HITACHI INVERTER

HFC-VWS3 U (H) SERIES

INSTRUCTION MANUAL

Thank you very much for your purchase of Hitachi Inverter HFC−VWS3 U (H) Series. This Instruction Manual covers the handling and maintenance, etc. for the HFC−VWS3 U (H) Series. Before starting operation, read this Manual carefully for your installation, maintenance and check. After reading this Manual, file it for your later reference.

This Instruction Manual should be delivered to the operator of the Hitachi Inverter.

HITACHI

Rev 2/26/92

(NB431XA)

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1. INTRODUCTION

1.0 Important

BE SURE TO STUDY THIS ENTIRE MANUAL BEFORE ATTEMPTING TO INSTALL, START, OR RUN THE INVERTER. FAILURE TO FOLLOW THE INSTRUCTIONS CAN RESULT IN PERSONAL HAZZARD OR DAMAGE TO THE UNIT. THIS MANUAL CONTAINS IMPORTANT SAFETY INFORMATION.

1.1 Receiving and Storage

1.1.1 Receiving

Terms of sale of this product in all instances are F.O.B. point of origin; therefore, IT IS IMPORTANT THAT YOU THOROUGHLY INSPECT THIS EQUIPMENT BEFORE ACCEPTING SHIPMENT FROM THE TRANSPORTATION COMPANY. If any of the items called for on the bill of lading or express receipt are damaged or the quantity is short, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight or express agent within 15 days of receipt and request that he make an inspection. IT IS YOUR RESPONSIBILITY TO MAKE CLAIMS AGAINST THE TRANSPORTATION COMPANY FOR ANY SHORTAGE OR DAMAGE IN TRANSIT.

Claims for loss or damage in shipment must not be deducted from the invoice, nor should payment of the invoice be withheld awaiting adjustment of such claims in as much as the transportation company guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest corporate or distributor Sales Office for assistance.

1.1.2 Unpacking and Storing

After receipt and inspection, repack and store the equipment in a clean, dry area until ready to use.

Under no condition should the equipment be stored where the ambient temperature will rise above 140°F (60°C) or fall below -4°F (-20°C), where corrosive conditions exist or where high humidity is likely to cause condensation on or within the equipment. Proper storage is a must to insure satisfactory drive operation and to maintain warranty coverage.

1.2 General Description

This Solid State Adjustable Frequency Motor Controller (Inverter) is designed to provide continuous speed adjustment of three phase AC motors. The 200 volt rating is designed to operate from three phase 200/230 volt 50/60 Hz power. The 460 volt rating is designed to operate from three phase, 380/460, 50/60 Hz power. Standard 208 volt, 230 volt, or 460 volt, three phase squirrel cage induction motors can be used when properly sized.

The inverter is supplied in an enclosure. The enclosure cover can be easily removed to allow the unit to be mounted as an open panel (chassis) device.

The conversion of the fixed frequency input to an adjustable frequency output is achieved in the following manner. The rectifier converts incoming ac supply voltage to a fixed potential dc bus level. The dc voltage is in turn inverted by a three phase, **sine-coded pulse-width-modulated** inverter section to an adjustable frequency output. The voltage is also adjusted proportionately to the frequency to provide constant volts per hertz excitation to the motor terminals up to 60 Hz. Above 60 Hz, the voltage typically remains constant at nominal line voltage. In this way energy efficient speed control is obtained in the range from 6 to 120 hertz.

1.3 Most Common Causes of Operation Problems

Certain conditions may damage any inverter or motor and must be avoided.

- Rapid and repeated on-off switching, jogging, or inching of the system.
- Attempting to restart the inverter into a motor which is still turning or coasting down, without proper programming.
- Attempting to accelerate or decelerate motor and load (particularly high inertia loads) too rapidly.
- Use of power factor correction capacitors between inverter and motor.
- Power supply unbalanced by more than 3%.
- High voltage transients, such as those caused by lightning, switching of line side power factor correction capacitors, etc.

2. INITIAL INSPECTION AND IMPORTANT NOTES

2.0 Initial Inspection

Before installing this inverter, please confirm:

(1) That there was no damage during shipment.

(2) That the unit name plate voltage, current and frequency matches requirement.

2.1 Qualified Personnel

(1) *If you are unfamiliar with this inverter, please read this entire manual prior to installation and start-up.* The inverter can be seriously damaged and/or a hazard created if installed or connected incorrectly.

(2) Application comments contained in this manual are provided as clarifications only of the features and functions of this inverter. Any inverter should be applied only by persons fully qualified and familiar with the operation of AC inverters and the process they are to control. If application support is required please contact the supplier for further assistance.

(3) This equipment should be installed, adjusted and serviced only by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and the hazards involved.

2.2 Recording set-up parameters

(1) The inverter is equipped with state-of-the-art non volatile RAM (NVRAM) memory that stores all set-up data even during periods when the unit has no external power (batteries are not used or necessary for this function). Please refer to Section 10 for more detailed information on this subject. It is recommended that a record of the set up data be recorded on a data sheet for future reference during service and maintenance (a blank data sheet is provided at the end of Section 10 for this purpose).

2.3 Factory settings

(1) The inverter is shipped with a 60 Hz maximum frequency and a constant torque setting. Please refer to Section 10, Table A for a list of the available V/F patterns and Table B for other preset factory settings.

3. INVERTER SPECIFICATIONS AND CAPACITY SELECTION

3.1 Standard Specifications

Table 3-1

Item			Specification
Input power supply 3-phase			200~220/200~230V+-10%, 50/60 Hz+-5% 380~415/400~460V+-10%, 50/60 Hz+-5%
Output voltage (Max.) 3-phase			Follows input
Control system			Voltage source type, sine coded PWM
Output frequency range			1 ~ 120 Hz (0.5 Hz start)
Frequency accuracy			+-0.5% (25+-10° C) of the maximum frequency
Voltage/frequency characterisitics			36 types set-up selectable
Overcurrent capacity			150% for 60 seconds (every 10 minutes)
Acceleration/deceleration time (Soft start/stop)			Individual setting can be made for acceleration and deceleration: Linear acceleration/deceleration: 0.1 ~ 2999.9 seconds Curved acceleration/deceleration: 0.1 ~ 230 seconds
Torque boost			Manual and automatic, set-up selectable
frequency resolution			0.01 Hz
Braking torque		Regenerative braking	Approx. 10 ~ 20% (Regenerative braking by feedback to capacitor)
		Dynamic DC braking	Available below the minimum frequency (Minimum frequency, braking time and brake are adjustable.)
Input signal	Speed setting	Internal keypad	▶ ▲ ▼ Key operation
		External signal	500 ~ 2 KΩ potentiometer, DC 0 ~ 5V, DC 0 ~ 10V (Input impedance 0 ~ 5V 15KΩ, 0 ~ 10V 30 KΩ) , 4 ~ 20 mA (Input 250Ω)
	Forward/ reverse operation stop	Internal keypad	FWD RUN Forward operation REV RUN Reverse operation STOP Stop operation
		External signal	Forward operation/stop (contact command) Reverse operation/stop (contact command)
	Reset		Fault reset, instantaneous cut-off of output (contact command or reset button on unit PCB)
	Free-run stop		Elimination of deceleration control (contact command)
	Jogging operation		Adjustable between 0.5 and 9.9 Hz (contact initiated)
	Multistage speed operation		Up to 4 stages can be pre-set (2 contact control)
	2-stage acceleration/ deceleration		2-stage command of acceleration/deceleration time (contact initiated)

Table 3-1 (continued)

Item		Specification	
Output signal	Frequency arrival signal	ON at frequency arrival (Open collector output 27V, 50 mA max.)	
	Running signal	ON during running (Open collector output 27V, 50 mA max.)	
	Frequency monitor	Pulse or analog (selectable) 0 to 10V DC, 1 mA full scale	
	Fault/alarm	Form C, 2.5A/230Vac, 3A/30Vdc (resistive load); 0.2A/230Vac (inductive load; held energized when inverter is normal)	
Protective functions	Overcurrent	Overcurrent at acceleration, constant speed and deceleration	
	Overvoltage	Trip at approx. 400V of converter output voltage for 200V class, approx. 800V for 400V class	
	Overload	Protection using electronic thermal relay (can be set from 50 to 100%)	
	Heat sink overheat	Protection using thermal relay	
	Undervoltage	200 Volt Class: Trip at <150 to 160V	400 Volt Class: Trip at < 280 to 320V up to 75 hp, at <320 to 360V 100hp and above.
	Instantaneous power failure/Unattended Start Protection	Ride thru occurs for 15 ms during power failure, unit will not restart or start on power up unless auto restart is selected (When auto restart function is selected, restart will occur if power failure is less than .3 to 3 sec. (selectable) and 0.3 sec. for 200V and 400V classes respectively.)	
	Stall prevention	Stall prevention is provided during overcurrent and overvoltage	
	Overload limit	Inverter output current is detected, and current limit control is performed.	
	Ground fault protection	Standard up to 20 hp	
Optional functions	Switching from commercial voltage	Enables external signal to initiate inverter operation (start into running motor) when switching from commercial voltage to inverter operation	
	Relay output of freq. arrival signal	Dry contact closure at frequency arrival. Contact rating: 2.5A/230Vac, 3A/30Vdc (resistive load); 0.2A/230Vac (inductive load)	
	Relay output of running signal	Dry contact closure during running. Contact rating: 2.5A/230Vac, 3A/30Vdc (resistive load); 0.2A/230Vac (inductive load)	
	Overload alarm signal	Dry contact closure during overload operation (Level is selectable) 2.5A/230Vac, 3A/30Vdc (resistive load); 0.2A/230Vac (inductive load)	
	Inverter output current signal	0-4V (4V DC at inverter rated output current)	
	DC brake external command	DC braking operation via an external contact command	
	Ground fault protection	Standard up to 20 hp, optional for 30 hp and above	
General Specifications	Ambient temperature	Up to 20 hp: -10 ~ 40°C (-10 ~ 50°C without terminal cover) 30 hp and above: -10 ~ 50°C	
	Humidity	20 ~ 90% RH (Non condensing)	
	Ambient conditions	1,000m or less in altitude, indoors (free of corrosive gas and dust or dirt)	

3.2 Output Ratings and Dimensions

Table 3-2

200v Class

CATALOG NUMBER HFC-VWS-	Output 230V		Typical motor hp	Dimensions-Inches (cm)			Approx Wt
	kVA	rms amps		Height	Width	Depth	Lb (kg)
1.5 LD 3 U H	2.0	5	1	11.8 (30)	8.7 (22)	5.5 (14)	10 (4.5)
2.5 LD 3 UH	3.0	7.5	2	11.8 (30)	8.7 (22)	6.9 (17.5)	11.5 (5.2)
3.5 LD 3 UH	4.1	10.5	3	11.8 (30)	8.7 (22)	6.9 (17.5)	13 (6.0)
5.5 LF 3 UH	6.5	16.5	5	11.8 (30)	8.7 (22)	6.9 (17.5)	14 (6.5)
8 LF 3 UH	9.5	24	7.5	17.3 (44)	9.8 (25)	7.7 (19.5)	26.5 (12.0)
11 LF 3 UH	12	32	10	17.3 (44)	9.8 (25)	7.7 (19.5)	30 (13.5)
16 LF 3 UH	18	46	15	17.3 (44)	9.8 (25)	7.7 (19.5)	31 (14.0)
22 LF 3 UH	25	64	20	17.7 (45)	12.8 (32.5)	9.5 (24)	48.5 (22.0)
33 LF 3 U	37	95	30	19.7 (50)	15.4 (39)	10.6 (27)	57 (26.0)
40 LF 3 U	48	121	40	24.4 (62)	15.4 (39)	10.6 (27)	66 (30.0)
50 LF 3 U	57	145	50	24.4 (62)	15.4 (39)	10.6 (27)	88 (40.0)
60 LF 3 U	72	182	60	31.5 (80)	18.9 (48)	10.6 (27)	128 (58.0)
75 LF 3 U	87	220	75	31.5 (80)	18.9 (48)	10.6 (27)	128 (58.0)

400v Class

CATALOG NUMBER HFC-VWS-	Output 460V		Typical motor hp	Dimensions-Inches (cm)			Approx Wt
	kVA	rms amps		Height	Width	Depth	Lb (kg)
2.5 HF 3 U H	3.0	3.8	2	11.8 (30)	8.7 (22)	6.9 (17.5)	16.5 (7.5)
3.5 HF 3 U H	4.2	5.3	3	11.8 (30)	8.7 (22)	6.9 (17.5)	16.5 (7.5)
5.5 HF 3 U H	6.8	8.6	5	11.8 (30)	8.7 (22)	6.9 (17.5)	19 (8.5)
8 HF 3 U H	10	13	7.5	17.3 (44)	9.8 (25)	7.7 (19.5)	32 (14.5)
11 HF 3 U H	12	16	10	17.3 (44)	9.8 (25)	7.7 (19.5)	33 (15)
16 HF 3 U H	18	23	15	17.7 (45)	12.8 (32.5)	9.5 (24)	50 (22.5)
22 HF 3 U H	25	32	20	17.7 (45)	12.8 (32.5)	9.5 (24)	54 (24.5)
33 HF 3 U	38	48	30	19.7 (50)	15.4 (39)	10.6 (27)	66 (30)
40 HF 3 U	46	58	40	24.4 (62)	15.4 (39)	10.6 (27)	88 (40)
50 HF 3 U	59	75	50	27.6 (70)	18.9 (48)	10.6 (27)	106 (48)
60 HF 3 U	71	90	60	27.6 (70)	18.9 (48)	10.6 (27)	124 (56)
75 HF 3 U	87	110	75	27.6 (70)	18.9 (48)	10.6 (27)	128 (58)
100 HF 3 U	118	149	100	41.7(106)	21.7(55)	11.8(30)	232(105)
120 HF 3 U	140	176	125	41.7(106)	21.7(55)	11.8(30)	232(105)
150 HF 3 U	172	217	150	51.2(130)	21.7(55)	11.8(30)	331(150)
180 HF 3 U	207	260	200	51.2(130)	21.7(55)	11.8(30)	353(160)

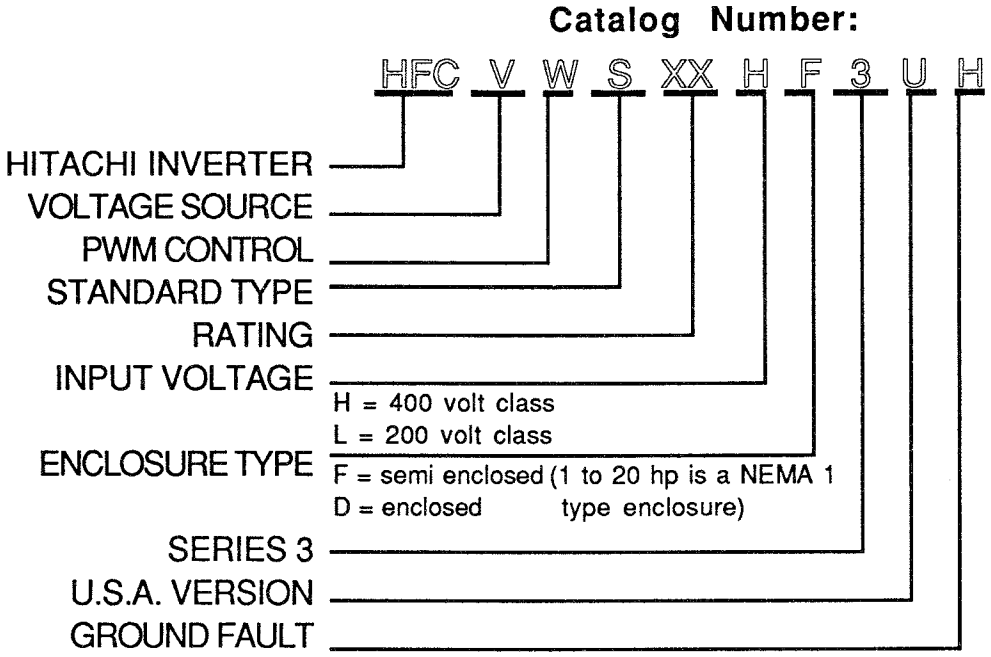
Comments to output rating data

1) The typical motor hp shown in table 2 refers to a general purpose NEMA design B, 3-phase 4-pole AC induction motor.
When selecting motors, choose a motor with current ratings that do not exceed the inverter rated current value at all speeds.

2) When a general-purpose motor is operated above 60 Hz contact the motor manufacturer.

3) When the inverter supply voltage drops, the output voltage also drops.

3.3 Catalog Number Identification



3.4 Capacity Selection

1) For maximum life, size the inverter for a minimum of 100 percent of the motor full load current.
For example, consider a 230 volt, 4-pole, fan-cooled motor, totally enclosed, 2 horsepower motor with a If current of 6A.

Referring to Table-2, the 230 volt 2 hp inverter output current of 7.5A is greater than 6.A, so the 2 hp unit fits the application.

NOTE: Inverter capacity should be increased when the motor:

Accelerates a large inertia load in a short time
Accelerates and **decelerates** frequently and quickly

2) For multiple motor applications, size the inverter so 100% of **all** motors' continuous rated current is less than the rated output of the inverter. The formula for sizing is:

$$(If1+If2+If3....) < I$$

Where:

Ifn = motor current
I = inverter rated output current

4. INSTALLATION ENVIRONMENT AND WIRING NOTES

IMPORTANT:
This equipment should be installed, adjusted and serviced only by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and the hazards involved.

Be sure the input power has been disconnected prior to beginning work.

Equipment terminals and other internal parts of the controller are at line voltage when ac power is connected to the controller. All ungrounded conductors of the ac power line must be disconnected from the controller before it is safe to touch any internal parts of this equipment. After power is removed, wait for the dc link filter capacitors to discharge before touching any internal parts of the controller (Refer to Table 3 for discharge time).

4.1 Installation Environment Considerations and Notes

1) Avoid areas with high temperature, humidity, ambient condensation or areas exposed to dust, dirt, corrosive gas or coolant mist. Install the unit in a well-ventilated room that is not exposed to direct sunlight.

2) Avoid areas subject to substantial vibration.

3) When installing the unit within a larger enclosure, remove the terminal cover and blind plates (refer to Fig. 1). With the terminal cover removed, the inverter can operate in an ambient temperature up to 50°C. Since the heat generated by the heat sink is approx. 5% of the rated inverter capacity, typically external heat sinks or re-circulating fan(s) with some ventilation of the enclosure is required.

4) When a number of inverters are installed in a single location, arrange the units horizontally. The stack effect of mounting inverters over one another should be avoided.

5) Refer to Fig.2 for minimum clearances.

6) When the installation surface is uneven, place spacers under the inverter mounting legs to eliminate any unevenness before installation. If the inverter is installed on an uneven surface, the strain (twisting) of the enclosure can damage the main circuit components. Ideally the unit should be mounted on a flat, dry, nonflammable surface (such as a concrete block wall) because the inverter radiates heat from the rear heat sink. When the unit is mounted on a base panel use a nonflammable material (such as a metal sheet).

7) Static electricity may cause a breakdown to the microprocessor or other integrated circuits on the printed circuit boards. Handle these parts only after grounding the work bench, soldering iron and technician properly.

TABLE 3

Class / Condition / Inverter output capacity	200 volt class Time in seconds, for bus voltage to drop to 50VDC from 270VDC	400 volt class Time in seconds, for bus voltage to drop to 50VDC from 560VDC
1 to 5 hp	13	40
7.5 to 10 hp	22	100
15 hp	25	180
20 to 30 hp	8	200
40 hp	10	220
50 hp	10	220
60 hp	15	230
75 hp	20	250
100 hp	NA	280
125 hp	NA	315
150 hp	NA	365
200 hp	NA	480

NOTE: The above discharge times are at input voltage of 200/400VAC. When the inverter supply voltage is higher, the discharge time increases. Please be certain that the charge lamp/LCD display are off prior to touching any inverter internal parts.

NOTE: The inverter is vented at the top and bottom. When installed outside of a larger enclosure, a shield to prevent air born particles from entering the vents is suggested. The shield should be installed 6 to 12 inches above the inverter as explained in the clearance diagram below.

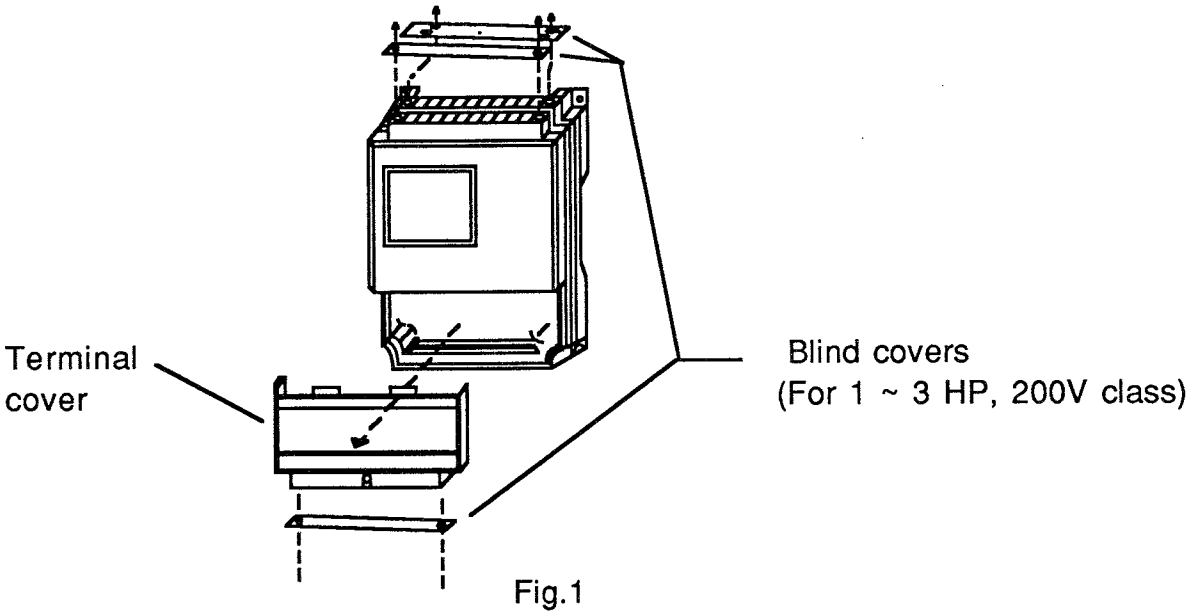


Fig.1

1-15 HP 200V;
2-10 HP 400V inverter

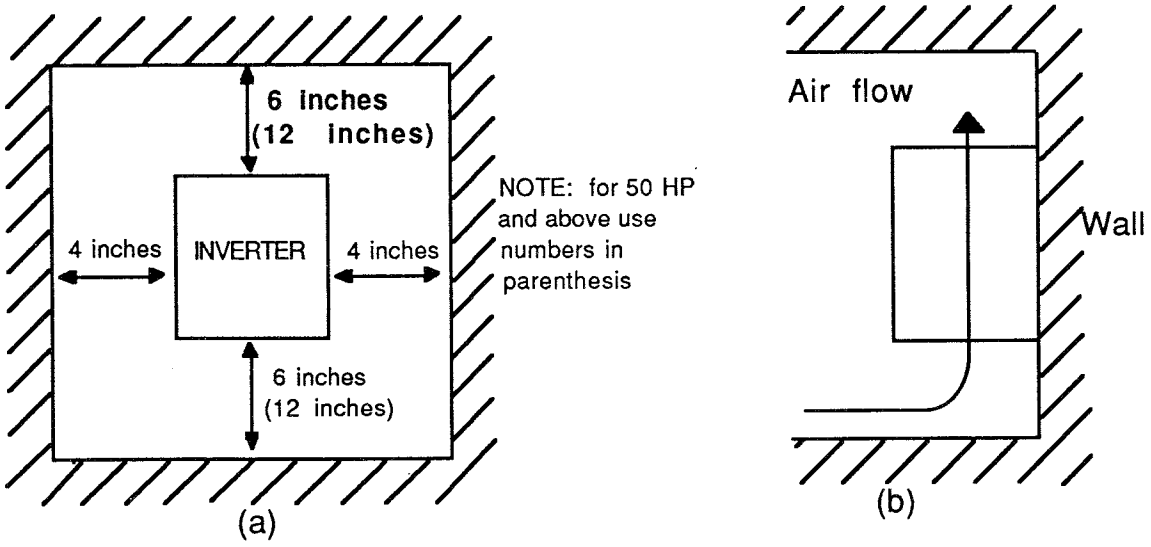


Fig. 2
Inverter Installation Clearance

4.2 Power Wiring Considerations and Notes

WARNING: For personal protection, an earth leakage breaker or earth leakage detection device must be installed on the power receiving side.

1) Always confirm that the input power matches the name plate rating of the inverter.

2) L1, L2 and L3 are used for **INPUT** power.

3) T1, T2 and T3 are used for **OUTPUT** to the 3-phase motor.

4) Always install a circuit breaker on the line side of the inverter for optimal protection.

Do not use an unfused blade type switch in place of a circuit breaker.

5) When a load side contactor is used, be sure that the inverter output has returned to zero and that the motor has stopped before closing the contactor. Opening and closing the contactor when the inverter is in an operating mode may result in overcurrent tripping of the inverter. Repeated operations may also damage the inverter.

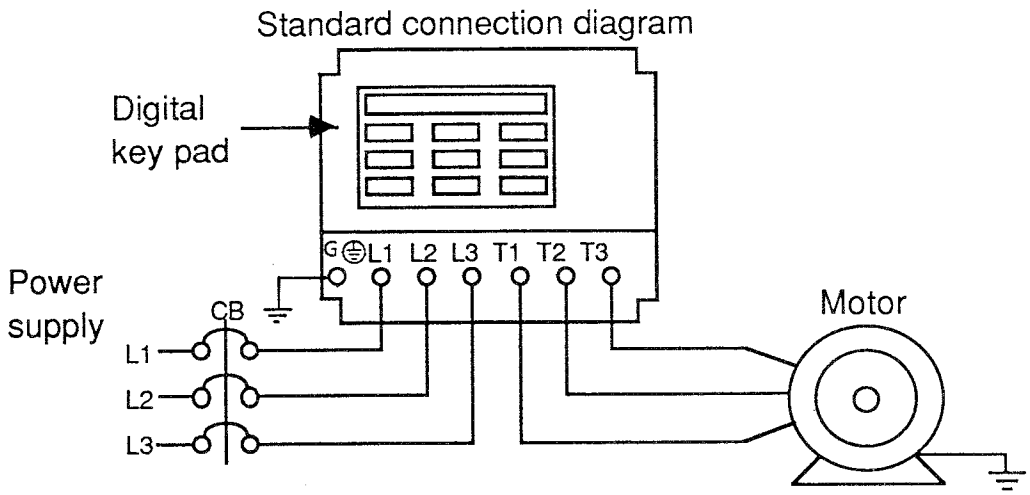
Contactors applied in conjunction with an automatic transfer sequence to/from commercial power require the inclusion of the option board.

6) A thermal relay is not required when a single standard NEMA Class B, 3-phase 4-pole induction motor is used at a minimum 10 Hz and less than 60 Hz (the inverter has built in thermal protection for standard motors). Adjust the RC value of any additional thermal relay installed to the rated current value of the motor.

7) The inverter current leakage is approximately 3mA/unit.

8) Do not connect a phase-advance capacitor or a surge absorber between the inverter and motor.

9) The inverter power factor is typically over90%, however actual value will depend on line impedance. Never put power factor correction devices on the output of the drive. Always locate capacitors on the line side of the inverter and as faraway from the drive as possible. If an installation uses a large number of inverters or has power factor correction capacitors nearby, it is best to add AC line reactors to the input of each inverter.



CB: Circuit Breaker

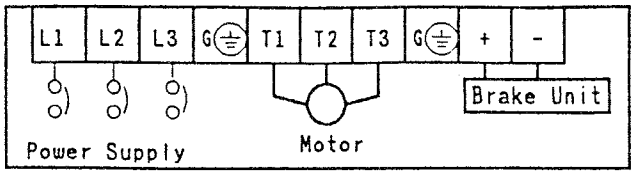
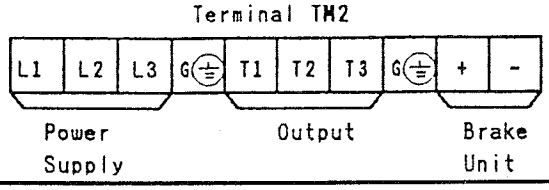
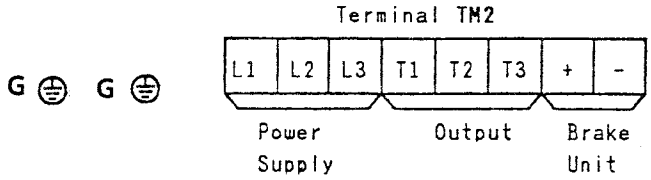
There is **no** warranty for damage caused by improper wiring or shorts in power wiring. Check all wiring connections to insure that a short does not exist prior to applying power.

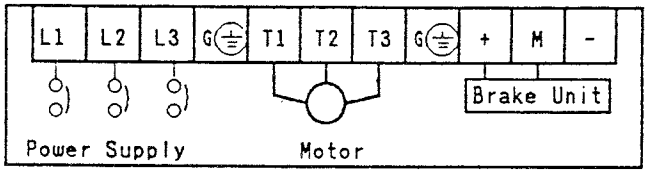
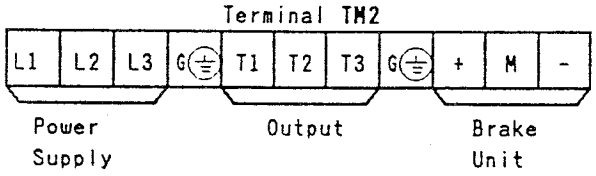
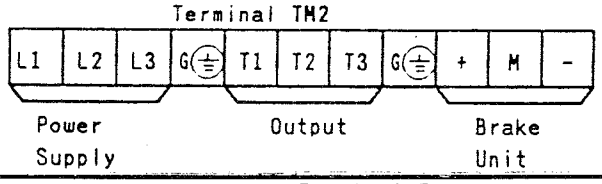
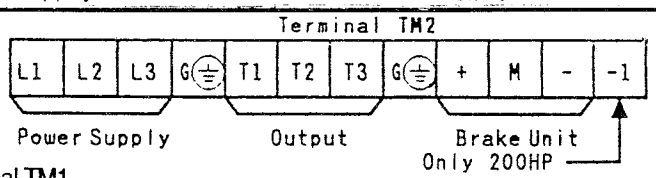
10) The ground fault protection circuit is not designed to protect against personnel injury. For personnel protection an earth leakage current breaker specifically designed for this level of protection must be located on the line side of the inverter.

11) The start into a coasting motor may cause a ground fault trip due to transient unbalance current.

12) Installation of an AC reactor on the line side of the inverter is recommended for protection of the dc link capacitors.

