FREQROL

# MITSUBISHI
# VVVF TRANSISTOR INVERTER

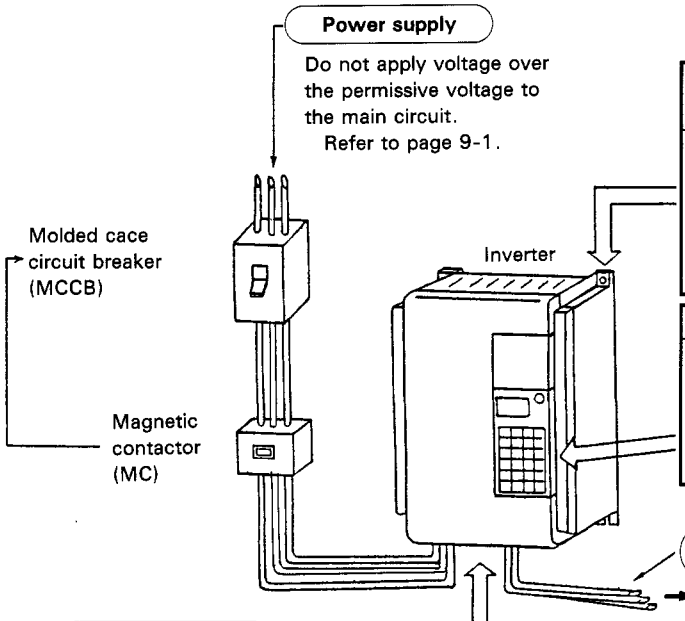
# FREQROL-Z120-UL

**— INSTRUCTION MANUAL —**

MITSUBISHI ELECTRIC

# HANDLING GUIDANCE

Improper use and operation might cause unforseen trouble. Before using your inverter, please read this manual carefully to operate inverter for a long tjme without trouble.




**Start/Stop by using MC**

DO NOT OPERATE THIS (MC) to start/stop the inverter and the motor.

MEGGER TEST

Refer to page 7-1 and 7-2 when this insulation resistance test is performed.

## INSTALLATION

Place the inverter in a clean and well-ventilated location. Do not install the inverter to direct sunlight, high temperature, etc.

- ○ Permissive ambient temperature : See page 9-1.
- ○ Location and space requirement for installation : See page 4-1.

## SETTING OF CONTROL VARIABLES

All control functions can be set by operating the PU "Parameter Unit".

- ○ How to use the PU : See page 11-1.
- ○ Operation check : See page 6-1.
- ○ Function list : See page 19-1 and 19-2.
- ○ Mondtor and display : See page 16-1.

## EQUIPMENT CONNECTED TO OUTPUT CIRCUIT

To the inverter output, DO NOT CONNECT the followings:

- ○ Power capacitor
- ○ Surge suppressor
- ○ Noise filter (model FR-BIF, option)

## WIRING

Note that miswiring not only causes damage to the inverter, but also endangers the operater.

- ○ Main circuit : See page 5-2.
- ○ Control circuit : See Page 5-2.

Terminals for wiring : See page 9-4 and 9-5.

- ○ Terminal arrangement. : See page 5-3.

# MITSUBISHI TRANSISTOR INVERTER

# FREQROL-Z120

Thank you for your purchase of Mitsubishi Transistor Inverter FREQROL-Z120.
This inverter is a variable-frequency power supply unit used to control a squirrel-cage induction motor.

**IMPORTANT NOTE**

This instruction manual describes handling, installation, operation and maintenance of the inverter. Although it is easy to use the inverter, improper use and mis-operation might cause unforeseen trouble.
Before operating the inverter, read this manual carefully.
Your inverter is built to a high standard of quality and reliability. Correct application and regular inspection, should give you long, trouble free, operation.

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# §1. UNPACKING AND CHECKING

After unpacking the inverter, check the following points.

(1) Check the rating plate on the front cover of inverter to make sure the model and output ratings meet your order.

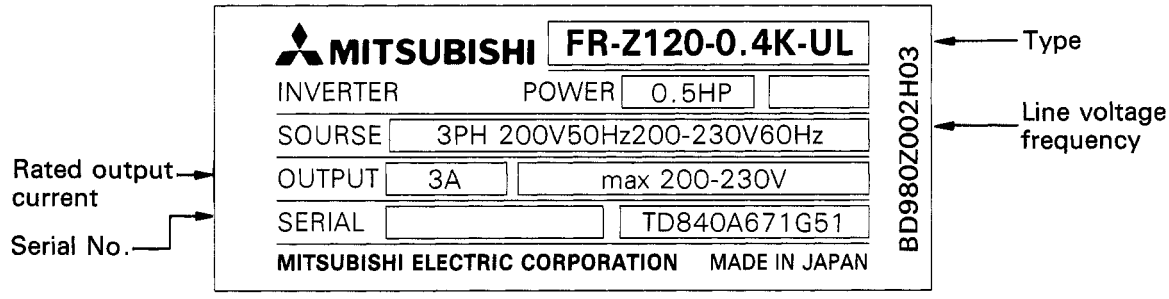



**Fig. 1-1 Rating plate**

(2) Check that the inverter has not been damaged during transportation.

**Table 1-1 Model and types**

| Applicable motor capacity (HP/KW) | 0.5/0.4 | 1/0.75 | 2/1.5 | 3/2.2 | 5/3.7 |
|---|---|---|---|---|---|
| With PU | FR-$Z_{120}$-0.4KP-UL | FR-$Z_{120}$-0.75KP-UL | FR-$Z_{120}$-1.5KP-UL | FR-$Z_{120}$-2.2KP-UL | FR-$Z_{120}$-3.7KP-UL |
| Without PU | FR-$Z_{120}$-0.4K-UL | FR-$Z_{120}$-0.75K-UL | FR-$Z_{120}$-1.5K-UL | FR-$Z_{120}$-2.2K-UL | FR-$Z_{120}$-3.7K-UL |

PU: Parameter Unit

# §2. CONSTRUCTION

## 2-1 External views and name of each parts

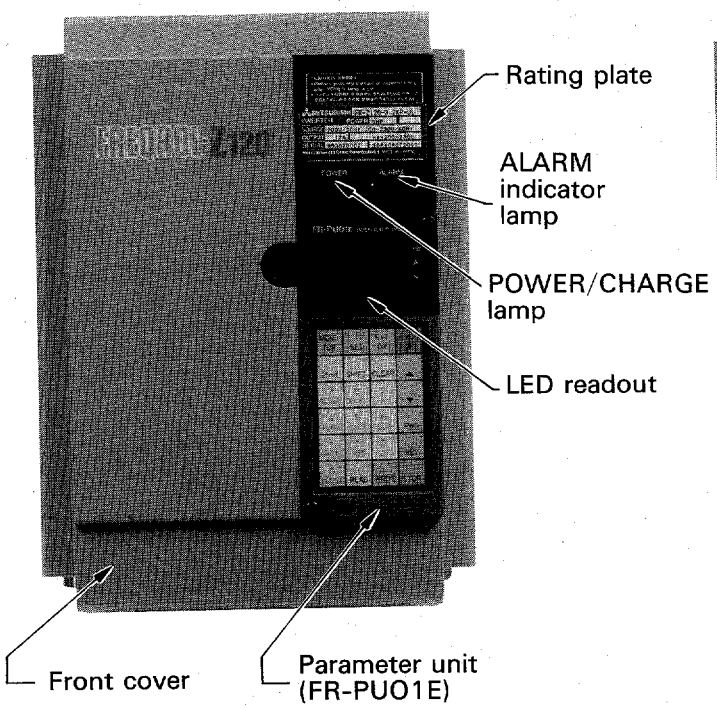



Fig. 2-1 Equipped with parmeter unit

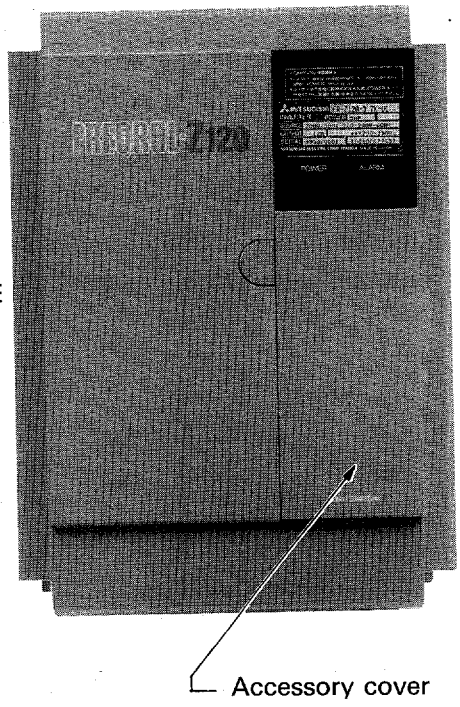



Fig. 2-2 Not equipped with parameter unit

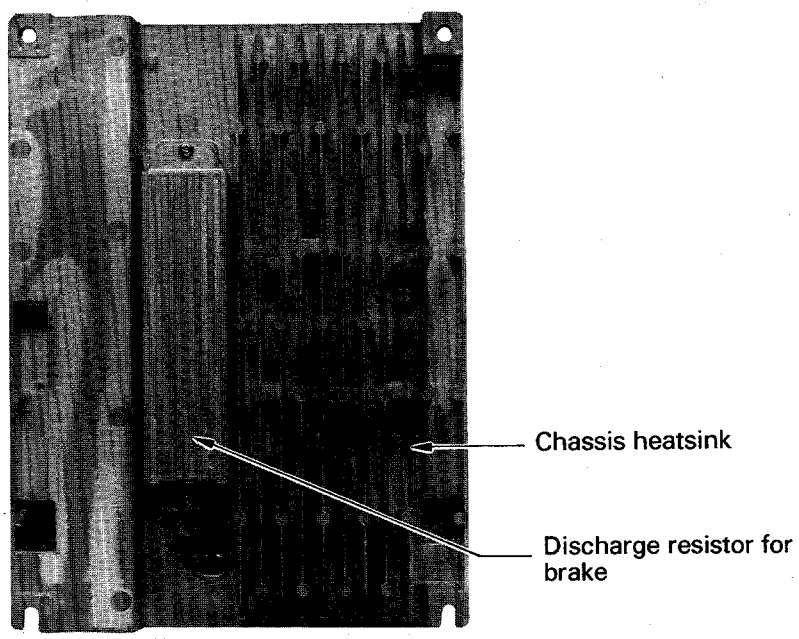



Fig. 2-3 Rear view (FR-Z120-1.5K-UL)

## 2-2 Removal and installation of front cover

**How to remove the front cover (see Fig. 2-4) :**

While pressing the white button at the top of the inverter, ease the cover forward and lift the plastic top cover from the bottom location sockets.

**How to attach the front cover (see Fig. 2-5) :**

Insert the luge at the bottom of the front cover into the sockets at the chassis bottom and press the cover lightly against the chassis. Ensure white button engages securely.

Inverter having no parmeter unit is equipped with an accessory cover. The accessory cover can be removed by pulling it to the front while holding the side wall lightly (Fig. 2-6).

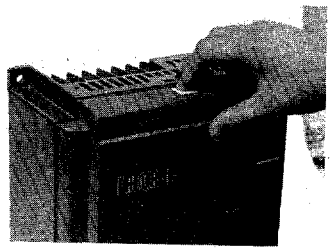


**Fig. 2-4 Removal of front cover**

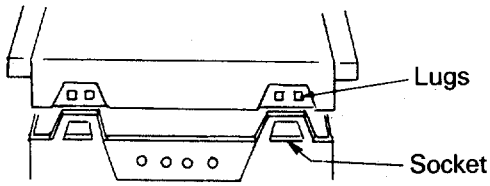



**Fig. 2-5 Installation of front cover**

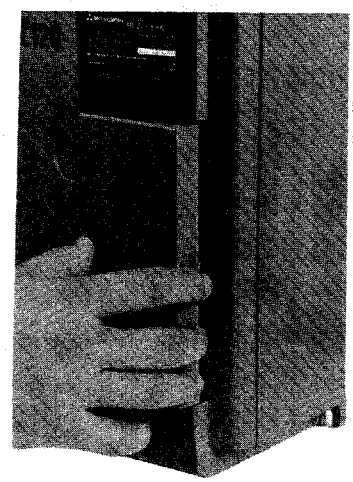


**Fig. 2-6 Removel of access cover**

**CAUTION:**

1. After the front cover is installed, make sure it is held in position securely.
2. The rating plate is stuck on the front cover.
   Do not attach the cover to another inverter.
3. When the parameter unit was removed for removal of the front cover, be sure to install it as instructed in 2-3.

## 2-3 Removal and installation of parameter unit

### How to remove the paramater unit (Fig. 2-7):

Remove two parameter unit mounting screws and ease the unit forward.

### How to install the parameter unit:

Put the plug (connector) of the parameter unit into the connector of the inverter. While holding the parameter unit in position, tighten two mounting screws. (Do not over-tighten.)

> **CAUTION**: Never install the parameter unit to the inverter with the front cover removed.

If the inverter must be operated with the front cover removed always, use the extension cable.
See page 21-1.

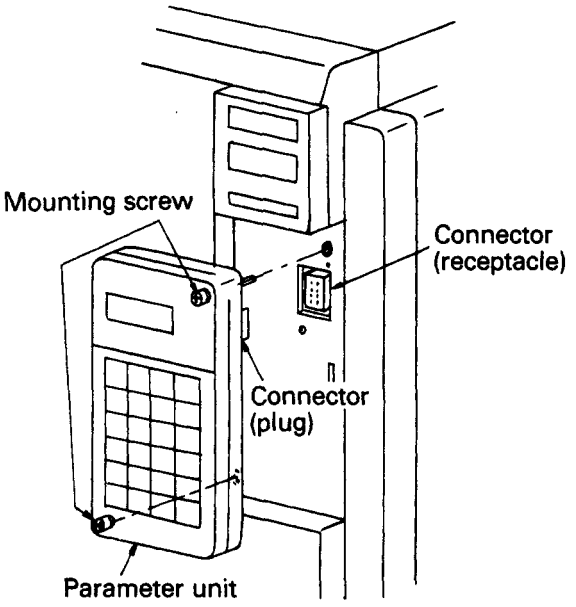



**Fig. 2-7 Removal and installation of parameter**

# §3. HANDLING INSTRUCTIONS

If the inverter is handled improperly, normal operatdon cannot be performed or the inverter may be damaged.

Note the followings:

1. Do not supply the over permissive voltage to the main circuit. (For power specifications, refer to page 9-1)
2. Do not connect the input voltage (power supply) wirings to the output terminals (U, V, W), because it causes damage to the inverter.
3. The life time of the inverter greatly depends on ambient temperature. For the long life time, it is important to use at low temperature.

   When the inverter is installed inside an enclosed box, pay attention to the box size and ventilation so that the inverter is operated at allowable temperature.
4. Do not operate the circuit breaker (MCCB) or magnetic contactom (MC) to start and stop the motor (inverter).
   Use the inverter start/stop signals (SFT, STR-SD).
5. To operate the inverter connected shortly to a large capacity power supply, surely use an AC reactor (power-factor correction reactor, model FR-BAL) to the inverter input side.
6. To the inverter output side, do not connect the power capacitor, surge suppressor,or noine filter (model FR-BIF, option).
7. To check insulation resistance with a megger, refer to page 7-2.
8. Do not perform overload operation over the inverter capabillity (d.g., repetition of thermal relay trip and reset).

# §4. INSTALLATION

## 4-1 Handling during unpacking and installation

Carefully handle hte inverter when it is trasferred and installed.
When the inverter is carried, do not hold it in such a manner that force is exerted on only the front panel.

## 4-2 Environment

(1) Place the inverter in a clean and well-ventilated location. Do not install the inverter in direct sunlight, high temperature, high humidity, dust, corrosive gases, or hazardous areas.

(2) Install the inverter in a vibration free location.

## 4-3 Mounting position and clearances

(1) Install the inverter securely and vertically with bolts or screws so that the letters "FREQROL-Z120" face front.

(2) When the inverter is equipped with a parameter unit, install the inverter where the operator can touch it easily.

(3) Since the inverter generates heat, provide sufficient clearance around the inverter.

(4) When braking is repeated frequently, the surface temperature of the discharging resistor, mounted at the rear of the inverter, may become high (maximum approx. 150°C, 302°F). Therefore, install the inverter on a non-flammable panel (such as metal plate).

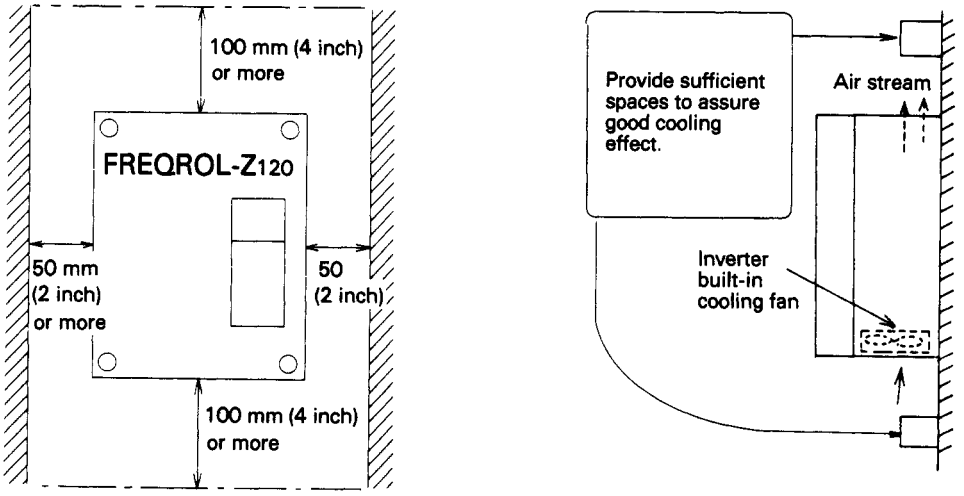



**Fig. 4-1 Clearance around inverter**

**CONSIDERATDON FOR AMBIENT TEMPERATURE**

The life time of the inverter depends on the ambient temperature. The ambient temperature should not exceed the permissive value.

Measure the ambient temperature at the positions shown in figure A.

Permissive ambient temperature: +50°C (+122°F)

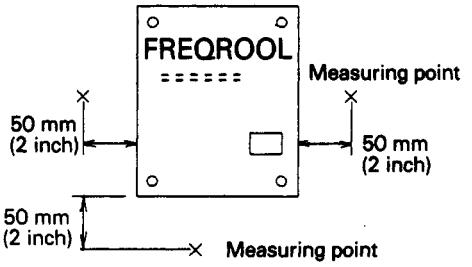
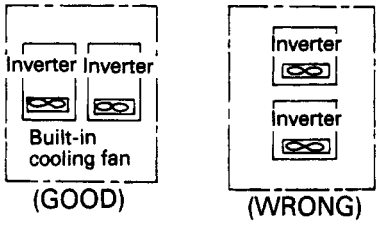


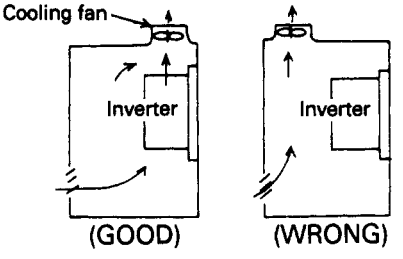

**Fig. A**

## 4-4 Inverter housed in enclosure

When two or more inverters are housed in an enclosure or one or more inverter are housed in an enclosure equipped with a fan, locate each inverter and fan so that the maximum cooling efficiency can be achieved.




