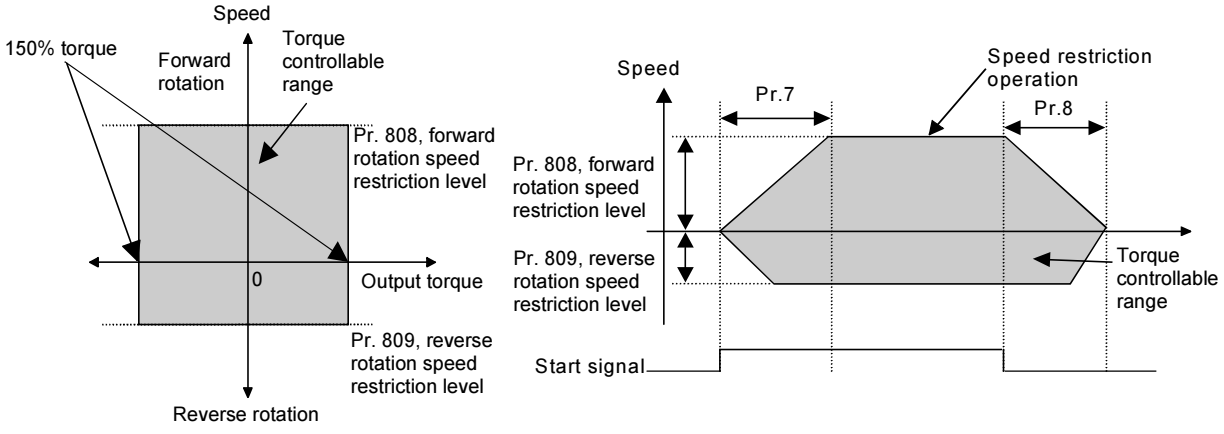
(1) When Pr. 807 =0

Refer to the Instruction Manual (basic).

(2) When Pr. 807 = 1

Parameter	Name	Factory Setting	Setting Range
808	Forward rotation speed restriction	1800r/min	0 to 3600r/min
809	Reverse rotation speed restriction	9999	0 to 3600r/min, 9999

Using the parameters, set the forward rotation and reverse rotation speed restriction levels individually.

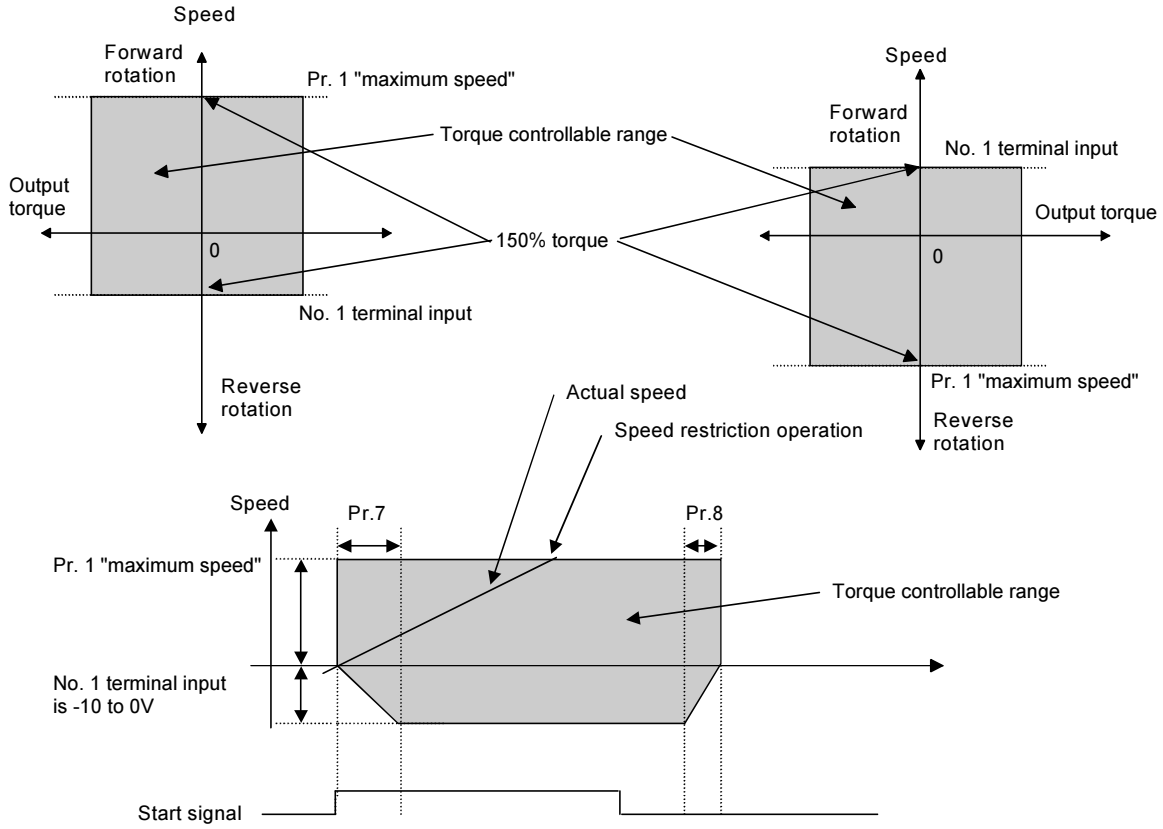


(3) When Pr. 807 = 2

Using the analog input of the terminal 1, set the forward rotation and reverse rotation speed restriction levels. At this time, the speed restriction made on the analog input is as shown below.

1) When terminal 1 input is -10 to 0V
Reverse rotation speed restriction

2) When terminal 1 input is 0V to 10V
Forward rotation speed restriction



Related parameters

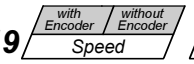
- Selection of No. 1 terminal function ⇒ Pr. 868 "No. 1 terminal function assignment" (Refer to page 195.)
- Speed restriction during acceleration/deceleration ⇒ Pr. 7 "acceleration time", Pr. 8 "deceleration time" (Refer to page 91.)
- DC injection brake operation level ⇒ Pr. 10 "DC injection brake operation speed" (Refer to page 95.)
- Speed restriction level maximum setting ⇒ Pr. 1 "maximum speed" (Refer to page 89.)

CAUTION

When speed ≥ speed restriction, torque control is switched to speed control.

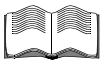
Pr. 810, Pr. 812 to Pr. 817 ➡ Refer to Pr. 22 (page 100)

4.32 Control system functions (Pr. 818 to Pr. 837)

4.32.1 Easy gain tuning selection (Pr. 818, Pr. 819  )

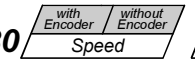
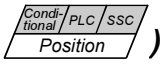
The ratio of load inertia to motor inertia (load inertia moment ratio) is estimated in real time from the torque command and speed during motor operation under vector control with encoder, and this value is used to automatically set the optimum gain for speed/position control, reducing the time and effort of making gain adjustment.

Parameter	Name	Factory Setting	Setting Range	
818	Easy gain tuning response level setting	2	1 to 15	
819	Easy gain tuning selection	0	0	No tuning
			1	With load estimation
			2	Manual load input

 Refer to the Instruction Manual (basic) for details.

Related parameters

- Adjusted gains ⇒ Pr. 820 "speed control P gain 1", Pr. 821 "speed control integral time 1", Pr. 828 "model speed control gain", Pr. 422 "position loop gain"
- Adjusted load inertia ratio ⇒ Pr. 880 "load inertia ratio"

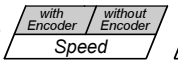
4.32.2 Speed loop proportional gain setting (Pr. 820, Pr. 830  )

Parameter	Name	Factory Setting	Setting Range	Remarks
820	Speed control P gain 1 (when RT signal is off)	60%	0 to 1000%	Extended mode
830	Speed control P gain 2 (when RT signal is on)	9999	0 to 1000%, 9999	

- Set the proportional gain of the speed loop.
  Increasing the gain enhances the speed response level and decreases the speed fluctuation relative to disturbance, but a too large gain will produce vibration and/or sound.
- Pr. 820 "speed control P gain 1" and Pr. 830 "speed control P gain 2" are 0 to 1000% in the setting range and 60% in the factory setting. For general adjustment, set them within the range of 20 to 200%.

REMARKS

1. The response level will be worse when the coupling is loose.
2. When performing positioning, increase the setting to enhance accuracy.
3. Decrease the setting when there is gear backlash, etc.

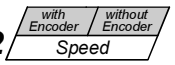
4.32.3 Speed control integral time setting (Pr. 821, Pr. 831  )

Parameter	Name	Factory Setting	Setting Range	Remarks
821	Speed control integral time 1 (when RT signal is off)	0.333s	0 to 20s	Extended mode
831	Speed control integral time 2 (when RT signal is on)	9999	0 to 20s, 9999	

- Set the integral compensation time of the speed loop.
  If speed fluctuation occurs relative to disturbance, decreasing the value shortens the recovery time, but a too small value will cause a speed overshoot.
  A large value improves stability but increases the recovery time (response time) and may cause an undershoot.

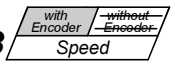
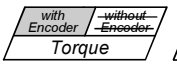
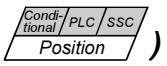
REMARKS

You can switch between PI control and P control under speed control using the X44 signal. (Refer to page 37.)

4.32.4 Speed setting circuit filter function (Pr. 822, Pr. 832  )

Set the time constant of the primary delay filter relative to the external speed command (analog input command).
Set a large time constant when you want to delay the tracking of the speed command or when the analog input voltage is unstable.

Parameter	Name	Factory Setting	Setting Range	Remarks
822	Speed setting filter 1 (when RT signal is off)	0s (without filter)	0 to 5s	Extended mode
832	Speed setting filter 2 (when RT signal is on)	9999	0 to 5s, 9999	

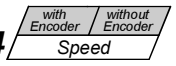
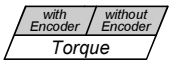
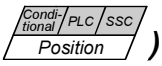
4.32.5 Speed detection filter function (Pr. 823, Pr. 833   )

- Set the time constant of the primary delay filter relative to the speed feedback signal.
  Since this function reduces the speed loop response, use it with the factory setting.
  Set the time constant when speed ripples occur due to harmonic disturbance.
  Note that a too large value will run the motor unstably.

Parameter	Name	Factory Setting	Setting Range	Remarks	
823	Speed detection filter 1 (when RT signal is off)	0.001s	0 to 0.1s	0: without filter	Extended mode
833	Speed detection filter 2 (when RT signal is on)	9999	0 to 0.1s, 9999	9999: same as the Pr. 823 setting	

REMARKS

When speed ripples are large, setting this parameter Pr. 823 or Pr. 833 ensures stability.

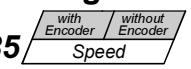
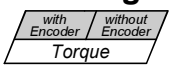
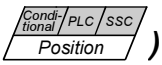
4.32.6 Current loop proportional gain setting for vector control (Pr. 824, Pr. 834   )

- Set the current loop proportional gain for vector control.
  Increasing the gain enhances the torque response level, but a too large gain will cause instability, generating harmonic torque pulsation.
- Pr. 824 "torque control P gain 1" and Pr. 834 "torque control P gain 2" are 0 to 200% in the setting range and 100% in the factory setting.
  For general adjustment, set them within the range 50 to 200%.

Parameter	Name	Factory Setting	Setting Range	Remarks
824	Torque control P gain 1 (when RT signal is off)	100%	0 to 200%	Extended mode
834	Torque control P gain 2 (when RT signal is on)	9999	0 to 200%, 9999	

REMARKS

The factory setting ensures fully stable operation.
For general adjustment, make setting within the range 50 to 200% as a guideline.

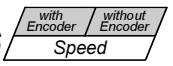
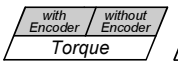
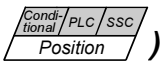
4.32.7 Current control integral time setting for vector control (Pr. 825, Pr. 835   )

- Set the current loop integral compensation time for vector control.
- A small value enhances the torque response level, but a too small value will cause current fluctuation.

Parameter	Name	Factory Setting	Setting Range	Remarks
825	Torque control integral time 1 (when RT signal is off)	5ms	0 to 500ms	Extended mode
835	Torque control integral time 2 (when RT signal is on)	9999	0 to 500ms, 9999	

REMARKS

The factory setting ensures fully stable operation.

4.32.8 Torque setting filter function (Pr. 826, Pr. 836   )

- Set the time constant of the primary delay filter relative to the external torque command (analog input command).
  Set a large time constant value when you want to delay the tracking of the torque command, the analog input voltage fluctuates, etc.

Parameter	Name	Factory Setting	Setting Range	Remarks
826	Torque setting filter 1 (when RT signal is off)	0s (without filter)	0 to 5s	Extended mode
836	Torque setting filter 2 (when RT signal is on)	9999	0 to 5s, 9999	

4.32.9 Torque detection filter function (Pr. 827, Pr. 837 with Encoder / without Encoder: Speed; with Encoder / without Encoder: Torque; Conditional / PLC / SSC: Position)

- Set the time constant of the primary delay filter relative to the torque feedback signal. Since the current loop response reduces, use it with the factory setting.

Parameter	Name	Factory Setting	Setting Range	Remarks
827	Torque detection filter 1 (when RT signal is off)	0s	0 to 0.1s	Extended mode
837	Torque detection filter 2 (when RT signal is on)	9999	0 to 0.1s, 9999	

4.32.10 Model speed control gain (Pr. 828 with Encoder / without Encoder: Speed; Conditional / PLC / SSC: Position)

Parameter	Name	Factory Setting	Setting Range	Remarks
828	Model speed control gain	60%	0 to 1000%	Extended mode

For details, refer to page 51.

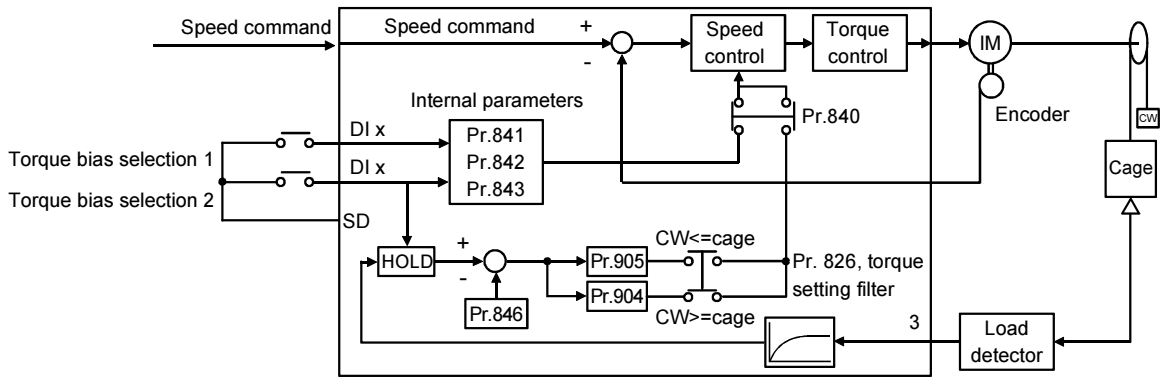
4.33 Torque biases (Pr. 840 to Pr. 848)

4.33.1 Torque bias function (Pr. 840 to Pr. 848 with Encoder / ~~without Encoder~~: Speed)

- This function accelerates the rise of the torque at a start. Adjust the torque at a motor start using the contact signals or analog signals .

Parameter	Name	Factory Setting	Setting Range	Remarks
840	Torque bias selection	9999	0 to 3, 9999	Extended mode
841	Torque bias 1	9999	600 to 1400%, 9999	
842	Torque bias 2	9999	600 to 1400%, 9999	
843	Torque bias 3	9999	600 to 1400%, 9999	
844	Torque bias filter	9999	0 to 5s, 9999	
845	Torque bias operation time	9999	0 to 5s, 9999	
846	Torque bias balance compensation	9999	0 to 10V, 9999	
847	Fall-time torque bias No. 3 bias	9999	0 to 400%, 9999	
848	Fall-time torque bias No. 3 gain	9999	0 to 400%, 9999	

Block diagram



(1) Parameter details

1) Pr. 840 "torque bias selection"
Select the setting method of the torque bias amount.

Pr. 840 Setting	Description
0	Set the torque bias amount based on the contact signals (DI1 to DI4) in Pr. 841 to Pr. 843.
1	To raise the cage when the motor runs in forward rotation direction. Set the terminal 3-based torque bias amount as desired in Pr. 904 and Pr. 905.
2	To raise the cage when the motor runs in reverse rotation direction. Set the terminal 3-based torque bias amount as desired in Pr. 904 and Pr. 905.
3	The terminal 3-based torque bias amount can be set automatically in Pr. 904, Pr. 905 and Pr. 846 according to the load.
9999	No torque bias

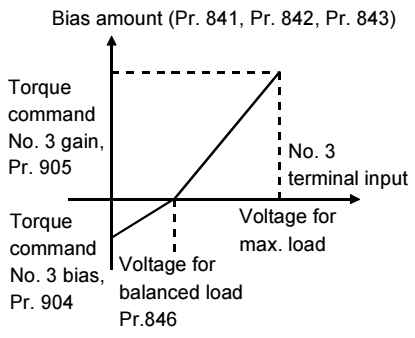
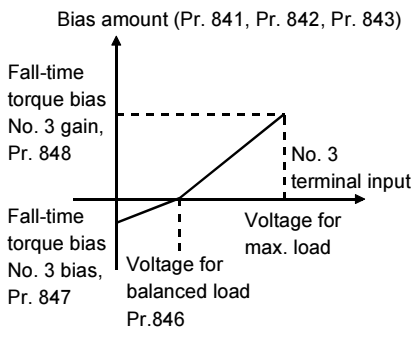
<Operation diagrams>

- When Pr. 840 = 0
  Set the torque bias values (Pr. 841 to Pr. 843) in the following table according to the combination of the contact signals (DI1 to DI4).

