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TOSHIBA

INSTRUCTIONS FOR

TRANSISTOR INVERTER FOR FAN AND PUMP APPLICATIONS

VF PACK-P

TOSHIBA CORPORATION

MMVJ-0301

The VF PACK-P series inverters have been chiefly designed for driving fans and pumps. Before commencing operation of the VF PACK-P, carefully read this manual to ensure proper performance of the VF PACK-P.

Please retain this manual for referencing, checking or servicing of the VF PACK-P inverter.

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1. INSPECTION AFTER PURCHASE

After uncrating, check for the following:

(1) Inspect for damage in shipment.

(2) Check that the ratings on the nameplate and ensure they match the application requirement.

If you find any problem, please contact your dealer.

2. FEATURES

(1) Best suited for energy savings operation of fans and pumps

The VF PACK-P detects the motor current and controls the output voltage which results in improvement of efficiency and energy savings.

(2) Choice of operation patterns

The VF PACK-P employs an automatic operation system that selects the optimal voltage/frequency (V/f) ratio automatically. A manual operation system is also available and has the choice of 12 constant V/f ratios.
According to the load condition, the best operational pattern can be selected. This V/f ratio versatility gives the VF PACK-P a broad range of applications.

(3) Compact, light weight, and highly reliable

Employing micro-computor for controlling, digital circuitry, selfadjusting system, and transistor module construction of

the main circuit make the VF PACK-P compact, light weight and highly reliable.

(4) Excellent system protection features

The VF PACK-P has the following: "Stall preventing function" "Over current protection", "Over voltage protection" and "Under voltage protection".
The unit also provides a relay for external alarm of abnormal conditions (fault detection). The unit also has a fuse to prevent burn out.

(5) Digital frequency indicator

For models with an operating panel, a digital frequency indication system is employed.
The frequency can be read clearly and set accurately.

3. STANDARD SPECIFICATIONS

The standard specifications are shown in table 1.

Table 1. Standard specifications

Item		Description						
Applicable motor output (HP)		1/4	1/2	1	1 1/2	2	3	5
Models and Ratings	Type-Form (Note 1)	VF10P-2015B0			VF10P -2020B0		VF10P -2030B0	VF10P -2050B0
	Capacity (KVA)	1.5			2		3	5
	Rated current (A)	4.5			7		9	15

Item		Description
Power Supply	Voltage/Frequency	3-phase 230V/60Hz
	Tolerances	Voltage max. ±10% Frequency max. ±2Hz
	Control system	Sinusoidal wave PWM control
Control Specifi-cation	Output voltage	3-phase 230 V (max.)
	Output frequency	6 to 60Hz
	Frequency resolution intervals	0.25Hz/step
	Output frequency accuracy	±0.5% at max. frequency (at 25°C ±10°C)
	Voltage/Frequency ratio	Manual : 12-patterns Automatic: 4-patterns
	Overload capacity	150%-30s, 115%-continuous
	Frequency setting signal	DC 0 to 10V (Input resistor 10KΩ)
Operating Specifi-cation	Acceleration and deceleration times	8 step select (Approx. 1s, 3s, 5s 10s, 20s, 30s, 40s, 60s)
	Braking	Braking due to capacitor charge
	Starting	Drive by 1a contact (hold) Acceralation by ON, deceleration by OFF
	Forward and reverse drive	Reverse drive command is possible by 1a contact (hold)
Protect Functions	Protect functions	Stall prevention, Overcurrent protection, Overvoltage protection, Undervoltage protection, Burn out protection (protection by fuse)
	Fault detecting signal	Relay 1b contact (Outputs for overcurrent, over-voltage and undervoltage faults)
	Display	Lamp on printed circuit board (in inverter) lights when capacitor is charged.

Item		Description
Ambient condition	Installing place	Indoors
	Ambient temperature	0 to 40 ℃ (around box)
	Ambient humidity	Less than 90% (relative) (no dew condensation)
	Vibration	Less than 0.5G
Construction		Box type (Non-dust proof type)
Panel mounted instruments (with operation panel)		Frequency meter (digital-display) Frequency setting rheostat (3kΩ-1W) Run-stop switch

(Note 1) In the last symbol of type-form "B" means without an operation panel and "BO" means with an operation panel.

4. INSTALLATION

The VF PACK-P is a wall mount type inverter. Securely install the VF PACK-P by using the mounting holes provided on the base of the unit. Install the inverter in the upright position, and leave sufficient space around the unit for ventilation as shown in Figure 1.

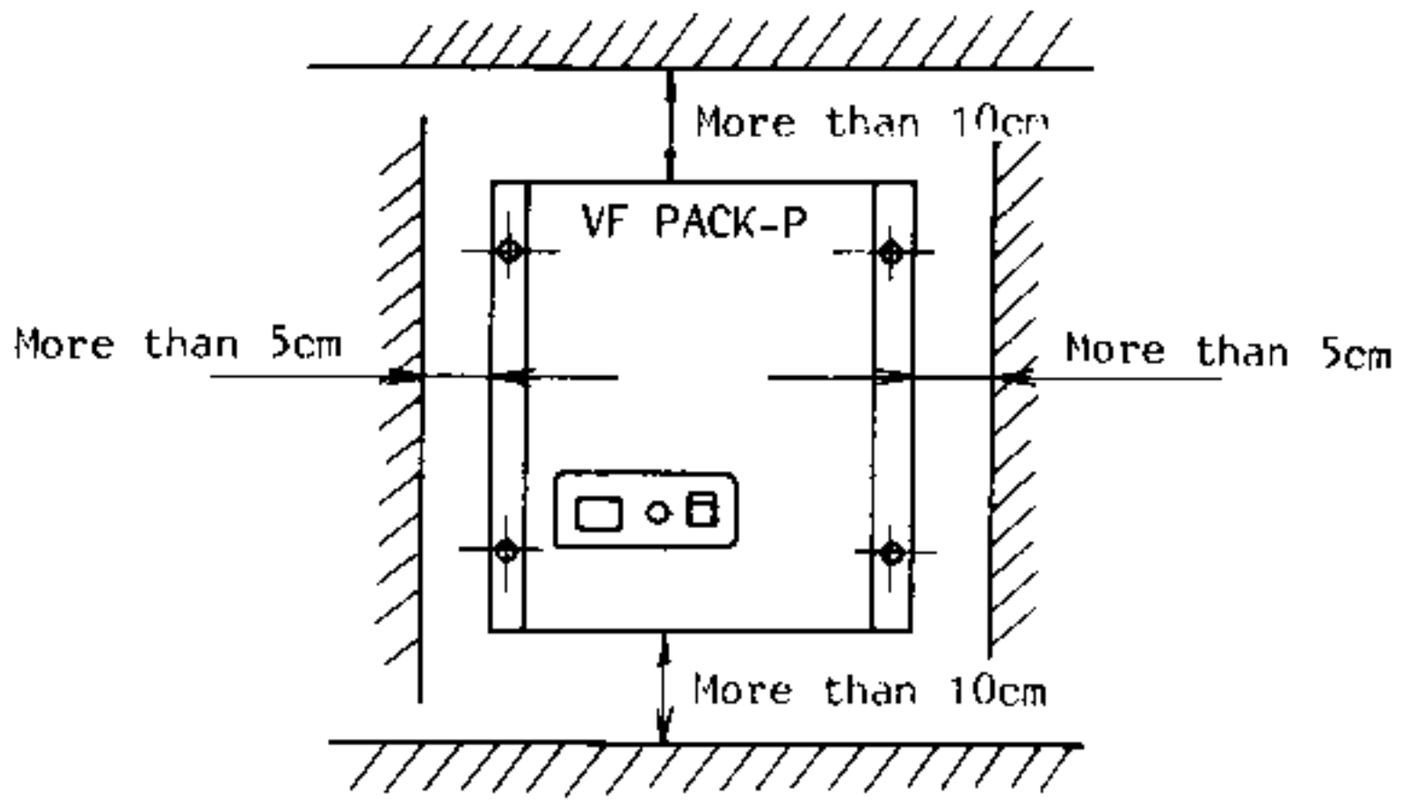


Figure 1. Inverter Installation

In selecting an installation location, keep the following in mind:

(1) Avoid a place with high temperature and humidity and an atmosphere full of dust, dirt or iron filings.

(2) Choose a place free of corrosive gases and machine coolants.

(3) Choose a place free of vibration, other near by power switches or noise sources and a place convenient for checking and maintenance of the unit.

5. WIRING

Wire the inverter in accordance with the standard connection diagram (Refer to figures 2 and 3). Table 2 shows connecting terminals functions.

