ADVANCED AND EVER ADVANCING MITSUBISHI ELECTRIC

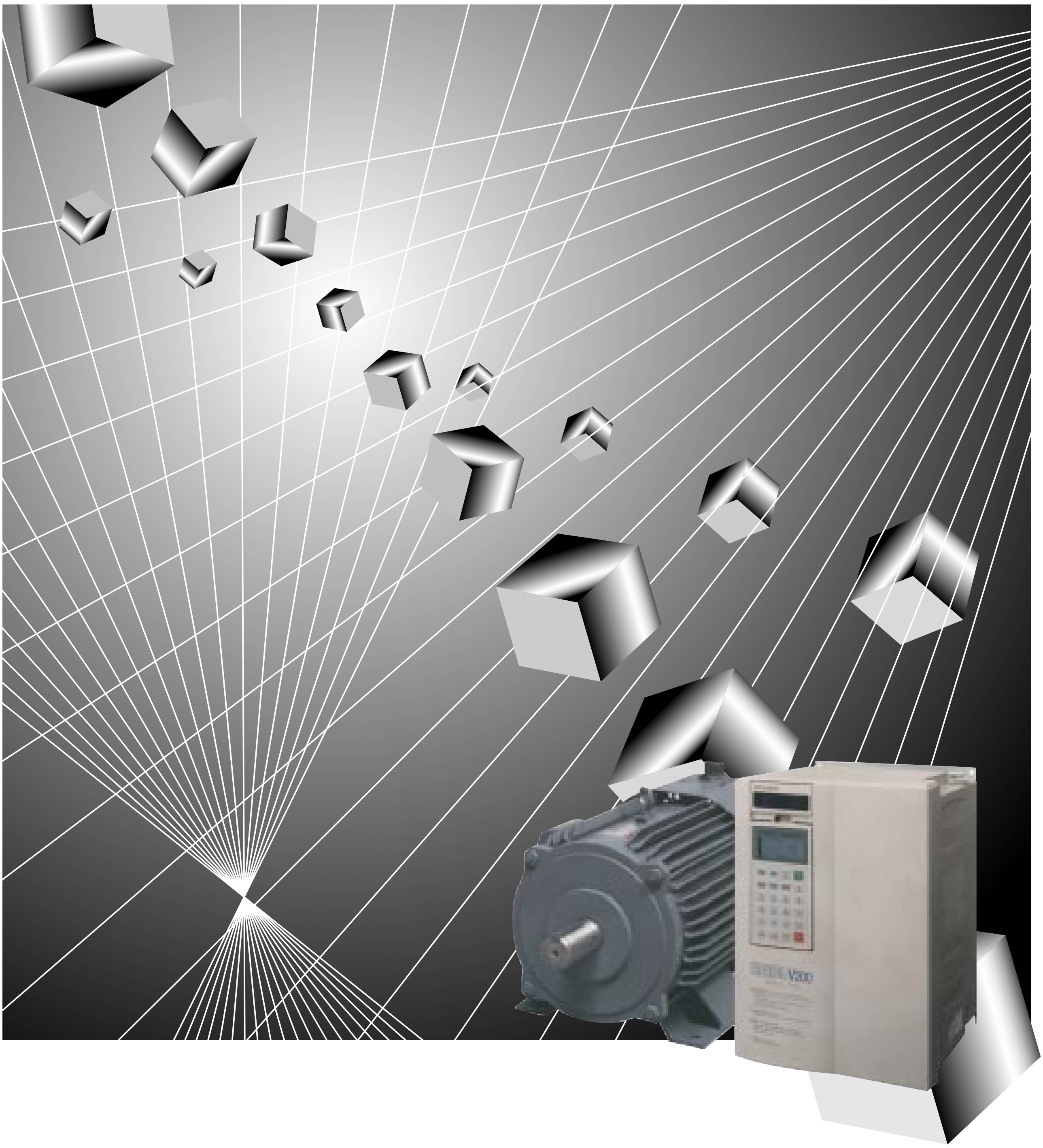
MITSUBISHI

VECTOR INVERTER

FR-V200

FR-V200 series

TECHNICAL MANUAL



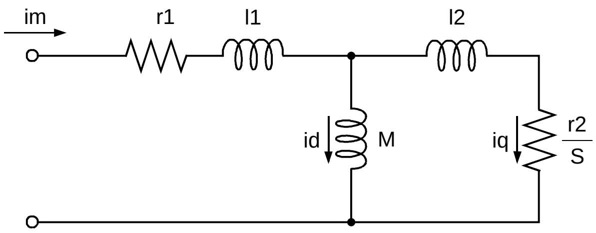
CONTENTS

1 SPECIFICATIONS

1.1 OPERATION PRINCIPLE

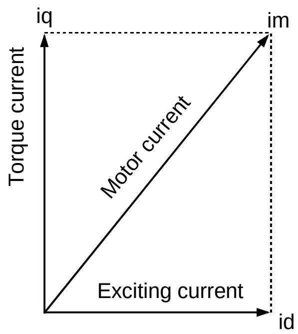
1.1.1 What is vector control?

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
l1 : Primary leakage inductance
l2 : Secondary leakage inductance
M : Mutual inductance
S : Slip
id : Exciting current
iq : Torque current
im : Motor current

In the above diagram, currents flowing in the induction motor can be classified into a current id (exciting 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 operated on to control the motor so that the exciting current and torque current (as shown in the left figure) flow to the optimum as described below:

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

(2) Speed control operation is performed to zero the difference between the motor speed command and the actual speed derived from the PLG connected to the motor shaft. At this time, the load applied to the motor is found and the torque current is controlled to match that load.

Motor-generated torque (TM), slip angular velocity (ωs) and the motor's secondary magnetic flux (Φ2) can be found by the following calculation:

$$T_M \propto \Phi_2 \times iq$$

$$\Phi_2 = M \times id$$

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

where, L2 = secondary inductance

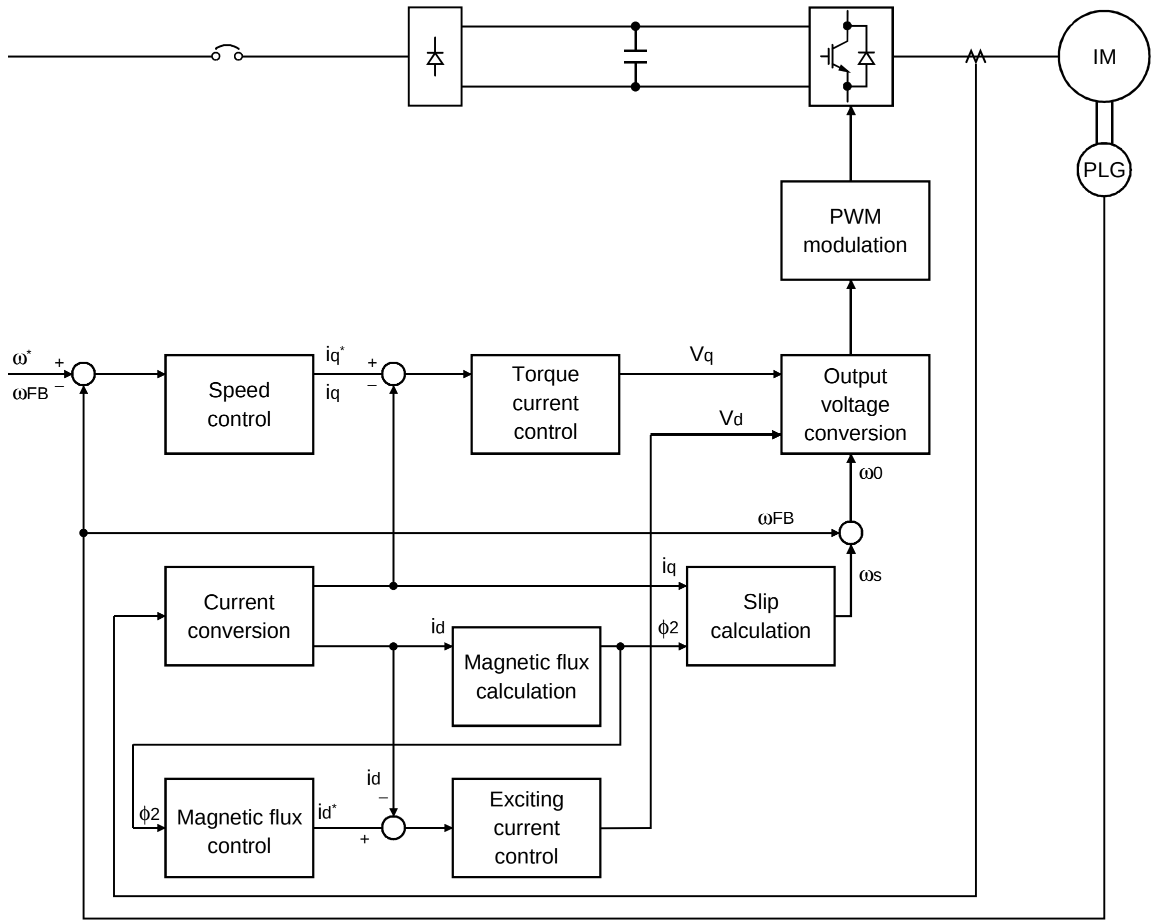
$L2 = l_2M$

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



In vector control, the following controls are exercised to drive a motor.

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

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

(3) Magnetic flux control
The magnetic flux (Φ2) of the motor is derived from the exciting current. The exciting current command (id*) is calculated to use that motor magnetic flux (Φ2) as a predetermined magnetic flux.

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

(5) Output frequency calculation
Motor slip (ωs) is calculated on the basis of the torque current value (iq) and magnetic flux (Φ2). The output frequency (ω0) is found by adding that slip (ωs) to the feedback ωFB found by a feedback from the PLG.

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

1.2 Instructions for Using the Inverter

The FR-V200E series inverter is a highly reliable product. However, its product life may be shortened or the product damaged if peripheral circuit assembling is incorrect or it is operated or handled inadequately.
Before starting operation, always recheck the following points:

(1) A short circuit or ground fault on the inverter output side may damage the inverter module.
- The inverter module may be damaged by short circuits repeated due to a peripheral circuit defect or a ground fault occurring due to improper wiring or reduced motor insulation resistance. Before running the inverter, check the insulation resistance of the circuit.
- Before switching power on, fully check the "to-ground" insulation and "phase-to-phase" insulation in the inverter's secondary side.
  For an especially old motor or a motor in a hostile environment, check the motor's insulation resistance etc.

(2) Do not use the inverter power supply side magnetic contactor to start/stop the inverter.
Always use the start signal (ON-OFF across terminals STF, STR-SD) to start/stop the inverter.

(3) Connect only a discharge resistor designed for external regenerative brake to terminals P and PR.
Do not connect a mechanical brake. When using an external, large thermal-capacity discharge resistor for regenerative braking, always remove the wiring of the built-in discharge resistor for regenerative braking or the jumper.

(4) Do not install a magnetic contactor in the inverter output side to switch it on-off during operation.
Turning on a magnetic contactor during inverter operation will cause a large starting current to flow, leading to a failure.

(5) Noises
In low-noise operation, electromagnetic noise tends to increase and noise reduction techniques should be considered.
Depending on the inverter installation conditions, the inverter may be affected by noise if the carrier frequency is reduced.

Main noise reduction techniques
- Lowering the carrier frequency can reduce noise levels.
- The FR-BIF(H) radio noise filter can reduce AM radio noise.
- The FR-BLF line noise filter can prevent the malfunctions of sensors and similar products.
- Induced noises from the power line of the inverter can be reduced by running it more than 30cm (at least 10cm) away and using twisted pair shielded cables as signal lines.

(6) Apply only a voltage within the permissible value to the inverter I/O signal circuits.
The I/O devices may be damaged if a voltage higher than the value indicated in Section 1.5.2 is applied to the inverter I/O signal circuits or reverse polarity is used. Before using the inverter, make sure that the speed setting potentiometer is connected correctly across terminals 10-5 to prevent a short circuit.

(7) When connecting the inverter near a large-capacity power supply, insert a power factor improving reactor.
The inverter input current varies with the impedance of the power supply (i.e. the power supply's power factor varies). For a power supply capacity of 1000KVA or more, insert a power factor improving reactor.

(8) Use of the inverter with a single-phase power supply.
Do not use the inverter with a single-phase power supply.

(9) Instructions for use of the inverter with any motor other than the vector control inverter motor (SF-VR) and general-purpose motor with PLG (SF-JR)
a) Without a PLG, vector control cannot be exercised.
b) Couple the PLG directly with a backlash-free motor shaft.

(10) Commercial power supply-inverter switch-over operation cannot be performed for the vector control inverter motor as its rated voltage is different from the commercial power supply voltage.

Motor	Rated Voltage
SF-VR	160V
SF-VRH	320V

(11) Power harmonics

Harmonics are defined to have a frequency that is an integral multiple of that of the fundamental wave. Usually, 40th to 50th harmonics (to several kHz) are handled as harmonics and those of higher frequencies are handled as noise. Noise and harmonics are clearly different in causes, reduction techniques etc. as listed below:

Item	Noise	Harmonics
Frequency band	High frequency (More than several 10kHz)	40th to 50th degrees (Up to several kHz)
Main source of generation	Inverter circuit	Converter circuit
Propagation path	Electric channel, space, induction	Electric channel
Influence	Distance, wiring route	Line impedance
Transmission amount	Voltage variation ratio Switching frequency	Current capacity
Phenomenon	Mis-detection by sensor, etc. and noises from radios	Heat generation, etc. of power capacitor and generator
Main remedy	Change the wiring route. Install a noise filter.	Install a reactor.

(12) Always ground the motor and inverter.

1) Purpose of grounding

Generally, electrical apparatus has an earth terminal and this 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 which can shut off a leakage current completely, and actually, a slight current will flow into the case. The purpose of grounding the case of electrical apparatus is to prevent someone from getting an electric shock from this leakage current when touching it.

To avoid the influence of external noise, this grounding is important to audio equipment, sensors, computers and other apparatus which handles low-level signals or operates very fast.

2) Grounding methods and grounding work

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 leakage current having the inverter's harmonic components from entering the malfunction prevention type grounding:

(a) Where possible, use independent grounding for the inverter.

(Note: For diagrams (i), (ii) and (iii) please see the following page.)

If independent grounding (i) is impossible, use joint grounding (ii) where the inverter is connected with the other equipment at a 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 harmonic 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 noise.

In a tall building, it will be a good policy to use the noise-affected malfunction prevention type grounding with steel frames and carry out electric shock prevention type grounding using the independent grounding method.

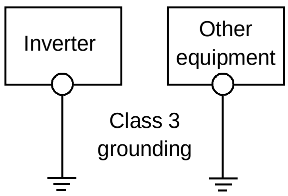
(b) Use Class 3 grounding (grounding resistance 100Ω or less) for the 200V class inverter, and use special Class 3 grounding (grounding resistance 10Ω or less) for the 400V class inverter.

(c) Use the thickest possible ground cable. The ground cable should be no less than the size indicated in the below table.

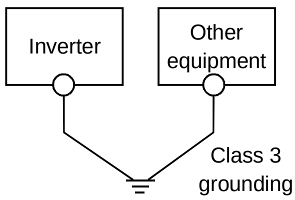
(d) The grounding point should be as near as possible to the inverter to minimize the ground cable length.

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

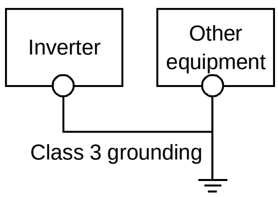
(f) Use one wire in a 4-core cable with the ground terminal of the motor and ground it on the inverter side.



(i) Independent grounding ... Best



(ii) Joint grounding ... Good



(iii) Joint grounding ... Not allowed

Ground Cable Sizes

Motor Capacity	Ground Cable Size	
	200V class	400V class
3.7kW or less	3.5mm^2	2mm^2
5.5kW, 7.5kW	5.5	3.5
11 to 15kW	14	8
18.5 to 37kW	22	14
45kW	38	22

(13) Leakage current

Capacitances exist between the inverter's I/O wiring, other cables and ground and in the motor and a leakage current flows through them. Its value depends on the carrier frequency etc. Therefore, for low noise operation, the leakage current may increase, actuating the earth leakage breaker and earth leakage relay unnecessarily. Take the following actions:

Actions

- Reduce the inverter's carrier frequency, Pr. 72. Note that this increases motor noise.
- Use harmonic/surge reduction products (e.g. Mitsubishi's Progressive Super NV series) as earth leakage breakers in the inverter system and other systems to perform operation with low noise (carrier frequency increased).

1.3 Specification List

1.3.1 Ratings

(1) Motor specifications

■Vector control inverter motor [SF-VR(H)]

	Motor type SF-VR □		5K	7K	11K	15K	18K	22K	30K	37K	45K
200V class	Rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45
	Rated torque (kgf · m)		3.57	4.87	7.15	9.75	12.0	14.3	19.5	24.0	29.2
	(N · m)		35.0	47.7	70.1	95.6	118	140	191	235	286
	Maximum torque (kgf · m)		5.35	7.31	10.7	14.6	18.0	21.5	29.3	36.0	43.8
	150% 60 seconds (N · m)		52.4	71.6	105	143	176	211	287	353	429
	Rated speed (r/min)		1500								
	Maximum speed (r/min)		3000								
	Frame No.		132S	132M	160M	160L	180M	180M	200L	200L	200L
	GD^2 (kgf · m^2)		0.11	0.16	0.30	0.35	0.69	0.75	1.30	1.45	1.45
	Noise		75dB or less						80dB or less		
	Cooling fan	Voltage	Single-phase 200V/50Hz Single-phase 200 to 230V/60Hz		Three-phase 200V/50Hz, three-phase 200 to 230V/60Hz						
		Input	34/28W (0.17/0.13A)		55/71W (0.39/0.39A)				100/156W (0.47/0.53A)		

	Motor type SF-VRH □		5K	7K	11K	15K	18K	30K	30K	37K	45K
400V class	Rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45
	Rated torque (kgf · m^2)		3.57	4.87	7.15	9.75	12.0	14.3	19.5	24.0	29.2
	(N · m)		35.0	47.7	70.1	95.6	118	140	191	235	286
	Maximum torque (kgf · m^2)		5.35	7.31	10.7	14.6	18.0	21.5	29.3	36.0	43.8
	150% 60 seconds (N · m)		52.4	71.6	105	143	176	211	287	353	429
	Rated speed (r/min)		1500								
	Maximum speed (r/min)		3000								
	Frame No.		132S	132M	160M	160L	180M	180M	200L	200L	200L
	GD^2 (kgf · m^2)		0.11	0.16	0.30	0.35	0.69	0.75	1.30	1.45	1.45
	Noise		75dB or less						80dB or less		
	Cooling fan	Voltage	Single-phase 200V/50Hz*5 Single-phase 200 to 230V/60Hz		Three-phase 200V/50Hz, three-phase 200 to 230V/60Hz *5 (Note 1)						
		Input	34/28W (0.17/0.13A)		55/71W (0.39/0.39A)				80dB or less		

Common specifications	Ambient temperature, humidity	–10°C to +40°C, 90%RH or less
	Structure	Totally enclosed forced draft system
	Detector	PLG 1000P/R, A, B, Z +5V power supply
	Equipment	PLG, thermal protector, fan
	Insulation	Class F
	Vibration rank	V 10

(Note 1) Though the motor is 400V class, the power supply of the cooling fan is 200V.

■General-purpose motor with PLG [SF-JR(4P)]

	Motor type SF-JR □	1.5kW	2.2kW	3.7kW	5.5kW	7.5kW	11kW	15kW	18.5kW	22kW	30kW	37kW	45kW
200/400V class	Rated output (kW)	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
	Rated torque (kgf · m)	0.81	1.19	2.0	2.98	4.06	5.96	8.12	10.0	11.9	16.2	20.0	24.4
	(N · m)	7.9	11.7	19.6	29.2	39.8	58.4	79.6	98	116	159	196	239
	Maximum torque (kgf · m)	1.22	1.79	3.0	4.47	6.09	8.9	12.2	15.0	17.9	24.3	30.0	36.6
	150% 60 seconds (N · m)	11.96	17.54	29.4	43.8	59.7	87.2	119.7	147	175	238	294	359
	Rated speed (r/min)	1800											
	Maximum speed (r/min)	3600					3000					1950	
	Frame No.	90L	100L	112M	132S	132M	160M	160L	180M	180M	180L	200L	200L
	GD^2 ($kgf \cdot m^2$)	0.027	0.032	0.065	0.11	0.16	0.28	0.40	0.69	0.83	1.1	1.5	1.8
	Noise	75dB or less										80dB or less	

Common Specification	Ambient temperature, humidity	–10°C to +40°C, 90%RH or less		
	Structure	Totally-enclosed, fan-cooled		
	Detector	PLG 1024P/R, A, B, Z DC+5V power supply		
	Equipment	PLG		
	Insulation	Class E	Class B	Class F
	Vibration rank	V 10		

(Note 2) The specifications of the general-purpose motor with PLG assume that the general-purpose motor with PLG is the SF-JR(4P). For the other motors with PLG, refer to the corresponding motor catalogs.
The specifications of the inverters are the same independently of the motors.

(Note 3) When driving the motor with PLG (4P or 6P), perform auto tuning operation. When driving the motor with PLG (2P), run it at or less than its permissible speed. (Maximum speed is 3600 r/min.) However, auto tuning operation is not required for the SF-JR 1.5kW to 3.7kW (2 to 5 HP) (4P) motors with PLG as the motor constants are factory-set to these motors.

(2) Inverter specification

■200Vclass

					1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Motor type				SF-VR□	—	—	—	5K	7K	11K	15K	18K	22K	30K	37K	45K
				SF-JR□	1.5kW	2.2kW	3.7kW	5.5kW	7.5kW	11kW	15kW	18.5kW	22kW	30kW	37kW	45kW
Inverter	Type FR-V220E-□				1.5K	2.2K	3.7K	5.5K	7.5K	11K	15K	18.5K	22K	30K	37K	45K
	Output	Rated capacity (kVA)			3.1	4.5	6.9	9.6	12.6	18.3	24.6	30.1	35.8	44.0	57.8	67.5
		Rated current (A)			9.0	13.0	20.0	27.7	36.3	52.7	71.0	87.0	103.5	126.5	166.8	192.0
		Overload current rating *1			150% 60 seconds, 200% 0.5 seconds (inverse-time characteristics)											
		Voltage *2			Three-phase, 200V to 220V 50Hz, 200 to 230V 60Hz											
		Regenerative braking torque	Maximum value/time		100%/5 seconds				20% *3							
			Permissible duty		3%ED		2%ED		Continuous *3							
	Power supply	Rated input AC voltage, frequency			Three-phase, 200V to 220V 50Hz, 200 to 230V 60Hz											
		Permissible AC voltage fluctuation			Three-phase, 170V to 242V 50Hz, 170 to 253V 60Hz											
		Permissible frequency fluctuation			±5%											
		Instantaneous voltage drop immunity			Operation continues at 165V or higher. If voltage drops from rated voltage to less than 165V, operation continues for 15ms.											
		Power supply capacity (kVA) *4			4.5	5.5	9	12	17	20	28	34	41	52	66	80
	Protective structure (JEM 1030)				Enclosed type (IP20)				Open type (IP00)							
	Cooling system				Forced air cooling											
	Approximate weight (kg)				3.7	3.7	7.5	7.7	7.7	14.5	17	17	33	54	54	72

■400V class

Motor type		SF-VRH□	—	—	—	5K	7K	11K	15K	18K	22K	30K	37K	45K
Motor type		SF-JR□	1.5kW	2.2kW	3.7kW	5.5kW	7.5kW	11kW	15kW	18.5kW	22kW	30kW	37kW	45kW
Inverter	Type	FR-V240E-□	1.5K	2.2K	3.7K	5.5K	7.5K	11K	15K	18.5K	22K	30K	37K	45K
Inverter	Output	Rated capacity (kVA)	3.1	4.5	6.9	9.6	12.6	18.3	24.6	30.1	35.8	44.0	57.8	67.5
Inverter	Output	Rated current (A)	4.5	6.5	10.0	13.9	18.2	26.4	35.5	43.5	51.8	63.3	83.5	97.5
Inverter	Output	Overload current rating *1	150% 60 seconds, 200% 0.5 seconds (inverse-time characteristics)											
Inverter	Output	Voltage *2	Three-phase, 380V to 460V 50Hz/60Hz											
Inverter	Output	Regenerative braking torque: Maximum value/time	100%/5 seconds				20% *3							
Inverter	Output	Regenerative braking torque: Permissible duty	2%ED				Continuous *3							
Inverter	Power supply	Rated input AC voltage, frequency	Three-phase, 380V to 460V 50Hz/60Hz *5											
Inverter	Power supply	Permissible AC voltage fluctuation	Three-phase, 323V to 506V 50Hz/60Hz *6											
Inverter	Power supply	Permissible frequency fluctuation	±5%											
Inverter	Power supply	Instantaneous voltage drop immunity	Operation continues at 320V or higher. If voltage drops from rated voltage to less than 320V, operation continues for 15ms.											
Inverter	Power supply	Power supply capacity (kVA) *4	4.5	5.5	9	12	17	20	28	34	41	52	66	80
Inverter	Protective structure (JEM 1030)		Enclosed type (IP20)				Open type (IP00)							
Inverter	Cooling system		Forced air cooling											
Inverter	Approximate weight (kg)		4.5	4.5	7.5	7.7	16	16	20	20	33	54	54	72

(Note 1) The overload current rating % value indicates the percentage to the inverter's rated output current. For repeated use, it is necessary to wait until the inverter and motor return to less than the temperature under 100% load.

(Note 2) The maximum output voltage cannot be higher than the power supply voltage.
The maximum output voltage can be set as desired below the power supply voltage.

(Note 3) Indicates the average torque when the motor is decelerated to a stop from 60Hz. This will change according to the motor loss.

(Note 4) The power supply capacity will change according to the value of the power supply side impedance (including input reactor and wiring).

(Note 5) If the power supply voltage fluctuation is 342V or less or 484V or more when using the 400V class inverter, the internal transformer's tap must be changed.

1.3.2 Common Specifications

<table>
<tr><td rowspan="7">Control specifications</td><td colspan="2">Control system</td><td colspan="4">High carrier frequency PWM control, full digital vector control</td></tr>
<tr><td colspan="2">Speed control range</td><td colspan="4">1 to 1500r/min (constant torque), 1500 to 3000r/min (constant output) (when vector inverter motor is used)</td></tr>
<tr><td rowspan="2">Speed setting resolution</td><td>Digital input</td><td colspan="4">0.03% to the maximum setting (minimum setting in 1r/min increments)</td></tr>
<tr><td>Analog input</td><td colspan="4">0.1% of the maximum set speed</td></tr>
<tr><td colspan="2">Acceleration/deceleration time</td><td colspan="4">0 to 3600 seconds (acceleration and deceleration can be set individually in 0.1 s increments)</td></tr>
<tr><td colspan="2">Acceleration/deceleration pattern</td><td colspan="4">Linear or S-pattern acceleration/deceleration mode can be selected.</td></tr>
<tr><td colspan="2">Torque limit level</td><td colspan="4">Torque limit value can be set (0 to 200% variable)</td></tr>
<tr><td rowspan="9">Input signals</td><td rowspan="7">Analog setting signals</td><td rowspan="4"></td><td>Terminal number</td><td>Setting range</td><td>Speed control</td><td>Torque control</td></tr>
<tr><td>2</td><td>0 to 10VDC (resolution 0.1%)</td><td>Main speed setting</td><td>Speed limit</td></tr>
<tr><td>1</td><td>0 to ±10VDC (resolution 0.2%)</td><td>Auxiliary speed setting</td><td>Speed limit compensation</td></tr>
<tr><td>3</td><td>0 to±10VDC (resolution 0.2%)</td><td>Torque limit (regeneration/drive)</td><td>Torque command</td></tr>
<tr><td>When option FR-VPA, FR-VPB is mounted</td><td>4</td><td>0 to 10VDC (resolution 0.1%)</td><td>Torque limit (regeneration only)</td><td>—</td></tr>
<tr><td>When option FR-VPC is mounted</td><td>6</td><td>0 to ±10VDC (resolution 0.01%)</td><td>Main speed setting (At this time, terminals 1, 2 are invalid)</td><td>Torque command (At this time, terminal 3 is invalid)</td></tr>
<tr><td>When option FR-VPD is mounted</td><td>7</td><td>0 to ±10VDC (resolution 0.05%)</td><td>Main speed setting (At this time, terminals 1, 2 are invalid)</td><td>Torque command (At this time, terminal 3 is invalid)</td></tr>
<tr><td rowspan="2">Contact signals</td><td>Fixed function terminal 4 points</td><td colspan="4">Forward rotation command, reverse rotation command, alarm reset, thermal protector: total 4 points</td></tr>
<tr><td>Multi-function terminal 3 points</td><td colspan="4">3 points can be selected with parameters from among multi-speed setting (maximum 7 speeds), jog operation selection (note 1), second function selection, pre-excitation, coasting terminal, running signal holding, S-pattern switching and control mode switching.</td></tr>
<tr><td rowspan="4">Output signals</td><td colspan="2">Contact signals</td><td colspan="4">Alarm output, change-over contact (230V 0.3A AC, 30V 0.3A DC)</td></tr>
<tr><td colspan="2">Open collector signals</td><td colspan="4">3 points can be selected from among up-to-speed, overload detection, instantaneous power failure, undervoltage detection, inverter running, minor fault, torque detection, ready, low-speed signal or open motor circuit detection, speed detection and parameter unit operation signal.</td></tr>
<tr><td colspan="2">Analog output</td><td colspan="4">2 points can be selected from among speed, output current, output voltage, speed setting, output frequency, output torque, DC bus voltage and load meter.</td></tr>
<tr><td colspan="2">Digital output (PLG output)</td><td colspan="4">A-phase, B-phase, Z-phase
(when option FR-VPA, VPB, VPC (A-phase, B-phase only) is mounted)</td></tr>
<tr><td colspan="3">Operation functions</td><td colspan="4">Upper/lower limit speed setting, external protection (thermal relay) input, forward/reverse rotation prevention, auto tuning function</td></tr>
<tr><td rowspan="2">Display</td><td colspan="2">Parameter unit</td><td colspan="4">PU02V, various monitoring (11 types: alarm, input/output terminal monitoring in addition to the above analog outputs)</td></tr>
<tr><td colspan="2">LED (7-segment)</td><td colspan="4">7-segment, 4-character display (8 types of data can be selected)</td></tr>
<tr><td colspan="3">Protective functions</td><td colspan="4">Overcurrent, output short circuit protection (acceleration, deceleration, constant speed), regenerative overvoltage, undervoltage, no signal, excessive speed deviation, overload (electronic thermal overload protection), brake transistor alarm (note 2), overspeed, motor overheat, etc.</td></tr>
<tr><td rowspan="5">Environment</td><td colspan="2">Ambient temperature</td><td colspan="4">-10°C to +50°C (14°F to 122°F) (non-freezing)</td></tr>
<tr><td colspan="2">Ambient humidity</td><td colspan="4">90%RH or less (non-condensing)</td></tr>
<tr><td colspan="2">Storage temperature (note 3)</td><td colspan="4">-20°C to +65°C (4°F to 149°F)</td></tr>
<tr><td colspan="2">Ambience</td><td colspan="4">Indoors. No corrosive gases, flammable gases, oil mist, dust and dirt.</td></tr>
<tr><td colspan="2">Altitude, vibration</td><td colspan="4">Below 1000m (3280.80 feet), 5.9m/s² {0.6G} or less (conforms to JIS C 0911)</td></tr>
</table>

(Note 1) Jog operation can also be performed from the parameter unit.

(Note 2) Not provided for the FR-V220E-7.5K to 45K and FR-V240E-7.5K to 45K which do not have a built-in brake circuits.

(Note 3) Temperature applicable for a short period in transit, etc.

1.4 Specification Comparison Table

Model series		FR-V200E	
Model capacity range	200V	1.5K to 45K (12 models)	
	400V	1.5K to 45K (12 models)	
Applicable motor		Inverter motor, general-purpose motor + PLG	
Control system		High carrier frequency PWM control, full-digital vector control	
Speed range (output frequency range)		0 to 3600r/min	
Speed (frequency) setting resolution	Digital input	0.03% to the maximum setting (minimum setting in 1r/min increments)	
	Analog input	0.1% of maximum set speed	
Acceleration/deceleration time setting		0 to 3600s (acceleration time and deceleration time can be set individually) Linear or S-pattern acceleration/deceleration mode may be selected.	
Torque limit level		0 to ±10VDC (0 to 200% variable)	
0-speed holding torque		Yes	
Speed control specifications (Output frequency control specifications)	Speed control range	1:1500, (Note 3) 1:4000	
	Speed variation ratio (Load variation 0 to 100%) Analog command input	±0.01% to rated speed (for digital setting) ±0.1% (for analog setting)	
		Terminal 2: 0 to 10VDC Resolution: 0.1%	Main speed setting
		Terminal 1: 0 to 10VDC Resolution: 0.2%	Auxiliary speed setting
		Terminal 3: 0 to 10VDC Resolution: 0.2%	Torque limit (drive/regeneration)
		Terminal 4: 0 to 10VDC (Note 1, 2) Resolution: 0.1%	Torque limit (regeneration only)
		Terminal 6: 0 to 10VDC (Note 3) Resolution: 0.01%	Main speed setting (terminals 1, 2 invalid)
		Terminal 7: 0 to 10VDC (Note 4) Resolution: 0.05%	Main speed setting (terminals 1, 2 invalid)
	Contact signal input (multi-speed)	Maximum 7 speeds	
Torque control specifications	Analog command input	Terminal 2: 0 to 10VDC Resolution: 0.1%	Main speed setting
		Terminal 1: 0 to 10VDC Resolution: 0.2%	Speed limit compensation
		Terminal 3: 0 to 10VDC Resolution: 0.2%	Torque limit (drive/regeneration)
		Terminal 6: 0 to 10VDC (Note 3) Resolution: 0.01%	Main speed setting (terminals 1, 2 invalid)
		Terminal 7: 0 to 10VDC (Note 4) Resolution: 0.05%	Main speed setting (terminals 1, 2 invalid)
Position control specifications	Maximum input pulse frequency	(Note 2)	200kpps (differential receiver, open collector)
	Positioning resolution		4000 pulses per motor revolution (for SF-VR)
	Electronic gear setting		1/50 to 20
	In-position width setting		0 to 32767 pulses
	Error excessive		0 to 400000 pulses
Output signals	Operating status	Open collector output ... 3 points, (Note 1) 6 points, (Note 4) 5 points	
	Alarm (inverter trip)	Contact output ... change-over contact	
	For meter	Analog output 0 to 10V, 0 to 10V ... 1 point each	
	PLG pulse output	Open collector (Note 1, 4), differential driver (Note 2, 3)	

FR-A500	FR-A200E	MELSERVO-VA	
0.4K to 55K (15 models)	0.4K to 55K (15 models)	11K to 37K (5 models)	
0.4K to 55K (15 models)	0.4K to 55K (15 models)	No	
General-purpose motor	General-purpose motor	Inverter motor	
Soft-PWM control/high carrier frequency PWM control (V/F control or advanced magnetic flux vector control may be selected)	High carrier frequency PWM control (V/F control or magnetic flux vector control may be selected)	Sine-wave PWM control, current control system	
0.2 to 400Hz	0.2 to 400Hz	0 to 3000r/min	
0.01Hz	0.01Hz		
0.015Hz/60Hz	0.015Hz/60Hz		
0 to 3600s (acceleration time and deceleration time can be set individually), linear or S-pattern acceleration/deceleration mode may be selected.	0 to 3600s (acceleration time and deceleration time can be set individually), linear or S-pattern acceleration/deceleration mode may be selected.	0 to 50s	
No	No	0 to ±10VDC/maximum current	
No	No	Yes	
1:120, 1:1000 (Note 5) (drive)	120	11000	
±0.2% (Note 5) (drive)		-0.03% (for digital setting) ±0.2% or less (for analog setting)	
Terminal 2: 0 to 10VDC (12 bits)/0 to 5VDC (11 bits) selectable	Terminal 2: 0 to 10VDC (12 bits)/0 to 5VDC (11 bits) selectable	VC (pin 33) 0 to ±10VDC	Speed command
Terminal 1: 0 to ±10VDC (12 bits)/0 to ±5VDC (11 bits) selectable	Terminal 1: 0 to ±10VDC (12 bits)/0 to ±5VDC (11 bits) selectable	TLAP (pin 35) 0 to +10VDC	Torque limit (Forward rotation in regeneration mode, reverse rotation in drive mode)
Terminal 4: 4 to 20VDC current input	Terminal 4: 4 to 20VDC current input	TLAN (pin 38) 0 to −10VDC	Torque limit (Forward rotation in drive mode, reverse rotation in regeneration mode)
—	—	—	
Maximum 15 speeds	Maximum 15 speeds	Maximum 3 speeds	
No	No	VC (pin 33) 0 to ±10VDC	Speed command
		TLAP (pin 35) 0 to ±8VDC	Torque command
		—	
No	No	200kpps (differential receiver, open collector)	
		4000 pulses per motor revolution	
		1/50 to 20	
		0 to 9999 pulses	
		0 to 20000 pulses	
Open collector output ... 5 points	Open collector output ... 5 points	Open collector output ... 5 points	
Contact output ... change-over contact Open collector output ... alarm code (4 bits)	Contact output ... change-over contact Open collector output ... alarm code (4 bits)	Contact output ... change-over contact	
Pulse train output (1440 pulses/second/full-scale) ... 1 point Analog output 0 to 10V ... 1 point	Pulse train output (1440 pulses/second/full-scale) ... 1 point Analog output 0 to 10V ... 1 point	Analog output 0 to 10V, 0 to ±10V ... 1 point each	
No	No	Open collector	

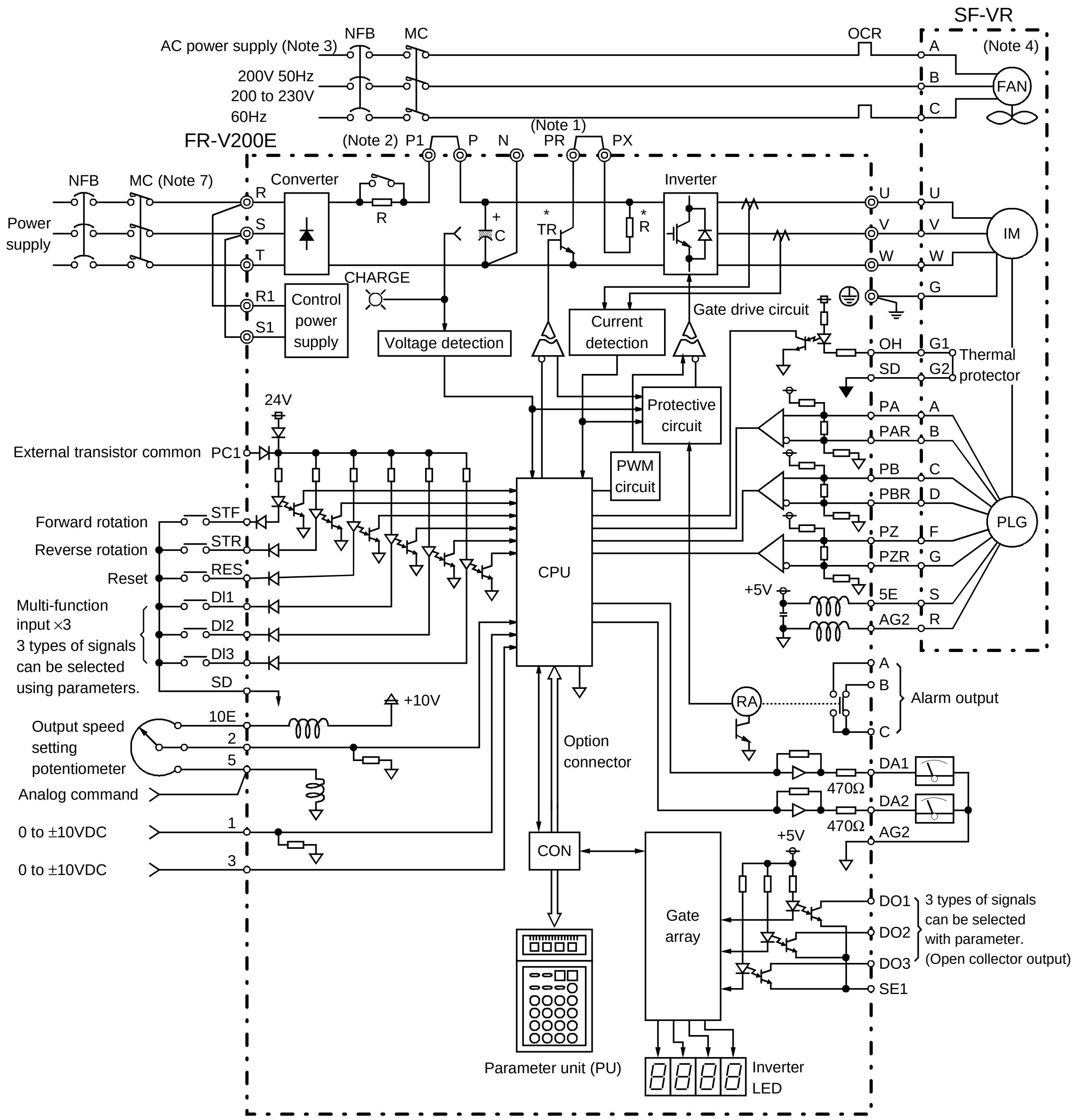
Model series		FR-V200E
Protective/alarm functions		Overcurrent, output short circuit, overvoltage, undervoltage, instantaneous power failure, main circuit device overheat, thermal relay operation, brake transistor alarm, overspeed occurrence, speed deviation large, parameter alarm, option alarm, CPU alarm, PLG no-signal, stall prevention, overload alarm, position error large, orientation PLG no-signal
Display/operation	Parameter unit	Interactive intelligent, ten-key pad direct setting liquid crystal monitor
	Inverter	4-digit LED

(Note 1) When the FR-VPA inboard option is mounted
(Note 2) When the FR-VPB inboard option is mounted
(Note 3) When the FR-VPC inboard option is mounted
(Note 4) When the FR-VPD inboard option is mounted
(Note 5) When the PLG and FR-A5AP inboard option are mounted

FR-A500	FR-A200E	MELSERVO-VA
Overcurrent, ground fault detection, output short circuit, overvoltage, undervoltage, instantaneous power failure, overload shut-off, main circuit device overheat, brake transistor alarm, external thermal relay operation, stall prevention, overload alarm, brake resistor overheat, fin overheat, fan failure, option alarm, parameter error, PU disconnection, retry count excess, output open-phase, CPU error, 24VDC power output short circuit, operation panel power supply short circuit, brake sequence error	Overcurrent, ground fault detection, output short circuit, overvoltage, undervoltage, instantaneous power failure, overload shut-off, main circuit device overheat, brake transistor alarm, external thermal relay operation, stall prevention, overload alarm, brake resistor overheat, option alarm, parameter error, PU disconnection, retry count excess, CPU error	CPU error, undervoltage, memory alarm, clock alarm, watchdog, card alarm, detector no-signal, main circuit alarm, overspeed, overcurrent, overvoltage, parameter error, heat sink overheat, motor overheat, overload, error excessive, emergency stop
Interactive intelligent, ten-key pad direct setting liquid crystal monitor (with backlight)	Interactive intelligent, ten-key pad direct setting liquid crystal monitor	No
Operation panel equipped as standard, 4-digit LED	4-digit LED	6-digit LED

1.5.1 Internal block diagram

(1) FR-V200E



(Note 1) Terminals PR and PX are provided for the 5.5K or less inverters. When using the FR-ABR, remove this jumper.

(Note 2) Terminal P1 is provided for the 3.7K or more inverters. When using the FR-BEL, remove this jumper.

(Note 3) The cooling fan power supply is single-phase for the 5.5kW and 7.5kW.

(Note 4) Connect the cooling fan power cables in correct phase sequence.

(Note 5) The built-in brake resistor and brake transistor marked * are not provided for the 7.5K or more inverters.

(Note 6) The inverter and motor must be grounded.

(Note 7) Avoid frequent power on-off because repeated inrush currents at power-on will shorten the converter life.