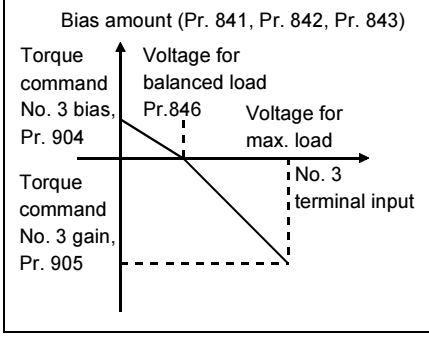
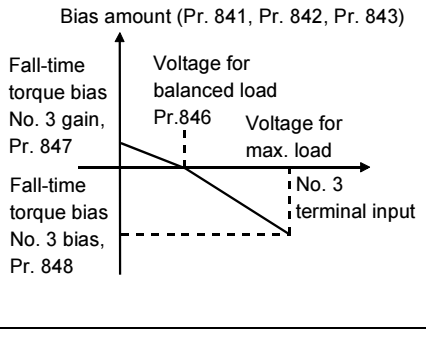
Torque Bias Selection 1 (X42 Terminal)	Torque Bias Selection 2 (X43 Terminal)	Torque Bias (Pr. 841 to Pr. 843)
OFF	OFF	No selection
ON	OFF	Pr.841 1000 to 1400%: Positive value 600 to 999%: Negative value
OFF	ON	Pr.842 1000 to 1400%: Positive value 600 to 999%: Negative value
ON	ON	Pr.843 1000 to 1400%: Positive value 600 to 999%: Negative value

(Example) 25% when Pr. 841 = 1025, -25% when Pr. 842 = 975, -75% when Pr. 843 = 925

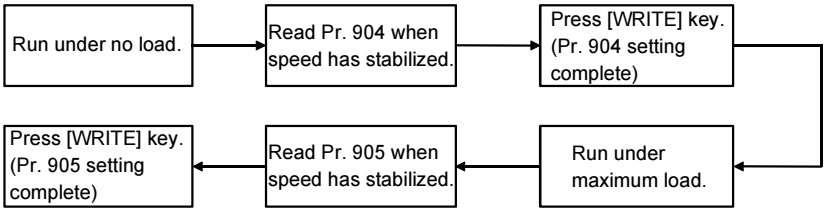
- When Pr. 840 = 1
  Calculate the torque bias from the analog input value of the terminal 3 as shown below and set the gain and bias (Pr. 904, Pr. 905) of the torque command.

Rise (Motor Forward Rotation)	Fall (Motor Reverse Rotation)
	

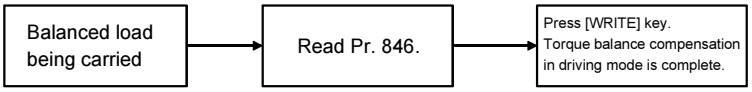
- When Pr. 840 = 2

Rise (Motor Reverse Rotation)	Fall (Motor Forward Rotation)
	

• When Pr. 840 = 3
Pr. 904 "torque command No. 3 bias", Pr. 905 "torque command No. 3 gain" and Pr. 846 "torque bias balance compensation" can be set automatically according to the load.
Pr. 904, Pr. 905 settings



Pr. 846 setting



CAUTION

When starting torque bias operation after completion of automatic setting, set "1 or 2" in Pr. 840.

2) Pr. 841 "torque bias 1", Pr. 842 "torque bias 2", Pr. 843 "torque bias 3"
On the assumption that the rated torque is 100%, the torque bias setting of 1000% is the center value of torque and the bias value is "0".

Setting	Description
600 to 999%	Negative torque bias amount (-400% to -1%)
1000 to 1400%	Positive torque bias amount (0% to 400%)
9999	Without torque bias setting

3) Pr. 844 "torque bias filter"
You can make a torque rise gentler. At this time, the torque rises according to the time constant of the primary delay filter.

Setting	Description
0 to 5s	Time until torque rises.
9999	Same operation as when 0s is set.

4) Pr. 845 "torque bias operation time"
Set the time for output torque be maintained with the torque bias command value alone.

Setting	Description
0 to 5s	Time for maintaining torque equivalent to the torque bias amount.
9999	Same operation as when 0s is set.

5) Pr. 846 "torque bias balance compensation"
Set the voltage of the torque bias analog input value input to the terminal 3 to compensate for the balance of the torque bias amount.

Setting	Description
0 to 10V	Set the voltage under balanced load.
9999	Same operation as when 0V is set.

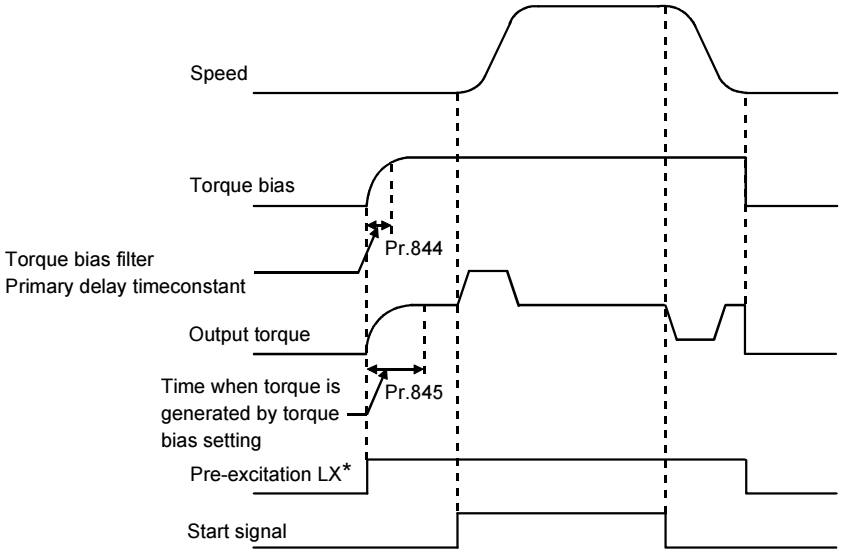
6) Pr. 847 "fall-time torque bias No. 3 bias"
Set the torque bias amount at a fall time (when the motor runs in the reverse rotation direction).

Setting	Description
0 to 400%	Set the bias value of the torque command.
9999	Same as at a rise time (Pr. 904).

7) Pr. 848 "fall-time torque bias No. 3 gain"
Set the torque bias amount at a fall time.

Setting	Description
0 to 400%	Set the gain value of the torque command.
9999	Same as at a rise time (Pr. 905).

(2) Torque bias operation



*When pre-excitation is not made, the torque bias functions simultaneously with the start signal.

Pr. 849 ➡ Refer to Pr. 902, Pr.903 (page 205)

Pr. 850 ➡ Refer to Pr. 10, Pr.11, Pr.12 (page 95)

4.34 Additional functions (Pr. 851 to Pr. 865)

4.34.1 Selection of number of encoder pulses

(Pr. 851 with Encoder / ~~without Encoder~~ Speed ; with Encoder / ~~without Encoder~~ Torque ; Conditional / PLC / SSC Position ***)***

Set the number of pulses of the encoder fitted to the motor. (number of pulses before multiplied by 4)

Parameter	Name	Factory Setting	Setting Range
851	Number of encoder pulses	1024	0 to 4096

Refer to page 10 for details.

4.34.2 Selection of encoder rotation direction

(Pr. 852 with Encoder / ~~without Encoder~~ Speed ; with Encoder / ~~without Encoder~~ Torque ; Conditional / PLC / SSC Position ***)***

You can set the rotation direction of the encoder.

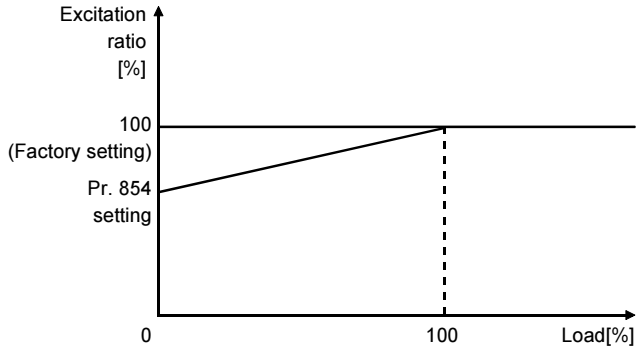
Parameter	Name	Factory Setting	Setting Range	Remarks
852	Encoder rotation direction	1	0, 1	Extended mode

Refer to page 10 for details.

4.34.3 Excitation ratio (Pr. 854)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

- Decrease the excitation ratio when you want to improve efficiency under light load. (motor magnetic noise decreases) Note that the rise of output torque becomes slow if excitation ratio is decreased. This function is appropriate for applications as machine tools which repeat rapid acceleration/deceleration up to high speed.



Parameter	Name	Factory Setting	Setting Range	Remarks
854	Excitation ratio	100%	0 to 100%	Extended mode

REMARKS

When "1" (magnetic flux command from the terminal 1) is set in Pr. 868 "No. 1 terminal function assignment", this Pr. 854 setting is made invalid.

Pr. 859 ➡ Refer to page 136

Pr. 860 ➡ Refer to page 136

4.34.4 Notch filter (Pr. 862, Pr. 863)

with Encoder / without Encoder — Speed
Conditional / PLC / SSC — Position

You can reduce the response level of speed control in the resonance frequency band of the mechanical system to avoid mechanical resonance.

Parameter	Name	Setting Range	Increments	Factory Setting	Remarks	
862	Notch filter frequency	0 to 31	1	0	0: Function invalid	Extended mode
863	Notch filter depth	0 to 3	1	0		

●Pr. 862 "notch filter frequency"

Pr. 862 Setting	Frequency	Pr. 862 Setting	Frequency	Pr. 862 Setting	Frequency	Pr. 862 Setting	Frequency
0	invalid	8	140.6	16	70.3	24	46.9
1	1125.0	9	125.0	17	66.2	25	45.0
2	562.5	10	112.5	18	62.5	26	43.3
3	375.0	11	102.3	19	59.2	27	41.7
4	281.3	12	93.8	20	56.3	28	40.2
5	225.0	13	86.5	21	53.6	29	38.8
6	187.5	14	80.4	22	51.1	30	37.5
7	160.7	15	75.0	23	48.9	31	36.3

●Pr. 863 "notch filter depth"

Pr. 863 Setting	Depth (Gain)
0	deep (-40dB)
1	↑ (-14dB)
2	↓ (-8dB)
3	sharow (-4dB)

CAUTION

- If you do not know the machine resonance frequency, decrease notch frequency gradually from the highest value. The point at which the smallest vibration is generated is the notch freqeuncy setting.
- The notch filter with deeper depth has an effect on minimizing mechanical resonance. However, large vibration may be generated adversely due to substantial phase delay.
- Machine characteristic can be obtained beforehand with machine analyzer by setup software. Necessary notch frequency can be determined from this.

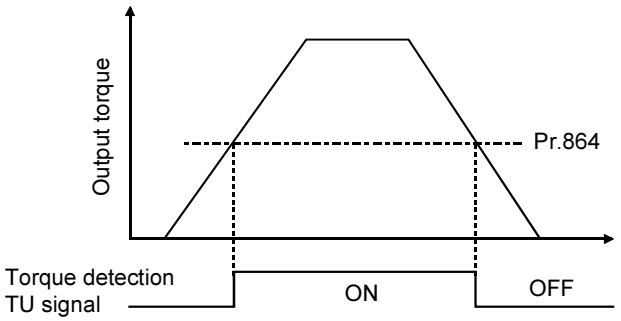
4.34.5 Torque detection (Pr. 864)

with Encoder / without Encoder — Speed; with Encoder / without Encoder — Torque; Conditional / PLC / SSC — Position

This function outputs a signal if the motor torque rises to or above the Pr. 864 setting.
The signal is used as operation and open signal for an electromagnetic brake.

Parameter	Name	Factory Setting	Setting Range	Remarks
864	Torque detection	150%	0 to 400%	Extended mode

The signal turns on when the output torque rises to or above the detection torque value set in Pr. 864.
It turns off when the torque falls below the detection torque value.



Related parameters

TU signal terminal assignment ⇒ Set "35" in any of Pr. 190 to Pr. 192 and Pr. 195 (output terminal function selection).
(Refer to page 165.)

4.34.6 Low speed detection (Pr. 865)

with Encoder / without Encoder — Speed; with Encoder / without Encoder — Torque; Conditional / PLC / SSC — Position

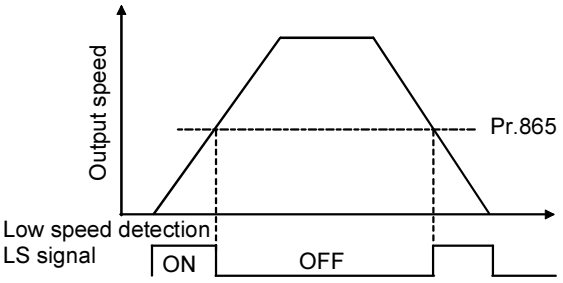
This function outputs a signal if the speed falls to or below the Pr. 865 setting.

Parameter	Name	Factory Setting	Setting Range	Remarks
865	Low speed detection	45r/min	0 to 3600r/min	Extended mode

<Operation>

The signal is output during inverter operation under the following conditions.

(1) Vector control with encoder
Motor speed ≤ Pr. 865 ... ON
Motor speed > Pr. 865 ... OFF
(2) Vector control without encoder
Speed estimated value ≤ Pr. 865 ... ON
Speed estimated value > Pr. 865 ... OFF
(3) V/F control
Output speed ≤ Pr. 865 speed equivalent ... ON
Output speed > Pr. 865 speed equivalent ... OFF



REMARKS

When "0" is set, low speed detection (LS signal) is output under position control only.

Related parameters

LS signal terminal assignment ⇒ Set "34" in any of Pr. 190 to Pr. 192 and Pr. 195 (output terminal function selection).
(Refer to page 165.)

Pr. 866 ➡ Refer to Pr. 55 (page 113)

4.35 Display function (Pr. 867)

4.35.1 DA1 output response level adjustment (Pr. 867)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

You can adjust the response level of the output voltage of the output signal DA1.

Parameter	Name	Factory Setting	Setting Range	Remarks
867	DA1 output filter	0.05s	0 to 5s	Extended mode

4.36 Terminal function assignment (Pr. 868)

4.36.1 No. 1 terminal function assignment (Pr. 868)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

The terminal 1 can be multi-functioned.

Parameter	Name	Factory Setting	Setting Range	Remarks
868	No. 1 terminal function assignment	0	0, 1, 2, 5, 9999	Extended mode

<No1. terminal function according to control>

Pr. 868 Setting	Terminal 1 Function under Speed Control	Terminal 1 Function under Torque Control	Terminal 1 Function under Position Control	Bias/Gain Setting	Remarks
0 (factory setting)	Speed setting auxiliary *	Speed restriction auxiliary	No function	Pr. 902 "speed setting No. 2 bias" Pr. 903 "speed setting No. 2 gain"	
1	Magnetic flux command	Magnetic flux command	Magnetic flux command	Pr. 919 "No. 1 terminal bias (torque/magnetic flux)" Pr. 920 "No. 1 terminal gain (torqe/magnetic flux)"	
2	Regenerative torque restriction	No function	Regenerative torque restriction	Pr. 919 "No. 1 terminal bias (torque/magnetic flux)" Pr. 920 "No. 1 terminal gain (torqe/magnetic flux)"	Setting can be made when Pr. 810 = 1.
5	No function	Forward/reverse rotation speed restriction (analog polarity switchover speed restriction)	No function	Pr. 917 "No. 1 terminal bias (speed)" Pr. 918 "No1. terminal gain (speed)"	
9999	No function	No function	No function	No function	No function

* The function is changed to main speed according to the Pr.73 setting with which override, polarity reversible function, etc. can be selected. (Refer to page 125.)

REMARKS

Refer to page 202 for bias/gain settings.

<Detailed operation>

The following table indicates the functional combinations of the terminals 1, 2 and 3.
Basically, the analog multiple functions are assigned to the terminal 1 alone and only one function may be selected for the multi-function analog input.

Control Method	Terminal 2 Speed Command/ Speed Restriction/ PID Set Point	Terminal 3 Torque Restriction/ Torque Command/ Torque Bias	Terminal 1 Multi-function	Remarks
Speed control	Speed command	No function (Pr. 810 = 0, Pr. 840=9999)	Speed auxiliary setting (Reversible operation also possible)	Factory-set status
			Magnetic flux command	
		Torque restriction (Pr. 810 = 1)	Speed auxiliary setting (Reversible operation also possible)	
			Magnetic flux command	
			Regenerative torque restriction	Setting can be made when Pr. 810 = 1.
		Torque bias (Pr. 810=0, Pr. 840=1,2,3)	Speed setting auxiliary	
			Magnetic flux command	
Torque control	Speed restriction	Torque command	Speed restriction auxiliary input	
			Magnetic flux command	
	No function		Forward/reverse rotation speed restriction (analog polarity switchover speed restriction)	Setting can be made when Pr. 807=2.
Position control	No function	No function (Pr. 810 = 0)	No function	
			Magnetic flux command	
		Torque restriction (Pr. 810 = 1)	No function	
			Magnetic flux command	
			Regenerative torque restriction	Setting can be made when Pr. 810=1.

