4U-6

Eff. 2/23/87
Supersedes
11/17/86

REFERENCE MANUAL

ADJUSTABLE FREQUENCY DRIVE

Lancer®

Lancer® JR. Type L1

208/230VAC 0.75 to 40HP
460VAC 1 to 100HP

TRANSISTOR INVERTER

MagneTek

CAUTION

IMPROPER USE OF POWER FACTOR CORRECTION CAPACITOR NETWORKS WILL DAMAGE EQUIPMENT.

NEVER CONNECT POWER FACTOR CORRECTION CAPACITORS ACROSS THE INVERTER OUTPUT AND MOTOR.UPON APPLICATION OF POWER, THE INVERTER INITIALLY SEES THE CAPACITORS AS A SHORT CIRCUIT, HIGH CURRENTS RESULT AND EQUIPMENT WILL BE DAMAGED.

IF REQUIRED, POWER FACTOR CORRECTION CAPACITOR NETWORKS MAY BE CONNECTED ACROSS THE INPUT POWER SOURCE, BUT ONLY AFTER CONSULTING LOUIS ALLIS.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION 1. INTRODUCTION

1.1 GENERAL

This manual provides functional description, special adjustment, maintenance and troubleshooting information for the Louis Allis Lancer JR. Type L1 inverter (hereafter referred to as inverter). This is a sinusoidal wave, pulse width modulated (PWM) voltage controlled inverter.

208/230 VAC units are available with ratings from 1.0 thru 40 KVA (0.75 thru 40HP). 460 VAC units are available with ratings from 1.5 thru 100 KVA (1 thru 100HP). Throughout this manual, any information which relates to only one of the voltage ratings will have that voltage rating indicated in parentheses.

The inverter may be combined with a general-purpose induction motor to constitute a reliable variable-speed drive system. The advantages provided by such a system include: easy operation, high efficiency, and energy savings. Before operation of your inverter, carefully read this manual and observe all precautions to ensure long trouble-free service.

1.1.1 Information Supplied.

The schematic and interconnect diagrams, supplied along with this Reference Manual, support the specific equipment, whether standard or custom engineered, as shipped from Louis Allis. Refer to these diagrams for circuit, equipment and interconnection details. If the equipment is modified after installation, the diagrams may have to be updated to reflect changes made. If options or modifications have been factory installed, appropriate Instruction Sheets will be supplied with this manual; instruction sheets pertaining to options or modifications which are added to the equipment after installation will be supplied at the time of installation.

1.2 SPECIFICATIONS.

Standard specifications are listed in Table 1.1. Some specifications may vary for custom engineered inverters; such differences will be indicated on the inverter nameplate or schematic, or in an Addendum or Supplement to this manual.

NOTE

This equipment is exempted from FCC regulations. See 47CFR15.801.

1.3 PRECAUTIONARY STATEMENTS.

In addition to notes, the following types of precautionary statements appear in this manual.

IMPORTANT

A statement of conditions which should be observed during drive system setup or operation to ensure dependable service.

CAUTION

A STATEMENT OF CONDITIONS WHICH MUST BE OBSERVED TO PREVENT UNDESIRED EQUIPMENT FAULTS OR DEGRADED DRIVE SYSTEM PERFORMANCE.

WARNING

A STATEMENT OF CONDITIONS WHICH MUST BE OBSERVED TO PREVENT PERSONAL INJURY OR SERIOUS EQUIPMENT DAMAGE.

Table 1.1. STANDARD SPECIFICATIONS

(208/230 VAC UNITS)			(460 VAC UNITS)		
HP	INVERTER CAPACITY (KVA)	RATED CURRENT (ADC) (SEE NOTE 1) INPUT/OUTPUT	HP	INVERTER CAPACITY (KVA)	RATED CURRENT (ADC) (SEE NOTE 1) INPUT/OUTPUT
0.75	1.0	6/4			
1.0	1.5	7.5/5	1.0	1.5	3.7/2.5
2.0	2.5	10.5/7	2.0	2.5	5.5/3.7
3.0	3.5	15/10	3.0	3.5	7.5/5
5.0	5.5	24/16	5.0	5.5	12/8
7.5	8.0	30/20	7.5	8.0	16.5/11
10.0	11.0	45/30	10.0	11.0	22.5/15
15.0	16.0	67.5/45	15.0	16.0	33/22
20.0	22.0	90/60	20.0	22.0	45/30
25.0	27.0	112.5/75	25.0	27.0	57/38
30.0	33.0	135/90	30.0	33.0	67.5/45
40.0	40.0	165/110	40.0	40.0	82.5/55
			50.0	50.0	104/69
			60.0	60.0	124.5/83
			75.0	75.0	156/104
			100.0	100.0	207/138

Input Power Supply			
Input Power Supply	Voltage	(208/230 VAC Units) 3PH, 208/230 VAC +/-10%	(460 VAC Units) 3PH, 460 VAC +/-10%
	Frequency	60 +/-2HZ	

1/ Input currents cited are maximum RMS values, based upon conducting rated output currents with negligible source impedance. Where the source impedance is 3% or greater, based upon the inverter KVA rating, or an input transformer sized for the particular inverter is used (impedance 3% or greater), the input current will be equal to the output current.

Table 1.1. STANDARD SPECIFICATIONS (Continued)

Control Specifications	Control System	Sinusoidal Wave PWM Control
	Output Voltage	Variable
	Output Frequency	0.5 to 80HZ (Inverters up to 40HP) 0.5 to 60HZ (Inverters 50HP and above)
	Frequency Drift	+/-0.5% of Maximum Frequency (at 25°C +/-10°C)
	Volts/Hertz Profile	0.5 to 60HZ: V/F Constant 60 to 80HZ: V Constant (Inverters up to 40 HP)
	Overload Capacity	150% for 60 Seconds 110% Continuous
	Frequency Reference	Voltage: 0-12 VDC Current: 4-20 mADC, Isolated and Undergrounded
Operating Functions	Acceleration/ Deceleration Time	1 to 20 seconds (+/-20%); acceleration and deceleration individually adjustable.
	Starting	Maintained Dry Contact
	Forward/Reverse	Reverse operation is selectable by wiring of external dry contact or switch.
Protecting Functions	Protection	Stall prevention, overcurrent protection, short circuit protection, DC bus overvoltage protection, input undervoltage protection, momentary power failure protection (approx. 15msec), input fuses.
	Fault Detection	Fault relay with form C contacts (rated 250 VAC 1A resistive). The relay will energize when overcurrent, short circuit, overvoltage or undervoltage is detected.
	Fault Reset	Reset manually by momentarily pressing the RESET push button on the Control Circuit PCB, or remote PB.

Table 1.1. STANDARD SPECIFICATIONS (Continued)

Displays	CHARGE	LED on Base Drive PCB, illuminated when charge is present on DC bus capacitor.
	FREQ./FAULT	3-digit, 7-segment LED; indicates: Output frequency, when not faulted. "OC" - Overcurrent fault "OP" - DC bus over-potential "UP" - Input undervoltage "OH" - Heat sink overtemperature (208/230V, 7.5-40HP; 460V, 15-100HP only)
Environmental Requirements	Ambient Temperature	Std. -10 to 40°C (-10 to 50°C if front, top and bottom covers are removed) (See Note 2)
	Relative Humidity	Less than 90%, Noncondensing
	Vibration	Less than 0.5G
Construction		(208/230V, 0.75-40HP) (460V, 1-50HP) (See Note 3) NEMA 1 power module (Inverter) (460V, 50-100HP) (See Note 3) Power module (Inverter) inside NEMA 1 enclosure, with circuit breaker, motor overload relay & door mounted digital Frequency/Fault display. Door mounted operator's controls optional.

2/ Only if the unit is mounted inside a NEMA enclosure.
3/ 460V 50HP may be either type.

SECTION 2. INSTALLATION AND START-UP; RESHIPMENT/STORAGE

2.1 INSTALLATION AND START-UP

Information relating to the installation and initial start-up of the standard inverter is included in Installation/Start-Up instructions 02Y00025-0220, and wiring diagrams shipped with the unit.

Installation dimensions for standard units are shown in the outline drawings included in this section. If your inverter was ordered with added circuits or components, or mounted inside a Louis Allis supplied enclosure, refer to the special dimension drawing provided.

2.2 RESHIPMENT/STORAGE

2.2.1 Packing Instructions for Reshipment or Storage

The inverter should be bolted in a crate which provides at least 2 inches clearance. The inverter should then be wrapped in polyethylene and covered with wax impregnated double walled #250 corrugation or crated. Assistance, if required, is available from the nearest Louis Allis District Office.