1.5.2 Description of I/O terminal specifications

	Terminal Symbol	Terminal Name	Rating, etc.	Description	Refer to Section
Main circuit, power circuit	R, S, T (L_1, L_2, L_3)	AC power input terminals	3-phase, 200 to 220V 50Hz 200 to 230V 60Hz 3-phase, 380 to 460V 50/60Hz	Connect to a commercial power supply.	1.6.1
	U, V, W	Inverter output terminals	————	Connect a vector control inverter motor or general-purpose motor with PLG. Output voltage does not exceed input voltage.	——
	P, PR (+, PR)	Brake resistor connection terminals	————	Remove the jumper from across terminals PR-PX and connect the optional brake resistor (FR-ABR) across terminals P-PR (+ – PR).	——
	P, N (+, –)	Brake unit connection terminals	————	Connect the optional brake unit or power return converter (FR-RC).	——
	PR, PX (Note 1)	Built-in brake circuit connection terminals	————	When terminals PX-PR are connected by a jumper (factory-connected), the built-in brake circuit is valid.	——
	P, P1 (+, P1)	Power factor improving DC reactor connection terminals	————	When using the optional power factor improving DC reactor (FR-BEL), remove the jumper from across terminals P1-P (P1 – +) and connect the reactor. A DC reactor cannot be connected to the 2.2K or less as it is not provided with terminal P1.	——
	R1, S1 (L_{21}, L_{22})	Control circuit power supply terminals	Same rating as that of AC power input terminals R, S, T (L_1, L_2, L_3) Capacity consumption 60VA	Connected with power input terminals R (L_1) and S (L_2) by jumpers. If the inverter power is off, the alarm display or alarm output signal can be held by supplying power from the other system. In this case, these jumpers must be removed.	1.6.3
	⏚	Earth terminal	————	Always earth this terminal.	——
Control circuit (input signals)	STF	Forward rotation start input signal terminal	Input resistance 4.7kΩ Voltage 21 to 27VDC when open 4 to 6mADC when shorted Photocoupler isolated Controllable by open collector output or no-voltage contact signal	Short STF-SD to provide a forward rotation command and open them to stop. Short STR-SD to provide a reverse rotation command and open them to stop. Short STF-SD and STR-SD at the same time to provide a stop command. During operation, this causes deceleration to a stop.	1.6.2
	STR	Reverse rotation start input signal terminal			
	DI1 DI2 DI3	Digital input 1, 2, 3 terminals	Input resistance 4.7kΩ Voltage 21 to 27VDC when open 4 to 6mADC when shorted Photocoupler isolated Controllable by open collector output or no-voltage contact signal	Selectively enter 3 different signals from among RH (high speed), RM (middle speed), RL (low speed), JOG (jog operation), RT (second function selection), MRS (output stop), STOP (start self-holding selection), LX (pre-excitation), MC (control mode change-over) and TL (torque control selection). Use Pr. 17 to choose the input signals.	1.6.6
	OH	Thermal protector input terminal	Input resistance 1kΩ Voltage 21 to 27VDC when open 21 to 26mADC when shorted Photocoupler isolated	Connect the thermal protector contact across OH-SD. When the thermal protector is activated, the inverter is stopped and kept stopped and alarm output is provided. If the thermal protector contact resets automatically, the inverter will not restart. Short terminals RES-SD to reset the inverter or make a power-on reset.	1.6.11

(Note 1) Terminals PR and PX are provided for the FR-V220E-5.5K or less and FR-V240-5.5K or less.

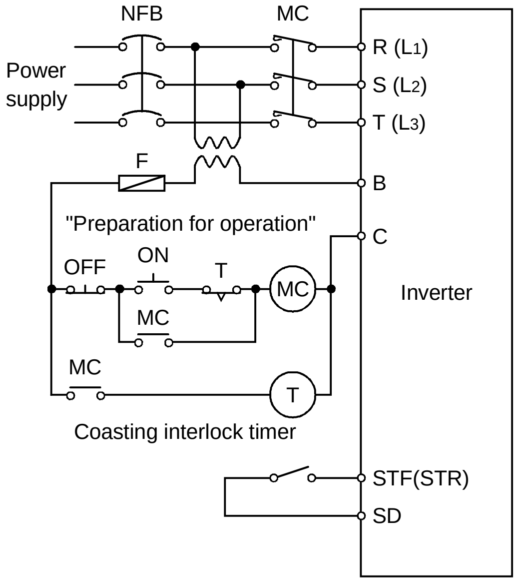
	Terminal Symbol	Terminal Name	Rating, etc.	Description	Refer to Section
Control circuit (input signals)	RES	Reset terminal	Input resistance 4.7kΩ Voltage 21 to 27VDC when open 4 to 6mADC when shorted Photocoupler isolated Controllable by open collector output or no-voltage contact signal	Designed to reset the inverter stopped by the protective circuit operated when an alarm occurs. Immediately sets each portion of the control circuit to the initial state and shuts off the inverter output at the same time. To provide this reset input, short terminals RES-SD 0.1 second or longer, then open them. Note that the initial reset at power-on is made automatically in the inverter, requiring 0.1 to 0.2 seconds after power-on. During reset, the inverter does not provide output.	1.6.7
	PC1	External transistor (+) common terminal	Power supply voltage range 22 to 26VDC Current consumption 100mA	When inputting the transistor output (open collector) having an external power supply, e.g. a programmable controller (PC), to the inverter, connect the positive common of the external power supply to prevent a malfunction due to leakage current.	1.6.8
	SD	Contact input common terminal	————	Common terminal for the contact input signals and frequency meter. Isolated from the CPU common of the control circuit.	1.6.13
	10E	Setting power supply terminals	10V±0.4VDC Permissible load current 10mA	Used as a power supply when a speed setting (torque setting) potentiometer is connected externally. (Terminal 5 is a common)	1.6.4
	2	Speed setting terminal	Input resistance 10±1kΩ Maximum permissible voltage 20VDC	Enter 0 to 10VDC to provide the maximum speed at 5V, making I/O proportional.	1.6.4
	3	Torque setting terminal	Input resistance 10±1kΩ Maximum permissible voltage 20VDC	Enter 0 to ±10VDC to provide a torque setting signal in the torque control mode or a torque limit signal in the speed or position control mode.	1.6.5
	1	Speed setting auxiliary input terminal	Input resistance 10±1kΩ Maximum permissible voltage 20VDC	Entering 0 to ±10VDC adds this signal to the setting signal of terminal 2.	1.6.4
	5	Analog input common terminal	————	Common terminal for the analog setting signals (terminal 1, 2, 3). Not isolated from the CPU common of the control circuit. Do not earth this terminal.	1.6.4
	PA	A-phase signal input terminal	Differential line receiver Equivalent to Am26LS32	The A-, B- and C-phase signals are input from the PLG.	——
	PAR	A-phase inverse signal input terminal			
	PB	B-phase signal input terminal			
	PBR	B-phase inverse signal input terminal			
	PZ	Z-phase signal input terminal			
	PZR	Z-phase inverse signal input terminal			
	5E	PLG power supply terminal (+ side)	5V±0.2VDC Permissible load current 350mA	5V power supply for PLG.	——
	AG2	Power supply ground terminal	————	Common terminal for PLG power supply. Not isolated from the CPU common of the control circuit. Do not earth this terminal.	——

	Terminal Symbol	Terminal Name	Rating, etc.	Description	Refer to Section
Control circuit (output signals)	B-C A-C	Alarm output terminals	Contact output Contact capacity 230VAC 0.3A (Cos∅ = 0.4) 30VDC 0.3A	This contact output indicates that the protective function of the inverter is activated and the inverter output shut off. In a normal status, terminals B-C are closed and A-C are open. When an alarm occurs, the internal relay operates to open terminals B-C and close A-C. When this signal is output, the motor coasts.	1.6.9
	DO1 DO2 DO3	Digital output 1, 2, 3 terminals	Open collector output Permissible load 24VDC 0.1A	Three different signals are output from among; ER (minor fault output), SU (up to speed), LS (low speed output), FU (speed detection), RUN (running), OL (overload), IPF/UVT (instantaneous power failure/undervoltage occurrence), PU (parameter operation mode or zero current detection), TU (torque detection) and RY (ready).	1.6.10
	SE1	Open collector output common terminal	————	Common for the digital (open collector) outputs DO1, DO2 and DO3. Isolated from the CPU common of the control circuit.	1.6.13
	DA1	Analog signal output	0 to ±10VDC Permissible load current 1mA Resolution 12 bits	One selected from nine different monitoring items, such as speed, is output. The output signal is proportional to the magnitude of each monitoring item.	1.6.12
	DA2	Analog signal output	0 to ±10VDC Permissible load current 1mA Resolution 8 bits		
	AG1	Analog signal output common	————	Common terminal for DA1 and DA2. Not isolated from the CPU common of the control circuit. Do not earth this terminal.	1.6.13

1.6 How to Use the External Terminals

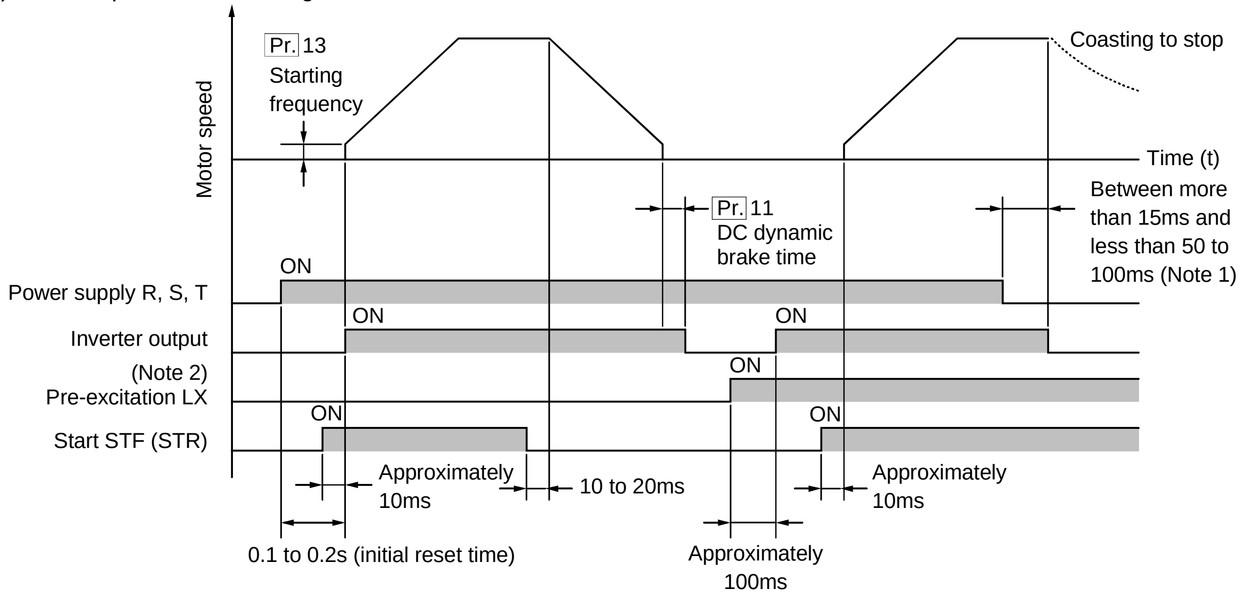
1.6.1 Switching the Inverter Power On/Off (Terminals R, S, T)

(1) No-fuse breaker and magnetic contactor on the inverter power supply side



- Use the specified no-fuse breaker with the power supply to protect wiring to the inverter. A no-fuse breaker of greater capacity may be required as compared to commercial power operation because of the low power factor of the power supply resulting from the distorted input current.
- To ensure safety at alarm occurrence, it is recommended to install a magnetic contactor on the power supply side of the inverter. Also, to prevent an accident etc. due to an automatic restart at the time of power restoration after a power failure, make up a circuit as shown on the right.
  When installing the magnetic contactor, make up the circuit as shown on the right and start and stop the motor by switching on-off the signal across terminals STF-SD or STR-SD.
- To protect the converter from repeated inrush current generated at power-on, the magnetic contactor in the inverter power supply side must not be used frequently to start and stop the motor with terminal STF or STR kept ON.
- Start and stop the motor by switching on/off the signal across the inverter terminals STF or STR and SD. If the MC is used to stop the motor, the motor coasts to a stop because regenerative braking inherent in the inverter is not applied. If the MC is used to start the motor during coasting when, for example, load GD^2 is extremely large, the protective circuit (overvoltage E.OV1 to E.OV3) may be activated to shut off the inverter output. When performing jog operation, the MC must not be used to start and stop the motor. Otherwise, slow response will result because of a start delay due to the initial reset time (approximately 0.2 seconds) after power on.

(2) Inverter power on/off timing chart

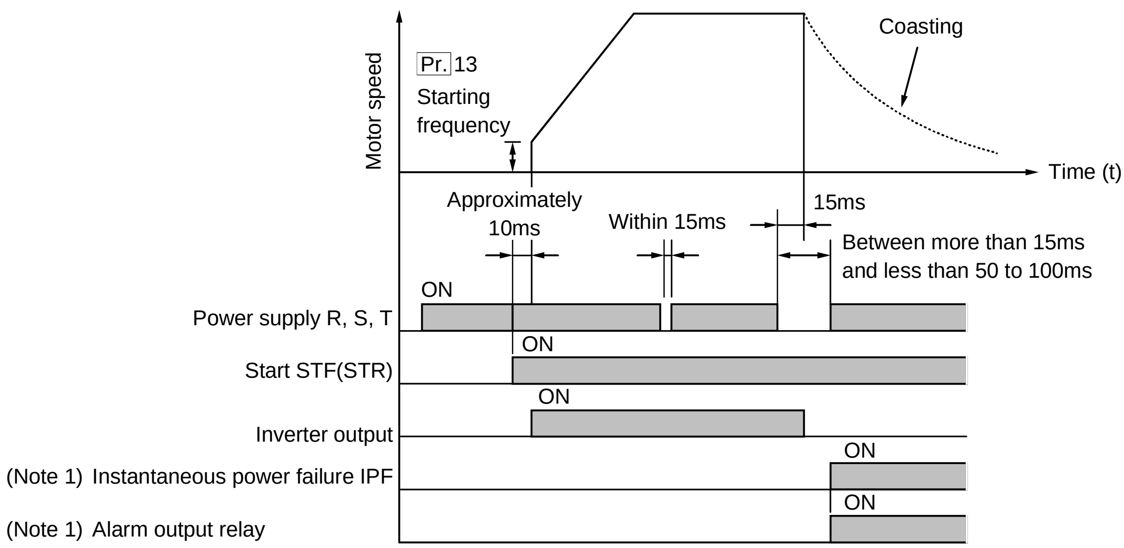


Power On/Off Timing Chart

(Note 1) The inverter output is shut off immediately (between more than 15ms and less than 50 to 100ms) after the power is switched off. 50 to 100ms after the power is switched off, the protective circuit is automatically reset by switching the power on again.

(Note 2) Using input terminal assignment, Pr. 17, allocate this signal to any of terminals DI1 to DI3.

(3) Inverter instantaneous power failure timing chart



Instantaneous Power Failure Timing Chart

(Note 1) Activated when the power is restored within 15 to 100ms. Note that when 0 or any of 0.1 to 5 is set in Pr. 61, restart coasting time, the function of automatic restart after instantaneous power failure is activated and the alarm output signal is not switched on.

(Note 2) An instantaneous power failure of 50 to 100ms or longer is identical to a long-time power failure (above pattern). If the start signal is on, the inverter is restarted when the power is restored.

1.6.2 Run and Stop (Terminals STF, STR, STOP)

(*Set terminal STOP by using Pr. 17, input terminal assignment.)

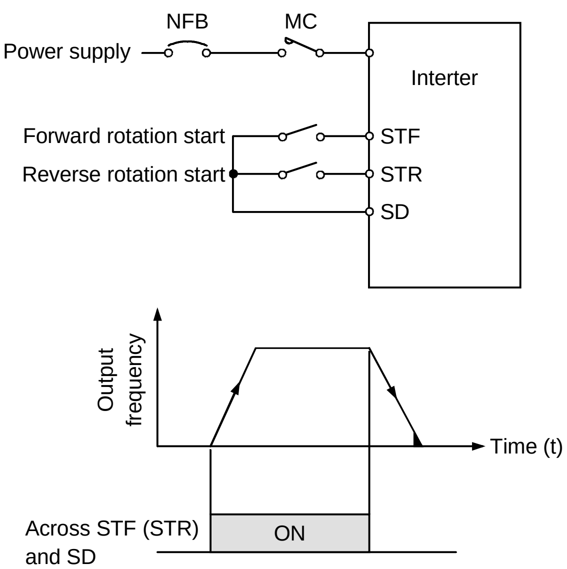
To start and stop the motor, first switch on the input power supply of the FR-V200E series inverter (switch on the magnetic contactor in the input circuit during preparation for operation), then start the motor by the forward or reverse rotation start signal.

- The FR-V200E series inverter starts running when the speed setting signal reaches or exceeds the starting speed set in Pr. 13 (factory setting 15r/min) after the start signal is input.
  When the minimum speed Pr. 2 (factory setting 0r/min) value is set to 60r/min, for example, merely entering the start signal operates the inverter to reach the minimum speed of 60r/min according to the acceleration time set in Pr. 7.
- To stop the inverter, apply the DC dynamic brake at no higher than the DC dynamic brake operation speed for the DC dynamic brake operation time set in Pr. 11 (factory setting 0.5s). To deactivate the DC dynamic brake function, set 0 in Pr. 11, DC dynamic brake operation time.

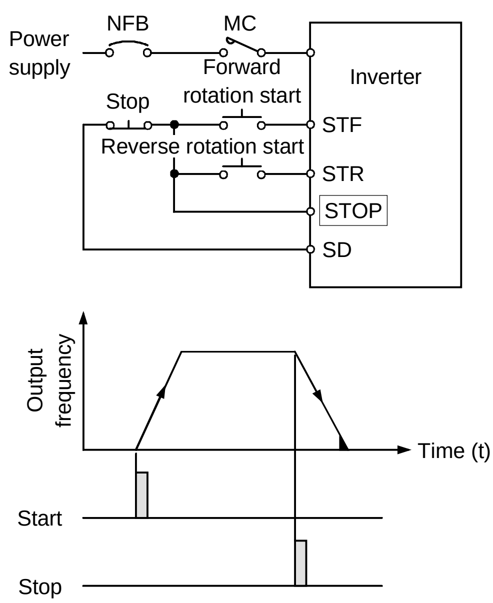
(1) Two-wire type connection (Terminals STF, STR)
A two-wire type connection is shown on the left below.
1) The forward/reverse rotation signal is used as both the start and stop signals. Switch on either of the forward and reverse signals to start the motor in the corresponding direction. Switch on both or switch off the start signal during operation to decelerate the inverter to a stop.
2) The speed setting signal may either be given by entering 0 to 10VDC across speed setting input terminal 2-5 or by three-speed setting (high, middle, low speeds (set by terminal assignment)).

(2) Three-wire type connection (Terminals STF, STR, STOP)
A Three-wire type connection is shown on the right below.

- Connect terminals STOP and SD to enable the start self-holding function. In this case, the forward/reverse rotation signal functions only as a start signal.
- If the start signal terminal STF (STR) and SD are once connected and then disconnected, the start signal is kept on. Either of the forward and reverse rotation signals switched on first is made valid and starts the inverter in the corresponding direction.
- If the reverse rotation signal is input during forward rotation or the forward rotation signal is input during reverse rotation, the inverter is switched to the opposite output polarity without going through the stop mode.
- The inverter is decelerated to a stop by opening terminals STOP-SD once. For the output speed setting signal and the operation of the DC dynamic brake at the stop time, refer to the previous paragraphs.
- When terminals JOG/OH and SD are connected, the signal of terminal STOP is invalid and jog operation has precedence.
- When output stop terminal MRS and SD are connected, the self-holding function is reset.



Two-Wire Type Connection Example



Three-Wire Type Connection Example

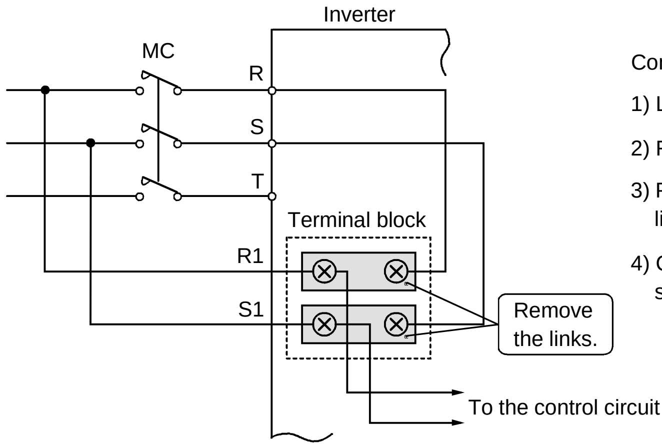
1.6.3 Connecting External Power Supply to the Control Circuit (Terminals R1, S1)

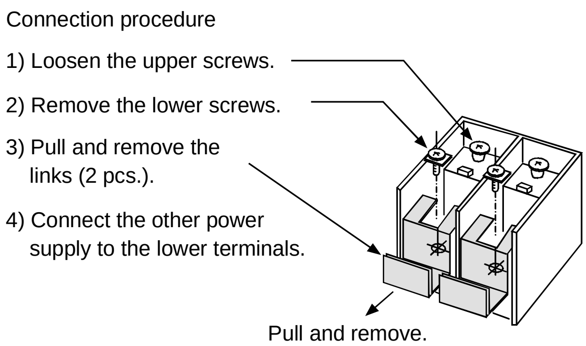
If any of the protective functions (other than the torque limit function) is activated, the alarm indicator lamp is lit and the corresponding alarm signal is output. If the magnetic contactor etc. in the inverter power supply is opened by the alarm signal at this time, the control power is lost and the alarm output cannot be kept on. To keep this alarm output on, use the other power supply with the control circuit (power supply with the same voltage as the one used with the main circuit).

Connection

The other power supply connection terminal block on the printed circuit board is a two-step type terminal block and links are connected across the upper and lower terminals before shipment from the factory. After loosening (or removing) the screws and removing the links as shown in the following figure, connect an external power supply to the lower terminals.

(Note) The other power supply must be connected to the lower terminals. If the other power supply is connected to the upper terminals, the inverter will be damaged.





Terminal block for use with other power supply

Using Terminals R1 and S1

(1) The control power supply (terminals R1, S1) should not be switched off when the main circuit power supply (terminals R, S, T) is on.
When the main circuit power supply is on, a DC voltage exists in the converter output area and the voltage is being applied to the transistors. If a signal enters the transistor gate circuit due to noise etc., the transistors conduct and the terminals P and N are connected, which may damage the transistor modules. When the control power supply is on, an inverse bias voltage is applied to the gate circuit to prevent the transistors from conducting.
The circuit should be made up so that the main circuit power supply terminals R, S and T are always off when the control power supply terminals R1 and S1 are off.

(2) If the primary MC is switched off (for more than 0.1 second), then on, the inverter is reset. Hence, this method may be used to perform alarm-on reset.

(3) If the primary MC is switched off once (for more than 0.1 second), then on during inverter output (operation), the inverter is initial-reset and the motor is restarted in the coasting state.
If the MC is switched off, the undervoltage (E. UVT) protection is not activated.
(Note) The undervoltage protection may be activated when a capacitor (noise filter) is being connected to the terminals R, S and T.

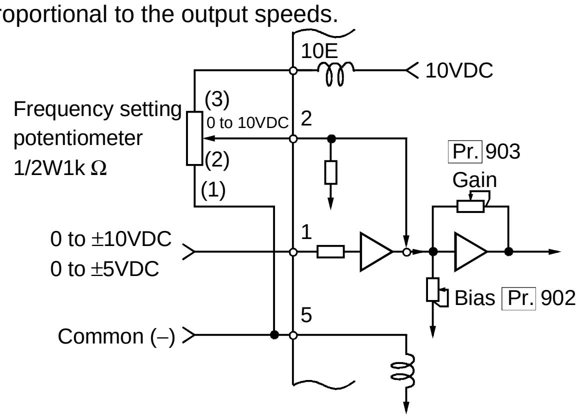
(4) If the primary MC is switched off, the alarm output signal is not switched on. When the MC is off, the parameter unit (FR-PU02V) can be operated. (The motor cannot be run.)

(5) Capacity (VA) of the other power supply
The capacity of the other power supply supplied to R1 and S1 is 60VA or more.
Inrush current of approximately 40A flows (1.3ms).

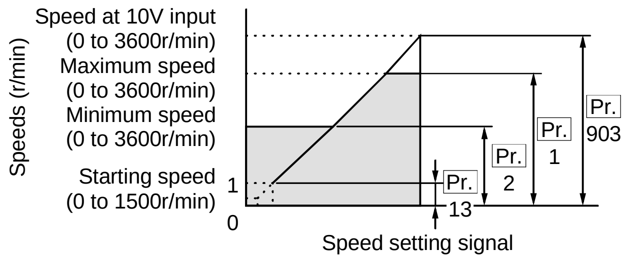
1.6.4 Relationships between speed setting input signals and output speeds (Terminals 10E, 2, 5, 1)

For the relationships between the speed setting input voltages and output speeds, refer to the diagram on the right below. The speed setting input signals are proportional to the output speeds.

Note that when the input signal is less than the start setting or minimum setting, the output speed of the inverter is 0r/min. If the input signal of 10VDC or higher is entered, the maximum output speed is not exceeded.



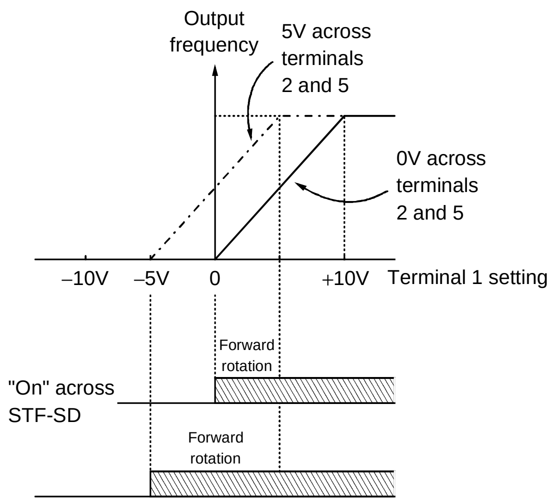
Analog Block Diagram



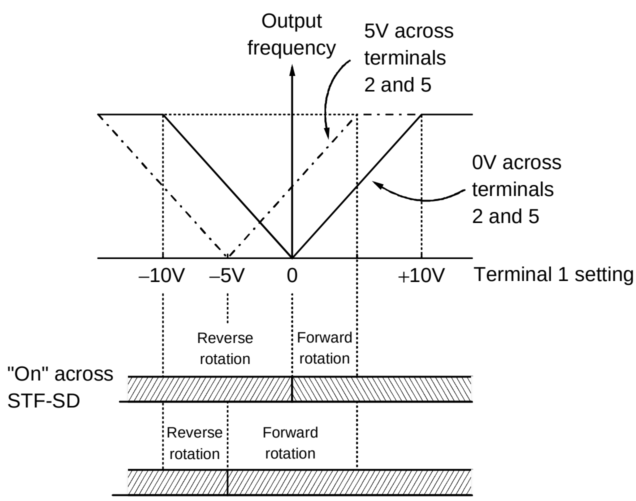
Relationships between Speed Setting Inputs and Outputs Speeds

(1) Speed setting input (terminals 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.

(2) Auxiliary input (terminal 1)
A compensation signal (0 to ±10VDC) may be entered across terminals 1-5. This compensates (synchronously) the speed setting signal which is entered across terminals 2-5.
- The function of terminal 1 depends on the setting of Pr. 73, frequency command voltage range selection, as follows:
  1) Pr. 73 setting = 0 (factory setting 0)
  The voltage across terminals 1-5 is added to the voltage signal (positive) across terminals 2-5. A negative addition result is regarded as 0 and brings the inverter to a stop. (Refer to following diagrams and table.)
  2) Pr. 73 setting = 1
  The polarity reversible operation function is selected.
  The voltage across terminals 1-5 is added to the voltage signal (positive) across terminals 2-5. A positive addition result starts forward rotation (if terminal STF is on) and a negative result starts reverse rotation (STF on).
  The compensation signal of terminal 1 may also be added to the multispeed setting.



(a) Pr. 73 setting = 0



(b) Pr. 73 setting = 1

(3) Multi-speed input compensation
Setting "1" in Pr. 28, multi-speed input compensation selection, (factory setting = 0) adds the voltage of auxiliary input terminal 1 to the multi-speed operation settings.

(4) Override
For the above auxiliary input, a fixed compensation value is applied to each speed.
The override function allows each speed to be easily changed at a constant rate.
Set "3" in Pr. 73 to use the override function. The override allows the multiple speeds set in the parameters or analog input across terminals 1-5 to be changed at a constant rate between 50% and 150% according to the external analog signal input to across terminals 2-5.

Finding each speed (frequency (f))

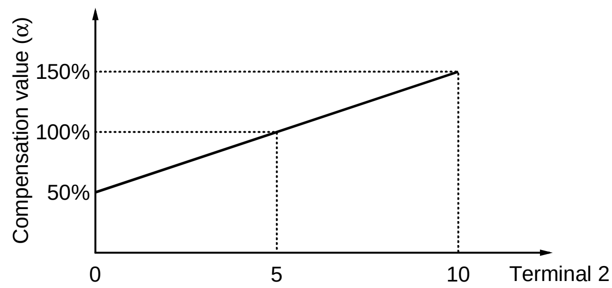
$N = N_{Pr.} \times \frac{\alpha}{100}$ [r/min] Multiple speeds
Analog input across terminals 1-5

$N_{Pr.}$: Speed Setting [r/min]

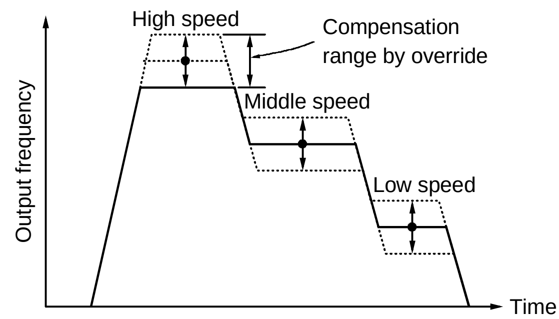
α: override compensation value (%)
(analog signal input to across terminals 2-5)

Inverter Output According to Start Signal and Auxiliary Input Terminal Polarity

Pr. 73 Setting	Command Voltage	Start Signal Input	
		STF-SD	STR-SD
0	+	Forward rotation	Reverse rotation
	–	Stop	Stop
1	+	Forward rotation	Reverse rotation
	–	Reverse rotation	Forward rotation



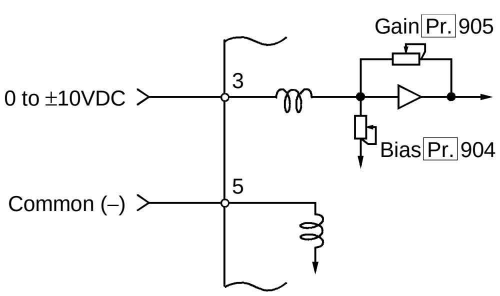
Override Setting Signal and Compensation value



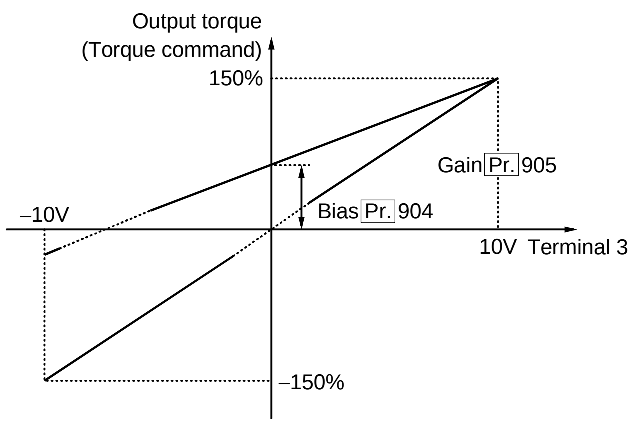
Override operation for Multiple Speeds

1.6.5 Torque setting input signal and motor-generated torque (Terminals 3, 5)

For the relationship between the torque setting input voltage and output voltage, refer to the diagram on the right below. The torque setting input signal is proportional to the output torque. Note that when the motor-generated torque varies with the motor temperature. The guidelines for the output torque accuracy relative to the torque setting input are the torque accuracy of ±5% (at 75°C) and temperature drift of 0.5%/°C when the SF-VR(H) vector control inverter motor is used.



Analog Input Block Diagram



Relationship between Torque Setting Input and Output Torque

1.6.6 Input signals (Terminals DI1 to DI3)

Pr. 17 "input terminal assignment"

- Any of 10 functions can be assigned to the DI1, DI2 and DI3 input terminals.

Pr. 17: First digit Second digit Third digit Example: Pr. 17 = ␣ 1 2 (factory setting)
Terminal: DI1 DI2 DI3 DI1 = RH
DI2 = RM
DI3 = RL

Setting	Symbol	Name	Function
0	RH	Multi-speed setting 1	Speed set in Pr. 4
1	RM	Multi-speed setting 2	Speed set in Pr. 5
2	RL	Multi-speed setting 3	Speed set in Pr. 6
3	JOG	Jog operation	Speed set in Pr. 15, acceleration/deceleration time in Pr. 16
4	RT	Second function switching	Second function selected
5	MRS	Coasting terminal	MRS and SD is switched on to shut-off output.
6	STOP	Operation signal holding	Used with STF/STR to enable 3-wire speed command.
7	LX	Pre-excitation	LX and SD is switched on to provide pre-excitation: 0 speed control or servo lock at a stop (according to Setting in Pr. 62).
8	MC	Control mode switching	Control mode is switched between speed, torque and position (according to Setting in Pr. 14).
9	TL	Torque restriction selection	Torque restriction value can be changed with Pr. 38.

(Note 1) Even if the Setting is "0" in the first digit of the three digits, it will not be displayed. However, if "0" is set in only the first digit, it will indicate the Setting "000".

(Note 2) If “1” is set in any digit of Pr. 46 "second multi-function input selection", the multi-function input terminal corresponding to that digit functions as an S-pattern switching terminal and the setting in the same digit of Pr. 17 is ignored.

(Note 3) When "3" or "4" is set in Pr. 30 "regenerative brake duty change selection/high power factor converter connection selection", the function of terminal DI2 set in Pr. 17 "input terminal assignment" is made invalid and terminal DI2 acts as the "output shut-off signal input terminal".

(Note 4) When "4" is set in Pr. 30 "regenerative brake duty change selection/high power factor converter connection selection", the function of terminal DI3 set in Pr. 17 "input terminal assignment" is made invalid and terminal DI3 serves as the terminal to accept the IPF signal (instantaneous power failure detection signal) from the high power factor converter (FR-HC).

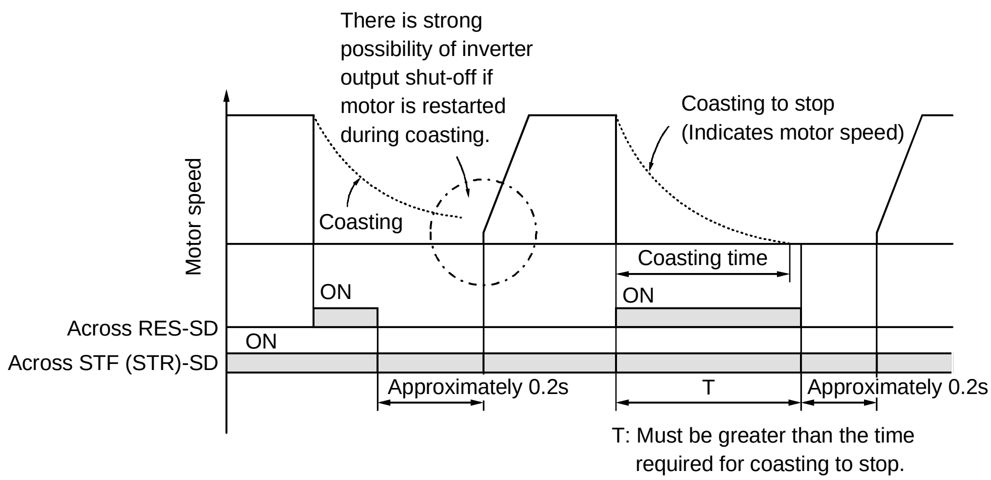
1.6.7 Reset Signal (Terminal RES)

Used to reset the alarm stop state established by the protective function of the inverter activated. The reset signal immediately sets the control circuit to the initial (cold) state, e.g. initializes the electronic thermal relay and built-in brake resistor overheat protection circuit. It shuts off the inverter output at the same time. During reset, the inverter output is kept shut off. To give this reset input, connect terminals RES and SD for more than 0.1 second. When the connection time is long, the PU displays the initial screen, which is not a fault.

Operation is enabled within 0.2 seconds after the terminals RES and SD are disconnected.

The reset terminal is used to reset the inverter alarm stop state. If the reset terminal is connected, then disconnected while the inverter is operating, the motor may be restarted during coasting (refer to the following timing chart) and the output may be shut off by overvoltage.

Note that frequent resetting will make the electronic thermal relay and brake resistor overheat protection invalid.

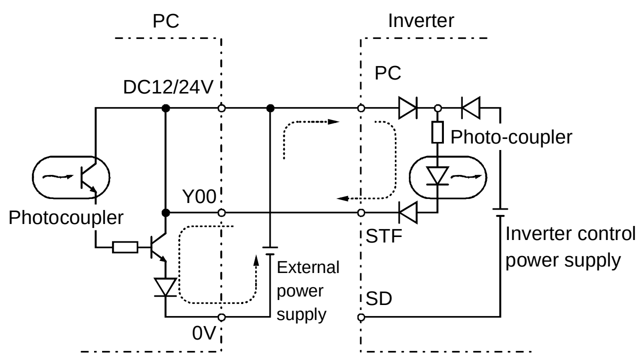


Reset Input Timing Chart During Normal Operation

1.6.8 External Transistor Common (Terminal PC)

When the transistor output (open collector) of a programmable controller (PC) having an external power supply is input to the inverter, supply external interface power to prevent a fault from occurring due to leakage currents as shown below.

By connecting as shown in the right figure, the external power is supplied to the photocoupler in the inverter as indicated by the dotted lines. Since terminal SD is not connected, no power is supplied to the photocoupler from the control power supply of the inverter.



Terminal PC Connection Example

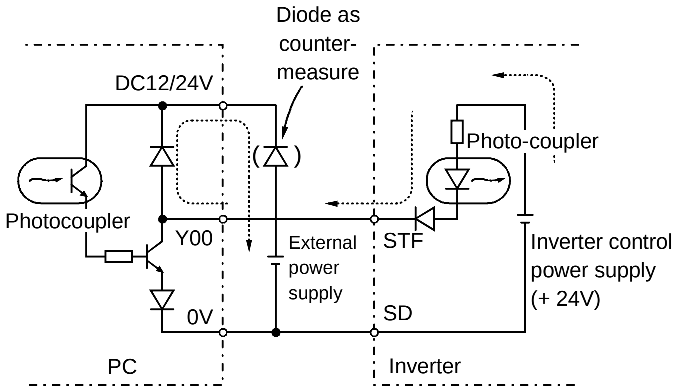
When terminal PC is not used

When the control power supply voltage in the inverter connected with the output module (open collector output) of the programmable controller has become higher than the external power supply voltage of the programmable controller as shown below, current indicated by the dotted lines flows if the transistor of the PC is not on, accidentally giving the inverter a command signal.

- Countermeasures

(1) Insert a diode to prevent leakage current.

(2) Use an all point independent type output module (such as the AY40A).

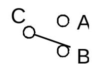
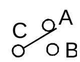


Connection Example Without Terminal PC Being Connected

1.6.9 Alarm Output (Terminals A, B, C)

For alarm output, a changeover contact is used and its operation is shown in the right table.
When any of the protective functions has been activated, the ALARM lamp is lit and remains lit. If the contact is opened by the magnetic contactor etc. in the inverter power supply, the inverter control power is lost and the alarm output signal cannot be kept on. To keep the alarm output signal on, the alarm output contact (across terminals B and C) must be kept open by the external circuit.
In this case, the alarm output signal may be kept on by connecting the control circuit with the other power supply using terminals R1 and S1.
If the current limit function, stall prevention or brake discharge resistor overheat protection is activated, the alarm output is not switched on, the contact across terminals B and C remains closed, and the ALARM lamp is not lit. When the protective functions have been activated, up to eight most recent alarm codes can be read in the monitoring mode of the parameter unit.

Alarm Relay Operation and Lamp On/Off

Status	Contact Operation	ALARM Lamp	Terminals
Normal or inverter power off	The relay coil is kept de-energized and the N/C (normally closed) contact closed.	Off	
Alarm	When any of the following protective functions is activated, the relay coil is energized, the N/C contact is opened, and the N/O (normally open) contact closed. Overcurrent shut-off (OC1 to OC3) Regenerative overvoltage shut-off (OV1 to OC3) Overload shut-off (electronic thermal relay) (THM, THT) Instantaneous power failure protection (IPF) Brake transistor alarm detection (BE) Alarm stop due to stall (OLT) Parameter error (PE) Undervoltage protection (UVT) External thermal relay operation (OHT) Inboard option connection fault (OPT) CPU error (CPU) Overspeed occurrence (OS) Speed deviation large (OSD) Encoder no-signal (ECT) Position error large (OD) Encoder A no-signal (ECA)	On	

1.6.10 Output signals (Terminals DO1 to DO3)

Any of 10 functions can be reassigned to the DO1, DO2 and DO3 output terminals.
Set a 3-digit integer in Pr. 40. The value of each digit indicates the function of the corresponding terminal.

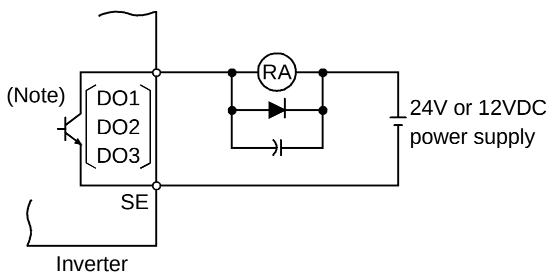
Pr. 40: First digit Second digit Third digit (Factory setting: 12)

Terminal: DO1 DO2 DO3

(E.g.) When Pr. 40 "output terminal assignment" is 562
Terminal DO1: OL (overload alarm) signal
Terminal DO2: IPF/UVT (instantaneous power failure/undervoltage alarm) signal
Terminal DO3: LS (low-speed output)

Note: Even if the setting value "0" is set in the first digit of the three digits, it will not be displayed. However, if "0" is set in only one digit, it will indicate the setting value "000".

No.	Symbol	Function Name	Operation
0	ER	Alarm output	When an alarm defined in Pr. 76 "alarm definition" occurs, state = ON.
1	SU	Up to speed	When the output speed is within the range set in Pr. 41, state = ON. OFF during deceleration
2	LS	Low-speed output	When the output speed is less than the value set in Pr. 43, state = ON.
3	FU	Speed detection	When the output speed is greater than the value set in Pr. 42, state = ON.
4	RUN	Inverter running	When forward run or reverse run signal is ON, state = ON. Note that this turns OFF during pre-excitation.
5	OL	Overload	When torque or speed restriction is activated, state = ON.
6	IPF/UVT	Instantaneous power failure/undervoltage	When instantaneous power failure or under voltage alarm occurs, state = ON.
7	PU	PU oeration	When PU OP is selected, state = ON. (Changes into open motor circuit detection signal by Pr. 68 setting.)
8	TU	Torque detection	When output torque is greater than the value set in Pr. 39, state = ON.
9	RY	Ready	When pre-excitation is completed, state = ON. When pre-excitation is not executed, state = ON at output start.



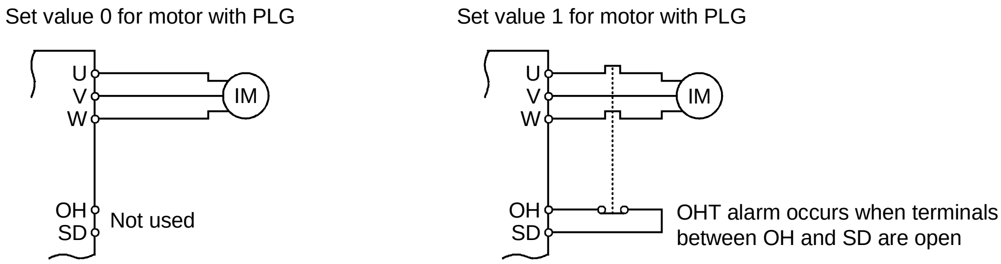
Output Terminal Connection Example

Note: The inverter will be damaged by voltage application in the incorrect direction. Also avoid incorrect wiring such as the diode connection orientation. The permissible load is 24VDC 0.1A.

1.6.11 Thermal protector input (Terminal OH)

When a motor with PLG is used, a contact signal such as a thermal relay can be input to terminal OH to protect the motor.

Pr. 23 Setting	Motor	
	Vector inverter motor (SF-VR)	Motor with PLG (SF-JR, etc.)
0 (factory setting)	No relation	Thermal relay etc. not used.
1	No relation	Thermal relay etc. used.



Connection Example

Note: To distinguish between vector inverter motor and a motor with PLG, see the setting of Pr. 99 ″motor constant selection.″

1.6.12 Analog output adjustment (Terminals DA1, DA2)

- A full-scale ±10VDC analog signal can be output from across terminals DA1-5, and a full-scale 10VDC analog signal from across DA2-5.
- Use Pr. 54 to Pr. 58 to choose the DA1 and DA2 functions.
- The analog output level can be calibrated from the PU. Pr. 900, Pr. 901 can be used for calibration.
- Since terminals DA1 and DA2 are not isolated from the control circuit of the inverter, use shielded cables which are shorter than 30m.

1.6.13 Control circuit common terminals (Terminals SD, 5, SE1, AG1, AG2)

Terminals SD, 5, SE1, AG1 and AG2 are all common terminals (0V) for I/O signals. Do not earth these terminals.

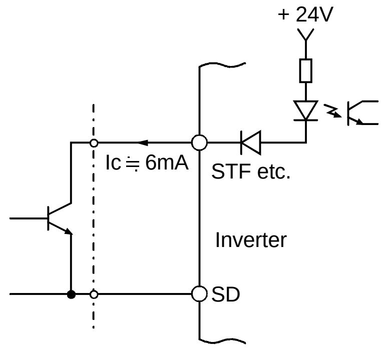
Terminal SD	Common terminal for the contact input terminals (STF, STR, DI1, DI2, DI3, OH, RES). It is photocoupler isolated from the internal control circuit.
Terminal 5	Common terminal for the analog command input signals. It is a 0V terminal of the internal control circuit and should be protected from external noise using a shielded or twisted cable.
Terminal SE1	Common terminal for the open collector output terminals (DO1, DO2, DO3). It is photocoupler isolated from the internal control circuit.
Terminal AG1	Common terminal for the analog signal output terminals DA1, DA2.
Terminal AG2	Common terminal for the PLG power supply.

