TOSHIBA

TRANSISTORIZED PWM INVERTER

VF PACK-P1

230V/460VCLASS 1~88kVA

TECHNICAL DATA

'87-JAN.

CONTENTS

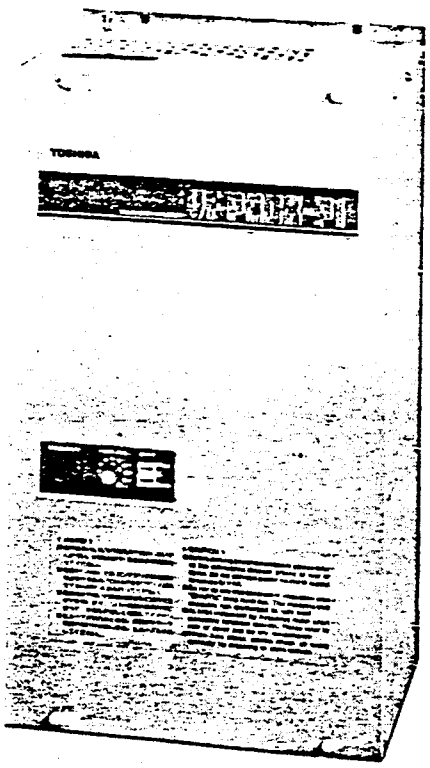
1. INTRODUCTION

1. Introduction

TOSHIBA Transister Inverter is a variable frequency power supply system designed to drive a general-purpose three phase squirrel cage induction motor at variable speed.

This inverter can contribute to automatic, power and energy saving to drive any machine by freely controlling rotated speed of the induction motor on the basis of TOSHIBA's latest microcomputer control technology and analog/digital control technology.

This technology is illustrated in the TOSHIBA Inverter VF PACK-P1 and its peripheral apparatus.



VF PACK-P1

2. SERIES AND FEATURES

Standard specification must be revised to the latest

Item			Discription																											
Series			230V												460V															
Examples of applicable motors of max. capacity		HP	0.5	1	2	3	5	7.5	10	15	20	25	30	40	1	2	3	5	7.5	10	15	20	25	30	40	50	60	75	
		kW	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55		
Model & Rating	Type		VFP1																											
	Form	With operation panel	2010P-B	2020P-B	2030P-B	2040P-B	2065P-B	2095P-B	2130P-B	2190P-B	2250P-B	2280P-B	2340P-B	2460P-B	4015P-B	4030P-B	4040P-B	4065P-B	4095P-B	4130P-B	4190P-B	4250P-B	4280P-B	4340P-B	4460P-B	4550P-B	4690P-B	4840P-B		
	Rated capacity (kVA)		1	2	3	4	6.5	10	13	20	26	29	35	48	2	3	4	6.5	10	13	20	26	29	35	48	57	72	88		
	Rated current (A)		3	5	8	11	17	25	33	49	66	73	88	120	2.5	4	5.5	8.5	13	16	25	33	37	44	60	72	90	110		
Power Supply	Voltage Frequency	Main Circuit	Three phase 208/230V – 60Hz												Three phase 460V – 60Hz															
		Operation Circuit	Single phase 208/230V – 60Hz												Single phase 115V – 60Hz															
	Tolerances		Voltage ±10% Frequency ±2Hz																											
Control	Control method		Sinusoidal PWM control																											
	Output voltage		Three phase Supply voltage (No loaded max. voltage)																											
	Output Frequency		0.5 to 63Hz (at shipment), 0.5 to 53Hz, 0.5 to 80Hz. Up to 126Hz, 106Hz, 160Hz																											
	Frequency resolution		0.025Hz step (0.05Hz when frequency rises to 160Hz mode)																											
	Frequency accuracy		±0.5% for max. frequency (25±25°C)																											
	Voltage/Frequency ratio		128 patterns selectable (Manual setting 120 patterns. Automatics operation 8 patterns) Selectable between V/F constant mode and V/F variable mode																											
	Overload (current)		150% – 60 seconds																											
	Frequency setting signal		DC0~10V/4~20mA					DC0~10V/0~5V/4~20mA changeover							DC0~10V/4~20mA					DC0~10V/0~5V/4~20mA changeover										
	Bais. Gain. Upper/Lower limitation		Gain Adjustment only					Available							Gain Adjustment only					Available										
Function	Acceleration/Decaleration time		1 ~ 1200 seconds (Independent setting)																											
	Braking		Braking through capacitor changing																											
	Starting		Starting by external contact (1a contact)																											
	Foward/Reverse operation		Changable by external contact																											
	Low speed signal		Open collector output (setting frequency is kept at 0.5 Hz)																											
	Jogging		Option					Available (Setting frequency is kept at 6Hz)							Option					Available (Setting frequency is kept at 6Hz)										
	2 stage speed setting		Lower speed setting can be done internally (Adjustable range from 0.5Hz to 75Hz)																											
	Motor characteristic changeover		Characteristics of the standard motor and constant toque use motor can be switched																											
	Output for current monitor		Option					A Voltmeter for monitoring motor current							Option					A voltmeter for monitoring motor's current										
	Output for frequency meter		Analog signal output (80Hz – 1mA) or digital signal output (Pulse output: 96 x Output frequency of inverter)																											
Protection	Protection		Overcurrent, Overvoltage, Undervoltage stall prevention. Overvoltage limitation, Short circuit, Overload, Momentary power failure.																											
			—					Overheat Burn-out (Fuse)							—					Overheat Burn-out (Fuse)										
	Fault output signal		Contact output (1c ontact: AC230V – 2A) At overcurrent, overvoltage, short circuit, overload, overheat																											
	Fault Reset		Reset by external reset contact (1a contact)																											
Display	Output frequency		Display by seven segment LED (3 Figures)																											
	Fault		Trouble display classified by cause at overcurrent, short circuit (OC), overvoltage (OV), undervoltage (UV), overload (OL), overheat (OH), emergency stop (E): option. When the stall prevention is operated lamp a last dicimal digit of LED.																											
	Capacitor charge		Indicated by LED on printed wiring board when capacitor charging																											
Operation panel	With operation panel		Digital frequency meter, Frequency setting variable resistor (3kΩ–1W), MANU-STOP-AUTO drive switch																											
	Without operation panel		Digital frequency meter																											
Cooling method			Self cooling					Air forced cooling							Self cooling					Air forced cooling										
Construction			Enclosed box type (Not dust proof construction)																											
Color			Munsell 5Y7/1																											
Ambient Condition	Place of installation		Indoors																											
	Ambient temperature		-10 to 40°C (Around the box) Up to 50°C without cover																											
	Relative humidity		Less than 90%. No dew																											
	Vibration		Less than 0.5G																											
	Atmospnere		Non corrective or non explosive gus, non steam or non dust																											
Rules and standard			JIS, JEC, JEM																											

(Note) "P", which is the last character of type-form, stands for unit with, operation panel, and "B" stands for unit without operation panel.

2–2 Features (1)

1. Variety of series applicable to wide range of uses

   The VF PACK-P1 is available in a total of 26 types ranging as 230V/460V class from 1 KV to 88 KVA, therefore, it is applicable to wide range of uses from general industrial machinery to fan/pump.

2. Optimum control of general-purpose motor

   Since the waveform distortion is limited by adopting sine wave PWM control, the motor operation characteristics and torque ripple can be greatly improved.

   The general-purpose motor can be directly applied as a variable-speed motor.

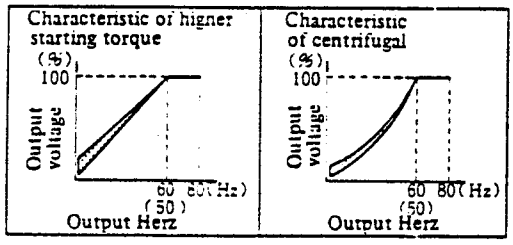
   A 2-chip CPU system makes it possible to improve the processing capability and speed, the motor noise and vibration are reduced.

3. The adjustment of 128 V/Hz characteristic patterns allows you to select a wide range of torque characteristics.

   The inverter characteristics are selectable.

   The voltage/Hertz (V/Hz) pattern is selectable for higher starting torque and "Centrifugal" mode.

   The V/F is readily selectable for each mode, and available in 128 patterns with digital switch.



4. Smooth acceleration/deceleration

   The frequency resolution was improved to 0.025 Hz.

   The acceleration/deceleration time can be adjusted in a range from "1 sec." to "20 minutes". Since there are 32 patterns changeover with a digital switch, the soft starting and stopping can be assured.

5. As standard the drive will accept various frequency setting signals.

   DC0 ~ 10V, 0 ~ 5V or 4 ~ 20 mA signal is acceptable as frequency setting signal input.

   The VF PACK-P1 is also provided with the Gain/Bias/Upper/Lower limit as adjustable function.

2–2 Features (2)

6. The VF PACK-P1 is fully furnished with the following built in functions to meet general applications.
   (1) Jogging
   A jogging terminal is equipped as standard.
   (2) 2-stage speed setting
   The 2-stage speed setting readily executes, high-speed operation by external setting signal and low-speed operation by internal one.
   (3) Output of various signals
   The maximum speed signal and speed attainable signal can be output (option), as the equipment is provided with low-speed signal in the standard specification.
   (4) Coast to stop function
   Since the VF PACK-P1 is provided with coast to stop function, the external brake can be actuated under free-run condition.
   (5) Reset function
   Since the VF PACK-P1 is provided with a reset function, the inverter can be reset without turning off the power.

7. Automatic energy-saving operation
   The motor current varies with the applied load ratio.
   The VF PACK-P1 monitors the load current all the time to change the voltage/Herz pattern automatically, depending upon the applied load.
   This serves to assure operation with the motor current minimized, so as to contribute to the energy-saving.

8. Safety features
   The VF PACK-P1 is provided with various protective functions (11 functions) as follows.
   (a) Stall prevention
   (b) Overcurrent protection
   (c) Short-circuit protection
   (d) Overvoltage limitation
   (e) Overvoltage protection
   (f) Undervoltage protection
   (g) Protection of overload by adopting electronic thermal circuit
   (h) Momentary power failure protection
   (i) Heat sink overheating protection
   (j) Emergency protection (option)
   (k) Fuse protection
   Besides, the above functions the drive will display "OC", "OV", "UV", "OL", "OH", or "E" which can be used to determine inverter fault condition.

   Some of the main options are as follows;
   (1) Speed feedback control unit
   (2) Automatic restart
   (3) By pass operation.
   (4) Frequency jump control unit
   (5) D/A conversion unit
   (6) Ground fault detection

3. VF PACK-P1 STANDARD SPECIFICATIONS

3–1 VF PACK-P1 Standard Specifications

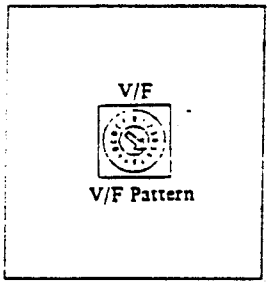
Standard specifications of 230V class and 460 V class inverters are shown in Table 2–1 of Section 2.

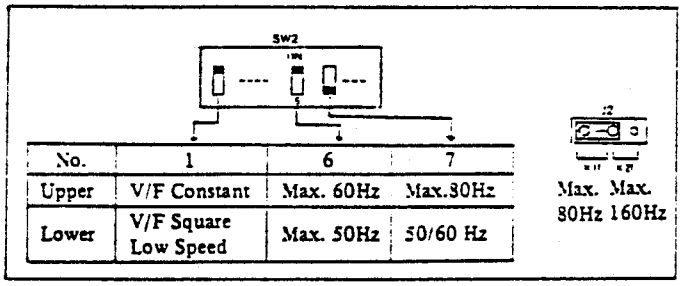
3–2 VF PACK-P1 Standard Specifications Description (1)

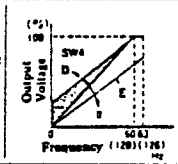
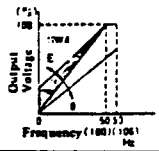
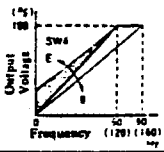
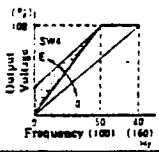
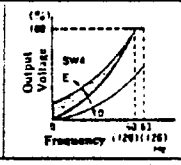
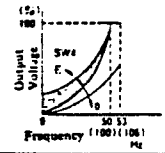
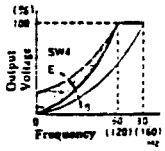
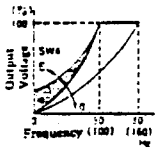
<table>
<tr><th>Specifications Item</th><th>Description</th></tr>
<tr><td>Inverter type-form</td><td>
VF P – 2 □□□ Ⓟ – B
For U.S.A.
P: with operation panel
B: without operation panel
P series
VF PACK
Capacity (kVA × 10)
2: 230V class
4: 460V class
</td></tr>
<tr><td>Capacity and rated current</td><td>
Rated current is the current when the output voltage is 230V or 460V.
• 230V class
$I_{INV} = \frac{kVA \times 1000}{\sqrt{3} \times 230\,(V)}$ (A)
• 460V class
$I_{INV} = \frac{kVA \times 1000}{\sqrt{3} \times 460\,(V)}$ (A)
The rated current does not change even if output frequency is changed.
</td></tr>
<tr><td>Control system</td><td>Sinusoidal wave PWM control is used as the control system generating output of variable voltage/variable frequency.</td></tr>
<tr><td>Output voltage</td><td>Since the output voltage of 230 or 460 V is the voltage at 60Hz, if frequency is decreased, the voltage is also decreased in accordance with the set voltage/frequency ratio. Depending on the load amount, the voltage/frequency ratio can be set with by the rotary switch V/F on the printed board. For details, refer to the output voltage adjusting method. Since the inverter output voltage changes with the power source voltage variation, the power source voltage must be kept within the allowable tolerance.</td></tr>
<tr><td>Output frequency and Frequency resolution</td><td>
Output frequency can be selected in one of 3 mode with a jumper pin.
<table>
<tr><th>Item</th><th>Output frequency</th><th>Frequency resolution</th><th>Operating method</th><th>Remarks</th></tr>
<tr><td rowspan="3">Standard</td><td>0.5 ~ 63Hz</td><td rowspan="3">0.025Hz</td><td>—</td><td>at shipment</td></tr>
<tr><td>0.5 ~ 80Hz</td><td rowspan="2">Changeover with dip switch</td><td rowspan="2">—</td></tr>
<tr><td>0.5 ~ 53Hz</td></tr>
<tr><td rowspan="3">Double Expansion</td><td>1 ~ 160Hz</td><td rowspan="3">0.05Hz</td><td rowspan="3">Reconnection with jumper pin
Changeover with dip switch</td><td rowspan="3">—</td></tr>
<tr><td>1 ~ 126Hz</td></tr>
<tr><td>1 ~ 106Hz</td></tr>
</table>
</td></tr>
</table>

3–2 VF PACK-P1 Standard Specifications Description (2)

Specifications Item	Description
Voltage/ Frequency Ratio	Optimum voltage/frequency pattern in accordance with application and load characteristics can be selected by changing the notch position of rotary switch and jumper-pin. VF PACK-P1 equips with 3 typical V/f pattern as follows. 1. Constant V/f pattern for constant torque machine 2. Square reduction V/f pattern for fans and pumps 3. Automatic energy-saving V/f pattern which automatically changes V/f ratio in accordance with load current The following each figure has 16 patterns, therefore V/f pattern selection sums to 128 patterns.



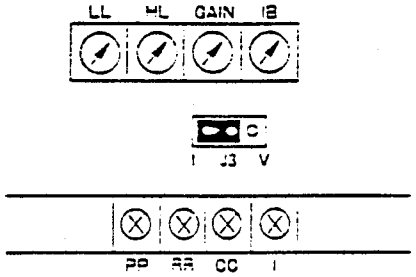


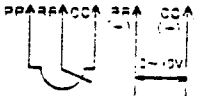
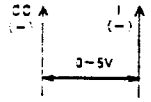
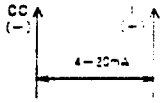
Frequency Range / V/F Pattern	0.5 ~ 60Hz (1 ~ 120Hz) 6 bit of SW2: Upper 7 bit of SW2: Lower	0.5 ~ 50Hz (1 ~ 100Hz) 6 bit of SW2: Lower 7 bit of SW2: Lower	0.5 ~ 80Hz (1 ~ 160Hz) 6 bit of SW2: Upper 7 bit of SW2: Upper	0.5 ~ 80Hz (1 ~ 160Hz) 6 bit of SW2: Lower 7 bit of SW2: Upper
V/F Constant (Constant Torque Machine) 1 bit of SW2: Upper				
V/F Square Low speed (Fans, Pumps) 1 bit of SW2: Lower				

(Note)
1. The values in the parentheses indicate frequency extension by changing the jumper-pin J2 to "2f" side.
2. Dotted area indicates the range of automatic evergy-saving V/f pattern. As selecting "F" notch of V/f ratio. V/f pattern automatically changes in accordance with load.

3–2 VF PACK-P1 Standard Specifications Description (3)

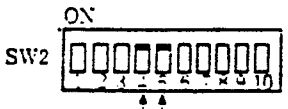
Specifications Item	Description
Frequency setting signal	The following 3 type of signals can be given as frequency setting signal. (1) 0 ~ 10 VDC (2) 0 ~ 5 VDC (3) 4 ~ 20 mADC



Signal level	DC0 ~ 10V	DC0 ~ 5V	DC4 ~ 20mA
Connection	 FRH External Signal	 External Signal	 External Signal
Jumper pin J3	V Side	V side	I side
Adjustable Function	LL (Lower Limit) HL (Upper Limit) GAIN (Gain) IB (Bias)	LL (Lower Limit) HL (Upper Limit) GAIN (Gain) IB (Bias)	LL (Lower Limit) HL (Upper Limit) GAIN (Gain) IB (Bias)

3–2 VF PACK-P1 Standard Specifications Description (4)

Specifications Item	Description
Accelerating and Decelerating Time	VF PACK-P1 has soft start and stop function. Accelerating and decelerating time can be changed individually up to 32 setting in the range of 1 to 1200 seconds.



Changeover Switch Between Long and Short Acceleration Times

Changeover Switch Between Long and Short Deceleration Times

OFF: Standard

Notch	SW2 ON	SW2 OFF
F	120 S	1000 S
E	90 S	900 S
D	70 S	700 S
C	60 S	600 S
B	45 S	450 S
A	35 S	350 S
9	25 S	250 S
8	18 S	180 S

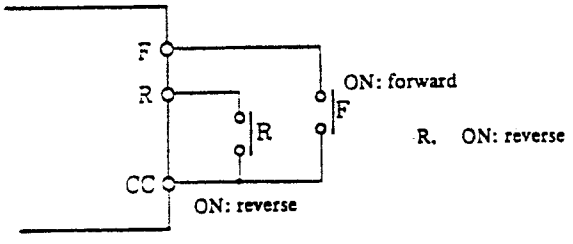
SW6 or SW7 (Acceleration) (Deceleration)

OFF: Standard

Notch	SW2 ON	SW2 OFF
0	1 S	10 S
1	2 S	20 S
2	3 S	30 S
3	4 S	40 S
4	5 S	50 S
5	8 S	80 S
6	10 S	100 S
7	15 S	150 S

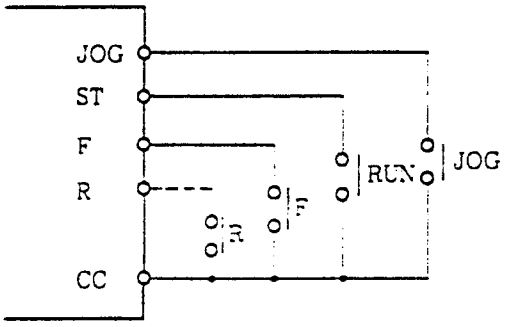
(Note) Both Acceleration and Deceleration Times are set on 20 Seconds of shipment.

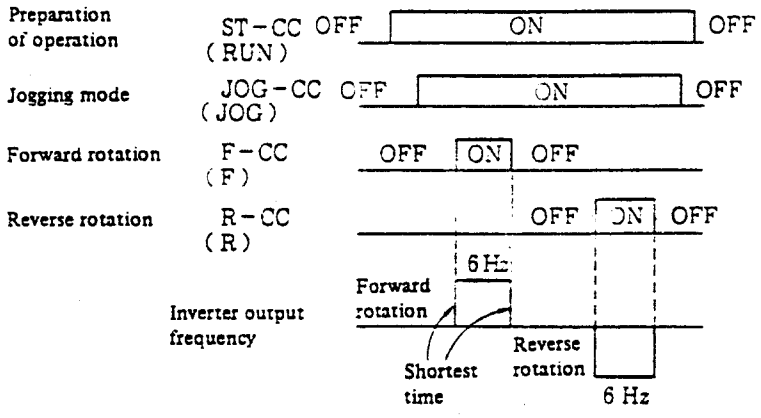
Starting	When 1a contact is closed between terminals F and CC, or between R and CC, DF PACK-P1 starts. When it is opened, UF PACK-P1 will stop.
Braking	A Motor has regenerative energy in the decelerating mode. In this occasion, regenerative power is fed back into verter output and the DC capacitor is charged. Regenerative braking torque is approximately 12% of rated motor torque. If a larger braking torque is required in a certain application, use regenerative power discharge unit as option.
Forward/ Reverse operation	When 1a contact is closed between terminals F and CC, it results in forward operation. When 1a contact is closed between terminals R and CC, it results in reverse operation. When the circuits between F and CC, and between R and CC are simultaneously closed. it results in reverse operation.



3–2 VF PACK-P1 Standard Specifications Description (5)

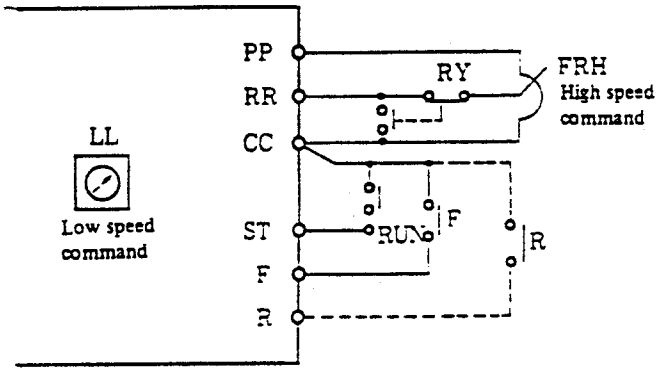
Specifications Item	Description
Low speed signal	Terminal LOW is open collector output of signal transistor. When relay is connected between terminals LOW and P24, low speed signal is detected. This signal has a fixed detecting level 0.5Hz. Relay is under opened condition below 0.5Hz. and under closed condition above 0.5Hz. Detecting level can be varied optionally at the range of 0.5 to 30Hz.
Jogging operation	When 1a contact is closed between terminals JOG and CC, it results in jogging operation mode. In the case of forward jogging operation, close N.D. contact or push button switch between terminals F and CC. In reverse jogging operation, prepare for it between terminals R and CC. If only switched on and off the inverter operates at 6Hz. In this case, rise and set time is the shortest time accelerating and decelerating time is bypassed.

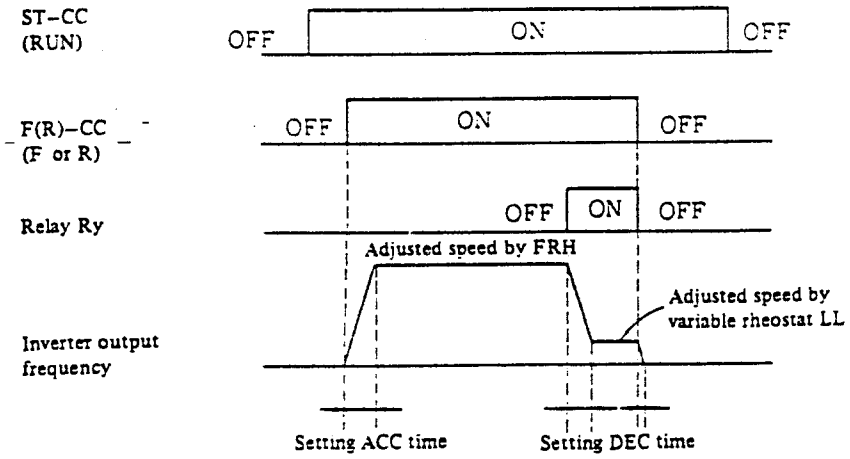




3–2 VF PACK-P1 Standard Specifications Description (6)

Specifications Item	Description
Two-stage speed operation	2 speed operation can be easily changed over between high and low speed operation. High speed command is given externally. Low speed command is adjusted by variable rheostat LL in VF PACK-P1.

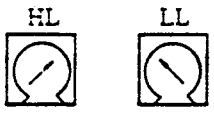




Output for current monitor	When motor current which is inverter output current is detected with current transformer CT and inverter rated current flows, signal 5V DC – 1 mA is taken out. Use DC voltage meter in full scale 7.5V DC – 1 mA externally.
Output for frequency meter	When adjusted frequency is monitored externally, use this meter. Two kinds of signals can be taken out with switching between analog signal, of which meter indicates 80Hz at 1 mA signal flows, and digital sequential pulse signal of which frequency is 96 times of output frequency. As for analog signal, use DC voltage meter of which rating is 7.5V DC – 1 mA in full scale.

3–2 VF PACK-P1 Standard Specifications Description (7)

Specifications Item	Description
Maximum/ minimum speed limit	There are two adjustable speed levels which are symbolized as HL and LL in inverter. HL has function of maximum or higher limit level, and LL is the lower or minimum speed limit level.

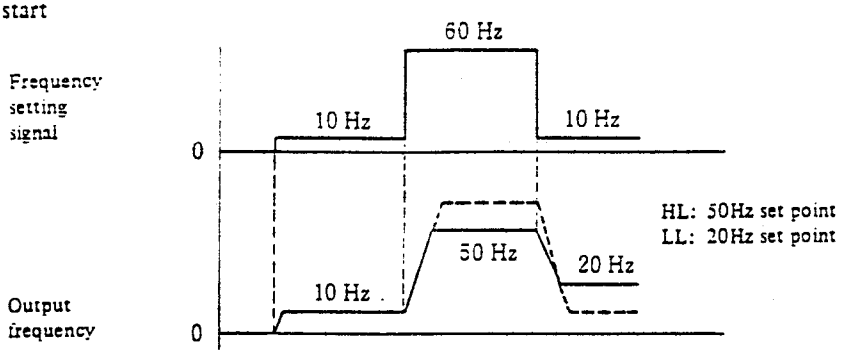


(1) Adjustable range

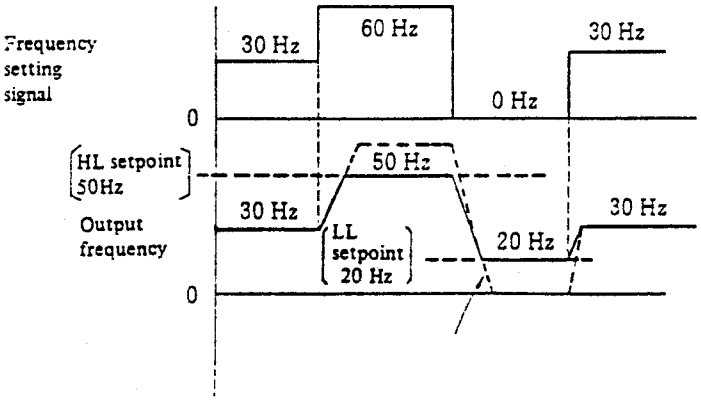
	Standard			Doubled frequency		
HL (Upper limit)	0~80Hz	0~53Hz	0~63Hz	0~160Hz	0~106Hz	0~126Hz
	5~80Hz	5~53Hz	5~63Hz	10~160Hz	10~106Hz	10~126Hz
LL (Lower limit)	0~75Hz	0~53Hz	0~63Hz	0~150Hz	0~106Hz	0~126Hz

(2) Operation

a. at start



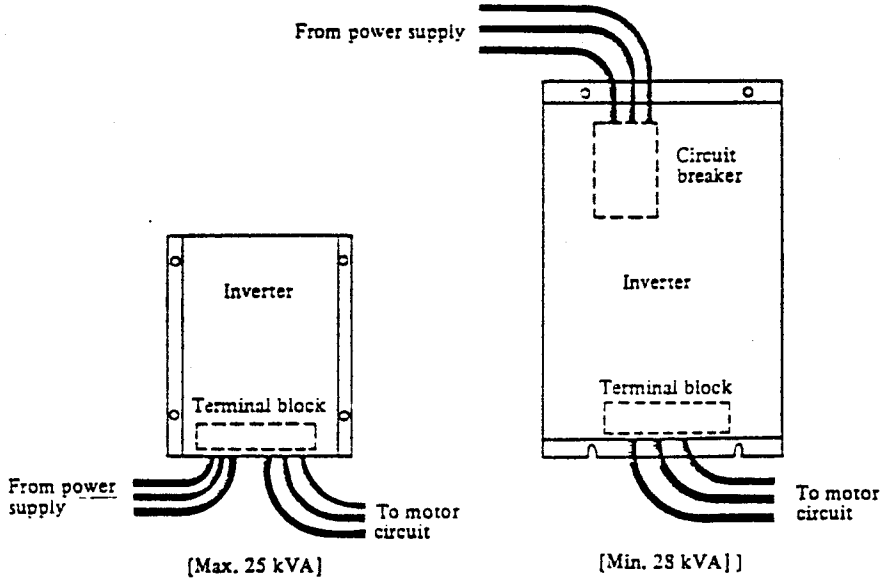
b. Frequency is changed in operation



c. If the higher limit is set below the lower level by mistake, for example upper setting point is 30Hz, and lower setting point is 60Hz, upper limit is only effective and lower limit does not function. In case of (b), it can operate below 30Hz.

3–2 VF PACK-P1 Standard Specifications Description (8)

Specifications Item	Description
Protective function	Refer to Item "Protective function" as for protective function and display.
Construction	VF PACK P1 has box type construction made of steel and NEMA type 1 enclosure.
Ambient condition	1. Installation •Install in a place free of corrosive gases, corrosive fluids, explosive gases, or steam. 2. Ambient temperature Ambient temperature –10° ~ 40°C (around the box) Take sufficient care for ventilation to avoid excessive heat build up inside the box. When installing the device in a self-supporting panel or in a large control panel, and where heat is generated from other components, use the type without an operation panel (a type bearing B at the end of type number) and with the cover removed for better ventilation. When the cover is removed, it will be available up to 50°C ambient temperature. 3. Ambient humidity Avoid placing in an area having a high temperature or humidity in an atmosphere full of dust, dirt, or conductive air contaminates such as iron filings. 4. Vibration Install in a place free from vibration, free from noise generating sources such as nearby power switches, and in a place convenient for maintenance and inspection.



4. SELECTION OF CAPACITY

4—1 To Drive One Motor with One Inverter

Select inverter capacity so that the current is over the rated full load of the motor current.

Inverter output current (rated current) ≥
Full load current of motor.

In the following cases, however, inverter capacity needs to be increased.

(1) In case the load of large WK^2 is started in a short time period.
(2) In case acceleration/deceleration is performed frequently.

4—2 To Drive Multiple Motors with One Inverter

(1) Simultaneous starting:

Inverter output current (rated current) $> 1.05 \times \Sigma I_M$

Where,

1.05 : Harmonic coefficient (tolerance since the above current is not a sinusoidal wave)

I_M : Total of rated motor currents (name plate value)

(2) Starting motors after operation

Inverter output current (rated current) $>$

$$(1.05 \times I_M + 2 \times \Sigma I_{ST}) \times \frac{1}{1.5}$$

Where,

I_M : Total of rated motor current during operation (name plate value)

I_{ST} : Starting current to inverter output voltage V and output frequency of at operating motors starting later (sinusoidal wave effective value)

ΣI_{ST} : Total of above I_{ST}

2 : Tolerance to starting current

1.5 : Overload capacity

Note 1. The starting time of the motors to be operated additionally should be within 30 seconds.

Note 2. Never make starting current exceed inverter overload capacity.

Reference

Overload capacity: Which allows operating current to exceed inverter rated current in very short time. As for VF PACK–P1, it has 150% capacity of rated current within 60 seconds.

4–3 To Set Accelerating Time

Since the motor acceleration time is normally as given below, set the acceleration time of inverter to a little greater time value than "ta".

$$\text{Acceleration time (ta)} = \frac{WK^2 \times \Delta N}{308 \times (T_M - T_L)} \quad (S.)$$

Where,

- GD^2 : Total of motor WK^2 and load WK^2 (converted into motor shaft) (lbs-FT^2)
- ΔN : Motor speed difference (r.p.m.)
- T_M : 1.2 – 1.3 x Rated motor torque (lbs-FT)
- T_L : Load torque converted into motor shaft (lbs-FT)

The settable range of inverter acceleration time is as given below, and cannot be set shorter than the minimum acceleration setting time.

Be sure to set acceleration time longer than "ta" found in the above formula.

> The acceleration time of VF PACK-P1 ranges from "1" to "1,200" S.

If necessary to shorten "ta", increase inverter and motor capacity to increase "T_M", as is evident from the formula for the acceleration time "ta".

Caution: Pay attention to setting the acceleration/deceleration time of inverter shorter than the acceleration time of motor may result in tripping due to overcurrent.

Reference: The machines with generally greater and smaller GD^2 are shown as follows;

Machinery with Large GD^2	Machinery with Small GD^2
• Fan blower (turbo) • Centrifugal separator • High speed conveyer (more than 30 to 50 m/min.) • Crasher • Press machine • Mixer	• Pump • Low speed conveyer (about 5 m/min)

4—4 To Set Decelerating Time

Since motor deceleration time is normally as given below, set the deceleration time of inverter to a little greater time value than "tb".

$$\text{Deceleration time (tb)} = \frac{WK^2 \times \Delta N}{308 \times (T_B + T_L)} \quad (S.)$$

Where,

GD^2 : Total of motor WK^2 and load WK^2 (converted into motor shaft) (lbs-FT^2)

ΔN : Motor speed difference (r.p.m.)

T_B : Without regenerated Power Discharge Resistor Unit
T_B = 0.2 x rated motor torque (lbs-FT)
With regenerated Power Discharge Resistor Unit
T_B = (0.8 – 1.0) x rated motor torque (lbs-FT)

T_L : Load torque converted into motor shaft (lbs-FT)

The settable range of inverter deceleration time is as given below, and cannot be set shorter than the minimum deceleration time.

Be sure to set deceleration time longer than "tb" found in the above formula.

> The deceleration time of VF PACK-P1 ranges from "1" S. to "1,200" S.

Further, please install a regenerated power discharge resistor unit (option) in a case required for shortening tb.

Deceleration time in this case becomes equal to setting time.

