MITSUBISHI
TRANSISTORIZED INVERTER

FREQROL-K400

Instruction Manual

IB (NA) 66135-A

MITSUBISHI ELECTRIC

CONTENTS

Thank you for your purchase of Mitsubishi VVVF transistor Inverter FREQROL-K400 series.
This inverter is a variable-frequency power supply unit used to control a squirrel-cage induction motor.
This instruction manual describes handling, installation, operation and maintenance of the inverter. Although it is easy to use the inverter, inadequate use and operation might cause unforeseen trouble. Before operating the inverter, read this manual carefully to use the inverter for a long time without problems.

1. UNPACKING AND CHECKING

After unpacking the inverter, check the following points at first:

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

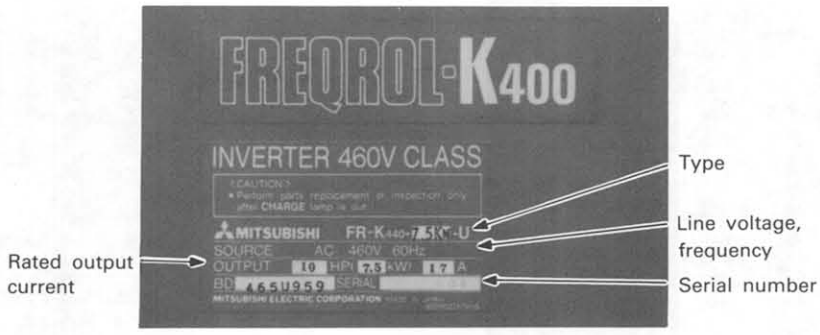


Fig. 1.1 Rating Plate

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

(3) Check that accessories (two enclosing plates and two mounting clips) are packaged with the inverter. (For FR-420-0.4K-U to 3.7K-U)

230V series

Nominal output (HP/kW)	0.5/0.4	1/0.75	2/1.5	3/2.2
With operation panel	FR-K420-0.4KM-U	FR-K420-0.75KM-U	FR-K420-1.5KM-U	FR-K420-2.2KM-U
Without operation panel	FR-K420-0.4K-U	FR-K420-0.75K-U	FR-K420-1.5K-U	FR-K420-2.2K-U

Nominal output (HP/kW)	5/3.7	7.5/5.5	10/7.5	15/11	20/15
With operation panel	FR-K420-3.7KM-U	FR-K420-5.5KM-U	FR-K420-7.5KM-U	—	—
Without operation panel	FR-K420-3.7K-U	FR-K420-5.5K-U	FR-K420-7.5K-U	FR-K420-11K-U	FR-K420-15K-U

460V series

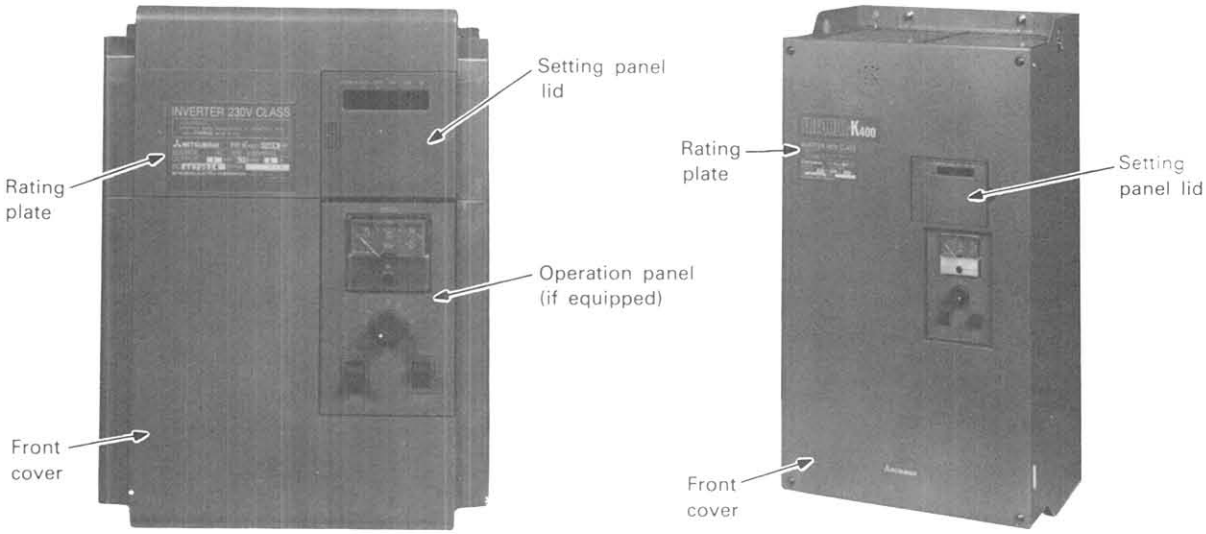
Nominal output (HP/kW)	3/2.2	5/3.7	7.5/5.5	10/7.5	15/11	20/15
With operation panel	FR-K440-2.2KM-U	FR-K440-3.7KM-U	FR-K440-5.5KM-U	FR-K440-7.5KM-U	—	—
Without operation panel	FR-K440-2.2K-U	FR-K440-3.7K-U	FR-K440-5.5K-U	FR-K440-7.5K-U	FR-K440-11K-U	FR-K440-15K-U

Nominal output (HP/kW)	25/18.5, 30/22	40/30	50/37	60/45	75/55
With operation panel	—	—	—	—	—
Without operation panel	FR-K440-22K-U	FR-K440-30K-U	FR-K440-37K-U	FR-K440-45K-U	FR-K440-55K-U

Table 1.1 Models and Compositions

2. CONSTRUCTION

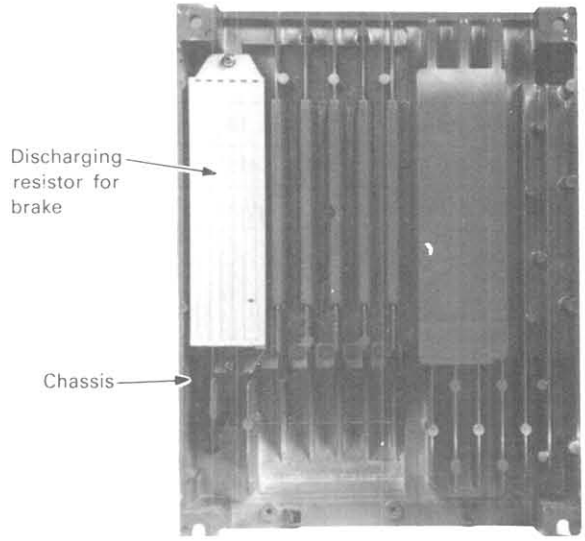
2.1 External Views and Name of Each Parts



(FR-K420-0.75KM-U)

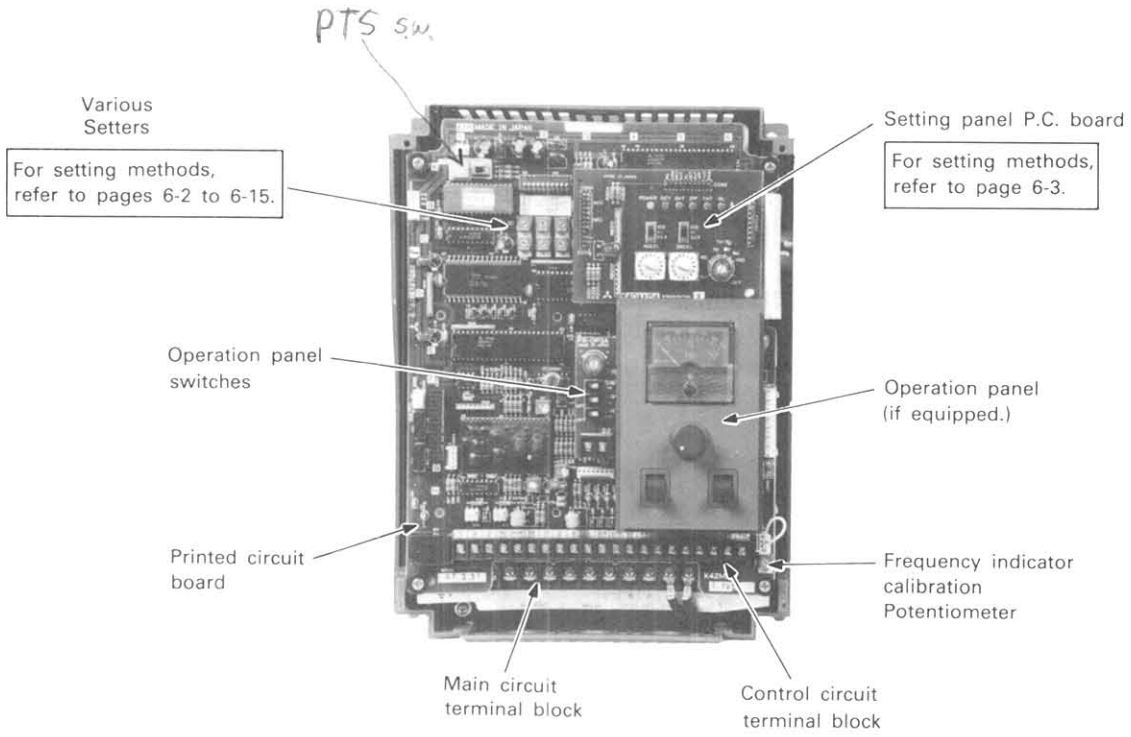
(FR-K440-7.5KM-U)

Fig. 2.1 Front View

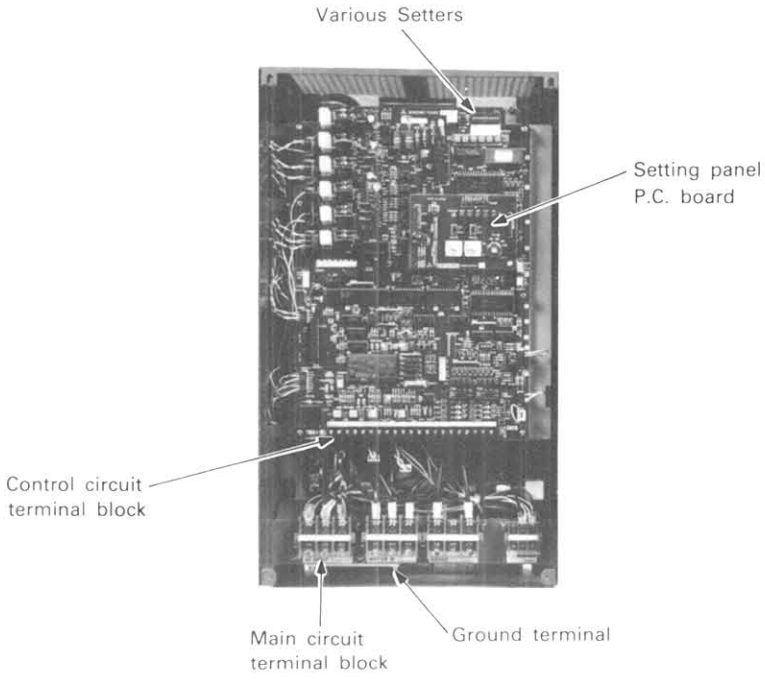


(FR-K420-0.75K-U)

Fig. 2.2 Rear View



(FR-K420-0.75KM-U)



(FR-K440-7.5K-U to 55K-U)

Fig. 2.3 Explanation of Internal Parts

2.2 Removal and Reinstallation

(1) Front cover

How to remove the front cover (Fig. 2.4):
While pressing the white button at the top of the inverter (as indicated by arrow ①), pull the cover to the front (arrow ②) and lightly push it down (arrow ③).

How to attach the front cover (Fig. 2.5):
As shown in Fig. 6, insert the pin inside the cover into the pin receiver at the chassis bottom and press the upper cover lightly against the chassis.

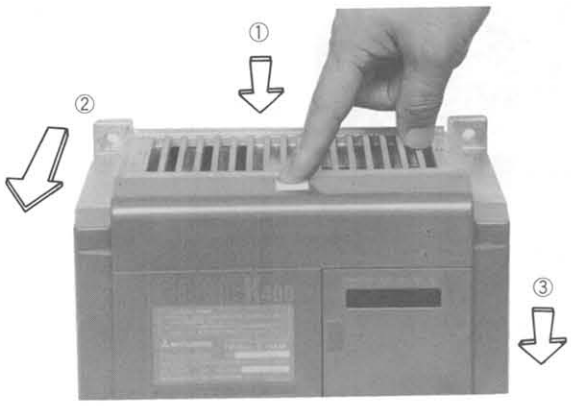


Fig. 2.4 Front Cover Removal

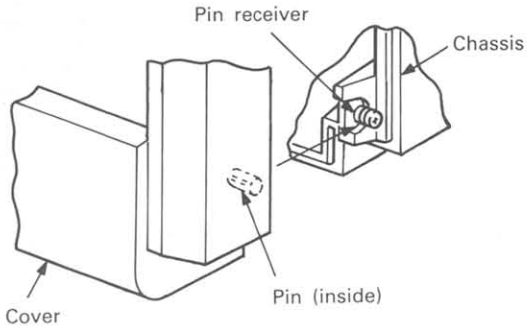


Fig. 2.5 Front Cover Re-Attaching

CAUTION

- **The rating plate is stuck on the front cover. Do not attach the cover to the other inverter.**
- **Check that the front cover has been reinstalled securely.**

The front cover can be installed without screws.
Screws may be used to fix the front cover as described followings.

a. Remove the front cover and make holes in the cover from the rear face with a drill, etc. (Two points on right and left at top as shown in Fig. 2.6) Hole diameter 4.5 to 5 mm.
b. After attaching the front cover, fix the cover using the following screws:
Two M4 x 0.7 x 30 screws···Not accessaries

Fig. 2.6 How to Fix the Cover with Screws

(2) Setting panel cover

How to remove the lid of setting panel (Fig. 2.7):
While pushing the left end of the setting panel lid, slide the setting panel lid to the right as shown in Fig. 2.7. Since the setting panel lid is completely separated from the front cover, please be careful not to lose it.

Fig. 2.7 Setting Panel Cover Removal

(3) Enclosing plate . . . . . provided for FR-K420-0.4K-U to 3.7K-U and 0.4KM-U to 3.7KM-U only

By attaching the accessory enclosing plates at the top and bottom of the inverter, the inverter can be used as a totally enclosed type. Use these plates in environments where much dust and dirt exist.

CAUTION: Do not install the enclosing plates to FR-K420-5.5K-U to 11K-U.

When the enclosing plates are used, the maximum permissive ambient temperature is 40°C. If the inverter is installed in a place where ambient temperature may exceed 40°C, do not use the enclosing plates. (For FR-K420-0.4K-U to 3.7K-U and 0.4KM-U to 3.7KM-U)

- Top enclosing plate:
  It can be attached easily by pushing the mounting clips into the holes in the chassis top.
- Bottom enclosing plate:
  After remove the attached closure plate (hold both ends of the closure plate and pull it up) and then thrust the two enclosing plate hooks into mounting holes.

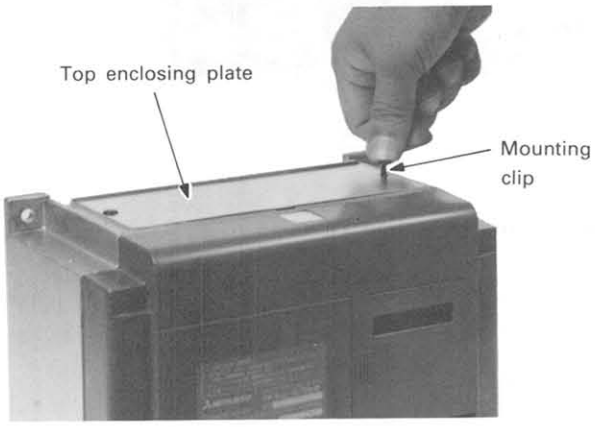


Fig. 2.8 Top Enclosing Plate Attaching

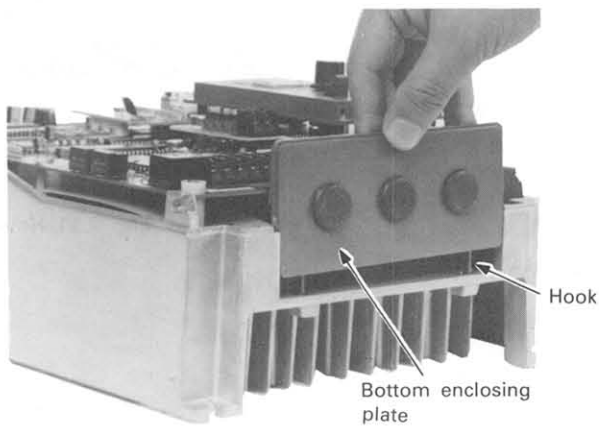


Fig. 2.9 Bottom Enclosing Plate Attaching

(4) Operation panel (For model with operation panel)

The operation panel is fixed to the printed circuit board with the hooks at the mounting leg ends.

How to remove:
While pushing two mounting legs at the bottom, pull the panel up.

How to re-attach:
Fit the operation panel connector pins into the inverter P.C. board connector accurately and securely, and thrust the hooks into the mounting holes in the P.C. board.

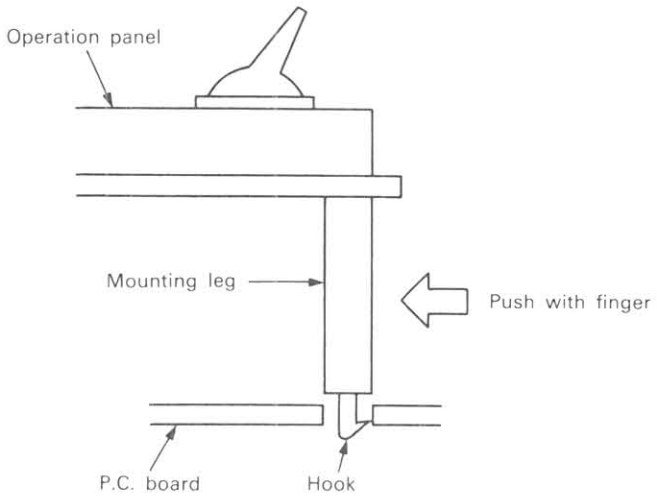


Fig. 2.10 Operation Panel Removal

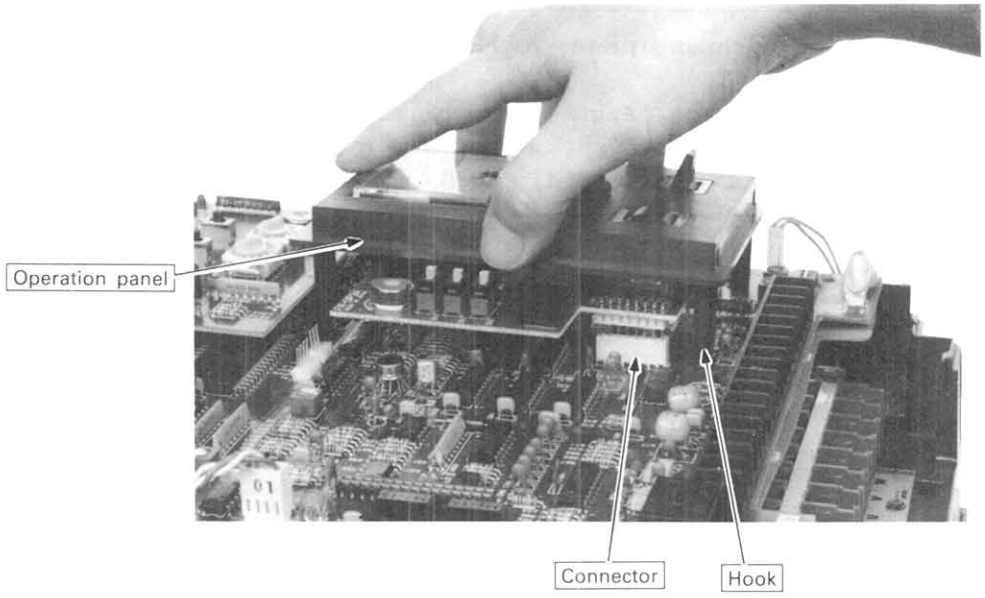


Fig. 2.11 How to Attach the Operation Panel

3. HANDLING INSTRUCTIONS

If the inverter is handled improperly, normal operation 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 10-1 to 10-4.)