2.2.2 Storage

For long periods of storage, equipment should be covered to prevent corrosion and should be placed in a clean, dry location. If possible, equipment should be stored in its original crating. Periodic inspection should be made to ensure that the equipment is dry and that no condensation has accumulated. The equipment warranty does not cover damage due to improper storage.

For an inverter stored six months or more, SPECIAL CARE MUST BE TAKEN DURING START-UP TO MINIMIZE THE CHANCE OF FAILURE OF THE ELECTROLYTIC FILTER CAPACITOR. Refer to Section 5.2 for electrolytic capacitor reforming procedure.

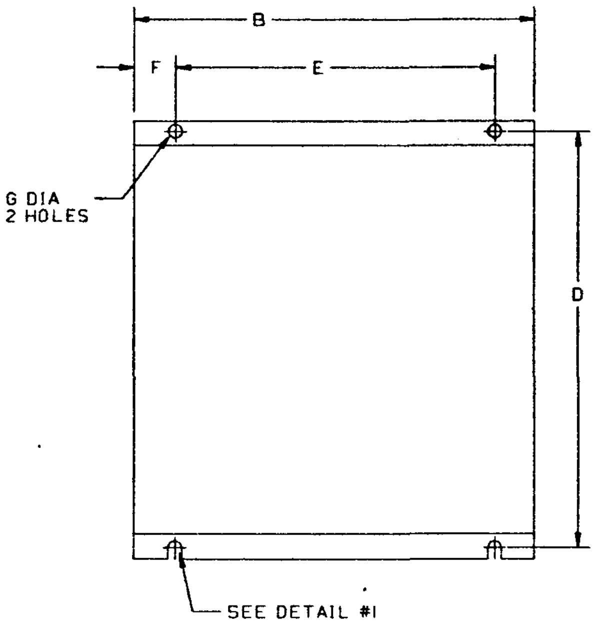
IMPORTANT

The MAXIMUM amount of time an electrolytic capacitor may be stored (either on a shelf or in the equipment) without power being applied is ONE YEAR. Prolonged periods without use may render the capacitor useless.

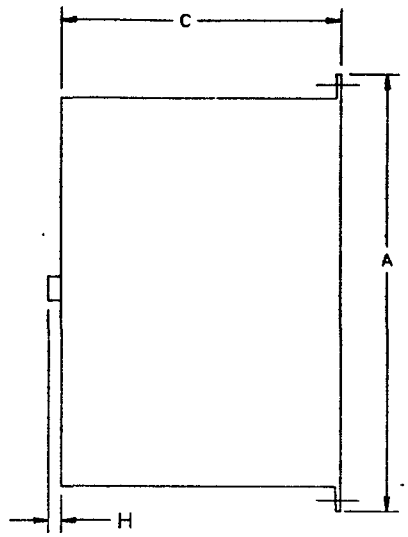
OUTLINE DRAWING

3/4 TO 70H.P 230 VOLT & 1.0 TO 100H.P. 460 VOLT, 3 PH LANCER ®JR TYPE LI INVERTER POWER UNIT WITHOUT HINGED FRONT COVER

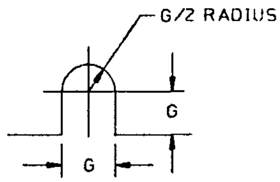
FRONT VIEW



SIDE VIEW



DETAIL #1



230V INVERTERS

H.P	DIMENSIONS (INCHES)								WEIGHT (LBS)
	A	B	C	D	E	F	G	H	
3/4,1,2	12.20	9.69	7.32	11.65	7.88	0.90	0.27	0.39	15
3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	0.39	18
7.5,10	16.73	15.04	7.72	16.06	11.81	1.61	0.39	0.51	36
15,20	19.49	15.04	7.72	18.82	11.81	1.61	0.39	0.51	53
25,30,40	26.77	15.04	7/72	25.98	11.81	1.61	0.47	0.51	95
50,60,70	45.28	23.62	11.81	43.31	11.81	5.91	0.79	1.97	170

460V INVERTERS

H.P.	DIMENSIONS (INCHES)								WEIGHT (LBS)
	A	B	C	D	E	F	G	H	
1,2,3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	0.39	20
7.5,10,15	16.73	15.04	7.72	16.06	11.81	1.61	0.39	0.51	42
20,25,30	26.77	15.04	9.96	25.98	11.81	1.61	0.47	0.51	106
40,50	35.63	16.14	11.50	34.45	9.65	3.25	0.59	0.51	126
60,75,100	45.28	23.62	11.81	43.31	11.81	5.91	0.79	1.97	176

NOTES:

1. (2) 1.14 DIA KNOCKOUT TYPE HOLES IN THE BOTTOM OF THE ENCLOSURE ARE PROVIDED FOR CONDUIT ENTRANCE ON 230V, 3/4-5HP AND 460V, 1-5HP UNITS.
2. UNITS THROUGH 5 H.P. ARE ETL APPROVED.

S-5114C

LouisAllis

DR. BY MB 9-20-84

CH. BY MB 9-20-84

APPVL. BY RRQ 9-16-86

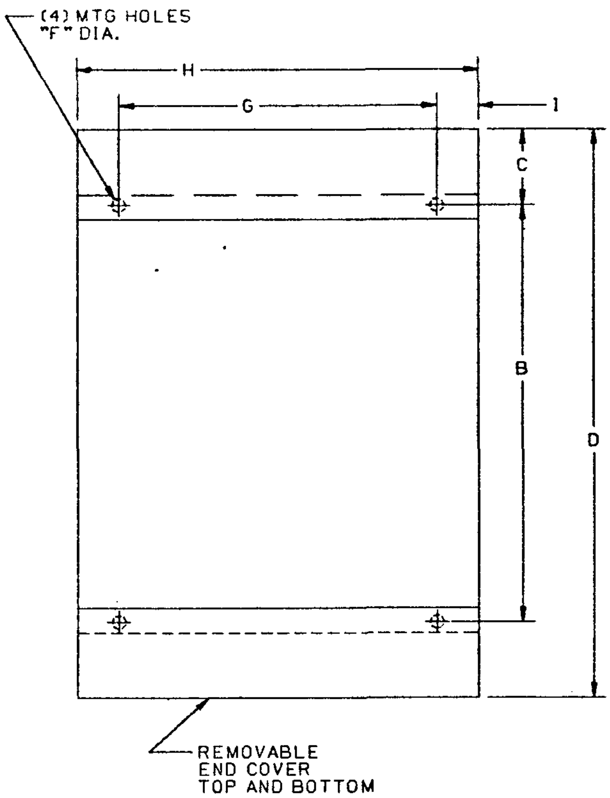
C

S-5114C

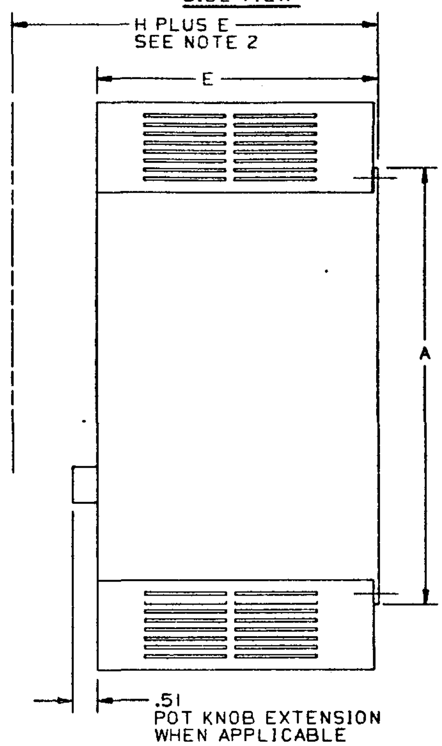
OUTLINE DRAWING

7.5 TO 40H.P.230 VOLT & 7.5 TO 50H.P. 460 VOLT, 3 PH LANCER® JR TYPE LI INVERTER
WITH/WITHOUT HINGED FRONT COVER, WITH END ENCLOSURE

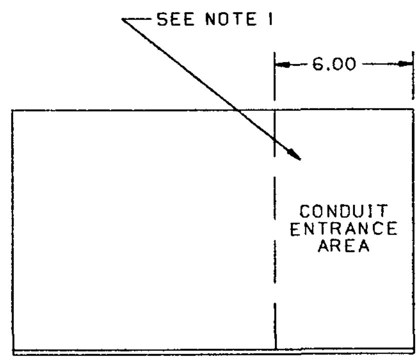
FRONT VIEW



SIDE VIEW



BOTTOM VIEW



230V INVERTERS

HP	DIMENSIONS (INCHES)									WEIGHT LBS
	A	B	C	D	E	F	G	H	I	
7.5,10	16.73	16.06	3.56	23.18	7.72	0.39	11.81	15.04	1.61	36
15,20	19.49	18.82	3.56	26.05	7.72	0.39	11.81	15.04	1.61	53
25,30,40	26.77	25.98	4.48	32.84	7.72	0.47	11.81	15.04	1.61	95