Two or more inverters housed in an enclosure




Location of ventilating fan

# §5. WIRING

Fig. 5-1 and 5-2 show the wirings for terminals.

Connect the wires referring them and according to the following instructions:

## 5-1 Wiring procedure

(1) For power supply terminals R, S and T, it is not necessary to consider phase sequence.

(2) When wires are connected to output terminals U, V and W, the motor is rotated counter-clockwise by a forward signal, as viewed from the shaft side.

(3) Connect shielded or twisted wires to the control circuit terminals separateqy from the main and high-voltage circuits (including 200V relay sequence circuit).

(4) The speed reference signal is a faint current.
To prevent miscontact, use two parallel connection of faint signal contacts or a twin contacts.

**CAUTIONS OF WIRING:**

(1) Do not connect power supply to the output terminals (U, V, W), because such miswiring causes not only damage to the inverter, but also danger to the operator.

(2) Be sure to use sleeved solderless terminals for the main circuit cable terminals.

(3) Terminals P and PR are used to connect a discharging resistor for increased braking (option). Do not connect a brake unit (type BU) or other devices to these terminals.

(4) The inverter cannot protect against accidents cue to leakage. Pay attention so that cables do not touch the chassis, etc. Be sure to ground the inverter with the ground terminal.

(5) In case of not inserting magnetic contactor (MC) to the inverter primary side, if the power failure happens for a short time, the inverter restarts automatically at the time of restoration of power, because STF or STR signal still remain.

If this automatic restart may give damage to human body or machine, re-supply the power with safety after being sure to shut off the power with MC.

(6) If the commercial power changeover circuit is connected outside the inverter, check the phase sequence that the motor rating direction is the same in any operation.

(7) Since the speed reference signals (terminals 2 and 5) are not isolated from the control circuit in the inverter, do not ground common terminal 5.

(8) Do not short- circuit terminals across 10 (Supply for speed reference) and 5 (common).
Connection of these terminals will damage the inverter.

## 5-2 Wiring diagram

For terminal description, refer to page 9-4.

(1) Control circuit

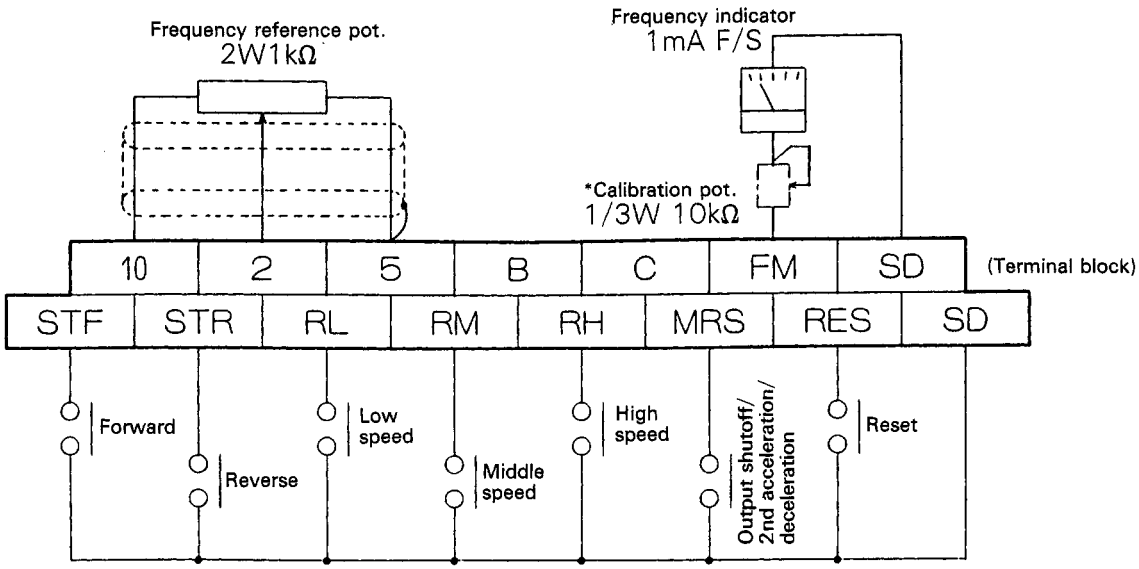
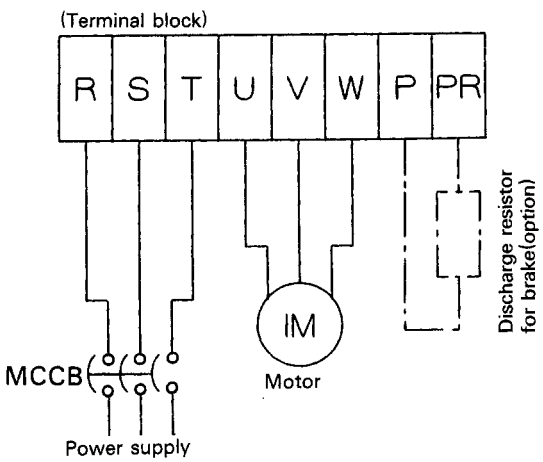


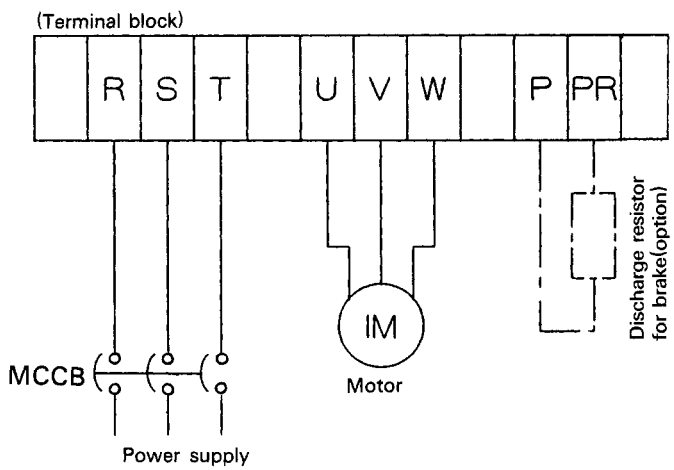

**Fig. 5-1**

※**Note:** This resistor is not required when meter is calibrated on parameter unit. (Refer to page 18-7.)

(2) Main circuit




FR-Z120-2.2K, 3.7K



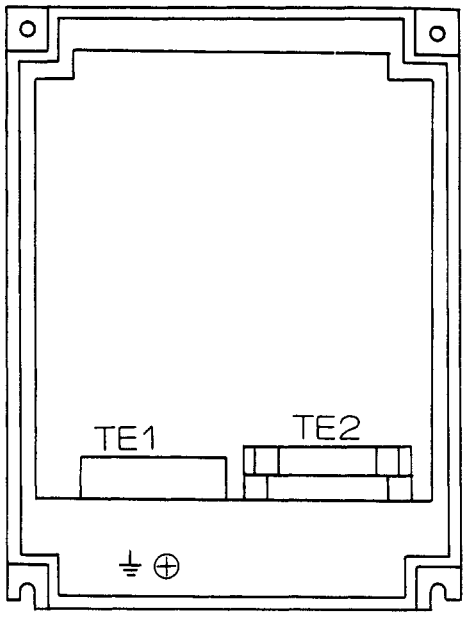

FR-Z120-0.4Kto1.5K

**Fig. 5-2**

**CAUTION:** The built-in resistor for brake is connected to terminals P and PR. If operation is in particularly heavy duty condition and requires a brake resistor having a larger capacity, disconnect the built-in resistor from these terminals and connect an exclusive external resistor to the terminals.

## 5-3 Terminal arrangement

(1) FR-Z120-0.4K to 1.5K




Control circuit terminal block TE2
(M3.5 screw)

| 10 | 2 | 5 | B | C | FM | SD |
|---|---|---|---|---|---|---|
| STF | STR | RL | RM | RH | MRS | RES | SD |

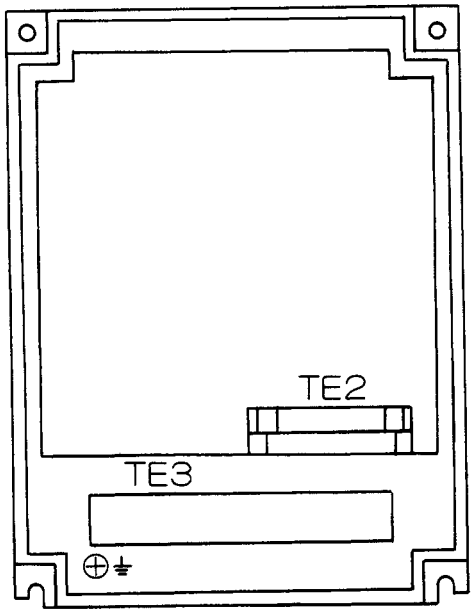
Main circuit terminal block TE1
(M4 screw)

| R | S | T | U | V | W | P | PR |
|---|---|---|---|---|---|---|---|

Ground terminal ⏚ (M4 screw)

**Fig. 5-3**

(2) FR-Z120-2.2K and 3.7K




Control Circuit terminal block TE2
(M3.5 screw)

| 10 | 2 | 5 | B | C | FM | SD |
|---|---|---|---|---|---|---|
| STF | STR | RL | RM | RH | MRS | RES | SD |

Main circuit terminal block TE3
(M4 screw)

| | R | S | T | | U | V | W | | P | PR | |
|---|---|---|---|---|---|---|---|---|---|---|---|

Ground terminal ⏚ (M4 screw)

**Fig. 5-4**

## 5-4 Field wiring reference table

For screw torque, crimping terminals and crimping tools, refer to the following table.

Note (＊1) Manufacturer: AMP INCORPORATED, HARRISBURG, PA 17105•
PHONE: 717-564-0100 TWX: 510-657-4
(＊2) Use copper wire only

| Voltage class | 200V | | | | | |
|---|---|---|---|---|---|---|
| Inverter model | Screw torque | | Crimping terminals type and tool type (＊1) | | Wire size and temp-rating (＊2) | |
| | Terminal block No. | (Proud -Inch) | Crimping terminals | Crimping tools | Size | temp-rating |
| FR-Z120-0.4K(P)-UL | TB1 | 10 | 32959 | 47387 | AWG14 | 75°C |
| FR-Z120-0.75K(P)-UL | TB1 | 10 | 32959 | 47387 | AWG14 | 75°C |
| FR-Z120-1.5K(P)-UL | TB1 | 10 | 32959 | 47387 | AWG14 | 75°C |
| FR-Z120-2.2K(P)-UL | TB3 | 13 | 32959 | 47387 | AWG14 | 75°C |
| FR-Z120-3.7K(P)-UL | TB3 | 13 | 32968 | 59239 | AWG10 | 75°C |

# §6. OPERATION

## 6-1 Pre-operation checks

### IMPORTANT

After the inverter has been installed and wired, check the following points before operation:

(1) Check that wiring is correct. Pay special attention to check that power supply cables are not connected to U, V and W.

(2) Check that there is no short-circuit due to wire offcuts, etc.

(3) Check that short-circuit and earth fault do not exist in the input and output circuits.

(4) Check that all screws, terminals and other fasteners are tight.

**CAUTION FOR INSULATION RESISTANCE TEST WITH MEGGER**

- For insulation resistance test with megger, refer to page 7-1.
- Never apply the test voltage to the control circuit terminals and across the inverter terminals.

## 6-2 Operation modes

The inverter can be operated in any one of the following three modes:

| Mode | Operation mode (FUNCTION 79) | Status after power is turned on (or reset) |
|---|---|---|
| 0 | Selection can be made between "Operation with external signal" and "operation on parameter unit" by operating the parameter unit (this mode is selected when the inverter is shipped). | "Operation with external signal" |
| 1 | The inverter can be operated only on the parameter unit.* | "Operation on parameter unit" |
| 2 | The inverter can be operated only with external signal.* | "Operation with external signal" |

**Note*:**
To use these modes, function No. 79 (operation mode) should be set on the parameter unit. (For details, refer to P. 12-1)

### OPERATION WITH EXTERNAL SIGNALS

A separatelly installed speed reference potentiometer and start switches (FWD/REV) are used to control the inverter (motor).
To start operation, only connection of the speed reference potentiometer and start switches to the terminals of the inverter is required.
The acceleration/deceleration time and the electronic thermal relay are set, as shown on page 18-1, when the inverter is shipped.

These settings can be changed by means of operation with parameter unit shown below. When the parameter unit is used in this operation mode,

- ○ speed is displayed by the readout,
- ○ setting of various functions can be checked,
- ○ in case of operation failure, the cause of the failure can be identified, and
- ○ operation status (motor current, motor rotating direction, etc.) can be monitored.

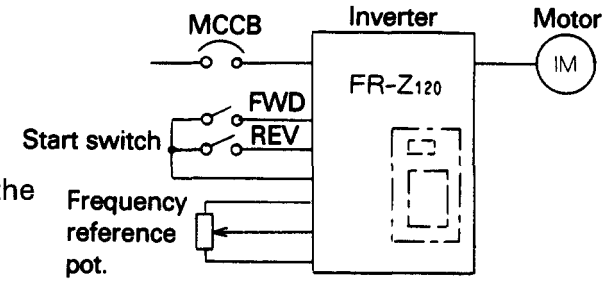



**Fig. 6-1 Operation with external signals**

## OPERATION WITH PARAMETER UNIT

Keys or switches of the parameter unit are pressed to control the inverter (motor).

To control the inverter by the parameter unit, press [PU] key.

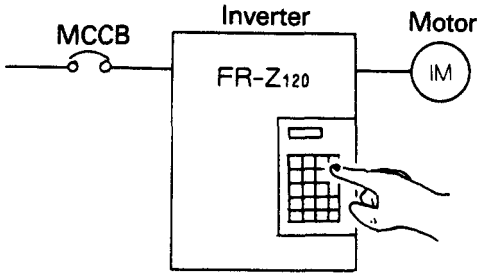



**Fig. 6-2 Operation with parameter unit**

## 6-3 Pre-operation settings and adjustments

The inverter itself does not have control devices such as select switches and potentimeter (as with previous models of FREQROL).
When the settings (acceleration/deceleration time, electronic thermal relay setting, etc.) must be changed, the parameter unit (FR-PU01E) is used.

(For the initial settings, refer to page 19-1).

For methods of changing parameter setting, refer to the description "PARAMETER UNIT". (P.11-1—19-7)

**Settings and Adjustments:**

○ Maximum output frequency setting (frequency at 5V input)

**For operation with external input signals**

The intial setting is that the maximum output frequency is 60Hz when speed reference signal (across terminals 2 and 5)is 5V.
If it is necessary to obtain output frequency higher than 60Hz, the maximum output frequency setting must be changed (refer to page 19-2).

**For operation with parameter unit**

Output frequence can be changed up to the maximum output frequency limit (set to 120Hz when the inverter is shipped).
Set the maximum frequency limit of inverter to frequency less than that at the maximum permissive speed of motor.

○ Acceleration/deceleration time
The intinal setting for acceleration and deceleration is 5sec.

The acceleration/deceleration time is the time from start to the frequency at 5V input. (For details, refer to page 19-3.)

○ Electronic thermal relay setting
This relay is set in terms of current.
Set the relay in accordance with the rated current of the motor.

○ Frequency meter calibration
If an analog frequency meter is connected to terminals FM and SD without using a calibration potentiometer, the frequency meter does not read correctly (the pointer of frequency meter may swing over the limit when frequency reference signal is maximum).

The requency meter can be calibrated in either one of thefollowing ways:

(1) Connect a calibration potentiometer.

(2) Use the parameter unit.

**How to calibrate the frequency meter using the parameter unit**

(1) Set the same output frequency as frequency at 5V input signal,operating keys of the parameter unit.

PU • 6 • 0 • WRITE

60Hz is set for output frequency.

(2) Press FWD or REV to start the motor.

(3) Enter PU 2ND 0 1 .

(4) Press ▲ or ▼ key to calibrate the frequency meter.

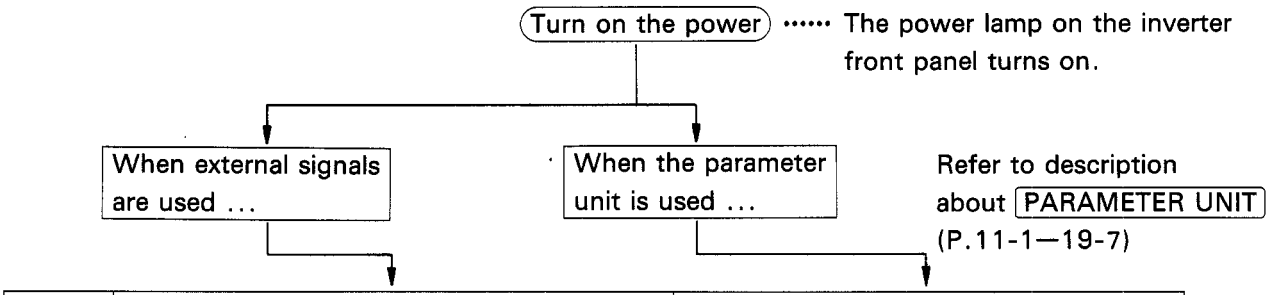
(5) After the frequency meter has been calibrated, press WRITE key.

(6) Press STOP key to stop the motor.

## 6-4 In-operation settings and adjustments

After checking that the inverter signal is off, turn on the circuit breaker (MCCB) and magnetic contactor (MC) in the inverter input circuit.

Then operate the inverter and check the operation.




| | | | |
|---|---|---|---|
| Operation mode | The inverter automaically becomes ready for operation with external signals when the power is turned on. | Press PU key to make operative the parameter unit. | |
| Constant speed ← Acceleration ← Start operation | Turn on forward or reverse start signal (or switch).<br>⇩<br>Slowly turn the speed reference pot. Clockwise until stops.<br>(Motor now at full speed.) | ○ For direct setting<br>Enter the desired output frequency by operating numerical keys of the parameter unit and then press WRITE key.<br>○ For analog setting<br>Press ▲ key to increase frequency displayed by the readout to the desired output frequency and then press WRITE key.<br>⇩<br>Press FWD or REV key | Note 1. |
| Deceleration → Stop | Slowly turn the speed reference pot. Counterclockwise to "zero".<br>(Motor now stopped.) | Press STOP key. | Note 2. |

Note 1: As the frequency displayed by the readout of parameter unit increases, the motor speed increases.

Note 2: As the frequency displayed by the readout of parameter unit decreases, the motor speed decreases. When the output frequence is reached to the starting frequency, the DC dynamic brake is activated and the motor is brought to sudden stop.