When the PID control function is selected, the terminal 2 is used for the PID set point. For PID control, refer to page 152.
When the torque bias function is selected, the terminal 3 is used for the torque bias input.

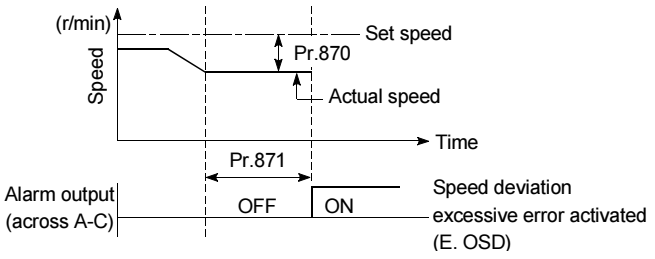
REMARKS

Magnetic flux command is a function used to command magnetic flux (strength of magnetic flux) from the external analog terminal (1). In addition to torque command "terminal 3", the inverter can control torque using magnetic flux as a command. For example, the characteristic of motor torque is that output torque is constant independently of the output speed when exercising line feed/tension constant control on a winder, unwinder, etc. Constant output control by variable magnetic flux, equivalent to field excitation control of the DC shunt motor, can be exercised.

4.37 Protective functions (Pr. 870 to Pr. 874)

4.37.1 Speed deviation excessive (Pr. 870, Pr. 871 with Encoder / ~~without Encoder~~ Speed)

- If the difference (absolute value) between the speed command value and actual speed exceeds the Pr. 870 "speed deviation level" setting for longer than the time set in Pr. 871 "speed deviation time", speed deviation excessive occurs and error "E. OSD" appears, resulting in a stop.



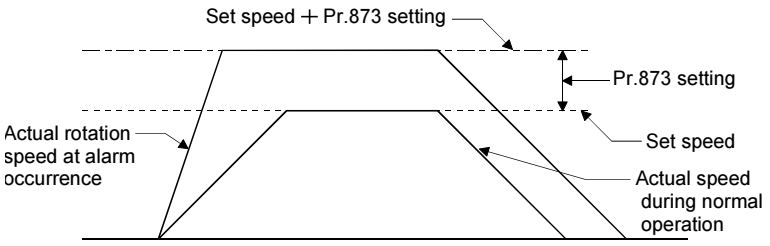
Parameter	Name	Factory Setting	Setting Range	Remarks	
870	Speed deviation level	9999	0 to 1500r/min, 9999	9999:Invalid	Extended mode
871	Speed deviation time	12s	0 to 100s	- - -	

REMARKS

1. Set these parameters when a speed difference will pose a problem.
2. This function is activated only under vector control with encoder.
3. When the motor with encoder is driven, setting the Pr. 851 "number of encoder pulses" value that is different from the actual number of encoder pulses may make control unstable, resulting in "E. OSD" (even if Pr. 870 = 9999).

4.37.2 Speed restriction (Pr. 873 with Encoder / without Encoder Speed)

This function prevents the motor from overrunning when the setting of number of encoder pulses and the actual number differ. When the setting of number of encoder pulses is smaller than the actual number, the motor may increase its speed. To prevent this, restrict the output speed with the synchronous speed obtained by adding the set speed and Pr.873 setting. (*)



Parameter	Name	Factory Setting	Setting Range	Remarks
873	Speed restriction	600r/min	0 to 3600r/min	Extended mode

CAUTION

*** When the setting of number of the encoder pulses is smaller than the actual number, selecting automatic restart after instantaneous power failure function (set a value other than "9999" in Pr. 57) restrict the output speed with the synchronous speed obtained by adding the maximum speed (Pr. 1) and Pr. 873 setting.**

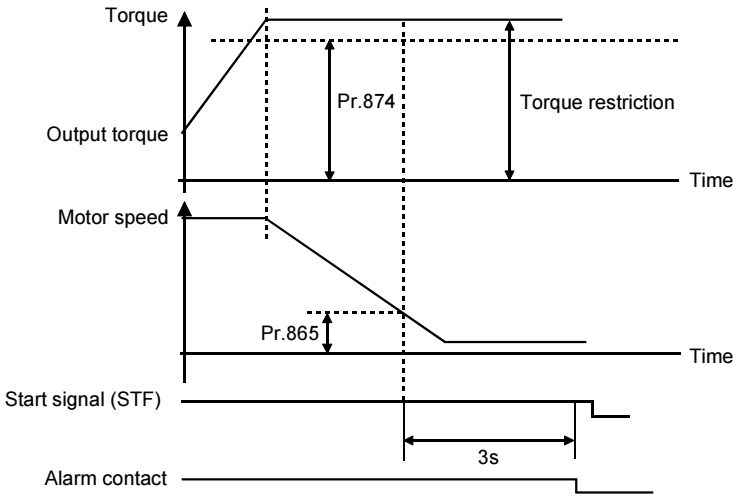
4.37.3 Stop by OLT level prevention (Pr. 874 with Encoder / without Encoder Speed Condi-tional / PLC / SSC Position)

This function can make an alarm stop if the torque restriction is activated to stall the motor.

Parameter	Name	Factory Setting	Setting Range	Remarks
874	OLT level setting	150%	0 to 200%	Extended mode

(1) Speed control, position control

The motor stalls if the torque restriction is activated under a high load applied during speed control or position control. At this time, if the motor speed is lower than the speed set in Pr. 865 (low speed detection) and also the output torque exceeds the level set in Pr. 874 for 3s, it is regarded as a stop effected by stall prevention and E. OLT is output, resulting in an alarm stop.



If torque restriction is activated and speed falls below Pr. 865 setting, OLT alarm does not occur when output torque at this time is lower than Pr. 874.

(2) V/F control

If the stall prevention function is activated and the output frequency is kept reduced to 0Hz for 3s, OLT will cause an alarm stop.

In this case, this function is activated regardless of Pr. 874.

(3) Torque control

This alarm is not activated.

Related parameters

- Low speed detection ⇒ Pr. 865 "low speed detection" (Refer to page 194.)

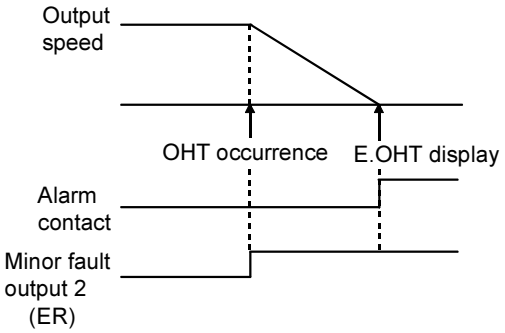
4.38 Operation selection functions 5 (Pr. 875)

4.38.1 Fault definition (Pr. 875 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque)

With the alarm definitions classified into major and minor faults, the base circuit is shut off immediately at occurrence of a major fault, or after deceleration to a stop at occurrence of a minor fault.

Parameter	Name	Factory Setting	Setting Range	Remarks
875	Fault definition	0	0, 1	Extended mode

1) Pr. 875 = 0: Normal operation
   At occurrence of any alarm, the base circuit is shut off immediately. At this time, the alarm output also turns on.
2) Pr. 875 = 1: Fault definition
   At occurrence of OHT or THM alarm, the motor is decelerated to a stop. At this time, minor fault output 2 (ER) signal turns on and the base circuit is shut off when the DC brake operation starts after deceleration.
   When the ER signal turns on, the electronic thermal relay function is activated and the inverter decelerates to a stop. Decrease load, etc. to allow the inverter to decelerate.
   At occurrence of an alarm other than OHT or THM, the base circuit is shut off immediately.



CAUTION

This function is invalid during position control.
The value "0" is recommended for the system in which the motor continues running without deceleration due to a large torque on the load side.

Pr.876 ➡ Refer to Pr.9 (page 93).

4.39 Control system function 2 (Pr. 877 to Pr. 881)

4.39.1 Speed feed forward control, model adaptive speed control (Pr. 877 to Pr. 881 with Encoder / without Encoder Speed, Conditional / PLC / SSC Position)

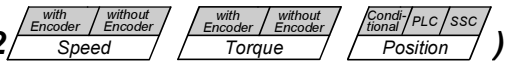
By making parameter setting, select the speed feed forward control or model adaptive speed control.
The speed feed forward control enhances the trackability of the motor in response to a speed command change.
The model adaptive speed control enables individual adjustment of speed trackability and motor disturbance torque response.

Parameter	Name	Factory Setting	Setting Range
877	Speed feed forward control/model adaptive speed control selection	0	0, 1, 2
878	Speed feed forward filter	0s	0 to 1s
879	Speed feed forward torque restriction	150%	0 to 400%
880	Load inertia ratio	7	0, 1 to 200 times
881	Speed feed forward gain	0%	0 to 1000%

Refer to page 51 for details.

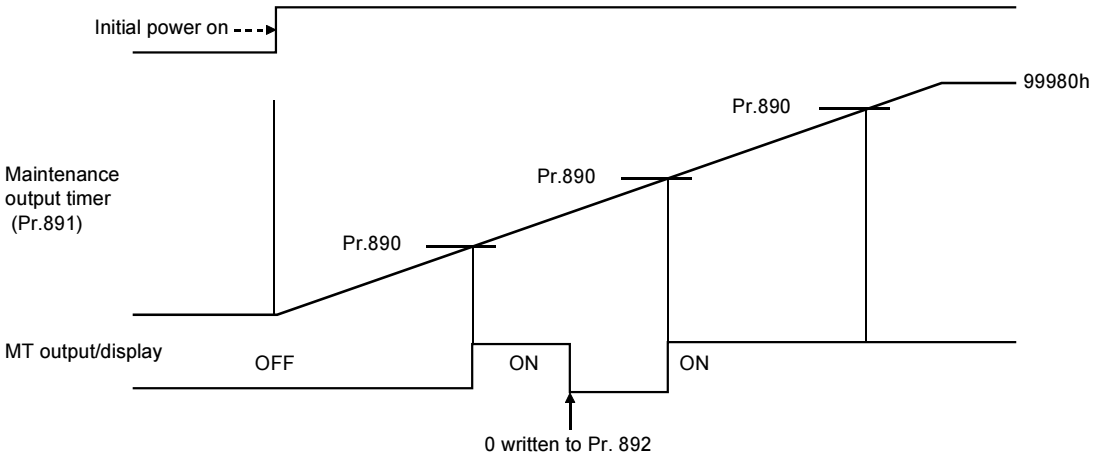
4.40 Maintenance function (Pr. 890 to Pr. 892)

4.40.1 Maintenance output function (Pr. 890 to Pr. 892)



When the cumulative operation time (Pr. 891 "maintenance output timer") of the inverter has elapsed the time set in Pr. 890 "maintenance output setting time", the maintenance output (MT) signal is output and an alarm is displayed on the PU (FR-DU04-1/FR-PU04V). A repetition signal output and alarm display st specified intervals can be set using Pr. 890 "maintenance output setting time". (usable for a capacitor life alarm, etc.)

Parameter	Name	Factory Setting	Setting Range	Remarks	
890	Maintenance output setting time	9999	0 to 9998, 9999	9999: Function invalid	Extended mode
891	Maintenance output timer	0	0 to 9998		
892	Maintenance output signal clear	0	0		



- The maintenance output timer count displayed on the FR-DU04-1 is clamped at 9998 (99980h).
- Writing 0 to Pr. 892 enables the maintenance (MT) output/display to be turned off.
  (This is designed to turn it off only when the user intends to turn it off.)
- When the Pr. 891 setting is less than the Pr. 890 value, the maintenance output turns off.

1) Pr. 891 "Maintenance output timer"

The cumulative operation time of the inverter is counted every 1hr and the stored time in E^2PROM is output in 10hrs increment.

REMARKS

- The time is counted regardless of the Pr. 890 "maintenance output setting time" value.
- The timer can be cleared by setting "0" in Pr. 891 when Pr. 77="801". Make sure that the Pr. 77 value is reset to the original value.

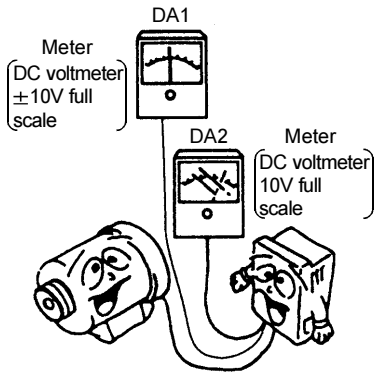
2) Setting the MT signal

Set "37" (maintenance output signal) in Pr. 190 to Pr. 192 or Pr. 195 (output terminal function selection) to set the MT signal. (Refer to page 165)

4.41 Calibration functions (Pr. 900 to Pr. 920)

4.41.1 DA1/DA2 terminal calibration (Pr. 900, Pr. 901 with Encoder / without Encoder Speed / with Encoder / without Encoder Torque / Conditional / PLC / SSC Position)

Pr. 900 "DA1 terminal calibration"
Pr. 901 "DA2 terminal calibration"



- When the item to be monitored is selected and set in Pr. 54 "DA1 terminal function selection" or Pr. 158 "DA2 terminal function selection", the inverter is factory-set to provide a 10VDC output in the full-scale status of the corresponding monitor item as described in the section of Pr. 54 and Pr. 158. These parameters allow the output voltage ratios (gains) to be adjusted according to the meter scale. Note that the maximum output voltage is 10VDC. (Terminal DA1 can also provide a -10VDC output.)
(Refer to page 110 for Pr. 54 and Pr. 158.)

CAUTION
DA1 and DA2 output voltage even at an alarm stop.

(1) Calibration of DA1 terminal

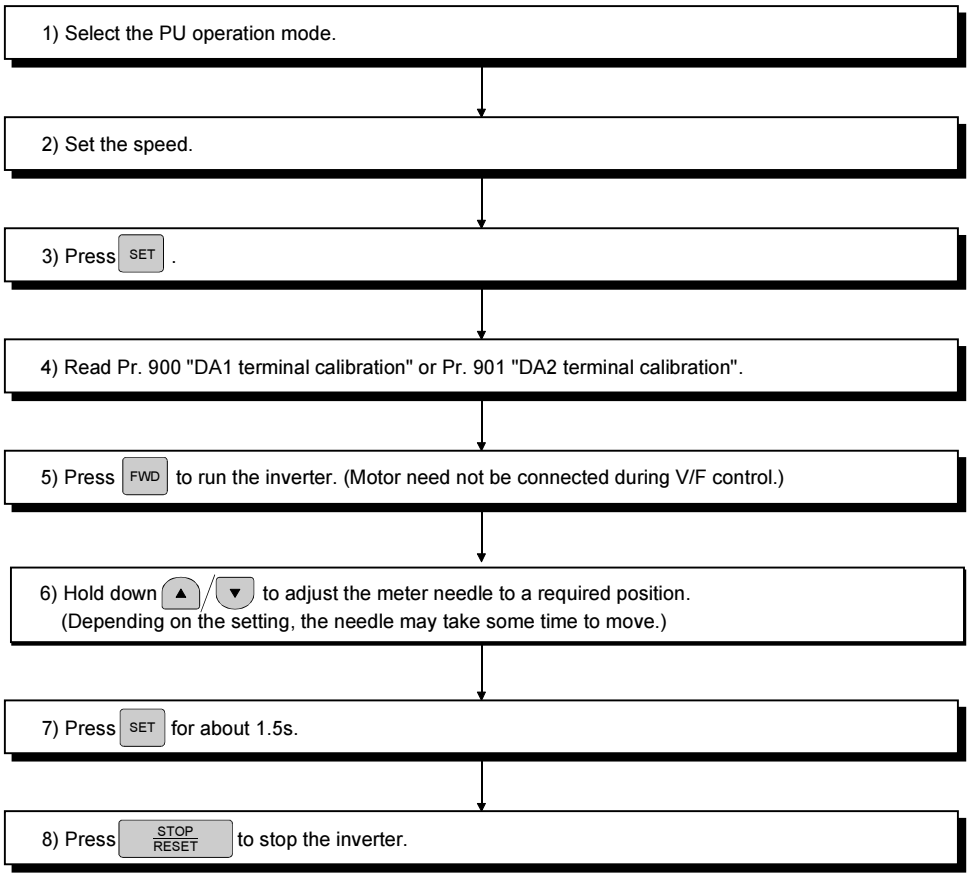
1) Connect a meter (speed meter) across inverter terminals DA1-5. (Note the polarity. DA1 is positive.)
2) When a calibration resistor has already been connected, adjust the resistance to "0" or remove the resistor.
3) Set any of "1 to 3, 5 to 12, 17, 18, 21, 32 to 34 and 36" in Pr. 54.
When the speed, inverter output current etc. has been selected as the output signal, preset in Pr. 55, Pr. 56 or Pr. 866 the speed, current value or torque at which the output signal is 1800r/min.
At this 1800r/min or rated current, the meter is normally deflected to full scale.
4) When outputting the item that cannot achieve a 100% value easily by operation, e.g. output current, set "21" (reference voltage output) in Pr. 158 and perform the following operation. After that, set "2" (output current, for example) in Pr. 158.

(2) Calibration of terminal DA2

1) Connect a 0-10VDC meter (speed meter) to across inverter terminals DA2-5. (Note the polarity. DA2 is positive.)
2) Set any of "1 to 3, 5 to 12, 17, 18, 21, 32 to 34, 36" in Pr. 158.
When the speed, inverter output current or the like has been selected as the output signal, preset in Pr. 55, Pr. 56 or Pr. 866 the speed, current value or torque at which the output signal is 10V.
3) When outputting the item that cannot achieve a 100% value easily by operation, e.g. output current, set "21" (reference voltage output) in Pr. 158 and perform the following operation. After that, set "2" (output current, for example) in Pr. 158.