460V INVERTERS

H.P.	DIMENSIONS (INCHES)									WEIGHT LBS
	A	B	C	D	E	F	G	H	I	
7.5,10,15	16.73	16.06	3.56	23.18	7.72	0.39	11.81	15.04	1.61	42
20,25,30	26.77	25.98	4.48	32.84	9.96	0.47	11.81	15.04	1.61	106
40,50	35.63	34.45	5.41	45.27	11.50	0.59	9.65	16.14	3.25	126

NOTES:

1. CONDUIT ENTRANCE AREA IN BOTTOM END COVER IS RESTRICTED AS SHOWN. 25 TO 40 H.P. 230V. AND 20 TO 50 H.P. 460V. INVERTERS REQUIRE WIRING ENTRY TO BOTH THE TOP & BOTTOM COVERS.
2. MINIMUM DISTANCE REQUIRED FOR HINGED COVER OPENING: APPLICABLE TO UNITS WHICH ARE SUPPLIED WITH HINGED FRONT COVERS.

S-5115B

S-5115B

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED

LouisAllis

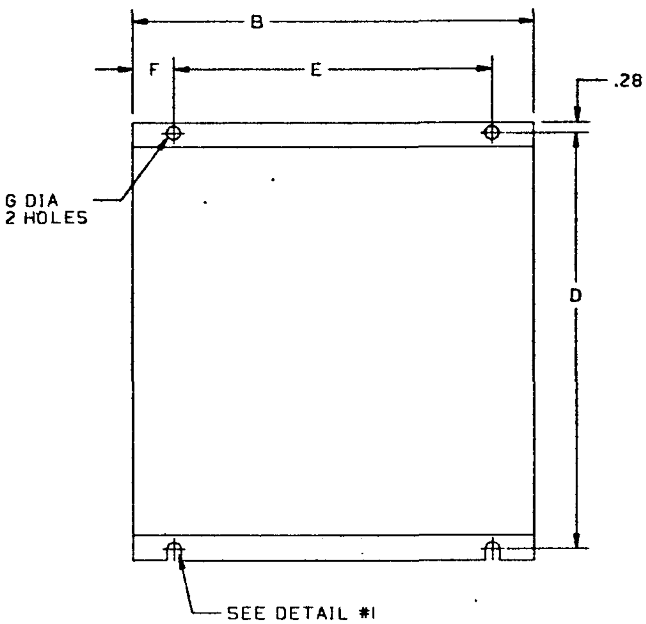
DR. BY MB 11-29-84
CH. BY MB 11-29-84
APPVL. BY [illegible] 9-15-86

C

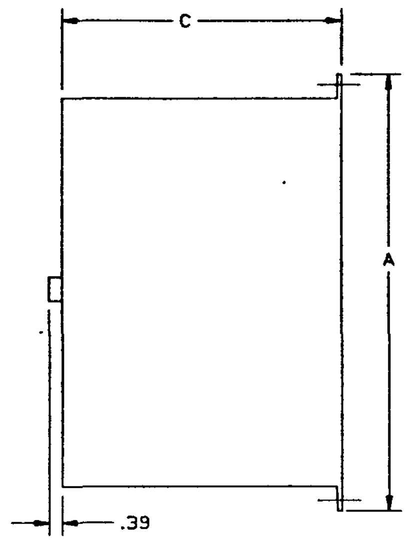
OUTLINE DRAWING

3/4 TO 5.0 H.P. 230 VOLT & 460 VOLT, 3 PH LANCER® JR TYPE LI INVERTER
WITHOUT HINGED FRONT COVER, WITHOUT BOTTOM END ENCLOSURE

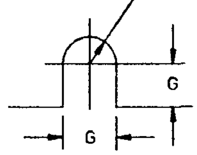
FRONT VIEW



SIDE VIEW



DETAIL #1



230V INVERTERS

H.P	DIMENSIONS (INCHES)							WEIGHT (LBS)
	A	B	C	D	E	F	G	
1,3/4,2	12.20	9.69	7.32	11.65	7.88	0.90	0.27	15
3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	18

460V INVERTERS

H.P	DIMENSIONS (INCHES)							WEIGHT (LBS)
	A	B	C	D	E	F	G	
1,2,3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	20

NOTES:

1 (2) 1.14 DIA KNOCKOUT TYPE HOLES IN THE BOTTOM OF THE ENCLOSURE ARE PROVIDED FOR CONDUIT ENTRANCE.

S-5119A

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED

LouisAllis

DR. BY MB 1-25-85
CH. BY MB 1-25-85
APPVL. BY RRR 9-12-86

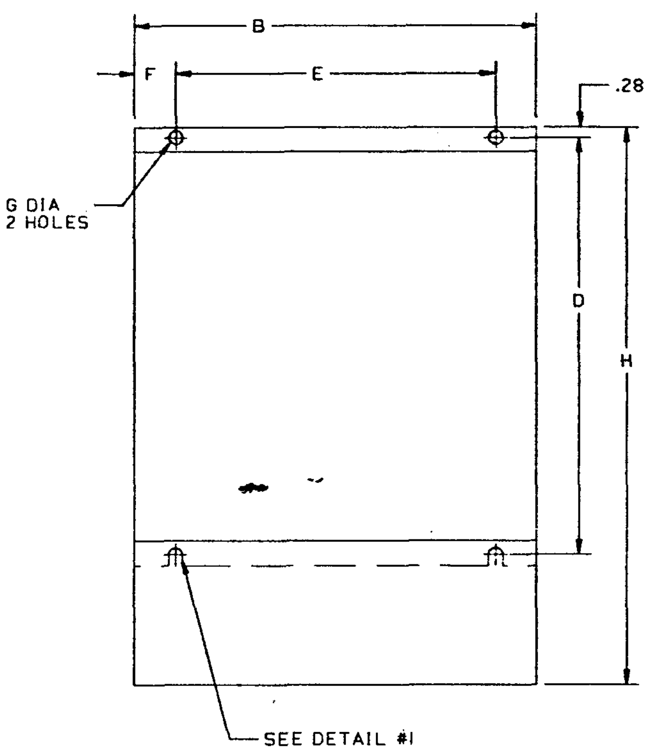
C

S-5119A

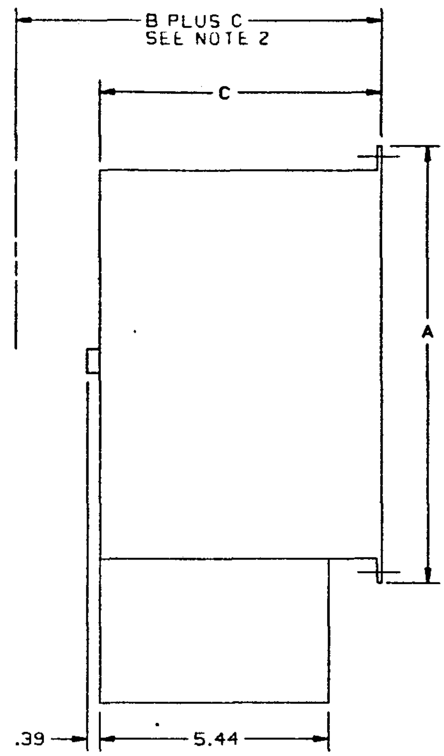
OUTLINE DRAWING

3/4 TO 5 H.P 230 VOLT & 1 TO 5 – P. 460 VOLT, 3 PH LANCER® JR TYPE LI INVERTERWITH BOTTOM END ENCLOSURE WITH/WITHOUT HINGED FRONT COVER

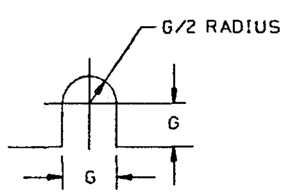
FRONT VIEW



SIDE VIEW



DETAIL #1



230V INVERTERS

HP	DIMENSIONS (INCHES)								WEIGHT (LBS)
	A	B	C	D	E	F	G	H	
3/4,1,2	12.20	9.69	7.32	11.65	7.88	0.90	0.27	15.75	15
3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	17.31	18

460V INVERTERS

H.P.	DIMENSIONS (INCHES)								WEIGHT (LBS)
	A	B	C	D	E	F	G	H	
1,2,3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	17.31	20

NOTES:

1. (2) 1.14 DIA KNOCKOUT TYPE HOLES IN THE BOTTOM OF THE ENCLOSURE ARE PROVIDED FOR CONDUIT ENTRANCE.
2. MINIMUM DISTANCE REQUIRED FOR HINGED COVER OPENING. APPLICABLE TO ETL APPROVED UNITS WHICH ARE SUPPLIED WITH HINGED FRONT COVERS.

