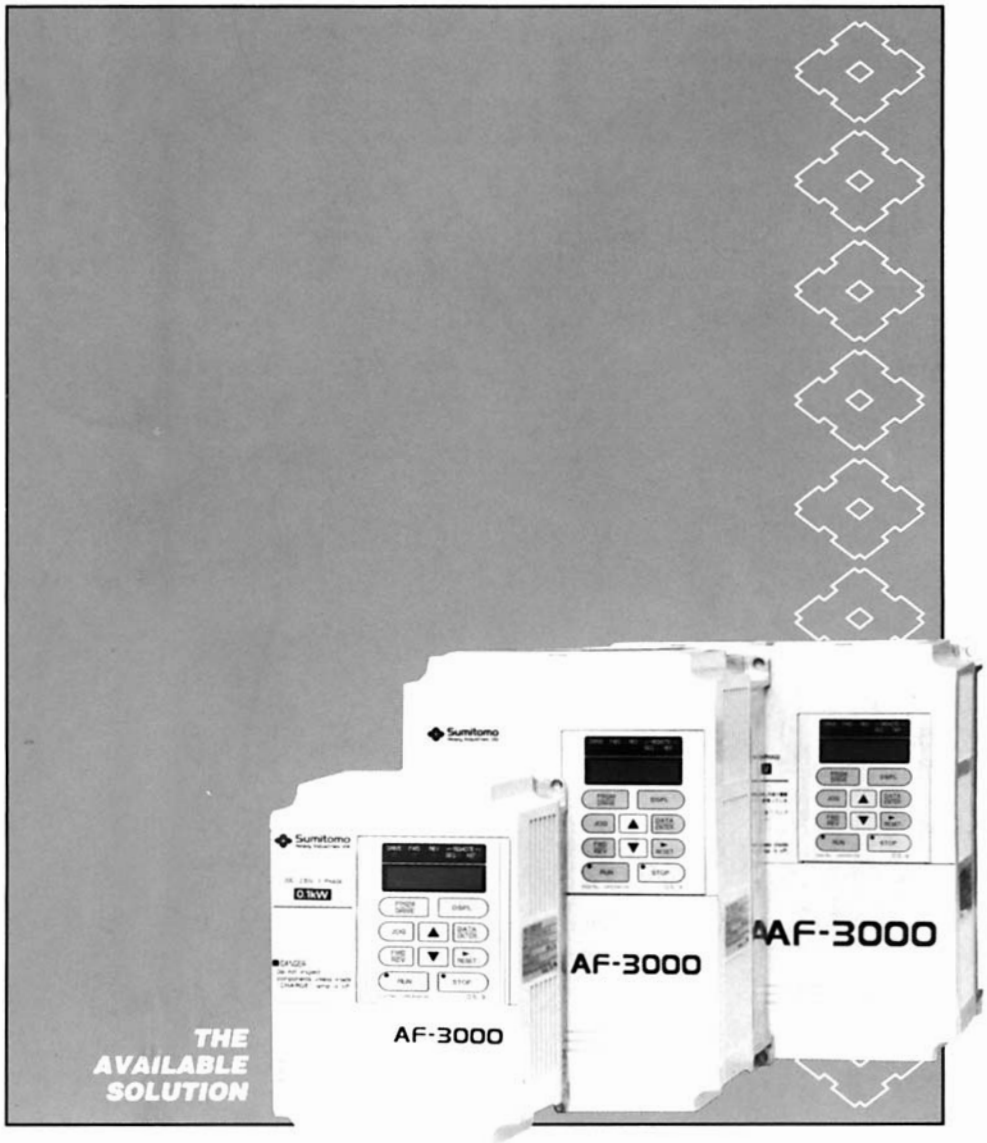
SUMITOMO
MACHINERY CORPORATION OF AMERICA

AF-3000®

Compact AC Inverter
Operating & Maintenance Manual



Catalog 10.091.60.002

DANGER

Voltage is present on capacitors for five minutes after input circuit is open. Risk of electric shock and/or electrical energy-high current levels.

WARNING

Disconnect electrical supply before servicing the electrical system.

Do not change the wiring while power is applied to the circuit.

Do not check signals during operation.

WARNING

Refer to this manual for connection of circuits and the rating of auxiliary circuits.

Be sure to ground AF-3000 using the ground terminal G(E).

Never connect main circuit output terminals T1(U), T2(V), T3(W) to AC main circuit power supply.

CAUTION

Separate motor overcurrent, overload and overheating protection is required to be provided in accordance with CANADIAN ELECTRICAL CODE, PART I and NEC.

This instruction manual is composed of 2 sections: The first section describes handling, wiring, operation, maintenance/inspection, troubleshooting and specifications of the AF-3000 Digital Compact Inverter. The second outlines the digital operator performance, constants, operation, etc.

Before using the AF-3000, a thorough understanding of this manual is recommended for daily maintenance, inspection and troubleshooting.

In this manual, "constant (No.□□)" indicates the item number of control constant set by digital operator.

DANGER

Voltage is present on capacitors for five minutes after input circuit is open. Risk of electric shock and/or electrical energy-high current levels.

WARNING

Disconnect electrical supply before servicing the electrical system.

Do not change the wiring while power is applied to the circuit.

Do not check signals during operation.

WARNING

Refer to this manual for connection of circuits and the rating of auxiliary circuits.

Be sure to ground AF-3000 using the ground terminal G.

Connect the motor to output terminals T1, T2, T3. Connect an AC power supply to input terminals L1, L2, L3 (for 240 V single-phase series, connect only to L1 and L2).

CAUTION

Separate motor overcurrent, overload and overheating protection is required to be provided in accordance with CANADIAN ELECTRICAL CODE, PART I and NEC.

CAUTION

All the potentiometers of AF-3000 have been adjusted at the factory. Do not change their settings unnecessarily.

Do not make withstand voltage tests on any part of the AF-3000 unit. It is electronic equipment using semiconductors and vulnerable to high voltage.

Make sure to tighten screws on the main circuit and control circuit terminals. Refer to installation instructions for torque values. See par. 1.5.3 "(5) Wire and terminal screw sizes."

Handle with care so as not to damage the inverter during transportation.

Do not pick up by the front cover or the unit cover (plastic portion). Use the die-cast portion.

ADVERTISSEMENT

Des tensions subsistent aux bornes des condensateurs pendant cinq minutes aprés l'ouverture de circuit d'entrée.

Couper l'alimentation avant d'entreprendre le depannage du système électrique.

ATTENTION

Une protection distincte contre les surintensités, la surcharge et la surchaufee de moteur doit être fournie conformément AU CODE CANADIAN DE L'ÉLECTRICITÉ PREMIER PARTIE et LE NATIONAL DE L' ÉLECTRICITE.

WARNING

Twist wires together before inserting in grounding terminal.

CAUTION

Separate motor overcurrent, overload and overheating protection is required to be provided in accordance with CANADIAN ELECTRICAL CODE, PART I and NEC.

Use 75°C copper wires only.

Low voltage terminals shall be wired with Class I Wiring.

When mounting units in an enclosure, remove the top, bottom and terminal covers.

ADVERTISSEMENT

Enroulex les fils ensemble avant de les introduire dans la borne.

Des tensions subsistent aux bornes des condensateurs pendant cinq minutes aprés l'ouverture de circuit d'entrée.

Couper l'alimentation avant d'entreprendre le depannage du système électrique.

ATTENTION

Une protection distincte contre les surintensités, la surcharge et la surchaufee de moteur doit être fournie conformément AU CODE CANADIAN DE L'ÉLECTRICITÉ PREMIER PARTIE et LE NATIONAL DE L'ÉLECTRICITE.

The AF-3000 is an ultra-compact, all-digital inverter which provides low noise operation.

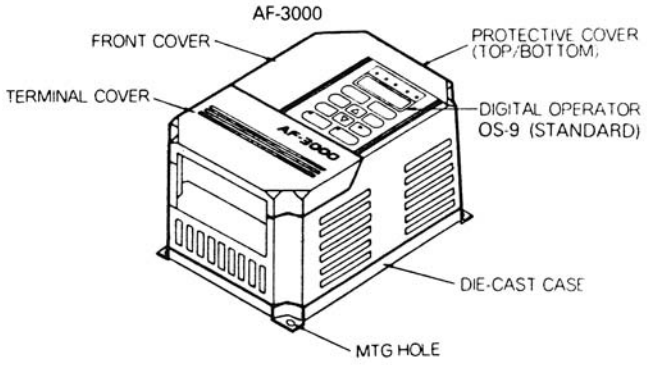
Two types are available : 1) with digital operator or 2) with drive status indicating plate (indicating plate).

The digital operator allows maximum utilization of the drive by providing access to the inverter's program constants and operation variables.

The model with the indicating plate provides status and fault codes while preventing unauthorized access to the programming constants. It is also useful for those applications where the programming operator can be moved from one unit to another.

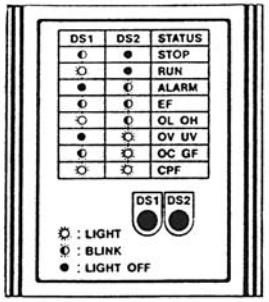
1.1 PARTS NAMES OF AF-3000

· With digital operator



· With indicating cover

The indicating cover shown to the right will be mounted in place of the digital operator which is installed in the unit.



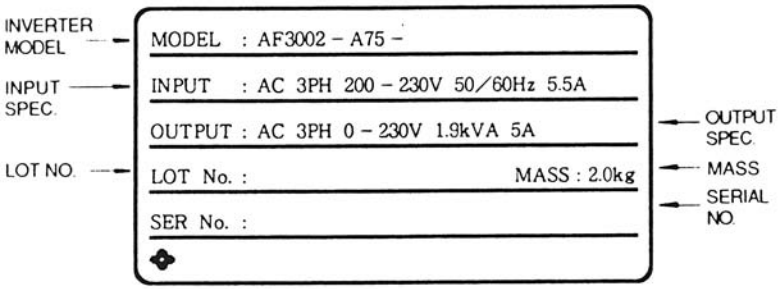
1.2 RECEIVING

This AF-3000 has been put through demanding tests at the factory prior to shipment. After unpacking, check the following.

- Verify the part numbers with the purchase order sheet and/or packing slip.
- Transit damage.

If any part of the AF-3000 is damaged or missing, immediately notify the shipper.

1.2.1 Nameplate Data



1.2.2 Type Designation

Nema 1

AF-300 2 A10 – U

AF-3000 Series Inverter

Specifies UL-Listed CSA-Certified component

Applicable kW rating

Voltage class
- 2 : Three-phase, 200-230 V
- 4 : Three-phase 380-460 V
- S : Single-phase, 200-230 V Input

A10 : 0.1 kW
A20 : 0.2 kW
to
3A7 : 3.7 kW
"A" indicates a decimal point.

Nema 4

AF-30 E2 – A10 – U

AF-3000 Series Inverter

Specifies UL-Listed CSA-Certified component

Applicable kW rating

Voltage class
- E2 : Three-phase, 200-230 V
- E4 : Three-phase 380-460 V
- ES : Single-phase, 200-230 V Input

A10 : 0.1 kW
A20 : 0.2 kW
to
3A7 : 3.7 kW
"A" indicates a decimal point.

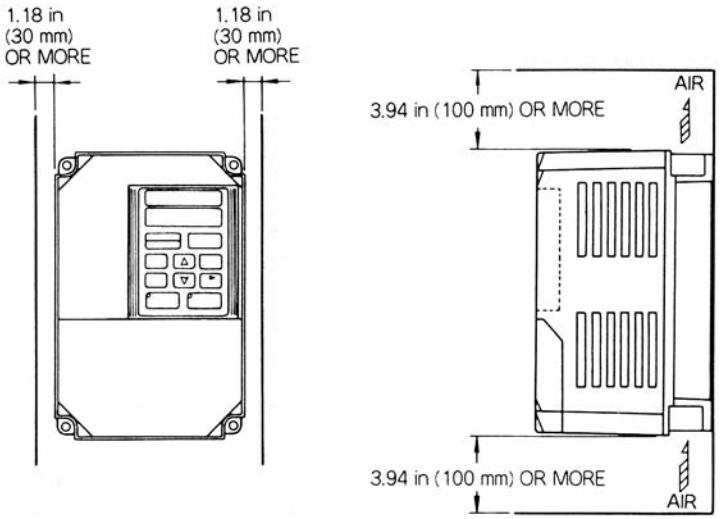
1.3 INSTALLATION

1.3.1 Transportation

- Handle with care so as not to damage the inverter during transportation.
- Do not pick-up by the face plate. Use the die-cast portion.
- Do not drop the inverter.

1.3.2 Mounting Space

Install the AF-3000 vertically and allow sufficient space for effective cooling as shown in Fig. 1.1.



(a) Front View (b) Side View

Note : For external dimensions, refer to Par. 1.8.2 "Dimensions in inches (mm)" on page 50.

Fig. 1.1 Mounting Space

1.3.3 Location

Location of the equipment is important to achieve proper performance and normal operating life. The AF-3000 units should be installed in areas where the following conditions exist.

- Ambient temperature : +14 to 104°F, -10 to +40℃.
- Protected from rain, oil mist or moisture.
- Protected from direct sunlight.
- Protected from corrosive gases or liquids.
- Free from airborne dust or metallic particles.
- Free from vibration.
- Free from magnetic noise.
- Protected from high humidity.
- Free from combustibles.

CAUTION

When mounting units in a common enclosure, install a cooling fan or some other means to cool the air entering the inverter below 113°F (45 ℃).

1.4 WIRING

Connect main circuit and control circuit wiring securely as described in the following.

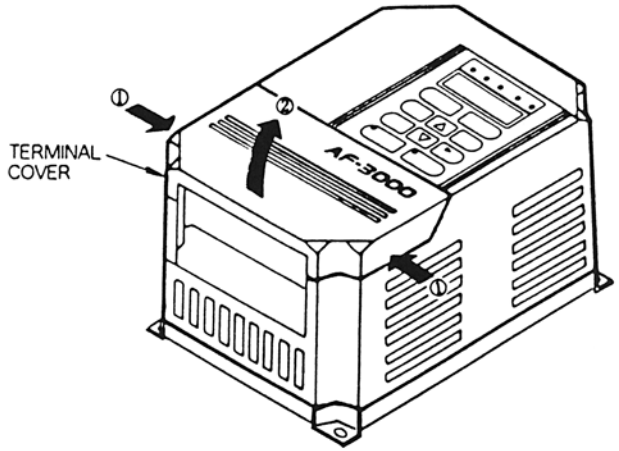
CAUTION

Use UL Listed and CSA Certified closed-loop (ring) connectors sized for the wire gauge involved. The connectors are to be installed using the correct crimp tool specified by the connector manufacturer.

1.4.1 Terminal Cover Mounting/Removing and Terminal Position

Terminal cover mounting/removing

For removing, press the cover in the direction of ① (on both sides) and, at the same time, lift in the direction of ②. For mounting, reverse the method.



Terminal position

Main circuit and control circuit terminal blocks are shown in the photo below. Usually the terminal designations are shown on the terminal nameplate.

For some inverters, the teminal numbers are printed on the printed circuit board.

1.4.2 Standard Wiring Diagram

Models with digital operator can be operated from the digital operator only by main circuit wiring. When these models are operated by control circuit terminals, control constant change is required. For details, refer to "OPERATION MODE SELECTION" on page 80.

Models without digital operator (with indicating cover) are preset in operation mode from control circuit terminals at the factory prior to shipping.

"Suitable for use on a circuit capable of delivering not more than 1000 rms symmetrical amperes, 240 V Max." Models AF-3002 or AF-300S -A10, -A20, -A40 only.

"Suitable for use on a circuit capable of delivering not more than 1000 rms symmetrical amperes, 460 V Max." Models AF-3004 -A20, -A40 only.

"Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240 V Max." Models AF-3002 or AF-300S -A75, -1A5, -2A2, -3A7 only.

"Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 460 V Max." Models AF-3004 -A75, -1A5, -2A2, -3A7 only.

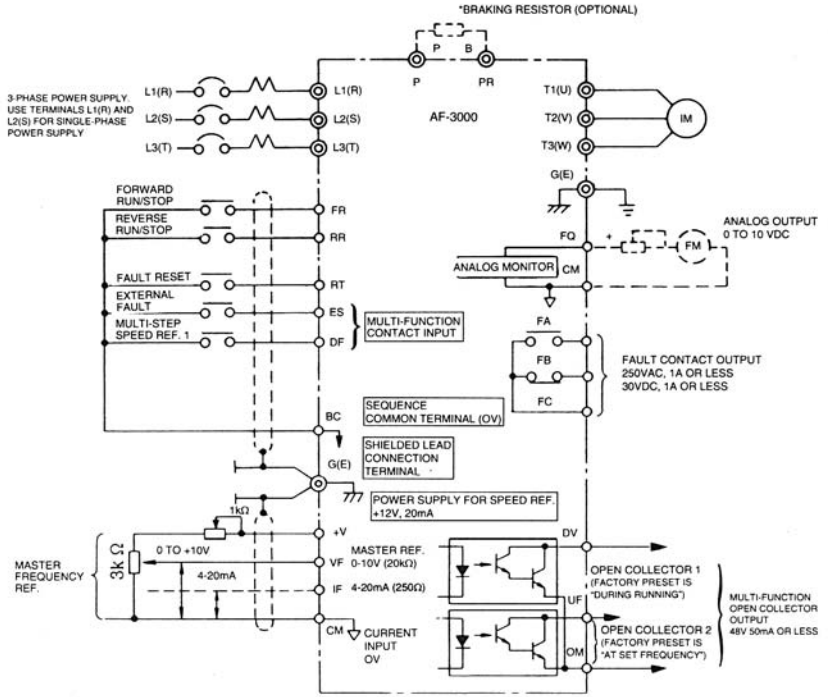


Fig. 1.2 Standard Wiring Diagram

Notes :

1. ⊏⊐ indicates shielded leads and ⊏⊐ twisted-pair shielded leads.
2. External terminal (+V) of +12 V has maximum output current capacity of 20 mA.
3. Terminal symbols : ◎ shows main circuit : ○ shows control circuit
4. Terminal point (BC) (sequence common) is isolated from terminal point (CM) (0V).

* Set thermal overload relay between braking resistor and inverter when using braking resistor to protect braking resistor from overheating.
Also, use sequencer to break power supply side on thermal overload relay trip contact when using braking resistor.

1.4.3 Main Circuit

(1) Main circuit wiring

Connect wiring as shown in Fig. 1.3.

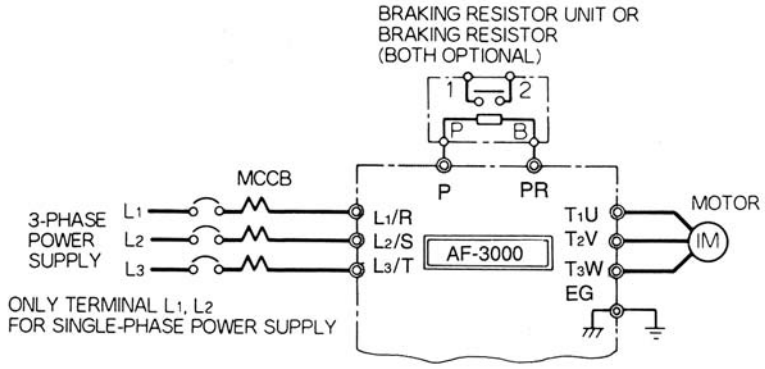


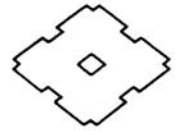
Fig. 1.3 Main Circuit Wiring

(2) Main circuit terminals

Table 1.1 AF-3000 Main Circuit Terminals

Terminal	Description
L1/R	Main circuit power input "L1", "L2" are used for single-phase input specifications.
L2/S	
L3/T	
T1/U	Inverter output
T2/V	
T3/W	
P	Braking resistor or braking resistor unit connector (options)
PR	
E/G*	Grounding (ground resistance should be 100 ohms or less)

* Use screw for frame ground.



· Main circuit terminal arrangement

3-phase series (all models)

L1R	L2S	L3T	P	PR	T1U	T2V	T3W

240 V single-phase series
0.13 to 2 HP (0.1 TO 1.5 kW)

L1R	L2S		P	PR	T1U	T2V	T3W

BLANK

240 V single-phase series
3/5 HP(2.2/3.7kW)

L1R	L2S	P	PR	T1U	T2V	T3W

(3) Molded-case circuit breaker (MCCB) and power supply magnetic contactor (MC)

Be sure to connect MCCBs between AC main circuit power supply and AF-3000 input terminals (L1/R), (L2/S), (L3/T) to protect wiring. Recommended MCCBS are listed in Table 1.2.

When a ground fault interrupter is used, select one not influenced by high frequency. Setting current should be 200 mA or more and operating time, 0.1 sec or more to prevent malfunctions.