1.6.14 Signal Inputs by Contactless Switch

If a transistor is used instead of a contacted switch as shown below, the input signals of the inverter can control the STF, STR, DI1, DI2, DI3, RES and OH signals.

☆Electrical Characteristics Required for the External Transistor

- •Ic: Collector current
  [10mA or more]
  If the rating is small, the external transistor may be damaged or the inverter input may not be active.
- •V_{CEX}: Open-time permissible collector-to-emitter voltage
  [30V or more]
  If the rating is small, the external transistor may be damaged.
- •$V_{CE(sat)}$: Collector-to-emitter saturation voltage
  [3V or less]
  If the rating is large, the inverter input may not be active.
- •I_{CEX}: Collector shut-off current (leakage current)
  [100 mA or less]
  If the shut-off current is large, it may be accidentally input to the inverter.



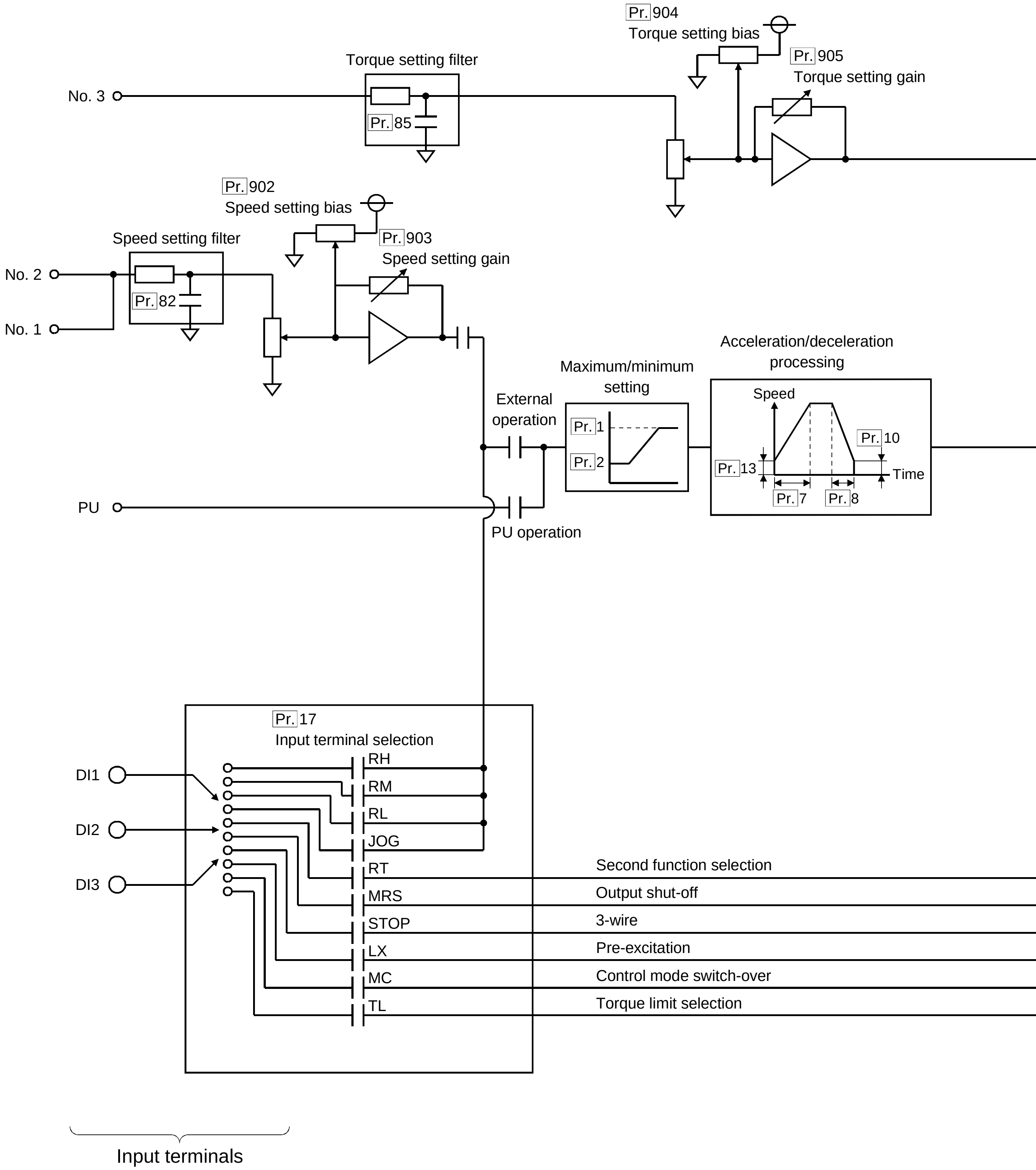
External Signal Input by Transistor

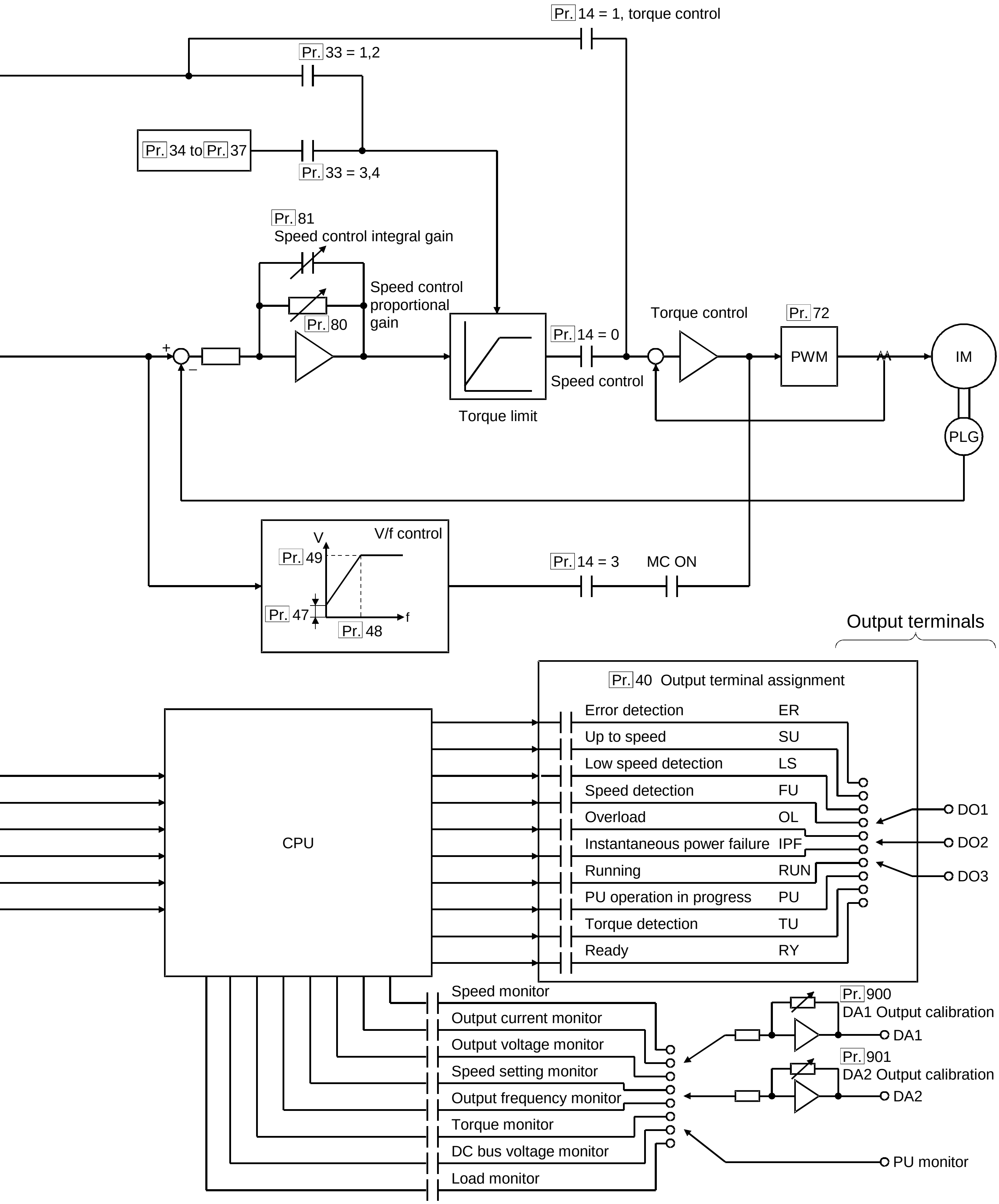
(Note 1) When an external transistor connected with the external power supply is used, use terminal PC to prevent a fault from occurring due to leakage current.

(Note 2) Note that a SSR (solid-state relay) has a relatively large leakage current at OFF time and it accidently activate an input of the inverter.

1.7 Function (Parameter) List

1.7.1 Control block diagram




Pr. 14 = 1, torque control
Pr. 33 = 1,2
Pr. 34 to Pr. 37
Pr. 33 = 3,4
Pr. 81
Speed control integral gain
Speed control proportional gain
Pr. 80
Torque limit
Pr. 14 = 0
Speed control
Torque control
Pr. 72
PWM
IM
PLG
V/f control
V
Pr. 49
Pr. 47
Pr. 48
f
Pr. 14 = 3
MC ON
Output terminals
Pr. 40 Output terminal assignment
CPU
Error detection ER
Up to speed SU
Low speed detection LS
Speed detection FU
Overload OL
Instantaneous power failure IPF
Running RUN
PU operation in progress PU
Torque detection TU
Ready RY
DO1
DO2
DO3
Speed monitor
Output current monitor
Output voltage monitor
Speed setting monitor
Output frequency monitor
Torque monitor
DC bus voltage monitor
Load monitor
Pr. 900
DA1 Output calibration
DA1
Pr. 901
DA2 Output calibration
DA2
PU monitor

1.7.2 Parameter list

For details, refer to the pages of the corresponding parameters.

Function	Parameter No.	Name	Setting Range	Minimum Setting Increment	Factory Setting	Purpose, Application etc.	Refer to Section
Basic functions	1	Maximum speed	0 to 3600r/min	1r/min	1500r/min	Motor speed limit	—
	2	Minimum speed	0 to 3600r/min	1r/min	0r/min	Motor speed limit	
	4	Multi-speed setting (high speed)	0 to 3600r/min	1r/min	1500r/min	Multi-speed operation speeds	
	5	Multi-speed setting (middle speed)	0 to 3600r/min	1r/min	750r/min		
	6	Multi-speed setting (low speed)	0 to 3600r/min	1r/min	150r/min		
	7	Acceleration time	0 to 3600s	0.1s	5s/15s (Note 1)	Acceleration/deceleration time setting	
	8	Deceleration time	0 to 3600s	0.1s	5s/15s (Note 1)		
	9	Electronic thermal O/L relay	0 to 500A	0.01A	Rated motor current/0A (Note 2)	Motor overheat protection	1.8.16
Application functions	10	DC injection brake operation speed	0 to 1500r/min, 9999	1r/min	90r/min	Stopping accuracy adjustment	1.8.1
	11	DC injection brake operation time	0 to 10s	0.1s	0.5s		
	12	DC injection brake voltage	0 to 30%	0.1%	3%		
	13	Starting speed	0 to 1500r/min	1r/min	15r/min	Motor torque adjustment	—
	14	Control mode	0 to 6, 11, 12, 16, 101, 102, 106	Integer	0	Control mode changing	1.8.2
	15	Jog speed setting	0 to 1500r/min	1r/min	300r/min	Jog operation	—
	16	Jog acceleration /deceleration time	0 to 3600s	0.1s	0.5s		
	17	Input terminal assignment	0 to 999	Integer	12	External input selection	1.6.6
	18	S acceleration pattern 1	0 to 50%	1%	0%	Acceleration/deceleration time changing pattern	1.8.4
	19	S deceleration pattern 1	0 to 50%	1%	0%		
	20	Acceleration/deceleration reference speed	0 to 3600r/min	1r/min	1500r/min		—
	21	S acceleration pattern 2	0 to 50%	1%	0%	Acceleration/deceleration time changing pattern	1.8.4
	22	S deceleration pattern 2	0 to 50%	1%	0%		
	23	Thermal protector input	0, 1	Integer	0	Output stop at the time of external thermal relay operation	1.6.11
	24	Multi-speed setting (speed 4)	0 to 3600r/min, 9999	1r/min	9999	Multi-speed operation speeds	1.6.6
	25	Multi-speed setting (speed 5)	0 to 3600r/min, 9999	1r/min	9999		
	26	Multi-speed setting (speed 6)	0 to 3600r/min, 9999	1r/min	9999		
	27	Multi-speed setting (speed 7)	0 to 3600r/min, 9999	1r/min	9999		
	28	Multi-speed compensation selection	0, 1	Integer	0		
	29	Acceleration/deceleration pattern	0, 1, 2, 10, 11, 12, 100 to 102, 110 to 112	Integer	0	Acceleration/deceleration time changing pattern	1.8.4
Protective functions	30	Regenerative brake duty change selection/high power factor converter connection selection	0, 1, 3, 4	Integer	0	Regenerative brake selection	1.8.5
	31	Speed deviation level	0 to 1500r/min, 9999	1r/min	9999	Speed deviation level setting	1.8.6
	32	Overspeed detection level	0 to 3600r/min	1r/min	3000r/min	Overspeed detection level setting	1.8.7
Torque restriction	33	Torque restriction mode	1, 2, 3, 4	Integer	3	Torque limit level setting	1.8.8
	34	Torque restriction level	0 to 400%	0.1%	150%		

(Note 1) The Setting depends on the inverter capacity: (5.5K or less)/(7.5K or more).

(Note 2) The Setting depends on the inverter capacity: (3.7K or less)/(5.5K or more).

Function	Parameter No.	Name	Setting Range	Minimum Setting Increment	Factory Setting	Purpose, Application etc.	Refer to Section
Torque restriction	35	Torque restriction level (Regeneration)	0 to 400%, 9999	0.1%	9999	Torque limit level setting	1.8.8
	36	Torque restriction level (No. 3 quadrant)	0 to 400%, 9999	0.1%	9999		
	37	Torque restriction level (No. 4 quadrant)	0 to 400%, 9999	0.1%	9999		
	38	Torque restriction level 2	0 to 400%, 9999	0.1%	9999		
Torque detection	39	Torque detection	0 to 400%	0.1%	150%	Output signal ON-OFF point adjustment	1.8.9
	40	Output terminal assignment	0 to 999	Integer	12	External output selection	1.6.10
	41	Up-to-speed sensitivity	0 to 100%	0.1%	10%	Output signal ON-OFF point adjustment	1.8.11
	42	Speed detection	0 to 3600r/min	1r/min	300r/min		
	43	Low speed detection	0 to 1500r/min	1r/min	45r/min		
Second functions	44	Second acceleration /deceleration time	0 to 3600s	0.1s	0.5s	For changing of operation pattern	—
	45	Second deceleration time	0 to 3600s, 9999	0.1s	9999		
	46	Second multi-function input selection	0 to 999, 9999	Integer	9999		
	47	Torque boost	0 to 30%	0.1%	3%	Motor torque adjustment	—
	48	Base frequency	50 to 200Hz	0.01Hz	60Hz	Frequency at rated motor torque	1.8.16
	49	Base frequency voltage	0 to 500V, 9999	0.1V	9999	Maximum output voltage limit	1.8.16
Display functions	51	Inverter LED display data	1 to 8,17	Integer	1	Selection of various monitor displays	1.8.12
	52	PU main display data	0, 17, 20	Integer	0		
	53	PU level display data	0 to 3, 5 to 8, 17	Integer	1		
	54	DA1 terminal function selection	1 to 3, 5 to 8, 17, 21	Integer	1		
	55	DA2 terminal function selection	1 to 3, 5 to 8, 17, 21	Integer	7		
	56	Speed monitoring reference	0 to 3600r/min	1r/min	1500r/min	External meter calibration	
	57	Current monitoring reference	0 to 500A	0.01A	Rated value		
	58	Torque monitoring reference	0 to 400%	0.1%	150%		
	59	Language switching	0, 9999	Integer	9999	Display language selection	—
Operation selection functions	60	Speed deviation time	0 to 100s	0.1s	12s	Speed deviation time setting	1.8.6
	61	Restart coasting time	0 to 0.1 to 5s, 9999	0.1s	9999	Restart operation	1.8.13
	62	Pre-excitation selection	0,1	Integer	0	Selection of control method during pre-excitation	1.8.14
	63	Torque command selection	0,1	Integer	0	Torque command method selection	1.8.15
	64	Motor capacity	0 to 55kW, 9999	0.01kW	9999	For auto tuning	1.8.16
	65	Number of motor poles	2, 4, 6, 9999	Integer	9999		
	66	Rated motor speed	0 to 3600r/min	1r/min	Rating of Mitsubishi SF-JR general-purpose motor with PLG		
	67	Open motor circuit detection level	0 to 50%	0.1%	5%	Vertical lift operation	1.8.17
	68	Open motor circuit detection time	0.05 to 1s, 9999	0.01s	9999		
	69	Number of PLG pulses	0 to 4096	1	1024/1000	For auto tuning	1.8.16
	70	Regenerative brake duty	0 to 30%/0% (Note 6)	0.1%	0%	Use of external brake resistor	1.8.5

Function	Parameter No.	Name	Setting Range	Minimum Setting Increment	Factory Setting	Purpose, Application etc.	Refer to Section
Operation selection functions	71	Applied motor	0,1	Integer	0	For auto tuning	1.8.16
	*72	PWM frequency selection	0 to 6	Integer	6	Noise, leakage current reduction	1.8.18
	73	Speed setting signal	0 to 3	Integer	0	Analog speed setting selection	1.8.19
	74	Torque characteristic selection	0,1	Integer	0	For auto tuning	1.8.20
	75	PU stop key selection	0 to 3	Integer	1	Stop key function selection	1.8.21
	76	Alarm definition	0,1	Integer	0	Alarm definition output selection	1.8.22
	77	Parameter write disable selection	0,1,2	Integer	0	Parameter data change inhibit	—
	78	Reverse rotation prevention selection	0,1,2	Integer	0	Limitation of rotation in one direction	—
	79	Operation mode selection	0,1,2	Integer	0	Operation mode selection	—
Speed control system functions	80	Speed control P gain 1	0 to 1000%	1%	30%	Speed loop proportional gain	2.2.1
	81	Speed control I gain 1	0 to 1000%	0.1%	3%	Speed loop integral compensation gain	2.2.1
	82	Speed setting filter 1	0 to 5s	0.001s	0s	Time constant to analog speed command	1.8.23
	83	Speed detection filter 1	0 to 5s	0.001s	0s	Speed ripple reduction	1.8.24
	84	Torque control P gain 1	0 to 1000%	1%	100%	Current loop proportional gain	2.3.1
	85	Torque control I gain 1	0 to 1000%	1%	100%	Current loop integral compensation gain	2.3.1
	86	Torque setting filter 1	0 to 5s	0.001s	0	Time constant to analog torque command	1.8.25
	87	Torque detection filter 1	0 to 5s	0.001s	0	Torque ripple reduction	1.8.26
	88	Droop gain	0 to 100%, 9999	00.1%	9999	Droop control	1.8.32
	89	OLT level setting	0 to 200%	0.1%	150%	OLT level setting	1.8.27
	90	Speed control P gain 2	0 to 1000%	1%	30%	For changing speed loop gain	2.2.1
	91	Speed control I gain 2	0 to 1000%	0.1%	3%		
	92	Speed setting filter 2	0 to 5s	0.001s	0s		1.8.23
	93	Speed detection filter 2	0 to 5s	0.001s	0s		1.8.24
	94	Torque control P gain 2	0 to 1000%	1%	100%	For changing current loop gain	2.3.1
	95	Torque control I gain 2	0 to 1000%	1%	100%		
	96	Torque setting filter 2	0 to 5s	0.001s	0s		1.8.25
	97	Torque detection filter 2	0 to 5s	0.001s	0s		1.8.26
	98	Auto tuning setting	0, 1	Integer	0	For auto tuning	1.8.16
	99	Motor constant selection	0 to 3, 9999	Integer	9999		
	103	Torque bias selection	0 to 3, 9999	Integer	9999	Torque bias selection	1.8.30
	104	Torque bias 1	600 to 1400, 9999	1%	9999		
	105	Torque bias 2	600 to 1400, 9999	1%	9999		
	106	Torque bias 3	600 to 1400, 9999	1%	9999		
	145	Droop operation selection	0, 1, 9999	Integer	9999	Droop control	1.8.32
	146	Speed limit	0 to 3600rpm, 9999	1rpm	9999	Prevention of misoperation at the time of PLG pulse count mis-setting	1.8.33
	147	Torque bias filter	0 to 5s, 9999	0.001s	9999	Torque bias selection	1.8.30

<table>
<tr><th>Func-tion</th><th>Parameter No.</th><th>Name</th><th colspan="2">Setting Range</th><th>Minimum Setting Increment</th><th colspan="2">Factory Setting</th><th>Purpose, Application etc.</th><th>Refer to Section</th></tr>
<tr><td rowspan="12">Speed control system functions</td><td>148</td><td>Torque bias operation time</td><td colspan="2">0 to 5s, 9999</td><td>0.01s</td><td colspan="2">9999</td><td rowspan="2">Torque bias selection</td><td rowspan="2">1.8.30</td></tr>
<tr><td>149</td><td>Torque bias balance compensation</td><td colspan="2">0 to 10V,9999</td><td>0.1V</td><td colspan="2">9999</td></tr>
<tr><td>150</td><td>Secondary resistance compensation coefficient</td><td colspan="2">0 to 200%,9999</td><td>1%</td><td colspan="2">9999</td><td rowspan="2">Reduced influence of output torque by motor temperature change</td><td rowspan="2">1.8.31</td></tr>
<tr><td>151</td><td>Secondary resistance compensation selection</td><td colspan="2">0 to 200°C, 9999</td><td>Integer</td><td colspan="2">9999</td></tr>
<tr><td>152</td><td>Fall-time torque bias No. 3 bias</td><td colspan="2">0 to 400%,9999</td><td>1%</td><td colspan="2">9999</td><td rowspan="2">Torque bias selection</td><td rowspan="2">1.8.30</td></tr>
<tr><td>153</td><td>Fall-time torque bias No. 3 gain</td><td colspan="2">0 to 400%,9999</td><td>1%</td><td colspan="2">9999</td></tr>
<tr><td>154</td><td>Droop filter time constant</td><td colspan="2">0 to 1s, 9999</td><td>0.01s</td><td colspan="2">9999</td><td>Droop control</td><td>1.8.32</td></tr>
<tr><td>155</td><td>Speed indication</td><td colspan="2">11 to 9998,9999</td><td>Integer</td><td colspan="2">9999</td><td>Speed monitor display selection</td><td>1.8.12</td></tr>
<tr><td>156</td><td>PLG rotation direction</td><td colspan="2">0,1</td><td>Integer</td><td colspan="2">0</td><td>Changing of PLG rotation direction</td><td>1.8.28</td></tr>
<tr><td>157</td><td>Excitation ratio</td><td colspan="2">0 to 100%</td><td>1%</td><td colspan="2">100%</td><td>Excitation rate setting</td><td>1.8.29</td></tr>
<tr><td>158</td><td>Deceleration torque limit</td><td colspan="2">0 to 400%, 9999</td><td>Integer</td><td colspan="2">9999</td><td rowspan="2">Torque limit level setting</td><td rowspan="2">1.8.8</td></tr>
<tr><td>159</td><td>Acceleration torque limit</td><td colspan="2">0 to 400%, 9999</td><td>Integer</td><td colspan="2">9999</td></tr>
<tr><td rowspan="6">Calibration functions</td><td>900</td><td>DA1 terminal calibration</td><td colspan="2">—</td><td>—</td><td colspan="2">—</td><td rowspan="2">For external meter calibration</td><td>—</td></tr>
<tr><td>901</td><td>DA2 terminal calibration</td><td colspan="2">—</td><td>—</td><td colspan="2">—</td><td>—</td></tr>
<tr><td>902</td><td>Speed setting second bias</td><td>0 to 10V</td><td>0 to 3600r/min</td><td>1r/min</td><td>(0V)</td><td>0r/min</td><td rowspan="2">Calibration of output speed to speed setting signal</td><td rowspan="2">1.8.34</td></tr>
<tr><td>903</td><td>Speed setting second gain</td><td>0 to 10V</td><td>0 to 3600r/min</td><td>1r/min</td><td>(10V)</td><td>1500r/min</td></tr>
<tr><td>904</td><td>Torque command third bias</td><td>0 to 10V</td><td>0 to 400%</td><td>0.1%</td><td>(0V)</td><td>0%</td><td rowspan="2">Calibration of output torque to torque setting signal</td><td rowspan="2">1.8.35</td></tr>
<tr><td>905</td><td>Torque command third gain</td><td>0 to 10V</td><td>0 to 400%</td><td>0.1%</td><td>(10V)</td><td>150%</td></tr>
</table>

(Note 3) The parameters hatched allow their settings to be changed during operation if 0 (factory setting) has been set in Pr. 77 (parameter write disable selection).

(Note 4) The parameter marked * cannot be written during operation even if Pr. 77 "parameter write disable selection" is set to "2".

(Note 5) Pr. 100 to 120 are parameters for the option unit.

(Note 6) The setting range depends on the inverter capacity: (5.5K or less)/(7.5K or more).

(Note 7) In the Screen Display section, S indicates a speed, f a frequency, V a voltage, I a current, t time, and T torque.

1.8 Functions (Parameters)

*For the functions not given in this Technical Manual, refer to the FR-A Series Technical Manual.

1.8.1 DC injection brake

Pr. 10 "DC injection brake operation speed", Pr. 11 "DC injection brake operation time", Pr. 12 "DC injection brake voltage"

- Accurate positioning is possible by adjusting the injection braking start speed, duration and voltage.

DC Injection Braking Possible	DC Injection Braking Not Possible
• Speed control • V/F control	• Torque control • Position control (with FR-VPB FR-VPD positioning control option)

(Note) Use Pr. 14 "control mode" to set the control mode.

- Parameters used

Parameter	Name	Setting Range	Factory Setting	Remarks
10	DC injection brake operation speed	0 to 1500, 9999	90r/min	9999: Same as starting speed
11	DC injection brake operation time	0 to 10s	0.5s	
12	DC injection brake voltage	0 to 30%	3%	Valid during V/F control

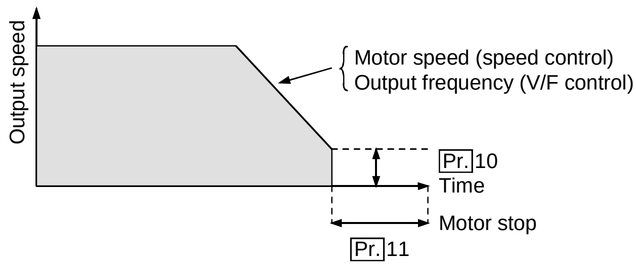
● Speed control

When the motor speed reduces to less than the value set in Pr. 10 "DC injection brake operation speed" during deceleration, the output speed is reduced to 0 and zero speed control is exercised for the period of time set in Pr. 11 "DC injection brake operation time". When the time set in Pr. 11 elapses, the motor will coast to a stop. When the Pr. 62 "pre-excitation selection" setting is 0 (zero speed control) and the signal across LX (allocated using Pr. 17 "input terminal assignment") and SD is on, zero speed control is exercised while the signal across LX and SD is on.

When the Pr. 62 setting is 1 (servo lock) and the signal across LX and SD is on, the motor is servo-locked to keep the current position if the motor speed reduces to less than the value set in Pr. 10 "DC injection brake operation speed" during deceleration.

● V/F control

When the frequency is lower than the value in Pr. 10, DC injection braking starts for the duration of Pr. 11 at a level of Pr. 12. If the Pr. 11 setting time is exceeded, the motor will coast to a stop.



1.8.2 Control mode selection

Pr. 14 "control mode"
With the "version up" the torque control specifications have been changed.

(1) By setting Pr. 14 "control mode", any of the following combinations is made possible by the control mode switching terminal (MC).
Use Pr. 17 "input terminal assignment" to assign the control mode switching (MC) to any of DI1, DI2 and DI3.

Setting	Control Mode	Switching Method	Remarks
0	Speed control	MC unconnected	Factory Setting
1 11 101	Torque control	MC unconnected	
2 12 102	Speed-torque control switching	MC OFF: Speed control MC ON: Torque control	
3	Speed-V/F control switching	MC OFF: Speed control MC ON: V/F control	
4	Position control	MC unconnected	Can be set by using the FR-VPB or FR-VPD inboard option.
5	Speed-position control switching	MC OFF: Speed control MC ON: Position control	
6 16 106	Position-torque control switching	MC OFF: Position control MC ON: Torque control	

(2) Details of torque control specifications
The following selection can be made by setting the torque control specifications in the parameter:

Setting	Torque Limit Operation for Speed Limit Operation	Speed Limit Value at Torque Command Voltage Polarity Reversal
1 2 6	In accordance with Pr. 33 setting.	Speed limit value does not change.
11 12 16	No. 3 terminal setting is used as torque limit, independently of Pr. 33 setting.	
101 102 106	In accordance with Pr. 33 setting.	Speed is reduced to 0rpm once and limit value is then increased.

(3) For selection of the same torque control specifications as in the conventional product

	Setting of Conventional Product	Setting of Version-up Product
Pr. 14	1	101
	2	102
	6	106

1.8.3 Input signal selection and assignment

Pr. 17 "input terminal assignment"

Refer to Section 1.6.6 Input signals (terminals DI1 to DI3).

1.8.4 Acceleration/deceleration pattern

Pr. 18 "S acceleration pattern 1", Pr. 19 "S deceleration pattern 1"
Pr. 21 "S acceleration pattern 2", Pr. 22 "S deceleration pattern 2"
Pr. 29 "acceleration/deceleration pattern", Pr. 46 "second multi-function input selection"

- The acceleration/deceleration pattern can be changed according to applications.
  Use the following parameter to set any of the acceleration/deceleration patterns shown below.

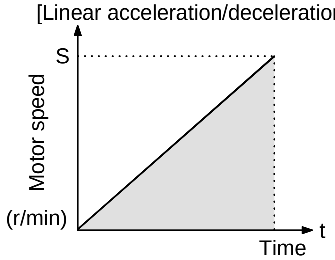
Parameter No.	Name	Setting Range	Factory Setting
29	Acceleration/deceleration pattern	0, 1, 2,	0

- Acceleration/deceleration pattern

(1) Set "0" in Pr. 29 to select linear acceleration/deceleration.
This is a standard pattern and generally use this setting for operation.

Set value 0

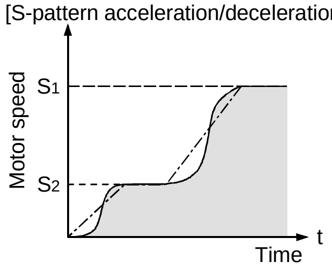
[Linear acceleration/deceleration]



(2) Set "1" in Pr. 29 to select S-pattern Acceleration/deceleration is as shown on the right.
As S-pattern acceleration/deceleration is made from S2 (current speed) to S1 (target speed), acceleration/deceleration shock can be eased to ensure smooth operation.

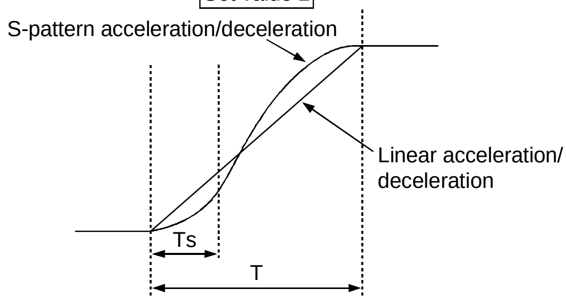
Set value 1

[S-pattern acceleration/deceleration B]



(3) Set "2" in Pr. 29 to select S-pattern acceleration/deceleration as shown below.
An acceleration/deceleration curve during S-pattern acceleration/deceleration can be set with the corresponding parameter and the setting of this curve can be changed with the external terminal.

Set value 2



Parameter No.	Name	Setting Range	Factory Setting
18	S acceleration pattern 1	0 to 50%	0%
19	S deceleration pattern 1	0 to 50%	0%
21	S acceleration pattern 2	0 to 50%	0%
22	S deceleration pattern 2	0 to 50%	0%
46	Second multi-function input selection	0 to 999,9999	9999

In Pr. 18, Pr. 19, Pr. 21 and Pr. 22, set the ratio of S-pattern time (Ts) to acceleration/deceleration time (T) in %.

Pr. 18 = (Ts/T)×100(%)

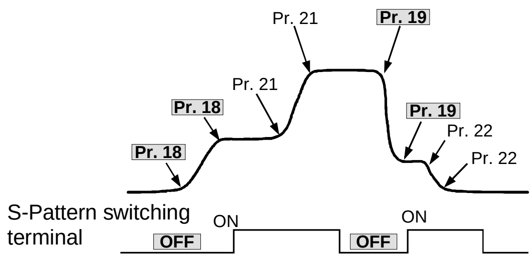
To change the acceleration/deceleration curve with the external terminal, the S-pattern switching terminal must be assigned to any of terminals DI1 to DI3. DI1 to DI3 have been assigned to the three digits of Pr. 46 as indicated below:

Pr. 46 =	First digit	Second digit	Third digit
	DI1	DI2	DI3

If 1 is set in any of the digits, the terminal corresponding to that digit functions as the S-pattern switching terminal and switching can be made as shown below. If the value set is other than 1, the set value is ignored and DI1 to DI3 function as set in Pr. 17.

S-Pattern Switching Terminal / Operation	During Acceleration	During Deceleration
OFF	Pr. 18 "S acceleration pattern 1"	Pr. 19 "S deceleration pattern 1"
ON	Pr. 21 "S acceleration pattern 2"	Pr. 22 "S deceleration pattern 2"

Note: Switching by the S-pattern switching terminal is invalid during acceleration or deceleration.



1.8.5 Regenerative brake duty (%ED)

Pr. 30 "regenerative brake duty change selection/high power factor converter connection selection"
Pr. 70 "regenerative brake duty"

- Set these parameters when it is necessary to increase the regenerative brake duty for frequent start/stop operations. In this case, as a higher brake resistor capacity is required, use the optional FR-ABR high-duty brake resistor.

<Setting method>
After setting "1" in Pr. 30 "regenerative brake duty change selection/high power factor converter connection selection", set the duty in Pr. 70 "regenerative brake duty".
<Regenerative brake duty when Pr. 30 = 0>
FR-V220E-1.5K to 3.7K 3%
FR-V220E-5.5K...........................2%
FR-V220E-1.5K to 5.5K 2%

<Pr. 70 can be set in the following range when Pr. 30 = 1>

Model	Factory Setting	Setting Range
1.5K to 5.5K	0%	0 to 30%
7.5K or more	0%	0%

(Note 1) When the Pr. 70 setting is increased from the factory setting, the set value must be matched to the permissible brake duty of the external brake resistor (FR-ABR).
(Note 2) Setting is invalid for models 7.5K and up.
(Note 3) The brake duty indicates %ED of the built-in brake transistor operation.
(Note 4) When Pr. 30 is "0", Pr. 70 is not displayed.

- When the high power factor converter (FR-HC) is connected for power harmonic suppression, Pr. 30 "regenerative brake duty change selection/high power factor converter connection selection" functions as described in the following table. Set this parameter according to your operating conditions.

	Pr. 30 = 3	Pr. 30 = 4
Operation	Other than as detailed on the right (i.e. Pr. 30 = 4)	Pr. 127 "link starting mode selection" = 2. Computer link operation mode (using FR-VPB option)
Terminals	DI2 (output shut-off signal input)	DI2 (output shut-off signal input) DI3 (terminal for accepting IPF signal from high power factor converter)
UVT detection	Disabled	Disabled
Brake resistor	Disabled	Disabled
IPF detection	Disabled	Disabled
Option error	Error occurs when voltage is supplied to terminals R (L_1), S (L_2).	Error occurs when voltage is supplied to terminals R (L_1), S (L_2).

1) Connect terminal RDY of the high power factor converter (FR-HC) and terminal DI2 of the inverter. When the inverter operation enable (RDY) signal of the high power factor converter (FR-HC) is switched on, the inverter is ready to operate. When the inverter operation enable (RDY) signal of the high power factor converter (FR-HC) switches off during operation of the inverter, the inverter will stop operation within 3ms.
2) When "4" is set in Pr. 30, connect terminal Y1 or Y2 of the high power factor converter and terminal DI3 of the inverter.
   The incoming IPF signal from terminal DI3 acts as an instantaneous power failure detection signal to store the operation command for automatic restart after instantaneous power failure during computer link operation.

(Note 1) This signal is not used as an instantaneous power failure detection signal for IPF processing.

(Note 2). The operation command is stored under the following conditions:

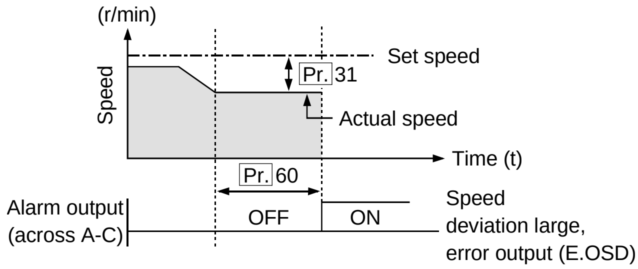
- Pr. 30 = 4
- Pr. 127 "link starting mode selection" = 2 (link mode for automatic restart after instantaneous power failure)
- Pr. 61 "restart coasting time"≠9999 (automatic restart after instantaneous power failure valid)
- PF signal from terminal DI3 is off

3) UVT (undervoltage protection) detection is made by the high power factor converter (FR-HC).
4) In the regenerative mode, power is returned through the high power factor converter (FR-HC) to power supply.
5) When an instantaneous power failure occurs, instantaneous power failure alarm output is provided by the high power factor converter (FR-HC).

1.8.6 Speed deviation function

Pr. 31 "speed deviation level", **Pr.** 60 "speed deviation time"

- If a difference (absolute value) in velocity between set value and actual motor speed is higher than the value set in Pr. 31 "speed deviation level" for longer than the value set in Pr. 60 "speed deviation time", speed deviation becomes large, error "E.OSD" is displayed, and the motor comes to a stop.



Parameter No.	Name	Setting Range	Factory Setting	Remarks
31	Speed deviation level	0 to 1500 r/min, 9999	9999	9999: Invalid
60	Speed deviation time	0 to 100s	12s	Can be read when Pr. 31 is not 9999.

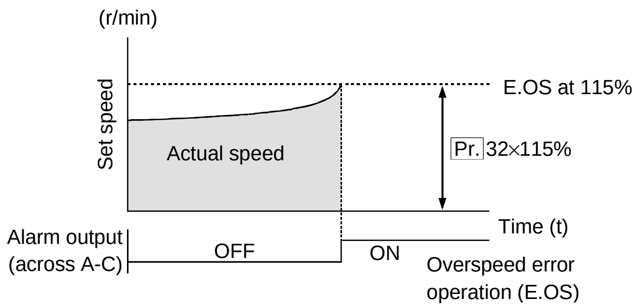
(Note 1) Set this parameter when a speed difference could pose a problem.
(Note 2) This function is invalid for torque control.
(Note 3) If the Pr. 69 "number of PLG pulses" setting is different from the actual number of PLG pulses when a motor with a PLG is driven, control may become instable, resulting in "E.OSD" (Even if Pr. 31 = 9999).

1.8.7 Overspeed detection function

Pr. 32 "overspeed detection level"

- Used to restrict the maximum speed.
- When the Pr. 32 × 115% speed is reached, i.e. overspeed detection level, an overspeed alarm occurs and error "E.OS" is displayed.

Setting Range	Factory Setting
0 to 3600r/min	3000r/min



(Note 1) This parameter is invalid for V/F control.
(Note 2) If the Pr. 69 "number of PLG pulses" setting is different from the actual number of PLG pulses when a motor with a PLG is driven, control may become instable, resulting in "E.OS".

1.8.8 Torque limit function

Pr. 33 "torque restriction mode", Pr. 34 "torque restriction level"
Pr. 35 "torque restriction level (regeneration)", Pr. 36 "torque restriction level (3 quadrant)"
Pr. 37 "torque restriction level (4 quadrant)", Pr. 38 "torque restriction level 2"
Pr. 158 "deceleration torque limit", Pr. 159 "acceleration torque limit"

(1) Parameters used

Pr. No.	Name	Setting Range	Factory Setting	Remarks
33	Torque restriction mode	1, 2, 3, 4	3	1: External input 2: External input (option (VPA, VPB) No. 4 terminal) 3, 4: Parameter set value
34	Torque restriction level	0 to 400%	150%	————
35	Torque restriction level (regeneration)	0 to 400%, 9999	9999	Pr. 33=3, 4 regeneration, 9999=Pr. 34
36	Torque restriction level (3 quadrant)	0 to 400%, 9999	9999	Pr. 33=3, 3 quadrant, 9999=Pr. 34
37	Torque restriction level (4 quadrant)	0 to 400%, 9999	9999	Pr. 33=3, 4 quadrant, 9999=Pr. 35
38	Torque restriction level 2	0 to 400%, 9999	9999	Valid with TL terminal input.

Note: Pr. 34 to Pr. 38 can be used during PU operation or external operation.

- Output torques during acceleration and deceleration can be limited independently.

Note: With the version-up, Pr. 158 and Pr. 159 have been added.

Pr. No.	Name	Setting Range	Factory Setting	Remarks
158	Deceleration torque limit	0 to 400%, 9999	9999	Same value as at constant speed when the setting is 9999.
159	Acceleration torque limit	0 to 400%, 9999	9999	Same value as at constant speed when the setting is 9999.

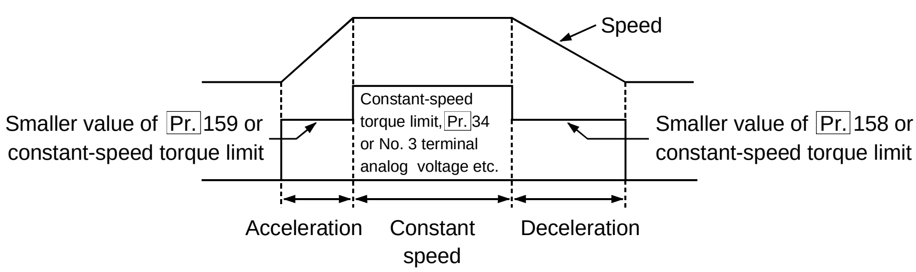
<Setting method>

Example: To set the deceleration torque limit to 150%

Set 150% in Pr. 158 "deceleration torque limit".

During acceleration/deceleration, torque is limited at the lowest value of the above acceleration/deceleration torque limit value, the Pr. 34 to Pr. 38 value and the torque limit value using terminal No. 3, 4.

Enter "9999" to return Pr. 158 and Pr. 159 to their factory settings.



For conventional product

Parameter Number	Name	Setting Range	Factory Setting	Remarks
118	Torque limit for deceleration	0 to 65535	9999	Factory-set to 100% (equivalent to 100% at setting of 4096)
119	Torque limit for acceleration	0 to 65535	9999	Factory-set to 150% (equivalent to 100% at setting of 4096)

<Setting procedure>

Example: To set the torque limit for deceleration to 150%

1) Set "801" in Pr. 77 "parameter write inhibit selection".
2) Set "6144" (= 4096 × 150%/100) in Pr. 118 "torque limit for deceleration".
3) Return Pr. 77 to the original value.
   During acceleration/deceleration, torque is limited to the lowest value of the above torque limit value for acceleration/deceleration, Pr. 34 to Pr. 38 values, and torque limit values using terminals 3, 4.

Enter "65535" to return the Pr. 118 and Pr. 119 values to the factory setting.
9999 sets the torque limit value to 224%
(= 9999/4096×100).

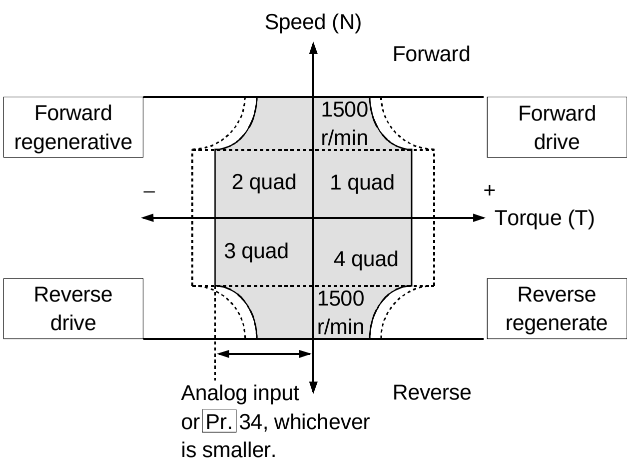
Note: The torque limit value for deceleration is factory-set to 100%.