5. APPEARANCE

5–1 Appearance and Construction of VF PACK-P1

5—1 Appearance and Construction of VF PACK-P1

For Reference only

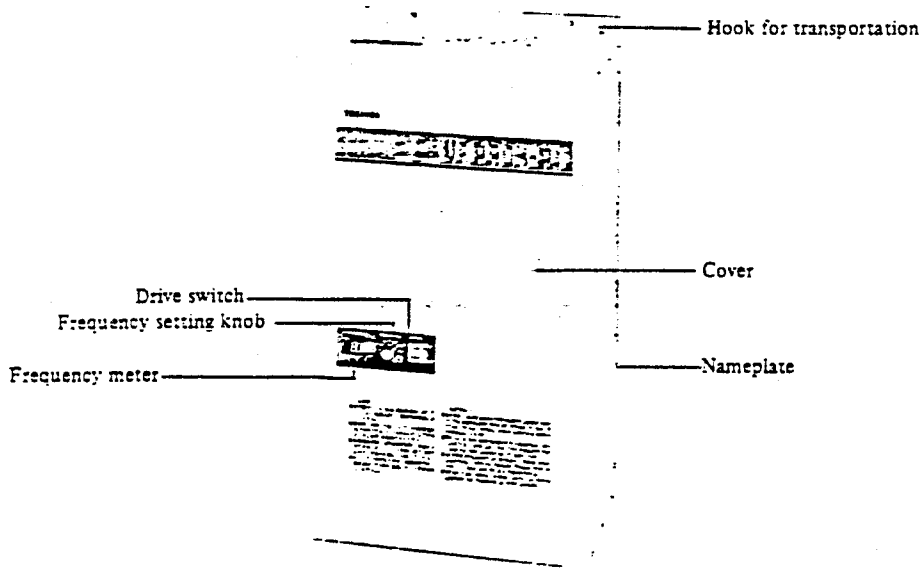


Fig. 5-1 Appearance

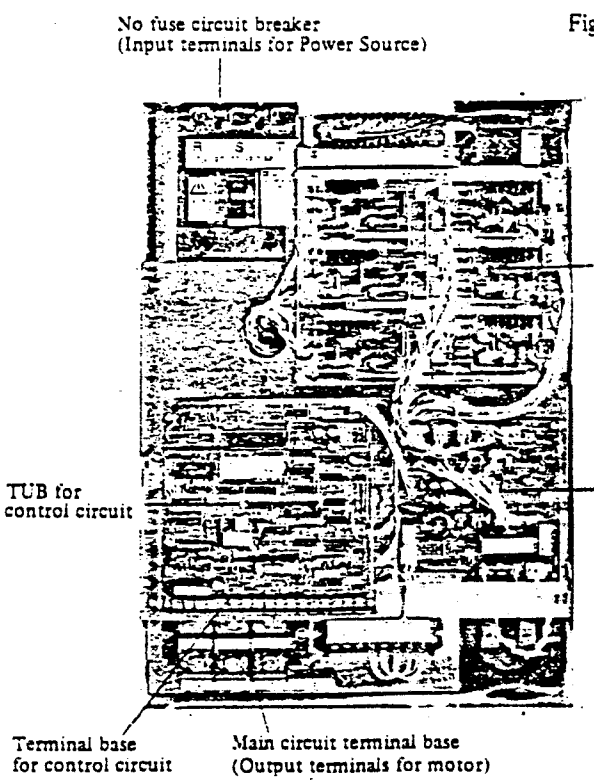


Fig. 5-2 Inner appearance

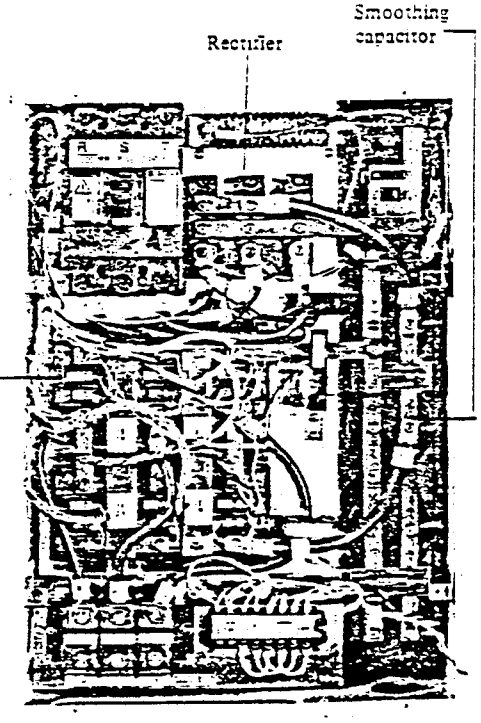


Fig. 5-3 Construction of main circuit

6. TERMINAL FUNCTION AND STANDARD CONNECTION

6—1 Dimension of Terminal Base

Terminal base of VF PACK-P1 for external distribution is separated to two sides.

One is main circuit terminal base on the cooling fin, and the other is the terminal base on control circuit printed wiring board.

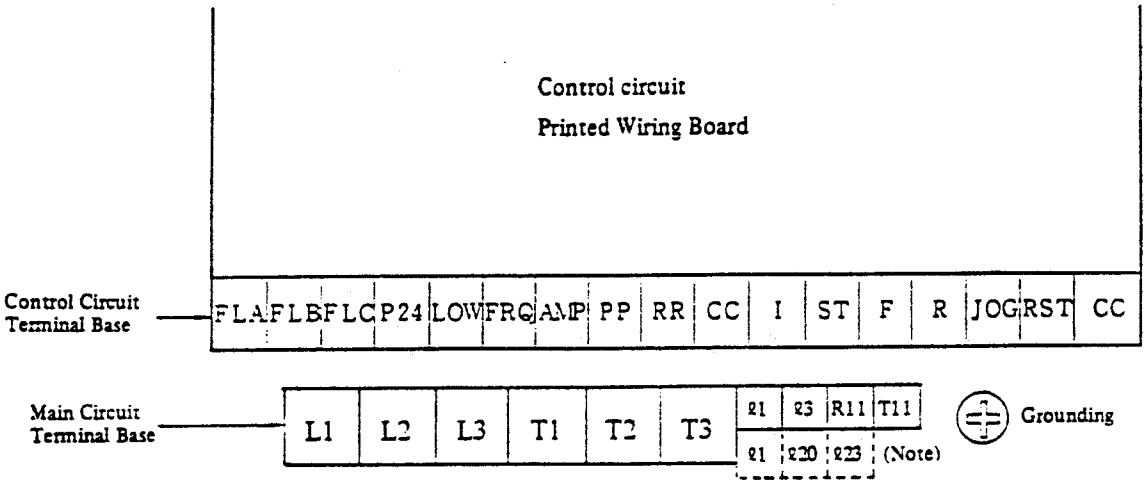


Fig. 6-1 Dimension of terminal base (types of more than 29 KVA)

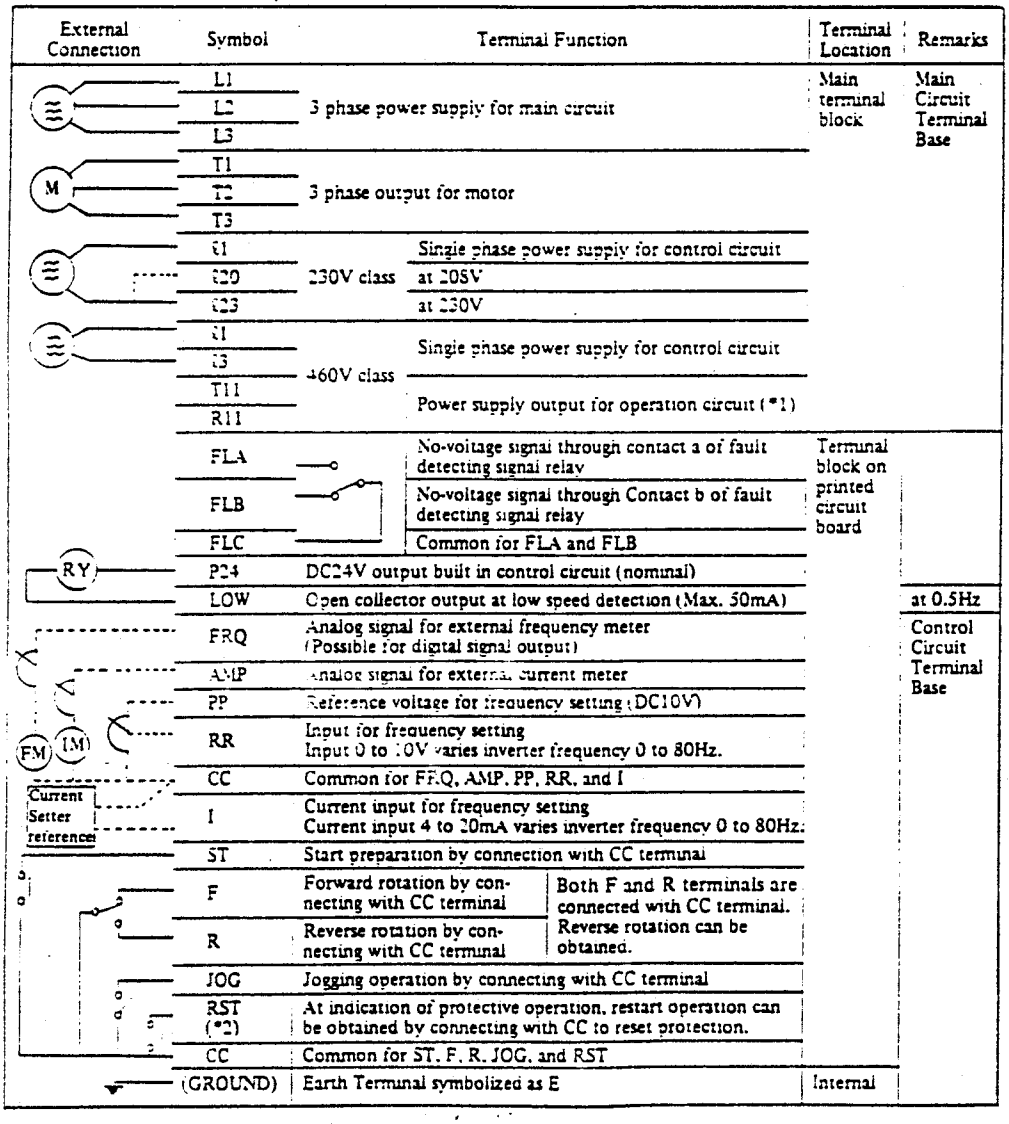
Note: Terminal ℓ_1, ℓ_{20}, ℓ_3 has 230V Class inverter

6–2 Terminal Function (1)

Table 6-2 shows each terminal function one by one. As conceptional explanation about purposes and external connection to use these terminals are described in Table 6-2. in practical case to connect the terminals with external devices. it is recommended to refer to standard connection diagrams or details of interface.

(Note) Terminals "P" and "N" connecting with a generated power discharge resistor unit, corresponding to terminals "P" and "N" of this unit, respectively *are not provided* on the terminal base.
Therefore, if it is required to connect with "P" and "N"; the P junction should be connected with the positive (+) side of the smoothing condenser provided in inverter: the N junction should be connected with the negative (–) side.

Table 6-2 Terminal Function

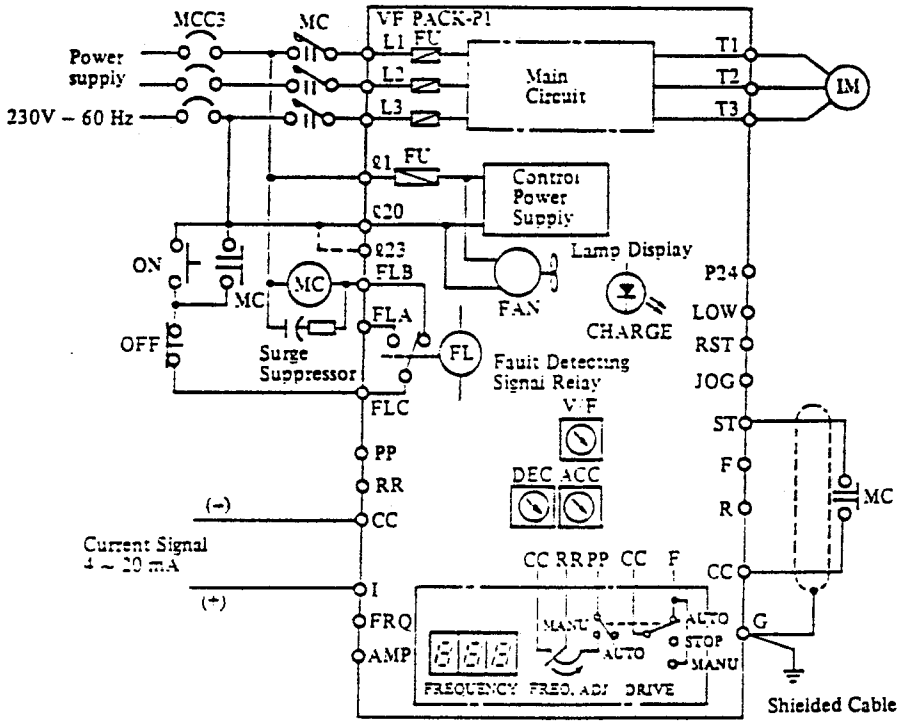


External Connection	Symbol	Terminal Function		Terminal Location	Remarks
	L1	3 phase power supply for main circuit		Main terminal block	Main Circuit Terminal Base
	L2				
	L3				
M	T1	3 phase output for motor			
	T2				
	T3				
	S1	230V class	Single phase power supply for control circuit		
	S20		at 208V		
	S23		at 230V		
	S1	460V class	Single phase power supply for control circuit		
	S3				
	T11		Power supply output for operation circuit (*1)		
	R11				
	FLA		No-voltage signal through contact a of fault detecting signal relay	Terminal block on printed circuit board	
	FLB		No-voltage signal through Contact b of fault detecting signal relay		
	FLC		Common for FLA and FLB		
RY	P24	DC24V output built in control circuit (nominal)			
	LOW	Open collector output at low speed detection (Max. 50mA)			at 0.5Hz
	FRQ	Analog signal for external frequency meter (Possible for digital signal output)			Control Circuit Terminal Base
	AMP	Analog signal for external current meter			
	PP	Reference voltage for frequency setting (DC10V)			
FM IM	RR	Input for frequency setting Input 0 to 10V varies inverter frequency 0 to 80Hz.			
	CC	Common for FRQ, AMP, PP, RR, and I			
Current Setter reference	I	Current input for frequency setting Current input 4 to 20mA varies inverter frequency 0 to 80Hz.			
	ST	Start preparation by connection with CC terminal			
	F	Forward rotation by connecting with CC terminal	Both F and R terminals are connected with CC terminal. Reverse rotation can be obtained.		
	R	Reverse rotation by connecting with CC terminal			
	JOG	Jogging operation by connecting with CC terminal			
	RST (*2)	At indication of protective operation, restart operation can be obtained by connecting with CC to reset protection.			
	CC	Common for ST, F, R, JOG, and RST			
	(GROUND)	Earth Terminal symbolized as E		Internal	

*1 Terminals R11 and T11 are AC115 V output terminals for making operating circuit. This out-put has limited power to operate only one specified electromagnetic contactor.

*2 Power should be reclosed after eliminating abnormality under cutting off power.

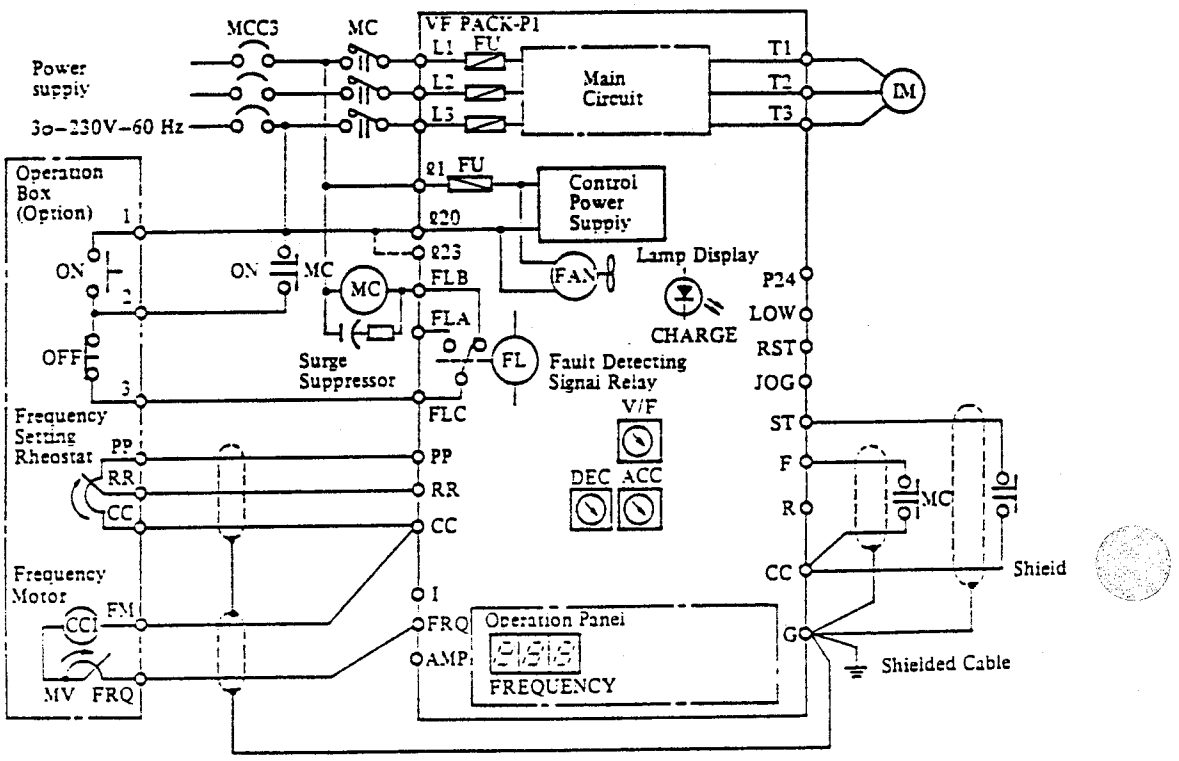
6–3 Standard Connection Diagram (1)



	Operation	Acceleration/ Deceleration
Preparation	MCCB ON, MC ON	–
Start	Drive switch: RUN	According to "ACC" adjustment
Stop	Drive switch: STOP	According to "DEC" adjustment
Trip	Cut-off of inverter output MC : OFF	Coast stop
Reset	MCCB : OFF or Shortcircuit between terminals RST and CC	–

Fig. 6-2 Standard Connection (230V class)
Diagram of Types with Operation Panel

6–3 Standard Connection Diagram (2)

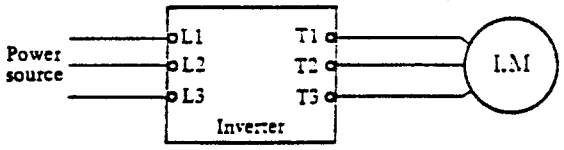


	Operation	Acceleration/Deceleration
Preparation	MCCB : ON, MC : ON	–
Start	Relay "F" : ON	According to "ACC" adjustment
Stop	Relay "F" : OFF	According to "DEC" adjustment
Trip	Cut off inverter output MC : OFF	Coast stop
Reset	MCCB : OFF or Short circuit between terminals RST and CC	–

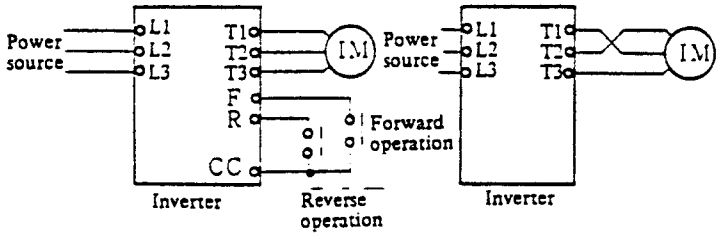
Fig. 6-3 Standard Connection (230V class)
Diagram of Types without Operation Panel

6—4 Cautions of Circuit Construction (1)

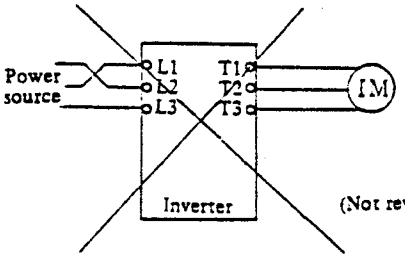
1. Do not connect the input power source terminals (L1, L2, L3) in the main circuit to inverter output terminals (U, V, W). This cause damage to the inverter circuits.



2. Change of motor rotating direction
   The motor rotation reverses when two wires on the motor-side terminals (U, V, W) are interchanged.
   The motor rotation can also be reversed by jumpering terminals, R-CC, in the control circuit.
   Reverse the motor rotation will not even though two wires on the power source terminals (L1, L2, L3) are reversed.
   (1) Utilization of terminals R–CC (reversed)
   (2) Reconnection in motor side (reversed)
   (3) Connection alteration in power source side (not reversed)



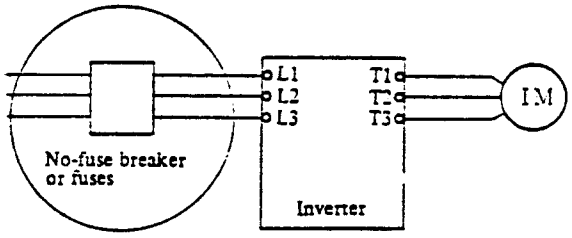
(Forward/Reverse Rotation) (Reverse Rotation)



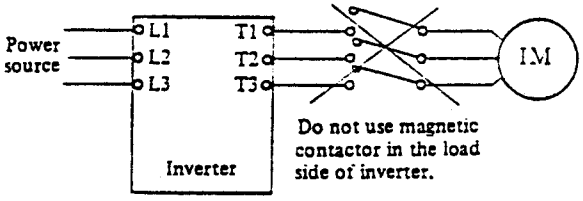
(Not reverse rotation)

(Note) Bear in mind that inverter is reversed when the terminals F–CC and R–CC are turned on at the same time.

3. Fuse protection of inverter
   In the event of an inverter failure, so as to minimize the danger toward externals, a fuse (equipped with series more than 6.5 kVA) is provided to inverter inputs. However, they are not useful for the protection of input power side.
   Therefore, it is recommended to provide fuses or a no-fuse breaker outside of the inverter which has sufficient capacity to meet the inverter kVA Rating.



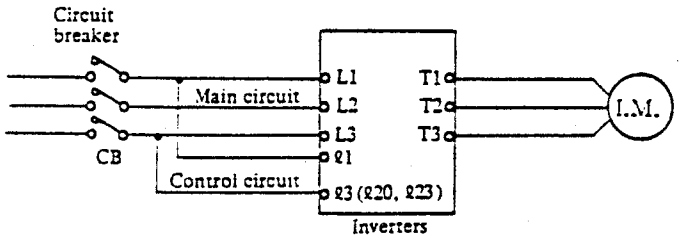
4. Contactor prohibition on load side
   Do not provide electromagnetic contactor between inverter and applied motor as a rule.
   If not, during the operation, an ON-OFF operation of electromagnetic contactor in the load side will result in possible failure of inverter.
   If such an ON-OFF operation is required in the load side, consult with the manufacturer to select suitable capacity.



6–4 Cautions of Circuit Construction (2)

5. It is recommended to use the fault detecting signal relay.
   If a failure is caused for any reason, power should be removed from the input with an electromagnetic contactor; MC so as to protect the inverter circuit from extensive damage.
   It is recommended to provide an external sequence which can shut off the main power source down with the functions of fault detecting signal relay (Signal output terminals: FLB and FLC).
   Moreover, whenever the protective circuit has energized, the cause of trouble is displayed on the digital frequency meter provided on the panel by a character display.
   For the purpose, it is necessary to keep the control power source under normal "ON" mode at terminal (ℓ1, ℓ3, etc.)

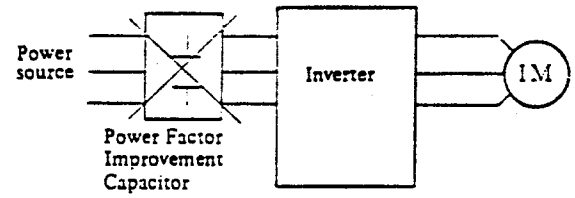
6. Simultaneous switching on and off operation of main power source with control power source is possible.
   Circuit configuration in simultaneous switching on and off operation of main power source with control power source is feasible.
   In this case, however, as shown in Item 5 above, the circuit that can cut off the operation circuit using fault relay should be provided.
   In addition, an external relay sequence should be provided so that the switching of the main circuit power source should not be switched ON prior to the switching ON by the control power source switch.
   Be careful in this circuit configuration, since it is impossible to display characters which show the cause of the trouble on the digital frequency meter if control power from ℓ1, ℓ3 is removed or the circuit breaker is turned off.

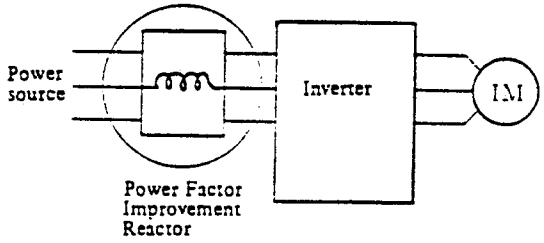


7. Changeover of characteristics corresponding to applicable motors
   The VF PACK P1 is provided with an overload protective function which is similar to the torque characteristics provided with general purpose motors. When VF PACK-P1 is combined and operated with TOSHIBA's general purpose motors, which conform to the applicable motor output as shown in specifications, it is not necessary to provide an overload relay (Th – Ry) in motor input circuit.
   In this case, however, if VF motor which is exclusively used with the applicable inverter featured by for 100% full load torque within the entire frequency zone, overload protection is feasible by switching OFF bit 2 of function selector switch (SW2).
   In other words, adequate overload protection is possible in proportion to the constant torque characteristics.
   If the following operation is required, contact Toshiba before use:

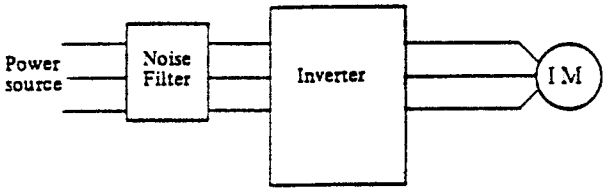
6—4 Caution About Circuit Configuration (3)

8. Elimination of capacitor for power-factor improvement.
   Do not install capacitor for power-factor improvement in the input section of inverter.
   Installing capacitor causes considerable large currents containing higher harmonic components flows in the circuit. resulting in the breakage of capacitor. The inverter might be subject to over-current trip.
   Therefore, it is recommended to use Power Factor Improvement Reactor should customer require this feature.

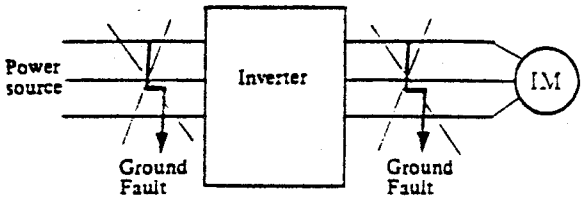




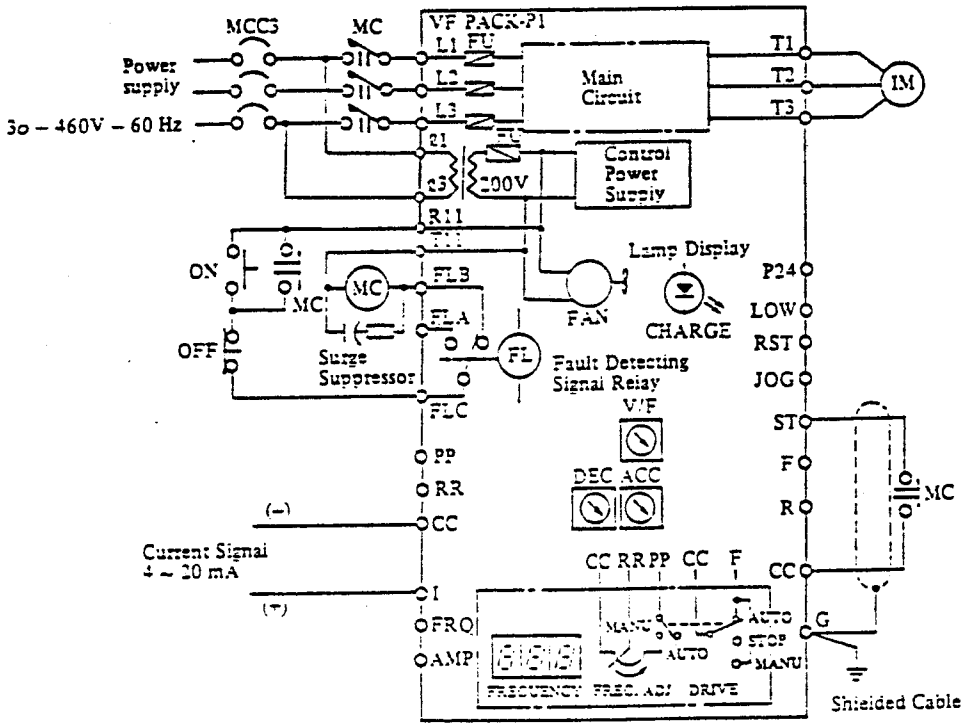
9. Removal of radio wave interference
   Since the output waveform of inverter is not a complete sine wave, it might have an influence on the middle wave band, represented by radio wave interference.
   In order to remove such causes from the inverter, it is advisable to install a noise-filter (option) in power source section to reduce interference.



10. Prevention of Ground Fault
    Before starting up inverter. carefully check to see if any short-circuit location is observed by carefully checking the cable connections and motor. If any short-circuit protection is required. use Ground Fault Detection Unit (option on some models).



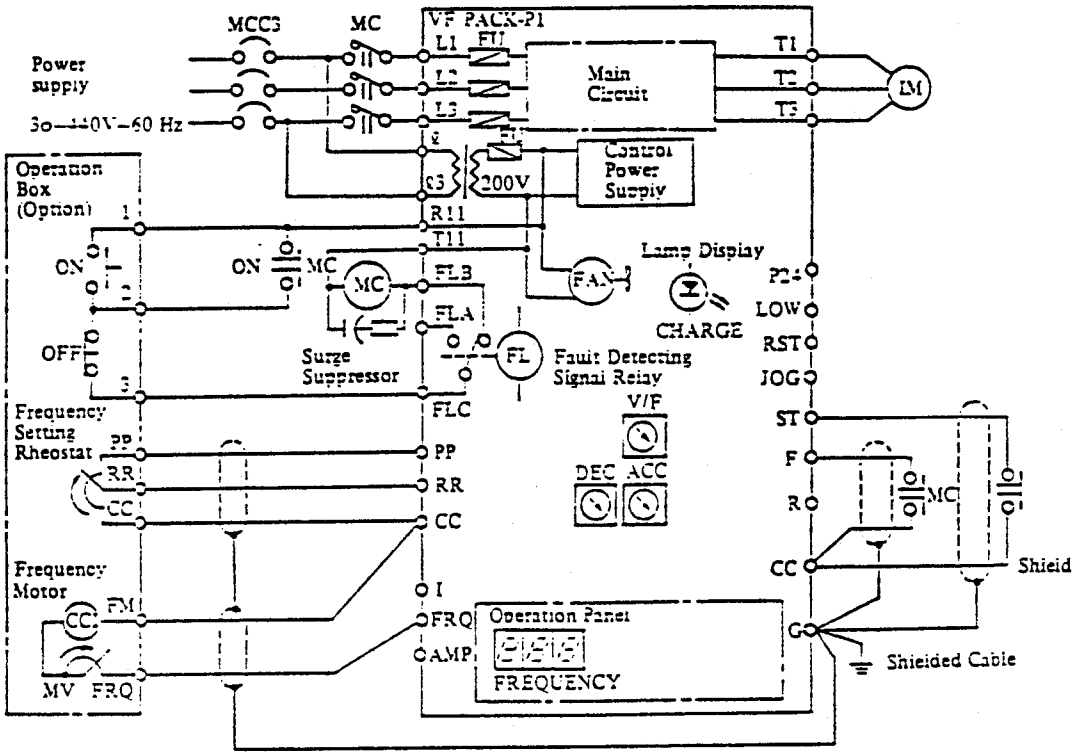
6-5 Standard Connection Diagram (1)



	Operation	Acceleration/Deceleration
Preparation	MCCB ON, MC ON	–
Start	Drive switch : RUN	According to "ACC" adjustment
Stop	Drive switch : STOP	According to "DEC" adjustment
Trip	Cut off inverter output MC : OFF	Coast stop
Reset	MCCB : OFF or Short circuit between terminals RST and CC	–

Fig. 6-4 Standard Connection Diagram of Types with Operation Panel (460V class. Operating circuit: 115V)

6–5 Standard Connection Diagram (2)



	Operation	Acceleration/Deceleration
Preparation	MCCB : ON, MC : ON	–
Start	Relay F : ON	According to "ACC" adjustment
Stop	Relay F : OFF	According to "DEC" adjustment
Trip	Cut off inverter output MC : OFF MC : OFF	Coast Stop
Reset	MCCB : OFF or Short circuit between terminals RST and CC	–

Fig. 6-5 Standard Connection Diagram of Types without Operation Panel (460V class, Operating circuit: 115V)

7. INTERFACE

7-1 Power Source Circuit (1)

When VF PACK-P1 is used, the minimum requirements of the external sequence must be observed, in order to exert inverter functions fully.

The following contents are described for the interface of VF PACK-P1.

On this occasion. refer to (Standrd Connection Diagrams) and (Terminal Functions).

7–1 Power Source Circuit

(1) 230 V – class

The connection between 230V–class VF PACK-P1 and Power Source is shown in Fig. 7-1.

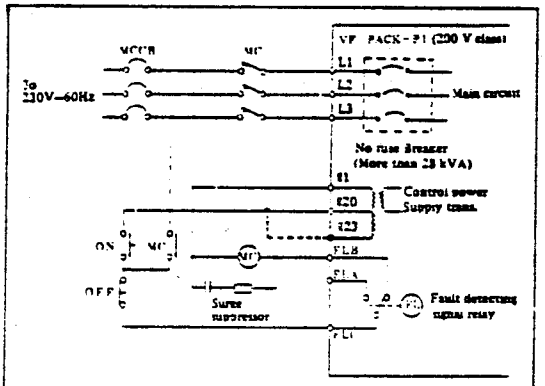


Fig. 7-1 Power Source Circuit
(VF PACK-P1 230 V-class)

(a) Connect 230V–60Hz, 3-phase power, or with the main circuit terminals R, S and T of VF PACK-P1 through no-fuse breaker (MCCB) and electromagnetic contactor (MC).

(b) Feed control power source from primary side of "MC".

(c) Connect the b-contact (terminals "FLB" and "FLC") of fault detecting signal relay (FL) to the exciting coil of "MC" in series.
In this way, whenever inverter protective circuit is energized, "MC" is switched off by the relay (FL).
As a result, inverter can be separable from the power source.
This means that re-closing of power source is impossible until the protective circuit is reset.
Connect surge-suppressor to the exciting coil in parallel.

(d) Since a-contact is inserted between terminals "FLA" and "FLC", during the protective operation, it can sound an external alarm buzzer.

(e) If power source is 230V, connect a terminal ℓ1–ℓ23.
If power source is 208V, connect a terminal ℓ1–ℓ20.

(f) The operation of start and – stop is possible by electromagnetic contactor MC, it is recommended to avoid frequent operation of start and stop actuated by excitation and extinction of MC coil. If not, the life time of inverter might be shorten.
In this case, it is recommended to provide sequence with which ON-OFF control is possible between the terminal "F" or "R" and CC in the control circuit.

(g) Inverters with capacity 28 kVA or more have a self-contains non-fuseable breaker for the inverter protection.

(h) As shown in Fig. 7-2 below, control power source is obtainable; not from the primary side of the MC, but from the secondary side; thereby it is possible to switch on and off main power source and control power source simultaneously. Operation in this manner can cause the inverter protective function to operate. If this happen reset the inverter.

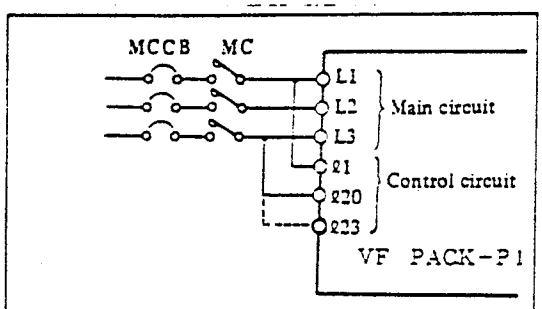


Fig. 7-2 Simultaneous Switching On and Off in Main Circuit and Control Circuit

7—1 Power Source Circuit (2)

(h) In case electromagnetic contactor MC is not used in power source circuitry, as shown in Fig. 7-3 below, connect power source with main power source terminals L1, L2 and L3, as well as with control power source terminals ℓ1 and ℓ3, through non-fuseable breaker MCCB.

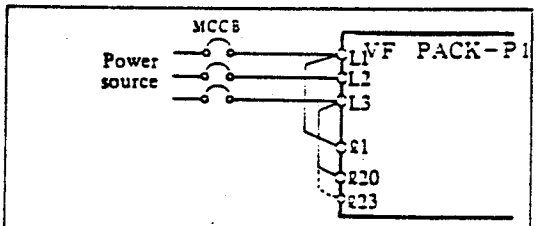


Fig. 7-3 In Case Electromagnetic MC is Not Used

(Note) Be careful that this circuit cannot shut off the main power source in protective operation.
If MCCB is not switched OFF, the power source continues to be applied to PACK-P1. Therefore, pay close attention at maintenance.