<Operation procedure>

- When operation panel (FR-DU04-1) is used



REMARKS

Calibration can also be made for external operation. Set the speed in the external operation mode and make calibration as in steps 4) to 8).

CAUTION

1. **Calibration can be made even during operation.**
2. **Refer to the FR-PU04V instruction manual for the operation procedure using the parameter unit (FR-PU04V).**

Related parameters

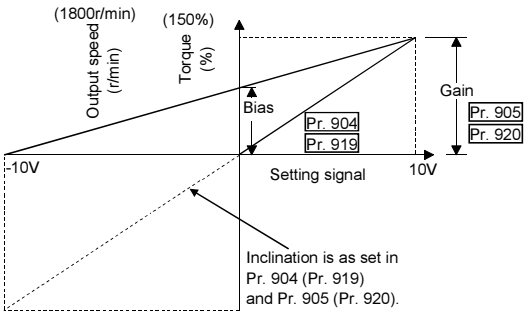
- Pr. 54 "DA1 terminal function selection" (Refer to page 110.)
- Pr. 55 "speed monitoring reference" (Refer to page 113.)
- Pr. 56 "current monitoring reference" (Refer to page 113.)
- Pr. 158 "DA2 terminal function selection" (Refer to page 110.)

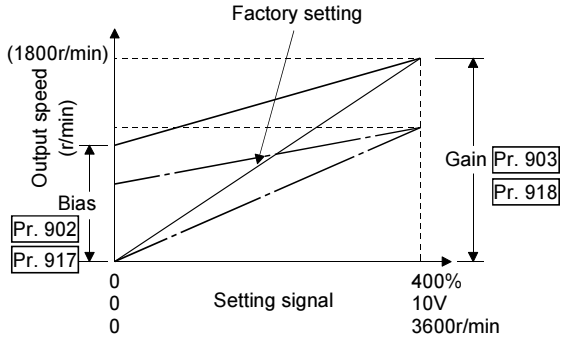
4.41.2 Biases and gains of speed setting terminals (speed setting terminal 2, torque command terminal 3, multi function terminal 1)

(Pr. 902 to Pr. 905, Pr. 917 to Pr. 920 with Encoder / without Encoder Speed, with Encoder / without Encoder Torque, Conditional / PLC / SSC Position)

The "bias" and "gain" functions are designed to adjust the relationships between the externally input 0-10V setting input signal and output speed to set the output speed.

- Using Pr. 902, set the bias speed at 0V.





Parameter	Name	Factory Setting		Setting Range		Remarks
902	Speed setting No. 2 bias	0V	0r/min	0 to 10V	0 to 3600r/min	Extended mode
903	Speed setting No. 2 gain	10V	1800r/min	0 to 10V	0 to 3600r/min	
904	Torque command No. 3 bias *1	0V	0%	0 to 10V	0 to 400%	
905	Torque command No. 3 gain *1	10V	150%	0 to 10V	0 to 400%	
917	No. 1 terminal bias (speed) *2	0V	0r/min	0 to 10V	0 to 3600r/min	
918	No. 1 terminal gain (speed) *2	10V	1800r/min	0 to 10V	0 to 3600r/min	
919	No. 1 terminal bias (torque/magnetic flux) *1	0V	0%	0 to 10V	0 to 400%	
920	No. 1 terminal gain (torque/magnetic flux) *1	10V	150%	0 to 10V	0 to 400%	

*1 Factory settings may differ because of calibration parameters.

*2 For calebration of forward/rotation speed restriction, PID control deveation, and measured value.

Parameter	Calibration Terminal	Speed Command/Speed Restriction (Pr. 807, Pr. 868, Pr. 73)			Forward/ Reverse Rotation Speed Restriction	Torque			Magnetic Flux	PID Control (Pr. 128 to Pr. 134)		
		Speed (main speed+auxiliary)	Compensation input	Override	Magnetic flux command	Torque restriction (Pr. 810)	Torque command (Pr. 804)	Torque bias (Pr. 840)	Magnetic command	Deviation	Set point	Process value
902	terminal 2 (+terminal 1)	●	●	● (terminal 1)							●	
903												
904	terminal 3					●	●	●				
905												
917	terminal 1				● (Pr. 868)					●		●
918												
919						● (regenerative torque restriction (Pr. 868))			● (Pr. 868)			
920												

<Setting>

There are three methods to adjust the speed setting voltage bias and gain.

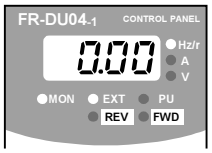
1) Method to adjust any point by application of voltage to across terminals 2-5
2) Method to adjust any point without application of voltage to across terminals 2-5
3) Method that does not adjust the bias voltage

Pr. 903 "speed setting No. 2 gain"

(You can also adjust Pr. 902 to Pr. 905 and Pr. 917 to Pr. 920 in the similar manner.)

<Adjustment procedure> Using the speed setting signal from the operation panel (FR-DU04-1) to make speed setting

(1) Power on (Monitoring mode)



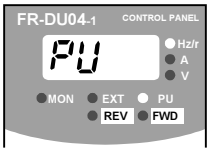
REMARKS

ON of the LED is indicated by ○, and OFF by ●.

(2) Choose the PU operation mode.

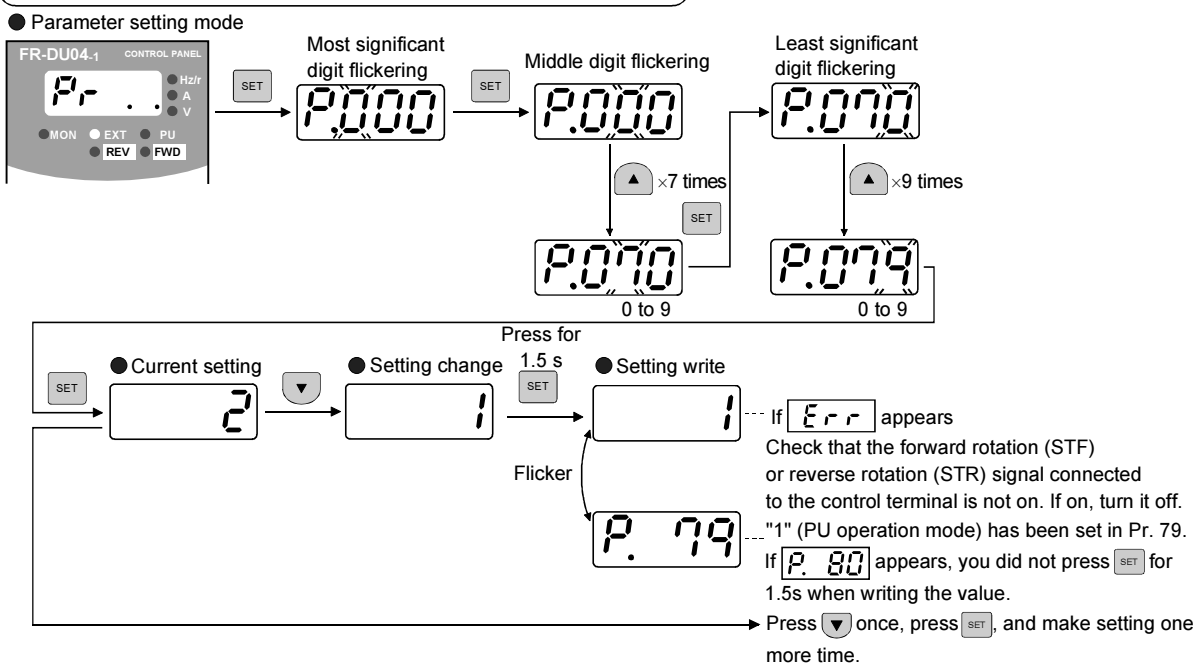
1. Press MODE to make sure that the inverter is in the PU operation mode. (LED of PU is lit.) (For monitoring displays, refer to the Instruction Manual (basic).)

● Operation mode (PU operation mode)

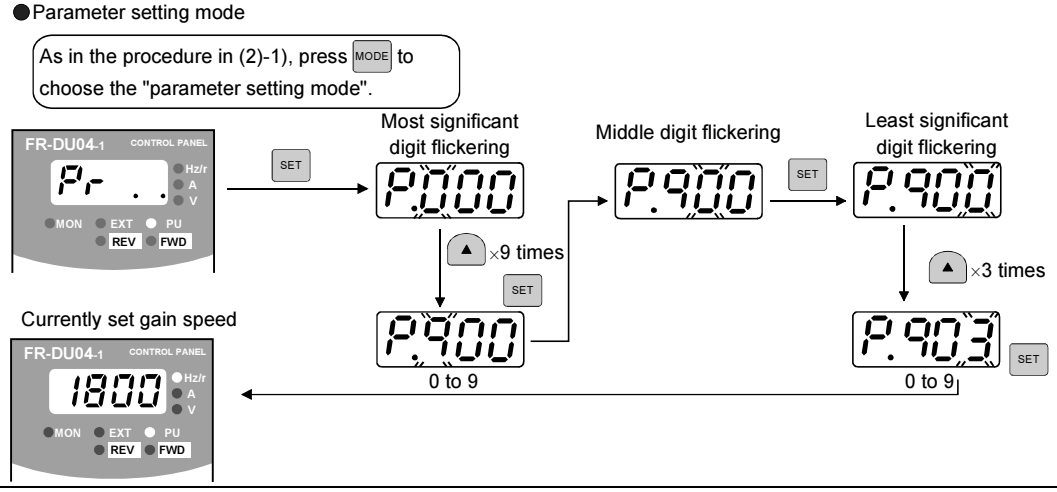


2. Set "1" (PU operation mode) in Pr. 79 "operation mode selection".
Example: To change the external operation mode (Pr. 79 = 2) to the PU operation mode (Pr. 79 = 1)

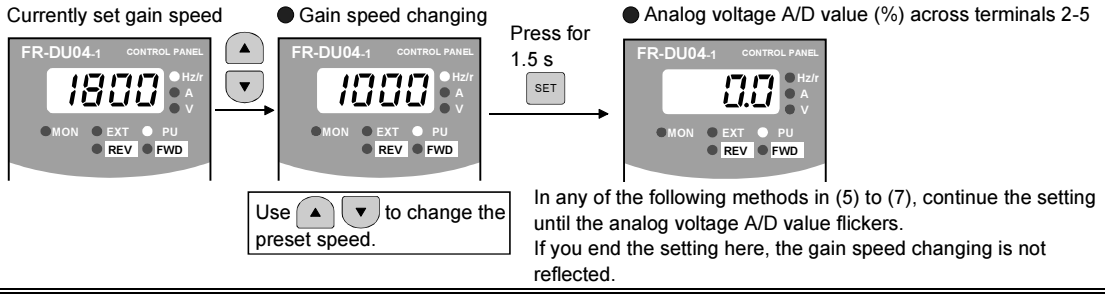
As in the procedure in 1), press MODE to choose the "parameter setting mode".



(3) Read Pr. 903 to display the currently set gain speed. (You can also adjust Pr. 902, Pr. 904 and Pr. 905 in a similar manner.)

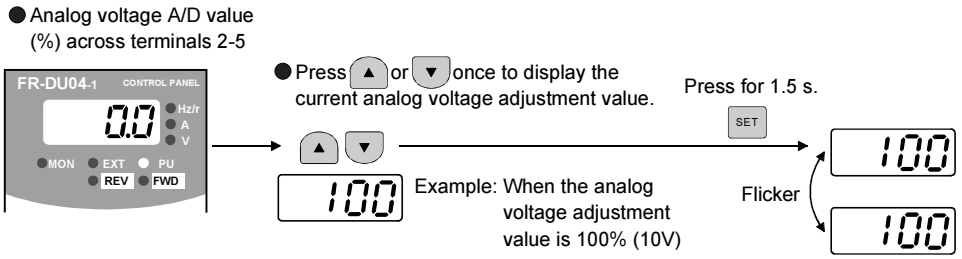


(4) Set the gain speed in Pr. 903 and display the analog voltage A/D value across terminals 2-5 in %.
(To change to 1000r/min)

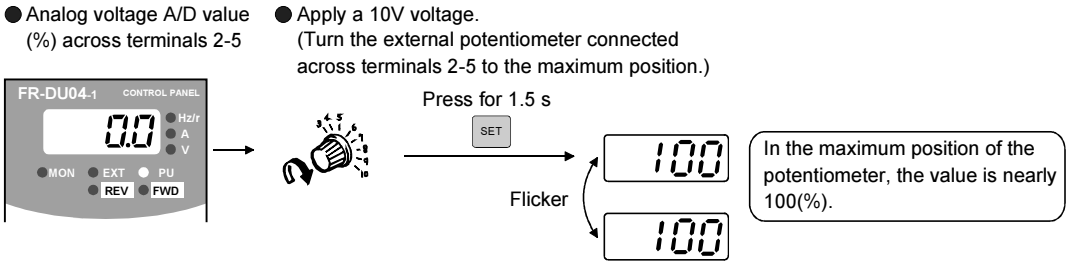


(1) When not adjusting the gain voltage To (5)-1
(2) When adjusting any point by application of voltage To (5)-2
(3) When adjusting any point without application of voltage To (5)-3

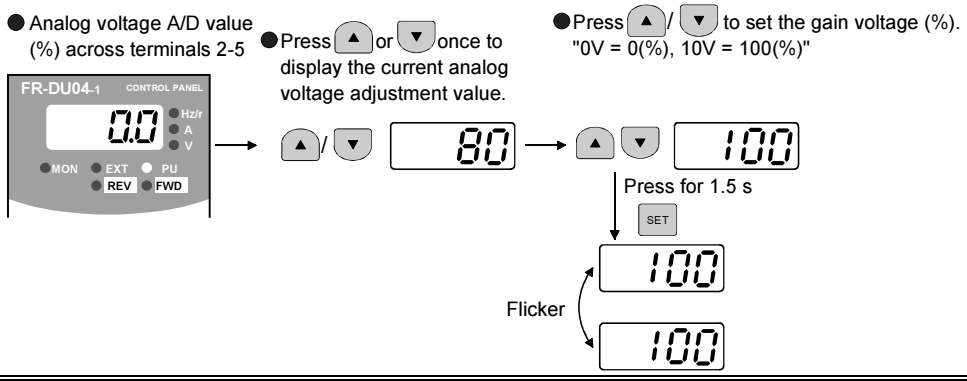
(5)-1 Method to adjust only the gain speed and not to adjust the voltage



(5)-2 Method to adjust any point by application of voltage to across terminals 2-5 (e.g. from external potentiometer)(Current: across terminals 4-5) (when 5V is applied)



(5)-3 Method to adjust any point without application of voltage to across terminals 2-5
(To change from 4V (80%) to 5V (100%))



(6) Pressing the SET key shifts to the next parameter.

(7) Re-set the Pr. 79 "operation mode selection" value according to the operation mode being used.

CAUTION

1. **Changing the Pr. 903 or Pr. 905 (gain adjustment) value will not change the Pr. 20 value. The input of terminal 1 (speed setting auxiliary input) is added to the speed setting signal.**
2. **For the operation procedure using the parameter unit (FR-PU04V), refer to the FR-PU04V instruction manual.**

⚠CAUTION

⚠ **Take care when setting any value other than "0" as the bias speed at 0V. If a speed command is not given, merely turning on the start signal will start the motor at the preset speed.**

Related parameters

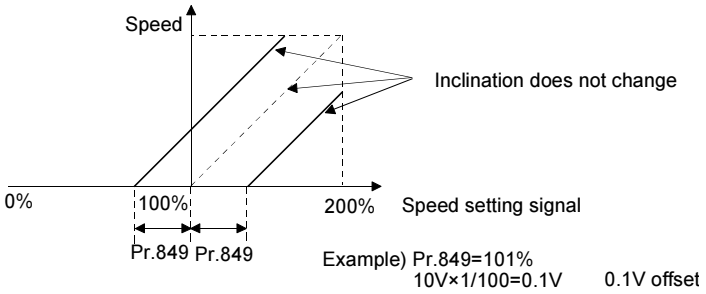
- Pr. 20 "acceleration/deceleration reference speed" (Refer to page 91.)
- Pr. 79 "operation mode selection" (Refer to page 129.)

● Analog input offset adjustment

When speed command by analog input is set, the range where the motor remains stop is created to prevent malfunction at very slow speed.

Parameter	Name	Factory setting	Setting Range	Remarks
849	Analog input offset adjustment	100%	0 to 200%	Pr. 77=801

Setting Pr. 849 provides speed command by analog input (terminal 2 or terminal 6 (FR-V5AX)) with offset and avoids speed command to be given due to noise under 0 speed command.



4.42 Additional function (Pr. 990)

4.42.1 PU buzzer control (Pr. 990)

with Encoder / without Encoder — Speed
with Encoder / without Encoder — Torque
Conditional / PLC / SSC — Position

You can make the buzzer "beep" when you press any key of the operation panel or parameter unit.

Parameter	Name	Factory Setting	Setting Range	Remarks	
990	PU buzzer control	1	0, 1	0: Without beep, 1: With beep	Extended mode

MEMO

5 PROTECTIVE FUNCTIONS

This chapter explains the "protective functions" for use of this product.
Always read this instructions before using the equipment.

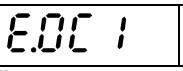
5.1 Errors (Alarms)

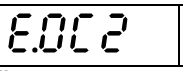
If any fault has occurred in the inverter, the corresponding protective function is activated to bring the inverter to an alarm stop and automatically give the corresponding error (alarm) indication on the PU display.
If the fault does not correspond to any of the following errors or if you have any other problem, please contact your sales representative or distributor.