(Example) NV series by Mitsubishi Electric Co., Ltd. (manufactured in and after 1988),
EGSG series by Fuji Electric., Co., Ltd. (manufactured in and after 1984)

1.4.3 Main Circuit (Cont'd)

Table 1.2 Molded-case Circuit Breakers and Magnetic Contactors

• 230 V Class 3-phase Input Series

AF-3000	Model AF3002	A10	A20	A40	A75	1A5	2A2	3A7
	Capacity kVA	0.3	0.6	1.1	1.9	2.5	4.2	6.7
	Rated Output Current A	0.8	1.5	3	5	6.5	11	17.5
Molded-case Circuit Breakers		5A	5A	5A	10A	20A	20A	30A

• 240 V Class 1-phase Input Series

AF-3000	Model AF300S	A10	A20	A40	A75	1A5	2A2	3A7
	Capacity kVA	0.3	0.6	1.1	1.9	2.5	4.2	6.7
	Rated Output Current A	0.8	1.5	3	5	6.5	11	17.5
Molded-case Circuit Breakers		5A	5A	10A	20A	20A	40A	50A

• 460 V Class 3-phase Input Series

AF-3000	Model AF3004	A20	A40	A75	1A5	2A2	3A7
	Capacity kVA	0.8	1.2	2	3	3.7	6.1
	Rated Output Current A	1	1.6	2.6	4	4.8	8
Molded-case Circuit Breakers		5A	5A	5A	10A	10A	20A

(4) Surge absorber

The surge absorbers should be connected to the coils of control relays, magnetic contactors, magnetic valves, or magnetic brake used for the AF-3000 periphery. Otherwise, large surge voltage occurs at switching and may cause devices to be damaged or to malfunction. Select type from Table 1.3.

Table 1.3 Surge Absorbers

Coils of Magnetic Contactor and Control Relay		Surge Absorber *		
		Model DCR2-	Specifications	Code No.
200 V to 230 V	Large-size Magnetic Contactors	50A 22E	250 VAC 0.5 μF 200Ω	C002417
	Control Relay MY-2, -3 (OMRON) HH-22, -23 (Fuji) MM-2, -4(OMRON)	10A 25C	250 VAC 0.1 μF 100Ω	C002482
380 to 460 V Units		50D 100B	1000 VDC 0.5 μF 220Ω	C002630

* Made by MARCON Electronics.

(5) Wire and terminal screw sizes

- Use 600 V vinyl-sheathed lead or equivalent.
- Use 75°C copper wires only.
- Low voltage terminals shall be wired with Class I Wiring.

Table 1.4 Torque Value and Wire Size for Field Wiring Terminals

● 230 V Class 3-phase Input Series

Circuit	AF-3002	Inverter Capacity (kVA)	Terminal Symbol	Terminal Screw	Wire Size AWG	Wire Size mm²	Torque Nm
Main Circuit	A10	0.3	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A20	0.6	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A40	1.1	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A75	1.9	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	1A5	2.5	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	12-10	3.5 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	2A2	4.2	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	12-10	3.5 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	3A7	6.7	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	12-10	3.5 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
Control Circuit	Common to All Models		Refer to page 22	M3.5	20-14	0.5 to 2	0.95

Table 1.4 Torque Value and Wire Size for Field Wiring Terminals (cont'd)

● 240 V Class Single-phase Input Series

Circuit	AF-300S	Inverter Capacity (kVA)	Terminal Symbol	Terminal Screw	Wire Size AWG	Wire Size mm²	Torque Nm
Main Circuit	A10	0.3	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A20	0.6	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A40	1.1	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A75	1.9	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	1A5	2.5	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	2A2	4.2	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M5	12-8	3.5 to 8	2.24
			G/E		14-8	2 to 8	1.43
	3A7	6.7	L1/R, L2/S, P, PR, T1/U, T2/V, T3/W	M5	10-8	5.5 to 8	2.24
			G/E		14-8	2 to 8	1.43
Control Circuit	Common to All Models		Refer to page 22	M3.5	20-14	0.5 to 2	0.95

Table 1.4 Torque Value and Wire Size for Field Wiring Terminals (cont'd)

● 460 V Class 3-phase Input Series

Circuit	AF-3004	Inverter Capacity (kVA)	Terminal Symbol	Terminal Screw	Wire Size AWG	Wire Size mm²	Torque Nm
Main Circuit	A20	0.8	L1/R, L2/S, L3/T, P, PR, T1/U,T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A40	1.2	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	A75	2	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	1A5	3	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	2A2	3.7	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
	3A7	6.1	L1/R, L2/S, L3/T, P, PR, T1/U, T2/V, T3/W	M4	14-10	2 to 5.5	1.43
			G/E		14-10	2 to 5.5	1.43
Control Circuit	Common to All Models		Refer to page 22	M3.5	20-14	0.5 to 2	0.95

IMPORTANT

- Lead size should be determined considering voltage drop of leads. Voltage drop can be obtained by the following equation : select such lead size that voltage drop will be within 2% of normal rated voltage.

  phase-to-phase voltage drop (V)
  $=\sqrt{3} \times$ lead resistance (Ω/km) $\times$ wiring distance (m) $\times$ current (A) $\times 10^{-3}$

- Insertion of power supply coordination AC reactor
  When the power supply capacity exceeds 600 kVA, connect an AC reactor at the inverter input side for power supply coordination. This reactor is also effective for power factor improvement of the power supply.

- Wiring length between inverter and motor
  If total wiring distance between inverter and motor is excessively long and inverter carrier frequency (main transistor switching frequency) is high, harmonic leakage current from the cable will increase to affect the inverter unit or peripheral devices. If the wiring distance between inverter and motor is long, reduce the inverter carrier frequency as shown below. Carrier frequency can be set by constant No. 40. For details, refer to "CARRIER FREQUENCY" on page 102. Carrier frequency is set to 10 kHz at the factory prior to shipping.

Wiring Distance between Inverter and motor	Up to 30 m	Up to 50 m	Up to 100 m	100 m or more
Allowable Carrier Frequency (Constant No. 40 set value)	15 kHz or less (6)	10 kHz or less (4)	5 kHz or less (2)	2.5 kHz or less (1)

(6) Wiring

(a) Main circuit input/output

(1) Phase rotation of input terminals (L1/R), (L2/S), (L3/T) is available in either direction, clockwise or counterclockwise.

(2) When inverter output terminals (T1/U),(T2/V), and (T3/W) are connected to motor terminals (T1/U), (T2/V), and (T3/W) , respectively, motor rotates counterclockwise, when viewed from opposite drive end, upon forward run command. To reverse the rotation, interchange any two of the motor leads.

(3) Never connect AC main circuit power supply to output terminals (T1/U) , (T2/V), or (T3/W). Inverter may be damaged.

(4) Care should be taken to prevent contact of wiring leads with the AF-3000 cabinet, for a ground fault or a short-circuit may result.

(5) Insert an L noise filter to the AF-3000 output, but never connect power factor correction capacitor, LC or RC to AF-3000 output.

(6) Be sure to tighten the main circuit terminal screws.

(7) Be sure to separate the main circuit wiring from inverter and peripheral device control lines. Otherwise, it may cause the devices to malfunction.

(b) Grounding

Ground the casing of the AF-3000 using ground terminal G/E.

(1) Ground resistance should be 100 Ω or less.

(2) Never ground AF-3000 in common with welding machines, motors, or other large-current electrical equipment, or a ground pole. Run the ground lead in a conduit separate from leads for large-current electrical equipment.

(3) Use ground leads which comply with AWG standards and keep length as short as possible.

(4) Where several AF-3000 units are used side by side, all the units should be grounded as shown in (a) or (b) of Fig. 1.4. Do not form a loop with the ground leads as shown in (c).

(a) GOOD (b) GOOD (c) POOR

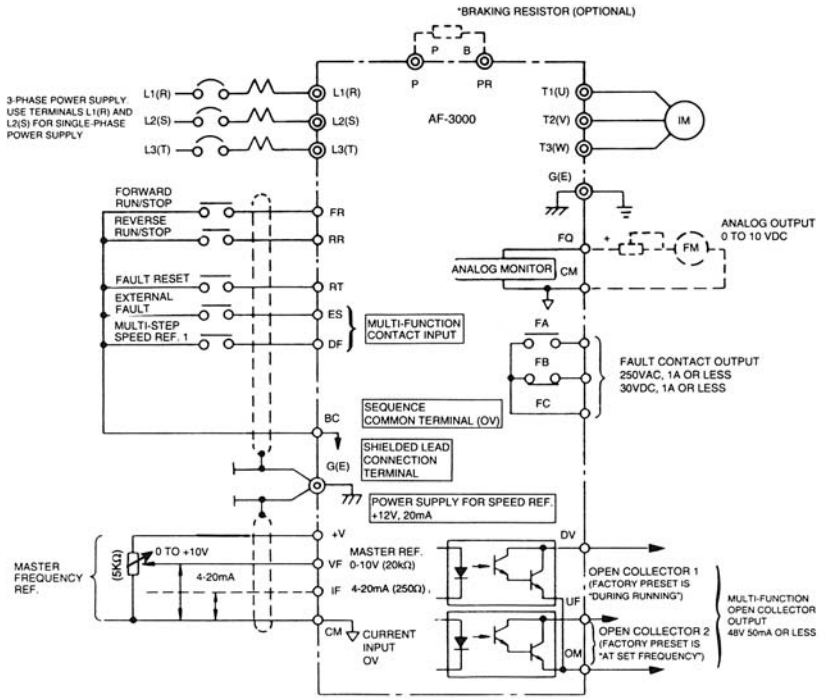
Fig. 1.4 Grounding of Three AF-3000 Units

1.4.4 Control Circuit

> **CAUTION**
>
> Low voltage terminals shall be wired with Class I Wiring.

(1) Control circuit wiring

The control signals are connected by screws. Fig. 1.5 shows the relation between the I/O signals (factory preset values) and screw terminal numbers. The terminal functions shown in the figure indicate standard setting prior to shipping. Since operation mode from the digital operator is set for the model with the digital operator, it is necessary to change the control constants when operation is performed from the control circuit terminals. For details, refer to "OPERATION MODE SELECTION" on page 80. For the model without digital operator (with indicating cover), operation mode from the control circuit terminals is the standard setting preset at the factory prior to shipping.



Notes :

1. ⊟ indicates shielded leads and ⊟ twisted-pair shielded leads.
2. Terminal symbols : ◎ shows main circuit ; ○ shows control circuit.

Fig. 1.5 Control Circuit Wiring

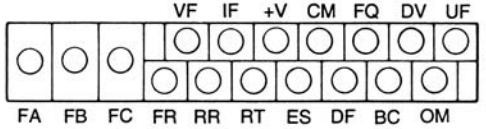
(2) Control circuit terminals (factory preset)

Table 1.5 Control Circuit Terminal Functions

Classification	Terminal	Signal Name	Function		Signal Level
Sequence Input Signal	FR	Forward run /stop signal	Forward run at "closed", stop at "open"		Photo-coupler insulation input 24 VDC 8 mA
	RR	Reverse run/stop signal	Reverse run at "closed", stop at "open"		
	RT	Fault reset input	Reset at "closed"	Multifunction contact input: 2 signals available to select	
	ES*	External fault	Fault at "closed"		
	DF*	Multi-step speed ref. 1	Effective at "closed"		
	BC	Sequence control input common terminal	——		
Analog Input Signal	+V	Power supply terminal for frequency setting	Speed ref. power supply		+12 V (Allowable current 20 mA max.)
	VF	Frequency ref.	0 to +10V/Max. output frequency		0 to +10 V (20kΩ)
	IF		4 to 20 mA/Max. output freqency		4 to 20 mA (250Ω)
	CM	Common terminal for control circuit	0V		——
Sequence Output Signal	DV	During running	"L" level at run	Multi-function photo-coupler output: two signals available to select †	Photo-coupler output +48 V 50 mA or less
	UF	Frequency agreed signal	"L" level at set frequency=output frequency		
	OM	Photo-coupler output common			
	FA	Fault signal contact output	"Closed" between A and C at fault "Open" between B and C at fault		Contact capacity 250 VAC : 1A or less 30 VDC: 1A or less
	FB				
	FC	Fault signal contact output common			
Analog Output Signal	FQ	Frequency meter	0 to 10 V/max. output frequency Possible to select current meter output. ‡		0 to 11 V max. 2 mA or less
	CM	Common			

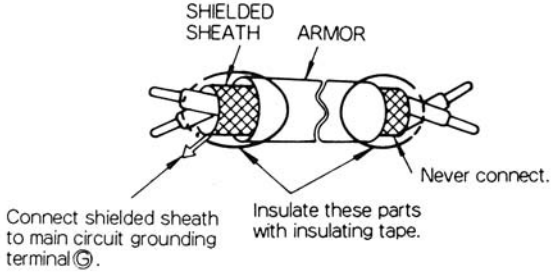
* For details, refer to "MULTIFUNCTION CONTACT INPUT FUNCTION SELECTION" on page 94.
† For details, refer to "MULTIFUNCTION PHOTO-COUPLER OUTPUT FUNCTION" on page 98.
‡ For details, refer to "MULTIFUNCTION ANALOG OUTPUT MONITOR SETTING" on page 90.

· Control circuit terminal arrangement

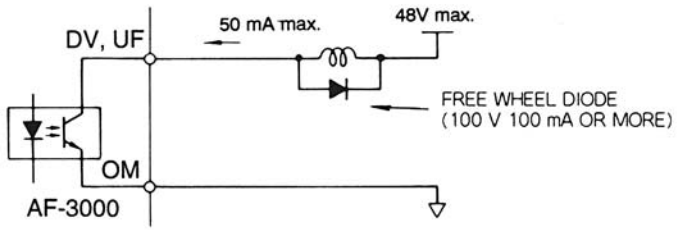


(3) Precautions on control circuit wiring

· Separate the control signal line from power lines. Otherwise, it may cause a malfunction.
· For frequency setting signal (analog), use shielded lead and conduct termination sufficiently.



· Wiring length of the control signal line must be 50 m or less.
· To drive the contact input signal by transistor, use one having ratings of 50 V 50 mA or more. Circuit leakage current at signal OFF must be 300 μ A or less.
· To drive an inductive load (relay coil, etc.) by multifunction photocoupler output, be sure to insert a free wheel diode.



1.5 OPERATION

1.5.1 Pre-operation Check

Check the following items after completion of installation and wiring :

(1) Proper wiring.
Double check that the power supply is not connected to the output terminals (T1/U) , (T2/V) and (T3/W).

(2) No shortcircuit due to wiring contamination (dust, oil, etc.).

(3) Screws and terminals are tightened.

(4) For safe operation, the motor should be uncoupled from the load. Pay close attention to output current when the motor is operated with the load coupled.

(5) Wiring is not grounded.

(6) Run command is not input.
When the forward/reverse run command is input in the operation mode (factory setting for the model with indicating cover) from the control circuit terminal, the motor is activated automatically after the main circuit power supply is turned on. Turn on the inverter only after making sure that the run command is not input.

1.5.2 Pre-operation Setting

Since the standard inverter models are provided with the values indicated in Par.2.8 (see page 70 and beyond), the digital operator (OS-9) must be used in order to change the constants from the initial values to the values in accordance with the load specifications.

(1) Preset values prior to shipping
The following describes the functions and initial constant set values which are often used for operation.

(a) Output frequency and accel/decel time
The maximum output frequency is set to 60 Hz and accel/decel time to 5 seconds at the factory prior to shipping. To change the values, refer to "ACCEL/DECEL TIME SETTING" on page 87.

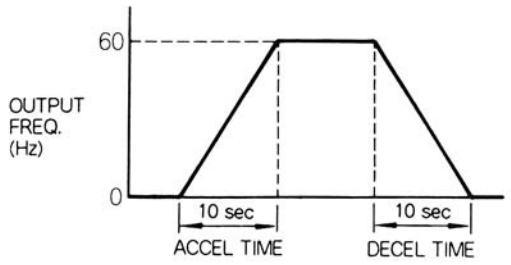


Fig. 1.6 Output Frequency and Accel/Decel Time

(b) Frequency setting signal and output frequency
Fig. 1.7 shows the inverters output frequency change as a result of changes of the input voltage signal at terminal (VF) or current at terminal (IF)

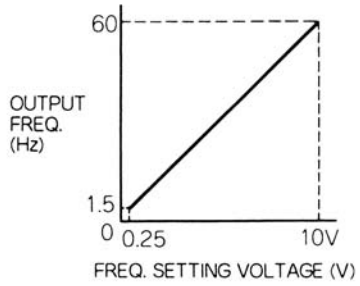
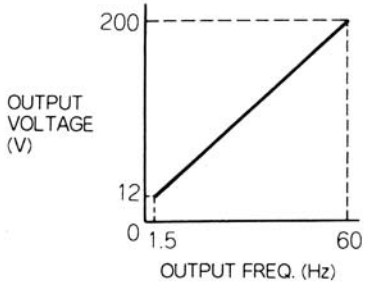


Fig. 1.7 Frequency Setting Signal and Output Frequency

(c) V/f characteristics
Fig. 1.8 shows the output voltage for inverter output frequency. When its characteristic (max. voltage / fre-frequency) differs from that of the optimum motor, refer to "V/f CHARACTERISTIC SETTING" on page 84.



Note : For 460 V class, the value is twice that of 230 V class.

Fig. 1.8 V/f Characteristics

(2) Motor rated current setting
Since the inverter is provided with an electronic thermal overload to protect the motor from overheating, the motor rated current should be programmed into constant (No. 19). Typical 4-pole motor current value is set as the initial value. For details, refer to "ELECTRONIC THERMAL OVERLOAD FUNCTION" on page 88.

Note : Provide a thermal overload relay or thermal protector for each motor when more than one motor is operated simultaneously from a single inverter.

1.5.3 Test Run Method

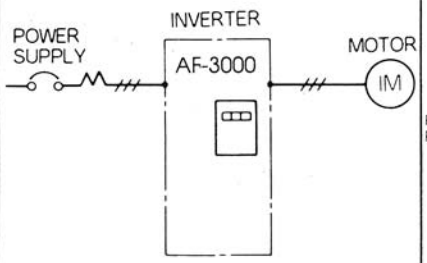
The inverter can be operated in the following two ways. The model with digital operator is set to "OPERATION MODE BY DIGITAL OPERATOR" and the model without digital operator (with indicating cover) is set to "OPERATION MODE FROM CONTROL CIRCUIT TERMINAL" prior to shipping.

Run by digital operator (Standard setting of model with digital operator)

This method is to operate the inverter by using the RUN (run command) key, etc. of the digital operator.

Since this operation mode is set at the factory prior to shipping, operation can be performed only by main circuit wiring.

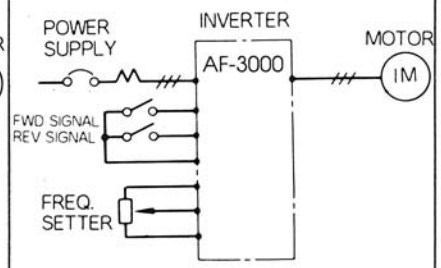
For details of the operation method, refer to Section 2 "DIGITAL OPERATOR" beginning on page 51.

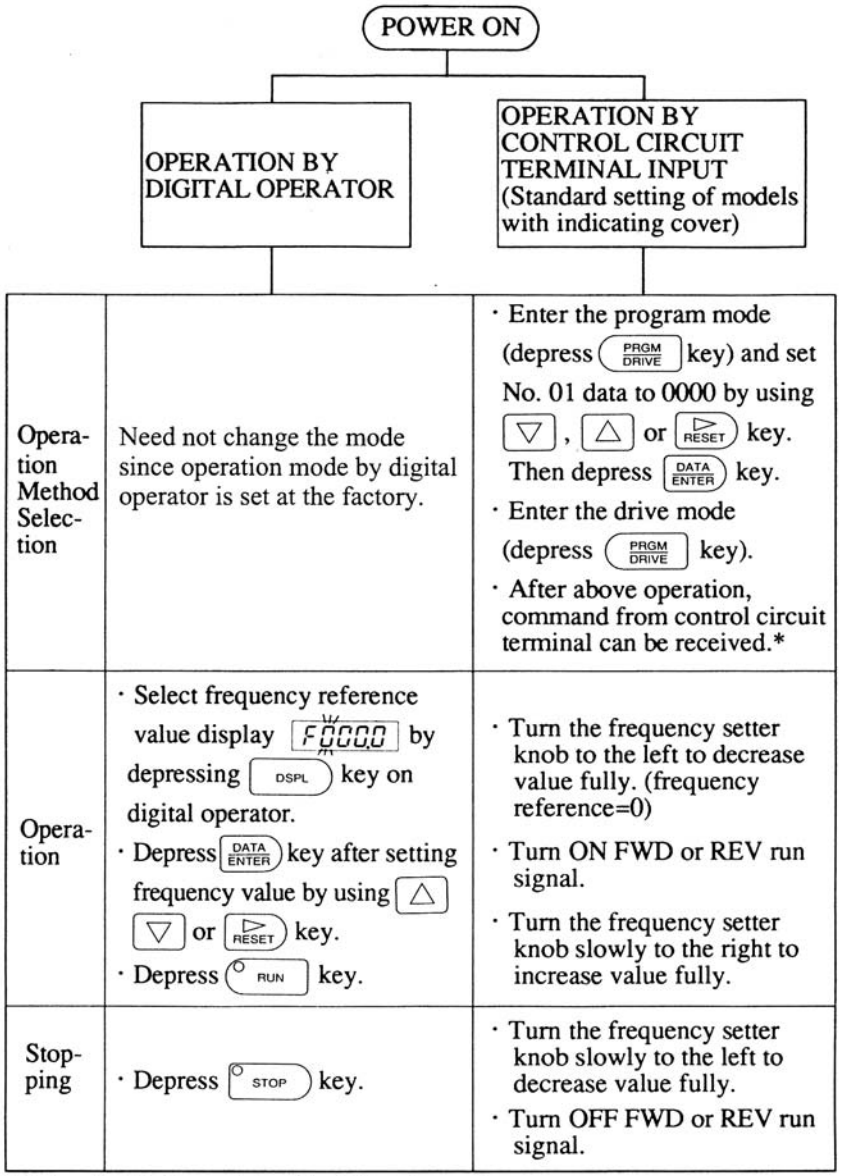


Run by control circuit terminal input (Standard setting of model with indicating cover)

This method is to operate the inverter by frequency setter or operation switch connected to the control circuit terminal.

