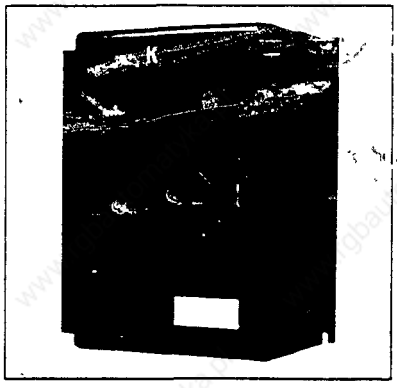
MITSUBISHI

TRANSISTORIZED INVERTER

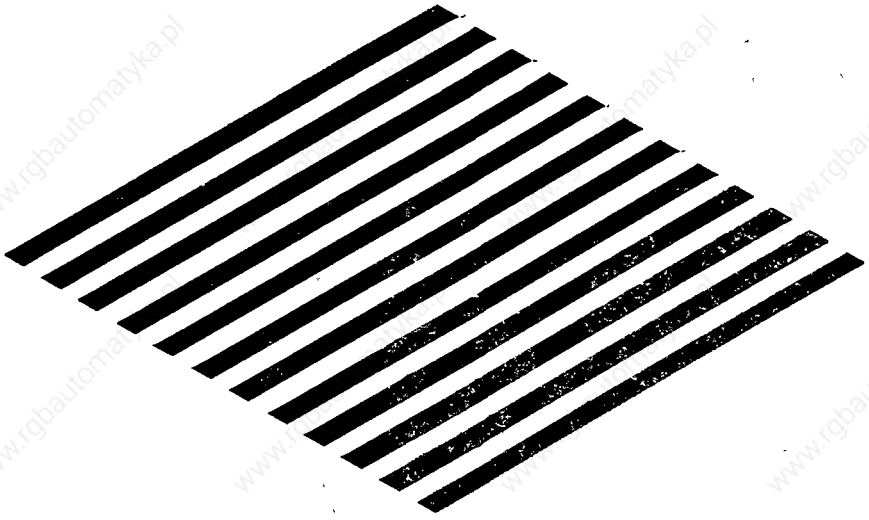
FREQROL-K

Neu Stand 20.1.87



Instruction Manual

Single-Phase input 220/240VAC series (1.5, 2.2, 3.0Kw)



IB (NA) 66038-D

MITSUBISHI ELECTRIC

- Thank you for your purchase of Mitsubishi General-Purpose Frequency Inverter FREQROL-K Series. This inverter is easy to operate and handle. However, mistakes in handling and operation may cause unforeseen accident, shorten the life of product and reduce the performances of product. Therefore, please read this instruction manual carefully to use the inverter correctly.

- Please keep this instruction manual carefully for latter use.

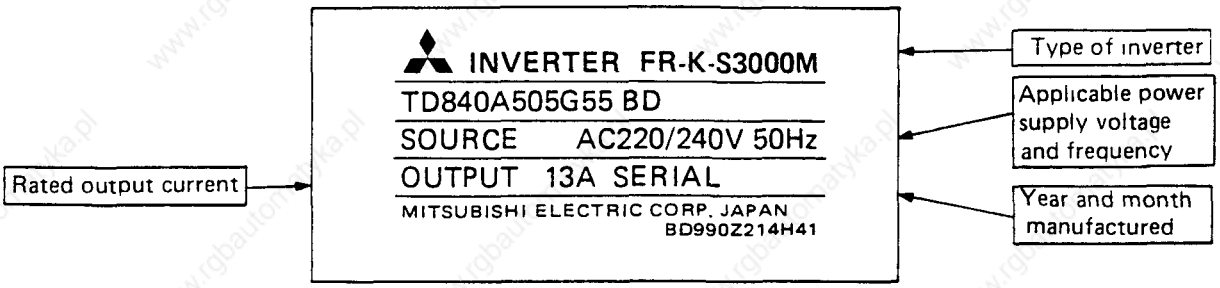
- Please attach this instruction manual to the machine in which the inverter is installed before shipment so that the manual is delivered to the customer.

CONTENTS

1. UNPACKING AND CHECKING

After unpacking the inverter, first check the following points:

- ○ Check if there has been any damage to the inverter due to an accident during transportation.
- ○ Check the nameplate applied to the front cover to confirm that the model and output rating meet your order.



Nameplate

For the details of standard specifications, see page 30.

If you have any doubts or find any damages to the unit, please contact your local service representative.

2. HANDLING

Carry and handle the inverter carefully to prevent damage.
When carrying the inverter, hold it with care so that force is not applied to the fan at the bottom of inverter.
The inverter is protected with a plastic enclosure. When carrying the inverter, however, handle with care so that undue force is not applied to the plastic cover.

3. EXTERNAL VIEW AND NOMENCLATURE

Fig. 1 and 2 show the external view and nomenclature of the inverter.

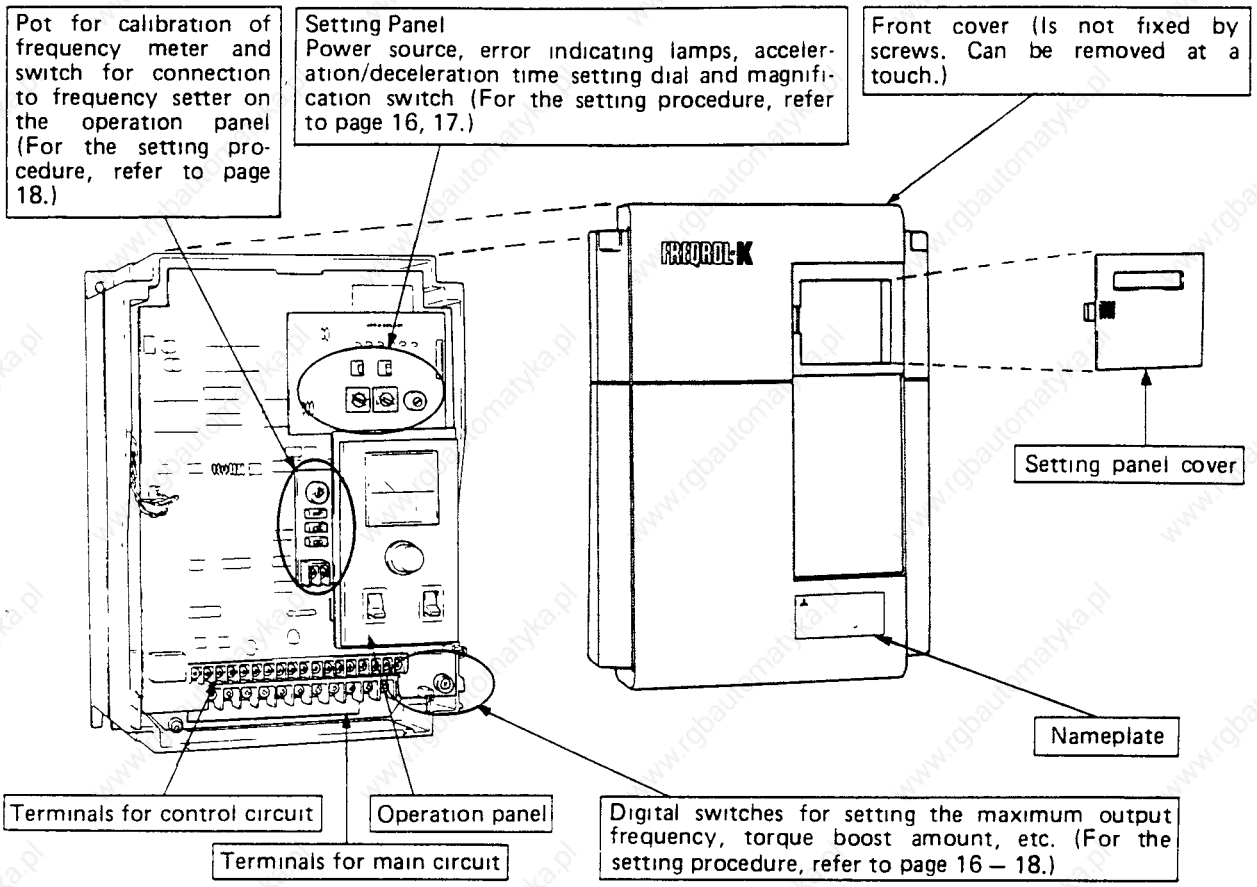


Fig. 1 External View and Nomenclature of Inverter

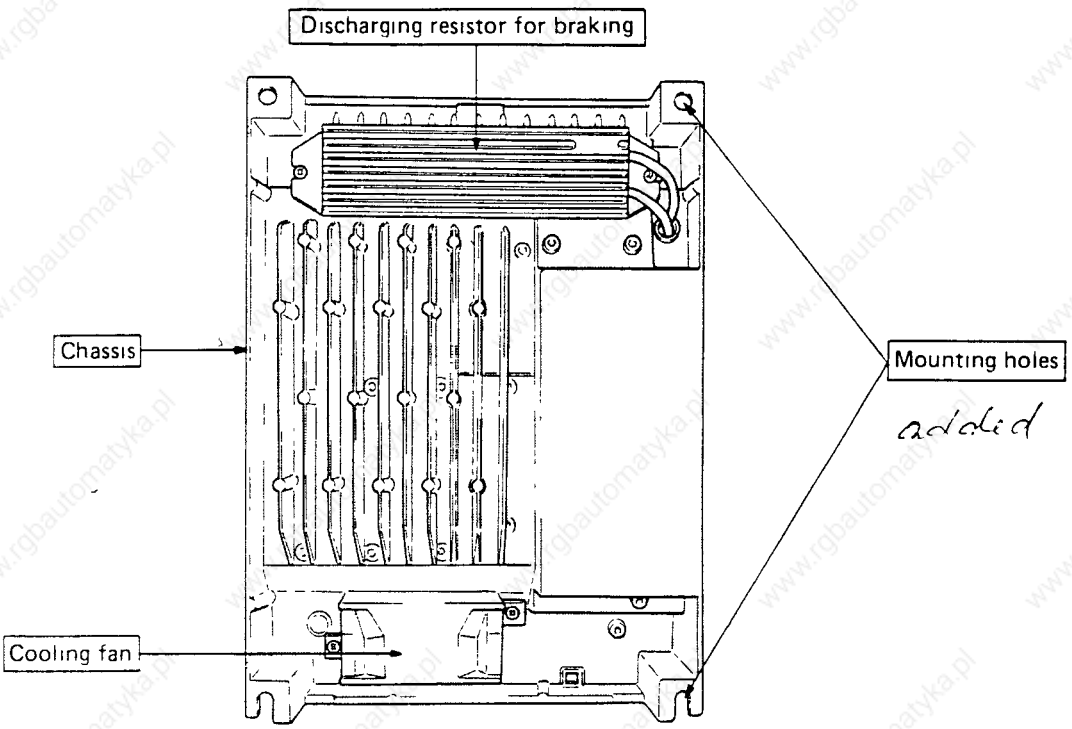


Fig. 2 Rear View of Inverter

4. INSTALLATION

(1) Place the inverter in a clean and well-ventilated location. Avoid locations exposed to direct sunlight or subjected to high temperature, high humidity, dust or corrosive gases.

(2) Install the inverter securely with bolts or screws, vertically (so that the letters "FREQROL-K" on the front cover of inverter, face front). Do not mount the inverter horizontally or aslant because efficient ventilation will be impaire.

(3) Since the inverter generates heat to some degree, install any other equipment or parts at least 10 cm away from the top and bottom of inverter and at least 5 cm away from both sides of inverter to allow efficient heat dissipation.

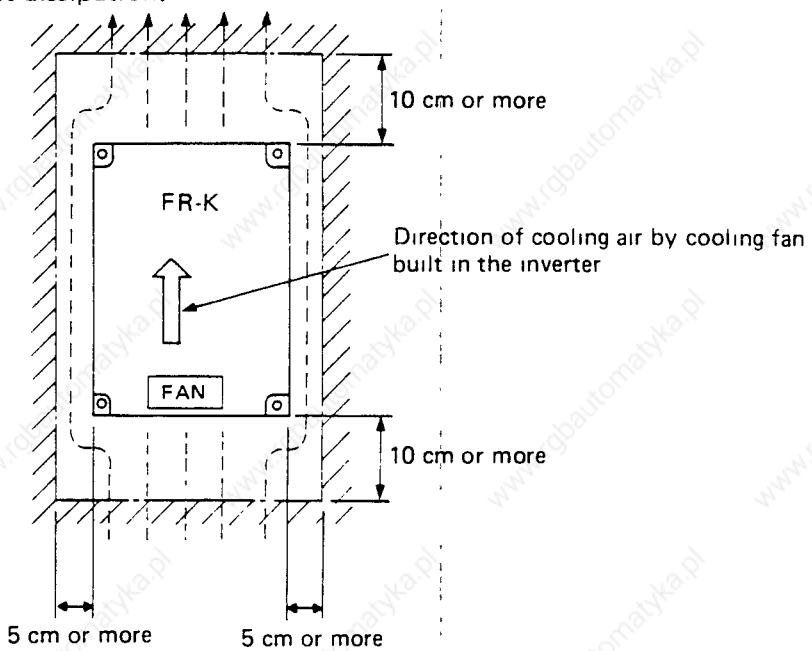


Fig. 3 Mounting of Inverter

(4) Repeated breaking operation, may cause, the rear mounted discharging break resistor to reach a maximum temperature of 150°C. Therefore mount the inverter to an incombustible surface such as concrete or metal. (See Fig. 2.)

(5) The FR-K series inverters are available in two types of protective constructions according to the output rating. Since the two types vary in the maximum allowable ambient temperature, caution should be exercised.

Inverter Model	Protective Construction	Max. Allowable Ambient Temperature
FR-K-S1500	Totally enclosed type (IP50)	+40°C
FR-K-S2200		
FR-K-S3000	Enclosed type (IP20)	+50°C

The maximum allowable ambient temperature of totally enclosed type inverter is 40°C. By removing the totally enclosing plates at the top and bottom of inverter, the maximum allowable ambient temperature can be changed to 50°C. (For the removal procedure, refer to page 6.)