- Retenation of alarm output signal..... When the alarm output signal holding protective function is activated, opening the magnetic contactor (MC) provided on the inverter's power supply side will cause the control power of the inverter to be lost and the alarm output not to be held.
- Alarm indication..... When the alarm display protective function is activated, the operation panel display section is changed automatically.
- Resetting method ..... When the resetting method protective function is activated, the inverter output stop status is held, and the inverter cannot restart unless it is reset. To reset, switch power off once, then on again, or turn on the RES signal for more than 0.1s.
  If the RES signal is kept on, "Err." appears (flickers) to indicate that the inverter is in a reset status.
- When any protective function is activated, take the corresponding corrective action, then reset the inverter, and resume operation.

5.1.1 Major faults

When the protective function is activated, the inverter output is shut off and an alarm is output.

Operation Panel Indication	**E.OC1**		**FR-PU04V**	**OC During Acc**
Name	Overcurrent shut-off during acceleration (*1)			
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. • Power is supplied to only the R1 and S1 terminals. This indication also appears when the start signal is entered. • This indication also appears when one of the output cables opens during vector control without encoder.			
Check point	• Check for sudden acceleration. • Check for long descending acceleration time of lift applications • Check for output short circuit. • Check that main circuit power (R, S, T) is supplied. • Check for wiring (Check that the motor is running normally.) (vector control without encoder.)			
Corrective action	• Decrease the acceleration time. • Supply main circuit power (R, S, T). • Perform correct wiring. (vector control without encoder.)			

Operation Panel Indication	**E.OC2**		**FR-PU04V**	**Stedy Spd OV**
Name	Overcurrent shut-off during constant speed (*1)			
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. • This indication also appears when one of the output cables opens during vector control without encoder.			
Check point	• Check for sudden load change. • Check for output short circuit. • Check for wiring (Check that the motor is running normally.) (under vector control without encoder.)			
Corrective action	• Keep load stable. • Perform correct wiring. (under vector control without encoder.)			

*1: E. OC3 appears if the overcurrent shutoff occurs during positioning.

Operation Panel Indication	E.OC3	E.OC3	FR-PU04V	OC During Dec
Name	Overcurrent shut-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. • This indication also appears when one of the output cables opens during vector control without encoder.			
Check point	• Check for sudden speed reduction. • Check for output short circuit. • Check for too fast operation of the motor's mechanical brake. • Check for wiring (Check that the motor is running normally.) (under vector control without encoder.)			
Corrective action	• Increase the deceleration time. • Check the mechanical brake operation. • Perform correct wiring. (under vector control without encoder.)			

Operation Panel Indication	E.OV1	E.OV1	FR-PU04V	OV During Acc
Name	Regenerative overvoltage shut-off during acceleration (*2)			
Description	If regenerative energy causes the inverter's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the inverter output. It may also be activated by a surge voltage generated in the power supply system.			
Check point	Check for too slow acceleration.(i.e. during descending acceleration with lifting load)			
Corrective action	• Decrease the acceleration time. • Use the brake unit.			

Operation Panel Indication	E.OV2	E.OV2	FR-PU04V	Stedy Spd OV
Name	Regenerative overvoltage shut-off during constant speed (*2)			
Description	If regenerative energy causes the inverter's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the inverter output. It may also be activated by a surge voltage generated in the power supply system.			
Check point	Check for sudden load change.			
Corrective action	• Keep load stable. • Use the brake unit.			

*2: E. OV3 appears if the over voltage shutoff occurs during positioning.

Operation Panel Indication	E.OV3	E.OV3	FR-PU04V	OV During Dec
Name	Regenerative overvoltage shut-off during deceleration or stop			
Description	If regenerative energy causes the inverter's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the inverter output. It may also be activated by a surge voltage generated in the power supply system.			
Check point	Check for sudden speed reduction.			
Corrective action	• Increase the deceleration time. (Set the deceleration time that meets the inertia moment of the load) • Decrease the braking duty. • Use the brake unit.			

Operation Panel Indication	E.THM	E.THM	FR-PU04V	Motor Overload
Name	Motor overload shut-off (electronic thermal relay function) (*3)			
Description	The electronic thermal relay function built in the inverter detects motor overheat due to overload or reduced cooling capability during low-speed operation to stop the inverter output. When running a multi-pole motor or two or more motors during V/F control, provide a thermal relay in the inverter output side since such motor(s) cannot be protected. Protection against burnout due to motor temperature rise			
Check point	Check the motor for use under overload.			
Corrective action	• Reduce the load weight. • For a constant-torque motor, set the constant-torque motor in Pr. 71 "applied motor".			

Operation Panel Indication	E.THT	E.THT	FR-PU04V	Inv. Overload
Name	Inverter overload shut-off (electronic thermal relay function) (*3)			
Description	If a current not less than 150% of the rated output current flows and overcurrent shut-off does not occur (200% or less), inverse-time characteristics cause the electronic thermal relay function to be activated to stop the inverter output in order to protect the output transistors. Protection of output transistors against overheat.			
Check point	Check the motor for use under overload.			
Corrective action	Reduce the load weight.			

*3. Resetting the inverter initializes the internal heat integrating data of the electronic thermal relay function.

Operation Panel Indication	E.IPF	E.IPF	FR-PU04V	Inst. Pwr. Loss
Name	Instantaneous power failure protection (*4)			
Description	If a power failure occurs for longer than 15ms (this also applies to inverter input shut-off), the instantaneous power failure protective function is activated to stop the inverter output in order to prevent the control circuit from malfunctioning. At this time, the alarm warning output contacts open (across terminals B-C) and close (across terminals A-C). If a power failure persists for longer than 100ms, the alarm warning output is not provided, and the inverter restarts if the start signal is on upon power restoration. (The inverter continues operating if an instantaneous power failure is within 15ms.)			
Check point	Find the cause of instantaneous power failure occurrence.			
Corrective action	• Remedy the instantaneous power failure. • Prepare a backup power supply for instantaneous power failure. • Set the function of automatic restart after instantaneous power failure (Pr. 57). (Refer to page 114.)			

*4: When an instantaneous power failure occurs, the alarm display and alarm output are not provided, but the inverter performs protective operation to prevent a fault from occurring in itself. In some operating status (load magnitude, acceleration/deceleration time setting, etc.), overcurrent or other protection may be activated upon power restoration.

Operation Panel Indication	E.UVT	E.UVT	FR-PU04V	Under Voltage
Name	Undervoltage protection			
Description	If the power supply voltage of the inverter reduces, the control circuit will not perform normal functions. In addition, the motor torque will be insufficient and/or heat generation will increase. To prevent this, if the power supply voltage reduces below about 618VDC, this function stops the inverter output. When a jumper is not connected across P-P1, the undervoltage protective function is activated.			
Check point	• Check for start of large-capacity motor. • Check that a jumper or DC reactor is connected across terminals P-P1.			
Corrective action	• Check the power supply system equipment such as power supply. • Connect a jumper or DC reactor across terminals P-P1.			

Operation Panel Indication	E.FIN	E.FIN	FR-PU04V	H/Sink O/Temp
Name	Fin overheat			
Description	If the heatsink overheats, the temperature sensor is actuated to stop the inverter output.			
Check point	• Check for too high ambient temperature. • Check for heatsink clogging. • Check that the cooling fan is stopped.			
Corrective action	• Set the ambient temperature to within the specifications. • Replace the cooling fan.			

Operation Panel Indication	E.BE	E.BE	FR-PU04V	Br. Cct. Fault
Name	Brake transistor alarm detection			
Description	This function stops the inverter output if an alarm occurs in the brake circuit, e.g. damaged brake transistors. In this case, the inverter must be powered off immediately.			
Check point	• Reduce the load inertia. • Check that the frequency of using the brake is proper. • Check that the brake resistor selected is correct.			
Corrective action	Replace the inverter.			

Operation Panel Indication	E.GF	E.GF	FR-PU04V	Ground Fault
Name	Output side ground fault overcurrent protection			
Description	This function stops the inverter output if an ground fault overcurrent flows due to an ground fault that occurred in the inverter's output (load) side.			
Check point	Check for a ground fault in the motor and connection cable.			
Corrective action	Remedy the ground fault portion.			

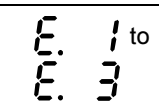
Operation Panel Indication	E.OHT	E.OHT	FR-PU04V	OH Fault
Name	External thermal relay operation			
Description	If the external thermal relay provided for motor overheat protection, or the internally mounted temperature relay in the motor, etc. switches on (contacts open), the inverter output is stopped. If the relay contacts are reset automatically, the inverter will not restart unless it is reset.			
Check point	Check for motor overheating.			
Corrective action	Reduce the load and operating duty.			

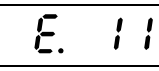
Operation Panel Indication	E.OLT	E.OLT	FR-PU04V	Stll Prev STP (OL shown during stall prevention operation)
Name	Motor overload			
Description	For V/F control, the stall prevention function is activated if the current flow in the motor exceeds 150% (factory setting) of the inverter rated current, an alarm stop is made if the status that the output frequency is lowered at 0Hz persists for 3s. For speed/position control, if the torque restriction is activated under high load, the motor stalls to the speed less than the low speed detection (Pr. 865) value, and an alarm stop is made if the status that the output torque is more than the OLT level setting (Pr. 874) value persists for 3s. This function is not activated for torque control.			
Check point	• Check the motor for use under overload. • Check that the low speed detection (Pr. 865) and OLT level setting (Pr. 874) values are correct. (Check the stall prevention operation level (Pr. 22) setting if V/F control is exercised.) • Check that the inverter is running at low speed under vector control without encoder without having performed start time tuning.			
Corrective action	• Reduce the load weight. • Change the stall prevention operation level (Pr. 22), low speed detection (Pr. 865) and OLT level setting (Pr. 874) values. (Check the stall prevention operation level (Pr. 22) setting if V/F control is exercised.) • Perform tuning if vector control without encoder is exercised.			

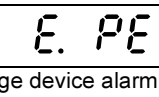
Operation Panel Indication	E.OPT	E.OPT	FR-PU04V	Option Fault
Name	Option alarm			
Description	Stops the inverter output when two or more communication options are mounted. (*5)			
Check point	• Check that the number of communication options mounted is one. • When the parameter set is for the option use, the option is not fitted nor connected securely.			
Corrective action	• Mount only one communication option. • Check the Pr. 30 setting and wiring. • Check the Pr. 419 and Pr. 804 settings.			

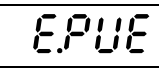
*5:The FR-A5NR (relay output/computer link) allows one more communication option to be fitted. In this case, only relay output is usable and computer link is unusable.

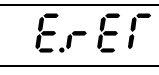
Operation Panel Indication	E.OP1 to OP3	E.OP1 to OP3	FR-PU04V	Option slot alarm 1 to 3
Name	Option slot alarm (1 to 3 indicate the option slot numbers.)			
Description	Stops the inverter output if a functional alarm (e.g. communication line error of the communication option or contact fault of the plug-in option other than the communication option) occurs in the plug-in option fitted to the corresponding slot.			
Check point	• Check for a wrong option function setting and operation. • Check that the plug-in option is plugged into the connector securely. • Check for an open communication cable. • Check that the termination resistor is fitted properly. • Check that the option card is normal.			
Corrective action	• Check the option function setting, etc. • Connect the plug-in option securely.			

Operation Panel Indication	E. 1 to E. 3		FR-PU04V	Fault 1 to Fault 3
Name	Option alarm			
Description	Stops the inverter output if a contact fault or the like of the connector between the inverter and communication option occurs.			
Check point	Check that the communication option is plugged into the connector securely. (1 to 3 indicate the option slot numbers.)			
Corrective action	• Connect the plug-in option securely. • Please contact your sales representative.			

Operation Panel Indication	E.11		FR-PU04V	Fault 11
Name	Reversing deceleration alarm			
Description	If the speed command and estimated speed direction differ when the rotation direction changes from forward to reverse rotation or reverse to forward rotation during vector control without encoder, the motor runs at low speed and stops decelerating. Since the rotation direction will not change to the opposite direction causing overload, the inverter stops output			
Check point	Check for an excessive error between R1 of the motor and R1 of the inverter.			
Corrective action	• Perform offline auto tuning or start time tuning. • Please contact your sales representative.			

Operation Panel Indication	E.PE		FR-PU04V	Corrupt Memry
Name	Parameter storage device alarm			
Description	Appears when an error occurred in the stored parameters. (E^2PROM fault)			
Check point	Check for too many number of parameter write times.			
Corrective action	• Please contact your sales representative. • When performing parameter write frequently for communication purposes, set "1" in Pr. 342 to enable RAM write. Note that powering off returns the inverter to the status before RAM write.			

Operation Panel Indication	E.PUE		FR-PU04V	PU Leave Out
Name	PU disconnection			
Description	This function stops the inverter output if communication between the inverter and PU is suspended, e.g. the operation panel or parameter unit is disconnected, when "2", "3", "16" or "17" was set in Pr. 75 "reset selection/disconnected PU detection/PU stop selection". This function stops the inverter output if the number of successive communication errors is greater than the permissible number of retries when the Pr. 121 value is other than "9999" for RS-485 communication from the PU connector. This function also stops the inverter output if communication is broken for the period of time set in Pr. 122.			
Check point	• Check for loose fitting of the FR-DU04-1 or FR-PU04V. • Check the Pr. 75 setting.			
Corrective action	Fit the FR-DU04-1 or FR-PU04V securely.			

Operation Panel Indication	E.RET		FR-PU04V	Retry No Over
Name	Retry count excess			
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	E.LF	E. LF	FR-PU04V	ELF
Name	Output phase failure protection			
Description	This function stops the inverter output if one of the three phases (U, V, W) on the inverter's output side (load side) opens.			
Check point	• Check the wiring (Check the motor for a fault.) • Check that the capacity of the motor used is not smaller than that of the inverter.			
Corrective action	• Wire the cables properly. • Check the Pr. 251 "output phase failure protection selection" setting.			

Operation Panel Indication	E.CPU	E.CPU	FR-PU04V	CPU Fault
Name	CPU error			
Description	Stops the inverter output if the communication error of the built-in CPU occurs.			
Check point	—			
Corrective action	Please contact your sales representative.			

Operation Panel Indication	E. 6	E. 6	FR-PU04V	Fault 6
	E. 7	E. 7		Fault 7
Name	CPU error			
Description	If the arithmetic operation of the peripheral circuit of the built-in CPU does not end within the predetermined period or if an error exists in the receive data of the built-in CPU, the inverter self-determines it as an alarm and stops the output.			
Check point	Check for excess electrical noises around the inverter.			
Corrective action	• Connect devices securely. • If there are any devices generating excessive electrical noise around the inverter, take measures against noise. • Please contact your sales representative.			

Operation Panel Indication	E.P24	E.P24	FR-PU04V	E.P24
Name	24VDC power output short circuit			
Description	When the 24VDC power output from the PC terminal is shorted, this function shuts off the power output. At this time, all external contact inputs switch off. The inverter cannot be reset by entering the RES signal. To reset it, use the operation panel or switch power off, then on again. When the 24VDC power for encoder is shorted, this function shuts off the power output.			
Check point	• Check for a short circuit in the PC terminal output. • Check for wrong wiring. • Check for a loose connector. Check that the cables are short-circuited.			
Corrective action	• Remedy the short circuit portion. • Connect the cables securely. Change the cables.			

Operation Panel Indication	E.P12	E.P12	FR-PU04V	E.P12
Name	12VDC power output short circuit			
Description	When the 12VDC power for encoder is shorted, this function shuts off the power output.			
Check point	• Check for wrong wiring. • Check for a loose connector. Check for a break in the cable.			
Corrective action	Connect the cables securely. Change the cables.			

Operation Panel Indication	E.CTE	E.CTE	FR-PU04V	—
Name	Operation panel power supply short circuit			
Description	When the operation panel power supply (P5S of the PU connector) is shorted, this function shuts off the power output. At this time, the operation panel (parameter unit) cannot be used and RS-485 communication from the PU connector cannot be made. To reset, enter the RES signal or switch power off, then on again. When the 5VDC power for encoder is shorted, this function shuts off the power output.			
Check point	• Check for a short circuit in the PU connector cable. Check for a loose connector. • Check that cables are short-circuited. • Check for wrong wiring.			

Operation Panel Indication	E.CTE	E.CTE	FR-PU04V	—
Corrective action	• Check the PU and cable. • Connect the cable securely. Change the cable.			

Operation Panel Indication	E.MB1 to 7	E.MB1 to 7	FR-PU04V	—
Name	Brake sequence error			
Description	• The inverter output is stopped when a sequence error occurs during use of the brake sequence function (Pr. 278 to Pr. 285). • If (detection frequency) - (output frequency) > Pr. 285 under vector control, E.MB1 occurs and the inverter output is stopped.			
Check point	Find the cause of alarm occurrence.			
Corrective action	Check the set parameters and perform wiring properly.			

Operation Panel Indication	E.OS	E. OS	FR-PU04V	Overspeed occurrence
Name	Overspeed occurrence			
Description	Indicates that the motor speed has exceeded the overspeed setting level.			
Check point	• Check that the Pr. 374 "overspeed detection level" value is correct. • Check that the number of encoder pulses differ from the actual number of encoder pulses.			
Corrective action	• Set the Pr. 374 "overspeed detection level" value correctly. • Set the correct number of encoder pulses in Pr. 851.			