To perform operation by control circuit terminal input of the model with digital operator, change the operation mode to "OPERATION FROM CONTROL CIRCUIT TERMINAL" (No. 01=0000).





*Not applicable for models without digital operator.

Note : Refer to Par. 2.4 "DITIGAL OPERATOR OPERATION EXAMPLE" (page 60) for details of digital operator operation.

1.5.4 Inverter Status Display LEDs

With the model without digital operator, LEDs provided for the inverter are of help to know the inverter status. These LEDs can be seen through the indicating cover on the inverter front side. There are two LEDs : green (DS1) and red (DS2). Inverter status can be seen by these two LED lighting modes. Table 1.6 shows the LED lighting modes and the contents. Check that the inverter is in the normal status at power ON in the test run stage.

Table 1.6 LED Display and Contents

Inverter Status	LED Display DS1 (GR)	LED Display DS2 (RD)	Display Contents	Remarks
Normal	◐	●	Operation ready (during STOP)	——
	☼	●	During normal RUN	
Alarm	●	◐	Undervoltage (UV), external B.B, while stopped.	Automatic recovery by protective operation release
Protective operation	◐	◐	Inverter external fault (EF is input.)	Can be reset after removing the cause of fault.
	☼	◐	Overload protection such as inverter overload (OL), fin overheat, etc.	
	●	☼	Voltage protection such as overvoltage (OV), undervoltage (UV)	
	◐	☼	Overcurrent protection (OC) Ground fault (GF)	
Inverter fault	☼	☼	Digital hardware memory fault (CPF)	Cannot be reset.* (Replace the inverter.)
	●	●	Hardware fault such as control power supply fault, CPU runaway, etc.	Cannot be reset. (Replace the inverter.)

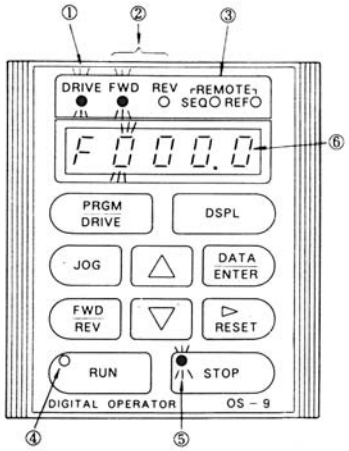
● : LED light off, ◐ : LED blink, ☼ : LED light.

* By initializing control constants using the digital operator, errors may be reset. For details of constant initialization, refer to "PASSWORD SETTING" on page 79.

1.5.5 Digital Operator Display

When the inverter power supply is turned ON for the first time, the digital operator displays as shown below. If an alarm is displayed, refer to Par 1.7 "FAULT DISPLAY AND TROUBLESHOOTING" on page 34 to remove the factor. For details of the digital operator display, refer to Par. 2.2 "DESCRIPTION OF DIGITAL OPERATOR DISPLAY AND OPERATING SECTIONS" on page 52. (in this paragraph, the status is where no command is input to the inverter).

① Drive mode display (DRIVE) : Lights.
② Rotating direction display (FWD) : Lights. (REV) : Extinguished.
③ REMOTE mode display (REMOTE SEQ, REF) : Extinguished.
④ During RUN display (RUN) : Lights.
⑤ During STOP display (STOP) : Lights.
⑥ 7-segment LED display (5 digits) : Output frequency reference set value



1.5.6 Check Points at Test Run

The following describes the check points at test run. If any fault occurs, recheck the wiring and load status. For details, refer to Par.1.7.3 "Corrective Action for Motor Faults" on page 40.

- Motor rotates smoothly.
- Motor rotates in the proper direction.
- Motor does not have any abnormal vibration or beat.
- Acceleration or deceleration goes smoothly.
- Current suitable for load flows.
- Status display LEDs or digital operator display is proper.

PRECAUTIONS

(1) The motor does not start up if both FWD and REV run signals are turned ON simultaneously. If they are turned ON simultaneously during run, the motor stops according to the stopping method selection of constant (No.01) 3rd digit. (Deceleration to a stop is selected for factory setting.)

(2) When output frequency is reduced to 1.5 Hz (preset value prior to shipping) at deceleration, the DC injection braking operates for 0.5 second (preset value prior to shipping) and metallic noise is generated by the motor. However, this noise is normal. To eliminate this noise, refer to "DC INJECTION BRAKING" on page 99.

(3) If a fault occurs during acceleration or deceleration and the motor coasts to a stop, check the motor stop and then the following items. For details, refer to Par. 1.7 "FAULT DISPLAY AND TROUBLESHOOTING" on page 34.

- Load is not excessively large.
- Accel/decel time is long enough for load.

(4) Resetting must be performed by fault reset input signal (or RESET key of the digital operator) or by turning OFF the power supply.

(5) If an input contactor is used to stop and start the inverter, the maximum number of starts/hour is 1.

1.6 MAINTENANCE

1.6.1 Periodic Inspection

AF-3000 requires very few routing checks. It will function longer if it is kept clean, cool and dry, while observing the precautions listed in "Location" (Par. 1.3.3). Check for tightness of electrical connections, discoloration or other signs of overheating. Use Table 1.7 as the inspection guide. Before servicing, turn OFF AC main circuit power and be sure that CHARGE lamp is OFF.

Table 1.7 Periodical Inspection

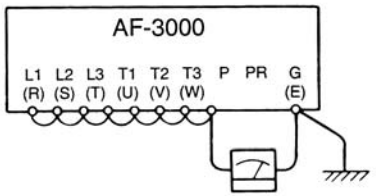
Component	Check	Corrective Action
External Terminals, Unit Mounting Bolts, Connectors, etc.	Loosened screws	Tighten
	Loosened connectors	Tighten
Cooling Fins	Build-up of dust or dirt	Blow with dry compressed air of 39.2×10^4 to 58.8×10^4Pa [57 to 85 psi (4 to 6 kg·cm^2)] pressure.
Printed Circuit Board	Accumulation of conductive dust or oil mist	Clean the board. If dust and oil cannot be removed, replace the inverter unit.
Cooling Fan	Abnormal noise or vibration. Whether the cumulative operation time exceeds 20,000 hours or not.	Replace the inverter unit.
Power Elements	Accumulation of dust or dirt	Blow with dry compressed air of 39.2×10^4 to 58.8×10^4Pa [57 to 85 psi (4 to 6 kg·cm^2)] pressure.
Smoothing Capacitor	Discoloration or odor	Replace the inverter unit.

1.6.2 High Voltage Test

Use an insulation resistance tester (500 V) to conduct insulation resistance test (high voltage test) on the main control circuit as described below.

(1) Remove the inverter main circuit and control circuit terminal wiring and execute the test only between the main circuit terminals and ground [ground terminal (G/E)] as shown in Fig. 1.9.

(2) The equipment is normal with the insulation resistance tester indicating 1MΩ or more.



Note : Do not conduct high voltage test on the control circuit terminals.

Fig. 1.9 High Voltage Test

1.7 FAULT DISPLAY AND TROUBLESHOOTING

If a fault occurs and the inverter functions are lost, check for the causes and provide proper corrective actions, referring to the following checking method.

Contact your Sumitomo representative if any fault other than described below occurs, if the inverter itself malfunctions, if any parts are damaged, or if you have any other problems. A list of the Sumitomo representatives is available on the last page.

1.7.1 Checking of Causes

The inverter has protective functions to protect it from faults such as overcurrent or overvoltage. If a fault occurs, the protective functions operate to shut off the inverter output and the motor coasts to a stop. All the same time, the fault contact signal is output.

When the protective functions operate in models with indicating cover, the digital display unit displays a fault shown in Table 1.8. Also when the digital operator is used, the fault display is provided.

Operation can be restarted by turning ON the fault reset input signal (or RESET key of the digital operator) or turning OFF the power supply and ON again.

Table 1.8 Fault Display and Contents

Fault Display			Contents	Possible Cause/ Corrective Actions
Digital Operator	Inverter LED Display*			
	DS1 (GR)	DS2 (RD)		
OC (Over-current) oC	◐	☼	Inverter output current exceeds 200% of rated current. (Momentary action)	The following causes can be considered : inverter output side short-circuit, excessive load inertia (J), excessively short setting of accel/decel time, [constant (No. 09 to 12)] special motor use, motor start during coasting, start of motor with larger capacity than inverter, inverter output side magnetic contactor ON/OFF. Reset after finding the cause.
GF (Ground Fault) GF	◐	☼	Inverter output side is grounded.	Check that the motor or load side wiring is not grounded.
OV (Over-voltage) ou	●	☼	Main circuit DC voltage exceeds 410 V or more for 230 V class, 820 V or more for 460 V class because of excessive regenerative energy from motor.(Exceeds overvoltage protection level.)	Decel time setting is not sufficient. [constant (No. 10, 12)] or minus load (cranes, etc.) is decreasing. Increase decel time or connect a braking resistor (option).
UV (Under-voltage) Uu1	●	☼	Undervoltage occurred is entered. [Main control DC voltage becomes approx. 210 V or less (230 V class 3-phase), 170 V or less (240 V class single-phase) or 420 V or less (460 V class 3-phase)].	Input power supply voltage is reduced, phases are opened or momentary power loss occurs, etc. Check the power supply voltage, or check that main circuit power supply wiring is connected properly or terminal screws are tightened well.
OH (Cooling Fin Overheat) oH	☼	◐	Temperature rise caused by inverter overload operation, or intake air temperature rise. Cooling fan r/min is decreased.	Load is too large, V/f characteristics are not proper, accel time is too short or intake air temperature exceeds 113° F (45°C), etc. Correct load size, V/f set value [constant No. 02 to 08] or intake air temperature. Check the cooling fan.

* LED display ☼: light ●: light off

Table 1.8 Fault Display and Contents (Cont'd)

Fault Display			Contents	Possible Cause/ Corrective Actions
Digital Operator	Inverter LED Display* DS1 (GR)	DS2 (RD)		
OL1 (Motor Overload) oL 1	☼	◐	Motor overload protection operates because of electronic thermal overload.	Correct load size, operation pattern or V/f set value [constant (No. 02 to 08)]. Set the rated current value described in the motor nameplate to constant (No. 19).
OL2 (Inverter Overload) oL2	☼	◐	Inverter overload protection operates because of electronic thermal overload.	Correct load size, operation pattern or V/f set value [constant (No. 02 to 08)]. Recheck the inverter capacity.
OL3 † (Overtorque Detection) oL 3	☼	◐	Motor current exceeding set value is applied because of machine fault or overload.	Check the machine using status and remove the cause. Or increase the set value up to the machine allowable value [constant (No. 38)].
EF4, 5‡ (External Fault) EF4, EF5	◐	◐	Inverter accepts external fault input from external circuit.	Check the external circuitry (sequence).
CPF# (Control Function Fault) CPF ⁝⁝	☼	☼	Inveter control functions are broken down.	Turn OFF the power supply once and then turn it ON again.Or initialize the control constant by using the digital operator. If the fault still exists, replace the inverter.
	●	●		
Digital display is extinguished.	●	●	·Main circuit fuse is blown. (for 460 V class only) ·Control power supply fault ·Hardware fault	Replace the inverter.

* LED display ☼: light ◐: blink ●: light off

† For OL3 (overtorque detection), fault display or alarm display can be selected according to the constant (No.37) setting. For details, refer to "OVERTORQUE DETECTION FUNCTION" on page 108.

‡ EF4 shows external fault input from multifunction contact input terminal (ES), EF5 from terminal (DF).

For details of CPF (control function faults), refer to Table 1.9, "Details of CPF Display".

Table 1.9 Details of CPF Display

Fault Display			Contents	Corrective Actions
Digital Operator	Inverter LED Display* DS1 (GR)	DS2 (RD)		
CPF-00 CPF00	●	●	Initial memory fault is detected.	Turn OFF the power supply once and turn it ON again. If the fault still exists, replace the inverter.
CPF-01 CPF01	●	●	ROM fault is detected.	Turn OFF the power supply once and turn it ON again. If the fault still exists, replace the inverter.
CPF-04 CPF04	☼	☼	Constant fault is detected.	Record all data, and then make initialization. Turn OFF the power supply once and turn it ON again. If the fault still exists, replace the inverter. For initialization of constants, refer to Par. 2.5.1 "Constant Initialization" on page 62.
CPF-05 CPF05	☼	☼	AD converter fault is detected.	

* LED display ☼: light ●: light off

1.7.2 Alarm Display and Contents

Alarms, among inverter protective functions, do not operate fault contact output and returns to the former operation status automatically when the factor is removed.

The following shows the types and contents.

Table 1.10 Alarm Display and Contents

Alarm Display			Contents	Possible Cause/ Corrective Actions
Digital Operator	Inverter LED Display*			
	DS1 (GR)	DS2 (RD)		
EF (Simultaneous Input of FWD and REV commands) EF blinks.	●	◐	Both FWD and REV commands are "closed" for 500 ms or larger. Inverter stops according to constant No. 01.	Check the control interface circuit.
BB (External Baseblock) bb blinks.	●	◐	External baseblock is input. Inverter output shuts off. (Operation restarts when the external baseblock signal is removed. For the external baseblock signal, refer to "MULTIFUNCTION CONTACT INPUT FUNCTION SELECTION" on page 94.	Check the control interface circuit.
UV (Main Circuit Undervoltage) Uv blinks.	●	◐	Main circuit DC voltage is reduced less than detection level when inverter is not outputting.	Check the power supply voltage, main circuit power supply wiring connection or terminal screw tightening.
OL3 (Overtorque Detection) † oL3 blinks.	●	◐	Motor current exceeding the set value flows due to machine fault or overload. Inverter continues operation.	Check the machine using status and remove the cause of the fault. Or increase the set value [constant (No. 38)] up to the machine allowable value.
OV	●	◐	Main circuit DC voltage is more than overvoltage detection level. When inverter is not outputting.	Check the power supply voltage.
OH	●	◐	Intake air temperature rises when inverter is not outputting.	Check the intake air temperature.

* LED display ◐: blink ●: light off

† For OL3 (overtorque detection), fault display can be selected according to the constant (No. 37) setting. For details, refer to "OVERTORQUE DETECTION FUNCTION" on page 101.

1.7.3 Corrective Action for Motor Faults

Table 1.11 shows the check points and corrective actions of motor faults.

Table 1.11 Motor Faults and Corrective Actions

Fault	Check Point	Corrective Action
Motor does not rotate.	Power supply voltage is applied to power supply terminals L_1/R, L_2/S, L_3/T. (Check that charge lamp is ON.)	· Turn ON the power supply. · Turn OFF the power supply and then ON again. · Check power supply voltage. · Check that terminal screws are tight.
	Voltage is output to output terminals T_1/U, T_2/V, T_3/W. (Use rectifier type voltmeter.)	· Turn OFF the power supply and then ON again.
	Load is excessively large. (Motor is locked.)	Reduce the load. (Release the lock.)
	Fault is displayed.	Check according to Par. 1.7.1
	FWD or REV run command is entered.	Correct the wiring.
	Frequency setting voltage is entered.	· Correct the wiring. · Check frequency setting voltage.
	Operation (method selection) mode setting is proper.	Check the operation method selection mode [constant (No. 01)] by using the digital operator.
Motor rotating direction is reversed.	Wiring of output terminals T_1/U, T_2/V, and T_3/W is correct.	Match them to the phase order of motor T_1/U, T_2/V, and T_3/W.
	Wiring of FWD and REV run signals is correct.	Correct the wiring.
Motor rotates but variable speed is not available.	Wiring of frequency setting circuit is correct.	Correct the wiring.
	Operation (method selection) mode setting is correct.	Check operation method selection mode [constant (No. 01)] by digital operator.
	Load is not excessively large.	Reduce the load.
Motor r/min is too high (low).	Motor ratings (number of poles, voltage) are proper.	Check the specifications and nameplate.
	Maximum frequency set value is correct.	Check the maximum frequency set value [constant (No.02)]
	Voltage between motor terminals is not excessively reduced. (Use rectifier type voltage.)	Check V/f characteristic set value [constant (No 02 to 08)].
Motor r/min is not stable during operation*	Load is not excessively large.	Reduce the load.
	Load variation is not excessively large.	· Reduce the load variation. · Increase the inverter or motor capacity.
	3-phase power supply is used.	Connect an AC reactor to the power supply if single-phase power supply is used.

* Because of motor and load (geared machine) characteristics, motor r/min becomes unstable or motor current ripples. To correct these problems, changing the inverter control constants may be effective. Refer to "CONSTANTS EFFECTIVE FOR REDUCTION OF MACHINE VIBRATION OR SHOCK" on page 106 for details of control constants to be changed.

SPECIFICATIONS

1.8 SPECIFICATIONS

1.8.1 Specifications

	Voltage Class	230 V 3-phase						
	Inverter Model AF-3002-	A10	A20	A40	A75	1A5	2A2	3A7
	Max. Applicable Motor Output HP (kW)*	0.13 (0.1)	0.25 (0.2)	0.5 (0.4)	1 (0.75)	2 (1.5)	3 (2.2)	5 (3.7)
Output Characteristics	Inverter Capacity kVA	0.3	0.6	1.1	1.9	2.5	4.2	6.7
	Rated Output Current A	0.8	1.5	3	5	6.5	11	17.5
	Max. Output Voltage V	3-phase, 200 to 230 V (proportional to input voltage)						
	Max. Output Frequency Hz	400 Hz (available with constant setting)						
Power Supply	Rated Input Voltage and Frequency	3-phase 200 to 230 V, 50/60 Hz						
	Allowable Voltage Fluctuation	±10%						
	Allowable Frequency Fluctuation	± 5%						
Control Characteristics	Control Method	Sine wave PWM						
	Frequency Control Range	0.1 to 400Hz						
	Frequency Accuracy (Temperature Change)	Digital command : 0.01% (+14 to 104°F, −10 to +40°C), Analog command : 0.1% (77±50°F, 25±10°C)						
	Frequency Setting Resolution	Digital operator reference : 0.1 Hz, Analog reference : 0.06/60 Hz						
	Output Frequency Resolution	0.1Hz						
	Overload Capacity	150% rated output current for one minute						
	Frequency Setting Signal	0 to 10 VDC (20kΩ), 4 to 20mA (250Ω)						
	Accel/Decel Time	0.1 to 600 sec (accel/decel time set independently)						
	Braking Torque	Approx. 20% (up to 150% possible with optional braking resistor externally mounted, braking transistor built-in)						
	V/f Characteristic	Possible to set any V/F pattern						
	Stall Prevention Level	Possible to set operating current						
Protective Functions	Instantaneous Overcurrent	Motor coasts to a stop at approx. 200% of inverter rated current.						
	Overload	Motor coasts to a stop after 1 minute at approx. 150% of inverter rated output current						
	Ground Fault	Protected by electronic circuit.						
	Motor Overload Protection	Electronic thermal overload relay						
	Overvoltage	Motor coasts to a stop if main circuit DC voltage exceeds 410 VDC						
	Undervoltage	Activated when DC voltage drops below 210 VDC						
	Momentary Power Loss	Stops if power loss is 15 ms or longer (preset prior to shipping) (operation can automatically restart after recovery from momentary power loss of up to approx. 2 seconds.) †						
	Cooling Fin Overheat	Protected by thermoswitch (only for units with fan)						
	Power Charge Indication	Charge lamp stays ON until main circuit DC voltage drops below 50 V.						

* Our standard 4-pole motor is used to determine max. applicable motor output.

† To select "automatic restart after momentary power loss," set the 1st digit of constant (No. 46) to "1." Automatic restart is available for up to 1 second for models of 1HP (0.75 kW) or less or up to 2 seconds for models of 2 HP (1.5 kW) or greater.