5. DISMOUNTING AND MOUNTING

5.1 Front Cover

To remove the front cover, as shown in Fig. 4, push down the white button located at the top of inverter (arrow ①), pull the top half of cover toward front (arrow ②), and further push it down lightly (arrow ③). Then, the cover is removed from the chassis. Since mounting screws are not used, the cover can be dismounted easily.

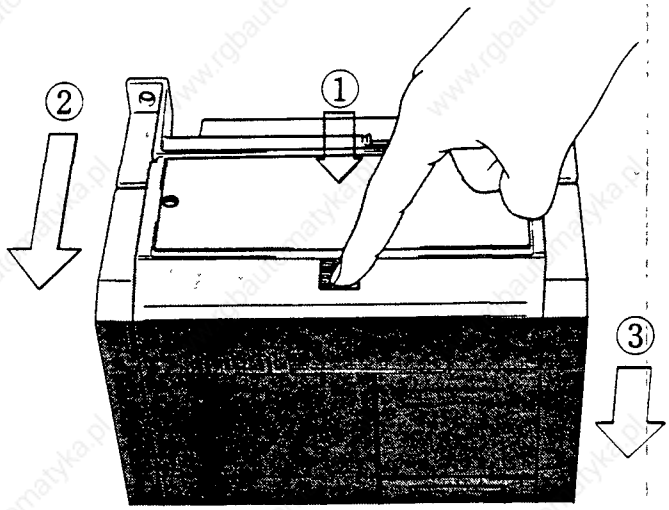


Fig. 4 Removal of Front Cover

To reinstall the cover to the chassis, as shown in Fig. 5, fit the pins inside the cover into the notches at the bottom of chassis. Then, lightly press the top half of cover against the chassis.

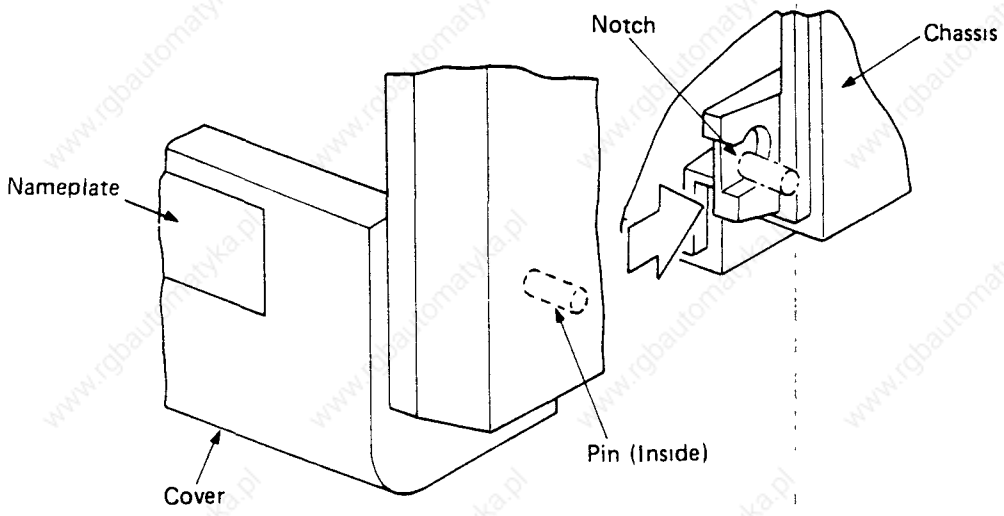


Fig. 5 Installation of Front Cover

The rating plate is affixed to the cover. Therefore, be sure to reinstall the removed cover to the same inverter.

As standard, the inverter is supplied without cover fixing screws. However, the cover can also be fixed by use of mounting screws. In this case, install the cover, referring to the following working procedure and Fig. 6.

Working procedure

(1) After removing the front cover, drill holes with a drill, etc. at positions shown in Fig. 6 from the rear surface of cover. The hole diameter should be 4.5 to 5.0 mm.

(2) After installing the front cover, securely fix the cover by use of the following screws:

Used screws FR-K-S1500, S2200 .....M4 x 0.7 x 30
FR-K-S3000 .....M4 x 0.7 x 55

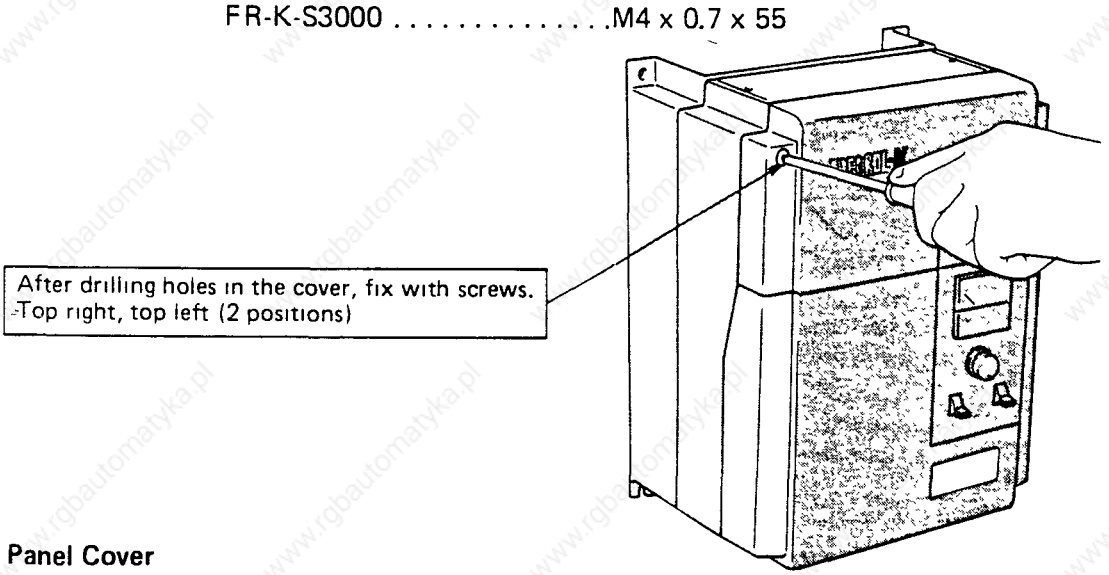


Fig. 6 Installation of Cover with Screws

5.2 Setting Panel Cover

As shown in Fig. 7, lightly push the left end portion of setting panel cover and slide it to the right. Then, the cover can be removed.
In this case, the setting panel cover is completely removed from the front cover. Therefore, take care not to drop or lose it.

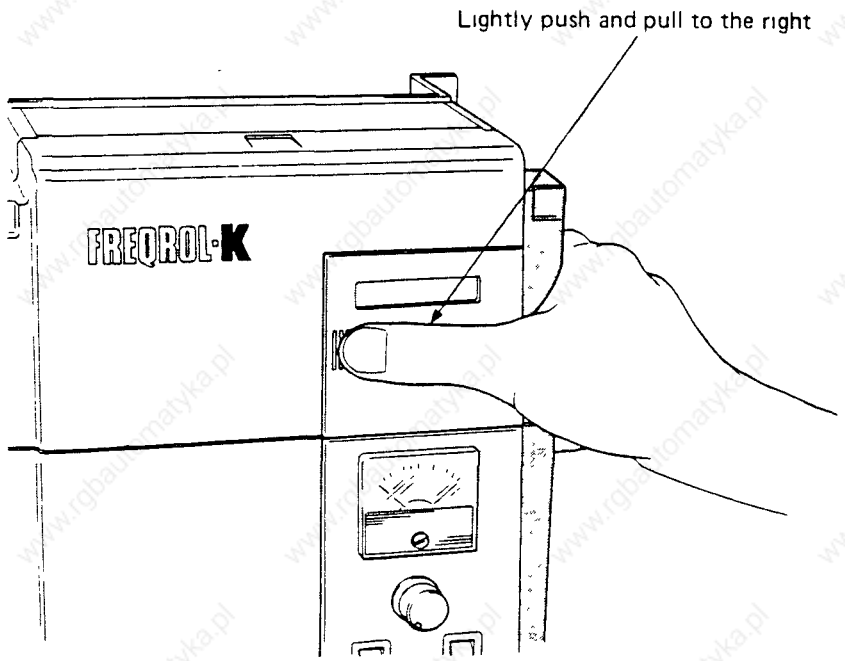


Fig. 7 Removal of Setting Panel Cover

5.3 Totally Enclosing Plates

When the totally enclosed type inverters FR-K-S1500 and FR-K-S2200 are installed inside a control box, etc. and the temperature inside the control box is expected to exceed 40°C, only use the inverter after removing the totally enclosing plates located at the top and bottom. The removal procedure of totally enclosing plates are shown in Fig. 8 and 9.
Since the totally enclosed type inverter is not of a waterproof construction, do not install this type of inverter outdoors or in a place where the inverter can be splashed with water, oil, etc.

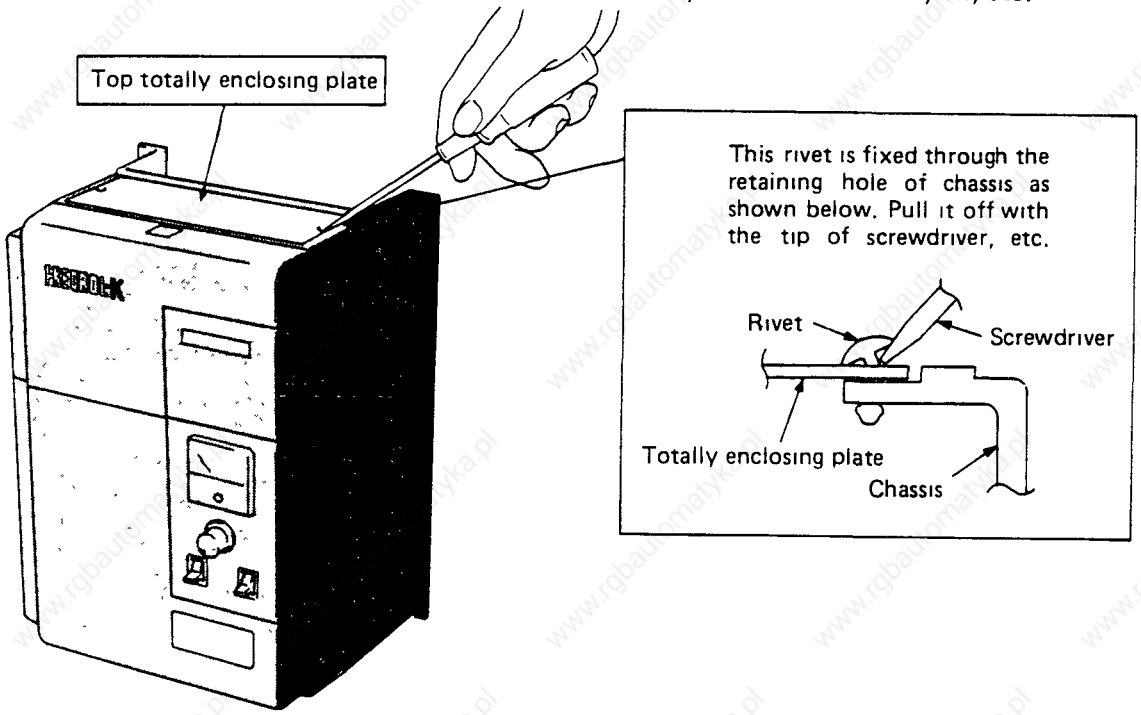


Fig. 8 Removal of Top Totally Enclosing Plate

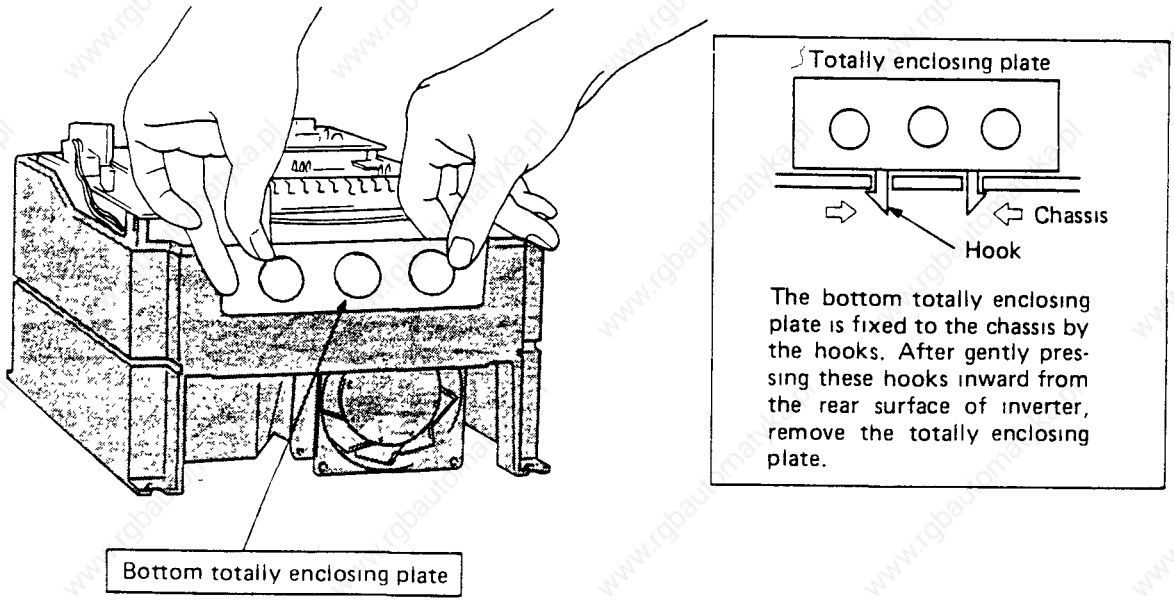
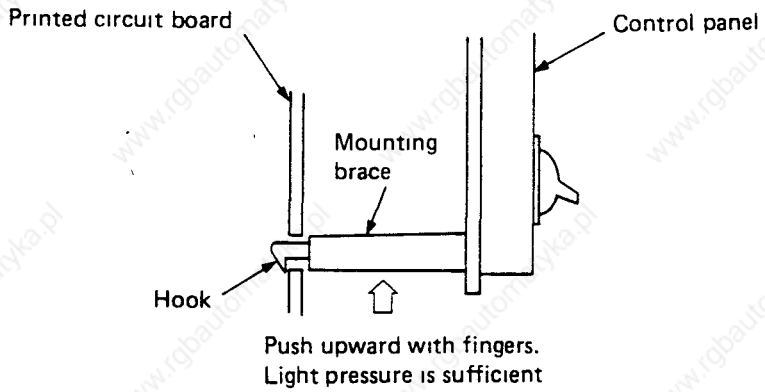


Fig. 9 Removal of Bottom Totally Enclosing Conduit Entry Plate

5.4 Control Panel

The control panel is fixed to the printed circuit board with 4 hooks and a connector. To remove the control panel, push the lower 2 mounting braces upward.
To reinstall the control panel, exercise care to correctly fit the connector of printed circuit board with the connector pins of control panel.