Table 2. Functions of Connecting Terminals

Symbol	Function	Place
R1, T1	Power supply terminals for control circuit. Single-phase 230V-60Hz	Main terminal board
R,S,T	Power supply terminals for main circuit. Three-phase 230V-60Hz	
U,V,W	Output terminals of the main circuit. (Wire the motor through the thermal relay.)	
P, N	Output terminals for the DC circuit. (For the Power Back Unit.)	Terminals of the capacitor
FLA FLB	Output terminals of emergency (Fault) detecting relay. Rating 200V-2A Normally-"closed", Emergnecy (Fault)-"open"	Terminal board of the printed circuit board

Symbol	Function	Place
FRQ	Output terminals for the frequency meter. (Voltage between FRQ and COM 0 to 10V DC, Rating max. 3mA)	Terminal board of printed circuit board
PP	Standard voltage terminal for frequency control potentiometer Generates +10V to COM.	
REF	Input terminal for frequency control. Frequency changes from 0 to 63Hz in relation with 0 to 10V between REF and COM.	
COM ST1	Common terminals of the control circuit. These terminals are not ground terminals on this inverter.	
FR	Input terminal for reverse operation. When FR short-circuits to ST1 (COM), motor rotation is reversed.	
ST2	Input terminal for starting. When ST2 short-circuits to ST1 (COM) motor starts.	

STANDARD CONNECTION DIAGRAM (WITH OPERATION PANEL)

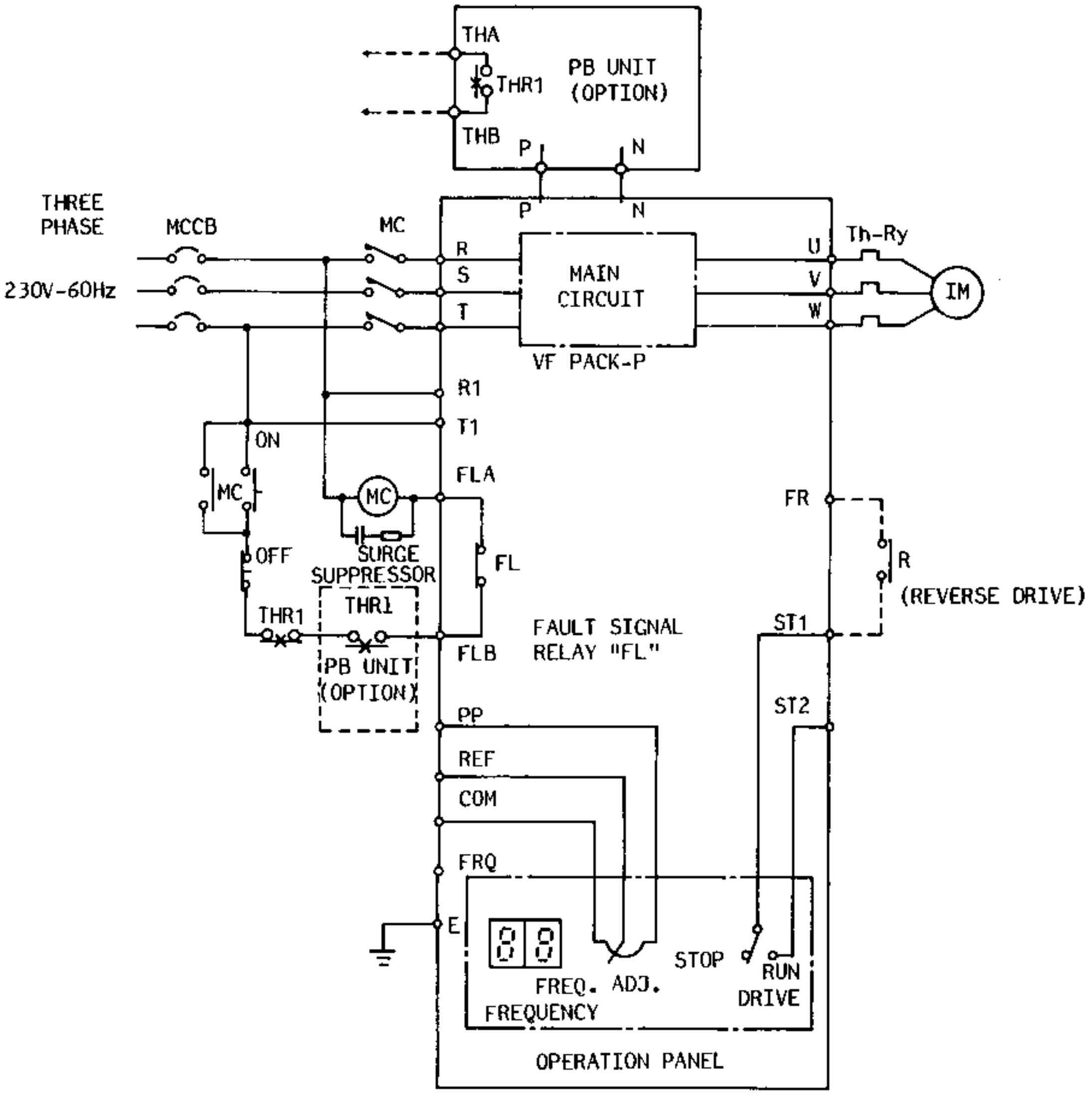


Figure 2

STANDARD CONNECTION DIAGRAM (WITHOUT OPERATION PANEL)

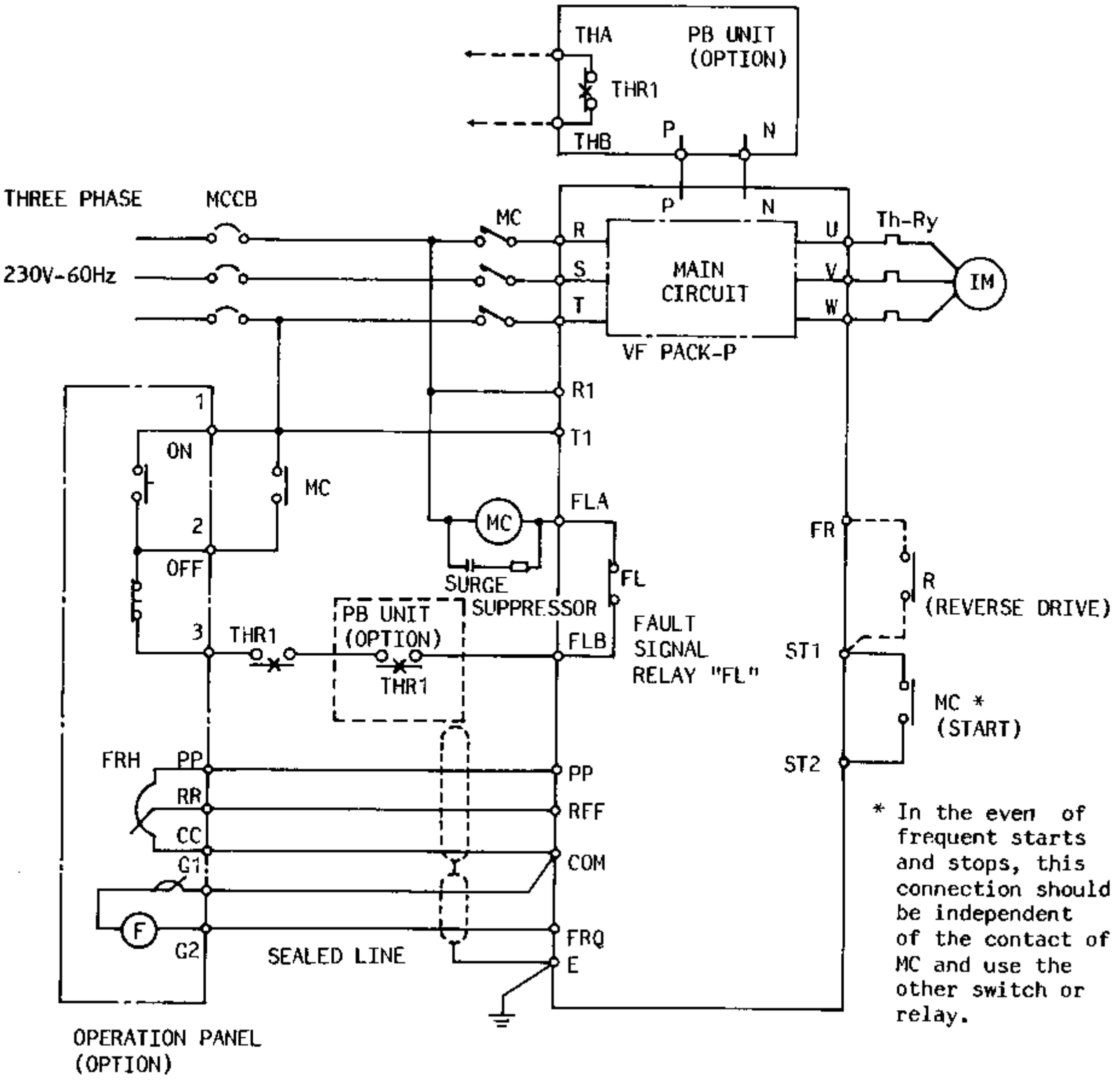


Figure 3

6. OPERATION

6-1. Check the following before commencing operation.

a. Re-check the wiring for possible errors.

b. Ensure the source voltage is 230V ±10%.

c. Ensure all connections are free from possible short circuits.