4.3 Main Power Terminal Designations

Rating	Main Power Terminals 200 Volt Class
1 to 15hp 200 volt class	
20 hp 200 volt class	
30 to 75 hp 200 volt class	

Rating	Main Power Terminals 400 Volt Class
2 to 10hp 400 volt class	
15 to 20 hp 400 volt class	
30 to 75hp 400 volt class	
100 to 200hp 400 volt class	 Terminal TM1 (CONTROL POWER) L1H L2H L3H L1M L2M L3M L1L L2L L3L For 460v input use L1H, L2H and L3H For 415 to 440v use L1M, L2M and L3M For 380 to 400v use L1L, L2L and L3L NOTE: Brake Unit contacts (+, M , -) on the 200hp are located on Terminal TM3

4.4 Selection of Power Wiring

All wiring should be sized and installed in accordance with national and local electrical and safety codes. Use adequate size wire to compensate for the voltage drops when the distance from the inverter to the motor is long. This is very important when operating the motor at reduced speeds because the voltage is already reduced along with the frequency.

The voltage drop between the inverter and the motor should be limited to 2% or less. Voltage drop increases with wire length. A voltage drop reduces the motor torque, increases the current and often causes overheating.

The formula for figuring voltage drop is:

$$V = \frac{\sqrt{3} \times R \times L \times A}{1{,}000}$$

Where:

V = Voltage drop
R = Resistance per foot in milli-ohms
L = Length of wire in feet
A = Current in amps

Insulation for power wiring should be in accordance to UL and CSA standards which are as following:

Inverters rated below 100 amps should have 65/75 degrees centigrade insulation

Inverters rated above 100 amps should have 75 degree centigrade insulation

4.5 Use of an Input Transformer

If an input transformer is used, an inverter requires a transformer with a kVA capacity of approximately 1.5 times the horsepower of the motor. The table below shows the relationship between the motor capacity and transformer capacity.

Motor Capacity (HP)	Transformer Capacity (KVA)	Motor Capacity (HP)	Transformer Capacity (KVA)
0.5	1.0	25	45
1.0	1.5	30	45
2.0	3.0	40	60
3.0	5.0	50	75
5.0	7.5	60	100
7.5	10	75	100
10	15	100	150
15	20	125	200
20	30	150	225

TYPICAL MOTOR/TRANSFORMER CAPACITIES

4.6 Grounding of Inverter

Provide an adequate earth ground as follows.

- Provide a 100Ω or less ground to the inverter ground terminal G ⏚.
- The inverter ground should be separate from the ground for other electrical equipment.
- When grounding several inverters, connect as shown in Fig. 3 below.

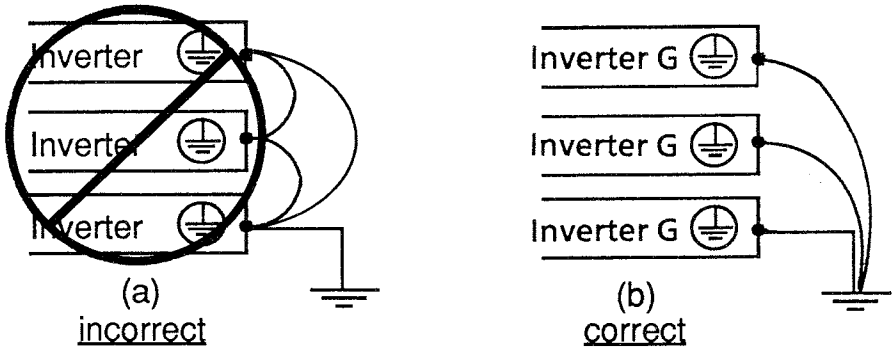


FIGURE 3

- Use a minimum size ground conductor of 12 AWG for inverters above 8 kVA, and the same size ground conductor as the power lines for inverters 5.5 kVA and less.

4.7 Signal Wiring Considerations

1) Use shielded wire for all signal lines. Connect the shield drain wire as shown in Fig. 4 below. Wire length should be kept to 60 feet or less.

If the wire length must exceed 60 feet, use an optional application controller or signal isolation converter (consult factory).

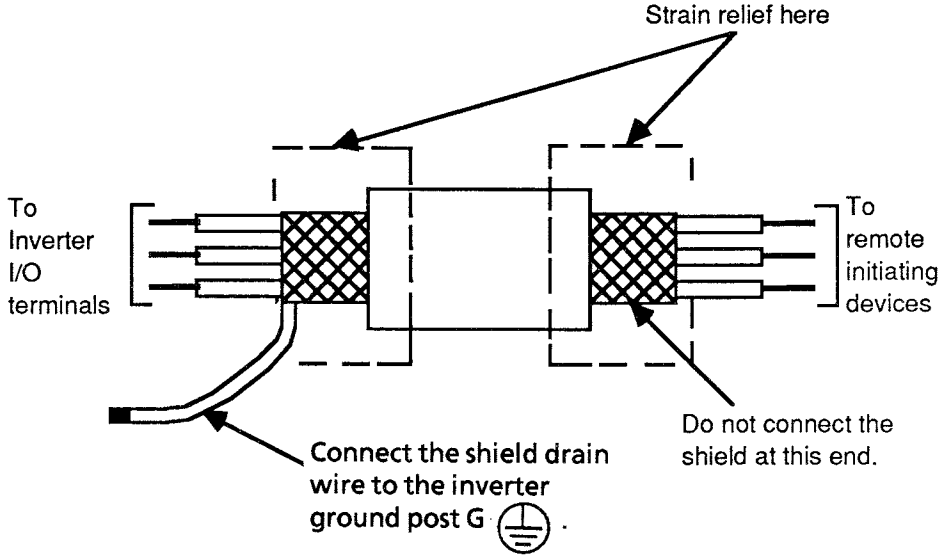
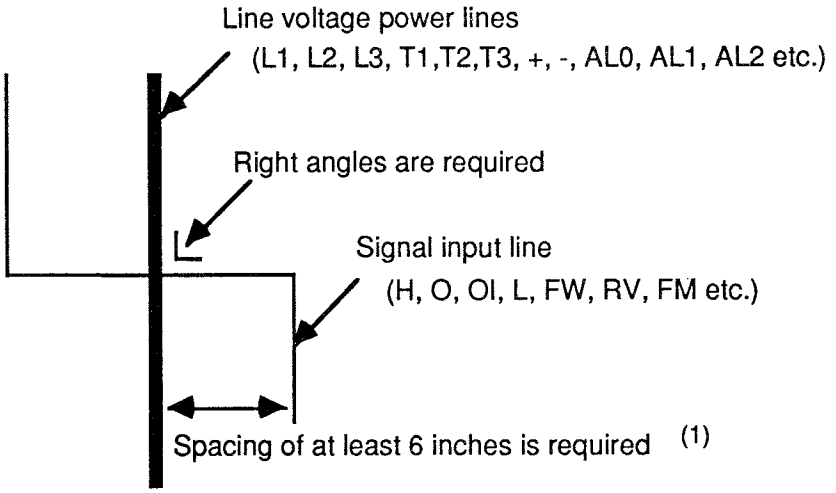


Fig.4 SIGNAL WIRE SHIELDING

2) Use shielded 18 AWG signal wire applicable to 12 volt DC, 3 mA signals.

3) Maintain a 6 inch minimum distance between the signal lines and any power lines as shown in Fig. 5. If a cross-over is unavoidable, cross wires perpendicular to each other.



(1) When the parallel distance for cables exceeds 100 feet on 40hp and larger inverters, 10 inch spacing is required, and when the parallel distance exceeds 300 feet for all sizes, spacing of at least 10 inches is required.

FIGURE 5

4.8 Input/Output (I/O) Signal Terminal Designations

Table A

Terminal Designation	Terminal Name	Function
+, -, M	DC voltage terminals	Connection of regenerative brake unit
2CH	initiation of 2nd acceleration or deceleration time	Contact closure between 2CH and L initiates the 2nd acceleration/deceleration time
AR	Frequency arrival	Transistor output "ON" when output frequency reaches the frequency setpoint
RUN	Running signal terminal	Transistor output "ON" when inverter is running
COM	Common terminal	Common terminal for use only with AR and RUN terminals
JG	Jogging terminal	Contact closure between JG-L initiates jogging frequency when inverter is commanded to run
CF2	Multistage speed terminals	Contact closures CF1-L and CF2-L enables initiation of up to 4 different pre-determined speed setpoints
CF1		
H	Ref. voltage terminal for external frequency setting potentiometer	+10V DC
O	Terminal for external frequency setting by voltage input	DC 0 ~ 10V, DC 0 ~ 5V (Selectable via DIP switch (Input impedance, 15 kΩ for 0-5V and 30 kΩ for 0-10V)
OI	Terminal for frequency setting by current input	4 ~ 20 mA (Input impedance 250Ω)
L	Common terminal	Common of control terminals (do not ground)
FW	Forward/stop terminal	Close FW-L: forward operation Open FW-L: stop
RV	Reverse/stop terminal	Close RV-L: reverse operation Open RV-L: stop
RS	Fault reset terminal	Toggle RS-L provides fault signal reset
FM	Remote frequency monitor device terminal	Digital frequency counter or analog meter (0 ~ 10V 1mA full scale, impedance 10 ~ 22 KΩ) selectable
FRS	Free-run stop terminal	Close FRS-L: driven motor is allowed to free-run stop
AL1	Fault/Alarm contact terminals	During fault/alarm: AL0 - AL1 (open) AL0 - AL2 (closed) Contact rating: AC 250V 2.5A (resistive load), 0.2A (COS ϕ 0.4) DC 30V 3A (resistive load), 0.7A (COS ϕ 0.4)
AL2		
AL0		

Please refer to Section 5 for a complete discussion of the purpose, operation, electrical characteristics and typical wiring designs for all input/output terminals and devices.

4.9 Input Phase Failure

The 230 volt inverter is not protected against an open phase on the input side. If a phase opens or is open when the inverter is operating the inverter will fail as follows:

(a) For 1 to 2 horsepower 230 volt:

1) When the load is small, the inverter operates normally, but the main capacitor ripple current increases, thus reducing the life of the main capacitor (CB) significantly.
2) When the load is increased, the over current or under voltage protection functions will trip the inverter, however the converter module (DM) may also be damaged.

(b) For 3 horsepower and above 230 volt:

1) Loss of L1 or L2 phase: Relay 84 does not energize causing resistor RS to overheat.
2) Loss of L3: Inverter reacts the same as for (a) above.

c) For 2 horsepower and above 460 volt:

When an input phase is lost, control power to the logic board is lost or disconnected, subsequently the inverter will not operate and there is no damage to the unit. **However, the loss of one phase causes the LCD to go off, be *certain* that the input power is off and the charge lamp is off before checking the inverter.**

5. TYPE AND FUNCTION OF I/O SIGNALS

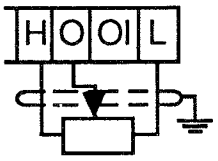
5.0 Terminals are provided for 14 input and output (9 input and 5 output) signals on the inverter I/O terminal strip to accomodate a variety of application needs. Programming parameters applicable to input and output signals are entered under the Operator/Monitor and Set-Up modes from the Operator Key Pad. In addition, specific wiring considerations must be followed during selection and installation of the initiating and control devices.

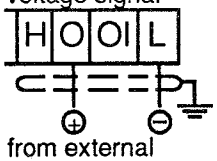
The following tables explain the purpose of each I/O signal, how it functions, programming requirements and proper wiring connections. In addition, the electrical characteristics of the inverter initiating circuitry is shown to assist in selecting the correct remote initiating or control device(s).

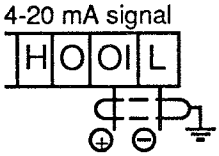
Applicable terminal designations for each input or output signal are also shown for each I/O function. A composite listing of all inverter terminal designations is included in Section 4, paragraph 4.8, Table A.

5.1 Input Signals

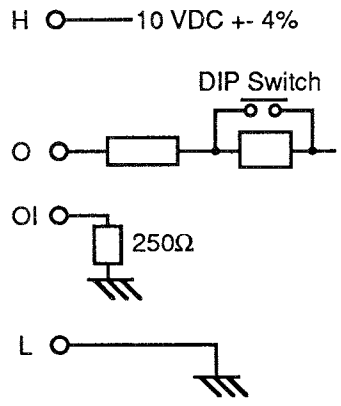
<table>
<tr><td>Input Signal
01</td><td colspan="2">Description</td></tr>
<tr><td>Name:
External output frequency setpoint adjust command

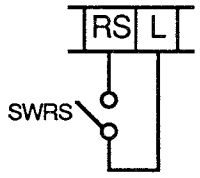
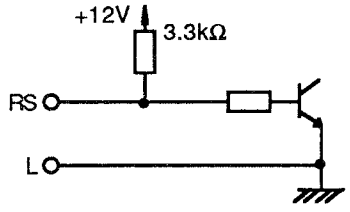
Terminal Designations:
H, O, OI and L</td><td colspan="2">The setpoint of the inverter output frequency may be set by the operator key pad to be either via the key pad or from these external signals (refer to Section 9; Operator/Monitor Display 3 for information on how to make this selection).</td></tr>
<tr><td>I/O Terminal Connections</td><td>Remarks</td><td>Electrical Characteristics</td></tr>
<tr><td>from potentiometer
 

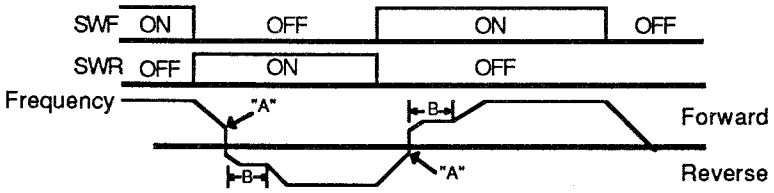
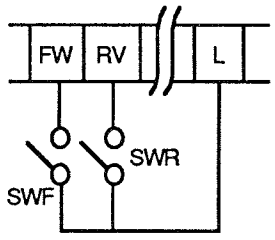
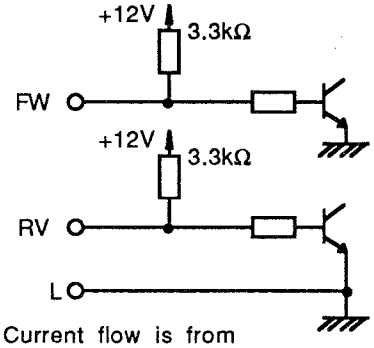
from external voltage signal
 

from external 4-20 mA signal
 
</td><td>Use 2W 500Ω or 1W 1kΩ or .5W 2kΩ potentiometer

Voltage input may be either 0-5 VDC or 0-10 VDC (refer to DIP Switch Adjustment in Section 10)
Input impedance: 15 kΩ for 0-5 VDC
30 kΩ for 0-10 VDC

Current input: 4-20 mA
Input impedance: 250Ω</td><td> 
</td></tr>
</table>

Input Signal 02	Description	
Name: External Reset Command Terminal Designations: RS and L	There is a manual reset button located on the logic board. In addition, these terminals provide a remote reset capability that can be initiated from a remote contact closure. When SWRS is closed the inverter output is shut off, and any existing inverter alarm/fault conditions are reset. In addition to resetting a fault, this command is used to immediately stop the inverter output such as when a driven load brake is applied.	
I/O Terminal Connections	Remarks	Electrical Characteristics
	When SWRS is closed, the digital display is blank. When the reset signal is removed and a run command is initiated (or in effect) the inverter will accelerate from the lowest output frequency setpoint (the inverter does not initiate a "start into a running motor" routine from a release of the reset command).	 Minimum input pulse width ≥ 50 ms Current flow is from RS to L at ≈ 3.5 mA L level ≤ 0.3 V H level ≥ 2.4 V

Input Signals 03 and 04	Description	
Name: External forward/reverse/stop command Terminal Designations: FW,RV and L	The forward/reverse/stop command may be set from the operator key pad to be either via the key pad operator keys or from these external signals. Representative timing chart: 	
I/O Terminal Connections	Remarks	Electrical Characteristics
	• Acceleration and deceleration times are individually adjustable as functions 01 and 02 (see Section 10). • Minimum frequency (point A) is adjustable as function 04 (see Section 10). • Dwell period (time period B) is adjustable as function 11 (see Section 10). • Inverter logic recognizes an external contact closure of SWF/SWR in approximately 50 milliseconds.	 Current flow is from FW/RV to L at ≈ 3.5mA L level ≤ 0.3V H level ≥ 2.4V

Input Signal 05

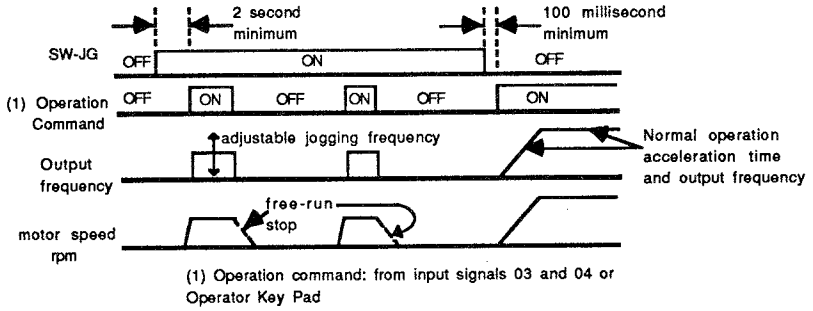
Name:
Jogging frequencycommand

Terminal Designations:
JG and L

Description

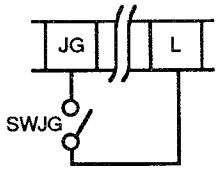
A separate jogging frequency setpoint may be set via Display 9 in the Operator/Monitor mode. When a jogging frequency has been set and this contact is closed, the inverter will output the jogging frequency whenever the inverter is commanded to operate (forward or reverse) from either the operator key pad or input signals 03 or 04.

Representative time chart:



(1) Operation command: from input signals 03 and 04 or Operator Key Pad

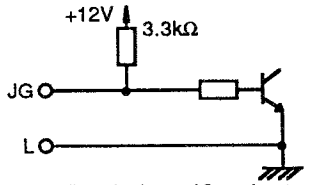
I/O Terminal Connections



Remarks

- Inverter operation command must be "OFF" for logic to recognize jogging operation request (closure of SW-JG).
- Operation command (to operate at jogging frequency) must occur at least 2 seconds after SW-JG closes.
- Operation command (to resume operation at normal output frequency) must occur at least 100 milliseconds after SW-JG opens.
- Inverter initiates a free-run stop at termination of jogging output frequency.
- If switch SWJG is opened while the inverter is jogging, the inverter will stop. The inverter will not operate again until switch SWF/SWR or key FWD RUN/ REV RUN is opened and then closed.

Electrical Characteristics



Current flow is from JG to L at ≈ 3.5 mA

L level ≤ 0.3V H level ≥ 2.4V

Input Signals 06 and 07

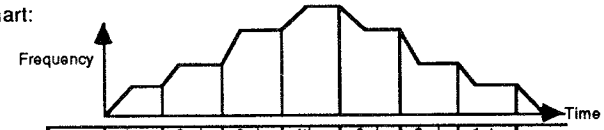
Name:
Multiple speed command

Terminal Designations:
CF1, CF2 and L

Description

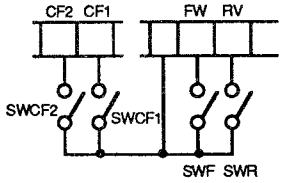
In addition to the normal output frequency setpoint, three additional output frequencies can be pre-programmed via set-up functions 12,13 and 14 (see Section 10). These signals allow four stage speed control to be initiated via a combination of contact closures.

Representative chart:



Switch	1st speed	2nd speed	3rd speed	4th speed	3rd speed	2nd speed	1st speed
CH1	Closed	Open	Closed	Open	Closed	Open	Closed
CH2	Open	Closed	Closed	Open	Closed	Closed	Open
SWF	Closed						Open
SWR	Open						

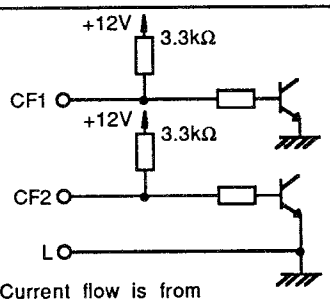
I/O Terminal Connections



Remarks

- For reverse operation open SWF and close SWR.
- 4th speed shown in chart (SWCF2 & SWCF1 open) is the speed set by the normal frequency setpoint.
- Acceleration and deceleration times are as set by set-up functions 01 and 02 (see Section 10).

Electrical Characteristics



Current flow is from CF1/CF2 to L at ≈ 3.5mA

L level ≤ 0.3V H level ≥ 2.4V

Minimum input pulse width ≥ 50 ms

Input Signal 08

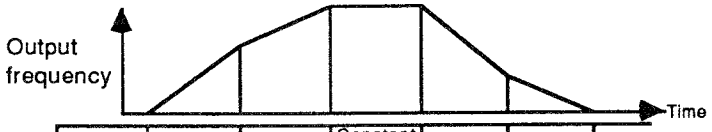
Name:
2nd stage acceleration/ deceleration command

Terminal Designations:
2CH and L

Description

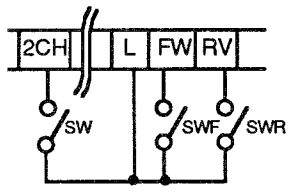
Inverter set- up functions 01, 02, 18 and 19 (see Section 10) provide the ability to pre-set two acceleration times and two deceleration times. This signal initiates the change to the inverter logic to begin the second acceleration or second deceleration time during an acceleration or deceleration period.

Representative chart:



Switch	$ACCEL_{-1}$	$ACCEL_{-2}$	Constant speed	$DECEL_{-1}$	$DECEL_{-2}$
2CH	Open	Closed	Open or Closed	Open	Closed
SWF	Closed			Open	
SWR	Open				

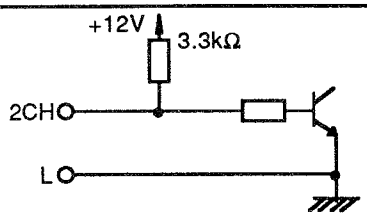
I/O Terminal Connections



Remarks

- For reverse operation open SWF and close SWR.
- Constant speed is set by output frequency setpoint.

Electrical Characteristics



Current flow is from 2CH to L at ≈ 3.5 mA
L level ≤ 0.3V H level ≥ 2.4V
Minimum input pulse width ≥ 50 ms

Input Signal 09

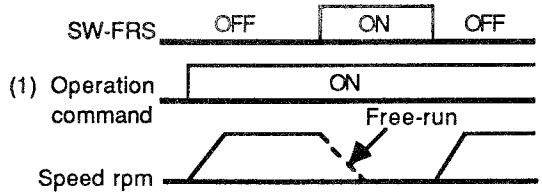
Name:
Free run stop command

Terminal Designations:
FRS and L

Description

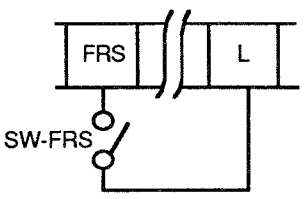
Typically a driven motor is slowed to a stop by the inverter through the deceleration time(s). When it is desirable to allow the driven motor to coast to a stop, free of any inverter output signal, the free run stop signal may be used.

Representative chart:



(1) Operation command: From I/O terminal (FR,RV) on operator key pad.

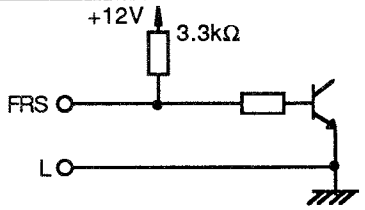
I/O Terminal Connections



Remarks

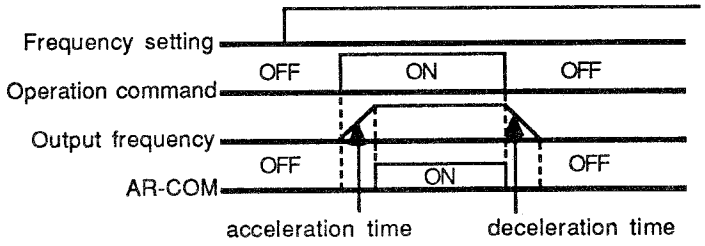
- The inverter logic recognizes a contact closure of SW-FRS and initiates a free run stop in approximately 200 ms. When it is necessary to turn off inverter output in less than 200 ms (such as in an external motor brake application) use the reset (RS) terminal without using the FRS terminal.

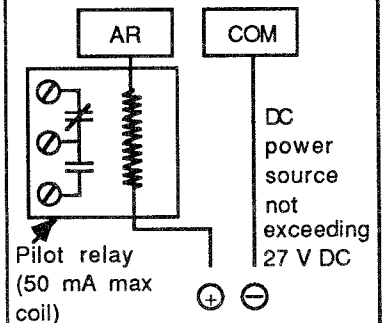
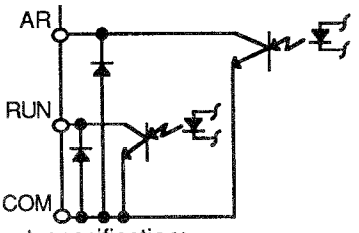
Electrical Characteristics

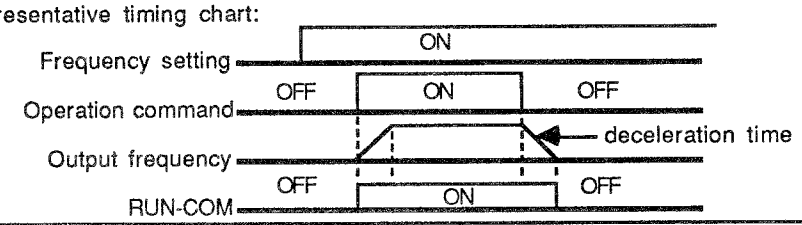


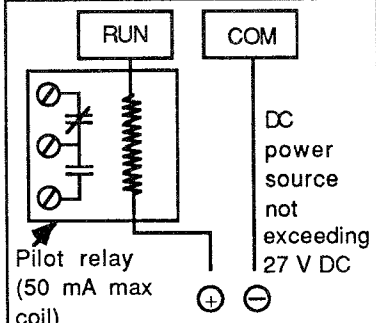
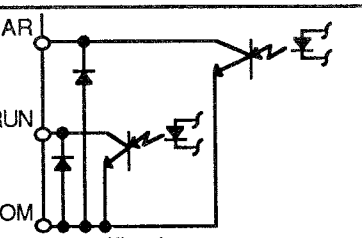
Current flow is from FRS to L at ≈ 3.5mA
L level ≤ 0.3V H level ≥ 2.4V

5.2 Output Signals

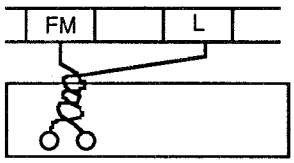
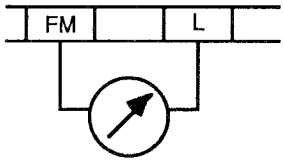
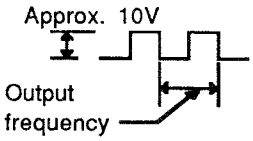
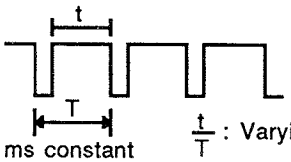
Output Signal 01	Description
Name: Frequency arrival signal Terminal Designations: AR and COM	An optically isolated open collector output signal is switched "ON" when the inverter output frequency arrives (after acceleration time) at the output frequency set point (+- 0.5Hz). This signal is typically used to energize a pilot relay coil. Representative timing chart: 

I/O Terminal Connections	Remarks	Electrical Characteristics
	• The open collector output for the AR signal is common with the RUN signal. If the AR signal is used in conjunction with the RUN signal a common DC power source must be used. • A pilot relay is pre-wired for this function on the option PC BOARD.	 Contact specification: Open collector output 27V, 50 mA max. Forward voltage drop is ≈ 1 volt.

Output Signal 02	Description
Name: Running signal Terminal Designations: RUN and COM	An optically isolated open collector output signal is switched "ON" when the inverter logic has received a command to run (forward or reverse). The "ON" signal is present through the acceleration and deceleration periods. This signal is typically used to energize a pilot relay coil. Representative timing chart: 

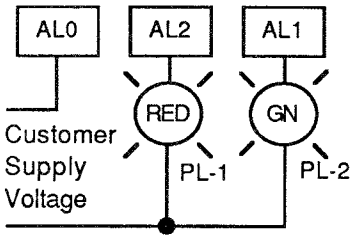
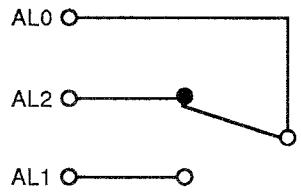
I/O Terminal Connections	Remarks	Electrical Characteristics
	• The open collector output for the RUN signal is common to the output of the AR signal. If the RUN signal is used in conjunction with the AR signal a common DC power source must be used. • This signal is typically used to energize a pilot relay coil (50 mA max) of an auxiliary circuit. • A pilot relay is pre-wired for this function on the option PC BOARD.	 Contact specification: Open collector output 27V, 50 mA max. Forward voltage drop is ≈ 1 volt.

Output Signal 03	Description
Name: Frequency monitor signal Terminal Designations: FM and L	This signal is available to drive a remote frequency meter, either an analog meter or digital (pulse) meter. The output signal is either a 50/50 duty cycle pulse train at a frequency equal to the inverter output frequency (digital meter) or a duty factor (t/T) pulse proportional to the output frequency (analog meter). The selection of either the digital or analog signal is made through set-up function 28 (see Section 10).

I/O Terminal Connections	Remarks	Electrical Characteristics
For a digital meter  For an analog meter  	• 50/50 duty cycle pulsed output   11 ms constant $\frac{t}{T}$: Varying • A fine tune adjustment (Pot "M Adj") is provided on the logic board for calibrating the analog meter (see Manual Adjustments Section 10).	pulse amplitude is approximately 10 volts. 0~10V Full scale (Load resistance: 10~22 kΩ 1 mA max.)

Output Signals 04 and 05	Description
Name: Fault alarm signals Terminal Designations: AL0, AL1 and AL2	These signals are available to switch a control voltage to alarm, signalling or control devices when such devices are to be energized when there is an inverter fault/alarm or to signal normal operation. They may also be used to override the Unattended Start Protection (Please refer to Section 8 wiring diagrams).