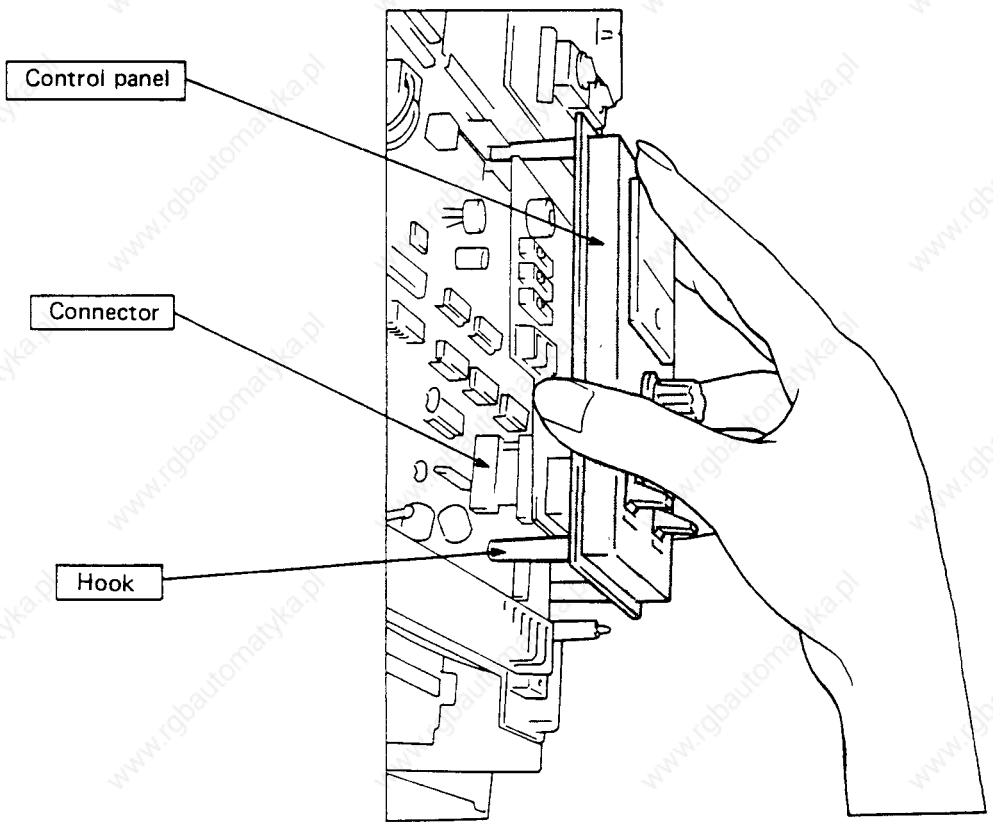


Fig. 10 Removal and Reinstallation of Control Panel

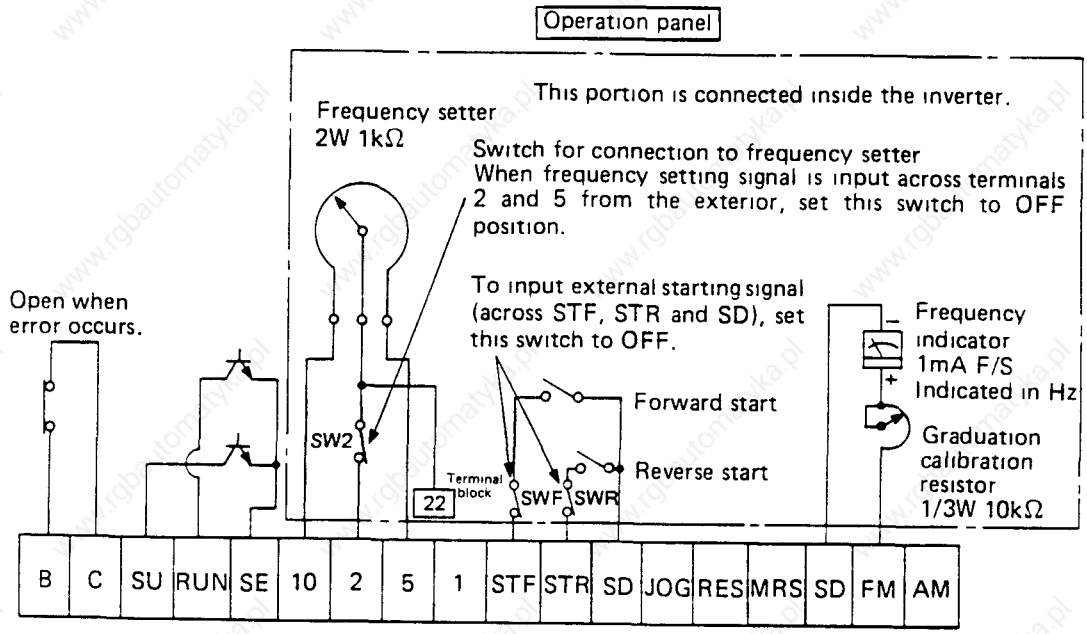
6. WIRING

Fig. 11 shows a terminal connection diagram. Referring to this diagram, properly wire the inverter according to the following instructions and as described on page 14.
For the connection of main circuit cables, it is recommended to use solderless terminals provided with insulation sleeves.

6.1 Connection Diagram

(1) Control circuit

● With operation panel



● Without operation panel

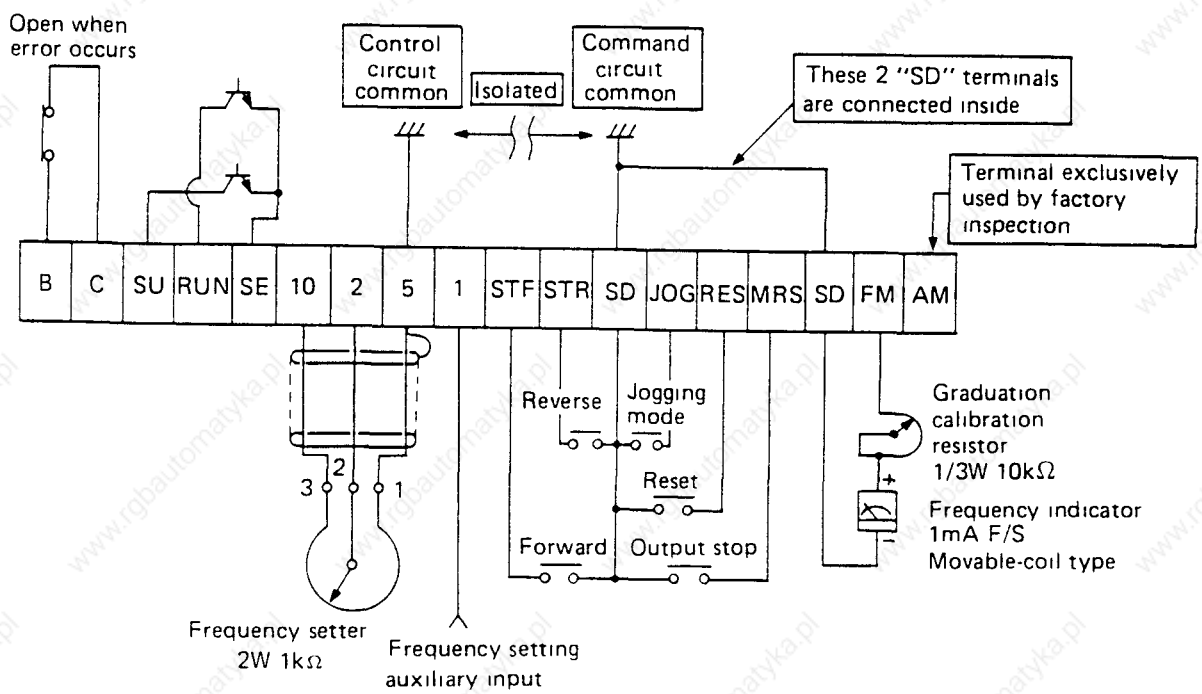


Fig. 11 Control Circuit Connection Diagrams

(2) Main circuit

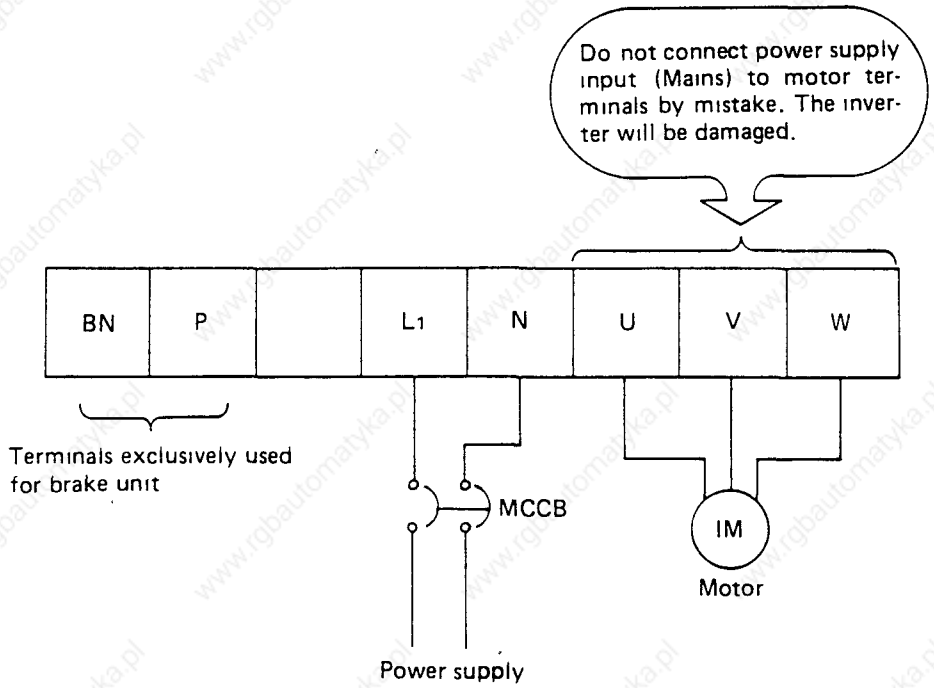
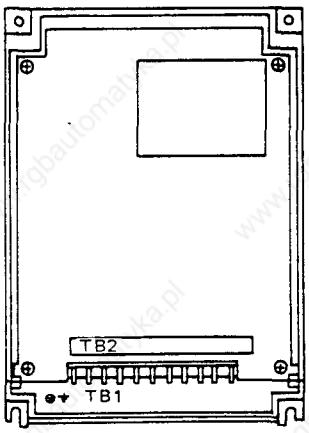


Fig. 12 Main Circuit Connection Diagram

6.2 Terminal Arrangement



Control circuit TB2

B	C	SU	RUN	SE	10	2	5	1	STF	STR	SD	JOG	RES	MRS	SD	FM	AM

Main circuit TB1

	BN	P			L1	N		U	V	W	

Earth terminal ⊗ ⏚

Terminal screw size

Model	Control Circuit	L1, N	U, V, W	BN, P	Earth Terminal
FR-K-S1500, S2200	M3	M4	M4	M4	M5
FR-K-S3000	M3	M5	M5	M4	M5

Fig. 13 Terminal Board Screw Sizes

6.3 Input/Output Terminals

- Main circuit terminals

Terminal Symbol	Terminal Name	Application and Specifications
L1, N	AC power supply input terminals	Terminals for connection of commercial power supply. Input voltage rating is single-phase 220/240V AC 50Hz.
U, V, W	Inverter output terminals	Terminals for connection of motor. Connect a three-phase squirrel-cage induction motor. **Do not connect the power supply by mistake. The inverter will be damaged.** Ensure motor is connected for 220/240/3/50Hz.
⏚	Earth terminal	Earth terminal of inverter.
P, BN	Converter output terminal	Terminals for connection of regenerative brake unit. **Do not connect other equipment.**

- Control circuit terminals

Terminal Symbol	Terminal Name	Application and Specifications
10	·Output terminal of power supply for frequency setting	Terminal for connection of frequency setter. Output voltage: 5V DC. Allowable load current: 6mA.
5	Common terminal for frequency setting signal	Common terminal of frequency setting input signal (terminals 2 and 1). Not isolated from the common circuit of control circuit.
2	Input terminal for frequency setting signal	Input terminal of command voltage signal for the inverter output frequency. Output frequency reaches the maximum (60Hz, 120Hz or 240Hz) at 5V DC and input and output are proportional. Input resistance: 11kΩ. Maximum allowable voltage: 20V DC.
1	Auxiliary input terminal for frequency setting signal	Terminal used for the addition of voltage signal to that of terminal 2 or when frequency setting signal voltage is 0 to 10V DC. When −10 to +10V DC is input, output frequency reaches the maximum at +10V and input and output are proportional. At the negative voltage, however, the addition of voltage to terminal 2 can be performed but the inverter comes to stop if voltage is applied only to one terminal. Example. ① When +10V applied only to terminal 1, output frequency reaches the maximum. ② When −5V is applied only to terminal 1, the inverter comes to stop. ③ When 5V is applied to terminal 2 and −5V to terminal 1, $5V + \left(\frac{-5V}{2}\right) = 2.5V$ operation is performed at half the maximum output frequency