(2) Detail

1) Torque control and speed control

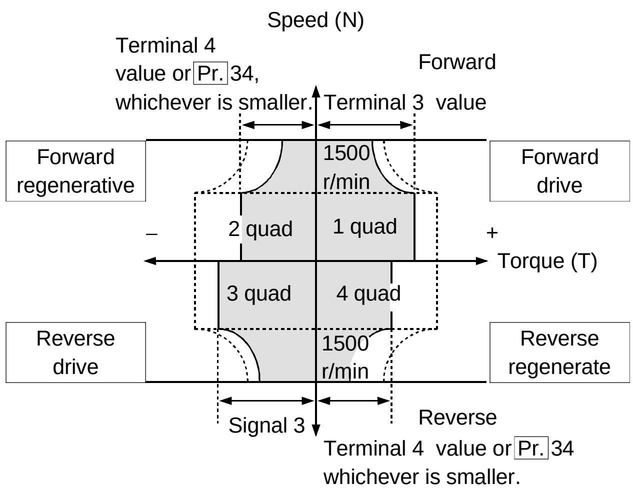
● Pr. 33 = 1

The absolute value of the external analog input No. 3 is validated, and the smaller of the Pr. 34 and terminal No. 3 will be used as the limit value.



● Pr. 33 = 2

In the driving mode, the absolute value of external analog input No. 3 is made valid (refer to Pr. 33 = 1). In the regenerative mode, the analog input terminal No. 4 of the inboard option (VPA, VPB) is made valid and the torque limit value is the terminal 4 input or Pr. 34 setting, whichever is smaller.

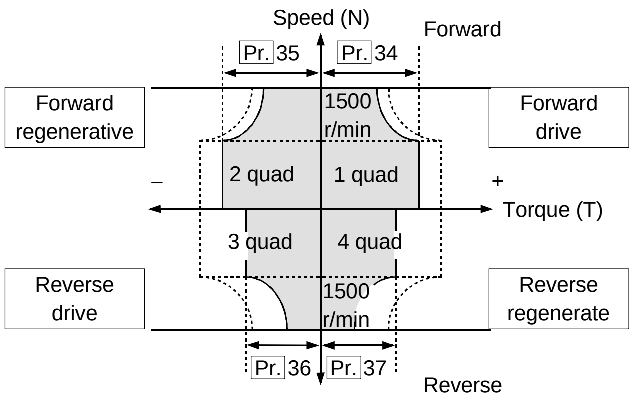


(Note 1) The terminal 4 input is limited when Pr. 33 = 2 and the inboard option (VPA, VPB) is fitted.
(Note 2) Pr. 34 value will be used if it is smaller than terminal 4 value

- Pr. 33 = 3

Using Pr. 34, Pr. 35, Pr. 36 and Pr. 37 values

Quadrant		Effective Parameters
1	Forward drive	Setting value = Pr. 34.
2	Forward regenerate	Setting value = Pr. 35 (When Pr. 35 = 9999, setting value = Pr. 34.)
3	Reverse drive	Setting value = Pr. 36 (When Pr. 36 = 9999, setting value = Pr. 34.)
4	Reverse regenerate	Setting value = Pr. 37 (When Pr. 37= 9999, setting value = Pr. 35.)

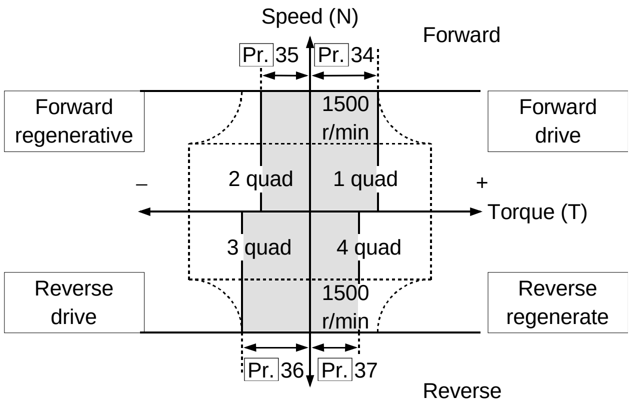


- Pr. 33 = 4

Torque restriction in kg·m.

Pr. 35 and Pr. 34 used. (Setting can be made between 0 and 200%.)

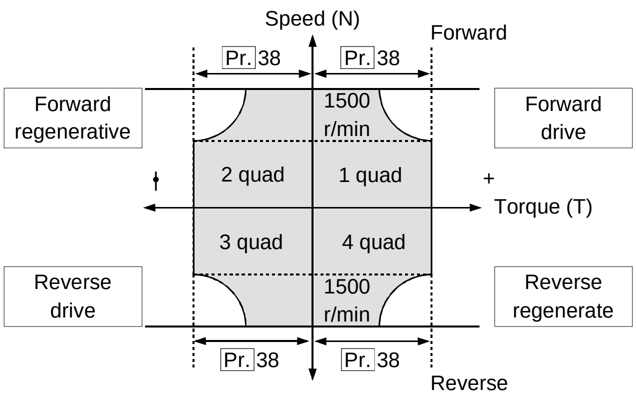
Pr. 35 = 9999 makes the setting the same as Pr. 34. (Pr. 36 and Pr. 37 are not effective.)



Note: Torque limit is not speed dependent.

2) Second torque restriction level

The value in Pr. 38 is used when TL and SD are connected. Allocate with Pr. 17 to terminal DI1, DI2 or DI3.

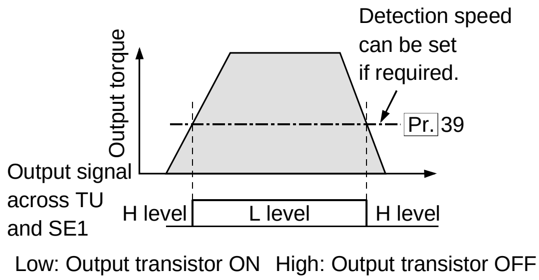


Note: When Pr. 38 = 9999, setting value = Pr. 34.

1.8.9 Torque detection function

Pr. 39 "torque detection"

- Terminal TU state changes from high to low when the output torque exceeds the value set in Pr. 39.



1.8.10 Output signal selection and assignment

Pr. 40 "output signal assignment"

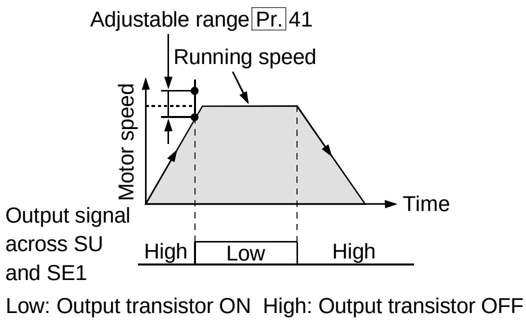
Refer to Section 1.6.10 Output signals (terminals DO1 to DO3).

1.8.11 Speed detection function

Pr. 41 "up-to-speed sensitivity"

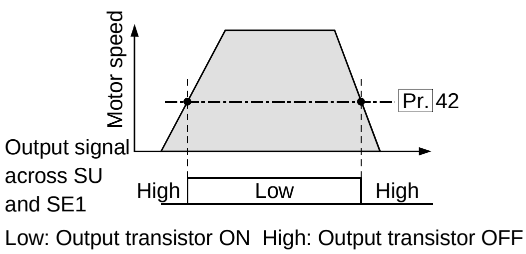
- Allows the output signal ON range to be adjusted between 0 and ±100% of the running speed when the output speed reaches the running speed

Setting Range	Factory Setting
0 to 100%	10%



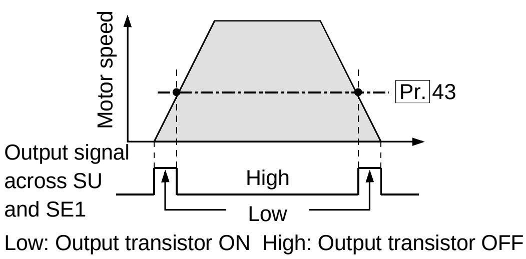
Pr. 42 "speed detection", **Pr.** 43 "low-speed detection"

- The signal across terminals FU and SE1 is switched low when the output speed reaches or exceeds the value set in "speed detection", Pr. 42, and is switched high when it drops below the detection speed. This function can be used for electromagnetic brake operation, open and other signals.



- The signal across terminals LS and SE1 is switched low when the output speed is less than the value set in Pr. 43, and is switched high when the speed is higher than Pr. 43.

Pr. No.	Setting Range	Factory Setting
42	0 to 3600r/min	300r/min
43	0 to 1500r/min	45r/min



1.8.12 Multi-function monitor display

Pr. 51 "inverter LED display data", Pr. 52 "PU main display data"
Pr. 53 "PU level meter display data", Pr. 54 "DA1 terminal function selection"
Pr. 55 "DA2 terminal function selection"
Pr. 56 "speed monitoring reference", Pr. 57 "current monitoring reference"
Pr. 58 "torque monitoring reference"

- By setting any of the numbers in the following table, the required signal can be selected from among the 11 signals for monitoring and output signals.
- There are two types of signal outputs: DA1 terminal and DA2 terminal. Different signals can be output at the same time. Select the signals using Pr. 54.

<Factory setting>

Pr. 51..."1", Pr. 52..."0", Pr. 53..."1", Pr. 54..."1", Pr. 55..."7"

Monitor Method / Monitor Details	Inverter LED Pr. 51	PU main monitor Pr. 52	PU level meter Pr. 53	DA1 12 bit Pr. 54	DA2 8 bit Pr. 55	Full-Scale Value of Level Meter, Analog Output
No display	×	×	0	×	×	—
Motor speed (r/min)	1	0	1	1☆	1	Pr. 56
Output current (A)	2	0	2	2	2	Pr. 57
Output voltage (V)	3	0	3	3	3	400V or 800V
Alarm display	4	0	×	×	×	—
Set speed (r/min)	5	*	5	5	5	Pr. 56
Output frequency (Hz)	6	*	6	6☆	6	Pr. 56
Torque (%)	7	*	7	7☆	7	Pr. 58
DC bus voltage (V)	8	*	8	8	8	400V or 800V
Input terminal (status)	×	*	×	×	×	—
Output terminal (status)	×		×	×	×	—
Load meter (%)	17	17	17	17☆	17	Pr. 58
Cumulative Operation time (Hours)	×	20	×	×	×	—
Reference voltage	×	×	×	21	21	

(Note 1) Monitoring of items marked × is not possible.

(Note 2) "set speed" to "output terminal status" on the PU main monitor are selected by "other monitor selection" of PU operation.

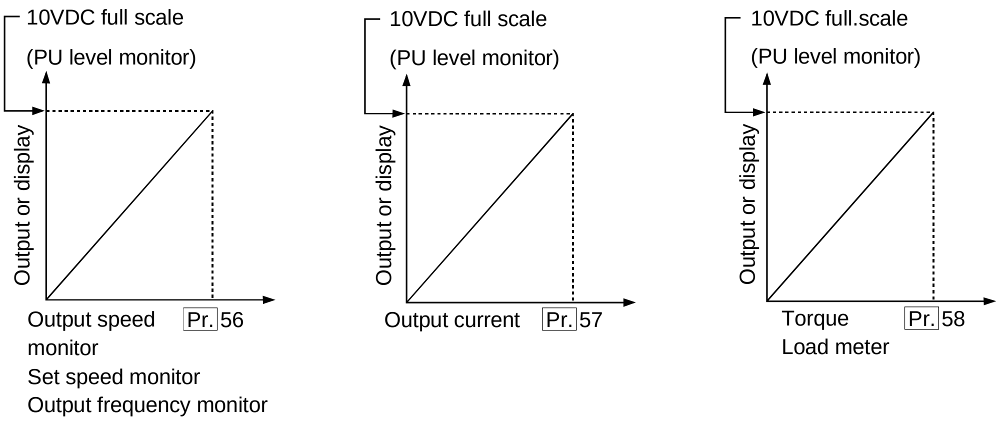
(Note 3) For torque, the value monitored is the ratio of torque to its absolute value. For the load meter, the value monitored is the ratio of load to constant-output torque in the constant-output region.

(Note 4) Monitored values marked ☆ are output in ±values.

- Setting with Pr. 56, Pr. 57 and Pr. 58

  Set so that the PU level meter displays the full scale.

  Note: DA1 and DA2 maximum output voltage is 10VDC



- The response level of the output voltage of output signal DA1 can be adjusted by setting the required value in Pr. 50 "DA1 output filter".

  (1) Set "801" in Pr. 77 "parameter write disable selection".

  (2) Set the required value in Pr. 50 "DA1 output filter".

Parameter Number	Parameter Number	Setting Range	Minimum Setting Increment	Factory Setting
50	DA1 output filter	0 to 5s, 9999	0.001s	9999

  (3) Return the setting of Pr. 77 "parameter write disable selection" to the original value "any of 0 to 2".

  Note: When Pr. 50 "DA1 output filter" = 9999, the output voltage response of terminal DA1 is approximately 50ms.

Pr. 155 "speed indication"

The machine running speed can be monitored.

Parameter Number	Function	Setting Range	Setting Increments	Factory Setting	Remarks
155	Speed display	11 to 9998, 9999	Integer	9999	Speed monitor at 9999 setting Machine speed monitor at 11 to 9998 setting

- Operation

i) When Pr. 155 is 9999

The speed is displayed when speed monitor is selected on the LED or PU main display.

ii) When Pr. 155 is 11 to 9998

The machine running speed is displayed when speed monitor is selected on the LED or PU main display.

At this time, use Pr. 155 to set the machine speed at the motor speed of 1500rpm.

- Note

When the machine speed is displayed in 5 digits, the LED monitor alternates between 0 and 9999.

1.8.13 Automatic restart after instantaneous power failure

Pr. 61 "restart coasting time"

The inverter can be started without stopping the motor (with the motor coasting) after the changing from commercial operation to inverter operation or after an instantaneous power failure state has been restored. (If restarting operation is validated, the error output signals UVT and IPF will not function even if an instantaneous power failure occurs.)

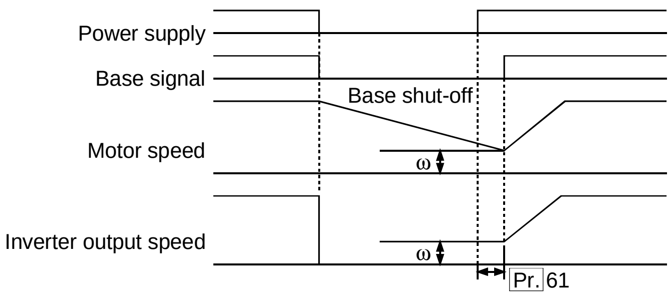
Parameter	Name	Setting Range	Factory Setting	Remarks
61	Restart coasting time	0, 0.1 to 5s, 9998, 9999	9999	9999: Restart after instantaneous power failure not possible

Setting	Automatic Restart Operation Enable/Disable
9999 (factory setting)	Disable
0, 0.1 to 5s*	Enable

* When Pr. 61 is set to "0", the coasting time will be set to the standard time shown below. Normally, there will be no problem with this setting. However, this time can be adjusted between 0.1 second and 5 seconds according to the load's moment of inertia (GD^2) and torque size.
All capacities ..... 0.1 second

Coasting time indicates a waiting time for automatic restart after power restoration.

● Operation



Note: Though automatic restart after instantaneous power failure can be made in speed control and torque control modes, automatic restart after instantaneous power failure is not made in position control and V/F control modes if it has been selected.

1.8.14 Pre-excitation function

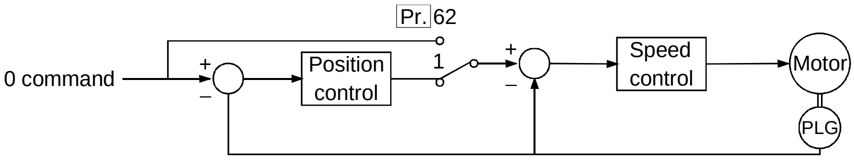
Pr. 62 "pre-excitation selection"

●When pre-excitation is executed, select whether to control the 0 speed or to use servo lock.

Parameter No.	Name	Setting Range	Factory Setting	Remarks
62	Pre-excitation selection	0,1	0	0: 0 speed control 1: Servo lock
133	Position loop gain	0 to 150	25	This parameter can be read when option FR-VPB is mounted or the servo lock is selected.

● Operation

Block diagram for pre-excitation



(1) Pre-excitation will be executed according to Pr. 62 "pre-excitation selection" for speed control and torque control.

(2) When using position control, the servo will be locked and the position will be retained regardless of Pr. 62 "pre-excitation selection" .

1.8.15 Torque command selection

Pr. 63 "torque command selection"

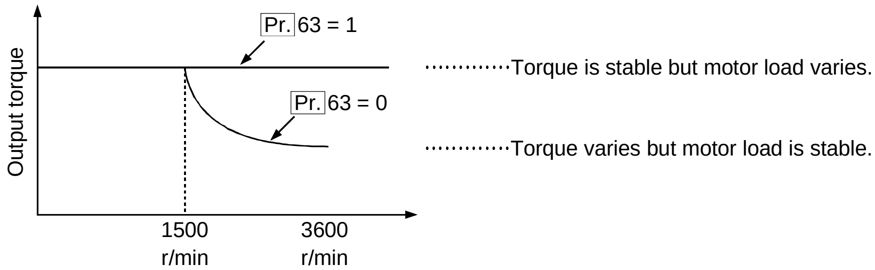
● Whether to set the torque command with an absolute value (kg·m) or load (%) is selected.

Parameter No.	Name	Setting Range	Factory Setting	Remarks
63	Torque command selection	0, 1	0	0: Load command 1: Absolute value command

● Operation

When Pr. 63 is set to 0, the No. 3 terminal input will be a load (%) command.

When Pr. 63 is set to 1, the No. 3 terminal input will be an absolute torque value (kg·m) command.



1.8.16 Auto tuning function

Pr. 9 "electronic thermal overload protection"
Pr. 48 "base frequency", Pr. 49 "base frequency voltage"
Pr. 64 "motor capacity", Pr. 65 "number of motor poles"
Pr. 66 "rated motor speed", Pr. 69 "number of PLG pulses"
Pr. 71 "applied motor",
Pr. 98 "auto tuning setting", Pr. 99 "motor constant selection"

- As the inverter itself measures the necessary motor constants by auto tuning, the FR-V200E can be used with any of the following motors in addition to the Mitsubishi vector control inverter motor (SF-VR):
  - SF-JR general-purpose motor with PLG (2 poles, 4 poles, 6 poles)
  - SF-JRCA constant-torque motor with PLG (4 poles)
  - Other manufacturers' motors with PLG (2 poles, 4 poles, 6 poles)

(Note 1) The condition that one motor may be auto-tuned by one inverter should be satisfied.
(Note 2) For a two-pole motor with PLG, run it at not more than its permissible speed. (Permissible speed is 3600r/min)

- Parameters used

Parameter	Name	Setting Range	Factory Setting	Remarks
9	Electronic thermal overload protection	0 to 500A	Rated motor current (1.5K to 3.7K)/0A (5.5K to 45K)	When Pr. 9=0, electronic thermal overload protection is invalid.
48	Base frequency	50 to 200Hz	60Hz	
49	Base frequency voltage	0 to 500V, 9999	9999	
64	Motor capacity	0 to 55kW, 9999	9999	
65	Number of motor poles	2 to 6, 9999	9999	
66	Rated motor speed	0 to 3600r/min	1710r/min(1.5K,3.7K) 1720r/min(5.5K,11K) 1730r/min(7.5K,15K) 1750r/min(18.5K to 30K) 1760r/min(37K,45K)	1800r/min before version update (all capacities)
69	Number of PLG pulses	0 to 4096	1000	Set the number of pulses before it is multiplied by 4.
98	Auto tuning setting	0, 1	0	Set 1 in Pr. 98 for auto tuning.
99	Motor constant selection	0 to 2, 9999	9999	9999•Mitsubishi vector inverter motor 0 to 2•Motor with PLG

- Parameters for motor with PLG

In addition to the above parameters, set the specifications of the motor with PLG.

Parameter	Name	Setting Range	Factory Setting	Remarks
23	Thermal protector input	0, 1	0	Set "1" for use of a thermal protector with the motor with PLG.
71	Applied motor	0, 1	0	0: Thermal characteristic matching the standard motor 1: Thermal characteristic matching the Mitsubishi constant-torque motor
74	Torque characteristic selection	0, 1	0	0: Cyclic operation mode 1: Continuous operation mode

Note: The PLG should be connected directly to the motor shaft without looseness.

- Use Pr. 99 "motor constant selection" to change the control constants of the motor used for vector control.

Pr. 99 Setting	Used Control Constants	Remarks
9999	Vector control constants for Mitsubishi vector inverter motor	Constants of SF-JR motor with PLG (4 poles) for 1.5K (2HP) to 3.7K (5HP).
0	Auto tuning constants for motor with PLG	
1	Y (star) connection direct setting constants for motor with PLG	
2	Δ (delta) connection direct setting constants for motor with PLG	

(1) For use in auto tuning mode

1) Checking the wiring and load
   - Make sure that the motor is connected. Also, the motor must be at a stop at the start of tuning.
   - The motor should be tuned without load, i.e. should not be connected with load (e.g. frictional stationary load), but may be connected with an inertia load (such as a coupling).

2) Parameter setting
   - Set the parameters listed on the preceding page.

     Pr. 9 "electronic overcurrent protection"
     Pr. 48 "base frequency"
     Pr. 49 "base frequency voltage"
     Pr. 64 "motor capacity"
     Pr. 65 "number of motor poles"
     Pr. 66 "rated motor speed"

     } Set the rated values of the motor.(When there is more than one rated value on the motor's rating plate, set the value for 200V/60Hz or 400V/60Hz.)

     Pr. 69 "number of PLG pulses" — Set the number of PLG pulses
     Pr. 98 "auto tuning setting" = 1
     Pr. 99 "motor constant selection"= 0

   When the above conditions are all satisfied, the tuning mode is entered. When frequency monitoring is then selected with the PU, TUNE is displayed.

   As a difference between Pr. 48 "base frequency" and Pr. 66 "rated motor speed" is calculated as rated slip, the settings of these parameters should not be the same.

   [Reference] $\dfrac{\text{Pr. } 48 \times 120}{\text{Pr. } 65} > \text{Pr. } 66$

⚠ CAUTION

- Always set the correct value in Pr. 69 "number of PLG pulses".
- If the PLG pulse count setting is incorrect, the inverter cannot perform normal operation and may misoperate.
- SF-JR general-purpose motor with PLG: 1024 pulses
- SF-VR(H) vector control inverter motor: 1000 pulses

Note that the SF-VR(H) does not require auto tuning.

3) Auto tuning command

   In the PU operation mode, press the [FWD] or [REV] key.

   In the external operation mode, turn on the start switch (connect terminals across STF and SD or STR and SD).

   The following operation is then performed:

   (a) 3-phase AC excitation (R2, l (l1, l2) tuning)
   (b) 2-phase DC excitation (R1 tuning)
   (c) Speed is increased up to 75% of Pr. 48 "base frequency".
   (d) Constant-speed operation (for about 5 seconds) (L1 tuning)
   (e) Deceleration to stop
   (f) Tuning end

4) Tuning state monitoring

When the PU main monitor is switched to the frequency monitor during tuning, the value of Pr. 98 "auto tuning setting" is displayed on the main monitor and level meter of the PU as indicated below. The value is also displayed on the inverter LED (when Pr. 51 "inverter LED display data" = 1 (factory setting)):

TUNE is not displayed on the speed monitor.

	Initial value	Setting	Tuning in progress	Completion	Error activated end	Forced end
Pr. 98	0 →	1 →	2 →	3	9	8
PU display		TUNE 1	TUNE 2	TUNE 3	TUNE 9	TUNE 8

When Pr. 98 "auto tuning setting" is 8 or 9, auto tuning has not successfully ended and the motor constants are not set.

5) Instructions

- Even after auto tuning has ended, the inverter is still running. Press the [STOP] key once in the PU operation mode, or switch STF/STR off in the external operation mode.
- During auto tuning, the only external terminals valid are OH, MRS, RES, STF and STR, all the others are invalid.

(2) For use in direct setting mode

When 1 or 2 is set in Pr. 99 "motor constant selection" and 801 set in Pr. 77 "parameter write disable selection", the following parameters are accessible as motor constant parameters. (The ordinary parameter values do not change.)

Parameter	Name	Setting Range	Factory Setting	Pr. 77≠801 (Ordinary parameter setting)
0	Primary resistance (R1)	0 to 10Ω, 9999	9999	—————
1	Secondary resistance (R2)	0 to 10Ω, 9999	9999	Maximum setting
2	Primary leakage inductance (l1)	0 to 500mH, 9999	9999	Minimum setting
3	Secondary leakage inductance (l2)	0 to 500mH, 9999	9999	—————
4	Mutual inductance (M)	0 to 500mH, 9999	9999	3-speed setting (high speed)
5	Exciting current (no-load current) (ID)	0 to 500A, 9999	9999	3-speed setting (middle speed)

Note: When 801 is set in Pr. 77 "parameter write disable selection", parameters from Pr. 6 onward will be displayed. As they are parameters for manufacturer setting, do not change their values.

(3) To select the motor constants of the SF-JR5.5K to 45K (7.5HP to 60HP) (4-pole motor) with PLG

The SF-JR5.5K to 45K (7.5HP to 60HP) 4-pole motor equipped with a PLG can be driven under vector control without auto tuning being performed.

Vector control may also be exercised by performing auto tuning operation as previously explained. For the torque characteristics at this time, refer to "torque control" on page 57.

1) Set "801" in Pr. 77 "parameter write disable selection". (Note previous setting)
2) Set "3" in Pr. 99 "motor constant selection".
3) Return Pr. 77 "parameter write disable selection" to pervious setting, any of 0 to 2.

(4) Utilization of auto tuning data

By setting the following parameters, the auto tuning data of a (source) motor-inverter combination can be used for subsequent combinations, if they are made up of the same motor and inverter without repeating autotuning.

1) Retrieval of data of source inverter

- Parameter setting

(a) Set "801" in Pr. 77 "parameter write disable selection". (Note previous setting)

(b) Parameters used

Parameter Number	Name	Setting Range	Factory Setting	Pr.77≠801
41	Primary inductance	0 to 65535	9999	Up-to-speed sensitivity
42	Secondary inductance	0 to 65535	9999	Speed detection
43	Primary inductance	0 to 65535	9999	Low speed detection
44	Secondary inductance	0 to 65535	9999	Second acceleration/deceleration time
45	Mutual inductance	0 to 65535	9999	Second deceleration time
46	Exciting current	0 to 65535	9999	Second input terminal assignment
47	Torque current	0 to 65535	9999	Torque boost

(c) Read and record the values of Pr. 41 to Pr. 47.

(d) Return Pr. 77 "parameter write disable selection" to the previous value, any of 0 to 2.

2) Writing data to destination inverter

Write the auto tuning data of the source inverter.

- Parameter setting

(a) Set the auto tuning data of the source inverter in the following parameters:

Parameter Number	Name	Setting Range	Factory Setting
9	Electronic thermal overload protection	0 to 500A	Rated motor current (1.5K to 3.7K)/0A (5.5K to 45K)
48	Base frequency	50 to 200Hz	60Hz
49	Base frequency voltage	0 to 500V, 9999	9999
64	Motor capacity	0 to 55kW, 9999	9999
65	Number of motor poles	2 to 6, 9999	9999
66	Rated motor speed	0 to 3600r/min	1710r/min(1.5K to 3.7K) 1720r/min(5.5K, 11K) 1730r/min(7.5K, 15K) 1750r/min(18.5K to 30K) 1760r/min(37K, 45K)
69	Number of PLG pulses	0 to 4096	1000
99	Motor constant selection	0 to 2, 9999	9999
71	Applied motor	0, 1	0
74	Torque characteristic selection	0, 1	0

(b) Set "801" in Pr. 77 "parameter write disable selection" (note previous setting).

(c) Set the recorded data of the source inverter in Pr. 41 to Pr. 47.

(d) Return Pr. 77 "parameter write disable selection" to the previous value, any of 0 to 2.

(e) Perform power OFF/ON or reset.

1.8.17 Zero current detection function

Pr. 67 "open motor circuit detection level", Pr. 68 "open motor circuit detection time"

- When using the inverter for elevation applications, a torque may not be generated when the output current reaches "0", causing the lifter to drop.
  When the output current reaches "0", the inverter can output a "0" signal to prevent this.
- The output current is detected during motor operation. If the detected value is lower than the value set in Pr. 67 "open motor circuit detection level" for longer than the time set in Pr. 68 "open motor circuit detection time", an open motor circuit detection signal will be output from the inverter's output terminal PU (Pr. 40 (output terminal assignment) = 7) as the open collector signal.
  If the alarm "speed deflection value excessive (E.OSD)" is being output, the motor will coast simultaneously with the open collector signal output, and "E.OSD" will occur.

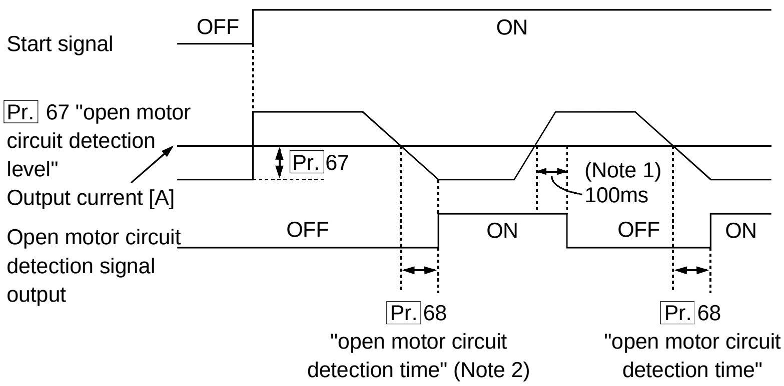
Parameter No.	Name	Setting Range	Factory Setting	Remarks
67	Open motor circuit detection level	0 to 50%	55%	100% rated current value
68	Open motor circuit detection time	0.05 to 1s, 9999	9999	9999: Zero current detection disabled
31	Speed deflection level	0 to 1500r/min, 9999	9999	9999: No OSD alarm

(1) Setting of open motor circuit detection level
In Pr. 67 "open motor circuit detection level", set at what rated current percent from 0A to detect the output current value is to be detected as a zero current.

(2) Setting of open motor circuit detection time
Set the time to output the alarm "speed deviation value excessive (E.OSD)" from the terminal PU after Pr. 67 "open motor circuit detection level" is entered.

Pr. 68	Open Collector	Alarm	
9999	PU signal (Pr. 40=7)	None	
Other than 9999	PU signal is used as open motor circuit detection	Pr. 31 = 9999	E.OSD display disabled
		Pr. 31 ≠ 9999	E.OSD display enabled

- Timing chart



(Note 1) The open motor circuit detection signal will hold the signal for approximately 100ms even if the set detection level is exceeded and the conditions are not established.
(Note 2) The sum of delay times such as current detection delay and transistor operation delay is up to 10ms.

1.8.18 PWM carrier frequency

Pr. 72 "PWM frequency"

- Use Pr. 72 to set the PWM carrier frequency of the FR-V200 series. This frequency can be changed by using Pr. 72 when trying to reduce the effects of motor-mechanical system resonance. Lowering the PWM carrier frequency will increase motor noise but reduce inverter-generated noise and leakage current
- Change the carrier frequency when the motor is at a stop.

- Parameter

Pr. 72 Setting	Carrier Frequency
0	Low
1	↓
2	
3	
4	
5	High
6	

1.8.19 Speed setting function (polarity reversible/override)

Pr. 73 "speed setting signal"

- When the override function is selected, the main speed can be set with the speed setting auxiliary terminal 1. Set the usage of terminals 1, 2 and 3 and the validity of the override function with Pr. 73.

Pr. 73	Control Mode	Function	Terminal 1 (+10V)*1	Terminal 2 (0 to 10V)	Terminal 3 (+10V)
☆0	Speed control	Analog uni-direction	Additional speed setting	Main speed setting	Torque restriction
1		Analog bi-direction			
2		Override uni-direction	Main speed setting	Override signal	
3		Override bi-direction*2			
☆0	Torque restriction	Speed restriction	Speed restriction correction	Speed restriction	Torque command
1					
2					
3					

*1: Terminal 1 (additional speed setting input) is added to terminal 2's main speed setting signal.

*2: When override is selected, terminal 1 becomes the main speed setting, and terminal 2 becomes the override signal (50 to 150% at 0 to 10V).

(Note 1) When changing the maximum output speed when the maximum speed command voltage is input, set the speed setting voltage gain Pr. 903 (Pr. 905).
The command voltage need not be input at this time.
The acceleration/deceleration time is sloped (has the same gradient) to the acceleration/deceleration reference speed and is not affected by changes of the Pr. 73 setting.

(Note 2) The setting marked ☆ is the factory setting.

1.8.20 torque characteristic selection

Pr. 74 "torque characteristic selection"

- When the motor with PLG is used, torque characteristics can be selected.

Pr. 74 Setting	Motor	
	Vector inverter motor (SF-VR)	Motor with PLG (SF-JR, etc.)
0 (factory setting)	Vector inverter motor torque characteristics	Cyclic operation mode
1		Continuous operation mode

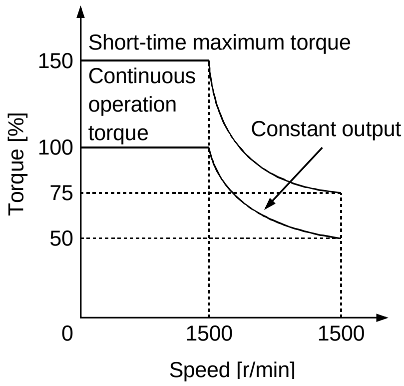
Note: To distinguish between vector inverter motor and motor with PLG, see the setting of Pr. 99 "motor constant selection".

- Torque characteristics of vector inverter motor

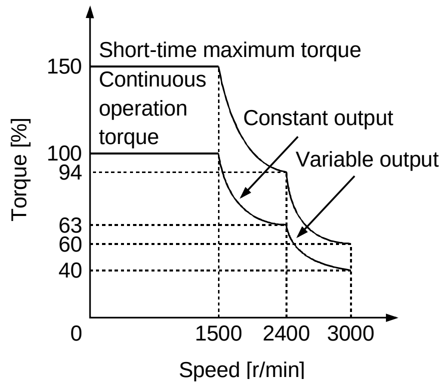
The torque characteristics of the motor used with the inverter of the same capacity when the rated voltage is input

1500r/min (50Hz) torque standard

<5.5 to 22 [kW]>



<30 to 45 [kW]>



Note: The above characteristics assume that the motor coil temperature is 75°C (167°F) or higher. At lower temperatures, torque will reduce.

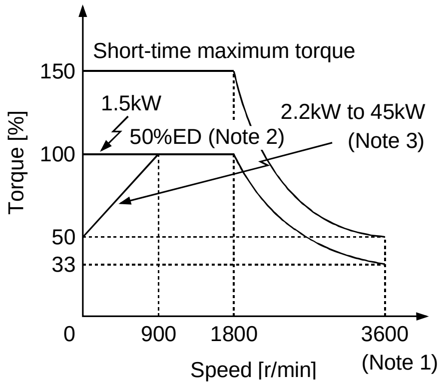
- Torque characteristics of motor with PLG (Example: SF-JR with PLG (4 poles)

The torque characteristics of the motor used with the inverter of the same capacity when the rated voltage is input

1800r/min (60Hz) torque standard

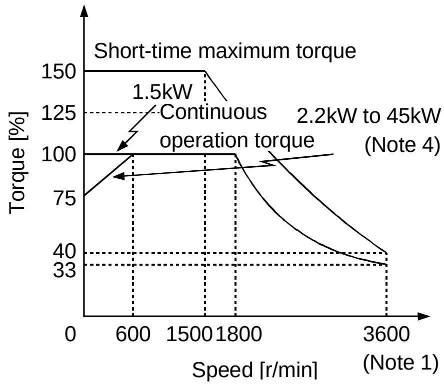
Cyclic operation mode setting

<1.5 to 45 [kW]>



Continuous operation mode setting

<1.5 to 45 [kW]>



(Note 1) Maximum speed is 1) 1.5kW (2HP) to 7.5kW (10HP): 3600r/min, 2) 11kW (15HP) to 30kW (40HP): 3000r/min, 3) 37kW (50HP) to 45kW (60HP): 1950r/min.

(Note 2) Continuously repeated operation at 50%ED is possible in the cycle time of 10 minutes. Note that continuous operation is performed up to 5 minutes.

(Note 3) When 50%ED of 100% torque is required for 2.2kW (3HP) or 3.7kW (5HP) at 900r/min or less, use the constant-torque motor (SF-JRCA).

(Note 4) When continuous 100% torque is required for 2.2kW (3HP) or 3.7kW (5HP) at 600r/min or less, use the SF-JRCA (constant-torque motor) with PLG.

1.8.21 PU stop key selection

Pr. 75 "PU stop key selection"

● Operation can be stopped by pressing the PU [STOP] key in a mode other than the PU operation mode.

Set Value	PU Stop Key Function	PU Disconnection Detection
0	PU stop key is valid in PU operation mode only.	Operation continues if PU is disconnected.
1 (Factory setting)	PU stop key is always valid.	
2	PU stop key is valid in PU operation mode only.	When PU is disconnected, inverter LED shows error and inverter shuts off output.
3	PU stop key is always valid.	

(Note 1) When the motor is decelerated to a stop with the PU [STOP] key during external operation, turn the terminal STF (STR) off once, press the PU [EXT OP] key, and then turn the terminal on again to restart operation.

(Note 2) Pr. 75 can be set any time regardless of the Pr. 77 "parameter write disable selection" value.

(Note 3) When the PU is not mounted, external operation will be used regardless of the Pr. 75 setting.

(Note 4) When "2" or "3" is set in Pr. 75

(a) When the PU is not connected in the connector from the beginning, it is not regarded as an alarm.

(b) The PU is judged as disconnected when it is kept disconnected for more than 1 second.

(c) To make a restart, make sure that the PU is connected, then reset the inverter.

(d) The Pr. 75 value can be set any time and this setting does not return to the initial value if parameter clear or all clear is performed.

1.8.22 Alarm definition

Pr. 76 "alarm definition"

● Alarms are classified into major and minor faults. When a major fault has occurred, the motor is immediately coasted.

● A minor fault indicates "E.OHT". A major fault indicates any alarm other than "E.OHT".

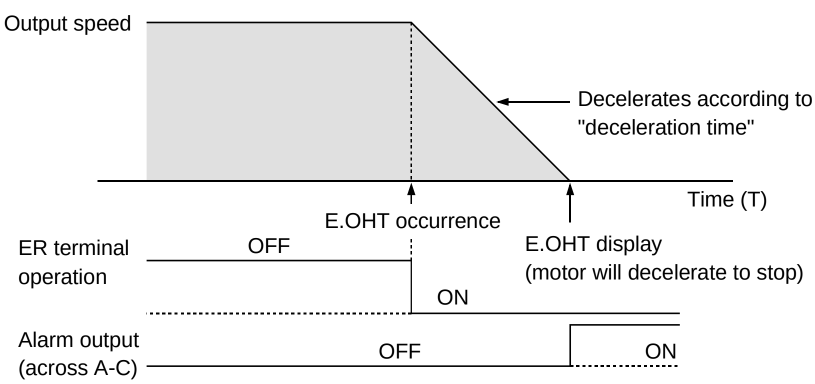
● Operation

(1) Pr. 76 = 0: Normal operation is performed.
When any alarm occurs, the inverter will shut off its output and coast the motor. If the ER terminal is assigned with Pr. 40 "output terminal assignment", the ER terminal will also turn on.

(2) Pr. 76 = 1: Fault definition selection

1) When an alarm other than OHT occurs, the inverter will shut off its output and coast the motor. The ER terminal will also turn on.

2) When an OHT alarm occurs, the motor will decelerate according to Pr. 8 "deceleration time". The ER terminal will also turn on. If DC braking is applied after decelerating, the inverter will shut off its output and coast the motor.



1.8.23 Speed setting filter function

Pr. 80 "speed control P gain 1" (when RT terminal is OFF)
Pr. 90 "speed control P gain 2" (when RT terminal is ON)

- The proportional gain of the speed loop is set. The speed response will increase when the setting is increased, but when set too high, vibration or noise may be generated.
- The setting range for Pr. 80 "speed control P gain 1" and Pr. 90 "speed control P gain 2" is 0 to 1000%. The factory setting is 30%.
  Generally these parameters are adjusted between 10 and 100 %.

1.8.24 Speed detection filter function

Pr. 83 "speed detection filter 1" (when RT terminal is OFF)
Pr. 93 "speed detection filter 2" (when RT terminal is ON)

- To prevent noise in the speed feedback signal from affecting the speed control, this smoothing filter can be set.
  The speed loop response will drop, but the speed ripple will be reduced.
  Set the time constant when the motor rotation needs to be stable.
  Note that if the value is too high, the motor operation will be unstable.
- The setting range for Pr. 83 "speed detection filter 1" and Pr. 93 "speed detection filter 2" is 0 to 5 seconds. The factory setting is 0 seconds (no filter).
  (Note) If the speed ripple is large, the operation can be stabilized by setting Pr. 83 and Pr. 93.

1.8.25 Torque setting filter function

Pr. 86 "torque setting filter 1" (when RT terminal is OFF)
Pr. 96 "torque setting filter 2" (when RT terminal is ON)

- To prevent noise in the torque setting signal line from affecting torque control, this smoothing filter can be set. When the follow-up to the torque command is to be delayed, set the time constant.
- The setting range for Pr. 86 "torque setting filter 1" and Pr. 96 "torque setting filter 2" is 0 to 5 seconds. The factory setting is 0 seconds (no filter).

1.8.26 Torque detection filter function

Pr. 87 "torque detection filter 1" (when RT terminal is OFF)
Pr. 97 "torque detection filter 2" (when RT terminal is ON)

- To prevent noise in the torque feedback signal from affecting torque control, this smoothing filter can be set.
  The current loop response will drop, but the torque vibration will be reduced.
  Set the time constant when the torque is to be generated stably.
- The setting range for Pr. 87 "torque detection filter 1" and Pr. 97 "torque detection filter 2" is 0 to 5 seconds. The factory setting is 0 seconds (no filter).

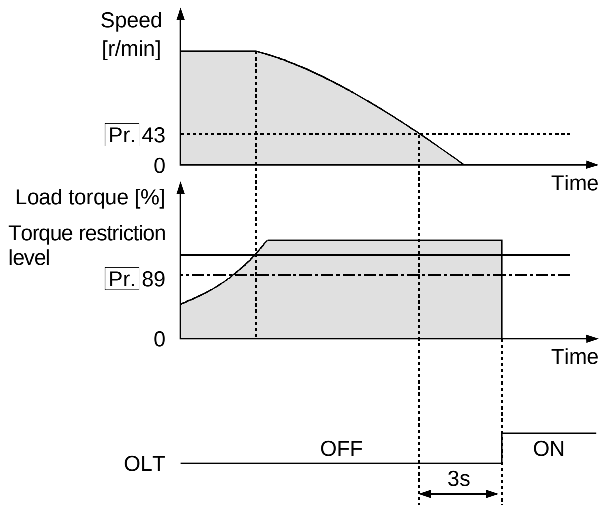
1.8.27 OLT level adjustment

Pr. 89 "OLT level adjustment"

- Set this parameter to determine the load level of the motor at which OLT will occur.

Setting Range	Factory Setting
0 to 200%	150%

- When the torque restriction is applied during operation to make the motor speed lower than Pr. 43 "low speed detection", the OLT alarm will occur if the load applied to the motor is larger than the Pr. 89 setting for more than 3 seconds.



1.8.28 PLG rotation direction selection

Pr. 156 "PLG rotation direction"

- The rotation direction of the PLG can be set as listed below:

Setting	Motor Rotation Direction	PLG Rotation Direction
0 (factory setting)	Counterclockwise (ccw)	Forward rotation
	Clockwise (cw)	Reverse rotation
1	Counterclockwise (ccw)	Reverse rotation
	Clockwise (cw)	Forward rotation

Note: The forward rotation of the PLG rotation direction indicates that the A-phase signal leads the B-phase signal by a phase angle of 90°.

- The rotation direction monitor screen of the parameter unit shows the rotation direction of the encoder.
  - ○ When the command is STF FWD is displayed.
    or
  - ○ When the command is STR REV is displayed.

  } Using Pr. 156, set the rotation direction to satisfy the left condition.

1.8.29 Excitation ratio setting

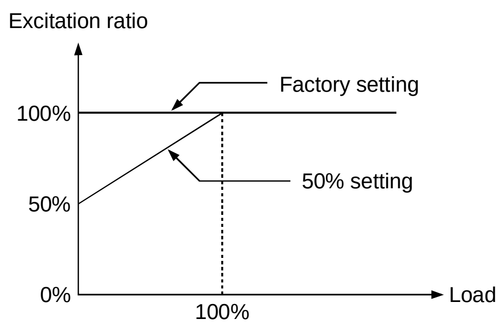
Pr. 157 "excitation ratio"

Note: With the version-up, Pr. 157 has been added.

(1) Excitation ratio parameter

Parameter Number	Name	Setting Range	Factory Setting
157	Excitation ratio	0 to 100%	100%

This parameter is used to set the excitation ratio under no load.