S-5120B

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED

LouisAllis

DR. BY MB 1-25-85
CH. BY MB 1-25-85
APPVL. BY RDD 4-15-86

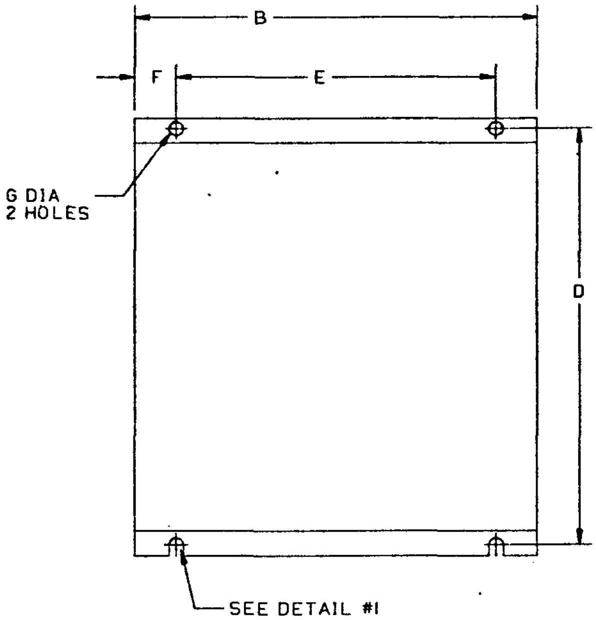
C

S-5120B

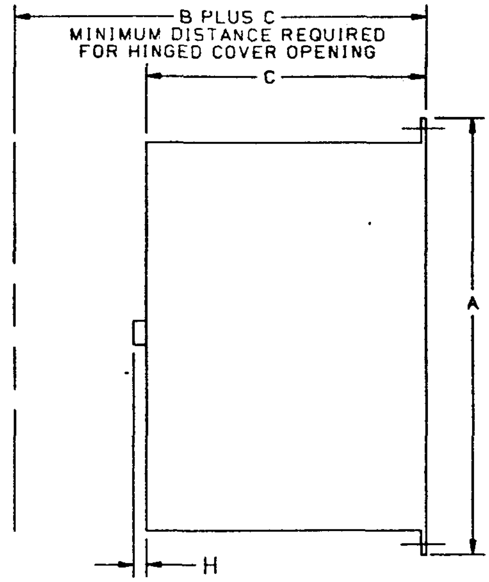
OUTLINE DRAWING

3/4 TO 40H.P 230 VOLT & 1.0 TO 50H.P. 460 VOLT, 3 PH LANCER® JR TYPE LI INVERTER WITH HINGED FRONT COVER WITHOUT END ENCLOSURES

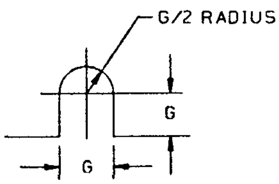
FRONT VIEW



SIDE VIEW



DETAIL #1



S-5124B

230V INVERTERS

H.P.	DIMENSIONS (INCHES)								WEIGHT LBS.
	A	B	C	D	E	F	G	H	
3/4,1,2	12.20	9.69	7.32	11.65	7.88	0.90	0.27	0.39	15
3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	0.39	18
7.5,10	16.73	15.04	7.72	16.06	11.81	1.61	0.39	0.51	36
15,20	19.49	15.04	7.72	18.82	11.81	1.61	0.39	0.51	53
25,30,40	26.77	15.04	7.72	25.98	11.81	1.61	0.47	0.51	95

460V INVERTERS

H.P.	DIMENSIONS (INCHES)								WEIGHT LBS.
	A	B	C	D	E	F	G	H	
1,2,3,5	13.78	9.69	8.07	13.23	7.88	0.90	0.27	0.39	20
7.5,10,15	16.73	15.04	7.72	16.06	11.81	1.61	0.39	0.51	42
20,25,30	26.77	15.04	9.96	25.98	11.81	1.61	0.47	0.51	106
40,50	35.63	16.14	11.50	34.45	9.65	3.25	0.59	0.51	126

NOTES:

1. (2) 1.14 DIA KNOCKOUT TYPE HOLES IN THE BOTTOM OF THE ENCLOSURE ARE PROVIDED FOR CONDUIT ENTRANCE ON 230V,3/4-5HP AND 460V, 1-5HP UNITS.
2. UNITS THROUGH 5 H.P. ARE ETL APPROVED.

S-5124B

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED

LouisAllis

A Division of MagneTek, Inc

DR. BY MB 8-21-85

CH. BY MB 8-21-85

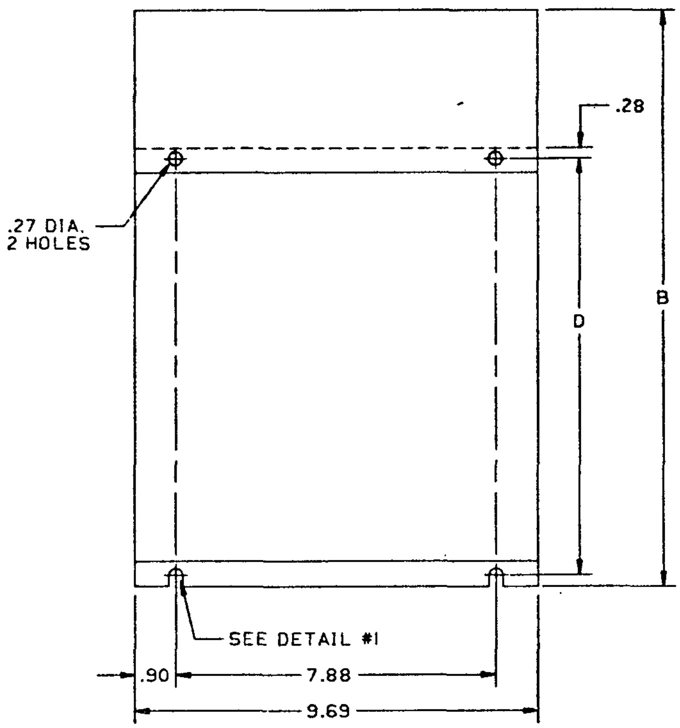
APPVL. BY RR 9-10-86

C

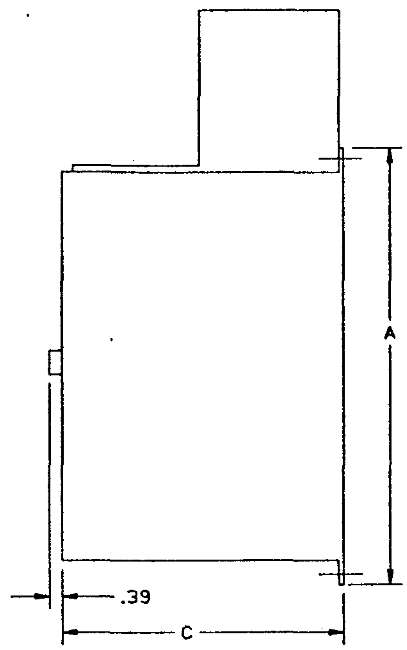
OUTLINE DRAWING

1.0 TO 5.0 H.P. 230 VOLT & 460 VOLT, 3 PH LANCER ® JR TYPE LI INVERTER
WITH 20% DYNAMIC BRAKING RESISTOR ASSEMBLY

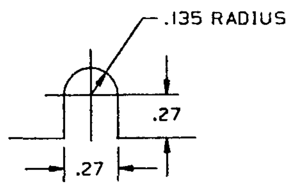
FRONT VIEW



SIDE VIEW



DETAIL #1



230V INVERTERS

HP	DIMENSIONS (INCHES)			
	A	B	C	D
.75,1,2	12.20	15.28	7.32	11.65
3,5	13.78	16.90	8.07	13.23

460V INVERTERS

H.P.	DIMENSIONS (INCHES)			
	A	B	C	D
1,2,3,5	13.78	16.90	8.07	13.23

NOTES:

1. (2) 1.14 DIA KNOCKOUT TYPE HOLES IN THE BOTTOM OF THE ENCLOSURE ARE PROVIDED FOR CONDUIT ENTRANCE.