Power available at inverter	Operating conditions	Contacts AL0-AL1	Contacts AL0-AL2
Yes	In normal conditions	Closed	Open
Yes	In abnormal conditions	Open	Closed
No	N/A	Open	Closed

I/O Terminal Connections	Remarks	Electrical Characteristics
 	• PL-1 would light whenever the inverter has power to L1, L2 and L3 and there is a fault/alarm condition (PL-1 will remain "ON" even if inverter fault caused an inverter trip). PL-1 will also light if power is lost to the inverter (i.e. AL0 - AL2 closes on a power loss to the inverter). • PL-2 would be lit whenever the inverter had power to L1, L2 and L3 and there was no fault/alarm condition. • Fault alarm signal contacts are re-set to a no fault condition when the inverter is re-set.	 Contact Ratings AC 250V, 2.5A (resistance load) 0.2A (cos ϕ =0.4) DC 30V, 3.0A (resistance load) 0.7A (cos ϕ =0.4)

6. BLOCK DIAGRAMS AND CIRCUIT DESCRIPTION

6.1 PC Board Location/Connections

The board location and its block diagrams are shown in figures 1,2 and 3.

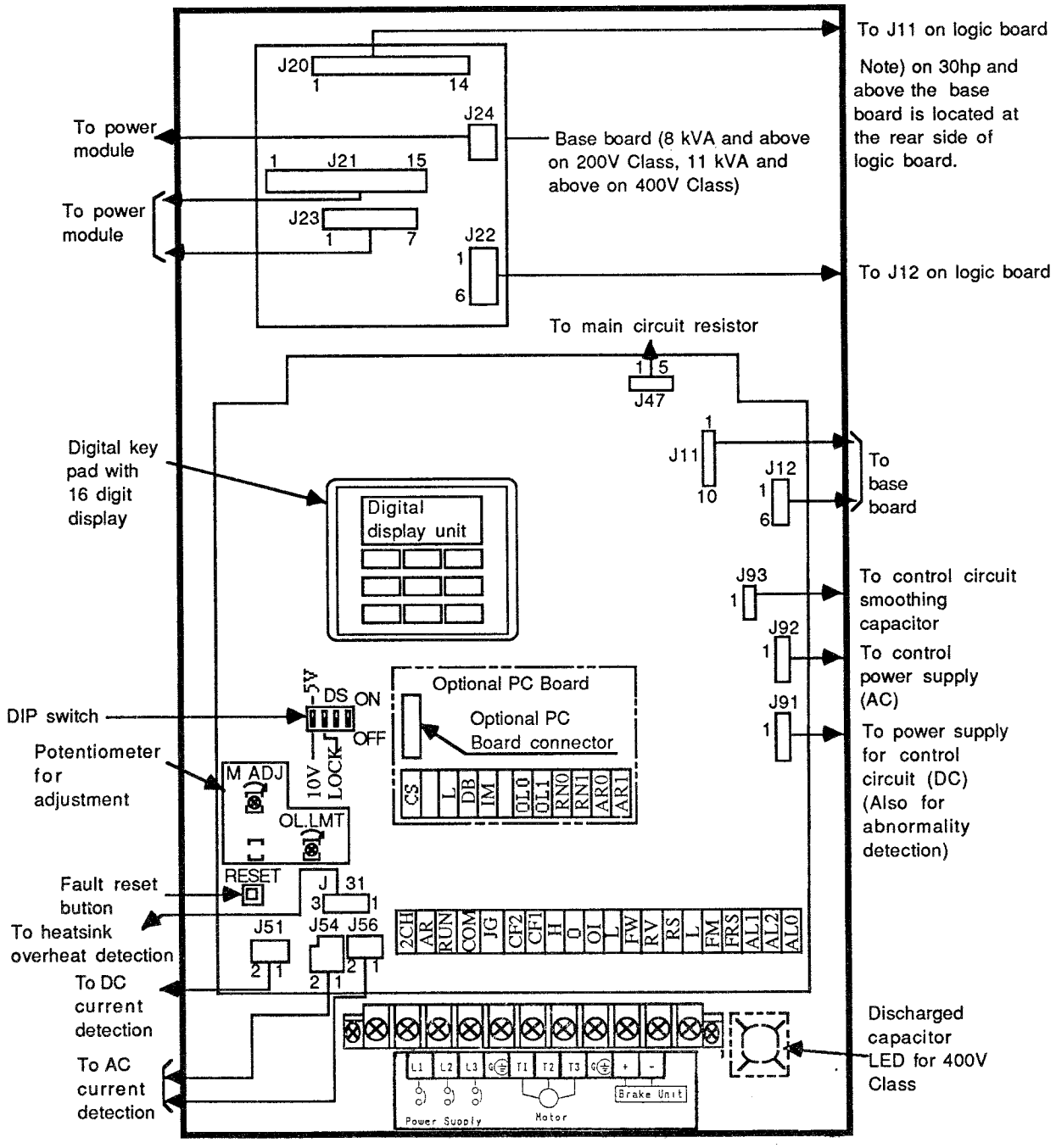
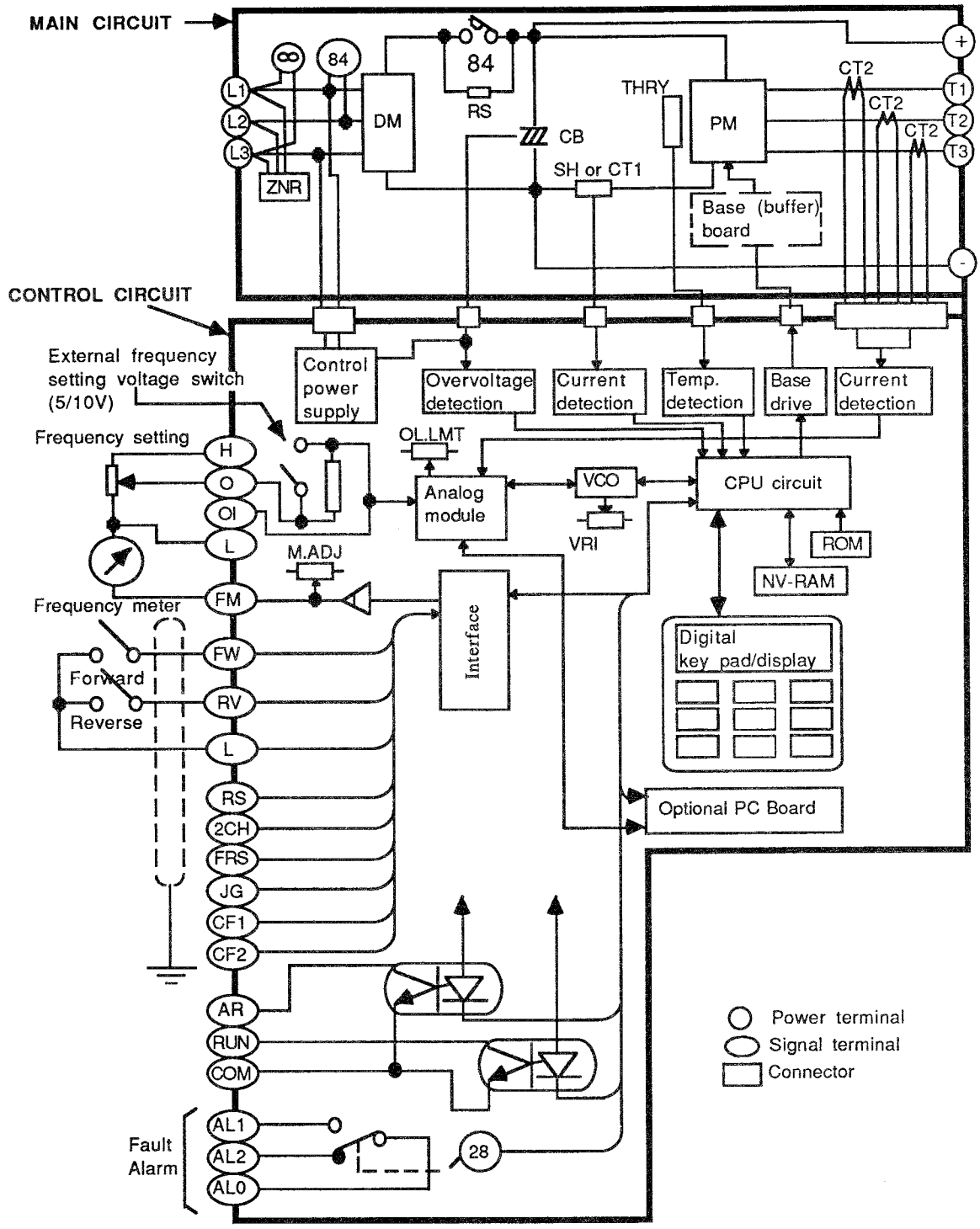


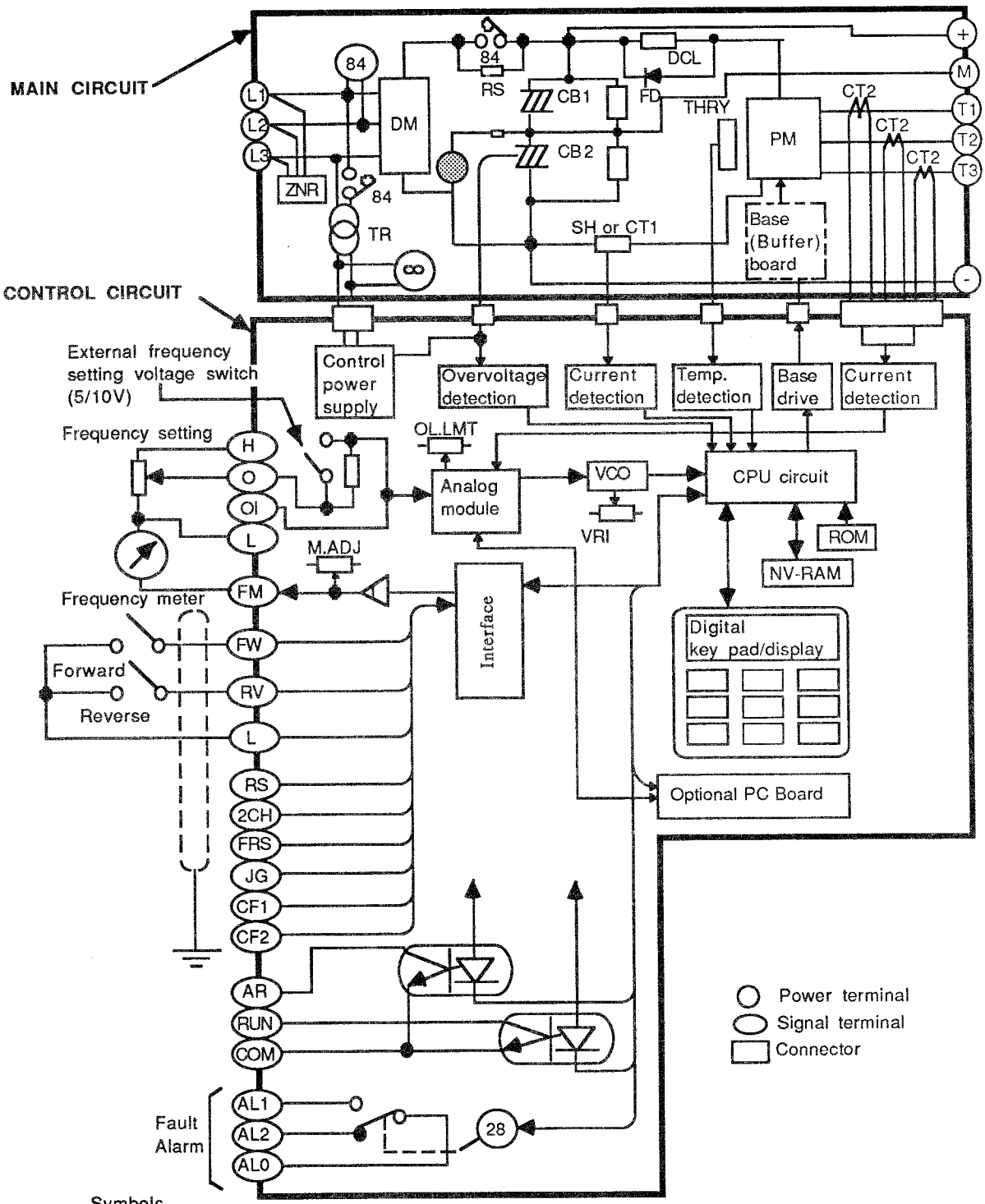
Fig. 1 PC Board Location (7.5-15 hp 200 Volt)



Symbols

- (84) : Electromagnetic contactor (Not provided on 2 hp and below for 200V Class)
- (∞) : Fan (3 hp and above)
- DM : Diode module (Converter module)
- CB : Smoothing capacitor
- (28) : Fault alarm relay
- ⬚ : Base (buffer) board (7.5 hp and above for 200V Class)
- SH : Shunt resistor (5 hp or less)
- CT1 : Current transformer (7.5 hp or more)
- RS : Current limiting resistor
- PM : Power module (Inverter module)
- THRY : Thermal relay
- CT2 : Current transformer
- ZNR : Surge absorber

Fig. 2 Block Diagrams (For 200V Class)



Symbols

- (84) Electromagnetic contractor
- FD: Flywheel diode
- TR: Transformer (Only for 400V Class)
- DM : Diode module (Converter module)
- CB : Smoothing capacitor
- (28): Fault alarm relay
- DCL: DC reactor
- Charge lamp
- (∞): Fan (7.5 hp or more)
- : Base board (10 hp and above for 400V Class)
- SH : Shunt resistor (5 hp and below)
- CT1 : Current transformer (7.5 hp and above)
- RS : Current limiting resistor
- PM : Power module (Inverter module)
- THRY : Thermal relay
- CT2 : Current transformer
- ZNR : Surge absorber

Fig. 3 Block Diagrams (For 400V Class)

6.2 Circuit description

6.2.1 Main circuit

1) 3-phase AC input voltage is converted to DC voltage through a full-wave rectifying diode module (DM).

2) DC voltage from the DM is smoothed through the smoothing capacitor (CB).

3) Smoothed DC voltage is converted to AC voltage through the inverter module (PM). This circuit outputs a waveform similar to a sine wave (sine coded PWM control) by changing the pulse width of the output voltage during conversion.

6.2.2 Control circuit

1) The CPU circuit is the heart of the control circuit acting on inputs from the external I/O, operator key pad and inverter detection circuits in conjunction with operating software and operator entered operating parameters (stored in NVRAM) to control the inverter output via sine coded PWM control.

2) The analog circuit receives and transmits various external I/O and analog detection circuit signals to the CPU circuit.

3) The interface circuit receives and transmits various external digital (on/off, enable/ disable) I/O commands to the CPU, including the forward/reverse/stop commands, multistage speed commands, jogging operation command and reset command.

4) The base drive circuit receives the sine coded PWM signal controlled by the CPU and drives the inverter module.

6.2.3 Protection circuits

Protection circuits for over and under voltage, overcurrent, overload and overheat are an integral part of the inverter circuitry. For a complete discussion of the protection circuits and fault display contents, please see Section 7.

7. PROTECTION CIRCUITS AND FAULT/ALARM MESSAGES

7.0 Overview

A principle objective during the design of this inverter was to minimize nuisance trips by including microprocessor based trip prevention sequences. In addition, because the microprocessor controls trip sequences, it is able to advise the user via the 16 digit display of a trip cause when a trip occurence is unavoidable. Many times when the cause of a trip can be identified, further trips can be avoided through an adjustment to the inverter logic or other process elements.

This section discusses some of the common causes of AC inverter tripping, the trip preventing sequences under microprocessor control included in this inverter and the fault/alarm messages displayed by the microprocessor.

7.1 Stall Prevention (Overcurrent Trip)

1) During acceleration

The stall prevention sequence compares the actual inverter output current value to the inverter rated output current. If the actual output current exceeds the stall prevent setpoint (adjustable between 50-150% of the rated output current), an acceleration prohibitor takes affect and the prevent sequence begins to decrease the output frequency. By reducing output frequency, motor speed, torque and current are reduced. When the output current falls below the stall prevent setpoint the acceleration prohibitor is removed and acceleration is allowed to resume.

If the overcurrent protection sequence is unable to prevent an overcurrent trip, the display "OC ACCEL." appears in the 16 digit display. The "OC ACCEL." message suggests that the acceleration rate(s)(time) programmed in function 01 and/or function 18 should be increased to avoid overcurrent tripping during acceleration.

NOTE: The stall prevent set point is adjustable between 50-150% via a pot on the logic board. Please refer to Logic Board Potentiometer Adjustments in Section 10. In addition, two programmable features are included (see Section 10, para 10.3 Set-Up Functions) that allow the user to adjust the stall prevention sequence.

1) Set-up function 28, entry 4, provides the ability to prohibit the stall prevention sequence from affecting output frequency during acceleration if required by the application.

2) Set-up function 30 provides the ability to adjust the rate of output frequency

change (rate of stall prevent response) when the stall prevent sequence takes affect.

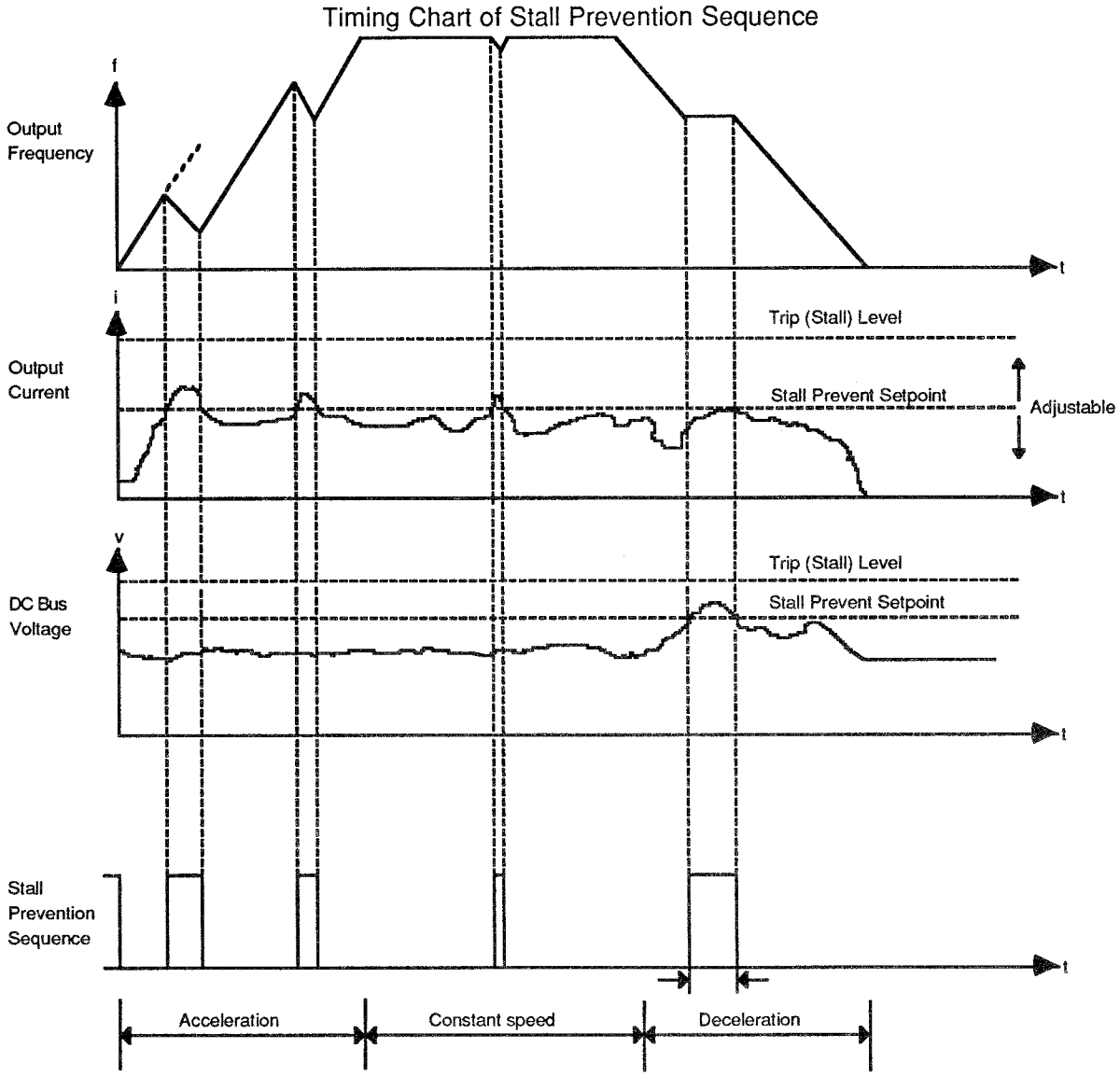
2) During deceleration

The protection provided during deceleration is similar to the acceleration protection with added provisions of protecting the inverter circuitry against regenerative voltage from the decelerating motor. During deceleration the protection sequence monitors DC-Bus voltage as well as current. If the voltage or current exceed the setpoints the sequence prohibits deceleration (reducing regenerative energy). As with the acceleration sequence, after the value falls below the setpoint the deceleration prohibitor is removed and deceleration is allowed to continue.

The deceleration prohibitor is allowed to be in effect for up to 95 seconds out of 100 seconds when necessary. If the prohibitor can not reduce the voltage or current, the microprocessor displays "OC DECEL." (overcurrent at deceleration) or "Over V." (over voltage at deceleration). An "OC DECEL." message suggests that the deceleration time is too short. An overvoltage message also suggests that the deceleration time is too short or that the motor is being driven by the load creating regenerative voltage. If the prohibitor is in effect for more than 95 seconds out of every 100 seconds, the microprocessor assumes the overcurrent is not being caused through regenerative forces and displays "OV SRC" (overvoltage source).

(3) During constant speed

The protection during constant speed is the same as during acceleration. If the output current exceeds the setpoint, the output frequency is reduced until the current falls below the setpoint. If the prohibitor can not reduce the output current the inverter displays "OC DRIVE." (overcurrent at constant speed setting).



7.2 Overload Protection

In almost all cases an inverter is used to drive a conventional induction motor which is cooled by a fan installed on the motor rotor shaft. Thus the cooling capacity of the motor depends on the speed of the rotor. If the motor is driven from a commercial power source, the motor operates at a constant speed and the motor cooling capacity can be said to be a constant.

Conventional thermal relays used to provide overload protection of electric motors are sized assuming a constant motor cooling capacity.

When a motor is driven by an inverter, the speed of the motor changes as a function of the inverter output (variable voltage and frequency). Consequently the thermal protection for an inverter driven motor must compensate for the loss of motor cooling capacity at lower speeds. Figure 1 represents the compensation curve programmed into the inverter Overload Protection sequence to keep from over heating a motor at low speed.

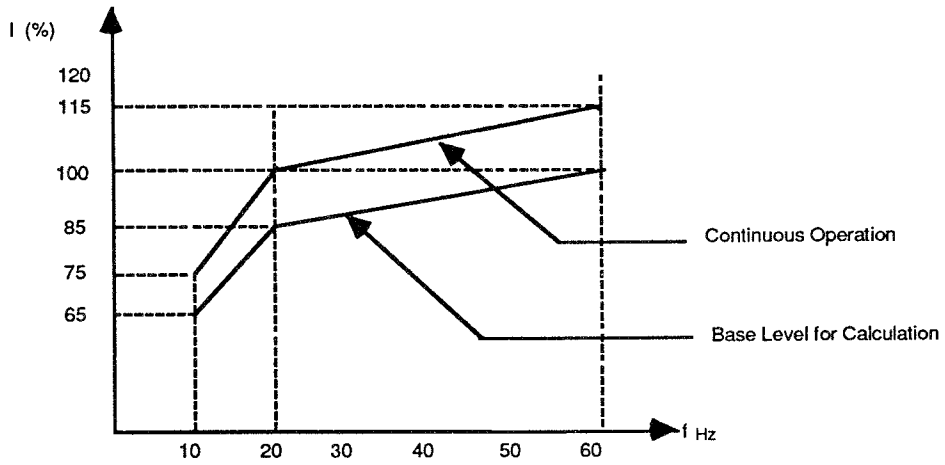


Figure 1

The inverter includes thermal protection (overload) circuitry that compensates for the decreased cooling capacity of a motor when driven at a reduced speed.

Figure 2 shows the inverter output current (%) vs time characteristics of the inverter overload protection.

The factory setting is 100% of the inverter output current rating. If a driven motor's rated current is less than the rating of the inverter, a set-up adjustment should be made to adjust the overload limit to the motor rating. (see Section 10, paragraph 10.3, Function 23).

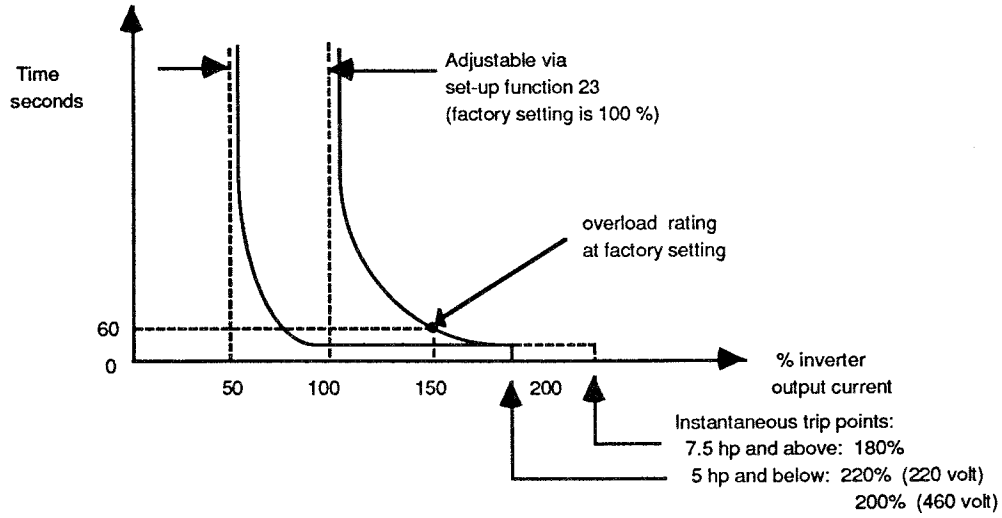


Figure 2

7.3 Fault/Alarm Messages

1) **OH Fin.** (Overheat on heat sink fins) - Inverters equipped with heat sinks using fan forced cooling include temperature sensing of the heat sink. This alarm message is displayed when the fan cooled heat sink becomes abnormally warm. This message typically indicates a failed cooling fan or an obstruction to the flow of air.

2) **OVER C.** (Overcurrent) - When the inverter is operating (acceleration, deceleration, or constant speed) and the stall prevention sequence can't prevent an overcurrent trip, the microprocessor displays OC ACCEL, OC Drive (constant speed) or OC DECEL to indicate to the user when the overcurrent occured. If the inverter detects an overcurrent on start-up,OVER C. is displayed.

3) **Under V.** (Under voltage) - If the microprocessor detects input voltages less than 150-160 volts for the 200 volt class inverter or 280-320 volts for the 400 volt class inverter, it displays "Under V."

4) **U V WAIT.** (Under voltage wait) - If the microprocessor detects input voltages less than 150-160 volts for the 200 volt class or 280-320 volts for the 400 volt class on re-start, it displays U V WAIT.

5) **Over V.** (Over voltage) - When the microprocessor detects a high DC bus voltage, it displays Over V. High DC bus voltage occurs when the driven motor is sending regenerative energy to the drive either during deceleration or if the process connected to the motor is driving the motor at a faster speed than being commanded by the inverter.

6) **OV SRC.** (Over voltage source) - When the microprocessor detects input voltages above the input rating of the inverter, it displays the message OV SRC.

7) **NG-FRS.** (NG - Free run stop) - The free run stop signal is initiated by a contact closure between terminals FRS and L. If retry function is selected, and an FRS input is applied between the time a trip occurs and a re-start is attempted, NG-FRS will be displayed. NG-FRS will also be displayed if undervoltage, instantaneous power failure or power loss occur during the time an FRS command is given.

8) **NG-JOG.** (NG-JOG) - Similar to the NG-FRS message the NG-JOG message is displayed by the microprocessors if a reset command is detected while the JOG signal is present on the JG-L terminals. It is also displayed if power is applied with Jog command present.

9) **NG DB.** (NG DC Brake) - Similar to the NG-FRS message the NG-DB message is displayed by the microprocessor if power is applied or a second input signal such as a reset command is detected while the DC Brake signal is present on the optional PC Board.

10) **GND FLT.** (Ground Fault) - If the factory installed ground fault protection detects a ground fault, the "GND FLT." message is displayed by the microprocessor.

11) **Inst. P-F.** (Instantaneous power failure) - If the microprocessor detects an instantaneous power failure, it displays Inst. P-F.

12) **O.C.ACCEL.** (Overcurrent during acceleration) - If the stall prevention sequence can not prevent an over current during an acceleration period, the microprocessor will display O.C.ACCEL.

13) **O.C.DECEL.** (Overcurrent during deceleration) - If the stall prevention sequence can not prevent an over current during a deceleration period, the microprocessor will display O.C.DECEL.

14) **O.C.DRIVE.** (Overcurrent during constant speed) - If the stall prevention sequence can not prevent an over current during a constant speed period, the microprocessor will display O.C.Drive.

15) **Over L.** (Overload) - If the overload prevention sequence can not prevent an overload trip, the microprocessor will display Over L.

16) **CPU.** (Microprocessor Malfunction) - If the microprocessor malfunctions or can not pass its self diagnostic test, CPU will be displayed.

17) **BOO##.** - Consult the factory if this display appears. BOO## indicates a memory location fault.

18) **USP** (Unattended Start Protection) - The inverter includes a protection circuit to prevent a startup without operator intervention. USP is displayed if the inverter has tripped off on this protection circuit. (see paragraph 7.4 below).

19) **DB-OT** (DC Braking Over Time) The external DC braking command has exceeded the preset time in F-22 (T-DCB). Set T-DCB longer or lower the external DC braking time period.

7.4 Instantaneous Power Failure Ride Thru/Unattended Start Protection (USP)

The inverter will ride through a 15 ms instantaneous power failure. However, a **USP** factory preset trip protection circuit is also included for operator safety. This circuit prevents unattended startup when power is first applied to the inverter or following a power loss longer than the 15 ms instantaneous ride-thru period.

1) Instantaneous Power Failure Ride-Thru:

A 15 ms instantaneous power failure ride-thru period is factory preset and the inverter will resume operation if power is off for less than 15 ms without requiring any operator intervention.

The preset 15ms Ride-Thru period can be extended via Set-Up Functions. A "10" or "11" entry must be made in area 5 of Function 28 to override the momentary power loss portion of the **USP** protection trip, as well as an entry in Function 33 to establish a new Ride-Thru time period.

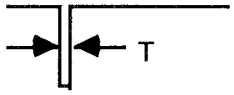
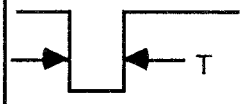
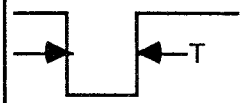
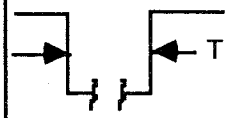
It is important to note that an entry of "10" or "11" made in area 5 of Function 28, will cause the inverter to attempt an Auto-Restart after Over Current, Over Voltage and Instantaneous Power Failure trips as well as during the extended Ride-Thru period. For a "10" entry the inverter will re-start and initiate the Start Into A Running Motor routine. When a "11" entry is made the inverter will re-start from zero speed after waiting the period of time entered in Function 36. Please see Functions 28, 33 and 36 in Section 10.