6-2. Adjustments before operation

VF PACK-P has two adjustments prior to operations.

(1) Adjustment of acceleration and deceleration time.

(Name: SPD, Symbol: SW02) (See fig. 4)

(2) Adjustment of voltage/frequency ratio.

(Name: V/F, Symbol: SW03) (See fig. 4)

Adjustment is made according to load or use. Figure 4 shows adjustments made prior to shipment.

If adjustment is necessary, refer to the following:

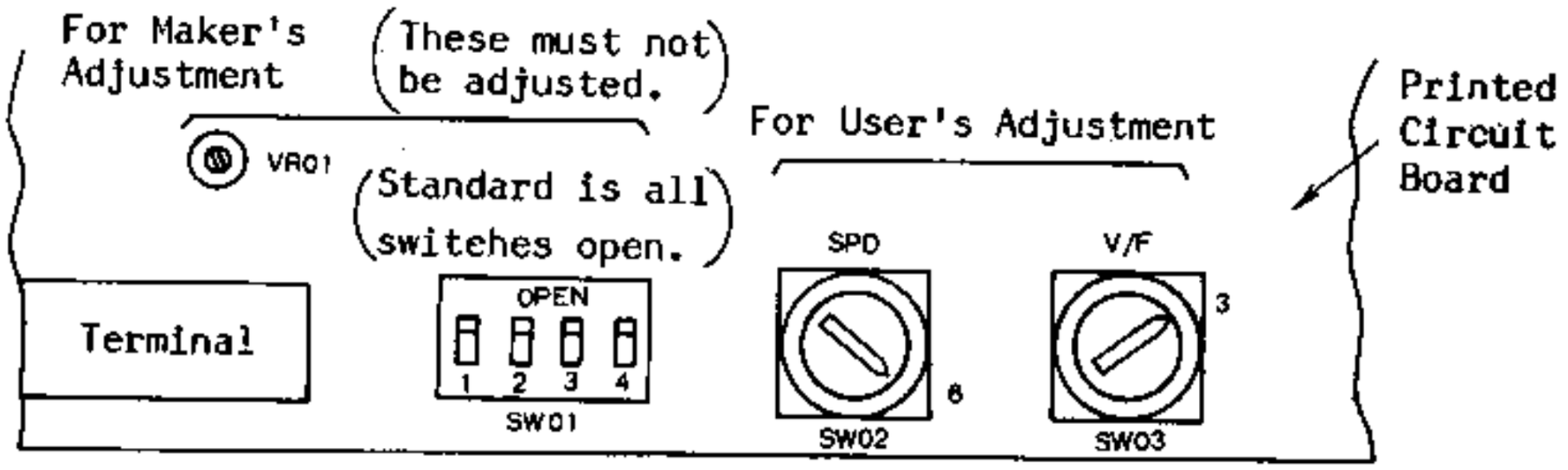


Figure 4

6-2-1. Adjustment of the acceleration and deceleration time SPD (SW02)

The acceleration and deceleration time is defined as the time required to go from 0 to the maximum frequency (63Hz) and vice versa.

Selection of the acceleration and deceleration times is made on SW02 and of equal value. (SW02 sets both acceleration and deceleration time.)

The relationship between location of notchs and time is shown in Figure 5. For example, the location of notch "0" and "1" is the same and means 1 second for acceleration and deceleration time. Choice of acceleration/deceleration times should be according to load inertia and the required acceleration and deceleration time. Ordinarily, we recommend an acceleration and deceleration time of 5 - 20 seconds.

If the load inertia is too large and the deceleration setting time is too short, the inverter will automatically change the deceleration time to the longest setting time, "60 seconds", or will stop operation. In the event this happens, the acceleration/deceleration time should be extended.

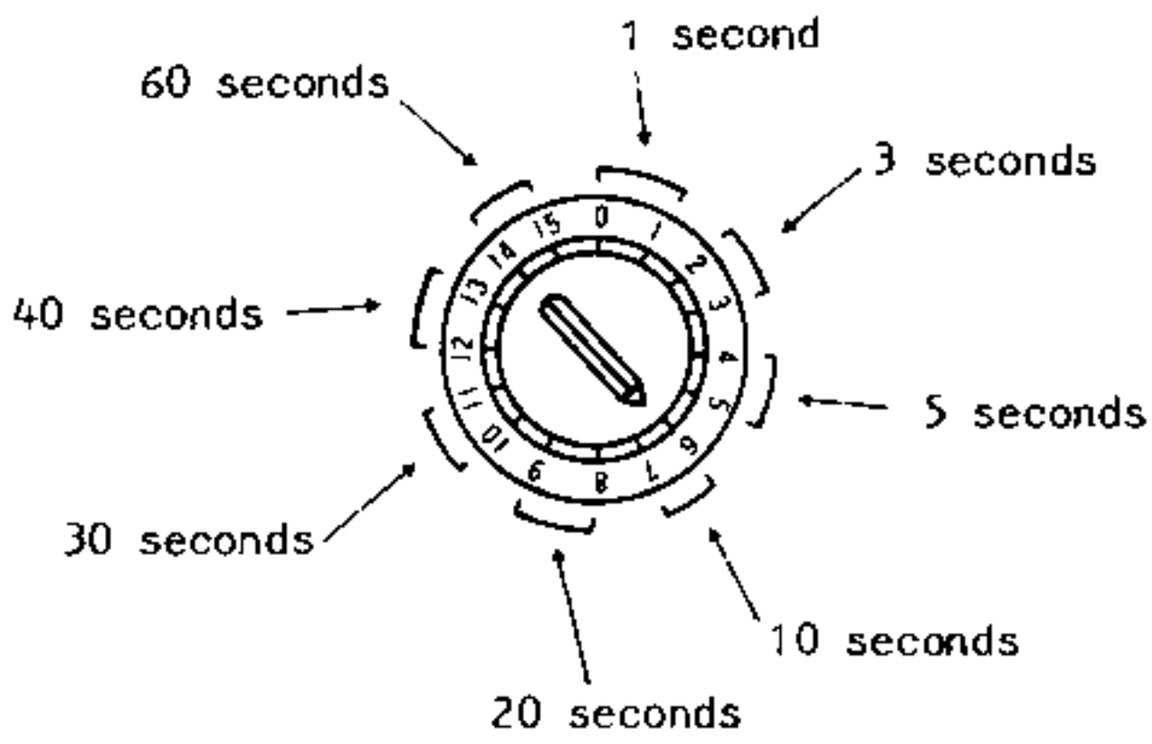


Figure 5

6-2-2. Adjustment of the voltage/frequency ratio V/F (SW03)

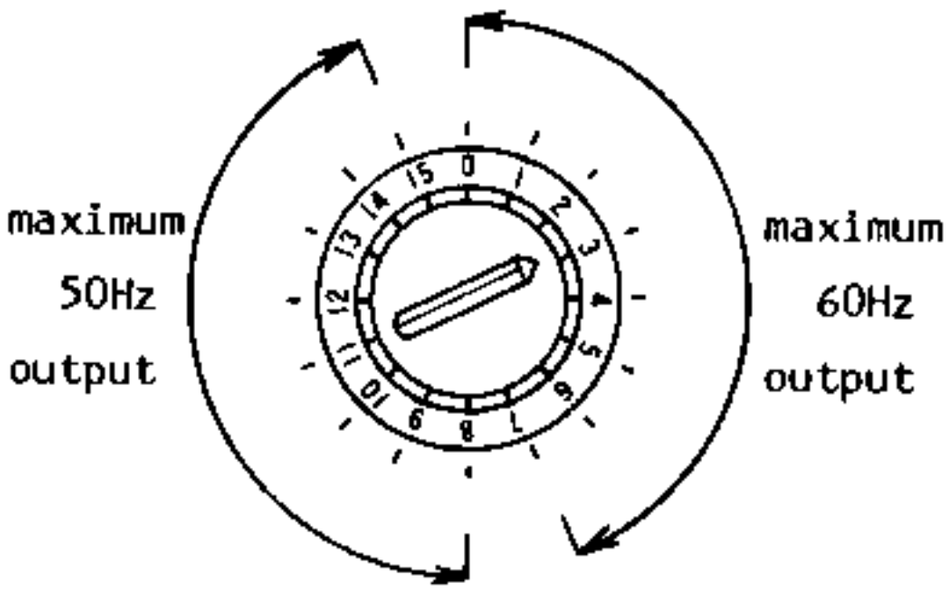
This switch has the following two functions:

Selection of the maximum output frequency of 50Hz or 60Hz

Selection of voltage/frequency ratio

The output voltage characteristic for each selector notch and the applicable frequency is shown in Figure 6. Notchs "0" - "7" are used for maximum output frequency of 60Hz and notchs "8" - "15" are used for maximum output frequency of 50Hz.