SD	Common terminal for forward/reverse start signal	Common terminal of forward/reverse start signal and frequency indicator Isolated from the common circuit of control circuit.
STF STR	Input terminal for forward start signal Input terminal for reverse start signal	Signal inputs for starting the inverter. Forward command is given when short is caused across STF and SD, and stop command is given when the circuit is opened. Reverse command is given when short is caused across STR and SD, and stop command is given when the circuit is opened When short is caused across STF and SD and across STR and SD simultaneously, stop command is given. Controllable by open collector output.
FM	Output terminal for frequency meter	Terminal for connection of frequency indicator Average voltage reaches approximately 5VDC at the maximum output frequency (60Hz, 120Hz or 240Hz) and is proportional to output frequency. Output voltage has pulse-shaped waveform Connect 1mA moving-coil type DC ammeter in series to 10kΩ graduation calibrating pot.
RES	Input terminal for reset signal	Terminal for resetting the error retention of inverter Cause short across RES and SD for 0.1 or more seconds and then open them.
MRS	Input terminal to stop inverter output	Signal input terminal which stops inverter output to avoid inverter overcurrent trip at the actuation of brake when mechanical brake (such as motor with brake) is used. Before applying the brake, cause short across MRS and SD. Inverter output is shut off and the motor is brought to coasting state. When the circuit is opened across MRS and SD again, the inverter is restarted if STF or STR is on.
JOG	JOG mode input terminal	Terminal for selecting jogging mode such as inching. Causing short across JOG and SD allows jogging operation (fixed at 5Hz). After causing short across JOG ans SD, operate and stop the inverter by STF (forward) or STR (reverse) signal. Though causing short across JOG and SD, jogging operation can not be done when STF (or STR) is ON
RUN	Output terminal of inverter's run	Signal for checking the run of inverter and providing interlock with the operation of other equipment. L level during run of inverter at higher frequency than minimum start frequency H level during stop or DC dynamic brake actuation. Open collector output. 24V DC 0.1A rating.
SU	Output terminal for frequency arrival	Signal for checking that the output frequency of inverter has reached the preset frequency and advancing the sequence of other equipment. L level when output frequency is within ±10% of preset frequency. Open collector output. 24V DC 0.1 A rating

SE	Open collector output common terminal	Common terminal of RUN and SU terminals Isolated from the common circuit of control circuit
B, C	Output terminals for alarm	1 NC contact output terminal for indicating that the protective function of inverter has been activated. ○ Closed circuit during normal operation and when the power supply is shut. ○ Open circuit when inverter protective function is activated. (Inverter output is shut off at the same time.) ○ When the power is turned off, the circuit is opened for 10 to 20 seconds, then the circuit is closed. Contact capacity: 230V AC 0.3A, 30V DC 0.3A.
AM		Terminal exclusively used by manufacturer. Cannot be used.

6.4 Wiring Instructions

Miswiring may lead to the failure of inverter. Therefore, take note of the following points described in the table.

Circuit System	Miswiring Which Should Be Avoided	Result
Main circuit	Do not connect the power supply to terminals U, V and W of main circuit. Also, check if external sequences may apply voltage to those terminals.	Main circuit parts will be damaged.
	Main circuit terminals P and BN are used to connect the brake unit and discharging resistor. Do not connect any other equipment or only the resistor.	
Control circuit	Do not apply 20VDC or larger voltage to the input terminal for frequency setting "2" and the auxiliary input terminal for frequency setting "1".	Control circuit parts will be damaged.
	Do not cause short across the output terminal of power supply for frequency setting "10" and the common terminal for frequency setting signal "5".	

7. ADJUSTMENT AND OPERATION

7.1 Checking before Adjustment

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

(1) Check if there is miswiring. Especially, check if the power supply is wired to the output terminal.

(2) Check for short circuit due to wire strands touching adjacent terminals.

(3) Check if the wire is deformed, and check for damaged cable insulation.

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

(5) Check that the load is in good condition, and safe to run.

(6) Check if there is ground fault on the output side (load side).

> When a megger is used for checking, use it only for measuring resistance to earth.
> **Never use the megger for measurement across the terminals of inverter.**
> **Do not use the megger for measurement across the terminals of control circuit.** For details of checking with the megger, refer to Section 8 on page 23.

7.2 Adjustment

After the checking is completed, set and adjust the following items according to the load specifications.

Adjustment (Setting) Item	Adjuster (Setter)	Location
Acceleration/deceleration time	ACCEL/DECEL setting dial and magnification switch	Setting panel
Boost control	Automatic and manual boost pots	Bottom right of printed circuit board
Maximum output frequency and base frequency (V/F pattern)	8 ON/OFF switches	
Use of frequency setter (only when operation panel is provided)	* Switch for connection to frequency setter	Operation panel

*Note** *When the inverter is equipped with the operation panel and the frequency setting signal is input from the exterior of inverter, move this switch to the OFF position*

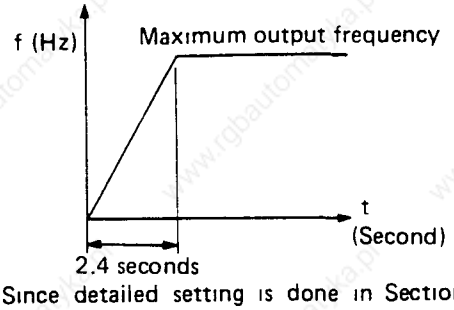
- **On Setting Panel**

Note:
1. *When the maximum output frequency is 120Hz, the shortest accel/decel time is 0.4 seconds. When the maximum output frequency is 240Hz, the shortest accel/decel time is 0.8 seconds.*
2. *Do not set the acceleration and deceleration setting dials (ACCEL/DECEL) to notch "0". If set to notch "0", the inverter may not operate normally. (Notch "0" is a dial position set when option is used.)*
3. *The setting cannot be changed during operation (or accleration or deceleration).*

Acceleration time magnification switch and acceleration time setting dial

The dial for setting the acceleration time (seconds) from when output frequency is 0 to when it reaches the maximum (60Hz, 120Hz or 240Hz) and the switch for setting its magnification.

Example:
Magnification setting switch . x 0.2
Time setting dial 12
Acceleration time = 12 seconds x 0.2
= 2.4 seconds

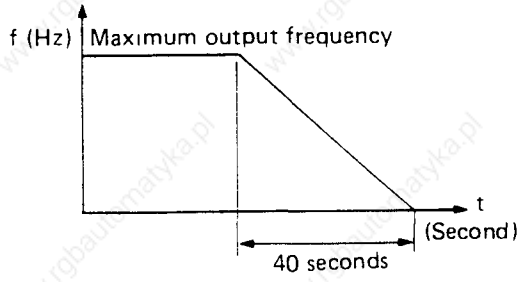


Since detailed setting is done in Section of "Operation" on page 20, temporarily set to 5 seconds. Acceleration time is factory-set to 5 seconds.

Decelaration time magnification switch and decelaration time setting dial

The dial for setting the deceleration time (seconds) from when output frequency is the maximum (60Hz, 120Hz or 240Hz) to when it reaches 0 and the switch for setting its magnification

Example
Magnification setting switch .x 10
Time setting dial . . 4
Deceleration time = 4 seconds x 10 = 40 seconds

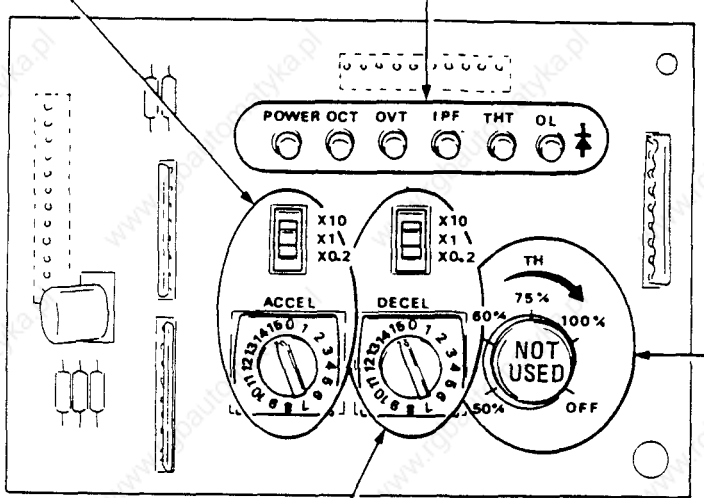


Since detailed setting is done in Section of "Operation" on page 20, temporarily set to 5 seconds. Deceleration time is factory-set to 5 seconds.

Operation indicating lamps

Indicator	Lamp Decription
POWER	Lit when the power is turned on. Kept lit approximately 10 to 30 seconds after the power is shut off.
OCT	Lit when inverter output overcurrent occurs.
OVT	Lit when the converter voltage inside inverter becomes over-voltage during regeneration of motor
IPF	Lit when instantaneous power failure or line voltage drop occurs.
THT	Lit when electronic thermal relay is activated.
OVT/THT simultaneous "on"	Lit when cooling fin is overheated.
OCT/THT simultaneous "on"	Lit when CPU fault prevention is activated.
OL	Flickers when load is large during stall prevention activating.

For details, refer to page 32.

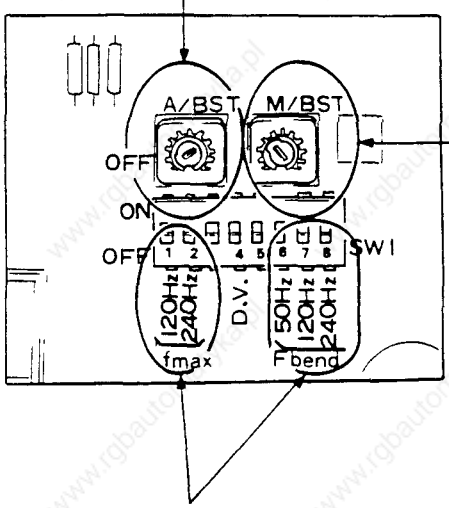


Electronic thermal relay setting pot

This pot is factory-set to 100% and can be ajusted by manufacturer only. (Labeled "Not Used")

Automatic boost (A/BST)

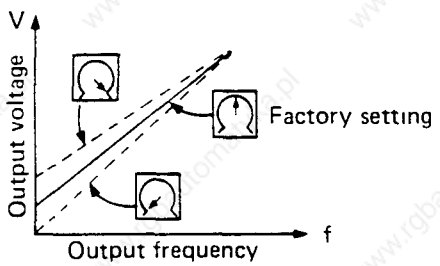
When larger motor torque is required, automatic increase of output voltage allows the increase of motor output torque. This is especially effective in low-speed operation and approximately 150% torque can be obtained at 6Hz
If the switch is turned too clockwise, overcurrent trip (OCT) may result during operation. The switch is factory-set to OFF position.



Manual boost (M/BST)

As shown in the figure below, V/F pattern can be changed according to motor characteristics. Clockwise turn increases motor torque especially in low-frequency operation. However, vibration and noise may become larger and the electronic thermal relay (TH) or overcurrent trip (OCT) may be activated in low-frequency operation.
Counterclockwise turn decreases vibration and noise but motor torque becomes smaller in low-frequency operation When high-efficiency motor is operated, it may be necessary to turn the switch counterclockwise depending on motor characteristics. The switch is factory-set to about notch 5 position.

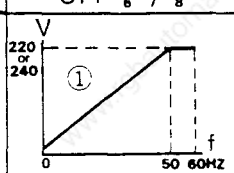
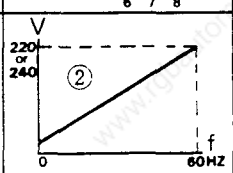
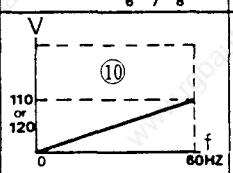
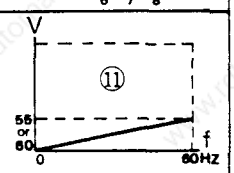
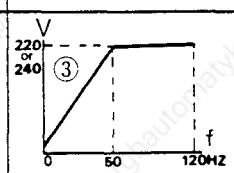
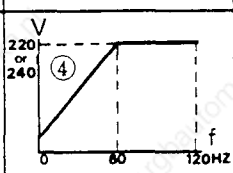
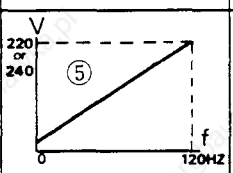
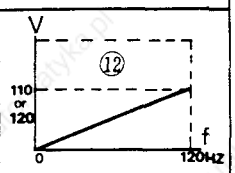
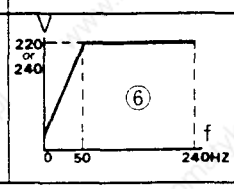
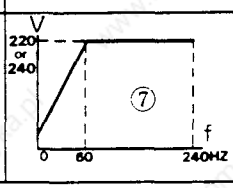
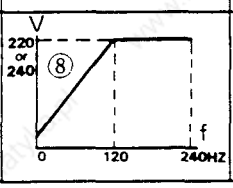
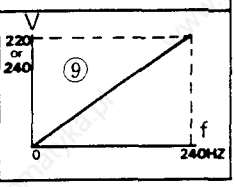
Note: The manual torque boost is activated only when the automatic torque boost is off. (Automatic torque boost is given priority.)