(2) 460V – class
The connection between 460V-class VF PACK-P1 and power source is shown in Fig. 7-4 and Fig. 7-5 below respectively.
As for Fig. 7-4, power source for operation circuit adopts 115V; as for Fig. 7-5, it adopts 460V.

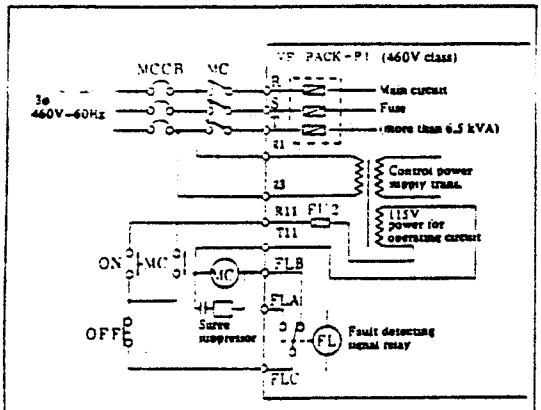


Fig. 7-4 Power Source Circuit (In the case of 115V Power Source for Operation Circuit)

(a) The 115V power source for operation circuit is built in inverter.
Connect terminals R11 and T11 with operation circuit.

(b) Since 115V power source for operation circuit is restricted in capacity, it's possible to operate only one MC (equivalent to C-10). Therefore, if other relays which need more capacity to be excited should be used, prepare another power source.

(c) Other connections should be referred to specifications of 115V—class.

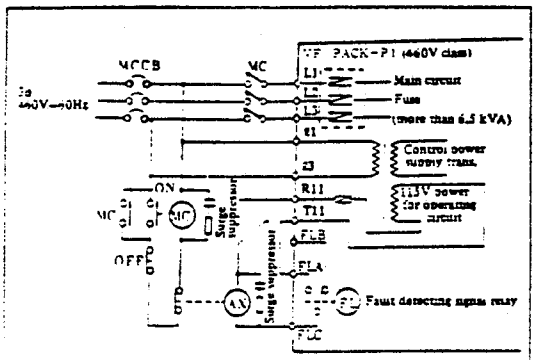


Fig. 7-5 Power Source Circuit (In the case of 460V power source for operation circuit)

(d) Actually, operation circuit is composed of 460V power source. But, fault detecting signal relay (FL relay) is featured by exclusive use with 115V circuit.
Accordingly, the relay should connect with 460V operation circuit by auxiliary relay AX (equivalent to C-10).

(e) Since 115V power source for operation circuit is restricted in capacity through which only one MC (applicable MC described in Item 8.1 below) can be driven, prepare another power source in case of lacking in capacity to drive other relays.

7–2 Motor Circuit (1)

(1) In case one motor is connected:
The connection between inverter and motor is shown in Fig. 7-6 below.

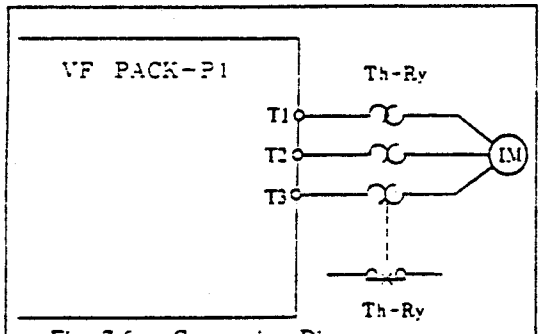


Fig. 7-6 Connection Diagram (In case one motor is used)

(a) Connect output terminals T1, T2, and T3 with motor.

(b) VF PACK-P1 has a built-in electronic thermal relay circuit.
If motor is the motor applicable for inverter capacity, it is not required to provide the overload relay (Th – Ty).
On the other hand, if applied motor is not the one specified for inverter, it is required to provide overload relay (Th – Ry) as shown in Fig. 7-6.

(Note 1) Overload relay (Th – Ry) should be selected depending upon the motor rated current (as indicated on the nameplate). Actually, adjust the operating value depending upon the allowable current characteristics during inverter operation.

(Note 2) Since the cooling efficiency of standard motor at low-speed operation decreases, it is required to reduce the loaded torque.
In proportion to the decrease of r.p.m., the allowable current will decrease. This means that protection is impossible even though an overload relay is used.
In this case, it is recommended to use a motor provided with a housed-in type thermal relay in the motor winding coil.

(c) In case overload relay (Th – Ry) is used, compose a circuit so that electromagnetic contactor MC in the main circuit can be cut off through overload signal.
(Also, refer to standard connection diagram)

(2) In case multipleable motors are used

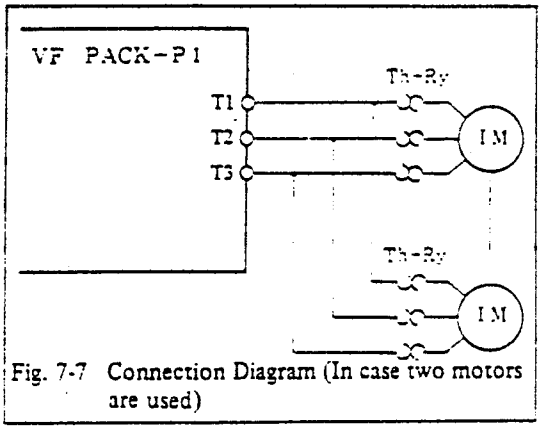


Fig. 7-7 Connection Diagram (In case two motors are used)

(a) This is the method to start, operate and stop by connecting multipleable motors in parallel with inverter.
The total of all motor full load currents is equal to the output current of inverter.

(b) Procure inverter capacity in accordance with the capacity selecting method given in Item 4.

(c) Select the overload relay (Th – Ry) which is suitable for motor rating. Then, insert one by one to the respective motor circuit.

(Note 1) Each motor is applied with the same voltage and frequency. But, acceleration, and deceleration are different depending upon the kind of motor, load torque, load WK^2 and other conditions.
Whenever the protective circuit is operated during starting or stopping set the acceleration and deceleration time to the longest setting.

(3) In case switchover of the operating motor is required:

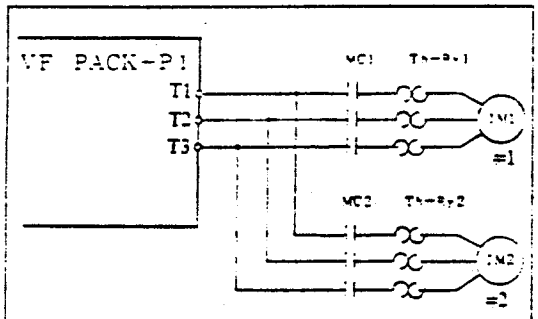


Fig. 7-8 Connection Diagram In Case Rotating Motor is Switched

(a) This is a servicing method in which the operation is selectable from rotating motor #1 to the stand by motor #2.

(b) Because the operation of the motor is restricted to only one motor as a time the inverter capacity is selected for only one motor application.

(c) Install an overload relay (Th – Ry) which is suitable for the motor rating to each motor circuit.

(d) In case it is required to switchover the motor operation from IM1 to IM2, firstly, switch off operation signal, of inverter set output frequency to "0", set MC1 to "OFF" and set MC2 to "ON".

(4) In case several motors are additionally started up during operation.

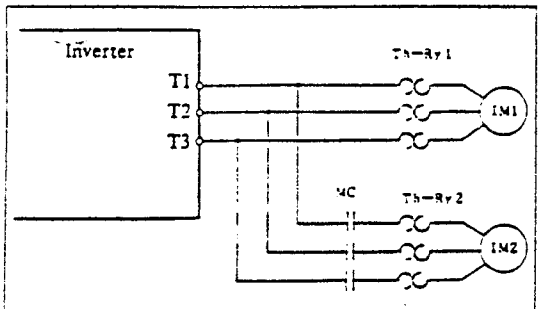


Fig. 7-9 Connection Diagram In Case Additional Motor is Started During Operation

(a) This is a method in which one or more motors are operating through an inverter, additionally one or more motors are operated.

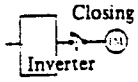
(b) Actually, motor current is flowing in the inverter output during operation.
Then, by adding one or more motors, starting current will flow in the inverter output.
Therefore, suitable inverter capacity should be selected referring to the method of selecting capacity specified in Item 4.

(c) Install an overload relay (Th – Ry) which is suitable for motor rating to each motor circuit.

(5) Closing/interrupting of motor circuit
As a rule, prohibit providing electromagnetic contactor between inverter and motor, closing, and interrupting of motor circuit during motor operation. Inverter may start up from 0.5 Hz. This means that a great current does not flow at start-up. On the contrary, if electromagnetic contactor MC is closed, while inverter is driven a larger starting current will flow resulting in a fault on the inverter.
But, as mentioned in case several motor are additionally started up during the operation, the selection of inverter is carried out in accordance with the requirements given in Chapter 4 (Selection of Capacity).

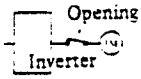
(a) Closing motor circuit

Motor / Inverter	Stop condition	During coast stop
In stop	Possible to close (This operation is recommended.)	Possible to close (In inverter starting, Motor must be stopped.)
In operation	Possible to close (Big starting current flows, as the same at direct starting. It is necessary to select carefully inverter capacity.)	Impossible to close



(b) Opening motor circuit

Motor / Inverter	Stop condition	During coast stop	In inverter operation
In stop	Possible to open (This operation is recommended)	Possible to open	
In operation			Possible to open

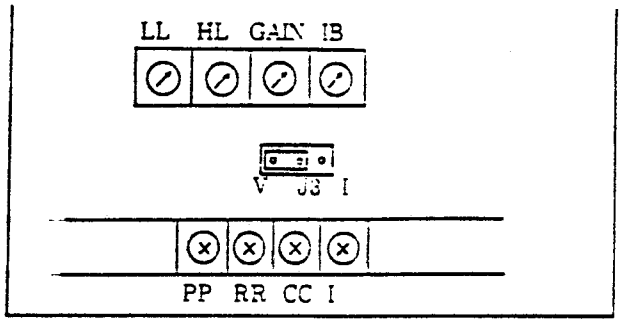


(Note) Whenever it is required to switch over from driving by commercial power source to driving by inverter, inverter may be closed during motor coasting.
In this case, it is recommended to use Commercial power source selector changeover as is option.

7–3 Frequency Command (1)

The VF PACK-P1 accepts to input 0 ~ 10V DC, 0 ~ 5V DC and 4 ~ 20 DC mA signals as frequency setting signals.

Interfaces and usage are slightly different depending upon frequency setting signals.



Signal level	DC 0 ~ 10 V	DC 0 ~ 5 V	DC 4 ~ 20 mA
Connection	PP RR CC, FRH, RR (+) CC (−), 0 ~ 10V	CC (−), 0 ~ 5V, I (+)	CC (−), 4 ~ 20 mA, I (+)
Jumper pin J3	V side	V side	V side
Adjustable functions	LL (Lower limit) HL (Upper Limit) GAIN (Gain)	LL (Lower Limit) HL (Upper Limit) GAIN (Gain)	LL (Lower Limit) HL (Upper Limit) GAIN (Gain) IB (Bias)

1. In case of 0 ~ 10V DC signal:
   (1) By setting device:
   As for operation panel type, a frequency setting device is provided on inverter unit, through which requested frequency can be set up.
   In case operation panel is not provided, use operation box provided as option of VF PACK-P1, or newly install an external frequency setting device.

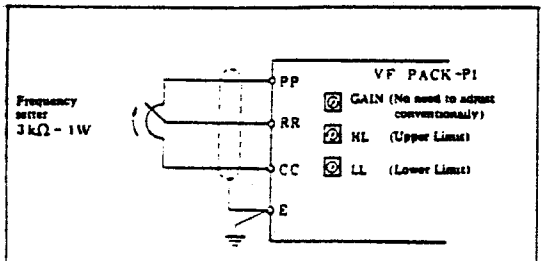


Fig. 7-10 Frequency Command (Setting device)

   a. Reference power source represented by +10V DC voltage is supplied across terminals PP – CC.
   When 0 to +10V DC voltage is applied across terminals RR – CC, output 0 to 80 Hz is obtainable. In this case, the maximum frequency is set to 63 Hz at shipment. For that purpose, as shown in Fig. 7-11 below, adjusting allowance of setting device exists in the range of 60 to 80 Hz.

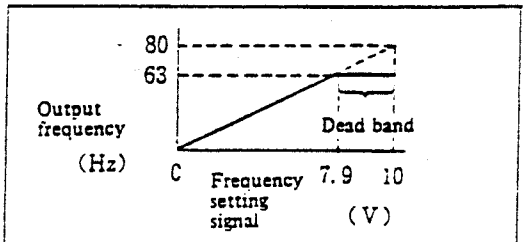


Fig. 7-11 Conditions at Shipment

7–3 Frequency Command (2)

b. Frequency setting device is standardized to 3 kΩ ~ 1W or more.
But, resistance value within the range of 1 ~ 5 kΩ. In this case, it is required to adjust "GAIN", which is variable resistor provided in inverter.

Recommended device:
Model RV30YN-B3 kΩ – 1W
(manufactured by TOKYO COSMOS ELECTRIC)

c. Electric wiring should be 3-core integrated shielding wire. Connect shielding portion with grounding terminal E.
d. Input impedance is 50 kΩ at the input terminal "RR" of frequency setting signal.
e. Adjustment of frequency setting device at shipment is as shown below:

GAIN adjustment . . . Gain: one-time (applicable to 0 ~ 80 Hz through 0 ~ 10V signals)
HL adjustment . . . . . Upper limit: 80 Hz (adjustable from 5 to 80 Hz)
LL adjustment . . . . . Lower limit: 0 Hz (adjustable from 0 to 75 Hz)

(Note) It is not necessary for user to adjust IB (bias).

7—3 Frequency Command (3)

(2) In case of external voltage signal (0 ~ 10V)

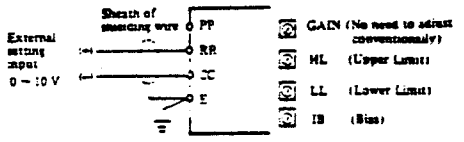


Fig. 7-12 External Voltage Signal (0 ~ 10V)

a. According input 0 ~ 10V between terminals RR – CC., output frequency 0 ~ 80 Hz is obtainable. But, maximum frequency is set to 63 Hz at shipment. As a result, as shown in Fig. 7.11, adjusting allowance of frequency setting device exists in the range of 60 to 80 Hz.
b. Electric wiring should be 2-core integrated shield wire. Connect shielding portion with terminal E.
c. IB (bias) is adjusted to bias "zero" at shipment. Depending upon usage, the bias adjustment is possible.

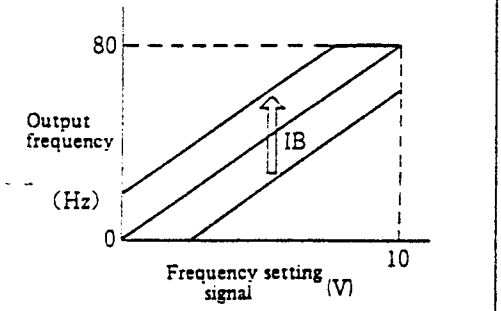


Fig. 7-13 Frequency Signal (V)

d. When the following sequence is applied, IB (bias) cannot be adjusted.

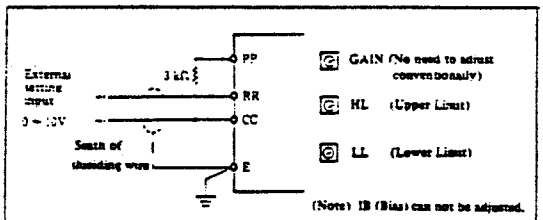


Fig. 7-14 External Voltage Signal (0 ~ 10V)

Whenever connecting terminals between PP–CC with 3 kΩ resistance, the adjustable function of IB (bias) may be eliminated. If any bias function is not required, adopt this sequence method.

e. Electric wiring should be 2-core integrated shielding wire. Connect shielding portion with terminal E.
f. The input impedance is 100 kΩ at the input terminal "RR" of frequency setting signal.
g. Adjustment of frequency setting device at shipment is as shown below:

GAIN adjustment . . .	Gain: one-time (applicable to 0 ~ 63(80) Hz Maximum through 0 ~ 10V signals)
HL adjustment	Upper limit: 80 Hz (adjustable from 5 to 80 Hz)
LL adjustment	Lower limit: 0 Hz (adjustable from 0 to 75 Hz)
IB adjustment	Bias 0 (adjustable according to the circuit shown in Fig. 7.12; but not adjustable according to the circuit shown in Fig. 7-14).

7–3 Frequency Command (4)

(3) Multipleable frequency setting potentiometers

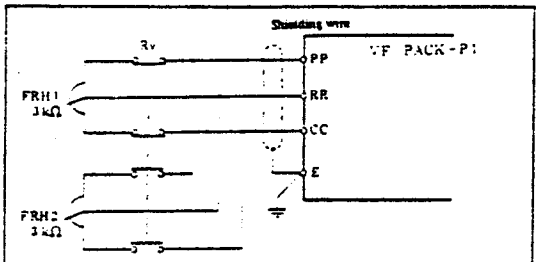


Fig. 7-15 Switching of frequency potentiometer

a. By providing two or more frequency setting devices, various kinds of frequency may be set up, which is actually serviced through a relay or switch.
b. A resistor for frequency pot should be 3 kΩ, of which capacity should be 1W or more. Both frequency pot should be same value.
c. Switching relay (Ry) provided for changing over frequency setting device should be relay with micro-current contacts, in which 10V DC – 3 or – 4 mA of current flows, while 10V DC voltage is applied.

Recommended relay (Ry)

Manufactured by TEC
Model MPM4P100
Available operating coil: 6/12/24/48/120/240 VAC – 50/60 Hz
6/12/24/32/48/120 VDC
Contacting section:
Continuous flowing current: 3 A
Contact configuration: 4C
Accessories:
Exclusive socket of plug-in and square

(Note) In order to prevent the contacts abnormality of relay (Ry) for changeover of frequency setting device, the contacts of Ry should be inserted in the both side of terminal "PP" and "CC".

(4) As a rule, 3 kΩ resistor is standardized as frequency setting device. But resistors are acceptable within the range of 2 k to 5 k ohms. If any other value of resistance should be adopted instead of 3kΩ, the adjustment of GAIN reoshat will be required.

7–3 Frequency Command (5)

2. In case of 0 ~ 5V DC signal:

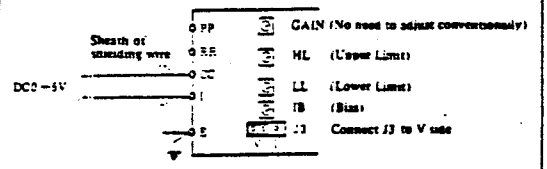


Fig. 7-16 External Voltage Signal (DC0 ~ 5V)

(1) By applying 0 ~ 5V DC signal between terminals I–CC, 0 to -80 Hz is obtainable as output frequency. But. output frequency is restricted to 63 Hz at shipment.

(2) Change the position of jumper pin J3 from I-side to V-side (I-side is set at shipment.)

(3) IB (bias) adjustment can be increased to both negative and positive side.
But. bias is set to "zero" at shipment.

(4) Electric wiring should be 2-core integrated shield wire. Connect shielding portion with terminal E.

(5) The input impedance at the current input terminal "I" is 240Ω.

(6) Adjustment of variable rheostats at shipment is as shown below:
GAIN adjustment . . . Gain: one-time
HL adjustment . . . . . Upper limit: 80 Hz
LL adjustment . . . . . Lower limit: 0 Hz
IB adjustment . . . . . Bias 0
J3 jumber pin - I-side
(Note) IB (bias) can not be adjusted.

3. 4-20 ma Current signal
Current signal, 4 ~ 20 mA is used for the frequency setting, which is shown in Fig. 7-17 below.

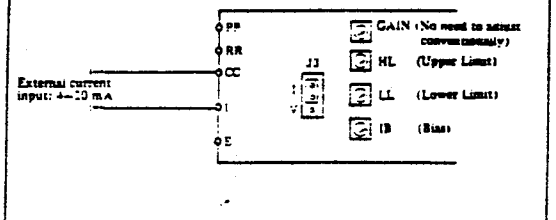


Fig. 7-17 External Current Signal (4 ~ 20 mA)

(1) Set jumper pin (J3) to I side (shipping condition).
(2) Current signal input is set as follows:
Terminal I . . . . . (+) side
Terminal CC . . . . . (–) side
(3) Since 240Ω resistor is connected across terminals I – CC, the terminal voltage applied between terminal I–CC is:
When the input is 4 mA:
4 mA x 240Ω = 0.96V
When the input is 20 mA:
20 mA x 240Ω = 4.8V
But, inside of inverter, voltage value is biased and amplified about twice as much as the input value. This means that frequency command has been converted to 0 ~ 10V inside of inverter.

(4) If required, adjust IB (bias) and GAIN inside inverter.
In the course of IB adjustment, when input is 4 mA, output frequency shows 0 Hz. This relationship is shown in Fig. 7-18.

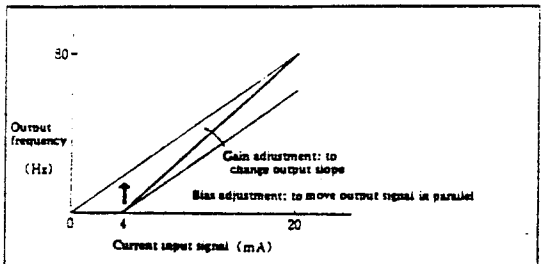


Fig. 7-18 Relationship between Current Input Signal and Output Frequency

(5) The adjustment at shipment and adjustable range of variable rheostats is as shown below:
GAIN adjustment . . . Gain: one-time (0.5 ~ 10 times)
HL adjustment . . . . . Upper limit: 80 Hz (adjustable within the range of 5 ~ 80 Hz)
LL adjustment . . . . . Lower limit: 0 Hz (adjustable within the range of 0 ~ 75 Hz)
IB adjustment . . . . . Bias 0 (adjustable within the range of 0 ~ ±4.5V)

4. In case of changeover between voltage and current signals
   (1) In case of frequency setting device and external current signal

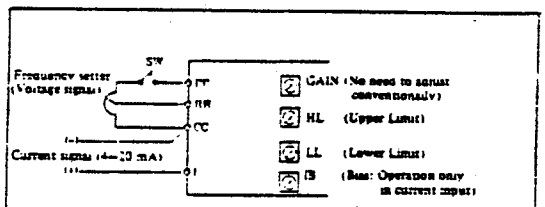


Fig. 7-19 Switching between voltage and current

By using frequency setting device, voltage signal input is changed over to external current signal, and vice versa. Thus a MANUAL/AUTOMATIC operation is obtainable.
In this case, switch or relay should be provided between the terminals PP–CC through frequency setting device.

SW	Operation
Closed condition	Voltage input is operated with priority. Inverter operated with frequency setter.
Opened condition	Current input is operated with priority. Inverter operates with external current input.

(Note)
a. Install switch or relay between the terminals PP and the frequency setting device.
   If switch is installed between the terminals RR–CC, switching is impossible.
b. Whenever voltage signal and current signal are input simultaneously, the voltage signal will take precedence over others inputs.
c. The voltage signal is 0 ~ 10V DC.
   The switching between 0 ~ 5V DC voltage signal and 4 ~ 20 mA current signal is not possible.
d. Gain, upper and lower limit function can adjust their voltage signals and current signals.
   The bias function is adjustable only for current signal.
   Respective adjustment are as shown in the above items.

(2) In case both voltage and current signals are given from external devices

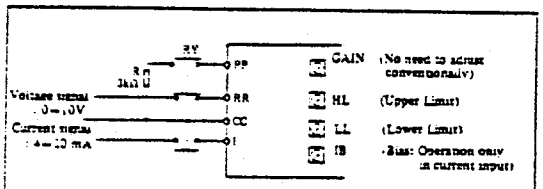


Fig. 7-20 Switching between voltage/current Signal

Switching between external voltage signal and external current signal should be conducted with a relay (RY). In this case, connect a 3 kΩ fixed resistor between terminals PP–CC. Other cautions are the same as Item (1).
Furthermore, never use the sequence as shown in Fig. 7-21.

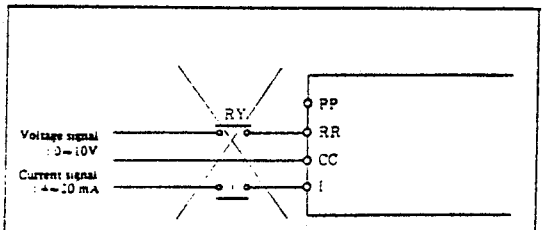


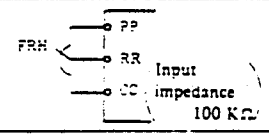
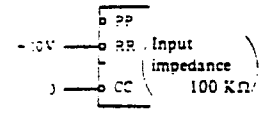
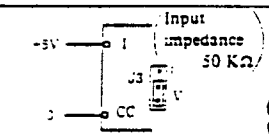
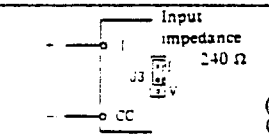
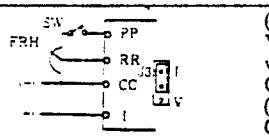
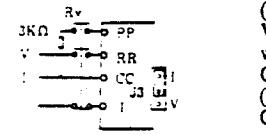
Fig. 7-21 Switching between voltage and current signal (Prohibitation Item)

7—3 Frequency Command (8)

5. Summary of frequency setting signals

The above mentioned various kinds of signal are summarized in Table 7-1 below:

Table 7-1 Frequency Setting Signals

External Signal	Connection Method	Adjustable function
Frequency setter (FRH) individually settable	 (Note) FRH can be used at the range of 2 to 5 KΩ – 1W. Standard is 3 kΩ.	Upper limit (HL) Lower limit (LL) Gain (GAIN) (Note) Bias adjustment does not not function.
External voltage signal (0 ~ 10V)	 (Note) Never connect PP terminal.	HL LL GAIN IB (Bias) Bias adjustment can be obtained. It is adjusted 0 at shipment.
External voltage signal (0 ~ 5V)	 (Note) Connected jumper pin J3 to V side.	ditto
External current signal (4 ~ 20mA)	 (Note) Connect jumper pin J3 to I side.	ditto
Voltage/ Current signal (I) (Changeover)	 (Note 1) Voltage input is operated with priority when SW is switched on. Current input functions with SW off. (Note 2) Connect J3 to I side.	In SW – ON HL, LL, GAIN, In SW – OFF HL, LL, GAIN, IB
Voltage/ Current signal (II) (Changeover)	 (Note 1) Voltage input is operated with priority when RY is switched on. Current input functions with RY off. (Note 2) Connect J3 to I side.	In Ry – ON HL, LL, GAIN In Ry – OFF HL, LL, GAIN, IB

(Note 1) Status of each adjustable rheostat at shipment and adjustable range:
- HL (80 Hz at shipment: 5 to 80 Hz in adjustable range)
- LL (0 Hz at shipment: 0 to 75 Hz in adjustable range)
- GAIN (One-time at shipment: 0.5 to 10 times in adjustable range)
- IB (0 at shipment: 0 to ±4.5 V in adjustable range)

(Note 2) FRH is acceptable within the range of 2 – 5 kΩ, but, when other devices (other than 3 kΩ) are used. GAIN adjustment will be required.

(Note 3) The input impedance is as follows:
- 0 to 10 V input (100 kΩ)
- 0 to 5 V input (50 kΩ)
- 4 to 20 mA (240 Ω)

7–3 Frequency Command (9)

The relationship between frequency setting signal and output frequency is shown in the below figure.

A. In case of voltage signal:

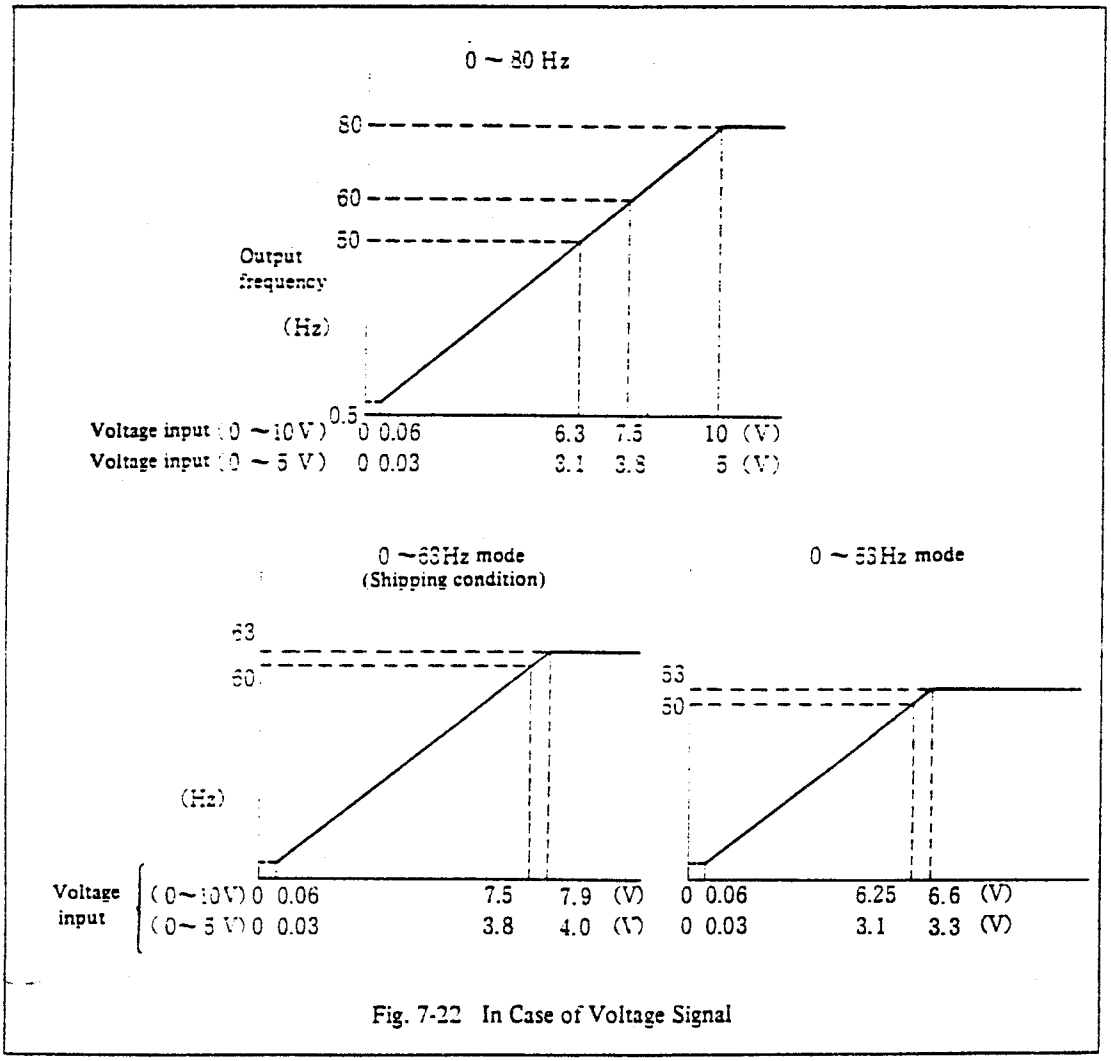


Fig. 7-22 In Case of Voltage Signal

(1) Frequency setting signal is proportional to output frequency.

(2) In the mode of 0 ~ 63 Hz and 0 ~ 53 Hz, it is clamped at more than 63 Hz and 53 Hz respectively. In case frequency setting signal is transmitted by frequency setting rheostat (FRH), signals which are more than 63 Hz and 53 Hz respectively become free and the frequency will not increase even though the control knob is turned to the increasing direction.

(3) In frequency expanding mode (0 ~ 160 Hz), output frequency shown in the above figure doubles respectively. (In the above figure, the scale of vertical axis becomes double.)

B. In case of current input:

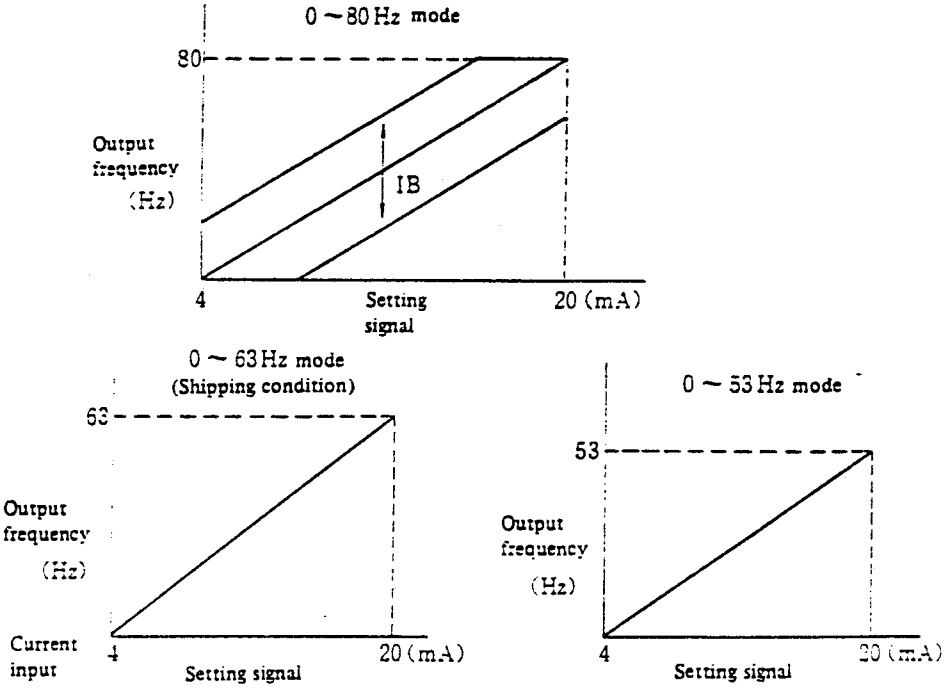


Fig. 7-23 In Case of Current Signal

(1) In setting shown above, GAIN and BIAS adjustment are required.
(2) Frequency setting signal is proportional to the output frequency.
(3) Set internal jumper pin (J3) to the I-side.

7—4 Operation Preparation, Start and Stop

1. Safety interlock of operation

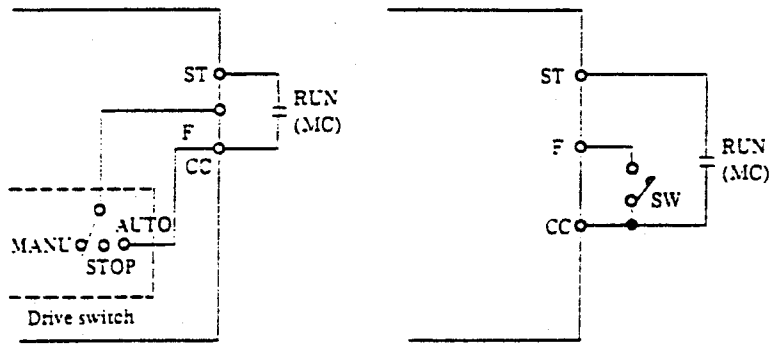


Fig. 7-24 Stand by Operation, Start and Stop

When circuit represented by terminals ST–CC is closed by the relay "RUN", the safety interlock operation is ready. In stead of relay "RUN", auxiliary a-contact in electromagnetic contactor "MC", which is used in power source circuit, may be serviceable.

2. Start
   (1) In case of inverter with operation panel:
   A drive switch is connected internally with the terminals F–CC.
   Whenever drive switch is switched on "MANU" side or "AUTO" inverter starts to drive.
   (2) In case inverter without operation panel:
   When switch (SW) or a contact of relay is connected with terminals F–CC, the system is energized by actuating the switch.

3. Stop
   (1) Braking stop
   In case it is required to stop inverter by deceleration time setting (according to the digital switch "DEC", take the following actions:
   When drive switch is set to the "STOP"-side, or switch off external switch (SW), braking stop is executable.
   (2) Coast stop
   In case it is required to conduct coast stop, make a contact of relay (RUN) or relay (MC) provided between the terminals ST–CC opened.