	Voltage Class	240 V Single-phase						
	Inverter Model AF-300S-	A10	A20	A40	A75	1A5	2A2	3A7
	Max. Applicable Motor Output HP (kW)*	0.13 (0.1)	0.25 (0.2)	0.5 (0.4)	1 (0.75)	2 (1.5)	3 (2.2)	5 (3.7)
Output Characteristics	Inverter Capacity kVA	0.3	0.6	1.1	1.9	2.5	4.2	6.7
	Rated Output Current A	0.8	1.5	3	5	6.5	11	17.5
	Max. Output Voltage V	3-phase, 200 to 240 V (proportional to input voltage)						
	Max. Output Frequency Hz	400 Hz (available with constant setting)						
Power Supply	Rated Input Voltage and Frequency	Single-phase 200 to 240 V, 50/60 Hz						
	Allowable Voltage Fluctuation	±10%						
	Allowable Frequency Fluctuation	± 5%						
Control Characteristics	Control Method	Sine wave PWM						
	Frequency Control Range	0.1 to 400Hz						
	Frequency Accuracy (Temperature Change)	Digital command : 0.01% (+14 to 104°F, −10 to +40°C), Analog command : 0.1% (77±50°F, 25±10°C)						
	Frequency Setting Resolution	Digital operator reference : 0.1 Hz, Analog reference : 0.06/60 Hz						
	Output Frequency Resolution	0.1Hz						
	Overload Capacity	150% rated output current for one minute						
	Frequency Setting Signal	0 to 10 VDC (20kΩ), 4 to 20mA (250Ω)						
	Accel/Decel Time	0.1 to 600 sec (accel/decel time set independently)						
	Braking Torque	Approx. 20% (up to 150% possible with optional braking resistor externally mounted, braking transistor built-in)						
	V/f Characteristic	Possible to set any V/F pattern						
	Stall Prevention Level	Possible to set operating current						
Protective Functions	Instantaneous Overcurrent	Motor coasts to a stop at approx. 200% of inverter rated current.						
	Overload	Motor coasts to a stop after 1 minute at approx. 150% of inverter rated output current						
	Ground Fault	Protected by electronic circuit.						
	Motor Overload Protection	Electronic thermal overload relay						
	Overvoltage	Motor coasts to a stop if main circuit DC voltage exceeds 410 VDC						
	Undervoltage	Activated when DC voltage drops below 170 VDC						
	Momentary Power Loss	Stops if power loss is 15 ms or longer (preset prior to shipping) (operation can automatically restart after recovery from momentary power loss of up to approx. 2 seconds.) †						
	Cooling Fin Overheat	Protected by thermoswitch (only for units with fan)						
	Power Charge Indication	Charge lamp stays ON until main circuit DC voltage drops below 50 V.						

* Our standard 4-pole motor is used to determine max. applicable motor output.

† To select "automatic restart after momentary power loss," set the 1st digit of constant (No. 46) to "1." Automatic restart is available for up to 1 second for models of 1HP (0.75 kW) or less or up to 2 seconds for models of 2 HP (1.5 kW) or greater.

Voltage Class				230 V 3-phase						
Inverter Model AF-3002-				A10	A20	A40	A75	1A5	2A2	3A7
Operation conditions	Input Signals	Operation Signal		Forward run/reverse run by separate commands						
		Fault Reset		Releases protection while the function is operating.						
		Multifunction Input Selection		**Multifunction contact input : 2 of the following signals available to select.** External fault, multispeed command, jog operation, accel/decel time select, 3-wire sequence, external baseblock, speed search command						
	Output Signals	Operation State	Photo-coupler Output	**Multifunction output: two of the following signals available to select. (48 VDC, 50 mA or less)** (During running output, zero speed, frequency agreement, output frequency ≧ set value, during overtorque detection						
			Fault Contact	1 NO/NC contact output (250 VAC 1 A, 30 VDC 1 A or less)						
	Built-in Function			The following setting-up is available : frequency reference bias/gain, upper/lower frequency limit. DC injection braking current/time at starting/stopping, full-automatic torque boost, frequency meter calibrating gain, fault retry, frequency jump, S-curve accel/decel.						
	Monitor Display Function	LED Status Display		Displays contents at RUN/STOP and protective function operation.						
		Digital Operator		Displays set frequency, output frequency, output current, direction of rotation, and the fault status.						
		Analog Output Monitor		Analog output (0 to 10 VDC). Possible to select output frequency or output current.						
Protective Configuration				Enclosed wall-mounted type NEMA 1 (Open chassis type is also available.)						
Cooling Method				Self-cooling						Forced cooling
Weight lb (kg)				2.4 (1.1)			4.4 (2)			**7.28 (3.3)**
Environmental Conditions	Location			Indoor (protected from corrosive gases and dust)						
	Ambient Temperature			+14 to 104°F (−10 to +40°C) (not frozen)						
	Storage Temperature *			−4 to 140°F (−20 to +60°C)						
	Humidity			90% RH or less(non-condensing)						
	Vibration			Up to 9.8 m/s² (1G) at less than 20 Hz, Up to 2 m/s² (0.2 G) at 20 to 50 Hz.						

*Temperature during shipping (for short period)

Voltage Class				240 V Single-phase						
Inverter Model AF-300S-				A10	A20	A40	A75	1A5	2A2	3A7
Operation conditions	Input Signals	Operation Signal		Forward run/reverse run by separate commands						
		Fault Reset		Releases protection while the function is operating.						
		Multifunction Input Selection		**Multifunction contact input : 2 of the following signals available to select.** External fault, multispeed command, jog operation, accel/decel time select, 3-wire sequence, external baseblock, speed search command						
	Output Signals	Operation State	Photo-coupler Output	**Multifunction output: two of the following signals available to select. (48 VDC, 50 mA or less)** (During running output, zero speed, frequency agreement, output frequency ≧ set value, during overtorque detection, etc.)						
			Fault Contact	1 NO/NC contact output (250 VAC 1 A, 30 VDC 1 A or less)						
	Built-in Function			The following setting-up is available : frequency reference bias/gain, upper/lower frequency limit. DC injection braking current/time at starting/stopping, full-automatic torque boost, frequency meter calibrating gain, fault retry, frequency jump, S-curve accel/decel.						
	Monitor Display Function	LED Status Display		Displays contents at RUN/STOP and protective function operation.						
		Digital Operator		Displays set frequency, output frequency, output current, direction of rotation, and the fault status.						
		Analog Output Monitor		Analog output (0 to 10 VDC). Possible to select output frequency or output current.						
Protective Configuration				Enclosed wall-mounted type NEMA 1 (Open chassis type is also available.)						
Cooling Method				Self-cooling					Forced-cooling	
Weight lb (kg)				**4.9 (2.2)**			6.6 (3)			**11.0 (5)**
Environmental Conditions	Location			Indoor (protected from corrosive gases and dust)						
	Ambient Temperature			+14 to 104°F (−10 to +40°C) (not frozen)						
	Storage Temperature *			−4 to 140°F (−20 to +60°C)						
	Humidity			90% RH or less(non-condensing)						
	Vibration			Up to 9.8 m/s² (1G) at less than 20 Hz, Up to 2 m/s² (0.2 G) at 20 to 50 Hz.						

*Temperature during shipping (for short period)

Voltage Class		460 V 3-phase		
Inverter Model AF3004-		A20	A40	A75
Max. Applicable Motor Output HP (kW)*		0.25 (0.2)	0.5 (0..4)	1 (0.75)
Output Characteristics	Inverter Capacity kVA	0.9	1.4	2.2
	Rated Output Current A	1	1.6	2.6
	Max. Output Voltage V	3-phase, 380 to 460 V (proportional to input voltage)		
	Max. Output Frequency Hz	400 Hz (available by programming)		
Power Supply	Rated Input Voltage and Frequency	3-phase 380 to 460 V, 50/60 Hz		
	Allowable Voltage Fluctuation	±10%		
	Allowable Frequency Fluctuation	± 5%		
Control Characteristics	Control Method	Sine wave PWM		
	Frequency Control Range	0.1 to 400 Hz		
	Frequency Accuracy (Temperature Change)	Digital command : 0.01% (+14 to 104°F, −10 to +40℃), Analog command : 0.1% (77±50°F, 25±10℃)		
	Frequency Setting Resolution	Digital operator reference : 0.1 Hz, Analog reference : 0.06/60 Hz		
	Output Frequency Resolution	0.1Hz		
	Overload Capacity	150% rated output current for one minute		
	Frequency Setting Signal	0 to 10 VDC (20kΩ), 4 to 20mA (250Ω)		
	Accel/Decel Time	0.1 to 600 sec (accel/decel time set independently)		
	Braking Torque	Approx. 20% (up to 150% possible with optional braking resistor externally mounted, braking transistor built-in)		
	V/f Characteristic	Possible to set any V/F pattern		
	Stall Prevention Level	Possible to set operating current		
Protective Functions	Instantaneous Overcurrent	Motor coasts to a stop at approx. 200% of inverter rated current.		
	Ground Fault	Protected by electronic circuit.		
	Overload	Motor coasts to a stop after 1 minute at approx. 150% of inverter rated output current		
	Motor Overload Protection	Electronic thermal overload relay		
	Overvoltage	Motor coasts to a stop if main circuit DC voltage exceeds 820 VDC		
	Undervoltage	Activated when DC voltage drops below 420 VDC		
	Momentary Power Loss	Stops if power loss is 15 ms or longer (setting prior to shipping) (operation can automatically restart after recovery from momentary power loss of up to approx. 2 seconds.) †		
	Cooling Fin Overheat	Protected by thermoswitch (only for fan cooled type)		
	Power Charge Indication	Charge lamp stays ON until main circuit DC voltage drops below 50 V.		

* Our standard 4-pole motor is used to determine applicable motor output.

† To select "automatic restart after momentary power loss," set the 1st digit of constant (No. 46) to "1."
Automatic restart is available for up to1 second for models of 1HP (0.75 kW) or less or up to 2 seconds for models of 2HP (1.5 kW) or greater.

Voltage Class		460 V 3-phase		
Inverter Model AF-3004-		1A5	2A2	3A7
Max. Applicable Motor Output HP (kW)*		2 (1.5)	3 (2.2)	4 (3.7)
Output Characteristics	Inverter Capacity kVA	3.4	4.1	6.9
	Rated Output Current A	4	4.8	8
	Max. Output Voltage V	3-phase, 380 to 460 V (proportional to input voltage)		
	Max. Output Frequency Hz	400 Hz (available by programming)		
Power Supply	Rated Input Voltage and Frequency	3-phase 380 to 460 V, 50/60 Hz		
	Allowable Voltage Fluctuation	±10%		
	Allowable Frequency Fluctuation	± 5%		
Control Characteristics	Control Method	Sine wave PWM		
	Frequency Control Range	0.1 to 400 Hz		
	Frequency Accuracy (Temperature Change)	Digital command : 0.01% (+14 to 104°F, −10 to +40℃), Analog command : 0.1% (77±50°F, 25±10℃)		
	Frequency Setting Resolution	Digital operator reference : 0.1 Hz, Analog reference : 0.06/60 Hz		
	Output Frequency Resolution	0.1Hz		
	Overload Capacity	150% rated output current for one minute		
	Frequency Setting Signal	0 to 10 VDC (20kΩ), 4 to 20mA (250Ω)		
	Accel/Decel Time	0.1 to 600 sec (accel/decel time set independently)		
	Braking Torque	Approx. 20% (up to 150% possible with optional braking resistor externally mounted, braking transistor built-in)		
	V/f Characteristic	Possible to set any V/F pattern		
	Stall Prevention Level	Possible to set operating current		
Protective Functions	Instantaneous Overcurrent	Motor coasts to a stop at approx. 200% of inverter rated current.		
	Ground Fault	Protected by electronic circuit.		
	Overload	Motor coasts to a stop after 1 minute at approx. 150% of inverter rated output current		
	Motor Overload Protection	Electronic thermal overload relay		
	Overvoltage	Motor coasts to a stop if main circuit DC voltage exceeds 820 VDC		
	Undervoltage	Activated when DC voltage drops below 420 VDC		
	Momentary Power Loss	Stops if power loss is 15 ms or longer (setting prior to shipping) (operation can automatically restart after recovery from momentary power loss of up to approx. 2 seconds.) †		
	Cooling Fin Overheat	Protected by thermoswitch (only for fan cooled type)		
	Power Charge Indication	Charge lamp stays ON until main circuit DC voltage drops below 50 V.		

* Our standard 4-pole motor is used to determine applicable motor output.

† To select "automatic restart after momentary power loss," set the 1st digit of constant (No. 46) to "1."
Automatic restart is available for up to1 second for models of 1HP (0.75 kW) or less or up to 2 seconds for models of 2HP (1.5 kW) or greater.

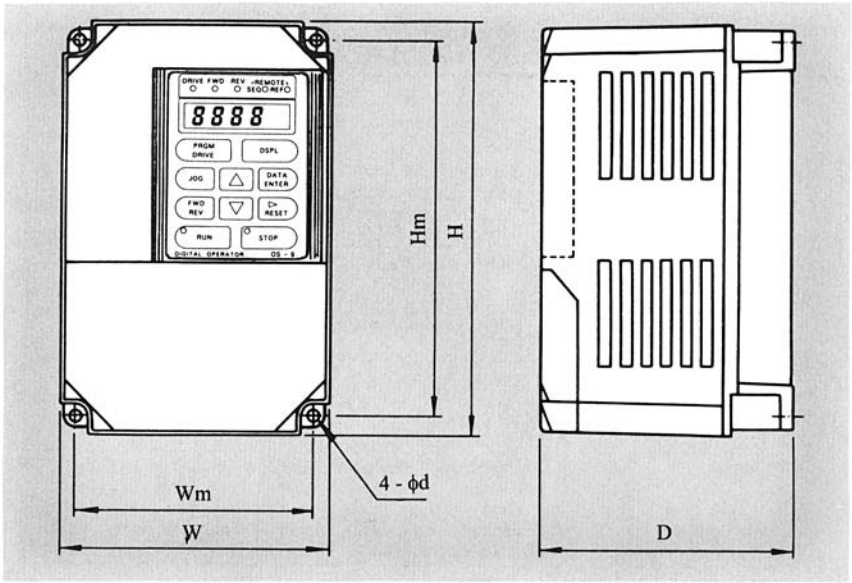
Voltage Class				460 V 3-phase		
Inverter Model AF-3004-				A20	A40	A75
Operation Conditions	Input Signals	Operation Signal		Forward operation/Reverse operation by separate commands		
		Fault Reset		Release protection while the function is operating.		
		Multifunction Setting Input Selection		**Multifunction contact input : 2 of the following signals available to select.** External fault, multispeed command, jog operation, accel/decel time select, 3-wire sequence, external baseblock, speed search command		
	Output Signals	Operation State	Photo-coupler Output	**Multifunction output: two of the following signals available to select. (48 VDC, 50 mA or less)** (During running output, zero speed, frequency agreement, output frequency ≧ set value, during overtorque detection, etc.)		
			Fault Contact	1 NO/NC contact output (250 VAC 1 A, 30 VDC 1 A or less)		
	Built-in Function			The following setting-up is available : frequency reference bias/gain, upper/lower frequency limit, DC injection braking current/time at starting/stopping, full-automatic torque boost, frequency meter calibrating gain, fault retry, frequency jump, S-curve accel/decel.		
	Monitor Display Function	LED Status Display		Displays contents at RUN/STOP and protective function operation.		
		Digital Operator (Option)		Displays set frequency, output frequency, output current, direction of rotation and the fault status.		
		Analog Output Monitor		Analog output (0 to 10 VDC). Possible to select output frequency or output current.		
Protective Configuration				Enclosed wall-mounted type NEMA 1 (open chassis type is also available.)		
Cooling Method				Self-cooling		
Weight lb (kg)				**4.41 (2.0)**	4.4 (2.0)	6.6 (3)
Environmental Conditions	Location			Indoor (protected from corrosive gases and dust)		
	Ambient Temperature			+14 to 104°F (−10 to +40°C) (not frozen)		
	Storage Temperature *			−4 to 140°F (−20 to +60°C)		
	Humidity			90% RH or less (non-condensing)		
	Vibration			Up to 9.8 m/s² (1G) at less than 20 Hz, Up to 2 m/s² (0.2G) at 20 to 50 Hz.		

* Temperature during shipping (for short period)

Voltage Class				460 V 3-phase		
Inverter Model AF-3004-				1A5	2A2	3A7
Operation Conditions	Input Signals	Operation Signal		Forward operation/Reverse operation by separate commands		
		Fault Reset		Release protection while the function is operating.		
		Multifunction Setting Input Selection		**Multifunction contact input : 2 of the following signals available to select.** External fault, multispeed command, jog operation, accel/decel time select, 3-wire sequence, external baseblock, speed search command		
	Output Signals	Operation State	Photo-coupler Output	**Multifunction output: two of the following signals available to select. (48 VDC, 50 mA or less)** (During running output, zero speed, frequency agreement, output frequency ≧ set value, during overtorque detection, etc.)		
			Fault Contact	1 NO/NC contact output,(250 VAC 1 A, 30 VDC 1 A or less)		
	Built-in Function			The following setting-up is available : frequency reference bias/gain, upper/lower frequency limit, DC injection braking current/time at starting/stopping, full-automatic torque boost, frequency meter calibrating gain, fault retry, frequency jump, S-curve accel/decel.		
	Monitor Display Function	LED Status Display		Displays contents at RUN/STOP and protective function operation.		
		Digital Operator (Option)		Displays set frequency, output frequency, output current, direction of rotation and the fault status.		
		Analog Output Monitor		Analog output (0 to 10 VDC). Possible to select output frequency or output current.		
Protective Configuration				Enclosed wall-mounted type NEMA 1 (open chassis type is also available.)		
Cooling Method				Self-cooling	**Forced-cooling**	
Weight lb (kg)				6.6 (3)	**10.14 (4.6)**	
Environmental Conditions	Location			Indoor (protected from corrosive gases and dust)		
	Ambient Temperature			+14 to 104°F (−10 to +40°C) (not frozen)		
	Storage Temperature *			−4 to 140°F (−20 to +60°C)		
	Humidity			90% RH or less (non-condensing)		
	Vibration			Up to 9.8 m/s² (1G) at less than 20 Hz, Up to 2 m/s² (0.2G) at 20 to 50 Hz.		

* Temperature during shipping (for short period)

1.8.2 Dimensions in inches (mm)



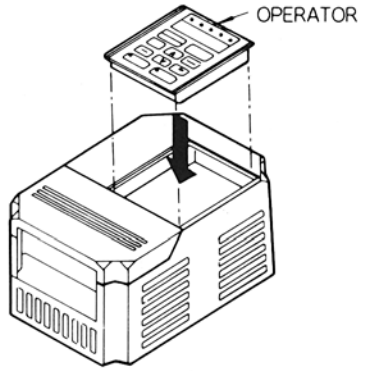
Voltage	Ratings		Dimensions							Weight
	HP	kW		H	Hm	W	Wm	D	d	
200-230 3-Phase Input	1/8-1/2	0.1-0.4	in	5.91	5.43	4.13	3.66	3.94	0.20	2.43 lb
			mm	150	138	105	93	100	5.0	1.1 kg
	1-2	0.75-1.5	in	5.91	5.43	5.51	5.04	5.47	0.20	4.41 lb
			mm	150	138	140	128	139	5.0	2.0 kg
	3-5	2.2-3.7	in	7.87	7.32	5.51	4.96	6.69	0.22	7.28 lb
			mm	200	186	140	126	170	5.5	3.3 kg
200-230 1-Phase Input	1/8-1/2	0.1-0.4	in	5.91	5.43	5.51	5.04	5.47	0.20	4.9 lb
			mm	150	138	140	128	139	5.0	2.2 kg
	1-2	0.75-1.5	in	7.87	7.32	5.51	4.96	6.69	0.22	6.6 lb
			mm	200	186	140	126	170	5.5	3.0 kg
	3-5	2.2-3.7	in	7.87	7.28	7.48	6.89	7.48	0.24	11.0 lb
			mm	200	185	190	175	190	6.0	5.0 kg
380-460 3-Phase	1/8-1/2	0.2-0.4	in	7.87	7.32	5.51	4.96	4.72	0.22	4.41 lb
			mm	200	186	140	126	120	5.5	2.0 kg
	1-2	.75-1.5	in	7.87	7.32	5.51	4.96	6.69	0.22	6.61 lb
			mm	200	186	140	126	170	5.5	3.0 kg
	3-5	2.2-3.7	in	7.87	7.28	7.48	6.89	7.48	0.24	10.14 lb
			mm	200	185	190	175	190	6.0	4.6 kg

2. DIGITAL OPERATOR (OS-9)

The digital operator (OS-9), mounted directly on the inverter, is an AF-3000 exclusive use operation panel which can perform operation, change the control constants and monitor operation status.

2.1 DIGITAL OPERATOR MOUNTING/REMOVING

The digital operator can be mounted and removed in the following procedures. It cannot be mounted or removed during current conduction. Be sure to turn off the inverter power supply and mount/remove it after the charge lamp is extinguished. Unless otherwise, it may cause malfunction.



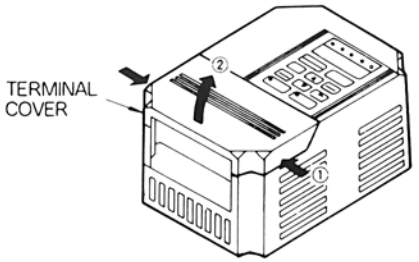
How to mount operator

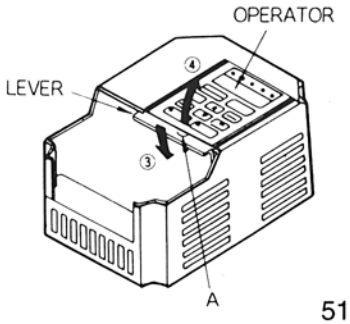
Insert the operator in the direction of the arrow mark until it goes to the end.