2. Do not connect the input voltage wirings to the output terminals, because it may damage the inverter.

3. The inverter P and N terminals are used exclusively for the brake unit. Do not connect resistor only or do not use as a DC power source.

4. 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 a enclosure box, pay attention to the enclosure box size and ventilation so that the inverter is operated at allowable temperature.

5. Do not use the circuit breaker (MCCB) or magnetic contactor (MC) to start and stop the motor (inverter). Use the inverter start signals (STF, STR-SD).

6. To operate the inverter connected shortly to a large capacity power source, surely use an AC reactor (power-factor improving reactor to the inverter input side.)
   The reacter model:
   230V class: FR-BAL- (capacity)
   460V class: FR-BAL-H- (capacity)

7. To the inverter output side, do not connect a power capacitor, surge suppressor, or noise filter model FR-BIF or FR-BIF-H (option).

8. To check insulation resistance with a megger, refer to page 7-4.

9. Do not perform overload operation over the inverter capability (e.g. repetition of thermal relay trip and reset).

4. INSTALLATION

4.1 Environments

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

(2) Install the inverter to low vibratory place.

4.2 Installing Direction and Space

(1) Install the inverter securely and vertically with bolts or screws so that the letters "FREQROL-K400" face front.

(2) When the inverter is equipped with a built-in operation panel, install the inverter where the operation can touch it easily.

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

(4) When operation is repeated frequently, the surface temperature of the **discharging resistor for brake** mounted rear side of the inverter may become high (maximum 150°C, 302°F). Then, install the inverter on a non-flammable panel (such as metal).
(The FR-K420-11K-U, 15K-U and FR-K440-15K-U to 55K-U does not mount a built-in discharging resistor.)

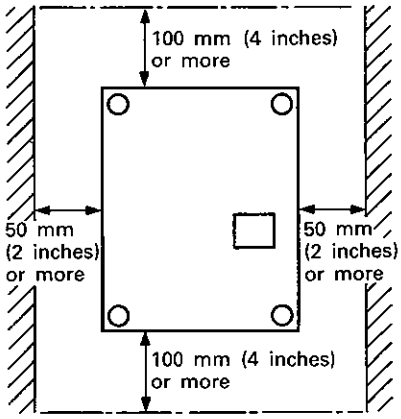
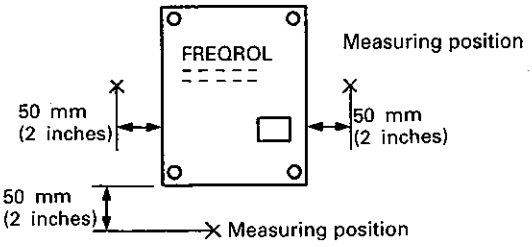


Fig. 4.1 Installation Clearance of Inverter

Consideration for Ambient Temperature

The life time of the inverter depends on ambient temperature. The ambient temperature should not exceed the permissive value.
Check the ambient temperature at the positions shown on the right.
Permissive ambient temperature: +50°C (+122°F)
(If the enclosing plates are installed, permissive temperature is +40°C (+104°F). This applies to the FR-K420-0.4K-U to 3.7K-U and 0.4KM-U to 3.7KM-U only.)



5. WIRING

Fig. 5.1 and 5.2 show the wirings for terminals. Please refer to them and connect the wires according to the following instructions.

5.1 Wiring Procedure

(1) For power source terminals R/L1, S/L2, and T/L3, it is not necessary to consider phase sequence.

(2) When wires are connected to output terminals U/T1, V/T2 and W/T3, the motor is rotated counterclockwise by a forward signal, as viewed from the load side.

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

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

(5) It is needless to use AC reactor (packaged with the inverter), when using power-factor improving reactor (model FR-BAL-H: option). (FR-K440-2.2K-U to 55K-U)

Caution of wiring

(1) Do not connect power source to the output terminals (U/T1,V/T2,W/T3), because that miswiring causes not only the damage of 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 N are used to connect the brake unit and discharging resistor. Do not connect either resistor only or any other device.

(4) The inverter cannot be covered accidents due to leakage. Pay attention so that the 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 same time of recovery 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, check the phase sequence so that the motor rotating direction is the same in any operations.

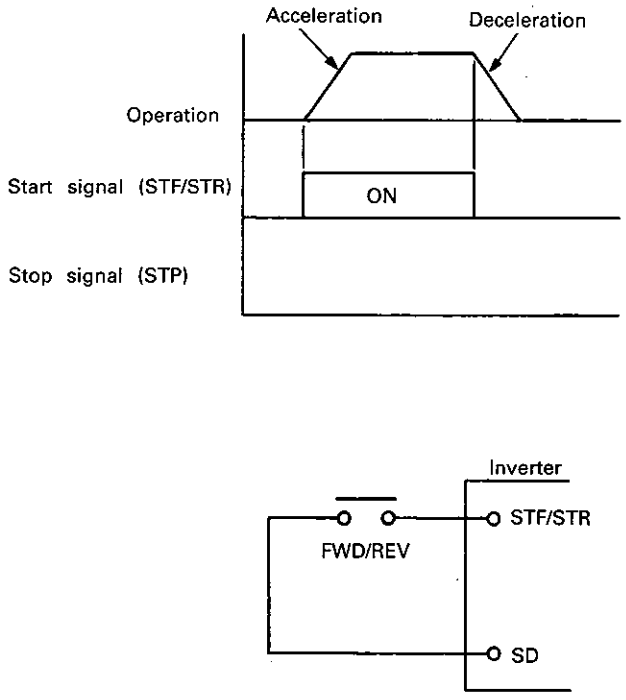
(7) Since the speed reference signals (terminals 2,1 and 5) are not isolated from the control circuit in the inverter, do not ground common terminal 5. Refer to Fig 5.1.

(8) Do not short-circuit terminals between No.10 (source for speed reference) and No.5 (common). Connection of these terminals will damage the inverter.

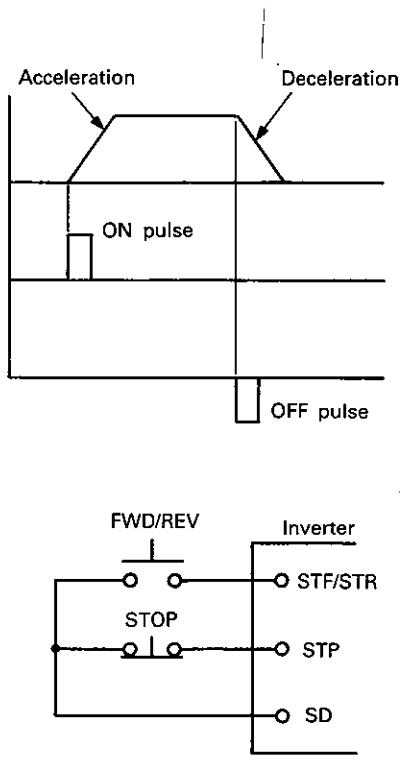
(6) 2-wire control or 3-wire control method

Either method can be connected to the inverter. (Refer to Fig 5.1 and Fig 5.2)

● 2-wire control

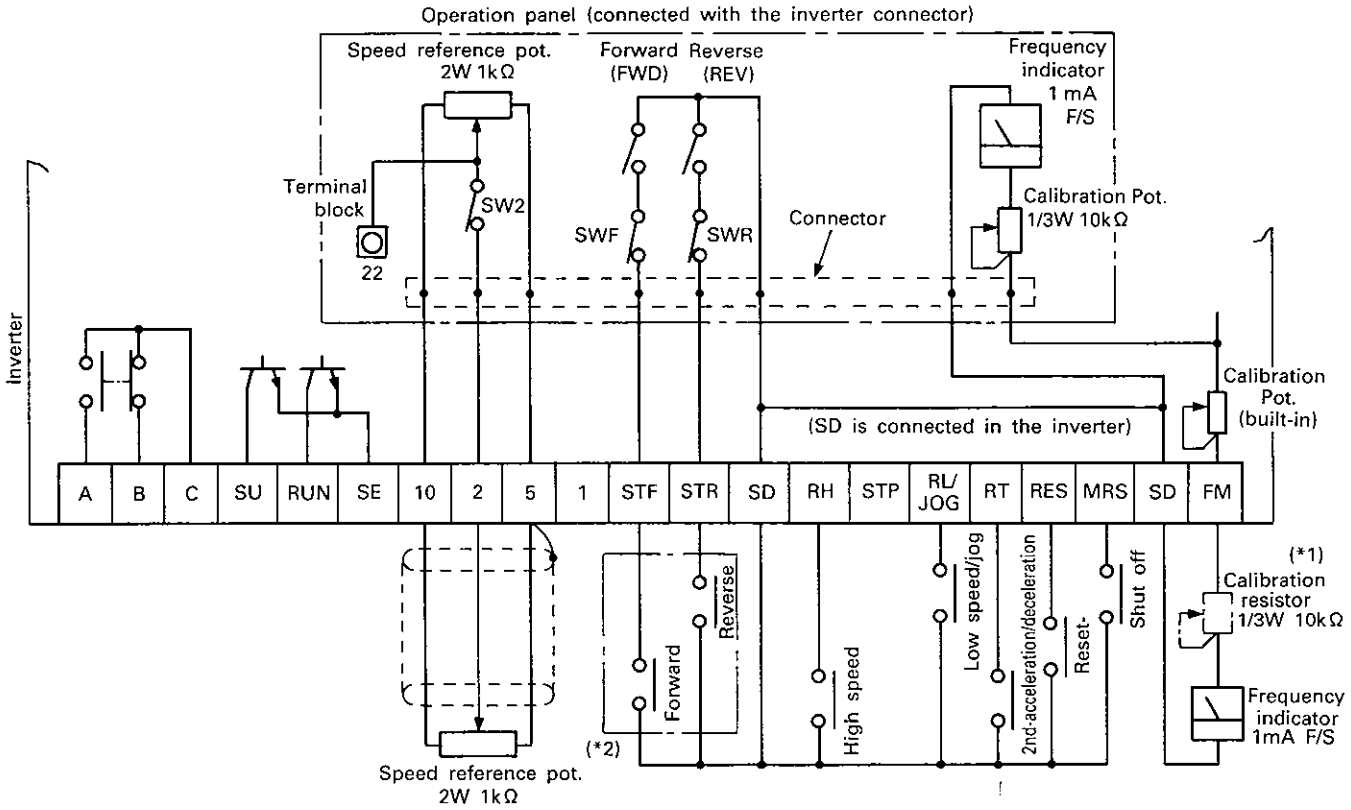


● 3-wire control



5.2 Wiring Diagrams (For terminal descriptions, refer to page 10-5 and 10-6.)

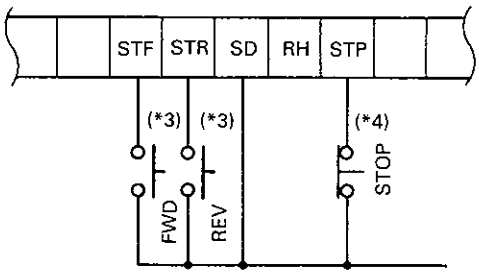
(1) Control circuit



*Note (*1): This resistor is not required when the built-in calibration pot is used.*

*(*2): [- - -] shows in case of 2-wire control method.*

Fig. 5.1 Connection to Control Circuit Terminals



*Note (*3): Normally open type push button.*

*(*4): Normally close type push button.*

Fig. 5.2 In Case of 3-Wire Control Method

(2) Main circuit

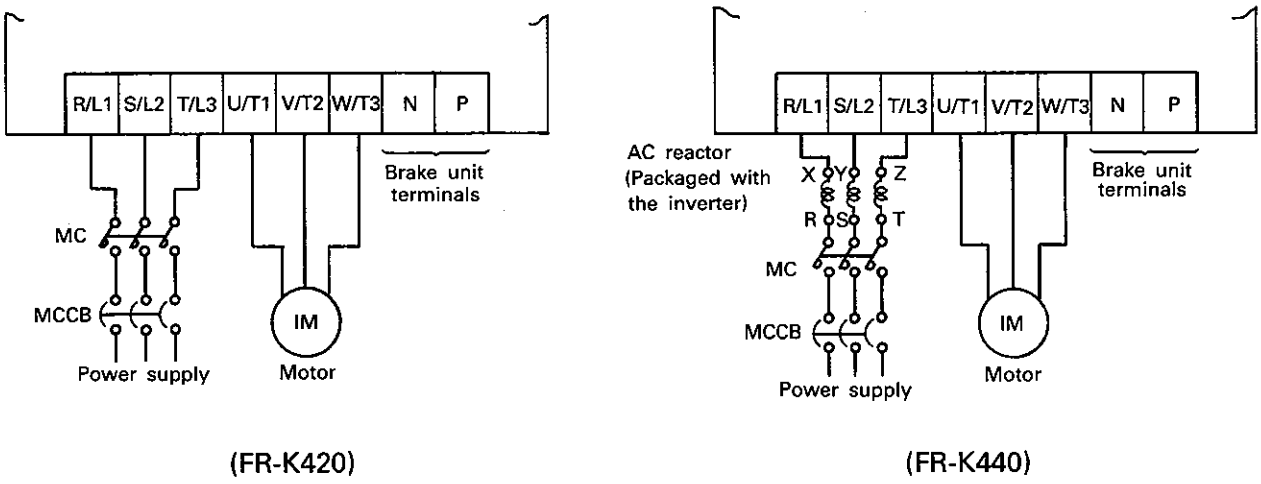
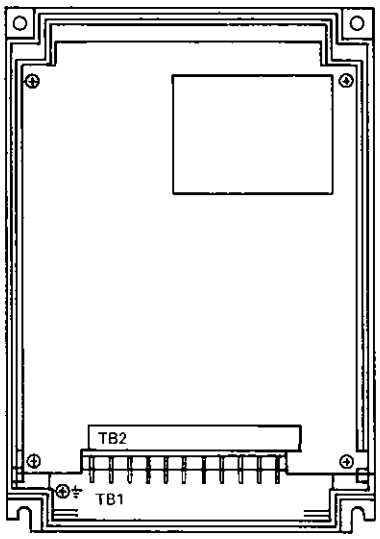


Fig. 5.3 Connection to Main Circuit Terminals

5.3 Terminal Arrangement

● FR-K420-0.4K-U to 11K-U (230V series)



Control circuit terminal block TB2

A	B	C	SU	RUN	SE	10	2	5	1	STF	STR	SD	RH	STP	RL/JOG	RT	RES	MRS	SD	FM

Main circuit terminal block TB1

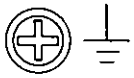
(For FR-K420-0.4K-U to 3.7K-U)

R/L1	S/L2	T/L3	U/T1	V/T2	W/T3	N	P

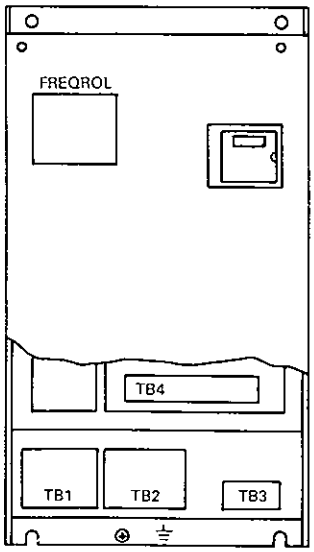
(For FR-K420-5.5K-U to 11K-U)

	N	P		R/L1	S/L2	T/L3		U/T1	V/T2	W/T3	

Ground terminal



● FR-K420-15K-U (230V series)



Control circuit terminal block TB4

A	B	C	SU	RUN	SE	10	2	5	1	STF	STR	SD	RH	STP	RL/JOG	RT	RES	MRS	SD	FM

Main circuit terminal block

TB1

R/L1	S/L2	T/L3

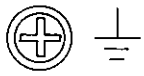
TB2

U/T1	V/T2	W/T3

TB3

N		P

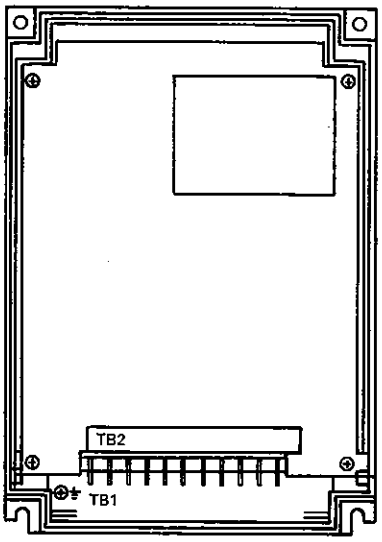
Ground terminal



Terminal screw size

Model	Control circuit	R/L1. S/L2. T/L3	U/T1. V/T2. W/T3	P. N	Ground terminal
FR-K420-0.4K-U to 3.7K-U	M3	M4	M4	M4	M5
FR-K420-5.5K-U to 11K-U	M3	M5	M5	M4	M5
FR-K420-15K-U	M3	M8	M8	M4	M6

● FR-K440-2.2K-U, 3.7K-U (460V series)



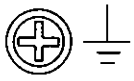
Main circuit terminal block TB1

A	B	C	SU	RUN	SE	10	2	5	1	STF	STR	SD	RH	STP	RL/JOG	RT	RES	MRS	SD	FM

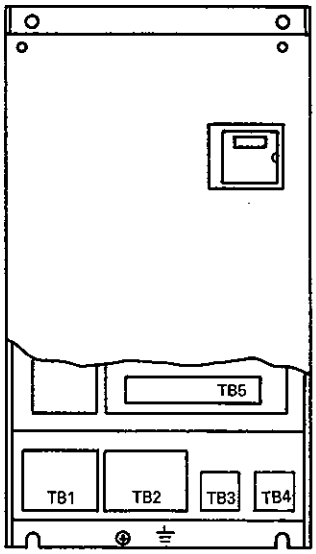
Control circuit terminal block TB2

R/L1	S/L2	T/L3	U/T1	V/T2	W/T3	N		P		R200	S200

Ground terminal



● FR-K440-7.5K-U to 55K-U (460V series)



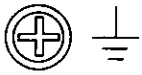
Control circuit terminal block TB5

A	B	C	SU	RUN	SE	10	2	5	1	STF	STR	SD	RH	STP	RL/JOG	RT	RES	MRS	SD	FM

Main circuit terminal block

TB1			TB2			TB3			TB4		
R/L1	S/L2	T/L3	U/T1	V/T2	W/T3	N		P		R200	S200

Ground terminal



Terminal screw size

Model	Control circuit	R/L1. S/L2. T/L3	U/T1. V/T2. W/T3	P.N	* Note R200, S200	Ground terminal
FR-K440-2.2K-U	M3	M4	M4	M4	M4	M5
FR-K440-3.7K-U	M3	M4	M4	M4	M4	M5
FR-K440-7.5K-U	M3	M5	M5	M5	M3.5	M6
FR-K440-15K-U	M3	M6	M5	M5	M3.5	M6
FR-K440-22K-U	M3	M6	M5	M5	M3.5	M6
FR-K440-37K-U	M3	M8	M6	M5	M3.5	M8
FR-K440-55K-U	M3	M8	M8	M5	M3.5	M8

** Note: R200·S200 TERMINALS (Factory Use)*

They are power source terminals for option unit. They supply following powers.