Note: The actual maximum frequency is 53Hz or 63Hz.



NOTCH	MAXIMUM 60Hz OUTPUT	NOTCH	MAXIMUM 50Hz OUTPUT
0	lowest	8	lowest
1	lower	9	lower
2	little low	10	little low
3	standard	11	standard
4	higher	12	higher
5	highest	13	highest
6	automatic 1	14	automatic 1
7	automatic 2	15	automatic 2

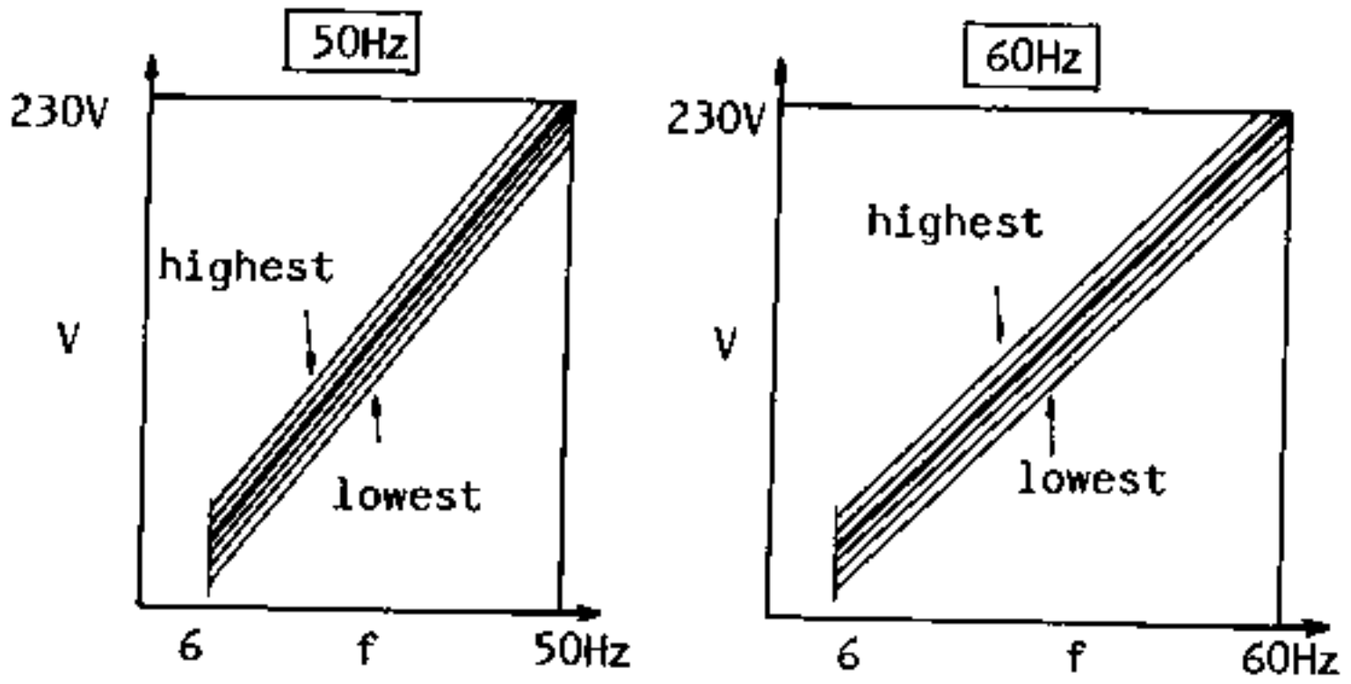


Figure 6

In Figure 6, note that the output voltage of 50Hz pattern is about 20% higher than 60 Hz pattern. Each pattern has six output voltage patterns. The standard pattern is shown by the thick line on the graphs in Figure 6 and has three patterns below and two patterns above the standard V/f ratio.

Ordinarily, the standard pattern (For 60Hz → the V/F Select switch is the 3rd notch and for 50Hz → the V/F Select switch is the 11th notch) is recommended. With this feature selecting the optional V/f pattern will operate the motor at the maximum energy savings and at a lower noise level.

(1) Automatic pattern selection

For automatic operation the motor rating recommendation is given for each inverter type in table 3.

In automatic operation the motor's current is detected which changes the Voltage/frequency ratio pattern automatically according to the load.

Table 3

Type-Form	Recommended motor for automatic pattern selection	Notes
VF10P-2015B VF10P-2015B0	1 HP	See table 4 for proper selection of automatic pattern 1 or pattern 2.
VF10P-2020B VF10P-2020B0	2 HP	
VF10P-2030B VF10P-2030B0	3 HP	
VF10P-2050B VF10P-2050B0	5 HP	

(2) Selection of the Voltage/frequency pattern

Selection of the V/f pattern should be in accordance with Tables 4-1 and 4-2.

Table 4-1 For output frequency of 0 to 60Hz

Condition of Load		Source Voltage	Notch 0	1	2	3	4	5	6	7
The load is comparatively low (less than 50%) and at low speed the torque requirements low (less than 25%)		200-220				←	—	→		
		220-240			⇔					
		240-260	←	—	→					
The load is comparatively high but at low speed the torque requirements low (less than 50%) for example, fans and pumps		200-220					←	—	→	
		220-240				⇔				
		240-260		←	—	→				
The load is comparatively high and at low speed the required torque high (more than 75%)		200-220						←	—	→
		220-240			⇔					
		240-260	←	—	→					
For applications with torque variation	large	200-260	⇔							
	small		⇔							

*1 Ensure the V/f selection notch agrees with the application torque requirements, improper selection may result in too low an output voltage and abnormal torque.

*2 Choice of automatic pattern 1 provides a greater range of V/f fluctuation and automatic pattern 2 provides a narrower range of V/f fluctuation.

Table 4-2 For output frequency of 0 to 50Hz

Condition of Load		Source Voltage	Notch 8	9	10	11	12	13	14	15
The load is comparatively low (less than 50%) and at low speed the torque requirements low (less than 25%)		200-220	←							
		220-240	↔							
		240-260	(Use notch "0" - "7")							
The load is comparatively high but at low speed the torque requirements low (less than 50%) for example, fans and pumps		200-220	←							
		220-240	↔							
		240-260	(Use notch "0" - "7")							
The load is comparatively high and at low speed the torque requirements high (more than 75%)		200-220	←							
		220-240	↔							
		240-260	(Use notch "0" - "7")							
For applications with torque variation	large	200-260	↔							
	small		↔							

*1 Never mind about adjustment of notch ±1 against above table in accordance of load characteristics and source voltage.

*2 Notch 13 should not be used for low source voltage (less 200V) as this will produce large no load motor current.

6-3. Running

After confirming correct wiring and adjusting of the acceleration/ deceleration and V/f ratio, perform the following running tests:

1.	After connection to the motor, check rotation of the motor.	It should rotate with ease.
2.	Put MCCB "ON".	Digital frequency meter of the inverter type BO should display "0". Analog frequency meter of the inverter type B should show "0" offer reaction.
3.	Put MC "ON" by the use of the push button switch. In the case of type BO, put the DRIVE switch to "RUN".	The CHARGE lamp should light.
4.	Turn the frequency setting rheostat to clockwise slowly.	The motor should start by the time 6Hz has been reached.
5.	Confirm the rotation of the motor.	If the direction of rotation is wrong, exchange 2 phases of U, V, W.
6.	Turn the frequency setting rheostat to clockwise fully. In the case of type B, turn the rheostat of the control box like frequency meter shows 63Hz or 53Hz.	The frequency should increase and the frequency meter should show 63Hz or 53Hz.
7.	Turn the frequency setting rheostat clockwise and counter-clockwise.	Speed should change according to SPD (SW02).
8.	In the case of type BO, put the DRIVE switch to "STOP". In the case of type B, put the push button switch to "OFF". (If starting and stopping by the use of the push button switch is frequent, the protection circuit may react adversely.	Speed should decrease and the motor finally stops. MC should cut off and the motor should coast to stop.

(Notes) *1 If the inverter is used to start the motor when it is in free-run, the protection circuit may react. For trouble free operation, avoid this type of operation.

*2 If the inverter is to restart after the MC is put to "OFF", confirm that the motor has stopped and the frequency meter shows "0"Hz.

*3 If the protection circuitry is activated, the MC trips off automatically.
In the case of type B0, the frequency meter will show "E".

*4 The motor can not be reversed while the motor is still rotating.
The reverse operation (FR shorted to ST1) should not be performed unless the motor is stopped.
If the reverse operation is performed while the motor is still rotating, the motor will continue to rotate in the same direction.

6-4. Precautions for operation

(1) Frequency indication

In case of a "B0" type, frequency is indicated digitally in increments of 1Hz. By turning the frequency setting rheostat, the frequency is changed in increments of 0.25Hz steps. The relationship between the indicated and the actual output frequency is shown on the following table.