Maximum output frequency (fmax) and base frequency (V/F bend)

Set V/F pattern according to load and motor characteristics

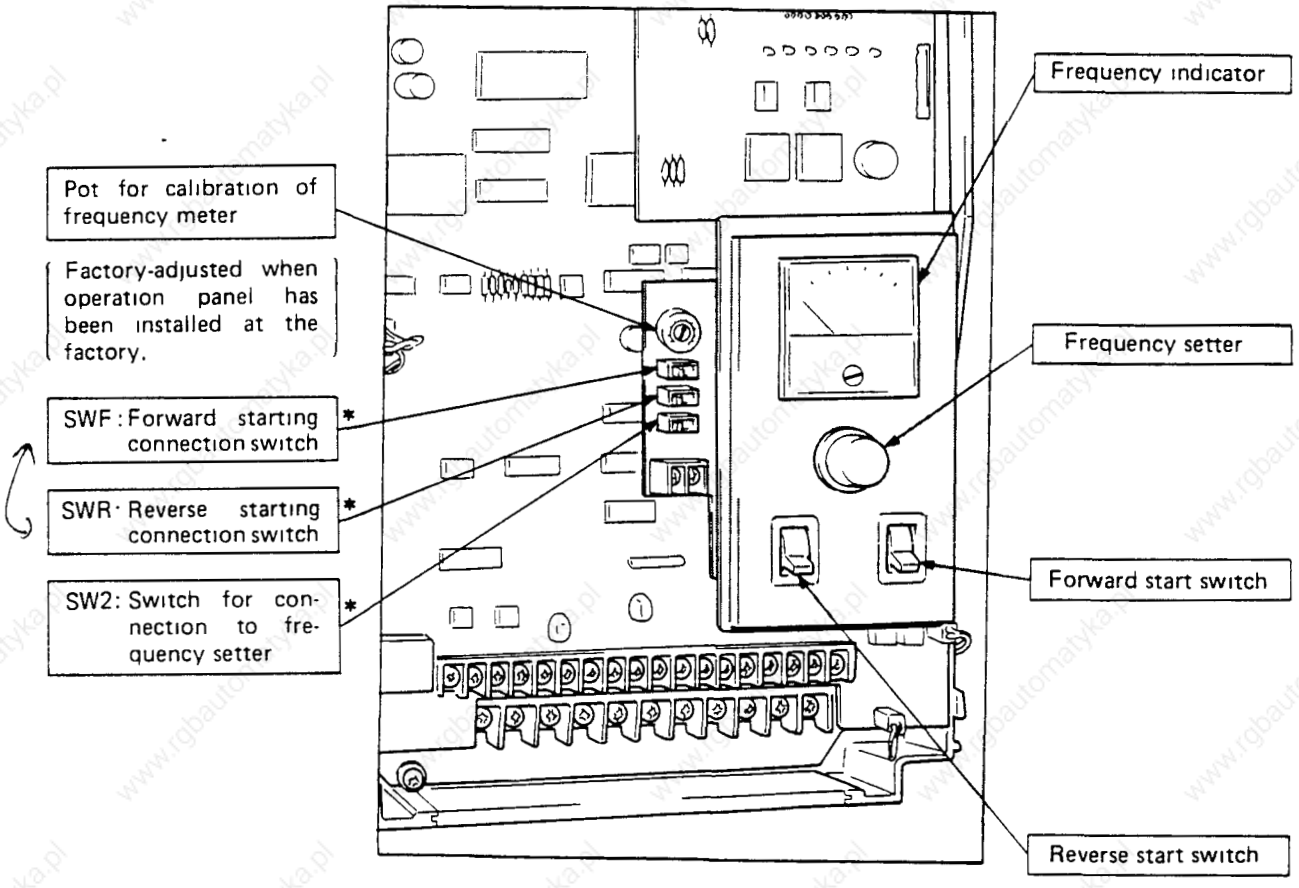
■ Position of switch

Maximum output frequency (fmax) \ V/F bend	ON OFF 6 7 8	6 7 8	6 7 8	6 7 8
60Hz (ON OFF 1 2)				
120Hz (1 2)				
240Hz (1 2)				

Note:

1. *Settings not indicated above are as shown at right.*
   - ○ 1 2 . . .*The maximum output frequency becomes 60Hz.*
   - ○ 6 7 8 . . .*Constant-torque V/F pattern up to 120Hz*
   - ○ *Constant-torque V/F pattern up to 50Hz for combination with switch 6 at ON position.*
2. *Special motor should be applied for V/F patterns of (10), (11) and (12).*
3. *Do not move the switches during the operation of inverter. Inverter will trip.*

Analogue operation panel



The operation panel can be mounted easily by inserting it carefully into the connector on the printed circuit board. After mounting, push the surface of operation panel gently to check if it has been connected securely.

Note: These switches are set to position ON when shipping. When inputting the external signal, please refer to page 9, Wiring Instructions.

A DIGITAL OPERATION PANEL IS ALSO AVAILABLE AS AN EXTRA OPTION.

7.3 Operation

After the preparation and adjustment for operation are completed, operate the inverter in the following procedure. In this section, the acceleration/deceleration time set temporarily on page16 and 17 is also set.

Step	Purpose	Description	Inverter Operation	Motor Operation
1	Power on	○ Turn on the no-fuse breaker (MCCB) on the input side of inverter. ○ When magnetic contactor (MC) is installed on the input side of inverter, also turn on the MC.	POWER lamp is lit.	The motor does not rotate. Make sure that there is no beat, vibration, etc.
2	Test run	(1) Set the forward (or reverse) start switch to ON position.	There is no change.	There is no change.
		(2) Gradually turn the knob of frequency setter clockwise from 0 position.	When frequency command becomes start frequency or larger, the frequency indicator begins to swing.	When the inverter outputs voltage, the motor begins to rotate slowly.
		(3) Next, slowly turn the knob clockwise to full clockwise position. ○ Make sure that the frequency has not exceeded the preprogrammed 60 or 120Hz. If it has exceeded, check the setting of maximum frequency, referring to page 18. ○ When OCT lamp is lit, ①check if the load is too heavy. ②reduce the boost amount of A/BST. ③reduce the boost amount of M/BST.	The indication (output frequency) of frequency indicator increases.	Motor speed increases gradually.
		(4) Gradually turn the knob of frequency setter counterclockwise to "0" position. ○ If OVT lamp is lit during deceleration, the setting of deceleration time is too short. Lengthen the setting referring to page 16 and 17.	According to the position of frequency setter, the indication (output frequency) of frequency indicator decreases.	Motor speed reduces gradually. When the minimum start frequency is passed, DC dynamic brake is applied, resulting in sudden stop of motor.

NOTE *If OCT or OVT lamp is lit during motor operation and the motor is brought to coasting state, make sure that the motor has stopped before shutting off the power to reset or perform "reset" by the reset terminal and then restart.*

Step	Purpose	Description	Inverter Operation	Motor Operation
3	Setting of acceleration time	(1) With the forward start switch at OFF position, turn the frequency setting knob fully clockwise.	Does not operate.	Does not operate.
		(2) Set the forward start switch to ON position. ○ If OL lamp flickers or OCT lamp is lit during acceleration, lengthen the setting of acceleration time and start operation again. ○ When OL lamp does not flicker and shorter setting is required, the setting can be shortened. **CAUTION** The setting of acceleration/deceleration time is valid only when the motor is at a stop. It cannot be changed during the rotation of motor.	The maximum output frequency is reached in preset acceleration time. *Note:* *For the setting of 120Hz or 240Hz, the shortest acceleration time is restricted.* *(Refer to page 16 and 17.)*	Motor speed increases according to the output frequency of inverter.
4	Setting of deceleration time	(1) Operate the inverter at the maximum output frequency and set the forward start switch to OFF position. ○ If OL lamp flickers or OVT or OCT lamp is lit during deceleration, lengthen the setting of deceleration time and start operation again. ○ When OL lamp does not flicker and faster deceleration is required, the setting time can be shortened.	The output frequency reaches 0 in preset deceleration time. *Note:* *For the setting of 120Hz or 240Hz, the shortest deceleration time is restricted.* *(Refer to page 16 and 17.)*	Motor speed decreases according to the output frequency of inverter. When 3Hz is passed, DC dynamic brake is applied and the motor is brought to a sudden stop.
5	Calibration of frequency meter (when operation panel is provided)	(1) Operate the inverter at the maximum output frequency (frequency setter knob at full clockwise position) and make sure that the voltage across terminals 2 and 5 is 5V	The maximum output frequency is output. The frequency indicator pointer shows the maximum output frequency.	The motor rotates according to inverter output frequency.
		(2) Make adjustment by use of adjust pot (VRN) so that the indicator pointer shows the maximum output frequency.	Indicating value changes.	The motor rotates at constant speed according to the maximum frequency.

Step	Purpose	Description	Inverter Operation	Motor Operation
6	Checking electronic reverse function	(1) By use of the forward start switch and frequency setter knob, operate the inverter at the maximum output frequency.	The inverter reachs the maximum output frequency.	The motor rotates according to the frequency.
		(2) Turn off the forward start switch and turn on the reverse start switch	Deceleration is made to 0.5Hz in preset deceleration time and rotating direction is reversed. After frequency reaches 0.5Hz, the reverse rotation is accelerated in preset acceleration time and tne inverter reaches the maximum frequency.	The motor rotates in reverse direction according to inverter output frequency and reaches the speed of the maximum frequency
		(3) Turn off the reverse start switch.	After deceleration is made, the output is shut off.	The motor decelerates and stops.

Note:

(1) If the forward start signal (STF) and reverse start signal (STR) are turned on the same time, the inverter is brought to a state in which both signals have been turned off simultaneously, and therefore, the inverter comes to a stop.

(2) When the frequency reduces to 3Hz or lower during deceleration, the DC dynamic brake is applied for 0.5 seconds. During this period, high-frequency sound is generated from the motor However, this is not abnormal.

(3) When the protection circuit such as overcurrent trip or regenerative overvoltage trip is activated, the OCT, OVT, IPF or THT error indicating lamp is lit red and the shut off of output is retained. Therefore, perform reset in the following procedure.

- *After shutting off the power of inverter for 0.1 or more seconds by the no-fuse breaker (MCCB) or magnetic contactor (MC), turn the power on again. When the power is shut off, the IPF lamp flickers instantaneously. However, this is normal.*
- *After causing short circuiting across the reset terminal (RES) and common terminal (SD) of control circuit for 0.1 or more seconds, then open the circuit.*

When the shut off retaining state of inverter is cleared by performing reset function, and at this time, if the start signal is on, the inverter is restarted. If the motor is coasting at this time, the protection circuit is activated again (IN THE WORST CASE, THE INVERTER MAY BE DAMAGED.) Therefore, perform reset function only after the motor has completely stopped.

8. MAINTENANCE AND INSPECTION

Since the inverter is of the static type, daily inspection and adjustment are rarely required and easy maintenance is ensured. When maintenance and inspection are performed, however, take care of the following points:

(1) **The capacitor remains charged at high voltage for a while after the power is shut off. Therefore, make checks after the POWER lamp in the setting panel goes off.**
The POWER lamp also acts as an indicator which shows the charging state of capacitor voltage.

(2) From time to time, check if dust and dirt have accumulated inside the inverter. If found, remove dust and dirt. Check ventilation is clear.

(3) Check if the terminal block screws and parts mounting screws are loose. When they are loose, retighten them securely. Also, check if there are defects in the wiring instruments, parts, etc. Replace defective ones or contact your service representative.

(4) **Insulation resistance test using a megger**

a) Before performing the insulation resistance test of external circuit by use of a megger, disconnect wires from all terminals of inverter so that test voltage is not applied to the inverter.

b) Conduct the insulation resistance test of inverter only for the main circuit as shown in the figure below and do not make the test for the control circuit.

c) **To check the control circuit for continuity, use a circuit tester (high resistance range) and do not use a megger or a buzzer.**

d) Before the insulation resistance test of FR-K-S1500 and S2200 by use of a megger, disconnect the earth wire (green shield) connected to the earth terminal.