Main circuit power source	R200·S200 Terminals output
AC 460V/60Hz	AC 230V/60Hz

(for FR-K440 series)

6. OPERATION

6.1 Pre-Operation Checks

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

(1) Check that wiring is correct. Especially check that power source cables are not connected to U/T1, V/T2 and W/T3.

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

(3) Check that no wire is deformed.

(4) Check that all screws, terminals are not loosened.

(5) Check that short and ground fault do not exist in the input and output circuits.

Caution for Insulation Resistance Test with Megger

When a megger is used for checking, use it only for measuring resistance between main circuit and ground. Never use the megger for measuring across the inverter terminals. Do not use the megger for measuring across the control circuit terminals. For details of checking with the megger, refer to page 7-4.

6.2 Pre-Operation Settings and Adjustments

After checks has completed, execute the following settings and adjustments in accordance with operational specifications.

Setting and Adjustment	Controls	Location
Acceleration/deceleration time	Acceleration and deceleration time setting dials and magnification selection switches	Setting panel
Electronic thermal relay	Electronic thermal potentiometer (TH)	
Maximum output frequency	DIP switch	Top of printed circuit board
Base frequency		
Torque boost amount must use some % of manual before using auto TORQUE BOOST.	Torque boost (automatic/manual) variable resistor	
2nd-acceleration/deceleration time	Acceleration/deceleration setting potentiometer	
Acceleration/deceleration mode (S-type/linear acceleration/deceleration)	DIP switch	
Starting frequency		
DC dynamic brake mounted/not mounted		
Output voltage compensation mounted		
Start signal and speed reference signal use mounted/not mounted (for model with operation panel)	Start connection switches and speed reference connection switch	Printed circuit board in operation panel
Maximum output frequency selection (240Hz) (For FR-K440-22K-U to 55K-U)	Slide switch	Top of printed circuit board

Table 6.1

(1) Setting panel

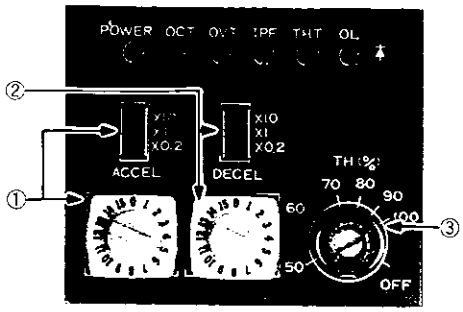


Fig. 6.1

Shipping adjustment
- Acceleration/deceleration time
  FR-K420-0.4K-U to 7.5K-U: 5 seconds
  FR-K420-11K-U to 15K-U : 15 seconds
  FR-K440-2.2K-U to 7.5K-U: 5 seconds
  FR-K440-11K-U to 55K-U : 15 seconds
- Electronic thermal relay
  FR-K420-0.4K-U, 0.75K-U : 85%
  FR-K420-1.5K-U to 15K-U : 100%
  FR-K440-2.2K-U to 55K-U : 100%

① Acceleration time setting dial and magnification selection switch (ACCEL)
Set acceleration time (second), from start to maximum output frequency (60Hz, 120Hz or 240Hz), by the dial and magnification selection switch.
Acceleration time = dial value x magnification value (second)
Example: If dial value = 12, magnification value = 0.2,
acceleration time = 12 x 0.2 = 2.4 seconds

CAUTION

(1) The selectable shortest acceleration time depends on the maximum output frequency (fmax). fmax 60Hz . . . 0.2 seconds, fmax 120Hz . . . 0.4 seconds, fmax 240Hz . . . 0.8 seconds
(2) Even if the setting is changed during operation or acceleration, the setting time does not change.
(3) Do not set the dial to "0" position. (0 is set when option is used.)

② Deceleration time setting dial and magnification selection switch (DECEL)
Set deceleration time, from maximum frequency to stop.
Set the time in the same method as acceleration time.
③ Electronic thermal relay setting potentiometer (TH)
Obtain the setting value (%) from the following expression.

$$\text{Setting} = \frac{\text{Motor rated current (A)} \times \alpha}{\text{Inverter rated output current (A)}} \times 100\ (\%)$$

Where α = 1.0 at 230V 60Hz or 460V 60Hz motor rating

CAUTION

(1) When the inverter is used to control several motors, a multi-pole motor having eight or more poles, or a special motor, the electronic thermal relay cannot protect the motor. Therefore, use a thermal relay outside the inverter. In this case, set the electronic thermal relay to "OFF" position.
(2) If the above setting value exceeds 100%, the load current (motor current) has exceeded the inverter rated current. In this case, increase the inverter capacity.

Sw#3 - only used for 240 cyc. opt of Dwn.

(2) DIP switches

Shipping adjustment :
All switches OFF

Fig. 6.2

For FR-K420-0.4K-U to 15K-U (230V series)

Function	DIP Switch	Description
Maximum output frequency (fmax)	① ②	V/F pattern is selectable in accordance with load and motor characteristics.
Base frequency (V/F bend)	⑥ ⑦ ⑧	
Acceleration/ deceleration mode (L/S)	⑩	Curved or linear acceleration/deceleration can be selected. DIP switch ON: S type (Curved) DIP switch OFF:Linear type When the inverter is needed to accel to high speed area (constant output area) at 120Hz (or 240Hz), the acceleration or deceleration time of S-type is shorter than that time of linear type.
Starting frequency (SF)	⑨	Starting frequency value can be selected. DIP switch ON: Fixed at 3Hz independently of maximum output frequency. DIP switch OFF: Depends on maximum output frequency (fmax) 0.5Hz for fmax 60Hz . . . 1Hz for fmax 120Hz . . . 2Hz for fmax 240Hz
DC dynamic brake mounted/ not mounted (DC.B)	⑤	During deceleration, the DC dynamic brake is actuated at less than 3Hz (for 0.5 seconds) to bring the motor to sudden stop. To stop the motor after coasting at less than the starting frequency, set this switch to ON position.
Output voltage compensation (D.V.)	④	For 230V, 60Hz rating motor, set DIP switch to OFF position, and the inverter output voltage is 230V, 60Hz maximum even if input voltage is over 230V. For 208V, 60Hz rating motor, set DIP switch to OFF position, too. The maximum output voltage of the inverter is the same as the input voltage. Note: If line voltage has reduced, output voltage cannot exceed line voltage.

V/F bend \ fmax

Base Frequency (Motor Frequency)

Maximum output frequency (Inverter Freq)	50Hz	60Hz	120Hz	240Hz
60Hz	220V, V, 0 f 50 60Hz; 1 2 6 7 8	230V, V, 0 f 60Hz; 1 2 6 7 8	V, 115V, 0 f 60Hz; 1 2 6 7 8	V, 57.5V, 0 f 60Hz; 1 2 6 7 8
120Hz	220V, V, 0 f 50 120Hz; 1 2 6 7 8	230V, V, 0 f 60 120Hz; 1 2 6 7 8	230V, V, 0 f 120Hz; 1 2 6 7 8	V, 115V, 0 f 120Hz; 1 2 6 7 8
240Hz	220V, V, 0 50 f 240Hz; 1 2 6 7 8	230V, V, 0 60 f 240Hz; 1 2 6 7 8	230V, V, 0 f 120 240Hz; 1 2 6 7 8	230V, V, 0 f 240Hz; 1 2 6 7 8

3H. 3 must be ON.

Note: Settings other than the above are as follows.

1 2 — Maximum output frequency 60Hz

6 7 8 — Constant-torque V/F pattern up to 120Hz.

6 7 8 — Constant-torque V/F pattern up to 50Hz.

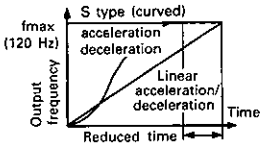
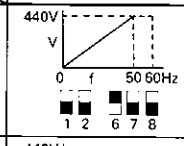
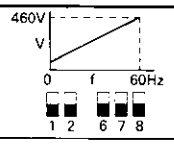
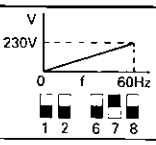
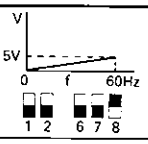
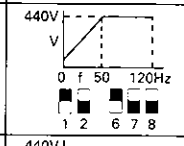
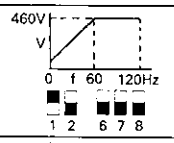
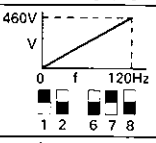
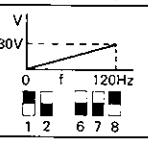
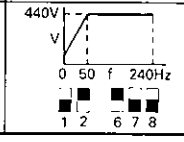
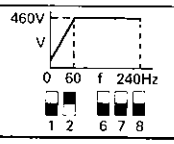
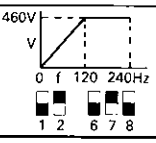
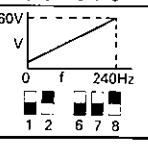


Table 6.2

CAUTION

(1) Do not move the DIP switches during operation.
(2) Do not touch DIP switch ③

<table>
<tr><th>Function</th><th>DIP Switch</th><th>Description</th></tr>
<tr><td>Maximum output frequency (fmax)</td><td>① ②</td><td>V/F pattern is selectable in accordance with load and motor characteristics.
<table>
<tr><th>Maximum output frequency \ V/F bend (fmax)</th><th>Base Frequency 50Hz</th><th>60Hz</th><th>120Hz</th><th>240Hz</th></tr>
<tr><td>60Hz</td><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>120Hz</td><td>  </td><td>  </td><td>  </td><td>  </td></tr>
<tr><td>240Hz</td><td>  </td><td>  </td><td>  </td><td>  </td></tr>
</table>
Note: Settings other than the above are as follows.

Maximum output frequency 60Hz
Constant-torque V/F pattern up to 120Hz.

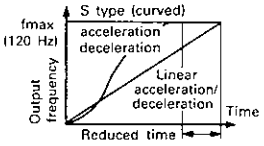
Constant-torque V/F pattern up to 50Hz.</td></tr>
<tr><td>Base frequency (V/F bend)</td><td>⑥ ⑦ ⑧</td><td></td></tr>
<tr><td>Acceleration/ deceleration mode (L/S)</td><td>⑩</td><td>Curved or linear acceleration/deceleration can be selected.
DIP switch ON: S-type (Curved)
DIP switch OFF:Linear type
When the inverter is needed to accel to high speed area (constant output area) at 120Hz (or 240Hz), the acceleration or deceleration time of S-type is shorter than that time of linear type.
  </td></tr>
<tr><td>Starting frequency (SF)</td><td>⑨</td><td>Starting frequency value can be selected.
DIP switch ON: Fixed at 3Hz independently of maximum output frequency.
DIP switch OFF: Depends on maximum output frequency (fmax)
0.5Hz for fmax 60Hz . . . 1Hz for fmax 120Hz . . . 2Hz for fmax 240Hz</td></tr>
<tr><td>DC dynamic brake mounted/ not mounted (DC.B)</td><td>⑤</td><td>During deceleration, the DC dynamic brake is actuated at less than 3Hz (for 0.5 seconds) to bring the motor to sudden stop. To stop the motor after coasting at less than the starting frequency, set this switch to ON position.</td></tr>
<tr><td>Output voltage compensation (D.V.)</td><td>④</td><td>For 460V, 60Hz rating motor, set DIP switch to OFF position, and the inverter output voltage is 460V, 60Hz maximum even if input voltage is over 460V.
Note: If line voltage has reduced, output voltage cannot exceed line voltage.</td></tr>
</table>

Table 6.3

CAUTION

(1) Do not move the DIP switches during operation.
(2) Do not touch DIP switch ③
(3) When the inverter is needed to set maximum output frequency (fmax) to 240Hz, move the slide switch (SW3) to ON position.

(3) Various settings

Higher = more horsepower - most generally

1) PWM mode selection potentiometer (PWM)
(Shipping adjustment is 7 position)
The resonance point of motor noise, tone and vibration can be changed by this pot. Please select according to the application.

2) Automatic torque boost adjusting potentiometer (A/BST)
(Shipping adjustment is full counterclockwise position, i.e. OFF position)
Since the output voltage is automatically adjusted depending on the load torque magnitude (load current detection), large torque can be provided. Clockwise turn of the potentiometer increase the output voltage and torque.
If the potentiometer is turned clockwise too much, overcurrent trip (OCT) may occur. With manual torque boost on, automatic torque boost can be activated. This provides high torque but adjustment is necessary to prevent overcurrent trip.

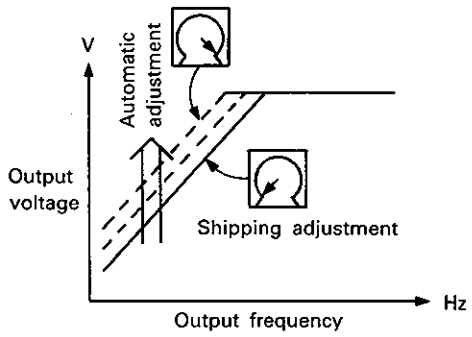


Fig. 6.3

3) Manual torque boost adjusting potentiometer (M/BST)
(Shipping adjustment about 3.5 . . . FR-K420-1.5K-U or lower. Shipping adjustment about 5 . . . FR-K420-2.2K-U or above, and FR-K440-2.2K-U or above)
As shown the figure, clockwise turn of the potentiometer increase output voltage and motor torque. Too much clockwise turn may causes motor vibration and/or noise increase, electronic thermal relay (THT) activation during low speed operation, and overcurrent trip (OCT).
Counterclockwise turn reduces the voltage, then minimizing motor vibration and noise. Since torque also reduces, adjust the that potentiometer so that the motor can be started.

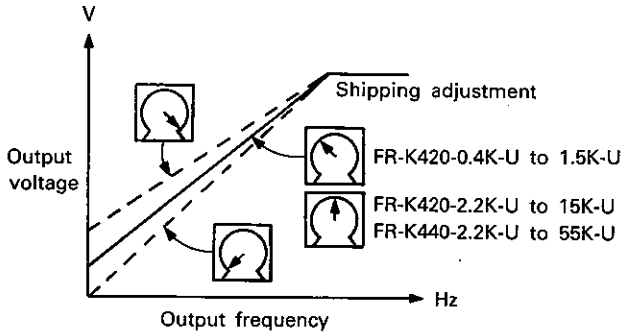


Fig. 6.4

For a energy-saving motor, reduce the boost (turn the that potentiometer fully counterclockwise).

4) 2-speed reference (High speed adjusting) potentiometer (VRH)/Upper limit frequency adjusting potentiometer
(Shipping adjustment is fully clockwise position)
This potentiometer has the following two functions.

- One is to adjust high speed operation reference.
  When control circuit terminals RH and SD are shorted, this adjustment value is selected.
  Frequency range: Starting frequency to maximum output frequency

- Another is to adjust the upper limit of inverter output frequency.
  If terminals RH and SD are not shorted, this potentiometer is available to this function.

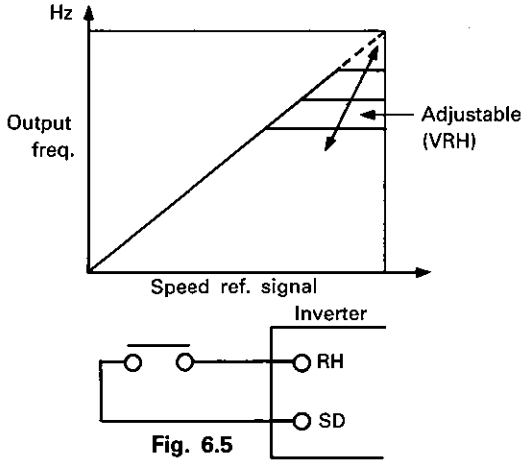


Fig. 6.5

5) Low limit frequency potentiometer (VRM)
This pot. is to adjust low limit frequency.
Even if the speed reference signal is nothing, the inverter starts to drive and continue to drive at the frequency adjusted by the pot. (VRM) during the start signal STF or STR is ON. When the value of the speed reference signal is larger than the value adjusted by VRM, output frequency depends on the speed reference signal.

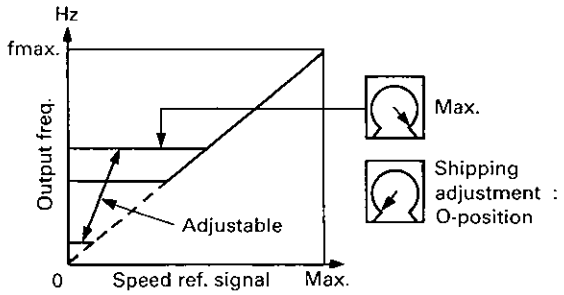


Fig. 6.6

Adjust VRM to O-position if it is needless to use the low limit frequency.

Dial of VRM	Low limit frequency (fL) (Hz)
Maximum 	$fL = \frac{1}{2} \times$ Maximum output frequency
Minimum 	$fL = 0$

When the setting value of VRM is larger than the setting value of VRH (high speed adjusting), output frequency depends on VRH.

6) 2-speed reference (Low speed adjusting) potentiometer (VRL)/Jog speed adjusting potentiometer
(Shipping adjustment is about 2.5 position . . . 5Hz)
This potentiometer has the following two functions.
- ○ One is to adjust low speed operation reference. When control circuit terminals RL/JOG and SD are shorted, this adjustment value is selected.
  Frequency range: Starting frequency to half of maximum output frequency
- ○ Another is to adjust jogging speed reference.