How to remove operator

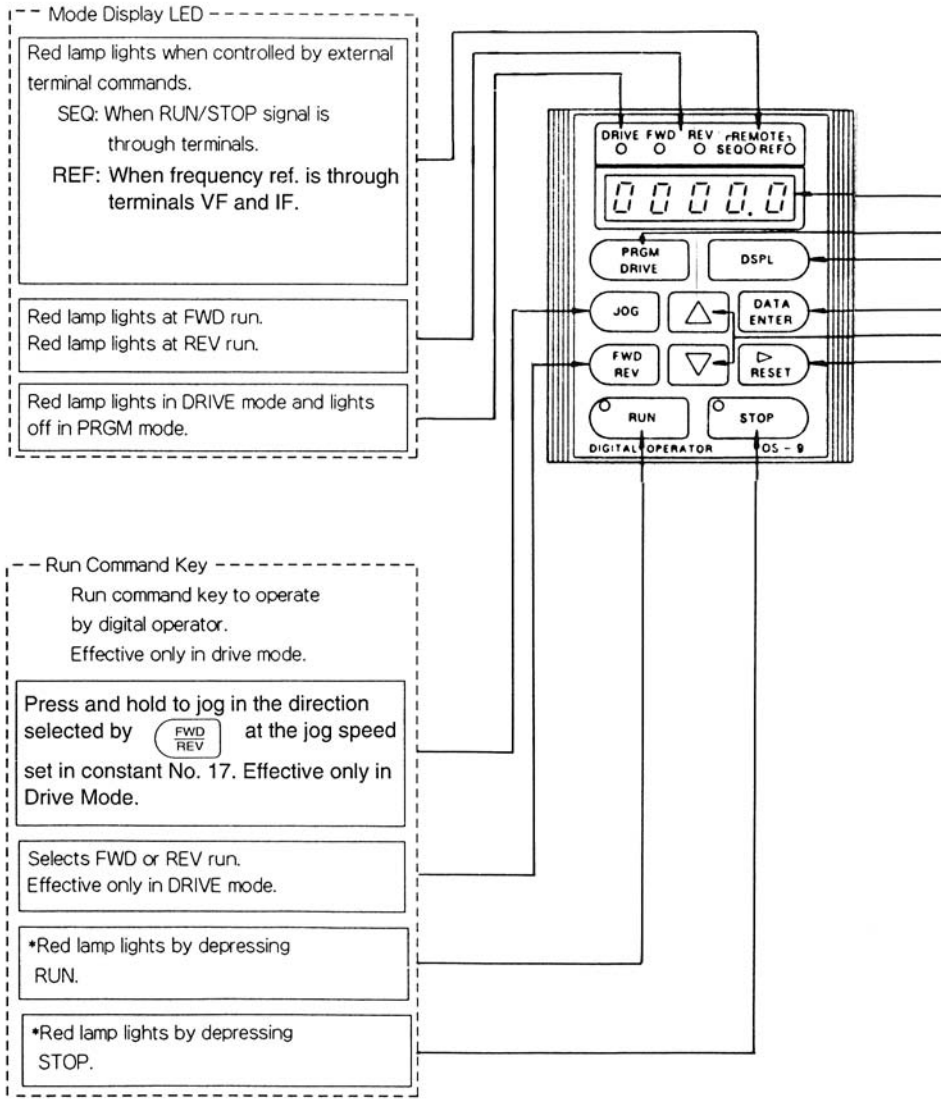
(1) Press in the direction of ① and, at the same time, lift it in the direction of ③ to remove the terminal cover.

(2) Lower the lever in the direction of ③ and insert the minus driver in section A. Then lift the operator in the direction of ④ to remove it.





2.2 DESCRIPTION OF DIGITAL OPERATOR DISPLAY AND OPERATING SECTIONS



Display

Displays set value of each function or monitoring values such as frequency and output current. (5 digits)

Mode Selection Key

Depressing this key changes mode. (DRIVE or PRGM)

Display Selection Key

Depressing this key changes the display. See next page for explanation.

Read/Write Key

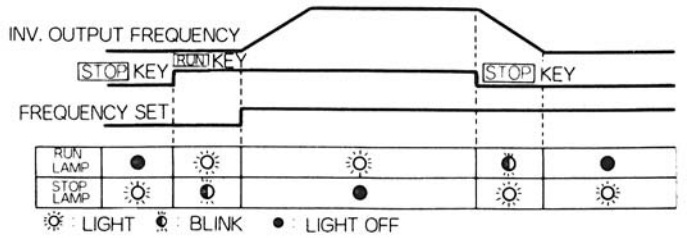
Depressing this key recalls and displays indicated data from memory. Depressing the second time enters displayed data into memory.

Numeral Change Key

Changes numeral such as set values and constant signals.
△: Increase
▽: Decrease

Digit Selection Key

Selects numerical digits.
This key resets operation at faults.



* RUN or STOP lamp charges in accordance with the operations

2.3 FUNCTION/CONSTANT SETTING

2.3.1 DRIVE Mode and PRGM (Program) Mode

Selection of DRIVE mode or PRGM mode can be performed by using the PRGM/DRIVE key when the inverter is stopped. When function selection or a change of set value is required, switch to the PRGM mode.

- Operation is enabled.

DRIVE mode

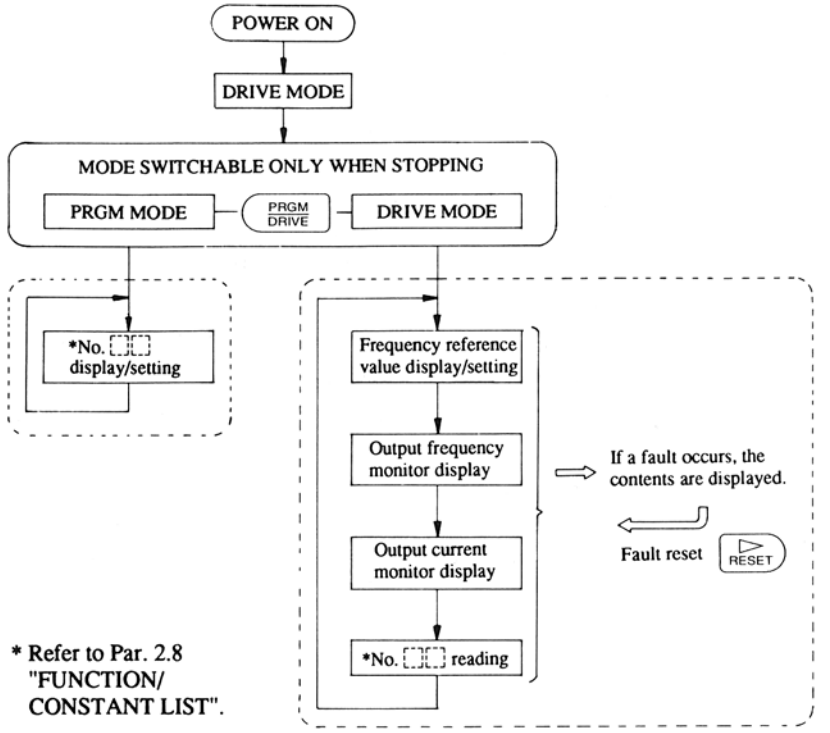
- An operation can be performed by RUN, STOP, JOG or FWD/REV keys.
- Frequency reference value can be changed during running.

PRGM mode

- Program (function selection, constant setting) can be changed. Operation is not enabled.

Display Contents of DRIVE Mode and PRGM Mode

- Display contents of the digital operator differ according to selected mode (PRGM/DRIVE).
- The constant group to be displayed is changed each time display selection key DSPL is depressed.
- If a fault occurs, the contents are displayed. Additionally, since the contents of the latest fault are stored, maintenance, inspection or troubleshooting can be performed quickly by checking the contents by the digital operator.



2.3.2 Constant Reading and Setting

The AF-3000 has various functions for the optimum operation. The first functions are those basic to drive motors. The second are for basic applications. The third are more advanced application functions. Use it with the set values according to the load conditions or operation conditions of the matching machine. Control constants are read or set by the digital operator. Set constant (No.00) as follows:

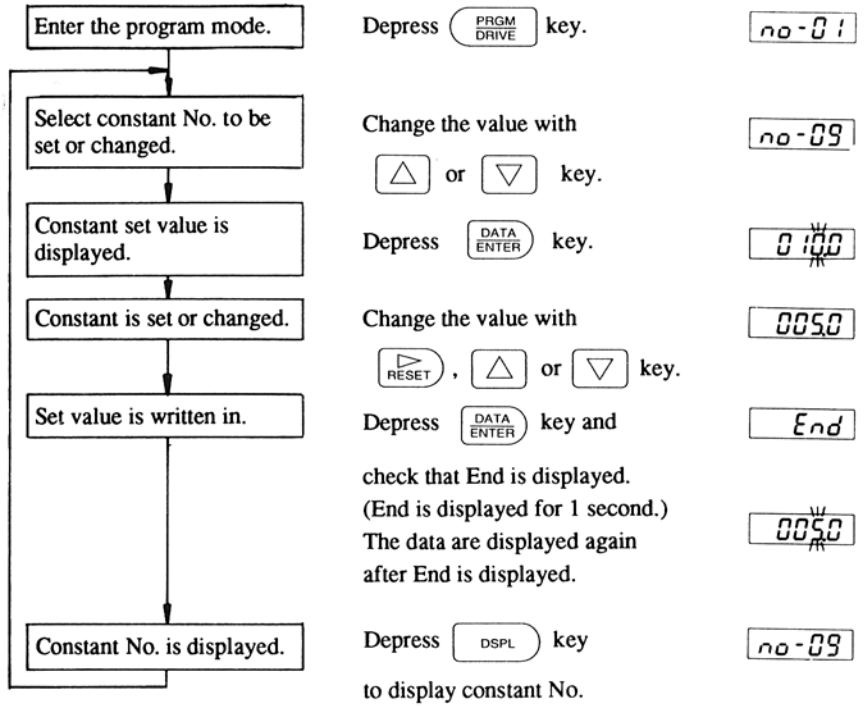
(1) 1st functions (constant Nos.00 to 19) can be set/read :
No.00 = 1 (Factory setting)

(2) 1st and 2nd functions (constant Nos.00 to 29) can be set/read :
No.00 = 2

(3) 1st, 2nd and 3rd functions (constant Nos.00 to 59) can be set/read :
No.00 = 3

<Typical setting>

- The following shows an example where acceleration time (No.09) is changed from 10 seconds to 5 seconds.
- Other constants can be changed in the same operation.



Note : Check that End is displayed for each constant setting. Constants cannot be changed simultaneously.

2.3.3 Precautions on Constant Setting

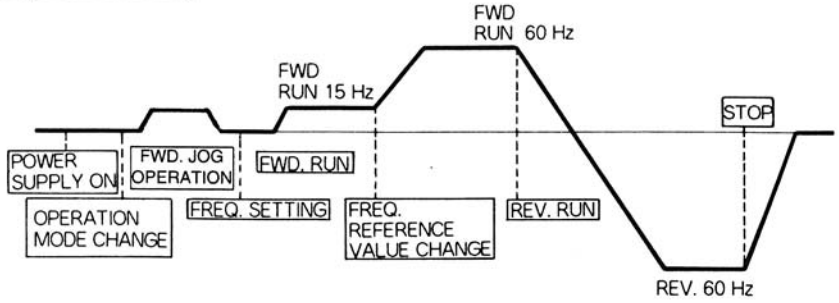
- Perform constant setting securely.
  Improper setting may cause functions not to operate or protective function to operate.
- Record the constants of which setting has been changed.
  Recording the final setting of constants is effective for maintenance or early troubleshooting. Refer to the Par. 2.8 "FUNCTION/CONSTANT LIST" which has a column for entering setting of constants on page 70.
- Change control constants little by little.
  Do not change the motor control constant setting such as V/f maximum output frequency, etc. rapidly. Change it little by little, checking the motor current or load machine status. Changing setting very rapidly may affect the inverter or machine.

- Setting Error
  In the following cases, the set value blinks for 3 seconds and the data before changing are returned.
  - When a value exceeding the setting range is set
  - If the following condition is not satisfied in the multifuncion input selection constant setting :
    Multifunction input selection 1 (No. 32)
    Multifunction input selection 2 (No. 33)
  - If the following conditions are not satisfied in the V/f constant setting :
    Max. output frequency (No. 02)≧Max. voltage frequency (No. 04)＞Intermediate output frequency (No.05)≧Min. output frequency (No. 07)
    For the following setting, intermediate output frequency voltage (No. 06) is disregarded :
    Intermediate output frequency = Min. output frequency.
    For details, refer to "V/f CHARACTERISTIC SETTING" on page 84.
  - If the following condition is not satisfied in the frequency reference constant setting :
    Set frequency reference (Nos. 13 to 17)≦Max. output frequency (No. 02)×Output frequency upper limit value (No. 24)
    For details, refer to "V/f CHARACTERISTIC SETTING" on page 84 and "OUTPUT FREQUENCY LIMIT" on page 91.
  - If the following condition is not satisfied in the frequency reference upper / lower limit value setting :
    Frequency reference lower limit value (No. 25)
    ≦Frequency reference upper limit value (No. 24)

2.4 DIGITAL OPERATOR OPERATION EXAMPLE

The following shows an example of digital operator operation.

Operation Pattern



Operation	[Description]	[Key Operation]	[Digital Operator Display]
Turn ON power supply	· Frequency reference value is displayed.		F 0.0.0
	· Check rotating direction. (FWD is default on power ON.)		LED lamp FWD lights.
Change operation mode.	· PRGM mode is selected.	PRGM/DRIVE	no-01
	· Constant (No.1) data is displayed.	DATA/ENTER	0000
	· Set value is changed.	RESET, △, ▽	0011
	· Set value is written in. (End is displayed for 1 second.)	DATA/ENTER	End
	The data are displayed again after End is displayed.		0011
Frequency Setting	· DRIVE mode is selected.	PRGM/DRIVE	F 0.0.0
15 Hz	· Change reference value.	RESET, △, ▽	F 0 15.0
	· Set value is written in. (Stops blinking for 3 seconds).	DATA/ENTER	F 0 15.0 (Stops blinking for 3 seconds.)
	· Select output frequency monitor display.	DSPL	0.0

(Cont'd)

Operation	[Description]	[Key Operation]	[Digital Operator Display]
			15.0
FWD run	· Running operation.	RUN	LED lamp RUN lights.
Change frequency reference value	· Select frequency reference value display.	DSPL (Depress 3 times.)	F 0 15.0
60 Hz	· Change reference value.	RESET, △, ▽	F 0 60.0
	· Write in set value (stops blinking for 3 seconds).	DATA/ENTER	F 0 60.0
	· Select output frequency monitor display.	DSPL	60.0
REV run	· Change to REV run.	FWD/REV	LED lamp REV lights.
REV 60 Hz			-60.0
	· Decelerating to stop	STOP	0.0
Stop			LED lamp STOP lights.
			(RUN blinks while decelerating.)

2.5 CONSTANT INITIALIZATION AND WRITE-IN PROHIBIT

2.5.1 Constant Initialization (Operation to return to factory setting)

· Write in 8 to constant (No.00).

[Description]	[Key Operation]	[Digital Operator Display]
· Select PRGM mode.	PRGM/DRIVE	no-01
· Select constant (No.00).	▽	no-00
· Constant (No.00) data is displayed.	DATA/ENTER	01 *
· Change the set value.	RESET △ ▽	08
· Write in the set value. (End is displayed for 1 second.) The data are displayed again after End is displayed.	DATA/ENTER	End 01 †

* Differs according to the setting data before changing.
† The display returns to 01 after write-in. This indicates that initialization is executed at writing in the data.

2.5.2 Constant Write-in Prohibit (Only constant reading possible)

· The following shows an example where 0 is written in to constant (No.00) [password (No.00) setting/reading and the first functions (constant Nos. 01 to 19) reading enabled].

[Description]	[Key Operation]	[Digital Operator Display]
· Select PRGM mode.	PRGM/DRIVE	no-01
· Select constant (No.00).	▽	no-00
· Constant (No.00) data is displayed.	DATA/ENTER	01 *
· Change the set value.	RESET △ ▽	00
· Write in the set value. (End is displayed for 1 second.) The data are displayed again after End is displayed.	DATA/ENTER	End 00

* Differs according to the setting data before changing.
For details, refer to "PASSWORD SETTING" on page 79.

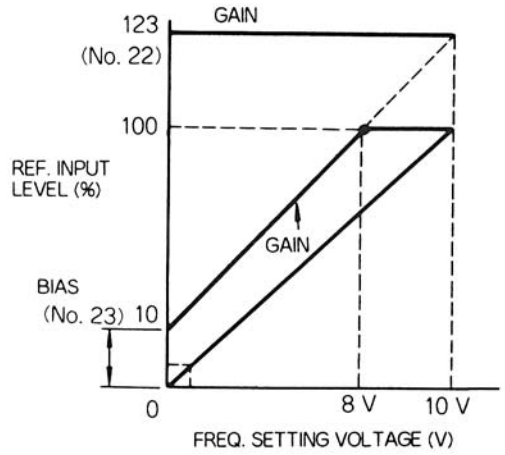
2.6 CORRECTIVE FUNCTION

2.6.1 Adjustment of Frequency Setting Value, Output Frequency Bias (No.23) and Gain (No.22)

Any desired value of output frequency for frequency set value (0 to 10V or 4 to 20mA) can be set.

<Example> Adjust so as to obtain 10% speed (6Hz) at frequency setting voltage 0V and 100% speed (60Hz) at 8V.
[Set constant (No.23)=0.10 and constant (No.22) =1.23.]

[Description]	[Key Operation]	[Digital Operator Display]
· Select PRGM mode.	PRGM/DRIVE	no.-01
<Bias> · Select constant (No.23).	△	no-23
· Data (No.23) are displayed.	DATA/ENTER	0.00
· Change the set value.	RESET ▽ △	0.10 (10%=0.1)
· Write in the set value. (End is displayed for 1 second.) The data are displayed again after End is displayed.	DATA/ENTER	End 0.10



<Gain>

· Select constant (No.22).	DSPL ▽	no-22
· Data (No.22) are displayed.	DATA/ENTER	1.00
· Change the set value.	RESET △ ▽	1.23 *
· Write in the set value. (End is displayed for 1 second.) The data are displayed again after End is displayed.	DATA/ENTER	End 1.23

*How to calculate gain

$$x = \frac{100 - b}{a} \cdots (1) \qquad G = \frac{10x + b}{100} \cdots (2)$$

x can be obtained by equation (1).

$$x = \frac{100 - 10}{8} = 11.25$$

Then by substituting x obtained in equation (1) for equation (2) to obtain G :

$$G = \frac{10 \times 11.25 + 10}{100} = 1.225$$

$$= 1.23$$

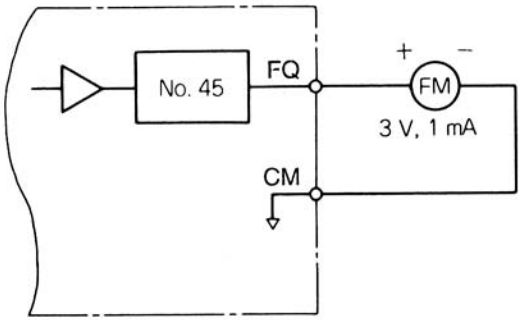
a : Setting voltage at 100% frequency (V)
In this example, since 100% speed (60Hz) is obtained at 8V, a =8.
b : Bias level (%)
In this example, since 10% speed (6Hz) is obtained at frequency setting voltage 0V, b =10.
G : Gain set value
In this example, it is 1.23.

2.6.2 Calibration of Frequency Meter

Calibration of frequency meter or ammeter connected to the inverter can be performed even without providing a calibration resistor.

<Example> When the frequency meter specifications are 3V (1mA) full-scale, 3V full-scale output is used at maximum output frequency [constant (No.02)] operation.

[Set constant (No.45)= 0.30.]



Frequency Meter Calibration

[Description]	[Key Operation]	[Digital Operator Display]
· Select PRGM mode.	PRGM DRIVE	no-01
· Select constant (No.45).	DSPL △ ▽	no-45
· Data are displayed.	DATA ENTER	1.00
· Change the set value.	RESET ▽ △	0.30 10 V× 0.3 = 3.0 V*
· Write in the set value. (End is displayed for 1 second.)	DATA ENTER	End
The data are displayed again after End is displayed.		0.30

* Since analog monitor gain is set to 1.00 prior shipping, 10V is output at maximum output frequency [constant (No.02)] operation.

Note : By data display of constant (No.45) in the program mode, voltage at 100% level according to the constant (No.45) set value is output by the meter calibrating function without any conditions.

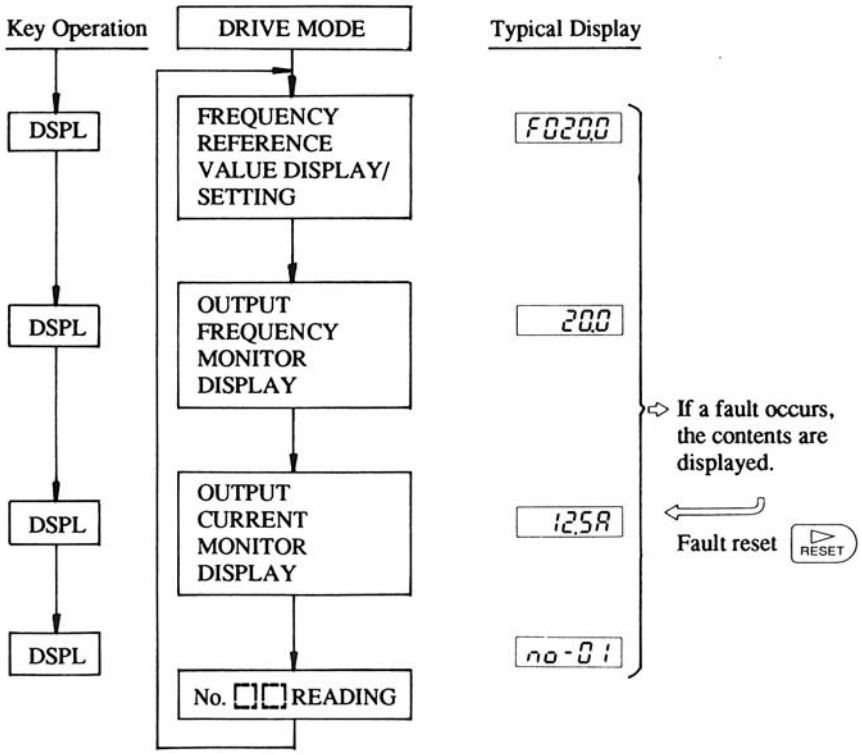
(Example) Assuming constant (No.45) = 0.30 : 10V×0.30 = 3V is output without any conditions.