S-5126

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED.

LouisAllis
A Division of MagneTek, Inc

DR. BY GJS 3-18-86
CH. BY MB 3-18-86
APPVL. BY DLB 3-19-86 RRP

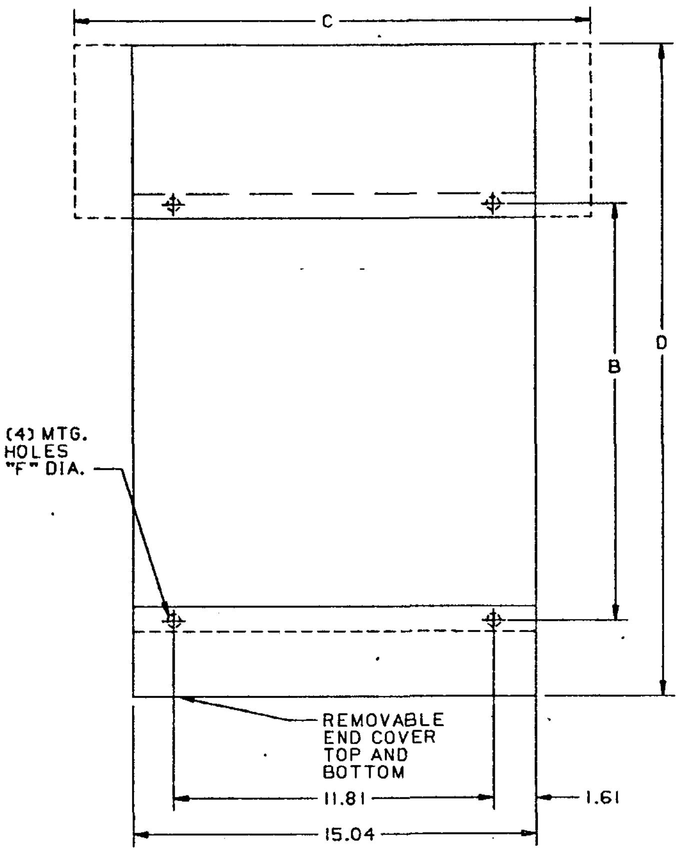
C

S-5126

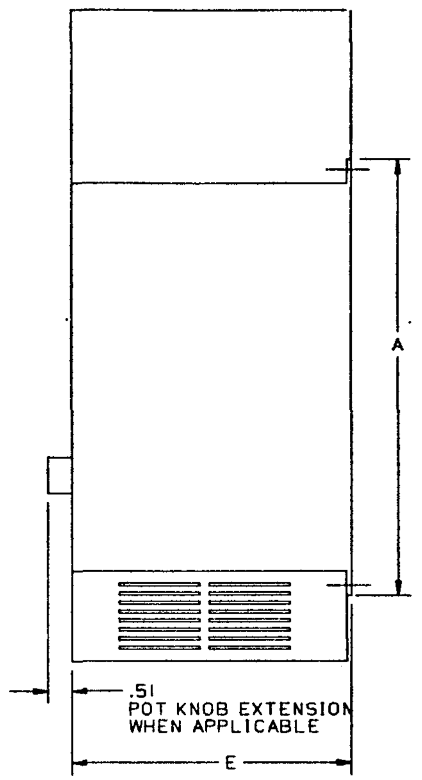
OUTLINE DRAWING

7.5 TO 40H.P. 230 VOLT & 7.5 TO 30H.P. 460 VOLT, 3 PH LANCER® JR TYPE LI INVERTER WITH 20% DYNAMIC BRAKING RESISTOR ASSEMBLY

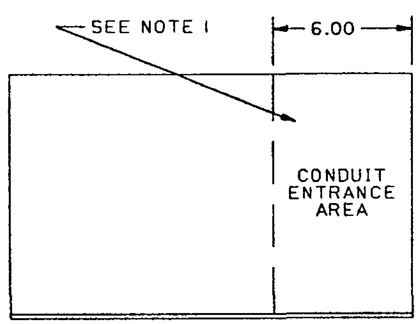
FRONT VIEW



SIDE VIEW



BOTTOM VIEW



230V INVERTERS

H.P.	DIMENSIONS (INCHES)						WEIGHT LBS
	A	B	C	D	E	F	
7.5	16.73	16.06	-	25.36	7.72	0.39	43
10	16.73	16.06	-	25.36	7.72	0.39	46
15	19.43	18.82	-	28.30	7.72	0.39	61
20	19.43	18.82	19.50	32.99	7.72	0.39	63
25	26.77	25.98	19.50	39.73	7.72	0.47	98
30	26.77	25.98	19.50	39.73	7.72	0.47	101
40	26.77	25.98	19.50	39.73	7.72	0.47	105

460V INVERTERS

H.P.	DIMENSIONS (INCHES)						WEIGHT LBS
	A	B	C	D	E	F	
7.5	16.73	16.06	-	25.36	7.72	0.39	43
10	16.73	16.06	-	25.36	7.72	0.39	46
15	16.73	16.06	-	25.36	7.72	0.39	52
20	26.77	25.98	19.50	39.73	8.42	0.47	102
25	26.77	25.98	19.50	39.73	8.42	0.47	107
30	26.77	25.98	19.50	39.73	8.42	0.47	116

NOTES:

1. CONDUIT ENTRANCE AREA IN BOTTOM END COVER IS RESTRICTED AS SHOWN 25 TO 40H.P. 230V. AND 20 TO 30H.P. 460V. INVERTERS REQUIRE WIRING ENTRY TO BOTH THE TOP & BOTTOM COVERS

S-5127

THIS DIMENSION SHEET IS FOR REFERENCE ONLY UNLESS PROPERLY ENDORSED.

LouisAllis
A Division of MagneTek, Inc.

DR. BY GJS 3-18-86
CH. BY MB 3-18-86
APPVL. BY DJS 3-19-86 RRR

C

S-5127

SECTION 3. APPLICATIONS

3.1 GENERAL

The Lancer JR. inverter may be used in a variety of applications. Because of this application versatility, AFTER drive installation and initial start-up (per Instruction Sheet 02Y00025-0220) have been completed, additional electrical wiring connections and inverter adjustments from this section can be made as required by the application.

3.1.1 Existing Motor

The Lancer JR. provides a high quality output voltage and current, but the output is not a perfect AC sine wave. Therefore, some increase in motor temperature, noise, and vibration may be noticed.

Special consideration must be taken when applying an inverter to an existing motor. At slower speeds, cooling is not as effective due to reduced fan RPM. Full load torque at slow speeds may damage the motor from overheating. In situations where the load requires high torque at slow speeds, the minimum speed must be raised for cooling effect. Figure 3-1 shows a curve plotting acceptable torque vs. speed (Hertz) for a typical

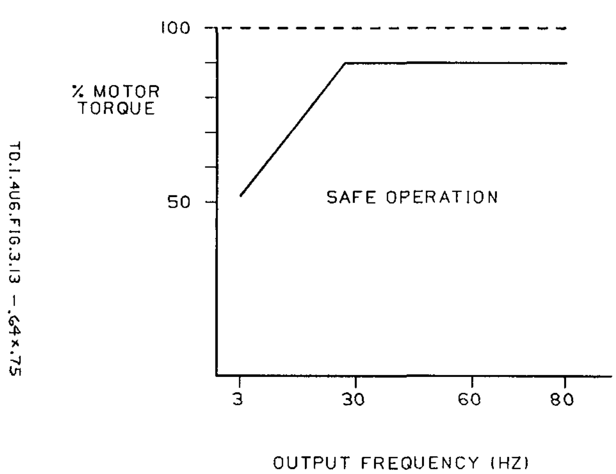


FIGURE 3-1

motor operating on a Lancer JR. (this type of motor is not specifically designed for variable speed operation on an inverter).

Note that for a safety margin, the curve shows no more than 90% motor rated torque. If torque requirements at slow speed continuously exceed levels shown in Figure 3-1, a motor rated for inverter operation can be substituted.