Check points:

(1) Check that the motor rotates in correct direction.
(For relationship between motor phase sequence and direction of rotation, refer to chapter §5. WIRING.)

(2) Check that the motor does not generate unusual hums or vibration.

(3) Check that change of output frequency is displayed correctly.

(4) Check if "ALARM" lamp lights during acceleration or deceleration (inverter trip).

If it lights, perform the following check:

- Check if load is too heavy.
- Reduce boost amount.
- Increase acceleration/deceleration time.

**CAUTION:**

(1) If the forward (STF) and reverse (STR) start signals turn on at the same time, the inverter will not start.
If these signals turn on simultaneously during operation, the inverter is decelerated to a stop.

(2) During deceleration, the DC dynamic brake is actuated at less than 3Hz (less than the starting frequency if speed reference signal is gradually reduced) for 0.5 seconds. During this period, the motor may generate a high-pitched hum, but this is not a failure, nor a sign of trouble. This is normal during DC braking.

(3) If "ALARM" lamp lights and the motor stops after coasting, check that the motor has completely stopped and then shut off the power or reset the inverter using the reset terminal.

# § 7. MAINTENANCE AND INSPECTION

The inverter is a piece of static equipment consisting mainly of semiconductor elements. To prevent troubles occurring due to high temperature, humidity, dust, intense vibration, component deterioration, etc., it is necessary to execute periodic inspection.

## 7-1 Caution for maintenance and inspection

(1) The operator must check whether power supply is ON or OFF by himself to prevent misoperation by others.

(2) After the power is switched off, the capacitor remains charged at high voltage for a while. Before making an inspection, check that the CHARGE lamp (used also as the POWER lamp) in the display panel is off and voltage across inverter main circuit terminals P and N is below 30 DC with a multimeter, etc.

## 7-2 Inspection points

This inverter is equipped with power and error indicator LED (located in the display panel). It is advisable that you recognize LED definitions.
Note the normal settings of the electronic thermal relay, acceleration/deceleration time, etc.

(1) Daily inspection
During operation, check the following:

(a) The motor operates properly.

(b) The environment is normal.

(c) The cooling system is normal.

(d) There is no unusual vibration and moise.

(e) There is no overheat and discoloration in any component.

During operation, check inverter input/output voltage with a multimeter.

(2) Periodic inspection
Check the following periodically with the inverter stopped:

(a) Check that the cooling system is in good condition.
Clean air filters, etc.

(b) Screws, bolts, nuts and other fasteners may become loose with time due to vibration, thermal expansion/retraction, etc.
Retighten loose screws or other fasteners.

(c) Check if conductors and insulators are not corroded or damaged.

(d) Measure insulation resistance.

(e) Check the cooling fan, smoothing capacitor, contactor and realy.

Table 7-1 shows the standard daily and periodic inspection schedule.

(3) Insulation resistance test with megger

(a) Before checking insulation resistance of the external circuit with a megger, disconnect wires from all inverter terminals so that test voltage is not applied to the inverter circuits.

(b) Conduct the insulation resistance test on the inverter main circuit only, as shown in Fig. 7-1.
DO NOT conduct the test on the control circuits.

(c) To check the control circuits for continuity, use a multimeter (high resistance range).
DO NOT USE A MEGGER OR BUZZER TO CHECK.

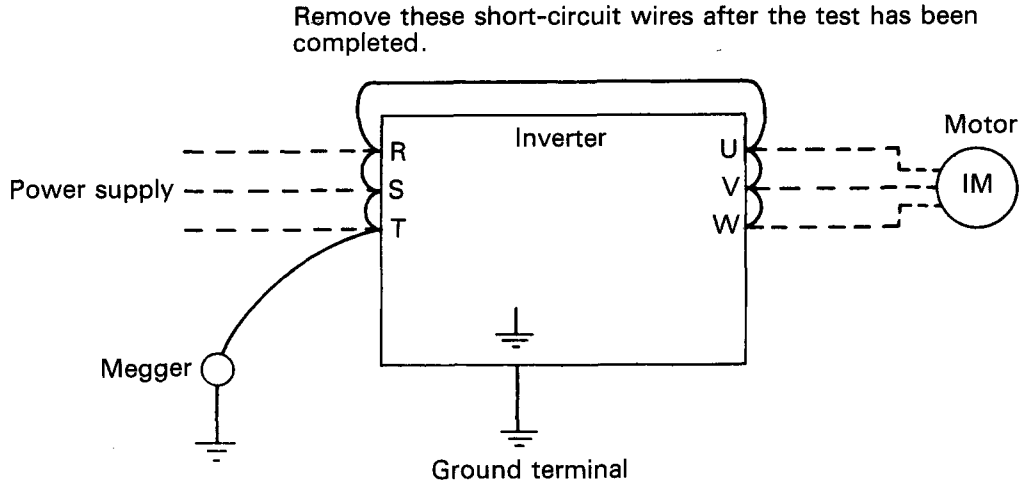



**Fig. 7-1 Insulation resistance test with megger**

## Table 7-1 Daily and Periodic inspection

| Check point | Checking Item | Description | Interval | | | Checking Method | Judgement | Measuing Instrument |
|---|---|---|---|---|---|---|---|---|
| | | | Daily | Periodic | | | | |
| | | | | 1 year | 2 year | | | |
| General | Environment | Check ambient temperature, humidity, dust, etc. | ○ | | | Refer to cautions on page 4—1 | Ambient temperature −10°C to +50°C (+14°F to +122°F) ; No freezing<br>Ambient humidity 90% RH or less ;<br>No condensing | Themometer, hydrometer, recorder |
| | Whole equipment | Check that there is unusual vibration and noise. | ○ | | | Visual and auditory checks | Should be normal | |
| | Sourse voltage | Check that main circuit and control voltages are normal. | ○ | | | Measure voltage across inverter terminal block terminals R, S and T. | • 50Hz 180 to 220V<br>• 60Hz 180 to 253V | multimeter<br>digital multimeter |
| Main circuit | General | (1) Check with megger (across main circuit and ground terminal)<br>(2) Check that fastened parts are not loose.<br>(3) Check that parts of not overheat traces.<br>(4) Clean | | ○<br>○<br>○ | ○ | (1) Disconnect the inverter and measure resistance across batch of terminals R, S, T, U, V, W and ground terminal with meggar<br>(2) Fasten<br>(3) Visual check | (1) 5M OHM or larger<br>(2) (3) should be normal | 500V megger |
| | Conductor, cable | (1) Check that conductor is not distorted.<br>(2) Check that cable sheath is not broken | | ○<br>○ | | (1) (2) visual check | (1) (2) should be normal | |
| | Transformer, reactor | Check for unusual smell | ○ | | | Smell check | Should be normal | |
| | Terminal block | Check for damage | | ○ | | Visual check | Should be normal | |
| | Transistor module<br>Diode module | Check resistance across each terminals | | | ○ | Disconnect the inverter and measure resistance across terminals R, S, T and P, N and across U, V, W and P, N with a multimeter by 1 OHM range. | Refer to Table 7—4 | Analog multimeter |
| | Smoothing capacity | (1) Check for leakage<br>(2) Check the safty valve<br>(3) Measure static capacity | ○<br>○ | <br><br>○ | | (1) (2) Visual check<br>(3) Measure with capacity measuring instruments. | (1) (2) Should be normal<br>(3) 85% or more rated capacity | Capacitor meter |
| | Relay, contactor | (1) Check for tremor<br>(2) Check time delay relay operation time<br>(3) Check for contact roughness | | ○<br>○<br>○ | | (1) Auditory check<br>(2) Delay from power-on to relay activation<br>(3) Visual check | (1) Should be normal<br>(2) Should operate in 0.1 to 0.15 seconds.<br>(3) Should be normal | Universal counter |
| | Resistor | (1) Check for resistor insulator crack<br>(2) Check for wire break | | ○<br>○ | | (1) Visual check ceramic resistor, wound resistor, etc.<br>(2) Disconnect lead on one side and measure with circuit multimeter. | (1) Should be normal<br>(2) Error should be within ±10% of specified resistance | Multimeter digital multimeter |
| Control circuit<br>Protection circuit | Operation check | (1) Check output voltage balance across each phases without motor.<br>(2) After sequence protective operation test, check that protective and display circuits should be normal. | | ○<br>○ | | (1) Measure voltage across inverter output terminals U, V and W.<br>(2) Simulatively short-circuit the inverter protective circuit outputs. | (1) Voltage balance for 200V should be within 4V<br>(2) Error should occur in the sequence. | Digital multimeter rectifier type voltmeter |
| Cooling system | Cooling fan | (1) Check for unusual vibration and noise.<br>(2) Check that connection if not loose.<br>(3) Clean air filter | ○<br><br>○ | <br>○ | | (1) Switch power off and turn by hand.<br>(2) Retighten. | (1) Should turn smoothly.<br>(2) Should normal. | |
| Display | Display | (1) Check that lamps have not blown.<br>(2) Clean. | ○ | <br>○ | | (1) Panel indicator lamps.<br>(2) Clean with cloth | (1) Check that lamps light. | |
| | Meter | Check that reading is correct | ○ | | | (1) Check panel meter reading. | (1) Should satisfy specified and control values. | Voltmeter, ammeter, etc. |
| Motor | General | (1) Check for unusual vibration and noise.<br>(2) Check for unusual smell. | ○<br>○ | | | (1) Auditory, tactile and visual checks.<br>(2) Check for unusual smell due to overheat, damage, etc. | (1) (2) Should be normal. | |
| | Insulation resistance | (1) Check with megger (across batch terminals and ground terminal) | | | ○ | (1) Disconnect U, V and W, Includes motor cable. | (1) Should be 5M OHM or larger. | 500V megger |

## 7-3 Measuring instrument selection and usage

To observe the insulation resistance, voltage, current, signal level, waveform, etc., use the measuring instruments described below.

(1) Main circuit measurements

There are input/output voltages and currents measurements, load (motor) continuity check, insulation check, voltage and current waveform observations.

The following are the particularly important items to be checked with the following instruments:

① Multimeter

For continuity check with a multimeter, be careful of sneak path circuit. DO NOT make continuity check for the inverter circuit transistor module with the motor connected, and for the converter circuit diode module with the power connected.
Make continuity check for only components to be checked and remove the wirings to other components.

② Voltmeter and ammeter

The input (power supply) voltage is sine-wave of the commercial frequency. To measure the input voltage, any appropriate instrument may be used.
The input and output current waveforms include many high harmonic components. To measure the input and output currents, use a moving-iron type ammeter as it indicates value in r.m.s.
To measure the output voltage, use a rectifier type voltmeter because it reads nearly the basic wave component of the voltage waveform which is used as the reference value of torque generated by the motor.

Anyhow, it is important to note the types of used instruments as well as normal value of measurements and always use the same instruments at inspection.

③ Oscilloscope

To measure high voltage (main circuit), insulate the power supply of oscilloscope and use a high-voltage probe or insulate the measured point with a potential transformer or current transformer. In the latter case, the potential transformer or current transformer should have sufficient capacity to prevent magnetic saturation.

(2) Control circuit measurements

There are speed refernce signal and inverter control voltage measurements and waveform observation.

Note the following:

① Voltage measurement and waveform observation

Since the flowing currents of these signals are faint and the circuit impedances are high, use an instrument, input resistance of which is as high as possible (100 kohm to 1 megohm).
It is recommended to measure using a digital multimeter and oscilloscope. Since input resistance of multimeter set in low range is significantly low, value read by multimeter may show lower than the true value.
Therefore, pay attention to it.

② Common line connection

Connect the instrument common line to the optimum point of circuit, i.e. nearest common point to the measuring point.

③ Instrument characteristics

For waveform observation, use an oscilloscope wich has characteristics meeting the waveform to be measured. For example, the inverter base drive waveform can be observed with a 10 MHz osciloscope. To measure transient waveform at rise of signal (dv/dt or di/dt), however, oscilloscope of 200 MHz or larger frequency is required.

**Table 7-2 Instruments and points to be measured**

| Instruments | Measurings point | | Measuring Item | | | | | Description |
|---|---|---|---|---|---|---|---|---|
| | Main circuit | Control circuit | insula-tion | Con-ductivity | Voltage | Current | Wave-form | |
| 500V megger | ○ | | ○ | | | | | Measure across batch of main circuit terminals and ground. (This does not apply to control circuit.) |
| Multimeter | ○ | ○ | | ○ | ○ | | | Judges whether semiconductor element is proper or not. Used to know conductivity or resistfnce value. |
| Voltmeter | ○ | | | | ○ | | | Measure line and inverter output voltage. Use a rectifier type. |
| Ammeter | ○ | | | | | ○ | | Measure line and output current. Use a moving-iron type. |
| Oscilloscope | ○ | ○ | | | ○ | ○ | ○ | Used to observe waveform and measure transient voltage and current. |
| Digital multimeter | ○ | ○ | | | ○ | | | Used to measure circuit voltage instead of multimeter. |

## 7-4 Method of measuing main circuit voltage, current and power

(1) Voltage and current measurements

Since the inverter input/output voltage and current include high harmonic components, data (measurement results) depend on the instruments and circuits used in measurement.

To measure voltage and current with an instrument for commercial frequency application, use the instrument selected from Table 7-3, and the circuit in Fig. 7-2.

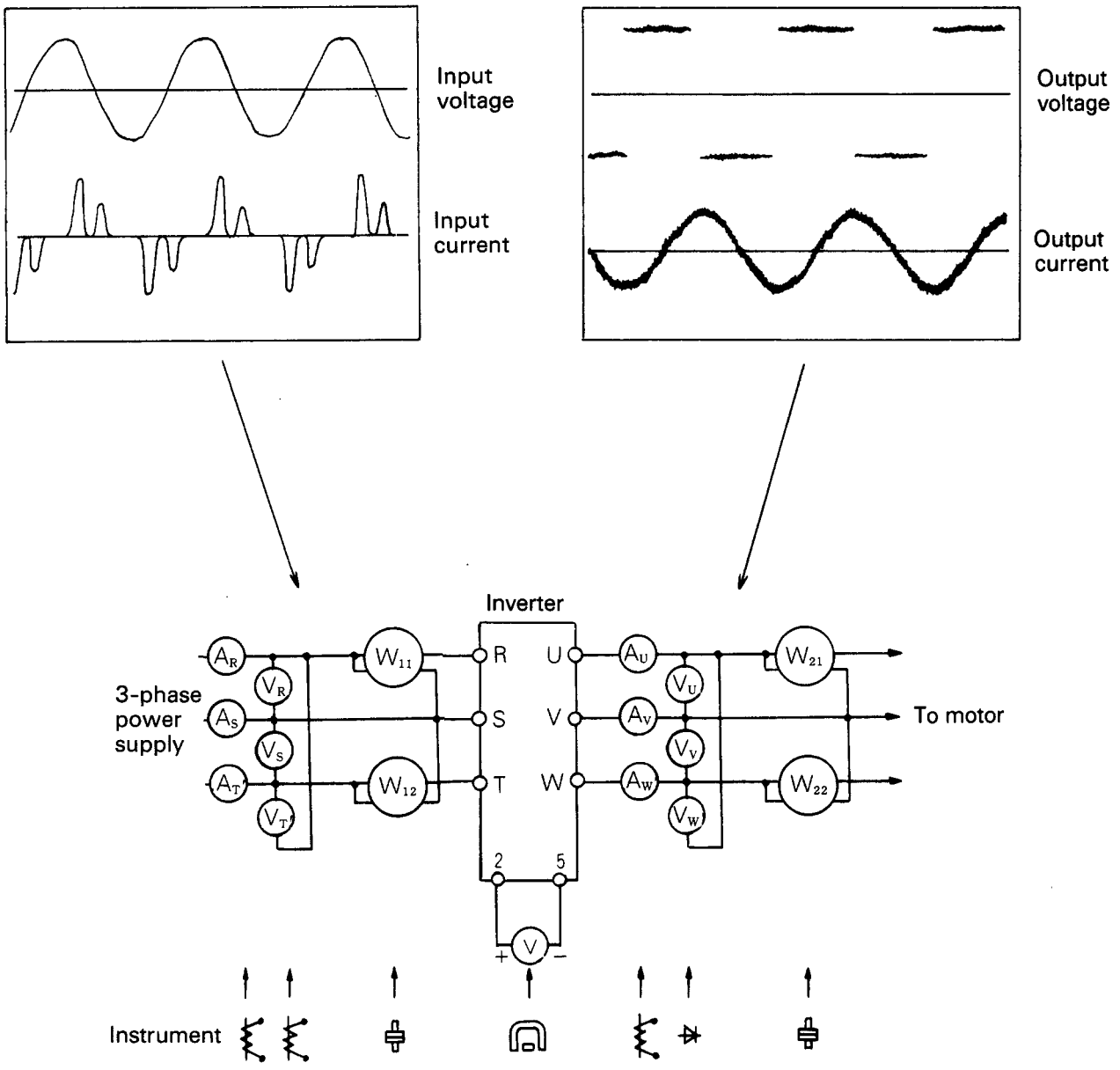



**Fig. 7-2 Measuring points and instrumests**

**Table 7-3 Measuring points and measuring instruments**

| Item | Measuring Point | Instrument | Remarks (Criterion) |
|---|---|---|---|
| Line voltage $V_1$ | Across R and S, S and T, fnd T and R | Moving-iron type | Commercial voltage<br>● For 200V class<br>50Hz 180−220V<br>60Hz 180−253V |
| Input current $I_1$ | R, S, and T line currents | Moving-iron type | |
| Input power $P_1$ | At R, S and T, and across R and S, and S and T | Electrodynamic type | $P_1=W_{11}+W_{12}$ |
| Input power factor $Pf_1$ | To be calculated from the equation shown below, after line voltage, input current and input power are measured.<br>$Pf_1=\frac{P_1}{\sqrt{3}V_1 \cdot I_1}\times 100\%$ | | |
| Output voltage $V_2$ | Across U and V, V and W,and W and U | Rectifier type (Moving-iron type is not acceptable) | Difference between phases is ± 1% or less of maximum output voltage. |
| Output current $I_2$ | U, V and W line currents | Moving-iron type | Current should be equal to or less than inverter rated current. Difference between phasses is 10% or less. |
| Output power $P_2$ | On U, V and W, and across U and V, and V and W | Electrodynamic type | $P_2=W_{21}+W_{22}$ |
| Output power factor $Pf_2$ | To be calculated from the equation shown below.<br>$Pf_2=\frac{P_2}{\sqrt{3}V_2 \cdot I_2}\times 100\%$ | | |
| Converter output | Across P and N | Moving coil type (Such as multimeter) | POWER lamp should light, 1.35×V1<br>Maximum voltage during regenerative braking:375±15V |

(To be continued)

| Item | Measuring Point | Instrument | Remarks (Criterion) | |
|---|---|---|---|---|
| Frequency reference | Across 2 and 5 | Moving coil type (multimeter, etc,) (Internal resistance: 50kOHM or larger) | DC 0 - 5V | "5" for common. |
| Power supply for frequency reference | Across 10 and 5 | Moving coil type (multimeter, etc,) (Internal resistance: 50kOHM or larger) | DC 5V | |
| Frequency meter signal | Across FM and SD | Moving coil type (multimeter, etc,) (Internal resistance: 50kOHM or larger) | Approx. 5V DC at maximum frequency (with frequency indicator connected) | SD for common |
| Start signal | Across STF and SD<br>Across STR and SD | Moving coil type (multimter, etc,) (Internal resistance: 50kOHM or larger) | When opened : 20 to 30V DC<br>When closed : 1V DC or less | SD for common |
| Reset signal | Across RES and SD | | | |
| Output halt signal | Across MRS and SD | | | |
| Base current shutoff signal<br>Error alarm signal | Across B and C | Moving coil type (such as multimeter) | Continuity checking<br>When normal or power supply OFF :<br>B-C is closed<br>When error :<br>B-C is opened | |

### 7-5 Transistor and diode module check

(1) Preparation

- ○ Disconnect the power supply cables (R,S,T) and motor cables (U,V,W).
- ○ Prepare a multimeter (Set the multimeter to "1 OHM" resistance measurement range).