2.7 MONITOR

Frequency reference value, output frequency, output current and fault contents can be monitored.

2.7.1 Typical Monitor Contents and Display (DRIVE Mode)

The monitor item is changed every time the DSPL key is depressed.



2.7.2 Monitoring of Fault Contents

- If a fault occurs, the fault contents are displayed with priority over other display items.

  Depress the RESET key or turn on the fault reset input signal to reset the fault.
- Since the latest fault content data are stored in the inverter, even if the power supply is turned off, they can be monitored after the power supply is turned on again.

(1) Checking fault contents
The latest data are stored in the constant (No.48). (except UV)

(2) Clearing fault contents
The contents are cleared by setting "6" to the constant (No.00).
Or they are also cleared by constant initialization. [Set constant (No.00) = 8 or 9.]
At this time, other constants are changed to the factory setting values. Therefore, record all of the constant data before initializing constant.

(3) Faults to be stored
OC (overcurrent), OV (overvoltage), OH (cooling fin overheat), OL1 (motor overload), OL2 (inverter overload), OL3 (overtorque detection), EF4, EF5 (external fault), CPF05 (AD converter fault).
For details, refer to Table 1.8 "Fault Display and Contents" on page 35.

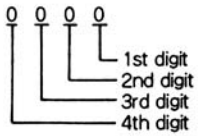
2.8 FUNCTION/CONSTANT LIST

2.8.1 First Functions (Constant Nos. 00 to 19)

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
Constant Group Selection Fault Contents Clear Constant Initialization	00	Password	0 : Password (No. 00) setting/reading and first function (constant Nos. 01 to 19) reading possible 1 : First function (constant Nos. 00 to 19) setting/reading possible 2 : First and second functions (constant Nos. 00 to 29) setting/reading possible 3 : First, second and third functions (constant Nos. 00 to 59) setting/reading possible 6 : Fault record clear 8 : Initialize factory reset 9 : Initialize factory reset 3-wire control 10 : Factory reset – UL unit 11 : Factory reset 3-wire control – UL unit	1		79
Constant Method Selection Stopping Method Selection	01*	Run Signal Selection 1	1st digit = 0: Master frequency reference – Control circuit terminals VF and CM; or IF and CM inputs = 1 : Master frequency reference – Operator FXXXX 2nd digit = 0 : Run by control circuit terminal run command = 1 : Run by operator run command 3rd digit = 0 : Deceleration to a stop = 1 : Coasting to a stop	0011† (0000)		80
V/f Pattern Setting		Output Voltage Limiter Selection	4th digit = 0 : Free choice V/f with output voltage limiter = 1 : Free choice V/f without output voltage limiter			

* The first to fourth digits indicated in the description of constant (No. 01) mean the following digits. This also applies to the other constants.

† The value in parentheses is factory set value of models without digital operator (with indicating cover).



Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
V/f Pattern Setting	02	Maximum Output Frequency	Setting unit : 0.1 Hz, Setting range : 50.0 to 400.0 Hz	60.0 Hz		84
	03	Maximum Voltage	Setting unit : 0.1 V, Setting range : 0.1 to 255.0 V	230V*		
	04	Maximum Voltage Output Frequency (Base Frequency)	Setting unit : 0.1 Hz, Setting range : 0.2 to 400.0 Hz	60.0 Hz		
	05	Intermediate Output Frequency	Setting unit : 0.1 Hz, Setting range : 0.1 to 399.9 Hz	1.5 Hz		
	06	Intermediate Output Frequency Voltage	Setting unit : 0.1 V, Setting range : 0.1 to 255.0 V	11.0 V		
	07	Minimum Output Frequency	Setting unit : 0.1 Hz, Setting range : 0.1 to 10 Hz	1.5 Hz		
	08	Minimum Output Frequency Voltage	Setting unit : 0.1 V, Setting range : 0.1 to 50 V	11.0 V		
First Accel/ Decel Time Setting	09	Acceleration Time 1	Setting unit : 0.1 s, Setting range : 0.0 to 600.0 s	5.0s		87
	10	Deceleration Time 1	Setting unit : 0.1 s, Setting range : 0.0 to 600.0 s	5.0s		
Second Accel/ Decel Time Setting	11	Acceleration Time 2	Setting unit : 0.1 s, Setting range : 0.0 to 600.0 s	10.0 s		
	12	Deceleration Time 2	Setting unit : 0.1 s, Setting range : 0.0 to 600.0 s	10.0 s		

* For 460 V class, the value is twice as that of 230 V class..

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
Frequency Reference*	13	Frequency Reference 1	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	10.0 Hz		82
	14	Frequency Reference 2	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	20.0 Hz		
	15	Frequency Reference 3	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	30.0 Hz		
	16	Frequency Reference 4	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	40.0 Hz		
	17	Jog Frequency Reference	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	6.0 Hz		
Electronic Thermal Overload Motor Protection	18	Motor Protection Selection	1st digit = 0 : Electronic thermal overload motor protection provided = 1 : Electronic thermal overload motor protection not provided 2nd digit = 0 : Electronic thermal overload characteristics is for standard motor = 1 : Electronic thermal overload characteristics is for constant torque motor 3rd digit = 0: Electronic thermal overload time constant is of standard rating = 1: Electronic thermal overload time constant is of short term rating 4th digit : Not used	0000		88
Electronic Thermal Overload Reference Current	19	Motor Rated Current	Setting unit : 0.1 A, Setting range : 10 to 120% of inverter rated current	†		

* Can be changed even during run.
The maximum setting frequency to be set to frequency reference is the maximum frequency (No. 02).
† Initial setting differs according to the inverter capacity.

2.8.2 Second Functions (Constant Nos. 20 to 29)

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
REV Run Prohibit	20	Run Signal Selection 2	1st digit = 0 : REV run enabled = 1 : REV run disabled	0000		80
Operator Stop Key Precedence			2nd digit = 0 : STOP key effective from control circuit terminals during run = 1: STOP key ineffective from control circuit terminals during run			—
			3rd digit : Not used.			
Stall Prevention During Deceleration			4th digit = 0 : Stall prevention during deceleration provided = 1 : Stall prevention during deceleration not provided (when braking resistor connected)			92
Analog Monitor Selection	21	Output Monitor Selection	1st digit : Not used. 2nd digit = 0 : Analog monitor - output frequency = 1 : Analog monitor - output current (Analog monitor gain is set by constant No. 45.)	0000		90
		S-curve Accel/decel Selection	3rd, 4th digit S-curve Accel/decel Selection: Not Provided / 0.2 sec / 0.5 sec / 1.0 sec 3rd Digit: 0 / 1 / 0 / 1 4th Digit: 0 / 0 / 1 / 1			83

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
	22	Frequency Reference Gain	Setting unit : 0.01, Setting range : 0.01 to 2.00	1.00		88
	23	Frequency Reference Bias	Setting unit : 0.01, Setting range : -1.00 to 1.00	0.00		88
Frequency Limit Control	24	Frequency Upper Limit	Setting unit : 1%, Setting range : 0 to 110%	100%		91
	25	Frequency Lower Limit	Setting unit : 1%, Setting range : 0 to 110%	0%		
DC Injection Braking	26	DC Injection Braking Current	Setting unit : 1%, Setting range : 0 to 100% of inverter rated current	50%		99
	27	DC Injection Braking Time at Stop	Setting unit : 0.1 s, Setting range : 0.0 to 5.0 s	0.5 s		
	28	DC Injection Braking Time at Start	Setting unit : 0.1 s, Setting range : 0.0 to 5.0 s	0.0 s		
Torque Compensation	29	Automatic Torque Boost Gain	Setting unit : 0.1, Setting range : 0.0 to 3.0	1.0		94

2.8.3 Third Functions (Constant Nos. 30 to 59)

Function		No.	Name	Description	Initial Setting	User Set Values	Reference Page
Stall Prevention		30	Stall Prevention Level during Acceleration	Setting unit : 1% Setting range : 30 to 200% of inverter rated current Note : Stall prevention during acceleration does not operate at 200%.	170%		92
		31	Stall Prevention Level during Run	Setting unit : 1% Setting range : 30 to 200% of inverter rated current Note : Stall prevention during run does not operate at 200%.	160%		
Multifunction Selection	Contact Input Signal	32	Multifunction Input Selection 1 (Terminal ES Function Section)	0 : FWD/REV run command (3-wire sequence selection) 1 : External fault (NO contact input) 2 : External fault (NC contact input) 3 : Multi-step speed reference 1 4 : Multi-step speed reference 2 5 : JOG command 6 : Accel/decel time select 7 : External baseblock (NO contact input) 8 : External baseblock (NC contact input) 9 : Search command from maximum frequency 10 : Search command from setting frequency 11 : Accel/decel prohibit	1		94
		33	Multifunction Input Selection 2 (Terminal DF Function Selection)	1 : External fault (NO contact input) 2 : External fault (NC contact input) 3 : Multi-step speed reference 1 4 : Multi-step speed reference 2 5 : JOG command 6 : Accel/decel time select 7 : External baseblock (NO contact input) 8 : External baseblock (NC contact input) 9 : Search command from maximum frequency 10 : Search command from setting frequency 11 : Accel/decel prohibit	3		94

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
Multifunction Selection (Photo-coupler Output Signal)	34	**Multifunction Output Selection 1 (Terminal DV Function Selection)**	0 : Running 1 : Frequency agreement 2 : Zero speed 3 : Frequency detection (output frequency ≧ frequency delection level) 4 : Overtorque detection	0		98
	35	**Multifunction Output Selection 2 (Terminal UF Function Selection)**	0 : Running 1 : Frequency agreement 2 : Zero speed 3 : Frequency detection (output frequency ≧ frequency delection level) 4 : Overtorque detection	1		
Desired Speed Detection	36	Frequency Detection Level	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	0.0 Hz		103
Over-torque Detection	37	Overtorque Detection Function Selection	1st digit = 0 : Overtorque detection not provided = 1 : Overtorque detection provided 2nd digit = 0 : Detected only frequency agreement = 1 : Detected during running 3rd digit = 0 : Operation continues after overtorque detection = 1 : Output shut-off at overtorque detection 4th digit : Not used	0000		101
	38	Overtorque Detection Level	Setting unit : 1%, Setting range : 30 to 200% of inverter rated current	160%		
	39	Overtorque Detection Level	Setting unit : 0.1 s, Setting range : 0.1 to 10.0 s	0.1 s		

Function	No	Name	Description	Initial Setting	User Set Values	Reference Page
Carrier Frequency Adjustment	40	Carrier Frequency	Setting unit : 1 (2.5 kHz) Setting range : 1 to 6 (2.5 to 15 kHz)	4 (10 kHz)		102
—	41 to 44	Not used	(Setting disabled.)	—		—
Analog Monitor Scale Calibration	45	Analog Monitor Gain	Setting unit : 0.01, Setting range : 0.01 to 2.00	1.00		100
Momentary Power Loss Protection	46	Operation Selection after Momentary Power Loss	1st digit = 0 : Continuous operation after momentary power loss not provided = 1 : Continuous operation after momentary power loss provided 2nd, 3rd, 4th digits = Not used.	0000		109
Fault Retry	47	Fault Retry Selection	Setting unit : 1 time, Setting range : 0 to 10 times Note : By setting 0 times, fault retry function becomes disabled.	0		112
Fault Trace	48	Fault Record	The latest fault is displayed (setting disabled).	—	—	—
Software Version	49	PROM No.	PROM No. is displayed (setting disabled).	—	—	—

Function	No.	Name	Description	Initial Setting	User Set Values	Reference Page
Prohibited Frequency	50	Prohibited Frequency 1	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	0.0 Hz		105
	51	Prohibited Frequency 2	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	0.0 Hz		
	52	Prohibited Frequency 3	Setting unit : 0.1 Hz, Setting range : 0.0 to 400.0 Hz	0.0 Hz		
	53	Prohibited Width	Setting unit : 0.1 Hz, Setting range : 0.0 to 25.5 Hz	1.0 Hz		
Speed Search Control	54	Speed Search Motion Level	Setting unit : 1%, Setting range : 0 to 200% of inverter rated current	150%		107
	55	Minimum Baseblock Time	Setting unit : 0.1 s, Setting range : 0.5 to 5.0 s	0.5 s		
	56	V/f during Speed Search	Setting unit : 1%, Setting range : 0 to 100%	100%		
Relay Contact Output Signal	57	Multifunder Relay Output (Terminal FA, FB, FC)	0 : Running 1 : Frequency Agreement 2 : Zero Speed 3 : Output Frequency ≥ Frequency Detection Level 4 : Overtorque Detection 5 : Operation Mode 6 : Fault Output			
		58 to 59	Not Used			

2.9 DESCRIPTION OF FUNCTIONS AND CONSTANTS

Constant Nos. are indicated as [N].

PASSWORD SETTING

Item Name	Constant to be Set	Factory Preset
Constant Group Selection	[0]	1

- [0]=0
  Password [0] setting/reading and the first function ([0] to [19]) reading are enabled.
  This setting prevents constant from being reset by improper operation after completion of constant setting.
  [0] can be written in.
- [0]=0 The first functions can be read.
- [0]=1 The first functions ([0] to [19]) can be set and read.
- [0]=2 The first and second functions ([0] to [29]) can be set and read.
- [0]=3 The first, second and third functions ([0] to [59]) can be set and read.
- [0]=6 Fault history is cleared.
- [0]=8 All control constants can be initialized. Terminal functions are returned to the factory setting.
- [0]=9 All control constants can be initialized. Terminal functions are of 3-wire sequence. Refer to "MULTIFUNCTION CONTACT INPUT FUNCTION SELECTION" on page 94.

OPERATION MODE SELECTION

Item Name	Constant to be Set	Factory Preset
Start/Stop Procedure	1	0011 (0000)*
Reverse Rotation Prevention	20	0000

* The value in parentheses is factory setting of models with indicating cover.

· Start procedure

Operation can be performed from the operator or control circuit terminal input.

1 = ×× 0 0 (× means 1 or 0.)

1st digit
- 0 : Frequency reference from control circuit terminal
- 1 : Frequency reference from the operator

2nd digit
- 0 : Start/stop control from control circuit terminal
- 1 : Start/stop control by the operator

· Stop procedure

Stopping mode can be selected according to the application.

1 = ×0 ××

3rd digit
- 0 : Deceleration to a stop
- 1 : Coasting to a stop

· Reverse rotation prevention

Prevents accidental selection of reverse rotation.
REV run command is disregarded if input.

20 = ××× 1

1st digit
- 0 : Reverse rotation is possible.
- 1 : Reverse rotation is impossible.

Note : The first to fourth digits indicated in the description of the constant mean the following digits.

1 = 0 0 0 0

- 1st digit
- 2nd digit
- 3rd digit
- 4th digit

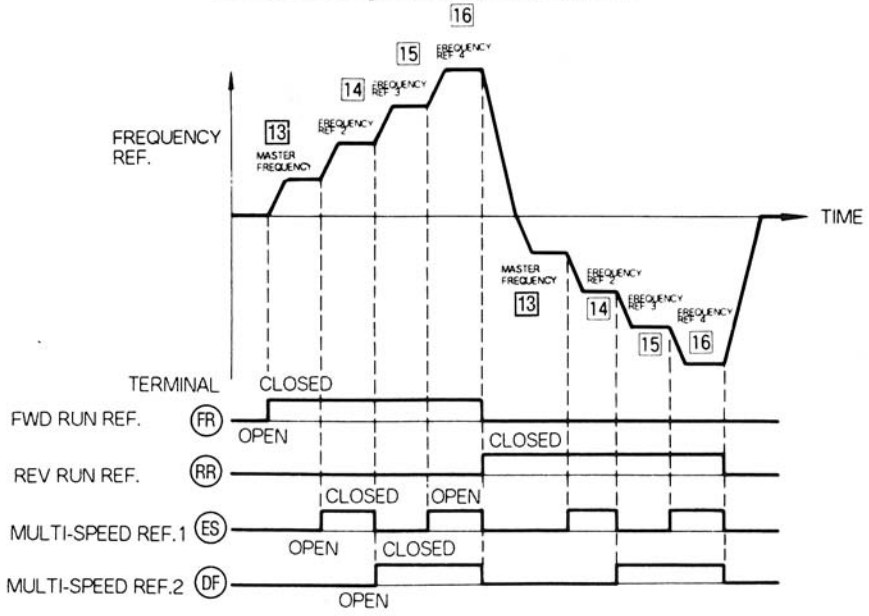
4-STEP SPEED CHANGE

Item Name	Constant to be Set	Factory Preset
Multi-speed Frequency Reference	13 to 16	See page 72.
Multi-speed Operation Function	32, 33	See page 75.

Up to 4 steps of speed can be set by contact input by setting multi-speed references to multifunction contact input terminals.

This eliminates the need for an analog signal thereby enabling operation even at low speed without being affected by noise. See the following example. (When setting 32 = ES, 33 = DF)

- Set according to run specifications.



Note : Frequency reference can be changed only if it is selected by multi-speed reference.

S-CURVE PATTERN SELECTION

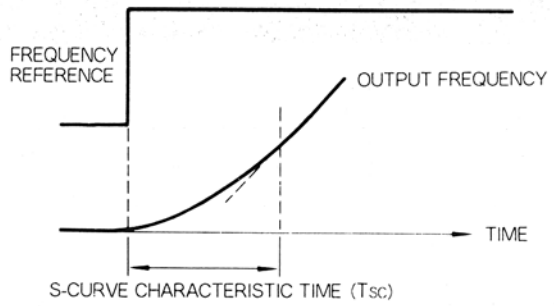
Item Name	Constant to be Set	Factory Preset
S-curve Pattern Selection	21	0000

To prevent shock at machine starting/stopping, accel/decel in S-curve pattern is enabled by the setting of 21.

21 = 0 0 × ×

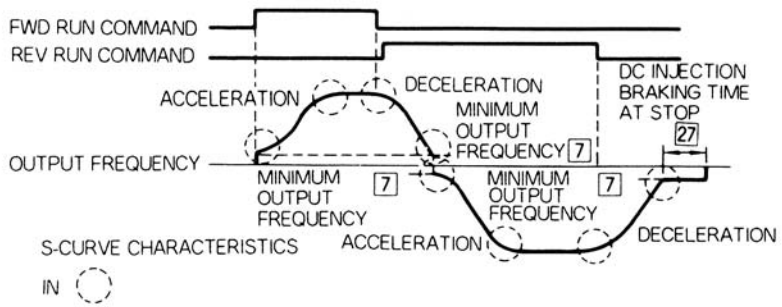
3rd, 4th digits

- 00 : S-curve section not provided (linear accel/decel)
- 01 : S-curve section 0.2 second
- 10 : S-curve section 0.5 second
- 11 : S-curve section 1 second



Note : S-curve characteristic time refers to the time from the acceleration rate 0 to regular acceleration rate determined by the set acceleration time.

The following shows the time chart at FWD/REV run switching at deceleration to a stop.

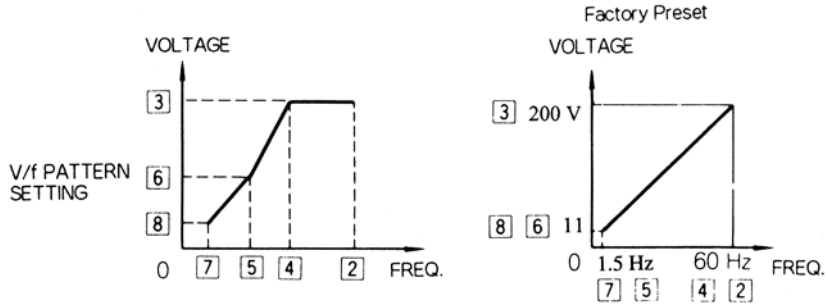


V/f CHARACTERISTIC SETTING

Item Name	Constant to be Set	Factory Preset
Max. Output Frequency	2	60.0 Hz
Max. Voltage	3	200.0 V
Max. Voltage Output Frequency	4	60.0Hz
Intermediate Output Frequency	5	1.5 Hz
Intermediate Output Frequency Voltage	6	11 V
Min. Output Frequency	7	1.5 Hz
Min. Output Frequency Voltage	8	11 V
Output Voltage Limiter Selection	1	0000

· V/f pattern setting

Any desired V/f pattern can be set for special specifications, too. Any V/f pattern can be set according to the load characteristics. The factory preset value is set to 60 Hz saturation type pattern.



Note : If an excessively large value is set in low-speed area (3Hz or less), motor overheat or inverter malfunction may occur. Change the constant gradually monitoring load or motor current.