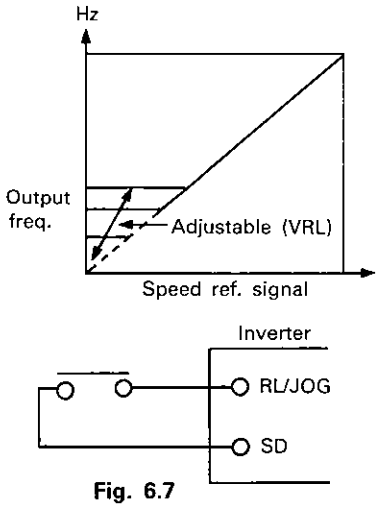
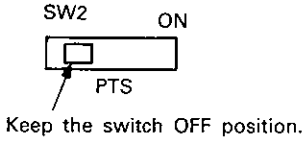


Fig. 6.7

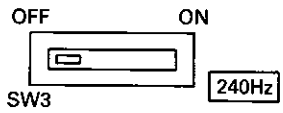
7) 2nd-acceleration/deceleration time setting potentiometer (VRT)
(Shipping adjustment is fully counterclockwise position)
When control circuit terminals RT and SD are shorted, this adjustment time is selected and the acceleration/deceleration time set in the setting panel is ignored.
The selection is available during operation (acceleration/deceleration included). The acceleration and deceleration times are set to the same value.
Acceleration/deceleration time range: 0.2 to 15 seconds
For further details, refer to "Operation using 2nd-acceleration/deceleration time" (page 6-14).

8) Option select switch (PTS)
Surely select the switch to OFF position.
If the switch is selected to ON position without the option FR-PTS, the inverter does not start to operate.



Keep the switch OFF position.

9) Maximum output frequency (240Hz) select switch [For FR-K440-22K-U to 55K-U]
(Shipping adjustment is OFF position)
When the inverter is needed to set maximum output frequency to 240Hz, move the slide switch (SW3) to ON position.
If this switch is set to OFF position, the inverter does not output frequency more than 120Hz, although the dip-switch (SW1) is set to 240Hz position.
(This switch save the upper middle class moters from being driven over speed by mis-setting the dip switch (SW1)).



10) Dial of each setting potentiometer

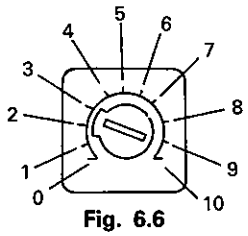


Fig. 6.6

(4) Operation panel (For model with operation panel)

The operation panel circuit is connected through the connector of P.C. board in the inverter.

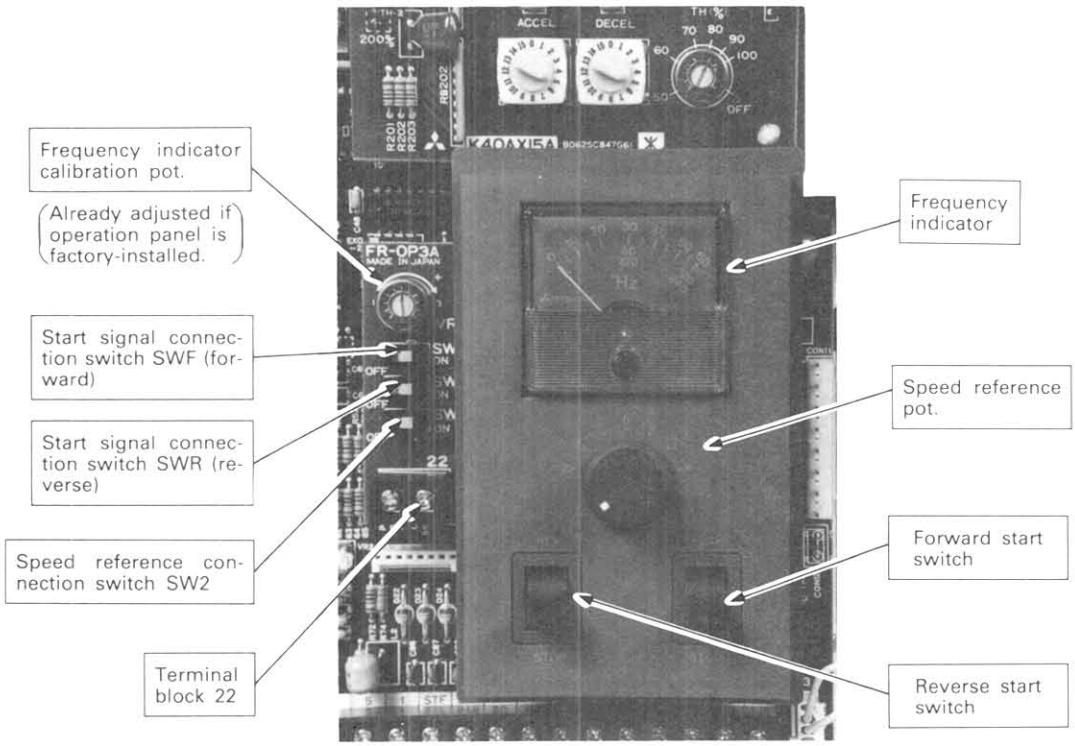


Fig. 6.7

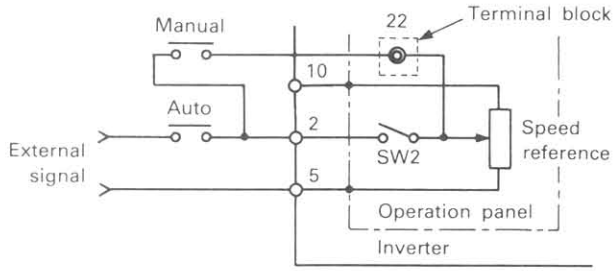
The switches and terminal block on the operation panel P.C. board can be set and described below.

- Switch

Switch	Symbol	Description	Shipping adjustment position
Start connection switches	SWR(Reverse)	To use the external start signal, set this switch to OFF position. The forward/reverse switch circuit on the operation panel is separated. If the start switch is accidentally set to ON position with the start signal OFF position, the inverter does not start.	ON
	SWF(Forward)		
Speed reference connection switch	SW2	To operate the inverter by the external speed reference signal without using the speed reference on the operation panel, set this switch to OFF position.	ON

Table 6.4

- Terminal block (Terminal symbol 22)
  This is the output terminal for speed reference signal set by the speed reference pot. in the operation panel.
  This is used for automatic-manual switching operation as shown on the right. (Of the two terminals, one is spare.)



Automatic-Manual Switching Example

6.3 In-Operation Settings and Adjustments

After checking that the inverter start signal is off, turn on the circuit breaker (MCCB) and magnetic contactor (MC) in the inverter input circuit. When power is supplied, the POWER lamp in the inverter setting panel lights. Operate the inverter and check the following settings and adjustments.

(1) Test

Turn forward or reverse start switch to ON position.

⇩

Slowly turn the speed reference pot. clockwise fully. ——— As the frequency indicator indicates a higher value, the motor speed increases. Maximum output frequency is achieved when the speed reference pot. is in full clockwised position.

⇩

Slowly turn the speed reference pot. counterclockwise fully (to zero). ——— As the frequency indicator indicates a lower value, the motor speed decreases. When the output frequency is reached to the starting frequency is reached to the starting frequency, the DC dynamic brake is activated (with DIP switch ⑤ OFF) and the motor is brought to sudden stop.

Check points

(a) Check that the motor rotates in correct direction.
(b) Check that the motor does not generate hums and unusual vibration.
(c) Check that the frequency indicator moves smoothly.
(d) Check that the [OL] lamp does not flicker during acceleration and deceleration.
(e) Check that the [OCT] and [OVT] lamps light during acceleration and deceleration.

If the inverter has tripped:

- Check if load is too large.
- Reduce boost amount (A/BST or M/BST).
- Prolong acceleration/deceleration time.

CAUTION

(1) If the forward (STF) and reverse (STR) start signals turn on at the same time, the inverter does not start. If these signals turn on simultaneously during operation, the inverter is decelerated to stop.
(2) During deceleration, the DC dynamic brake is actuated at less that 3Hz (less than the starting frequency if the frequency setting signal is gradually reduced) for 0.5 seconds. During this period, the motor generates high-frequency sound but this is not failure.
(3) If the [OCT] or [OVT] 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.

(2) Frequency indicator calibration

Perform operation with the speed reference pot. in full clockwised position.

⇩

With a multimater, check that voltage across inverter control circuit terminals 2 and 5 is 5V.

⇩

Adjust the calibration pot. so that the frequency indicator shows the maximum output frequency.

Frequency indicator calibration pot.

CAUTION

(1) When the inverter is equipped with the operation panel, adjust the calibration pot. on the operation panel. The calibration pot. (FM) on P.C. board is ignored.
(2) When the inverter is not equipped with the operation panel, adjust the P.C. board calibration pot. (FM) or external pot.
(3) The inverter P.C. board calibration pot. has adjusted to the full clockwise position at shipping.

(3) Acceleration/deceleration time confirmation

Set the start switch to OFF position and adjust the speed reference pot. to full clockwise position. —— Set the speed reference signal for the maximum output frequency.

⇩

Set the forward (or reverse) switch to ON position. —— Acceleration → maximum output frequency reached.

⇩

Set the forward (or reverse) switch to OFF position. —— Deceleration → stop.

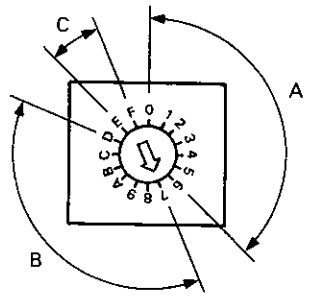
Check and Adjustment Points

(a) If, during acceleration or deceleration, the OL lamp flickers or the OCT or OVT lamp lights, prolong the acceleration/deceleration time and re-start.
In the best operating condition, the OL lamp does not flicker during acceleration or deceleration.
(b) If the OL lamp does not flicker, re-adjustment of shorter acceleration/deceleration time is possible.
(c) The acceleration/deceleration time cannot be changed during motor operation (acceleration and deceleration included). It is only time to change when the motor is at a stop.

(4) PWM mode adjustment

The following three PWM modes (A, B, C on the following figure) are available. In each mode, adjustment can be made in two to seven steps.

Mode A (notch 0 to 6) . . .
for low-noise operation
Operation can be performed quietly.
Mode B (notch 7 to D) . . .
Mode A and C combination mode
As the dial is moved from 7 to D, tone increases.
Mode C (notch E, F) . . .
for powerful operation
Useful for high frequency operation with short time acceleration or deceleration.



PWM mode selection dial

Caution for setting

Switch from one mode to other (e.g. from A to B) and move the dial in mode B (e.g. from 7 to 8) when the motor is at a stop (inverter start signal OFF.)
Mode switching or dial movement during operation is invalid. (The dial movement in mode A and C may be executed during operation.)

(5) Upper limit frequency adjustment

To clamp the upper limit of output frequency because of the machine and load specificaitons, use the following procedure.

Adjust pot. VRH on the inverter P.C. board to full counterclockwise position.

⇩

Adjust the speed reference to full clockwise position and the start switch to ON position. ——— In this state, the motor is not rotate yet.

⇩

Turn pot. VRH clockwise and adjust to the upper limit frequency to be clamped.

Points

(a) When high accuracy is required for the upper limit frequency to be set, it is necessary to make adjustment while simultaneously checking the motor speed.

(b) Potentiometer VRH overrides the external speed reference signal and speed reference from operation panel.

6.4 2-Speed Operation

By connecting 2-speed setting signals (contact signals), 2-speed operation can be performed easily.

(1) Wiring

As shown in Fig. 6.8, provide a 2-speed setting contact circuit outside the inverter.

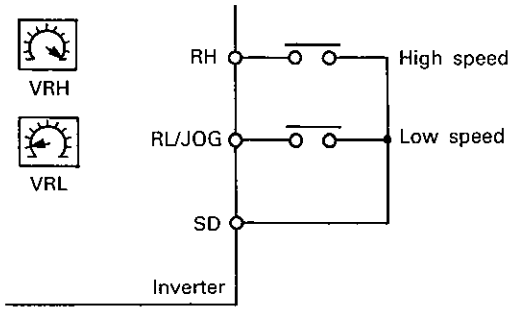


Fig. 6.8 2-Speed Setting Input Signal Wiring

(2) Operation

Turn on the each external speed setting input and adjust the operation frequencies by each potentiometer. Fig. 6.9 shows relationship between setting signals and operation speeds (output frequencies).

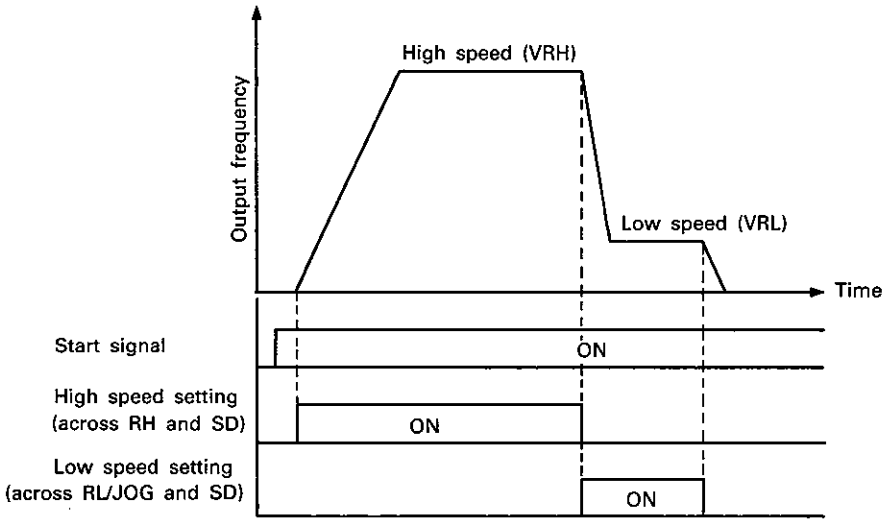


Fig. 6.9 2-Speed Operation

Caution for operation

(1) If two external setting inputs (e.g. high and low speeds) are turned on, the inverter does not start. (If two inputs are turned on during operation, the inverter is decelerated to stop.)
(2) The high-speed operation adjusting pot. is used also for the upper limit speed reference. To execute three or four-speed operation with the external speed reference signal or speed reference on operation panel, use potentiometer VRH for maximum speed operation.

6.5 Operation with 2nd-Acceleration/Deceleration Time

Independently of the acceleration/deceleration time with the dials and magnification selection switches in the setting panel, the 2nd-acceleration/deceleration time can be used for various operation.

(1) Wiring

Provide a 2nd-acceleration/deceleration selection circuit shown in Fig. 6.10 outside the inverter.

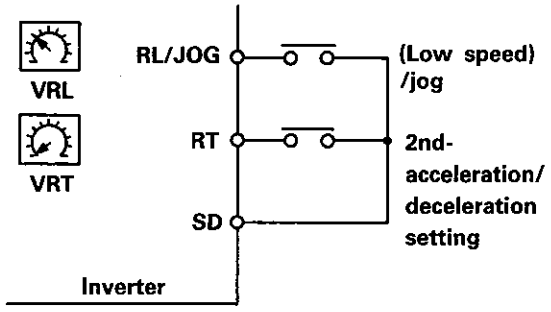
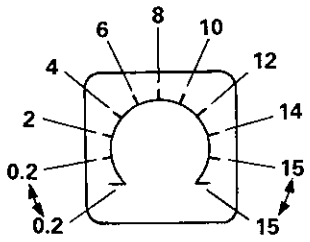


Fig. 6.10 2nd-Acceleration/Deceleration Time-,JOG Mode Select Signal Wiring

(2) Operation

The 2nd-acceleration/deceleration time (0.2 to 15 seconds) adjusted by pot. VRT is selected by shorting the terminals RT and SD.
Even if the inverter is driving at a constant speed, at accelerating or at decelerating, the 2nd-acceleration/deceleration time can be selected by shorting the terminals RT and SD. Then acceleration time can be changed during accelerating.



Reference acceleration/ deceleration time setting value (second) (Setting pot VRT.)

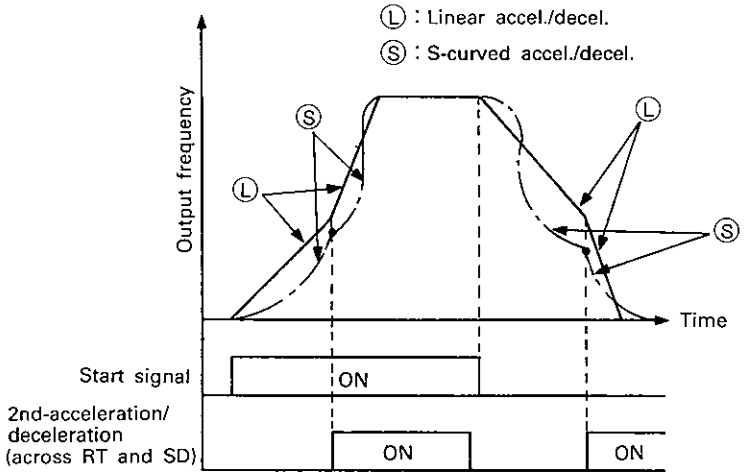


Fig. 6.11 Operation Example with 2nd-Acceleration/ Deceleration Time

S-curved accel./decel. as well as linear accel./decel. are applicable to the 2nd accel./decel. function.

6.6 Jogging

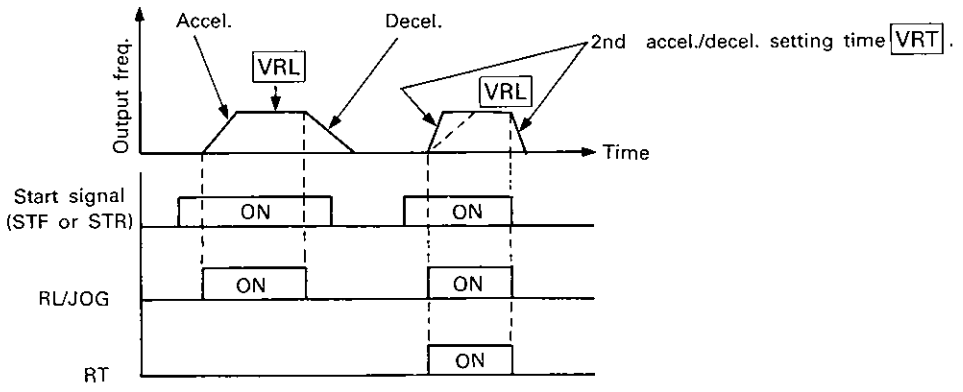
To perform jogging, input the JOG mode signal.

(1) Wiring

Provide a JOG mode selection circuit as shown in Fig. 6.10.

(2) Operation

The operation frequency adjusted by pot. VRL can be selected by short-circuiting the terminals.
By switching the start signal (switch) ON and OFF, jogging can be started and stopped.
The motor response at jogging or inching can be faster by this 2nd-acceleration/deceleration time (with adjusting shorter time).



7. MAINTENANCE AND INSPECTION

The inverter is a static equipment mainly consisting of semiconductor elements. To prevent troubles occuring due to temperature, humidity, dust, vibration, other operation environments, component deterioration with age, life time of components, etc., it is necessary to execute daily inspection.