The relationship of operation mentioned above is shown as time chart in Fig. 7-25.

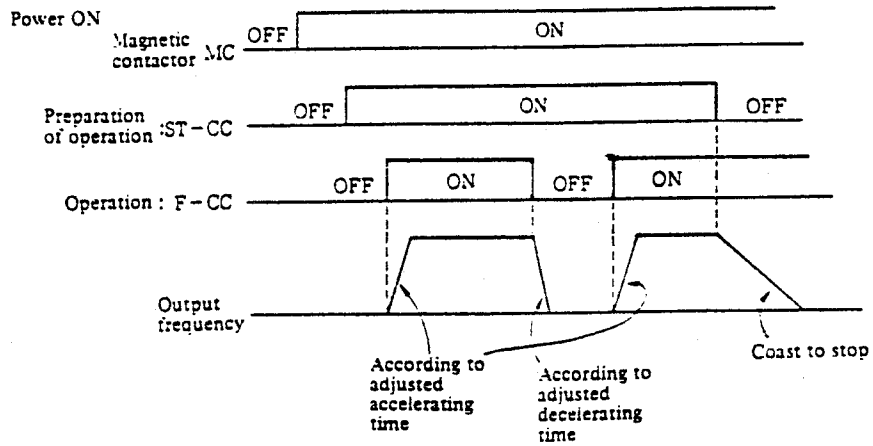
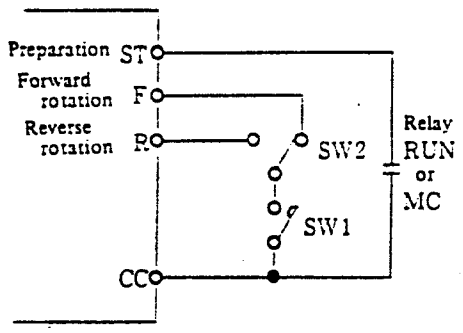
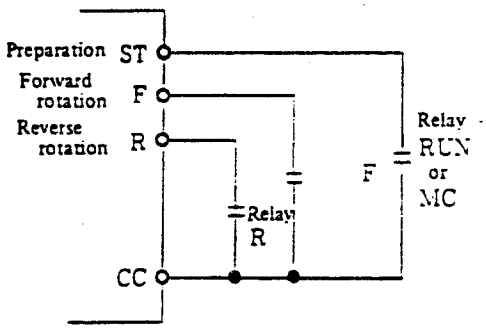


Fig. 25 Stand by of Operation, Start, and Stop

7–5 Forward and Reverse Rotation



(a) Changeover by switch

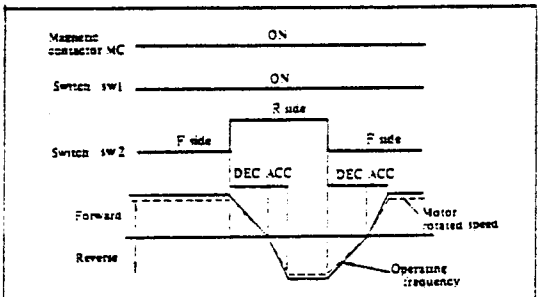


(b) Changeover by relay

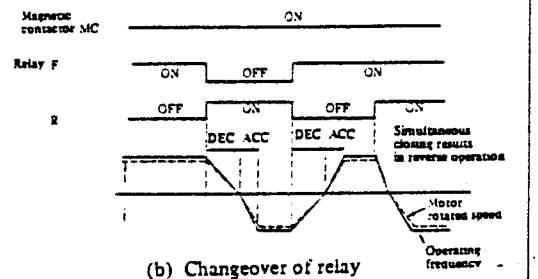
Fig. 7-26 Forward and Reverse Rotation

1. When terminals F–CC are closed, forward rotation is obtainable: when terminals R–CC are closed. reverse rotation is obtainable.
   Moreover, when terminals F–CC and R–CC are closed simultaneously, the signal applied to terminals R–CC takes precedence over others, and thus. reverse rotation is obtainable.

2. During forward rotation. if terminals R–CC are closed, and thus, reverse command is issued, motor will automatically operates as follows:
   Decelerate forward rotation deceleration – Exchange phase sequence – Accelerate reverse rotation.
   On the other hand, if forward rotation command is issued after reverse rotation command, motor will automatically operates as follows:
   Decelerate reverse rotation → Exchange phase sequence – Accelerate forward rotation.



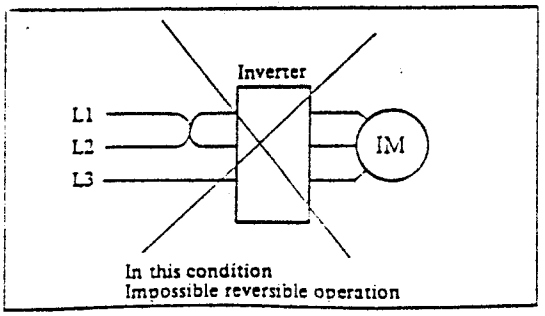
(a) Changeover by switch



(b) Changeover of relay

Fig. 7-27 Reversible Operation

(Note) Among 3 phases in the input side, if two phase connections are exchanged, reverse rotation is not obtainable. Moreover, among phases in the output side, if two phase connections are exchanged, the reverse revolution is obtainable.



7–6 Jogging Operation (1)

Jogging operation is obtainable by composing the circuitry as described in the following Items 1–2. The frequency in jogging operation is standardized to 6 Hz fixed. As option, the frequency is variable within the range of 1 to 15 Hz (by 1 Hz step).

1. Jogging operation 1

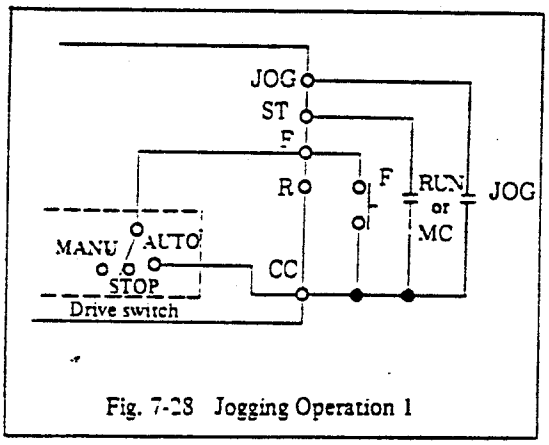


Fig. 7-28 Jogging Operation 1

(1) Set frequency setting signal to zero.
(2) As for inverter with operation panel, surely set drive switch to the "STOP" side.
(3) When the Terminals JOG–CC are closed, jogging mode can be set up.
(4) Provide push-button switch "F" between terminals F–CC.
By depressing the push-button switch under to status of "ON" or "OFF", 6 Hz (fixed) jogging operation is obtainable. Whenever the push-button switch is set to "ON", acceleration at the minimum time is obtainable; by setting to OFF, deceleration at minimum time is obtainable.
In this case, minimum time is automatically set regardless of the acceleration/deceleration time setting (ACC/DEC setting).
(5) When jogging of reverse rotation is required, provide a push-button switch between the terminals R–CC instead of terminals F–CC.

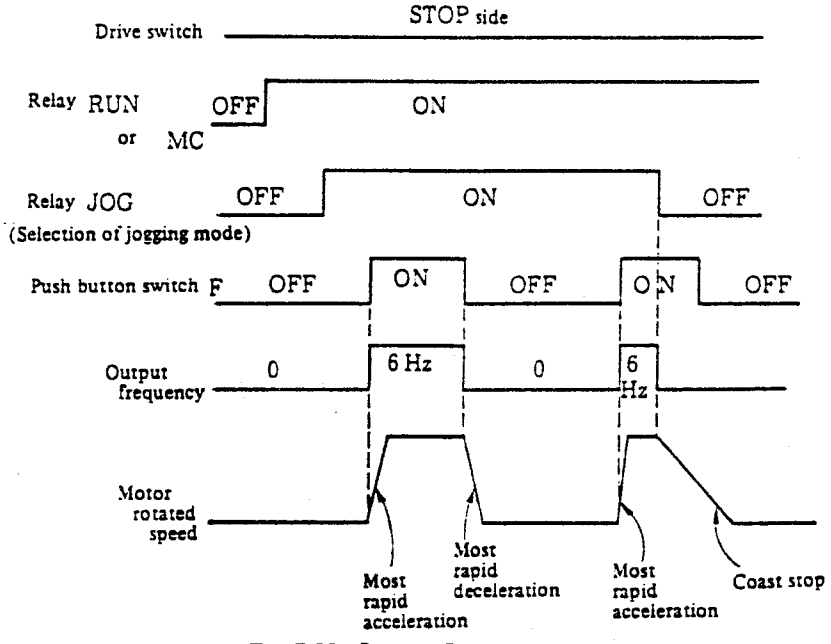


Fig. 7-29 Jogging Operation

7–6 Jogging Operation (2)

2. Jogging Operation 2

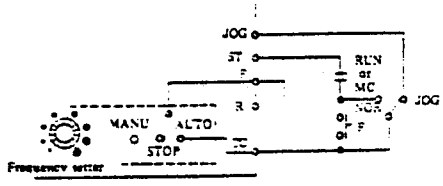


Fig. 7-30 Jogging Operation (2)

As shown in Fig. 7-30 above, jogging operation is obtainable by composing circuitry which is switched over with normal operation.

(1) As for inverter with operation panel, set drive switch to the "STOP" side.

(2) Make a short-circuit between terminals F–CC.

(3) Provide relay "RUN" or "MC" and push-button switch "F" between terminals ST–CC.

(4) When the changeover switch of jogging and normal operation is set to the "JOG" side, the jogging operation mode is obtainable.

(5) By actuating monantary push-button under the status of "ON" and "OFF", 6 Hz (fixed) jogging operation is obtainable.
Whenever the monitary push-button is set to "ON", acceleration at the minimum time is obtainable; by setting to "OFF", deceleration at the minimum time is obtainable.
In this case, minimum time is automatically set regardless of the acceleration/deceleration time setting (ACC/DEC setting).

(6) When jogging under reverse rotation is required, provide push-button switch between terminals R–CC instead of terminals F–CC.

(7) When the changeover switch of jogging and normal operation is set to the "NOR" side, normal operation is obtainable.

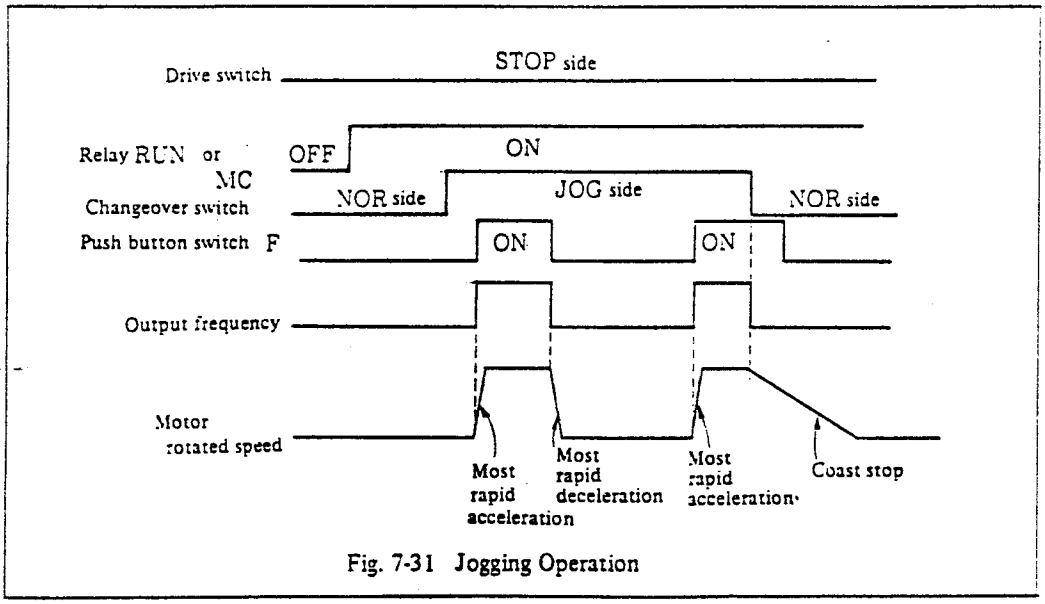


Fig. 7-31 Jogging Operation

(Note) In the state that the frequency setting signal is input, the inverter will start at the acceleration time set by adjustable rheostat "ACC".
Be careful that the overcurrent protection are available depending upon the load condition.

7–7 Low Speed Signal

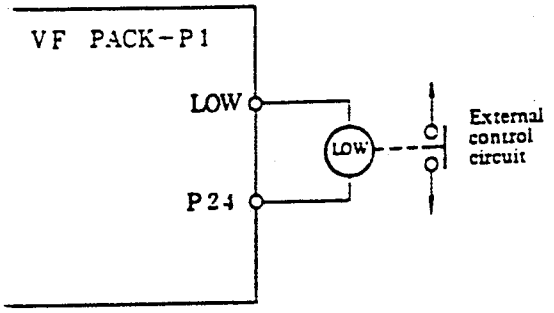


Fig. 7-32 Connection of Low Speed Signal

VF PACK-P1 can obtain low speed signal by composing the circuitry as shown in Fig. 7-32.

1. By connecting 24V DC relay with the terminals LOW-P24, the relay "ON" signals are obtainable at more than minimum frequency (0.5 Hz fixed.)
   (Variable frequency is also obtainable through option.)
2. The relay which will be connected between the terminals LOW-24 should be lower capacity than the following:

   Coil rating:
   24V D-Max 50 mA or less
   Recommended relay:
   Operating coil: 24V DC
   Contactor : 220/440V AC – 2A/1A
   (Induced load COS ϕ = 0.4)
3. Timing chart of detecting low-speed signal (detection) is shown in Fig. 7-33.

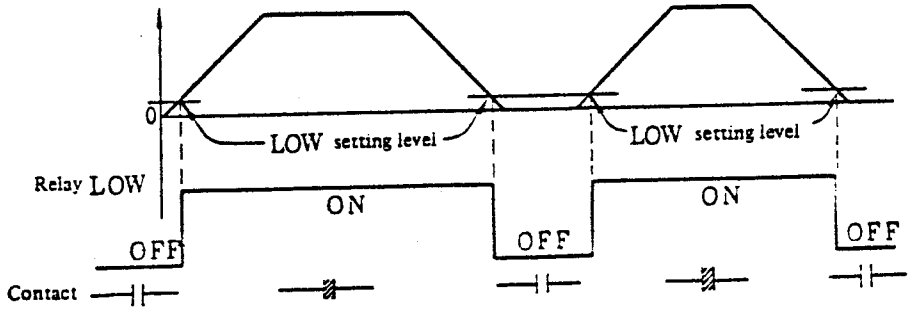


Fig. 7-33 Operation of Low Speed Signal

7–8 2 Step Speed Operation

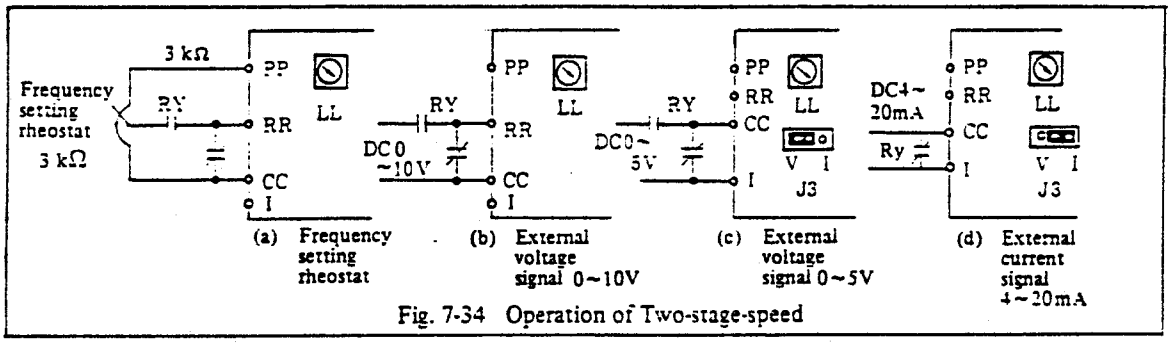


Fig. 7-34 Operation of Two-stage-speed

Two-stage-speed operation which consists of high-speed and low-speed is easily obtainable.

High-speed command can be issued through frequency setting rheostat or external voltage signal input. The low-speed command can be issued through adjusting variable rheostat "LL" built in inverter by changing over relay (RY) externally.

1. Relay "RY" OFF: High-speed command through external signal
   Relay (RY) ON: Low-speed command through internal variable rheostat "LL"
2. The adjustable range of the variable rheostat "LL" is 0.5 to 75 Hz.
3. It is recommended to use relay (RY) with 1a and 1b contact for micro-current.
   Recommended relay:
   Operating coil: 6/12/24/48/120/240VAC – 50/60 Hz
   6/12/24/32/48/120 VDC
4. In case external signals are 0 ~ 10V, 0 ~ 5V and 4 ~ 20 mA. pay attention to bias "IB". When bias adjusting value shows more than that of "LL", low-speed depends on the bias adjusting value.

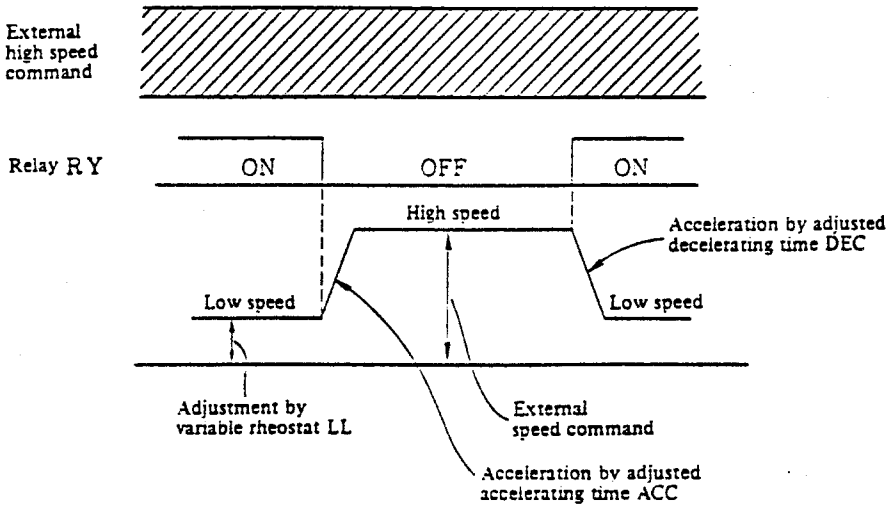


Fig. 7-35 Two-stage Speed Operation

7–9 Frequency Meter

1. Frequency meter built in inverter body
   (1) Digital frequency meter is provided to both inverters with operation panel and without operation panel.
   (2) Frequency setting is possible through the following steps. But, digital frequency meter has 3 digits display (LED).
   (3) As option, operation box (Model: CBF-7B) is provided to remote control digital display. In this case, the wiring distance should be within 1 m.

Max. free	Frequency setting	Digital frequency display
80 Hz	0.025 Hz step	0.1 Hz step
160 Hz	0.05 Hz step	1 Hz step

(Note) Display is rounded off below the step in the above table.

2. External frequency meter

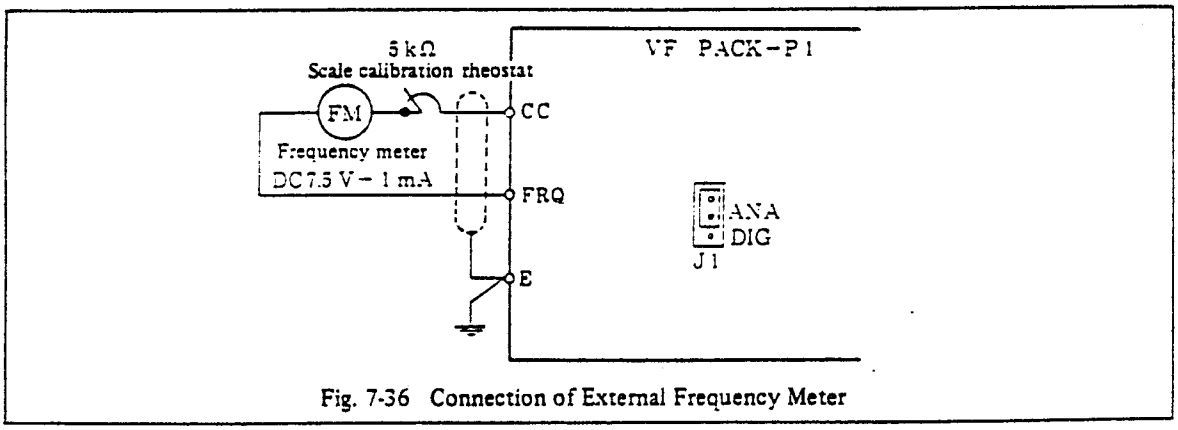


Fig. 7-36 Connection of External Frequency Meter

(1) Inverter outputs analog frequency output which is simultaneously indicated on an analog frequency meter apart from the digital frequency meter. This means that analog frequency meter can be externally installed in parallel to digital frequency meter. (Analog frequency meter is featured by a movable pointer).
(2) In case frequency meter is equipped externally, connect frequency meter and variable rheostat for meter calibration in series. Then, they should be connected with terminals CC–FRQ. (Ref. Fig. 7-36)
(3) Set jumper pin (J1) equipped on the PWB (printed wired board) to "ANA" (This stands for "Analog output") side. At shipment, it is set to the ANA side.
(4) Frequency meter should be 7.5 VDC, –1 mA at full scale.
(5) The scaling of indication should be adjusted through variable rheostat for scale calibration. The resistance should be specified as 5 kΩ ~ 0.3 W or more.
    Recommended resistance:
    Model RV24YL-B5 kΩ
(6) Electric wiring should be 2-core integrated shield wire. The shield should be connected with terminal E.
(7) In case operation box (option) is used, set jumper pin (J1) provided on the PWB to the "DIG" side.
    In this case, pulse output of which frequency is equal to 96 times as large as output frequency.

7—10 Current Meter

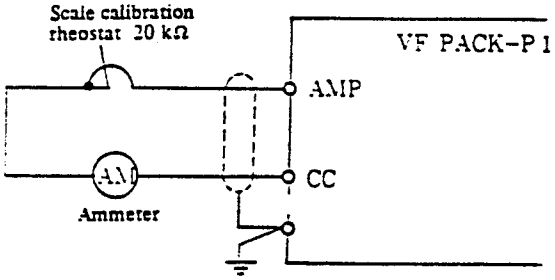


Fig. 7-37 Connection of External Ammeter

1. VF PACK-P1 can monitor motor current.
2. As shown in Fig. 7-37, connect an ammeter with the variable rheostat for meter calibration in series. They are then connected with terminals AMP–CC.
3. The ammeter should be 10 VDC, −1 mA voltmeter at full-scale. In this case, 5V output will be obtainable through the inverter rated current.
4. The scale adjustment should be conducted through the variable rheostat for scale calibration.
   The specified rheostat should be 20 kΩ ~ 0.25W or more.

   Recommended resistance:
   Model RV24YL-B20 kΩ
5. The electric wiring should be 2-core integrated shield wire. The shield should be connected wit terminal E.

The relationship between the ammeter output and the motor current is shown in Fig. 7-38.

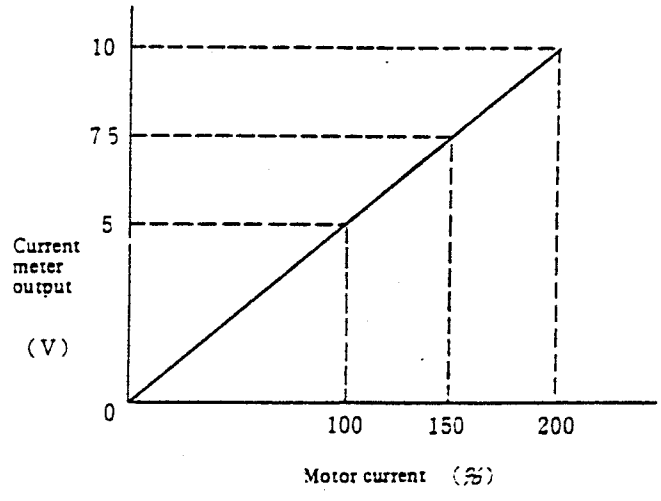


Fig. 7-38 Ammeter Output

7—11 Emergency Signal

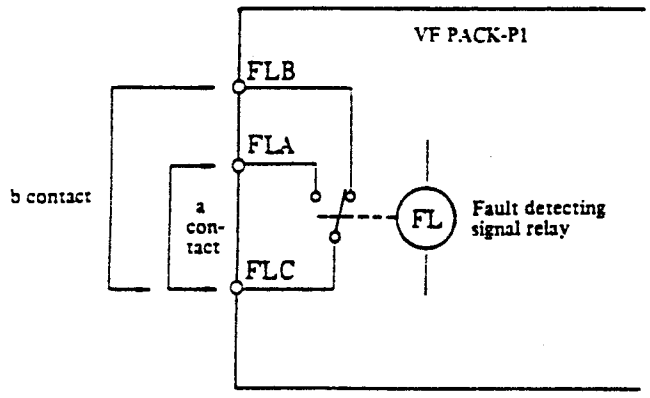


Fig. 7-39 Fault Detecting Signal Relay

(1) In case the protective circuit operates, firstly, the base drive circuit in the main transistor circuitry will be cut off.
Practically at the same time, abnormal command is transmitted to the micro computer (CPU).
As a result, the fault detecting signal "FL" is energized, of which protective causes are displayed on digital frequency meter.
Then, "FL" signal is stemmed from the 1c contact among terminals "FLA", "FLB", and "FLC".

(2) Whenever fault detecting signal relay "FL" is energized, the following abnormalities are recognized:

- Overload ..... "OL"
- Overcurrent or short-circuit ..... "OC"
- Overvoltage ..... "OV"
- Undervoltage ..... "U"
- Overheat ..... "OH"
- Emergency stop ..... "E"

(3) In case sequence is composed at user's side it is required to cut off the main circuit power source instantaneously by actuating fault detecting signal relay.

(4) Relay contacts should be used in 100V or 200V circuit.

7–12 Reset of Relay FL

(1) Whenever protective circuit is operates and fault detecting signal is generated, inverter can not be restarted unless the relay is reset.
In case it is required to reset the relay "FL", switch off the control power source for at least 5 seconds. In case relay (FL) works out again as soon as operation restarts, failure might exist in the inverter. Therefore, do not operate it repeatedly.

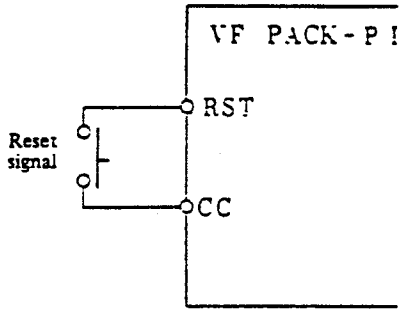


Fig. 7-40 Connection of Reset Push-button Switch

(2) Terminal RST can be utilized so that the control circuit is reset, and restore the operation after the protective functions have been executed and the system is stopped.
The connection of reset push-button switch is shown in Fig. 7-40.
When the terminals RST–CC are closed momentarily reset operates.
Be careful that when the circuit re-closing is conducted without removing troubles, the failure of the system might expand or become intensified.
Especially pay attention to the overcurrent (OC) which might be observed in the circuit.

8. SELECTION OF APPARATUS FOR WIRING

8—1 Selection of Apparatus for Wiring (1)

Table 8-1 shows selectable example of no fuse circuit breaker, electromagnetic contactor, overload relay and surge suppressor.

Table 8-1 (a) Examples of Material for Inverters (230V class)

Inverter TYPE-FORM	Applicable Motor Output (HP/kW)	Electromagnetic Contactor MC	Circuit Breaker CB	Overload Relay Th-Ry	Wiring Size (mm²)			Surge Suppressor
					Main Circuit	Control Circuit	Grounding Wire	
VFP1-2010P.B	0.5/ 0.4	C-20E	MCP0358R-7A	R20E-1.8A	#14	#18	#12	SS-2 (type-form of Toshiba) DCR2-22A25 (type-form of Maycon Electronics)
VFP1-2015P.B	1 / 0.75	C-20E	MCP0358R-7A	R20E-3.6A	#14			
VFP1-2030P.B	2 / 1.5	C-20E	MCP0315R-15A	R20E-6.6A	#12			
VFP1-2040P.B	3 / 2.2	C-20E	MCP0315R-15A	R20E-9.3A	#12			
VFP1-2065P.B	5 / 3.7	C-25E	MCP0330R-30A	R35E-15A	#10			
VFP1-2095P.B	7.5/ 5.5	C-35E	MCP0330R-30A	R35E-22A	#8			
VFP1-2130P.B	10 / 7.5	C-35E	MCP23480R-50A	R35E-28A	#5			
VFP1-2790P.B	15 /11	C-50E	MCP331000R-100A	R65E-43A	#5			
VFP1-2250P.B	20 /15	C-65E	MCP331000R-100A	R65E-57A	#4			
VFP1-2280P.B	25 /18.5	C-100E	MCP331000R-100A	R80E-70A	#2			
VFP1-2340P.B	30 /22	C-180E	MCP331000R-100A	R150E-108A	#1			
VFP1-2460P.B	40 /30	C-180E	MCP431800R-150A	R150E-138A	#2/0			

Table 8-1 (b) Examples of Material for Inverters (460V class)

Inverter TYPE-FORM	Applicable Motor Output (HP/kW)	Electromagnetic Contactor MC	Circuit Breaker CB	Overload Relay Th-Ry	Wiring Size (mm²)			Surge Suppressor
					Main Circuit	Control Circuit	Grounding Wire	
VFP1-4015P.B	1 / 0.75	C-20E	MCP0322R-3A	R20E-1.8A	#14	#18	#12	DCR4-60A55U
VFP1-4030P.B	2 / 1.5	C-20E	MCP0358R-7A	R20E-3.6A	#14			
VFP1-4040P.B	3 / 2.2	C-20E	MCP03150R-15A	R20E-4.2A	#14			
VFP1-4065P.B	5 / 3.7	C-20E	MCP03150R-15A	R20E-6.6A	#12			
VFP1-4095P.B	7.5/ 5.5	C-20E	MCP03150R-15A	R20E-11A	#12			
VFP1-4130P.B	10 / 7.5	C-25E	MCP13300R-30A	R35E-15A	#10			
VFP1-4190P.B	15 /11	C-35E	MCP13300R-30A	R35E-22A	#6			
VFP1-4250P.B	20 /15	C-35E	MCP23480R-50A	R35E-28A	#6			
VFP1-4280P.B	25 /18.5	C-35E	MCP23480R-50A	R35E-35A	#5			
VFP1-4340P.B	30 /22	C-50E	MCP23980R-50A	R65E-43A	#3			
VFP1-4460P.B	40 /30	C-65E	MCP331000R-100A	R65E-57A	#2			
VFP1-4550P.B	50 /37	C-100E	MCP331000R-100A	R80E-70A	#2			
VFP1-4690P.B	60 /45	C-100E	MCP331000R-100A	R150E-108A	#1			
VFP1-4840P.B	75 /55	C-180E	MCP431800R-150A	R150E-138A	#2/0			

8—1 Selection of Apparatus for Wiring (2)

(1) Selection of Non-Fuseable breaker (MCCB)
Fuse are installed at the primary (input) side of inverter, which is used for the purpose of protecting from abnormalities represented by overload and short-circuit troubles at the primary side.
Pay attention to the following points:
a. Select suitable MCCB in accordance with the requirements of breaking capacity and type which meet power source capacity.
Table 8-1 shows the forecasting power source facility with about 200 to 500 kVA capacity.
b. Table 8-1 shows example of selection when inverter rated output current flows.
c. When the power factor improvement reactor improvement is inserted, the waveform distortion will be improved, and input current will be descreased. When total impedance in the power utility is small, it is recommended to insert the power-factor improvement reactor, and reduce the peak values of inverter input current.

(2) Selection of electromagnetic contactor (MC)
a. Select suitable electromagnetic contactors (MC) provided in inverter input section, is accordance with Table 8-1.
b. As a rule, in inverter output section, ON-OFF operation through electromagnetic contactor should be avoided.
c. In inverter input section, connection without using electromagnetic contactor is possible. But, it is recommended to use the electromagnetic contactor for the following purposes:
1 In order to prevent re-starting automatically after the inverter was stopped due to momentary power interruption and when momentary power interruption has been removed.
Inverter can continuously operate when instantaneous interruption (within 30 ms) has occurred.
On the contrary, if the power interruption continued for 30 ms or more, under voltage protection functions and inverter circuit trips.
Then, the protection is removed during interruption and re-starting is made after the power source returns.
2 When the protection functions, the fault detecting signal relay is energized in order to separate inverter from the power source.
By using "FL" relay, the main circuit can be separated from the power source, and serious accidents can be prevented.
3 In case inverter is stopped for a long time:
When inverter which directly comments to power source is not served, power source for inverter control circuit is applied and the cooling fan is operated at all times. This means a small amount of power is consumed.
When the inverter is not used for a long period of time, it may switch off electromagnetic contactor and separate from power source so as to save energy.

(3) Selection of overload relay
The inverter has built-in electrical thermal relay. If any overload relay is installed externally, select such type of relay in accordance with Table 8-1.

(4) Surge suppressor
The coil of electromagnetic contactor should be connected with the surge suppressor in parallel without fail. In addition, if any other contactor is observed in the customer's panel, connect surge suppressor to the respective coil of electromagnetic contactors.

8–2 Selection of Wires for Wiring (1)

If main circuit wiring distance to terminals R, S, T, U, V, and W is long, voltage drops occur in cable line. It is necessary to choose adequate distributing cable so as to protect lack of motor torque and increase of current.

Table 8-2 Example of Material for Inverters

Series	Inverter		Applicable Motor Output (HP/kW)	Wiring to Main Circuit		Control Circuit	Grounding wire
	TYPE FORM	Capacity (kVA)		Wiring size (AWG)	Conductor resistance 20°C (mΩ/m)		
230V class	VFP1-2010P-B1	1	0.5/ 0.4	#14		More than 0.75 mm² (AWG#18)	More than 3.5 mm² (AWG#12)
	VFP1-2015P-B1	2	1 / 0.75	#14			
	VFP1-2030P-B1	3	2 / 1.5	#12			
	VFP1-2040P-B1	4	3 / 2.2	#12			
	VFP1-2065P-B1	6.5	5 / 3.7	#10			
	VFP1-2095P-B1	10	7.5/ 5.5	#8	2.31		
	VFP1-2130P-B1	13	11 / 7.5	#5	1.30		
	VFP1-2190P-B1	20	15 /11	#5	1.30		
	VFP1-2250P-B1	26	20 /15	#4	0.824		
	VFP1-2280P-B1	29	25 /18.5	#2	0.624		
	VFP1-2340P-B1	35	30 /22	#1	0.487		
	VFP1-2460P-B1	48	40 /30	#2/0	0.303		
460V class	VFP1-4015P-B1	2	1 / 0.75	#14			
	VFP1-4030P-B1	3	2 / 1.5	#14			
	VFP1-4040P-B1	4	3 / 2.2	#14			
	VFP1-4065P-B1	6.5	5 / 3.7	#12			
	VFP1-4095P-B1	10	7.5/ 5.5	#12	5.20		
	VFP1-4130P-B1	13	11 / 7.5	#10	3.33		
	VFP1-4190P-B1	20	15 /11	#6	2.31		
	VFP1-4250P-B1	26	20 /15	#6	2.31		
	VFP1-4280P-B1	29	25 /18.5	#5	1.30		
	VFP1-4340P-B1	35	30 /22	#3	0.824		
	VFP1-4460P-B1	48	40 /30	#2	0.624		
	VFP1-4550P-B1	57	50 /37	#2	0.624		
	VFP1-4690P-B1	72	60 /45	#1	0.487		
	VFP1-4840P-B1	88	75 /55	#2/0	0.303		

(Note) 1. Electric wires are stranded annealed copper wires.
2. Distribution of U, V, W in the above table, the distance between motor and inverter is within 30 meters.