2) Unattended Start Protection

If ac power is applied to the inverter when a RUN signal is already present (e.g. a contact closure between FW and L), the inverter is factory preset not to start. In this situation the message **ERROR USP** (**U**nattended **S**tart **P**rotection) will appear in the 16 digit display. To start the inverter when this **USP** condition occurs, either turn the RUN switch OFF and then ON again or Reset the inverter.

In the event of a momentary power loss longer than the Ride-Thru period, the inverter will also not restart as an operator safety protection. In this case the inverter may first display the **UNDER V** or the **Inst P-F** message. If either of these messages appear, it will be necessary to press the Reset twice, once to clear the under voltage or instanteous power failure message and once to clear the **USP** condition.

The chart on the following page shows the inverter action in each of the above conditions and programmed settings

Restart selection made in area 5 of Function 28 / AC Power Outage Time (T)	"00" Do Not Re-Start	"10" Start Into Coasting Motor	"11" Start At Zero Speed After Time-Delay
 T<15ms	← Ride-Thru →		
 T>15ms T< IPS-T	Unit Trips and Displays: Inst. P-F or Under V	Unit re-starts when ac power returns utilizing start into running motor routine	Unit re-starts from zero speed after wait time ISP-R-T
 T>15ms T>IPS-T T<300ms(400v) T<3000ms(200v)	←	Unit Trips* and Displays: Under V. or Inst. P-F	→
 T>300ms (400v) T>3000ms (200v)	←	Unattended Start Protection will be in affect when ac power returns*	→

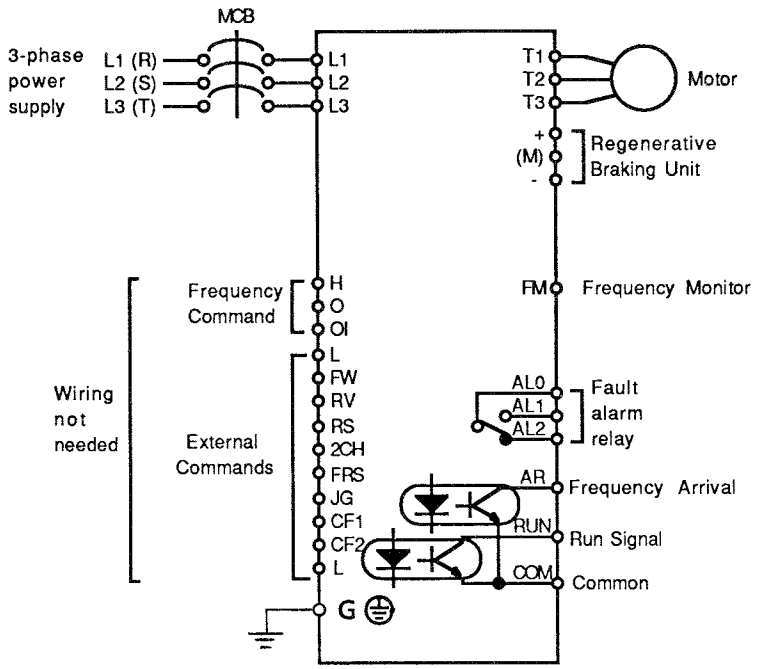
Note: The 300ms for the 400 voltage class and the 3000ms for the 200 voltage class units shown above are minimum times for the dc power supply to decay, actual time will vary depending on the load on the inverter and may be as much as 2 seconds for the 400 voltage class and up to 8 seconds for the 200 voltage class. Once the dc power decays to less than 5 volts, the microprocessor resets itself and the inverter initializes from a Cold Start.

*Refer to Section 8, paragraph 8.3 for wiring methods to override the Unattended Start Protection feature and obtain true two-wire control thereby causing the inverter to revert to the RUN mode on a power-up and after a momentary power interruption when the RUN command is present.

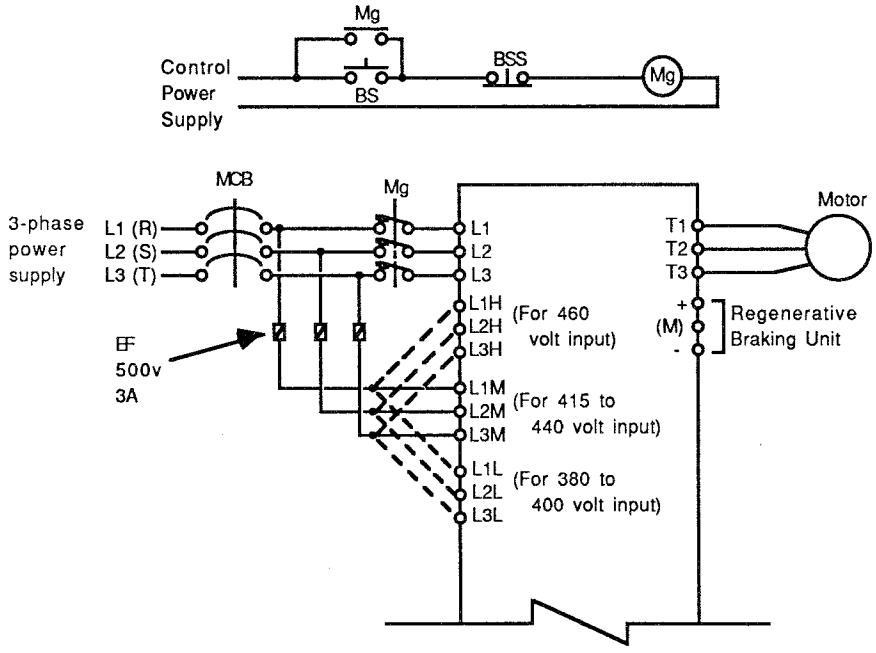
INVERTER BEHAVIOR WHEN POWER IS INTERRUPTED

8. TYPICAL WIRING DIAGRAMS

8.1 Wiring Diagrams for Operation From Operator

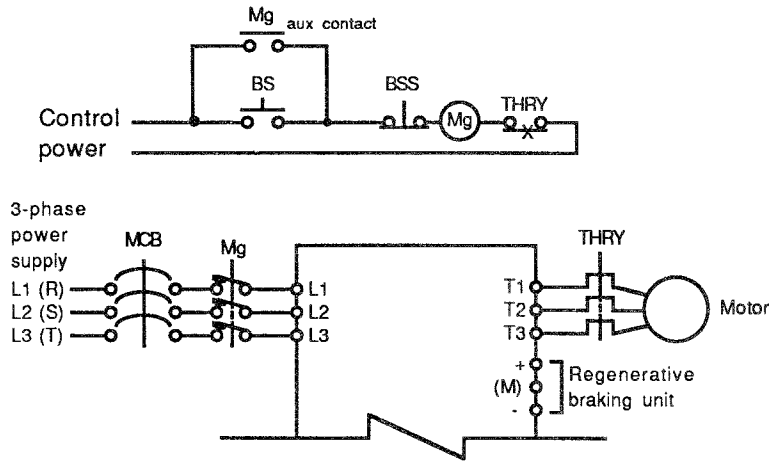


• Typical wiring when all operations are to be performed from the digital operator key pad (standard connection diagram).



• Suggested wiring when all operations are to be performed from the digital operator key pad (standard connection diagram) 100 horsepower and above.

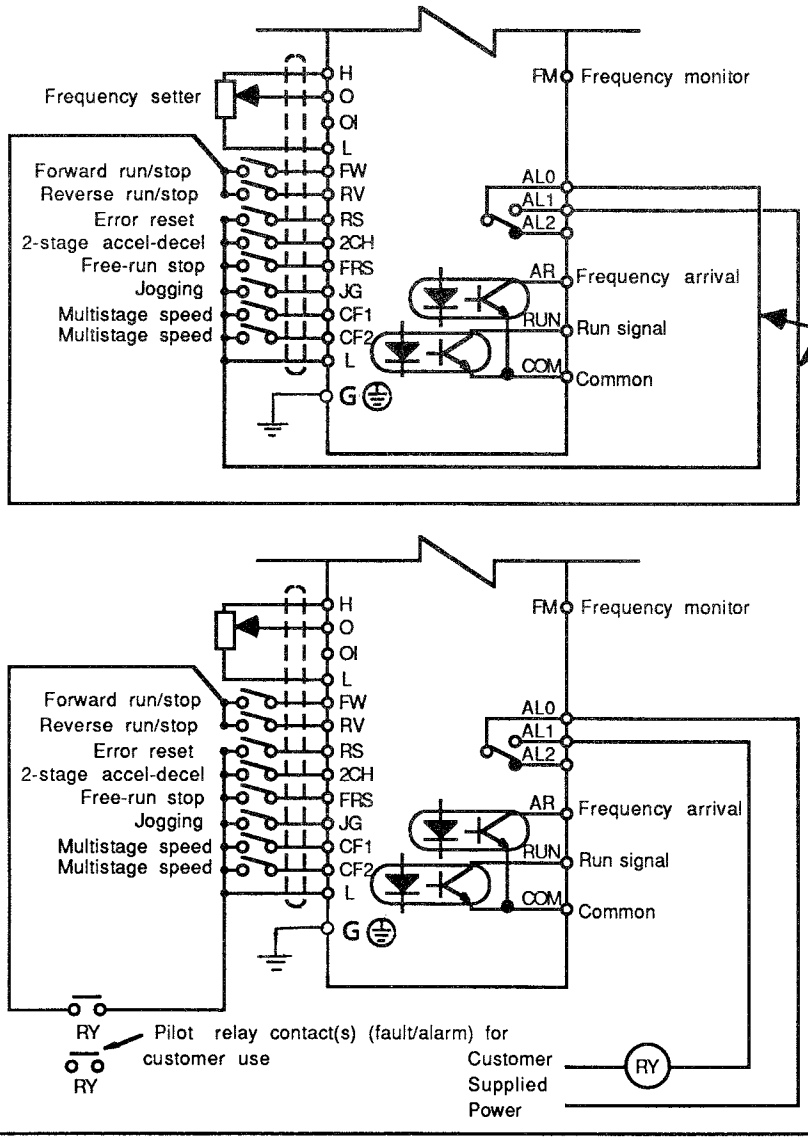
8.2 Wiring of Thermal Relay



• Typical wiring when an electromagnetic contactor (Mg) is mounted on the inverter primary side and a thermal relay (THRY) is inserted in the secondary circuit.

If a line side Mg is not used the thermal relay may be wired to initiate a Free Run Stop via the control terminals, however it should be noted that if FRS is used the inverter will RESTART automatically when the THRY is reset

8.3 Wiring to Defeat Unattended Start Protection



● Typical wiring when all operations are to be performed from external commands and the alarm/fault contacts are used directly to initiate an auto-restart on application of ac power defeating the unattended start protection.

wiring to defeat unattended start protection (delete this wiring if unattended start protection is desired i.e. connect the common of FW and RW to terminal L directly).

● Typical wiring when all operations are to be performed from external commands and the alarm/fault contacts are used in conjunction with a pilot relay to initiate an auto-restart on application of ac power defeating the unattended start protection. Dry contacts on the pilot relay can then be used as alarm/fault contacts.

8.4 Suggested wiring and configuration diagram when a mechanical brake is used to stop the motor:

When a brake is applied to the motor, the inverter output must be turned off, placing the motor in a coast to stop condition, otherwise the inverter may trip on overcurrent. If the FRS terminal is used for this application up to 100ms may be required before the FRS signal is processed by the inverter microprocessor and a coast to stop is initiated.

It is therefore recommended that the reset terminal (RS), which operates on an interrupt priority to the microprocessor and initiates a coast to stop immediately, be used in a motor brake application. Recommended connections are shown in Figs. 16 (a), (b) and (c).

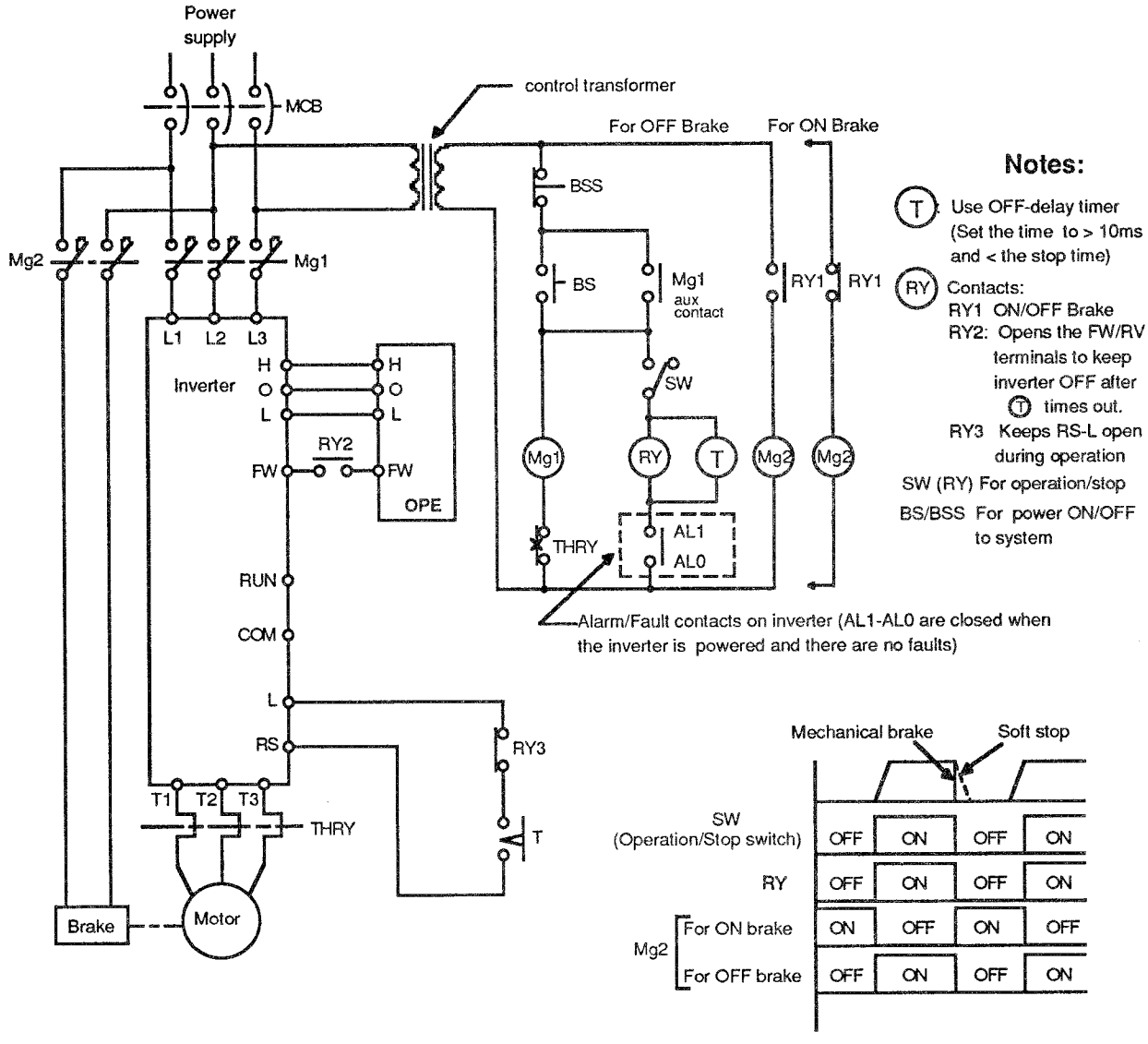
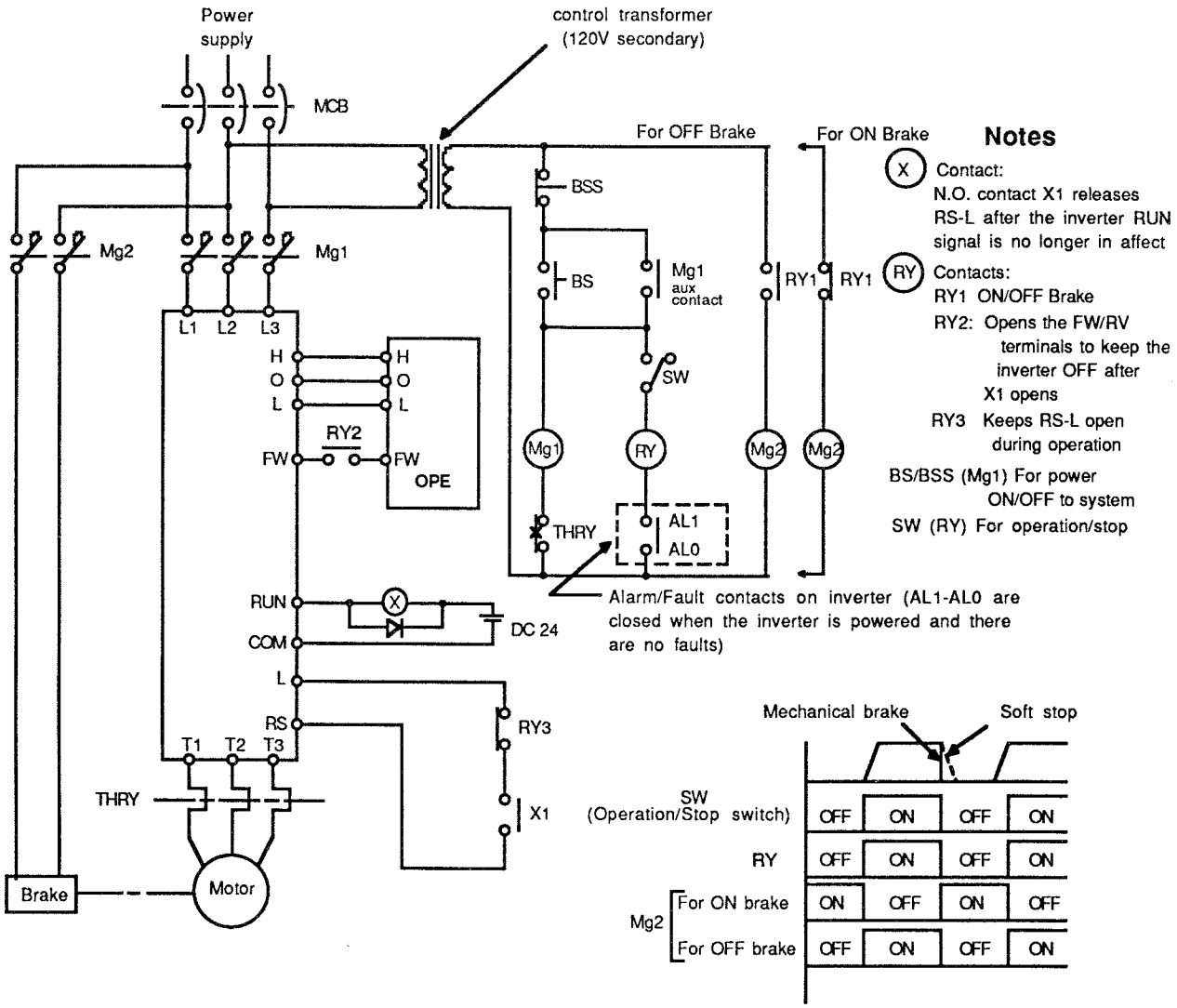
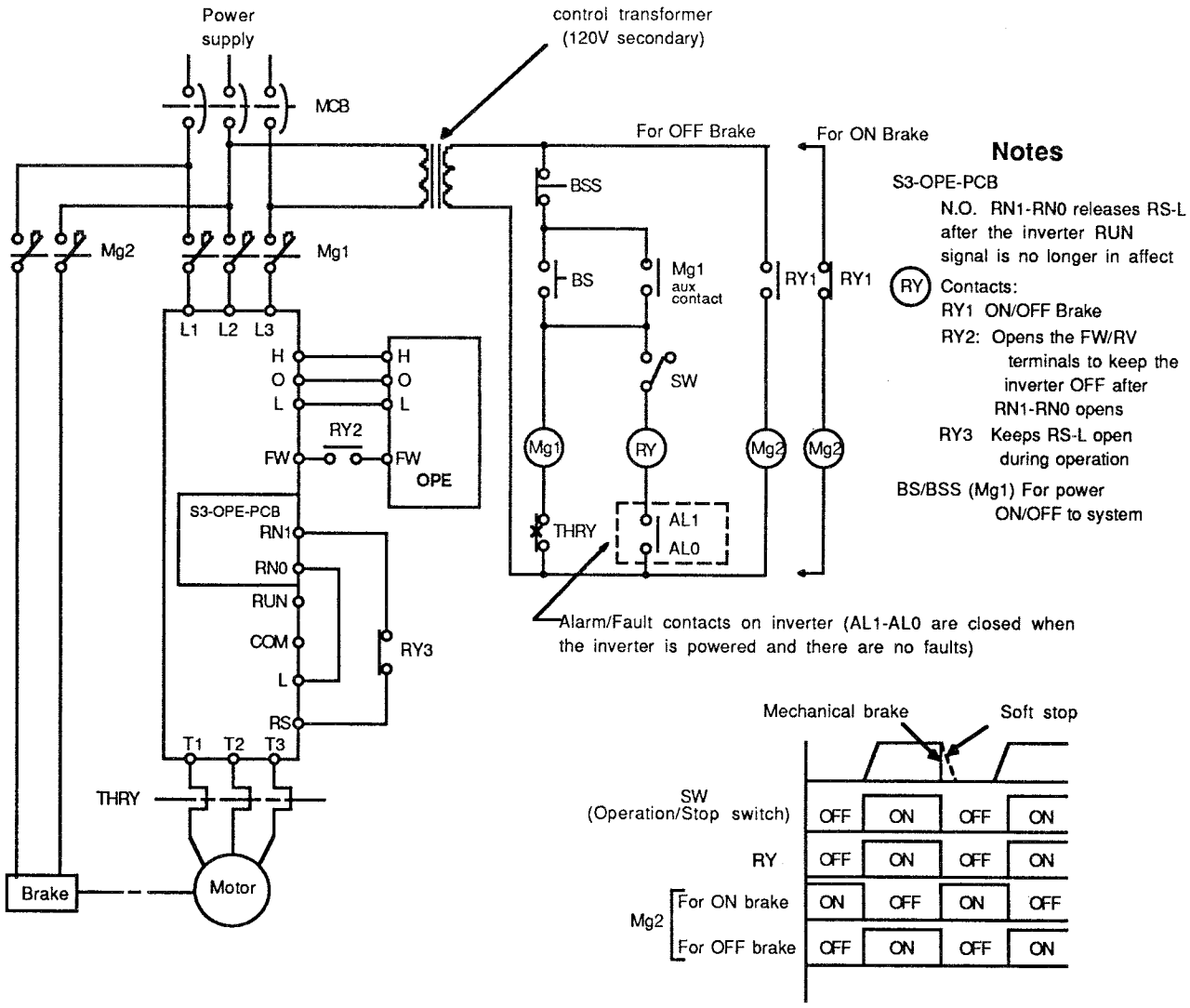


Figure 16 - (a)
Mechanical Brake Wiring With Use of TDR



NOTE: When timer (T) is not used as shown in Figure 16-(a), a 24 Vdc power supply is required as shown above to provide power to the "X" relay connected through the inverter RUN signal.

Figure 16 - (b)
Mechanical Brake Wiring Without Use of TDR



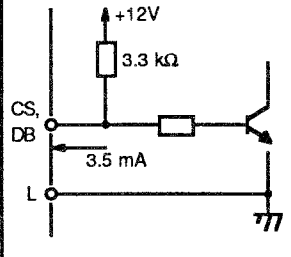
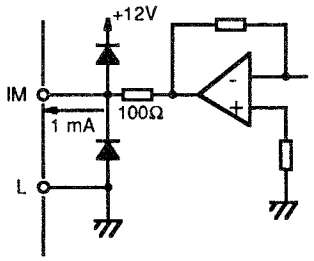
NOTE: When timer (T) is not used as shown in Figure 16-(a), the optional Printed Circuit Board (S3-OPE-PCB) can be used as shown above eliminating the need for a separate 24Vdc power supply and relay "X" as shown in Figure 16-(b).

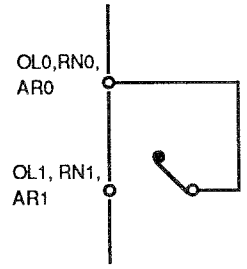
Figure 16 - (c)
Mechanical Brake Wiring With Use of Option PCB S3-OPE-PCB

8.5 Wiring of Optional Function Printed Circuit

The optional PC board provides 6 additional functions.
The respective functions are shown in Table A below.

Table A

<table>
<tr><th>Function No.</th><th>Function name</th><th>Terminal used</th><th>Contents</th><th>Terminal specification</th></tr>
<tr><td>①</td><td>Commercial power supply switch</td><td>CS on the optional PCB and RS and L on the inverter I/O terminal.</td><td>• This function is used when switching the motor from commercial power supply to inverter operation.
• The switch timing chart is shown in Fig. 20.</td><td rowspan="2"> 
</td></tr>
<tr><td>②</td><td>DC brake external command</td><td>DB-L</td><td>• DC brake is applied at other than F-min during deceleration by short-circuiting the circuit between DB and L.
• The following adjustment can be made, using the digital operator key pad.
<table>
<tr><th>Function mode No.</th><th>Function Name</th><th>Variable range</th><th>Factory setting</th></tr>
<tr><td>F-20</td><td>DC braking start frequency</td><td>0.5 ~ 15 Hz</td><td>1.0 Hz</td></tr>
<tr><td>F-21</td><td>DC braking power</td><td>0 ~ 20</td><td>0</td></tr>
<tr><td>F-22</td><td>DC braking time</td><td>0 ~ 15 sec</td><td>0 sec</td></tr>
</table>
• When F-22 DC braking time < DC braking external command time, "DB OT" tripping occurs.
• If power is turned ON and resetting operation is performed with the circuit between DB-L short-circuited, "NG .DB" tripping occurs.</td></tr>
<tr><td>③</td><td>Inverter output current signal</td><td>IM-L</td><td>• A 0-4 volt output proportional to inverter output current is transmitted.
• Output voltage at rated current = 4 VDC
Accuracy: +-0.4V (10-135 Hz)</td><td> 
</td></tr>
</table>

Function No.	Function name	Terminal used	Contents	Terminal specification
④	Overload alarm signal relay output	OL0-OL1	• The contact is closed when the overload alarm limit level is reached. • The overload alarm limit level can be adjusted between 100 ~ 150% of the inverter output rating via Function 31. • The overload alarm signal becomes effective at an output frequency of 10 Hz or more. When overload occurs during deceleration, an alarm signal is maintained even when the inverter stops after deceleration. When 10 Hz is exceeded during acceleration after a re-start and no overload occurs, the alarm signal is reset.	 Contact SPEC. AC 250V, 2.5 A (R Load) 0.2 A (Cos ϕ = 0.4) DC 30V, 3.0 A (R Load) 0.7 A (Cos ϕ = 0.4)
⑤	Running signal relay output	RN0-RN1	• The contact is closed while the inverter is operating. • Refer to Figure 20-a.	
⑥	Frequency arrival signal relay output	AR0-AR1	• When the output frequency setpoint is reached, the contact is closed. • Refer to Figure 20-a.	

Note: For commercial power switch, set the function mode F-28 SWITCH 1 as follows.

SWITCH 1	00	00	0	1	1	1

Set this to 10.