(2) Checking method

Change the polarity of the multimeter alternately at the inverter terminals R,S,T,U,V,W, P, and N and check for continuity as listed below.

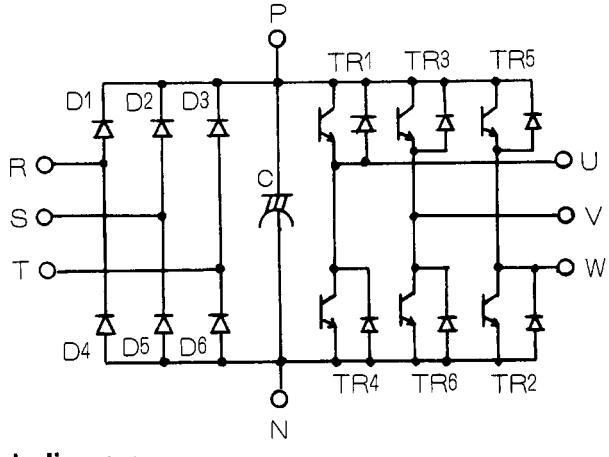



**Fig. 7-3 Power circuit block diagram**

**Table 7-4 Checking the transistor modules and diode modules**

| | | Multimeter polarity ⊕ | Multimeter polarity ⊖ | Measurement | | Multimeter polarity ⊕ | Multimeter polarity ⊖ | Measurement |
|---|---|---|---|---|---|---|---|---|
| Diode module | D1 | R | P | Discontinuity | D4 | R | N | Continuity |
| | | P | R | Continuity | | N | R | Discontinuity |
| | D2 | S | P | Discontinuity | D5 | S | N | Continuity |
| | | P | S | Continuity | | N | R | Discontinuity |
| | D3 | T | P | Discontinuity | D6 | T | N | Continuity |
| | | P | T | Continuity | | N | T | Discontinuity |
| Transistor module | TR1 | U | P | Discontinuity | TR4 | U | N | Continuity |
| | | P | U | Continuity | | N | U | Discontinuity |
| | TR3 | V | P | Discontinuity | TR6 | V | N | Continuity |
| | | P | V | Continuity | | N | V | Discontinuity |
| | TR5 | W | P | Discontinuity | TR2 | W | N | Continuity |
| | | P | W | Continuity | | N | W | Discontinuity |

**Notes:**

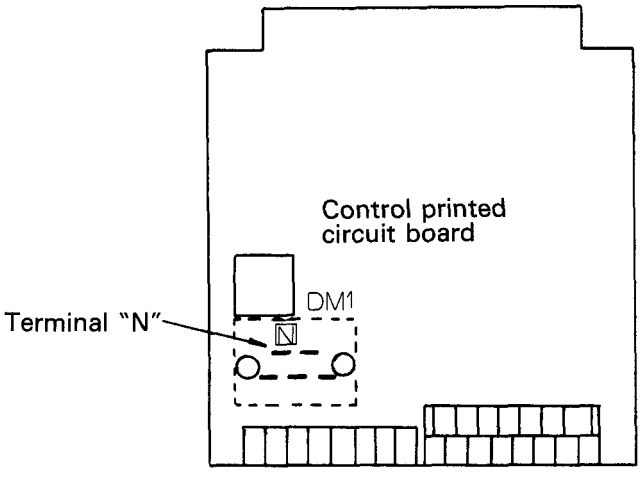
1. Before measuring, check that the smoothing capacitors have been already discharged.
2. "Discontinuity" means that the multimeter reading is almost infinite. Due to electricity remaining in smoothing capacitor, the multimeter may indicate "continuity" momentarily.

   "Continuity" means that the multimeter reading is about 1 — 100 ohm, depending on number of total modules, number of modules connected in parallel, type of modules, etc.

   If all measurement results are almost same, the modules are in good condition.

(3) Location of check terminal N

① FR-Z$_{120}$-0.4K to 1.5K




② FR-Z$_{120}$-2.2K,3.7K

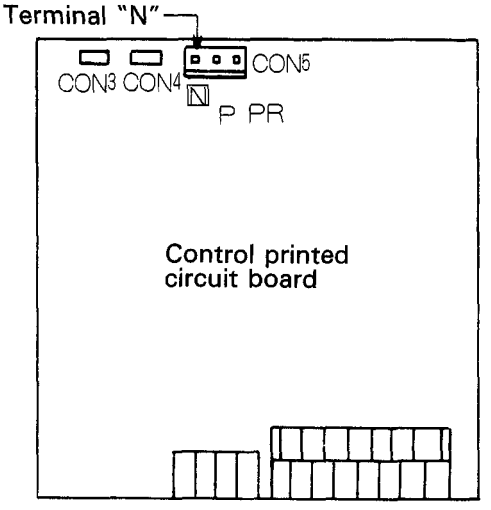



**Fig. 7-4 Check terminal N location**

## 7-6 Parts replacement

The inverter consists of many electronic parts such as semiconductors.

The parts described below may deteriorate with time in electrical and physical characteristics. As preventeive maintenance, therefore, these parts require to be replaced periodically.

(1) Cooling fan

The service life of the bearings of the fan used to cool heatgenerating parts such as main circuit semiconductors is usually within a range from 10,000 to 35,000 hours.
Hence, it is necessary to replace the cooling fan every 2 or 3 years.

If unusual noise and/or vibration is found during inspection, it is necessary to replace the cooling fan.

(2) Smoothing capacitor

For smoothing (rectification of input power supply), large-capacity aluminum electric capacitors are used in the DC main circuit.
Its characteristics are adversely affected by ripple current, etc.
When the inverter is used in normal air-conditioned environment, for example, replace the capacitors about every 5 years.
When a capacitor is used for the period specified as life, it may deteriorate suddently.
It is necessary to check all smoothing capacitors yearly (several months if life is about to expire).

Check the followings:

① Case : Side walls and bottom for deformation

② Sealing plate : For unusual warp and cracks

③ Pressure relief valve : For excessive valve expansion and operation

④ Appearance, crack in case, discoloration and leakage:

When capacitance, of a capacitor is reduced below 85% of rated capacitance, replace that capacitor.
To measure capacitance, use an instrument available commercially.

(3) Relays

To prevent miscontact, it is necessary to replace relays in accordance with the acumulated switching times.

For approximate interval of parts replacement, refer to Table 7-5.
Other parts having a relatively short service life, such as lamps. Replace when deemed necessary as periodic inspection result will reveal.

**Table 7-5 Inverter replacement parts.**

| Part name | Standard interval | Description |
|---|---|---|
| Cooling fan | 2 to 3 years | Replace (determine after checking) |
| Smoothing capacitor | 5 years | Replace (determine after checking) |
| Relays | — | Determine after checking |

# §8. TROUBLESHOOTING

If a fault occurs and the inverter does not work properly, determine the cause referring to the following troubleshooting list and apply the remedy.

If the cause cannot be determined in accordance with the list, the inverter or its parts(s) is likely to be defective.
For remedy of serious trouble or any inquiry, contact the nearest service representative.

## 8-1 Troubleshooting

(1) Troubleshooting by indicator lamps of parameter unit.

| Indicator lamp | Possible cause | Checkup | Remedy |
|---|---|---|---|
| OVT:<br>Regenerative over voltage shut off (deceleration time set improperly) | Overvoltage in DC output circuit (across terminals P and NB) | Is deceleration too fast? | Increase deceleration time (it should meet load $GD^2$ ... inertia). |
| IPF:<br>Instantaneous power failure | Instantaneous power failure | Determine the cause of instantaneous power failure. | |
| FIN:<br>Heatsink overheat | Heatsinks are overheated. | Is cooling fan stopped (for models larger than 2.2K)?<br>Is ambient temperature too high? | Replace cooling fan.<br>Reduce ambient temperature. |
| BE:<br>Brake transistor fault | Brake transistor is defective. | Is brake operating duty proper? | Reduce load $GD^2$.<br>Reduce brake operating duty. |
| OC1:<br>Acceleration overcurrent | Overcurrent | Is acceleration too fast?<br>Is output short-circuited? | Prolong acceleration time. |

(To be continued)

| Indicator lamp | Possible cause | Checkup | Remedy |
|---|---|---|---|
| OC2:<br>Steady speed overcurrent | Overcurrrent | Is load changed suddenly?<br>Is output short-circuited? | Eliminate sudden load change. |
| OC3:<br>Deceleration overcurrent | | Is deceleration too fast?<br>Is output short-circuited? | Prolong deceleration time. |
| THM:<br>Overload alarm | Motor thermal relay | Is motor overloaded? | Lighten load.<br>Change motor/inverter capacity. |
| THT:<br>Overload alarm | Inverter thermal relay | | |
| OLT:<br>Stall prevention | Long-lasting action of stall preventive function | Is motor overloaded? | Lighten load.<br>Change motor/inverter capacity. |

* If an indicator lamp lights, the motor stops after casting.
  To resume motor operation, remove the cause, reset the protective function and restart the inverter.

(2) Troubleshooting list

| Trouble | Checkup | Remedy |
|---|---|---|
| Motor does not start... | Are all wirings correct? | Correct wirings. |
| | Are voltages across power supply terminals R and S, S and T, and T and S normal (POWER and CHARGE lamps should light)? | Supply voltages. |
| | Are there output voltages across terminals U and V, V and W, and W and U? | Supply voltages. |
| | Is motor locked (due to excessively large load)? | Remove cause of locking of motor. |
| | Does any indicator lamp (ALARM) light? | See the previous page. |
| | Is parameter unit set up properly? | Check settings. |
| | Others | Turn off, and then on the power supply. |
| Motor starts and rotates in wrong direction... | Is output phase sequence (U, V, W) proper? | Correct output phase sequence. |
| | Are "FWD" and "REV" signal lines connected to correct terminals? | "FWD"signal: Terminals STF – SD closed "REV" signal: Terminals STR – SD closed |
| Motor runs, but its speed cannot be changed... | Is frequency reference signal wiring correct? | Correct frequency reference signal wiring. |
| | Is load too heavy? | Lighten load |
| Motor acceleration or deceleration is not smooth... | Is time for acceleration or deceleration too short? | Prolong acceleration or deceleration time. |
| Motor speed is out of control (motor speed is too high or low)... | Are number of poles of motor correct? Does voltage meet specificaions? | Check Specifications and Rating Plate. |
| | Is gear reduction ratio correct? | |
| | Is maximum frequency set properly? | Check maximum frequency setting. |
| | Are voltages across motor terminals correct? | Check base frequency (V/F). |
| Motor speed is unstable... | Is load too large? | Lighten load. |
| | Is load change excessive? | Minimize load change. Increase inverter and motor capacities. |

(To be continued)

# § 9. SPECIFICATIONS

## 9.1 Standard specifcations

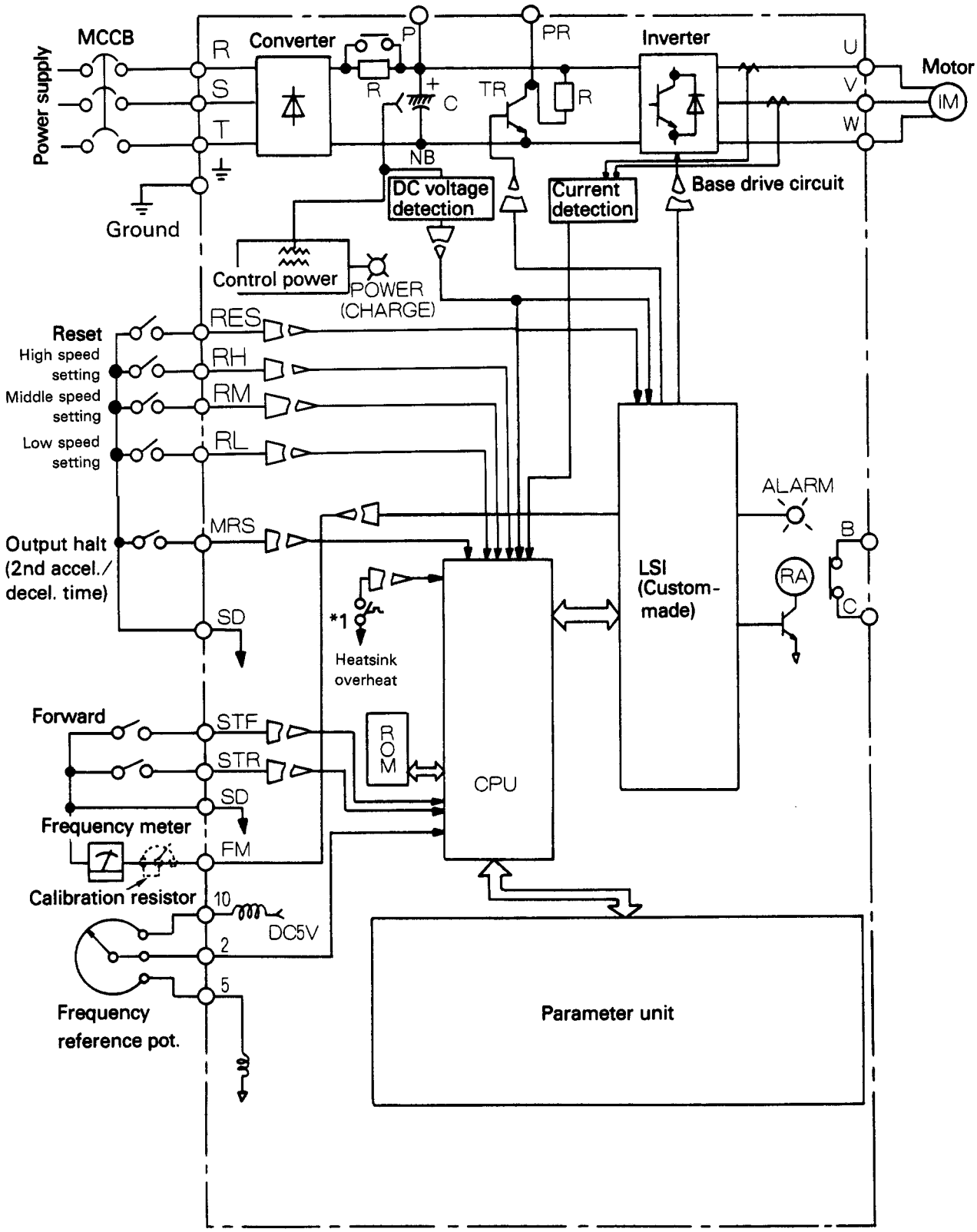
| Model | | | FR-Z120-0.4K-UL | FR-Z120-0.75K-UL | FR-Z120-1.5K-UL | FR-Z120-2.2K-UL | FR-Z120-3.7K-UL |
|---|---|---|---|---|---|---|---|
| Output ratings | Applicable motor capacity (HP/kW) | | 0.5/0.4 | 1/0.75 | 2/1.5 | 3/2.2 | 5/3.7 |
| | Nominal output (kVA) | | 1.1 | 1.9 | 3.1 | 4.2 | 6.5 |
| | Output current (A) | | 3 | 5 | 8 | 11 | 17 |
| | Maximum output voltage (*1) | | Three-phase,200VAC/50Hz,or 200/220/230/60Hz | | | | |
| Power supply | Voltage and frequency | | Three-phase,200VAC/50Hz,or 200/220/230/60Hz | | | | |
| | Permissive voltage regulation | | 180 to 220V(220V±10%)/50Hz,<br>180 to 253V(200V−10%,230V+10%)/60Hz | | | | |
| | Permissive frequency regulation | | ±5% | | | | |
| | Power supply capacity (kVA)(*2) | | 1.5 | 2.5 | 4.5 | 5.5 | 9 |
| Controller specification | Control method | | Sinusoidal wave PWM control system | | | | |
| | Output frequency range | | 0.5−360Hz | | | | |
| | Starting frequency | | 0.5−10Hz adjustable | | | | |
| | Frequency resolution | | 0.01Hz(less than 100Hz),<br>or 0.1Hz(more than 100Hz)···digital setting,<br>or 1/1000 of maximum frequency···analog setting | | | | |
| | Frequency accuracy | | Max. 0.01% of preset output frequency···digital setting<br>Max.±0.5% of maximum output frequency<br>(at 25°C±10°C,77°F±18°F)···analog setting. | | | | |
| | Voltage/frequency characteristic | | Base frequency selectable within 50-360Hz<br>Constant torque or reduced torque pattern is selectable. | | | | |
| | Torque boost | | With manual torque boost | | | | |
| | Braking torque | Regenerative | Min.150%<br>(short time) | | | Min.100%<br>(short time) | |
| | | DC dynamic | Actuated at less than 3Hz | | | | |
| | Overcurrent withstand capability | | 150% for 1 minute,200% for 0.5 seconds | | | | |

(To be continued)

| Model | | FR-Z120-0.4K-UL | FR-Z120-0.75K-UL | FR-Z120-1.5K-UL | FR-Z120-2.2K-UL | FR-Z120-3.7K-UL |
|---|---|---|---|---|---|---|
| Operattional specification | Frequency reference signal | 0 to 5V DC(Input resistance:10kohm) | | | | |
| | 3-speed setting | "HIGHT" , "MIDDLE" and "LOW" ,0−360Hz selectable | | | | |
| | Max./Min.frequency limit setting | Max. limit:0-360Hz<br>Min. limit:0-60Hz | | | | |
| | start signal | Forward("FWD")and reverse("REV")individual | | | | |
| | Accelertion/deceleration time | 0.1 to 3600 sec.(in 0.1 sec.increment)<br>(Acceleration and deceleration times can be set independently.) | | | | |
| | 2nd-acceleration/ deceleration time | 0.1 to 3600 sec.(acceleration and deceleration time are the same) | | | | |
| | Reset signal | Terminals are provided for reset signal. | | | | |
| | Inverter output halt signal | Terminals are provided for inverter output halt signal. | | | | |
| | Alarm output signal | "1b" contact output(normally-closed,230V AC 0.3A) | | | | |
| Protective,alarm and warning functions | | Overcurrent shutoff(three modes), regenerative overvoltage shutoff, overload shutoff(electronic thermal relay), instantaneous power failure protection, brake transistor fault detection, heatsink overheat protection(*3), brake resistor overheat protection, overcurrent stall prevention, | | | | |
| Environment | Ambient temperature | −10°to +50°C,+14°F to+122°F(to be free from freezing) | | | | |
| | Ambient humidity | 90%HR or less(to be free from feezing) | | | | |
| | Atmosphere | Indoor To be free from corrosive gasses and dense dust | | | | |
| | Storage temperature | −20°C to +65°C,−4°F to +149°F,short time for transportation | | | | |
| | Altitude,vibration | Below 1000m,3300ft<br>0.6G or less(conforms to JIS C0911) | | | | |
| Protective structure (JEM 1030) | | Enclosed type(IP20) | | | | |
| Cooling system | | self cooling | | | Fan cooling | |
| Weight (Kg/1bs) | | 3.1/6.8 | 3.3/7.3 | 4.0/8.8 | 6.3/14 | 6.4/14 |

Notes: *1.If line voltage reduces,output voltage over line voltage cannot be guranteed.
*2.Power source capacity indicates the inverter input KVA and may change depending on power supply impedance.
*3.Heatsink overheat protection is not provided for FR-Z120-0.4K to 1.5K.