8–2 Selection of Wires for Wiring (2)

When the wiring distance is excessively long, voltage drop will increase. resulting in difficulty in keeping specified characteristics. In an extreme case, the motor would heat up abnormally.

Referring to the above fact, select suitable sizes of wire and wiring distance after setting the voltage drop within a few percentage (%) between inverter and motor.

The voltage drop between lines is calculated as follows:

$$\text{Line voltage drop (V)} = \frac{\sqrt{3} \times \text{Wire resistance (m}\Omega\text{/m)} \times \text{Wiring distance (m)} \times \text{Current (A)}}{1000}$$

The voltage drop, when the wiring distance is 30 m, is shown in Table 8-3 below:

Table 8-3 Voltage Drop (For wiring distance of 30 m)

Series	Applicable Motor (HP/kW)	Inverter		Inverter Output Voltage		Standard Applicable Wires		Line Voltage Drop		
		Type-Form	Rated Current (A)	at 60Hz (V)	at 10Hz (V)	Wire Size (AUG)	Conductor Resistance 20°C (mΩ/m)	Voltage drop (V)	at 60Hz (%)	at 10 (%)
230V class	6.5/ 1.0									
	7.5/ 5.5	VFP1-2095P.B	25	230	52	#8	2.31	3.00	1.5	5.1
	11 / 7.5	VFP1-2130P.B	33	230	52	#5	1.30	2.23	1.2	5.0
	15 /11	VFP1-2190P.B	50	230	52	#5	1.30	3.38	1.7	7.5
	20 /15	VFP1-2250P.B	65	230	52	#4	0.824	2.78	1.4	6.2
	25 /18.5	VFP1-2280P.B	73	230	52	#2	0.624	2.36	1.2	5.2
	30 /22	VFP1-2340P.B	88	230	52	#1	0.487	2.23	1.2	5.0
	40 /30	VFP1-2460P.B	120	230	52	#2/0	0.303	1.89	1.0	4.2
460V class	6.5/ 1.0									
	7.5/ 5.5	VFP1-4095P.B	13	460	104	#12	5.20	3.51	0.9	3.9
	11 / 7.5	VFP1-4130P.B	17	460	104	#10	3.33	2.94	0.8	3.3
	15 /11	VFP1-4190P.B	25	460	104	#6	2.31	3.00	0.8	3.3
	20 /15	VFP1-4250P.B	33	460	104	#6	2.31	3.96	1.0	4.4
	25 /18.5	VFP1-4280P.B	37	460	104	#5	1.30	2.50	0.7	2.8
	30 /22	VFP1-4340P.B	44	460	104	#3	0.824	1.88	0.5	2.1
	40 /30	VFP1-4460P.B	60	460	104	#2	0.624	1.95	0.5	2.2
	50 /37	VFP1-4550P.B	72	460	104	#2	0.624	2.33	0.6	2.6
	60 /45	VFP1-4690P.B	90	460	104	#1	0.487	2.28	0.6	2.5
	75 /55	VFP1-4840P.B	110	460	104	#2/0	0.303	1.73	0.4	1.9

8–2 Selection of Wires for Wiring (3)

[Example of calculation]

Select suitable wire so as to keep the line voltage drop within 2% under the following condition:

where,
- 230V class
- 22 kW motor
- 34 kVA inverter
- Wirng distance: 30 m
- Output frequency: 10 Hz

[Solution]:

Use the above mentioned expression.

When output frequency is 10 Hz, inverter output voltage is set to 45V.

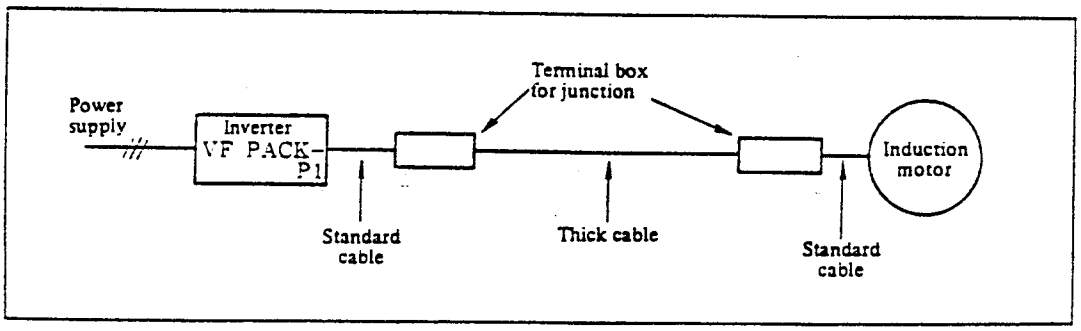
Then, line voltage drop should be 0.9V or less.

$$0.9\,(V) = \frac{\sqrt{3} \times X\ (\text{conductor resistance}) \times 30\,(m) \times 88(A)}{100}$$

Then, $X = 0.197\ (m\Omega/m)$

Accordingly, when the conductor resistance is 0.197 (mΩ/m) or less, wire size will be 100 mm^2.

(Note) When cable size is increased, it might be difficult to connect wire with motor or with inverter directly.
In this case, it is recommended to provide the following intermediate terminal connection box.



9. ADJUSTMENT

9—1 Adjustable Functions (1)

The following adjustments are equipped on the VF PACK-P1. Figure 9-1 is list table.

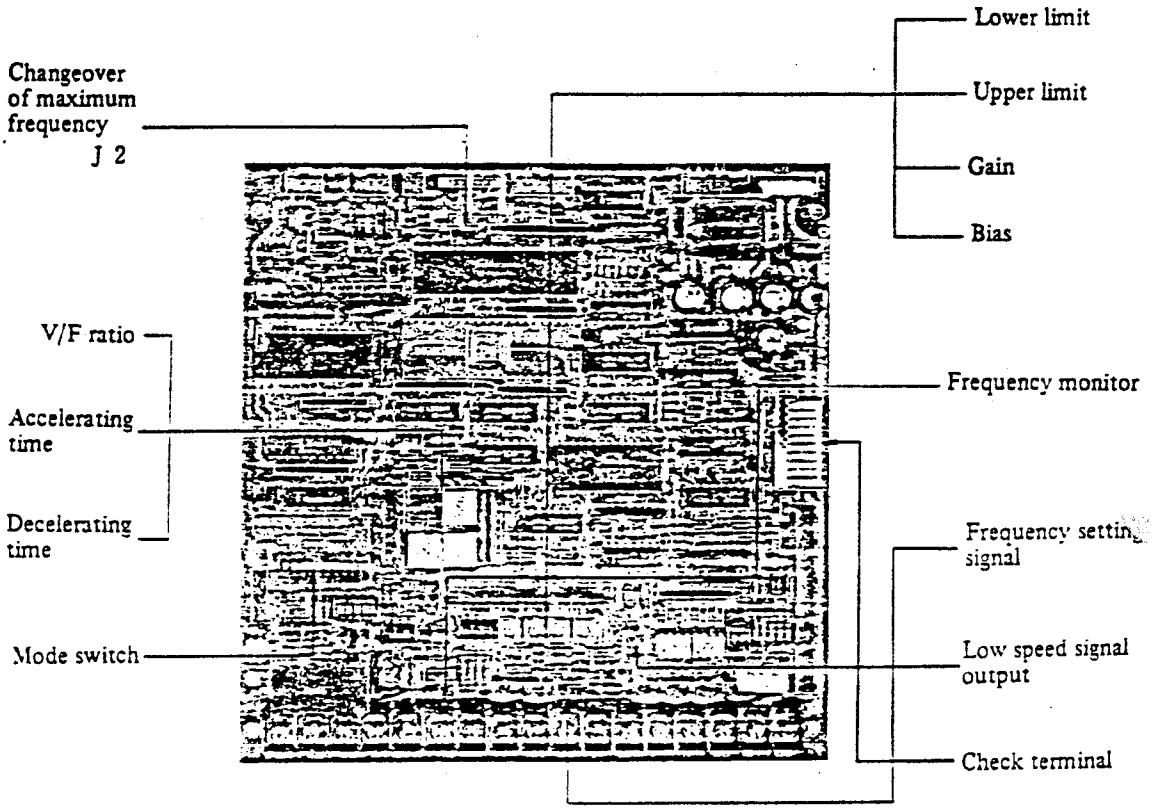
(1) Voltage/frequency pattern adjustment by Bit 1, 6 and 7 of SW2, and SW4 bymbolized as V/F.
(2) Accelerating time adjustment by Bit 4 of SW2 and SW5 symbolized as ACC.
(3) Decelerating time adjustment by Bit 5 of SW2 and SW6 symbolized as DEC.
(4) Gain adjustment symbolized as GAIN.
(5) Bias adjustment symbolized as BIAS
(6) Upper limit adjustment symbolized as HL
(7) Lower limit adjustment symbolized as LL
(8) Mode selection by SW2
(9) Changeover of jumper pins J1, J2, and J3.

The following adjustable functions exist as options.

(1) Changeover of jogging frequency
(2) Changeover of low speed signal output level
(3) Adjustment of stall prevention level

It is not necessary to readjust, as the adjustable part with the exception of the above options.

9—1 Adjustable Functions (2)



(Note) Switches with the exception of the above ones have already been adjusted at shipment.

Fig. 9-1 Adjustable functions

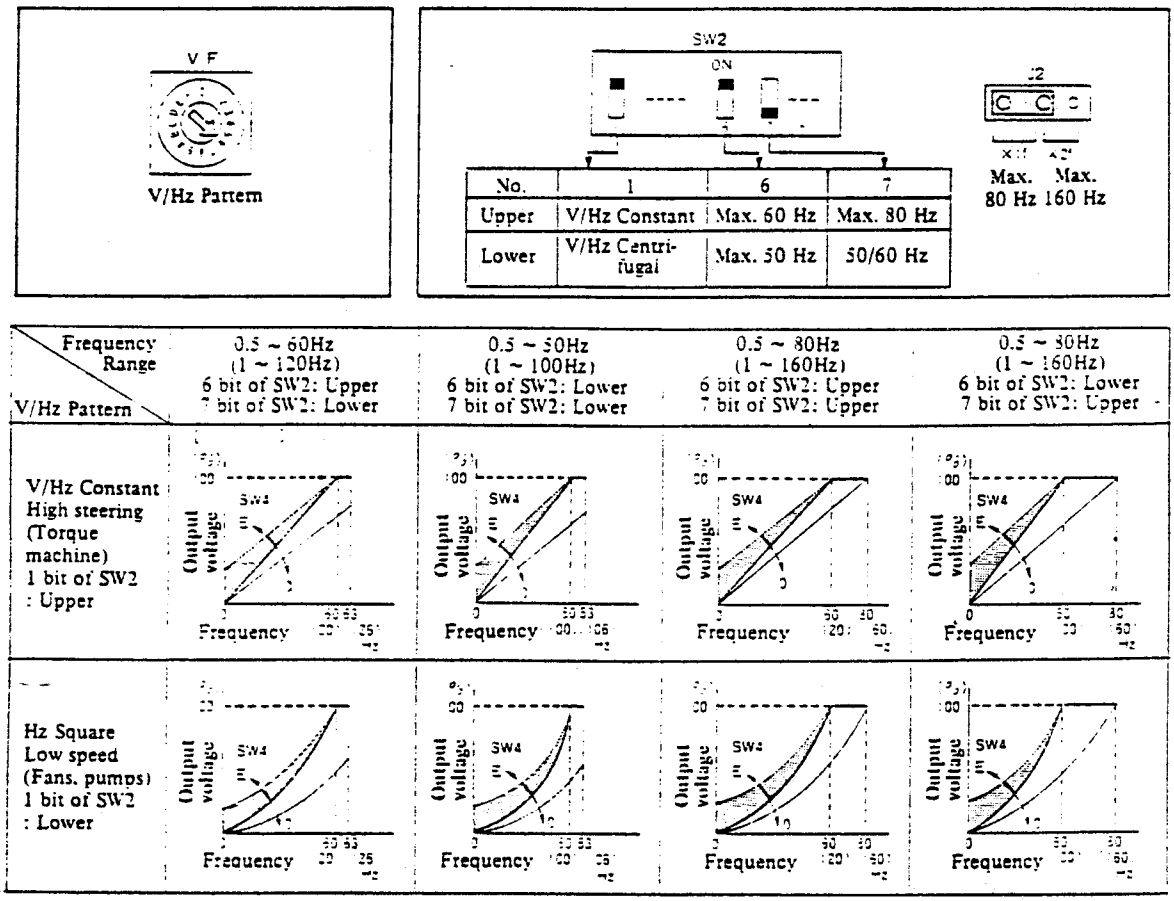
9–2 Voltage/Herz Ratio (V/Hz) (1)

Optimum V/Hz pattern can be selected and changed over easily, which meets the requirements of the applications and load characteristics by using digital switch and jumper pin provided on the printed wired board.

The following patterns are available and miscellaneous characteristics are obtainable:

- V/Hz constant pattern (for High starting torque)
- Centrifugal pattern (for fan/pump)
- Power-saving pattern which can automatically change-over the V/Hz pattern in proportion to the load current.

As adjustable section, the rotary switch V/F, digital switch for mode selection (SW2) and jumper pin (J3) are provided.



(Note 1) Figures in parentheses show the case of frequency expansion by setting the jumper pin to "2f"-side.

(Note 2) Dotted portion represents automatic energy-saving patterns. As selecting "F" notch of SW4, V/Hz pattern automatically changes in accordance with load.

Fig. 9-2 Voltage/Hz Ratio (V/Hz)

(1) In case of high starting torque machine

When No.1 of mode selector switch (SW2) is set to the upper side of digit, the V/Hz constant pattern for constant torque machines is obtainable.

No.6 bit and No.7 bit of SW2 select, maximum frequency modes among 80 Hz, 60 Hz and 50 Hz.

Rotary swtch (SW4) is selectable for 16 kinds of pattern through 0 to F notch. The notch F is featured by automatic pattern described later.

Fig. 9-3 shows notch map of SW4 (V/F).

Fig. 9-4 shows V/Hz characteristics (Typical notch).

9–2 Voltage/Herz Ratio (V/Hz) (2)

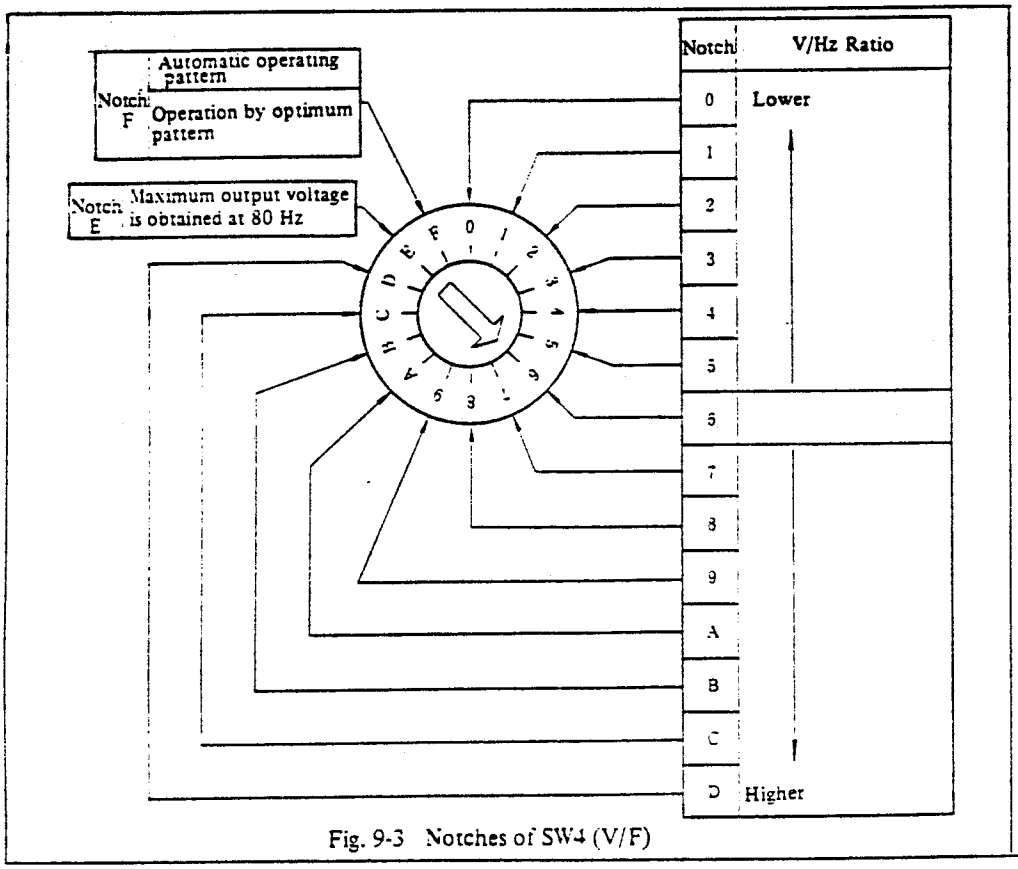


Fig. 9-3 Notches of SW4 (V/F)

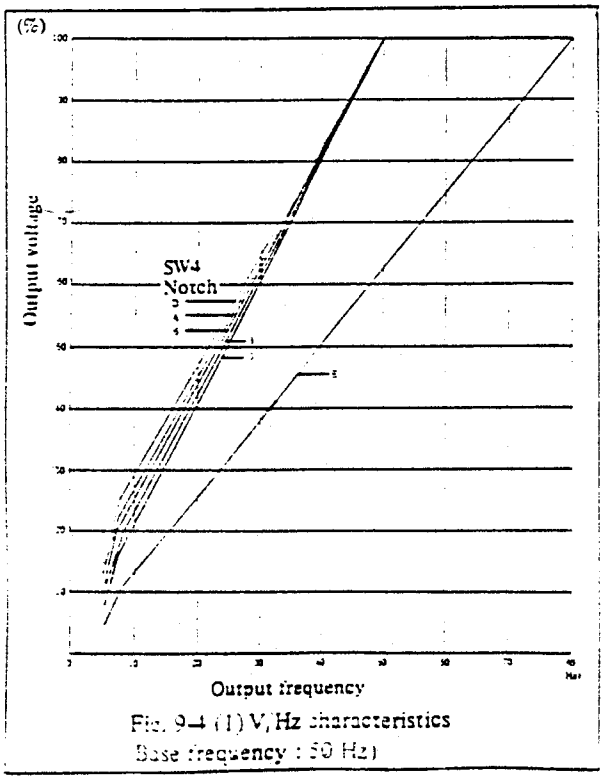


Fig. 9-4 (1) V/Hz characteristics
Base frequency : 50 Hz)

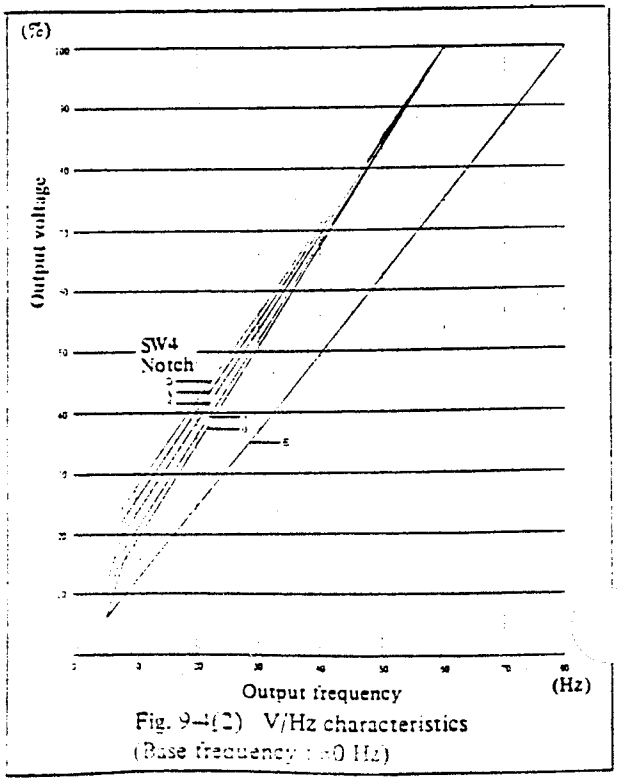


Fig. 9-4 (2) V/Hz characteristics
(Base frequency : 60 Hz)

9–2 Voltage/Herz Ratio (V/Hz) (3)

(2) In case of Square reduction torque load such as for fan and pump
When No.1 of the mode selector switch (SW2) is set to the lower side of bit. the V/Hz pattern for square reduction torque load is obtainable.
The rotary switch (SW4) is selectable for 16 kinds of pattern through 0 to F notch. The notch F is featured by automatic pattern described later.
Fig. 9-5 shows V/Hz characteristics (typical notch).

(3) Automatic pattern
Heavy load increased motor current light load decreases motor current.
In this way, the motor current varies in proportion to the load factor.
According to VF PACK-P1, motor current is detected by CT, and V/Hz pattern is controlled optimally depending on current flowing.
When output frequency is constant, output voltage is decreased and output current is detected at all times, and motor can be operated at the pattern featurized by minimum current, resulting in energy-saving. The range of this automatic pattern is the full range of 0 to E notch as indicated in Fig. 9-4 and Fig. 9-5.

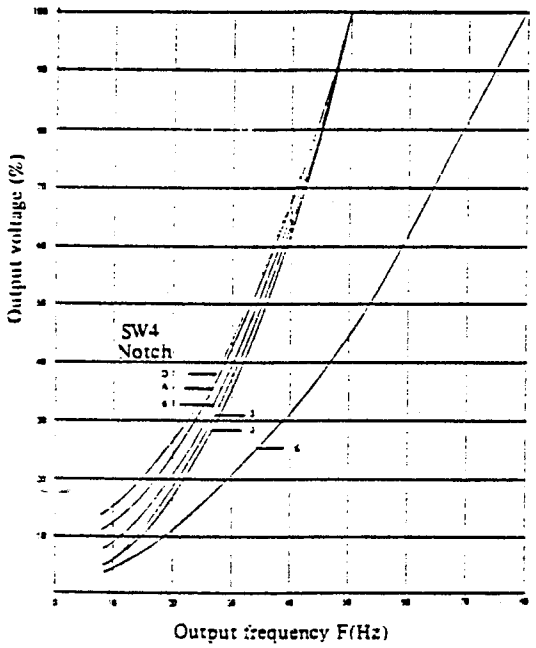


Fig. 9-5 (1) V/Hz Characteristics
(Base frequency: 60 Hz)

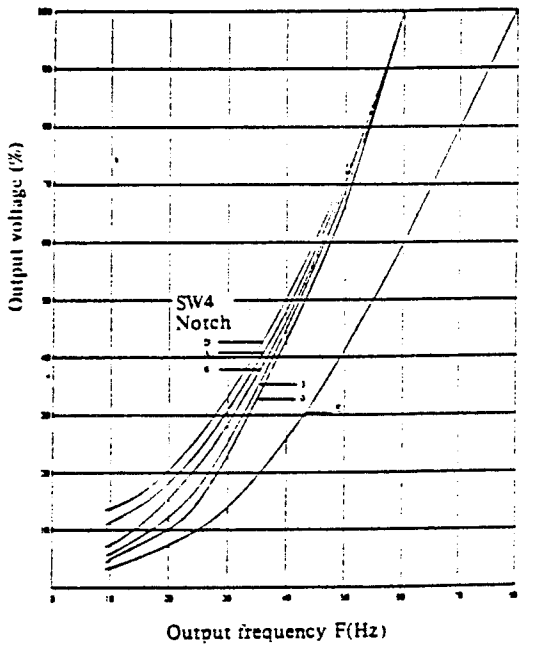


Fig. 9-5 (2) V/Hz Characteristics
(Base frequency: 50 Hz)

9–3 Accelerating and Decelerating Times (ACC/DEC) (1)

VF PACK-P1 has function to adjust accelerating and decelerating times individually at the range of 1 to 1200 seconds.

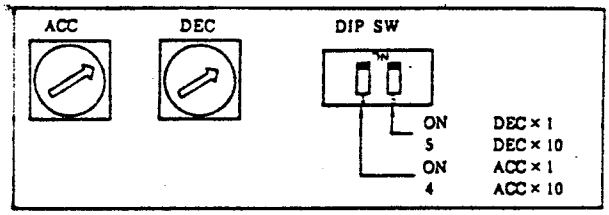


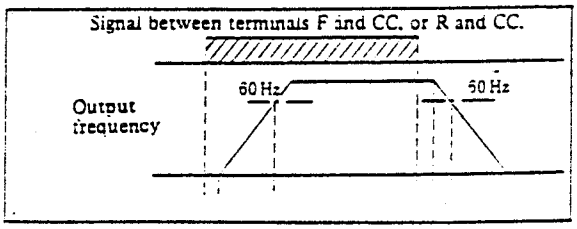
Table 9-1 Accelerating and decelerating times

ACC/DEC Notch Position	Accelerating time (s)		Decelerating time(s)	
	DIP SW Position		DIP SW Position	
	ON side	4 side	ON side	5 side
0	1 s	10 s	1 s	10 s
1	2	20	2	20
2	3	30	3	30
3	4	40	4	40
4	5	50	5	50
5	8	80	8	80
6	10	100	10	100
7	15	150	15	150
8	18	180	18	180
9	25	250	25	250
A	35	350	35	350
B	45	450	45	450
C	60	600	60	600
D	70	700	70	700
E	90	900	90	900
F	120	1200	120	1200

(1) Accelerating and decelerating times as shown in the above Table are the time to need accelerate and decelerate of the range of 0.5 to 60 Hz.
In case of 0.5 to 80 Hz mode accelerating and decelerating times are given by the following equation.

Accelerating or decelerating time

$$= (\text{table value}) \times \frac{80}{60} \text{ (S)}$$



(2) Operation signal between terminals F and CC. or R and CC is related to output frequency as the above figure.
As for accelerating and decelerating times. operation deadtime exists by at most 35 miliseconds.

9–3 Accelerating and Decelerating Times (ACC/DEC) (2)

(3) Output frequency immediately changes from 0Hz to 0.5 Hz.

(4) Accelerating and decelerating time of a voluntary setting frequency can be calculated from the following formula. Dead times are not counted in this formula.

$$t_a = \frac{f\,(Hz) - 0.5\,(Hz)}{60\,(Hz) - 0.5\,(Hz)} \times t_{ACC}$$

$$t_b = \frac{f\,(Hz) - 0.5\,(Hz)}{60\,(Hz) - 0.5\,(Hz)} \times t_{DEC}$$

Where,

- t_a : Accelerating time
- t_b : Decelerating time
- f : Voluntary frequency
- t_{ACC} : Adjusted accelerating time
- t_{DEC} : Adjusted decelerating time

(5) Inverter accelerates and decelerates quickly.

(6) When output frequency is doubled to 160 Hz, accelerating and decelerating times as shown in Table 9-1 become equal to the time taken in the doubled frequency.

(Note) When the motor speed does not reach the set frequency smoothly in the accelerating or decelerating operation, readjust the accelerating or decelerating time to a longer time.
Knowing the load torque and inertia moment symbolized by WK^2, accelerating or decelerating time can be calculated from the following formula.
Do not forget to readjust ACC or DEC longer than calculated time.

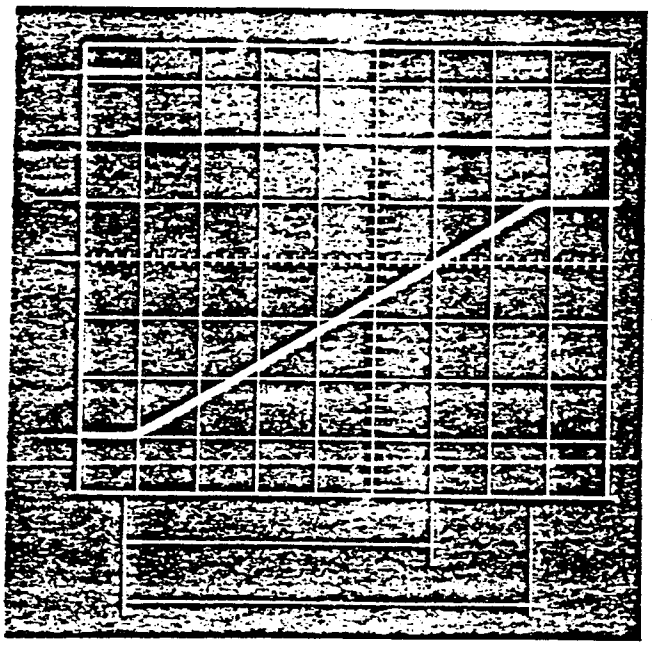
$$t_{ACC} = \frac{\Sigma GD^2 \cdot N}{375\,(T_M - T_L)}$$

$$t_{DEC} = \frac{\Sigma GD^2 \cdot N}{375\,(T_M - T_L)}$$

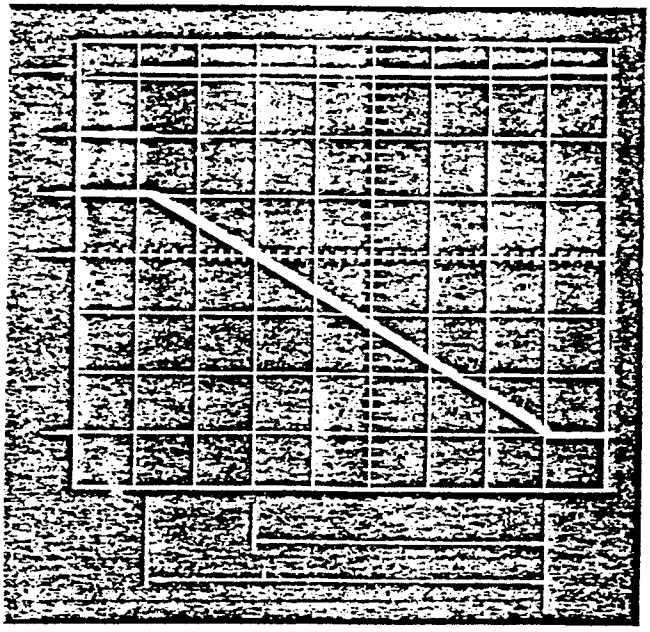
- t_{ACC} : Accelerating time (Unit: S)
- t_{DEC} : Decelerating time (Unit: S)
- ΣGD^2 : Total GD^2 of motor GD^2 and Load GD^2 (Converted to motor shaft) (Unit: kg.m)
- N : Motor rotated speed (rpm)
- T_M : Motor torque (Unit: kg.m)
- T_L : Maximum load torque (Unit: kg.m)

9–3 Accelerating and Decelerating Times (ACC/DEC) (3)

Fig. 9-6 demonstrates measured data.



(1) Setting of accelerating time 10 seconds



(2) Setting of decelerating time 10 seconds

Fig. 9-6 Accelerating and decelerating characteristics

9—4 Gain (GAIN)

(1) The relative ratio between the frequency setting signal and the output frequency is adjusted by means of GAIN set.
When frequency setting signal/output frequency ratio is set to 0V/0 Hz, – 10V/80 Hz, GAIN is selected as one time.

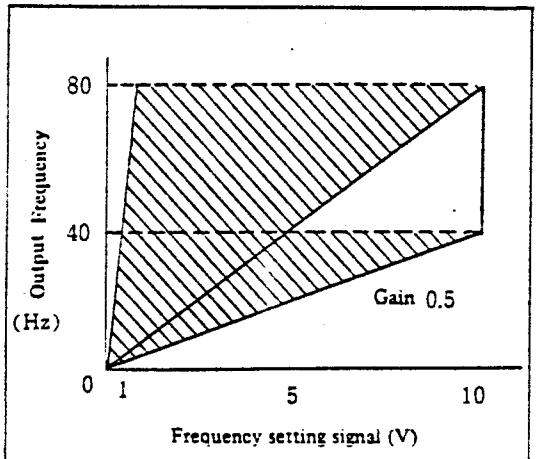


Fig. 9-7 Relative Ratio between Setting Signal and Output Frequency

(2) Adjustable range of GAIN is 0.5 ~ 10 times as compared with input (stepless).
(3) The GAIN is adjusted as one time at shipment.
This means that it is necessary to adjust for conventional use.

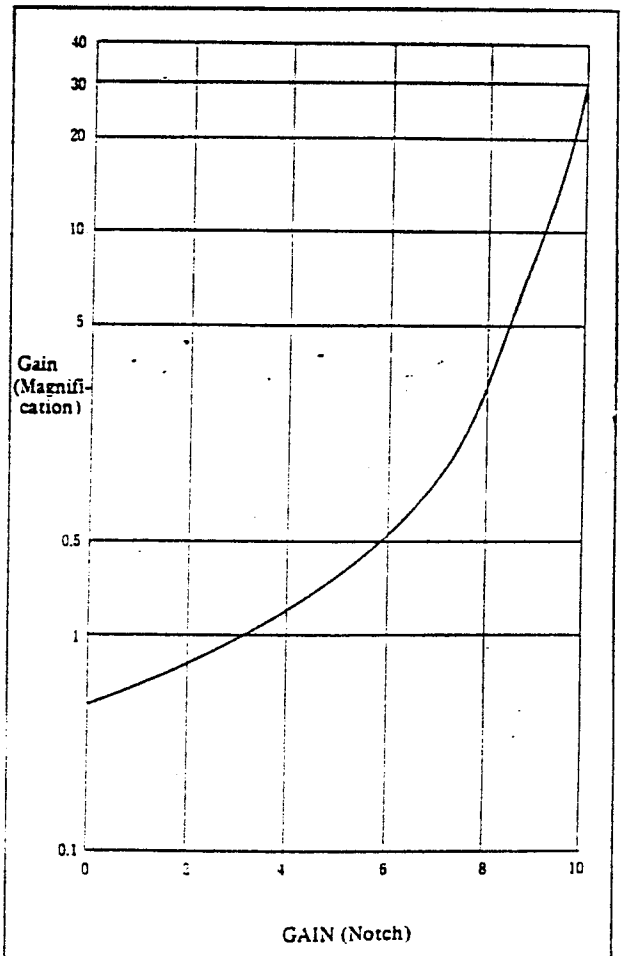


Fig. 9-8 Adjustable Range of GAIN

9–5 Bias (IB)

(1) Bias can be adjusted under the following conditions:

- Current input ..... 4 ~ 20 mA signal
- Voltage input ..... 0 ~ 5V signal
- External voltage ..... 0 ~ 10V signall

On the contrary, Voltage 0 ~ 10V signal according to the FRH condition, bias cannot be adjusted.

(2) The bias adjusting width is from –4.5V to +4.5V (stepless) when 0 ~ 5V signal is input.
(3) Bias is adjusted to 0V at shipment.
(4) Adjustable range of bias is shown in Fig. 9-9 and Fig. 9-10 respectively.

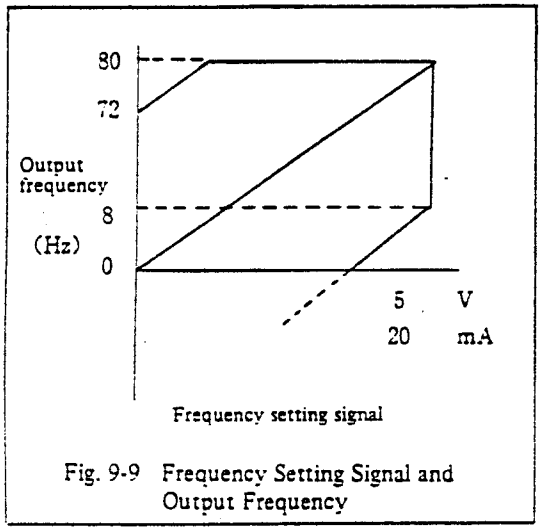


Fig. 9-9 Frequency Setting Signal and Output Frequency

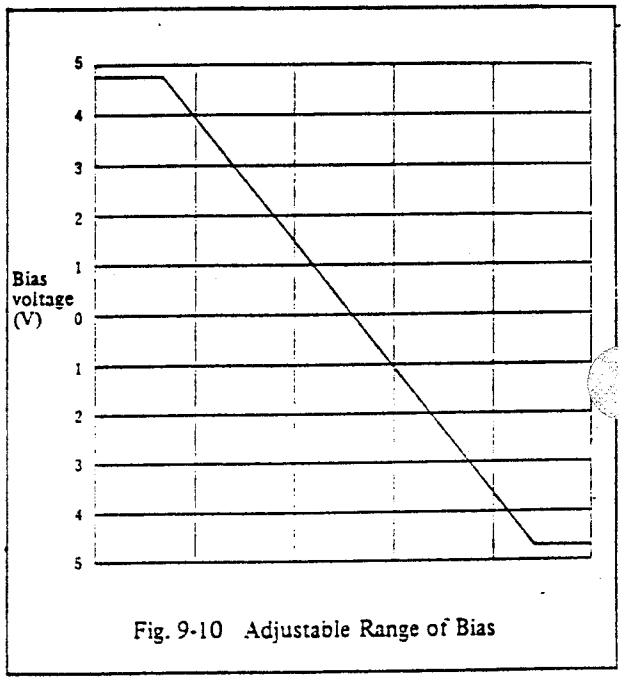


Fig. 9-10 Adjustable Range of Bias

9–6 Upper and Lower Limit (HL, LL)

(1) Some restrictions can be applied to high limit and low limit of output frequence.
(2) High limit and low limit can be applied to the following signals.
- Voltage input ..... 0 ~ 10V signal
  0 ~ 5V signal
- Current input ..... 4 ~ 20 mA signal

(3) Adjustable width of High Limit is 5 to 80 Hz (stepless). Adjustable width of Low Limit is 0 to 75 Hz (stepless).
(4) High Limit is adjusted to 80 Hz, and low limit is adjusted to 0 Hz respectively at shipment.