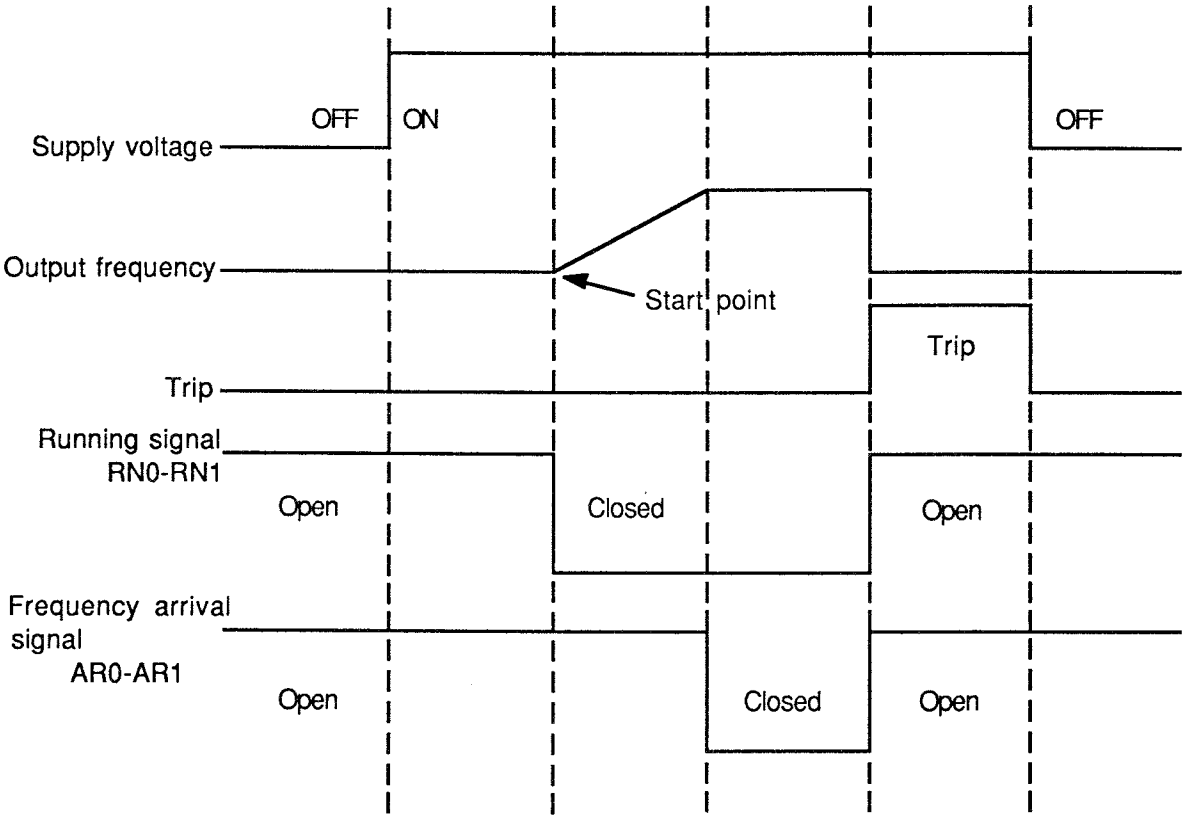
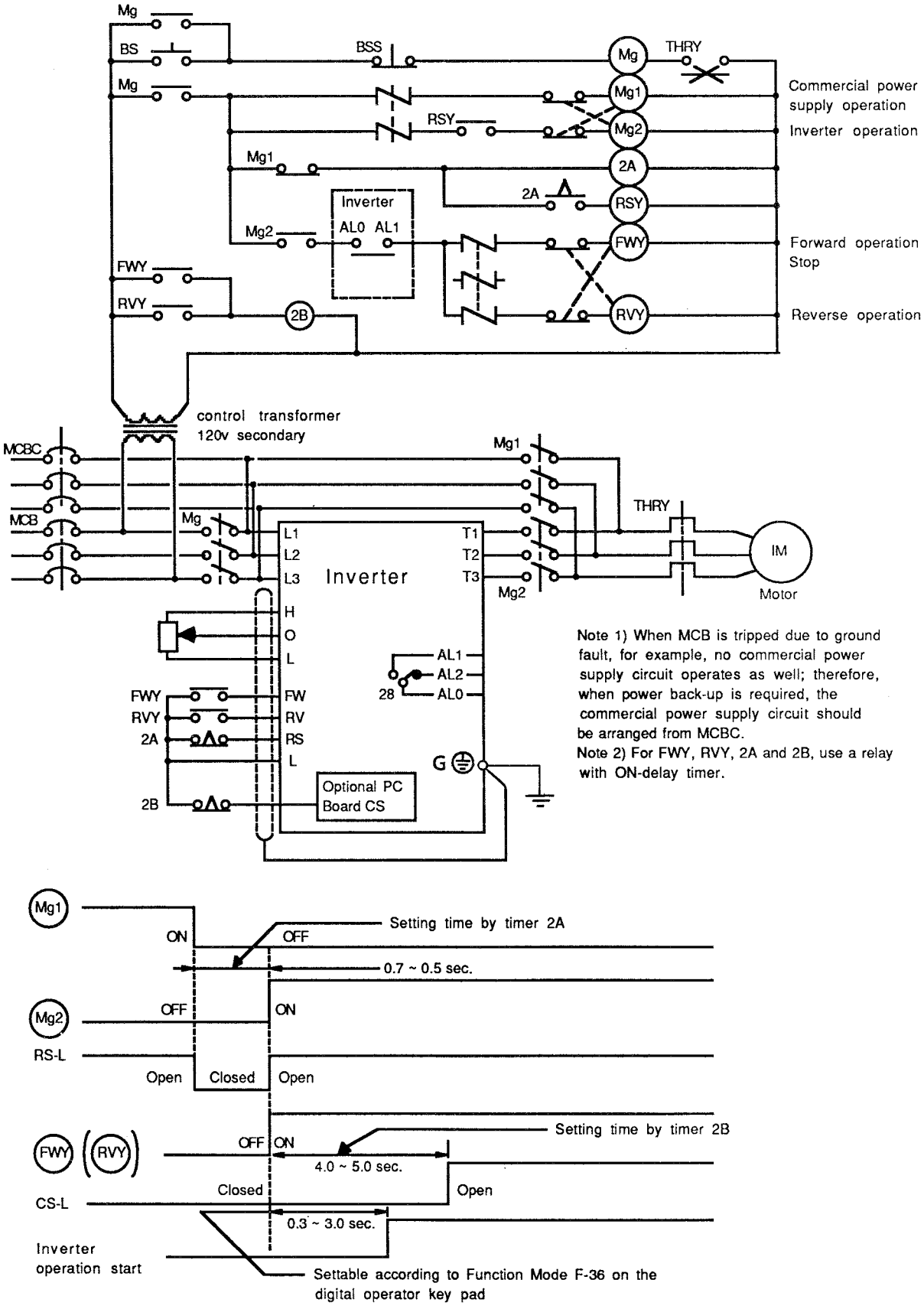


Figure 20 - (a) Timing Chart



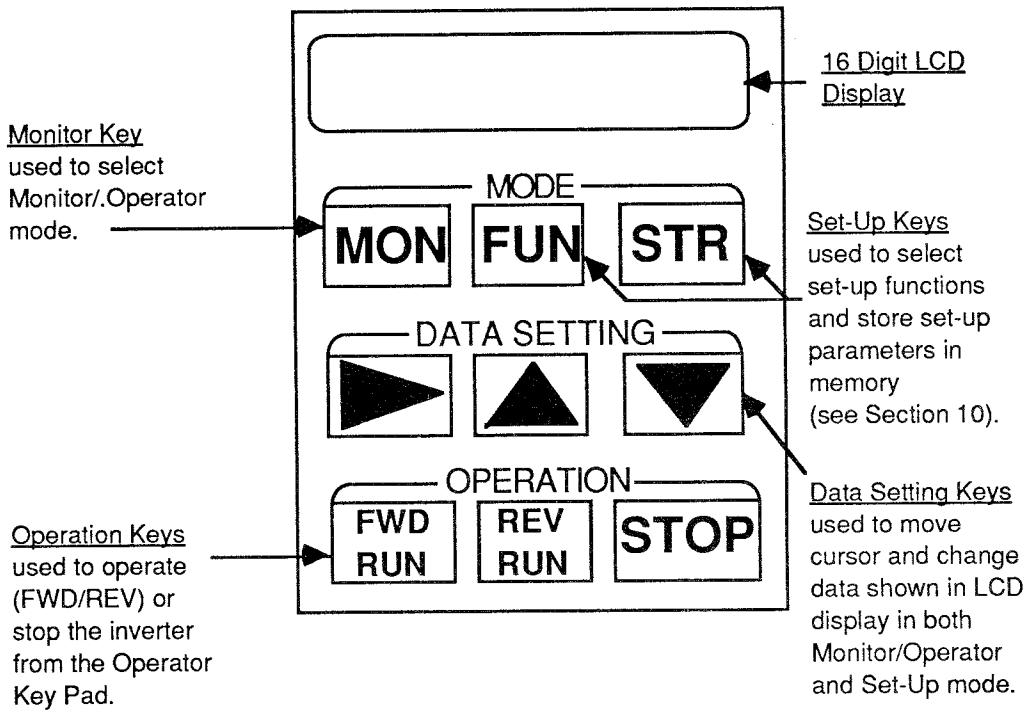
(The circuit shows a 200V class inverter.)

Figure 20 - (b) Connection Diagram for Commerical Power Supply Switch Operation

9. OPERATION FROM OPERATOR KEY PAD AND MONITOR/OPERATOR MODE

CAUTION: Please read this entire section to gain a complete understanding of the key pad operation prior to attempting to operate this inverter.

9.1 Configuration of Operator Key Pad



Set-Up Keys: **FUN** **STR**

The function key (FUN) is used to select the inverter Set-Up or Function mode to allow the user to enter or modify parameters required to configure the inverter to a specific application. The store key (STR) is used to enter set-up parameters into RAM memory. A complete discussion of the set-up functions and parameters, including parameter selection is included in Section 10. It is recommended that this section (Operation From Operator Key Pad) be read prior to entering set-up data to familiarize the user with the use of the Data Setting Keys, which are discussed in this section and are applicable to changing data in both the Monitor/Operator and Set-Up modes.

9.1.1 16 Digit LCD Display Description

1) The 16 digit LCD display is used to: 1) display an inverter fault condition, 2) display an operating or set-up parameter or inverter operating condition and 3)provide visual

feedback to the user of the operating or set-up parameter as they are being entered into the inverter memory, or a combination of this information.

2) With the exception of a FAULT display, each LCD display contains two fields of data. The field to the left is static (a description of the data to the right), the field to the right is dynamic (an actual operating parameter and/or operating/set-up parameter).

Example

In the display: RPM 4P 1800 rpm

descriptor dynamic data

The descriptor section designates that the dynamic data being displayed is the synchronous speed, in RPM, for the driven motor at the actual inverter output frequency. The dynamic data section informs the operator that the rpm value being displayed is the equivalent speed for a 4 pole motor being driven at the actual output frequency. In this display, the operator can confirm and change the set-up parameter (number of motor poles) and monitor the speed as the output frequency changes.

3) If there is an inverter fault or alarm, any existing display is overriden with the appropriate fault/alarm condition message. Please refer to Section 7 for a list of the fault/alarm message displays and Section 11 for diagnosing fault conditions.

9.2 Monitor/Operator Mode Description

1) The Monitor key (**MON**) is used to select the Monitor/Operator mode. Depression of this key will display the first of 10 Monitor/Operator displays. These displays inform the operator of key inverter operating conditions as well as to provide data entry capability for the operator to change every day operating data/setpoints.

9.2.1 Monitor/Operator Mode Displays

The following is a list of the 10 Monitor/Operator displays and a description of the operating conditions they depict. A complete discussion of the method of data entry is included in paragraph 9.5.

Display 01: actual inverter output frequency and driven motor rotation

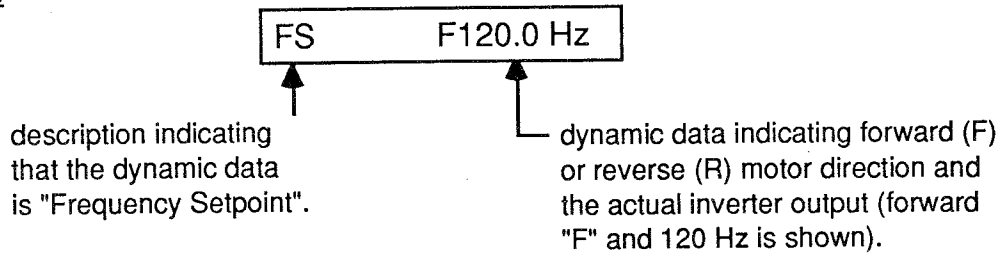
FM F120.0 Hz

description indicating that the dynamic data is "Frequency Monitoring".

dynamic data indicating forward (F) or reverse (R) motor direction and the actual inverter output (forward "F" and 120 Hz is shown).

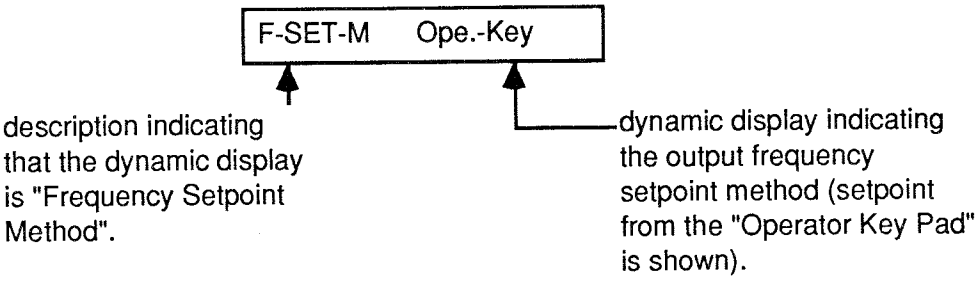
Display 02: actual inverter output frequency setpoint.

Example



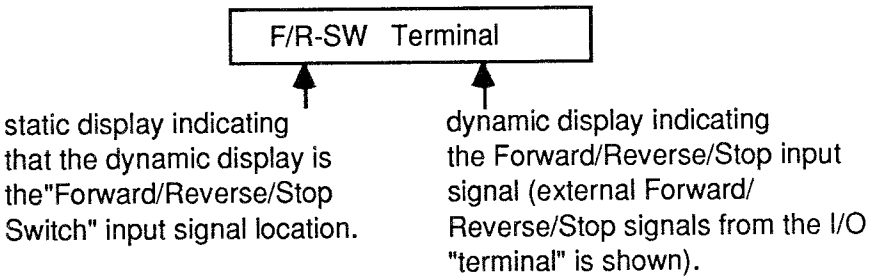
Display 03: method by which the inverter control circuit is receiving the output frequency setpoint.

Example



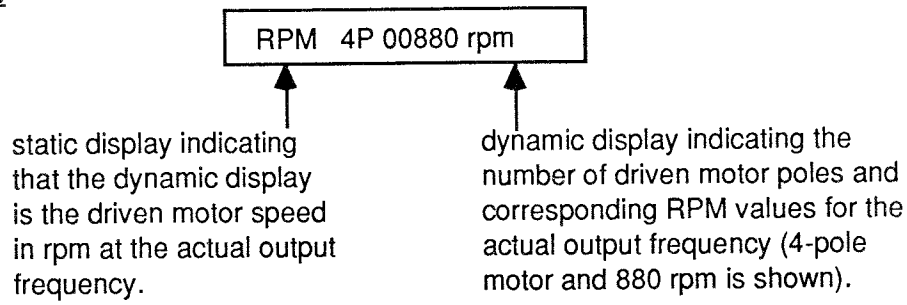
Display 04: method by which the inverter control circuit is receiving forward/reverse/stop switch commands.

Example



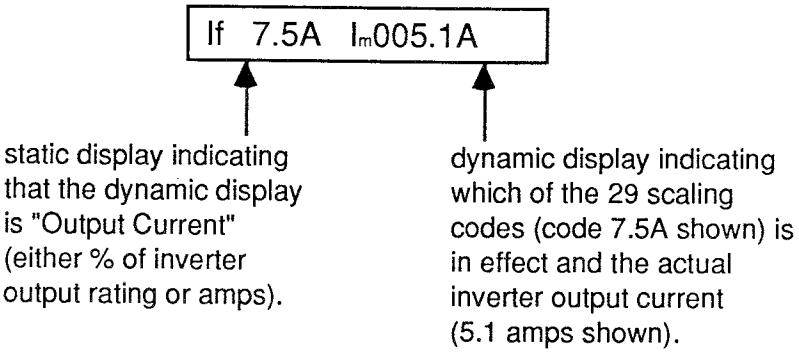
Display 05: driven motor speed.

Example



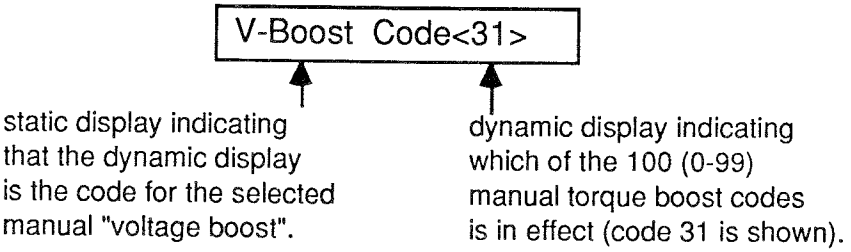
Display 06: inverter output current.

Example



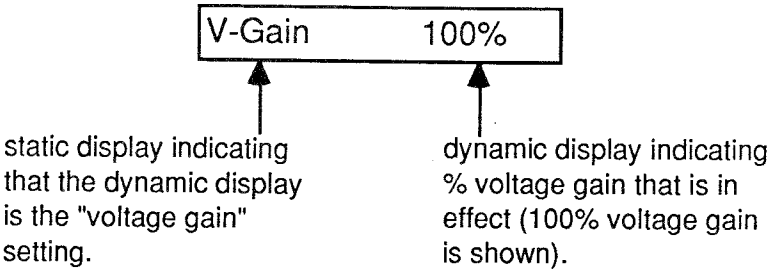
Display 07: manual torque boost adjustment.

Example



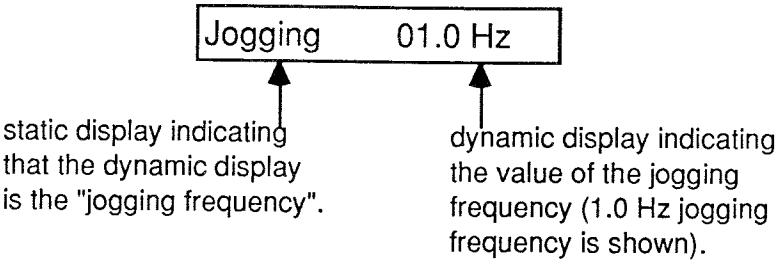
Display 08: voltage gain adjustment.

Example



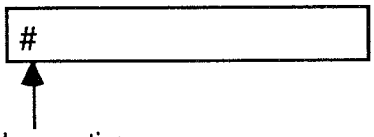
Display 09: jogging frequency.

Example



Display 10: fault/alarm message.

Example



shows normal operation.
If the inverter has an alarm
or fault, the fault/alarm
display takes precedence over
all other displays.

9.3 Data Setting Keys ▶▼▲

The data setting keys are used in both the Monitor/Operator and in Set-Up modes to change operating or set-up data. Each of the three data setting keys performs a specific task:

a) Cursor movement ▶
b) Increment ▲ data to the next highest pre-programmed value (e.g. for numeric data from 1 to 2 to 3 etc.; for alpha data, from A to B to C etc.).
c) Decrement ▼ data to the next lowest pre-programmed value (e.g. for numeric data, from 3 to 2 to 1; for alpha data, from C to B to A).

9.3.1 Cursor Movement Key: ▶

1) When first viewing a Monitor/Operator or the Set-Up mode display, the cursor will be visible in the far left position. The cursor may be moved from left to right by depressing the ▶ Cursor Movement key.

2) When moving the cursor with the ▶ key, you will note that the cursor movement is influenced by two microprocessor controlled actions.
   (a) The cursor only moves from left to right, returning to the far left position when moved from the last right hand position.
   (b) The cursor movement to the right is restricted to only those display fields that require or allow operation or set-up data to be entered. Through these two actions the microprocessor prohibits entry to display fields not requiring an entry, thus minimizing operator error and speeding data input.

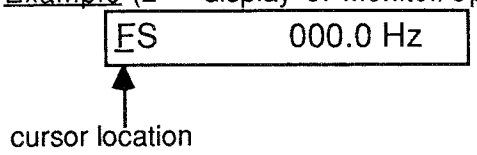
9.3.2 Increment ▲ and Decrement ▼ keys

The ▲ and ▼ keys are used to change from one display to another and to change data within a display.

1) To change from one Monitor/Operator or Set-Up display to another.

When first viewing a Monitor/Operator display or a Set-Up display the cursor will be in the further most left hand position

Example (2nd display of Monitor/Operator mode)



Depression of the increment ▲ or decrement ▼ key will change the entire display to the next Monitor/Operator or Set-Up display. That is, from the 2nd Monitor/Operator display shown above, if the increment key ▲ is depressed the display will change to the 3rd Monitor/Operator display F-SET-M Ope.-Key ; if the decrement key ▼ is depressed, the display will change to the 1st Monitor/Operator display FM 000.0 Hz . In this way, any Monitor/Operator display or Set-Up display may be indexed. There are 10 Monitor/Operator displays (see paragraph 9.2 Monitor/Operator Key and Display Description above). There are 31 Set-Up displays (see Section 10).

2) Changing data within Monitor/Operator or Set-Up display fields.

To change Monitor/Operator or Set-Up data, first index the display to the display containing the data requiring change. If, for instance, you wanted to set the output frequency to 109.0 Hz from 000.0 Hz, Monitor/Operator display 02 (output frequency setpoint) should be indexed onto the 16 digit LCD display using the increment ▲ or ▼ key. Next, using the cursor movement key ▶ , the cursor should be moved to the right to the position under the 100's place. 000.0 Hz Again, using the increment ▲ key, the 100's place is incremented one place to 100.0 Hz . Next, the ▶ key is depressed twice by-passing the 10's place (retaining a "0" in the 10's place) to the 1's place. 100.0 Hz . The 1's place is then decremented from 0 to 9 (or incremented 9 times from 0 to 9) 109.0 Hz . ▶ key is then used to return the cursor to the original position FS 109.0 Hz .

9.4 Operation Keys: FWD RUN | REV RUN | STOP

NOTE: FWD RUN and REV RUN keys are only operational if Display 04 indicates OPE-KEY. If

Display 04 indicates TERMINAL, the inverter is being commanded to RUN/STOP (forward/ reverse) from REMOTE devices connected to the remote I/O terminals (see Section 5). However, STOP key is effective regardless of what is programmed on Display 04.

9.4.1 Forward key: FWD RUN

Depression of the forward key will cause the inverter to output a signal to the driven motor causing the motor to run in a forward direction. The acceleration rate and final output frequency will be as set by the set-up parameters.

9.4.2 Reverse key: REV RUN

Depression of the reverse key will cause the inverter to output a signal to the driven motor causing the motor to run in a reverse direction. The acceleration time and the output frequency will be as set by the operating/set-up parameters.

9.4.3 Stop key: STOP

Depression of the stop key will cause the inverter to stop the driven motor. The deceleration time and the applicability of a DC brake will be as set by the Set-Up parameters (see Section 10).

9.5 Monitor/Operator Mode Data Entry Description

On the following pages is a chart of the 10 Monitor/Operator displays, a description of the purpose of each display, the key strokes applicable to entering data, initial (factory) settings and applicable range of settings allowed.

Display 01	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Output Frequency Monitor	Selection MON ▼ ▲	Initial setting FM 000.0 Hz ③ ② ①	not applicable only monitor	FM ■ > F020.0 Hz (display for forward operation at 20 Hz output when maximum frequency is set at 60 Hz)	N/A

Description and Remarks

Part ① displays the actual inverter output frequency. F or R is displayed during forward or reverse operation as applicable in part ②. The percent the actual output frequency represents of the maximum frequency is displayed in 10% increments on a 5 segment bar chart in part ③.
Each ■ represents 20%, each > represents 10%.
Example:

>	=10%	■■>	=50%	■■■■	=80%	■■■■■	=100%

Display 02	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Output Frequency Setpoint	Selection MON ▼ ▲	Initial setting FS 000.0 Hz ③ ② ①	Data setting ▶ ▼ ▲	FS 050.0 Hz	0~up to the maximum frequency (every 0.1 Hz)

Description and Remarks

Part ① displays the commanded output frequency setpoint and allows a new setpoint to be entered if under operator key pad control ("OPE.-key" appears in Monitor/Operator Display 03). The output frequency increases up to the setpoint frequency when the forward/reverse command is entered. The new setpoint may be made to increase or decrease the output frequency during inverter operation. This display only includes the setpoint of the output frequency; therefore, select the Output Frequency Monitor (Display 01) when wishing to monitor the actual output frequency during operation. Part ② displays F or R during forward or reverse operation as applicable. Part ③ displays the ratio of the setpoint frequency value to the maximum frequency in 10% increments on a 5 segment bar chart.
Example:

>	=10%	■■>	=50%	■■■■	=80%	■■■■■	=100%

Display 03	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Output Frequency Command Method	Selection MON ▼ ▲	Initial setting E-SET-M Ope.-key ①	Data setting ▶ ▼ ▲	F-SET-M Terminal	Ope.-key or Terminal

Description and Remarks

Part ① displays whether the output frequency is to be commanded by the operator key pad (OPE.-key) or external I/O terminal (Terminal) Input Signal 01 and allows a new selection to be made. A selection can only be made when the inverter is stopped. Please see Section 5, Input Signal 01, for the correct method of wiring the I/O terminals and Section 10, Manual Adjustments, for the correct method of selecting the applicable type, 0-5 VDC, 0-10 VDC or 4-20 mA current input signal.

Display 04	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Run/Stop Operation Command Method	Selection MON ▼ ▲	Initial setting F/R-SW Ope.-key ①	Data setting ▶ ▼ ▲	F/R-SW Terminal	Ope.-key or Terminal

Description and Remarks

Part ① displays whether forward operation/stop and reverse operation/stop are controlled by the operator key pad (OPE.-key) or external I/O terminal (Terminal) Input Signals 03 and 04 and allows a new selection to be made. A selection can be made only when the inverter is stopped. Please see Section 5, Input Signals 03 and 04, for the correct method of wiring the external I/O terminals.

Display 05	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Driven Motor Speed rpm	Selection MON ▼ ▲	Initial setting RPM P 0000 rpm ① ②	Data setting ▶ ▼ ▲	RPM 4P 1500 rpm	2~48

Description and Remarks

Part ① displays the number of motor poles being used to calculate and display the synchronized motor speed for the actual output frequency. The selection of the number of motor poles may be made in part ①. During inverter operation, calculated synchronous speed is displayed in part ②.

Motor pole selection table

Index sequence	1	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of motor poles shown in part ①	2	4	6	8	10	12	14	16	18	20	24	32	36	48

Display 06	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Output Current	Selection MON ▼ ▲	Initial setting If A Im000.0% ① ②	Data setting ▶ ▼ ▲	A If 5.0A Im004.0A	Code 1-29 (3.0~260A)
			—	B If----A Im080.0%	

Description and Remarks

Part② displays the ratio of the actual output current to the inverter rated output current in % when the inverter rated current has not been entered in part① e.g. display B above. The value (RMS amps) of the inverter actual output current is displayed in part ② if the inverter rated current from table A below has been entered in part ① e.g. display A above. In display A above, a rated current of 5 amps (1.5 kVA 200V) has been entered.

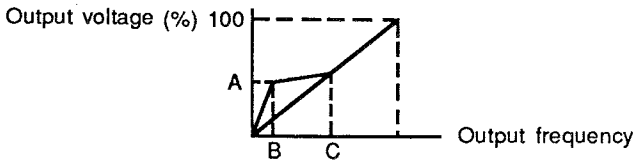
Display Sequence	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Inverter rated current	3.0	3.8	5.0	5.3	7.5	8.6	10.5	13.0	16.0	16.5	23	24	32	46	48	58	64	75	90	95	110	121	145	149	176	182	217	220	260
200V Class hp rating	1.0		1		2		3			5		7.5	10	15			20			30		40	50			60		75	
400V Class hp rating		2		3		5		7.5	10		15		20		30	40		50	60		75			100	125		150		200

Table A

Display 07	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Manual Torque Boost Adjustment	Selection MON ▼ ▲	Initial setting V-Boost Code<31> ①	Data setting ▶ ▼ ▲	V-Boost Code<99>	00~99 (every 1 step)

Description and Remarks

Part ① displays the existing code and allows a new selection of the V-Boost code. Referring to the chart, point C is established by the microprocessor at 1/2 the max frequency of the V/F pattern. Point B is established by the microprocessor at 1/10 the max frequency of the V/F pattern. Point A is adjusted by the V-Boost Code. Maximum boost is 18% (code 99) of the max output voltage of the V/F pattern.

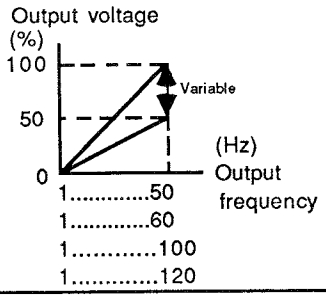


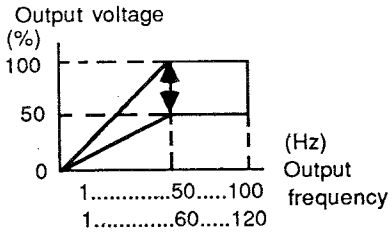
5	25	50
6	30	60
10	50	100
12	60	120

Display 08	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Output Voltage Gain Adjustment	Selection MON ▼ ▲	Initial setting V-Gain 100% ①→	Data setting ▶ ▼ ▲	V-Gain 50%	100~50 (every 1 step)

Description and Remarks

Part ① displays and allows the voltage component of the selected V/F pattern to be reduced to between 50-100% of corresponding V/F pattern voltage, resulting in energy savings for low torque loads.





Display 09	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Jogging Frequency Setpoint	Selection MON ▼ ▲	Initial display Jogging 01.0 Hz ①→	Data setting ▶ ▼ ▲	Jogging 08.0 Hz	0.5~9.9 (every 0.1 Hz)

Description and Remarks

Part ① displays the jogging frequency setpoint and allows a new setpoint to be entered. Input Signal 05 (see Section 5) controls when the inverter is to operate at the jog frequency. Since rapid operation of jogging may cause tripping, set this frequency to less than 5 Hz whenever possible.

Display 10	Selection Key	Display	Data setting keys	Display with typical data change	Setting/ Change Range
Name: Fault Display	Selection MON ▼ ▲	During normal operation #	N/A	See remarks	N/A

Description and Remarks

# indicates normal operation. When the inverter faults/alarm, the message takes precedence over all displays.

Fault/Alarm Displays (see Section 7 for complete discussion of fault/alarm messages)

OH Fin: Over heat on heat sink fin
OVER C.: Over current
Under V.: Under voltage
U V WAIT: Under voltage wait
Over V.: Over voltage
OV SRC: Over voltage source
NG-FRS: NG-free run stop
JG-JOG: NG-JOG
DB-OT: DC braking time over
NG DB: NG DC Brake
GND FLT: Ground fault
Inst. P-F: Instantaneous power failure
O.C.ACCEL: Over current during acceleration
O.C.DECEL: Over current during deceleration
O.C.DRIVE: Over current during constant speed
Over L.: Overload trip
CPU: microprocessor error
USP: Unattended Start Protection
BOO##: memory location fault

9.5.1 Notes to Monitor/Operator mode operation

a) On inverter power-up, the Monitor/Operator display 01 (output frequency monitor) is displayed automatically.

b) The data which can be changed during inverter operation in the Monitor/Operator mode are:

Operator/Monitor Display		Data entry	Remarks
No.	Name		
1	Output frequency monitor	N/A display only	
2	Output frequency setpoint	possible	
3	Output frequency command method	not possible	Change is possible only when the inverter is stopped.
4	Run/Stop Operation command method	not possible	Change is possible only when the inverter is stopped.
5	Driven motor speed rpm	possible	entering the number of motor poles is allowed.
6	Output current	possible	entering the inverter rated output current is allowed.
7	Manual torque boost adjustment	possible	entering a torque boost
8	Output voltage gain adjustment	possible	entering a % of output voltage gain is allowed.
9	Jogging frequency setpoint	possible	entering a jogging frequency setpoint is allowed.
10	Fault display	N/A display only	

c) Data changes made under the Monitor/Operator mode are effective when entered, without requiring use of the **STR** (store) key. The **STR** key is only applicable when entering set-up parameters via function codes as discussed in Section 10.

10. SET-UP MODE: MANUAL ADJUSTMENTS AND PROGRAMMING

CAUTION: The adjustments and programming of this inverter should be attempted only by a qualified technician familiar with the general application of V/F inverters and their set-up requirements.

10.0 General

It is suggested that the user read this entire section prior to making any adjustments or entering any data into the programmable parameters.

This section contains complete instructions for selecting and making adjustments to the manual adjustments on the logic board as well as the programming of the 31 functions. A table of the 31 functions and pertinent information is included at the end of this section for quick reference by technicians familiar with this inverter in addition, a blank data sheet is also provided to record data. We recommend that a record of the set-up data be recorded on the data sheet for future reference during service and maintenance.

10.1 Manual Adjustments

There are two POTs and one DIP switch located on the logic board (see Figure 1) which may require adjustment.