- Increasing the excitation ratio
  The speed control gain rises equivalently. Therefore, setting the no-load excitation ratio to 100% reduces speed fluctuation as compared to the excitation ratio of 50%. However, light-load motor magnetic noise increases.
- Decreasing the excitation ratio (weak excitation function)
  Light-load motor magnetic noise decreases.
  However, the speed control gain lowers equivalently.
- Instruction information
  The initial value differs from that of the conventional product. To set the same initial value as the conventional product, set the following value in the parameter:
  Pr. 157 = 50%

(2) Conventional product

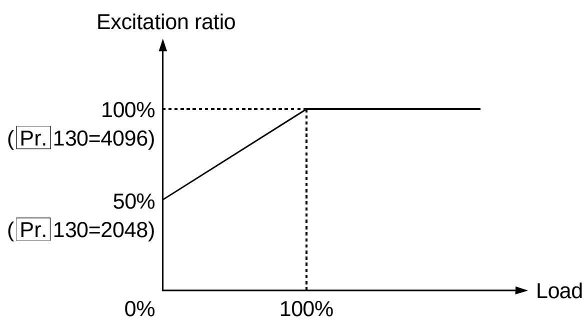
Parameter Number	Name	Setting Range	Factory Setting	Remarks
130	Excitation ratio	0 to 65535	9999	Factory-set to 50%. (Equivalent to 100% at setting of 4096)

<Setting procedure>

Example: To set the excitation ratio to 100%

1) Set "801" in Pr. 77 "parameter write inhibit selection".
2) Set "4096" (= 4096 × 100%/100) in Pr. 130 "excitation ratio".
3) Return Pr. 77 to the original value.

Note: Enter "65535" to return the Pr. 130 value to the factory setting

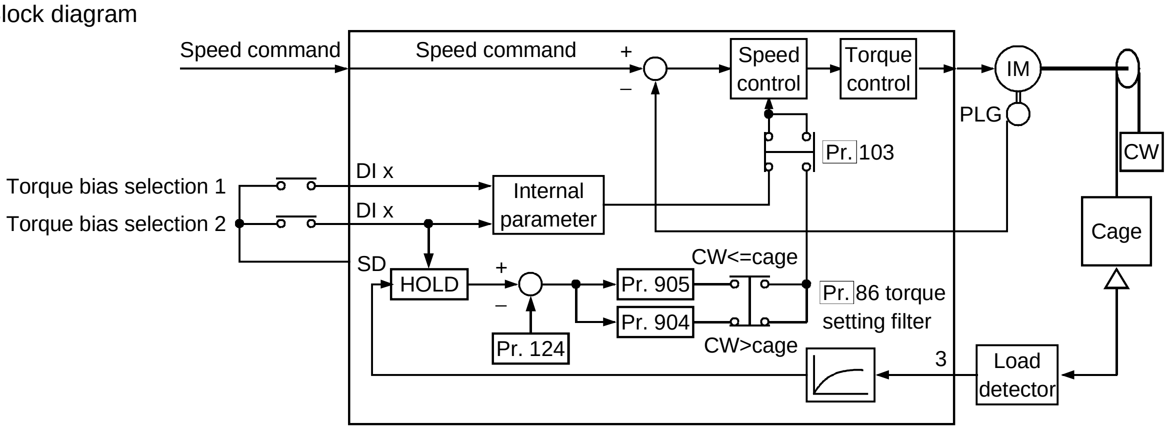


1.8.30 Torque bias function

Pr. 46 "second multi-function input selection"
Pr. 103 "torque bias selection"
Pr. 104 "torque bias 1"
Pr. 105 "torque bias 2"
Pr. 106 "torque bias 3"

The torque bias function makes the torque rise faster when the motor starts. Use the contact signal or analog signal to set the output torque at that time.

(1) Block diagram



(2) Terminal functions

Terminal Name	Symbol	Description
Torque bias selection 1	Assigned from among DI1 to DI3 using Pr. 46.	Torque bias selection signal for torque bias function used by setting internal parameter.
Torque bias selection 2		Torque bias selection signal for torque bias function used by setting internal parameter.
Torque bias analog input	3	Input terminal for torque bias function used by entering external analog signal.

(3) Parameter

Pr.	Name	Setting Range	Factory Setting	Setting Increments	Remarks
46	Second input terminal assignment	0 to 999, 9999	9999	Integer	Torque bias selection 1 by setting of 2. Torque bias selection 2 by setting of 3. No second multi-function input assignment by setting of 9999.
103	Torque bias selection	0 to 3, 9999	9999	Integer	9999: No torque bias selection.
104	Torque bias 1	600 to 1400, 9999	9999	1%	No torque bias setting by setting of 9999. Rated torque is 100%. Torque bias is 0 by setting of 1000%. Centering around 1000%, (setting - 1000%) is a torque bias amount.
105	Torque bias 2	600 to 1400, 9999	9999	1%	
106	Torque bias 3	600 to 1400, 9999	9999	1%	
147	Torque bias filter	0 to 5s, 9999	9999	0.001s	9999 is equal to 0 seconds.
148	Torque bias operation time	0 to 5s, 9999	9999	0.01s	9999 is equal to 0 seconds.
149	Torque bias balance compensation	0 to 300, 9999	9999	0.1V	9999 is equal to 0 setting.
152	Fall-time torque bias No. 3 bias	0 to 300, 9999	9999	1%	9999 is equal to rise.
153	Fall-time torque bias No. 3 gain	0 to 300, 9999	9999	1%	9999 is equal to rise.
904	Torque command bias	0 to 10V 0 to 400%	0V ¦ 0%	– ¦ 0.1%	
905	Torque command gain	0 to 10V 0 to 400%	0V ¦ 150%	– ¦ 0.1%	

(4) Parameter details

1) Pr. 46 (second multi-function input selection)

Pr. 46 =	☐	☐	☐
	First digit	Second digit	Third digit
	DI1	DI2	DI3

- Assign the terminal by setting 2 (torque bias selection 1) or 3 (torque bias selection 2) in any digit.
- If the numeral set in any of the digits is other than 2 or 3, the setting in Pr. 17 is made valid.

2) Pr. 103 (torque bias selection)

When Pr. 103 = 9999, torque bias selection is not made.

When Pr. 103 = other than 9999, torque bias selection is made. The torque bias setting is as follows:

Pr. 103 Setting	Torque Bias Setting Method	Description
0	3-point internal parameter	Torque bias setting is made by internal parameters.
1	External analog input	Cage rises when motor runs in forward rotation direction.
2	External analog input	Cage rises when motor runs in reverse rotation direction.
3	External analog input	Automatic setting.

(a) Pr. 103 = 0

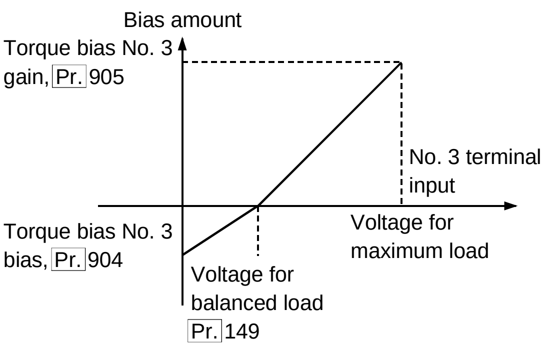
Any of the following torque bias amounts is chosen by the combination of contact signals:

Torque Bias Selection 1	Torque Bias Selection 2	Torque Bias
OFF	OFF	No selection
ON	OFF	Pr. 104, 1000 to 1400%: Positive value 600 to 999%: Negative value
OFF	ON	Pr. 105, 1000 to 1400%: Positive value 600 to 999%: Negative value
ON	ON	Pr. 106, 1000 to 1400%: Positive value 600 to 999%: Negative value Example: 25% when Pr. 104 = 1025 –25% when Pr. 105 = 975 –75% when Pr. 106 = 925

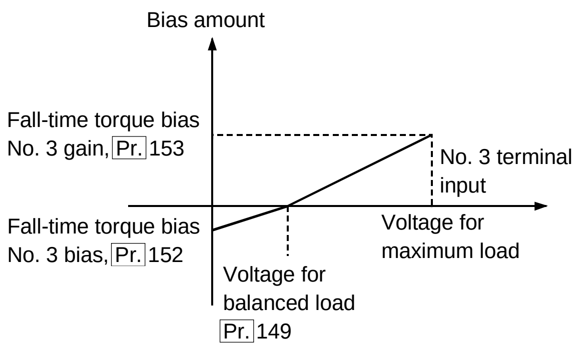
(b) Pr. 103 = 1

From the load input from No. 3 terminal, the torque bias is calculated as shown below, applying the torque bias.

During rise (motor in forward rotation)

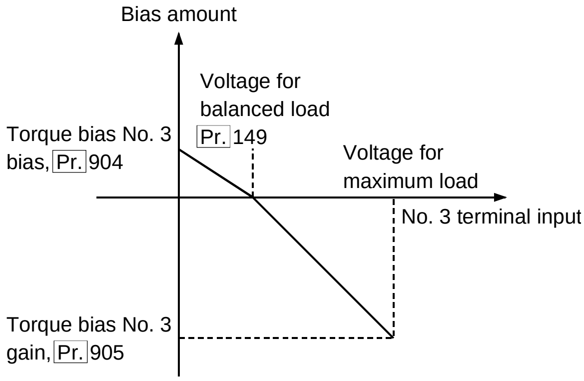


During fall (motor in reverse rotation)

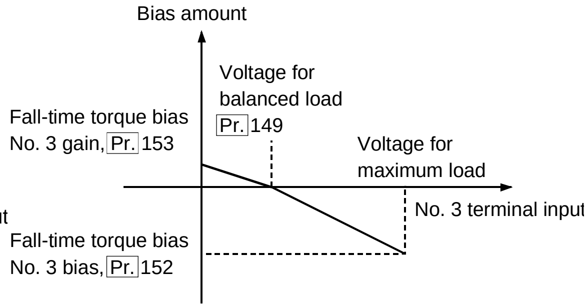


(c) Pr. 103 = 2 (cage rises when motor runs in reverse rotation)

During rise (motor in reverse rotation)



During fall (motor in forward rotation)



(d) Pr. 103 = 3 (automatic adjustment mode)

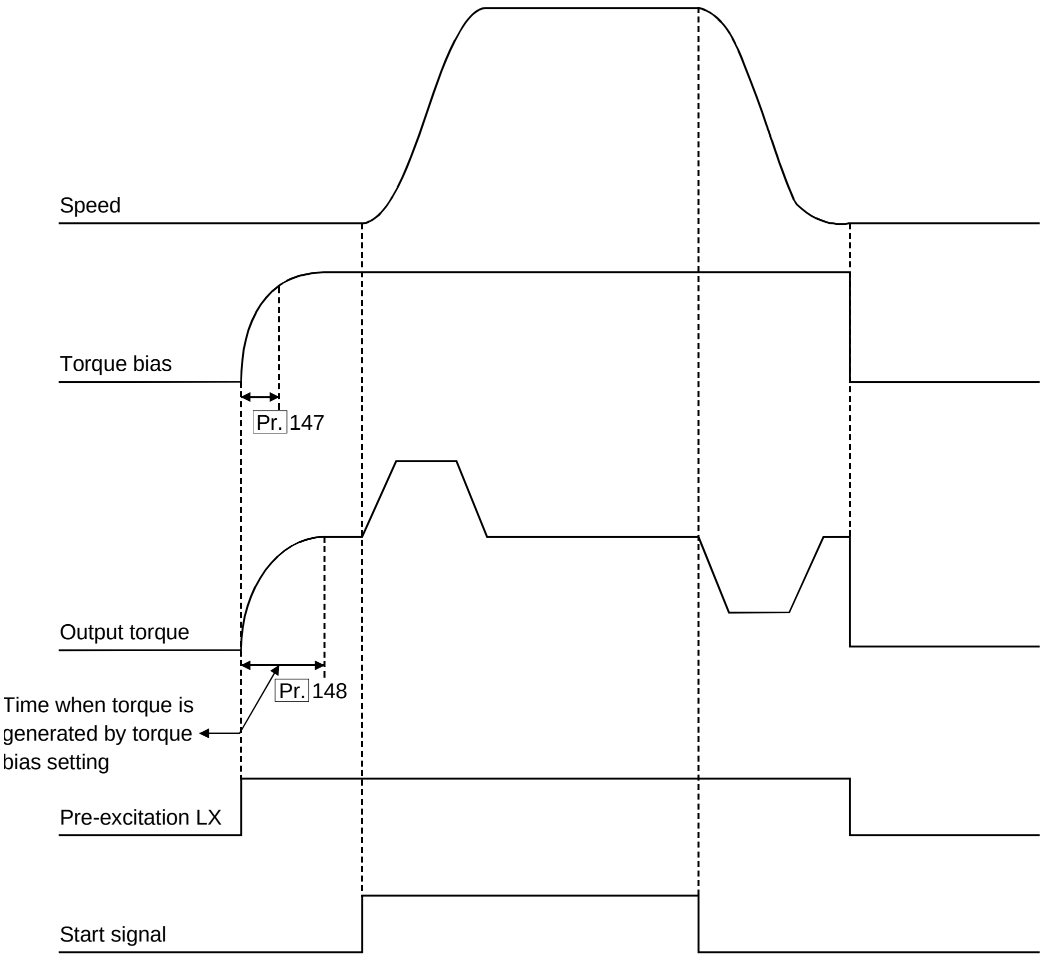
Torque bias operation is not performed.

Run under no load, read the Pr. 904 value when the speed has stabilized, and press the write key with no setting to automatically set the torque bias No. 3 bias. Run under the maximum load, read the Pr. 905 value, and press the write key with no setting to automatically set the torque bias No. 3 gain.

Under a balanced load, read the Pr. 124 value and press the write key with no setting to set the torque bias balance compensation for the driving mode.

When performing torque bias operation after setting, re-set "1" or "2" in Pr. 103.

(5) Torque bias operation



When pre-excitation is not made, the torque bias functions simultaneously with the start signal.

1.8.31 Secondary resistance compensation function

Pr. 150 "secondary resistance compensation coefficient"
Pr. 151 "secondary resistance compensation function selection"

Reduces the temperature drift of the output torque caused by temperature change after auto tuning.

(1) Parameters

Pr.	Function	Setting Range	Setting Increments	Factory Setting	Remarks
150	Secondary resistance compensation coefficient	0 to 200%, 9999	1%	9999	When 100% is set, the auto tuning result value or the secondary resistance setting of the inverter motor is used unchanged. No compensation for 9999 (equivalent to 100%). This value can be read when Pr. 77 = 801.
151	Secondary resistance compensation (Permissible temperature rise of motor)	0 to 200°C, 9999	Integer	9999	Permissible temperature rise 75°C for motor insulation class E Permissible temperature rise 80°C for motor insulation class B Permissible temperature rise 100°C for motor insulation class F No compensation for a setting of 9999.

(2) Details

- Pr. 150, secondary resistance compensation coefficient

  Compensates for the value of secondary resistance R2 found by auto tuning or the setting of the secondary resistance R2 for the vector control inverter motor.

  R2 = R2' × Pr. 150/100

  ● Adjustment method

Phenomenon	Pr. 150
Torque is slightly less at low speed.	Reduce from 100%.
Excitation is slightly excessive at low speed.	Increase setting from 100%.
Voltage saturation takes place near rated speed. (Voltage monitor value slightly increases)	Increase setting from 100%.

- Pr. 151, secondary resistance compensation function selection

  Make selection whether R2 is compensated for by estimation of heat generated. When making temperature compensation, set the upper limit of temperature rise in Pr. 151 according to the type of motor insulation.

  (a) Setting = 9999

  No compensation.

  (b) Setting = other than 9999

  R2" is compensated for R2 on the basis of the heat generation amount estimated.

  $R2'' = R2'(1+\Delta T/234.5)$ ΔT is estimated from the current.

1.8.32 Droop control function

Pr. 88 "droop gain"
Pr. 145 "droop operation selection"
Pr. 155 "droop filter time constant"

This function provides a droop characteristic for the speed in proportion to the load torque.

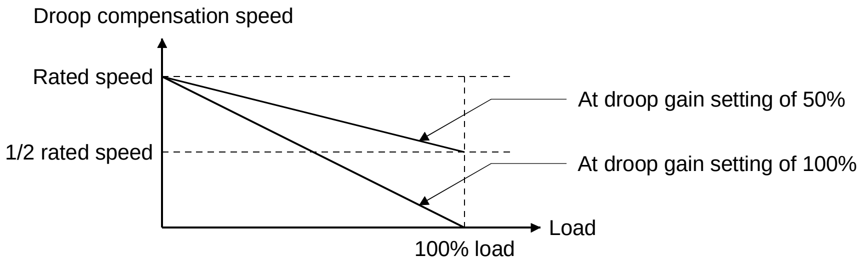
(1) Parameters

Pr.	Function	Setting Range	Setting Increments	Factory Setting	Remarks
88	Droop gain	0 to 100%, 9999	0.01%	9999	9999: No droop
145	Droop operation selection	0,1, 9999	Integer	9999	Accessible when Pr. 77=801 9999 or 0: No droop operation during acceleration/deceleration 1: Droop operation performed during acceleration/deceleration
154	Droop filter time constant	0.00 to 1.00s, 9999	0.01s	9999	Droop filter 0.3 seconds for 9999

(2) Details

- The speed command is variable according to the magnitude of the motor load (inverter's load meter).
  As the droop gain, set the rated-torque droop amount in % with reference to the rated speed.
  At the setting of 100% droop gain, the speed for droop compensation under 100% load is the rated speed.
  As the droop filter time constant, set the time constant of the primary delay filter for the torque current.

$$\text{Droop compensation speed} = \frac{\text{After-filtering load meter}}{\text{100\% load meter}} \times \frac{\text{Rated speed} \times \text{droop gain}}{100}$$



- Droop compensation frequency limiter
  Limited to 3600rpm or Pr. 1 (maximum speed) value.
- Valid range for droop control
  Made valid when droop gain ≠ 0 or 9999.
  When Pr. 145 = 0 or 9999, droop control is not exercised during acceleration/deceleration.
  When Pr. 145 = 1, droop control is always performed during operation. (Droop control is exercised also during acceleration/deceleration.)

1.8.33 Misoperation prevention function for different PLG pulse count

Pr. 146 "speed limit"

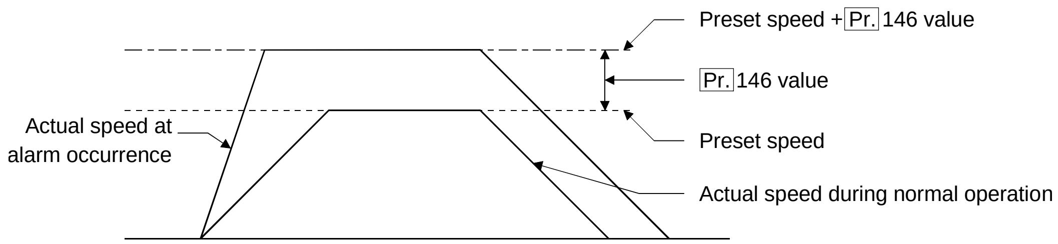
This function prevents misoperation from occurring even when the actual number of pulses is different from the setting of the PLG pulse count.

(1) Parameter

Pr.	Function	Setting Range	Setting Increments	Factory Setting	Remarks
146	Speed limit	0 to 3600rpm, 9999	1rpm	9999	9999: 150rpm (10% of rated speed of SF-VR) Accessible when Pr. 77=801.

(2) Details

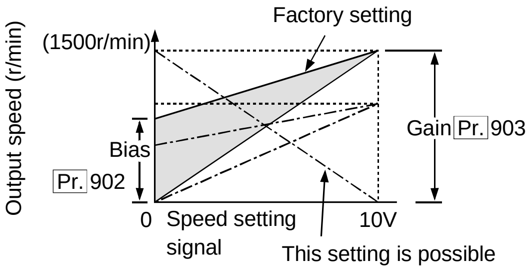
If the setting of the PLG pulse count is smaller than the actual number of pulses, the motor may increase speed. Hence, the output frequency is clamped at the synchronous frequency derived from the preset speed + Pr. 146 value.



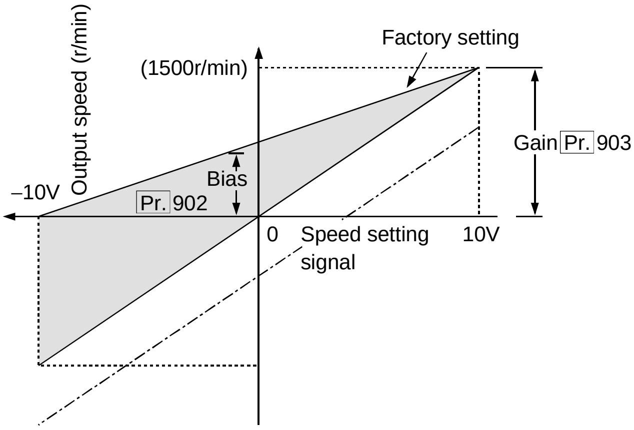
1.8.34 Speed setting signal calibration (bias, gain)

Pr. 902 "speed setting second bias", Pr. 903 "speed setting second gain"

- Allows the output speed to be set in relation to the speed setting signal (0 to 10VDC).



- The terminal 1 (speed setting auxiliary input) setting is also inclined as set in Pr. 902 and Pr. 903.



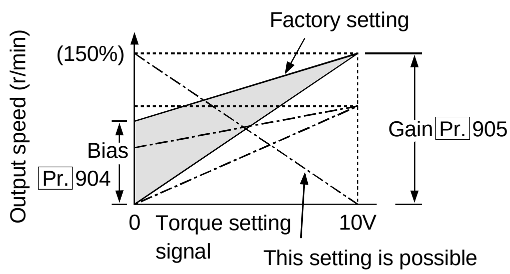
(Note 1) If the gain adjustment (Pr. 903) is changed, the acceleration/deceleration reference speed (Pr. 20) does not change. The signal to the terminal 1 (auxiliary input) is added to the speed setting signal.

(Note 2) Positive value may only be set in Pr. 902 "speed setting second bias" and Pr. 903 "speed setting second gain".

1.8.35 Torque setting signal calibration (bias, gain)

Pr. 904 "torque bias No.3 bias", Pr. 905 "torque bias No.3 gain"

- Allows the output speed to be set in relation to the torque setting signal (0 to 10VDC).



(Note 1) If the gain adjustment (Pr. 905) is changed, the acceleration/deceleration reference speed (Pr. 20) does not change. The signal to the terminal 1 (auxiliary input) is added to the speed setting signal.

1.9 Protective Functions

1.9.1 Errors

If any fault has occurred with the inverter, the corresponding protective function is activated to bring the inverter to an alarm stop and automatically give the corresponding alarm indication on the PU display and inverter LED. When the protective function is activated, reset the inverter.

(1) Alarms

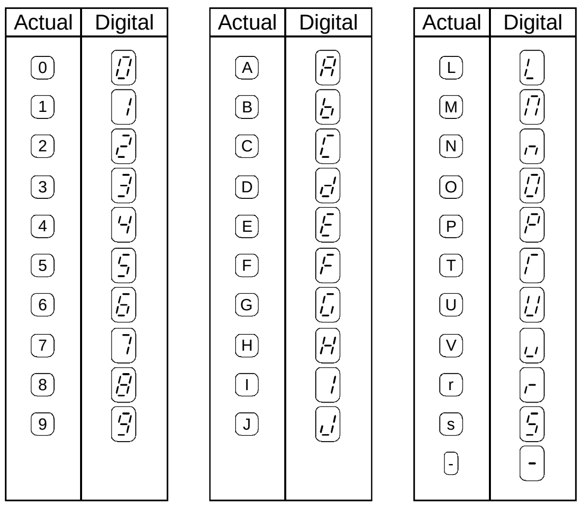
Display: Parameter unit	Display: Inverter LED	Description	Alarm Output (Across B - C)
OC During Acc	E.OC1	If the inverter output current reaches or exceeds 200% of the rated current, the protective circuit is activated to stop the inverter. When any main circuit device is overheated or a ground fault occurs, the protective circuit is also activated to stop the inverter output.	Provided (Open)
Stedy Spd Oc	E.OC2		
OC During Dec	E.OC3		
Ov During Acc	E.OV1	If the converter output voltage is excessive due to the regenerative energy from the motor, the protective circuit is activated to stop the transistor output. This may also be activated by a surge voltage generated in the power supply system.	Provided (Open)
Stedy Spd Ov	E.OV2		
Ov During Dec	E.OV3		
Motor Overload	E.THM (Motor protection)	The electronic overcurrent protection in the inverter detects inverter overload or motor overheat and activates the protective circuit to stop the inverter output. When a multi-pole motor or more than one motor is driven, for example, the motor(s) cannot be protected by the electronic overcurrent protection. Provide a thermal relay in the inverter output circuit. In this case, setting the electronic overcurrent protection value to 0A activates the inverter protection only. (Activated at a current 150% or more of the rated current.)	Provided (Open)
Inv. Overload	E.THT (Inverter protection)		
Inst. Pwr. Loss	E. IPF	If an instantaneous power failure has occurred for longer than 15ms (this applies also to inverter input power shut-off), this function is activated to stop the inverter output to stop the inverter output. (If the power failure is within 15ms, the control circuit operates without fault. If the power failure persists for more than about 100ms, the protective circuit is reset.)	Provided (Open)
Under Voltage	E.UVT	If the inverter power supply voltage has reduced, the control circuit cannot operate properly, resulting in the decrease in motor torque and/or the increase in heat generation. To prevent this, if the power supply voltage reduces below about 150V (300V for the 400V class), this function stops the inverter output.	Provided (Open)
Br. Cct. Fault (Note)	E. BE	If the brake transistor fault has occurred due to extremely large regenerative brake duty etc., this function detects that fault and stops the inverter output.	Provided (Open)
OH Fault	E.OHT	If the internally mounted temperature relay or the like in the motor has been switched on (relay contacts "open"), this function stops the inverter output and keeps it stopped.	Provided (Open)

Note: Displayed only for the FR-V220E-5.5K or less and FR-V240E-5.5K or less.

Display		Description	Alarm Output (Across B - C)
Parameter unit	Inverter LED		
OL is shown during motor rotation. Stll Prev STP is shown to indicate that motor speed is lower than low-speed detection setting.	E.OLT	When torque restriction is activated during operation and motor speed has become lower than Pr. 43 "low-speed detection", the output is stopped if load applied to the motor is higher than Pr. 89 "OLT level setting" for longer than 3 seconds.	Provided by OLT display (Open)
Option Fault	E.OPT	Stops the inverter output if the dedicated option used in the inverter results in setting error or connection (connector) fault.	Provided (Open)
Corrupt Memry	E. PE	Stops the output at occurrence of the device fault of E^2PROM which stores the function set values.	Provided (Open)
CPU Fault	E.CPU	If the arithmetic operation of the built-in CPU does not end within a predetermined period of time, the inverter self-determines it as an alarm and stops its output.	Provided (Open)
Overspeed occurrence	E. OS	Indicates that the motor speed has exceeded the set overspeed level.	Provided (Open)
Excessive speed deflection	E.OSd	Indicates that deflection between the speed setting and motor speed has exceeded the deflection level. This is also displayed when the current does not flow in the motor after the forward rotation (reverse rotation) command is turned on.	Provided (Open)
No encoder signal	E.ECT	The PLG pulse is not being input.	Provided (Open)
Excessive position error	E. Od	Indicates that the difference between the position command and position feedback has exceeded the reference.	Provided (Open)
No encoder A signal	E.ECA	The PLG pulse for the FR-VPA is not being input.	Provided (Open)

● To know the operating status at the occurrence of alarm
When any alarm has occurred, the display automatically switches to the indication of the corresponding protective function. By pressing the [MONITOR] key at this point without resetting the inverter, the display shows the speed. In this way, it is possible to know the running speed at the occurrence of the alarm. It is also possible to know the current in the same manner. These values are not stored in memory and are erased when the inverter is reset.

(2) Correlation between Digital and Actual Characters
There are the following correspondences between the alphanumeric characters and actual characters given in the display examples of this manual.



1) Alarm History (History of alarm definitions)
Up to eight most recent alarms (alarm definitions) are stored in memory. To check these, use the help function.

2) Erasing the Alarm History (History of alarm definitions)
To erase the alarm history (history of alarm definitions), use the help function.

(3) Faults and Check Points

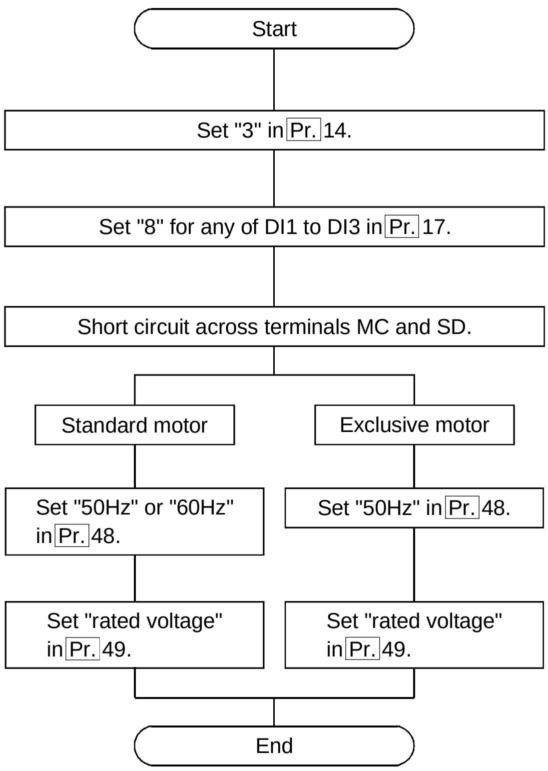
Fault	Typical Check Point
Motor does not rotate.	(1) Checking the main circuit ●Check that a proper power supply voltage is applied (inverter LED display is lit). ●Check that the motor is connected properly. (2) Checking the input signals ●Check that the start signal is present. ●Check that both the forward and reverse rotation start signals are not present simultaneously. ●Check that the speed setting signal is not zero. ●Check that the output stop signal (across terminals DI and SD) or reset signal (across RES and SD) is not on. (3) Checking the parameter set values ●Check that the reverse rotation prevention (Pr. 78) is not set. ●Check that the operation mode (Pr. 79) setting is correct. ●Check that the bias and gain (Pr. 902 to Pr. 905) settings are correct. ●Check that various operational functions (such as three-speed operation), especially the maximum frequency, are not zero. (4) Checking the load ●Check that the load is not too heavy and the shaft is not locked. (5) Others ●Check that the inverter LED display (alarm such as E.OC1) is not lit.
Motor does not operate properly.	●Check that the PLG wiring is connected properly. ●Check that the PLG signal is input properly.
Motor rotates in opposite direction.	●Check that the start signals (forward rotation, reverse rotation) are connected properly. ●Check that the phase sequences of the output terminals U, V, W and PLG signal (phases A, B) are correct.
Speed greatly differs from the set value.	●Check that the speed setting signal is proper. (Measure the input signal level.) ●Check that the following parameter settings are proper: Maximum setting (Pr. 1), minimum setting (Pr. 2), bias, gain (Pr. 902 to Pr. 905). ●Check that the input signal lines are not affected by external noise. (Use of shielded cables)
Acceleration/deceleration is not smooth.	●Check that the acceleration/deceleration time set value is not too short. ●Check that the load is not too heavy.
Motor current is large.	●Check that the load is not too heavy.
Speed does not increase.	●Check that the maximum frequency set value is proper, i.e. it is not too small. ●Check that the load is not too heavy.
Speed varies during operation.	(1) Inspection of load ●Check that the load is not varying. (2) Inspection of input signal ●Check that the speed setting signal is not varying.
PU to Inverter comms. Error Inv. Reset ON	●Check that the reset signal (across terminals RES and SD) is not ON. ●Check that the parameter unit is connected to the connector correctly.
Motor current is unbalanced.	●Check that there are no open phases.

Note: Pr. indicates a parameter.

Display		Cause of Fault	Check Point	Remedy
Parameter unit	Inverter LED			
No encoder signal	ECT: No encoder signal	The PLG pulse is not being input.	● Check for loose connector. ● Check for wire breakage in cable.	● Securely connect. ● Replace cable.
PU to Inverter comms. Error Inv. Reset ON	0.00 (LED display proper)	● Reset signal ON ● Loose connection between PU and inverter ● Communication circuit fault	● Check for miswiring to reset terminal. ● Check for loose connector.	● Turn the reset signal off. ● Securely connect. ● Change inverter.
Excessive position error	OD: Position error large	Difference between position command and position feedback exceeded detection level.	● Check that the installation direction of the encoder for position detection and parameters match. ● Is the load too large?	● Check the parameters. ● Lighten the load.
No encoder A signal	ECA: No encoder signal	The PLG pulse for the FR-VPA is not being input.	● FR-VPA connected properly? ● Check for loose connector. ● Check for wire breakage in cable. ● Check for detector fault.	● Securely connect. ● Replace cable. ● Replace the detector.

(4) Temporary Measures for PLG Fault

Vector control may be disabled and the motor may not rotate when a PLG fault occurs. In this case, V/F control operation can be used to rotate the motor as a temporary measure until the PLG is replaced with a good one.



·········· Pr. 14 "control mode" changes to "speed-V/F control".

·········· "Control mode switching" (terminal MC) will be assigned to any of DI1 to DI3 in Pr. 17 "input pin assignment".

·········· The operation will change to "V/F control".

·········· The factory setting for Pr. 48 "base frequency" is 60Hz, but this must be rewritten to the rated value 50Hz of the motor for vector control, but this must be rewritten to the rated value 50Hz of the motor when vector control is used.

·········· The factory setting for Pr. 49 "base frequency voltage" is 9999, but this must be rewritten to the rated value. (When using Mitsubishi vector motor, 160V (200V class) or 320V (400V class), "when using standard motor, rated value is 200V (200V class) or 400V (400V class).")

V/F control operation is possible with the above settings.

Note: During V/F control operation, torque control and position control will be disabled. Also, the current limit (torque restriction) function and automatic restart after instantaneous power failure are invalid.

1.9.2 Troubleshooting

If any function of the inverter is lost due to occurrence of a fault, establish the cause and make correction in accordance with the following inspection procedure. Contact your sales representative if the corresponding fault is not found below, the inverter has failed, a part has been damaged, or any other fault has occurred.

Checking the Parameter Unit Display

The displays of the parameter unit and inverter LED are switched as follows to indicate the cause of a faulty operation.

Display		Cause of Fault	Check Point	Remedy
Parameter unit	Inverter LED			
OC During Acc	OC1: Overcurrent during acceleration	Overcurrent Main circuit device overheat	● Acceleration too fast? ● Check for output short circuit or ground fault. ● Check for cooling fan stop.	● Increase acceleration time. ● Change fan. Remove obstacle to cooling fan. (Note 1)
Stedy Spd Oc	OC2: Overcurrent during constant speed		● Sudden load change? ● Check for output short circuit or ground fault. ● Check for cooling fan stop.	● Keep load stable. ● Change fan. Remove obstacle to cooling fan. (Note 1)
OC During Dec	OC3: Overcurrent during deceleration		● Deceleration too fast? ● Check for output short circuit or ground fault. ● Check for cooling fan stop. ● Mechanical brake of motor operate too fast?	● Increase deceleration time. ● Change fan. Remove obstacle to cooling fan. (Note 1) ● Check brake operation.
Ov During Acc	OV1: Overvoltage during acceleration	Overvoltage on DC bus (terminals P (+) and N (–))	Acceleration too fast?	Increase acceleration time.
Stedy Spd Ov	OV2: Overvoltage during constant speed		Sudden load change?	Keep load stable.
Ov During Dec	OV3: Overvoltage during deceleration		Deceleration too fast?	● Increase deceleration time. (Set deceleration time which matches load GD^2.) ● Reduce braking duty.
Motor Overload	THM: Overload alarm	Thermal relay for motor	Motor used under overload?	● Reduce load. ● Increase motor and inverter capacities.
Inv. Overload	THT: Overload alarm	Thermal relay for inverter		
Inst. Pwr. Loss	IPF: Instantaneous power failure	Instantaneous power failure	Check the cause of instantaneous power failure.	
Under Voltage	UVT: Under voltage	● Drop of power supply voltage ● No jumper across terminals P (+)-P1.	● Large-capacity motor started? ● Check for jumper across terminals P (+)-P1.	● Check power system equipment such as power supply capacity. ● Install jumper if disconnected.
Br. Cct. Fault	BE: Brake transistor alarm	Brake transistor fault (only 5.5K or less)	Braking duty proper?	● Reduce load GD^2. ● Reduce braking duty.
Overspeed occurrence	OS: Overspeed occurrence	The motor speed exceeded the set overspeed level.		
OH Fault	OHT: External thermal relay operation	Temperature detector in motor operated.	Check motor for overheat.	Reduce load and frequency of operation.
Stll Prev STP	OLT: Stall prevention	Stall prevention or current limit function activated too long.	Motor used under overload?	● Reduce load. ● Increase motor and inverter capacities.
Option Fault	OPT: Inboard option connection alarm	Option and inverter connected improperly.	Check for loose connector.	Securely connect.
Corrupt Memry	PE: Parameter storage device alarm	Storage device (E^2PROM) faulty.	Number of parameter write times too many?	Change inverter.
Excessive speed deflection	OSD: Excessive speed deflection	The deflection between the speed setting and motor speed exceeded the deflection level.	● Is the load too large?	● Lighten the load.
CPU Fault (Note 2)	CPU:CPU error	Internal CPU malfunction	Check for loose connector.	Change inverter.

(Note 1) This alarm does not occur due to the cooling fan stop, but it will occur to prevent the main circuit devices from overheating due to the cooling fan stop.

(Note 2) If a CPU alarm has occurred, other alarms cannot be detected.

*1: The parameter unit display remains unchanged but operation may be performed in the external operation mode.

*2: When the protective function is activated, remove the cause, then reset the inverter, and resume operation.

*3: If the alarm is kept displayed on the parameter unit and unit LED after remedy, the internal circuit may be faulty. Consult your sales representative.

2 PARAMETER ADJUSTMENT

2.1 Preparations for Adjustment

The Mitsubishi FR-V200E vector inverters have dedicated parameters to ensure that they can exhibit higher performance than general purpose inverters. These parameters are factory-set to provide fully stable operation. Depending on the machine, vibration, noise and other unfavorable phenomena may take place. This section provides information on how to adjust these parameters so that they may be adjusted according to your application.

2.1.1 Wiring check

(1) Always connect the power supply cables to terminals R, S, T (L_1, L_2, L_3).

(2) Never connect the power supply cables to terminals U, V, W. Doing so will damage the inverter.

(3) Connect the motor to terminals U, V, W. (Match the phase sequence.)

(4) When connection has been made as in the standard connection diagram, turning on the forward rotation switch (signal) rotates the motor in the counterclockwise direction as viewed from the load shaft.

(5) Make connection of terminals U, V, W correctly. If they are connected incorrectly, the motor will not rotate properly.

(6) Always connect the fan power supply cable in the correct phase sequence to run the fan in the suction direction.

(7) Regarding the PLG cable, use a cable which matches the motor.
   1) FR-VCBL (option) for connection with the vector control inverter motor (SF-VR series).
   2) FR-JCBL (option) for connection with the Mitsubishi general-purpose motor with PLG.

(8) Wire the PLG connection cable correctly.
   If the connection of phases A, B, Z is incorrect, the motor will not rotate properly.

2.1.2 Check the initial values of the special parameters

* Some parameter values change depending on the manufacturing period. Set the parameters to meet the manufacturing period.

(1) Before making adjustment, first set the following special parameter values for the product before version update:

	Product	Function	Parameter No.	Parameter Category	Factory Setting	Adjustment Setting
1	Before version update	Excitation ratio	Pr. 130	Special parameter	9999 (equivalent to 50%)	4096 (equivalent to 100%)
2		Deceleration torque limit	Pr. 118	Special parameter	9999 (equivalent to 100%)	30000 (Note 1)
3		Acceleration torque limit	Pr. 119	Special parameter	9999 (equivalent to 150%)	30000 (Note 1)

Note 1: Same setting as in Pr. 34. For the way of setting the acceleration and deceleration torque limits individually, refer to the next special parameter setting procedure.

(2) Special parameter setting procedures

- Excitation ratio Pr. 130
  1) Set "801" in Pr. 77.
  2) Set "4096" in Pr. 130.
  3) Return Pr. 77 to its original setting.
- Deceleration torque limit Pr. 118

  Example: To set the deceleration torque limit to 150%
  1) Set "801" in Pr. 77 "parameter write inhibit selection".
  2) Set "6144" (= 4096 × 150%/100) in Pr. 118 "deceleration torque limit".
  3) Return Pr. 77 to its original setting.

During acceleration/deceleration, the limit is imposed at the lower value of the acceleration/deceleration torque limit value indicted on the left and the torque limit value set in Pr. 34 to Pr. 38 or using terminal No. 3, 4.

Enter "65535" to return Pr. 118 and Pr. 119 to the factory setting.

9999 sets the torque limit value to 224% (= 9999/4096 × 100 = 224%).

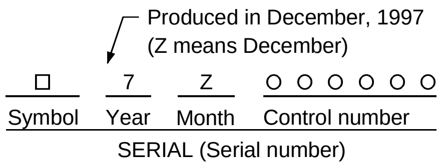
(Set the acceleration torque limit, Pr. 119, in the similar manner to Pr. 118.)

(3) Identification of the version-updated product

- Identification method

  To indicate the version-updated product, the SERIAL (serial number) given in the rating plate and package plate of the inverter is the following code or later:

Type	SERIAL (Serial Number)
FR-V220E-1.5K to 7.5K	H7ZOOOOOOO
FR-V220E-11K to 45K	D7ZOOOOOOO
FR-V240E-1.5K to 5.5K	H7ZOOOOOOO
FR-V240E-7.5K to 45K	D7ZOOOOOOO



The SERIAL (serial number) given in the rating plate of the inverter is made up of one symbol (alphabetic) character, two manufacture (year/month) characters and six control number characters.

- Product version update timing

  Each product manufactured in and after December, 1997 was updated in version (i.e. "version-up" inverters).

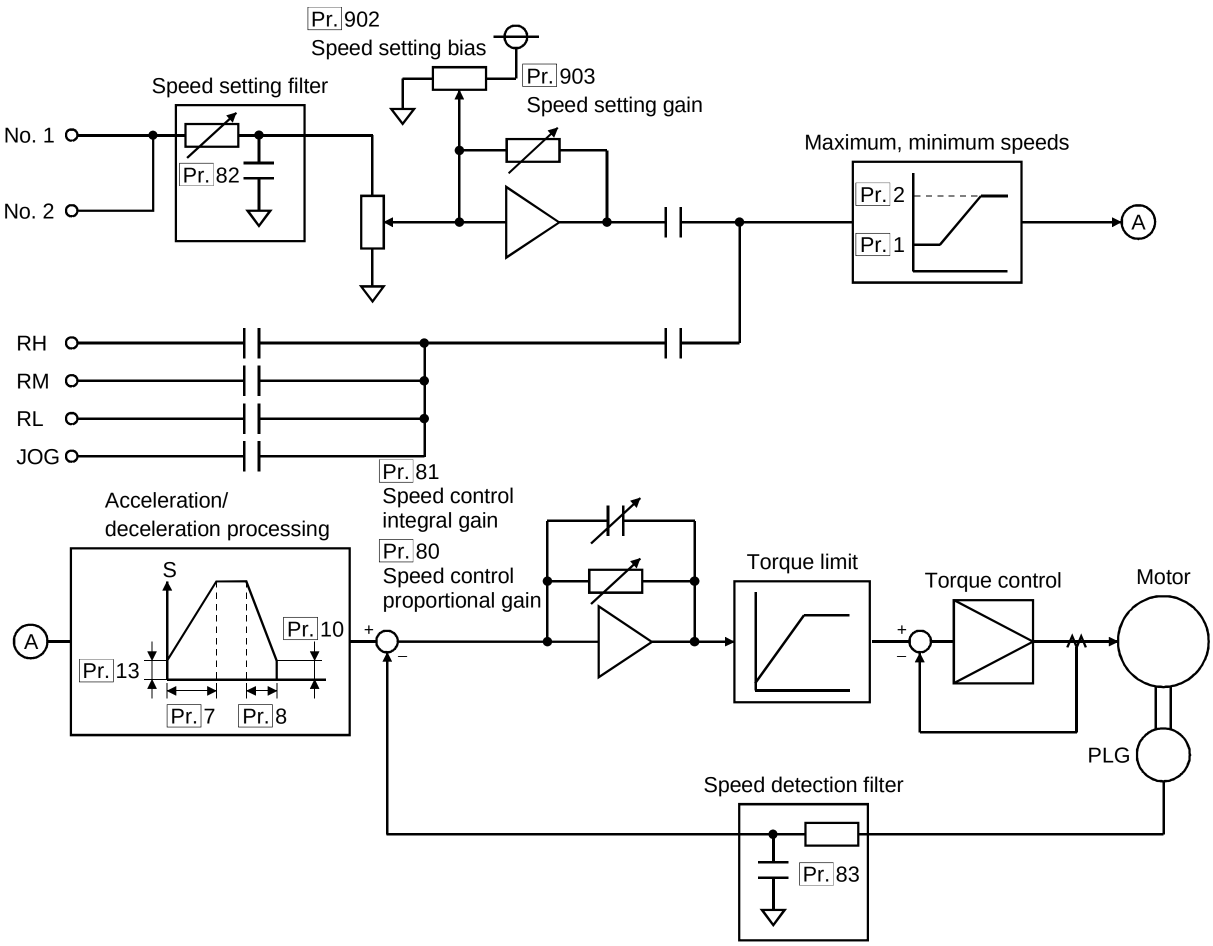
2.2 Speed Control

The FR-V200E has speed loop gain parameters for adjustment of the speed control operation status. The factory-set parameter values provide fully stable operation. However, when a large load inertia, gear backlash etc. gives rise to vibration, noise or other unfavorable phenomenon or when it is desired to exhibit the best performance according to the machine, refer to the following description and adjust the parameter values.