Indication	Actual output frequency
0	0
6	6.0, 6.25, 6.5, 6.75
7	7.0, 7.25, 7.5, 7.75
:	:
63	63.0, 63.25, 63.5, 63.75

In case of the "B" type, the characteristics of the analog output frequency are shown in Figure 7.

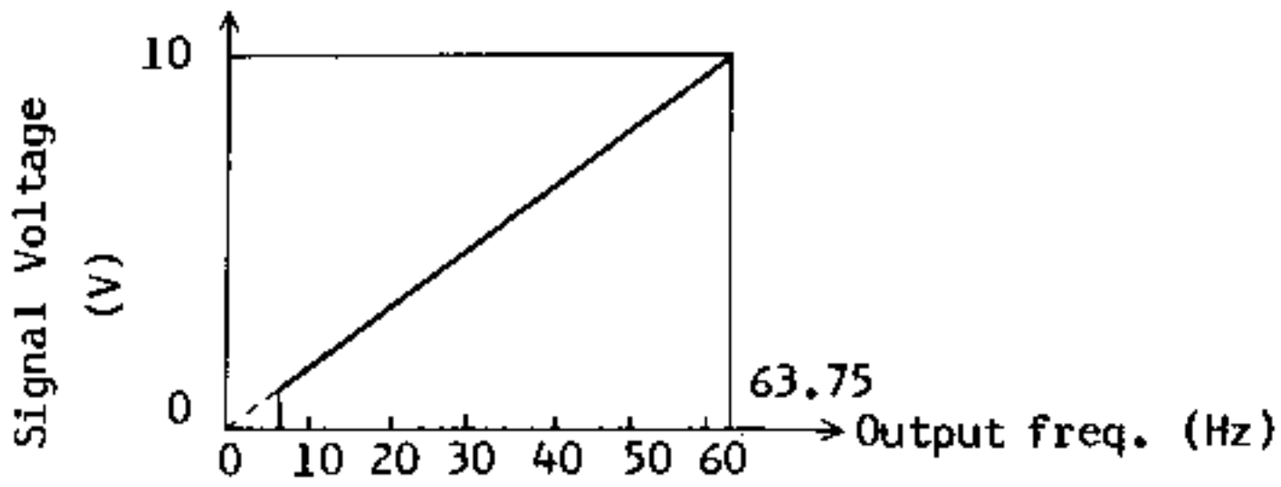


Figure 7

Note: An analog signal is output for the "B0" type as well as for "B" type.

(2) Frequency setting voltage and output frequency

When setting the frequency by using the frequency setting rheostat, the maximum output frequency for 60Hz (63Hz) is achieved at the maximum rheostat turn. For 50Hz the maximum output frequency (53Hz) is achieved before the rheostat is fully turned. (Turning the rheostat further will not increase the output frequency, only maintain it at the maximum output.)

This relationship between the frequency setting voltage (taken between terminals [REF] and [COM]) and the output frequency is shown in Figure 8.

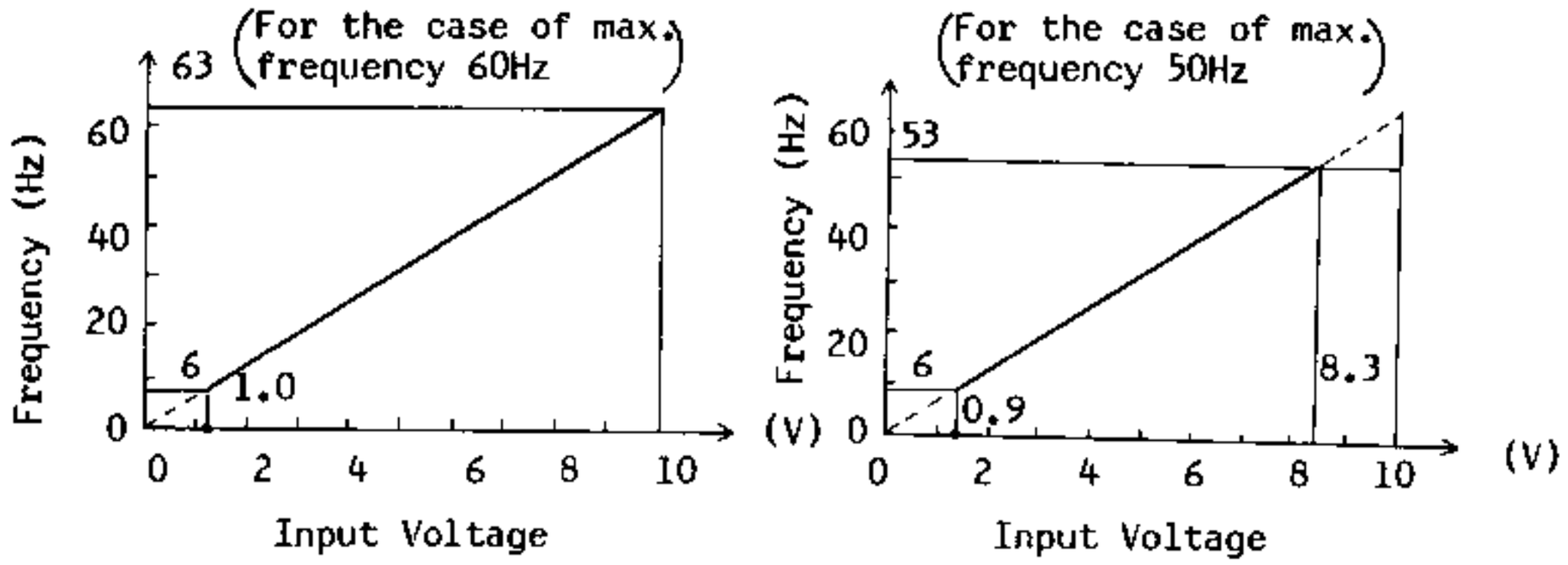


Figure 8

* The recommended value of the frequency setting rheostat resistance connected between [PP] and [COM] is 3kΩ and minimum allowed value of 2kΩ.

(3) Protective actions and effects

The inverter will stop in emergency faults in order to protect the equipment from overcurrent, overvoltage, or undervoltage. The protective circuitry and trip causes are shown in Table 6.

Table 6

Protective circuits	Cause (example)	Outcome
1. Overcurrent on the DC bus	(1) Mechanical lock by the motor overload or single phase lock (2) Motor rating is too large for the inverter capacity (3) The acceleration time (SW02) is too short (4) Short circuit of the output terminals (5) The motor is restarted while it is running by inertia (6) Faulty transistor	Output voltage will be zero and the contacts of FL relay will be opened and MC will be cut off. In case of type "B0", "E" will be indicated on LED.
2. Overcurrent in the motor circuit	(1) Overload of the motor (2) Output voltage (SW03) is too low	
3. Overvoltage	(1) Power source voltage is too high (More than 250V) (2) The deceleration time (SW02) is too short	
4. Undervoltage	(1) Power source voltage is too low (Less than 160V) (2) Immediate power stop	

* If a protect circuit fault occurs, disconnect the MCCB (NFB) immediately and ensure the motor stops, determine the cause, before restarting.

6-5. Other precautions

(1) The VF PACK-P is of a sinusoidal wave PWM control system. The output voltage and current do not have a perfect sinusoidal waveform but is somewhat distorted.
Therefore, the motor temperature, noise, and vibration increase to somewhat as compared to operating the motor directly across the line.

(2) After power is disconnected, the capacitor remains charged at high voltage for approximately 10 minutes. If maintenance or inspection is to be performed, wait until the Charge lamp, attached on the printed circuit board, is turned off to prevent possible injury.

(3) Do not use an electromagnetic contactor between the inverter and the load motor.
Switching a load on and off in this manner may damage the equipment.

(4) Do not bundle cables of the main circuit and control circuit with other signal lines. As cross talk among the lines may cause improper operation of the inverter.

7. MAINTENANCE

The VF PACK-P is high in semiconductor component content and has few mechanical parts, which are subjects to wear. However, the following should routinely be checked.

The inverter employs large-capacitance capacitor. This capacitor retains charged voltage for about 10 minutes after power is switched off. Therefore, before checking or servicing the inverter, ensure the "Charge" lamp is off and check the capacitor with a tester to ensure the capacitor is discharged.

(1) Check the wire terminals for looseness and possible wire damage.

(2) Check the ventilation holes and ensure they are free of dust and foreign matter.

(3) Remove any accumulated dust on the printed circuit board and on the inverter's case.

(4) If inverter will not be used for a long period of time, it is suggested that it be switched on and checked for operation about once every six months.

(5) Use a D.C. 500-volt megger for megger tests on the main circuit terminal board (R1, T1, R, S, T, U, V, W) only. Never conduct a megger test on the terminals on the printed circuit board.

(6) Do not conduct a dielectric strength test. It can cause component break down of the parts inside.

Periodically check the inverter, and ensure it remains in the proper environment.