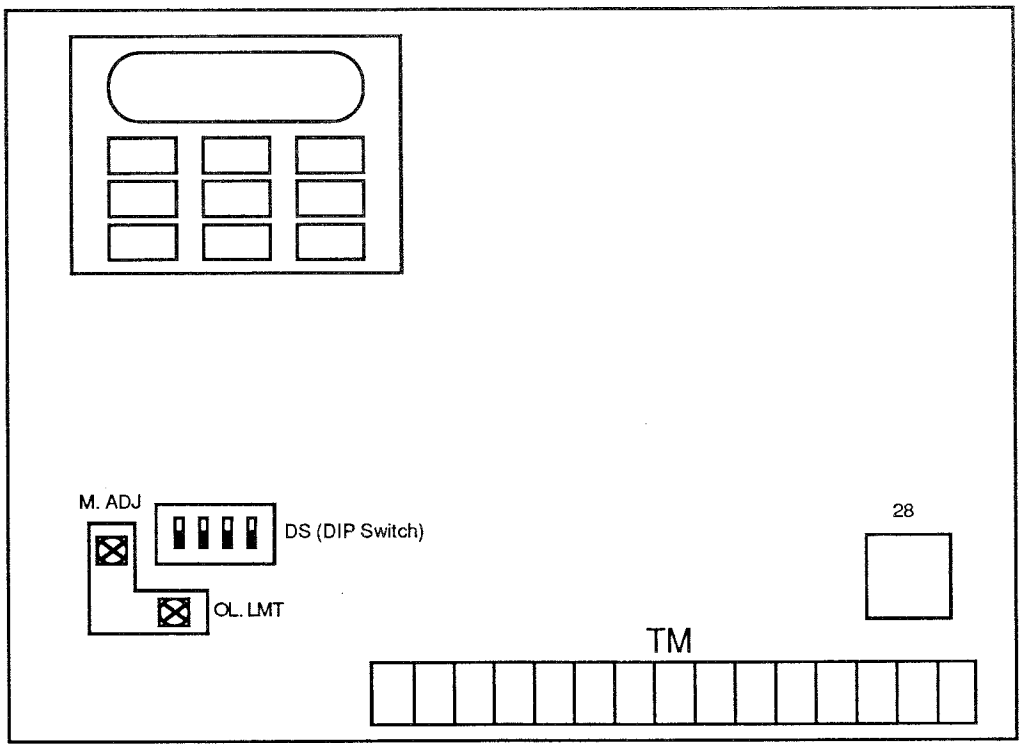
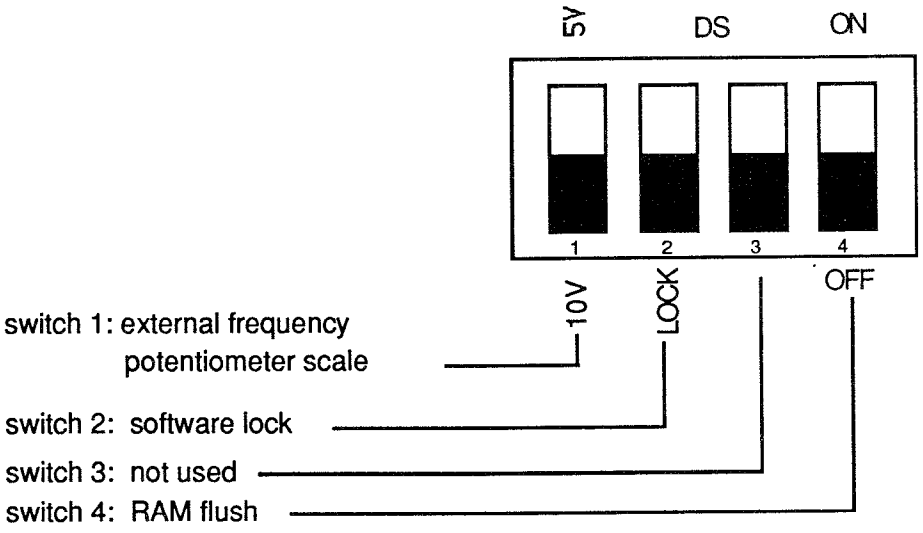


Figure 1

10.1.1 DIP Switch

The DIP switch has 4 switches marked as shown



1) Switch 4: RAM Flush

The inverter is furnished with pre-set factory settings for most set-up and operating parameters. These factory settings are resident in read only memory (ROM). (See table B at the end of this section for a listing of pre-programmed values)

Operator entered parameters are stored in non volatile RAM (NV-RAM). The operator entered parameters will be retained even during periods when power is not applied to the inverter

To remove all operator entered parameters and return to the original factory settings follow the steps below:

1) Turn power ON.
2) Set Switch 4 to "ON".
3) Depress the [MON] [FUN] and [STR] keys and the reset button at the same time and hold for 2-3 seconds.
4) At this point, [BOO.....] (ROM No.) will be displayed and operation stops.
If the display unit displays [FM 000.0 Hz] , the 3 keys have been released too quickly.
5) Turn power OFF.
6) Set switch 4 to OFF.
7) Turn power ON again and check that the data corresponds to the factory preset values.

CAUTION:

1) **RAM Flush** removes all previously entered operator parameters.
2) Switch 4 must be in the "OFF" position for the NV-RAM to store operator entered parameters.
3) Always make a record of desired application specific set-up parameters.

2) Switch 3: Not Used. This switch should remain in the "OFF" position.

3) Switch 2: Software Lock

Switch 2 is used to lock-out the ability to change operating or set-up parameters. With Switch 2 in the "ON" position, operator key pad functions are limited to FWD, REV, STOP and the ability to monitor parameters with the [MON] key.

Switch 2 is typically used (placed in the "ON" position) when operators unskilled in the full function capability of the operator key pad may have access to the operator key pad.

When wishing to make changes to one or more of the 31 set-up functions or one or more of the 9 operator displays, switch 2 must be in the "OFF" position.

4) Switch 1 External Frequency Potentiometer Scale

Switch 1 is used to scale the voltage range of the external frequency setting potentiometer. Either a 0-5V DC or 0-10V DC range may be set via switch 1. If a 4-20 mA external frequency setting device is used, switch 1 may be placed in either the 5V or 10V DC setting.

10.1.2 Potentiometers

1) Output frequency, analog meter adjustment (M.ADJ)

The M.ADJ potentiometer is used to perform a fine adjust to an analog meter used to display output frequency (See section 4, Output Singals for meter connection).

Adjust M.ADJ in conjunction with any integral meter adjustment so that the meter is at its maximum at the highest frequency.

2) Over Load (stall prevention) setpoint adjustment (OL.LMT)

The inverter is factory set with an over load limit setpoint of approximately 125%. The over load limit is adjustable via the OL.LMT potentiometer from 50 to 150% of inverter rated output current. The limit is increased by turning OL.LMT clockwise and decreased by turning OL.LMT counterclockwise (See Section 7.1 and 7.2 for a discussion of the Stall Prevention and Over Load Protection).

10.2 Programming Of Set-Up Parameters

It is assumed that the user is familiar with the use of the data entry keys on the operator key pad. The proper use and function of these keys is included in Section 9.

The inverter is programmed via 31 function codes (codes 00 to 36; codes 15, 16, 17, 29, 34 and 35 are not used). Depressing the function [FUN] key initializes the programming on "Function mode." The microprocessor acknowledges the initiation of the Function mode by displaying the first function code (F00).

Additional function codes may be indexed with the increment [▲] /decrement [▼] keys. Once the function code of the display containing the data field requiring change is displayed, press the [FUN] key a second time to initiate the display. Data within the data entry field of the display is changed via the cursor movement [▶] key and increment [▲] / decrement [▼] keys.

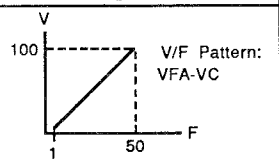
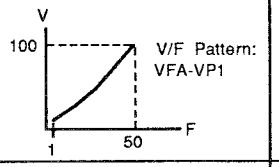
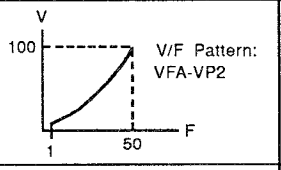
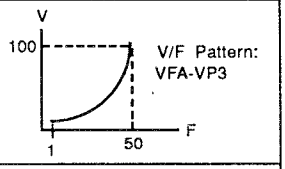
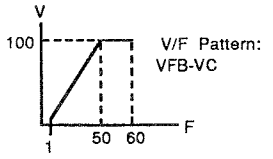
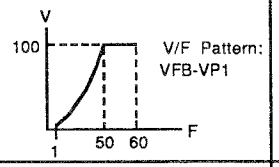
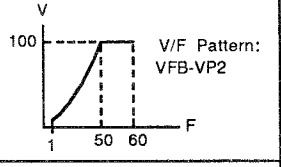
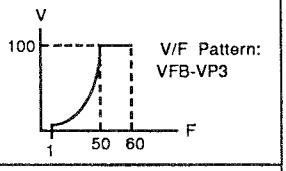
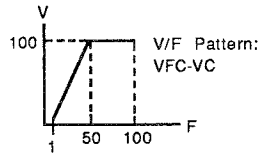
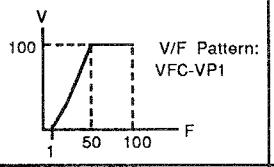
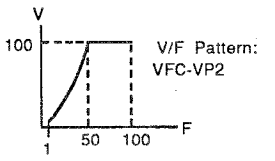
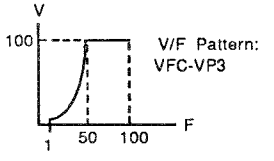
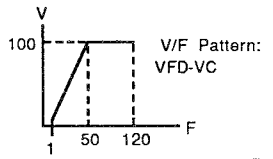
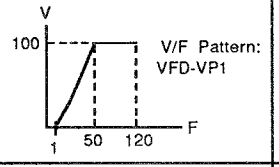
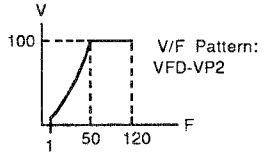
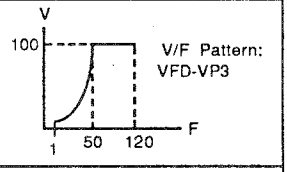
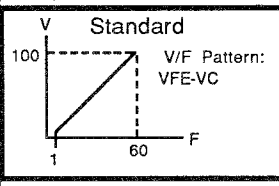
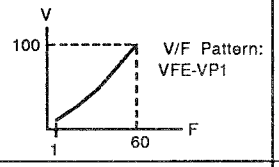
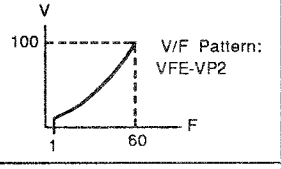
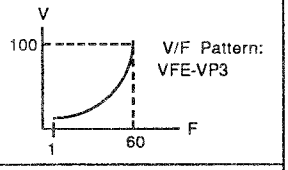
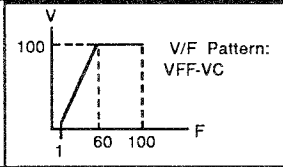
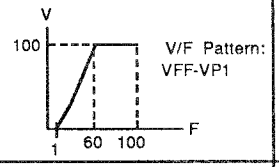
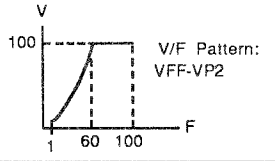
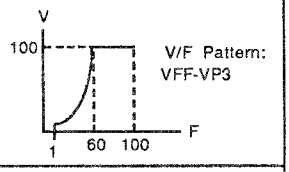
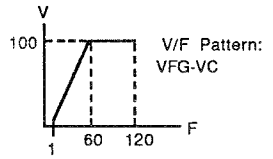
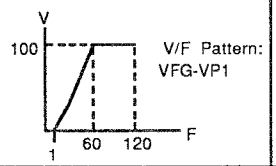
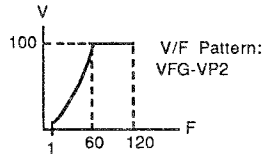
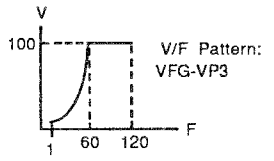
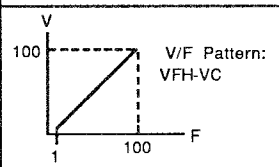
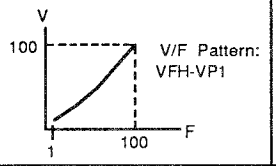
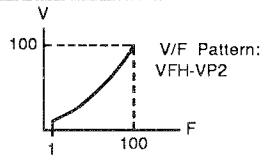
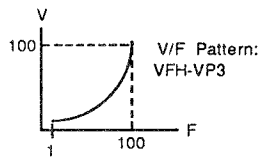
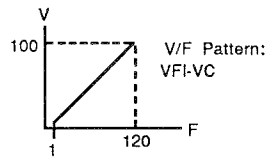
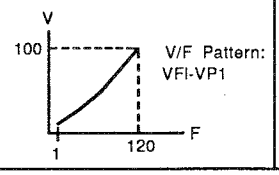
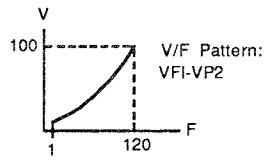
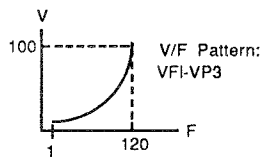
Important Notes:

1. Programming can only be accomplished while the inverter is stopped.
2. Once in the Function mode the inverter will not operate. The [MON] key must be depressed to exit the Function mode.
3. THE STORE [STR] KEY MUST BE PRESSED TO STORE ANY DATA ENTRY CHANGES INTO RAM MEMORY THAT HAVE BEEN MADE TO A FUNCTION CODE DISPLAY PRIOR TO EXITING THAT FUNCTION CODE. NEW DATA WILL NOT BE STORED IN RAM MEMORY UNLESS THE [STR] KEY IS DEPRESSED.
   - An asterisk "*" will appear as the eighth digit in a function code display when data has been changed but not yet stored.
   - An exclamation "!" will appear in the eighth digit if a data value entry outside the allowable range is attempted.
4. Refer to paragraph 10.1.1 DIP Switch Settings for the effect of the DIP Switch on programming.
5. ALTHOUGH THE [STR] KEY PLACES DATA INTO RAM MEMORY, NEW DATA IS NOT PERMANENTLY STORED IN NVRAM MEMORY UNTIL THE INVERTER INPUT POWER IS CYCLED OFF.

   AFTER EXITING THE FUNCTION MODE BY DEPRESSING THE [MON] KEY, INPUT POWER TO THE INVERTER SHOULD BE TURNED OFF AND BACK ON TO PERMANENTLY STORE DATA.

   IF THE INVERTER IS "RESET" BEFORE DATA IS PERMANENTLY STORED (VIA CYCLING INPUT POWER) DATA WILL BE LOST.

Table A: Voltage/Frequeycy (V/F) Patterns

	VC	VP1	VP2	VP3
A				
B				
C				
D				
E				
F				
G				
H				
I				

Notes:

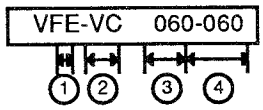
VC: V/F pattern curves in column VC represent a constant torque (linear) relationship between output voltage and frequency.

VP-1: V/F pattern curves in column VP-1 represent a reduced torque relationship between output voltage and frequency as a function of $x^{1.5}=y$.

VP-2: V/F pattern curves in column VP-2 represent a reduced torque relationship between output voltage and frequency as a function of $x^{1.7}=y$.

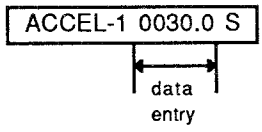
VP-3: V/F pattern curves in column VP-3 represent a reduced torque relationship between output voltage and frequency as a function of $x^{2}=y$.

10.3 Set-Up Functions Description and Selection

Function 00	Initial Display	Range of Data
Name: Voltage-Frequency (V/F) selection Designation: V/F		36 V/F patterns (A-VC to I-VP3) see Table A.

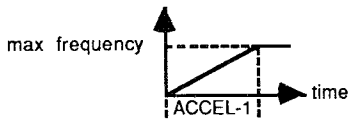
Description

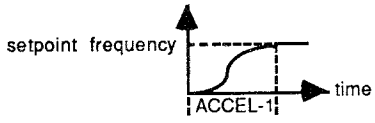
Please refer to Table A on page 5 for the 36 V/F patterns available. Use Table A to select the V/F pattern that matches the torque characteristics of the driven load. To program the inverter to operate at the selected V/F pattern, index the V/F pattern row designation (A to I) in area① and the column designation (VC, VP1, VP2, or VP3) shown in Table A in area②. Area③ will display the "basic frequency" (output frequency corresponding to the maximum output voltage) and area④ will display the maximum output frequency of the V/F pattern entered.

Function 01	Initial Display	Range of Data
Name: Acceleration Time 1 Designation: ACCEL-1		For linear selection 0.1~2999.9 seconds (0.1 increments). For S-curve selection 0.1~230 seconds (0.1 increments).

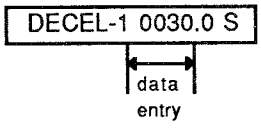
Description

This function sets the acceleration time in seconds. The acceleration time for a linear ramp curve is the time to reach the maximum frequency, the time for a S-curve ramp is the time to reach the setpoint



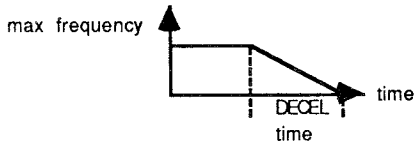


A value for ACCEL-1 is factory set to be in effect. Please refer to the discussion under Function 18 regarding the use of a second accleration time (ACCEL-2) in place of or in conjunction with ACCEL-1. Please refer to the discussion under Function 24 regarding a linear or "S" curve acceleration ramp selection.

Function 02	Initial Display	Range of Data
Name: Deceleration time 1 Designation: DECEL-1		For linear selection 0.1~2999.9 seconds (0.1 increments). For S-curve selection 0.1~230 seconds (0.1 increments).

Description

This function sets the deceleration time in seconds, before a full stop is reached from maximum speed.



A value for DECEL-1 is factory set to be in effect. Please refer to the discussion under Function 19 regarding the use of a second deceleration time (DECEL-2) in place of or in conjunction with DECEL-1. Please refer to the discussion under Function 25 regarding a linear or "S" curve deceleration ramp selection.

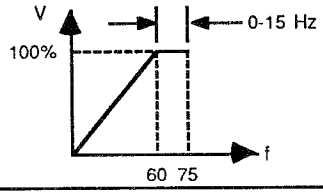
Function 03	Initial Display	Range of Data
Name: Maximum Output Frequency Increase Bias Designation: +F max	+Fmax. 000.0 Hz data entry	0-15 Hz (0.1 increments)

Description

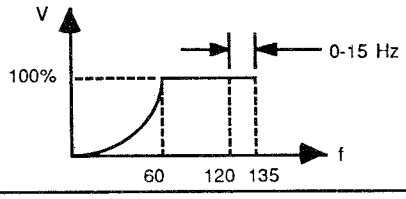
This function provides the ability to add a 0 to 15 plus bias to the maximum output frequency established by the V/F pattern.

Example:

Pattern E-VC



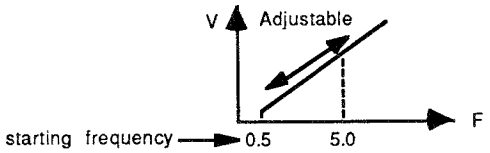
Pattern F-VP1



Function 04	Initial Display	Range of Data
Name: Minimum Starting Output Frequency Designation: Fmin	Fmin. 00.5 Hz data entry	0.5 to 5.0 Hz (0.1 increments)

Description

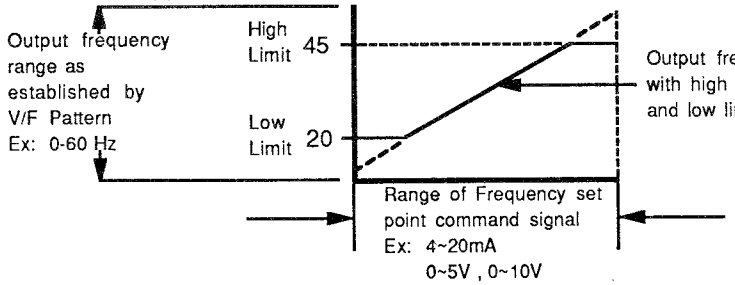
This function provides the ability to adjust the starting frequency from the initial factory setting of .5 to as much as 5.0 Hz.



Function 05	Initial Display	Range of Data
Name: Output Frequency Upper (High) Limit Designation: H-LIM-F	H-LIM-F 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

This function and Function 06 provide the ability to set upper and lower limits on the inverter response to a commanded output frequency. There is no boundary for the setting of either limit, except that an error occurs if the upper limit is set below the lower limit.



Output frequency change with high limit at 45 Hz and low limit at 20 Hz.

Notes:

1. To initially set or modify this parameter the sequence should be as follows: Execute H-LIM-F, then execute L-LIM-F. Reversing this sequence makes the setting impossible.
2. To remove this function: First execute L-LIM-F.
3. Range of frequency setpoint command is set via functions 26 and 27.

Function 06	Initial Display	Range of Data
Name: Output Frequency Lower (Low) Limit Designation: L-LIM-F	L-LIM-F 000.5 Hz data entry	0-135 Hz (0.1 increments)

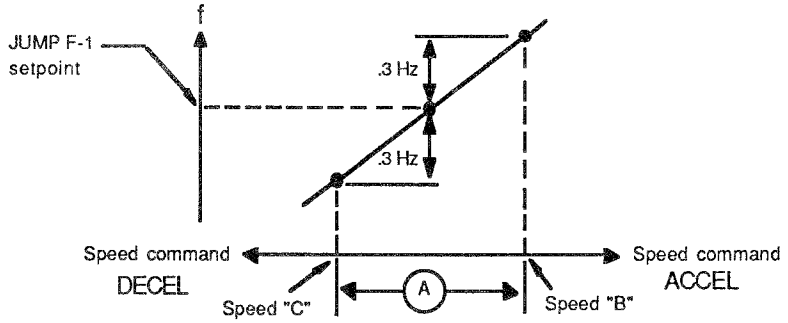
Description

This function is used to set the low frequency limit. See discussion under Function 05.

Function 07	Initial Display	Range of Data
Name: First Jump Frequency Designation: Jump-F1	JUMP-F1 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

This function and functions 08 and 09 provide the ability to jump (mask out the corresponding speed command of) 3 frequencies on the V/F curve if an undesirable resonance should occur at one or more frequencies. The frequency to be jumped may be set to within 0.1 Hz. The hysterysis around the setpoint is .3Hz. When a frequency is selected as a JUMP-F, the inverter will establish area (A) on the corresponding speed command curve. Note that if a speed command enters area (A) from a lower speed setting (ACCEL) the inverter will operate at speed B, if it enters from a higher speed setting (DECEL) the inverter will operate at speed C.



Function 08 and Function 09	Initial Display	Range of Data
Name: Second and third Jump frequencies Designation: JUMP F-2 and F-3	JUMP-F2 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

Please see the discussion under Function 07 above.

Function 10	Initial Display	Range of Data
Name: Carrier Frequency Adjustment Designation: CF-code	CF-code <N> data entry	Code "N" ≈ 1 kilohertz. Adjustable up or down in 40 Hz increments. 19 increments are provided.

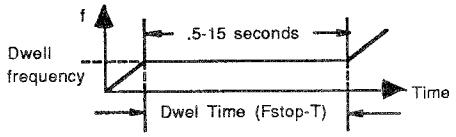
Description

This function provides the ability to fine tune the carrier frequency of the inverter PWM sine coded wave form to over come vibration and audible noise tone of the motor created at certain frequencies.

Function 11	Initial Display	Range of Data
Name: Dwell (Stop) Time of Output Frequency on Start-Up Designation: Fstop-T	Fstop-T 0.5 S data entry	0.5-15 seconds (0.1 increments)

Description

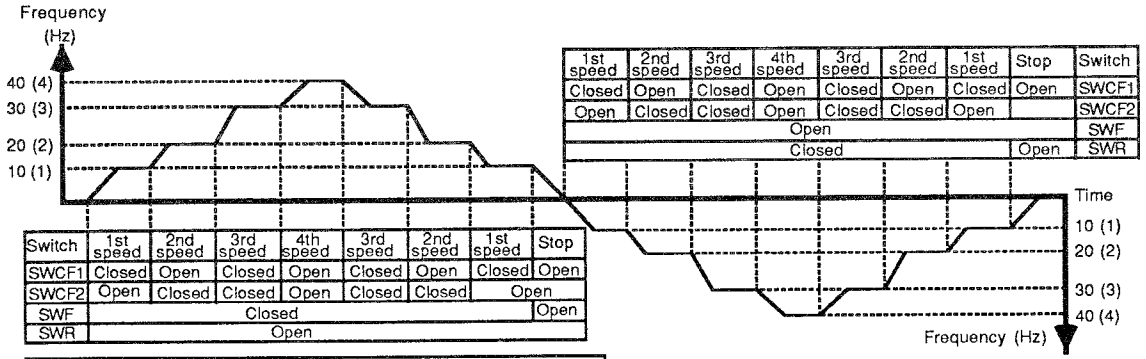
This function provides the ability to adjust the stop or dwell time at which the output frequency is held constant during start-up to help reduce the overcurrent condition occuring at start-up. The dwell frequency at which this dwell time occurs is set by the microprocessor at Fmin or 1/12 the basic frequency, whichever is greater.



Function 12	Initial Display	Range of Data
Name: First Multi Stage Speed (output frequency) Setpoint Designation: Speed-1	Speed-1 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

The inverter may be programmed to operate at up to 4 different preset speeds initiated through contact closures between terminal L and the terminals CF1 and CF2. One of the speeds is the speed set from the Operator Key Pad or Input signal 01 and is in effect when neither L-CF1 or L-CF2 is closed. The other 3 speed setpoints are entered via this function and functions 13 and 14. In the following chart, output frequency setpoints have been entered as 10, 20 and 30 Hz in functions 12,13 and 14 respectively. A setpoint of 40 Hz has been entered under Display 02 of the Operator/ Monitor mode (inverter speed setpoint is under Operator Key Pad control; Start/Stop is under terminal control).

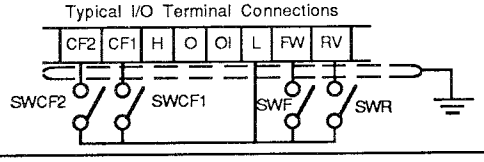


Switch	1st speed	2nd speed	3rd speed	4th speed	3rd speed	2nd speed	1st speed	Stop
SWCF1	Closed	Open	Closed	Open	Closed	Open	Closed	Open
SWCF2	Open	Closed	Closed	Open	Closed	Closed	Open	
SWF	Closed							Open
SWR	Open							

Switch		Output frequency (Hz)
CF1	CF2	
Open	Open	Frequency command from OPE-key or terminal mode
Closed	Open	Value preset by Speed-1
Open	Closed	Value preset by Speed-2
Closed	Closed	Value preset by Speed-3

1st speed	2nd speed	3rd speed	4th speed	3rd speed	2nd speed	1st speed	Stop	Switch
Closed	Open	Closed	Open	Closed	Open	Closed	Open	SWCF1
Open	Closed	Closed	Open	Closed	Closed	Open		SWCF2
Open								SWF
Closed							Open	SWR

Typical I/O Terminal Connections



Function 13	Initial Display	Range of Data
Name: Second Multi Stage Speed (output frequency) Setpoint Designation: Speed-2	Speed-2 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

Please see the discussion under Function 12.

Function 14	Initial Display	Range of Data
Name: Third Multi Stage Speed (output frequency) Setpoint Designation: Speed-3	Speed-3 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

Please see the discussion under Function 12.

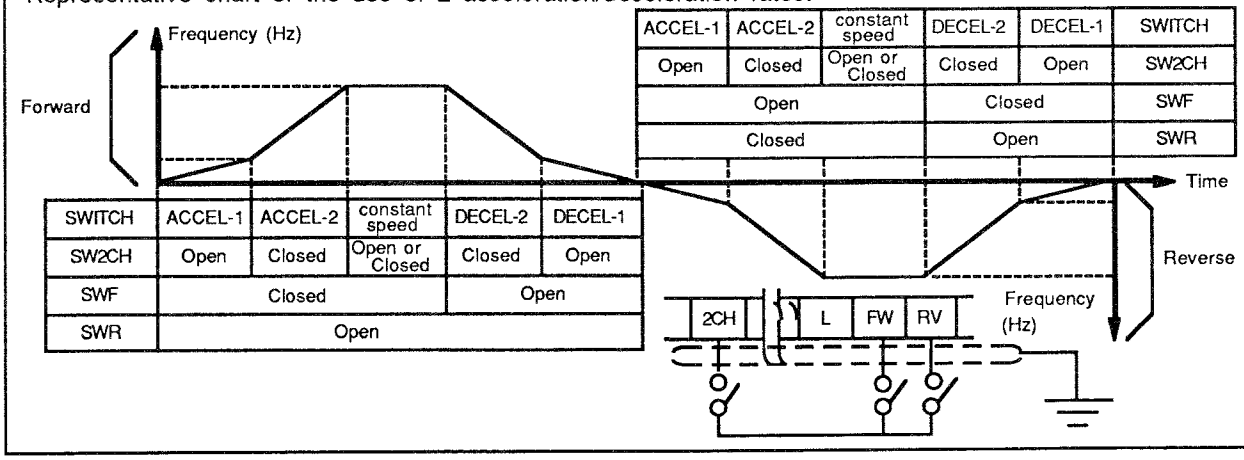
Function 15 Function 16 Function 17	Not used

Function 18	Initial Display	Range of Data
Name: Acceleration Time 2 Designation: ACCEL-2	ACCEL-2 0030.0 S data entry	For linear selection 0.1~2999.9 seconds (0.1 increments). For curve selection 0.1~230 seconds (0.1 increments).

Description

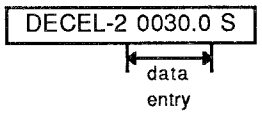
The inverter has the capability to accelerate/decelerate at two different rates. The first accelerate/decelerate rate is entered via Functions 01 and 02 respectively. This function is provided along with Function 19 to provide for entry of the 2nd acceleration/deceleration rate. Initiation of the 2nd acceleration/deceleration rate is made by Input Signal 08 (a contact closure between terminal 2CH and L).

Representative chart of the use of 2 acceleration/deceleration rates:



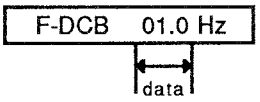
SWITCH	ACCEL-1	ACCEL-2	constant speed	DECEL-2	DECEL-1
SW2CH	Open	Closed	Open or Closed	Closed	Open
SWF	Closed			Open	
SWR	Open				

ACCEL-1	ACCEL-2	constant speed	DECEL-2	DECEL-1	SWITCH
Open	Closed	Open or Closed	Closed	Open	SW2CH
Open			Closed		SWF
Closed			Open		SWR

Function 19	Initial Display	Range of Data
Name: Deceleration Time 2 Designation: DECEL-2		For linear selection 0.1~2999.9 seconds (0.1 increments). For curve selection 0.1~230 seconds (0.1 increments).

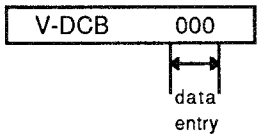
Description

Please see the discussion under Function 18 above.