2.2.1 What is speed control?

(1) Control block diagram

The following is the control block diagram for speed control.

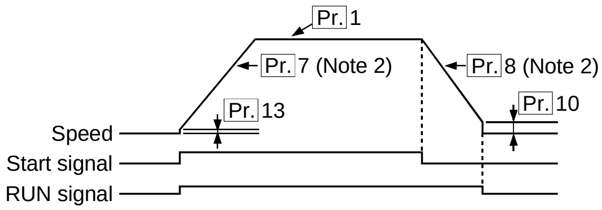


Note 1: When the RT signal is OFF, Pr. 80 (proportional gain) and Pr. 81 (integral gain) are used as gains.
When the RT signal is ON, Pr. 90 (proportional gain) and Pr. 91 (integral gain) are used as gains.

Speed control is exercised to zero the difference between the speed command and speed feedback (actual speed), i.e. to match the speed command and actual speed.

(2) Operation

The following diagram shows operation during speed control:



Note 2: When the RT signal is OFF, the Pr. 7 and Pr. 8 values are acceleration and deceleration times.
When the RT signal is ON, the second acceleration and deceleration times are made valid.

- Turning on the start signal causes the speed to increase up to the preset speed according to the acceleration time.
- Turning off the start signal causes the speed to decrease according to the deceleration time.
  When the speed has reduced to the DC dynamic brake operation speed, DC dynamic brake operation is started.

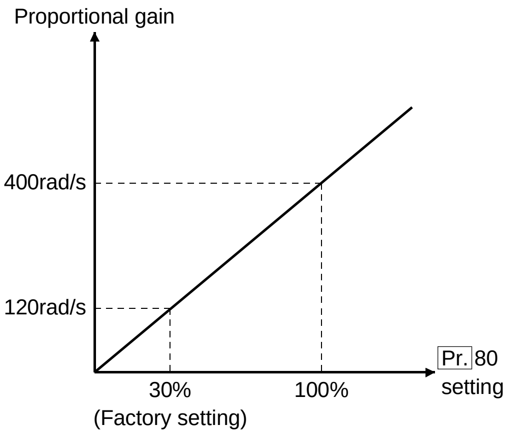
(3) Points of speed control gains

The speed control gains are proportional to the parameter settings.

Their factory settings are as follows when the motor is used alone:

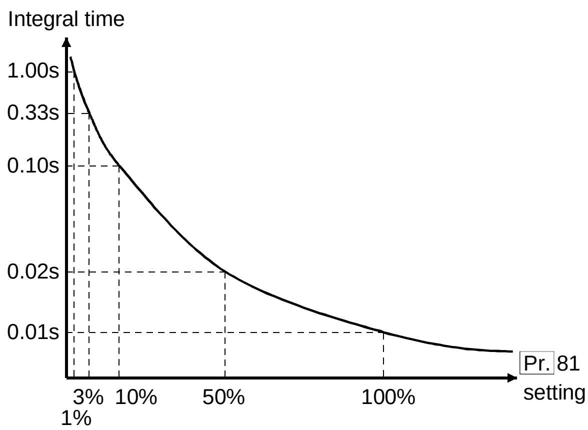
1) Speed proportional gain

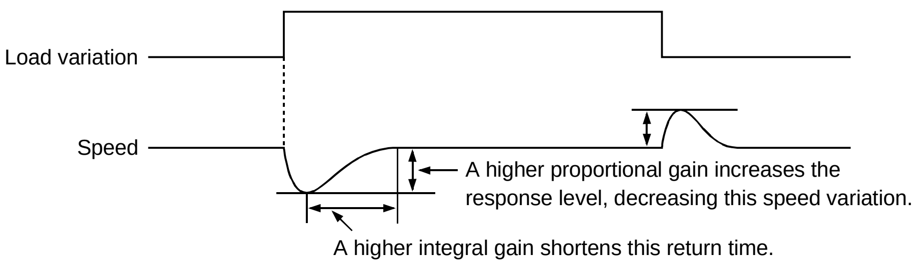
- 120 rad/s when Pr. 80 = 30% (factory setting).
- A higher proportional gain increases the response level. However, a too high gain will generate vibration and/or unusual noise.



2) Speed integral gain

- 3 rad/s at broken point when Pr. 81 = 3% (factory setting).
- A higher integral gain shortens the return time at a speed change.
  However, a too high gain will produce an overshoot. (See the chart below.)
- The integral gain is in inverse proportion to the integral time.





When a load inertia is provided, the actual speed gain reduces as indicated below:

$$\text{Actual speed gain} = \text{speed gain for a motor used alone} \times \frac{GD^2_M}{GD^2_M + GD^2_L}$$

GD^2_M: Motor GD^2

GD^2_L: Motor shaft-equivalent load GD^2

2.2.2 Parameter adjustment method

(1) Parameter types

The following speed loop parameters are adjusted:

· Speed control P (proportional) gain: Pr. 80 (Pr. 90 when RT terminal is ON)
· Speed control I (integral compensation) gain: Pr. 81 (Pr. 91 when RT terminal is ON)

(2) Adjustment procedure

1) Adjust the speed control P (proportional) gain.
2) Check for unusual vibration and noise and whether the response level is high enough and the current value is proper.
3) When the parameter cannot be adjusted properly, slightly change the speed control I (integral compensation) gain value and restart from step 2).

<Adjustment outline>

1) Adjust the speed control P (proportional) gain.
   - A higher proportional gain increases the speed response level but a too high gain will generate vibration and/or unusual noise.
   - The speed control P (proportional) gain is set within the range 0 to 1000% and is factory-set to 30%.
   - For general adjustment, set it in the range 0 to 100% (between 0 to 30% is usual).

	Phenomenon	Pr. 80	Proper Value	Remarks
1	Slow response	Increase in units of 5%.	Set a value derived from (setting immediately before mechanical system generates vibration/noise) × about 0.8 to 0.9.	The upper setting limit of the P gain depends on the load inertia ratio and mechanical system rigidity.
2	Mechanical system generates vibration/noise	Decrease in units of 5%.	Set a value derived from (setting at which mechanical system stops generating vibration/noise) × about 0.8 to 0.9.	A too low P gain may cause instable phenomenon. In this case, the I gain must be changed.

2) Adjust the speed control I (integral compensation) gain.
   - A higher gain shortens the return time at a speed change but a too high gain will produce speed overshoot.
   - The speed control I (integral compensation) gain is set within the range 0 to 1000% and is factory-set to 3%.
   - For general adjustment, set it in the range 0 to 10%.
   - As a guideline, set the speed control I gain to a value about 1/10 of the speed control P (proportional) gain.

	Phenomenon	Pr. 81	Proper Value	Remarks
1	Long return (response) time	Increase in units of 1%.	Set a value derived from (setting immediately before overshoot or instable phenomenon occurs) × about 0.8 to 0.9.	A too high I gain will produce overshoot or instable phenomenon.
2	Overshoot or instable phenomenon occurs.	Decrease in units of 0.5%.	Set a value derived from (setting at which overshoot or instable phenomenon stops occurring) × about 0.8 to 0.9.	Decreasing the I gain improves stability but increases return (response) time and may cause undershoot.

2.2.3 Troubleshooting

	Phenomenon	Cause	Remedy	Refer to Section
1	Motor does not rotate. (OL occurs if it is started.)	Wrong phase sequence of motor wiring or PLG wiring.	Check wiring.	2.1.1
2	Running speed is incorrect. (Difference between speed command and actual speed.)	• Different speed command from command unit. • Noise compounded with speed command.	• Check whether command unit gives correct speed command. • Reduce PWM carrier frequency in Pr. 72.	1.8.18
		Speed command value is different from value recognized by inverter.	Recalibrate speed command bias and gain, Pr. 902 and Pr. 903, in accordance with adjustment procedure 2.	1.8.34
		PLG pulse count setting is not correct.	Check Pr. 69 setting.	1.8.16
3	Speed does not increase to speed command.	Torque shortage	Increase torque limit value.	1.8.8
		Speed control I gain in Pr. 81 is 0.	Increase Pr. 81.	2.2.1
4	Motor speed is not uniform.	Speed command varies.	• Check whether command unit gives correct speed command. • Decrease PWM carrier frequency in Pr. 72. • Set speed setting filter in Pr. 82.	1.8.18 1.8.23
		Torque shortage	• Increase torque limit value. • Confirm year/month of manufacture and check parameter setting.	2.1.2
		Speed control gains do not match the machine.	Adjust Pr. 80, Pr. 81.	2.2.1
5	Motor or machine hunts (generates vibration/noise).	Speed control gains are high.	Decrease Pr. 80, Pr. 81	2.2.1
6	Acceleration/deceleration time does not match setting.	Torque shortage	• Increase torque limit value. • Confirm year/month of manufacture and check parameter setting.	2.1.2
		Too large load inertia	Set acceleration/deceleration time which matches load.	••
7	Machine operates unstably.	Speed control gains do not match the machine.	Adjust Pr. 80, Pr. 81.	2.2.1
		Acceleration/deceleration time setting is not appropriate.	Set acceleration/deceleration time setting to optimum value.	••
8	Speed fluctuation at low speed	High carrier frequency has an adverse effect.	Reduce PWM carrier frequency in Pr. 72.	1.8.18
		Torque shortage	Confirm year/month of manufacture and check parameter setting.	2.1.2
		Speed control gain is low.	Increase Pr. 80.	2.2.1

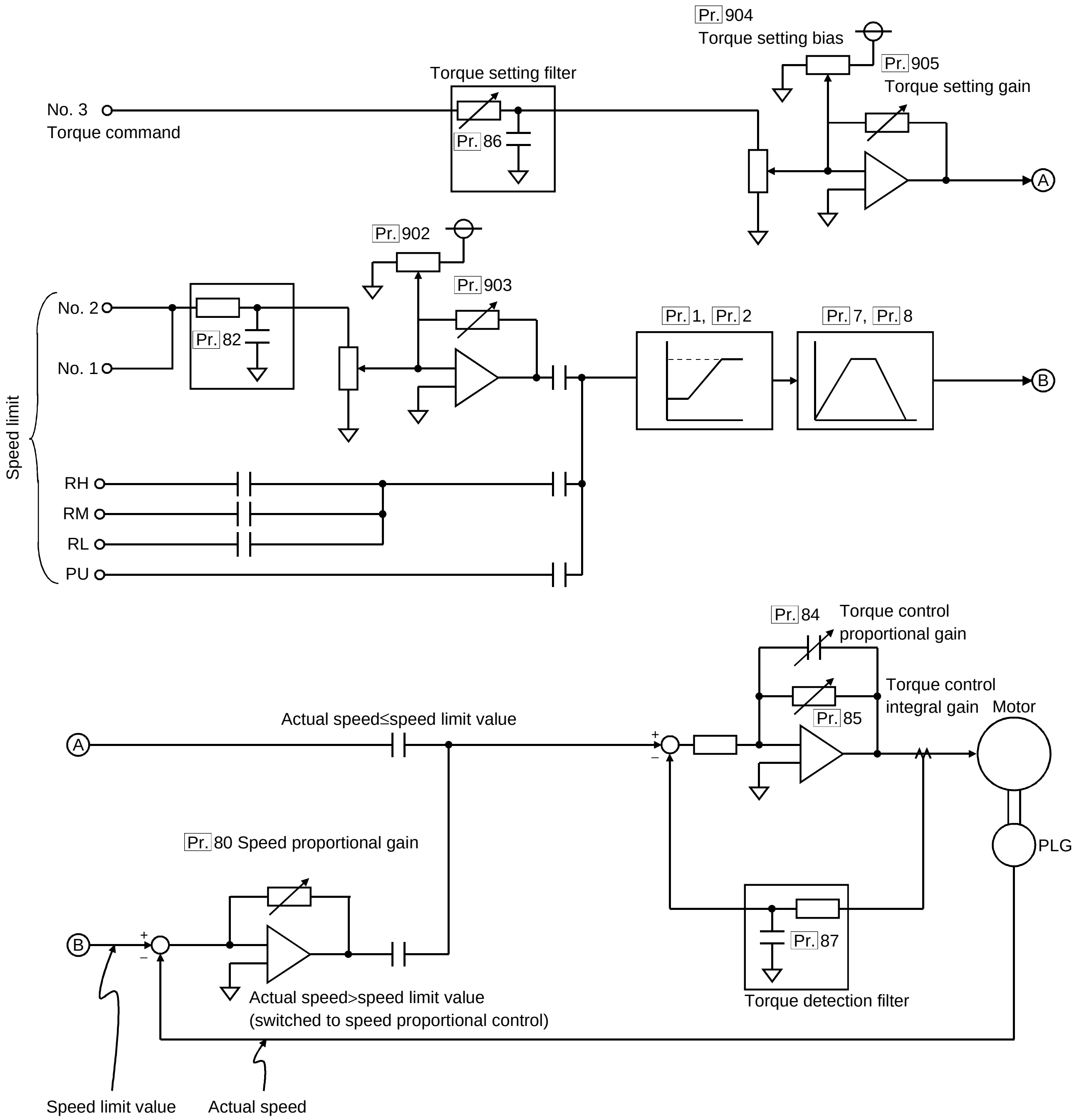
2.3 Torque Control

The FR-V200E has current loop gain parameters for adjustment of the torque control operation status. The factory-set parameter values provide fully stable operation. However, when a torque pulsation or other unfavorable phenomenon takes place in some machines or under some operating conditions or when it is desired to exhibit the best performance according to the machine, refer to the following description and adjust the parameter values.

2.3.1 What is torque control?

(1) Control block diagram

The following is the control block diagram for torque control.



(Note 1) When the RT signal is OFF, Pr. 84 and Pr. 85 are used as torque control gains.
When the RT signal is ON, Pr. 94 and Pr. 95 are used as torque control gains.

Torque control is exercised to develop a torque with respect to the torque command value. The motor speed becomes constant when the output torque of the motor matches the load torque. In torque control, therefore, the speed is determined by the load.
In torque control, the motor picks up its speed when its output torque exceeds its load. The speed limit value should be set so that the motor speed does not rise too high at this point. The speed limit value may be set in either of the following ways. When the speed limit is not specified, the speed limit value setting is regarded as 0rpm and torque control cannot be exercised.

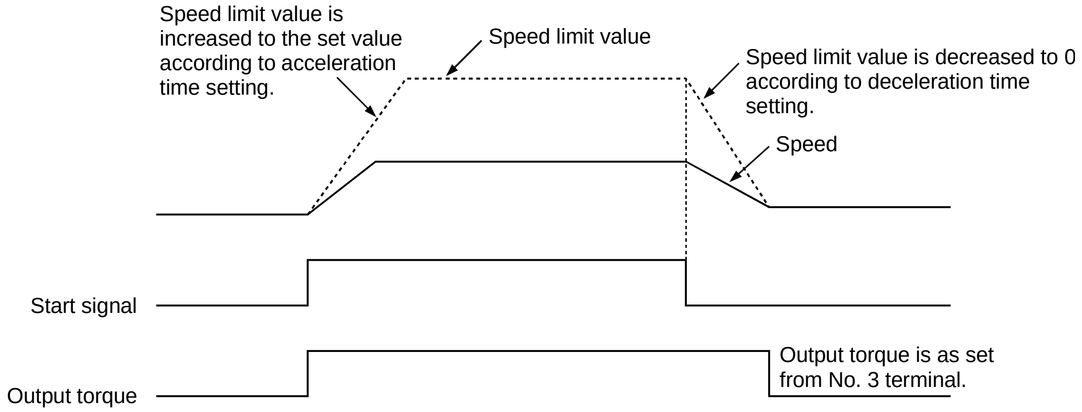
1) External operation
- Setting by analog voltage from terminals No. 2, No. 1
- Setting by RH, RM and RL contact signals

2) PU operation
Direct speed setting from PU

The speed limit is as set in the speed command for speed control.

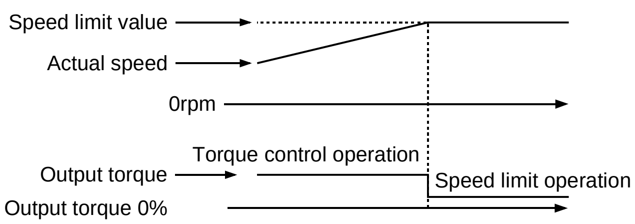
(2) Operation

1) Torque control operation



*If load is smaller than torque command, speed increases to speed limit value.

2) Operation performed when speed limit is activated



If actual speed is lower than the speed limit value, torque control is exercised.

When the actual speed reaches or exceeds the speed limit value, the speed limit function is activated. At this time, the control mode is switched to speed control and torque control is disabled.
The speed limit is a function designed to suppress a motor speed increase. Before starting torque control, make adjustment to prevent the speed limit from being activated during ordinary operation.

(3) Notes regarding gain
The torque control gains are proportional to the parameter settings and their factory settings are as follows:

1) Torque control proportional gain
- 2000 rad/s when Pr. 84 = 100% (factory setting).

2) Torque control integral gain
- 200 rad/s at broken point when Pr. 85 = 100% (factory setting).

2.3.2 Parameter adjustment method

(1) Parameter types
The following current loop parameters are adjusted:

- Torque command No. 3 bias: Pr. 904
- Torque command No. 3 gain: Pr. 905
- Torque setting filter: Pr. 86 (Pr. 96 when RT terminal is ON)

(2) Adjustment procedure
1) Check the control mode selection, Pr. 14, setting (factory-set to speed control).
2) Set the speed limit value.
3) Check for unusual vibration and noise and whether the response level is high enough and the current value is correct.

<Instructions>
* Normally, the current loop gains, Pr. 84, Pr. 85, need not be changed.
* Fully note that unnecessary changing of the current loop gain settings may invite an instable phenomenon or reduced response level.

2.3.3 Troubleshooting

	Phenomenon	Cause	Remedy	Refer to Section
1	Torque control is not performed properly.	Wrong phase sequence of motor wiring or PLG wiring.	Check wiring.	2.1.1
		Control mode selection, Pr. 14, setting is inappropriate.	Using Pr. 14, choose torque control mode. (Factory setting is speed control mode.)	1.8.2
		Speed limit value is not input. [If so, speed limit value is 0rpm and motor does not rotate.]	Set speed command value using 0-+10V input to terminal 2 or multi-speed setting (RH, RM, RL).	——
		Torque command varies.	• Check whether command unit gives correct speed command. • Reduce PWM carrier frequency using Pr. 72. • Set torque setting filter using Pr. 86.	1.8.18 1.8.25
		Torque command value is different from value recognized by inverter.	Recalibrate torque command bias and gain, Pr. 904 and Pr. 905, in accordance with adjustment procedure 2.	1.8.35
2	When torque command value is small, motor rotates in opposite direction to start signal.	Torque command offset calibration is improper.	Recalibrate torque command bias, Pr. 904, in accordance with above adjustment procedure 2.	1.8.35
3	Proper torque control cannot be exercised during acceleration/deceleration.	Speed limit is activated since speed limit value increases/decreases according to acceleration/deceleration time setting, Pr. 7, Pr. 8.	Set "0" in Pr. 7 and Pr. 8.	——
4	Output torque is not linear in response to torque command.	Torque shortage	Confirm year/month of manufacture and check parameter setting.	2.1.2
5	If torque command is set to 0%, large torque ripple is produced as soon as motor stops.	Near 0rpm at which motor stops, rotation direction hunts between forward and reverse rotation in terms of control. An attempt to return from this reverse rotation direction activates speed limit, resulting in torque ripple.	Set "1" in torque control mode, Pr. 33.	1.8.8

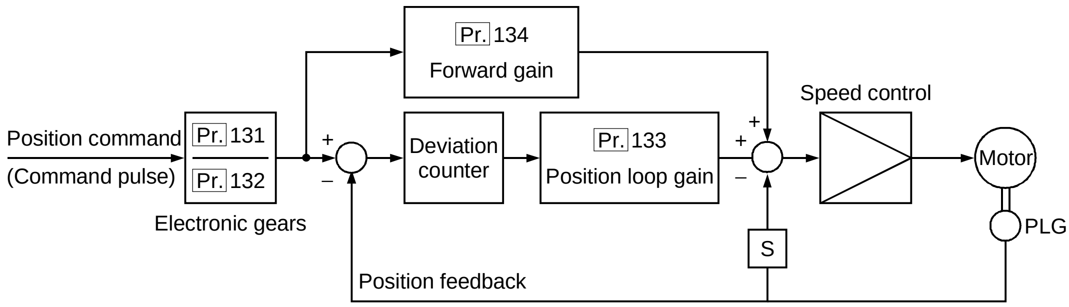
2.4 Position Control

When fitted with the FR-VPB or FR-VPD inboard option, the FR-V200E is enabled to exercise position control. The FR-V200E has a position loop gain parameter for adjustment of the position control operation status. The value of this position loop gain parameter is determined not individually but by the relationship with the speed loop parameters. Therefore, first adjust the speed loop gains in accordance with the adjustment method explained in Section 2.2, then adjust the position loop gain parameter using the following procedure.

2.4.1 What is position control?

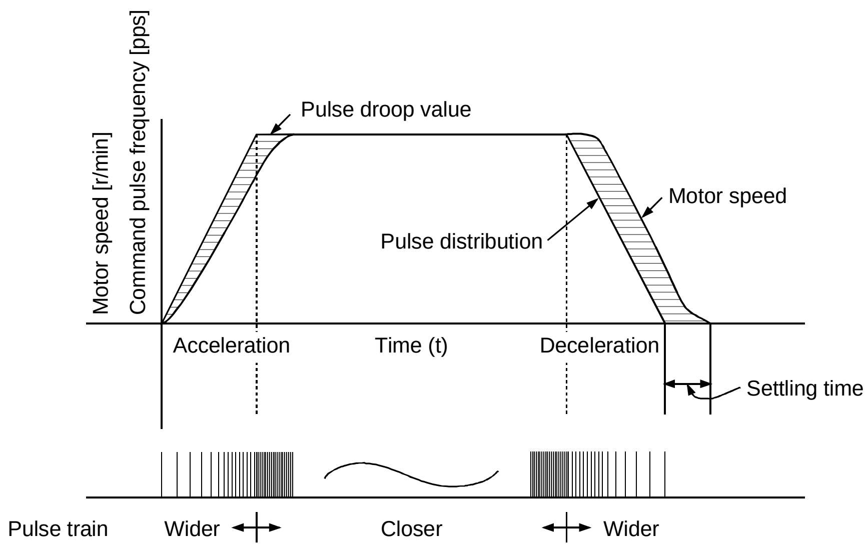
(1) Control block diagram

The following is the control block diagram for position control.



(2) Operation

The motor is rotated in response to the number of pulses entered by the position command (pulse train). For example, when the motor is equipped with a PLG of 1000 pulses/rev., entering 4000 pulses four times greater than those pulses as command pulses rotates the motor one revolution and brings it to a stop.



1) In position control, a pulse train is input as a position command. This pulse train is accumulated in the deviation counter through the electronic gears. This cumulative value is a pulse droop value and is used to calculate the speed command to rotate the motor.
2) When the motor begins to rotate under the speed command calculated in 1), feedback pulses proportional to the speed are produced. The deviation counter is decremented by these feedback pulses. While command pulses are input, the pulse droop value is held in the deviation counter to rotate the motor.
3) When the command pulse input stops, the motor rotates until there are no pulses accumulated in the deviation counter. When there are no droop pulses, the motor comes to a stop.
   By operations 1), 2) and 3), the motor can be rotated by the number of entered pulses and then stopped. At this time, the motor speed is proportional to the input pulse speed. As shown on the previous page, the pulse train is made wider to be slower in the low-speed region where the motor begins to pick up speed and will stop soon, and is made closer to be faster in the high-speed region.

(3) Notes regarding gain setting

1) Position loop gain, [Pr.] 133: 25 rad/s (factory setting)
   The set value is used unchanged as a rad/s value.
   Increasing the value raises position command trackability and increases servo rigidity at a stop, but makes overshoot and/or vibration more easily to occur.
   Normally, set this parameter within the range of about 5 to 50.
2) Feed forward gain, [Pr.] 134: 0% (factory setting)
   Set 100% to cancel all droop pulses.
   "Feed forward gain"
   This function cancels the delay of the deviation counter due to droop pulses. When a command pulse tracking delay poses a problem, increase the set value gradually until overshoot and vibration do not take place. This function does not have an effect on stop-time servo rigidity. Normally set "0" in this parameter.

2.4.2 Parameter adjustment method

(1) Parameter type

The following position loop parameter is adjusted:

Position loop gain: [Pr.] 133

(2) Adjustment procedure

1) Determine the speed control gains, then start position loop gain adjustment.
2) While simultaneously checking the command pulse tracking ability, adjust the position loop gain.
3) Then return the control mode selection, [Pr.] 14, to position control and adjust the position loop gain.
4) Check for overshoot, unusual vibration and noise.

<Adjustment outline>

1) Adjust the position loop gain.

- A higher gain increases the command pulse trackability and stop-time rigidity but a too high gain makes overshoot and/or vibration more liable to occur.
- The position loop gain is set within the range 0 to 150sec^{-1} and is factory-set to 25sec^{-1}.
- The position loop gain value may be said to be determined by the speed control P (proportional) gain value and they have the following relationship:

Position loop gain, Pr. 133 $\times$ 3.3 < speed control P gain, Pr. 80 (adjusted value) $\times \dfrac{GD^2_M}{GD^2_M+GD^2_L}$ ....(2-1)

where, GD^2_M: Motor GD^2

GD^2_L: Motor shaft-equivalent load GD^2

- For general adjustment, set it in the range 2 to 50sec^{-1} and use Formula (2-1) as a guideline.

	Phenomenon	Pr. 133	Proper Value	Remarks
1	Slow response	Increase in units of 3 sec^{-1}.	Set a value derived from (setting immediately before overshoot, stop-time vibration or other instable phenomenon occurs) $\times$ about 0.9.	Example: Pr. 80 = 25%, GD^2_M + $3GD^2_L$ Pr. 133 < 25 $\times$ 1/(1 + 3) $\times$ 3.3 = 20.6 Set 20 sec^{-1} in Pr. 133 and use this value as a guideline for adjustment.
2	Overshoot, stop-time vibration or other instable phenomenon occurs.	Decrease in units of 3 sec^{-1}.	Set a value derived from (setting at which overshoot, stop-time vibration or other instable phenomenon stops occurring) $\times$ about 0.9.	

2.4.3 Troubleshooting

	Phenomenon	Cause	Remedy	Refer to Section
1	Motor does not rotate.	Wrong phase sequence of motor wiring or PLG wiring.	Check wiring.	2.1.1
		Control mode selection, Pr. 14, setting is inappropriate.	Using Pr. 14, choose torque control mode. (Factory setting is speed control mode.)	1.8.2
		Pre-excitation (servo lock setting) signal (DI_) or stroke end signal (STF, STR) is not input.	Check whether signals are input properly.	——
		Command pulses are not input correctly.	• Check the settings of command pulse form and command pulse selection, Pr. 139. • Check whether command pulses are input properly. (Confirm cumulative command pulse value in pulse monitor, Pr. 141.)	——
2	Position mismatch occurs.	Command pulses are not input correctly.	• Check the settings of command pulse form and command pulse selection, Pr. 139. • Check whether command pulses are input properly. (Confirm cumulative command pulse value in pulse monitor, Pr. 141.)	——
		Noise is compounded with command pulses.	• Decrease PWM carrier frequency in Pr. 72. • Change grounding place of PLG cable's shield wire. • Keep PLG cable's shield wire clear from ground (do not earth).	1.8.18
3	Motor or machine hunts.	Position loop gain is high.	• Decrease Pr. 133.	2.4.1
		Speed loop gains are high.	• Decrease Pr. 80, Pr. 81.	2.2.1
4	Machine operates unstably.	Acceleration/deceleration time setting has an adverse effect.	Set "0" in Pr. 7 and Pr. 8.	——
		Torque shortage	Confirm year/month of manufacture and check parameter setting.	2.1.2

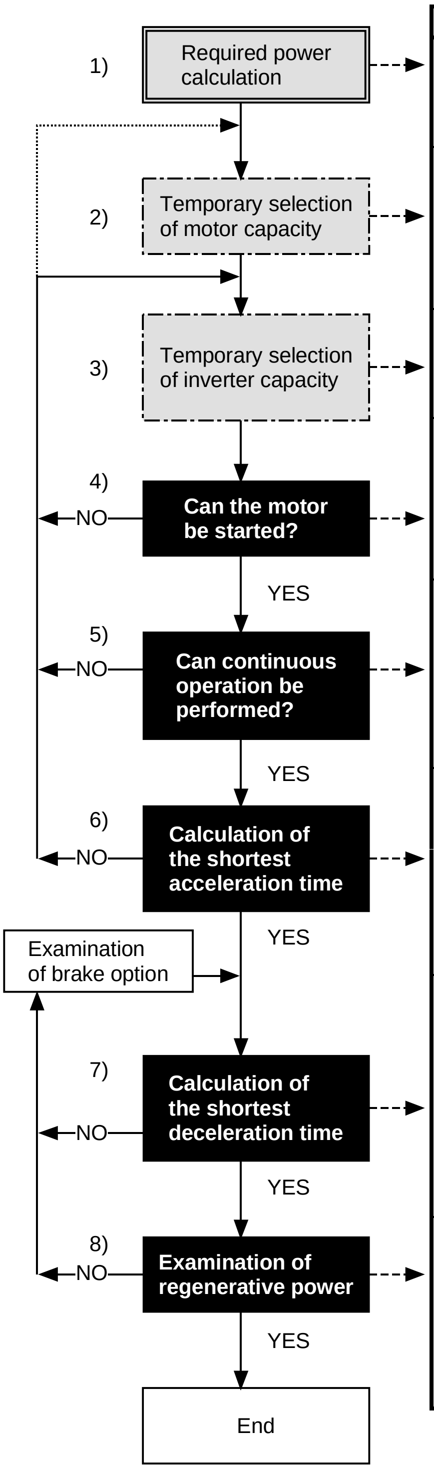
3 SELECTION

3.1 Capacity Selection

Different operation patterns (e.g. continuous operation, cyclic operation, elevating operation) have different selection procedures. Respective examination procedures are given below.
For the details of examination methods and the special data required for examination, refer to the Inverter Technical Notes No. 22 to No. 25.

3.1.1 Continuous operation examination procedure

Selection Flowchart

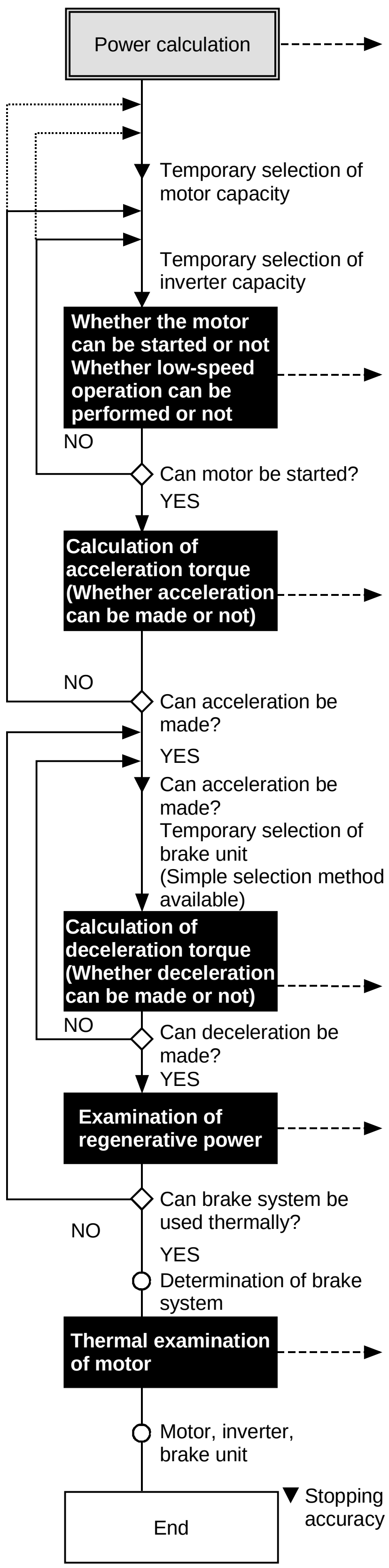


	Selection Outline	Judgment
1)	● Calculate the power required for examination.	(Required power (P_L)) (Load torque (T_L)) $T_L = 9550 \times P_L/N$ [N•m] 974 [kgf•m]
2)	● According to the magnitude of the required power, temporarily select the capacity of the motor used.	Motor capacity (P_M) ≥ required power (P_L) Rated motor torque (T_M) ≥ load torque (T_L) $T_M = 9550 \times P_M/N_M$ [N•m] 974 [kgf•m]
3)	● Temporarily select the inverter capacity corresponding to the motor capacity temporarily selected.	Inverter capacity (P_{INV}) ≥ motor capacity (P_M) (Rated inverter output current > rated motor current)
4)	● For operation, the motor must be at a stop when starting rotation. Hence, examine whether the motor can be started or not.	Motor starting torque (T_{MS}) > load torque at start (T_{LS}) αs: Maximum starting torque coefficient σ: Heat coefficient
5)	● Examine whether or not the magnitude of the load causes the permissible temperature of the motor to be exceeded.	Continuous motor operation torque (T_{MC}) > load torque (T_L) Continuous operation torque coefficient (αc) > load torque ratio (T_F) = T_L/T_M or Continuous torque (T_M) × (αc) > load torque (T_L) αc: Continuous operation torque coefficient
6)	● Calculate the minimum value of acceleration time. ● Examine whether the resultant value satisfies the planned acceleration time.	Shortest acceleration time (tas) < planned acceleration time (ta) Shortest acceleration time (tas) ≤ 45 seconds $tas = \dfrac{(GD^2_L \times GD^2_M) \times N}{38.2 \times (T_M \times \alpha h - T_L max)}$ [N•m] 375 [kgf•m] αh: Non-linear acceleration torque coefficient
7)	● Calculate the minimum value of deceleration time. ● Examine whether the resultant value satisfies the planned deceleration time. ● From deceleration time during operation, calculate the torque needed for deceleration.	Shortest deceleration time (tds) < planned deceleration time (td) $tas = \dfrac{(GD^2_L \times GD^2_M) \times N}{38.2 \times (T_M \times \beta h - T_L min)}$ [N•m] 375 [kgf•m] β: Deceleration torque coefficient Deceleration torque (Td)
8)	● Examine the capability to handle regenerative power in deceleration period. ● Examine the capability to handle regenerative power during continuous regenerative operation.	Short-time permissible power (W_{RS}) > regenerative power during deceleration (W_{INV}) Continuous permissible power (W_{RC}) > regenerative power during continuous operation (W_{INV})

(Note) The unit is expressed in the SI systems of units. The half-tone screen areas indicate the gravitational systems of units.

3.1.2 Cyclic operation examination procedure

Selection Flowchart



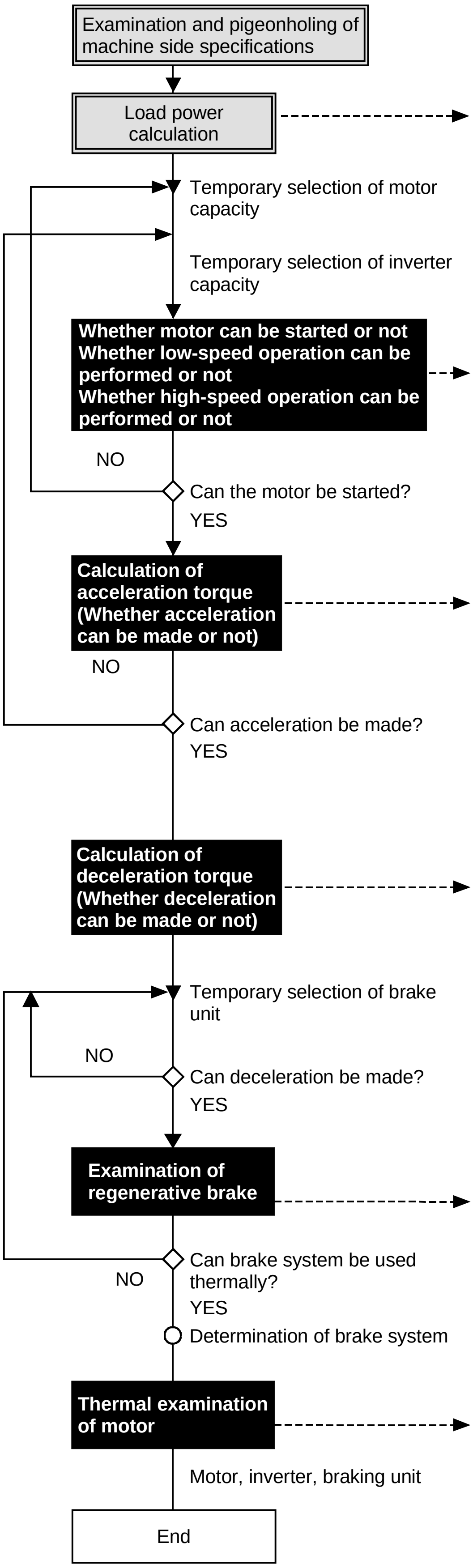
Selection Outline	Judgment
$P_L = \dfrac{\mu W \bullet V}{6120 \times \eta}$ [kW] Also calculate load torque and GD^2.	
(1) Select the motor capacity greater than the required power.	Temporarily selected motor capacity $(P_M) > P_L$ Temporarily selected inverter capacity $\geq P_M$
(1) Select the inverter corresponding to the motor capacity. (2) If necessary, increase the inverter capacity to increase acceleration torque.	
● Make sure that the starting torque and low-speed torque of the motor are larger than the load torque. σ: Motor heat coefficient	$T_{MS} > T_{LS}$ $T_M \times \alpha m \times \delta > T_{LS}$
● Calculation of relationship between acceleration and acceleration time ● Acceleration torque $Ta = \dfrac{\Sigma GD^2 \times Nmax}{38.2 \times ta}$ [N•m] 375 [kgf•m] ● Calculate the torque required for acceleration. αa: Linear acceleration torque coefficient	$\alpha a > \dfrac{Ta + T_L max}{T_M}$
● Deceleration torque $Td = \dfrac{\Sigma GD^2 \times Nmax}{38.2 \times td}$ [N•m] 375 [kgf•m] ● Calculate the torque required for deceleration. βmin: Brake torque coefficient	$\beta min > \dfrac{Td + T_L min}{T_M}$
(1) Check the short-time permissible power. (2) Check the average regenerative power. W_{INV}: Power returned to the inverter td: Deceleration time during 1 cycle tc: Time in the whole 1 cycle	$W_{INV} < W_{RS}$ $W_{INV} \times td/tc > W_{RC}$
Make sure that the equivalent current value does not exceed 100%. $I_{MC} = \sqrt{\dfrac{\Sigma (In^2 \times tn)}{\Sigma (Cn \times tn)}} < 100$ [%]	
● Calculate the stopping accuracy provided by the mechanical brake.	

(Note) The unit is expressed in the SI systems of units. The half-tone screen indicates the conventional gravitational systems of units.

chapter 3

3.1.3 Elevating operation examination procedure

Selection Flowchart



Selection Outline

Required power (P_L) = $\dfrac{W \times V}{6120 \times \eta}$ [kW]

(1) Select the motor capacity which is not less than the required power.
(2) Increase the motor capacity to increase starting torque.

(1) Select the inverter equivalent to the motor capacity.
(2) Increase the inverter capacity to increase acceleration torque.

(1) Motor starting torque (T_{MS}) >load torque at start (T_{LS})
(2) Motor torque at low speed
$T_M \times \alpha m \times \delta$ >load torque (T_L)
(3) Motor torque at high speed
$T_M \times \alpha m$ >load torque (T_L)

Acceleration torque

$Ta = \dfrac{\Sigma GD^2 \times N}{38.2 \times ta}$ [N•m]
375 [kgf•m]

Ta: Acceleration torque
ta: Acceleration time [s]

Examination of whether acceleration can be made or not

$\dfrac{Tamax}{T_M} < \alpha a$ αa: Acceleration torque coefficient

Deceleration torque

$Td = \dfrac{\Sigma GD^2 \times N}{38.2 \times td}$ [N•m]
375 [kgf•m]

Td: Deceleration torque
td: Deceleration time [s]

$\dfrac{Tdmax}{T_M} < \beta min$

βmin: Brake torque coefficient
Temporarily select the brake unit.

Check the short-time permissible power.
$W_{INV} < W_{RS}$
Check the continuous permissible power.
$W_{INV} \times t/tc < W_{RS}$
W_{INV}: Power returned to the inverter
t: Time when negative load torque is applied [s]
tc: Time of whole 1 cycle [s]

Motor equivalent current value

$I_{MC} = \sqrt{\dfrac{\Sigma\,(In^2 \times tn)}{\Sigma\,(Cn \times tn)}} < 100$ [%]

(Note) The unit is expressed in the SI systems of units. The half-tone screen indicates the conventional gravitational systems of units.

3.1.4 Calculation of required power

The formulas used to calculate the required powers of various machines and apparatuses are given below:

(1) General formula

Required power P [kW]

$$P=\frac{T\cdot N}{974} \quad \text{.......... (2.1)}$$

T: Required torque [kgf·m]

N: Speed [r/min]

(2) Cargo-handling machines

1) For winding

$$P=\frac{(Q+g_0)V}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.5)}$$

Q: Load [kgf]

g_0: Hanger weight [kgf]

V_1: Winding velocity [m/min]

η: Machine efficiency (0.7 to 0.85)

2) For traversing

$$P=\frac{(Q+g_0+G_0)W_{2r}\cdot V_2}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.6)}$$

G_0: Grab's own weight [kgf]

W_{2r}: Running resistance [kgf/kgf]

V_2: Traversing velocity [m/min]

3) For running

$$P=\frac{(Q+G)W_{3r}\cdot V_3}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.7)}$$

W_{3r}: Running resistance [kgf/kgf]

V_3: Running velocity [m/min]

G: Crane's own weight [kgf]

4) For swiveling

$$P=\frac{(Q+G_1)W_{4r}\cdot V_4}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.8)}$$

W_{4r}: Running resistance [kgf/kgf]

V_4: Running velocity [m/min]

G_1: Crane swivel section weight [kgf]

5) Pulling up an object along the slant of angle α relative to the horizontal surface

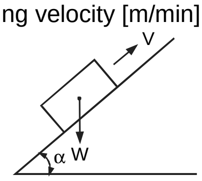
$$P=\frac{W(\sin\alpha+\mu\cdot\cos\alpha)V}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.9)}$$

W: Weight [kgf]

μ: Friction coefficient

η: Winding machine efficiency

V: Winding velocity [m/min]



(3) Machine tools

1) Table feeding work

$$P=\frac{(W+T)\mu\cdot V}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.10)}$$

W: Workpiece weight [kgf]

μ: Table weight [kgf]

η: Friction coefficient of table/bed

V: Table feedrate [m/min]

2) Press

$$P=\frac{K\cdot E\cdot N}{6120\eta}\ [\text{kW}] \quad \text{.......... (2.11)}$$

E: Press work load [kgf·m]

$$E=\frac{GD^2}{8g}\cdot\left(\frac{\mu}{60}\right)^2\cdot(N_1^2-N_2^2)\ [\text{kgf·m}] \quad \text{.......... (2.12)}$$

GD^2: GD^2 of load [kgf·m]

g: 9.8 [m/s^2]

N_1: No-load speed [r/min]

N_2: Pressing speed [r/min]

N: Number of strokes [times/min]

η: Press efficiency (0.75 to 0.8)

K: Constant determined by the following specifications (normally 1.5 to 2)

(1) Work load and time of single press operation

(2) Cycle time

(3) GD^2 of flywheel

(4) Flywheel speed

(4) Others

1) Driving an inertia object

$$P=\frac{1}{974}\cdot\frac{GD^2}{375}\cdot\frac{N^2}{t}\ [\text{kW}] \quad \text{.......... (2.13)}$$

N: Speed [r/min]

GD^2: Flywheel effect [$kgf\cdot m^2$]

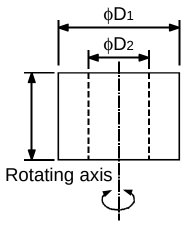
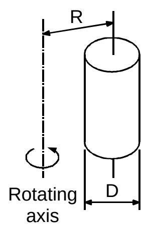
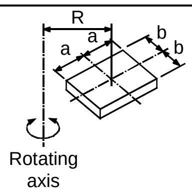
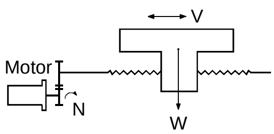
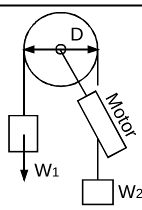
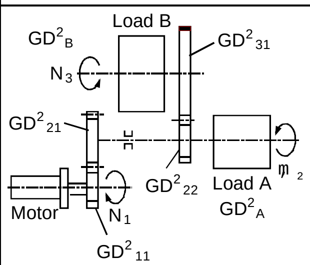
t: Acceleration time [s]

3.1.5 Formulas for calculating load GD^2

Typical GD^2 calculation formulas are listed below.

Note: When load inertia J ($kg\cdot cm^2$) is used, the conversion formula between J and GD^2 is $GD^2=4J$.