8. TROUBLESHOOTING

If the inverter fails to function properly due to some failure, the following inspection method should be followed to determine the cause, and remedy the problem.

If the equipment malfunctions, the fault signal relay "FL" is actuated by a protect circuitry, and the equipment is brought to an emergency stop.

If this happens, check whether the inverter can be restarted after equipment malfunction is corrected. (Refer to Table 6 for possible causes.)

8-1. Circuit composition

A block diagram of the circuitry is shown in Figure 9.

In Figure 9, the connectors, terminal numbers and the functions are shown.

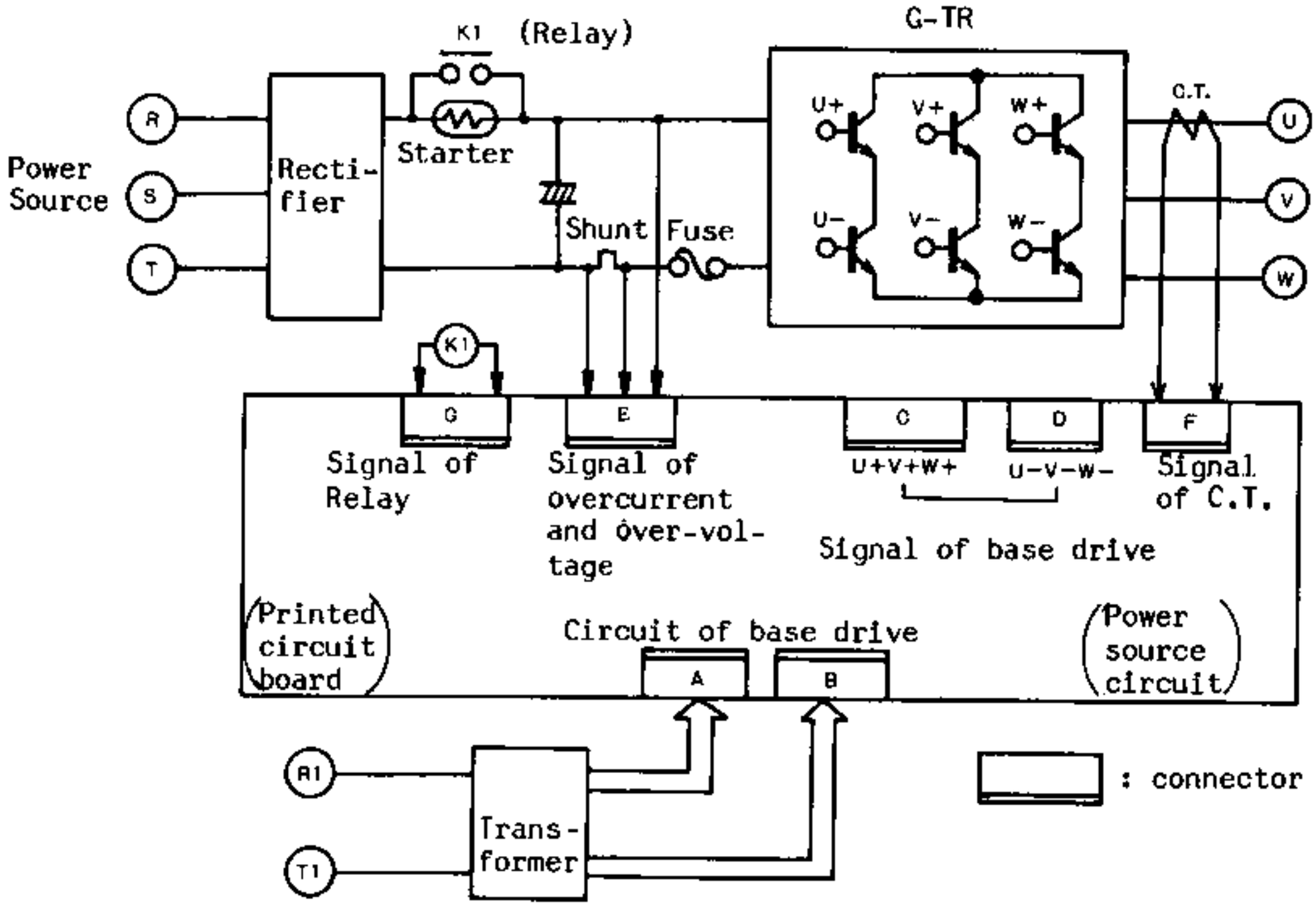


Figure 9

8-2. Troubleshooting

(1) Figure 10 shows a flow chart to be followed in case the motor fails to run when the inverter is put in operation.

(2) Figure 11 shows the check procedure testing the G-TR (Giant transistor). (use Tester)

Troubleshooting Chart

*1 As to the checking on G-TR and PC board, refer to Fig. 11.