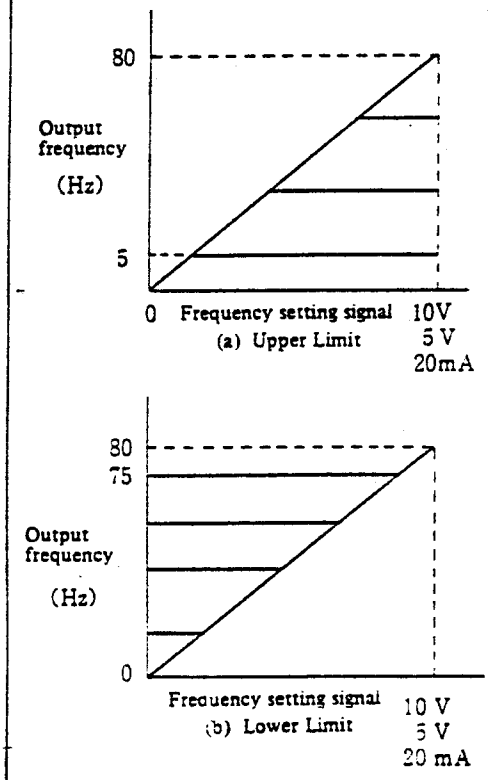


Fig. 9-11 The Relative Ratio between Setting Signal and Output Frequency

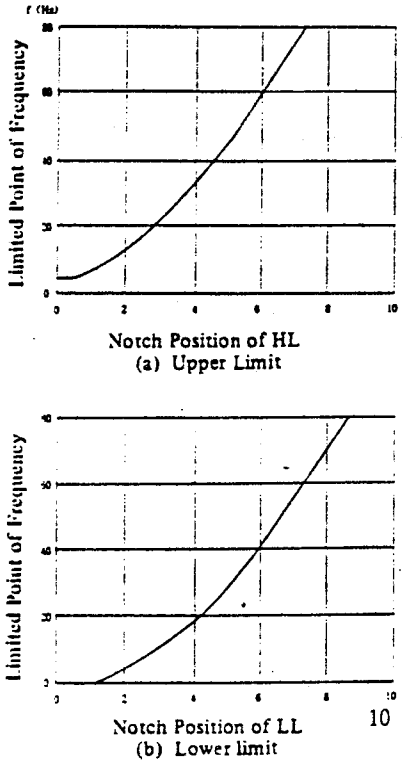
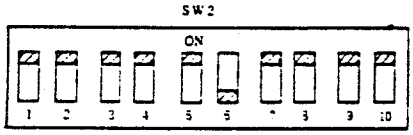


Fig. 9-12 Adjustable range

9–7 Operational Mode Selector Switch (SW2) (1)

The digital switch (SW2) allows you to select differ modes of operation



▨ Status condition at time of shipment.

No. 1 to No.10 bit function switches are explained as follows:

(1) Bit No.1 functions for selection of V/F pattern
The V/F pattern is selectable for a constant V/F operation mode or a V/F square operational mode.

▨ ON selection (upper side)
Constant U/F operation

□ OFF selection (Lower side)
Square L/F operation

(2) Bit No.2 functions switch selection of applicable motor
The current setting values for overload protection detected by the electronic thermal relay is adjustable for different in the kinds of motors to be applied, that is:
– General-purpose motors or
– Exclusively designed motor (Constant U/F operation)
This changeover of the protective level can be made through bit No.2.

□ – Upper side . . . . . for general purpose motors
▨ – Lower side . . . . . for constant V/F motor

(3) Bit No.3 for optional Tachgenerator feed back circuit
▨ When the optional board, is installed, the switch should be set to the lower side.

(4) Bit No.4 for selecting acceleration time
Acceleration time can be selected between long term and short term mode.
▨ Lower side : Short term mode:
By actuating rotary switch (ACC), 16 steps can be set within 1 to 120 seconds.
□ Upper side: Long term mode:
By actuating rotary switch (ACC), 16 steps can be set within 10 to 1200 seconds.
Upper side is set at shipment.

(5) Bit No.5 for selecting deceleration time
Deceleration time can be selected between long term and short term mode.
▨ Lower side : Short term mode:
By actuating rotary switch (DEC), 16 steps can be set within 1 to 120 seconds.

□ Upper side : Long term mode:
By actuating rotary switch (DEC), 16 steps can be set within 10 to 1200 seconds range.

Deceleration mode is set to Upper side (Long term mode).

(6) Bit No.6 and Bit No.7 to set maximum frequency
Three kinds of maximum frequency are selectable among 50/60/80 Hz.
When maximum frequency is expanded, three kinds of maximum frequency are selectable among 100/120/160 Hz.

No. 6	No. 7	Maximum frequency
6 side ▨ (Lower side)	ON side □ (Upper side)	53 Hz (106 Hz)*
ON side □ (Upper side)		63 Hz (126 Hz)*
–	7 side ▨ (Lower side)	80 Hz (160 Hz)*

(Note) *In case frequency is extended, jumper pin (J2) should be moved.

9–7 Operation Mode Selecting Switch (SW2) (2)

(7) Bit No.8 for option (Automatic restart unit)

In case automatic restart unit is provided, set bit No.8 to the lower side.

(8) Bit No.9 for option (Ground fault protection)

In case ground fault protection unit is provided, set bit No.9 to the lower side.

(9) Bit No.10 for changing over to function overvoltage limitation

During deceleration, regenerative braking would be applied.

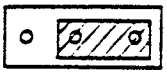
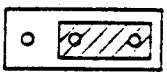
But. when voltage elevates to overvoltage limitation level, deceleration operation will stop operating temporarily. This function is called "Overvoltage limitation".

By actuating Bit No.10 to upper side, overvoltage limitation functions; by actuating to lower side, overvoltage limitation doesn't function.

(Note) Never set to lower side of bit No.10 except when using regenerative power discharge unit because inverter is subject to operate overvoltage protection and trip.

9–8 Connection of Jumper Pin

There are jumper pins of J1 to J3 on printed wiring board.

Jumperpin	Contents	Shipping condition
J 1	Used for switching between analog or digital outputs frequency signal. DIG ANA 	ANA side
J 2	Used for switching of maximum output frequency between 80 Hz or 160 Hz. 2 f Lf  1f : Maximum frequency is 80 Hz. 2f : Maximum frequency is 160 Hz.	1f side
J 3	Used for switching of frequency setting signals between 4 to 20 mA or 0 to 5V. V I  V : Voltage signal of 0 to 5 VDC I : Current signal of 4 to 20 mA dc	I side

9—9 Another Adjusting Functions

(1) Option

The following component modification can be add as an option.

A) JOG (rotary switch)
The jogging frequency can be set between 1 to 15 Hz. and is adjustable in 1 Hz steps.
(Standard is set at 6 Hz.)

B) LOW (variable rheostat)
The output frequency for low-speed signal can be adjusted within the range of 0.5 to 30 Hz.
(Standard is set at 0.5 Hz.)

C) STL (variable reostat)
The current level stall prevention functions can be adjusted.

(2) Digital switch set by manufacturer

The digital switch have already been adjusted by the manufacturer, users need not adjust the following digital switches.

A) Digital switch "SW1" (to select applicable motor)
VF PACK-P1 has a selectable detecting and monitoring functions for load current. Digital switch "SW1" is provided to select applicable motors suitable for the inverter capacity.

B) Digital switch (SW7) (option)
When automatic restart unit is installed and the availability of input/output reverse connecting preventive circuit is selected, this switch is adjusted.
The above option operates by selecting "ON" side. It does not operate when selecting "OFF" side.

* Input/output reverse connecting preventive circuit.
This protection functions as reversely connecting by mistaking output (U.V.W) for input (R.S.T). If only bit No.2 of "SW7" is selected at "OFF" side, inverter does not operates for reverse connection and will not be damage.

10. CAUTIONS AND COUNTERMEASURES FOR APPLICATIONS

10—1 Cautions for Inverter Applications

(1) Inverter current setting level (about overload protection, stall prevention and overcurrent protection) is set to the maximum applicable motor FLA specifications level.
Accordingly, when small capacity motor is driven by large capacity inverter, current setting level might require adjusting, depending upon the application (such as High WK^2 loading start).

(2) In case large capacity motor (kW) is driven by small capacity (kVA) inverter, even if the current on the ammeter indicates less than the inverter rated current, current ripple can increases more than an acceptable current. Therefore, such usage is not recommend.

(3) When 460V power source is used, use 460V class inverter.

(4) Since the inverter output waveform is not a true sine wave form, one should check to see that there is no electromagnetic or audio apparatus interference due to inverter location.
If it is determined that a problem exist, it is recommended to use a noise filter (option) on the inverter's power source side. harmful radio noise and interference can be eliminated to a certain degree. For more details refer to Chapter 14.

(5) It is not recommend to install power-factor improvement capacitor to the output section of an inverter. When induction motor with capacitor for the improvement of power-factor is used with inverter, remove these capacitor from the motor. For details on improvement of the power-factor, referred to Chapter 14.

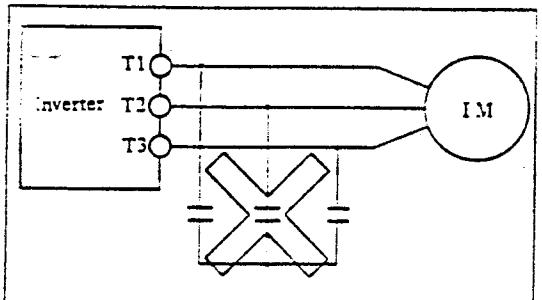


Fig. 10-1 Removing the Power Factor Improvement Capacitor

(6) A non fuseable circuit breaker (MCCB) is provided in the inverter (Series more than 28 kVA) to protect inverter.

(7) The insulation resistance test and dielectric test should be conducted by using the following circuitry.

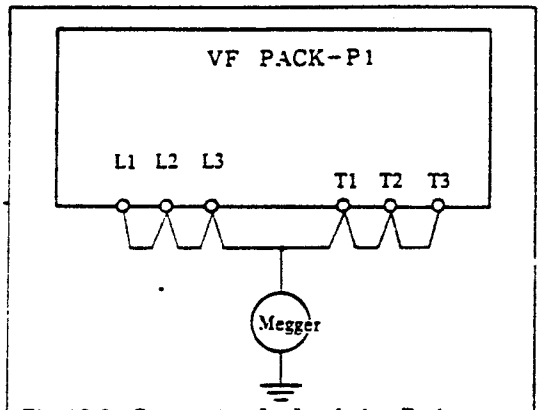


Fig. 10-2 Connection for Insulation Resistance Test/ Withstand Voltage Test

(a) The insulation resistance test should be conducted by using 500V DC megger.

(b) The dielectric test should be conducted after making a short-circuit between two terminals provided for the main circuit electrolytic condenser by applying the following voltages.

– 2,000V AC to 230V class and 460V class inverter for at least one minute

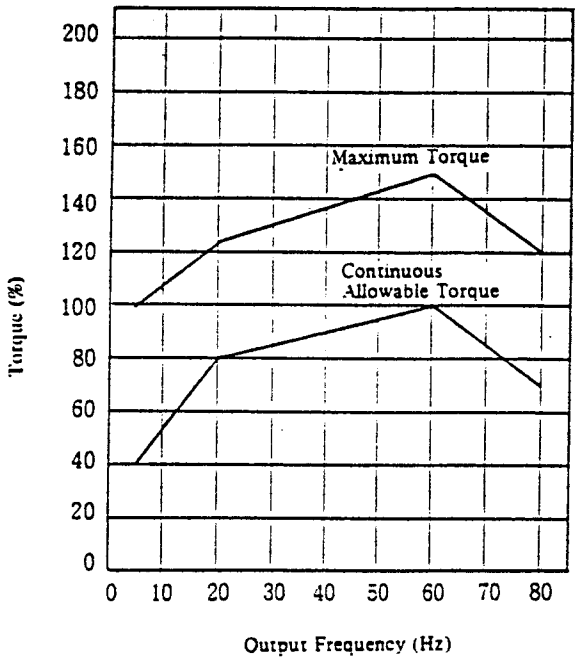
(c) Never conduct the such voltage test on any inverter portion except on terminals specified in Fig. 10.2.

(d) In case insulation resistance test or withstand voltage test is conducted. remove all connectors from the printed wired boards.
If not, a high-voltage could be applied to the printed circuits boards. resulting in the damage of semiconductors and electronic parts on the board. Therefore. pay attention to these tests.
For this reason. the tester must pay close attention when preforming these tests.

10–2 Applications to General Purpose Motors (1)

(1) The inverter is a PWM type voltage wave form, and as a results, the output voltage and current waveform are not a complete sine waveform in comparison with those of commercial power sources.
The inverter waveform is a distortion waveform.
As a result any voltage wave form that is not a true sine wave could cause a motor temperature to as well as increase the motor noise and vibration when those motors driven by commercial power sources.

(2) Inverter output frequency varies from 0.5 to 80 Hz. As the cooling effect of general purpose AC motor will decrease with-speed, the motors load factor should be reduced. (Refer to Fig. 10-3).
Should the application require a uniform load factor over an external range, the motor cooling and temperature problem should be addressed.



(Note) 100% torque is the value based upon the synchronous revolution speed at 60 Hz. Moreover, starting torque will be decreased in comparison with the case driven by a commercial power source. Therefore, pay attention to the characteristics of loaded machines.

Fig. 10-3 Allowable Torque Characteristic (Example for 4-pole/7.5 kW)

10—2 Applications to General Purpose Motors (2)

(3) Application of motor at no load driven by an inverter, or a load WK^2 that is extremely small could exhibit some unstabilized at low frequency below 25 Hertz.
This unstabilized phenomenon may arise only when a motor with no load is driven. There are no problems with light loads of 5% or more.
This can normally be solved by adding a light load or the adjustment of minimum speed potentiometer.

(4) In case negative torque will be applied from the load, overvoltage protection or overcurrent protection might be energized and inverter might stop. In this case, contact your Toshiba representative.

10–3 Applications to Special Motors

(1) Pole change motors
Pole change motors can be operated by inverter. Any pole change should be carried out only after stopping the motor.
In selecting of inverter capacity, check the rated current at each pole and ensure it smaller than the rated current of inverter.

(2) Multipolar motor
For multipolar motors of 8 poles or more as used in fans, rated current is larger than that of standard motors.
In selecting inverter capacity, ensure that the rated current capacity of motor is smaller than that of inverter.

(3) Submersible motor
The rated current of submersible motor is larger than that of standard motor.
Ensure that the rated current of motor is smaller than that of inverter.

(4) Single-phase motor
Single-phase motors are provided with a starting centrifugal switch and condensor and are not recommend to be operated by inverter.
Refer to your Toshiba representative for more information.

11. INTERNAL OPERATION OF VF PACK–P1

11–1 Block Diagram (1)

Control circuit block diagram of VF PACK-P1 is shown in Fig. 11-1 (200V Series) and Fig. 11-2 (400V Series).

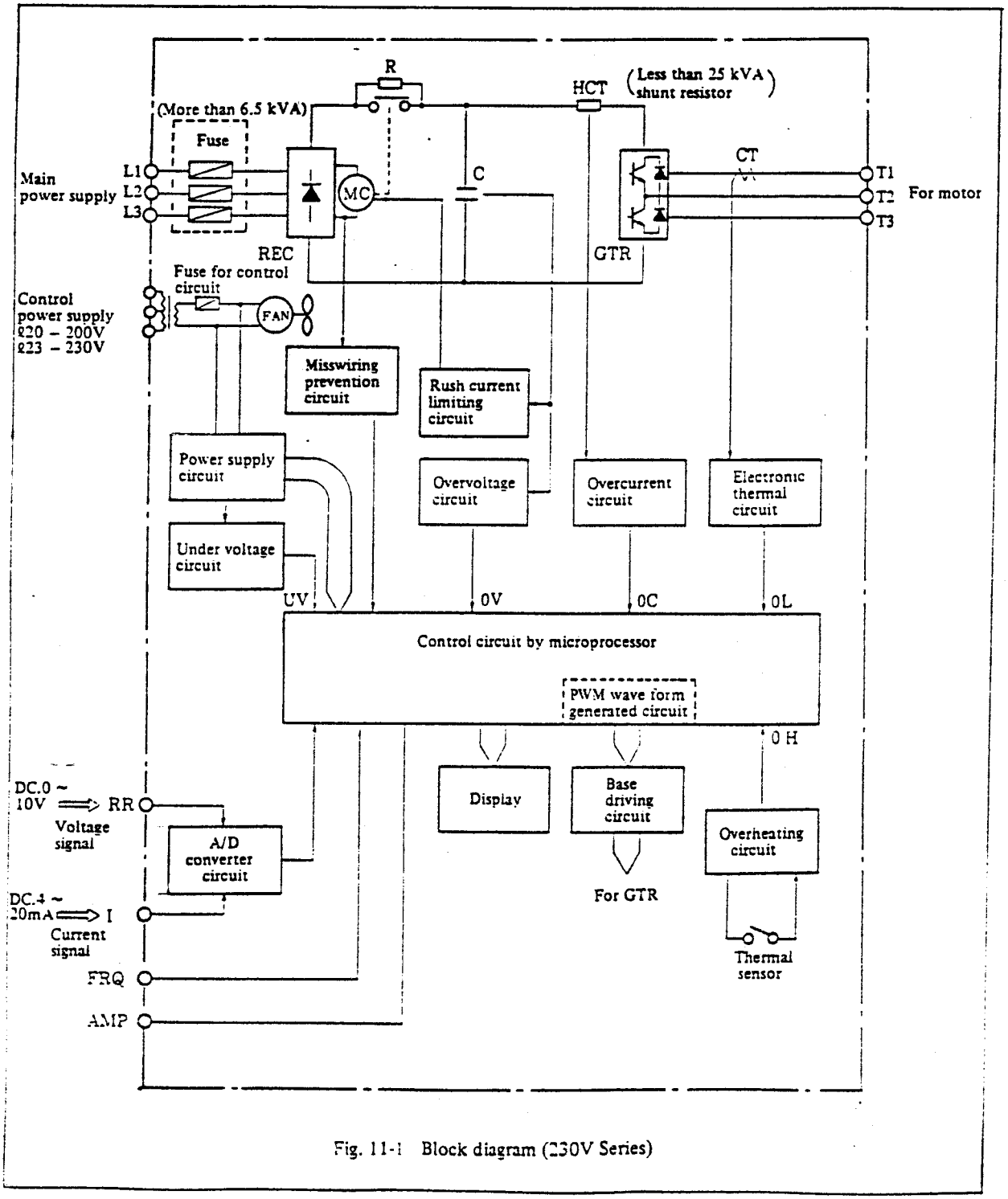


Fig. 11-1 Block diagram (230V Series)

11–1 Block Diagram (2)

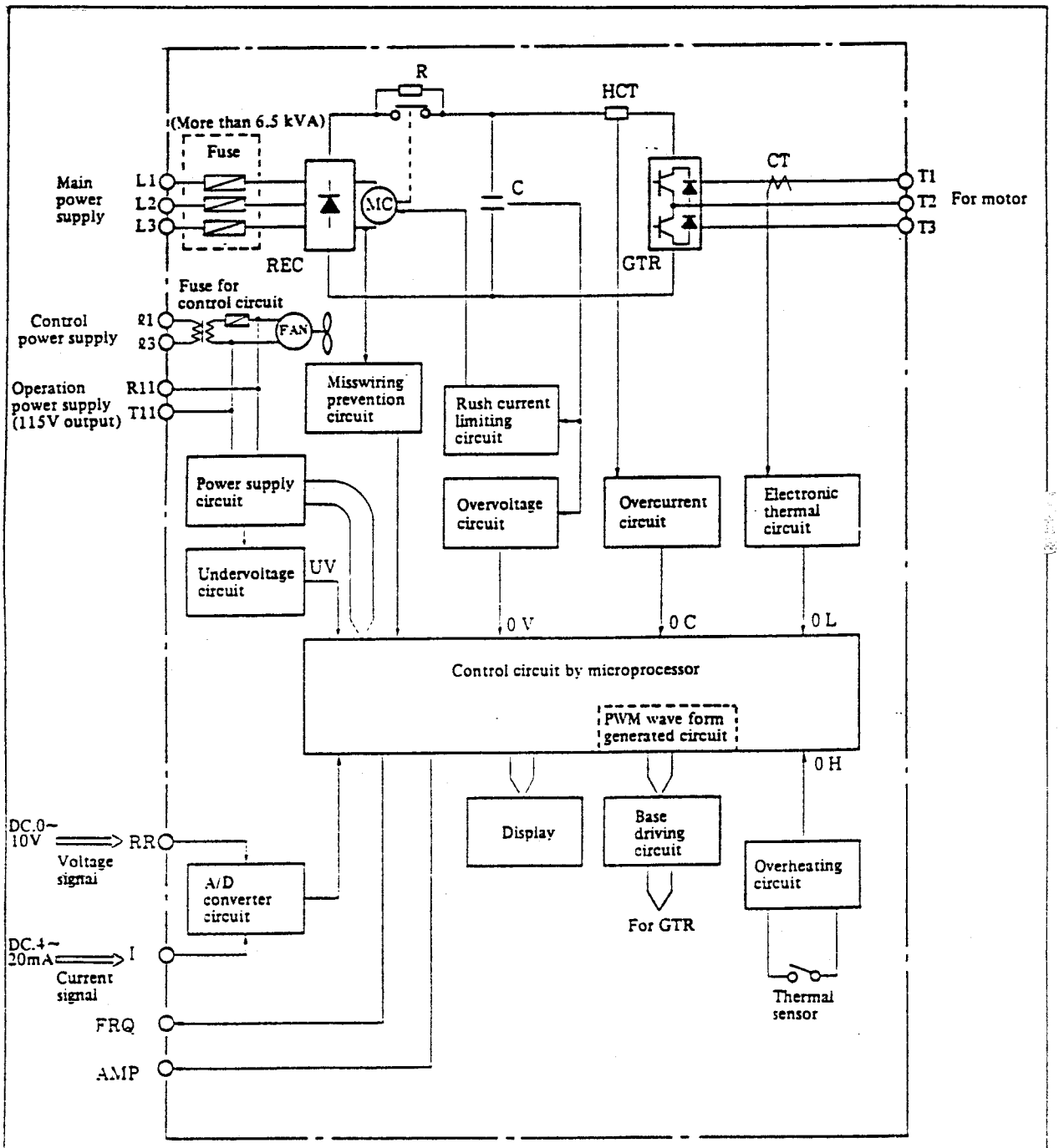


Fig. 11-2 Block diagram (460V Series)

11—2 Description of Operation (1)

Referring to the block diagram indicated on Item 11-1, the functions of each circuit in the inverter are explained as follows.

(1) Main circuit

Main circuit

- **Rectifying circuit** — Incoming 3 phase A.C. line voltage is rectified to a D.C. bus by the full wave rectifier.
- **Smoothing circuit** — The voltage of D.C. bus contains ripples, which are smoothed by a filtering capacitor.
- **Power inverter circuit** — Output to the motor is obtained by chopping the D.C. bus with the G-TR bridge.
  G-TR control signal comes from the base amplifiers on the control circuit board.
  By varying the output voltage pulse width ratio, the amounts of the output voltage is simultaneously controlled, and thus the approximate sinusoidal wave is obtainable.
  This control method is called sinusoidal PWM (Pulse Width Modulation).
- **D.C. Fuse** — Inverters 1.5 ~ 25 kVA capacity are provided with a D.C. semiconductor fuse.
- **No-fuse breaker in input section** — Inverters 28 ~ 84 kVA capacity are provided with the non fuseable circuit breaker MCCB, which is connected with the input section. This MCCB should be normally slipped switched ON.

11–2 Description of Operation (2)

(2) Control circuit

Control circuit

- **Analog/Digital (A/D) conversion circuit** — The frequency setting signals, 0~10V DC, 0~5V DC or 4~20 mA DC signals are input to the terminal RR or I. These signals are analog, which can not operate the inverter without modification. The analog signal is inputed to the A/D conversion circuit, and converted into a digital signal, which is transmitted to the micro computer CPU control circuit.
- **Micro computer CPU control circuit** — This is the center and most vital part of the control circuit. This is where the output frequency and calculated voltage are as well as the protective circuits.
- **Base drive amplifiers circuit** — Signals which were calculated and controlled by the micro computer circuit are then amplified so that G–TR, U-phase, V-phase and W-phase are driven in the power inverter circuit.
  Through this circuit, the G-TR is effectively selected.
- **Control power source circuit** — This is constant voltage control power source circuit, through which constant voltage supplies power for all circuits on the board.
  As typical constant voltage, +5V dc, ±15V dc and ±24V dc are available.
- **Display circuit** — This is a circuit through which the output frequency and operational error displayed on the LED (seven segments light sources) provided on the inverter panel.
- **Reverse connection detecting circuit** — When power is supplied in error to the inverter output terminals. the inverter could be damaged.
  In order to protect the inverter from this error, the inverter is so designed as to not operate unless the input section MC will be switched ON (when power is connected with the circuit normally, this will be switched ON).

11–2 Description of Operation (3)

Protective Circuit

Stall prevention, overload protection

This can detect load current, and monitor the load factor at all times.
When the inverter unit is judged as overloading, the circuit can adjust the voltage and frequency automatically (Stall prevention).
Moreover, when the current level is high, the output is current limited, and at the same time, the Fault detecting relay (FL) is energized and "OL" is displayed on the digital frequency indicator.

Overcurrent and Short-circuit protection

When the output terminals were short circuited in error or an abnormal current flows, this circuit can detect this immediately, the output is shut off to protect the inverter and at the same time, the Fault detecting relay (FL) is energized ("OC" is displayed on the digital frequency indicator).

Overvoltage protection

During the deceleration operation, when a regenerative power from the load is larger than normal, the voltage in the DC circuit is raised.
This circuit can detect this overvoltage, and automatically control the deceleration speed.
In addition, when the voltage level is above Maximum level, the output is shut off, and the inverter is protected from damage and the fault relay is energize.
("OU" is displayed on the digital frequency indicator).

Undervoltage protection

When the power source voltage drops, the output is shut off and the inverter is protected from damage.
At the same time, it energizes the Fault detecting relay (FL).
("UU" is displayed on the digital frequency indicator).

Instantaneous power interruption protection.

When there is an instantaneous power interruption to the inverter for greater than 15 ms, the FL relay is energized, and the inverter shut down safety.

Overheat protection

Through the thermal sensor installed on the cooling fin, an overheating condition can be detected, and the output shut off. At the same time, it will energize the Fault detecting relay (FL) ("OH" is displayed on the digital frequency indicator).

Thermal fuse for control transformer

The 460 volt-class VF PACK-P1 inverter has built-in thermal fuses, in the control transformer.
Whenever the temperature has risen extremely high, the thermal fuse will "OPEN" and the control power source is set to OFF and the inverter shut down.

Main circuit fuse

Most abnormalities are preventable by means of various kinds of protective circuits. Should a problem not be detected by the protection circuits for any reasons, the circuitry is protected by the main circuit fuses or the nonfuseable circuit breaker.
Consequently, *should the fuses blown or the breaker trips, it is presumed that there exist a fault in the inverters circuits.*
Therefore, if re-starting is required, first, remove the cause of trouble.

12. PROTECTIVE FUNCTION

12—1 Protective Functions

The inverter is provided with various protective functions, which functions are as follows.

Table 12-1 List of Protection Functions

Protective Function	Operation Level	Explanation of Operation	Output Frequency	Operation of FL relay	Display
Stall prevention	150% of rated current	Whenever the current exceeds the set value. The frequency and current is phased back. The stalling prevention function is operational during the acceleration and normal operation.	Frequency is lowered and the current becomes decrease.	Non	300 Lighting
Overcurrent and short-circuit protection	250% of rated current	When current reaches the overcurrent setting level (even instantaneously), the inverter will be instantaneously interrupted, and stopped.	Instantaneously set to 0Hz.	Available	OC
Restriction of overvoltage	200V class 360V DC ±20V 400V class 720V DC ±40V	When a motor is decelerated suddenly, regenerative energy is fed back in to the inverter. As a result, DC bus voltage will increase. In order to prevent this phenomenon, when the voltage reaches the limit setting value, the V/F standard is temporarily stopped and, it is duties waits for a drop in the bus voltage. Whenever the voltage decreases to the setting value, deceleration operation is resumed.	The deceleration operation is stopped until the voltage will decrease.	Non	Non
Overvoltage protection	200V class 400V DC ±20V 400V class 800V DC ±40V	If the DC bus voltage does not decrease in the above overvoltage restriction, and the overvoltage reaches the overvoltage interruption level, the inverter will instantaneously shut down.	Instantaneously set to 0Hz.	Available	Ou
Undervoltage protection	200V class 160V AC ±10V 400V class 330V AC ±20V	When the line voltage decreases to a set value, the control circuit will not operate normally. Whenever the voltage decreases to the undervoltage setting value, the inverter will be instantaneously shut down.	Instantaneously set to 0Hz.	Available	Uu
Overload protection	Counter-time-limit characteristics	Motor current is detected by means of a thermal relay circuit, overload monitoring is conducted. The electronic thermal relay circuit is featured by the counter-time-limit characteristics. 	Instantaneously set to 0Hz.	Available	OL
Instantaneous power interruption protection	Within 15 ms, the operation will continue	There is a 15 ms ride through characteristic an instantaneous power interruption.	Interruption within 15 ms is regarded as continuous operation	Non	Non
Overheat protection	70°C or more	Should the cooling fan be broken or inlet/outlet port be cloded, the inner temperature of the inverter will be rise. As a result, this overheating, will shut down the inverter.	Instantaneously set to 0Hz.	Available	OH
Fuse protection	—	In case the above protection circuits are not functioning, the fuses in or breaker will protect the inverter. 25 kVA or less inverter ..... D.C. fuse is used. 28 kVA or more larger inverter ..... no-fuse circuit breaker is used.		Non	Non
Emergency stop protection (Option)	Emergency stop signal is input, the operation is energized.	The inverter can be stopped from the external (emergency) signal. By making a shorting the connectors provided on the printed circuit board, the inverter can be stopped immediately.	Instantaneously set to 0Hz.	Available	E

12–2 Protection against Overcurrent (1)

The following protection are available:
(1) Stall prevention
(2) Overcurrent protection
(3) Overload protection
Explanation as follows:

1. Stall prevention
In case of starting (acceleration) and normal operation, when the current exceeds the stall setting value, the output frequency is lowered so the motor current is decreased.
Whenever the current reaches the setting value or less, the frequency is again accelerate. In this way, if any stall preventive level is activated, the output frequency is decreased. The lowering time is according to the deceleration time (DEC) which was set up.
In case the acceleration/deceleration time is extremely short and load variation is extremely large, the overcurrent can not be suppressed by means of the stall preventing measures. On this occasion, below mentioned overcurrent protection circuit is energized and the inverter's output is stopped instantaneously.

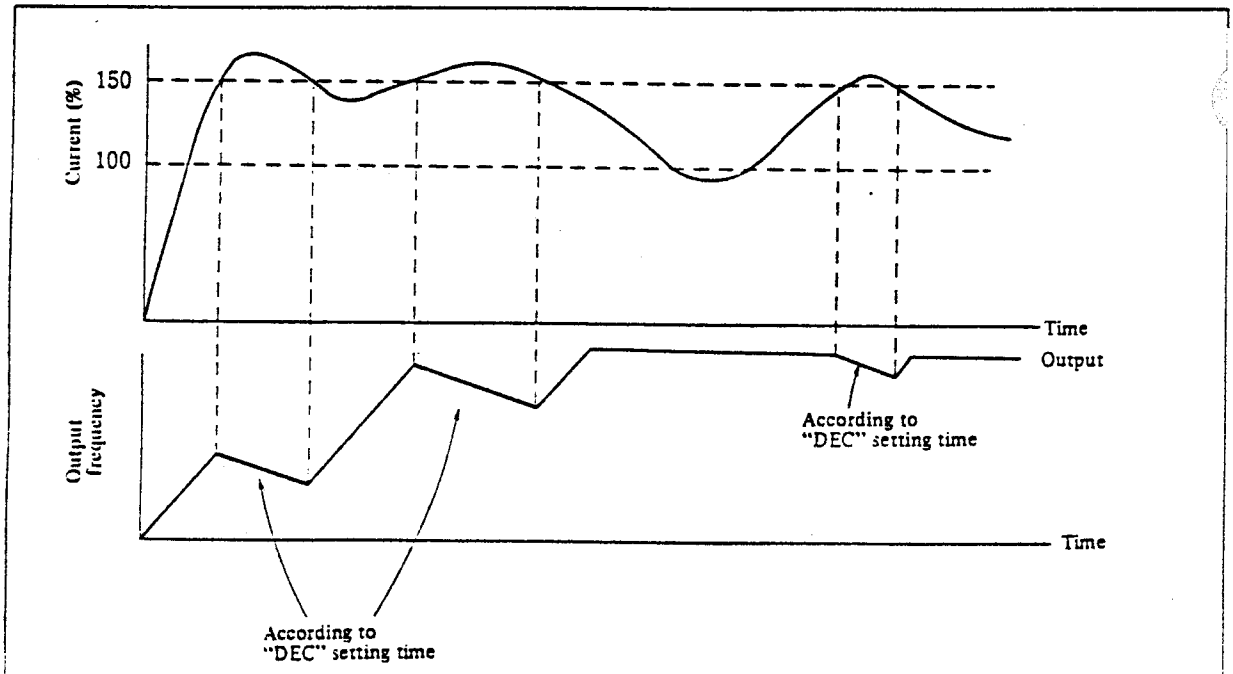


Fig. 12-1 Example of Stall Prevention

12–2 Protection against Overcurrent (2)

2. Overcurrent protection

The inverter is featured by the overcurrent protection; Actually, the inverter's main power device GTR can protect the inverter from flowing overcurrent. Actually, this overcurrent protection function can instantaneously trip the inverter, as a result, the motor becomes free run stop.

The below shows protection level. On this occasion, 100% current shows the inverter rated current.