7.1 Caution for Maintenance and Inspection

(1) The operator must check whether power supplies 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 inspection, check that the CHARGE lamp (used also as the POWER lamp) in the setting panel is off and voltage across inverter main circuit terminals P and N is 15V DC or less with a multimeter etc.

7.2 Inspection Points

The general-purpose inverter is equipped with power and error indicator LEDs. (in the setting panel). Recognize LED definitions. Note the adjusted values of the electronic-thermal relay, acceleration/deceleration time, etc.

(1) Daily inspection
During operation, check the followings:
(a) The motor operates properly.
(b) The environment is normal.
(c) The cooling system is normal.
(d) There is no unusual vibration and noise.
(e) There is no overheat and discoloration.
During operation, check inverter input/output voltages with a multimeter.

(2) Periodic inspection
Check the followings periodicaly when the inverter can be stopped:
(a) Check that the cooling system has no problem. Clean air filters, etc.
(b) Fasten screws and bolts, as vibration, temperature change, etc, may loosen screws, bolts, etc.
(c) Check that conductors and insulators are not corroded or damaged.
(d) Measure insulation resistance. Refer to page 7-4.
(e) Check the cooling fan, smoothing capacitor, contactor, and relay.

Table 7.1 shows daily and periodic inspection items and judgements.

Check Point	Checking Item	Description	Interval			Checking Method	Judgement	Measuring Instrument
			Dairy	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. Ambient humidity 90%RH or less: No condensing	Thermometer, hygrometer, recorder
	Whole equipment	Check that there is no unusual vibration and noise.	○			Visual and auditory checks	Should be normal	
	Source voltage	Check that main circuit and control voltages are normal.	○			Measure voltage across inverter terminal block terminals R/L1, S/L2 and T/L3.	• 60Hz 187 to 253V (or 414 to 506V)	Multimater Digital multimater
Main circuit	General	(1) Check with megger (across main circuit and ground terminal) (2) Check that fastened parts are not loose. (3) Check that parts do not overheat traces. (4) Clean		○ ○ ○	○	(1) Disconnect the inverter and measure resistance across batch of terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3 and ground terminal with megger. (2) Fasten (3) Visual Check	(1) 5M OHM or larger (2) (3) should be normal	500V megger
	Conductor, cable	(1) Check that conductor is not distorted. (2) Check that cable sheath is not broken.		○ ○		(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 Diode module	Check resistance across each terminals			○	Disconnect the inverter and measure resistance across terminals R/L1, S/L2, T/L3 and P, N and across U/T1, V/T2, W/T3 and P, N with a multimeter by 1 OHM range.	Refer to Table 7.4	Analog multimeter
	Smoothing capacitor	(1) Check for leakage (2) Check the safety valve (3) Measure static capacity	○ ○	 ○		(1) (2) visual check (2) Measure with capacity measuning instruments.	(1) (2) should be normal (3) 85% or more of rated capacity	Capacity meter
	Relay, contactor	(1) Check for tremor (2) Check time delay relay operation time (3) Check for contact roughness		○ ○ ○		(1) Auditory check (2) Delay from power-on to relay activation (3) Visual check	(1) Should be normal (2) Should operate in 0.1 to 0.15 seconds. (3) Should be normal	Universal counter
	Resistor	(1) Check for resistor insulator crack (2) Check for wire break		○ ○		(1) Visual check. Cement resistor, would resistor, etc. (2) Disconnect lead on one side and measure with circuit multimater.	(1) Should be normal (2) Error should be within ±10% of specified resistance	Multimeter, Digital multimeter
Control circuit Protection circuit	Operation check	(1) Check output voltage balance across each phases without motor. (2) After sequence protective operation test, check that protective and display circuits should be normal.		○ ○		(1) Measure voltage across inverter output terminals U/T1, V/T2, and W/T3. (2) Simulatively short-circuit the inverter protective circuit outputs.	(1) Voltage balance for 230V should be within 4V and for 460V should be within 8V. (2) Error should occur in the sequence.	Digital multimeter, Rectifier type voltmeter
Cooling system	Cooling fan	(1) Check for unusual vibration and noise. (2) Check that connection is not loose. (3) Clean air filter.	○ ○	○		(1) Switch power off and turn by hand. (2) Retighten.	(1) Should turn smoothly. (2) Should be normal.	
Display	Display	(1) Check that lamps have not blown off. (2) Clean	○	○		(1) Panel indicator lamps. (2) Clean with rag.	(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. (2) Check for unusual smell.	○ ○			(1) Auditory, tactile and visual checks. (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/T1, V/T2, and W/T3 Includes motor cable.	(1) Should be 5M OHM or larger.	500V megger

Table 7.1 Daily and Periodic Inspection

7.3 Measuring Instrument Selection and Usage

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

(1) Main circuit measurements
Those are included power and output voltage and current measurements, load (motor) continuity check, insulation check, voltage and current waveform observations. The followings are the important items to check with measuring 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 another components.

2) Voltmeter, ammeter
The input (power supply) voltage is the sine wave of the commercial frequency. To measure the input voltage, any 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 an r.m.s value. 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 used instruments as well as normal measurements and always use the same instruments at inspection.

3) Oscilloscope
To measure high voltage 460V class, insulate the instrument power supply and use a high-voltage probe or insulate the mesured point with a potential transformer or current transformer. In this case, the potential transformer or current transformer should have sufficient capacity to prevent magnetic saturation.

(2) Control circuit measurements
Those are included speed reference signal and inverter control voltage measurements and waveform observation.
Note the followings:

1) Voltage measurement, waveform observation
Since flowing current is faint and circuit impedance is high, use an instrument of which input resistance is as high as possible (100KOHM to 1MOHM). It is recommended to measure using a digital multimeter and oscilloscope. Since input resistance in low range of multimeter is especially low, measuring value may show lower than the actual value. Therefore, pay attention to it.

2) Common line connection
Connect the instrument common line to the optimum point i.e. nearest common to the measuring point.

3) Instrument characteristics
For waveform observation, use a oscilloscope which has characteristics meeting the waveform to be measured. For example, the inverter base drive waveform can be observed with a 10MHz oscilloscope. To measure signal rise transient waveform (dv/dt or di/dt), a 200MHz or more oscilloscope is required.

Instruments	Measuring point		Measuring Item					Description
	Main circuit	Control circuit	Insulation	Conductivity	Voltage	Current	Waveform	
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 resistance 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.

Table 7.2 Instruments for Maintenance

7.4 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 supplied to the inverter.

(b) Execute the insulation resistance test of inverter only for the main circuit as shown in Fig. 7.1. Do not execute the test for the control circuit.

(c) To check the control circuit for continuity, use a multimeter (high resistance range). Do not use a megger or a buzzer.

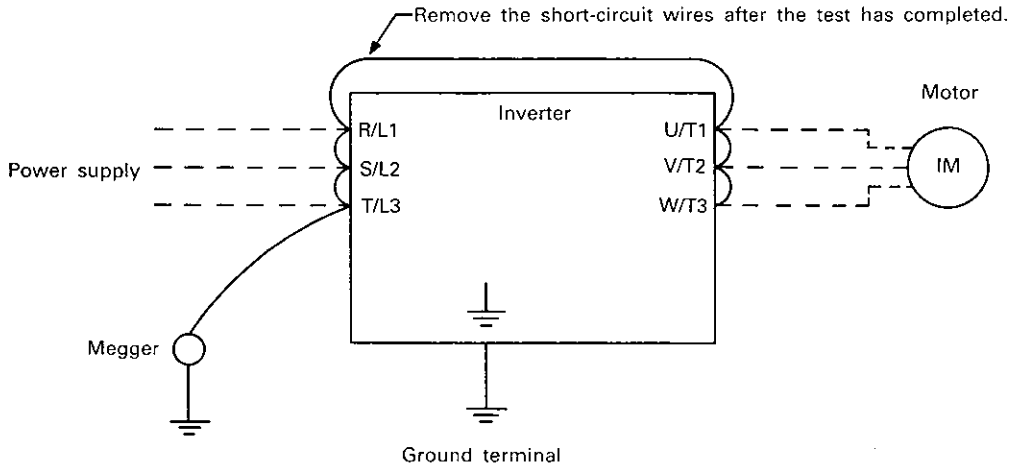


Fig. 7.1 Insulation Resistance Test with Megger

7.5 Parts Replacement

The inverter consists of many electronic parts such as semiconductor elements. The following parts may deteriorate with age because of their structures or physical characteristics. For preventive maintenance, it is necessary to replace the parts periodically.

(1) Cooling fan
The life time of the bearing of fan which cools heat-generating parts such as the main circuit semiconductors elements, is usually 10000 to 35000 hours. Hence, it is necessary to replace the cooling fan every 2 or 3 years. If unusual noise and/or vibaration is found during inspection, it is necessary to also replace the cooling fan.

(2) Smoothing capacitor
For smoothing, a large-capacity aluminum electrolytic capacitors are used in DC area of the main circuit. Its characteristics are adversely affected by ripple current, etc. When the inverter is operated in normal, air-conditioned environments, replace the capacitors about every 5 years. When a given period has passed, the capacitor deteriorates suddenly, it is necessary to check it once a year (several months if life will be expired soon).
Check the followings:
1) Case : sides and bottom
2) Sealing plate : for remarkable warp and extreme crack
3) Explosion-proof valve : for excessive valve expansion and operation
4) Appearance, external crack, discoloration, leakage. When the rated capacity of the capacitor has reduced below 85%, replace the capacitor. For its capacity measurement, a handy device is available on the market.

(3) Relays
To prevent miscontact, it is necessary to replace relays in accordance with the accumulative switching times.
For the inverter parts replacing guide, refer to Table 7.3 Lamps and other short-life time parts must also be replaced at periodic inspection.

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

Table 7.3 Inverter Replacement Parts

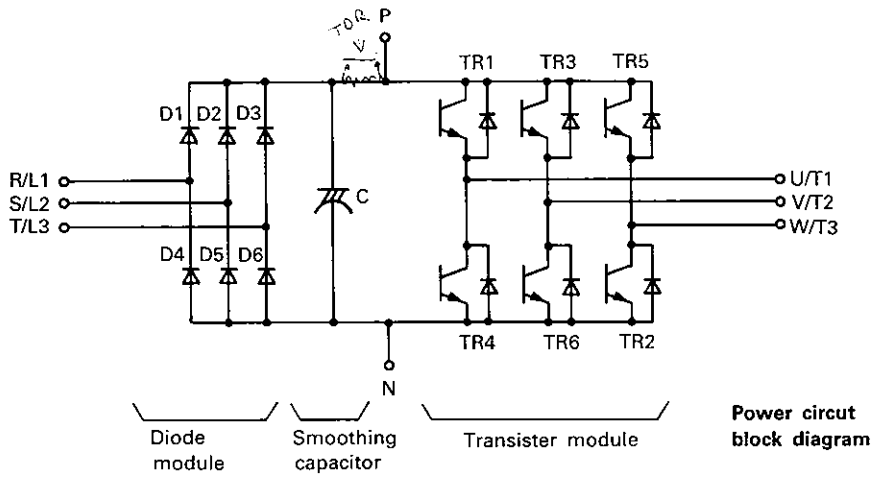
7.6 Transistor and Diode Module Check

(1) Preparation
- Disconnect the power supply cables (R/L1, S/L2, T/L3), motor cables (U/T1, V/T2, W/T3) and option brake unit cables (P, N).
- Prepare a multimater. (1Ω resistance measurement range)

(2) Checking method

Change the polarity of the multimater alternately at the inverter terminals R/L1, S/L2, T/L3 ,U/T1, V/T2, W/T3, P and N and check for continuity.

If the measurements in Table 7.4 are satisfied, the modules are normal.



Power circut block diagram

	Multimeter Polarity		Measurement	Multimeter Polarity		Measurement
	+	−		+	−	
Diode ~~Transistor~~ module	R/L1	P	Discontinuity	R/L1	N	Continuity
	S/L2	P	〃	S/L2	N	〃
	T/L3	P	〃	T/L3	N	〃
	P	R/L1	Continuity	N	R/L1	Discontinuity
	P	S/L2	〃	N	S/L2	〃
	P	T/L3	〃	N	T/L3	〃
Transistor ~~Diode~~ module	U/T1	P	Discontinuity	U/T1	N	Continuity
	V/T2	P	〃	V/T2	N	〃
	W/T3	P	〃	W/T3	N	〃
	P	U/T1	Continuity	N	U/T1	Discontinuity
	P	V/T2	〃	N	V/T2	〃
	P	W/T3	〃	N	W/T3	〃

Table 7.4 Judging Method of Modules

Note 1: Before measurements, check that the smoothing capacitors have already discharged.

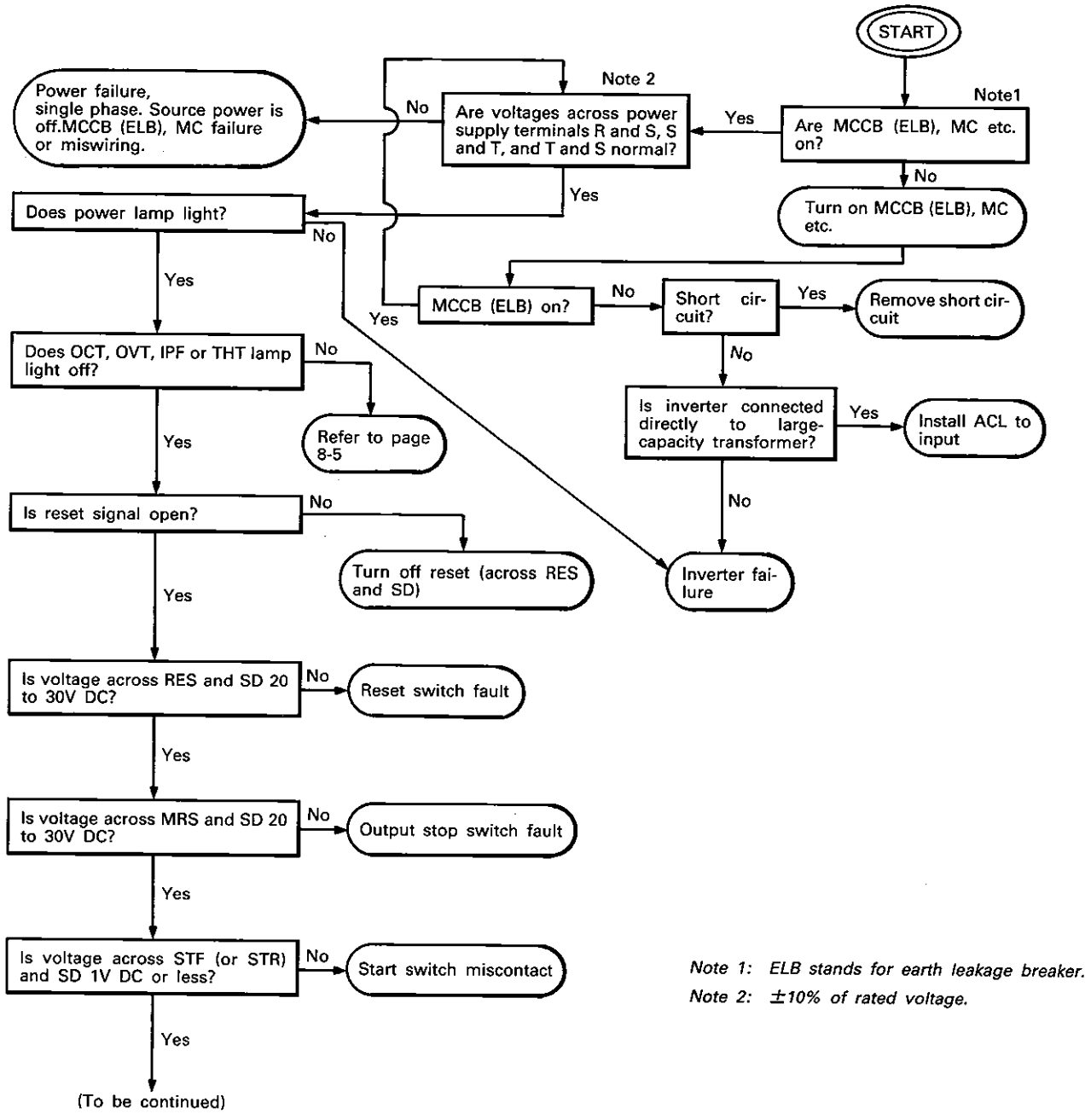
Note 2: Discontinuity means a nearly infinite value. Due to the influence of the smoothing capacitor, continuity may instantaneously be established and infinite not indicated. Continuity means several to scores of ohms depending on the module numbers, parallel numbers, multimater types, etc. If all measure ments are almost the same, the modules are OK.

8. TROUBLESHOOTING

If fault occurs and the inverter does not drive properly, determine the cause referring to the following troubleshooting charts and take appropriate proper action. If the cause cannot be determined by those charts, the inverter is defective or the parts are damaged. Otherwise, please contact nearest service representative.