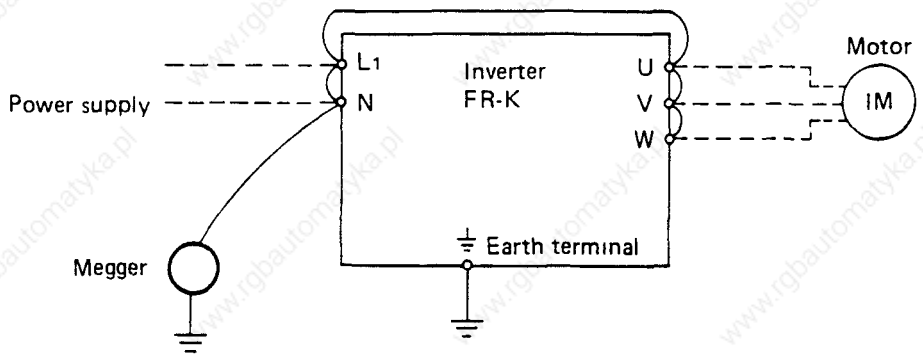


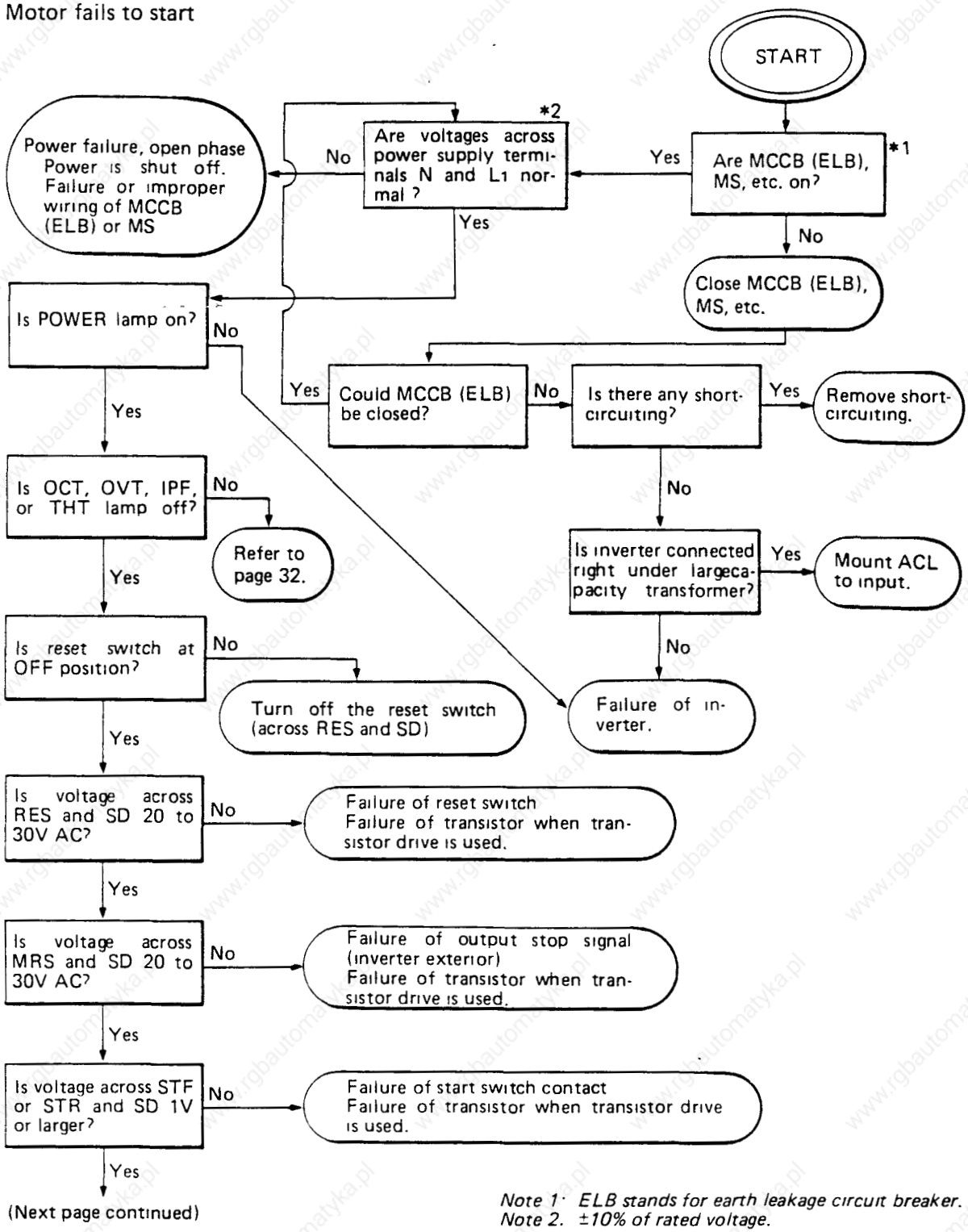
Fig. 14 Insulation Resistance Test Using Megger

9. TROUBLESHOOTING

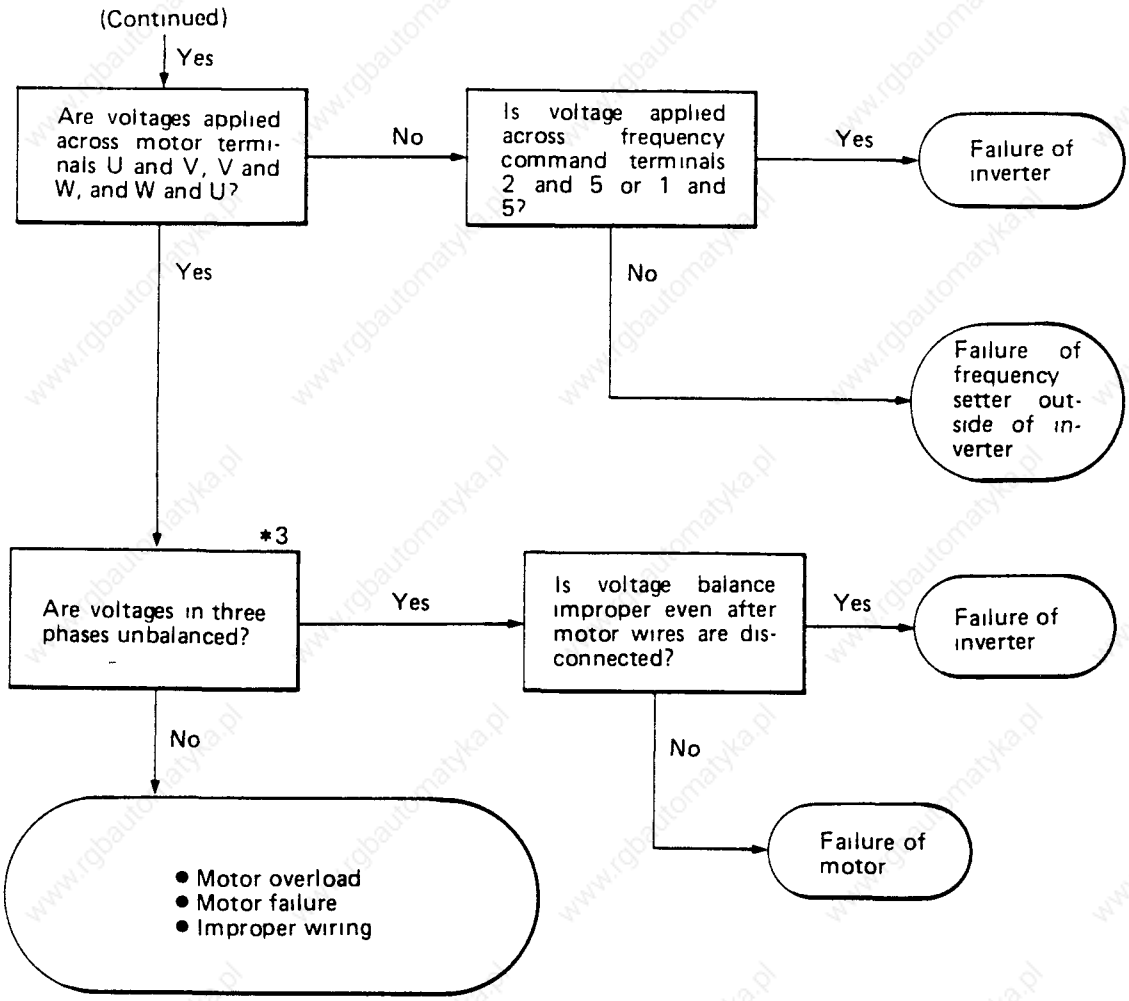
In the event that trouble occurs and the inverter fails to function, check the cause referring to the troubleshooting chart shown below and take corrective action. If the cause of trouble cannot be determined by the chart, the inverter may be detective, or the parts are damaged, or in other cases, please contact your local service representative.

9.1 Troubleshooting Chart

(1) Motor fails to start

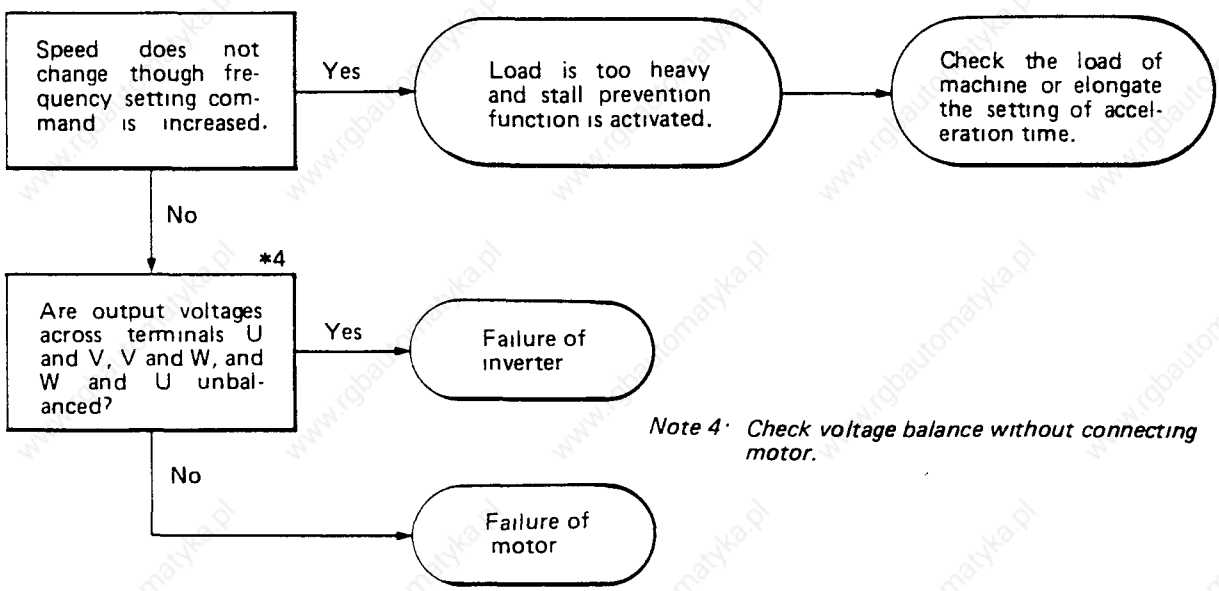


Note 1. ELB stands for earth leakage circuit breaker.
Note 2. ±10% of rated voltage.



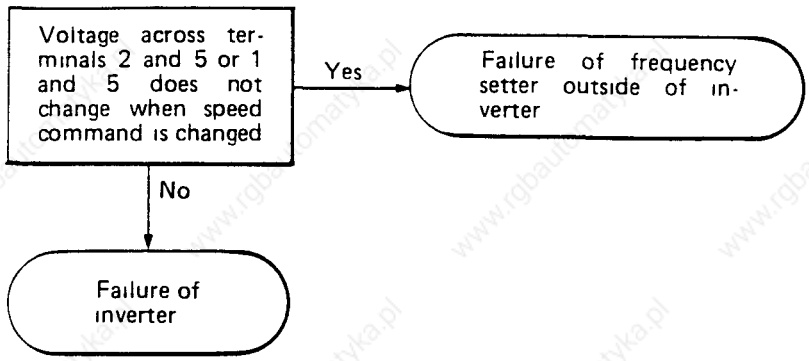
Note 3: Voltage unbalance should be 1% or less of the maximum output voltage.

(2) Motor does not run, but being noisy.

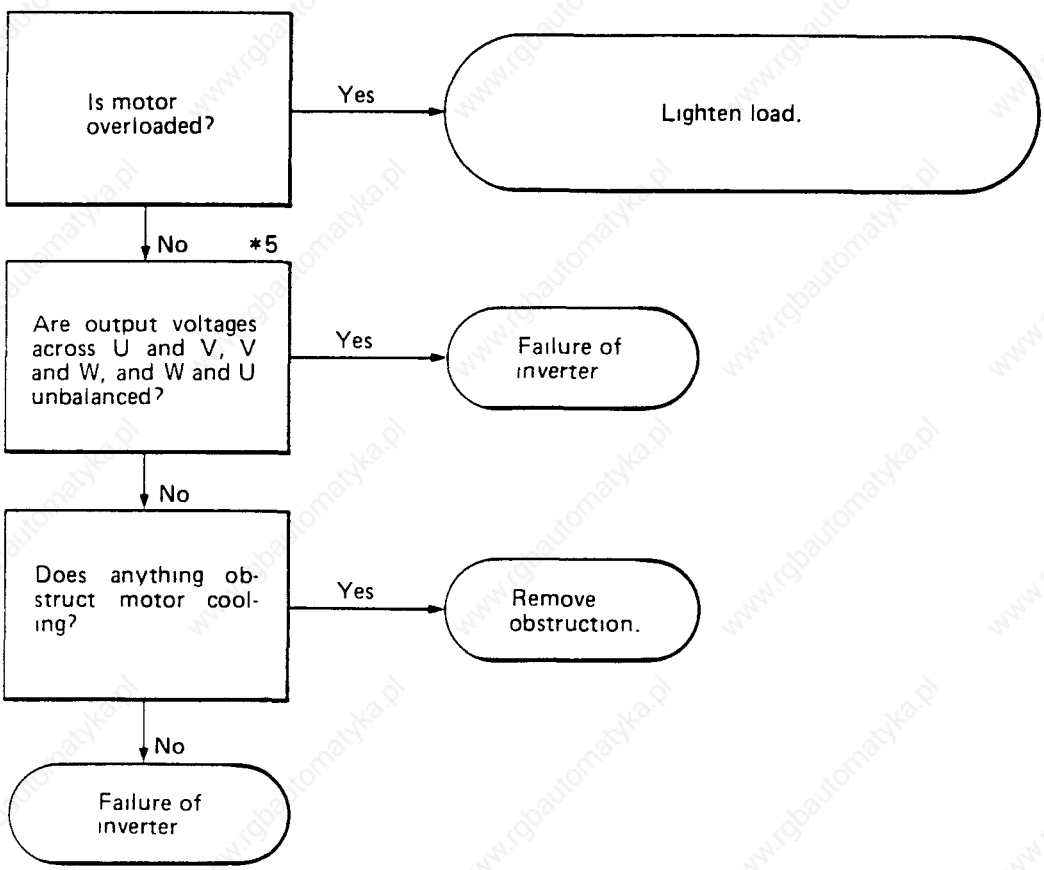


Note 4: Check voltage balance without connecting motor.

(3) Motor runs at constant speed, but can not change the speed.