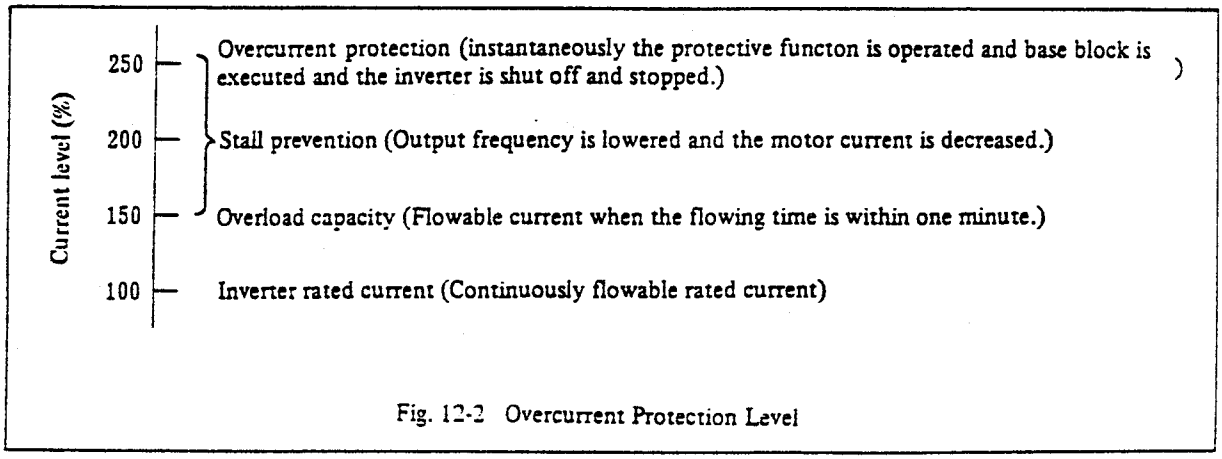


Fig. 12-2 Overcurrent Protection Level

12–2 Protection against Overcurrent (3)

3. Overload protection

If the inverter is operated at lower current which is less than the overcurrent protection level, and if such operation is continued for a long period of time, the motor might be subject to overload.

The VF PACK-P1 is featured by built-in electronic thermal relays, through which overload protection is operated. This means that the thermal relays are not required to be installed outside.

But, be careful to the following matters:

(1) The 100% current of the electronic thermal relay is coincided with the rated current of the inverter. In case small capacity motors are combined with the inverter, the thermal characteristics are different, so provided a external thermal relay depending upon the capacity.

(2) In case of multipole motors (8 poler or more), special motors or plural numbers of motors are combined, provided external thermal relays.

(3) In case motors are operated at a low speed, it is recommended to use a motor with thermal relay in the motor winding to ensure the thermal protection.

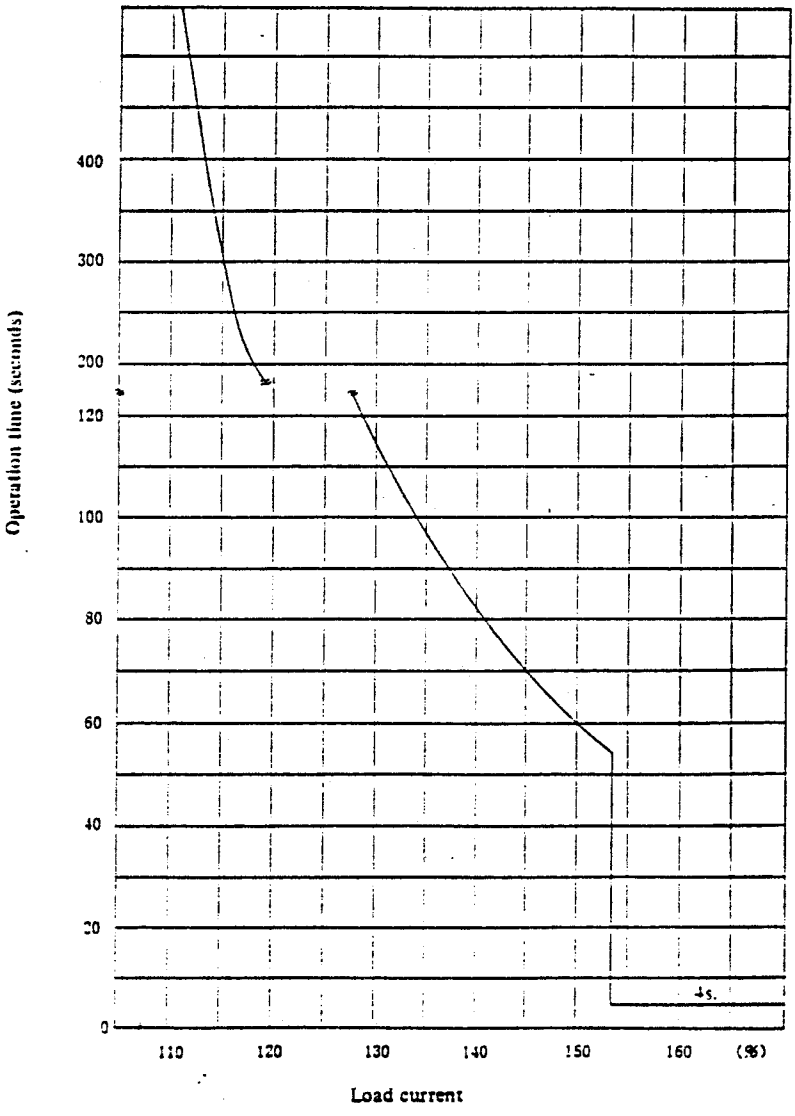


Fig. 12-3 Performance Characteristics of Electronic Thermal Relay

12–3 Protection against Overvoltage and Undervoltage

The VF PACK-P1 is featured by protection from overvoltage and from undervoltage, by detecting the power source voltage and main circuit DC voltage at all times.

The protection from abnormal voltage shows as follows:

(1) Overvoltage restriction
(2) Overvoltage protection
(3) Undervoltage (Unstable) protection
(4) Momentary power interruption protection

Then, explanation will proceed as follows:

1. Overvoltage restriction and overvoltage protection

Whenever a motor is decelerated, a regenerative braking is applied. Then, the regenerated energy is accumulated in a capacitor provided in the inverter main circuit. When rapid deceleration is conducted, the regenerative energy is increased and the amount of the capacitor can accumulate may exceed the allowable value (voltage). In order to protect this occasion, the D.C. voltage is detected at both ends of the capacity and, if the voltage exceeds the limit setting value, the deceleration command is temporarily stopped. It is required to wait for a while until the voltage decreases.

When the voltage reduces to the setting value, the deceleration is resumed. This is defined as "Overvoltage restriction".

Furthermore, when the DC voltage can not be lowered by this overvoltage restricting method, the voltage reaches the power shut off setting level, where the inverter is shut off and stopped. This is defined as "Overvoltage protection".

When the overvoltage protection is operated, set the deceleration time setting (DEC) to a longer value.

2. Undervoltage protection

Whenever the line voltage drops, the control circuit may not operate normally. To protect the circuit from such troubles, the control power source voltage is detected. When the value becomes less than the setting value, the inverter is shut off and stopped.

Check to see if the line voltage is within the range of rated voltage.

3. Momentary power interruption protection

Whenever the momentary power interruption period is longer, semi conductors in control circuit and micro processor will not operate normally. To prevent such troubles, control power source voltage is detected, and if the power interruption time is more than 15 ms, the inverter will be stopped.

On the contrary, if the momentary power interruption time is within 15 ms, the system can be operated normally and continuously.

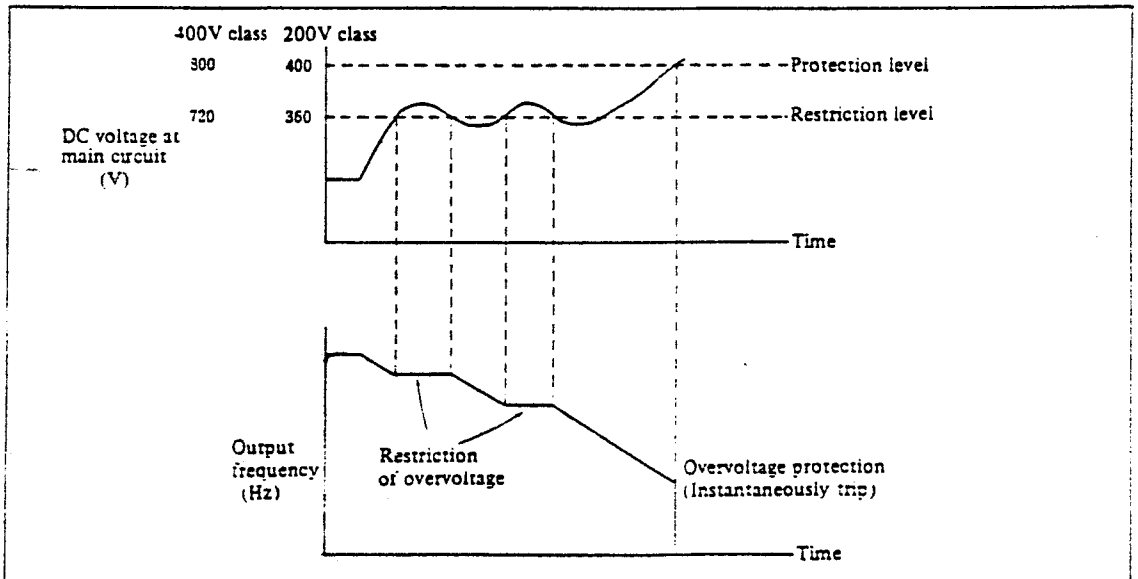


Fig. 12-4 Performance of Overvoltage Restriction and Protection

13. INSTALLATION

13–1 Installing Method

The VF PACK-P1 is featured by wall hanging installing methods.

Install the inverter on the wall utilizing installing holes provided on the base.

The inverter requires vertical installation as shown in Fig. 13-1 to provide sufficient ventilating spaces.

The inverter is 9.5 kVA or larger types. the inverter have cooling fans.

This means that ventilation directions should be provided for sufficient air flow.

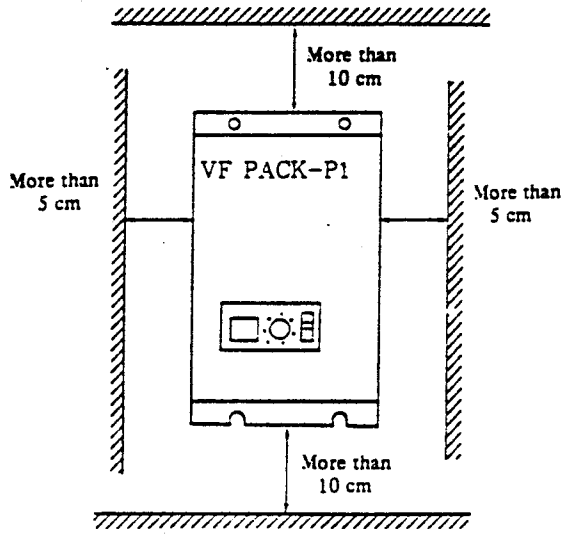


Fig. 13-1 Installing

For inverter 55 kVA or larger, four hanging hooks are provided and should be utilized for installation. We recommended that four hooks be utilized to ensure safe operation.

13–2 Location Environment

As for the installation location of inverters, pay special attention to the following points:

(1) Ambient temperature
10–50°C (around the enclosure)
(If the inverter is used under the ambient temperature of 40–50°C, remove the front cover from the inverter of the enveronment permits.)
Be careful that sufficient ventilation is provided to protect the inverter from heat accumulation. In case the self-supporting panel or larger control panel inside is effected by other heat generating parts, the inverter cover should be removed.
Examples where ambient temperature is high:
1. Adjacent to an oven
2. When inverter is stored in an non ventilated enclosure.
3. Adjacent to heating tank
4. When inverter is installed in Nema 12, Nema 4, Nema 7 & 9 or other similar type enclosure.

(2) Ambient humidity
The inverter should be installed in a location where the ambient humidity is less than 90% non condusing.
Examples where ambient humidity is high:
- Brewery and food processing shop, heat treating room or production line
- Wood drying room, etc.

(Note): The inverter should be used non condensing environments.
- Since the inverter is composed of many electronic parts, be careful not to allow water to enter inside the inverter.

Examples where dew-formation is forecast:
- Frozen foods transportation conveyor lines
- Cold districts

(3) Dust and impurity
Avoid installing inverters where dust and impurities are excessive.
Since the inverters are not fully enclosed, if any dust or impurity should infiltrate into the inner parts of the inverter, it might result in service shut down.
If the inverters are used in dusty locations, take appropriate measures to protect against harmful dust.
Examples where dust and impurities are high:
- Wood processing factory, adjacent to machine tools, metal processing shop, mill plant, casting shop, adjacent to grinding machine.

(4) Corrosive gases and corrosive cutting liquid.
Because inverters are composed of electronic component parts, they should be protected from corrosive gases and liquid.

(5) Since inverters are not provided with explosion-proof properties, these should be avoided.

(6) Even though the inverters are fully tested throug vibration test, the inverter should be installed in vibration-free locations. The allowable vibration degree is 0.5 G or less.

(7) The inverters should be free from noise generating sources (such as from power source switching gear). The inverter should be installed in locations easily accessible for inspection and maintenance.

13–3 Relation between Inverter Temperature Rise and Cooling Space

The heat generating amount by the heating loss of the inverters should be taken into account when the control panel is designed.

The inverter's heating value is caused by heating loss of the inverter, which is closely related with the inverter efficiency.

The inverter efficiency is 95% or more of the rated operation.

This means that 5% loss of efficiency in the inverter with 3% due to heat.

Under the assumption relative expression is described as follows:

$$P \times 0.03 = Q \quad \ldots\ldots (1)$$

where, P : Inverter capacity x 1000 (VA)
Q : Heat loss (W)

When the heat loss is known, the heat generation of the control panel (θ) can be calculated by the following expression:

$$\theta = \frac{Q}{\alpha \times A} \quad \ldots\ldots (2)$$

where, θ : Temperature rising value (deg)
α : Heat exchange efficiency ($W/m^2 \cdot K$)
A : Heat dissipation required area (m^2)

In this course, α is assumed as follows:

No cooling wind condition $\alpha = 5.4$ ($W/m^2 \cdot K$)
Cooling by a fan $\alpha = 14$ V 0.68 ($W/m^2 \cdot K$)
where V: wind velocity (m/s)

The heat generating (dissipation) required data area A is configured as shown below when a cabinet is used. But, the bottom face's heat dissipation efficiency set to 0. This is assume as floor mounted.

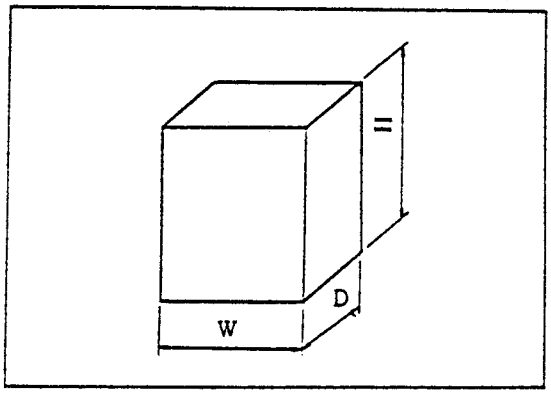


Table 13–1 shows the required heat dissipation when setting the temperature rise inside the control panel below 10 deg.

Table 13-1 Required Heat Dissipation Area of Inverter Housing Panel

Capacitor (KW/HP)	Loss (at rating) (W)	Required heat dissipation (m^2)	Control Box Dimension (mm) (Reference)		
0.75/1			W	H	x D
1.5/2					
2.2/3					
3.7/5					
5.5/7.5	285	5.3	1300 x	2100 x	400
7.5/10	390	7.2	1500 x	2300 x	400
11/15	570	10.6	1600 x	2100 x	600
15/20	750	13.9	2200 x	2300 x	600
18.5/25	840	15.6	2500 x	2300 x	1000
22/30	1020	18.9	2500 x	2300 x	1000
30/40	1380	25.6	3500 x	2300 x	1000
37/50	1650	30.6	4000 x	2300 x	1000
45/60	2070	38.3	4000 x	2300 x	1900
55/75	2520	46.6	5000 x	2600 x	1900

Notes: 1. The values are true for the housing panel (without cooling fans) of fully enclosed dust-proof type 12 enclosures.
2. The values may vary with service conditions and ambient temperatures. The temperature rise inside the panel is calculated below 10 deg.
3. Heat generation except for the inverter is not taken into account.
4. 230V and 400V inverters show nearly the same value.

14. OPTION SPECIFICATIONS

14—1 Option

The following optional specification is available.

Table 14-1 Kinds of Optional Specification

Class	Item	Details
Separate type	Operation Box	This is a remotely provided operation box which is used when (without operation panel) type. In the box, a frequency meter, frequency setting resistor, and ON-OFF push-button switch are housed. (Model: CBV-7B)
	Operation panel unit	This is a remote operation panel, where the operation panel is required to be installed separately from the inverter unit. A digital frequency meter, frequency setting resistor and drive switch are attached. (Model: CBF-7B)
	Radio noise Reduction filter	Sometimes during inverter runs, noise is generated in radio receivers being operated in their vicinity. In such cases, insert this option on the input side of the inverters. It will contribute to the reduction of such noise.
	Motor Noise Reduction Reactor	This is used for the purpose of reducing magnetic noises generated from a motor driven by the inverter.
	Total process controller	By combining with the total process controller, AP series, various kinds of application control become possible.
Built-in type	Speed Feedback Control	By installing the option PWB, speed feedback control becomes possible. On this occasion, AC-TG is required. TG rating: Singlephase – 2-P – 1800 rpm – 25 V Speed feedback control accuracy is approximately 0.5% or less (60 Hz typical).
	Set Point Control	By installing optional PWB, the Set point control is possible. On this occasion, the feedback signal is 4 – 20 mA of current signals.
	Speed reaching signal	By installing the optional PWB, the speed setpoint signal is obtainable. When a relay is installed between terminals SL-P24, the relay is energized by the value of the setting frequency.
	D/A conversion unit	By installing the optional PWB, a pulse array (several times of integer of setting frequency) input to the speed setting signals is serviceable.
	Ground Fault detection	By installing the optional PWB and a external ZCT, ground fault in the loading section can be detected, and protect of the inverter.
	BCD code or binary 12-bit Input Signal	By installing the optional PWB, as the speed setting signal, BCD code input or binary 12-bit input is possible.
	Commercial power source bypass	By improving the inverter unit, when the power source is changed over from commercial power operation to the inverter operation, inverter mode operation is selectable without stopping the motors.
	Automatic Restart	By modifying the assembly, without stopping the motor at the momentary power interruption, restarting is possible through the inverter.
	Overcurrent stalling protection level adjustment	The overcurrent stalling protection level can be adjusted variably. On this occasion, the level adjusting range is 75 – 150% (AC).
	Low speed signal output setting frequency adjustment	The setting frequency in the low-speed signal output can be adjusted variably. On this occasion, the setting frequency adjusting range is 0.5 – 30Hz.
	Jogging controll frequency adjustment	The jogging control frequency adjustment can be set up variably. On this occasion, the setting frequency range is within 1 – 15Hz (1 Hz step).
	Current Frequency Control	In order to avoid resonance phenomena caused by mechanical natural oscillation, the frequency band can be jumped as required.
	Emergency stop	Emergency stop signal is input (Connector pin), inverter becomes an coast stop.

14–2 Operation Panel Unit (Model CBF-7B)

(1) This is a remote operation panel, where the operation panel is required to be installed separately from inverter unit.

(Note) An operation panel built-in the inverter can not use a remote panel in spite of noise affected.
External dimension is shown in Fig. 14-7.

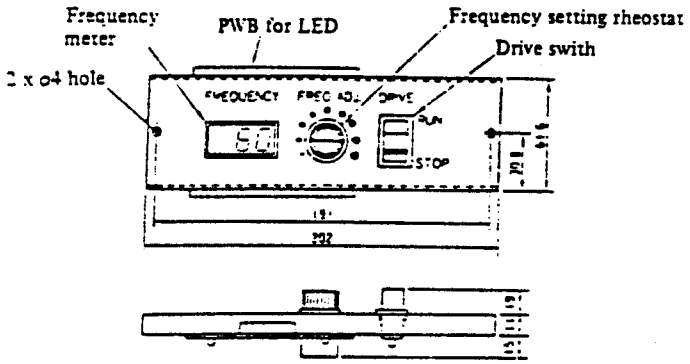


Fig. 14-7 Operation Panel Unit

(2) Connection is shown in Fig. 14-8.

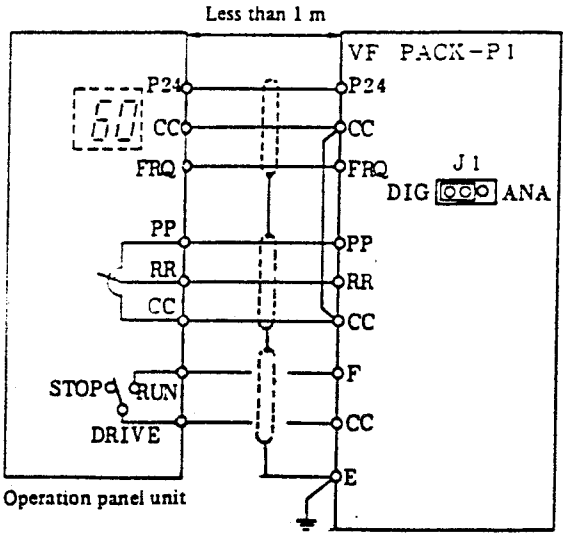


Fig. 14-8 Connection

(Note) 1. Display can indicate 1 Hz step.
2. When operates some protection, display can indicate " 0 ".
3. Use a shield wire for connection.

14–3 Radio Noise Reduction Filter (1)

1. High reduce effect type

(1) Rating and model

Series	Inverter Type-Form	Motor (kW/HP)	Noise Filter Type-Form	Rating Current (A)
230V class	VFP1-2015P-B	0.75/ 1	LF305	5
	VFP1-2020P-B	1.5 / 2	LF310	10
	VFP1-2040P-B	2.2 / 3	LF310	10
	VFP1-2065P-B	3.7 / 5	LF320	20
	VFP1-2095P-B	5.5 / 7.5	LF330	30
	VFP1-2130P-B	7.5 /10	LF340	40
	VFP1-2190P-B	11 /15	LF360	60
	VFP1-2250P-B	15 /20	RCL-2250	80
	VFP1-2280P-B	18.5 /25	RCL-2340	100
	VFP1-2340P-B	22 /30	RCL-2340	100
	VFP1-2460P-B	30 /40	RCL-2460	150
	VFP1-2550P-B	37 /50	RCL-2690	200
	VFP1-2690P-B	45 /60	RCL-2690	200
	VFP1-2840P-B	55 /75	RCL-2840	240
460V class	VFP1-4015P-B	0.75/ 1	LF310A	10
	VFP1-4040P-B	2.2 / 3	LF310A	10
	VFP1-4065P-B	3.7 / 5	LF310A	10
	VFP1-4095P-B	5.5 / 7.5	LF315A	15
	VFP1-4130P-B	7.5 /10	LF320A	20
	VFP1-4190P-B	11 /15	LF330A	30
	VFP1-4250P-B	15 /20	LF340A	40
	VFP1-4280P-B	18.5 /25	LF350A	50
	VFP1-4340P-B	22 /30	LF350A	50
	VFP1-4460P-B	30 /40	RCL-4460	80
	VFP1-4550P-B	37 /50	RCL-4690	100
	VFP1-4690P-B	45 /60	RCL-4690	100
	VFP1-4840P-B	55 /75	RCL-4840	150

(2) Connection

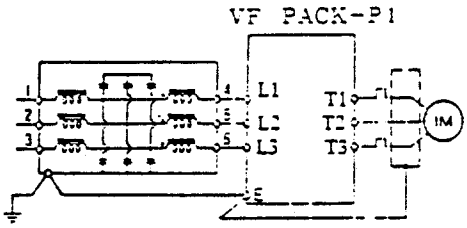


Fig. 14-9 Connection

(3) Effect

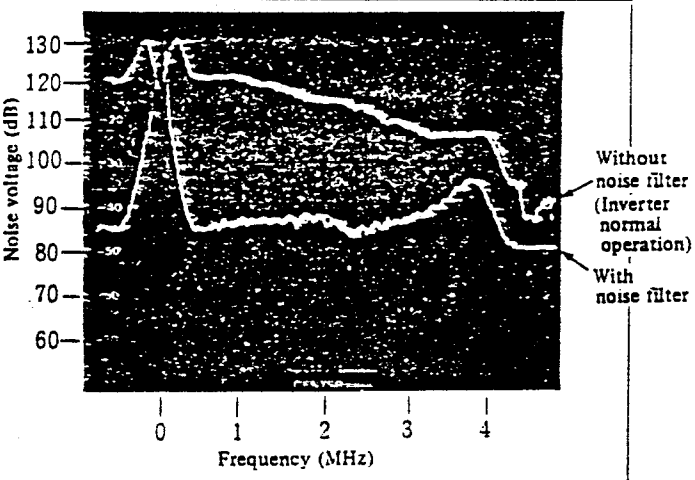


Fig. 14-10 Effect of Noise Filter (example)

14–3 Radio Noise Reduction Filter (2)

2. Simple type

(1) Rating and Model

Series	Type – Form	Rating
200V	RCL – M2	250V – 50/60 Hz
400V	RCL – M4	500V – 50/60 Hz

(2) Connection

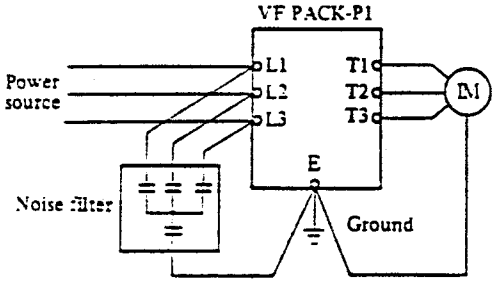
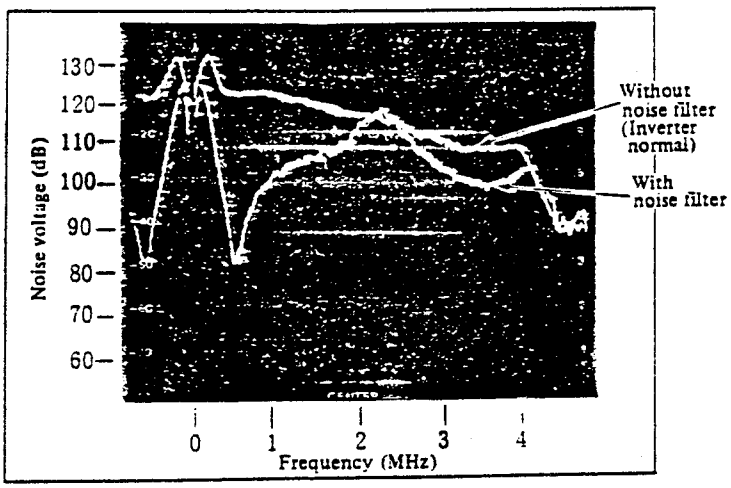


Fig. 4-12 Connection

(3) Effect

Especially, frequency band 1 MHz can reduce a radio noi



14—4 Motor Noise Reduction Reactor

(1) Rating and model

Series	Inverter Type-Form	Motor (kW/HP)	Reactor Type-Form	Rating	Fig. No.
230V class	VFP1-2015P-B	0.75/ 1			1
	VFP1-2020P-B	1.5 / 2			
	VFP1-2040P-B	2.2 / 3			
	VFP1-2065P-B	3.7 / 5			
	VFP1-2095P-B	5.5 / 7.5	RCT-2110	33A-2 mH	
	VFP1-2130P-B	7.5 /10	RCT-2110	33A-2 mH	
	VFP1-2190P-B	11 /15	RCT-2160	50A-1.2 mH	
	VFP1-2250P-B	15 /20	RCT-2220	66A-0.8 mH	
	VFP1-2280P-B	18.5 /25	RCT-2280	80A-0.64mH	2
	VFP1-2340P-B	20 /30	RCT-2460	130A-0.44mH	
	VFP1-2460P-B	30 /40	RCT-2460	130A-0.44mH	
	VFP1-2550P-B	37 /50	RCT-2690	200A-0.33mH	
	VFP1-2690P-B	45 /60	RCT-2690	200A-0.33mH	
	VFP1-2840P-B	55 /75	RCT-2840	240A-0.22mH	
460V class	VFP1-4015P-B	0.75/ 1			1
	VFP1-4040P-B	2.2 / 3			
	VFP1-4065P-B	3.7 / 5			
	VFP1-4095P-B	5.5 / 7.5	RCT-4110	17A-6 mH	
	VFP1-4130P-B	7.5 /10	RCT-4110	17A-6 mH	
	VFP1-4190P-B	11 /15	RCT-4220	33A-2.4 mH	
	VFP1-4250P-B	15 /20	RCT-4220	33A-2.4 mH	
	VFP1-4280P-B	18.5 /25	RCT-4280	40A-2.4 mH	2
	VFP1-4340P-B	22 /30	RCT-4460	70A-1.6 mH	
	VFP1-4460P-B	30 /40	RCT-4460	70A-1.6 mH	
	VFP1-4550P-B	37 /50	RCT-4690	100A-1.2 mH	
	VFP1-4690P-B	45 /60	RCT-4690	100A-1.2 mH	
	VFP1-4840P-B	55 /75	RCT-4840	120A-0.8 mH	

(2) External dimension

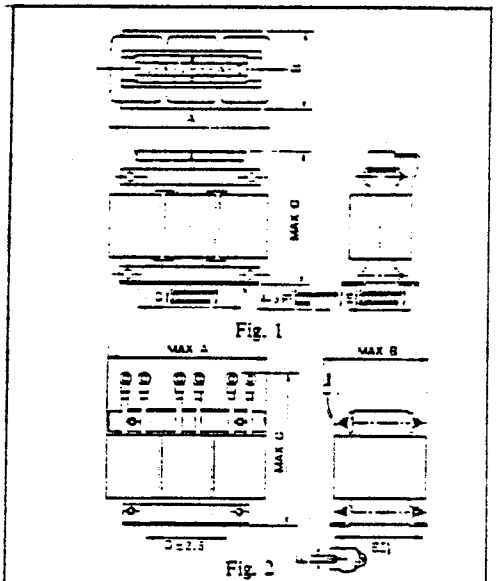


Fig. 1

Fig. 2

Fig. 14-14 Dimension

(3) Connection

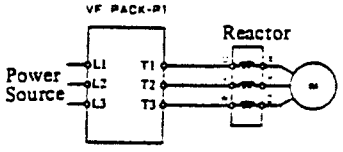


Fig. 14-15 Connection

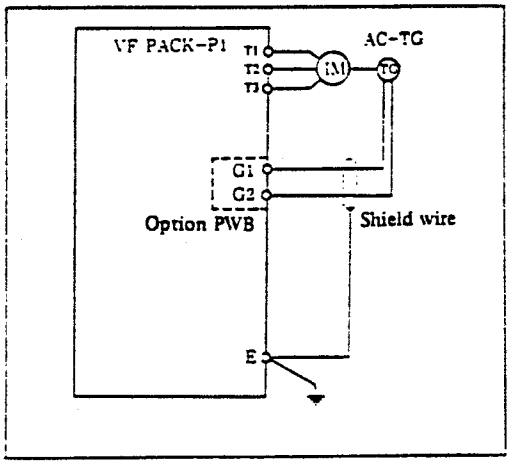
14–5 Speed Feedback Control (1)

By installing the option PWB. speed feedback control becomes possible. On this occasion, AC-TG is required. Speed feedback control accuracy is approximately 0.5% or less (60 Hz typical).

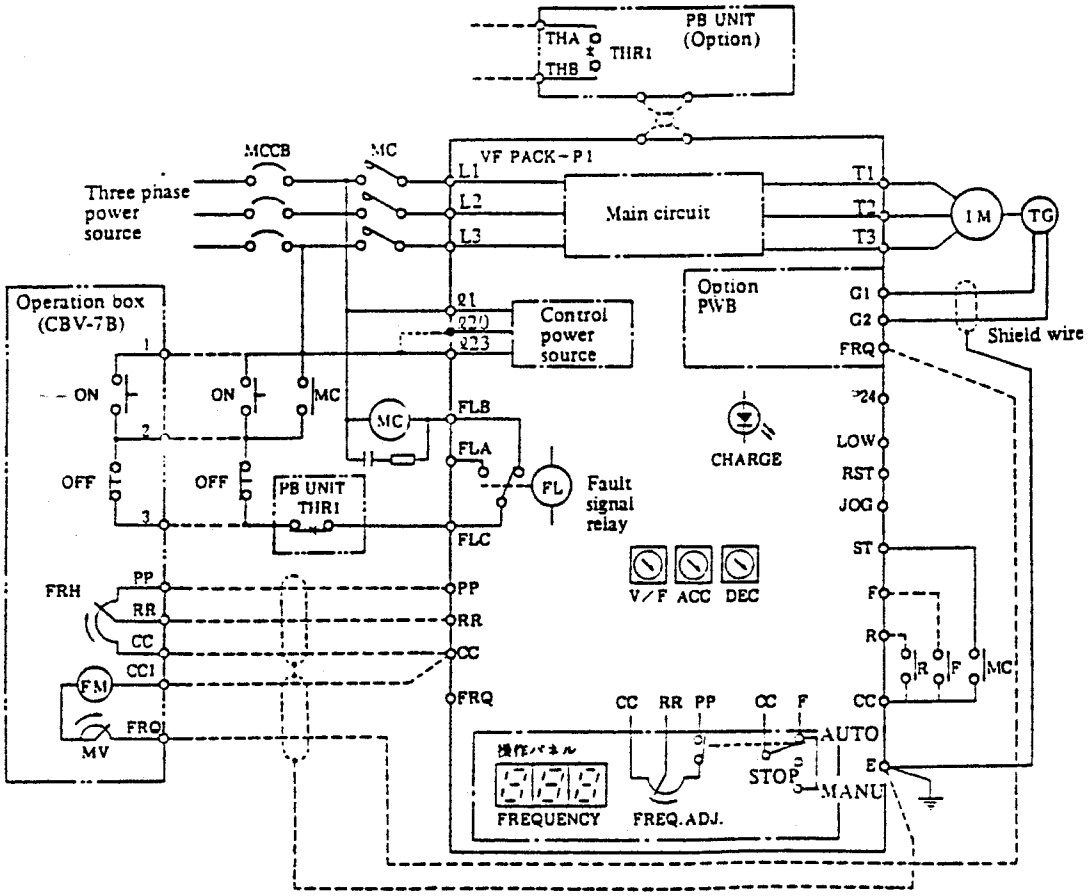
1. Rating and specification

Item		Rating and Specification
Input	Signal	Pulse array (Open collector signal)
	Pulse width	More than 10 μs
	Pulse number	16 times of output frequency
Output signal		0 ~ 10V-DC
Gain adjustment		0.4 ~ 1.3
Bias adjustment		−1.6 ~ +1.7V-DC
Control power supply		±15V-DC (provides the VF PACK-P1)

2. Construction



3. Connection



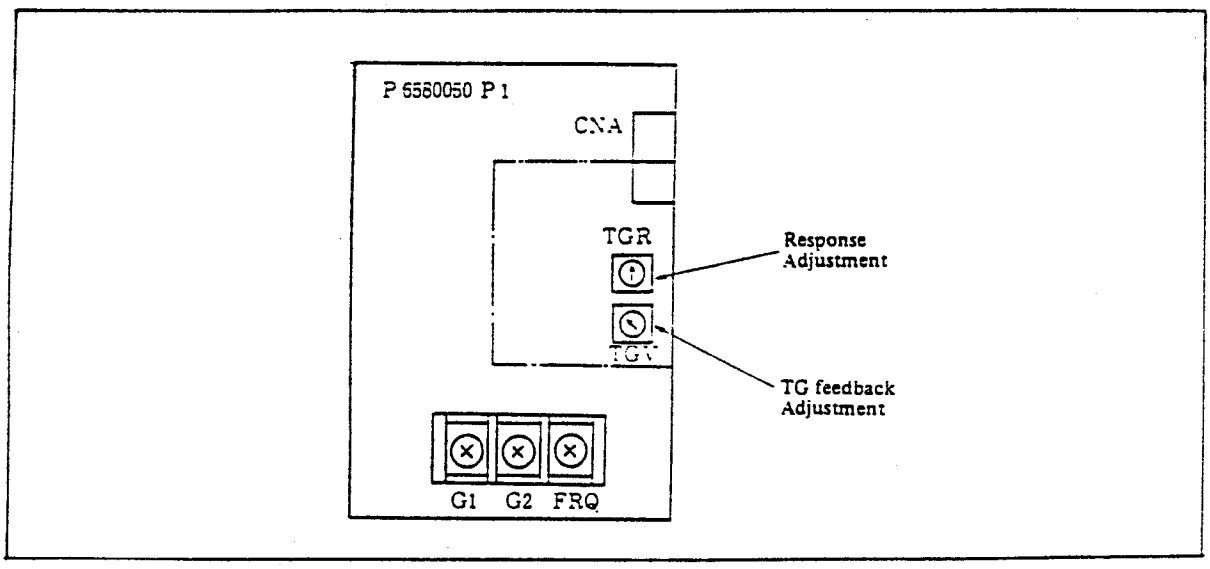
14–5 Speed Feedback Control (2)

4. Adjustment

The following variable resistor for adjustment is provided on the sub PWB.