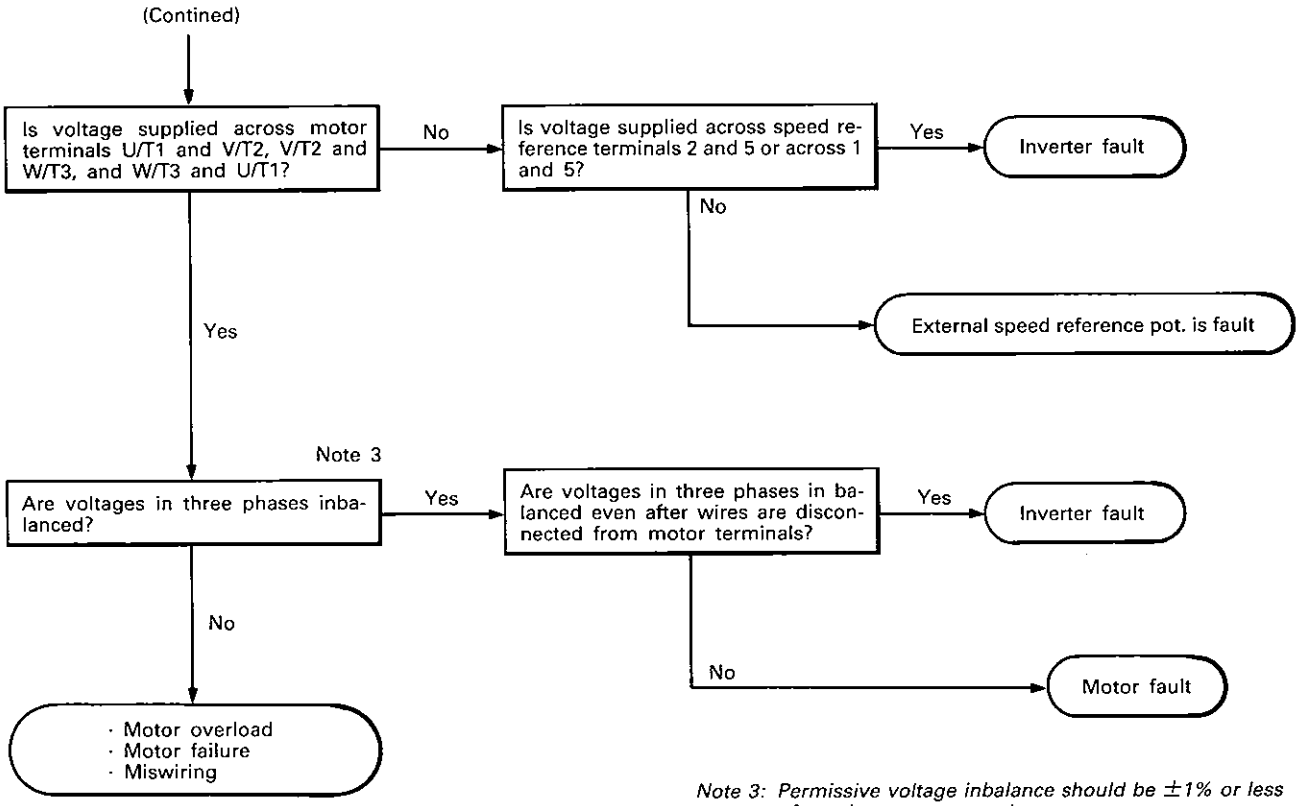
8.1 Troubleshooting Charts

(1) Motor does not start



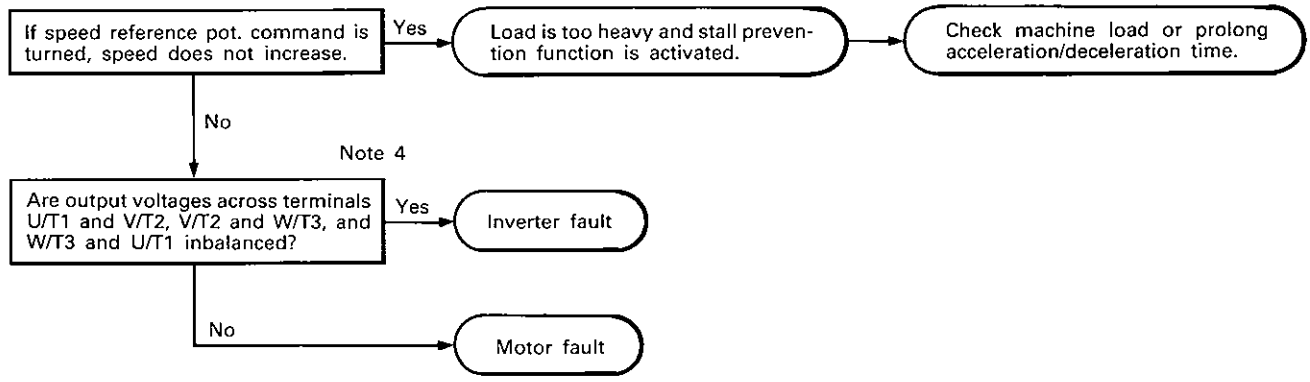
Note 1: ELB stands for earth leakage breaker.

Note 2: ±10% of rated voltage.



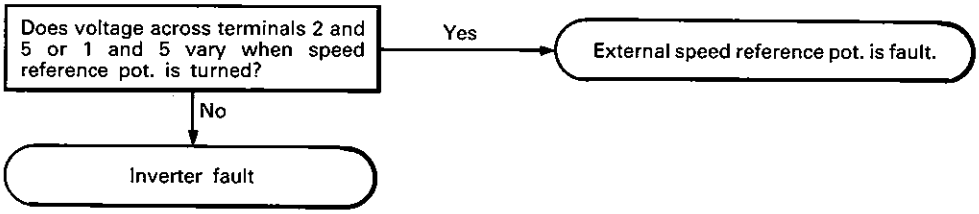
Note 3: Permissive voltage inbalance should be ±1% or less of maximum output voltage.

(2) Motor buzzes and does not run

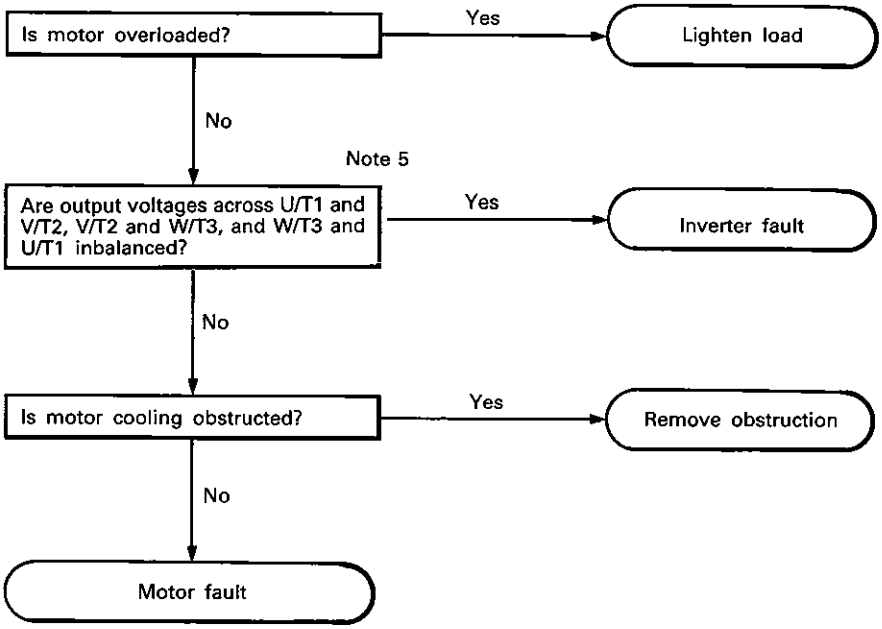


Note 4: Check voltage balance after removing.

(3) Motor runs at constant speed and connot be controlled

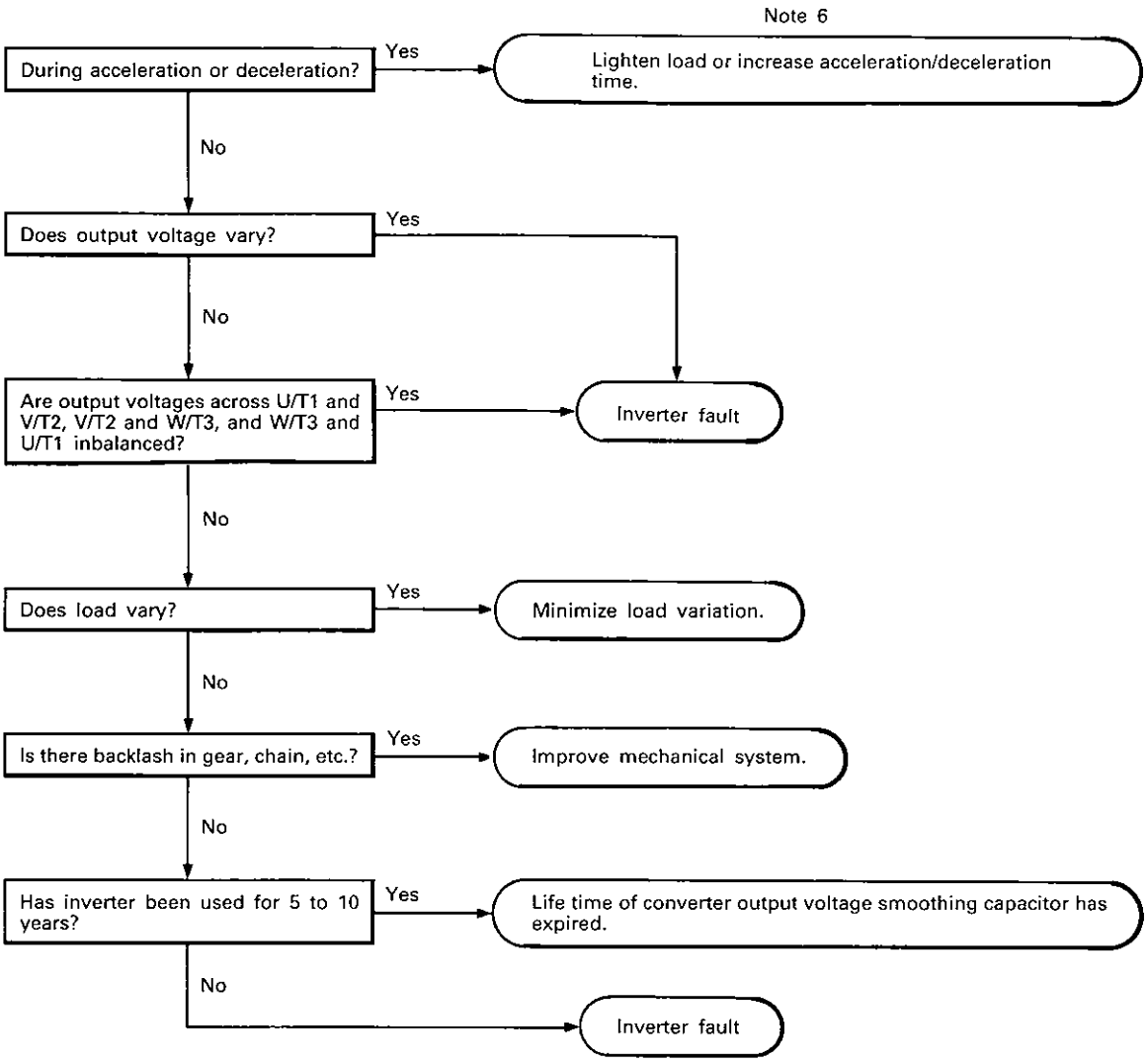


(4) Motor generates excessive heat



Note 5: Voltage inbalance should be ±1% or less or maximum output voltage.

(5) Motor does not run smoothly

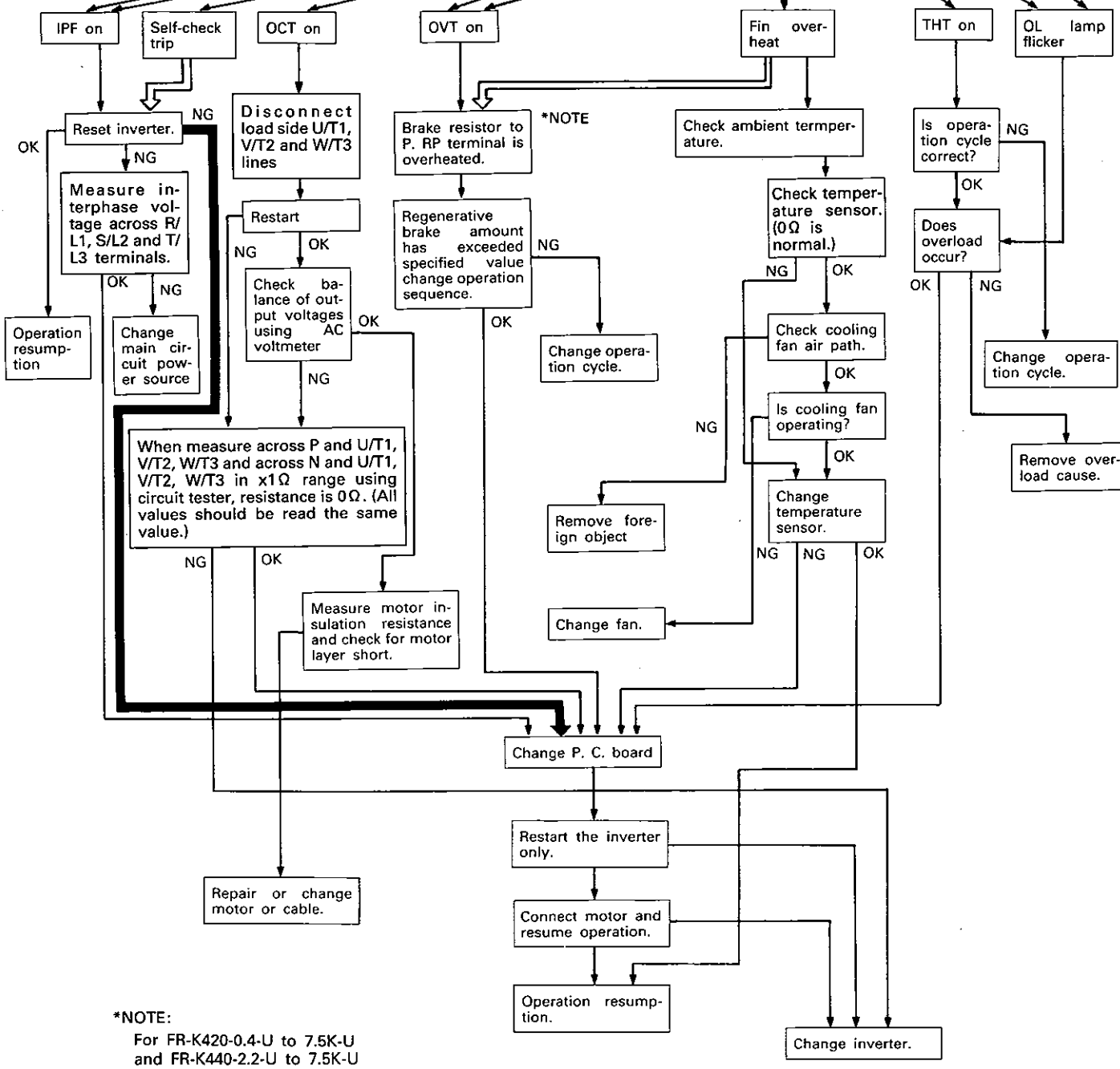


Note 6: Lighten load or prolong acceleration/deceleration time.

8.2 Troubleshooting by Indicator Lamps

Instruments and tools to be used: Multimeter, screwdriver, change box, 500V megger, AC voltmeter (500V)

Item		1	2	3	4	5	6	7	8	9	10
Error indicator lamp check	OL									☒ Flicker	☒ Flicker
	THT			☒				☒	☒		
	IPF	☒	☒								
	OVT					☒	☒	☒			
	OCT			☒	☒						
Failure		Instantaneous power failure	Undervoltage	Self-check trip	Overcurrent shut off	Regenerative overcurrent shut off	Brake resistor overheat	Fin overheat	Overload shut off	Stall prevention	Overload alarm



*NOTE:
For FR-K420-0.4-U to 7.5K-U
and FR-K440-2.2-U to 7.5K-U

9. VOLTAGE AND CURRENT WAVEFORMS

9.1 Voltage and Current Measurements

Since the inverter power supply, output voltages and currents include high harmonic components, data depends on the instruments used and circuits measured.
To measure voltage and current with an instruments for commercial frequency, use the instruments in table 6 and the circuit in Fig. 9.1.

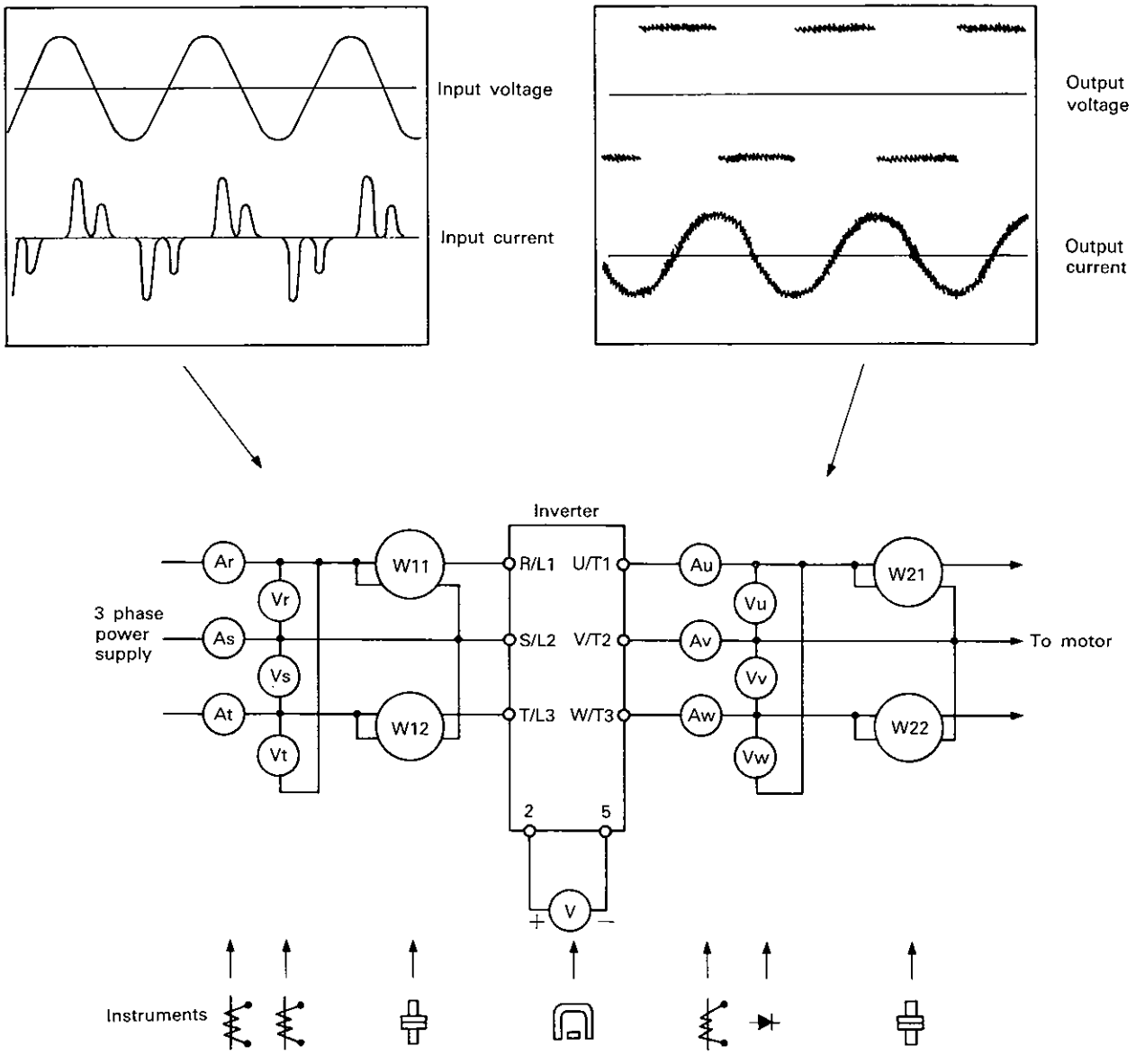


Fig. 9.1 Measuring Points and Instruments

Item	Measuring Point	Instrumnet	Remarks (Criterion)	
Line voltage V1	Across R/L1 and S/L2, S/L2 and T/L3, and T/L3 and R/L1	 Moving-iron type	Commercial voltage ● For 230V class 50Hz 180 to 220V 60Hz 187 to 253V (208V.−10%, 230V+10%) ● For 460V class 50Hz 360 to 440V 60Hz 414 to 506V (460V±10%)	
Source current I1	R/L1, S/L2 and T/L3 line currents	 Moving-iron type		
Source power P1	R/L1, S/L2 and T/L3 line currents, and across R/L1 and S/L2, and S/L2 and T/L3 voltages	 Electrodynamic type	P1 = W11 + W12	
Source power factor Pf1	Calculate after measuring line voltage, source current and source power. $Pf1 = \frac{P1}{\sqrt{3} \cdot V1 \cdot I1} \times 100\%$			
Output voltage V2	Across U/T1 and V/T2, V/T2 and W/T3, and W/T3 and U/T1	 Rectifier type (Do not use moving-iron type)	Difference between phases is ± 1% or lower of maximum output voltage.	
Output current I2	U/T1, V/T2 and W/T3 line currents	 Moving-iron type	Current should be equal to or less than inverter rated current. Different between phases is 10% or lower.	
Output power P2	At U/T1, V/T2 and W/T3, and across U/T1 and V/T2, and V/T2 and W/T3	 Electrodynamic type	P2 = W21 +W22	
Source power factor Pf2	Calculate same as source power factor. $Pf2 = \frac{P2}{\sqrt{3} \cdot V2 \cdot I2} \times 100\%$			
Converter output	Across P and N	 Moving coil type (such as multimater)	POWER lamp lights 1.35 × V1 Maximum voltage during regenerative braking: ● 230V Class: 380V DC ● 460V class: 760V DC	
Speed reference	Across 2 and 5	 Moving coil type (multimater, etc, may be used) (Internal resistance: 50KOHM or larger)	DC 0 to 5V	"5" is common.
	Across 1 and 5		DC 0 to ± 10V	
Power source for speed reference	Across 10 and 5	 Moving coil type (multimater, etc, may be used) (Internal resistance: 50KOHM or larger	DC 5V	
Frequency meter signal	Across FM and SD	 Moving coil type (multimater, etc, may be used) (Internal resistance: 50KOHM or larger)	Approx. 5V DC at maximum frequency (with frequency indicator connected)	SD is common.
Start signal	Across STF and SD Across STR and SD	 Moving coil type (multimater, etc, may be used) (Internal resistance: 50KOHM or larger)	When OFF: 20 to 30V DC When ON : 1V DC or less	SD is common.
Reset	Across RES and SD			
Output stop	Across MRS and SD			
Base shutoff signal Error signal	Across A and C Across B and C	 Moving iron type (such as multimater)	Continuity checking When normal: A—C is opened. B—C is closed When error or power supply OFF: A—C is closed. B—C is opened	