· Output limiter selection

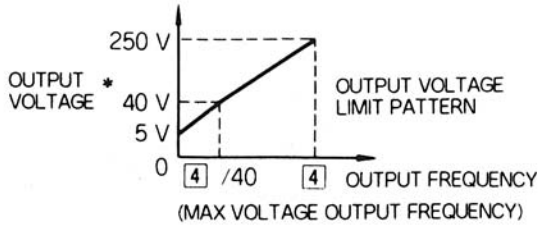
When V/f is set to excessively large value, an inverter fault may occur. Therefore, in order to prevent malfunction, the upper limit is provided for the output voltage. However, the setting is not necessary under normal operation.

1 = 0 ×××

4th digit

0 : Desired V/f with output voltage limiter

1 : Desired V/f without output voltage limiter



*** For 460 V class, the value is twice that of 230 V class.**

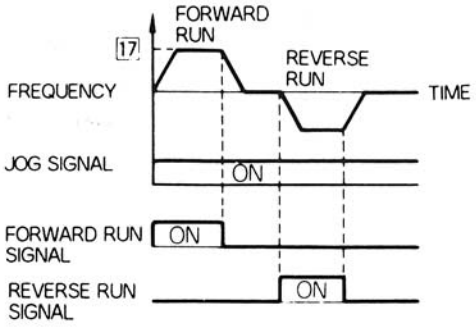
If "1" is set, V/f matching the motor characteristics must be selected.

JOG OPERATION

Item Name	Constant to be Set	Factory Preset
Jog Frequency Reference Setting	17	6.0 Hz
Jog Reference Selection	32, 33	See page 75.

To select the jog mode, close between terminals (ES) - (BC). Jog operation can then be performed by closing the FWD/REV run command (when setting 32 = 5).

Depressing the JOG key on the digital operator performs the same operation.



ACCEL/DECEL TIME SETTING

Item Name	Constant to be Set	Factory Preset
Acceleration Time 1	9	5.0
Deceleration Time 1	10	5.0
Acceleration Time 2	11	10.0 s
Deceleration Time 2	12	10.0 s
Accel/Decel Time Select	32, 33	See page 75.

- Each item can be set from 0.0 sec to 600 sec.

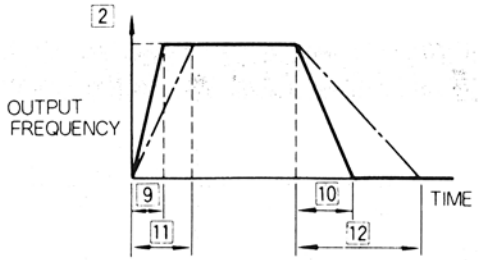
The set time indicates the interval required before the maximum output frequency setting 2 is reached.

Accel/decel time can be set for two-step switching using multifunction contact input, even during running.

Between control circuit terminals (DF) - (BC)

- Open : 9 and 10 are selected.
- Closed : 11 and 12 are selected.

(when setting 33 = 2)

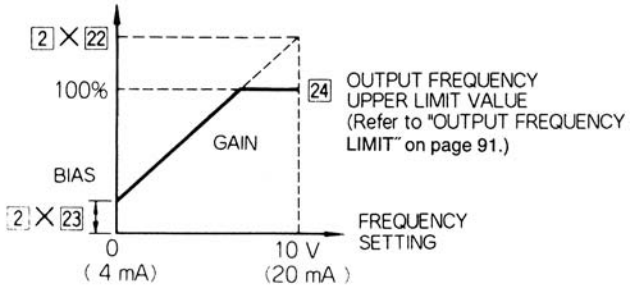


Note : S-curve accel/decel reducing shock at motor starting is also enabled. When S-curve accel/decel is needed, refer to "S-CURVE PATTERN SELECTION" on page 83.

OUTPUT FREQUENCY CONTROL (GAIN/BIAS)

Item Name	Constant to be Set	Factory Preset
Frequency Reference Gain	22	1.00
Frequency Reference Bias	23	0.00

Output frequency (gain/bias) can be set freely according to frequency setting (0 to 10V or 4 to 20mA).



For the setting method, refer to Par.2.6.1 "Adjustment of Frequency Setting Value, Output Frequency Bias (No. 23) and Gain (No. 22)" on page 64.

ELECTRONIC THERMAL OVERLOAD PROTECTION

Item Name	Constant to be	Factory Preset
Motor Type	18	0000
Motor Rated Current	19	–

Motor output current is detected by the inverter built-in electronic thermal overload function, and inverter exclusive-use motors or standard motors are prevented from overloading. (It is not necessary to mount the thermal overload relay externally. However, to connect several motors to one inverter, a thermal overload relay must be inserted for each motor. It is necessary to reduce carrier frequency according to the wiring distance between the inverter and motor when thermal overload relays are inserted. For details, refer to the precautions on wiring described on page 18.)

19 = Motor rated current value
Set the motor rated current value according to the value on the motor nameplate.

18 = × × 0 ×
2nd digit
0 : Standard motor
1: Inverter duty motor

18 = × × × 1 can make electronic thermal overload function disabled.
1st digit
0 : Electronic thermal overload protection provided
1 : Electronic thermal overload protection not provided

18 = × 0 × ×
3rd digit
0 : Electronic thermal overload time constant is used for standard motors or inverter duty motor (standard ratings)
1 : Electronic thermal overload time constant is used for motors other than described above (short-term ratings)

MULTIFUNCTION ANALOG OUTPUT MONITOR SETTING

Item Name	Constant to be Set	Factory Preset
Output Monitor Select	21	0000
Analog Monitor Gain	45	1.00

Either output frequency or output current can be monitored by analog output between control circuit terminals (FQ) and (CM). (0 to 10V output)

21 = ×× 0 ×

- Not used
- Output contents between control circuit terminals (ES) - (BC)
- 2nd digit
  - 0 : Output frequency monitor
  - 1 : Output current monitor

Analog output monitor gain can be set by 45.
Additionally, analog output monitor voltage is output as shown below :
Output frequency monitor :
Output voltage (V)

$$= \text{Output frequency} \times \frac{10\ \text{V}}{\text{Max. output frequency } 2} \times 45$$

Output current monitor :
Output voltage (V)

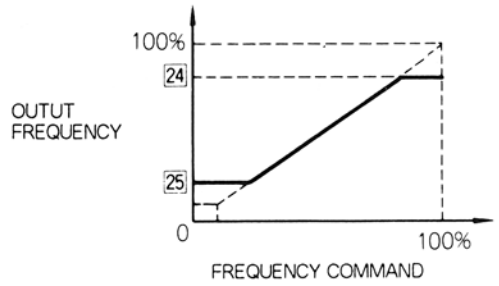
$$= \text{Output current} \times \frac{10\ \text{V}}{\text{Inverter rated current}} \times 45$$

Note : Since output current becomes approx. 200% maximum of the inverter rated current, output voltage is clamped at approx. 11V when 45 is used at 1.00 and the inverter rated current is exceeded. To keep linearity, set 45 to approx. 0.5.

OUTPUT FREQUENCY LIMIT

Item Name	Constant to be Set	Factory Preset
Output Frequency (Speed) Upper Limit	24	100%
Output Frequency (Speed) Lower Limit	25	0

The upper and lower limits for the output frequency can be set. When the lower limit is not 0, acceleration to that lower limit setpoint begins until frequency reference reaches the lower limit value when the start command is input.



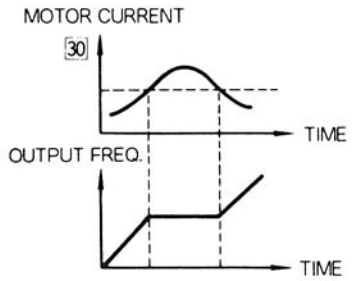
Note : By setting 24 to 110%, frequency up to 2 × 1.1 can be output.
(Example) Assuming 2 = 60Hz, 24 = 1.1, up to 66 Hz can be output. However, when the voltage exceeds 400 Hz, it is clamped at 400 Hz.

MOTOR STALL PREVENTION FUNCTION

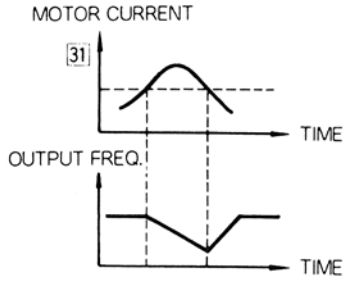
Item Name	Constant to be Set	Factory Preset
Operation Level for Stall Prevention during Acceleration	30	170%
Operation Level for Stall Prevention during Running	31	160%
Stall Prevention Function during Deceleration	20	0000

Automatically adjusts output frequency according to the load so as to continue operation of the machine without stalling the motor.

- Stall prevention during acceleration
  If the motor current exceeds the value set to 30 during acceleration, acceleration is stopped until the motor current is reduced to the 30 set value or less.



- Stall prevention during running
  If the motor current exceeds the value set to 31 because of impact load during running, output frequency is automatically lowered. When the motor current is reduced to the 31 set value or less, the motor starts acceleration again and the operation is continued.



- Stall prevention during deceleration
  Automatically adjusts deceleration rate with monitoring DC voltage to prevent overvoltage during deceleration. Set "1" for connecting braking resistor.

20 = 0 × × ×

4th digit
- 0 : Stall prevention during deceleration enabled
- 1 : Stall prevention during deceleration disabled

- When the motor load is large or accel/decel time is short, the accel/decel time may be longer than the set value because of the stall preventive function.

FULL-RANGE AUTOMATIC TORQUE BOOST

Item Name	Constant to be Set	Factory Preset
Torque Compensation Gain	29	1.0

Automatic control of V/f ratio according to the load torque ensures tripless operation and optimum output current. Therefore, tripless operation with excellent energy-saving effect is available. When the wiring distance between the inverter and motor is long (normally approx. 100 m) and when the motor torque is a little short, increase torque compensation gain gradually, checking the motor current. Normally, no adjustment is necessary.

MULTIFUNCTION CONTACT INPUT FUNCTION SELECTION

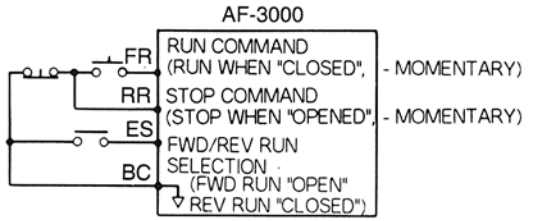
Item Name	Constant to be Set	Factory Preset
Multifunction Contact Input Function	32, 33	Refer to page 75.

The function of control circuit terminals (ES) and (DF) can be changed if necessary. Set 32 < 33.
Terminal (ES) function : Set to 32.
Terminal (DF) function : Set to 33.

32 Set Value and its Functions

Set Value	Function	Page
0 *	FWD/REV run command (3-wire sequence selection)	—
1	External fault (NO contact input)	118
2	External fault (NC contact input)	118
3	Multi-step speed reference 1	82
4	Multi-step speed reference 2	82
5	JOG command	86
6	Accel/decel time select	87
7	External baseblock (NO contact input)	122
8	External baseblock (NC contact input)	122
9	Search command from maximum frequency	107
10	Search command from setting frequency	107
11	Accel/decel hold command	114

Terminal function at 3-wire sequence selection.

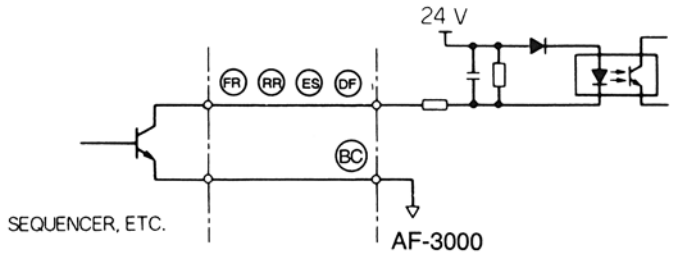


33 Set Value and its Functions

Set Value	Function	Page
1	External fault (NO contact input)	118
2	External fault (NC contact input)	118
3	Multi-step speed reference 1	82
4	Multi-step speed reference 2	82
5	JOG command	86
6	Accel/decel time select	87
7	External baseblock (NO contact input)	122
8	External baseblock (NC contact input)	122
9	Search command from maximum frequency	107
10	Search command from setting frequency	107
11	Accel/decel prohibit command	114

- Contact input capacity is 24 VDC 8 mA or less.
- Circuit leakage current at signal OFF must be 100 μ A or less.

Wiring Example (Open-collector Input)



- The control signal line should not be longer than 50 m.
- To drive the contact input by transistor, use one rated for 50 V, 50 mA or more.
- Circuit leakage current at the signal OFF must be 300 μA or less.

MULTIFUNCTION PHOTO-COUPLER OUTPUT FUNCTION

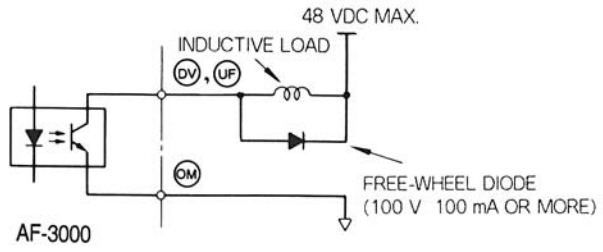
Item Name	Constant to be Set	Factory Preset
Multifunction Contact Output Function	34, 35	See page 76.

Functions of control circuit terminals (DV) - (OM) and (UF) - (OM) can be switched.
Function of terminal between (DV) - (OM) at "L" : Set into 34
Function of terminal between (UF) - (OM) at "L" : Set into 35

Set Value	Function
0*	In operation
1†	Frequency agreed
2	Zero speed
3	Frequency detection (output frequency≧frequency detection level)
4	Overtorque detected

* Factory preset value of 34
† Factory preset value of 35

- Maximum output capacity is 48 VDC 50mA.
- To drive an inductive load, be sure to insert a free-wheel diode to control surge voltage.

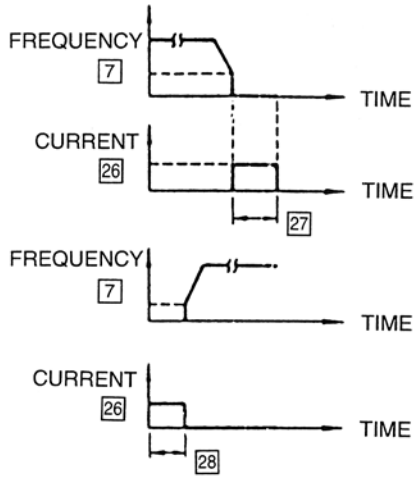


DC INJECTION BRAKING

Item Name	Constant to be Set	Factory Preset
DC Injection Braking during Stop	27	0.5 s
DC Injection Braking at Start	28	0.0 s
DC Injection Braking Current	26	50%

- DC injection braking at stop

  Prevents overrun at stop. If output frequency becomes minimum output frequency 7 or less, DC injection brake is applied for the time set by 27 and the motor is stopped. By setting 0.0 s to 27 , DC injection braking becomes disabled: the motor coasts to a stop when the output frequency is less than the minimum output frequency 7 .



- DC injection braking at start.
  Starts a coasting motor without tripping even when the direction of rotation is unknown.

  When the run command is input, DC injection brake is applied for the time set by 28 , and the motor stops. Then the motor starts operation.

- DC braking current
  DC injection braking current 100% equals the inverter rated current. It is set to 50% at factory prior to shipping.

FREQUENCY/CURRENT METER CALIBRATION

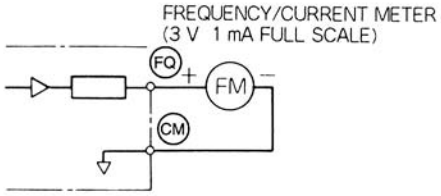
Item Name	Constant to be Set	Factory Preset
Analog Monitor Gain	45	1.00
Output Monitor Selection	21	0000

Frequency/current meter connected to the inverter can be calibrated by 45 without using a resistor for calibration. For the setting method, refer to Par. 2.6.2 "Calibration of Frequency Meter" on page 66 and "MULTIFUNCTION ANALOG OUTPUT MONITOR SETTING" on page 90.

Selection of output between control circuit terminals (FQ) - (CM)

21 = × × 0 ×

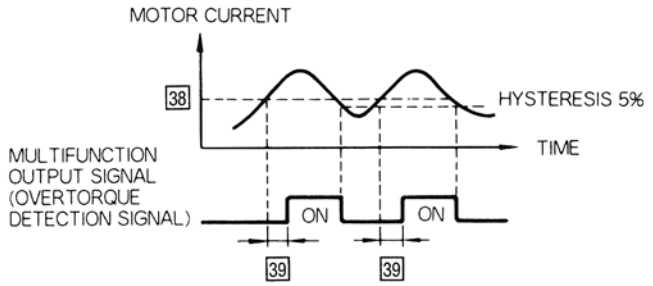
2nd digit
0 : Output frequency
1 : Output current



OVERTORQUE DETECTION FUNCTION

Item Name	Constant to be Set	Factory Preset
Overtorque Detection Level	38	160%
Overtorque Detection Time	39	0.1 s
Overtorque Detection Signal	34, 35	See page 76.
Overtorque Detection Selection	37	0000

When excess load is placed on the machine, the increase in motor current is detected. If current exceeding the value set by 38 lasts for a time exceeding the value set by 39, the overtorque detection signal is output to control circuit terminal (DV) or (UF) until the current is reduced to the 38 set value or less. To output the signal to control circuit terminal (DV), set 34 to 4, and to (UF), 35 to 4.



The [37] setting can select overtorque detection only during agreed speed or during running. Additionally, it can select continuous operation or output shut-off at overtorque detection.

[37] = ×00×

2nd digit
- 0 : Detected only during agreed speed
- 1 : Detected during running

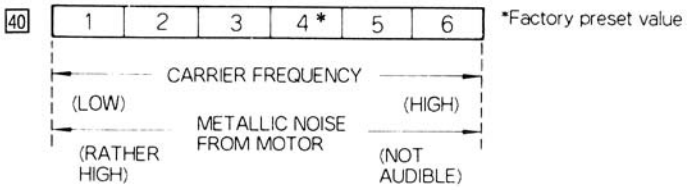
3rd digit
- 0 : Continuous operation after overtorque detection
- 1 : Output shut off at overtorque detection

CARRIER FREQUENCY

Item Name	Constant to be Set	Factory Preset
Carrier Frequency	[40]	4

Changing the carrier frequency reduces RFI noise and leakage current without increasing motor noise.

Carrier frequency (kHz) = 2.5 kHz x [40] set value



Note : Reduce continuous output current for changing the frequency to 5 or 6.

Carrier Frequency Set Value	Maximum Continuous Output Current
1 to 4	Up to 100% of inverter output current
5	Up to 90% of inverter output current
6	Up to 80% of inverter output current

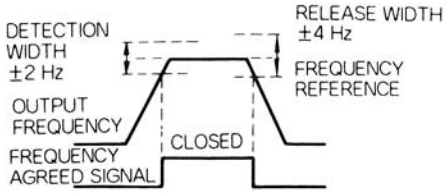
If wiring distance between inverter and motor is long, reduce the carrier frequency. For details, refer to wiring precautions on page 17.

ARBITRARY SPEED DETECTION LEVEL ADJUSTMENT AND SELECTION

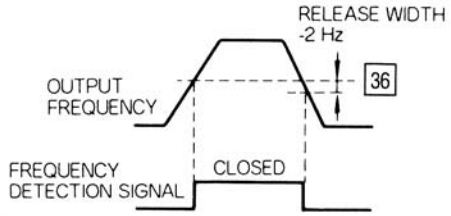
Item Name	Constant to be Set	Factory Preset
Frequency Detection Level	[36]	0.0 Hz
Multifunction Contact Output Function	[34], [35]	See page 76.

This function is used when operation at an arbitrary speed must be indicated. By setting either set value to multifunction contact output function ([34], [35]), the following signal output to control circuit terminal (DV) or (UF) is enabled. Set 1 or 3 to [34] or [35] when the signal is to be output to control circuit terminals (DV) and (UF), respectively.

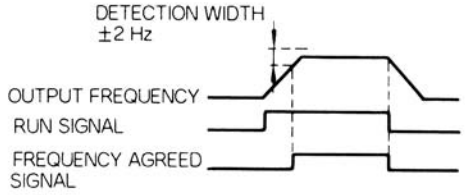
(1) Set value
= 1 : frequency agreed



(2) Set value
= 3 : output frequency
≧ frequency detection level



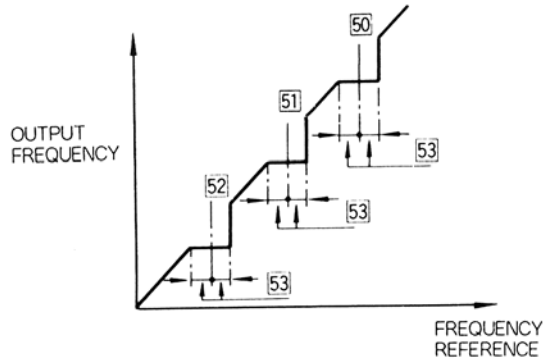
However, when "frequency agreed" is selected, the frequency agreed signal is turned OFF immediately at stop signal input.



PROHIBITED FREQUENCY SETTING

Item Name	Constant to be Set	Factory Preset
Prohibited Frequency 1	50	0.0 Hz
Prohibited Frequency 2	51	0.0 Hz
Prohibited Frequency 3	52	0.0 Hz
Prohibited Width	53	1.0 Hz

To operate the inverter without resonance caused by machine system characteristic frequency, resonance generating frequency can be prohibited. This function can be also for dead band control.