Table 14-8 Speed Feedback Control

Name	Function	Adjustable CCW (↺)	Range	AT shipment
TGR	Response	Become slow	–	Most available (Note 2)
TGV	Amount of TG feedback	Become few amount (Speed becomes fast)	(Note 1)	1φ–AC–TG 24 pole – 1800 rpm – 25 V



(Note 1): The output of the tachometer generator (TG) to be used is sufficiently serviceable, when its specifications shows the following values:
[Rating: Singie-phase – 24 poles – 1800 rpm – 20 ~ 75 V]; resistor [TGV] adjust speed for a variable.

(Note 2): The variable resistor [TGR] should be used only when the control system shows hunting and unstabilized conditions. Practically, it is unnecessary to adjust it.

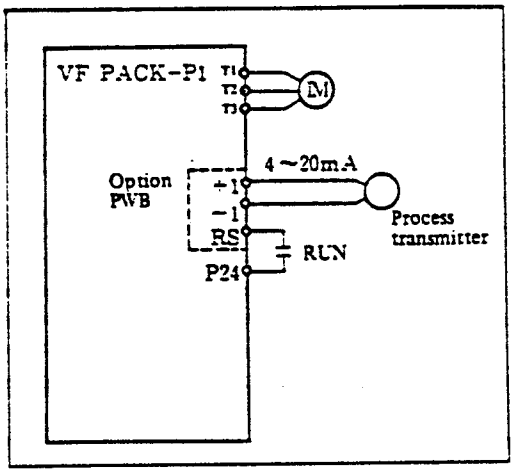
14—6 Set Point Control (1)

By installing option PWB. the set point control is possible. On this occasion, the feed back signal is 4 to 20 mA of current signal.

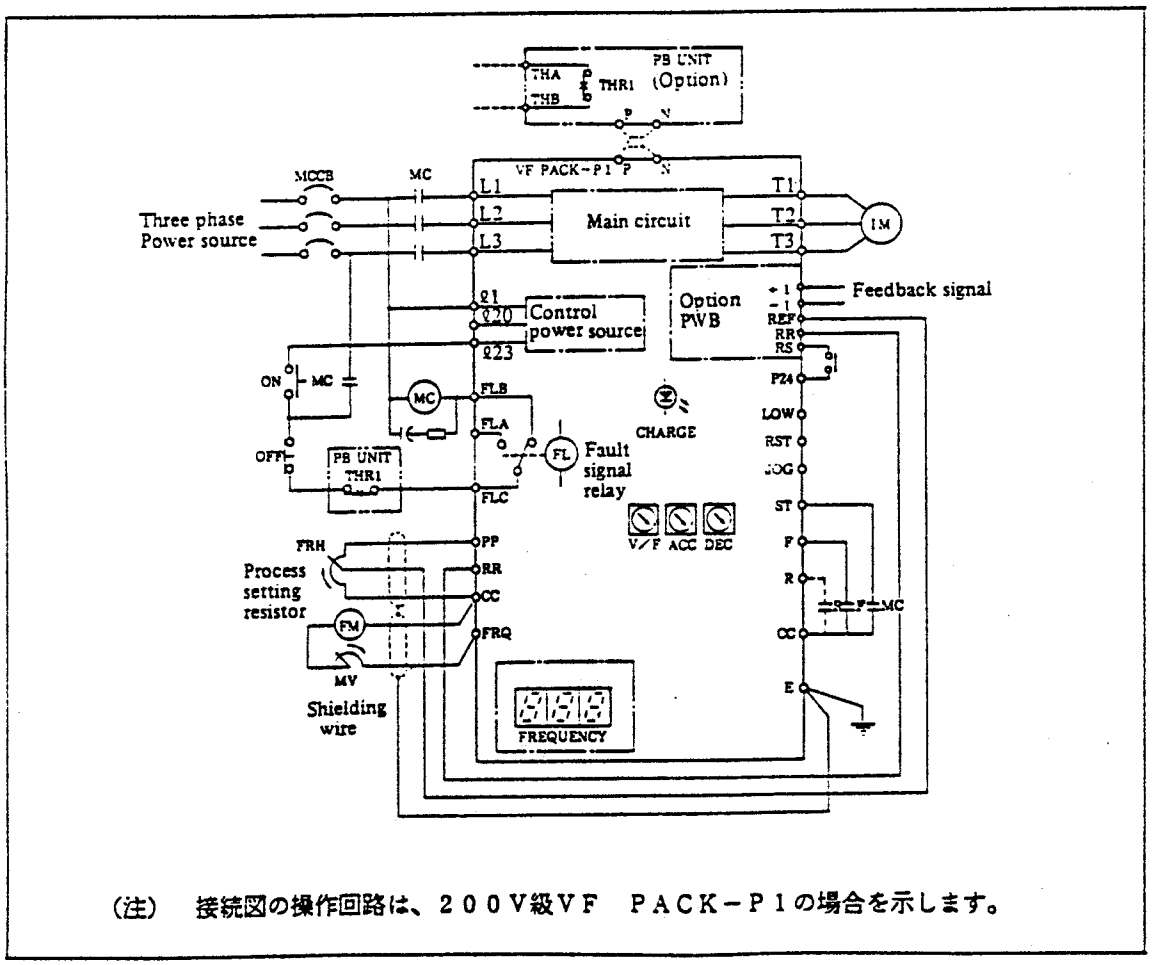
1. Rating and specification

Item	Rating and specification
Current signal	4 to 20 mA (Input impedance 240Ω)
Output signal	0 to 10V (Output to VF PACK-P1)
Gain adjustment	0.2 to 3 (Gain 1 means Input 20 mA – Output 10V)
Bias adjustment	−4.5 to 4.5V·DC
Upper/Lower limit	0 to 10V·DC (Upper/Lower limit can be adjustable individually)
Integrated time	0.7 to 115 seconds

2. Construction



3. Connection



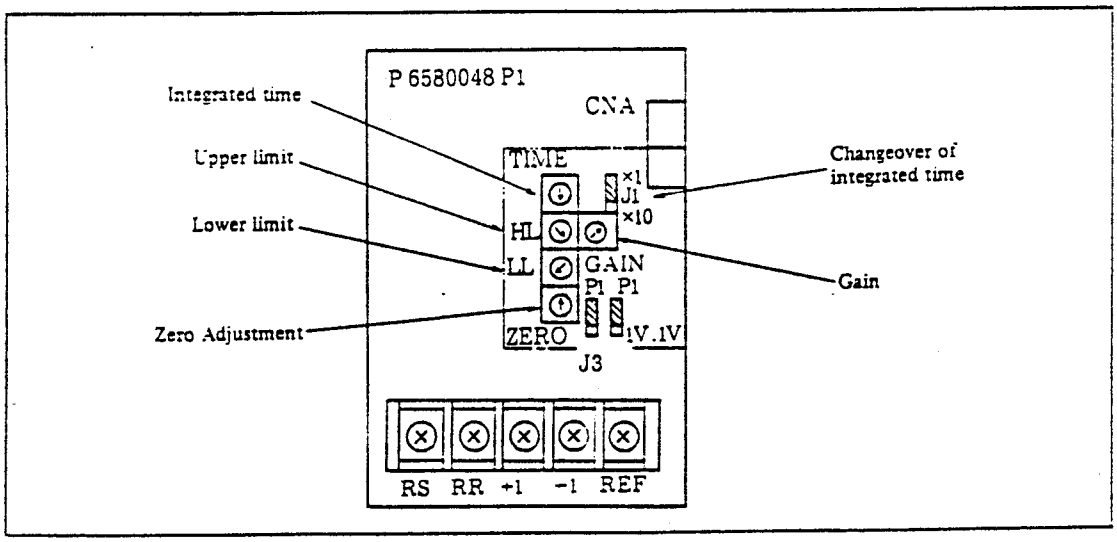
(注)　接続図の操作回路は、２００Ｖ級ＶＦ　ＰＡＣＫ－Ｐ１の場合を示します。

14–6 Set Point Control (2)

4. Adjustment
The following variable resistor for adjustment is provided on sub PWB.

Table 14-9 Set Point Control

Name	Function	Adjustable CCW (↺)	Range	AT shipment
Gain	Gain	Larger Gain	0.4 ~ 3	About 7 notch (20mA – 80 Hz)
ZERO	ZERO start adjustment	Higher output frequency	–4.5 ~ +4.5V	About 4.5 notch (4mA – 0 Hz)
HL	Upper limit	Higher upper limit	0 ~ 10V	10 notch (max.)
LL	Lower limit	Higher lower limit	0 ~ 10V	0 notch (Min.)
TIME	Integrated time	Longer integrated time	0.7 ~ 115 S. Conbine with Jumperpin J1	5 notch (6 Seconds)



Note: Jumper pin J1 is setting at x1 side (▨) at shipment.

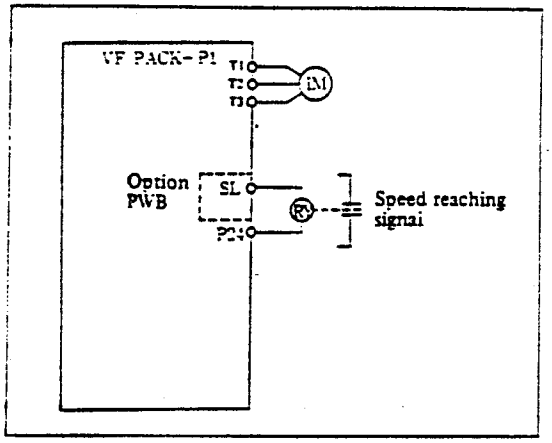
14–7 Set Speed Signal (1)

By installing the option PWB, a set speed signal is obtainable. When a relay is installed between terminals SL-P24, the relay is energized by the value of the setting frequency or more.

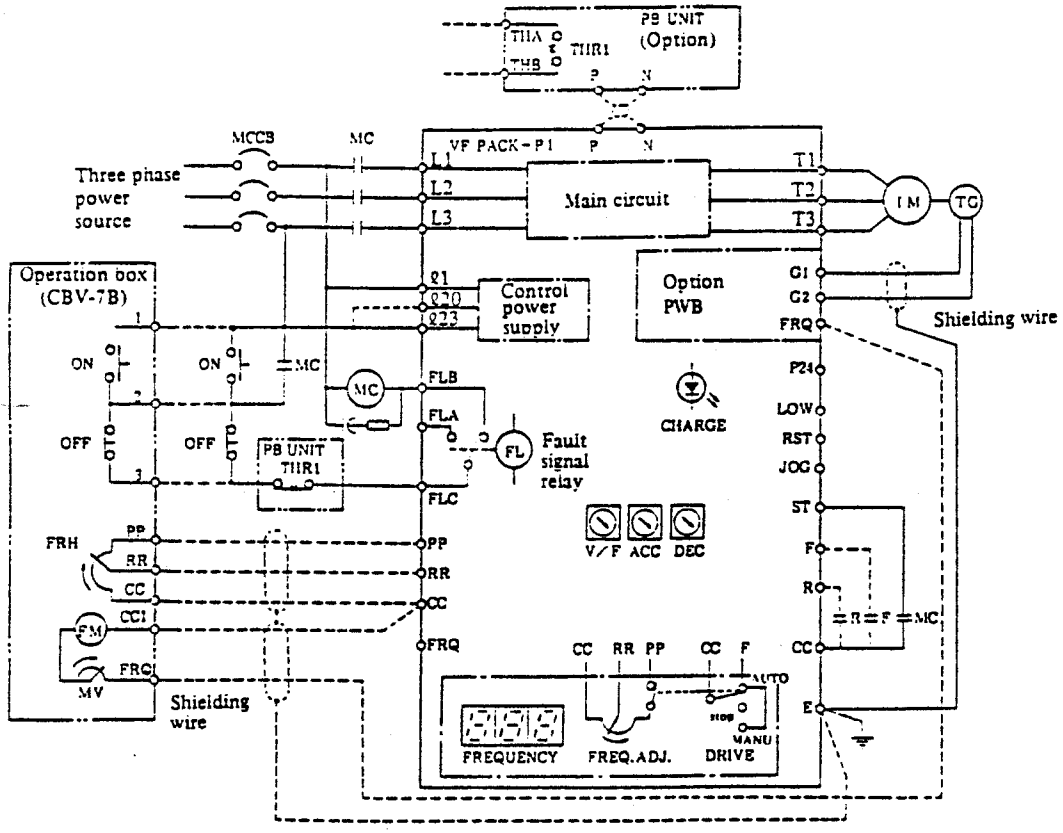
1. Rating and specification

Item			Rating and specification
Mode	Input signal	Input	0 to 10V·DC
		Deflection	0.5 to 25 Hz adjustable (AT 80 Hz)
	Setting signal		15 to 80 Hz adjustable
Speed reaching signal			Open collector (24V·DC – 50 mA·max.)

2. Construction



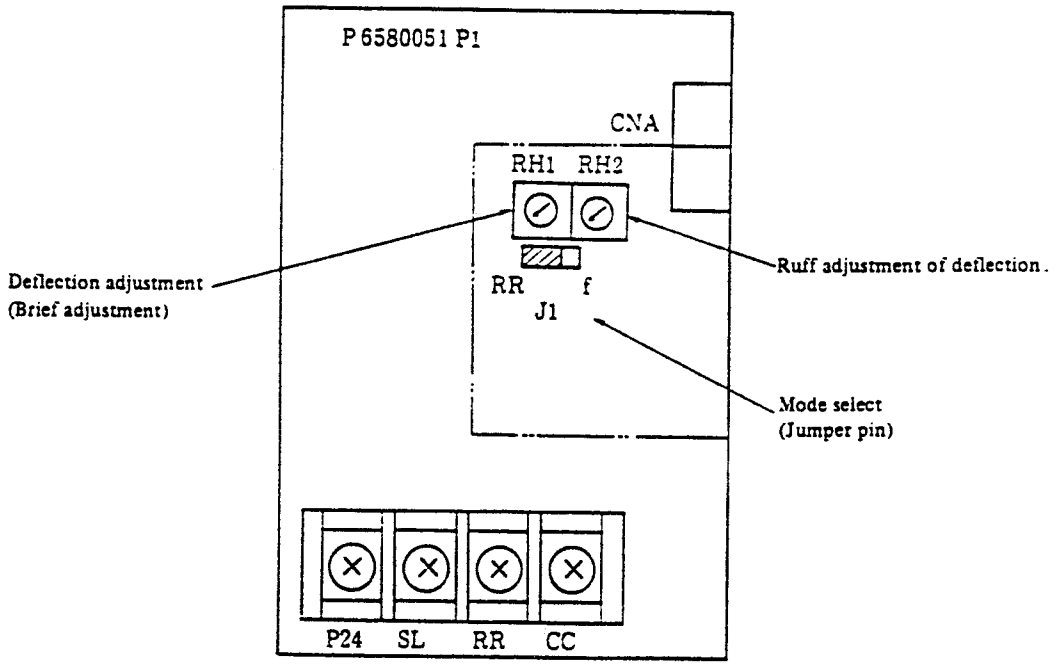
3. Connection



14–7 Set Speed Signal (2)

4. Adjustment

Jumper pin J1	Name	Function	Adjustment CCW (↶)	Range	AT shipment
"RR" External signal	RH1	Deflection of reaching frequency	Larger deflection	0.5 to 25 Hz	About 2 notch (0.5 Hz)
	RH2	No need	–	–	–
"f" Internal signal	RH1	Deflection (brief adjustable)	Setting frequency becomes smaller	According to RH2	(About 2 notch)
	RH2	Deflection (Ruff adjustable)	Setting frequency becomes smaller	15 to 80 Hz	0 notch



Note: 1. Jumper pin J1 set "RR" side at shipment
2. (▨) value shows when J1 set "f" at above table.

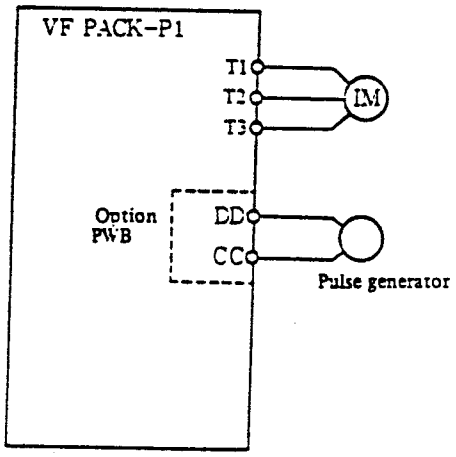
14–8 D/A Conversion Unit (1)

By installing the option PWB, a pulse array (several times of integer of setting frequency) input to the speed setting signals is serviceable.

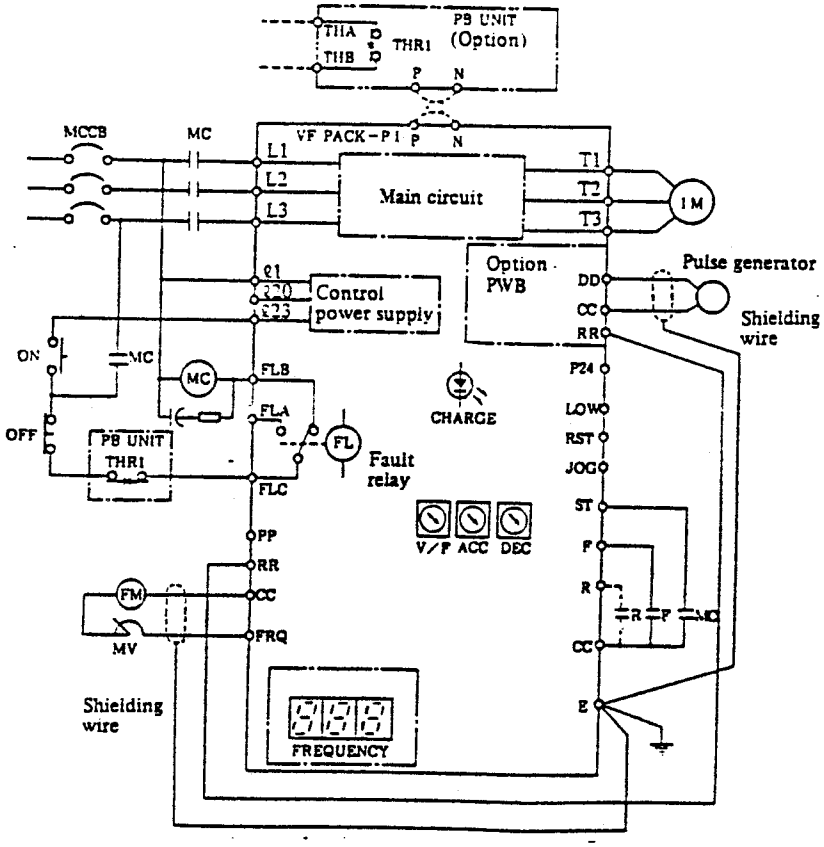
1. Rating and specification

Item		Rating and specification
Input	Signal	Pulse array (Open collector)
	Pulse width	More than 10 μs
	Pulse number	16 x Output frequency of inverter
Output signal		0 to 10V·DC
Gain adjustment		0.4 to 1.3
Bias adjustment		−1.6 to 1.7V·DC

2. Construction



3. Connection



14–8 D/A Conversion Unit (2)

4. Adjustment

Name	Function	Adjustment CCW (↶)	Range	AT shipment
GAIN	Gain	Large	0.4 to 1.3	About 5 notch
BIAS	Bias	(–) bias is provided	–0.6 to 1.7V	About 6 notch (Bias 0)
RH1 (Note)	Input signal range	Input signal range is smaller	–	About 6 notch

14–9 Automatic Reset

By modifying the assembly, without stopping the motor at the momentary power interruption, restarting is possible through the inverter.

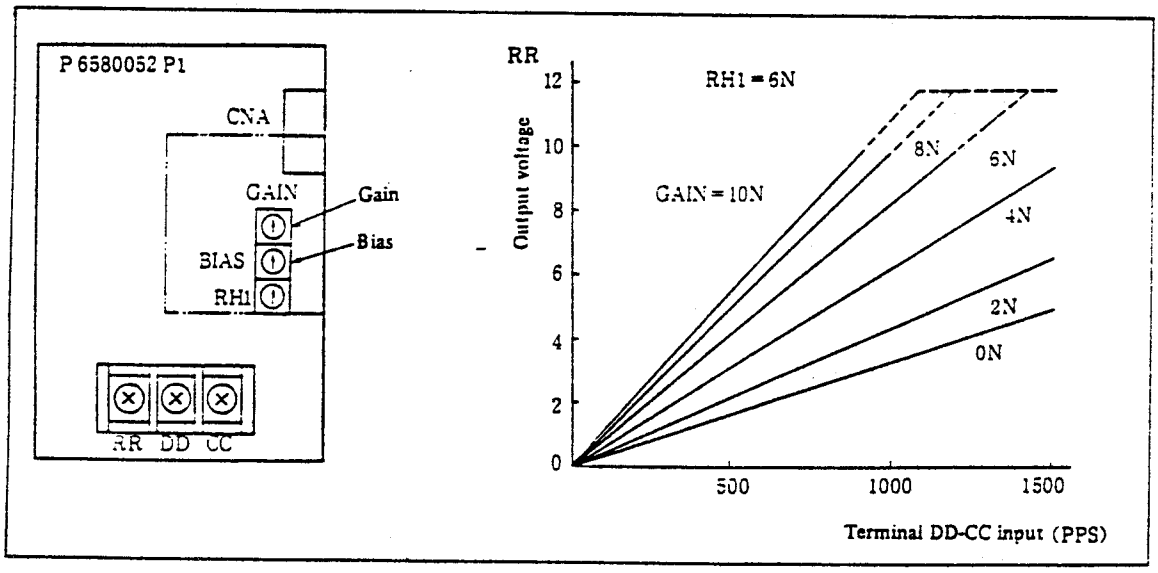
1. Rating and specification

Item	Rating and specification
Time of the momentary power interruption	Longer than 15 ms (No limitation)
Detected range	0 to 80 Hz

(Note) At occasion in long time power interruption (longer than 15 ms), input magneticontactor becomes "OPEN" condition, so inverter becomes an coast stop.

2. Connection

The connection is same as a standard connection.



(Note) 1. Ordinary, adjustment of RH1 is not need. Contact for Toshiba.
2. Gain characteristics is as reference.

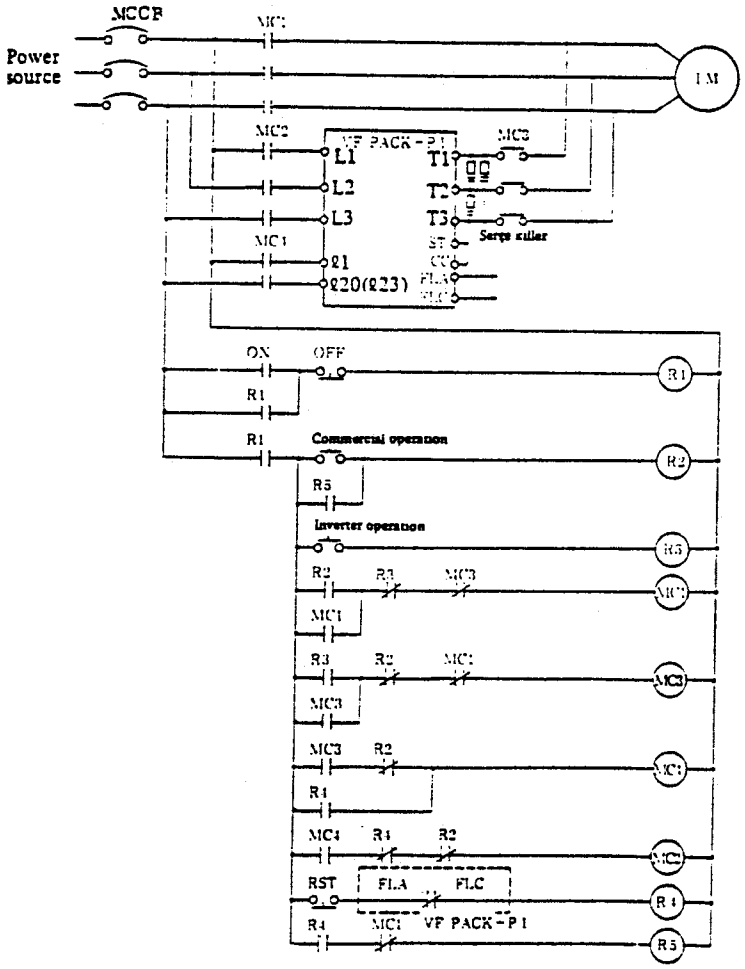
14—10 Maintenance — Bypass

The inverter can be transfered across the line operation in the case of an inverter failure or as required by maintenance personnel.

1. Rating and specification

Item	Rating and specification
Range of detection	0 to 80 Hz
Control power supply	±15V·DC and + 5V·DC (provided the VF PACK-P1)

2. Connection



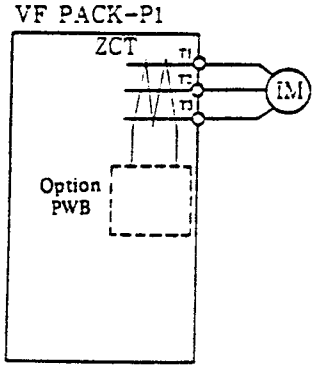
14–11 Ground Fault Detection (Standard)

By installing the option PWB and the external ZCT, ground fault can be detected. to protect the inverter.

1. Rating and specification

Item		Rating and specification
Level of detection	Current	Larger than 30 mA
	Frequency	10 to 80 Hz
	Interrupted time	Smaller than 20 ms.

2. Construction



(Note)
ZCT is provided externally at 20 kVA and more.

3. Connection
The connection is same as the standard connection.

15. INSPECTION AND MAINTENANCE

15—1 Current and Voltage Waveform

When the inverter is operating, the current and voltage waveform contain higher harmonic properties.

As a result, complete sinusoidal waveform is unobtainable.

The below shows actual voltage waveform and current waveform displayed on a synchroscope.

1. Inverter input voltage, current waveforms:
   Capacitor input type current will flow.
   Actual measuring waveform is shown in Photo 15-1.
   Voltage (upper) : 200 V/div.
   Current (lower) : 5 A/div.
   5 ms/div.

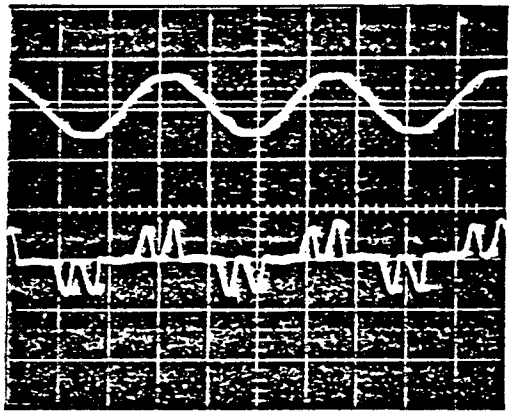


Photo 15-1

2. Inverter output voltage/current waveform
   Actual measuring waveform at 50 Hz is shown in Photo 15-2.
   Referring to the photo, a rectangular wave containing sinusoidal wave distribution pulse width in line voltage, and proximity sinusoidal wave containing modulation frequency ripple current are observed.
   Voltage (upper) : 200 V/div.
   Current (lower) : 5 A/div.
   5 ms/div.

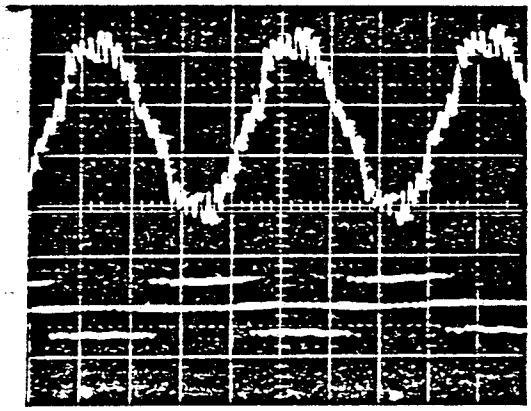


Photo 15-2

15–2 Measuring Method of Current and Voltage

As mentioned above. during the inverter operation, higher harmonic properties are contained in the voltage and current.

Accordingly, the measuring data is variable depending upon the performance of the instruments and measuring circuits.

Therefore, it is requested to use the specified instruments described on Table 15-1 while referring to the applicable circuit shown on the figure.

In this case. however, even if it is the same accuracy instrument. errors might arise depending on the type, manufacturer. manufacturing date, etc. of the instruments served.

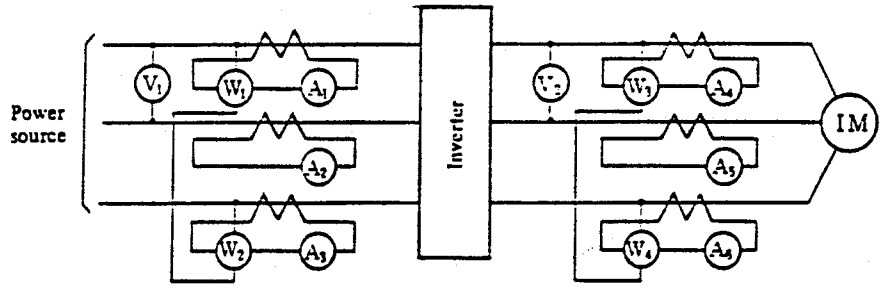


Fig. 15-1 Measuring Method

15–3 Failure Inspection and Troubleshooting (1)

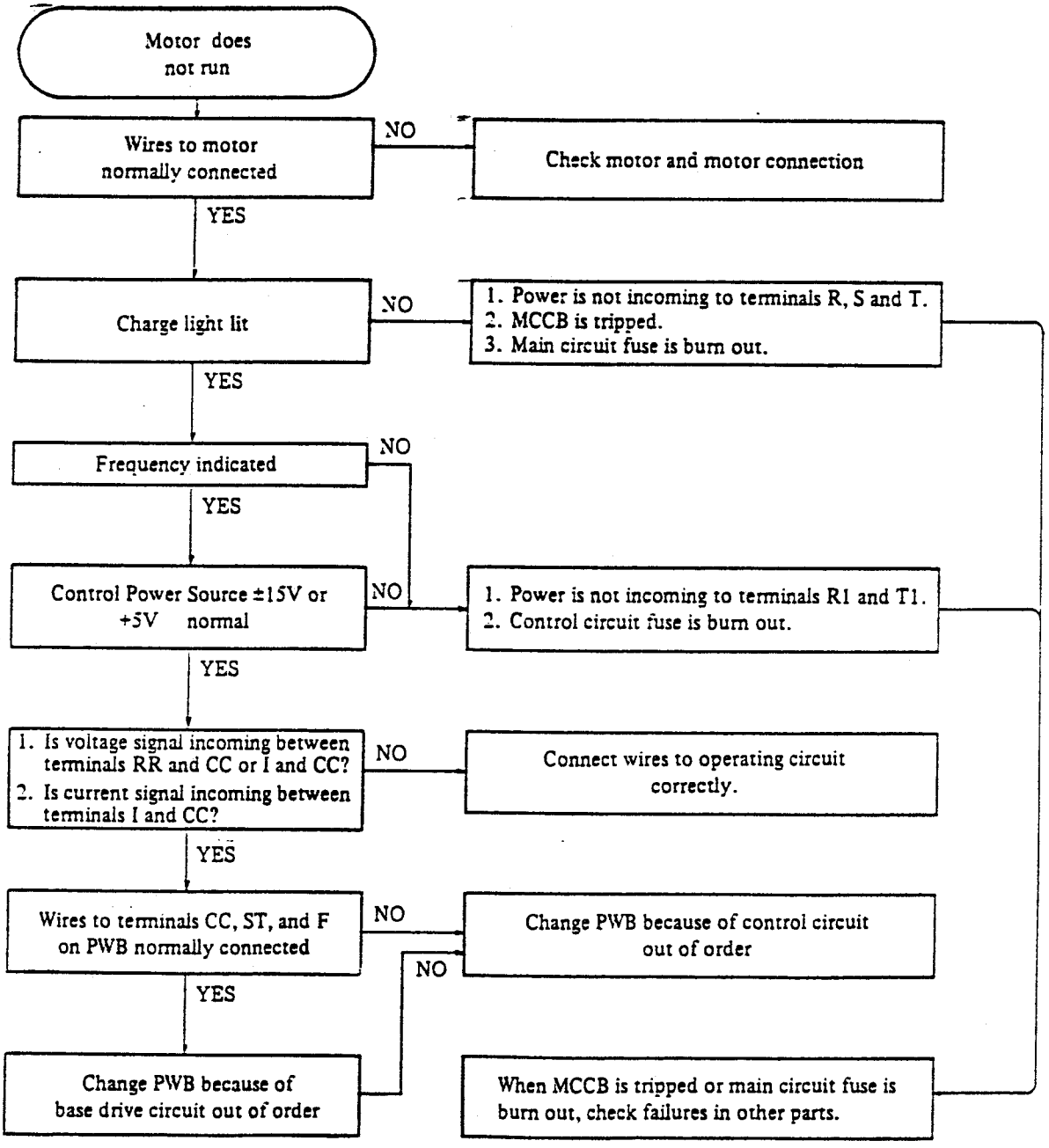


Fig. 15-2 Diagnosis chart of modern operating troubles

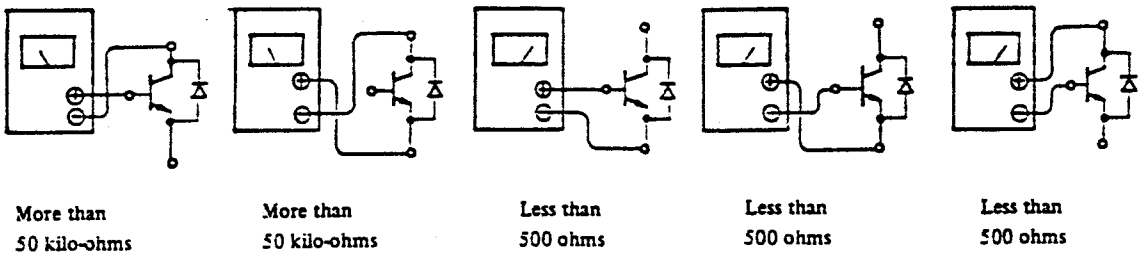


Fig. 15-3 Check of GTR (normal resistance)

It is necessary to apply a thin coat of a heat-conductive silicone compound to the surface of the heat sink before attaching GTR.

Recommended silicone compound
(Jointal S–200 - manufactured by NIKKEI KAKO K.K.)
(Clamping torque of GTR is 20 or 30 kg.cm.)
GTR is installed with screws.

15—4 Inspection and Maintenance

Conduct inspection after turning OFF the no-fuse circuit breaker (MCCB).

Precautions during Maintenance/Inspection

> A large capacity is employed on Toshiba's VF PACK-P.
> After interrupting the power source, voltage still remains in this capacitor for 15 minutes.
> Prior to starting maintenance/inspection, confirm that the "CHARGE" lamp is extinguished. Also, use a tester to confirm that no residual voltage exists on the capacitor (between terminals + and −).

Inspection Items

(1) Are there any loose wiring terminals or damaged cables?
(2) Are air-inlets clogged with dust or dirt?
(3) Has dirt or dust penetrated the unit interior or accumulated on PC boards?
(4) When not used over a long period of time, operation confirmation semiannually by supplying power is recommended.
(5) When conducting an insulation test, use a DC 500V megger only on the main circuit terminal block (R1, T1, R, S, and T). Never conduct this test on the terminals of PC boards.
(6) When conducting an insulation test on motors, apply a single motor-unit test by disconnecting connections at the output terminals (U, V and W).
(7) Do not conduct a withstand voltage test: interior component damage may occur.

Periodic inspections a month are recommended to maintain a good operating environment.