CAUTION

THE INVERTER IS SHIPPED FROM THE FACTORY WITH A 0.5 TO 80HZ SPEED RANGE CAPABILITY. NOTE THAT THE MAXIMUM OUTPUT FREQUENCY ATTAINABLE, WITH THE FREQ. ADJ. POTENTIOMETER ON THE OPERATION PANEL TURNED FULLY CW, IS 80HZ. FIXED SPEED MACHINERY MAY NOT RUN PROPERLY ABOVE THE 60HZ FREQUENCY NORMALLY SUPPLIED DIRECTLY FROM THE POWER LINE. OPERATION ABOVE 60HZ MAY DAMAGE BEARINGS OR ROTATING PARTS. SLOW SPEEDS MAY NOT PROVIDE SUFFICIENT COOLING FOR THE MOTOR, OR LUBRICATION ON OIL FILLED GEAR BOXES OR SPEED REDUCER. MANUFACTURER SPECIFICATIONS MAY NEED TO BE CONSULTED. THESE PRECAUTIONS SHOULD BE LOOKED AT CAREFULLY TO PREVENT ANY PROBLEM. IT IS MOST OFTEN THE CASE, HOWEVER, THAT THE MOTOR OR MOTORS ON A FIXED SPEED APPLICATION CAN BE DIRECTLY APPLIED TO THE LANCER JR. PROVIDED THE MECHANICAL LIMITATIONS OF THE SYSTEM ARE NOT EXCEEDED. 9RH, UL (UPPER LIMIT), CAN BE USED TO READJUST THE MAXIMUM OUTPUT FREQUENCY FROM 80HZ TO 60HZ (SEE INSTALLATION/START-UP INSTRUCTIONS 02Y00025-0220).

3.1.2 Power Factor Correction Capacitors

CAUTION

IMPROPER USE OF POWER FACTOR CORRECTION CAPACITOR NETWORKS WILL DAMAGE EQUIPMENT.

NEVER CONNECT POWER FACTOR CORRECTION CAPACITORS ACROSS THE INVERTER OUTPUT AND MOTOR. UPON APPLICATION OF POWER, THE INVERTER INITIALLY SEES THE CAPACITORS AS A SHORT CIRCUIT, HIGH CURRENTS RESULT AND EQUIPMENT WILL BE DAMAGED.

IF REQUIRED, POWER FACTOR CORRECTION CAPACITOR NETWORKS MAY BE CONNECTED ACROSS THE INPUT POWER SOURCE, BUT ONLY AFTER CONSULTING LOUIS ALLIS.

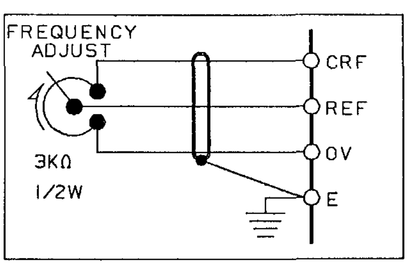
3.2 ADDITIONAL ELECTRICAL INTERCONNECTION CONSIDERATIONS

3.2.1 Connection of Remote Frequency Reference Signal

IMPORTANT

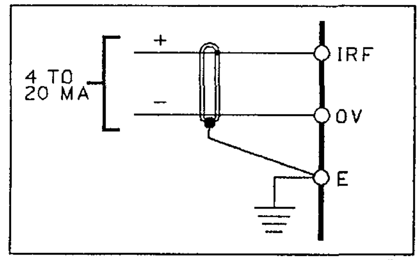
Disconnect internal FREQ. ADJ. potentiometer from terminals CRF, REF and OV.

1. Voltage (0-12VDC); no Auto/Manual.



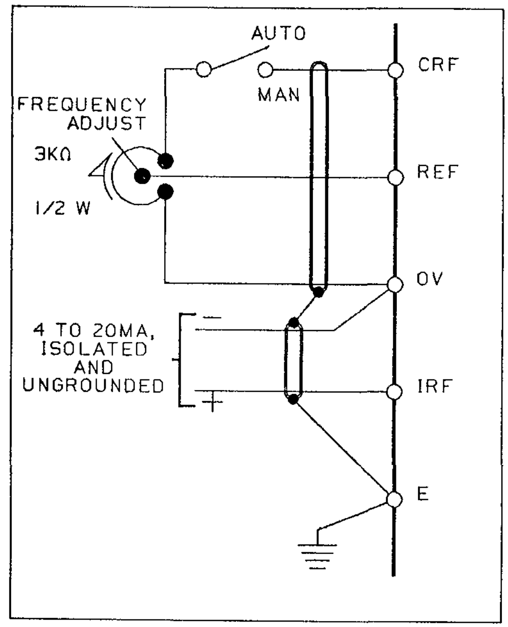
TD.I.4U6.FIGA.I -.64

2. Current (4-20mADC); no Auto/Manual.



TD.I.4U6.FIGA.2

3. Voltage (0-12VDC) in Manual; current (4-20mADC) in Auto.

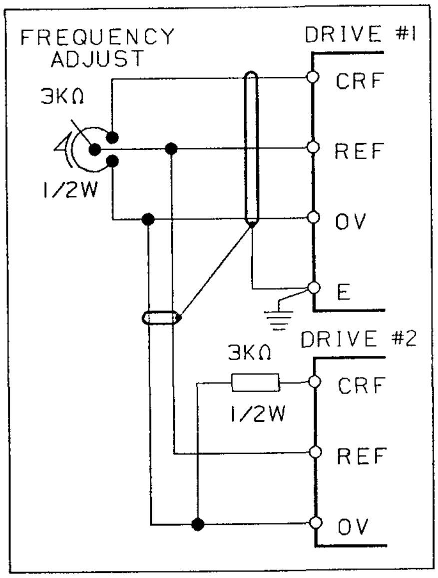


TD.I 4U6.FIGA.3 - .64

Switch closed (Manual):
Remote FREQ. ADJ. pot is selected.

Switch open (AUTO):
4-20 mA current signal is selected.

4. Two inverter drives with one remote FREQ. ADJ. potentiometer.



TD.I.4U6.FIGA.4 -.77x.64

Connect a 3K ohm, 1/2 W resistor between terminals CRF and OV on Drive #2 as shown.

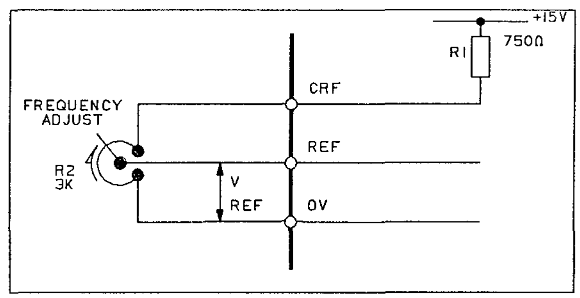
In both inverters, disconnect internal FREQ. ADJ. potentiometers from terminals CRF, REF and OV. The DRIVE RUN-STOP switch in each inverter is still functional.

5. Use of remote FREQ. ADJ. potentiometer other than 3K ohms.

The standard FREQ. ADJ. potentiometer provided on the Operator Control Panel integral to the unit is 3K ohms. If a remote pot of an ohmic value less than 3K is to be used, the following must be considered:

The maximum output frequency is directly related to the maximum voltage referenced available with the FREQ. ADJ. potentiometer turned fully clockwise. The maximum voltage reference, in turn, is directly related to the ohmic value of the FREQ. ADJ. pot. The larger the ohmic value of the pot, the larger the maximum voltage reference, and the greater the maximum output frequency.

The following is a schematic representation of the frequency reference circuit for a standard unit. The maximum voltage reference can be calculated as follows:



TD.I.4U6.FIGA.5A -.75

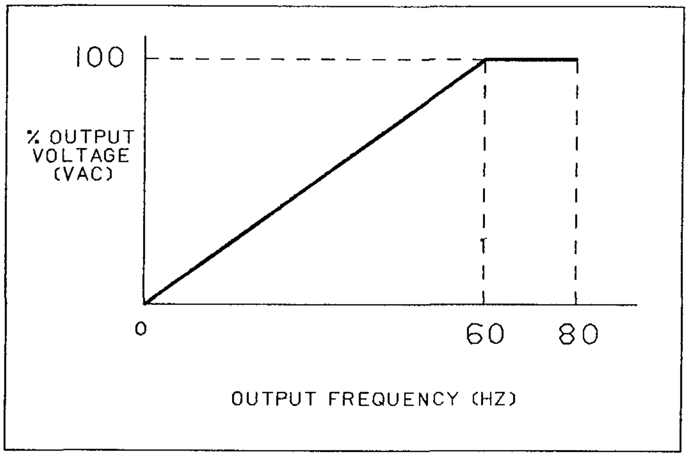
FREQUENCY REFERENCE CIRCUIT, STANDARD

$$VREF\ (Max) = \frac{15V \times R2}{R1 + R2}$$

$$= \frac{15V \times 3K}{.750K + 3K}$$

$$= 12V$$

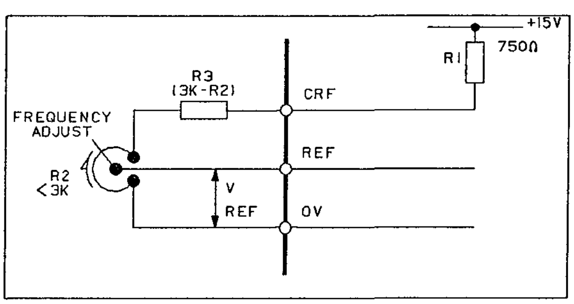
The graph below shows the volts/hertz profile for a standard unit. With a maximum voltage reference of 12V, the maximum output frequency is 80Hz as shown.