## 9-3 Block diagram




*1: Heatsink overheat protection is not provided for FR-Z120-0.4K to 1.5K.

**Fig.9-1**

## 9-4 Terminals for wiring

| Symbol | Terminal | Description |
|---|---|---|
| R,S,T | AC power supply input terminals | Connected to commercial power supply (200V/50Hz or 200-230V/60Hz) |
| U, V, W | Inverter output terminals | Connected to three-phase squirrel cage motor. |
| ⏚ | Grounding terminal | Inverter chassis grounding terminal |
| P, PR | Brake resistor terminals | Connected to exclusive external brake resistor (option). |
| 10 | Power supply terminal for frequency reference | 5V DC<br>Allowable maximum load current: 10mA |
| 5 | Common terminal for frequency reference | Common to frequence reference input signal.<br>Not insulated from common circuit of the control circuit.<br>Do not ground this terminal. |
| 2 | Frequency reference input signal | When 0 to 5V is input, maximum output frequency is at a maximum at 5V of input voltage.<br>The output frequency is directly proportional to the input frequency reference signal voltage.<br>Input resistance: 10 kohm<br>Allowable max. voltage: 10V DC |
| SD | Common terminal for contact input | Common to contact input signal and frequency indicator.<br>Insulated from common circuit of inverter control circuit. |
| STF | Forward start input signal terminal | Motor starts rotating in forward direction when STF and SD are short-circuited.<br>Stop when opened. |
| STR | Reverse start input signal terminal | Motor starts rotating in reverse direction when STR and SD are short-circuited.<br>Stop when opened. |
| FM | Frequency indicator (display) output terminal | When inverter is shipped, the signal is set so that about DC5V (FM — SD opened) is output when inverter output frequency is 60Hz.<br>The output voltage is proportional to the output frequency, and has pulse train waveform.<br>Connect 1mA moving coil type DC ammeter. |

(To be continued)

| Symbol | Terminal | Description |
|---|---|---|
| RH | 3-speed select terminal ("HIGHT" speed) | When RH and SD are connected, motor can be driven at high speed set by parameter unit. |
| RM | 3-speed select terminal ("MIDDLE" speed) | When RM and SD are connected, motor can be driven at middle speed set by parameter unit. |
| RL | 3-speed select terminal ("LOW" speed) | When RH and SD are connected, motor can be driven at low speed set by parameter unit. |
| RES | Reset signal input terminal | To reset inverter after tripping, RES and SD are connected for more than 0.1 sec. |
| MRS | Inverter output halt input terminal*1 (2nd acceleration/ deceleration time selection) | Shuts off transistor base to make the motor stop after coasting.<br>Used to shut off inverter output when stopping the motor with a mechanical brake.<br>Before activating brake, short circuit terminals MRS and SD. |
| B,C | Error alarm output terminal | "1b" contact output indicating that base has been shut off by inverter protective function.<br>Normal: B and C blose<br>Error: B and C open<br>(Contact capacity: 230V AC 0.3A, 30V DC 0.3A) |

*1: If 0.1 sec. or longer time is set by parameter unit, 2nd acceleration/deceleration time setting is automatically selected.

## 9-5 Protective functions

The inverter is provided with the following protective functions for protection from overcurrent or overvoltage.

If a protective function is activated, the transistor base current (output) is shut off and the motor stops after coasting. Its cause is displayed by the readout of parameter unit (when parameter unit is used).
For details, refer to the description "PARAMETER UNIT". (P17-1)
To restart the motor, it is necessary to reset the inverter by closing the reset (RES) terminal to SD terminal or by turning off the power supply.

| Function | Description | Remedy |
|---|---|---|
| Overcurrent stall prevention | When 150% (Note 1) or more of the inverter rated current flows to the motor during acceleration, this function stops increasing of frequency until load current reduces to prevent the inverter from overcurrent tripping.<br><br>When 150% (Note 1) or more of the rated current flows during normal (constant-speed) operation, this function reduces frequency until load current reduces to prevent inverter from overcurrent tripping. When load current has reduced below 150%, this function allows increase of frequency up to preset frequency. | Prolong acceleration time or reduce load to prevent recurrence of action of this function. |
| Regenerative overvoltage stall prevention | If converter output voltage is increased excessively by regenerative energy during motor deceleration, this function stops decrease of frequency until converter voltage reduces to prevent inverter from overvoltage tripping.<br><br>As soon as regenerative energy has reduced, this function decreases frequency again to allow deceleration to be continued. | Prolong deceleration time. |
| Overcurrent shutoff<br>(OC1)<br>(OC2)<br>(OC3) | When 200% or more of the inverter rated output current flows, this protective circuit is activated to stop the inverter. | The most possible causes of overcurrent shutoff include inverter output short-circuit, ground fault, excessive load inertia ($GD^2$), extremely short setting of acceleration/deceleration time, start during motor coasting, start of special motor or motor of capaity larger than inverter rating. |

(To be continued)

| Function | Description | Remedy |
|---|---|---|
| | | Restart after examining and removing the cause. |
| Regenerative overvoltage shutoff (OVT) | When converter output overvoltage is caused by regenerative energy from the motor, this protective function is activated to stop and hold transistor off. | This function is activated mainly due to short deceleration time or negative load.<br>Prolong deceleration time (it should be noted that overheat of incroporated brake resistor may cause activation to this function). |
| Instantaneous power failure protection (IPF) (Note 2) | To prevent failure when instantaneous power failure lasting for 15 msec or longer (also when inverter input power supply is shut off for 15 msec or longer) occurs, instantaneous power failure protective function is activated and stops and holds inverter shut off.<br>In this case, alarm output contact is open (across B and C).<br>If power failure continues for more than 100 msec, error alarm output contact is closed (across B and C).<br>(If powr failure is shorter than 15 msec, normal opration is performed.) | If power is switched on after inverter output shutoff, the resultant restart during motor coasting may trip the inverter.<br>To prevent tripping of the inverter, use an automatic restart prevention circuit. |
| Brake transistor fault detection (BE) | If trouble occurs with brake transistor, this function detects it and shuts off inverter output. | Examine thermal capacity of brake resistor and regenerative braking duty (%ED) and use inverter having a larger capatity, if necessary. |
| Overload shutoff (Electronic thermal relay)<br>(THT)<br>(THM) | Electronic thermal relay in the inverter deetects overload of motor during operation under rated conditions, or motor overheating at low speed, and activates this protective function which stops (holds stopped) inverter output.<br>For parallel driving of several motors, the electronic thermal relay cannot protect the motor(s). | Examine the cause of overload, and lighten load, change operation pattern, or use inverter and motor having larger capacities if necessary. |

(To be continued)

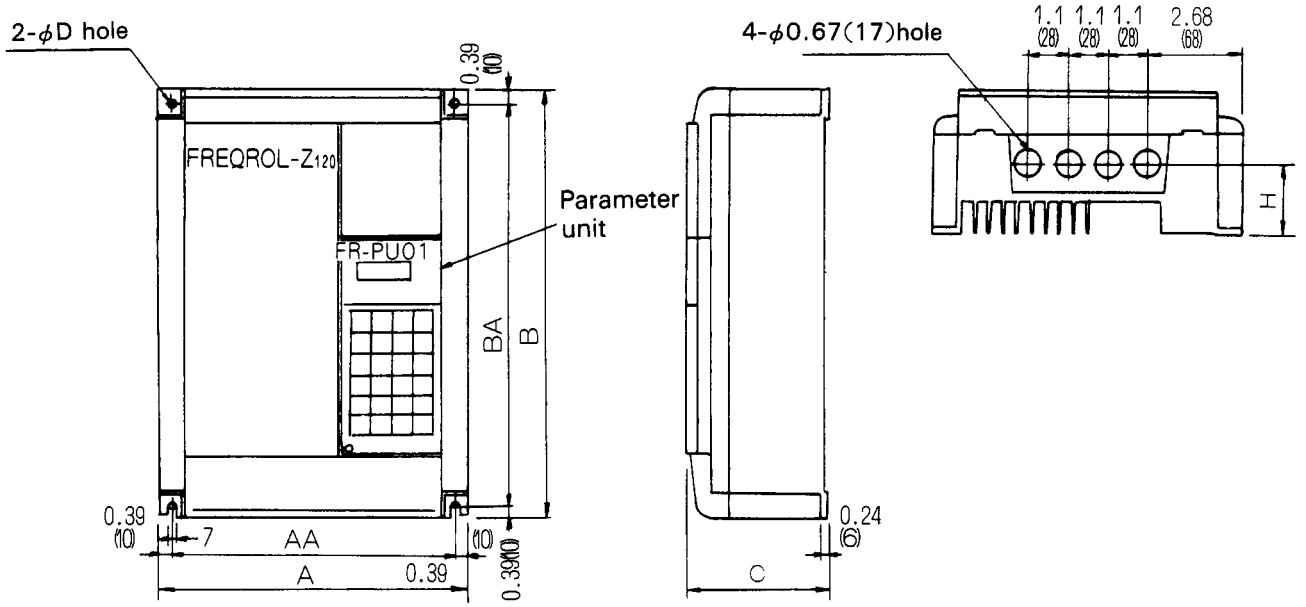
| Function | Description | Remedy |
|---|---|---|
| | Provide a thermal relay on the inverter output side or fit thermistors in each motor.<br>In this case, the electronic thermal relay adjusted to OA position activates transistor protection only. | |
| Heatsink overheat protection (FIN) | Models larger than 2.2K are equipped with cooling fan.<br>If the fan fails to rotate, rotation sensor is activated to shut off (hold shut off) inverter output. | Examine cooling fan operation and ambient temperature. |
| Brake resistor overheat protection | If regenerative brake energy from motor has exceeded the specified value, the brake operation is stopped to protect the brake resistor from overheating.<br>When the brake resistor is cooled, the brake operation automatically restarts. | Prolong acceleration time or change operation sequence to reduce braking duty. |

**Note 1 :**
The stall prevention threshold level is set to "150%" of inverter rated current when the inverter is shipped.
This setting can be changed by user (the overcurrent stall prevention is activated at the threshold level set by user).
Use this function parameter with care.

**Note 2 :**
When inverter power supply circuit is opened or power failure occurs for more than 100 msec, the IPF lamp and error output contact are not activated.

**Note 3 :**
When any protective function (except stall prevention, overload alarm, and brake resistor overheat protection) is activated, a relevant error indicator lamp lights and remain. By opening the inverter power supply circuit using a magnetic contactor (MC), etc., inverter control power is lost and the error signal cannot be held. To hold the error signal, hold the error output contact outside the inverter.

## 9-6 External dimensions




**Note:**
When parameter unit FR-PU01E is not used, an accessory cover is installed in lieu of parameter unit.

**Fig. 9-2**

Unit : inch(mm)

| | A | AA | B | BA | C | D | H |
|---|---|---|---|---|---|---|---|
| FR-Z120-0.4K(P)-UL | 8.66 (220) | 7.87 (200) | 11.81 (300) | 11.02 (280) | 3.94 (100) | 0.27 (7) | 1.93 (49) |
| FR-Z120-0.75K(P)-UL | 8.66 (220) | 7.87 (200) | 11.81 (300) | 11.02 (280) | 3.94 (100) | 0.27 (7) | 1.93 (49) |
| FR-Z120-1.5K(P)-UL | 8.66 (220) | 7.87 (200) | 11.81 (300) | 11.02 (280) | 5.12 (130) | 0.27 (7) | 3.11 (79) |
| *FR-Z120-2.2K(P)-UL | 8.66 (220) | 7.87 (200) | 11.81 (300) | 11.02 (280) | 6.69 (170) | 0.27 (7) | 4.69 (119) |
| *FR-Z120-3.7K(P)-UL | 8.66 (220) | 7.87 (200) | 11.81 (300) | 11.02 (280) | 6.69 (170) | 0.27 (7) | 4.69 (119) |

Models with mark * in the list are equipped with cooling fan.

## 9-7 Selection of peripheral devices

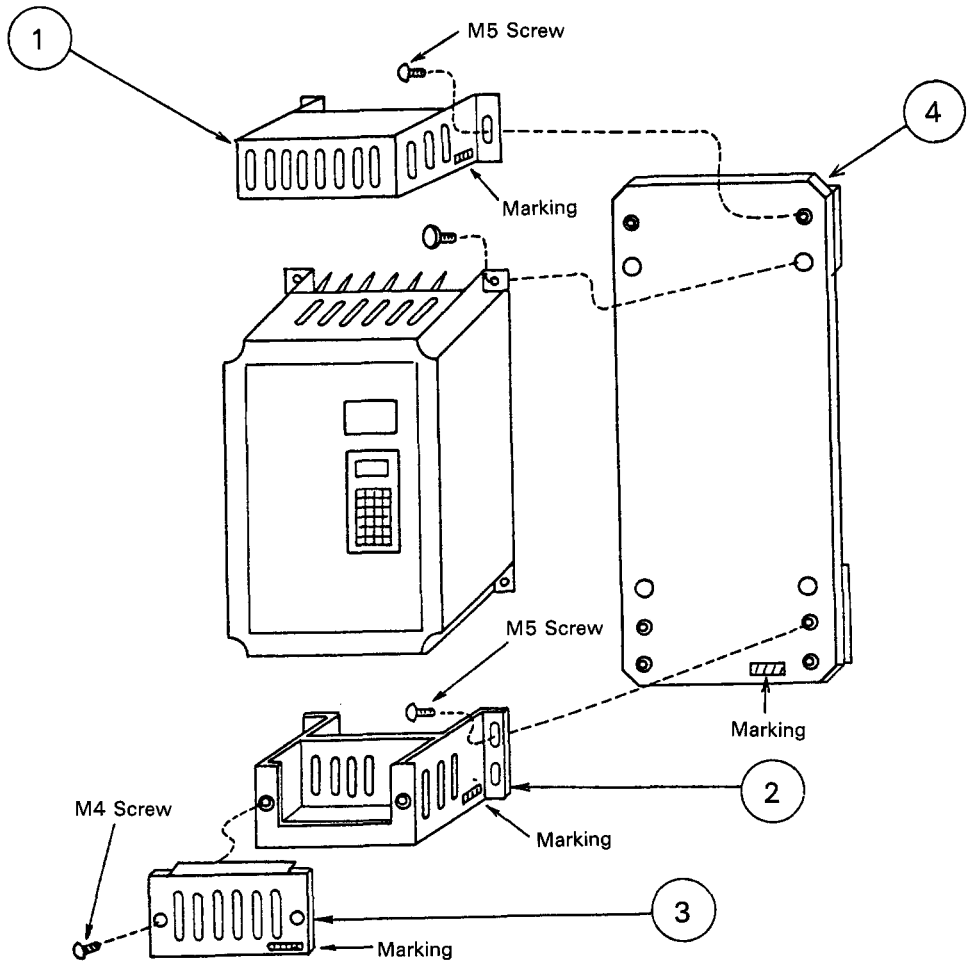
| Moter output (HP/kW) | Inverter model | Circuit breaker(MCCB) | | Magnetic contactor (MC) |
|---|---|---|---|---|
| | | Standard | Equipped with reactor(*1) | |
| 0.5/0.4 | FR-Z120-0.4K-UL | NF30 5A | NF30 5A | S-K10 |
| 1/0.75 | FR-Z120-0.75K-UL | NF30 10A | NF30 10A | S-K10 |
| 2/1.5 | FR-Z120-1.5K-UL | NF30 15A | NF30 15A | S-K10 |
| 3/2.2 | FR-Z120-2.2K-UL | NF30 20A | NF30 15A | S-K11.K12 |
| 5/3.7 | FR-Z120-3.7K-UL | NF30 30A | NF30 30A | S-K20 |

**Notes** : *1.Equipped with power factor correction reactor FR-BAL(option).
*2.Moter cable(U,V,W)size applies to 20m(66ft)or less wiring distance.

## 9.8 Overload protection

External overload protection must be provided to protect the motor in accordance with the National Electrical Code.

## 9.9 Drip shield kits




Marking : Part No. is stamped.

| Inverter type | CAT.No. | Part No. | | | |
|---|---|---|---|---|---|
| | | ① | ② | ③ | ④ |
| FR-Z120-0.4K(P)-UL | TD840A662G55 | D784C012G51 | D784C013G51 | D785C020H01 | D783C500G51 |
| FR-Z120-0.75K(P)-UL | TD840A662G55 | D784C012G51 | D784C013G51 | D785C020H01 | D783C500G51 |
| FR-Z120-1.5K(P)-UL | TD840A662G56 | D784C012G52 | D784C013G52 | D785C020H01 | D783C500G51 |
| FR-Z120-2.2K(P)-UL | TD840A662G57 | D784C012G53 | D784C013G53 | D785C020H01 | D783C500G51 |
| FR-Z120-3.7K(P)-UL | TD840A662G57 | D784C012G53 | D784C013G53 | D785C020H01 | D783C500G51 |

# PARAMETER UNIT

Parameter unit, model FR-PU01E, is directly attached to the inverter (FR-Z series), or connected to the inverter with the cable (option).

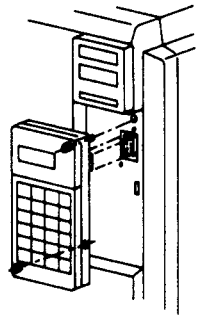
The parameter unit permits the operator to set (read and wirte) various control variables (parameters), and to monitor operation status through its readout.

In this manual, parameter unit is abbreviated as "PU".

## §11 INSTALLATION

The PU can be directly attached to the inverter, or remotely installed and connected to the inverter with the approved cable. It can be attached or connected even when the inverter is operating.

● Direct attachment to inverter



(1) Connection

Engage the plug of PU with the receptacle of inverter and gently press the PU against the inverter.

(2) Securing the PU in position

Lightly tighten two screws to secure the PU in position.