Operation Panel Indication	E.OSD	E.OSd	FR-PU04V	Excessive speed deflection
Name	Speed deviation excess detection			
Description	Stops the inverter output if the motor speed is increased or decreased under the influence of the load etc. during vector control with encoder and cannot be controlled in accordance with the speed command value.			
Check point	• Check that the Pr. 870 "speed deviation level" and Pr. 871 "speed deviation time" values are correct. • Check for sudden load change. • Check that the number of encoder pulses differ from the actual number of encoder pulses.			
Corrective action	• Set the Pr. 870 "speed deviation level" and Pr. 871 "speed deviation time" values correctly. • Keep load stable. • Set the correct number of encoder pulses in Pr. 851.			

Operation Panel Indication	E.ECT	E.ECT	FR-PU04V	No encoder signal
Name	Break in the cable detection			
Description	Stops the inverter output if the encoder signal is shut off.			
Check point	• Check for a break in the cable of the encoder signal. • Check that the encoder specifications are correct. • Check for a loose connector. • Check that the jumper connector of the rear of the control terminal is correctly set.			
Corrective action	• Remedy the break in the cable. • Use the encoder that meets the specifications. • Make connection securely. • Set the jumper connector of the rear of the control terminal correctly. (Refer to page 9.)			

Operation Panel Indication	E.OD	E. Od	FR-PU04V	Excessive position error
Name	Position error large			
Description	Indicates that the difference between the position command and position feedback exceeded the reference.			
Check point	• Check that the position detecting encoder mounting orientation matches the parameter. • Check that the load is not large. • Check that the Pr. 427 "error excess level" and Pr. 851 "number of encoder pulses" values are correct.			
Corrective action	• Check the parameters. • Reduce the load weight. • Set the Pr. 427 "error excess level" and Pr. 851 "number of encoder pulses" values correctly.			

Operation Panel Indication	E.ECA	E.ECA	FR-PU04V	No encoder A signal
Name	Orientation encoder no-signal			
Description	The encoder pulse for the FR-V5AM or FR-A5AP is not input.			
Check point	• Check that the FR-V5AM or FR-A5AP is connected correctly. • Check for a loose connector. • Check for a break in the cable. • Check for a detector fault.			
Corrective action	• Make connection securely. • Change the cable. • Replace the detector.			

Operation Panel Indication	E.EP	E.EP	FR-PU04V	E.EP
Name	Encoder mis-wiring detection			
Description	The rotation command of the inverter differs from the actual motor rotation direction detected from the encoder during offline auto tuning.			
Check point	• Check for mis-wiring of the encoder cable. • Check for wrong setting of Pr. 852 "encoder rotation direction".			
Corrective action	• Perform connection and wiring securely. • Change the Pr. 852 "encoder rotation direction" value.			

5.1.2 Minor fault

If the protective function is activated, the output is not shut off. You can also output a minor fault signal by making parameter setting. (Set "98" in any of Pr. 190 to Pr. 192 and Pr. 195 (output terminal function selection). Refer to page 165.)

Operation Panel Indication	FN	Fn	FR-PU04V	Fan Failure
Name	Fan fault			
Description	For the inverter that contains a cooling fan, Fn appears on the operation panel when the cooling fan stops due to a fault or different operation from the setting of Pr. 244 "cooling fan operation selection".			
Check point	Check the cooling fan for a fault.			
Corrective action	Replace the fan.			

5.1.3 Warnings

When the protective function is activated, the output is not shut off.

Operation Panel Indication	OL	OL	FR-PU04V	OL
Name	Stall prevention (overcurrent)			
Description	V/F control	Output if the inverter output current exceeds torque restriction level. (Refer to page 100.).		
	Speed control	• Output if torque restriction level is exceeded. • Output if the encoder setting is wrong.		
	Position control			
Check point	• Check the motor for use under overload. • The acceleration/deceleration time may vary during V/F control. Check that the Pr. 0 "torque boost" setting is not higher than required. • Check that the Pr. 851 "number of encoder pulses" and Pr. 852 "encoder rotation direction" values are correct.			
Corrective action	• Increase the operation level using torque restriction level (analog input or parameter input). • Check for the Pr. 851 "number of encoder pulses" and Pr. 852 "encoder rotation direction" values.			

*5:Torque restriction level can be set using Pr. 22 "torque restriction level" as desired. (150% with the factory setting)

Operation Panel Indication	oL	oL	FR-PU04V	oL
Name	Stall prevention (overvoltage)			
Description	During deceleration	If the regenerative energy of the motor becomes excessive 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	PS	FR-PU04V	PS
Name	PU stop			
Description	Appears when a stop was made by pressing of the operation panel STOP RESET or parameter unit (FR-PU04V) during operation in the external operation mode with the Pr. 75 "reset selection/PU stop selection" setting.			
Check point	Check for a stop made by pressing STOP RESET of the operation panel during external operation.			
Corrective action	Refer to page 217.			

Operation Panel Indication	RB	rb	FR-PU04V	RB
Name	Regenerative brake prealarm			
Description	Appears if the regenerative brake duty reaches or exceeds 85% of the Pr. 70 "special regenerative brake duty" value. If the regenerative brake duty reaches 100%, a regenerative overvoltage (E. OV_) occurs.			
Check point	• Check that the brake resistor duty is not high. • Check that the Pr. 30 "regenerative function selection" and Pr. 70 "special regenerative brake duty" values are correct.			
Corrective action	• Increase the deceleration time. • Check the Pr. 30 "regenerative function selection" and Pr. 70 "special regenerative brake duty" values.			

Operation Panel Indication	TH	TH	FR-PU04V	TH
Name	Electronic thermal relay function prealarm			
Description	Appears if the integrating value of the electronic thermal relay function reaches or exceeds 85% of the preset level. If it reaches 100% of the preset level, a motor overload shutoff (E. THM) occurs.			
Check point	Check for large load or sudden acceleration.			
Corrective action	Reduce the load weight or the number of operation times.			

Operation Panel Indication	MT	MT	FR-PU04V	MT
Name	Maintenance signal output			
Description	Indicates that the cumulative operation time of the inverter has reached a given time.			
Check point	Check that Pr. 890 "maintenance output setting time" has been set. (A short time has been set.)			
Corrective action	After checking the energization time, write "0" to Pr. 892 "maintenance output signal clear".			

Operation Panel Indication	SL	SL	FR-PU04V	SL
Name	Speed limit indication (speed restriction)			
Description	Output if the speed restriction level is exceeded during torque control.			
Check point	• Check that the torque command is not larger than required. • Check that the speed restriction level is not low.			
Corrective action	Decrease the torque restriction. Increase the speed restriction level.			

Operation Panel Indication	Err.	Err.
Description	This alarm appears if: • The RES signal is on; • You attempted to make parameter setting in the external operation mode; • You attempted to change the operation mode during operation; • You attempted to set any parameter value outside its setting range; • The PU and inverter cannot make normal communication; • You attempted to make parameter setting during operation (when signal STF or STR is on); or • You attempted to make parameter setting when Pr. 77 "parameter write disable selection" has been set to disable parameter write.	
Corrective action	Perform run and operation securely.	

5.1.4 How to recover from PU stop error (PS)

(1) Restarting method when stop was made by pressing STOP RESET from operation panel (Method of restarting from PS indication)

1) After the motor has decelerated to a stop, turn off the STF or STR signal.
2) Press MODE twice* to display OPMd.

CAUTION

When Pr. 79 = 3, press MODE three times to display PU. Then press ▼ to proceed to 3).

(*For monitor screen) ... Refer to the Instruction Manual (basic) for details of the monitor display provided by pressing MODE.

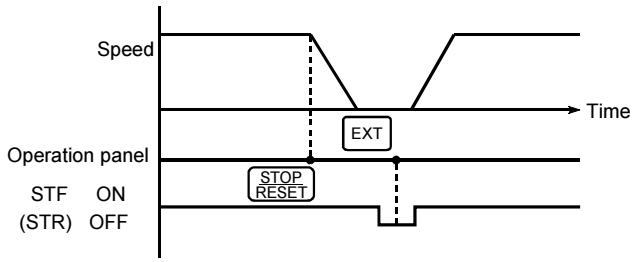
3) Press SET.
4) Turn on the STF or STR signal.

REMARKS

- When you provide a reset input (RES) during operation, the inverter that is being reset shuts off the output and resets the internal heat integrating value of the electronic thermal relay function and the number of retries, and the motor coasts.
- The Pr. 75 value can be set any time. This value does not return to the initial value if parameter (all) clear is executed.
- When the motor is stopped from the PU, PS and 0.0 are displayed alternately. An alarm output is not provided.

(2) Restarting method when stop was made by pressing STOP RESET from PU

1) After the motor has decelerated to a stop, turn off the STF or STR signal.
2) Press EXT.
   .....(Recovery from PS)
3) Turn on the STF or STR signal.



Example of stop and restart during external operation

Alternatively, you can make a restart by making a power-on reset or resetting the inverter using the reset terminal of the inverter.

REMARKS

- When you provide a reset input (RES) during operation, the inverter that is being reset shuts off the output and resets the data of the electronic thermal relay function, and the motor coasts.
- To make a restart, confirm that the PU is connected and then reset the inverter.
- The Pr. 75 value can be set any time. This value does not return to the initial value if parameter (all) clear is executed.
- When the motor is stopped from the PU, PS is displayed. An alarm output is not provided.
- Since PS is not an inverter error, the inverter can not be reset with STOP RESET.

⚠CAUTION

⚠ Do not reset the inverter with the start signal input.
Doing so will start the inverter immediately after it has recovered from the error, causing hazard.

5.2 Correspondences between digital and actual characters

There are the following correspondences between the actual alphanumeric characters and the digital characters displayed on the operation panel.

Actual	Digital
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Actual	Digital
A	A
B	b
C	C
D	d
E	E
F	F
G	G
H	H
I	I
J	J
L	L

Actual	Digital
M	M
N	n
O	O
o	o
P	P
S	S
T	T
U	U
V	v
r	r
-	-

5.3 Resetting the inverter

The inverter can be reset by performing any of the following operations. Note that the electronic thermal relay function's internal heat integrating value and the number of retries are cleared (erased) by resetting the inverter.
It takes about 1s for reset.

Operation 1: Using the operation panel, press STOP RESET to reset the inverter.
(Enabled only when the inverter protective function (major fault) is activated. (Refer to page 208 for major faults.))
Operation 2: Switch power off once, then switch it on again.
Operation 3: Turn on the reset signal (RES) for more than 0.1s.

6 SPECIFICATIONS

This chapter explains the "specifications" for use of this product. Always read this instructions before use.

6.1 Model specifications

● 575V class

Inverter	Type FR-V560-[][]K-NA			2.2	3.7	7.5	15	22	37	55
	Applied motor capacity (kW (HP))			2.2 (3)	3.7 (5)	7.5 (10)	15 (20)	22 (30)	37 (50)	55 (75)
	Output	Rated capacity (kVA) (Caution 1)		4	6.1	12	22	33	55	84
		Rated current (A)		4	6.1	12	22	33	55	84
		Overload current rating (Caution 2)		150% 60s, 200% 0.5s (inverse-time characteristics)						
		Voltage (Caution 3)		Three-phase, 575V 60Hz						
		Regenerative braking torque (Caution 7)	Max. value	100% 5s		20%				
			Permissible duty	2%ED		Continuous				
	Power supply	Rated input AC voltage, frequency		Three-phase, 575V 60Hz						
		Permissible AC voltage fluctuation		490 to 632V 60Hz						
		Permissible frequency fluctuation		±5%						
		Power supply capacity (kVA) (Caution 5)		5.5	9	17	28	41	66	100
	Protective structure (JEM 1030)			Enclosed type (IP20 NEMA1) (Caution 6)						
	Cooling system			Forced air cooling						
	Approx. weight (kg (lbs))			6.0 (13.2)	6.0 (13.2)	6.0 (13.2)	14.0 (30.9)	14.0 (30.9)	35.0 (77.0)	35.0 (77.0)

CAUTION

1. **The rated output capacity indicated assumes that the output voltage is 575V.**
2. **The overload current rating indicated in % is the ratio of the overload current to the rated output current of the inverter. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.**
3. **The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the PWM pulse voltage value of the inverter output side voltage remains unchanged at about $\sqrt{2}$ that of the power supply.**
4. **The short-time rating is 5s.**
5. **The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).**
6. **Open type (IP00) when the plug-in option is fitted after removal of the option wiring port cover.**
7. **For the 2.2K to 15K capacities, using the high-duty brake resistor will achieve the performance of 100% torque/10%ED.**
8. **If the motor is one rank lower in capacity than the inverter, it can be used by setting Pr. 80 "motor capacity" and Pr. 81 "number of motor poles". Other manufacturers' motors and special motors can be used by performing online auto tuning.**

6.2 Common specifications

Inverter	Control specifications	Control system		Soft-PWM control or high carrier frequency sine-wave PWM control can be selected. vector control with encoder, vector control without encoder, or V/F control can be selected.		
		Control mode		Speed control, torque control, position control		
		Speed setting resolution	Analog input	0.03% of the maximum set speed		
			Digital input	0.003% to the maximum setting (minimum setting 0.1r/min)		
		Acceleration/deceleration time		0 to 3600 s (0.1 s increments)		
		Acceleration/deceleration pattern		Linear, S pattern (3 types) or backlash compensation acceleration/deceleration can be selected.		
		Torque restriction level		Torque restriction value can be set (0 to 400% variable)		
	Input signals	Analog setting signal		Terminal No.	Setting Range	Speed Control	Torque Control
				2	0 to 10V (resolution 0.03%)	Main speed setting	Speed restriction
				1	0 to ±10V (resolution 0.05%)	Auxiliary speed setting/magnetic flux command/regenerative torque restriction	Speed restriction compensation/ magnetic flux command/forward/ reverse rotation speed restriction (analog polarity switchover speed restriction)
				3	0 to ±10V (resolution 0.05%)	Torque restriction/Torque bias	Torque command
			Option (FR-V5AX)	6	0 to ±10V (resolution 0.003%)	Main speed setting (at this time, terminal 2 is invalid)/torque restriction	Speed restriction (at this time, terminal 2 is invalid)/Torque command (at this time, terminal 3 is invalid)
		Contact signal		3 fixed function terminals		Forward rotation command, alarm reset, external thermal relay	
				5 function terminals		Selection can be made from reverse rotation command, multi-speed setting (max. 15 speeds), remote setting, jog operation (Caution 1), second function selection, third function selection, output stop, start signal self-holding, pre-excitation, control mode switchover, torque restriction selection, start time tuning, S pattern switchover, PID control terminal, orientation command, break opening completion signal, PU operation/external operation switchover, torque bias selection 1, torque bias selection 2, P control selection, servo on, and PU/external interlock.	
			Option (FR-V5AX)	6 multi-function terminals			
	Output signals	Contact signal		1 changeover contact (230VAC 0.3A, 30VDC 0.3A)		Selection can be made from inverter running, inverter running 2, up to speed, instantaneous power failure (undervoltage), speed detection, second speed detection, third speed detection, PU operation mode, overload alarm, regenerative brake prealarm, electronic thermal relay function prealarm, output current detection, zero current detection, PID lower limit, PID upper limit, PID forward/reverse rotation output, operation ready, operation ready 2, brake opening request, fan fault output, heatsink overheat prealarm, orientation in-position, forward rotation output, reverse rotation output, low speed output, torque detection, regenerative status output, minor fault output, minor fault output 2,alarm output, maintenance timer output, start time tuning completion, remote output, output speed detection, second (third) output speed detection, in-position and trace status.	
		Open collector signal		3 multi-function terminals			
			Option (FR-V5AY)	3 multi-function terminals			
			Option (FR-V5AM)	1 multi-function terminal			
			Option (FR-A5AY))	7 multi-function terminals			
		Analog output		0 to ±10V 12 bits ×1CH 0 to 10V 12 bits ×1CH		Selection can be made from speed, output current, output voltage, preset speed, output frequency, motor torque, converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, load meter, motor exciting current, motor output, reference voltage output, torque command, torque current command and torque monitoring.	
			Option (FR-A5AY)	0 to 10V 10 bits × 1CH 0 to 20mA 10 bits × 1CH			
		Encoder pulse output option (FR-V5AY)		A phase, B phase, Z phase (A and B phases can be divided) Open collector/differential line driver.			
	Operational functions			Maximum/minimum speed setting, speed jump, external thermal relay input selection, polarity reversible operation, override function, automatic restart operation after instantaneous power failure, forward/reverse rotation prevention, operation mode selection, offline auto tuning function, online auto tuning function, easy gain tuning, computer link operation, remote setting, brake sequence, second function, third function, multi-speed operation, coasting to stop, power failure stop, PID control, speed feed forward, model adaptive speed control, master/slave, torque bias, 12-bit digital command (FR-A5AX option), 16-bit digital command (FR-A5AH option), pulse train input (FR-A5AP option), motor thermistor interface (FR-V5AX option)		
	Display	Parameter unit (FR-DU04-1/FR-PU04V)		Selection can be made from speed, output current, output voltage, preset speed, output frequency, motor torque, converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, input terminal status (Caution 4), output terminal status (Caution 4), load meter, motor exciting current, position pulse, cumulative operation time, actual operation time, motor load factor, torque command, torque current command, feedback pulse, motor output, trace status.		
		Alarm definition		Alarm definition is displayed when protective function is activated. 8 past alarm definitions are stored. (Only 4 alarm definitions are displayed on the operation panel.)		
	Protective functions			Overcurrent shut-off (during acceleration, deceleration, constant speed), regenerative overvoltage shut-off (acceleration, deceleration, constant speed), undervoltage, instantaneous power failure, overload shut-off (electronic thermal relay function), brake transistor alarm (Caution 2), ground fault current, power output short circuit (12/24VDC/operation panel), stall prevention, external thermal relay, heatsink overheat, fan fault, option alarm, parameter error, PU disconnection, encoder no-signal, speed deviation large, overspeed, position error large, CPU error, encoder phase error, output phase failure, retry count excess, brake sequence error		
	Environment	Ambient temperature		-10C to +50°C (14°F to 122°F) (non-freezing)			
		Ambient humidity		90%RH or less (non-condensing)			
		Storage temperature (Caution 3)		-20 to +65°C (-4°F to 149°F)			
		Atmosphere		Indoor use. (No corrosive gas, flammable gas, oil mist, dust and dirt)			
		Altitude, vibration		Maximum 1,000m (3280.80feet) above sea level, 5.9m/s^2 or less (compliant with JIS C 0040)			