Calculation of Load GD^2

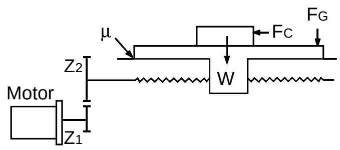
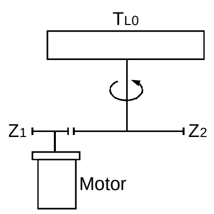
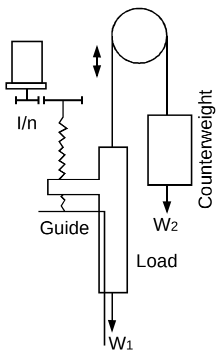
Type	Mechanism	Formula
Cylinder	Rotating axis is the center of a cylinder. 	$GD^2_L = \frac{\pi\cdot\rho\cdot L}{8}(D^4_1 - D^4_2)\times 10^{-4}\ \frac{W}{2}(D^2_1 - D^2_2)\times 10^{-4}$ .... (3.1) GD^2_L: Load GD^2 [$kgf\cdot m^2$] ρ: Specific gravity of cylinder material [kgf/cm^3] L: Length of cylinder [cm] D_1: OD of cylinder [cm] D_2: ID of cylinder [cm] W: Weight of cylinder [kgf] Reference data: Specific gravities of materials Iron .... 7.8×10^{-3} [kgf/cm^3] Aluminum .... 2.7×10^{-3} [kgf/cm^3] Copper .... 8.96×10^{-3} [kgf/cm^3]
	Misaligned rotating axis and cylinder axis 	$GD^2_L = \frac{W}{2}(D^2+8R^2)\times 10^{-4}$ .... (3.2) GD^2_L: Load GD^2 [$kgf\cdot m^2$] D, R: As shown on the left [cm]
Square pillar		$GD^2_L = Wx\left(\frac{a^2+b^2}{3}+R^2\right)\times 10^{-4}$ .... (3.3) GD^2_L: Load GD^2 [$kgf\cdot m^2$] a, b, R: As shown on the left [cm]
Object that moves linearly		$GD^2_L = W\times\left(\frac{V}{\pi N}\right)^2 = 4W\cdot\left(\frac{\Delta S}{20\pi}\right)\times 10^{-4}$ .... (3.4) GD^2_L: Motor shaft-equivalent load GD^2 [$kgf\cdot m^2$] V: Velocity of object that moves linearly [m/min] N: Motor speed [r/min] ΔS: Moving distance of linearly moving object per motor revolution [mm/rev] W: Weight of object that moves linearly [kgf]
Object hung		$GD^2_L = W\cdot D^2 + GD^2_P$ .... (3.5) W: Overall weight (W_1+W_2) [kgf] GD^2_P: GD^2 of pulley [$kgf\cdot m^2$] D: Diameter of pulley [m]
Load varied in speed		$GD^2_L = GD^2_{11} + (GD^2_{21}+GD^2_{22}+GD^2_A)\cdot\left(\frac{N_3}{N_1}\right)^2 + GD^2_{31}+GD^2_B)\cdot\left(\frac{N_3}{N_1}\right)^2$ .... (3.6) GD^2_A, GD^2_B: GD^2 of loads A, B [$kgf\cdot m^2$] GD^2_{11} to GD^2_{31}: GD^2 of gears $kgf\cdot m^2$] N_1 to N_3: Shaft speeds [r/min]

3.1.6 Formulas for calculating load torque

Typical load torque calculation formulas are listed below:

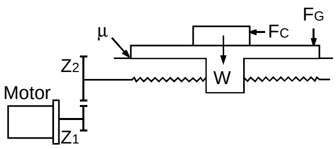
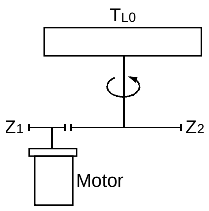
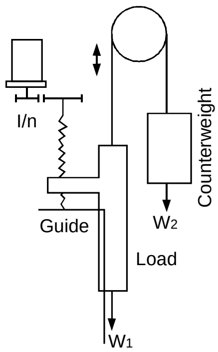
(1) Load torque calculation formulas [kgf·m]

Load Torque Calculation Formulas [kgf·m]

Type	Mechanism	Formula
Linear motion		$T_L=\frac{F}{20\pi\eta}\cdot\left(\frac{V}{N}\right)\times 10^{-2}=\frac{F\cdot\Delta S}{20\pi\eta}\times 10^{-2}$[kgf·m] .... (4.1) F: Axial force of machine which moves linearly [kgf] η: Drive system efficiency V: Moving velocity [mm/min] N: Motor speed [r/min] ΔS: Moving distance per motor revolution [mm/rev] When the table is moved, e.g. as shown on the left, F in the above formula can be found by the following formula (4.2): $F=F_C+\mu(W+F_G)$ [kgf·m] .... (4.2) F_C: Axially moving force of moving part [kgf] F_G: Tightening force of table guide surface [kgf] W: Overall weight of moving part [kgf] μ: Friction coefficient
Rotary motion		$T_L\ \frac{1}{n}\cdot\frac{1}{\eta}\ T_{L0}+T_F$[kgf·m] .... (4.3) T_{LO}: Load torque on load axis [kgf·m] T_F: Motor shaft-equivalent friction load torque [kgf·m] 1/n: Reduction ratio (Z_1/Z_2) η: Drive system efficiency
Vertical motion		Rising $T_L=T_U+T_F$ [kgf·m] .... (4.4) Lowering $T_L=-T_U\cdot\eta+T_F$ [kgf·m] .... (4.5) T_U: Unbalance torque [kgf·m] T_F: Friction torque of moving part [kgf·m] η: Drive system efficiency $T_L=\frac{(W_1-W_2)}{20\pi\eta}\cdot\left(\frac{V}{N}\right)\times 10^{-2}=\frac{(W_1-W_2)\cdot\Delta S}{20\pi\eta}\times 10^{-2}$ .... (4.6) $T_F=\frac{\mu\cdot(W_1+W_2)\cdot\Delta S}{20\pi\eta}\times 10^{-2}$ .... (4.7) W_1: Weight of load [kgf] W_2: Weight of counterweight [kgf] η: Drive system efficiency μ: Friction coefficient V: Moving velocity [mm/min] ΔS: Moving distance per motor revolution [mm/rev]

(2) Load torque calculation formulas [N·m]

Load Torque Calculation Formulas [N·m]

Type	Mechanism	Formula
Linear motion		$T_L = \frac{F}{2\times 10^3\pi\eta}\cdot\left(\frac{V}{N}\right)\times 10^{-2} = \frac{F\cdot\Delta S}{2\times 10^3\pi\eta}$ [kgf·m]................... (4.8) F: Axial force of machine which moves linearly [N] η: Drive system efficiency V: Moving velocity [mm/min] N: Motor speed [r/min] ΔS: Moving distance per motor revolution [mm/rev] When the table is moved, e.g. as shown on the left, F in the above formula can be found by the following formula (4.9): $F=F_C+\mu(W+F_G)$ [kg] .... (4.9) F_C: Axially moving force of moving part [N] F_G: Tightening force of table guide surface [N] W: Overall weight of moving part [kg] g: Acceleration of gravity [$9.8m/s^2$] μ: Friction coefficient
Rotary motion		$T_L \frac{1}{n}\cdot\frac{1}{\eta} T_{L0}+T_F$ [N·m] .... (4.10) T_{LO}: Load torque on load axis [N·m] T_F: Motor shaft-equivalent friction load torque [N·m] 1/n: Reduction ratio (Z_1/Z_2) η: Drive system efficiency
Vertical motion		Rising $T_L=T_U+T_F$ [N·m] .... (4.11) Lowering $T_L=-T_U\cdot\eta+T_F$ [N·m] .... (4.12) T_U: Unbalance torque [kgf·m] T_F: Friction torque of moving part [kgf·m] η: Drive system efficiency $T_U = \frac{(W_1-W_2)}{2\times 10^3\pi\eta}\cdot\left(\frac{V}{N}\right)\times 10^{-2} = \frac{(W_1-W_2)\cdot g\cdot\Delta S}{2\times 10^3\pi\eta}$ .... (4.13) $T_F = \frac{\mu\cdot(W_1-W_2)\cdot g\cdot\Delta S}{2\times 10^3\pi\eta}$ .... (4.14) W_1: Weight of load [kg] W_2: Weight of counterweight [kg] η: Drive system efficiency μ: Friction coefficient V: Moving velocity [mm/min] ΔS: Moving distance per motor revolution [mm/rev]

3.2 Motor Selection

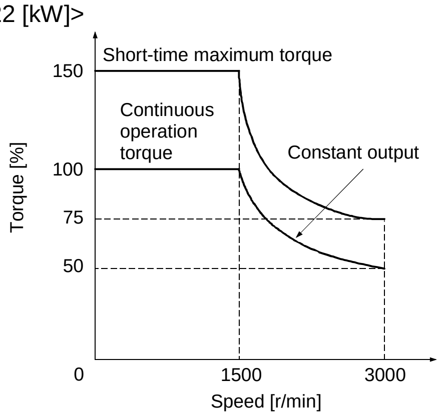
3.2.1 Torque characteristics

(1) Vector inverter motor (SF-VR [H])

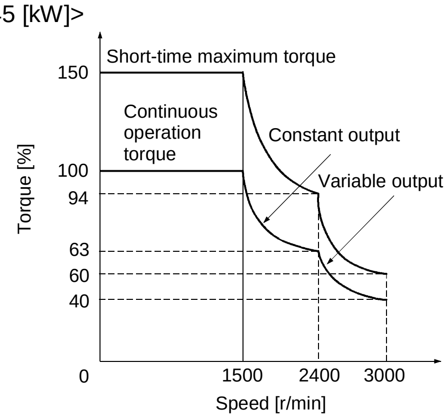
When the rated voltage is input, the torque characteristics of the motor used with the inverter of the same capacity are as shown below:

1500r/min (50Hz) torque standard

<5.5 to 22 [kW]>



<30 to 45 [kW]>



Note: The above characteristics assume that the motor coil temperature is 75°C or higher. At lower temperatures, torque will reduce.

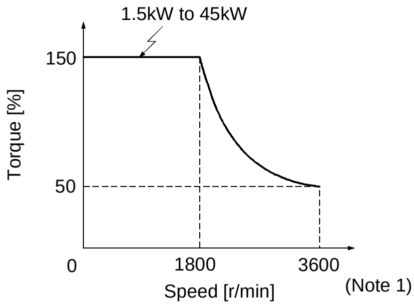
(2) Motor with PLG (Example: SF-JR [4P])

When the rated voltage is input, the torque characteristics of the motor used with the inverter of the same capacity are as shown below:

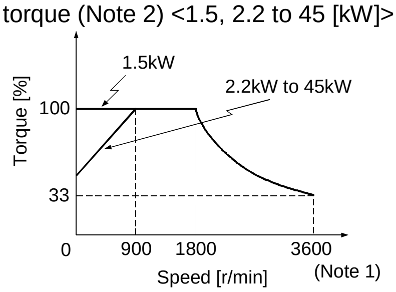
1800r/min (60Hz) torque standard

Cyclic operation mode setting

● Short-time maximum torque <1.5 to 45 [kW]>

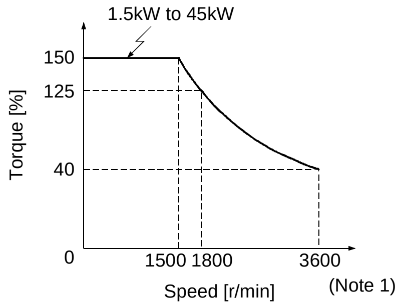


● 50% ED torque (Note 2) <1.5, 2.2 to 45 [kW]>

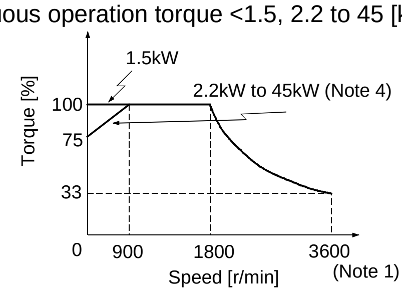


Continuous operation mode setting

● Short-time maximum torque <1.5 to 45 [kW]>



● Continuous operation torque <1.5, 2.2 to 45 [kW]>



(Note 1) Max. speed is 1) 1.5kW to 7.5kW: 3600r/min, 2) 11kW to 30kW: 3000r/min, 3) 37kW to 45kW: 1950r/min.

(Note 2) Continuously repeated operation at 50%ED is possible in the cycle time of 10 minutes. Note that continuous operation is performed up to 5 minutes.

(Note 3) When 50%ED of 100% torque is required for 2.2kW or 3.7kW at 900r/min or less, use the constant-torque motor (SF-JRCA).

(Note 4) When continuous 100% torque is required for 2.2kW or 3.7kW at 600r/min or less, use the constant-torque motor (SF-JRCA).

3.2.2 Dedicated motor installation

(1) Direction of dedicated motor installation

Type	Basic Type Code	Manufac-turable Capacity [kW]	Motor Installation Direction (○: Installable, ×: Uninstallable)					
			Floor installation Shaft horizontal	Floor installation Shaft down	Wall installation Shaft down	Wall installation Shaft horizontal	Wall installation Shaft up	Ceiling installation Shaft up
Standard legged	SF-VR□ SF-VRH□	5.5 to 45	○		15kW or less only ○	15kW or less only ○	15kW or less only ○	
Flange type	SF-VRF□ SF-VRFH□	5.5 to 45		○		○		15kW or less only ○
With brake	SF-VR□B SF-VRH□B	5.5 to 45	○		×	×	×	
Flange type with brake	SF-VRF□B SF-VRFH□B	5.5 to 15		×		15kW or less only ○		×

(2) Permissible shaft loads of dedicated motors

Type Code	Permissible Shaft Load	
	Radial	Thrust
SF-VR(F)(H)5K SF-VR(F)(H)7K	1323 {135}	657 {67}
SF-VR(F)(H)11K SF-VR(F)(H)15K	1660 {170}	980 {100}
SF-VR(F)(H)18K SF-VR(F)(H)22K	2250 {230}	1470 {150}
SF-VR(F)(H)30K SF-VR(F)(H)37K SF-VR(F)(H)45K	2550 {260}	1810 {185}

(Note 1) The permissible values indicated are those at the base speed.
(Note 2) The permissible radial loads are values at the shaft end.
(Note 3) The permissible thrust loads are values when the motor shaft is horizontal.

(3) Specifications of dedicated motors with brakes

Applicable Motor SF-VR□ SF-VRH□			5KB	7KB	11KB	15KB	18KB	22KB	30KB	37KB	45KB
Brake type (Note 1)			ESB-165		ESB-190		ESB-220			ESB-250	
Brake specifications		Static friction torque [N · m (kgf · m)]	73.5 {7.5}		147 {15}		294 {30}			456.7 {46.6}	
		Brake power supply	90VDC (not provided). Use Osaki Dengyo's HD-110M2, HD-110M3 or equivalent.								
		Application (Note 2)	Usually used for load holding purpose and should not be used for other than emergency braking.								
		Rated current [A] (20°C)	0.581		0.841		0.947			1.154	
		Exciting coil resistance [Ω] (20°C)	155		107		95			78	
		Capacity [W]	52.3		75.7		85.3			103.8	
		Release delay time (Note 3) [s]	0.09		0.15		0.18			0.235	
		Braking delay time (Note 3) [s]	0.08		0.09		0.075			0.065	
	Emergency braking	Permissible overall work load × 106 [kgf · m]	56		104		205			267	
		Permissible heat dissipation capacity [kgf · m/min]	1190		1345		2490			3130	
		Frequency (Note 4) [times/min or less]	7	5	3	2	2		1	1	
		Maximum speed [r/min]	1800								
Motor GD_M^2 [kgf · m^2]			0.12	0.17	0.31	0.36	0.72	0.78	1.33	1.50	1.50
Special mention		Installation	Shaft horizontal								

(Note 1) Check the brake gap about once a month to use the motor with the gap length of 1mm or less. Also clean the brake about once a month to remove wearout dust.

(Note 2) A manual release mechanism is not fitted. When the motor shaft is required to turn for core alignment of the machine, etc., use a separate 90VDC power and open the brake electrically.

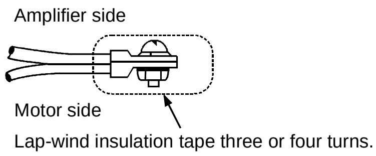
(Note 3) The value for initial suction gap.

(Note 4) This value assumes that the motor shaft-equivalent load GD^2 is twice larger than the motor GD^2m. Note that this value does not apply to vertical lift applications.

(Note 5) Leakage magnetic flux will occur at the shaft end.

(4) Instructions for connecting the dedicated motor

1) Always match the phases of the motor power supply leads (U, V, W) with those of the inverter output terminals (U, V, W).
2) Connect a 200VAC power supply to the cooling fan power supply leads (A, B, C).
3) Always connect the thermal protector terminals to the inverter terminals (MOH, SD).
4) Connect a 90VDC power supply to the brake power supply leads (B1, B2).
5) Lap-wind an insulation tape three or four turns around the connection to provide sufficient insulation.



6) Connect the ground terminal to the inverter's ground terminal and earth it with the earth plate in the control box.

3.3 Dedicated Option Selection

3.3.1 Inboard option list

Function	Description	Remarks	Option FR-VPA (Extension input/output function)	FR-VPB (Position control function)	FR-VPC (12-bit digital I/O function)	FR-VPD (PLG pulse division output function)
Orientation control (Orientation PLG input)	• Used with a position detector (PLG) mounted on a machine tool spindle or a PLG at motor end to allow the spindle to be stopped at a predetermined position (orientation function).	• Positioning accuracy: ±1° • PLG specifications: Three-phase (A, B, Z) Differential output 1024ppr 5VDC power supply.	○			
Position control (Pulse train input)	• Positioning control is possible by inputting a pulse train from an external source. • Connection with the MELSEC-A (positioning module AD71, AD75) is also possible.	• Maximum permissible number of pulses: 200kpps • Input interface: Differential receiver or open collector.		○		○
Extension input	• Can be expanded by up to 6 input terminal points. • When not using the orientation function, six points from the multi-function input terminals can be selected as with the standard specifications.	• When the orientation function is valid, the input terminals are fixed to orientation start input (DI11) and stop position command input (DI12 to DI16).	○			
	• Can be expanded by up to 3 input terminal points. • Up to three multi-function input terminal points can be chosen.					○
Extension output	• Can be expanded by 3 output terminal points. • When not using the orientation function, three points from the multi-function output terminals can be selected as with the standard specifications.	• When the orientation function is valid, the terminal output DO11 is fixed to the orientation end output.	○			
	• Can be expanded by 2 output terminal points. • Up to two multi-function output terminal points can be chosen.					○
Extension analog input	• Can be expanded by one analog command option input (0 to +10V).	• This is used to set the torque limit exclusively for regeneration when using speed control.	○	○	○	
High-resolution analog input	• Can be expanded by one analog command option input (±10V).	• 0.05% resolution.				○
		• 0.01% resolution.			○	
PLG pulse output — Open collector	• The spindle end PLG pulse input can be output. • The motor end PLG pulse input can be output by changing the parameters.	• The output can also be provided by dividing the number of pulses by 1/2, 1/4, 1/8 or 1/16 times. However, rotation direction of motor cannot be identified at the time of division.	○			
PLG pulse output — Line driver	• The motor end PLG pulse input can be output.			○	○	

Function		Description	Remarks	Option			
				FR-VPA (Extension input/ output function)	FR-VPB (Position control function)	FR-VPC (12-bit digital I/O function)	FR-VPD (PLG pulse division output function)
PLG pulse division output	Open collector	• Motor end PLG pulse input can be divided and output. • Division ratio 1/n (n=1 to 32768 integer)	• Rotation direction of motor can be identified at the time of division.				○
Power for long distance cable		• This is used as the power for the spindle end PLG cable or for motor end PLG cable having a length of 50m (164.04 feet) or more (100m (328.08 feet) or less).	• Power supply voltage: 5.5V (55E-AG2).	○	○	○	○
RS-485 interface		• Using the communication cable, the inverter can be connected to a computer such as a personal computer or FA controller. The inverter can be run and monitored, and the parameters can be read and written from the computer using a user program.	• Conforming standards: EIA Standards.		○		
Motor thermistor interface		• When the vector control inverter motor (with thermistor) is used, motor temperature can be detected by the thermistor and the temperature fluctuation of the torque generated can be reduced.				○	
12-bit digital input		• Input interface used to set the inverter frequency accurately using external BCD or binary digital signals. • The external contact signal is used to make 12-bit digital speed setting.	• Input voltage, current: 24VDC, 5mA (per circuit) • Input signal format: contact signal input or transistor open collector (sink type) input			○	

○ indicates the functions provided.

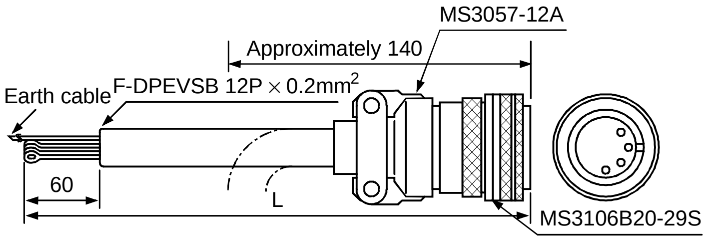
Only one option unit may be installed in the inverter, the inverter unit only has space for 1 option.
Each option unit has several functions as listed above.

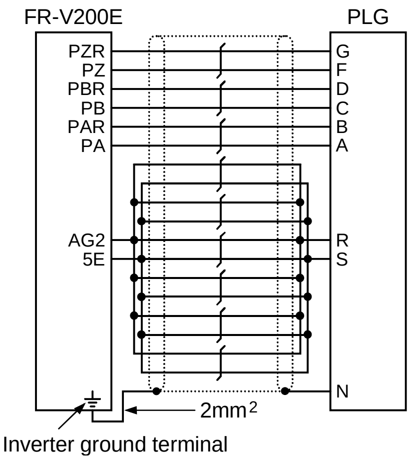
3.3.2 PLG cables

The cable for connection of the inverter and PLG differs with the motor used.
Choose either of the following options (FR-VCBL and FR-JCBL) according to the motor type.

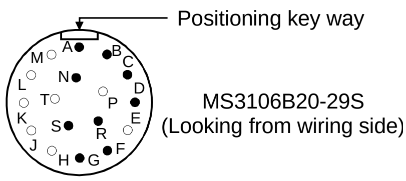
(1) FR-VCBL

Use this cable when using the vector control inverter motor (SF-VR series) with the vector inverter (FR-V200E).



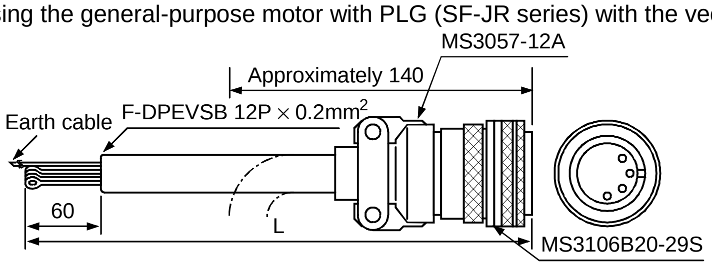


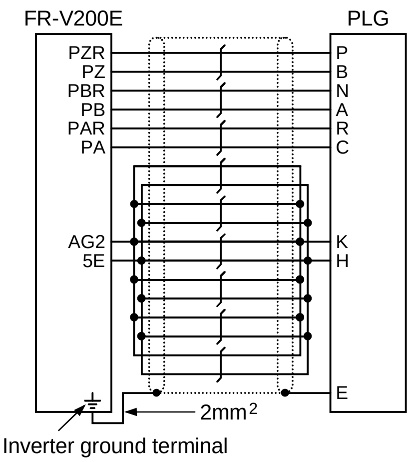
Option (Type)	Length (L) [m]	Remarks
FR-VCBL5	5	Standard product
FR-VCBL15	15	
FR-VCBL30	30	
FR-VCBL2	2	*Produced on order Please consult separately.
FR-VCBL50	50	
FR-VCBL70	70	
FR-VCBL100	100	



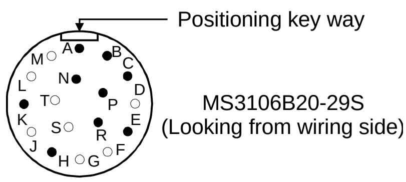
(2) FR-JCBL

Use this cable when using the general-purpose motor with PLG (SF-JR series) with the vector inverter (FR-V200E).





Option (Type)	Length (L) [m]	Remarks
FR-JCBL5	5	Standard product
FR-JCBL15	15	
FR-JCBL30	30	
FR-JCBL2	2	*Produced on order Please consult separately.
FR-JCBL50	50	
FR-JCBL70	70	
FR-JCBL100	100	



(3) Specifications for selection and cable fabrication

For connection of the motor end PLG and inverter, refer to the following table and select or fabricate the cable:

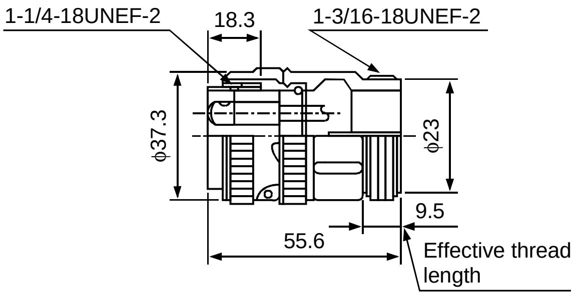
<table>
<tr><th rowspan="2">Wiring Distance</th><th rowspan="2">Optional PLG Cable</th><th colspan="2">Fabricated Cables</th><th rowspan="2">Connection of PLG Power Supply</th></tr>
<tr><th>Number of parallel cables of 0.2mm^2</th><th>Larger-size cables</th></tr>
<tr><td>0 to 5m</td><td>FR-VCBL5
FR-JCBL5</td><td>2 or more cables</td><td rowspan="2">0.4mm^2 or more</td><td rowspan="6">Terminals 5E-AG2
(inverter)
(Approximately 5V)</td></tr>
<tr><td>5 to 10m</td><td rowspan="2">FR-VCBL15
FR-JCBL15</td><td>2 or more cables</td></tr>
<tr><td>10 to 15m</td><td>4 or more cables</td><td rowspan="2">0.75mm^2 or more</td></tr>
<tr><td>15 to 20m</td><td rowspan="2">FR-VCBL30
FR-JCBL30</td><td>4 or more cables</td></tr>
<tr><td>20 to 30m</td><td>6 or more cables</td><td rowspan="3">1.25mm^2 or more</td></tr>
<tr><td>30 to 50m</td><td rowspan="2">*Produced on order
Please consult separately.</td><td rowspan="2">6 or more cables</td></tr>
<tr><td>50 to 100m</td><td>Terminals 55E-AG2
[Inboard option
FR-VPA, FR-VPB
FR-VPC, FR-VPD]
(Approximately 5.5V)</td></tr>
</table>

1) Wiring between inverter and motor end PLG
- Use the optional PLG connection cable (FR-VCBL or FR-JCBL).
- When there is no appropriate optional connection cable, fabricate the necessary cable in accordance with the PLG cable fabrication specifications in the above table.

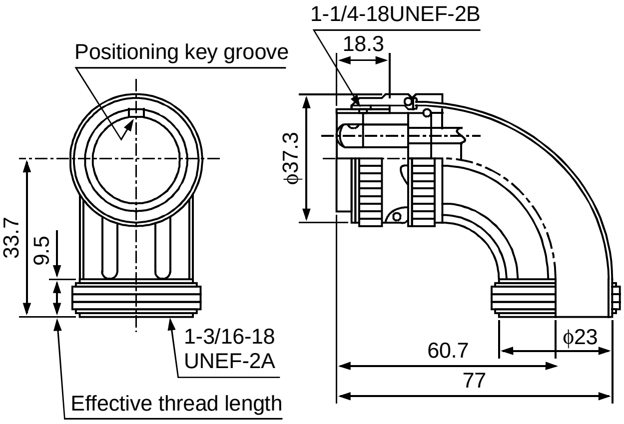
2) For wiring between terminals "55E" and "AG2" and motor end PLG, connect cables in parallel or use larger-sized cables. Details of selection and fabrication are given on the next page.

(4) PLG connector (Japan Aviation Electronics Industry) .... Reference

Straight plug MS3106B20-29S



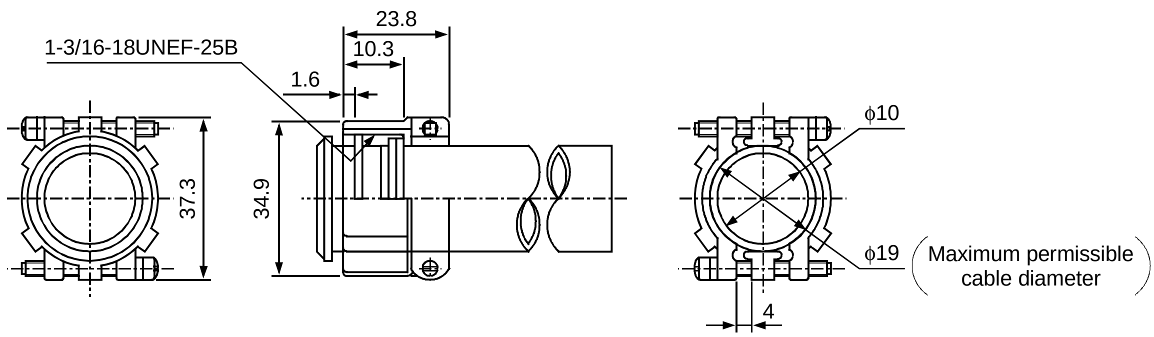
Angle plug MS3108B20-29S



Notice

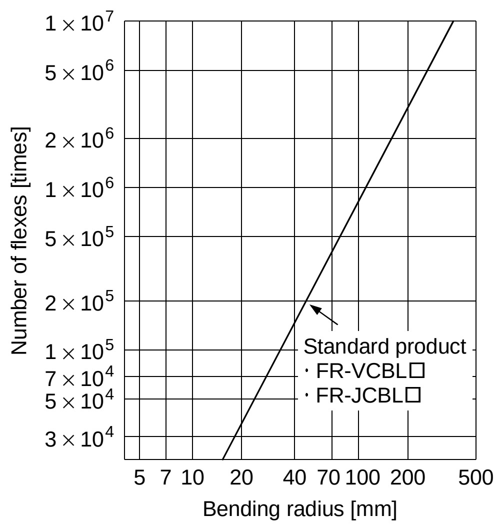
This angle type connector is not optional and should be prepared by the user.

Cable clamp MS3057-12A



(5) 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 stamped by workers or vehicles.
4) The reference value of PLG cable flexing life is shown on the right.
   When mounting the PLG on a machine where the motor will move, the flexing radius should be as large as possible.



Note: This graph shows calculated values and not guaranteed values.

3.4 PLG Specifications

3.4.1 PLG specifications

Item	PLG for Vector Control Inverter Motor (SF-VR)	PLG for General-Purpose Motor with PLG (SF-JR)
Resolution	1000 pulses per revolution	1024 pulses per revolution
Power supply voltage	5VDC ±10%	4.5V to 5.25VDC
Current consumption	150mA	150mA
Output signal form	A-, B-phases (90° phase) Z-phase: 1 pulse per revolution	A-, B-phases (90° phase) Z-phase: 1 pulse per revolution
Output circuit	Differential line driver Equivalent to AM26LS31	Differential line driver Equivalent to 74LS113
Output voltage	"High" 2.4V or more "Low" 0.4V or less	"High" 2.4V or more "Low" 0.5V or less

The above specifications should be used as reference only when the motor used is a motor other than the vector control inverter motor (SF-VR) or general-purpose motor with PLG (SF-JR).

3.5 Peripheral Devices

SELECTION

3.5.1 Selection

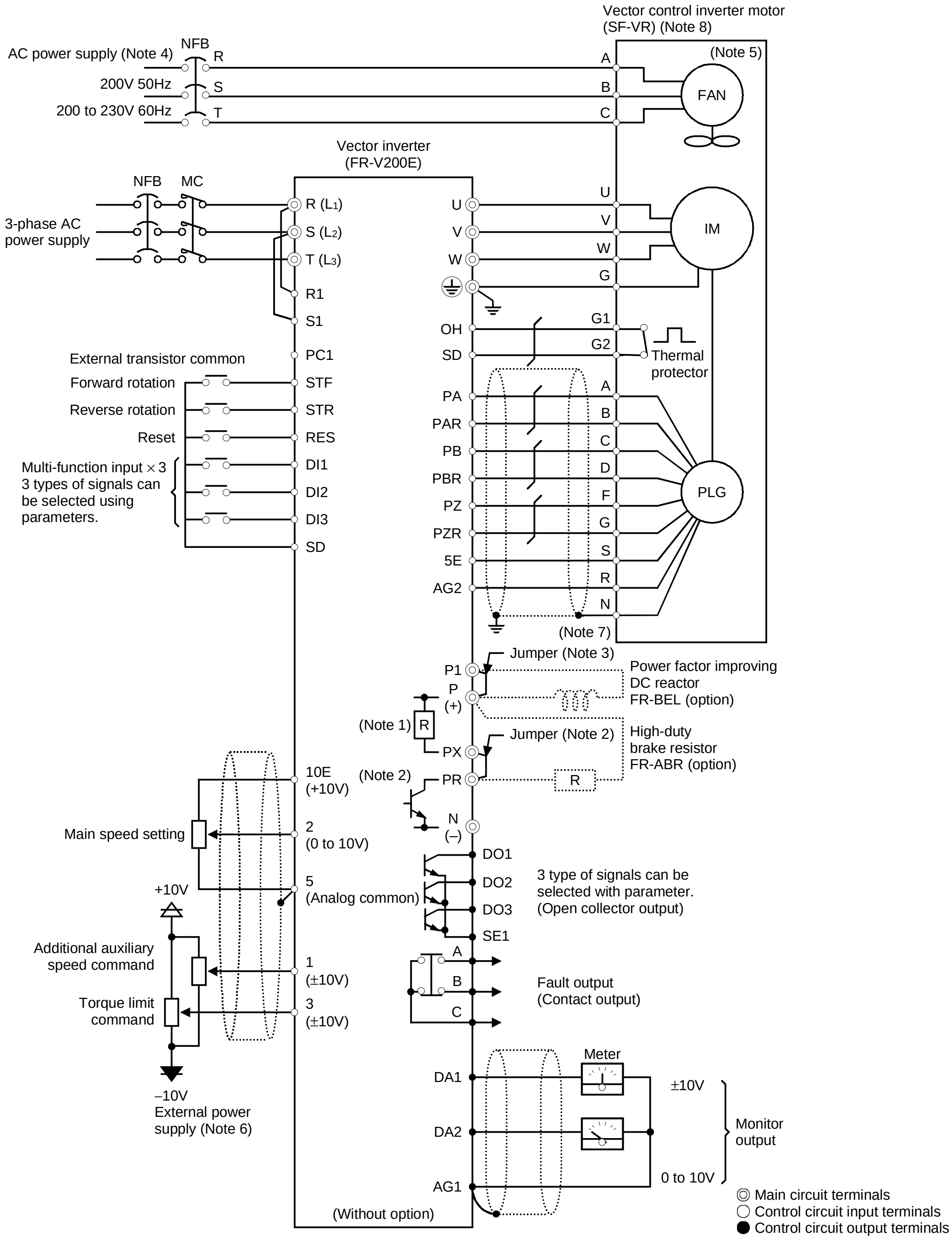
Voltage	Motor Output (kW)	Applicable Inverter Type	No-Fuse Breaker (NFB) or Earth Leakage Circuit Breaker (NV) Standard	No-Fuse Breaker (NFB) or Earth Leakage Circuit Breaker (NV) With power factor improving reactor	Magnetic Contactor (MC)	Cables (mm^2) R, S, T (L_1, L_2, L_3)	Cables (mm^2) U, V, W
200V class	1.5	FR-V200E-1.5K	Type NF30, NV30 15A	Type NF30, NV30 15A	S-N10	2	2
	2.2	FR-V220E-2.2K	Type NF30, NV30 20A	Type NF30, NV30 15A	S-N11, N12	2	2
	3.7	FR-V220E-3.7K	Type NF30, NV30 30A	Type NF30, NV30 30A	S-N20	3.5	3.5
	5.5	FR-V220E-5.5K	Type NF50, NV50 50A	Type NF50, NV50 40A	S-N25	5.5	5.5
	7.5	FR-V220E-7.5K	Type NF100, NV100 60A	Type NF50, NV50 50A	S-N35	14	8
	11	FR-V220E-11K	Type NF100, NV100 75A	Type NF100, NV100 75A	S-K50	14	14
	15	FR-V220E-15K	Type NF225, NV225 125A	Type NF100, NV100 100A	S-K65	22	22
	18.5	FR-V220E-18.5K	Type NF225, NV225 150A	Type NF225, NV225 125A	S-K80	38	38
	22	FR-V220E-22K	Type NF225, NV225 175A	Type NF225, NV225 150A	S-K95	38	38
	30	FR-V220E-30K	Type NF225, NV225 225A	Type NF225, NV225 175A	S-K125	60	60
	37	FR-V220E-37K	Type NF400, NV400 250A	Type NF225, NV225 225A	S-K150	80	80
	45	FR-V220E-45K	Type NF400, NV400 300A	Type NF400, NV400 300A	S-K180	100	100
400V class	1.5	FR-V240E-1.5K	Type NF30, NV30 10A	Type NF30, NV30 10A	S-N10	2	2
	2.2	FR-V240E-2.2K	Type NF30, NV30 15A	Type NF30, NV30 10A	S-N20	2	2
	3.7	FR-V240E-3.7K	Type NF30, NV30 20A	Type NF30, NV30 15A	S-N20	2	2
	5.5	FR-V240E-5.5K	Type NF30, NV30 30A	Type NF30, NV30 20A	S-N20	3.5	2
	7.5	FR-V240E-7.5K	Type NF30, NV30 30A	Type NF30, NV30 30A	S-N20	3.5	3.5
	11	FR-V240E-11K	Type NF50, NV50 50A	Type NF50, NV50 40A	S-N20	5.5	5.5
	15	FR-V240E-15K	Type NF100, NV100 60A	Type NF50, NV50 50A	S-N25	14	8
	18.5	FR-V240E-18.5K	Type NF100, NV100 75A	Type NF100, NV100 60A	S-N35	14	8
	22	FR-V240E-22K	Type NF100, NV100 100A	Type NF100, NV100 75A	S-K50	22	14
	30	FR-V240E-30K	Type NF225, NV225 125A	Type NF100, NV100 100A	S-K65	22	22
	37	FR-V240E-37K	Type NF225, NV225 150A	Type NF225, NV225 125A	S-K80	38	22
	45	FR-V240E-45K	Type NF225, NV225 175A	Type NF225, NV225 150A	S-K80	38	38

3.5.2 Combination of inverter and FR-HC high power factor converter

Voltage	High Power Factor Converter	Inverter Used	Main Circuit Cable Size (mm^2)	NFB	MC
200V	FR-HC-7.5K	FR-V220E-3.7K	3.5	Type NF30, NV30 30A	S-K20
		FR-V220E-5.5K	5.5	Type NF50, NV50 40A	S-K25
		FR-V220E-7.5K	14	Type NF50, NV50 50A	S-K35
	FR-HC-15K	FR-V220E-11K	14	Type NF100, NV100 60A	S-K50
		FR-V220E-15K	22	Type NF100, NV100 75A	S-K65
	FR-HC-30K	FR-V220E-18.5K	38	Type NF100, NV100 100A	S-K80
		FR-V220E-22K	38	Type NF225, NV225 125A	S-K95
		FR-V220E-30K	60	Type NF225, NV225 150A	S-K125
	FR-HC-55K	FR-V220E-37K	80	Type NF225, NV225 175A	S-K150
		FR-V220E-45K	100	Type NF225, NV225 225A	S-K180
400V	FR-HC-H7.5K	FR-V240E-3.7K	2	Type NF30, NV30 15A	S-K20
		FR-V240E-5.5K	3.5	Type NF30, NV30 20A	S-K20
		FR-V240E-7.5K	3.5	Type NF30, NV30 30A	S-K20
	FR-HC-H15K	FR-V240E-11K	5.5	Type NF50, NV50 40A	S-K20
		FR-V240E-15K	14	Type NF50, NV50 50A	S-K25
	FR-HC-H30K	FR-V240E-18.5K	14	Type NF50, NV50 50A	S-K35
		FR-V240E-22K	22	Type NF100, NV100 60A	S-K50
		FR-V240E-30K	22	Type NF100, NV100 75A	S-K65
	FR-HC-H55K	FR-V240E-37K	38	Type NF100, NV100 100A	S-K80
		FR-V240E-45K	38	Type NF225, NV225 125A	S-K80

4 STANDARD CONNECTION DIAGRAMS

4.1 Speed Control Operation



(Note 1) Terminals PR and PX are provided for the 5.5K or less.

(Note 2) When using the FR-ABR, remove this jumper.

(Note 3) When using the FR-BEL, remove this jumper.

(Note 4) The motor fan power supply is single-phase for 5.5kW or 7.5kW (7.5 HP or 10 HP).

(Note 5) Take care to connect the cooling fan power supply cables in the correct phase sequence.

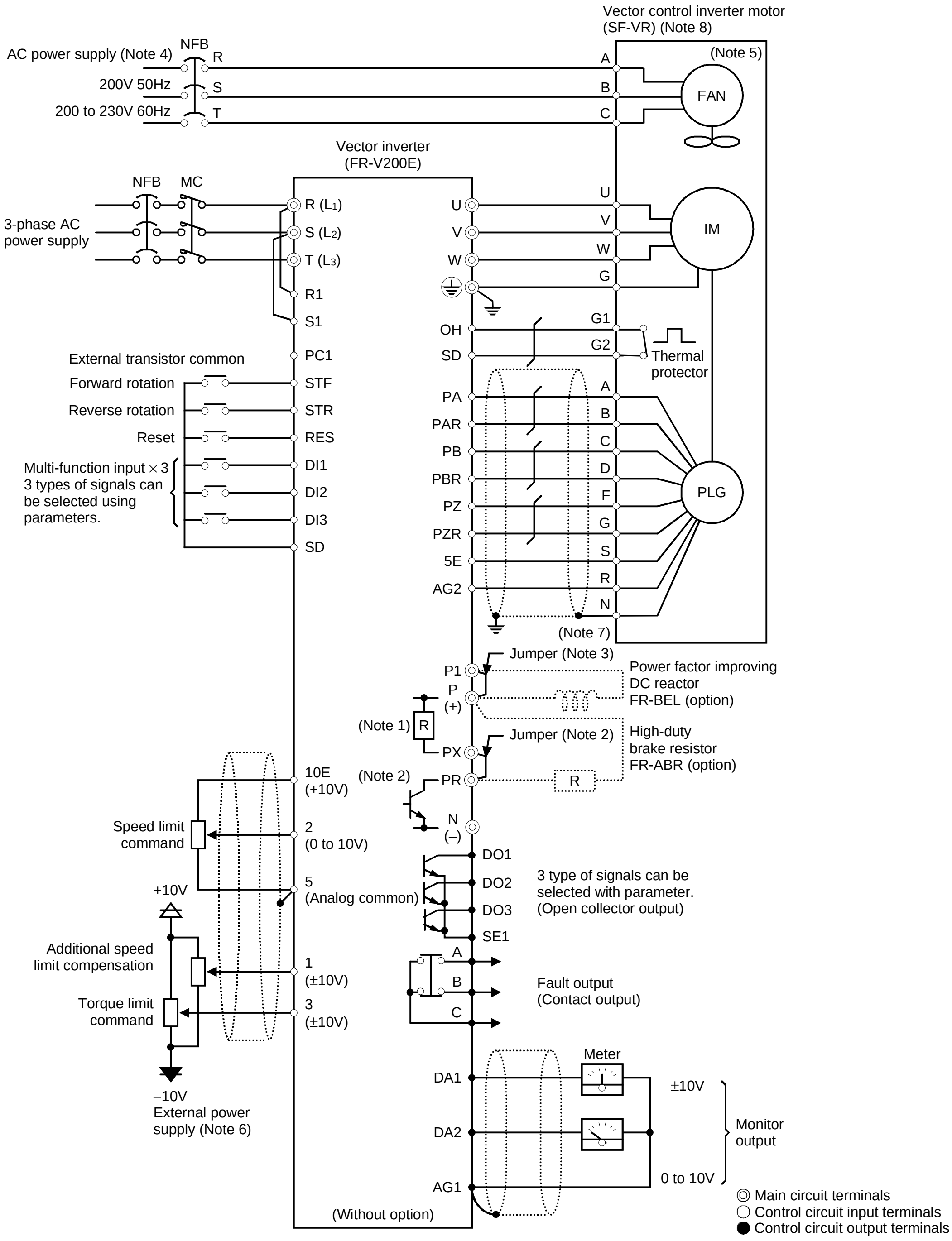
(Note 6) Prepare a ±10V external power supply for terminals 1, 3.

(Note 7) To reduce radiated noise, connect the shield wire of the PLG cable to the case earth pin.

(Note 8) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

(Note 9) When the PLG cable used is longer than 50m, refer to section 4.7.

4.2 Torque Control Operation



(Note 1) Terminals PR and PX are provided for the 5.5K or less.

(Note 2) When using the FR-ABR, remove this jumper.

(Note 3) When using the FR-BEL, remove this jumper.

(Note 4) The motor fan power supply is single-phase for 5.5kW or 7.5kW (7.5 HP or 10 HP).