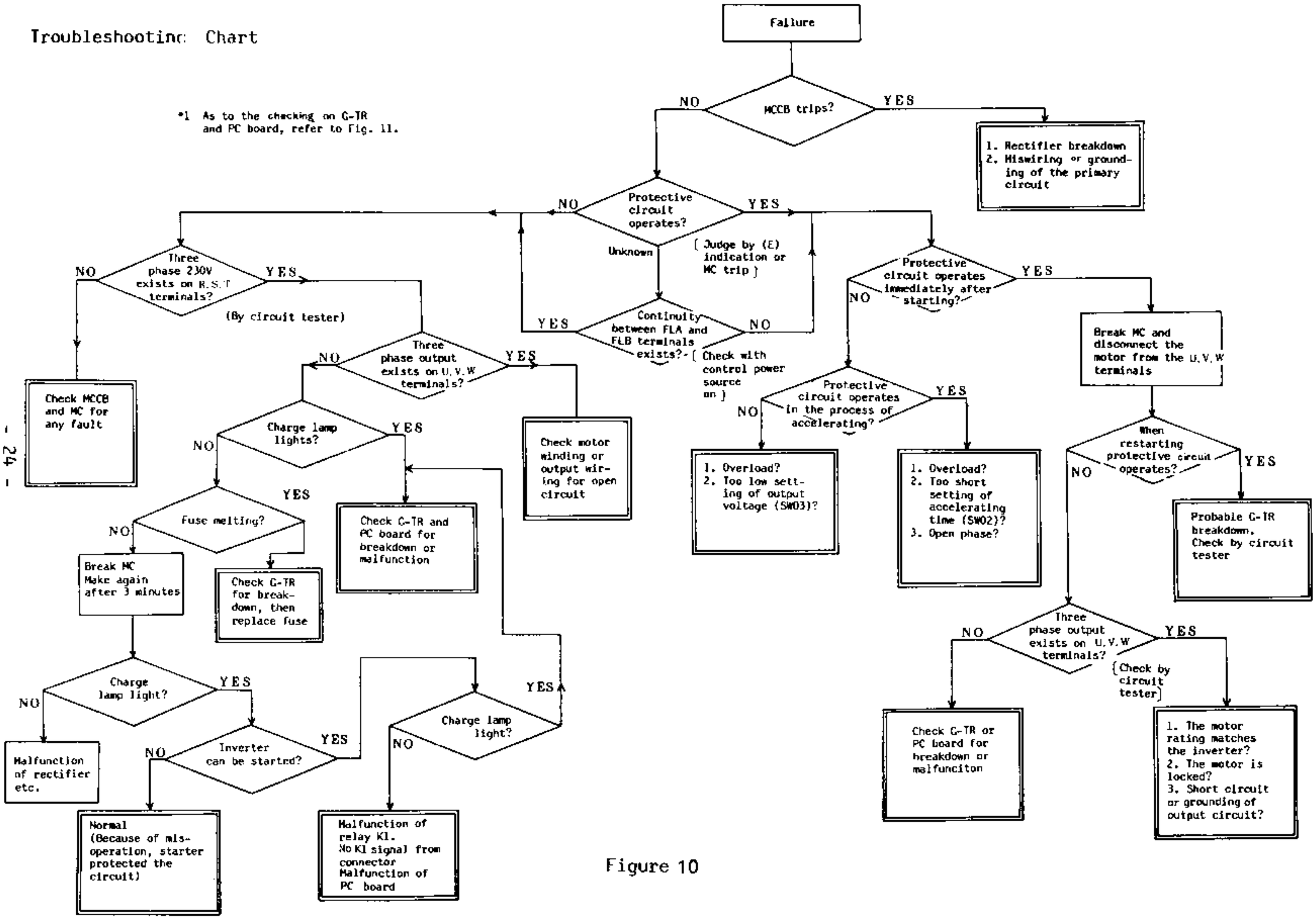


Figure 10

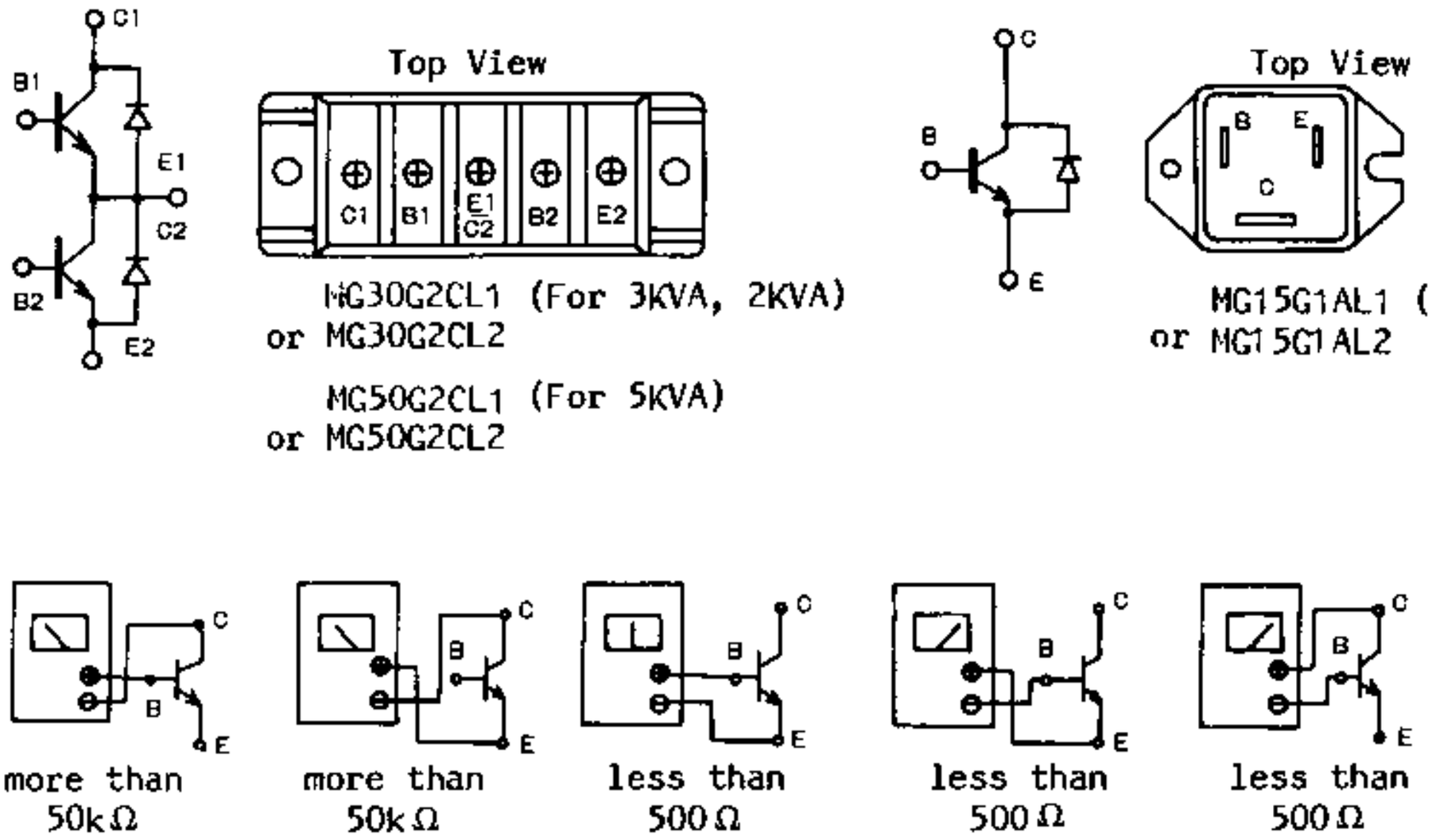


Figure 11 G-TR Testing
(Resistance where G-TR is in good condition)

When replacing a G-TR, be sure to apply a thin coat of heat-conductive silicon compound to the surface and ensure a good contact is made with the fins.

There is no specified tightening torque for a G-TR, but it should be tightened evenly on both sides.

(3) Printed circuit board testings

The printed circuit board can be checked by the following procedure:

a. Connect the terminals R1 and T1 only to the power supply. (these terminals supply power to the printed circuit board)

b. Short testpins CHK1-CHK2

c. Short terminals ST1-ST2

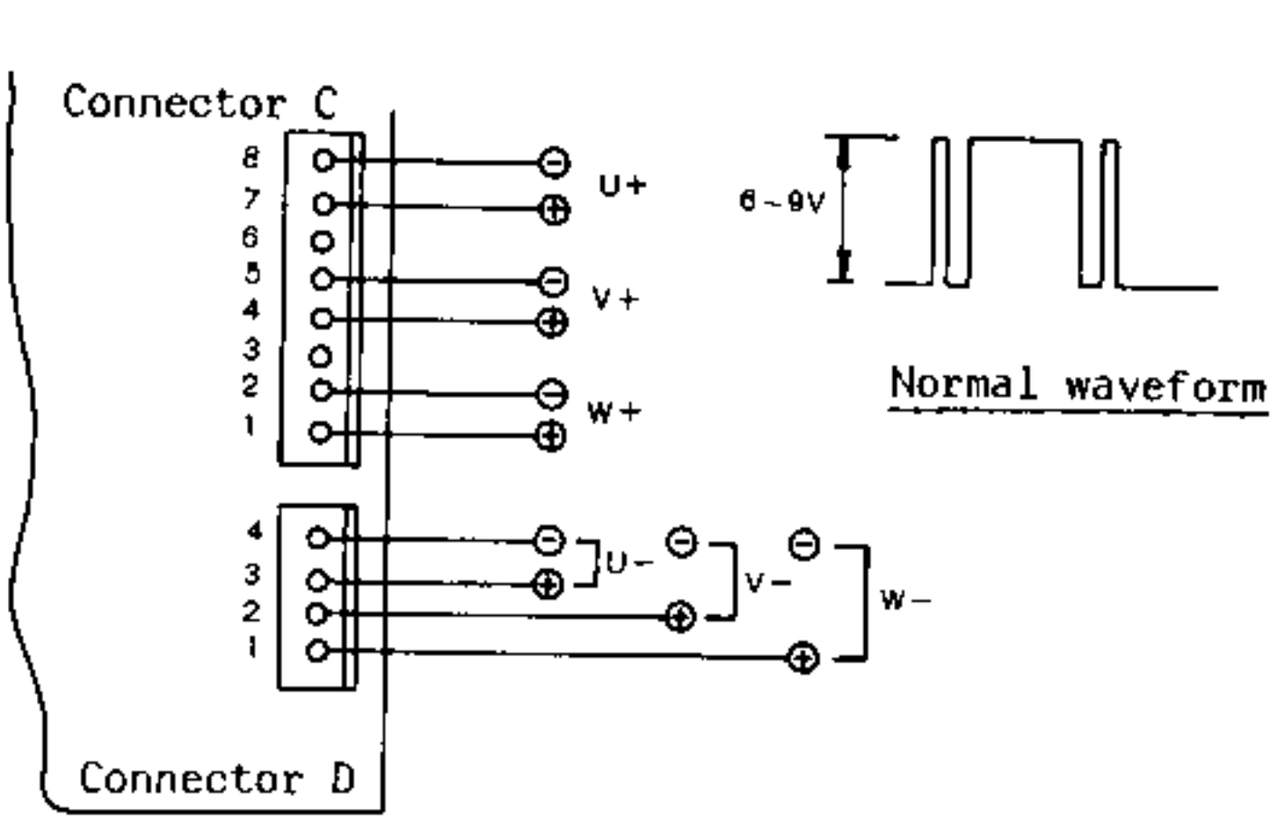
Procedure for checking the printed circuit board

a. Remove the connectors C and D from the printed circuit board

b. After performing the above. the printed circuit board should be isolated from the rest of the inverter circuitry.

c. Turn the frequency setting rheostat to the full clockwise position. (The frequency meter should show 63Hz)

d. Check by use of an oscilloscope whether the connector C and D terminals generates the transistor base drive signals.



In above figure, check by using an oscilloscope each pair of terminals ⊕ - ⊖ (U+, V+, W+, U-, V-, W-).

If the above waveform will be generated the board is correct.

(If the waveform is generated the control should be replaced and/ or repaired.)