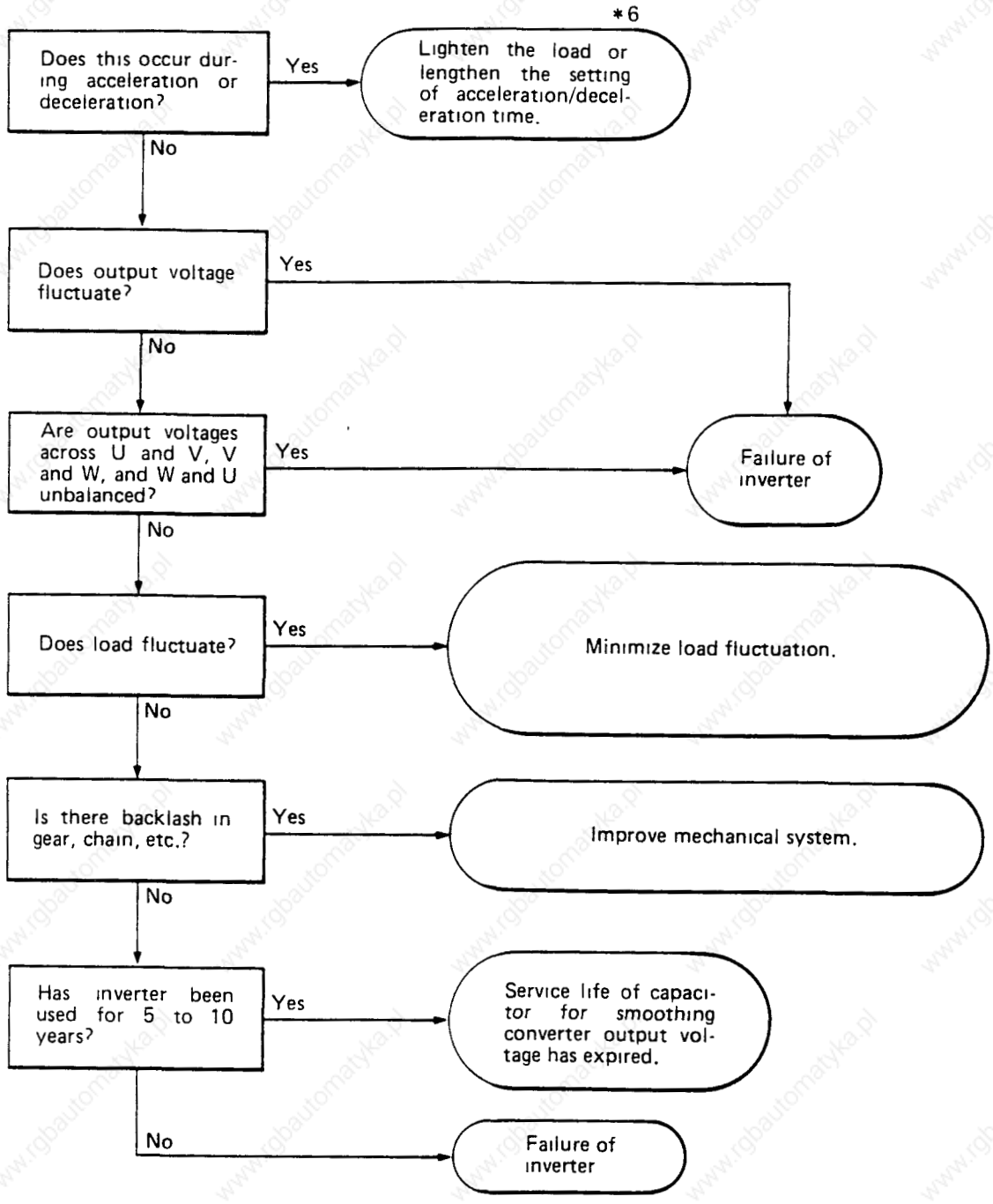


(4) Motor overheats abnormally.



Note 5 Voltage unbalance should be 1% or less of the maximum output voltage.

(5) Moter failes to run smoothly.



Note 6: Motor is accelerated or decelerated irregularly by stall prevention function.

9.2 Measuring Methods for Voltage and Current

Since the primary and secondary voltages and currents of inverter contain higher harmonic waves, measured values differ depending on measuring instruments and measured circuits.
When an instrument for commercial frequency is used for measurement, select one from the measuring instruments listed in Table 1 and make measurements at the measuring points shown in Fig. 15.
Fig. 16 shows an example of differences between the readings of measuring instruments used. However, the measuring instruments having the same measuring accuracy may produce errors depending on manufacturers, models, and manufacture dates.

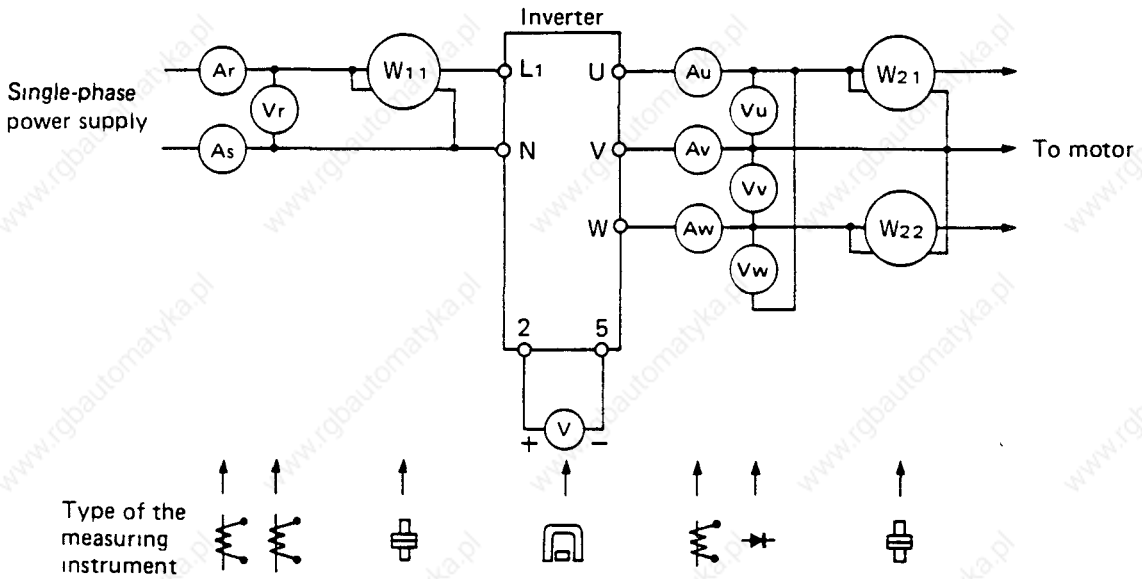


Fig. 15 Measuring Points and Measuring Instruments

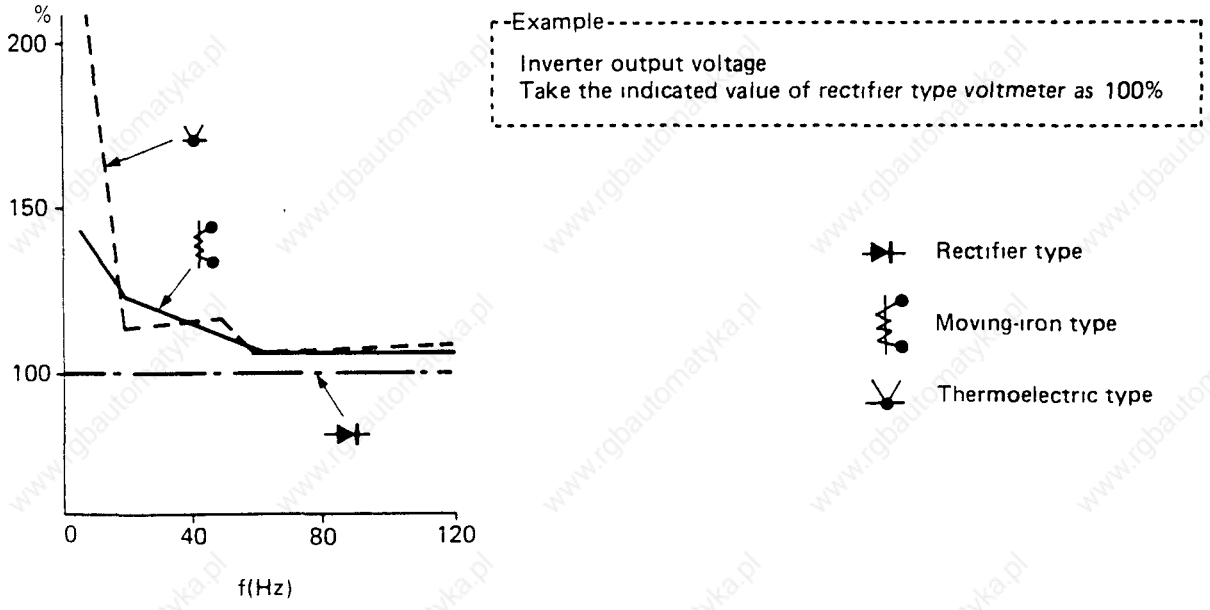


Fig. 16 Differences of indicated value with various measuring instruments

Measured Item	Measured Point	Measuring Instrument	Remarks (Reference measured value)
Power supply voltage V1	Across terminals L1 and N	Moving-iron type	Commercial voltage Single-phase 50Hz 198 to 262V AC
Power source side current I1	L1 and N line current	Moving-iron type	Commercial voltage Single-phase 50Hz 198 to 262V AC
Source side power P1	At terminals L1, N and across L1-N	Dynamometer type	P1 = W11
Power source side power factor Pf1	Calculate after measuring source voltage, source current and source power. $Pf1 = \frac{P1}{\sqrt{3}V1 \times I1} \times 100(\%)$		
Output voltage V2	Across U-V, V-W and W-U	Rectifier type (this is not moving-iron type)	Difference between each phase is 1% or less.
Output current I2	U, V and W line currents	Moving-iron type	Current should be no more than inverter rated current. Difference between each phase is 10% or less.
Output power P2	At terminals U, V and W, and across U-V, and V-W	Dynamometer type	P2 = W21 + W22
Output power factor Pf2	Calculate like power source side power factor. $Pf2 = \frac{P2}{\sqrt{3}V2 \times I2} \times 100(\%)$		
Converter output	Across terminals P and BN	Moving coil type (such as circuit tester)	POWER lamp is lit. 1.35 x V1 Maximum 380V during Regenerative operation
Frequency setting signal	Across terminals 2 and 5	Moving coil type (Circuit tester, etc. may be used (Internal resistance: 50kΩ or larger)	0 to 5V DC; "5" is common
	Across terminals 1 and 5		0 to 10V DC; "5" is common
Frequency setting power supply	Across terminals 10 and 5		DC 5V; "5" is common
Frequency meter signal	Across terminals FM and SD		Approx. 5VDC at maximum frequency (when frequency meter is connected)
Start signal	Across terminals STF and SD		20 to 30V DC when opened 1V DC or less at ON voltage; SD is common.
	Across terminals STR and SD		20 to 30V DC when opened 1V DC or less at ON voltage; SD is common.
Reset	Across terminals RES and SD		20 to 30V DC when opened 1V DC or less at ON voltage; SD is common.
Output stop	Across MRS and SD		20 to 30V DC when opened 1V DC or less at ON voltage; SD is common.
Base shut-off operation alarm signal	Across terminals B and C	Moving coil type (such as circuit tester)	Continuity checking ●Under normal condition, there is continuity across B and C. ●When power is off or base is shut off, there is non-continuity across B and C.

Table 1 Measured Points and Measuring Instruments

10. STANDARD SPECIFICATIONS

	Model	FR-K-S1500	FR-K-S2200	FR-K-S3000
Output rating	Applicable motor output	1.5kW	2.2kW	3.0kW
	Rated output current	7.0A	10.0A	13.0A
	Output capacity (at 220V/240V)	2.7/2.9kVA	3.8/4.2kVA	5.0/5.4kVA
	Maximum output voltage	Three-phases 220V or 240V AC 50Hz *1		
Power supply	Voltage/frequency	Single phase 220V or 240V AC 50Hz		
	Permissive voltage regulation	198V to 262V AC		
	Power source requirement	4.5kVA	5.5kVA	9kVA
Control Specifications	Control method	Sinusoidal PWM control system		
	Output frequency range	1 to 60Hz, 2 to 120Hz or 4 to 240Hz selectable		
	Start frequency	0.5Hz/max. 60Hz, 1Hz/max. 120Hz, 2Hz/max. 240Hz		
	Frequency resolution	0.015Hz/max. 60Hz, 0.03Hz/max. 120Hz, 0.06Hz/max. 240Hz		
	Frequency accuracy	±0.5% (25°C ± 10°C)		
	Voltage/frequency ratio	9 steps selectable. . . .constant V/F, constant V selectable for 50, 60, 120Hz or more		
	Overcurrent capacity	300% for 1 minute	250% for 1 minute	
	Instantaneous power failure withstand capability	Normal operation within 15msec.		
	Undervoltage withstand capability	Normal operation at 150V AC or larger		
	Starting torque	150% 6Hz (by automatic torque boost) 130% 6Hz (by manual torque boost) *2		
	Regenerative braking torque	120% or more for a short time		
	DC braking torque	50% or more on average at less than 3Hz		
	Frequency setting signal	0 to 5V DC		
	Auxiliary input signal	0 to ± 10V DC (Addition to frequency setting signal is possible.)		

*1: *Does not exceed the line voltage.*
*2: *Values are based on Mitsubishi's 3.7kW 4-pole (cold) motor.*

	Model	FR-K-S1500	FR-K-S2200	FR-K-S3000
Control specifications (Continued)	Acceleration/deceleration time	0.2 to 3.0 seconds, 1 to 15 seconds, 10 to 150 seconds selectable		
	Operation signal	Independent setting of forward and reverse With JOG (5Hz fixed) mode terminal, with output stop terminal		
	Reset signal	With reset terminal		
	Output signal	Inverter run, preset frequency coincidence (open collector output)		
	Alarm output signal	1b contact (normally closed, opened at alarm) 230V AC 0.3A		
Protective functions		Overcurrent stall prevention, regenerative overcurrent stall prevention, overcurrent protection, regenerative overvoltage protection, overload protection (electronic thermal relay), fin overheat protection, CPU fault prevention, power source undervoltage protection, instantaneous power failure protection, overload alarm, built-in brake resistor protection		
Environment	Ambient temperature	−10°C to +40°C *3 *4		−10°C to +50°C *3
	Ambient humidity	90% or less (no dew condensation)		
	Atmosphere	No corrosive gas location *5		No corrosive gas and dust location *5
	Altitude	Below 1000m		
	Vibration	0.5 G or less (conforms to JIS C 0911)		
Enclosure		Totally enclosed type (IP50)		Enclosed type (IP20)
Weight		7.0kg	7.0kg	9.5kg

*3: *Should be free of freezing. At temperature lower than −10°C, the inverter may not be started. If not started immediately, the inverter is started approximately 30 seconds later. Therefore, caution should be exercised.*

*4: *If totally enclosing plates at the top and bottom are removed, the maximum is 50°C.*

*5: *Should be installed indoors.*

11. PROTECTIVE FUNCTION

Protective functions are incorporated to protect the inverter from overcurrent and overvoltage. When the protective function is activated, the output of the inverter is shut off and the motor comes to a stop after free running. To restart the motor, reset by use of the reset (RES) terminal or by shutting off the input power supply, then restarting the inverter on the normal manner.