(Note 5) Take care to connect the cooling fan power supply cables in the correct phase sequence.

(Note 6) Prepare a ±10V external power supply for terminals 1, 3.

(Note 7) To reduce radiated noise, connect the shield wire of the PLG cable to the case earth pin.

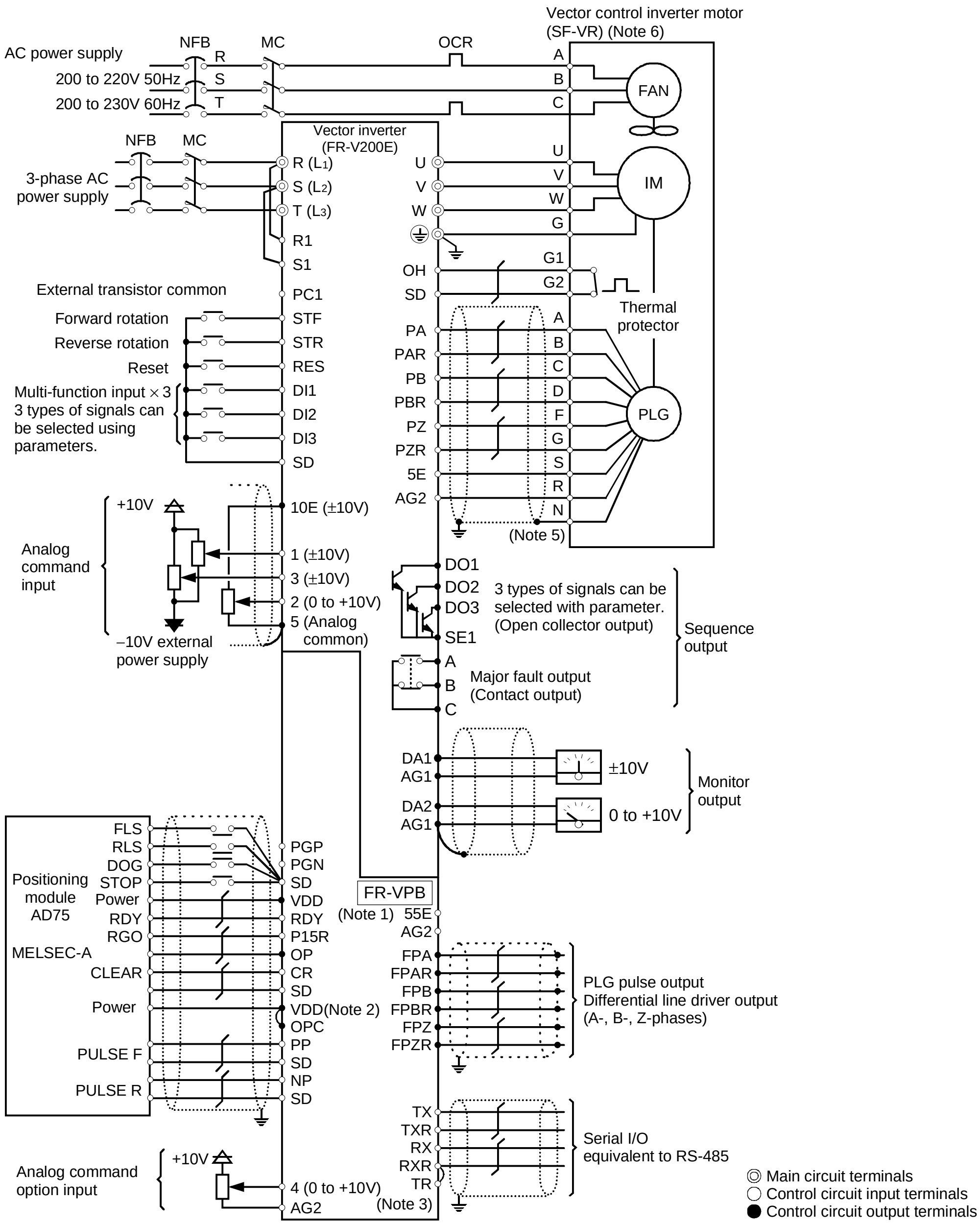
(Note 8) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

(Note 9) When the PLG cable used is longer than 50m, refer to section 4.7.

4.3 Position Control Operation

When connected with the MELSEC-A series programmable controller positioning module (e.g. AD75), the FR-V200E fitted with the FR-VPB or FR-VPD dedicated option can exercise position control.

(1) Connection example (FR-VPB)
Example of connection with the MELSEC-A series AD75 positioning module



(Note 1) To be used as a PLG power supply when the cable used is a long-distance cable longer than 50m.

(Note 2) The pulse train signal from the positioning module may either be open collector or line driver signals. In this case, connection differs slightly between them. (The example shown is for open collector.)

(Note 3) Remove the jumper across RXR-TR in the remotest inverter.

(Note 4) As the FR-VPB option has only one SD terminal, it is recommended to connect several cables together to one solderless terminal.

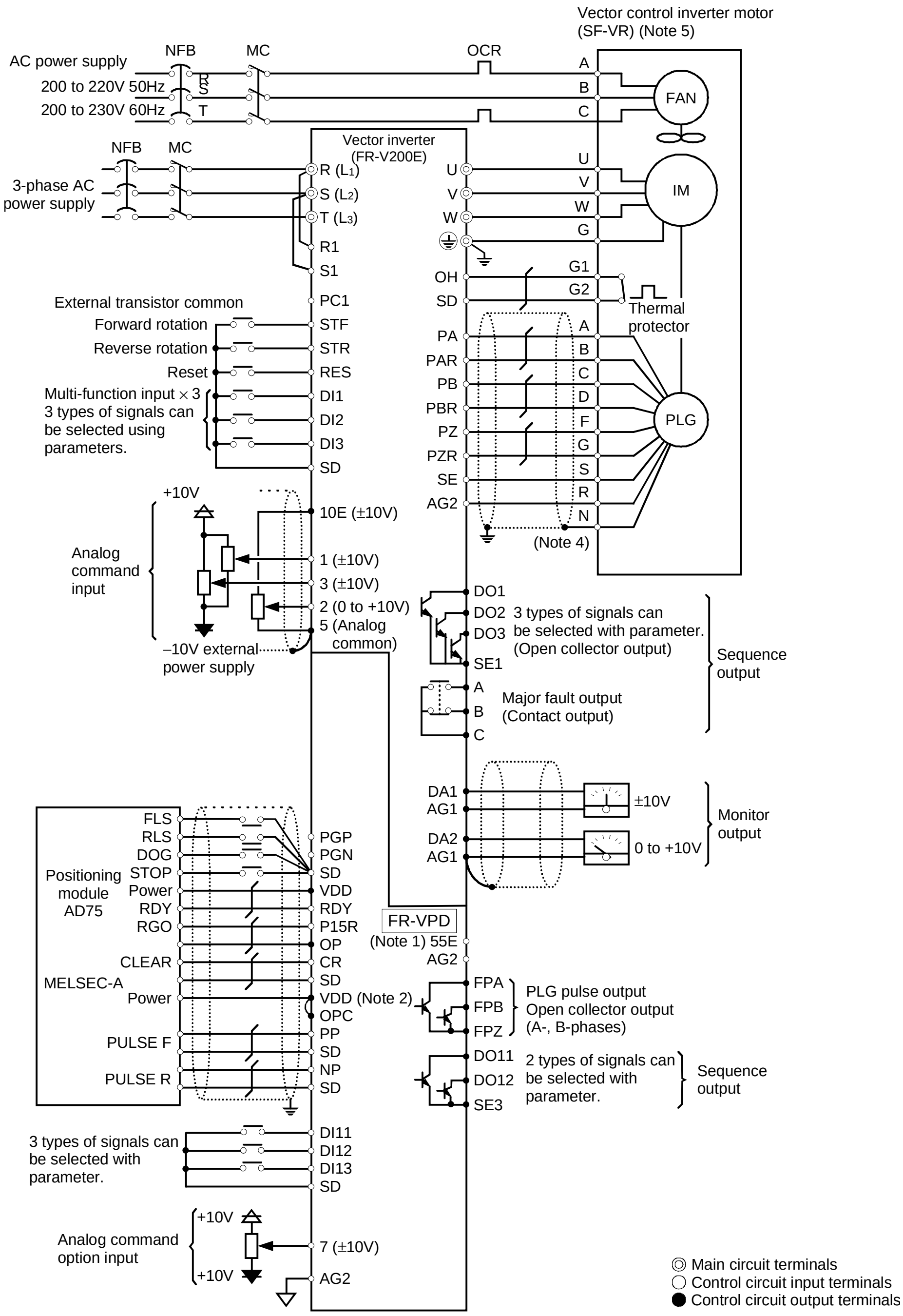
(Note 5) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

(Note 6) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

(Note 7) When the PLG cable used is longer than 50m, refer to section 4.7.

(2) Connection example (FR-VPD)

Example of connection with the MELSEC-A series AD75 positioning module



(Note 1) To be used as a PLG power supply when the cable used is a long-distance cable longer than 50m.

(Note 2) The pulse train signal from the positioning module may either be open collector or line driver signals. In this case, connection differs slightly between them. (The example shown is for open collector.)

(Note 3) The FR-VPD option has two SD terminals. It is recommended to connect several cables together to one solderless terminal.

(Note 4) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

(Note 5) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

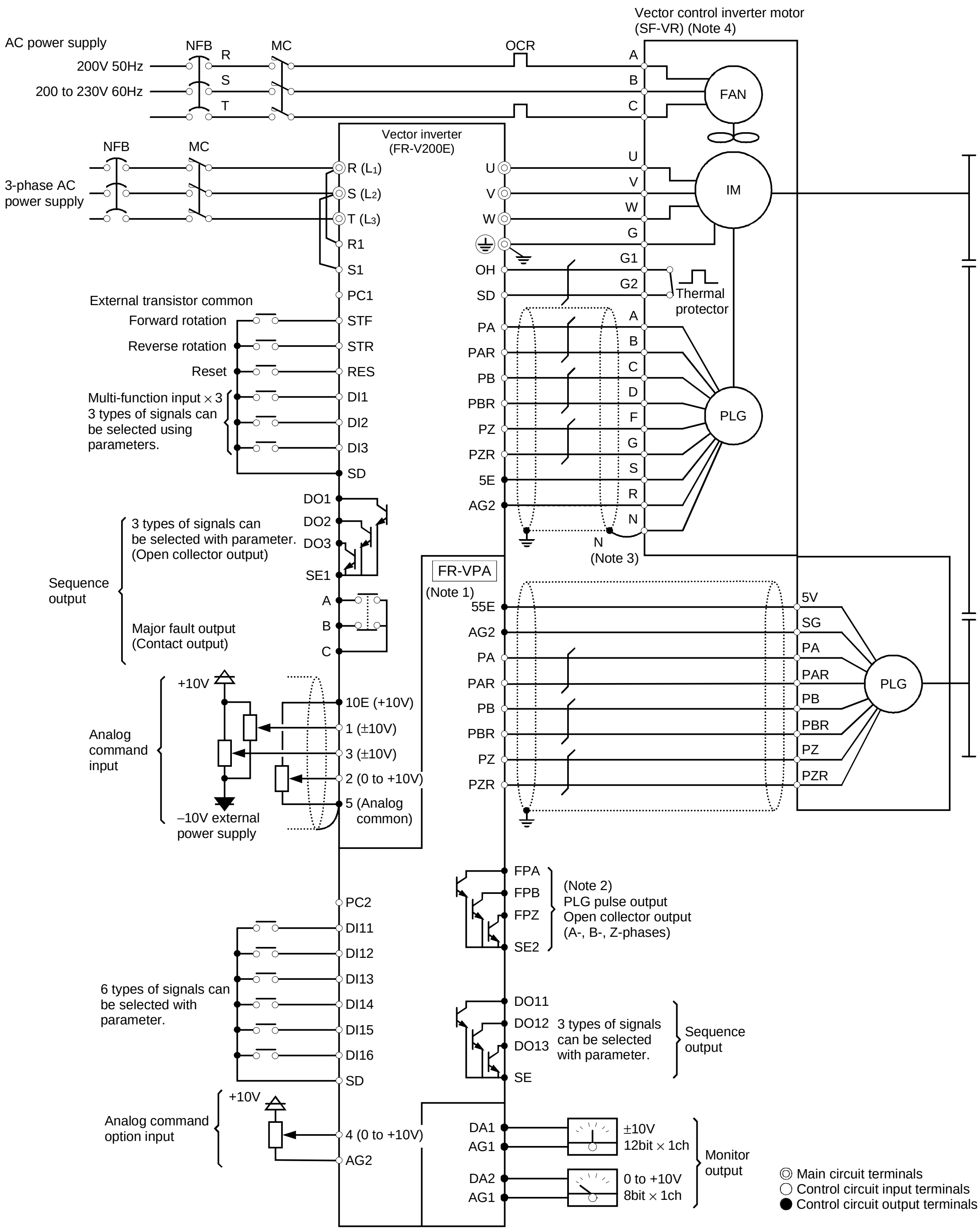
(Note 6) When the PLG cable used is longer than 50m, refer to section 4.7.

4.4 Orientation Control Operation

When used with a position detector (PLG pulse) mounted on a machine tool spindle or the like, the FR-V200E fitted with the FR-VPA dedicated option can exercise fixed-position stop (orientation function) control for the rotary shaft.

- Connection example (FR-VPA)

  Example of orientation PLG provided (machine end)



(Note 1) To be used as a PLG power supply when the cable used is a long-distance cable longer than 50m.

(Note 2) For the PLG pulse output, you can choose either of motor-mounted PLG and machine-mounted PLG by parameter setting.

(Note 3) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

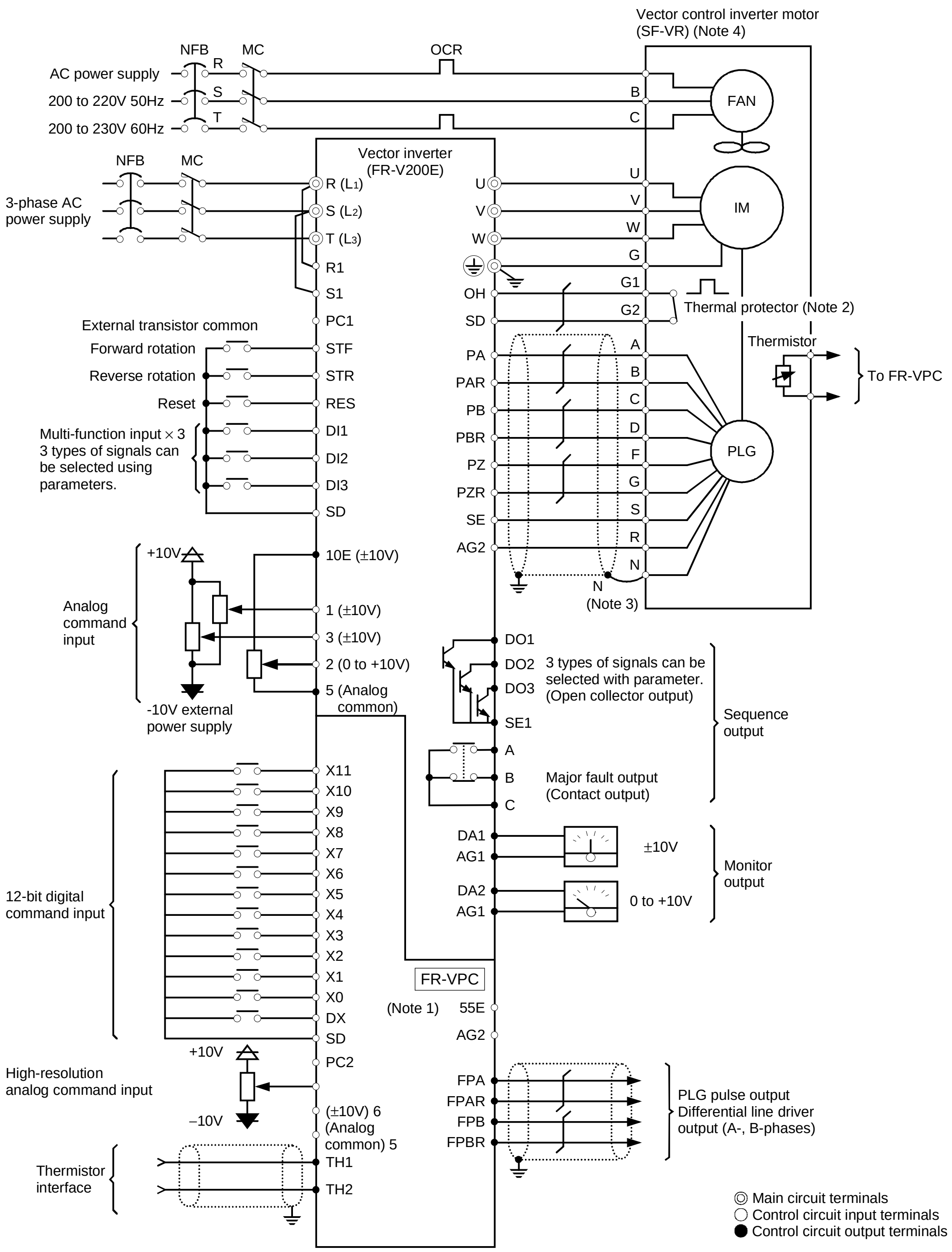
(Note 4) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

(Note 5) When the PLG cable used is longer than 50m, refer to section 4.7.

4.5 12-Bit Digital Command Input (Speed Control)

The FR-V200E fitted with the FR-VPC dedicated option allows you to make speed setting using external BCD or binary digital signals.

- Connection example (FR-VPC)



(Note 1) To be used as a PLG power supply when the cable used is a long-distance cable longer than 50m.

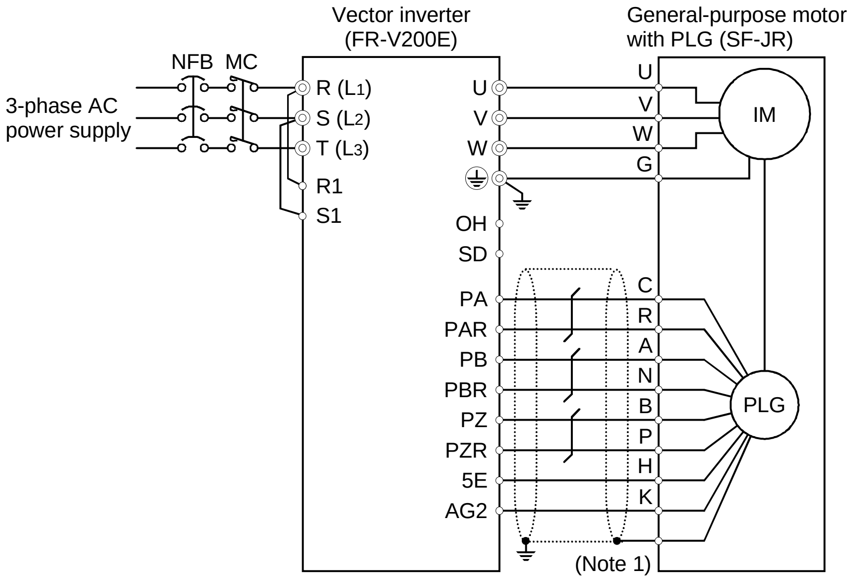
(Note 2) When the motor used is the SF-VR, either the thermal protector or thermistor can be mounted. (The thermal protector is standard and the thermistor is optional.)
When the motor is provided with the thermistor, the motor temperature is detected on the inverter side and the temperature fluctuation of the torque generated is reduced.

(Note 3) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

(Note 4) When the motor used is the general-purpose motor with PLG (SF-JR), refer to section 4.6.

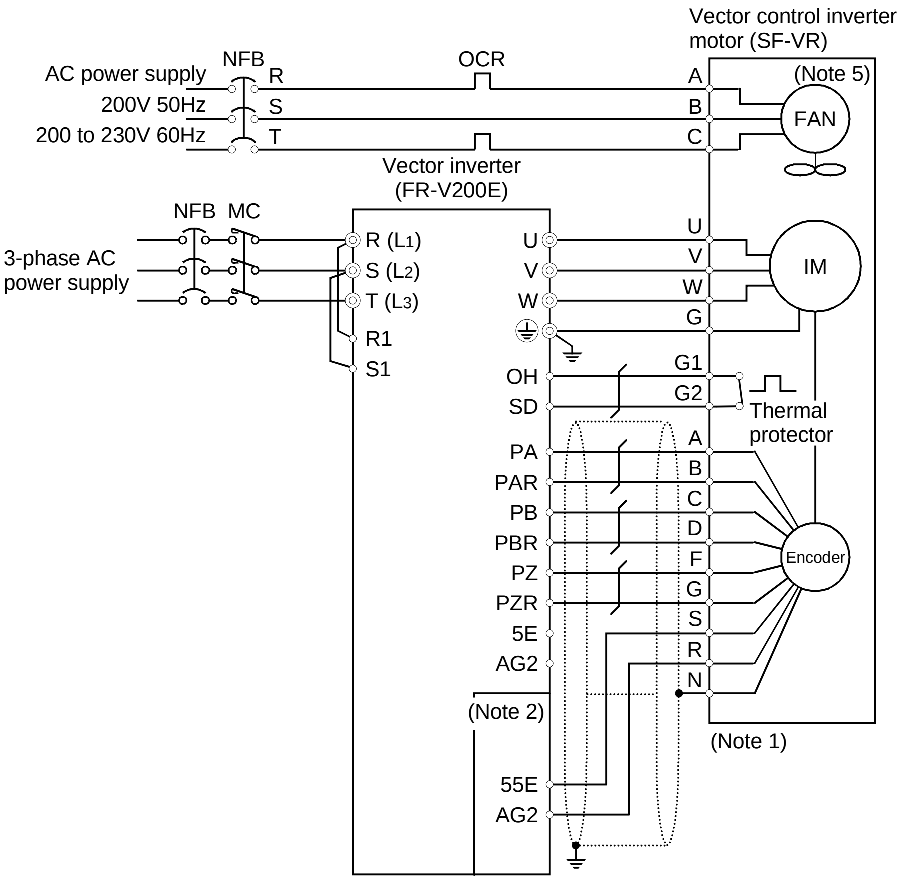
(Note 5) When the PLG cable used is longer than 50m, refer to section 4.7.

4.6 Use of General-Purpose Motor with PLG (SF-JR)



(Note 1) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

4.7 Use of PLG Cable Longer than 50m



(Note 1) To further reduce radiated noises, connect the shield wire of the PLG cable to the case earth pin.

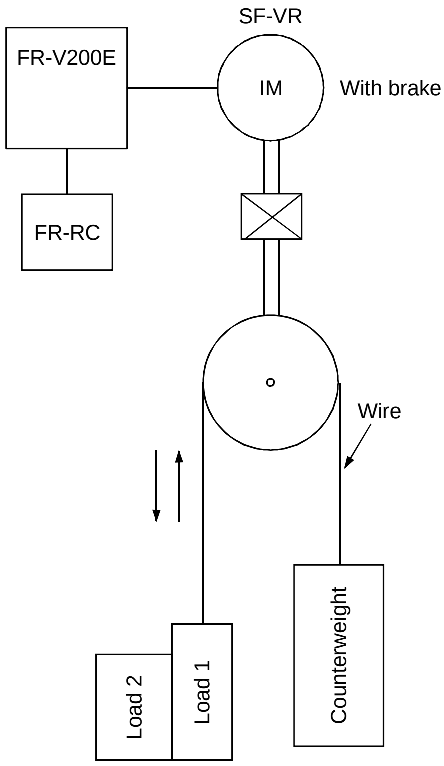
(Note 2) Use the 55E and AG2 terminals of the FR-VP☐ (A to D) dedicated option as a PLG power supply.

5 APPLICATION EXAMPLES

5.1 Speed Control Operation

5.1.1 Elevating operation

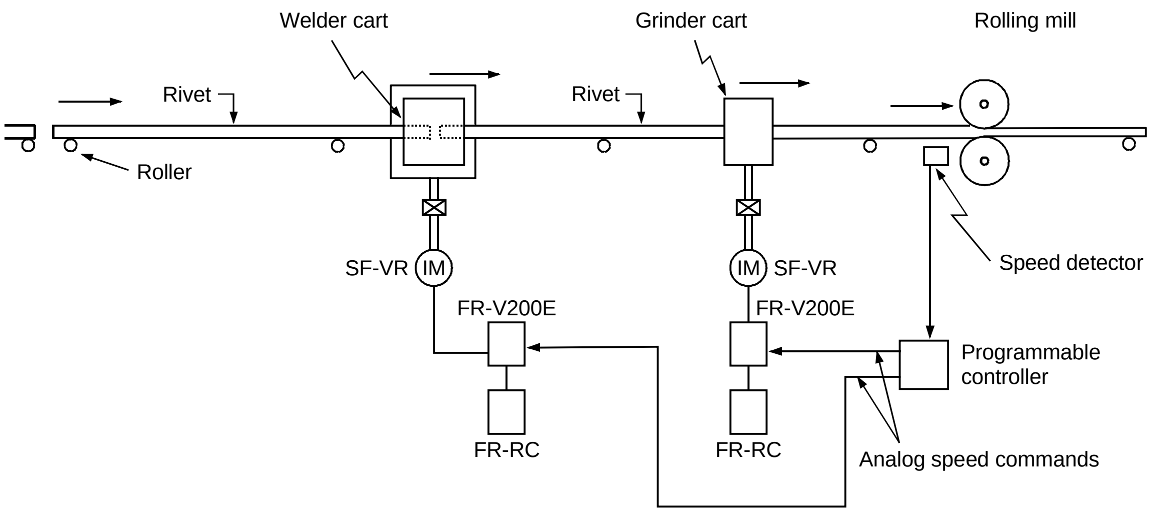
Item	Elevating operation by speed control
Machine/apparatus name	Lifter
System configuration	



Features/Considerations	Related parameters
• When the motor is used with a mechanical brake, use pre-excitation to prevent the load from slipping down when the mechanical brake is opened.	• Pre-excitation Pr. 17 "Input terminal assignment" Pr. 62 "pre-excitation selection"
• Torque shortage should not be occur during acceleration and deceleration.	• Acceleration/deceleration torque Pr. 34 "torque limit level" Pr. 118, Pr. 158 "torque limit for deceleration" Pr. 119, Pr. 159 "torque limit for acceleration" Pr. 130, Pr. 157 "excitation ratio"
• Generally, due to expansion and contraction of the wire and presence of the gears, machine rigidity is low and therefore the gains cannot be increased high enough.	• No overshoot or undershoot Pr. 80 "speed control P gain 1" Pr. 81 "speed control I gain 1"

5.1.2 Synchronous operation

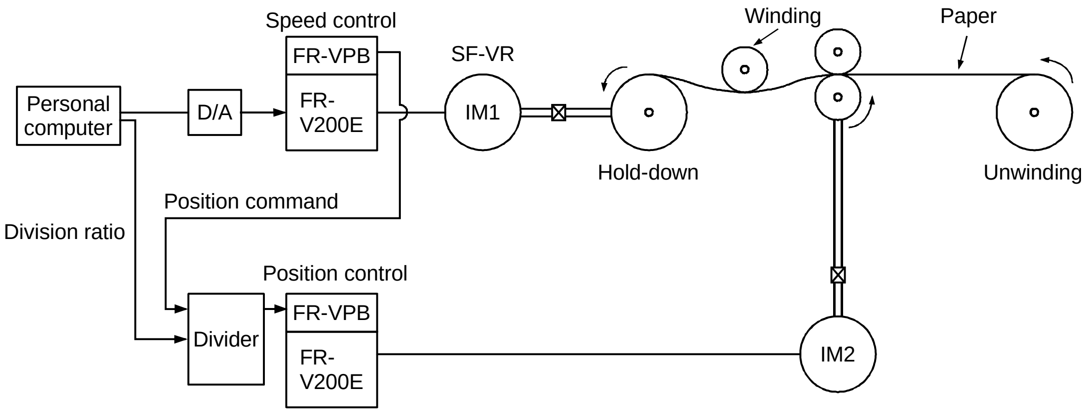
Item	Synchronous operation by speed control
Machine/apparatus name	Cart running
System configuration	



Features/Considerations	Related parameters
• In synchronization with the rolling speed, the welder cart is run to feed and simultaneously weld rivets. Further, the grinder cart is also synchronized to deburr the rivets.	• Analog speed command calibration Pr. 902 "speed setting No. 2 bias" Pr. 903 "speed setting No. 2 gain"
• When analog commands are used, they must be calibrated so that the same command may give the same speed. If possible, digital speed commands are favorable.	• Noise reduction Pr. 72 "PWM frequency selection"

5.1.3 Draw tension control

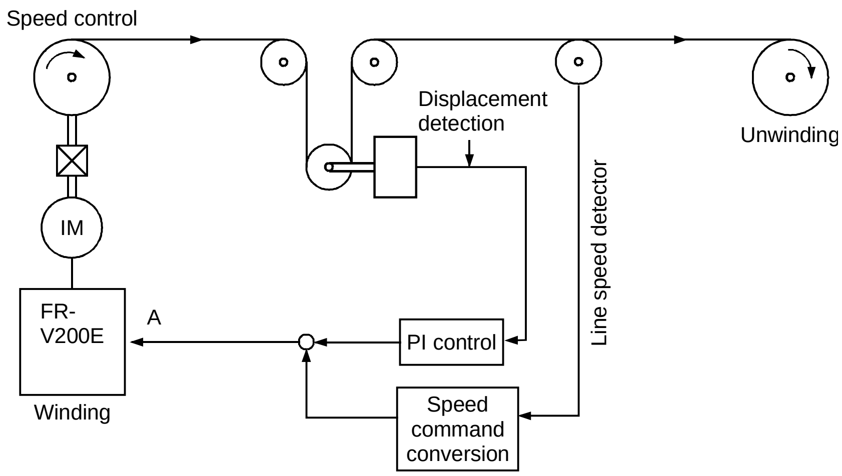
Item	Tension control by draw
Machine/apparatus name	Winder
System configuration	



Features/Considerations	Related parameters
• Always run IM2 at lower speed than IM1 to control tension applied to the paper so it is uniform. • Use a digital speed command as an intricate speed difference is required. • Use the MR-RT since the IM2 speed is set by the personal computer.	• Adjust the gains in accordance with the winding degree. Pr. 80 "speed control P gain 1" Pr. 81 "speed control I gain 1" Pr. 133 "position loop gain"

5.1.4 Dancer roll

Item	Dancer control
Machine/apparatus name	Wire drawing machine
System configuration	



Features/Considerations

- Speed tracking control is exercised using a dancer roll.
- As the wire is wound, the line speed increases. Hence, the line speed is used as the main speed and the dancer roll output used as the compensation input to maintain the dancer at a given position.
- No shortage in acceleration/deceleration torque of the unwinding shaft.
- Pr. 7, Pr. 8 (acceleration/deceleration time) settings should be adequate.
- Speed command value A should be appropriate for application.

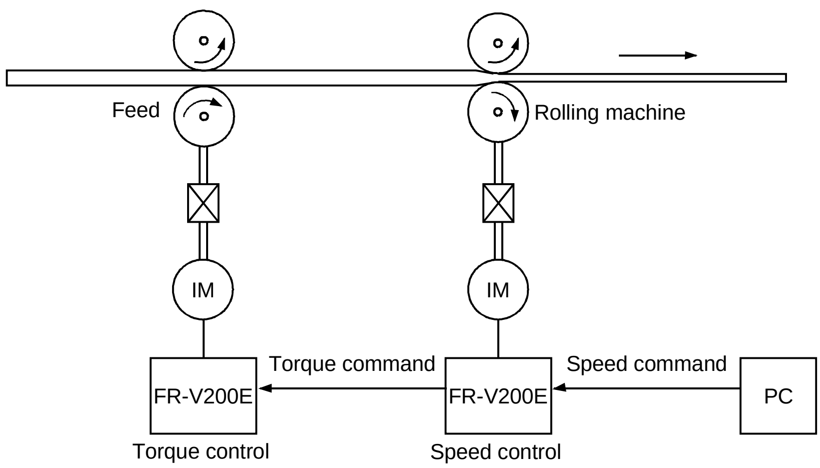
Related parameters

- Adjust the gains in accordance with the dancer motion.
  Pr. 80 "speed control P gain 1"
  Pr. 81 "speed control I gain 1"
- Acceleration/deceleration torque
  Pr. 34 "torque limit level"
  Pr. 118, Pr. 158 "torque limit for deceleration"
  Pr. 119, Pr. 159 "torque limit for acceleration"
  Pr. 130, Pr. 157 "excitation ratio"

5.2 Torque Control Operation

5.2.1 Helper control

Item	Helper control by speed-torque
Machine/apparatus name	Steel line
System configuration	



Features/Considerations

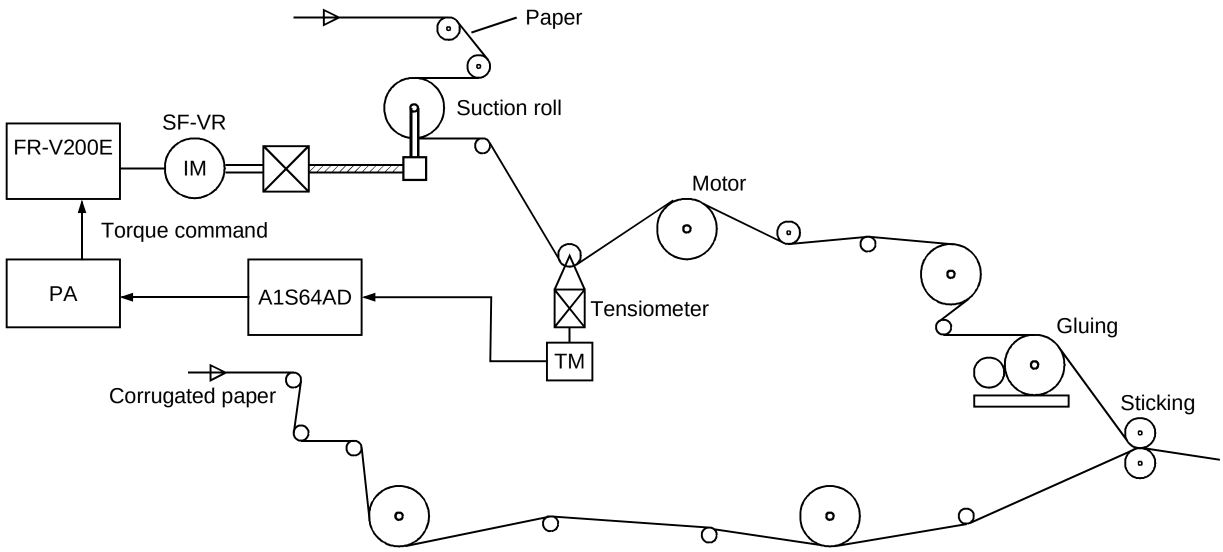
- The rolling machine speed is used as the main speed and the feed rolls are used to help torque.
- The load meter monitor output of the speed control side inverter is provided from the DA1 terminal and input as the torque command for the torque control side inverter.

Related parameters

- The filter of the DA1 output is 0. (Speed control side)
  Pr. 50 "DA1 output filter"
- Calibrate the output torque for the torque command. (Torque control side)
  Pr. 903 "Torque command No. 3 bias"
  Pr. 904 "Torque command No. 3 gain"

5.2.2 Tension control

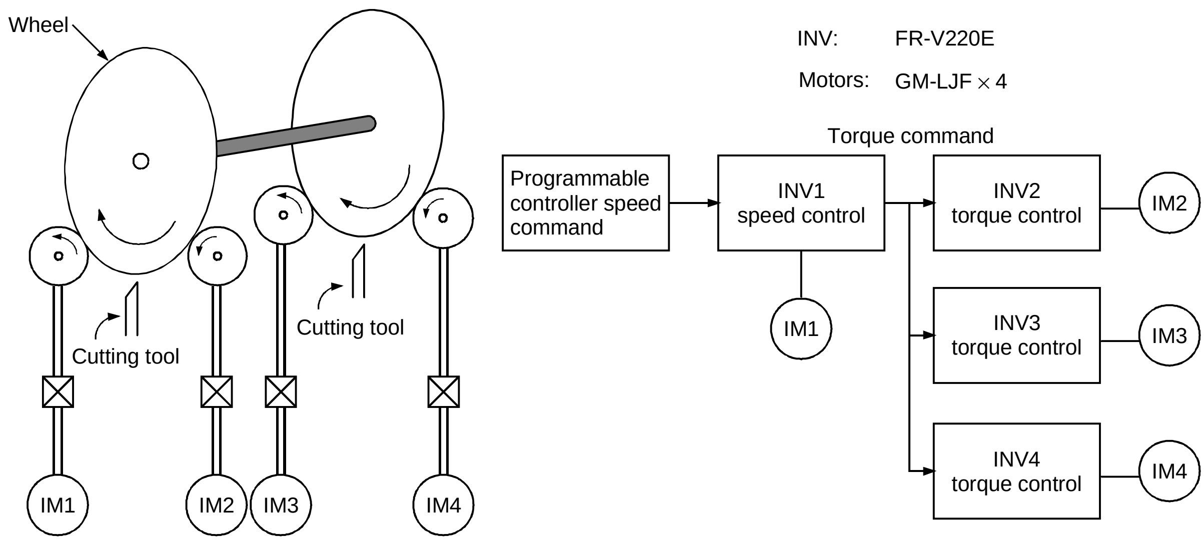
Item	Corrugator's delivery apparatus
Machine/apparatus name	Corrugator
System configuration	



Features/Considerations	Related parameters
• Used with a tensiometer to make up a tension control loop. • Paper tension control is exercised by torque control to apply back tension to prevent shrinkage at the time of paper sticking. • Speed limit should not be activated during torque control. (Torque control cannot be exercised if speed limit is activated) • Confirm the direction in which torque is developed.	• Set acceleration/deceleration time to 0 so that speed limit is not activated. Pr. 7 "Acceleration time setting" Pr. 8 "Deceleration time setting"

5.2.3 Helper control (speed-torque)

Item	Helper control by master (speed control) - slave (torque control)
Machine/apparatus name	Train wheel grinder
System configuration	



Features/Considerations

- One inverter is used for speed control and the others for torque control.
- The torque monitor output of the speed control side inverter is provided from the DA1 terminal and input as the torque commands for the torque control side inverters.
- The torque commands are regulated to balance the torques of the four inverters.

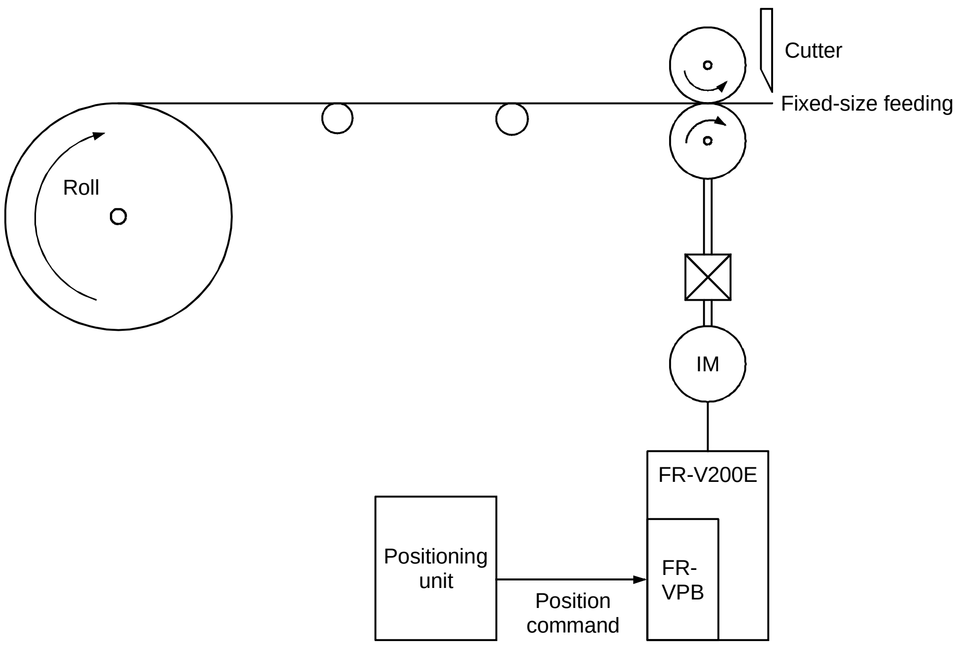
Related parameters

- The torque control side acceleration/deceleration time is set to 0 seconds.
  Pr. 7 "Acceleration time setting"
  Pr. 8 "Deceleration time setting"
- The filter of the DA1 output is 0.
  (Speed control side)
  Pr. 50 "DA1 output filter"
- Torque balance
  Pr. 903 "Torque command No. 3 bias"
  Pr. 904 "Torque command No. 3 gain"

5.3 Position Control Operation

5.3.1 Positioning operation

Item	Positioning control
Machine/apparatus name	Cutting machine
System configuration	



Features/Considerations

- The command from the positioning unit is input to the FR-VPB option to perform fixed-size cutting.

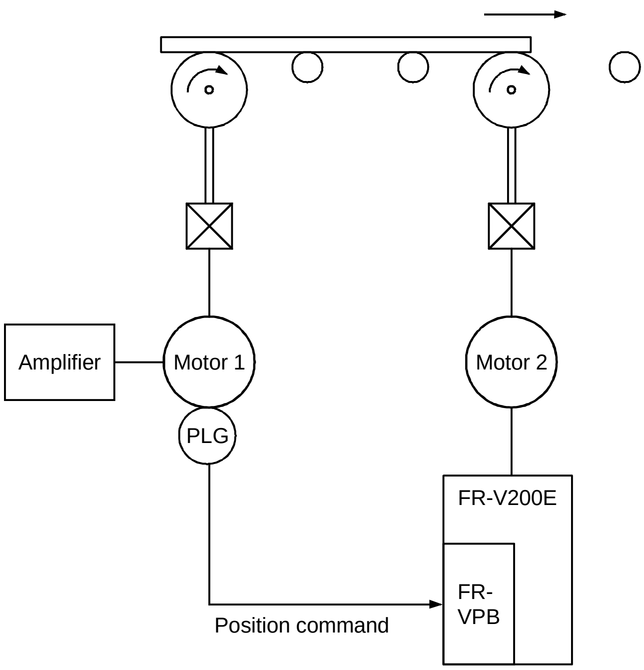
Related parameters

- Gain adjustment
  - Pr. 80 "Speed control P gain 1"
  - Pr. 81 "Speed control I gain 1"
  - Pr. 133 "Position loop gain"

chapter 5

5.3.2 Synchronous operation

Item	Synchronous operation by position control
Machine/apparatus name	Transfer line
System configuration	



Features/Considerations

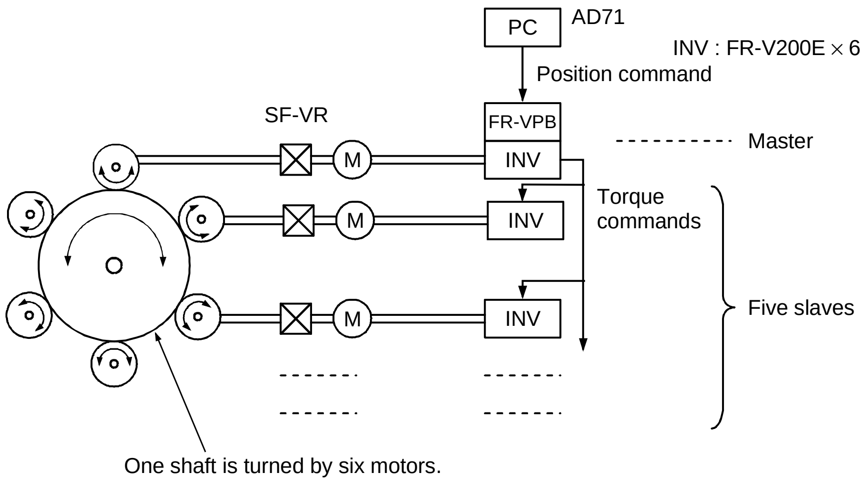
- The pulse signal of the PLG at shaft end of Motor 1 is input to the FR-VPB option to perform synchronous operation of motors 1 and 2.
- Motor 1 lags behind Motor 2 by the position control droop pulses. This delay should be compensated for on the machine side.

Related parameters

- Make gain adjustment in accordance with line motions.
  Pr. 80 "Speed control P gain 1"
  Pr. 81 "Speed control I gain 1"
  Pr. 133 "Position loop gain"
- Acceleration/deceleration time is set to 0 seconds.
  Pr. 7 "Acceleration time setting"
  Pr. 8 "Deceleration time setting"

5.3.3 Helper control (position-torque)

Item	Helper control by master (position control) - slave (torque control)
Machine/apparatus name	Shield machine
System configuration	



Features/Considerations

- One shaft is driven by several motors.
- One inverter is used for speed control and the others for torque control.
- The torque command is output from the DA1 terminal of the inverter which exercises position control.
- Torques should be balanced.

Related parameters

- The filter of the DA1 output is 0.
  Pr. 50 "DA1 output filter"
- Balance the slave shaft torques.
  Pr. 903 "Torque command No. 3 bias"
  Pr. 904 "Torque command No. 3 gain"
- Adjust the master shaft gains in accordance with the machine motion.
  Pr. 80 "Speed control P gain 1"
  Pr. 81 "Speed control I gain 1"
  Pr. 133 "Position loop gain"

chapter 5