Table 9.1 Measuring Points and Measuring Instruments

10. SPECIFICATIONS

10.1 Standard Specifications

230V series

Model (FR-K420- ☐)			0.4K-U	0.75K-U	1.5K-U	2.2K-U	3.7K-U	5.5K-U	7.5K-U	11K-U	15K-U
Rated output	Nominal output (HP/kW)		0.5/0.4	1/0.75	2/1.5	3/2.2	5/3.7	7.5/5.5	10/7.5	15/11	20/15
	Output capacity (kVA)		1.2	2.0	3.2	4.4	6.8	9.6	13.1	18.3	24.3
	Rated output current (A)		3	5	8	11	17	24	33	46	61
	Maximum output voltage (*1)		Three phase 230V/60Hz								
Power supply	Voltage, frequency		Three phase 208 or 230V/60Hz								
	Permissive voltage regulation		187 to 253V/60Hz (208V −10%, 230V + 10%)								
	Permissive frequency regulation		Within ± 5%								
	Power source capacity (kVA) (*2)		1.5	2.5	4.5	5.5	9	12	17	20	28
Control specifications	Control method		Sinusoidal PWM control, or PWM mode selectable								
	Output frequency range		1 to 60Hz, 2 to 120Hz or 4 to 240Hz selectable								
	Starting frequency (Hz/maximum frequency)		0.5/60Hz, 1/120Hz, or 3Hz selectable								
	Frequency resolution (Hz/maximum frequency)		0.015/60Hz, 0.03/120Hz, or 0.06/240Hz								
	Frequency accuracy		±0.5% of maximum frequency (25°C ± 10°C) (77°F ± 18°F)								
	Output voltage/frequency ratio		9 steps switched (V/F constant or 50, 60, 120Hz or more voltage constant selectable)								
	Torque boost		With manual and automatic torque boost								
	Braking Torque	Regenerative (short time)	150% or more			100% or more				Approx. 20%	
		DC	Use of DC dynamic brake (actuated at less than 3Hz) or not, selectable								
	Overcurrent capacity		150% 1 minute, 200% 0.5 seconds								

(To the next page)

Table 10.1 (1/2)

230V series

(From the preceding page)

Model (FR-K420- ☐)		0.4K-U	0.75K-U	1.5K-U	2.2K-U	3.7K-U	5.5K-U	7.5K-U	11K-U	15K-U
Operational specifications	Speed reference signal	0 to 5V DC, auxiliary input 0 to ± 10V (input resistance 11KOHM)								
	2-speed setting	High, . . . starting frequency to maximum frequency, adjustable Low . . . starting frequency to half maximum frequency, adjustable								
	Upper limit frequency setting	Between starting frequency and maximum frequency, adjustable								
	Operation signal	Forward, reverse individual, with JOG mode (operation frequency variable)								
	Acceleration/deceleration time	0.2 to 3 seconds (in 0.2 second increments) 1 to 15 seconds (in 1 second increments), or 10 to 150 seconds (in 10 second increments) selectable linear or S-type (curved) acceleration/deceleration selectable								
	2nd-acceleration/deceleration time	0.2 to 15 seconds selected (acceleration and deceleration times are the same)								
	Reset, inverter output shut off	With protective function reset terminal, inverter output shut off terminal								
	Output signal	"RUN" signal and "Up to setting frequency" signal are available (open collector output)								
	Error output signal	1C contact output (230V AC 0.3A)								
	2-wire control or 3-wire control	Either method can be connected.								
	Low limit frequency setting	0 to half maximum frequency, adjustable								
Protective functions		Overcurrent stall prevention, regenerative over voltage stall prevention, overcurrent shutoff, regenerative overvoltage shutoff, overload shutoff (electronic thermal relay), overload alarm, undervoltage/instantaneous power failure protection, buit-in brake resistor protection (*3), diagonostic tripping, heatsink overheat protection (*4)								
Environment	Ambient temperature	—10°C to 50°C (+14°F to +122°F), to be free from freezing (*6)								
	Storage temperature(*5)	—20°C to 65°C (—4°F to +149°F)								
	Ambient humidity	90% RH or less (to be free form condensation) (*6)								
	Atmosphere	To be free form corrosive gases and dense dust, indoor								
	Altitude, vibration	Below 1000m, 0.6G or less (conforms to JIS C 0911)								
Protective structure (JEM 1030)		Enclosed type (IP20) (*6)							Open type (IP00)	
Weight (kg)		2.9	3.3	3.5	6.1	6.5	9.1	9.5	14	20

Table 10.1 (2/2)

460V series

Model (FR-K440- ☐)			2.2K-U	3.7K-U	5.5K-U	7.5K-U	11K-U	15K-U	22K-U	30K-U	37K-U	45K-U	55K-U
Rated output	Nominal output (HP/kW)		3/2.2	5/3.7	7.5/5.5	10/7.5	15/11	20/15	30/22	40/30	50/37	60/45	75/55
	Output capacity (kVA)		4.8	7.2	10.4	13.5	18.3	24.7	34	45	57	69	88
	Rated output current (A)		6	9	13	17	23	31	43	57	71	86	110
	Maximum output voltage (*1)		Three phase 460V/60Hz										
Power supply	Voltage, frequency		Three 460V/60Hz										
	Permissive voltage regulation		414 to 506V/60Hz (460V ± 10%)										
	Permissive frequency regulation		Within ±5%										
	Power source capacity (kVA) (*2)		5.5	9	12	17	20	28	41	52	66	80	100
Control specifications	Control method		Sinusoidal PWM control, or PWM mode selectable										
	Output frequency range		1 to 60Hz, 2 to 120Hz or 4 to 240Hz selectable										
	Starting frequency (Hz/maximum frequency)		0.5/60Hz, 1/120Hz, or 3Hz selectable										
	Frequency resolution (Hz/maximum frequency)		0.015/60Hz, 0.03/120Hz, or 0.06/240Hz										
	Frequency accuracy		±0.5% of maximum frequency (25°C ± 10°C) (77°F ± 18°F)										
	Output voltage/frequency ratio		9 steps switched (V/F constant or 50, 60, 120Hz or more voltage constant selectable)										
	Torque boost		With manual and automatic torque boost										
	Braking Torque	Regenerative (short time)	100% or more					Approx. 20%					
		DC	Use of DC dynamic brake (actuated at less than 3Hz) or not, selectable										
	Overcurrent capacity		150% 1 minute										

(To the next page)

Table 10.2 (1/2)

460V series

(From the preceding page)

Model (FR-K440- ☐)		2.2K-U	3.7K-U	5.5K-U	7.5K-U	11K-U	15K-U	22K-U	30K-U	37K-U	45K-U	55K-U
Operational specifications	Speed reference signal	0 to 5V DC, auxiliary input 0 to ± 10V (input resistance 11KOHM)										
	2-speed setting	High, . . . starting frequency to maximum frequency, adjustable Low . . . starting frequency to half maximum frequency, adjustable										
	Upper limit frequency setting	Between starting frequency and maximum frequency, adjustable										
	Operation signal	Forward, reverse individual, with JOG mode (operation frequency variable)										
	Acceleration/deceleration time	0.2 to 3 seconds (in 0.2 second increments) 1 to 15 seconds (in 1 second increments), or 10 to 150 seconds (in 10 second increments) selectable linear or S-type (curved) acceleration/deceleration selectable										
	2nd-acceleration/deceleration time	0.2 to 15 seconds selected (acceleration and deceleration times are the same)										
	Reset, inverter output shut off	With protective function reset terminal, inverter output shut off terminal										
	Output signal	"RUN" signal and "Up to setting frequency" signal are available (open collector output)										
	Error output signal	1C contact output (230V AC 0.3A)										
	2-wire control or 3-wire control	Either method can be connected.										
	Low limit frequency setting	0 to half maximum frequency, adjustable										
Protective fuctions		Overcurrent stall prevention, regenerative over voltage stall prevention, overcurrent shutoff, regenerative overvoltage shutoff, overload shutoff (electronic thermal relay), overload alarm, undervoltage/instantaneous power failure protection, built-in brake resistor protection (*3), diagonostic tripping, heatsink overheat protection (*4)										
Environment	Ambient temperature	−10°C to 50°C (+14°F to +122°F), to be free from freezing										
	Storage temperature(*5)	−20°C to 65°C (−4°F to +149°F)										
	Ambient humidity	90% RH or less (to be free form condensation) (*6)										
	Atmosphere	To be free form corrosive gases and dense dust, indoor										
	Altitude, vibration	Below 1000m, 0.6G or less (conforms to JIS C 0911)										
Protective structure (JEM 1030)		Enclosed type (IP20)		Open type (IP00)								
Weight (kg)		9.5	9.5	20	20	28	28	30	50	50	70	70

Table 10.2 (2/2)

Note

**1: If line voltage reduces, output voltage over line voltage cannot be guaranteed.*

**2: Power source capacity indicates the inverter input kVA and may change depending on power supply impedance (including input reactor).*

**3: Built-in brake resistor protection is not available for the FR-K420-11K-U, 15K-U and FR-K440-15K-U to 55K-U.*

**4: Heatsink overheat protective is not provided for the FR-K420-0.4K-U, 0.75K-U and FR-K440-2.2K-U.*

**5: Indicates temperature is short time during transportation, etc.*

**6: Attaching the accessory enclosing plates to the inverter top and bottom, the inverter can be used as a totally-enclosed type. (Applies to FR-K420-0.4K-U to 3.7K-U.) In this case, maximum operating temperature is 40°C (+104°F).*

**7: FR-K440-22K-U to 55K-U are provided maximum output frequency 240Hz selectable switch (SW 3).*

10.2 Terminals for wiring

Symbol	Terminal	Description
R/L1, S/L2, T/L3	AC power supply input terminals	Connect to commercial power supply. FR-K420-U: 208 or 230V/60Hz FR-K440-U: 460V/60Hz
U/T1, V/T2, W/T3	Inverter output terminals	Connect to three-phase squirrel-cage motor.
	Grounding terminal	Inverter chassis grounding terminal.
P, N	Converter output terminals	Used exclusively to connect regenerative brake unit.
10	Power source terminal for speed reference	5V DC. Allowable load current 10mA.
5	Common terminal for speed reference	Common to speed reference input signals. Not insulated from common circuit of the control circuit. Do not ground.
2	Speed reference input signal terminal	When 0 to 5V DC is input, maximum output frequency (60Hz, 120Hz, or 240Hz) is achieved at 5V and speed reference is proportional to output voltage. Input resistance: 11KOHM Allowable maximum voltage: 20V DC.
1	Speed reference auxiliary input terminal	When −10V to +10V DC is input, maximum output frequency is achieved at + 10V and speed reference is proportional to output voltage. Added to terminal 2 signal. If input is 0 to +10V, terminal 1 may be used independently. Input resistance:11KOHM Allowable maximum voltage: 20V DC.
SD	Common terminal for contact input	Common to contact input signal and frequency indicator. Insulated from common circuit of inverter control circuit.
STF	Forward start input signal terminal	Forward when STF and SD are short-circuited. Stop when opened.
STR	Reverse start input signal terminal	Reverse when STR and SD are short-circuited. Stop when opened.
FM	Frequency indicator output terminal	Reaches about 5V DC at maximum output frequency (60Hz, 120Hz, or 240Hz) and proportional to output frequency. Output voltage has pulse train. Connect 1mA moving coil type DC ammeter.
RH	External frequency setting input terminal (high speed)	Short circuitting of RH and SD can be driven at frequency (starting to maximum frequency) adjusted by potentiometer VRH.
STP	Stop signal terminal for 3-wire control	Connect STOP push-button to this terminal for 3-wire control.
RL/JOG	External frequency setting input (low speed) and JOG mode signal input terminal	Short circuitting of RL and SD can be driven at frequency (starting to half maximum frequency) adjusted by potentiometer VRL. Connection of RL and SD selects jogging at frequency adjusted by VRL. Execute jogging by start signals (STF, STR).
RT	Secondary acceleration/deceleration time select input terminal	Short-circuitting of RT and SD can be selected secondary acceleration/ deceleration time (0.2 to 15 seconds). Opening of RT and SD can be selected acceleration/deceleration time set by the setting panel (setting dials and magnification switches).
RES	Reset signal input terminal	To release inverter tripping, short circuit the terminals RES and SD for more than 0.1 second.
MRS	Inverter output shut off input terminal	Shut off trnsistor base to make the motor stop after coasting. Used to shut off inverter output when stopping the motor with a mechanical brake. Before activating brake, short circuit the terminals MRS and SD.
SE	Open collector common terminal	Common to open collector output signals (RUN, SU). Insulated from common circuit of the inverter control circuit. Do not ground.
RUN	Inverter operating output terminal	Open collector output. Low level at above minimum starting frequency during operation. High level during stop or DC dynamic brake activating. Rated 24V DC, 0.1A.
SU	Up to speed signal terminal	Open collector output. Low level when output frequency reaches within ± 10% of the set frequency. High level during acceleration, deceleration, or stop. Rated 24V DC, 0.1A.
A, B, C	Error alarm output terminal	1C contact output indicating that base has been shut off by inverter protective function. Instantaneous power failure protective function is activated also at power off, so the circuit is closed for a moment. Normal: B and C close, A and C open Error: B and C open, A and C close (Contact capacity: 230V AC 0.3A, 30V DC 0.3A)
*R200 S200	Power source for option unit (Factory use only)	These terminals are power source for option unit. Output power is a half voltage of input (main circuit) power source.

*FR-K440 series only

10.3 Protective Functions

The inverter is incorporated with the following protective functions to protect itself from overcurrent or overvoltage. When the protective circuit is activated, the transistor base is shut off. This causes the motor to stop after coasting. 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	Remarks
Overcurrent stall prevention	When 150% or more of the inverter rated current flows to the motor during acceleration, this function stops increasing of frequency until load current reduces, and then prevents the inverter from overcurrent tripping. When 150% or more of the rated current flows during normal (constant-speed) operation, this function reduces frequency until load current reduces to prevent the inverter form overcurrent tripping. When load current has recuded below 150%, this function increases frequency again and continues acceleration up to preset frequency.	OL lamp flickers.
Regenerative overvoltage stall prevention	If converter output voltage is increased excessively by regenerative energy during motor deceleration, this function stops the fall of frequency until converter voltage (across terminals P and N) reduces to prevent the inverter from overvoltage tripping. As soon as regenerative energy has reduced, this function decreases frequency again to allow deceleration to be continued.	OL lamp flickers.
Overcurrent shut off (OCT)	When 200% or more of the inverter output current flows, protective circuit is activated to stop the inverter.	OCT lamp light. (OCT occurs mainly due to inverter output short-circuit, ground fault, excessive load inertia (GD^2), extermely short setting of acceleration/deceleration time, start during motor coasting, start of special motor or motor larger than inverter rating. Therefore, restart after fully examining the cause.)
Regenerative overvoltage shut off (OVT)	When converter output overvoltage is caused by regenerative energy form the motor, protective circuit is activated to stop and hold transistor off.	OVT lamp lights. (OVT is activated mainly due to short deceleration timer or negative load. Prolong deceleration time or use the option brake unit. OVT may occur also when built-in brake resistor overheat protection is activated.)
Instantaneous power failure protection (IPF)	To prevent failure when instantaneous power failure occurs for 15 msec or longer (this applies to inverter input power shut off), instantaneous power failure protective function is activated and stops and holds inverter shut off. If power failure continues for more than 100 msec, error alarm output contact is closed (across B and C). (If power failure is shorter than 15 msec, normal operation is performed.)	IPF lamp lights. (If power is switched on after inverter output shutoff, automatic restart during motor coasting may trip the inverter. Hence, use an automatic restart prevention circuit or instantaneous power failure restart control option.)
Supply voltage drop protection (IPF)	If inverter line voltage reduces, the control circuit cannot provide normal functions, resulting in motor heat generation or insufficient torque. To prevent this, if line voltage reduces below about 150V (FR-K420), 300V (FR-K440), protective circuit is activated to stop and hold transistor output. (At about 150V (FR-420), 300V (FR-K440) or more, normal operation is executed.)	IPF lamp lights. (Line voltage may fall, when power transformer capacity is insufficient or large capacity motors connected to the same power supply have been started. Check the power supply.)
Overload shut off (Electronic thermal relay) (THT)	Electronic thermal relay in the inverter detects overload of motor during rated operation or motor overheating at low speed, activates protective circuit, and stops and holds inverter shutoff. For multi-pole motor and parallel driving of several motors, the electronic thermal relay cannot protect the motor. Provide a thermal relay in the inverter output. In this case, the electronic thermal relay adjusted to OFF position activates transistor protection only.	THT lamp lights. (Examine the cause of overload, and lighten load, change operation pattern, or use inverter and motor having large capacities.)