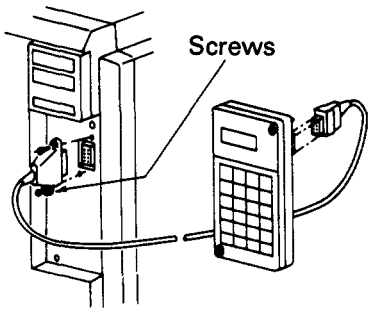
**CAUTION:** (1) The PU should be attached to the inverter with the front cover installed on the inverter.

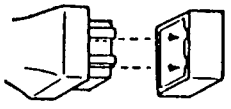
(2) Never operate the inverter with the PU with the front cover removed. To prevent accidental damage to the inverter P.C.B and the PU unit.

(3) If the inverter **must** be operated with the front cover removed, always use the approved extension cable with the PU unit.

(4) Dangerous high voltages are present inside the inverter. Always use with great care and attention.

○ Remote installation using the approved cable connector



Fit the guides to the grooves.

(1) Connection

Plug one end of the cable into the receptacle of inverter, and the other end into the PU.

(2) Locking of plugs

The plug on the inverter side should be locked with screws as shown to the left.

On the PU side, secure the cable so that the cable cannot be disconnected by its own weight.

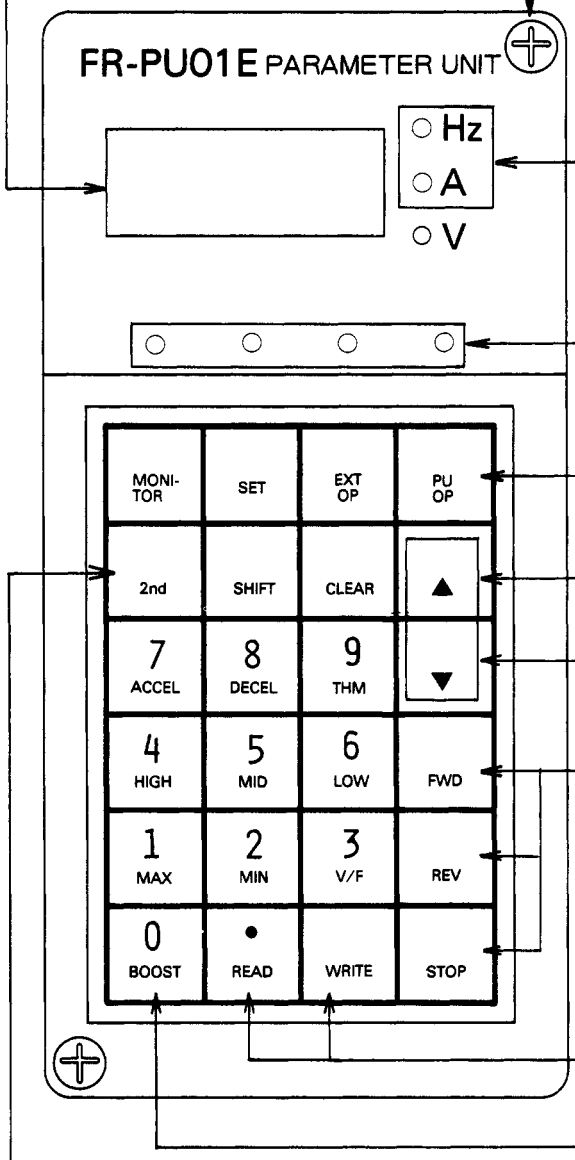
**CAUTION:** (1) For cable, use only that specified by us (available as optional accessory).

(2) The cable plugs and sockets only fit in one position. Do not force plugs into sockets.

# §12. OUTLINE OF FUNCTION

| Function | Description | | Refer to |
|---|---|---|---|
| Selection of operation mode<br><br>"Parameter mode" | Parameter unit can be used as control source for inverter operation | Keys of parameter unit are operated. | Page 14-2 |
| "External mode" | External signals can be used as control source for inverter operation. | Separately installed frequency reference potentiometer, START switch, etc. are operated. | Page 14-2 |
| Setting (read/write) of control variables<br><br>(Monitor/alter) | Set control variable can be read. | Settings are checked. | Page 15-1 |
| | Setting of control variable can be changed. | Change of setting | |
| | User's settings can be reset to the initial settings (settings made at shipment) . . . "ALL CLEAR". | | Page 15-1 |
| | Write parameter can be prohibited. | | Page 15-1 |
| | Frequency meter (indicator) can be calibrated. | | Page 15-1 |
| Monitor | Operation status can be monitored. | Output frequency (Hz) | Page 16-1 |
| | | Motor current (A) | |
| | | Direction of rotation of motor | |
| | | Motor RUN | |
| | Alarm information | | §16, §17 |

# §13. CONTROL DEVICES OF PARAMETER UNIT "ONLY LIGHT FINGER PRESSURE IS NECESSARY"




**DISPLAY (READOUT)**

Frequency, motor current, preset control variables, alarm message, etc. are displayed by this 4-digit readout.

**MOUNTING SCREW**

By loosening these two screws, the unit can be separated from the inverter.

**VARIABLE INDICATOR LAMP**

Control variable to be monitored (frequency, motor current, etc.) is indicated.

**OPERATION MODE INDICATOR LAMPS**

When an operation mode key (MONITOR, SET, EXT OP, PU OP) is pressed, the corresponding lamp lights.

**OPERATION MODE KEYS**

Operation mode can be selected from MONITOR, SET, EXT OP and PU OP. After operation mode is selected, desired control variable can be set, read (checked) or written (changed).

**FREQUENCY ADJUST KEYS**

While it is held down, frequency continously increases or decreases.
(Slowly at first, progressively faster)

**OPERATION KEYS**

Motor rotating direction can be selected and operation can be stopped.

**READ/WRITE KEYS**

Variable setting can be read (checked) by pressing [READ] and written (changed) by pressing [WRITE] after [SET] key is pressed.

**FUNCTION/NUMERAL KEYS**

Function No. of 1st group function and value or frequency can be specified.

**2nd or 3rd group function key (2nd)**

When setting of 2nd or 3rd group function is read or written, this key is pressed. 3rd group function is selected by SHIFT KEY after this key is presed.

**SHIFT KEY**

Variable (frequency, motor current, alarm message) to be monitored is shifted or 3rd group function is selected.

**CLEAR KEY**

If wrong key is pressed during setting, it can be cancelled by pressing this key.

| Key | Description |
|---|---|
| EXT OP | This key is pressed when external signals are used to control the inverter. (Inverter always powers up in this mode) |
| PU OP | This key is pressed when the PU (parameter unit) is used to control the inverter. |
| SET | This key is pressed to read (check) or write (change) setting of variable. |
| MONITOR | This key is pressed to read frequency, motor current, output voltage or alarm message (alarm code). |
| 2nd | 2nd or 3rd group function can be selected. |
| SHIFT | This key is pressed to change variable to be monitored, to select 3rd group function, or to specify JOG mode. |
| CLEAR | This key is pressed to correct wrong key operation, or erase previous entry. |
| ▲ | During operation with the PU, this key is pressed to increase output frequency. |
| | During operation with external signals, this key is pressed to increase reading of externally connected frequency meter. (Calibration mode) |
| ▼ | During operation with the PU, this key is pressed to decrease output frequency. |
| | During operation with external signals, this key is pressed to decrease reading of externally connected frequency meter. (Calibration mode) |
| FWD | During operation with the PU, this key is pressed to make the motor rotate in normal direction. |
| REV | During operation with the PU, this key is pressed to make the motor rotate in opposite direction. |
| STOP | During operation with the PU, this key is pressed to stop the motor. |
| WRITE | This key is pressed to change setting of frequency or other control variable. |
| ● READ | "." is used to specify decimal point. |
| | This key is pressed to check setting of variable. |

| Key | Description (Dual functions) |
|---|---|
| 0 BOOST | "0" ..... Numeral "0" is specified. |
| | "BOOST" ..... Variable "BOOST" is selected. |
| 1 MAX | "1" ..... Numeral "1" is specified. |
| | "MAX" ..... Variable "MAXIMUM FREQUENCY LIMIT" is selected. |
| 2 MIN | "2" ..... Numeral "2" is specified. |
| | "MIN" ..... Variable "MINIMUM FREQUENCY LIMIT" is selected. |
| 3 V/F | "3" ..... Numeral "3" is specified. |
| | "V/F" ..... Variable "V/F" (base frequency) is selected. |
| *1 4 HIGH | "4" ..... Numeral "4" is specified. |
| | |
| *1 5 MID | "5" ..... Numeral "5" is specified. |
| | |
| *1 6 LOW | "6" ..... Numeral "6" is specified. |
| | |
| 7 ACCEL | "7" ..... Numeral "7" is speecified. |
| | "ACCEL" ..... Variable "ACCELERATION TIME" is selected. |
| 8 DECEL | "8" ..... Numeral "8" is specified. |
| | "DECEL" ..... Variable "DECELERATION TIME" is selected. |
| 9 THM | "9" ..... Numeral "9" is specified. |
| | "THM" ..... Variable "ELECTRONIC THERMAL RELAY OPERATING CURRENT" is selected. |

Note: *1 Three speed setting (HIGH, MID, LOW) is not available on this model.

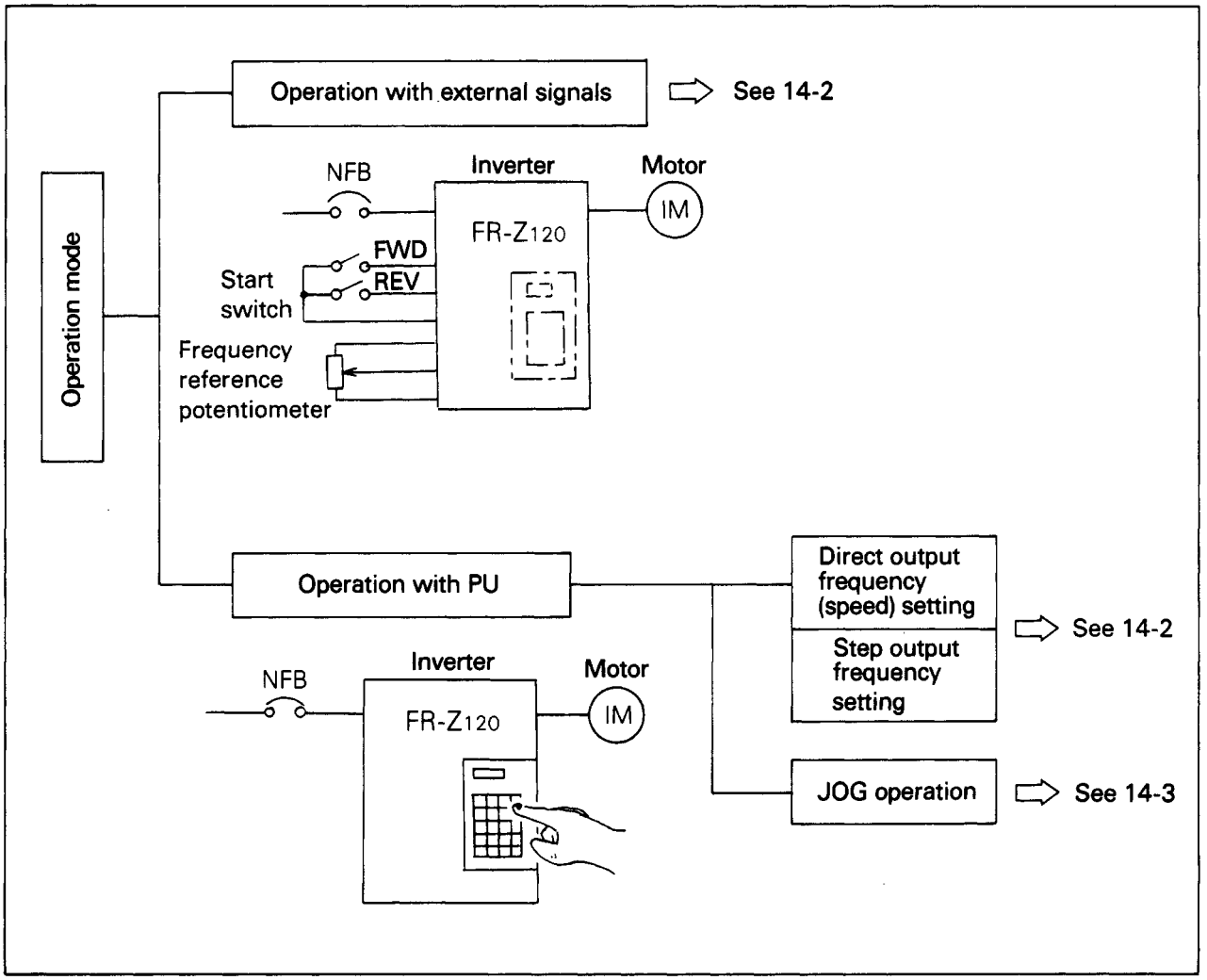
# §14. OPERATION

## 14-1 Operation modes

The inverter can be operated either with external signals, or with PU (parameter unit).

Selection of operation mode (external signal mode or parameter mode) can be made by pressing key of PU.

It is possible to fix operation mode. (FUNCTION 79)




INITIAL OPERATION MODE

When the power is turned on (or CLEAR key is pressed to reset), "external signal operation" mode is automatically selected and the inverter can be operated with external signals ..... the motor starts when START signal (STF - SD or STR - SD closed) is given.

HOW TO FIX OPERATION MODE (FUNCTION 79)

Initial setting of operation mode can be changed so that "PU operation" mode is automatically selected whenever the power is turned on.

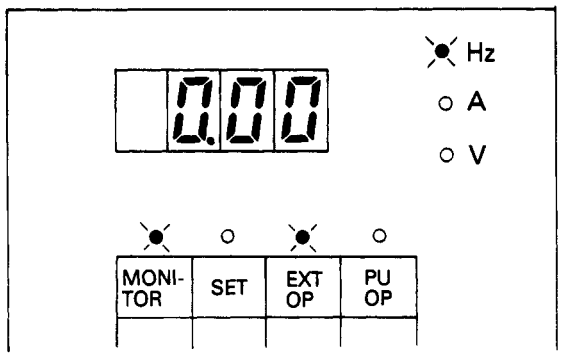
For details, refer to §19

## 14-2 Operation with external signals

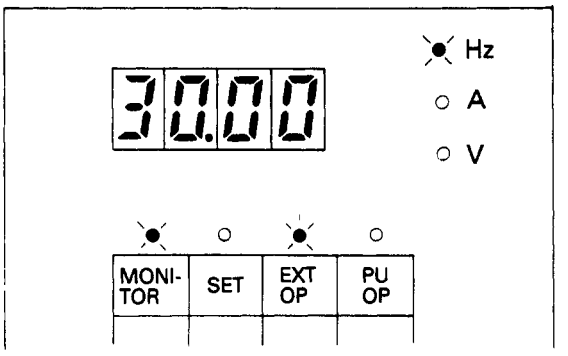
When "PU operation" mode has been selected, press [EXT OP] key to select "external signal operation" mode (check that the indicator lamp of selected operation mode lights).

**Example of operation and indication**

○When the inverter is turned on or [EXT OP] key is pressed .....




○During operation with external frequency reference set at 30Hz .....




Note: ✱ and ○ show that lamp lights and does not light respectively.

(1) When "external signal operation" mode is selected, "MONITOR" mode is automatically selected and output frequency is displayed by the readout (see §16).

(2) While inverter output is on (during rotation of the motor), the mode indicator lamp just above [EXT OP] key flickers (the same occurs druing DC dynamic brake operation).

**CAUTION:** Changing operation mode from "PU operation,, to "External signal operation"

Operation mode cannot be changed when START signal is on (STF - SD or STR - SD is closed).

Before changing operation mode, START signal should be turned off and it should be verified that the motor stops completely.

## 14-3 Operation with PU

To operate the inverter with the PU press [PU OP] Key.

After that, the inverter can be started and stopped by pressing keys of PU (without use of externally installed frequency reference potentiometer and START switch).
In this operation mode, it is also possible to jog the motor by pressing keys of PU.

IMPORTANT NOTE

If the inverter is turned off or reset, operation mode changes from "PU operation" to "external signal operation" (initial mode setting).

(1) DIRECT OUTPUT FREQUENCY SETTING

PU OP · Desired frequency · WRITE · FWD (or REV ) · STOP

(2) OUTPUT FREQUENCY SETTING, USING ▼ OR ▲ KEY (STEP SETTING)

PU OP · ▲ (or ▼ ) · WRITE · FWD (or REV ) · STOP

This method of setting corresponds to the method where externally installed ferquency reference potentiometer is used. While ▼ or ▲ key is held down, frequency increases (or decreases) continuously.
Increase (or decrease) of frequency is slow immediately after key is pressed, and becomes faster with time.

(3) JOG operation

To jog the motor, perform the following operation:

PU OP · SHIFT · FWD (or REV )

The motor starts and runs only while FWD or REV key is held down.

- When the motor is started by pressing START key( FWD or REV ), MONITOR mode is selected automatically and output frequency is displayed.
- While inverter output is on (during rotation of the motor), the mode indicator lamp just above PU OP flickers (the same occurs during DC dynamic brake operation).

Examples of operation and indication

○ Example where 60Hz is set for desired output frequency (from srtart to 60Hz)

| | Set to 60Hz | | Start | Stop |
|---|---|---|---|---|
| Key | 6 · 0 | WRITE | FWD or REV | STOP |
| Indication | 60 Hz A V | 60.00 ↕ Alternate F | 60.00 Hz A V | 0.00 Hz A V |

○ Example where speed is changed during operation (from 60Hz to 30Hz)

| | (Set to 60Hz) | | Set to 30Hz | |
|---|---|---|---|---|
| Key | ——— | PU OP | 3 0 | WRITE |
| Indication | 60.00 ☼ Hz ○ A ○ V | 60.00 | 30 | 30.00 ↕ Alternate F |

Pressing PU OP clears alternating display and sets to selected frequency.

**Note:**
Direct setting of output frequency is impossible while the MONITOR mode indicator lamp is on.
To set output frequency, press PU OP key to break MONITOR mode.

● JOG operation

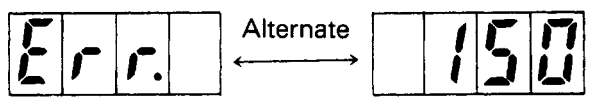
| | JOG mode selection | Operation* |
|---|---|---|
| Key | PU OP · SHIFT | FWD (or REV) |
| Indication | JOG ○ Hz ○ A ○ V ○ ○ ○ ☼ | * 5.00 ☼ Hz ○ A ○ V ☼ ○ ○ ☼ |

*If the motor does not start, check the starting frequency.
(FUNCTION 13)
You cannot jog at 5Hz, if "Min. Frequency" is set higher than 5Hz.
(FUNCTION 2)
Reset 13 and 2.

**Notes:**
1. JOG mode cannot be selected while the motor is in operation. Press STOP key to stop the motor and then select JOG mode.
2. To break JOG mode operation, press PU OP key
3. Desired frequency and acceleration/deceleration time for JOG mode operation can be set by specifying the corresponding function (control variable). (FUNCTION 15 and 16)

   When the inverter is shipped, the JOG frequency and acceleration/deceleration time are set to 5Hz and 0.5sec., respectively (it takes 0.04sec. for increase of frequency up to 5Hz).