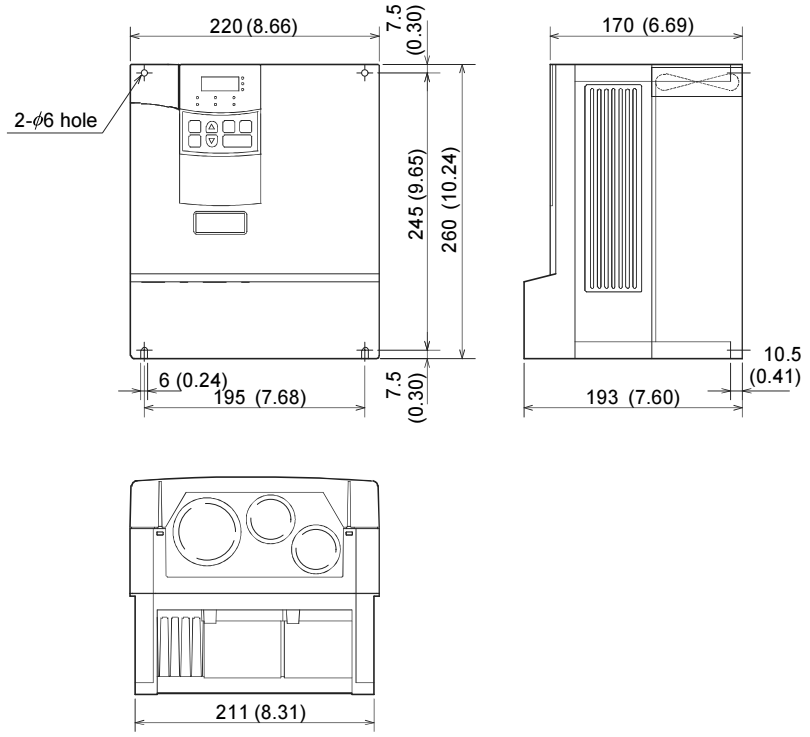
CAUTION

1. **Jog operation may also be performed from the operation panel (FR-DU04-1) or the parameter unit (FR-PU04V).**
2. **Not provided for the FR-V560-22K to 55K that do not have a built-in brake circuit.**
3. **Temperature applicable for a short period in transit, etc.**
4. **Not provided for the operation panel (FR-DU04-1).**

6.3 Outline dimension drawings

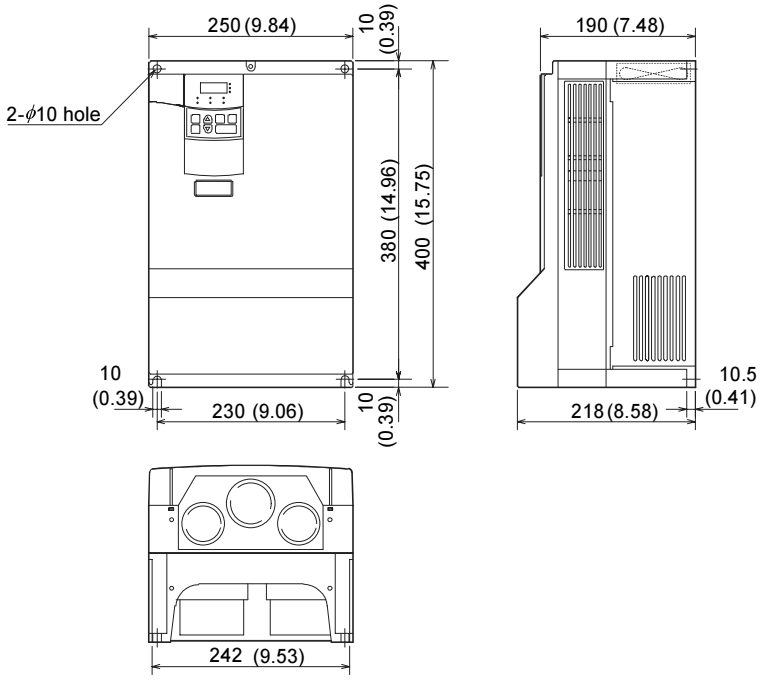
6.3.1 Inverter outline dimension drawings

● FR-V560-2.2K, 3.7K, 7.5K-NA



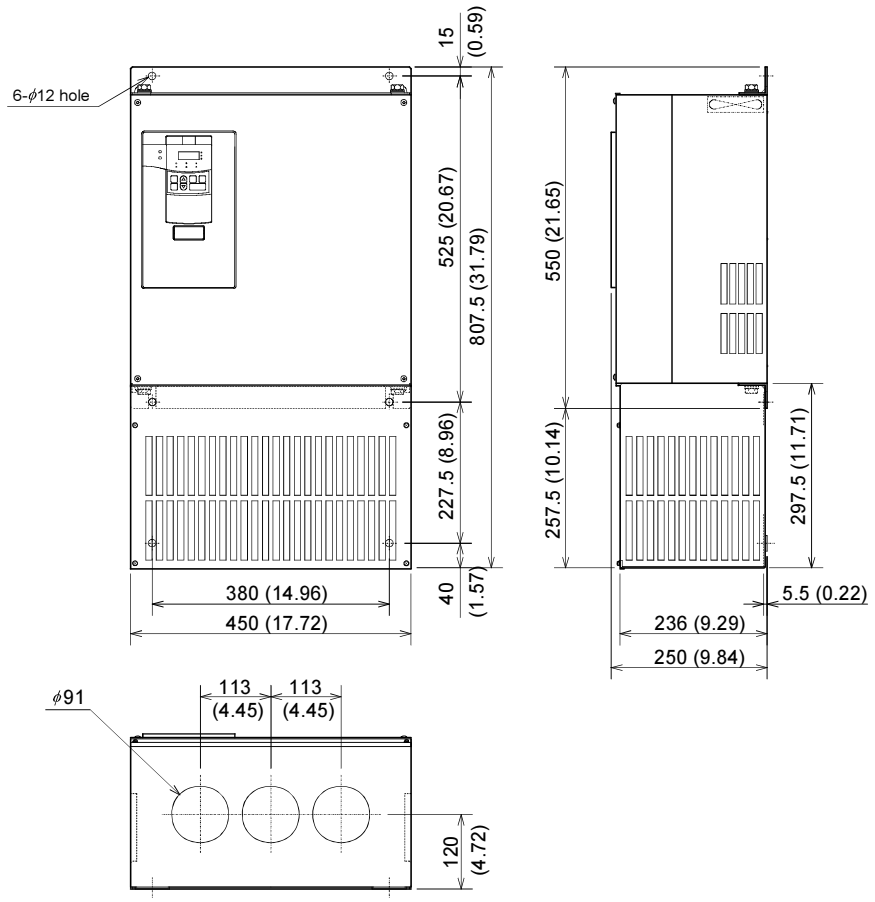
(Unit: mm (inches))

● FR-V560-15K, 22K-NA



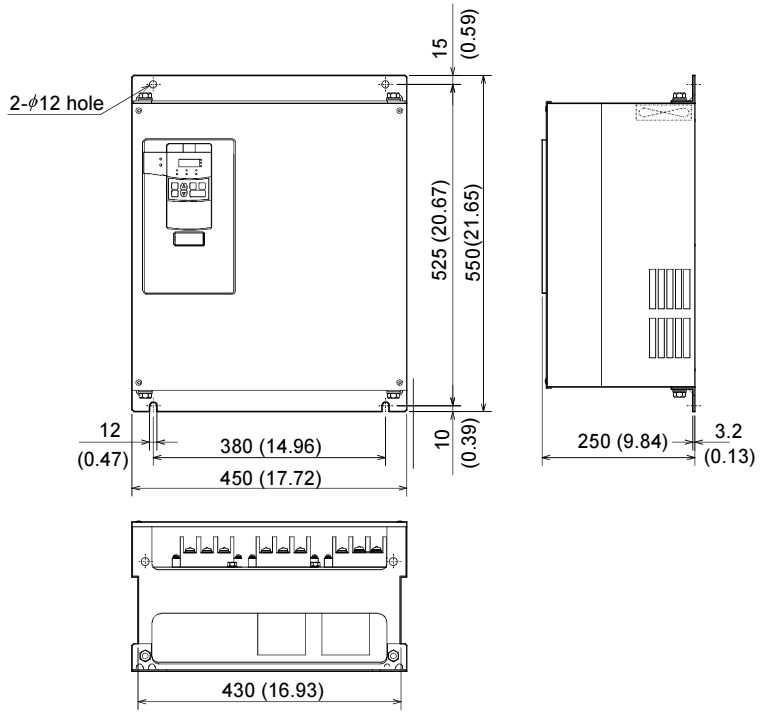
(Unit: mm (inches))

● **FR-V560-37K, 55K-NA with the attachment for conduit connection**



(Unit: mm (inches))

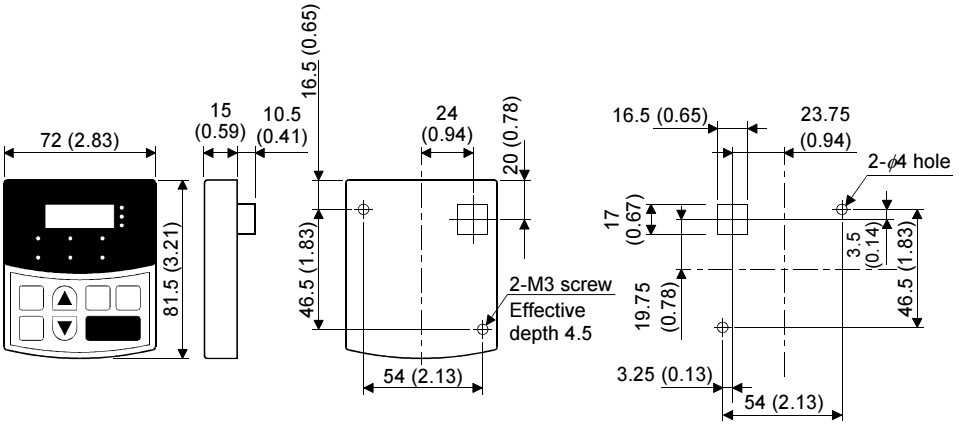
● **FR-V560-37K, 55K-NA without the attachment for conduit connection**



(Unit: mm (inches))

6.3.2 Operation panel (FR-DU04-1) outline dimension drawings

<Outline drawing> <Panel cut dimension drawing>

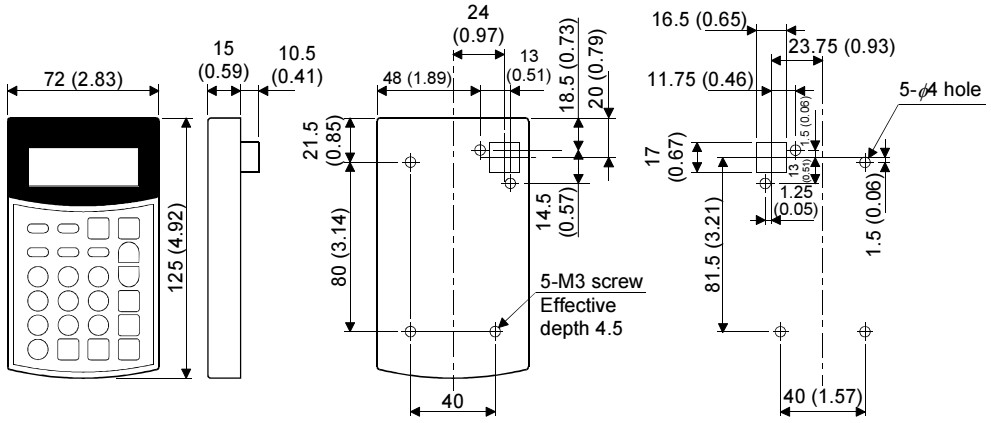


Select the mounting screw whose length will not exceed the effective depth of the mounting screw hole.

(Unit: mm (inches))

6.3.3 Parameter unit (FR-PU04V) outline dimension drawings

<Outline drawing> <Panel cut dimension drawing>



Select the mounting screw whose length will not exceed the effective depth of the mounting screw hole.

(Unit: mm (inches))

APPENDIX

This chapter provides the "appendix" for use of this product. Always read this instructions before use.

Appendix Parameter Data Code Lists

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Basic functions	0	Torque boost (manual)	00	80	0
	1	Maximum speed (simple mode)	01	81	0
	2	Minimum speed (simple mode)	02	82	0
	3	Base frequency	03	83	0
	4	Multi-speed setting (high speed) (simple mode)	04	84	0
	5	Multi-speed setting (middle speed) (simple mode)	05	85	0
	6	Multi-speed setting (low speed) (simple mode)	06	86	0
	7	Acceleration time (simple mode)	07	87	0
	8	Deceleration time (simple mode)	08	88	0
	9	Electronic thermal O/L relay (simple mode)	09	89	0
Standard operation functions	10	DC injection brake operation speed	0A	8A	0
	11	DC injection brake operation time	0B	8B	0
	12	DC injection brake voltage	0C	8C	0
	13	Starting speed	0D	8D	0
	15	Jog speed setting	0F	8F	0
	16	Jog acceleration/deceleration time	10	90	0
Operation selection functions	17	MRS input selection	11	91	0
	19	Base frequency voltage	13	93	0
	20	Acceleration/deceleration reference speed	14	94	0
	21	Acceleration/deceleration time increments	15	95	0
	22	Torque restriction level	16	96	0
	24	Multi-speed setting (speed 4)	18	98	0
	25	Multi-speed setting (speed 5)	19	99	0
	26	Multi-speed setting (speed 6)	1A	9A	0
	27	Multi-speed setting (speed 7)	1B	9B	0
	28	Multi-speed input compensation	1C	9C	0
	29	Acceleration/deceleration pattern	1D	9D	0
	30	Regenerative function selection	1E	9E	0
	31	Speed jump 1A	1F	9F	0
	32	Speed jump 1B	20	A0	0
	33	Speed jump 2A	21	A1	0
	34	Speed jump 2B	22	A2	0
	35	Speed jump 3A	23	A3	0
	36	Speed jump 3B	24	A4	0
	37	Speed display	25	A5	0
Output terminal functions	41	Up-to-speed sensitivity	29	A9	0
	42	Speed detection	2A	AA	0
	43	Speed detection for reverse rotation	2B	AB	0
Second functions	44	Second acceleration/deceleration time	2C	AC	0
	45	Second deceleration time	2D	AD	0
Terminal assign-ment functions	50	Second speed detection	32	B2	0
Display functions	52	DU/PU main display data selection	34	B4	0
	53	PU level display data selection	35	B5	0
	54	DA1 terminal function selection	36	B6	0
	55	Speed monitoring reference	37	B7	0
	56	Current monitoring reference	38	B8	0
Automatic restart	57	Restart coasting time	39	B9	0
	58	Restart cushion time	3A	BA	0
Additional function	59	Remote setting function selection	3B	BB	0
Operation selection functions	60	Intelligent mode selection	3C	BC	0
	65	Retry selection	41	C1	0
	67	Number of retries at alarm occurrence	43	C3	0
	68	Retry waiting time	44	C4	0
	69	Retry count display erasure	45	C5	0
	70	Special regenerative brake duty	46	C6	0
	71	Applied motor (simple mode)	47	C7	0
	72	PWM frequency selection (simple mode)	48	C8	0
	73	Speed setting signal	49	C9	0
	75	Reset selection/disconnected PU detection/PU stop selection	4B	CB	0
	77	Parameter write disable selection (simple mode)	4D	CD (Caution)	0
	78	Reverse rotation prevention selection	4E	CE	0
	79	Operation mode selection (simple mode)	4F	CF (Caution)	0