9. EXTERNAL DIMENSIONS

9-1. VF PACK-P

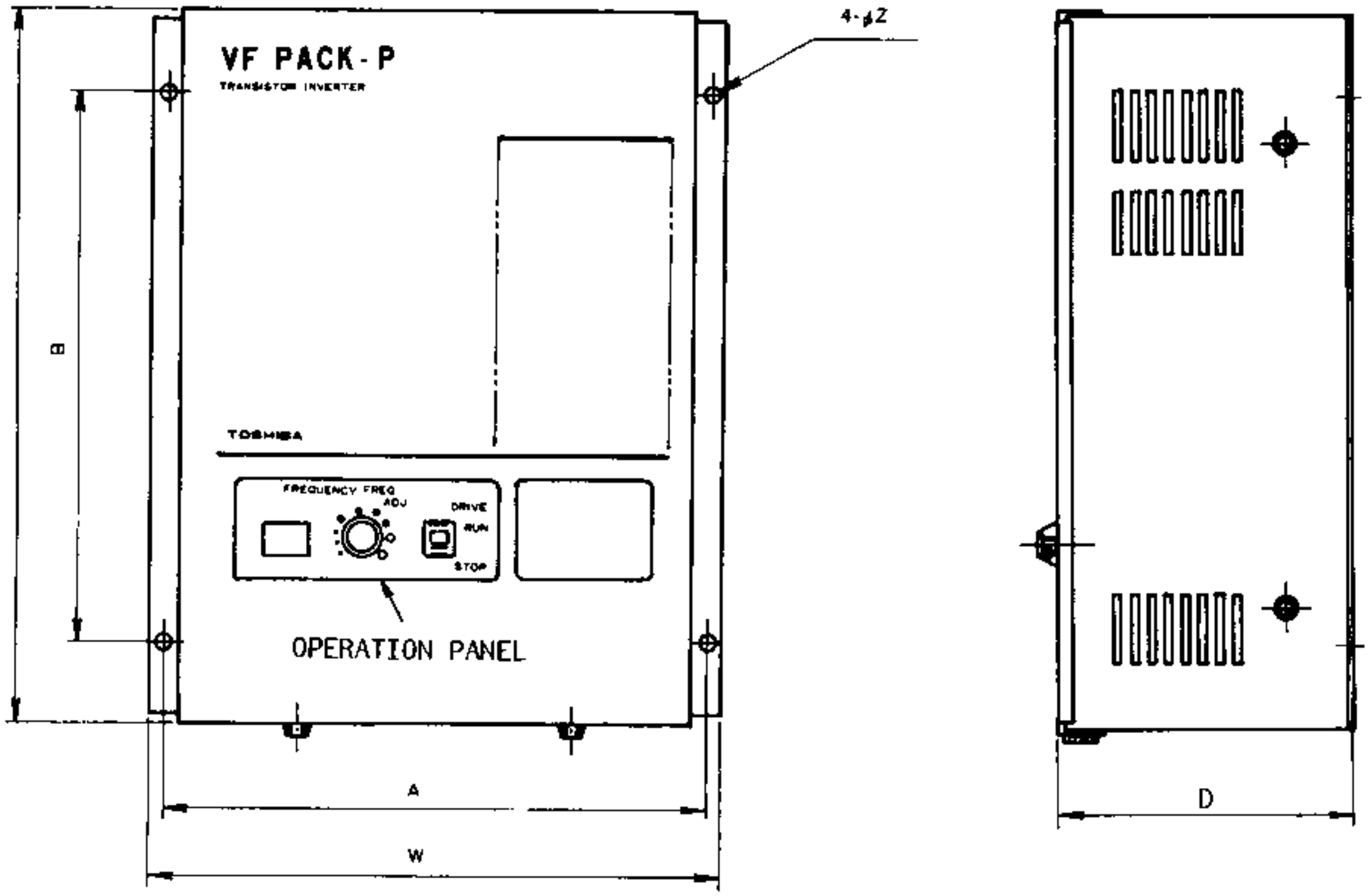


Figure 11

(mm)

CAPACITY (KVA)	TYPE-FORM	W	H	D	A	B	Z	APPROX. WEIGHT (kg)
1.5	VF10P -2015B, B0	230	290	130	215	220	6	5.0
2	VF10P -2020B, B0							
3	VF10P -2030B, B0	284	367	155	268	280	7	9.2
5	VF10P -2050B, B0							

Note: In the last symbol of type-form, "B0" indicates the unit comes with an operation panel, and "B" indicates the unit comes without an operation panel.

9-2. Operation Panel (type-form VF10-CBN1)

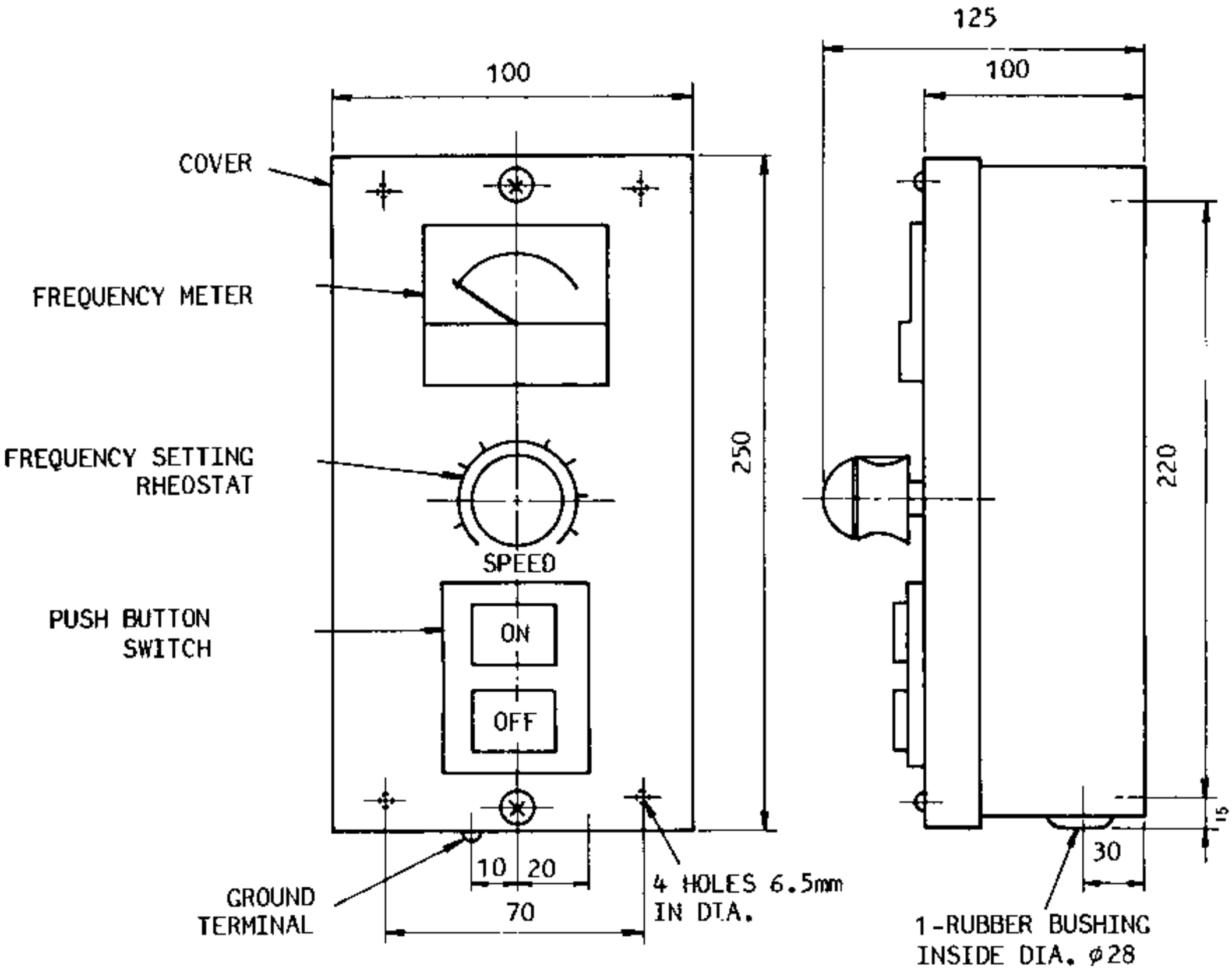


Figure 12

10. SPARE PARTS

The following spare parts are recommended to be kept on hand to reduce any possible system down time.

Inverter Model	Fuse			G-TR			Printed circuit board		
	Model	Stock Ratio	Q'ty Used	Model	Stock Ratio	Q'ty Used	Model	Stock Ratio	Q'ty Used
VF10P-2015B VF10P-2015B0	(250V-10A)	(%) 10	1	MG15G1AL1 or MG15G1AL2	(%) 5	6	*MCC-56 MCC-57	5(%) 5	1 1
VF10P-2020B VF10P-2020B0	BLC023-1 (550V-23A)	(%) 1.0	1	MG30G2CL1 or MG30G2CL2	(%) 5	3	MCC-50	(%) 5	1
VF10P-2030B VF10P-2030B0	BLC023-1 (550V-23A)	(%) 1.0	1	MG30G2CL1 or MG30G2CL2	(%) 5	3	MCC-50	(%) 5	1
VF10P-2050B VF10P-2050B0	BLC023-1 (550V-23A)	(%) 1.0	1	MG50G2CL1 or MG50G2CL2	(%) 5	3	MCC-50	(%) 5	1

(*2 boards use)

Quantity of parts to be stocked is calculated by the following formula.

Quantity of specific part number = Quantity of inverters x Quantity used in inverter x Stock ratio