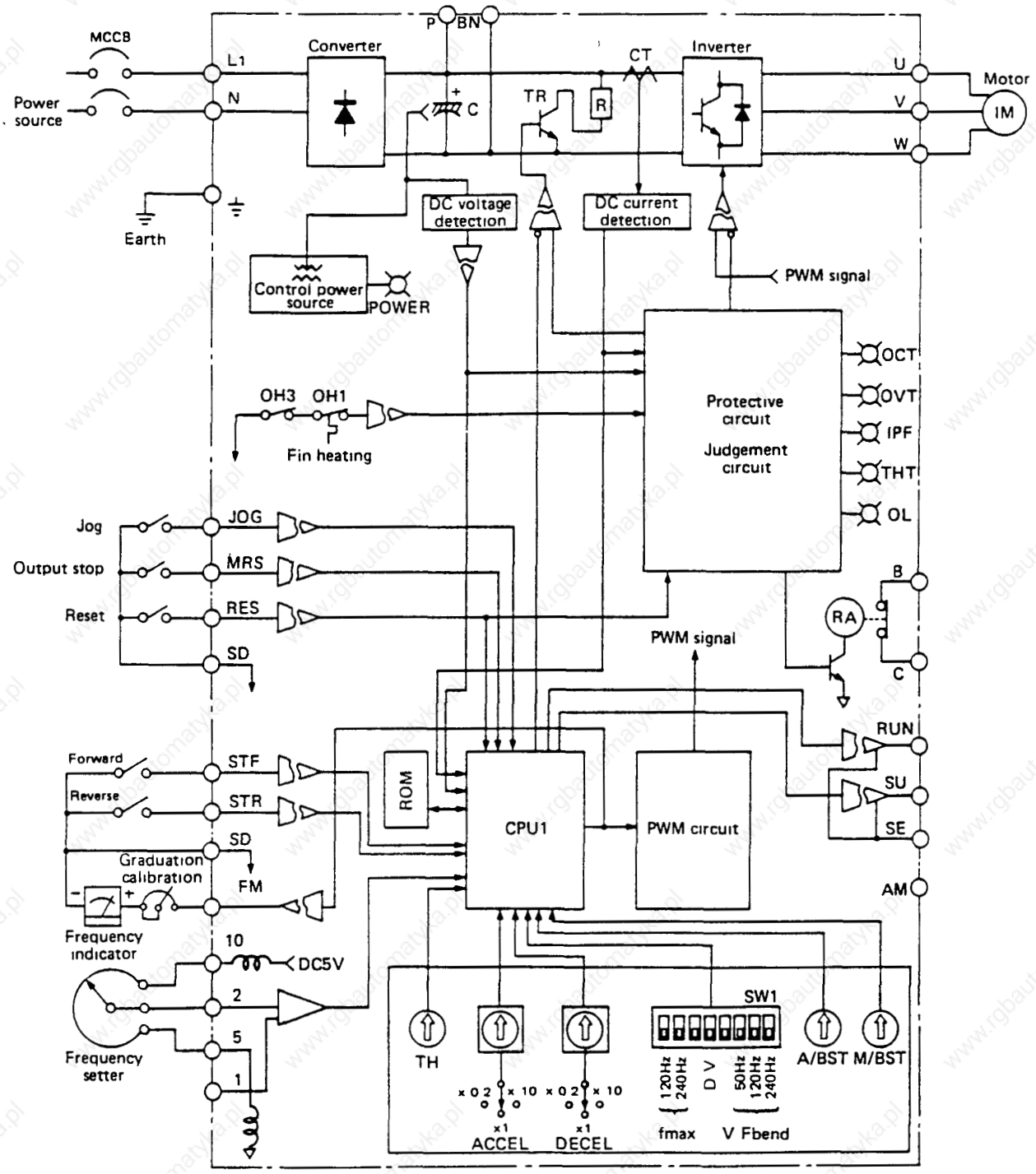
Overcurrent stall prevention	When current of 150% or more of inverter rated current flows in the motor during the acceleration of motor by the inverter, this function stops the rise of frequency until load current reduces to prevent the inverter from resulting in overcurrent trip. Also, when overcurrent of 150% or more of rated current flows during steady (constant-speed) operation, this function reduces frequency until load current reduces to prevent the inverter from resulting in overcurrent trip. When load current has reduced below 150%, this function increases frequency again and permits acceleration to be continued up to preset frequency.	OL lamp flickers.
Regenerative overvoltage stall prevention	When the output voltage of the converter rises to over predetermined value by regenerative energy during deceleration of motor, this function stops the fall of frequency until the voltage of capacitor (across terminals P and N) reduces to less than the predetermined value in order to prevent the inverter from resulting in overvoltage trip. As soon as regenerative energy has reduced, this function decreases frequency again to allow deceleration to be continued.	OL lamp flickers.
Overcurrent trip (OCT)	This function detects the DC current of converter. When overcurrent of 200% or more of the inverter rated output current occurs, the protective circuit is activated to stop the inverter. *Clear the fault and reset the inverter.*	OCT lamp is lit. (Possible causes of OCT are, short on the inverter output side, earth fault, excessive load GD^2, extremely short setting of acceleration time, start during free running of motor, motor larger than inverter rating, start of special motor, etc. Therefore, restore the circuit after fully examining the cause of trouble.)
Regenerative overvoltage trip (OVT)	When the converter output occurs an overvoltage, caused by regenerative energy from the motor, protective circuit is activated to switch off the transistor output and keep it switched off. *Clear the fault and reset the inverter.*	OVT lamp is lit. (Causes of OVT include short setting of deceleration time and negative load. Therefore, lengthen the setting of deceleration time or use an optional brake unit.)

Instantaneous power failure protection (IPF)	When instantaneous power failure occurs for 15 msec or longer (this applies also at switch off of inverter input power supply), instantaneous power failure protective function is activated to stop the output of inverter and keep it stopped. In the case of light load, normal operation can be continued up to approximately 100msec, although it depends on loads. When power failure continues about 10 ~ 20sec, the error alarm is restored to reset state due to the loss of power. When the power is restored 100msec or later, the protective function is automatically reset. (When the power failure has occurred within 15msec, or in the case of light load, when the power failure has occurred for about 100msc, normal operation is performed.)	IPF lamp is lit. (When the power is restored after the stop of inverter output, if automatic restart is made during free running of motor, the inverter may be tripped Therefore, provide an automatic restart prevention circuit or an instantaneous power failure restart option.)
Power supply undervoltage protection (IPF)	When the line voltage of inverter is reduced, the control circuit cannot provide normal operation and malfunctions result, such as heat generation of motor and insufficient torque. Therefore, when the line voltage is reduced to less than 150V, the protective circuit is activated to stop the output of transistor and keep it stopped.	IPF lamp is lit. (Line voltage tends to reduce when the capacity of power source transformer is insufficient or large-capacity motor connected to the same circuit is started. Check the power supply system capacity.)
Overload alarm (OL)	When motor is overloaded and inverter output current exceed 150% of rated current,the overload alarm (OL) lamp is lit. When the current is reduced to less than 150%, the lamp is turned off. Since the OL lamp detects and indicates an overload state before tripping occurs by overcurrent or overvoltage, it acts as an error alarm.	OL lamp is lit. (If the OL lamp flickers during acceleration or deceleration, set the acceleration or deceleration time longer. If it is activated during constant-speed operation, lighten load or reconsider inverter and motor capacities.
Fin overheat protection (OVT/THT)	The inverter performs forced cooling with built-in fan. When the cooling fin of semiconductor is overheated due to the failure of fan, temperature sensor is activated to stop the inverter output and keep it stopped.	OVT and THT lamps are lit at the same time. (Check cooling fin and ambient temperature and also check for obstacle in the way of air.) See page 4.
Brake resistor overheat protection (OVT)	The inverter is equipped with built-in brake unit. When the regenerative brake amount from motor has exceeded predetermined value, the use of brake is temporarily stopped to protect brake resistor from overheat. When the brake resistor is cooled, the use of brake is restarted.	OVT lamp may be lit. (Set the deceleration time longer or use an optional brake unit.)

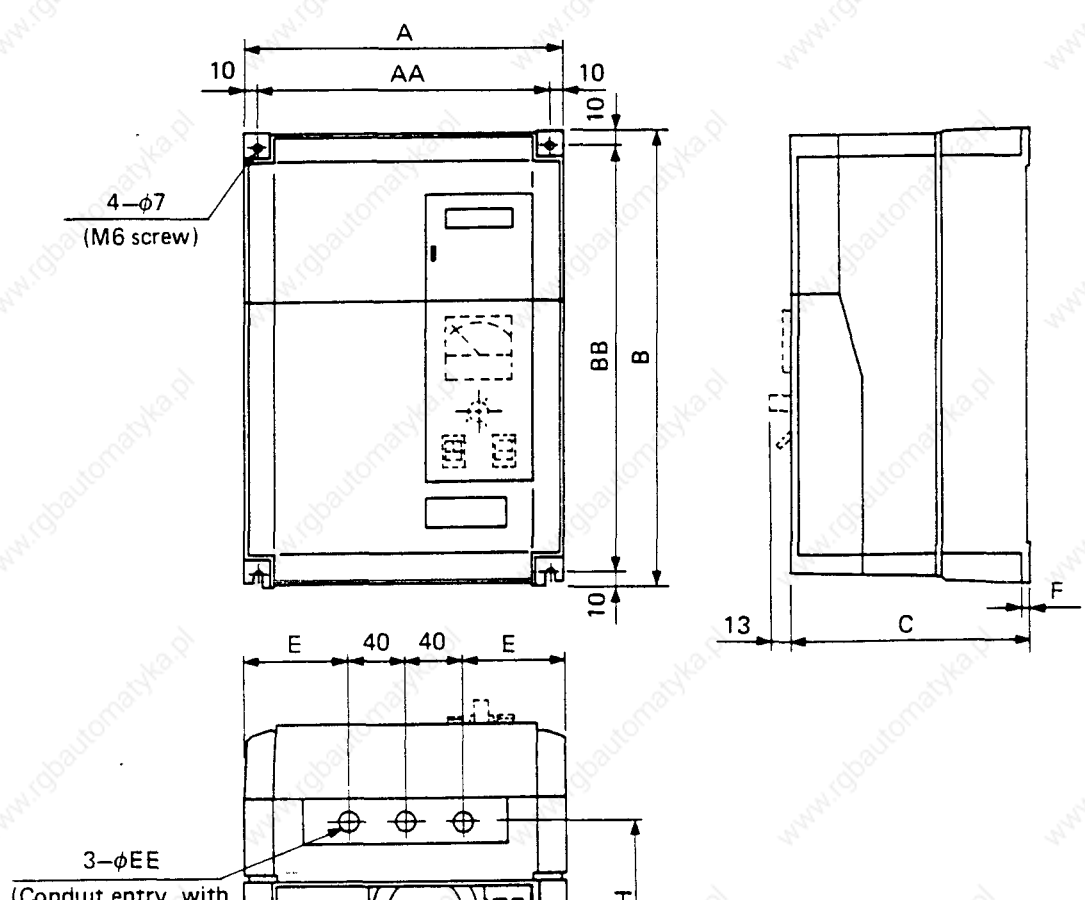
Self-diagnosis trip (OCT/THT)	This function monitors if the CPU for control inside the inverter is always operating normally. Since control error results in a motor overcurrent and insufficient torque, the protective circuit is activated to protect the inverter. This function is also activated when misoperation, such as a setting change of the maximum output frequency, during operation.	OCT and THT lamps are lit at the same time. (The control circuit may have malfunctioned due to external noise, etc. Perform reset and check conditions. If this occurs frequently, fully check if noise has entered peripheral circuit.)
Ground fault protection (at load side) (OVT/THT) (option)	When earth fault has occurred on the load side of inverter and earth fault current has flowed, the inverter is stopped and kept stopped to protect the transistor. (An optional earth fault overcurrent protection unit FR-BGF is required.)	OVT and THT lamps are lit at the same time. (Check if ground fault has occurred on the load side. After removing the cause, restore the output.)

Note: When the protective function (except stall prevention, overload alarm, and brake resistor overheat protection) is activated, the error indicator lamp is lit and kept lit. When the power source circuit of inverter is opened by the magnetic contactor, etc., the control power of inverter runs out and the error signal cannot be retained. When it is desired to retain the error signal, make up the circuit so that the error output contact (terminals B and C) is retained in the external circuit. Alternatively, it is possible to retain the error signal and indication by separating the power source of inverter control circuit from the main circuit power source terminals (L_1 and N) by use of the optional error display retaining unit (FR-PCU).

12. INTERNAL BLOCK DIAGRAM



13. EXTERNAL DIMENSION DRAWING



unit mm

Dimension Table

	A	AA	B	BB	C	D	E	EE	F	H
FR-K-S1500, S2200	220	200	300	280	165	7	70	17	5	100
FR-K-S3000	250	230	400	380	190	10	85	28	7	115

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