Function 20	Initial Display	Range of Data
Name: DC Brake Frequency Adjustment Designation: F-DCB		0.5-15 Hz (0.1 increments)

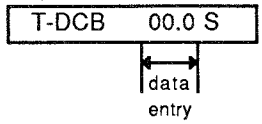
Description

A DC brake can be selected to operate via a software switch setting (see Function 28). If a DC brake is selected to be in effect via the software switch, the DC brake signal will be initiated during deceleration at Fmin. If it is desirable to have the DC brake signal applied at a frequency other than Fmin, the option PCB is required. Terminals on the option PCB provide input signal terminals to signal the inverter to apply a DC brake at the frequency entered via this function.

Function 21	Initial Display	Range of Data
Name: DC Brake Power (voltage) Adjustment Designation: V-DCB		0-20 (1.0 increments)

Description

This function provides the ability to adjust the DC brake applied voltage. The higher the value the higher the DC brake voltage level.

Function 22	Initial Display	Range of Data
Name: DC Brake Time Designation: T-DCB		0-15 seconds (0.1 increments)

Description

This function provides the ability to adjust the period in time that a DC brake signal is to be in effect.

Function 23	Initial Display	Range of Data
Name: Electronic Thermal Level Adjustment Designation: E-therm	E-therm 100% data entry	100-50% (1.0 increments)

Description

The inverter is equipped with an electronic thermal protection function applicable to standard NEMA Class B, 3ϕ, 4-pole induction motors. The preset level of this protection is set to the rated output (RMS Amps) of the inverter. If the driven motor has a name plate rating less than the inverter rating the thermal protection provided by the inverter should be adjusted to the motor name plate value via this function.

Example: Inverter Rated Output Amps: 13
Driven Motor Name Plate Amps: 11.3

Then: $\frac{\text{Motor Rated Current}}{\text{Inverter Rated Current}} \times 100\% = \frac{11.3}{13} \times 100\% = 87\%$

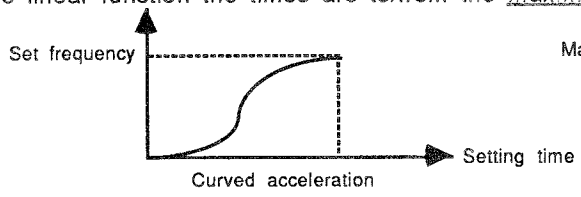
and 87% should be entered under Function 20.

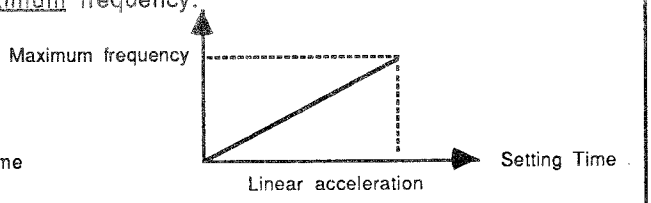
Caution: When a motor is continuously operated at 10 Hz or below a thermal relay must be used.

Function 24	Initial Display	Range of Data
Name: Selection of Linear or S-Curve Acceleration Designation: ACCline	ACCline Linear data entry	Linear or S-curve

Description

In addition to the ability to vary the rate of acceleration/deceleration (see functions 01, 02, 18, 19) it is sometimes desirable that the acceleration/deceleration rates not be a linear function, but rather a non-linear S-curve (changing slope) function. Functions 24 and 25 provide the ability to select an S-curve function for the acceleration and deceleration as desired. When the S-curve is selected, the acceleration/deceleration times correspond to times required to accelerate/decelerate to/from the setpoint frequency, for the linear function the times are to/from the maximum frequency.





Note: The acceleration time range between the linear and curved accelerations differs (see Function 01).

Function 25	Initial Display	Range of Data
Name: Selection of Linear or S-Curve Deceleration Designation: DECline	DECline Linear data entry	Linear or S-curve

Description

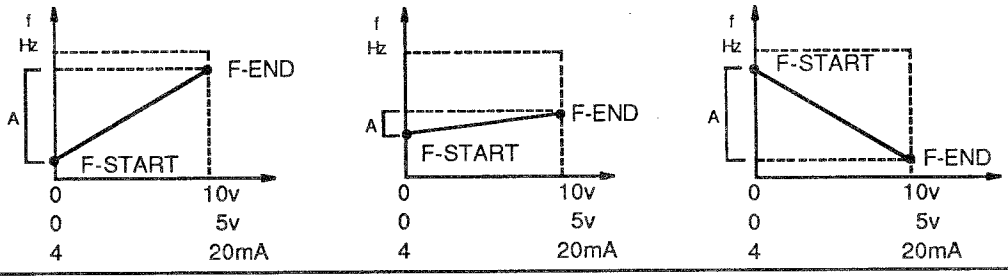
Please see the discussion under Function 24.

Function 26	Initial Display	Range of Data
Name: "Start" Frequency of External Output Frequency Siginal command Designation: F-Start	F-START 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

Functions 26 and 27 allow alteration of the slope of the curve and thereby the relationship of the output frequency to the process follower input. Entries of "0" in both F-START and F-END will cause the output frequency to follow the selected V/F pattern. If the V/F pattern is changed always be certain to readjust F-START and F-END.

EXAMPLES:
(A = output frequency for a 0-10v, 0-5v or 4-20mA input)



Function 27	Initial Display	Range of Data
Name: "End" Frequency of External I/O Output Frequency Setpoint Scale Designation: F-END	F-END 000.0 Hz data entry	0-135 Hz (0.1 increments)

Description

Please see discussion under Function 26 above.

Function 28	Initial Display	Range of Data
Name: Software Switch -Enable/Disable auto-restart, overload protection during acceleration and DC Brake -Select analog or digital output for remote frequency indication Designation: SWITCH1	SWITCH1 00000111 6 5 4 3 2 1	For area ① do not change from "1". For areas ②③④⑤ 0 or 1. For area ⑥ do not change from "00".

Description

This software switch is used to make several determinations in microprocessor logic.

Area ① Do not change from "1".

Area ② A "0" entry eliminates the DC braking action, a "1" entry initializes the DC braking action (see functions 20, 21 and 22 for further discussion of DC braking settings.

Area ③ A "0" entry initiates a digital pulse on Output 03 (terminal FM) for use with a digital frequency counter, a"1" entry initiates an analog signal on Output 03 (terminal FM) for use with analog frequency meter (see Section 5 for further discussion of the wiring of Output 03).

Area ④ A "0" entry allows overload (stall prevention) to remain in effect throughout the entire ACCEL/RUN /DECEL. A "1" entry prohibits overload (stall prevention) from being in effect during acceleration.

Area ⑤ A "00" entry causes the inverter to trip and close alarm contacts on all trip occurances. "10" inverter attempts auto re-start up to 3 times/10 minutes with a "start into spinning motor routine" for Over V, Under V, Over C, Inst. P-F and USP after momentary power failure; "11" inverter attempts auto re-start for these trips after waiting the IPS-R-T time (function 36) and does not initiate the "start into spinning motor routine".

Area ⑥ Do not change from "00".

Function 29	Not Used

Function 30	Initial Display	Range of Data
Name: Overload Limit Reaction Constant Designation: LM.CONS	LM.CONS 001.0 data entry	.3 to 30 (0.1 increments)

Description

When the microprocessor initiates a stall prevention sequence during acceleration or constant speed the output frequency is decreased until the output current drops below the stall prevent setpoint (plus a hysterysis). The rate at which the output frequency is decreased (reaction time) is adjusted by this function (max rate at 0.3).
NOTE: Please refer to the discussion on stall prevention in Section 7.0 for a more complete understanding of the stall protection sequence.
CAUTION: Do not use this function to adjust for an overcurrent trip during acceleration or deceleration. If a trip occurs during acceleration/deceleration increase the acceleration/deceleration time.

Function 31	Initial Display	Range of Data
Name: Overload Alarm Level Adjustment Designation: OLalarm	OLalarm 100% data entry	100-150% (1.0 increments)

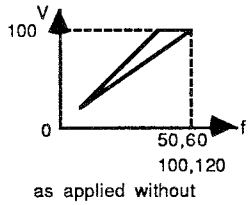
Description

As part of the overload protection sequence, the microprocessor is capable of issuing a warning of a pending overload condition. Contacts necessary to issue the warning signal are available on the option PC Board. Function 31 provides the method of setting the overload warning level.

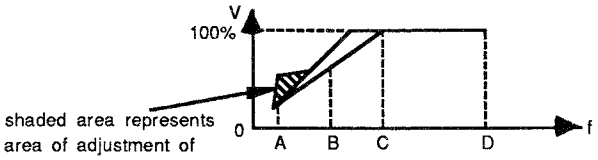
Function 32	Initial Display	Range of Data
Name: Automatic Torque (Voltage) Boost Adjustment Designation: V-auto	V-auto +00 data entry	0 to 20 (1.0 increments) voltage is increased by approximately 10% at +20 (no increase at +00).

Description

In addition to the manual torque (voltage boost) initiated under Display 07 of the Monitor/Operator mode an automatic torque boost may be applied. This function provides the method of setting the value of the automatic torque boost desired. When the output frequency reaches the constant speed setpoint the V-auto is removed to avoid continued operation of the driven motor in an over-excited condition.



as applied without manual torque boost



shaded area represents area of adjustment of manual torque boost

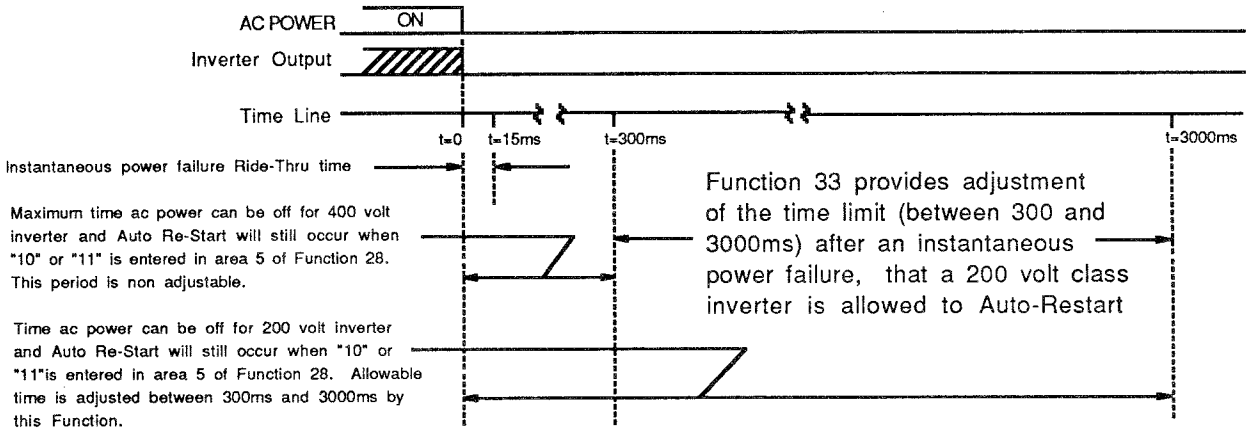
A = 1/10 of fmax
B = 1/2 fundamental f
C = fundamental f
D = fmax

as applied in conjunction with manual torque boost

Function 33	Initial Display	Range of Data
Name: Instantaneous power failure duration (time) within which an auto-restart should be initiated Designation: IPS-T	IPS-T 001.0 S data entry	For 200 V Class 0.3~3.0 seconds (0.1 increments). For 400 V Class 0.3 non adjustable.

Description

The inverter automatically rides through a power failure of 15 milliseconds or less. After 15 milliseconds the inverter microprocessor continues to operate from power stored in an internal capacitor. This capacitor powers the microprocessor for at least 3000 ms for the 200V Class and at least 300ms for the 400V Class (see chart below).



Function 34 Function 35	Not used

Function 36	Initial Display	Range of Data
Name: Wait (Standby) time after a trip occurance before the Auto Re-Start is initiated if Auto Re-Start has been selected in area 5 of Function 28. Designation: IPS-R-T	IPS-R-T 001.0 S data entry	.3 to 30 seconds (0.1 increments)

Description

Please refer to the timing chart in Function 33 above. If power returns within time period (A) the auto-restart sequence can be delayed for up to 30 seconds with Function 36. This delay is useful when it is desirable to auto restart the controlled process but only after enough time has elapsed to allow the process to stop through its own inertia.

Function Name	Function Code	Function Display Name	Factory Setting	Range of Data	Remarks NOTE: Function codes 15,16,17,29,34 and 35 are not used
Voltage-Frequency (V/F) selection	F-00	VFE-VC	060-060		
Acceleration Time 1	F-01	ACCEL-1	0030.0 S	0.1~2999.9 (s) At linear acceleration 0.1~230.0 (s) At S-character curved acceleration	
Deceleration Time 1	F-02	DECEL-1	0030.0 S	0.1~2999.9 (s) At linear deceleration 0.1~230.0 (s) At S-character curved deceleration	
Maximum Output Frequency Increase Bias	F-03	+Fmax.	000.0 Hz	0~15 (Hz)	
Minimum Starting Output Frequency	F-04	Fmin.	000.5 Hz	0.5~5.0 (Hz)	
Output Frequency Upper (High) Limit	F-05	H-LIM-F	000.0 Hz	0~135 (Hz)	This frequency is effective up to the highest frequency of the selected V/F pattern plus the maximum output frequency increase bias (F-03). Error when the max. limit is smaller than the min. limit.
Output Frequency Lower (Low) Limit	F-06	L-LIM-F	000.0 Hz	0~135 (Hz)	
First Jump Frequency	F-07	JUMP-F1	000.0 Hz	0~135 (Hz)	This frequency is effective up to the highest frequency of the selected V/F pattern plus the maximum output frequency increase bias (F-03).
Second Jump Frequency	F-08	JUMP-F2	000.0 Hz	0~135 (Hz)	
Third Jump Frequency	F-09	JUMP-F3	000.0 Hz	0~135 (Hz)	
Carrier Frequency Adjustment	F-10	CF-code	<N>	C~U	
Dwell (Stop) Time of Output Frequency on Start-Up	F-11	Fstop-T	001.0 S	0~15 (S)	This frequency is effective up to the highest frequency selected by V/F pattern.
First Multi Stage Speed (output frequency) Setpoint	F-12	Speed-1	000.0 Hz	0~135 (Hz)	
Second Multi Stage Speed (output frequency) Setpoint	F-13	Speed-2	000.0 Hz	0~135 (Hz)	This frequency is effective up to the highest frequency selected by V/F pattern.
Third Multi Stage Speed (output frequency) Setpoint	F-14	Speed-3	000.0 Hz	0~135 (Hz)	This frequency is effective up to the highest frequency selected by V/F pattern.
Acceleration Time 2	F-18	ACCEL-2	0030.0 S	0.1~2999.9 (S) At linear acceleration 0.1~230.0 (S) At S-character curved acceleration	
Deceleration Time 2	F-19	DECEL-2	0030.0 S	0.1~2999.9 (S) At linear deceleration 0.1~230.0 (S) At S-character curved deceleration	
DC Brake Frequency Adjustment	F-20	F-DCB	001.0 Hz	0.5~15 (Hz)	Effective only when option al PC board is used.
DC Brake Power (voltage) Adjustment	F-21	V-DCB	000	00~20	
DC Brake Time	F-22	T-DCB	000.0 S	00~15 (S)	
Electronic Thermal Level Adjustment	F-23	E-therm	100%	100~50 (%)	
Selection of Linear or S-Curve Acceleration	F-24	ACCline	Linear	Linear or S-Curve	
Selection of Linear or S-Curve Deceleration	F-25	DECline	Linear	Linear or S-Curve	
"Start" Frequency of External Output Frequency Setpoint Range	F-26	F-START	000.0 Hz	0~135 (Hz)	
"End" Frequency of External I/O Output Frequency Setpoint	F-27	F-END	000.0 Hz	0~135 (Hz)	
Softwware Switch	F-28	SWITCH1	00000111	0 or 1	
Overload Limit Reaction Constant	F-30	LM.CONS	0001.0	0.3~30	
Overload Alarm Level Adjustment	F-31	OLalarm	100%	100~150 (%)	Effective only when optional PC board is used.
Automatic Torque (Voltage) Boost Adjustment	F-32	V-auto	+00	00~20	
Instantaneous Power Failure duration (time) within which an auto-restart should be initiated	F-33	IPS-T	001.0 S	0.3~3.0 (S)	Class 200V 0.3~3 (S) Class 400V 0.3 (S)
Wait (Standby) time before initiating re-start after power is restored within the instantaneous power failure time set by F33	F-36	IPS-R-T	0001.0 S	0.3~30 (S)	

The inverter has many parameters that can be changed by the user. It is recommended that this data sheet be used to record parameters for future reference.

TYPE: _____
MFG. No.: _____ from inverter name plate

Display	Name	Initial Display	Factory Setting	Setting Data
01	Output Frequency Monitor	FM 000.0 Hz	—	
02	Output Frequency Setpoint	FS 000.0 Hz	—	
03	Output Frequency Command Method	F-SET-M Ope.-key	Ope.-key	
04	Run/Stop Command Method	F/R-SW Ope.-key	Ope.-key	
05	Driven Motor Speed RPM	RPM 4P 0000RPM	4	
06	Output Current	If----A Im000.0%	—	
07	Manual Torque Boost Adjustment	V-Boost Code<31>	31	
08	Output Voltage Gain Adjustment	V-Gain 100%	100	
09	Jogging Frequency Setpoint	Jogging 01.0 Hz	1.0	
10	Fault Display	#	—	—

Note: Function Codes 15,16,17,29,34 and 35 are not used.

Function Name	Function Code	Function Display Name	Factory Setting	Set-Up Value
Voltage-Frequency	F-00	VFE-VC	060-060	
Acceleration Time 1	F-01	ACCEL-1	0030.0 S	
Deceleration Time 1	F-02	DECEL-1	0030.0 S	
Maximum Output Frequency Increase Bias	F-03	+Fmax.	000.0 Hz	
Minimum Starting Output Frequency	F-04	Fmin.	000.5 Hz	
Output Frequency Upper (High) Limit	F-05	H-LIM-F	000.0 Hz	
Output Frequency Lower (Low) Limit	F-06	L-LIM-F	000.0 Hz	
First Jump Frequency	F-07	JUMP-F1	000.0 Hz	
Second Jump Frequency	F-08	JUMP-F2	000.0 Hz	
Third Jump Frequency	F-09	JUMP-F3	000.0 Hz	
Carrier Frequency Adjustment	F-10	CF-code	<N>	
Dwell (Stop) Time of Output Frequency on Start-Up	F-11	Fstop-T	001.0 S	
First Multi Stage Speed (output frequency) Setpoint	F-12	Speed-1	000.0 Hz	
Second Multi Stage Speed (output frequency) Setpoint	F-13	Speed-2	000.0 Hz	
Third Multi Stage Speed (output frequency) Setpoint	F-14	Speed-3	000.0 Hz	
Acceleration Time 2	F-18	ACCEL-2	0030.0 S	
Deceleration Time 2	F-19	DECEL-2	0030.0 S	
DC Brake Frequency Adjustment	F-20	F-DCB	001.0 Hz	
DC Brake Power (voltage) Adjustment	F-21	V-DCB	000	
DC Brake Time	F-22	T-DCB	000.0 S	
Electronic Thermal Level Adjustment	F-23	E-therm	100%	
Selection of Linear or S-Curve Acceleration	F-24	ACCline	Linear	
Selection of Linear or S-Curve Deceleration	F-25	DECline	Linear	
"Start" Frequency of External Output Frequency Setpoint Range	F-26	F-START	000.0 Hz	
"End" Frequency of External I/O Output Frequency Setpoint Scale	F-27	F-END	000.0 Hz	
Softwware Switch	F-28	SWITCH1	00000111	
Overload Limit Reaction Constant	F-30	LM.CONS	0001.0	
Overload Alarm Level Adjustment	F-31	OLalarm	100%	
Automatic Torque (Voltage) Boost Adjustment	F-32	V-auto	+00	
Instantaneous Power Failure duration (time) within which an auto-restart should be initiated	F-33	IPS-T	001.0 S	
Wait (Standby) time before initiating re-start after power is restored within the instantaneous power failure time set by F33	F-36	IPS-R-T	0001.0 S	

11. MAINTENANCE AND TROUBLE-SHOOTING

CAUTION:
Hazardous voltage is present on terminals and printed circuit boards. Always disconnect supply power before beginning any service. After turning off the input power, do not touch the inverter internal parts until the 16 digit LCD display on the operator key pad goes out for the 200V class, or the LED (visible after the terminal cover is removed) at the right side of the terminal strip goes off for the 400V class. The inverter has a charged capacitor that must fully discharge before the unit is safe to service (Refer to Section 4, Table 3 for discharge time).
NOTE: Do not rely on the LCD for indication that the line side power has been shut off. The LCD may go off if only a single line side phase is off. **Always** electrically (via volt meter) confirm that power is not present on L1, L2 and L3 before servicing.

11.1 Routine Maintenance

1) Keep the controller clean, dry and free of dust and dirt. Check periodically for broken wires and poor or loose connections. All connections should be tightened once a year. Note that all electronic equipment may develop trouble if exposed to humidity, oil mist, dust or corrosive atmosphere.

2) Printed circuit boards are normally maintenance free. To help assure continued operation of the boards when handling printed circuit boards, connect the bench soldering iron and your body to a good earth ground to protect the LSI's and microprocessors on the printed circuit board from static electricity. Also, repeated plugging and unplugging of socketed IC's may deteriorate contact between the pins and the socket.

We do no recommend that the user try to replace any soldered parts on the printed circuit boards. In almost all cases it is better to completely replace a defective board than to try to repair it.

3) The main circuit smoothing capacitor used in inverters has a life expectancy of 5-10 years depending on the load, ambient temperatures and line voltage.

Toward the end of its useful life the capacity of a capacitor goes down. As a result, in an inverter the ripple of the output voltage increases leading to unstable motor operation.

It is recommended that the inverter smoothing capacitor (CB) be replaced on a regular basis every 5 to 10 years as conditions dictate.

11.2 Measuring Output Voltage, Input/Output Current

1) A standard volt-ohm meter (20,000 ohm/volt) can be used to measure AC and DC voltage. AC voltage readings may not be entirely accurate, particularly at lower frequencies due to harmonic content of the wave form. A closer approximation of

output voltage can be obtained by using the circuit shown in Figure 1.

2) A moving-iron type meter cannot precisely measure the output voltage of a V/F inverter. The circuit shown in Figure 1 will give an effective value, V_{AC},of the fundamental wave that directly affects the motor torque. A moving-iron type meter, or clamp-on ammeter can be used to measure the approximate output and input current. The input power can be measured by using 3 single-phase electrodynamic type meters.

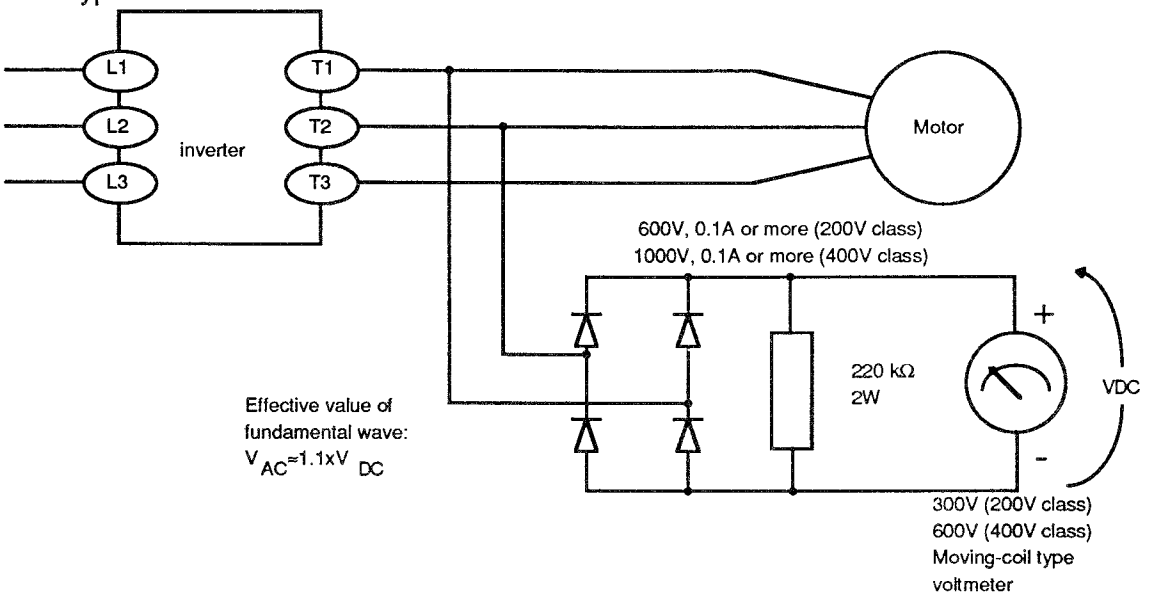


FIGURE 1-Output Voltage Measuring Circuit

When no load is connected to outputs T1, T2 and T3, even if the output frequency command is set to zero, DC voltage appears at terminals T1, T2 and T3 because of leakage current (about 2 mA) of the semiconductors.

When connecting a voltmeter to the output terminals in such a case, make connections as shown in Figure 2 so as to avoid faulty meter indications.

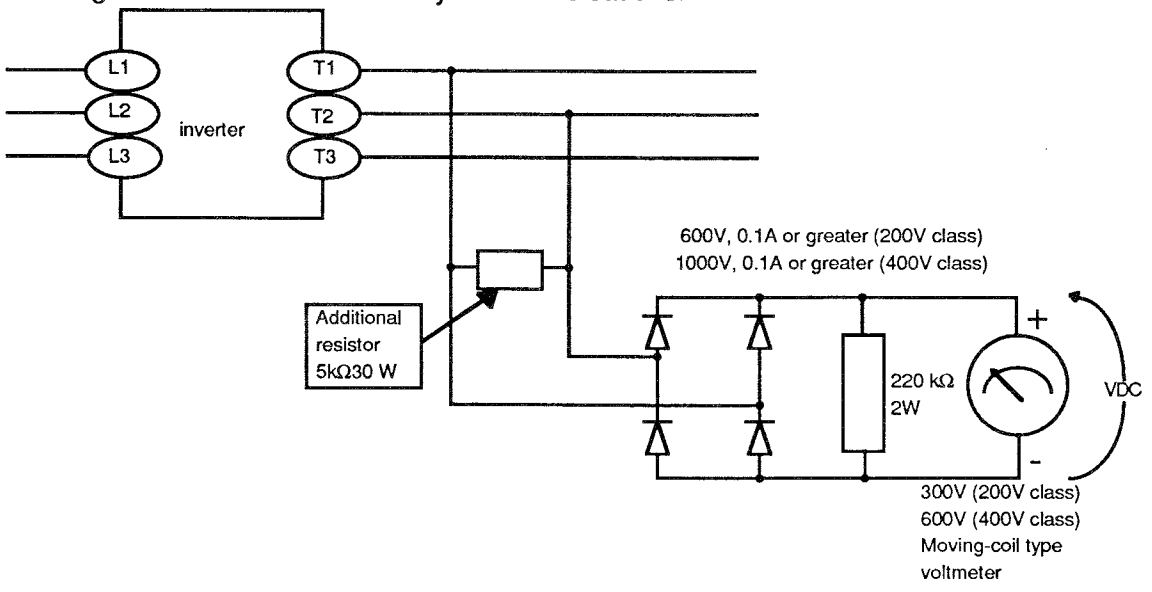


FIGURE 2-Output Voltage Measuring Circuit

11.3 Checking Inverter Transistor Modules

1) The inverter power transistor modules can be checked for shorts or opens by conducting ohmmeter checks across the transistor modules (Q1 thru Q6) using the T1, T2 and T3 output terminals and the dynamic brake terminals + and -.

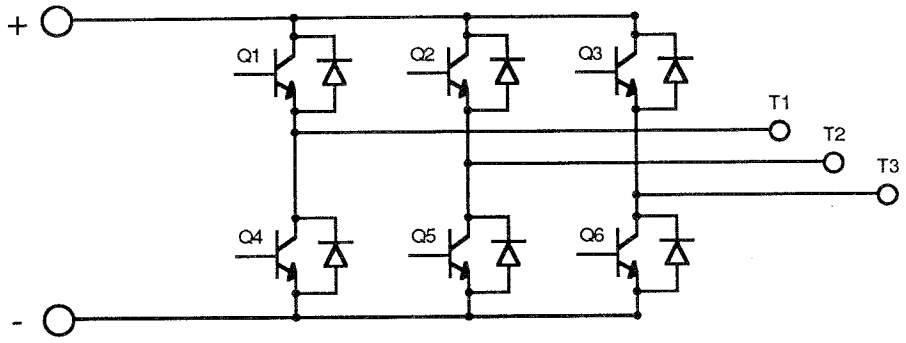


FIGURE 3-Inverter Module Circuit Diagram

2) Measure with the ohmmeter set on a single ohm range.

3) Measure as shown in Figure 4, repeating the 4 checks for each output terminal (T1,T2,T3).

4) Connect the tester for about 10 seconds. A small resistance value may be indicated initially because of a capacitor charging effect.