Function	Description	Remarks
Overload alarm (OL)	When motor is overloaded and inverter output current exceeds 150% of the rated current, overload alarm (OL) lamp flickers to give advance warning. The lamp turns off at less than 150%. The OL lamp detects overload before the inverter trips due to overcurrent or overvoltage. (Flickers while stall prevention is activated.)	OL lamp flickers. (When OL lamp flickers during acceleration or deceleration, prolong acceleration or deceleration time. When it flickers during constant-speed operation, lighten load or use inverter and motor having larger capacities.)
Heatsink overheat protection	The FR-K420-1.5K-U to 15K-U and FR-K440-3.7K-U to 55K-U executes forced cooling by the fan. If the fan fails and the semiconductor cooling heatsink overheats, temperature sensor is activated to stop and hold inverter shutoff.	OVT and THT lamps light at the same time. (Check the cooling fan and ambient temperature.)
Brake resistor overheat protection	If regenerative brake power from the motor has exceeded the specified value, the brake is stopped to protect the braking resistor from overheating. When the brake resistor is cooled, the brake operation is restarted. (This function is not available for the FR-K420-11K-U, 15K-U and FR-440-15K-U to 55K-U.)	If the brake capacity has reduced, OVT lamp may light. (increase deceleration time or use the option brake unit together.)
Diagonostic tripping	CPU in the inverter always monitors wheter the inverter operates properly or not, control error causes motor overcurrent, insufficient torque, etc. This activates protective circuit to protect the inverter. This function is activated also due to misoperation, e.g. setting of maximum output frequency has been changed during operation.	OCT and THT lamps light simultaneously. (the control circuit may have failed due to external noise, etc. Reset the inverter and check. If this occurs frequently, check for noise in peripheral circuit.)

Note:

1. *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 the magnetic contactor (MC), inverter control power is lost and the error signal connot be held. To hold the error signal, hold the error output contact outside the inverter. The error signal and indication can be held with the option model FR-PCU error indication holding unit.*
2. *When inverter power source circuit is opened or power failure occurs, the IPF lamp and error output contact are activated. To separate this from an error, provide a time delay relay circuit.*

10.4 Peripheral Device List

(At rated 208V60Hz, 230V60Hz/460V60Hz)

Motor output (kW)	Model		Circuit Breaker (MCCB)		Magnetic Contactor (MC)	Wire (mm^2)*2	
			Standard	With power-factor improving reactor*1		R/L1, S/L2, T/L3	U/T1, V/T2, W/T3
0.4	230V series	FR-K420-0.4K-U	Model NF30 5A	Model NF30 5A	S-K10	2	2
0.75		FR-K420-0.75K-U	Model NF30 10A	Model NF30 10A	S-K10	2	2
1.5		FR-K420-1.5K-U	Model NF30 15A	Model NF30 15A	S-K10	2	2
2.2		FR-K420-2.2K-U	Model NF30 20A	Model NF30 15A	S-K11,K12	2	3.5
3.7		FR-K420-3.7K-U	Model NF30 30A	Model NF30 30A	S-K20	3.5	3.5
5.5		FR-K420-5.5K-U	Model NF50 50A	Model NF50 40A	S-K25	5.5	8
7.5		FR-K420-7.5K-U	Model NF100 60A	Model NF50 50A	S-K35	14	8
11		FR-K420-11K-U	Model NF100 75A	Model NF100 75A	S-K50	14	14
15		FR-K420-15K-U	Model NF225 125A	Model NF100 100A	S-K65	22	22
2.2	460V series	FR-K440-2.2K-U	Model NF30 15A	Model NF30 10A	S-K20	2	2
3.7		FR-K440-3.7K-U	Model NF30 20A	Model NF30 15A	S-K20	2	2
5.5		FR-K440-7.5K-U	Model NF30 30A	Model NF30 20A	S-K20	3.5	2
7.5		FR-K440-7.5K-U	Model NF30 30A	Model NF30 30A	S-K20	3.5	3.5
11		FR-K440-15K-U	Model NF50 50A	Model NF50 40A	S-K20	5.5	5.5
15		FR-K440-15K-U	Model NF100 60A	Model NF50 50A	S-K25	14	8
18.5		FR-K440-22K-U	Model NF100 75A	Model NF100 60A	S-K35	14	8
22		FR-K440-22K-U	Model NF100 90A	Model NF100 75A	S-K50	22	14
30		FR-K440-37K-U	Model NF225 125A	Model NF100 100A	S-K65	22	22
37		FR-K440-37K-U	Model NF225 150A	Model NF225 125A	S-K80	30	22
45		FR-K440-55K-U	Model NF225 175A	Model NF225 150A	S-K80	38	30
55		FR-K440-55K-U	Model NF225 200A	Model NF225 175A	S-K100	50	50

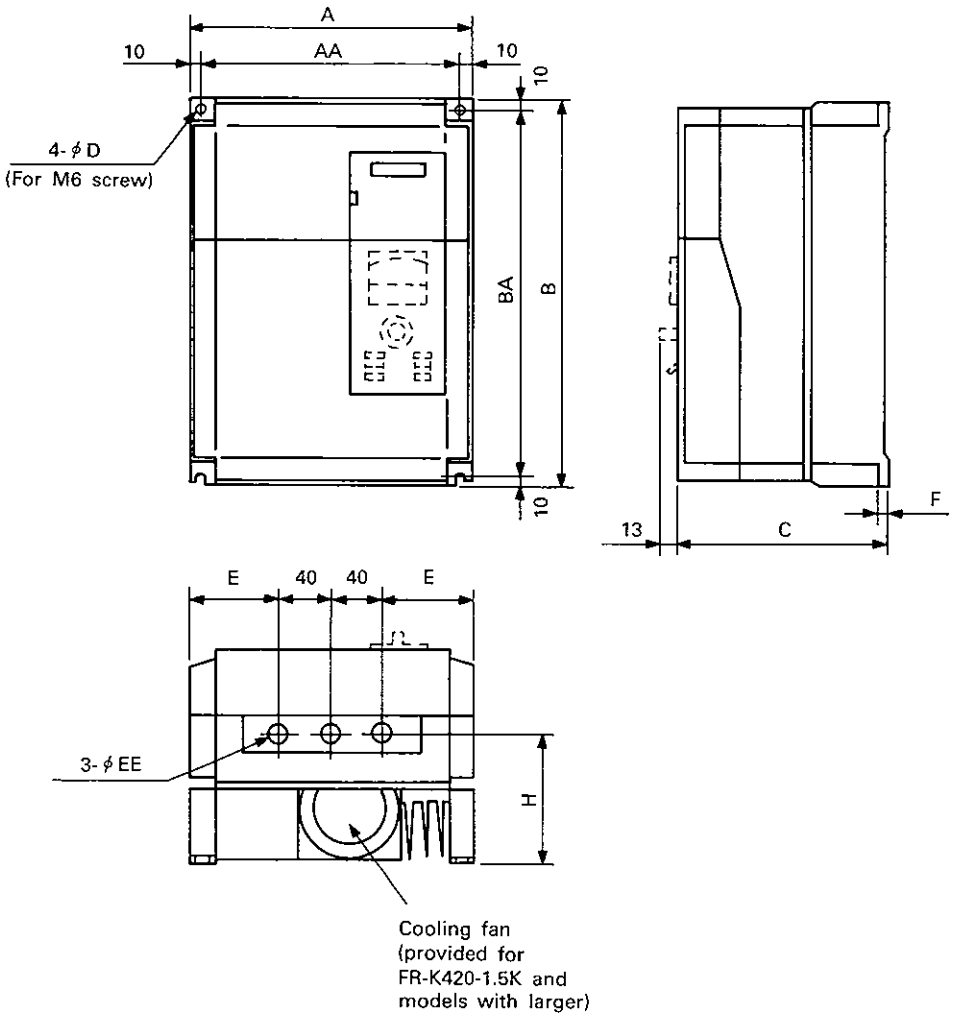
Note:

**1: With the option power-factor improving reactor model FR-BAL (230V class) or model FR-BAL-H (460V class)*

**2: Motor cable (U/T1, V/T2, W/T3) size applies to 30m(100 feet) or less wiring distance.*

10.5 External Dimensions

FR-K420-0.4K-U to 11K-U (230V series)



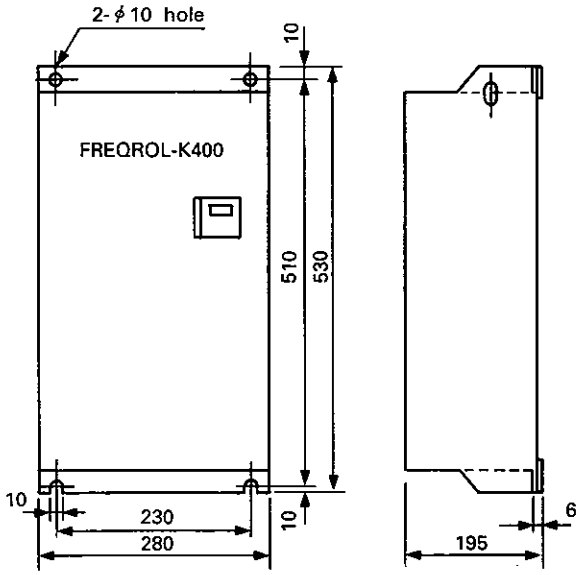
Dimensions

unit: mm

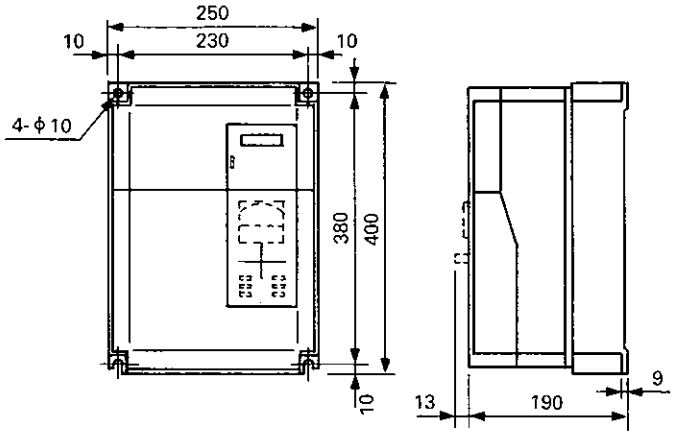
	A	AA	B	BA	C	D	E	EE	F	H
FR-K420-0.4K(M)-U	220	200	300	280	100	7	70	17	7	50
FR-K420-0.75K, 1.5K(M)-U	220	200	300	280	130	7	70	17	7	80
FR-K420-2.2K, 3.7K(M)-U	220	200	300	280	165	7	70	17	7	115
FR-K420-5.5K, 7.5K(M), 11K-U	250	230	400	380	190	10	85	28	9	115

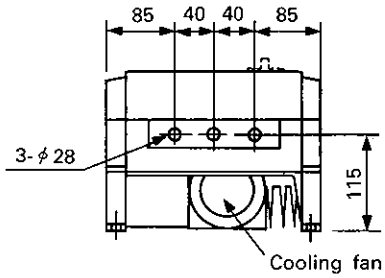
● FR-K420-15K-U (230V series)

unit: mm

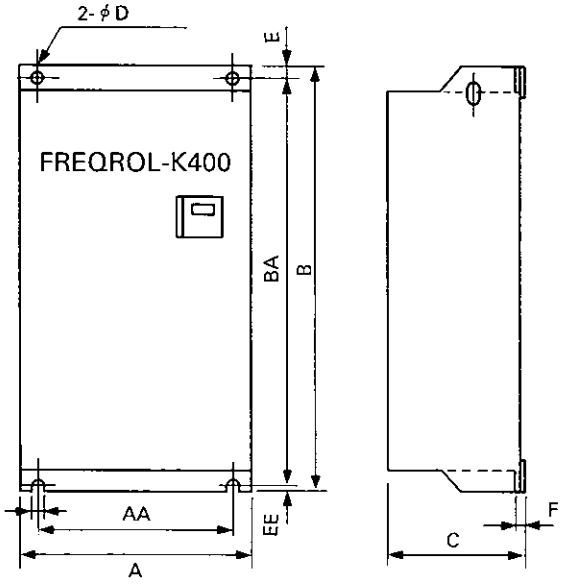


FR-K440-2.2K (M)-U, 3.7 (M)-U (460V series)





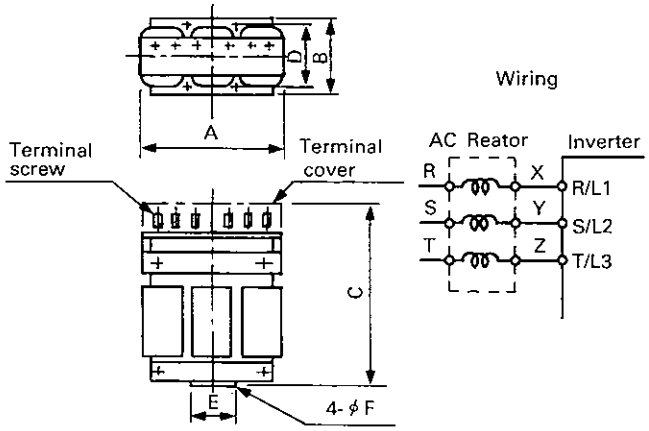
FR-K440-7.5K-U to 55K-U (460V series)



Dimensions (mm)

	A	AA	B	BA	C	D	E	EE	F
FR-K440-7.5K-U	280	230	530	510	195	10	10	10	6
FR-K440-15K-U	340	290	595	570	195	12	15	10	6
FR-K440-22K-U	340	290	595	570	195	12	15	10	6
FR-K440-37K-U	480	420	745	720	250	14	15	10	8
FR-K440-55K-U	480	420	885	860	250	14	15	10	8

AC REACTOR for 460V series

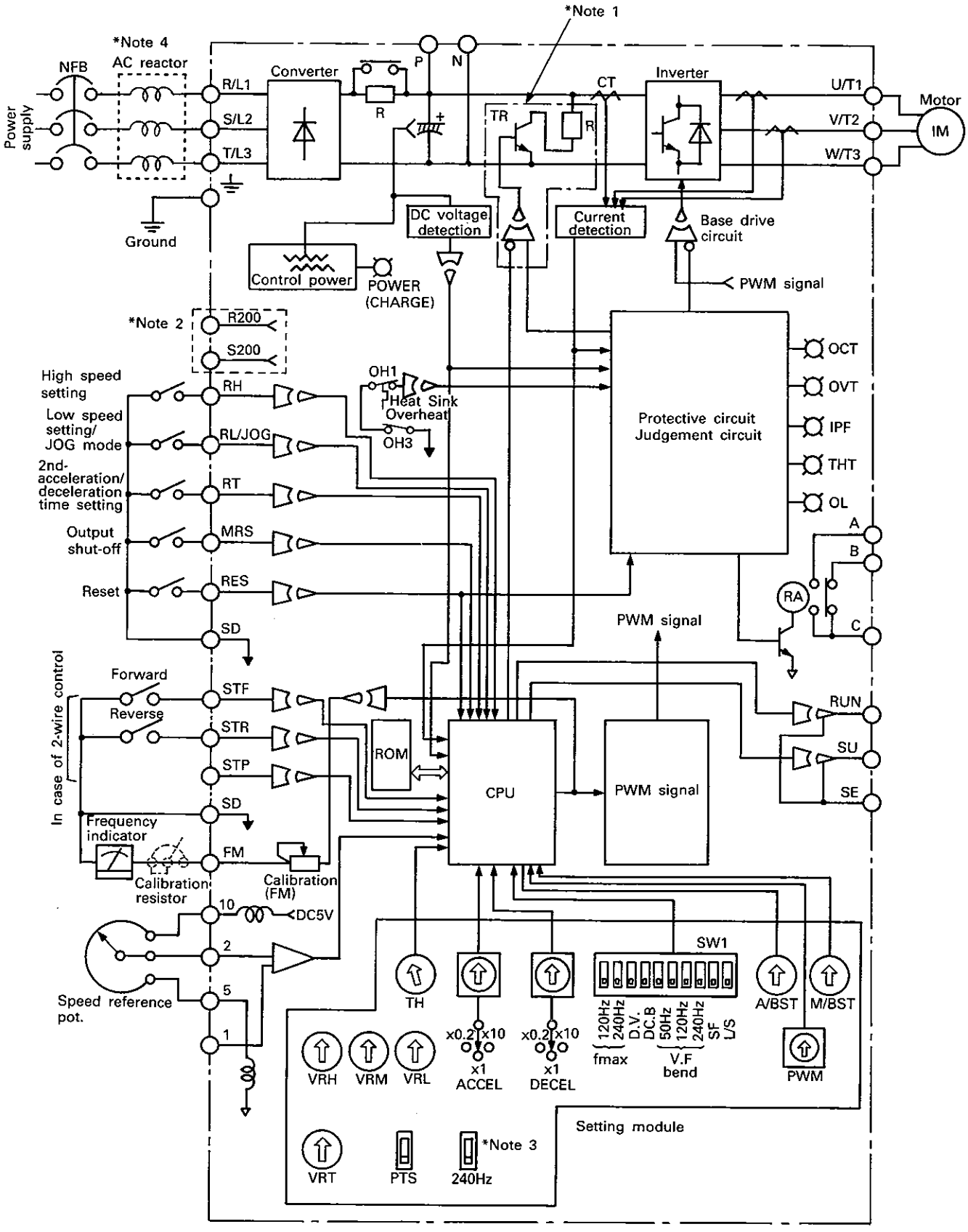


Dimensions (mm) and weight

Motor capacity(kW)	Reactor model (Inverter model)	A	B	C	D	E	F	Weight (kg)
2.2 3.7	BKO-C 1820H01 FR-K440-3.7K	150	91	160	75	50	6.5	4
5.5 7.5	BKO-C 1820H02 FR-K440-7.5K	150	111	165	95	50	6.5	5.5
11 15	BKO-C 1820H03 FR-K440-15K	170	112	200	95	50	6.5	9
18.5 22	BKO-C 1820H04 FR-K440-22K	190	128	225	110	75	8	12
30 37	BKO-C 1820H05 FR-K440-37K	250	124	255	100	75	8	13.5
45 55	BKO-C 1820H06 FR-K440-55K	250	134	255	110	75	8	16.5

- FR-K440 series is provided the AC Reactor (Packaged with the inverter).
  Connect it in the input side of the inverter, but it is needless to use the AC reactor when using power-factor improving reactor (model FR-BAL-H: option).

10.6 Block Diagram



Note 1: This area is not mounted in FR-K420-11K-U, 15K-U and FR-K440-11K-U to 55K-U.

Note 2: These terminals are mounted in 460V series only (FR-K440-2.2K-U to 55K-U)

Note 3: This slide switch is provided for FR-K440-22K-U to 55K-U.

Note 4: FR-440 series (460V class) is provided the AC reactor packaged with the inverter. Refer to page to 10-11.

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE: MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
NAGOYA WORKS : 1-14 , YADA-MINAMI 5 , HIGASHI-KU , NAGOYA , JAPAN

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