## 14-4 Caution for operation

| | | |
|---|---|---|
| 1. | Selection of operation mode | Operation mode cannot be changed during operation of the inverter. Note that an operation mode indicator lamp flickers during operation of the inverter.<br><br>When external start signal is on, operation mode cannot be changed from "PU operation" to "external signal operation" (turn off the signal before changing operation mode). |
| 2. | Digits of numerical value and decimal point | (1) To specify numerical value, maximum 4-digit numerals can be entered (if a nemerical value of more than 4 digits is entered, the first digit is ignored).<br><br>Ex.: 12345 ..... "2345" is entered.<br><br>(2) When "0.**" (* is for any numeral) must be entered, "0" should not be omitted.<br>If ".**" is entered, it is read as "**". |
| 3. | Range of setting | (1) Direct setting (reference frequency is set by operating ten keys)<br>If a value above the pre-set frequency is entered in direct setting, an error occurs.<br>In this case, press [CLEAR] key and enter correct value below pre-set value.<br>Range of setting ... From the minimum frequency limit to the maximum frequency limit. (When the product is shipped, the maximum and minimum frequency limits are set to 0Hz and 120Hz respectively.)<br>Ex.: If "150Hz" is entered, error is displayed as shown below.<br>  <br>This is because the maximum frequency (FUNCTION 1) is already pre-set to 120Hz.<br><br>(2) Step setting ( [▲] and/or [▼] key is pressed to specify reference frequency).<br><br>Reference frequency can be set within the specified range (from maximum frequency limit to minimum frequency limit).<br>If key is held down while frequency is at the maximum or minimum limit value, the frequency remains unchanged. |
| 4. | Conditions under which reference frequency (or speed) is unacceptable (PU operation mode) | (1) "External signal operation" mode is selected.<br><br>(2) MONITOR mode is selected (step setting is posible during MONITOR mode).<br><br>(3) Reference frequency (speed) is out of the specified range. (Above or below pre-set max and min frequency.) (FUNCTION 1 and 2) |

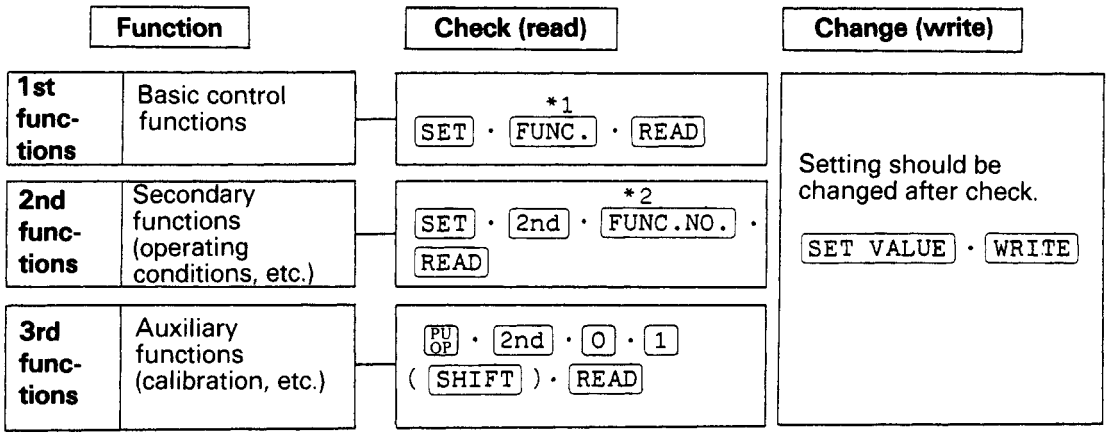
# §15. SETTINGS OF CONTROL VARIABLES (PARAMETERS)

The inverter has various control functions. To assure the best performance from your inverter and motor, these functions should be used with care and thought for application to the driven machine.

These functions can be set, and setting can be checked or changed by operating the PU.

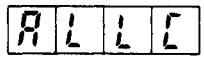
## 15-1 Control functions and setting method

| 1 | "READ" and "WRITE" of function . . . . . See P. 18-1 |
|---|---|




| 2 | "ALL CLEAR" . . . . . By performing the following operation, user's settings are reset to the initial settings (i.e., setting made at shipment of inverter). |
|---|---|

PU OP · SET · 2nd · 8 · ● · 9 · ● · WRITE

After WRITE is pressed,  appears and flickers.

| 3 | Prohibition of parameter WRITE |
|---|---|

PU OP · SET · 2nd · 7 ACCEL · 7 DECEL · 1 MAX · WRITE

| 4 | Calibration of frequency meter . . . . . Calibration using PU |
|---|---|

(1) Set the frequency for meter full-scale reading*

(2) Press [FWD] or [REV] key to start the motor.

(3) Press the following keys to select CALIBRATION mode.

[PU OP] [2nd] [0] [1]

[PU OP] [6] [0] [WRITE]

When output frequency at 5V of frequency reference voltage is 60Hz.

(4) While observing the pointer of frequency meter, press [▲] or [▼] key ..... reading will increase or decrease.

(5) When the meter has been calibrated, press [WRITE] key.

(6) Press [STOP] key to stop the motor.

*: For full-scale reading, "output frequency at 5V of frequency reference voltage" is specified.

**Note:**
When "prohibition of parameter WRITE" has been set, frequency meter cannot be calibrated.

## IMPORTANT NOTE

This frequency inverter allows you access to multiple control variables which must be used with care. It has been fully tested to perform to it's own control parameters. But this may not be the case of the electric motor to which it is to be applied.
If you require to increase the speed of any electric motor over it's rated nameplate speed, then you must check with the motor manufacturer first, that the motor will operate safely and satisfactorily and that you are not excèeding any electrical or mechanical design parameters of the motor.

If in doubt————ASK.

### 15-2 Examples of operation

(1) Setting of 1st function (acceleration/deceleration time)

| | 1st function | Setting of acceleration time | Read present value | Change to 10 sec. | Write |
|---|---|---|---|---|---|
| Key | [SET] → | [7 ACCEL] → | [● READ] → | [1] [0] → | [WRITE] |
| Display | PR ○ Hz ○ A ○ V ○ ● ○ ● | PR 7 | 5.0 (5 sec.) Initial setting | 10 (10 sec.) | 10 ↕ Alternate. PR 7 |

**Note:**
When another 1st function must be set after the 1st function has been set, the new desired function can be called by just pressing the corresponding functin key (that is, [SET] key is not required to be pressed).

(2) Setting of 2nd function (frequency reference for JOG operation)

| | Selection of 2nd function | Setting of frequency for JOG operation | Read present value | Change to 10 Hz | Write |
|---|---|---|---|---|---|
| Key | SET 2nd → | 1 5 → | READ → | 1 0 → | WRITE |
| Display | P r. Hz A V | P r. 1 5 | 5.0 0 (5Hz) Initial setting | 1 0 (10Hz) | 1 0.0 0 ↕ Alternate. P r. 1 5 |

**Notes:**

1. A dot is placed after P r when the 2nd function is selected, like P r..
2. When another 2nd function has to be set immediately after a 2nd function has already been set, the new desired function can be called by pressing 2nd key, and specifying the function No. ( SET key is not required to be pressed).

(3) Setting of 3rd function (examples of bias and gain settings for frequency reference voltage signal)

| | Selection of 3rd function |
|---|---|
| Key | PU OP 2nd 0 1 |
| Display | C - 1 Hz A V |

| Bias | Read | Set to 10Hz | Write |
|---|---|---|---|
| SHIFT | READ | 1 0 | WRITE |
| C - 2 | 0 (0HZ) | 1 0 (10Hz) | 1 0 ↕ Alternate C - 2 |

Note:
Do not input frequency reference signal across terminals 2 and 5.

| Gain | Read | Set to 120Hz | Write |
|---|---|---|---|
| SHIFT SHIFT | READ | 1 2 0 | WRITE |
| C - 3 | 6 0.0 0 | 1 2 0 (120Hz) | 1 2 0.0 ↕ Alternate C - 3 |

Note:
Do not input frequency reference signal or use 5V input signal.

Note:
For calibration of frequency meter, see P. 15-2.

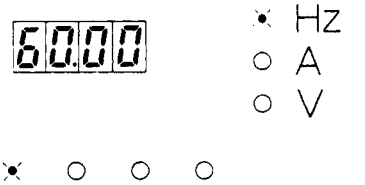
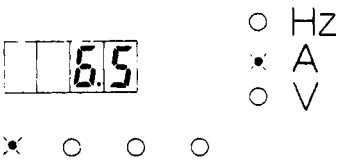
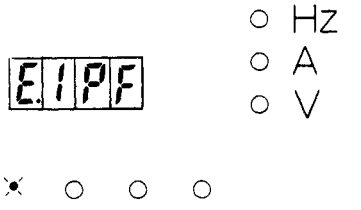
## 15-3 Caution

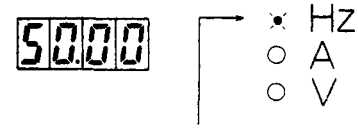
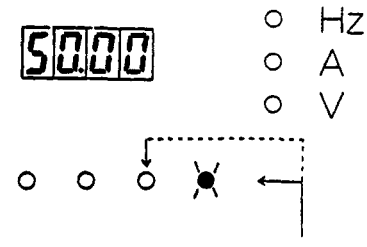
| | | |
|---|---|---|
| 1 | READ function | READ is possible in "external signal operation" mode as well as "PU operation" mode.<br>It is also possible even during operation of motor. |
| 2 | WRITE function | WRITE is possible only in "PU operation" mode.<br>It is impossible during operation of motor (setting of function No. 10 (PWM mode), however, can be changed during operation of motor). |
| 3 | Selection of 3rd function | READ and WRITE of 3rd function are possible only in "PU operation" mode. |
| 4 | ERROR ( E r r. ) display | Error appears when,<br>(1) WRITE is tried during operation of motor, or<br>(2) entered value is out of the specified range, or<br>(3) illegal function No. is set, or<br>(4) WRITE is tried during "external signal operation" mode, or<br>(5) WRITE is tried while parameter WRITE has been prohibited (see §15. and §19.). |
| 5 | Clear of ERROR display | Error condition can be cleared as follows:<br>(1) Press [CLEAR] key.<br>(2) If error is caused by setting illegal function No. (see §18.), press [SET] key. |

# §16. MONITOR

Output frequency, motor current, direction of rotation of motor, and alarm condition can be monitored by performing operations described below.

MONITOR is possible after [MONITOR] key is pressed.

| | Operation | Display example |
|---|---|---|
| Output frequency | Inverter ouput frequency can be read by pressing [MONITOR] key.<br><br>Note:<br>If [PU/OP] key is pressured during monitoring, MONITOR mode is cancelled and the preset output frequency id displayed. |  |
| Motor current | Motor current can be read by pressing [SHIFT] key.<br><br>Note:<br>Motor current during acceleration or deceleration can be also displayed.<br>Displayed current, however, will not change if acceleration or deceleration is momentary. |  |
| Alarm condition | Alarm code can be read by pressing [SHIFT] twice successively.<br><br>Notes:<br>1. The function is capable of storing a maximum of four alarm codes.<br>Stored alarm codes can be read one after another (see §7. for alarm codes).<br><br>How to read alarm codes<br><br>Display of latest alarm → [READ] 3rd alarm → [READ] 2nd alarm → [READ] 1st alarm<br><br>○ When [READ] key is pressed, the latest alarm code appears again.<br>○ When [SHIFT] key is pressed, the output frequency at the time is displayed.<br><br>2. Stored alarm codes are held even after the inverter is turned off. |  <br><br>(1) For the latest alarm, a dot is placed by after E (see an example shown above).<br>(2) If no alarm has been stored, the display is as shown below.<br><br>  |

| | Operation | Display example |
|---|---|---|
| Directon of rotation | During "PU operation" or "external signal operation" mode, direction of rotation of the motor can be checked through the MONITOR indicator lamp.<br>FORWARD ... "Hz" (or "A") lamp lights.<br>REVERSE "Hz" (or "A") ... lamp flickers. |  <br>**This lamp flickers when the motor rotates in reverse direction.** |
| Operation status | Status of inverter during operation can be monitored through the OPERATION MODE indicator lamps (lamps just above EXT OP or OP PU key).<br>The lamp which corresponds to the selected mode flickers during operation of motor. |  <br>**During operation, either one of these lamps flickers.** |

# §17. DISPLAY

## 17-1 Alarm display

If failure occurs during operation of the inverter, an alarm code is displayed automatically.

| Alarm code | | Description |
|---|---|---|
| Display | Code | |
| E0C 1 | EOC1 | Inverter output current exceeded the overcurrent limit during acceleration. |
| E0C 2 | EOC2 | Inverter output current exceeded the overcurrent limit during constant-speed operation. |
| E0C 3 | EOC3 | Inverter output current exceeded the overcurrent limit during deceleration. |
| E0uF | EOVT | Braking regenerative power from motor exceeded the regenerative overvoltage limit. |
| ETHn | ETHM | Electronic thermal relay in the inverter was activated (current is below 150% of preset current). |
| ETHF | ETHT | Electronic thermal relay in the inverter was activated (current is over 150% of preset current). |
| EIPF | EIPF | Instantaneous power failure protective function was activated. |
| EFIn | EFIN | Cooling fan failed to rotate. |
| E bE | E BE | Brake transistor fault detection. |
| E0LF | EOLT | Stall preventive function was activated during constant-speed operation and stopped the motor. |
| E PE | E PE | Memory in the inverter is corrupted. |

## 7-2 Indicator lamps in MONITOR mode

| Indication | Description | |
|---|---|---|
| ○ Hz | Frequency is displayed. | If stall preventive function is activated during MONITOR mode, all MODE lamps, other than that selected flicker. |
| ○ A | Motor current is displayed. | |
| ○ V | Not used. | |

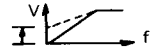
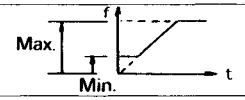
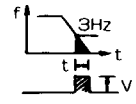
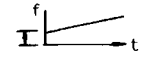
## 17-3 Characters appearing in readout

The alphanumerics which appear in the readout are as listed below.

| Letter | Display |
|---|---|
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |

| Letter | Display |
|---|---|
| A |  |
| B |  |
| C |  |
| E |  |
| F |  |
| G |  |
| H |  |
| I |  |
| J |  |
| L |  |

| Letter | Display |
|---|---|
| M |  |
| N |  |
| O |  |
| P |  |
| T |  |
| U |  |
| V |  |
| r |  |
| - |  |

| Function No. (Parameter) | | Function | Range of setting | Least setting increment | Initial setting | Refer to | Remarks |
|---|---|---|---|---|---|---|---|
| Non | | Operating frequency | 0 — 360Hz | 0.01Hz*1 | 0Hz | P.14 — 3 | |
| 1st function | 0 | Torque boost (manual) | 0 — 30% | 0.1% | 6% | P. 19 — 4 |   |
| | 1 | Max. frequency limit | 0 — 120Hz | 0.01Hz*1 | 120Hz | P.19 — 2 |   |
| | 2 | Min. frequency limit | 0 — 60Hz | 0.01Hz | 0Hz | P.19 — 2 | |
| | 3 | V/F (base frequency) | 50 — 360Hz | 0.01Hz*1 | 50Hz | P.19 — 4 |   |
| | 7 | Acceleration time | 0.1 — 3600 sec. | 0.1 sec.*2 | 5 sec. | P.19 — 3 | Time from starting to the frequency set by function No. 20. |
| | 8 | Deceleration time | 0.1 — 3600 sec. | 0.1 sec.*2 | 5 sec. | P.19 — 3 | Time from the frequency set by function No. 20 to zero Hz. |
| | 9 | Electronic thermal relay (overheat) | 0 — 999.9A | 0.1A | Inverter rated current | P.19 — 3 | Model: 0.4 / 0.75 / 1.5 / 2.2 / 3.7<br>Setting: 2.6 / 4.3 / 8.0 / 11.0 / 17.0 |
| 2nd function | 10 | "PWM" mode | 0 — 6 | Integer | 3 | P.19 — 5 | Carrier frequency is changed. |
| | 11 | DC dynamic brake time | 0 — 10 sec. | 0.1 sec.*2 | 0.5 sec. | P19 — 5 |   |
| | 12 | DC dynamic brake voltage | 0 — 20% | 1% | 8% | P.19 — 5 | |
| | 13 | Starting frequency | 0.5 — 10Hz | 0.01Hz | 0.5Hz | P.19 — 6 |   |
| | 14 | Load pattern selection | 0 or 1 | Integer | 0 | P.19 — 5 | 0: For constant-torque operation<br>1: For reduced torque operation |
| | 15 | JOG frequency | 0 — 360Hz | 0.01Hz*1 | 5Hz | P.19 — 6 | |
| | 16 | JOG acceleration/ deceleration time | 0.1 — 3600 sec. | 0.1 sec.*2 | 0.5 sec. | P.19 — 6 | Time from starting to the frequency set by function No. 20 |

| Function No. (Parameter) | | Function | Range of setting | Least setting increment | Initial setting | Refer to | Remarks |
|---|---|---|---|---|---|---|---|
| 2nd function | 17 | 2nd acceleration/ deceleration time | 0.1 — 3600 sec. | 0.1 sec.*2 | 0 sec. | P.19 — 3 | The function of terminal MRS is changed to "Output shutoff" when "0 sec." is set. |
| | 18 | High-speed maximum frequency | 120 — 360Hz | 0.1Hz | 120Hz | P.19 — 2 | Set maximum frequency over 120Hz. |
| | 20 | Frequency at 5V input voltage | 1 — 360Hz | 0.01Hz*1 | 60Hz | P.19 — 2 | Same as setting for 3rd function |
| | 21 | Stall prevention level | 120 — 180% | 10% | 150% | P.19 — 6 | 0% setting prohibits "stall prevention". |
| | 30 | Regenerative brake duty | 0 — 30% | 1% | 3% | P.19 — 6 | An externally connected resistor is necessary when setting is over 4% (option). |
| | 77 | Parameter WRITE prohibition | 0 or 1 | Integer | 0 | P.19 — 1 | |
| | 78 | Reversing prevention | 0 or 1 | Integer | 0 | P.19 — 1 | |
| | 79 | Operation mode selection | 0, 1, or 2 | Integer | 0 | P.19 — 1 | |
| 3rd function | C-1 | Frequency meter calibration | — | — | 60Hz | P.19 — 7 | For external meter, that of 1mAFS is required. |
| | C-2 | Bias for frequency reference voltage signal | 0 — 120Hz | 0.01Hz*1 | 0Hz | P.19 — 7 | For input equal to 0V |
| | C-3 | Gain for frequency reference voltage signal | 1 — 360Hz | 0.01Hz*1 | 60Hz | P.19 — 7 | For input equal to 5V |

Notes *1 0.1 Hz for the setting beyond 100 Hz.
*2 1 sec for the setting beyond 1000 Sec.