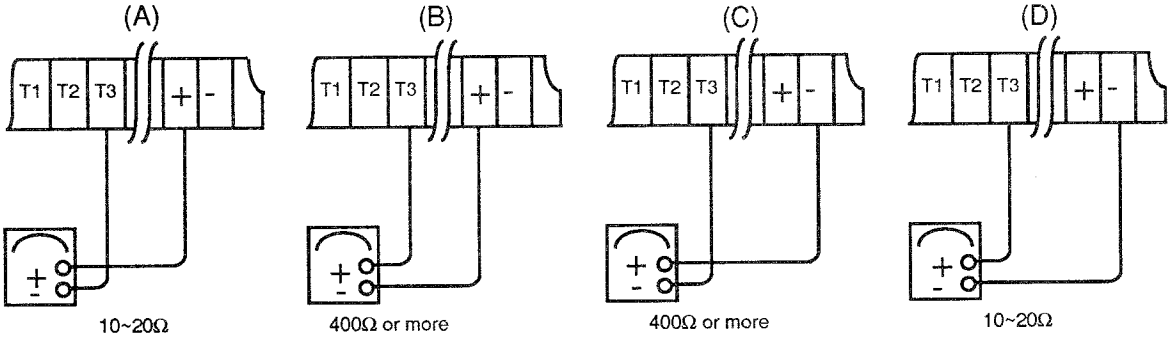
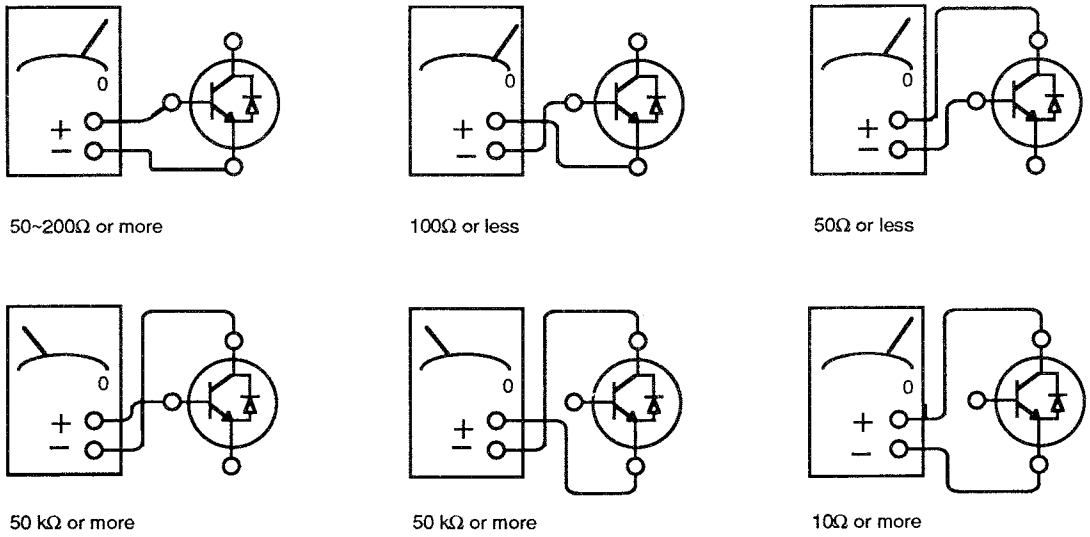


FIGURE 4-Determination of Inverter Module Integrity by Measuring at the Power Terminals

5) Check of the transistor module

A more complete check of the transistor module requires disassembly of the inverter to gain access to the module itself. It is recommended that this testing be done only by a properly trained electronic service technician or that the unit be returned to an authorized repair facility. See Figure 5 for how to perform these tests.



(The inverter module is good if all is satisfied)
Note: Measure with the tester set to 1Ω range.

FIGURE 5-How to Check Individual Inverter Modules

11.5 Trouble Shooting

11.5.1 Fault Message Diagnostics

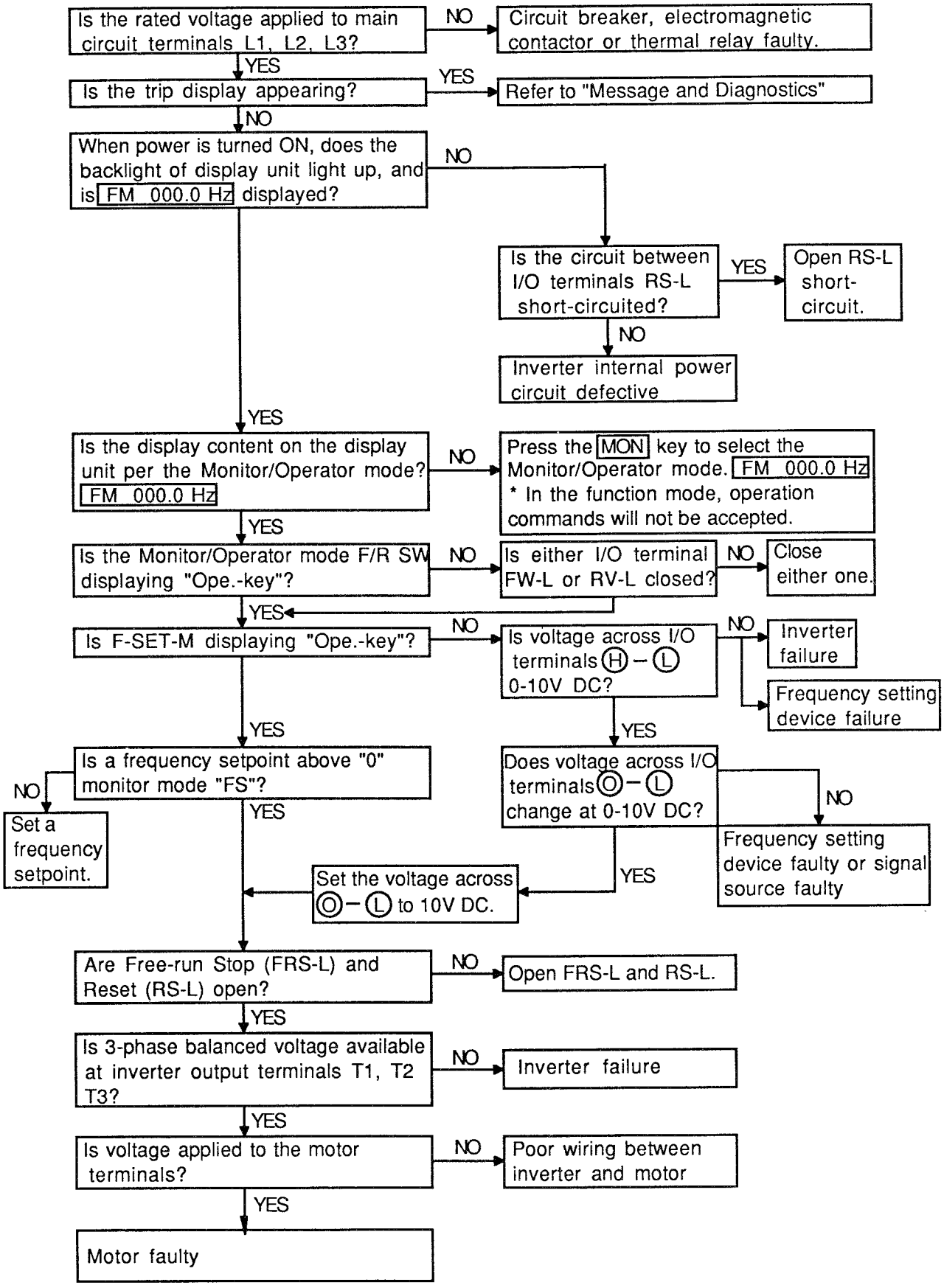
The 15 Fault/Alarm messages displayed by the inverter microprocessor can be very helpful in diagnosing a system problem. Following is a chart of the 15 messages, an explanation of the message meaning and suggested check points and remedies.

Fault/Alarm Message

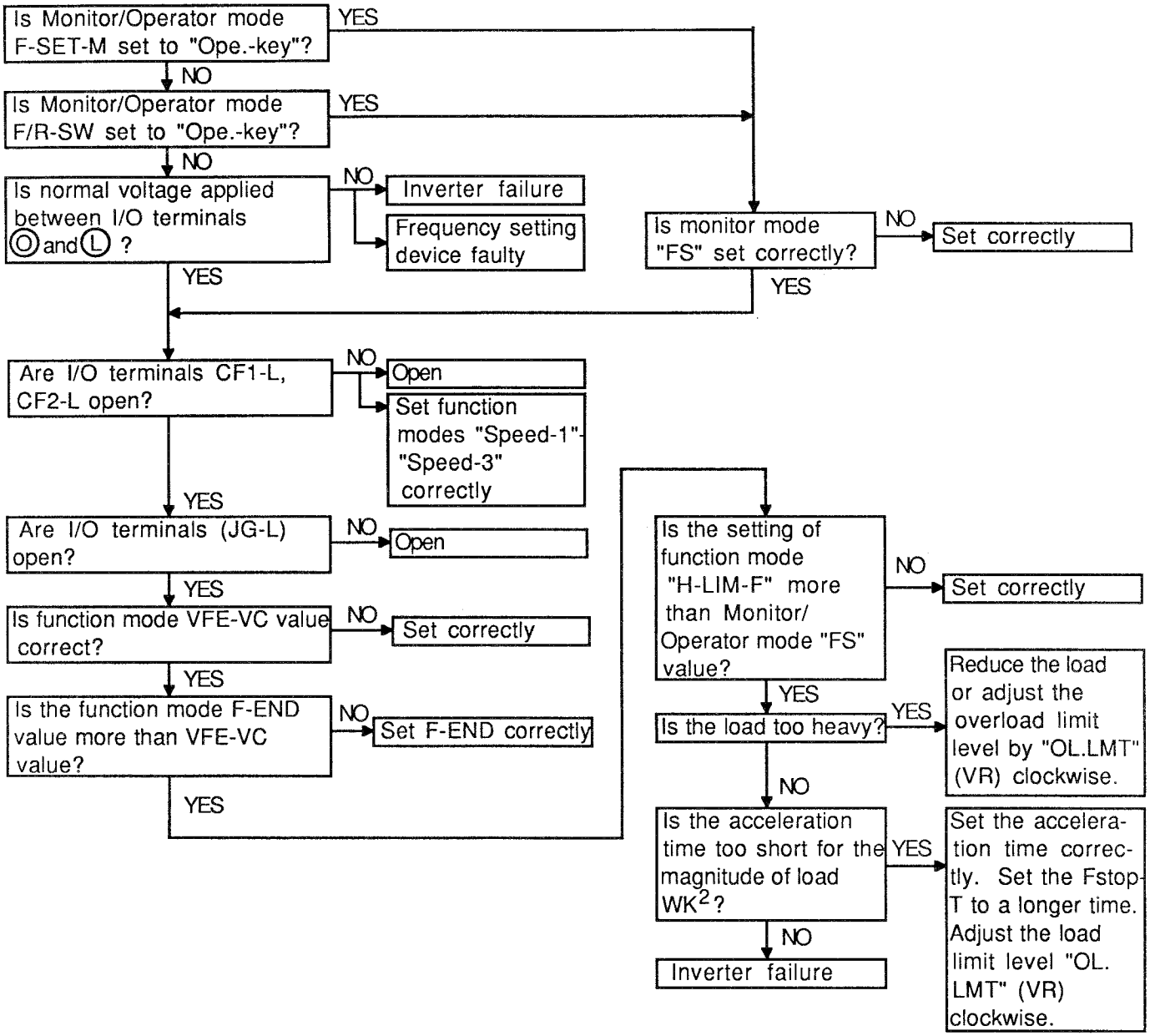
16 Digit LCD	Explanation	Check Points	Suggested Remedy
Over.V	DC smoothing circuit -Overvoltage	Check for sudden deceleration.	Increase the deceleration time.
		Check that the motor is not being rotated by the driven load.	The motor cannot be applied to a continuous regenerative load.
OC. ACCEL	Overcurrent during motor acceleration (overcurrent at acceleration)	Check for sudden acceleration.	Increase the acceleration time.
		Check for an output shortcircuit or ground fault.	Check the output wiring and motor for a shortcircuit.
		Check that the torque boost is not set too high.	Reduce the torque boost.
		Check that the motor is not locked.	Free the motor or load.
		Check that the jogging frequency is not set too high.	Reduce the jogging frequency.
OC. DECEL	Overcurrent during motor deceleration (Overcurrent at deceleration)	Check for sudden deceleration.	Increase the deceleration time.
		Check for an output shortcircuit or ground fault.	Check the output wiring and motor for a shorcircuit.
OC.DRIVE	Overcurrent during constant operation of motor (Overcurrent during operation)	Check for sudden change in load.	Eliminate sudden changes in load.
		Check for an output shortcircuit and ground fault.	Check the output wiring and motor for a shortcircuit.
Over.L	Inverter overload (Overloaded operation)	Check that the load is not too heavy.	Reduce the load factor.
		Check that the electronic thermal level is correct.	Adjust to a proper level.

16 Digit LCD	Explanation	Check Points	Suggested Remedy
OH Fin	Temperature significantly increasing at the heat sink fins	Check that the cooling fan is operating.	Replace the cooling fan.
		Check that the ambient temperature is not too high.	
OVER C.	Overcurrent detection just after power ON	Check that the detector current circuit is normal.	Check abnormal conditions of current detector and PC board detector circuit.
Under V.	Power supply abnormal (Undervoltage)	Check for low input voltage.	Review the power supply system.
		Check the contacts of MCB and Mg for poor contact.	Replace MCB and Mg.
		Check that the power has not been turned OFF or an instantaneous power failure has occurred during jogging.	Do not turn power OFF during jogging operation.
		Check that a 15 msec or more instantaneous power failure has not occurred .	Re-check the power supply system
Inst. P-F	Power supply abnormal (instantaneous power failure)	Check for low input voltage.	Review the power supply system.
		Check the contacts of MCB and Mg for poor contact.	Replace the MCB and Mg.
NG•FRS	Free-run stop command abnormal	Check that the operation command was not given while a free-run stop in retry mode was also present.	Do not enter an operation command while a FRS signal is in effect.
		With Free-run Stop applied, under-voltage or instantaneous power failure occurred.	Re-start operation after reset.
		With Free-run Stop applied, power was cut off.	Restart operation after reset. With Free-run Stop applied, do not turn power OFF.
		With Free-run Stop applied, power was turned ON or reset command was given.	
CPU	(CPU error)	Check that noise is not being intro-duced onto the logic board.	Keep any noise source away from the logic board or signal wires.
		Inverter abnormal.	Repair
DB OT	(DC braking setting time over.)	Check that the DC braking external command input time does not exceed the time preset by Function 22 T-DCB.	Re-set the T-DCB time or adjust DC braking external command input time to less than T-DCB.
NG•JOG	(The jogging mode is used inadvertently)	Check that the power was not turned ON, commercial power supply voltage switched or reset operation applied while jogging signal was present.	With the jogging signal ON, do not turn power ON, switch commercial power supply voltage or reset.
NG•DB	DB terminal was used inadvertently.	With DB signal applied power was turned ON or reset operation applied.	With DB ON, do not turn power ON or reset.
UV WAIT	Supply voltage abnormal (Undervoltage)	When restart function was selected, supply voltage dropped below the under voltage level.	Review the power supply system.
OV SRC	Overvoltage of the input power sourc	Check for high input voltage.	Review the power supply system.
USP	Unattended Start Protection is in effect	ac power is being applied while a run command is in effect	Be certain that run command is closed after ac power is available at the inverter input
GND Flt	Ground Fault	Check for a short circuit between the inverter output and ground, or unbalanced output current.	Check the output wiring and the motor for a ground fault.
BOO###	BOO### indicates that the microprocessor can not read the ### memory location. Replace the logic board or contact an authorized repair facility.		

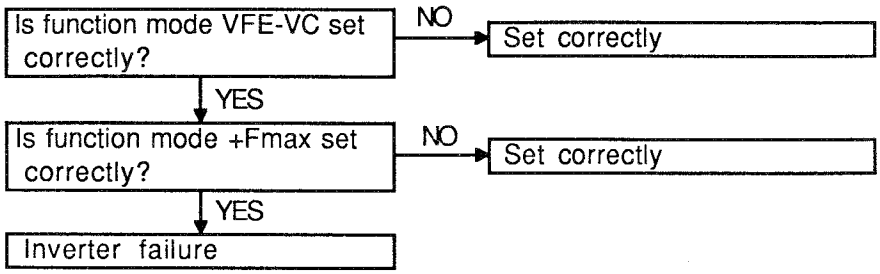
11.5.2 Motor Does Not Operate



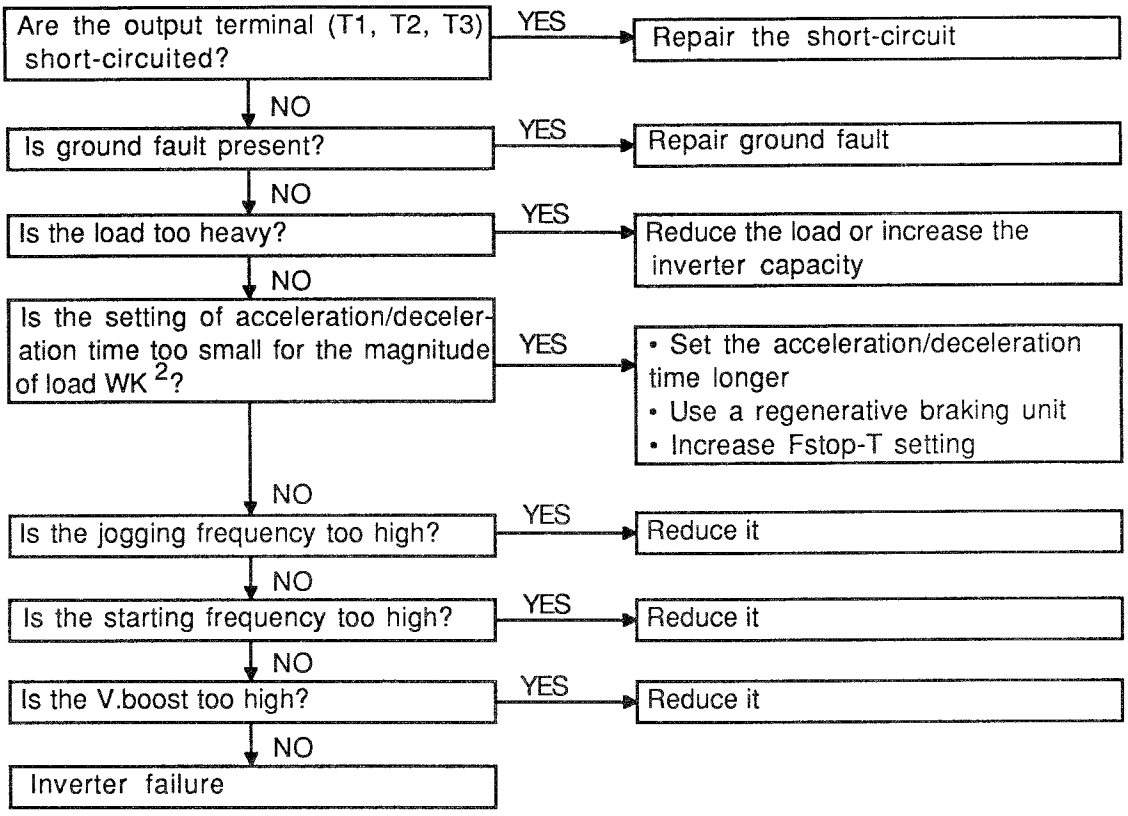
11.5.3 Motor Does Not Accelerate



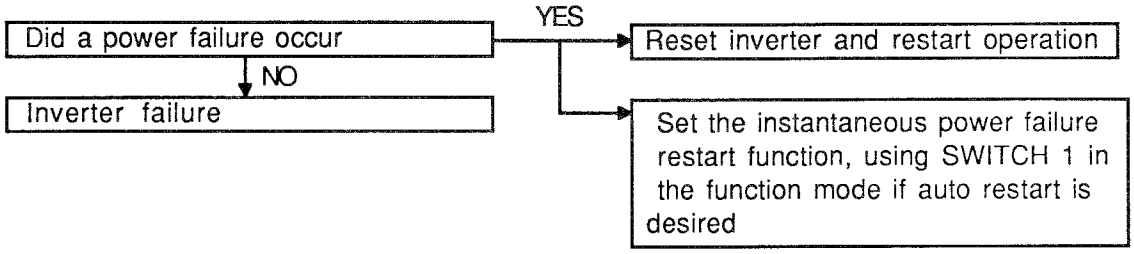
11.5.4 Motor Speed Is Too Fast



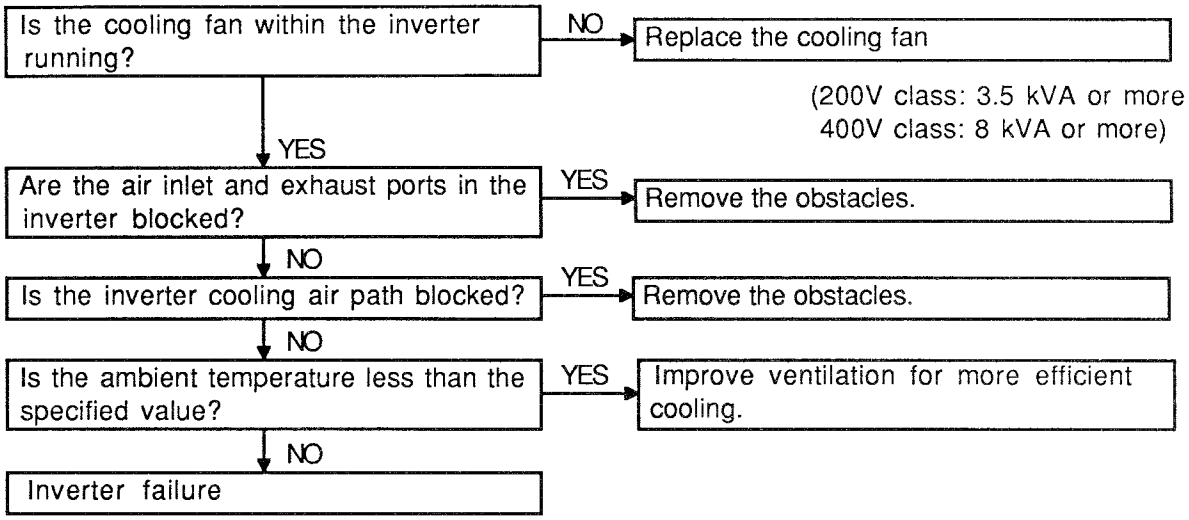
11.5.5 Inverter Trips on Overcurrent



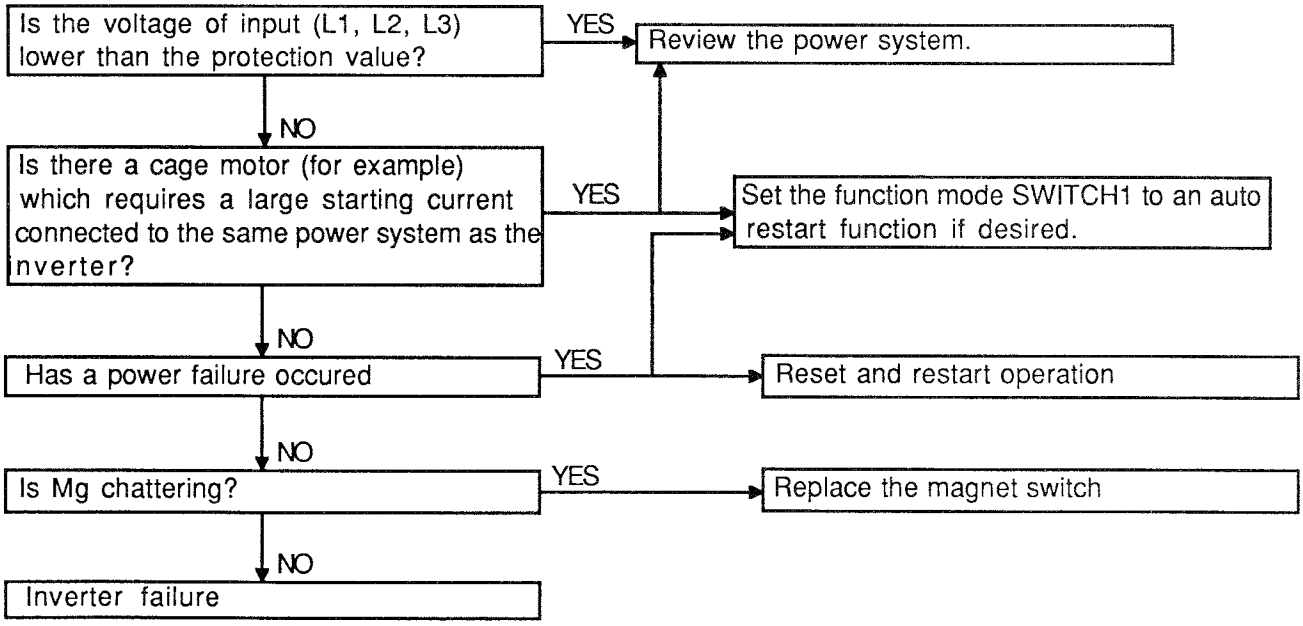
11.5.6 Inverter Trips On Instantaneous Power Failure



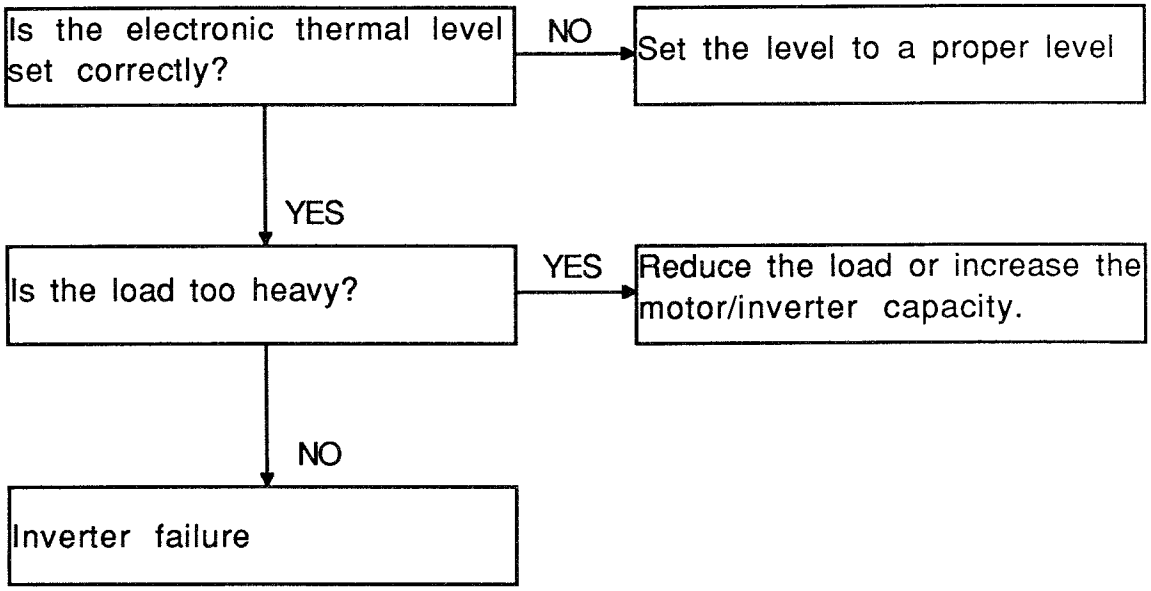
11.5.7 Inverter Trips On OH Fin



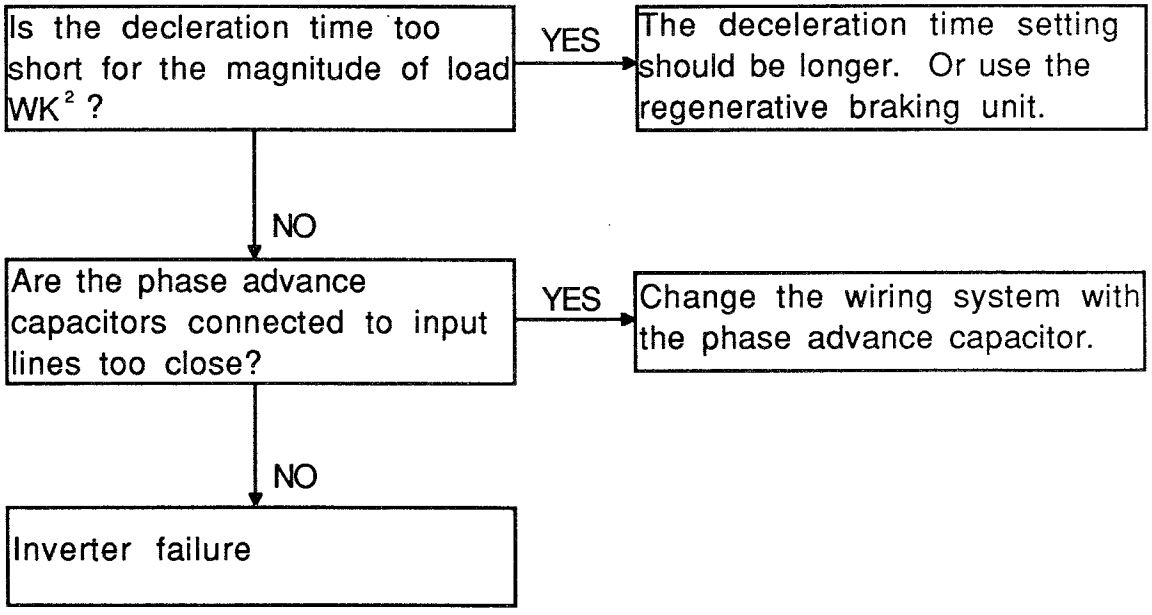
11.5.8 Inverter Trips On Undervoltage



11.5.9 Inverter Trips On Overload



11.5.10 Inverter Trips On Overvoltage



11.6 Common Errors On Initial Start-Up

Symptom of malfunction	Check point	Suggested remedy
inverter will not operate	Check that the [STOP] key on the digital operation panel was not depressed while inverter was in "Terminal" mode.	Open the operation command switch on the I/O terminal once and input the operation command once again.
	Check that DB command is not input to optional PC board (S3 OP-PCB).	After breaking DB command, input the operation command.
	Check that FRS command is not input.	After breaking FRS command, input the operation command.
	Check that the frequency setting is not "0".	Set the frequency to a desired setpoint.
	Check that the digital operation panel display does not indicate a function code.	Press the [MON] key to select the monitor mode.
	Check for tripping.	Reset.
	Check the speed command input between O-L or OI-L when the frequency setting designation method (F-SET-M) is "Terminal".	Review the speed command circuit.
	A command is input to multistage speed input terminal CF1, CF2, but SPEED 1, SPEED 2 and SPEED 3 setpoints are 0.	Set SPEED 1-3 to a desired frequency or open the command to CF1 and CF2.
	Check that RS command is not input.	Open RS command.
	Are you attempting to set the output frequency setpoint, or command the start/stop of the inverter from the I/O terminal when set to operate from operator key pad or vice versa.	Select "Terminal" or "OPE.-key" to match input command.
	Check that the jogging command is not interrupted during jogging operation.	• During internal command (ope-key) mode: Press the stop key, then press the [FWD RUN] or [REV RUN] for operation. • During external command (Terminal) mode: Stop the operation command once, and input the operation command from I/O Terminal.
	Check that the operation command is not input within 100 ms after interrupting the jogging command.	The jogging command-OFF and operation command-ON timing must be more than 100 ms.
	• Check that the [FWD RUN], [REV RUN] keys are not depressed at the same time in the internal command (ope-key) mode. • Check that the external command (Terminal) mode FW/RV terminals are not input simultaneously. • Check that the setting frequency is not less than the lowest frequency.	Be sure to make wiring connections on control so as not to allow simultaneous forward or reverse operation. Set the frequency to more than the lowest frequency.
No jogging operation is possible.	• Check that the jogging command is not input during normal operation.	Stop operation once and turn the jogging command ON more than 2 seconds, then input either forward or reverse operation command.
	• Check that the relationship between the jogging frequency setting (JOG-F) and the lowest frequency setting (Fmin) is not JOG-F < Fmin.	The relation should be JOG-F ≥ Fmin.
	• Check that the relationship between the jogging frequency setting (JOG-F) and the frequency lower limiter setting (L-LIM-F) is not JOG-F < L-LIM-F.	The relation should be JOG-F ≥ L-LIM-F.