Constant-speed operation is prohibited within the prohibited range. However, output frequency is not prohibited during acceleration or deceleration for smooth acceleration or deceleration.

(1) Prohibited frequency 1 to 3 (50 to 52)
By setting the value to 0.0Hz, this function becomes disabled.
Set prohibited frequency 1 to 3 as described below :
Prohibited frequency 3 52 ≦ Prohibited frequency 2 51
≦ Prohibited frequency 1 50

(2) Prohibited width (53)
By setting the value to 0.0Hz, this function becomes disabled.
The range to be prohibited is : 50 to 52 - 50 to 53 < prohibited range < 50 to 52 + 50 to 53
(Example) When prohibited frequency 1 50 is 45Hz and the prohibited width 53 is 2.0Hz : Prohibited range = 43 to 47Hz.

CONSTANTS EFFECTIVE FOR REDUCTION OF MACHINE VIBRATION OR SHOCK

The following constants are effective for reduction of vibration or shock.

Effective Method	Constant to be Set	Factory Preset	Adjustment	Page
Shock				
· To decrease generating torque · To increase generating torque	2 to 8	See page 71.	Decrease or increase V/f.	71
	29	1.0	Decrease or increase torque boost.	94
To reduce shock at acceleration	21	0000	Set S-curve accel/decel.	83
	9, 11	10.0 s	Increase accel time.	87
	30	170%	Increase stall prevention level during accel.	92
To reduce shock at deceleration	1	0000	Set coasting to a stop.	80
	21	0000	Set S-curve accel/decel.	83
	10, 12	10.0 s	Increase decel time.	87
	7	1.5 Hz	Decrease or increase minimum output frequency.	84
	26	50%	Decrease DC injection braking current.	99
Vibration				
To decrease carrier frequency	40	4	——	102

SPEED SEARCH FUNCTION

Item Name	Constant to be Set	Factory Preset
Speed Search Function	32, 33	See page 75.
Speed Search Operation Level	54	150%
Minimum Baseblock Time	55	0.5 s

When the motor during coasting is started during changing operation of commercial power supply and inverter, etc., the motor can be operated without tripping by using the speed search function.

The speed search command is input from multifunction contact input terminals (ES) and (DF). For the functions of terminals (ES) and (DF), "6" or "7" is set to 32 or 33.

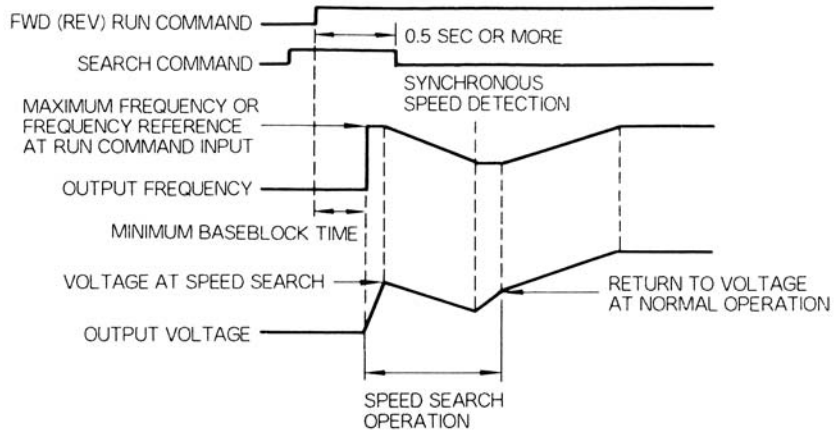
When setting to "6" : **Search from maximum frequency**

When setting to "7": **Search from setting frequency**

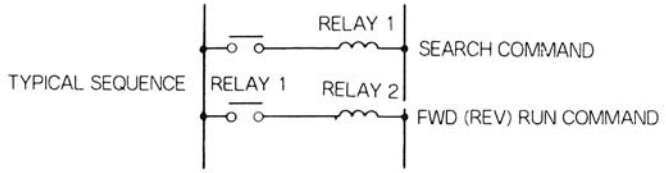
By closing the search command during baseblock and inputting the run command, speed search is started after the inverter output is shut off for the minimum baseblock time 55.

When the inverter output current is larger than the set value of the speed search operation level 54, the speed search operation starts. Frequency in which the inverter output current becomes smaller than the speed search operation level 54 is judged to be the speed synchronized point, and the motor starts reacceleration/redeceleration up/down to the setting frequency in the set accel/decel time.

The following shows the time chart where the speed search command is input.



Notes :
1. When the search commands are input from maximum frequency and setting frequency simultaneously, the search command of lower terminal No. has the priority.
2. Make such sequence that FWD (REV) run command is to be input at the same time or after the search command.



3. The minimum baseblock time is a time when the inverter output is shut off during the motor remaining voltage occurrence. Setting this time shorter can reduce the time until speed search start, but an inverter protective function such as overcurrent (OC) may operate because of the motor remaining voltage and the like. Therefore, do not reduce the time unnecessarily.

CONTINUOUS OPERATION AT MOMENTARY POWER LOSS

Item Name	Constant to be Set	Factory Preset
Operation Selection after Momentary Power Loss	46	0000
Speed Search Operation Level	54	150%
Minimum Baseblock Time	55	0.5 s

Even if a momentary power loss occurs, operation can be continued without any problem.

46 = ××× 0

1st digit
0 : Continuous operation after momentary power loss not provided
1 : Continuous operation after momentary power loss provided

Momentary power loss ride-thru time differs as shown below, according to the capacity of the models. (common to both 3-phase and single-phase series)
- 1/8 to 1HP (0.1 to 0.75 kW) : Approx. 1 second
- 2 to 5HP (1.5 to 3.7 kW) : Approx. 2 seconds

Note : If a power loss exceeds the momentary power loss ride-thru time, low voltage fault occurs, fault contact is output and the motor coasts to a stop.

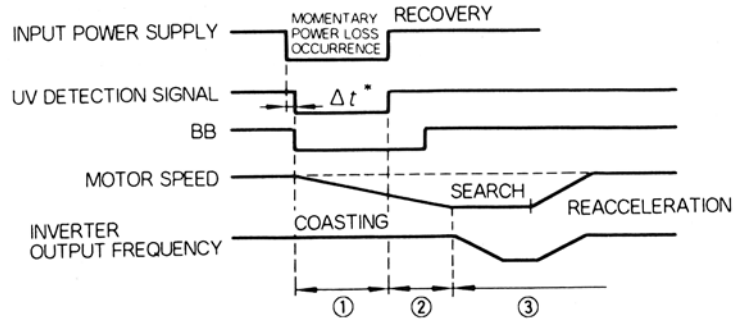
Operation when continuous operation after momentary power loss is provided is as described below :

① When undervoltage (UV) is detected, the inverter output is shut off and the frequency reference value and run command given before the momentary power loss are held.

Additionally, counting of the undervoltage time starts ; during counting, Uu is displayed, blinking on the digital display unit and digital operator. If undervoltage is detected, the inverter output is shut off for the minimum baseblock time [55] sec.

② After recovery from the momentary power loss, after checking that the inverter DC voltage has recovered sufficiently, speed search operation is performed.

③ Speed search operation starts when the inverter output current exceeds the speed search operation level [54] set value. At this time, the new frequency reference value and run command are read in. The frequency in which the inverter output current is smaller than the speed search operation level [54] set value is judged to be the speed synchronized point, and reacceleration/redeceleration is performed up/down to the set frequency in the set accel/decel time.



* $\triangle t$: Varies according to the inverter size. (Assured at 15 ms minimum.) Operation is automatically continued if recovery from momentary power loss in $\triangle t$ or less.

· Do not provide an excessively small value for the minimum baseblock time setting. Otherwise, the inverter protective function may operate at search operation start. (Refer to page 108.)

AUTOMATIC RESTART AFTER A FAULT

Item Name	Constant to be Set	Factory Preset
Fault Retry Selection	47	0
Speed Search Operation Level	54	150%
Minimum Baseblock Time	55	0.5 s
V/f during Speed Search	56	100%

If an inverter fault occurs during running, the inverter performs self-diagnosis to restart automatically.

The number of the self-diagnosis and restarting times can be set up to 10 times to 47. By setting 0 times, the fault retry function becomes disabled.

The inverter restarts automatically in case of the following faults.

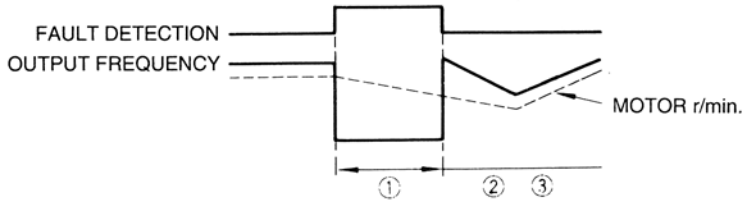
① Overcurrent protection (OC)
② Overvoltage protection (OV)
③ Cooling fin overheat (OH)

The number of fault retry times is cleared to 0 in the following cases :

① No fault occurs for more than 10 minutes
② Fault reset input signal (or RESET key on the digital operator) is turned ON when the fault is checked.
③ The power supply is turned OFF.

Fault retry operation is described below :

① If a fault is detected, the inverter output is shut off for the minimum baseblock time 55. While the inverter output is shut off, the fault is displayed on the digital display unit and the digital operator.
② After the minimum baseblock time 55, the fault is automatically reset, and the speed search operation is performed from the output frequency at the fault occurrence.
③ If the inverter output current is larger than the speed search operation level 54 set value, the speed search operation starts. The frequency in which the inverter output current is smaller than the speed search operation level 54 set value is judged to be the speed synchronized point, and reacceleration/redeceleration is performed up/down to the set frequency in the set accel/decel time.
④ If the total number of faults exceeds the number of retry times 47, automatic reset is not performed and the inverter output is kept off. Then fault contact is output. (Fault contact is not output during fault retry.)



ACCEL/DECEL HOLD COMMAND

Item Name	Constant to be Set	Factory Preset
Accel/Decel Hold Function	32, 33	See page 78.

When the accel/decel hold command is input during acceleration or deceleration, acceleration or deceleration is prohibited while the command is input, and the output frequency is held.

By inputting the stop command, the accel/decel command is released and the operation is in the stopped condition.

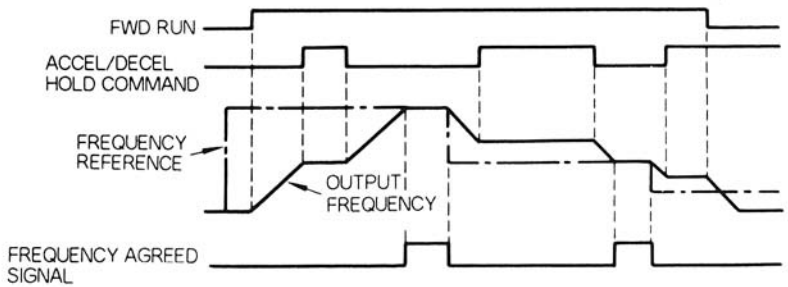
The accel/decel hold command is input from multifunction contact input terminal (ES) or (DF).

For the function of terminal (ES) or (DF), set "11" to 32 or 33.

To use terminal (ES) : Set 32.

To use terminal (DF) : Set 33.

The following shows the time chart when the accel/decel hold command is input :



Note : When the FWD (REV) run command is input in the status where the accel/decel hold command is input, the baseblock status is continued and the motor does not operate.

However, when frequency reference lower limit 25 ≧ minimum output frequency 7 is set, the motor operates at the frequency reference lower time 25.

2.10 PROTECTIVE FUNCTIONS

Protective Function		Explanation	Monitor Display	Fault Output
Low Voltage Protection	Main Circuit Voltage Low	When the inverter power supply voltage drops, torque becomes insufficient and motor is overheated. Inverter output is stopped when the main circuit DC voltage becomes lower than the low voltage detection level. Detection level : Approx. 210 V or less (230 V, 3-phase), 170 V (240 V, single-phase), 420 V (460 V, 3-phase).	UU 1 (UV1)	Operation
Overcurrent Protection		The inverter output is shut-off when the inverter output current becomes approx. 200% and above of inverter rated current.	oC (OC)	Operation
Ground-fault Protection		The inverter output is shut-off when a ground-fault occurs at the inverter output side.	GF (GF)	Operation
Overvoltage Protection		The inverter output is shut-off when the main circuit DC voltage becomes excessive because of regeneration energy caused by motor deceleration and negative load. Detection level : Approx. 410 V or more (230 V class 3-phase, 240 V class single-phase), 820 V or more (460 V class).	ou (OV)	Operation
Fuse Blown		The fuse clears to prevent wiring from being damaged by the short-circuit current when the main circuit transistor fails.	(Not displayed)	Non Operation
Cooling Fin Overheat (Only for Types of Forced Cooling)		The inverter output is shut-off when the cooling fin overheat is detected by thermistor. Check for a defective cooling fan or clogged filter.	oH (OH)	Operation

Protective Function		Error Causes	Action to be Taken
Low Voltage Protection	Main Circuit Voltage Low	· Inverter capacity is too small. · Voltage drop due to wiring. · A motor of large capacity connected to the same power system has been started. · Rapid acceleration with generator power supply · Operation sequence when power is off · Defective electromagnetic contactor	· Check the power supply voltage. · Check the power capacity and power system.
Overcurrent Protection		· Extremely rapid accel/decel · Motor ON/OFF switching at the inverter output side · Short-circuit at the inverter output side · Motor of a capacity greater than the inverter rating has been started. · High-speed motor or pulse motor has been started.	Transistor error may occur. Investigate the error cause, correct it, then restart.
Ground-fault Protection		Ground-fault at the inverter output side.	· Check that motor insulation is not deteriorated. · Check that wiring of load side are not damaged.
Overvoltage Protection		· Insufficient deceleration time · Negative load (Motor is turned by the load.) · High input voltage compared to motor rated voltage	· If braking torque is not proper, extend the decel time or connect a braking resister unit (option). · Check that the load is not minus. · Check the power supply voltage.
Fuse Blown		· Repeated overcurrent protection (OC) · Repeated overload protection (OL2) power reset · Rapid deceleration in excess excitation (improper V/f characteristic setting)	· Turn OFF the power supply once and turn it ON again. If the fault occurs again, replace the inverter. · Do not replace the fuse.
Cooling Fin Overheat (Only for Types of Forced Cooling)		· Defective cooling fan · Intake air temperature rise · Clogged filter	· Wash the filter. · Replace the inverter when the inverter cooling fin is defective. · Intake air temperature : 104° F (40℃) or less.

Protective Function		Explanation	Monitor Display	Fault Output
Over-load Protec-tion	Motor	The inverter output is stopped when output current to the motor is detected by the electronic thermal in the inverter. Either a inverter duty constant-torque specialized motor or general-purpose motor can be selected. If more than two motors are driven, overload protection should be disabled. Use a thermal relay or thermal protector for each motor.	oL 1 (OL1)	Operation
	Inverter	The electronic thermal operates by the inverse time limit and the inverter output is shut-off when 105% or more of the inverter rated current occurs. Overload capacity : 150%, 1 min.	oL2 (OL2)	Operation
	Over-torque Detec-tion*	The motor operates according to operation selection [constant (No. 37)] when the inverter output current exceeds the overtorque detection level. This function is used to protect the machine or to monitor the output torque.	oL3 (OL3)	Operation
External Fault Signal Input		When an external fault signal is input, the inverter output is shut-off.	EF3 (EF3) EF4 (EF4) EF5 (EF5)	Operation
Control Circuit Fault †		The inverter output is shut-off when a transmission error occurs in the control circuit or a component fails.	CPF00‡ to CPF05	Operation

* For overtorque detection (OL3), fault display or alarm display can be selected according to the constant (No. 37) setting. For details, refer to "OVERTORQUE DETECTION FUNCTION" on page 101.

† For details of control circuit faults, refer to Table1.9 "Details of CPF Display" on page 37.

‡ CPF00 to 05 indicate the contents of digital operator display.

Protective Function		Error Causes	Action to be Taken
Over-load Protec-tion	Motor	· Overload, long operation at low speed, improper V/f characteristic setting. · Motor rated current [constant (No. 19)] setting is wrong.	· Investigate the cause of over-load and review the operation pattern, V/f characteristic, and motor/inverter capacities. (If inverter is repeatedly reset after an overload occurs, the inverter may fault. Investigate and correct the cause of overload before restart.). · Set the rated current of motor nameplate value to constant (No. 19). · If the above measures are not effective, lower the carrier frequency [constant (No. 40)].
	Inverter		
	Over-torque Detec-tion*	Motor current exceeds the preset value because of machine error or overload.	Check the use of machine. Correct the overload cause or set a higher detection level [constant (No. 38)] which is within the allowable range.
External Fault Signal Input		External fault condition occurred.	Correct the cause of the fault input.
Control Circuit Fault †		· External noise · Excess vibration or shock	· Record all data of CPF04, then make initialization. · Turn OFF power, then turn ON again. If an error is persistent, replace the inverter.

* For overtorque detection (OL3), fault display or alarm display can be selected according to the constant (No. 37) setting. For details, refer to "OVERTORQUE DETECTION FUNCTION" on page 101.

† For details of control circuit faults, refer to Table1.9 "Details of CPF Display" on page 37.

‡ CPF00 to 05 indicate the contents of digital operator display.

2.11 PROTECTIVE FUNCTIONS (WARNINGS)

Protective Function	Explanation	Monitor Display	Fault Contact Output
Low-voltage Protection (Main Circuit Voltage Insufficient)	Monitor display appears when the main circuit DC voltage drops under the detection level while the inverter output is off. Detection level : Approx. 210 V or less (230 V 3-phase) Approx. 170 V or less (240 V single-phase) Approx. 420 V or less (460 V 3-phase)	(UV) Uu (Blink)	Non Operation
Overvoltage Protection	Monitor display appears when the main circuit DC voltage rises above the detection level while the inverter output is off. Detection level : Approx. 410 V or more (230 V class 3-phase, 240 V class single-phase) Approx. 820 V or more (460 V class)	(OV) ou (Blink)	Non Operation
Cooling Fin Overheat (Only for Types of Forced Cooling)	Monitor display appears when the cooling fin overheats : due to intake air temperature rise.	(OH) oH (Blink)	Non Operation
Overtorque Detection	This function is used to protect the machine and to monitor the inverter output torque. The motor operates according to selection of constant (No. 37) when the inverter output current exceeds the overtorque detection level. The monitor blinks when "operation continues" is preset.	(OL3) oL 3 (Blink)	Non Operation
Simultaneous Forward and Reverse Run Commands	When forward and reverse run commands are simultaneously closed for a period of time exceeding 500 ms, the inverter is stopped according to the preset stop method [constant (No. 01)]	(EF) EF (Blink)	Non Operation

Protective Function	Error Causes	Action to be Taken
Low-voltage Protection (Main Circuit Voltage Insufficient)	Input voltage drop	· Check the main circuit DC voltage. · Check the power supply capacity and power system.
Overvoltage Protection	Motor current exceeds the preset value because of machine error or overload.	Check the use of machine. Correct the overload cause or set a higher detection level [constant (No. 38)] which is within the allowable range.
Cooling Fin Overheat (Only for Types of Forced Cooling)	· Defective cooling fan · Intake air temperature rise · Clogged filter	Replace the cooling fan and clean the filter. Intake air temperature : 104° F(40°C) or less
Overtorque Detection	Motor current exceeded the set value because of machine fault or overload.	Check the driven machine and correct the cause of the fault or increase the set value [constant (No. 38)] up to the machine allowable value.
Simultaneous Forward and Reverse Run Commands	· Operation sequence error · 3-wire/2-wire selection error	• Recheck the control sequence. • Recheck constant settings (Nos. 32 and 33).

Protective Function		Explanation	Monitor Display	Fault Contact Output
External Baseblock Signal Input (Main Circuit Transistor Instantaneous Shut-off)		When an external baseblock signal is input, the motor coasts to a stop. When the external baseblock signal is removed, the inverter output is immediately turned on at the previously set frequency.	(BB) bb (Blink)	Non Operation
Stall Prevention Accel/Decel is Accomplished with Maximum Capacity of the Inverter without Tripping on Overcurrent or Overvoltage.	During Acceleration	Inverter acceleration is stopped when 170% or more of the inverter rated current is required by the load. This prevents overload protection (OL1, OL2) or overcurrent (OC) from occuring. When current is reduced to less than 170%, acceleration is enabled.	——	Non Operation
	During Normal Operation	Output frequency is decreased when 160% of the inverter rated current or greater is required by the load. This prevents motor and inverter overload (OL1, OL2). When current is reduced below 160%, inverter acceleration is enabled.		
	During Deceleration	Deceleration is stopped when the DC voltage is caused to rise by motor regenerative energy. This prevents overvoltage trips (OV). When DC voltage decreases, deceleration to the set value resumes.		

Protective Function		Error Causes	Action to be Taken
External Baseblock Signal Input (Main Circuit Transistor Instantaneous Shut-off)		——	——
Stall Prevention Accel/Decel is Accomplished with Maximum Capacity of the Inverter without Tripping on Overcurrent or Overvoltage.	During Acceleration	· Insufficient power for accel/decel · Overload · Phase loss	· Set proper accel/decel time [constant (Nos. 09 to 12)] for smooth operation. · For stall prevention during normal operation, lighten the load or increase inverter capacity.
	During Normal Operation		
	During Deceleration		