# §19. DETAILS OF EACH FUNCTION

## OPERATION MODE SELECTION, PARAMETER WRITE PROHIBITION AND REVERSING PREVENTION

### Parameter WRITE prohibition [7] [7]

WRITE parameter can be prohibited.

| Setting | Description |
|---|---|
| "0" | WRITE parameter is possible.<br>(Initial setting) |
| "1" | WRITE parameter is impossible. (Note) |

Note: Function (parameter) No. 77 and 79 can still be written.

### Reversing prevention [7] [8]

Reversing of motor operation can be prevented.

| Setting | Description |
|---|---|
| "0" | Motor operation can be reversed.<br>(initial setting) |
| "1" | Motor operation cannot be reversed. (Note) |

Note: Reversing is impossible in "PU operation" mode as well as in "external signal operation" mode.

### Operation mode selection [7] [9]

Operation mode can be fixed to either "PU operation" or "external signal operation", or both.

| Setting | Description |
|---|---|
| "0" | Switching between "PU operation" and "external signal operation" is possible. (Initial setting) |
| "1" | Only "PU operation" is possible. |
| "2" | Only "external signal operation" is possible. |

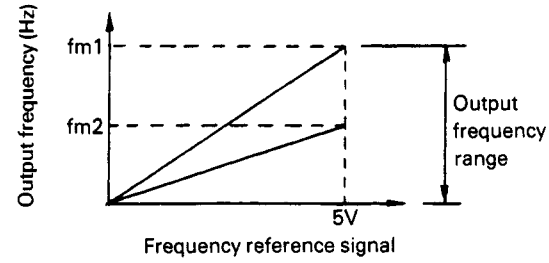
Note: Function (parametr) No. 79 can be changed even in "external signal operation" mode.

## MAXIMUM OUTPUT FREQUENCY SETTING

Frequency with reference voltage signal at 5V [2] [0]

Output frequency at DC5V of frequency reference signal can be set. That is, the maximum output frequency in "external signal operation" mode is set.

Acceleration/deceleration time is the time taken for acceleration or deceleration up to the maximum frequency.




Note: The set maximum frequency changes automatically when setting of "gain for frequency reference voltage signal" (see p. 15-3) is changed. Since this function has the priority level same as that of 3rd function (C-3), priority is given to the latest set function, when this function is set together with a 3rd function.

## MAXIMUM/MINIMUM FREQUENCY LIMIT

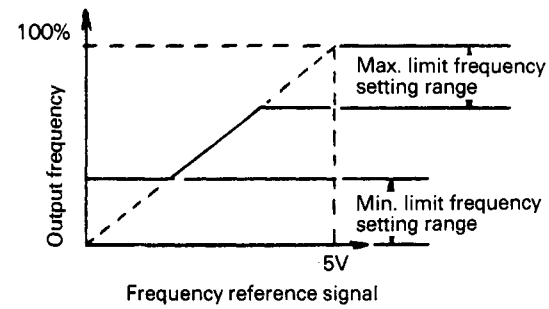
Maximum frequency limit [1]

Minimum frequency limit [2]

Output frequency can be clamped to desired maximum and/or minimum frequency.

**Notes:**

1. When minimum limit frequency is set, it should be higher than the starting frequency (see "Starting frequency setting", P. 19-6).
2. Maximum limit frequency may not be higher than 120Hz.




High-speed maximum frequency limit [1] [8]

Maximum limit frequency can be set to a frequency higher than 120Hz for exceptionally high-speed operation.
The maximum frequency limit set by the 1st function is overriden by this setting.

## ELECTRONIC THERMAL RELAY SETTING

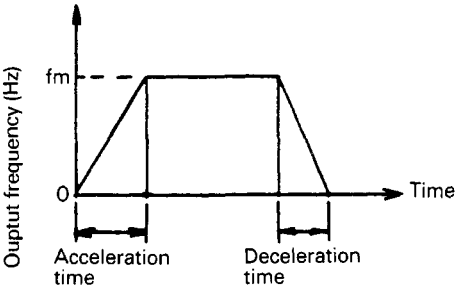
Electronic thermal relay [9]

To protect the motor from overheating, motor rated current value can be set directly in amperage.
When the inverter is shipped, it is set to the rated output current of inverter. See standard spec. Page 9-1.

## ACCELERATION/DECELERATION TIME SETTING

Acceleration time [7]  Deceleration time [8]

Acceleration/deceleration time can be set within the range from 0.1sec. to 3,600sec.
Acceleration time is the time taken for acceleration to output frequency (fm) set by function No. 20 (frequency at 5V input voltage) ..... (same for acceleration time in JOG operation, and for 2nd acceleration/deceleration time).



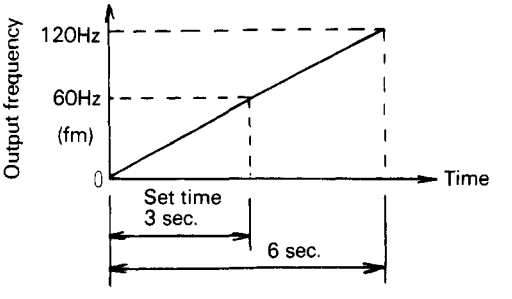

Initial setting ..... 5 sec.

2nd acceleration/deceleration time [1] [7]

Terminal MRS can be used for "output shutoff" and "2nd acceleration/deceleration time control".
When 2nd acceleration/deceleration time is set to zero second, the terminal MRS can be used for "output shutoff".
When 2nd acceleration/deceleration time is set to 0.1 second or larger, the terminal MRS can be used for "2nd acceleration/deceleration time control" (when the inverter is shipped, it is set for "output shutoff".)

Example in "PU operation" mode

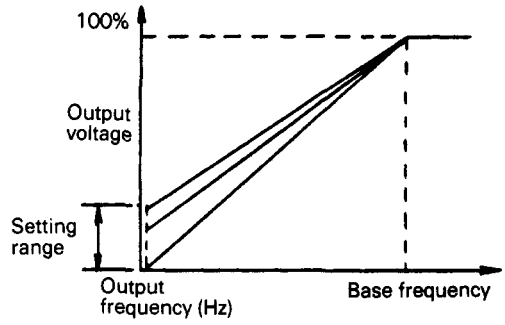
When the inverter is operated at 120Hz of output frequency with "frequency at 5V input voltage" set at 60Hz, and acceleration time set at 3sec., the acceleration time is 6sec.



## MOTOR TORQUE ADJUSTING (TORQUE BOOST)

Torque boost (manual) [0]

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



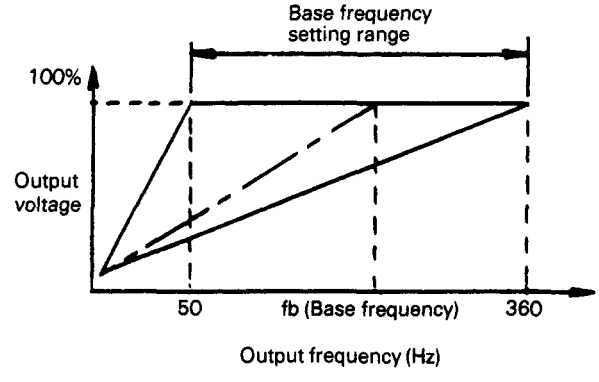

Initial setting ..... 6%

**Note:** If setting is excessively large, overcurrent trip may occur. It is recommended to set while observing motor current (use MONITOR function).

## VOLTAGE/FREQUENCY (V/F) CHARACTERISTIC SETTING

V/F (base frequency) [3]

Base frequency (frequency at the rated motor torque) can be set in accordance with the motor rating within the range from 50Hz to 360Hz.



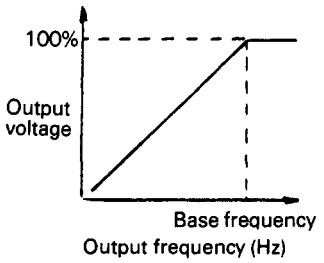
## LOAD PATTERN SELECTION

Load pattern selection [1][4]

V/F characteristic which match load characteristic can be selected.

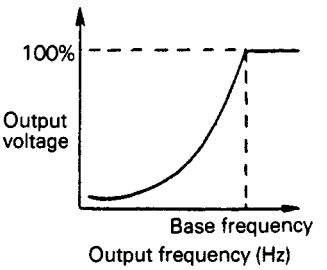
Setting "0" (initial setting)

For constant-torque load
(conveyor, carriage, etc.)




Setting "1"

For reduced torque load
(fan, pump, etc.)




Desired V/F characteristic can be obtained by co-ordinating this setting with "torque boost" and "V/F" settings.

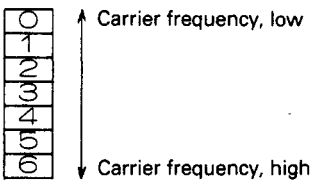
## PWM MODE

PWM mode [1][0]

**By changing carrier frequency (hertz), motor sound and vibration can be reduced. 80Hz per graduation change.**

**One of 7 carrier frequencies can be selected.**

**Note:** Initial setting is "3".

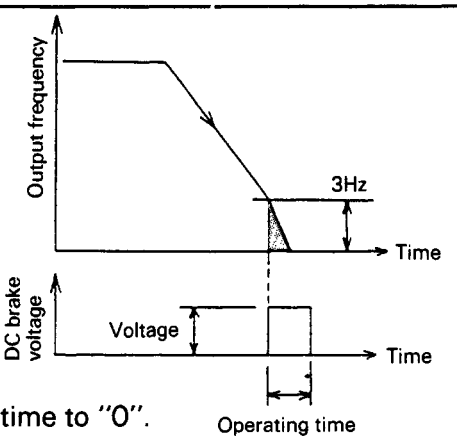



## DC DYNAMIC BRAKE SETTING

DC dynamic brake time [1][1]

DC dynamic brake voltage [1][2]

Accuracy in stop position can be adjusted by setting the DC dynamic brake torque (voltage) and braking time (time taken for braking).
The DC dynamic brake is turned on when output frequency is blow 3Hz.



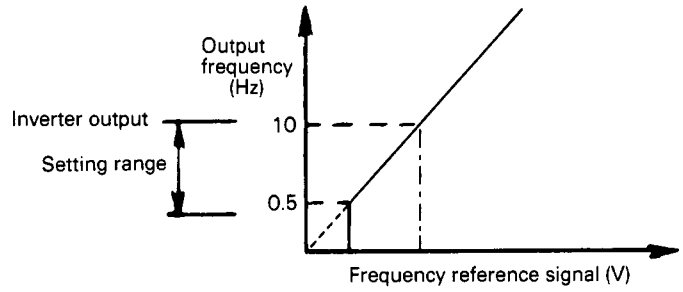

**Notes:**

1. When DC dynamic brake is not required, set brake time to "0".
2. If speed is decelerated by decreasing frequency reference signal voltage (or by pressing [▼] key), the DC dynamic brake starts operating at 0.5Hz of output frequency (initial setting)
3. Initial setting of DC dynamic brake voltage ..... 8%

## STARTING FREQUENCY SETTING

Starting frequency [1][3]

Frequency for start of motor operation can be set within the range from 0.5Hz to 10Hz.




## SETTING FOR JOG OPERATION

Jog frequency [1][5]

Jog accel./decel. time [1][6]

JOG operation can be realized by selecting JOG mode on PU.

When the motor is jogged without changing the initial (shipping) setting, the time taken for acceleration or deceleration is 0.04sec.

## REGENERATIVE BRAKE DUTY (%ED) SETTING

Regenerative brake duty [3][0]

Duty imposed on discharge resistor for regenerative braking can be set.
For exceptionally arduous duty, use of resistors having a larger capacity should be considerd.

Initial setting ..... 3%

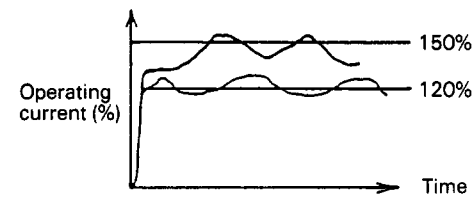
## STALL PREVENTION LEVEL SETTING

Stall prevention level [2][1]

When a small-capacity motor (as compared with capacity of inverter) is driven by a large-capacity inverter, overload (excessively large torque) can be prevented by changing current level at which the stall preventive function is activated.

**Notes:**

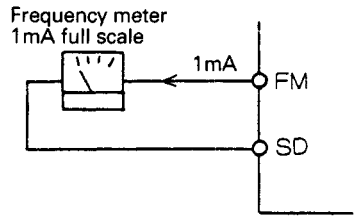
1. Operating current (%) is a ratio of the set current to the rated output current of the inverter.
2. Least setting increment: 10%
3. When setting is zero, the stall preventive function is not activated.



## FREQUENCY METER CALIBRATION

Frequency meter calibration C-1

Frequency meter can be calibrated, without use of calibration potentiometer, by operating the PU.
(For method refer to 15-1).




**Note:** The initial setting is that 1mA full scale is read and pulse train signal frequency is 1440Hz when the output frequency is 60Hz.

## OUTPUT FREQUENCY ADJUSTMENT

Bias for frequency reference voltage signal C-2

Gain for frequency reference voltage signal C-3

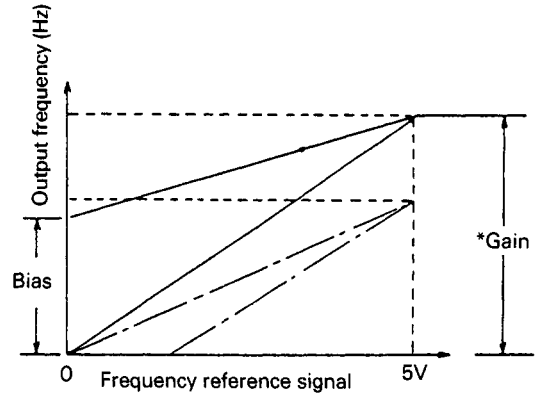
Output frequency ramp for frequency reference signal can be set.

BIAS

Output frequency can be set for frequency reference signal input through terminals 2 and 5.

GAIN

Output frequency can be set for frequency reference signal input through terminals 2 and 5.
When frequency reference signal is 0V, the signal is judged to be 5V.



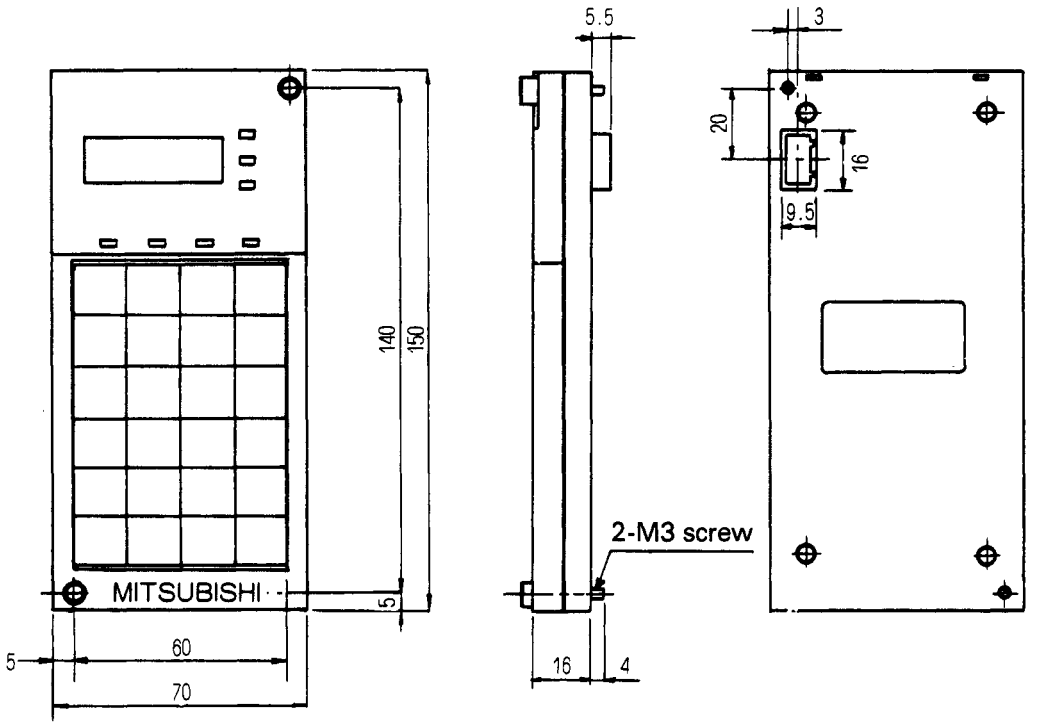

*When this gain is specified, value set for "frequency at 5V input voltage" (function No.20) is changed correspondingly.

# §20. PARAMETER UNIT SPECIFICATIONS

| | Description |
|---|---|
| Ambient temperature | Operating temperature −10 to +50°C |
| | Storage temperature −20 to +65°C |
| Ambient humidity | Less than 90%RH<br>To be free from condensation |
| Environment | To be free from oil mist, corrosive gas and dense dust |
| Cooling method | Self-cooling |
| Connection | Direct installation to FR-Z series inverter, or connection with special cable |
| Power supply | Fed from FR-Z series inverter |
| Display | 4-digit 7-segment LED readout and indicator lamps |
| Operation | 24 keys (protected with polyurethane film) are operated. |
| Outside dimensions | 150mm (high) x 70mm (wide) x 16mm (deep) |
| Weight | 0.1 kg |
| Max. WRITE cycles | 100,000 cycles |

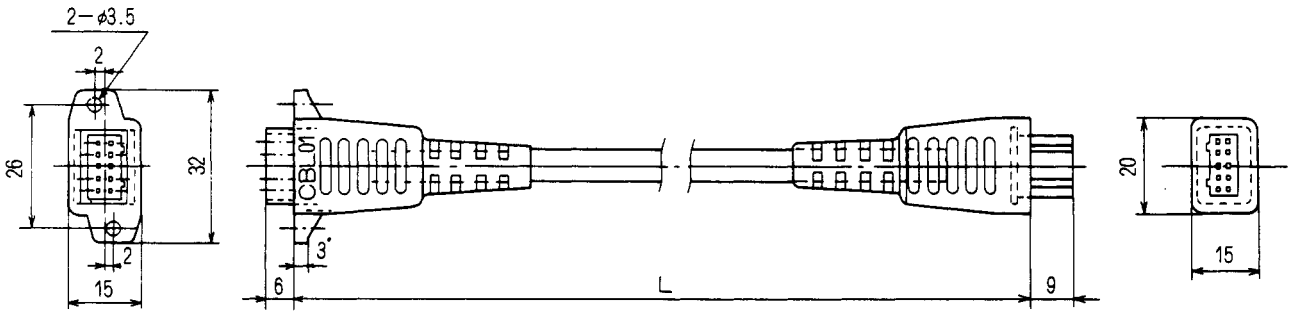
# §21. PARAMETER UNIT OUTSIDE DIMENSIONS, CABLE DETAILS

● Parameter unit (PU)




(Unit: mm)

● Cable (option)




Inverter side

Parameter unit side

| Model | L (m) |
|---|---|
| FR-CBL01 | 1 |
| FR-CBL03 | 3 |
| FR-CBL05 | 5 |

MITSUBISHI ELECTRIC CORPORATION

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