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Motor constants	80	Motor capacity (simple mode)	50	D0	0
	81	Number of motor poles (simple mode)	51	D1	0
	82	Motor excitation current (no load current)	52	D2	0
	83	Rated motor voltage(simple mode)	53	D3	0
	84	Rated motor frequency (simple mode)	54	D4	0
	90	Motor constant R1	5A	DA	0
	91	Motor constant R2	5B	DB	0
	92	Motor constant L1	5C	DC	0
	93	Motor constant L2	5D	DD	0
	94	Motor constant X	5E	DE	0
	95	Online auto tuning selection (simple mode)	5F	DF	0
	96	Auto tuning setting/status (simple mode)	60	E0	0
Third functions	110	Third acceleration/deceleration time	0A	8A	1
	111	Third deceleration time	0B	8B	1
Terminal assign-ment functions	116	Third speed detection	10	90	1
Communication functions	117	Communication station number	11	91	1
	118	Communication speed	12	92	1
	119	Stop bit length/data length	13	93	1
	120	Parity check presence/absence	14	94	1
	121	Number of communication retries	15	95	1
	122	Communication check time interval	16	96	1
	123	Waiting time setting	17	97	1
	124	CR, LF presence/absence selection	18	98	1
PID control	128	PID action selection	1C	9C	1
	129	PID proportional band	1D	9D	1
	130	PID integral time	1E	9E	1
	131	Upper limit	1F	9F	1
	132	Lower limit	20	A0	1
	133	PID action set point for PU operation	21	A1	1
	134	PID differential time	22	A2	1
Backlash	140	Backlash acceleration stopping speed	28	A8	1
	141	Backlash acceleration stopping time	29	A9	1
	142	Backlash deceleration stopping speed	2A	AA	1
	143	Backlash deceleration stopping time	2B	AB	1
Display functions	144	Speed setting switchover	2C	AC	1
	145	PU display language selection	2D	AD	1
Current detection	150	Output current detection level	32	B2	1
	151	Output current detection period	33	B3	1
	152	Zero current detection level	34	B4	1
	153	Zero current detection period	35	B5	1
Sub functions	156	Stall prevention operation selection	38	B8	1
	157	OL signal output timer	39	B9	1
Display functions	158	DA2 terminal function selection	3A	BA	1
	160	Extended function selection (simple mode)	00	80	2
Automatic restart after instantaneous power failure	162	Automatic restart after instantaneous power failure selection	02	82	2
	163	First cushion time for restart	03	83	2
	164	First cushion voltage for restart	04	84	2
	165	Restart current restriction level	05	85	2
Initial monitor	171	Actual operation hour meter clear	0B	8B	2
Terminal assignment functions	180	DI1 terminal function selection	14	94	2
	181	DI2 terminal function selection	15	95	2
	182	DI3 terminal function selection	16	96	2
	183	DI4 terminal function selection	17	97	2
	187	STR terminal function selection	1B	9B	2
	190	DO1 terminal function selection	1E	9E	2
	191	DO2 terminal function selection	1F	9F	2
	192	DO3 terminal function selection	20	A0	2
	195	A, B, C terminal function selection	23	A3	2
Multi-speed operation	232	Multi-speed setting (speed 8)	28	A8	2
	233	Multi-speed setting (speed 9)	29	A9	2
	234	Multi-speed setting (speed 10)	2A	AA	2
	235	Multi-speed setting (speed 11)	2B	AB	2
	236	Multi-speed setting (speed 12)	2C	AC	2
	237	Multi-speed setting (speed 13)	2D	AD	2
	238	Multi-speed setting (speed 14)	2E	AE	2
	239	Multi-speed setting (speed 15)	2F	AF	2
Sub functions	240	Soft-PWM setting	30	B0	2
	244	Cooling fan operation selection	34	B4	2

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Stop selection function	250	Stop selection	3A	BA	2
Operation selection function	251	Output phase failure protection selection	3B	BB	2
Additional functions	252	Override bias	3C	BC	2
	253	Override gain	3D	BD	2
Power failure stop functions	261	Power failure stop selection	45	C5	2
	262	Subtracted speed at deceleration start	46	C6	2
	263	Subtraction starting speed	47	C7	2
	264	Power-failure deceleration time 1	48	C8	2
	265	Power-failure deceleration time 2	49	C9	2
	266	Power-failure deceleration time switchover speed	4A	CA	2
Brake sequence	278	Brake opening speed	56	D6	2
	279	Brake opening current	57	D7	2
	280	Brake opening current detection time	58	D8	2
	281	Brake operation time at start	59	D9	2
	282	Brake operation speed	5A	DA	2
	283	Brake operation time at stop	5B	DB	2
	284	Deceleration detection function selection	5C	DC	2
	285	Overspeed detection speed	5D	DD	2
Droop	286	Droop gain	5E	DE	2
	287	Droop filter constant	5F	DF	2
	288	Droop function activation selection	60	E0	2
Digital input	300	BCD input bias	00	80	3
	301	BCD input gain	01	81	3
	302	Binary input bias	02	82	3
	303	Binary input gain	03	83	3
	304	Digital input and analog compensation input enable/ disable selection	04	84	3
	305	Read timing operation selection	05	85	3
Analog output	306	Analog output signal selection	06	86	3
	307	Setting for zero analog output	07	87	3
	308	Setting for maximum analog output	08	88	3
	309	Analog output signal voltage/current switchover	09	89	3
	310	Analog meter voltage output selection	0A	8A	3
	311	Setting for zero analog meter voltage output	0B	8B	3
	312	Setting for maximum analog meter voltage output	0C	8C	3
Digital output	313	Y0 output selection	0D	8D	3
	314	Y1 output selection	0E	8E	3
	315	Y2 output selection	0F	8F	3
	316	Y3 output selection	10	90	3
	317	Y4 output selection	11	91	3
	318	Y5 output selection	12	92	3
	319	Y6 output selection	13	93	3
Relay output	320	RA1 output selection	14	94	3
	321	RA2 output selection	15	95	3
	322	RA3 output selection	16	96	3
Digital input	329	Digital input unit selection	1D	9D	3
Relay output	330	RA0 output selection	1E	9E	3
Communication	331	Station number	1F	9F	3
	332	Communication speed	20	A0	3
	333	Stop bit length	21	A1	3
	334	Parity check presence/absence	22	A2	3
	335	Number of communication retries	23	A3	3
	336	Communication check time interval	24	A4	3
	337	Waiting time setting	25	A5	3
	338	Operation control command source	26	A6	3
	339	Speed command source	27	A7	3
	340	Link startup mode selection	28	A8	3
	341	CR/LF presence/absence selection	29	A9	3
	342	E^2PROM write selection	2A	AA	3
	345	DeviceNet address (lower)	2D	AD	3
	346	DeviceNet baud rate (lower)	2E	AE	3
	347	DeviceNet address (higher)	2F	AF	3
	348	DeviceNet baud rate (higher)	30	B0	3

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Orientation	350	Stop position command selection	32	B2	3
	351	Orientation switchover speed	33	B3	3
	356	Internal stop position command	38	B8	3
	357	In-position zone	39	B9	3
	359	Orientation encoder rotation direction	3B	BB	3
	360	External position command selection	3C	BC	3
	361	Position shift	3D	BD	3
	362	Orientation position loop gain	3E	BE	3
	369	Number of orientation encoder pulses	45	C5	3
Control system function	374	Overspeed detection level	4A	CA	3
S-pattern C	380	Acceleration S pattern 1	50	D0	3
	381	Deceleration S pattern 1	51	D1	3
	382	Acceleration S pattern 2	52	D2	3
	383	Deceleration S pattern 2	53	D3	3
Pulse train input	384	Input pulse division scaling factor	54	D4	3
	385	Speed for zero input pulse	55	D5	3
	386	Speed for maximum input pulse	56	D6	3
Orientation	393	Orientation selection	5D	DD	3
	394	Number of machine side gear teeth	5E	DE	3
	395	Number of motor side gear teeth	5F	DF	3
	396	Orientation speed gain (P term)	60	E0	3
	397	Orientation speed integral time	61	E1	3
	398	Orientation speed gain (D term)	62	E2	3
	399	Orientation deceleration ratio	63	E3	3
Extension inputs	400	DI11 terminal function selection	00	80	4
	401	DI12 terminal function selection	01	81	4
	402	DI13 terminal function selection	02	82	4
	403	DI14 terminal function selection	03	83	4
	404	DI15 terminal function selection	04	84	4
	405	DI16 terminal function selection	05	85	4
	406	High resolution analog input selection	06	86	4
	407	Motor temperature detection filter	07	87	4
Extension outputs	410	DO11 terminal function selection	0A	8A	4
	411	DO12 terminal function selection	0B	8V	4
	412	DO13 terminal function selection	0C	8C	4
	413	Encoder pulse output division ratio	0D	8D	4
Position control	419	Position command right selection	13	93	4
	420	Command pulse scaling factor numerator	14	94	4
	421	Command pulse scaling factor denominator	15	95	4
	422	Position loop gain	16	96	4
	423	Position feed forward gain	17	97	4
	424	Position command acceleration/deceleration time constant	18	98	4
	425	Position feed forward command filter	19	99	4
	426	In-position width	1A	9A	4
	427	Excessive level error	1B	9B	4
	428	Command pulse selection	1C	9C	4
	429	Clear signal selection	1D	9D	4
	430	Pulse monitor selection	1E	9E	4
Torque command	432	Pulse train torque command bias	20	A0	4
	433	Pulse train torque command gain	21	A1	4
Position control	434	IP address 1	22	A2	4
	435	IP address 2	23	A3	4
	436	IP address 3	24	A4	4
	437	IP address 4	25	A5	4
	438	Sub-net mask 1	26	A6	4
	439	Sub-net mask 2	27	A7	4
	440	Sub-net mask 3	28	A8	4
	441	Sub-net mask 4	29	A9	4
	442	Gateway address 1	2A	AA	4
	443	Gateway address 2	2B	AB	4
	444	Gateway address 3	2C	AC	4
	445	Gateway address 4	2D	AD	4
	446	Password	2E	AE	4
Torque command	447	Digital torque command bias	2F	AF	4
	448	Digital torque command gain	30	B0	4

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Motor constants	450	Second applied motor	32	B2	4
	451	Second motor control method selection	33	B3	4
	452	Second electronic thermal O/L relay	34	B4	4
	453	Second motor capacity	35	B5	4
	454	Number of second motor poles	36	B6	4
	455	Second exciting current	37	B7	4
	456	Rated second motor voltage	38	B8	4
	457	Rated second motor frequency	39	B9	4
	458	Second motor constant (R1)	3A	BA	4
	459	Second motor constant (R2)	3B	BB	4
	460	Second motor constant (L1)	3C	BC	4
	461	Second motor constant (L2)	3D	BD	4
	462	Second motor constant (X)	3E	BE	4
	463	Second auto tuning setting/status	3F	BF	4
Position control	464	Digital position control sudden stop deceleration time	40	C0	4
	465	First position feed amount lower 4 digits	41	C1	4
	466	First position feed amount upper 4 digits	42	C2	4
	467	Second position feed amount lower 4 digits	43	C3	4
	468	Second position feed amount upper 4 digits	44	C4	4
	469	Third position feed amount lower 4 digits	45	C5	4
	470	Third position feed amount upper 4 digits	46	C6	4
	471	Fourth position feed amount lower 4 digits	47	C7	4
	472	Fourth position feed amount upper 4 digits	48	C8	4
	473	Fifth position feed amount lower 4 digits	49	C9	4
	474	Fifth position feed amount upper 4 digits	4A	CA	4
	475	Sixth position feed amount lower 4 digits	4B	CB	4
	476	Sixth position feed amount upper 4 digits	4C	CC	4
	477	Seventh position feed amount lower 4 digits	4D	CD	4
	478	Seventh position feed amount upper 4 digits	4E	CE	4
	479	Eighth position feed amount lower 4 digits	4F	CF	4
	480	Eighth position feed amount upper 4 digits	50	D0	4
	481	Ninth position feed amount lower 4 digits	51	D1	4
	482	Ninth position feed amount upper 4 digits	52	D2	4
	483	Tenth position feed amount lower 4 digits	53	D3	4
	484	Tenth position feed amount upper 4 digits	54	D4	4
	485	Eleventh position feed amount lower 4 digits	55	D5	4
	486	Eleventh position feed amount upper 4 digits	56	D6	4
	487	Twelfth position feed amount lower 4 digits	57	D7	4
	488	Twelfth position feed amount upper 4 digits	58	D8	4
	489	Thirteenth position feed amount lower 4 digits	59	D9	4
	490	Thirteenth position feed amount upper 4 digits	5A	DA	4
	491	Fourteenth position feed amount lower 4 digits	5B	DB	4
	492	Fourteenth position feed amount upper 4 digits	5C	DC	4
	493	Fifteenth position feed amount lower 4 digits	5D	DD	4
	494	Fifteenth position feed amount upper 4 digits	5E	DE	4
Remote output	495	Remote output selection	5F	DF	4
	496	Remote output data 1	60	E0	4
	497	Remote output data 2	61	E1	4
Communication	499	Action selection at SSCNET communication inter ruption	63	E3	4
	500	Communication error recognition waiting time	00	80	5
	501	Communication error occurence count display	01	81	5
	502	Communication error-time stop mode selection	02	82	5
Operation selection functions	800	Control system selection (simple mode)	00	80	8
	801	Torque characteristic selection	01	81	8
	802	Pre-excitation selection	02	82	8
	803	Constant output region torque characteristic selection	03	83	8
	804	Torque command right selection	04	84	8
	805	Torque command value (RAM)	05	85	8
	806	Torque command value (RAM, E^2PROM)	06	86	8
	807	Speed restriction selection	07	87	8
	808	Forward rotation speed restriction	08	88	8
	809	Reverse rotation speed restriction	09	89	8

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Control system functions	810	Torque restriction input method selection	0A	8A	8
	812	Torque restriction level (regeneration)	0C	8C	8
	813	Torque restriction level (3 quadrant)	0D	8D	8
	814	Torque restriction level (4 quadrant)	0E	8E	8
	815	Torque restriction level 2	0F	8F	8
	816	Acceleration torque restriction level	10	90	8
	817	Deceleration torque restriction level	11	91	8
	818	Easy gain tuning response level setting (simple mode)	12	92	8
	819	Easy gain tuning selection (simple mode)	13	93	8
	820	Speed control P gain 1	14	94	8
	821	Speed control integral time 1	15	95	8
	822	Speed setting filter 1	16	96	8
	823	Speed detection filter 1	17	97	8
	824	Torque control P gain 1	18	98	8
	825	Torque control integral time 1	19	99	8
	826	Torque setting filter 1	1A	9A	8
	827	Torque detection filter 1	1B	9B	8
	828	Model speed control gain	1C	9C	8
	830	Speed control P gain 2	1E	9E	8
	831	Speed control integral time 2	1F	9F	8
	832	Speed setting filter 2	20	A0	8
	833	Speed detection filter 2	21	A1	8
	834	Torque control P gain 2	22	A2	8
	835	Torque control integral time 2	23	A3	8
	836	Torque setting filter 2	24	A4	8
	837	Torque detection filter 2	25	A5	8
Torque biases	840	Torque bias selection	28	A8	8
	841	Torque bias 1	29	A9	8
	842	Torque bias 2	2A	AA	8
	843	Torque bias 3	2B	AB	8
	844	Torque bias filter	2C	AC	8
	845	Torque bias operation time	2D	AD	8
	846	Torque bias balance compensation	2E	AE	8
	847	Fall-time torque bias No. 3 bias	2F	AF	8
	848	Fall-time torque bias No. 3 gain	30	B0	8
	849	Analog input offset adjustment	31	B1	8
Operation selection function	850	Brake operation selection for vector control without encoder	32	B2	8
Additional functions	851	Number of encoder pulses	33	B3	8
	852	Encoder rotation direction	34	B4	8
	854	Excitation ratio	36	B6	8
	859	Torque current	3B	BB	8
	860	Second torque current	3C	BC	8
	862	Notch filter frequency	3E	BE	8
	863	Notch filter depth	3F	BF	8
	864	Torque detection	40	C0	8
	865	Low speed detection	41	C1	8
Display functions	866	Torque monitoring reference	42	C2	8
	867	DA1 output filter	43	C3	8
Terminal assignment function	868	No. 1 terminal function assignment	44	C4	8
Protective functions	870	Speed deviation level	46	C6	8
	871	Speed deviation time	47	C7	8
	873	Speed restriction	49	C9	8
	874	OLT level setting	4A	CA	8
Operation selection functions	875	Fault definition	4B	CB	8
	876	Thermal relay protector input	4C	CC	8
Control system functions	877	Speed feed forward/model adaptive speed control selection	4D	CD	8
	878	Speed feed forward filter	4E	CE	8
	879	Speed feed forward torque restriction	4F	CF	8
	880	Load inertia ratio	50	D0	8
	881	Speed feed forward gain	51	D1	8
Maintenance functions	890	Maintenance output setting time	5A	DA	8
	891	Maintenance output timer	5B	DB	8
	892	Maintenance output signal clear	5C	DC	8

Function	Parameter No.	Name	Data Codes		Link Parameter Expansion Setting (Instruction code 7F/FF)
			Read	Write	
Calibration functions	900	DA1 terminal calibration	5C	DC	1
	901	DA2 terminal calibration	5D	DD	1
	902	Speed setting No. 2 bias	5E	DE	1
	903	Speed setting No. 2 gain	5F	DF	1
	904	Torque command No. 3 bias	60	E0	1
	905	Torque command No. 3 gain	61	E1	1
	917	No. 1 terminal bias (speed)	11	91	9
	918	No. 1 terminal gain (speed)	12	92	9
	919	No. 1 terminal bias (torque/magnetic flux)	13	93	9
	920	No. 1 terminal gain (torque/magnetic flux)	13	94	9
	925	Motor temperature detection calibration	19	99	9
	926	No. 6 terminal bias (speed)	1A	9A	9
	927	No. 6 terminal gain (speed)	1B	9B	9
	928	No. 6 terminal bias (torque)	1C	9C	9
	929	No. 6 terminal gain (torque)	1D	9D	9
Additional functions	990	PU buzzer control	5A	DA	9
	991	PU contrast adjustment	5B	DB	9

CAUTION

Note that read and write of the Pr. 77 and Pr. 79 values are enabled for computer link operation that uses the PU connector, but write is disabled for computer link operation that uses the option (FR-A5NR).

MEMO

REVISIONS

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