VOLTS/HERTZ PROFILE, STANDARD

If the ohmic value of the remote FREQ. ADJ. potentiometer is LESS THAN 3K ohms, and a maximum output frequency of 80HZ is required, an additional resistor, R3 MUST BE ADDED. The resistor's ohmic value must equal the DIFFERENCE between 3K ohms and the ohmic value of the potentiometer. See below example.

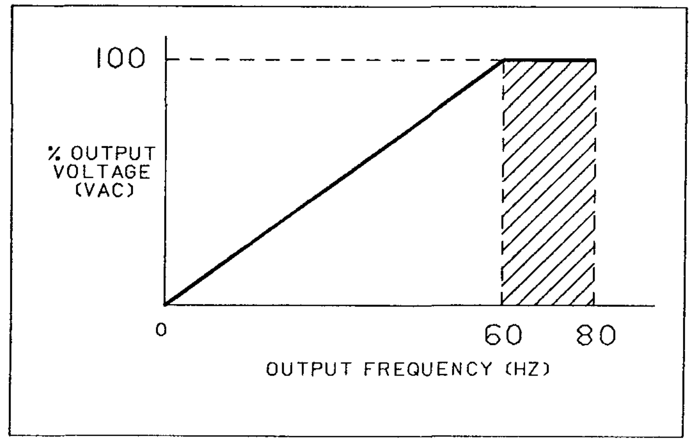
$$R2 + R3 = 3K$$
$$R3 = 3K - R2$$



FREQUENCY REFERENCE CIRCUIT,
R2 LESS THAN 3K OHMS

If the maximum output frequency will be more than 60HZ BUT LESS THAN 80HZ, only the remote FREQ. ADJ. potentiometer is needed. However, its value CANNOT BE LESS THAN 1.2K ohms nor MORE THAN 3K ohms, respectively.

This operating range is shown graphically by the shaded area of the volts/hertz profile below.



VOLTS/HERTZ PROFILE,
1.2K OHMS $\leq$ R2 $\leq$ 3K OHMS

Refer to the following example for determining the maximum output frequency for a particular FREQ. ADJ. pot (R2) ohmic value.

Example: Let R2 = 2.5K ohms

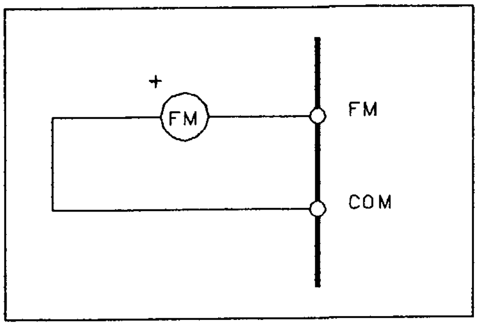
$$VREF\ (max) = \frac{15V \times 2.5K}{.750K + 2.5K} = 11.54V$$

Max output freq = 11.54V x 6.67 = 77HZ

3.2.2 Connection of Remote Frequency Meter and/or Ammeter.

1. Connection of frequency meter, FM.

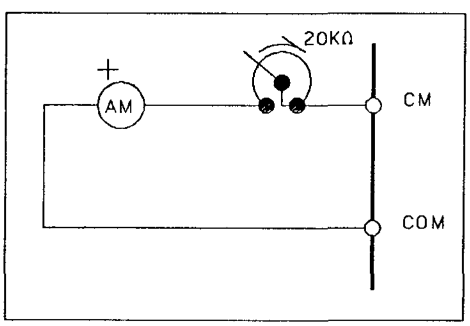
TD.I.4U6.FIGB.I -.75



For external inverter output frequency indication (in addition to the digital FREQ./FAULT display integral to the unit), connect a 1 mADC meter (analog or digital) between terminals FM and COM, observing proper polarity as shown. Calibrate with 1RH on the Control Circuit PCB (see Section 3.3.1.1). Multiple meters with the same rating may be connected in series.

2. Connection of ammeter, AM.

TD.I.4U6.FIGB.2 - 75



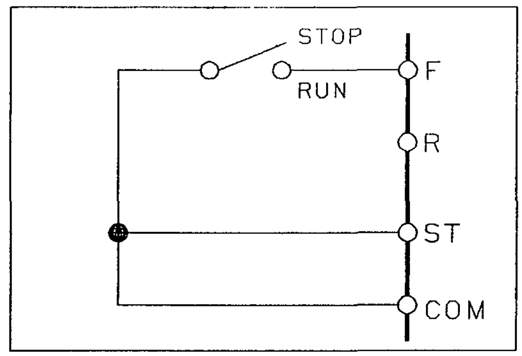
For inverter output current indication, connect a 1 mADC meter (analog or digital) between terminals CM and COM, observing proper polarity as shown. Note that customer must supply a potentiometer for meter calibration (20K ohms, 1/4 watt). Multiple meters with the same rating may be connected in series.

3.2.3 Addition of Remote Run/Stop and Forward/Reverse Capability

(See Notes on page 3-7.)

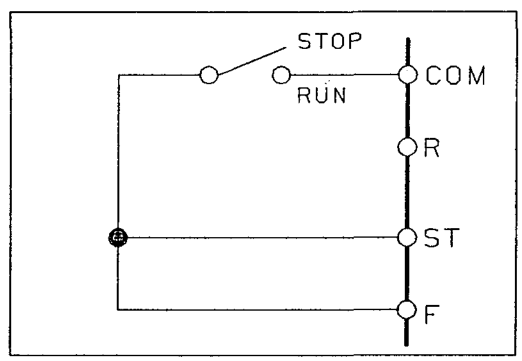
1. Remote RUN/STOP (up to 5HP); Motor will control (ramp) stop, on the inverter, when switching to "STOP" position.

TD.I.4U6.FIGC.I -.75

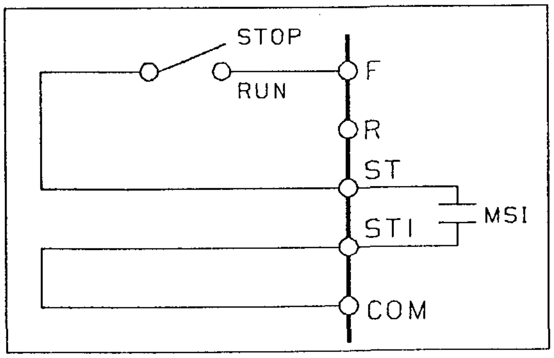


2. Remote RUN/STOP (up to 5HP); Motor will coast-to-stop when switching to the "STOP" position.

TD.I.4U6.FIGC.2 -.75

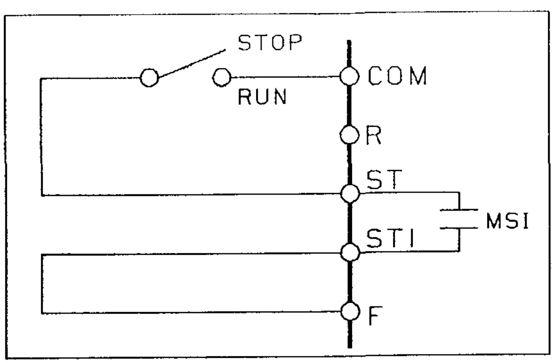


3. Remote RUN/STOP (7.5HP and above); Motor will control (ramp) stop, on the inverter, when switching to "STOP" position.



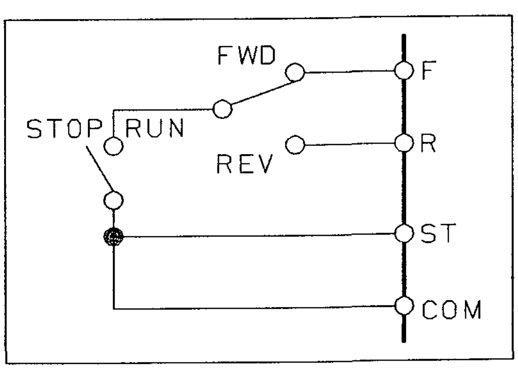
TD.I.4U6.FIGC.3 -.75

4. Remote RUN/STOP (7.5 and above); Motor will coast-to-stop when switching to the "STOP" position.



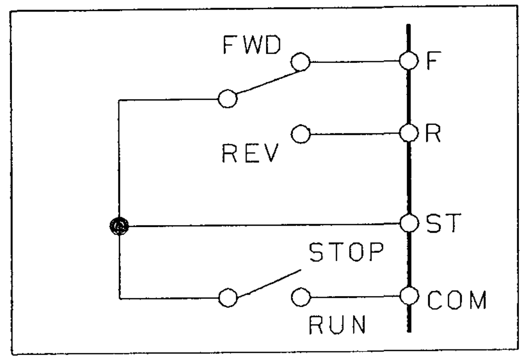
TD.I.4U6.FIGC.4 -.75

5. Remote RUN/STOP and FWD/REV (up to 5HP); Motor will control (ramp) stop, on the inverter, when switching to the "STOP" position.



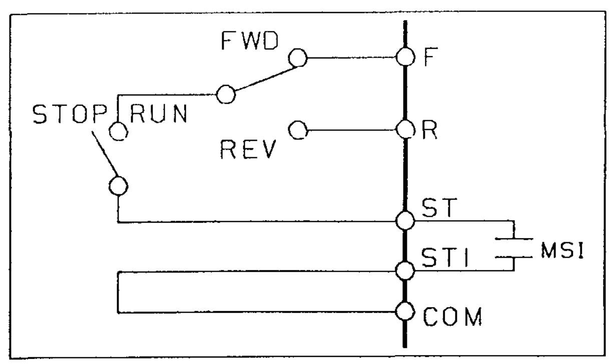
TD.I.4U6.FIGC.5 -.75

6. Remote RUN/STOP and FWD/REV (up to 5HP); Motor will coast-to-stop when switching to the "STOP" position.



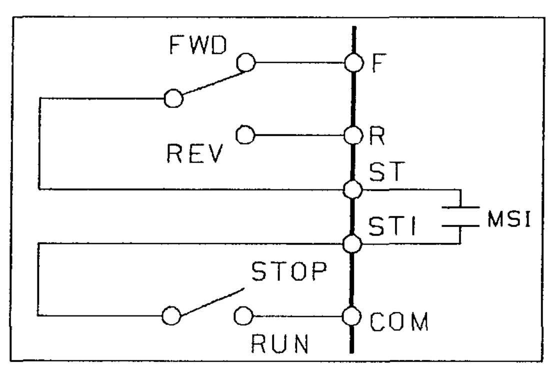
TD I.4U6.FIGC.6 -.75

7. Remote RUN/STOP and FWD/REV (7.5HP and above); Motor will control (ramp) stop, on the inverter, when switching to the "STOP" position.



TD.I.4U6.FIGC.7 -.75

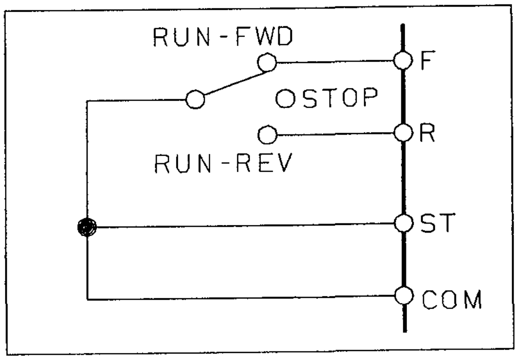
8. Remote RUN/STOP and FWD/REV (7.5HP and above); Motor will coast-to-stop when switching to the "STOP" position.



TD.I.4U6.FIGC.8 -.75

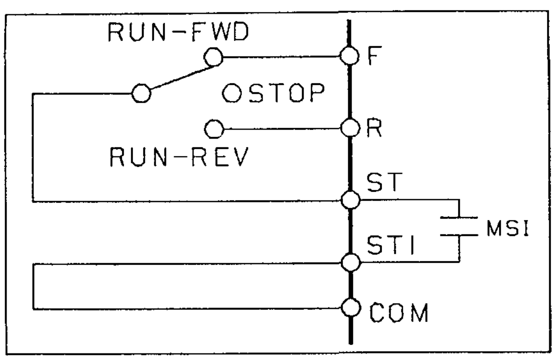
9. Remote RUN-FWD/STOP/RUN-REV (3-position switch required) (up to 5HP); Motor will control (ramp) stop, on the inverter, when switching to the "STOP" position.

TD.I 4U6.FIGC.9 -.75



10. Remote RUN-FWD/STOP/RUN-REV (3-position switch required) (7.5HP and above); Motor will control (ramp) stop, on the inverter, when switching to the "STOP" position.

TD.I.4U6.FIGC.IO -.75



NOTES

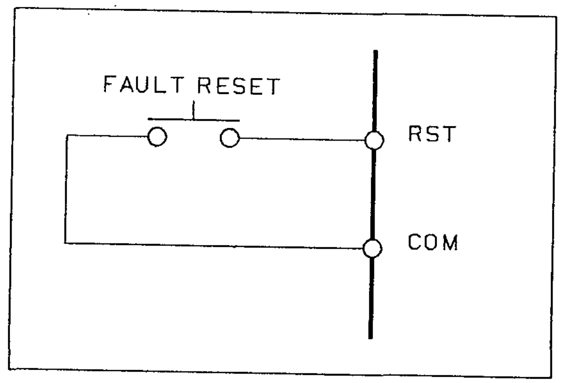
1. For cases (5) thru (10), a change in direction (FWD to REV and vice versa) can be made while running. The inverter will respond by decelerating the motor to a stop, then accelerating to set speed in the opposite direction

2. If terminal ST is erroneously connected to terminals F and R simultaneously, Forward will override.

3. For all cases, the existing DRIVE RUN-STOP switch must be disconnected from terminals ST and F. The FREQ. ADJ. potentiometer on the Operator Control Panel integral to the unit still provides the frequency reference in the Manual mode, and the Manual/Auto reference select function.

3.2.4 Remote Inverter Fault Reset

TD.I.4U6.FIG.D -.75



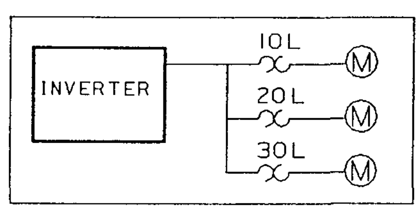
3.2.5 Parallel Motor Operation

PRECAUTIONS

a. The total current of all motors (including transient associated with starting and stopping) must not exceed the inverter current rating.

b. An overload relay for each motor is necessary to provide adequate protection.

TD.I 4U6.FIGE.I



3.2.6 Operation With an Electromechanical Brake

Presented below is a basic block diagram for an inverter drive system incorporating an electro-mechanical brake, and the correct switching sequence of operation.

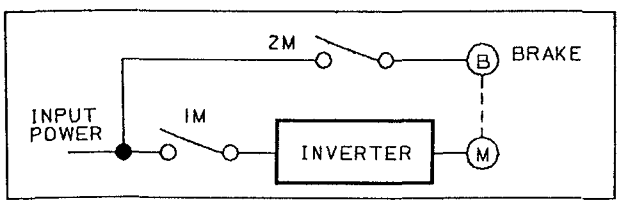
CAUTION

CONTACTORS 1M AND 2M MUST BE ELECTRICALLY INTERLOCKED AND SHOULD BE MECHANICALLY INTERLOCKED TO PREVENT OPERATING THE INVERTER WITH THE BRAKE APPLIED. IF THIS SHOULD OCCUR, THE DRIVE WILL TRIP.

3.3 ADDITIONAL ADJUSTMENTS

The standard inverter is shipped calibrated for 0.5 to 80HZ (208/230VAC units) or 3 to 80HZ (460VAC units) operation. If the speed range is excessive with respect to the motor or machine, or if inverter stalling or shutdown occurs during normal machine operation, recalibration is necessary.

TD.I.4U6.FIGF.I



SYSTEM BLOCK DIAGRAM

3.3.1 Adjustment Procedures.

CAUTION

a. When monitoring the output waveform with an oscilloscope, turn off power before connecting or disconnecting the probe.

WARNING

ADJUSTING THE INVERTER WITH POWER ON REQUIRES SPECIAL PRECAUTIONS: ALL TEST EQUIPMENT SHOULD BE CONNECTED AND DISCONNECTED WITH POWER OFF. HIGH VOLTAGE EXISTS ON THE REGULATOR BOARD; ALL POTENTIOMETERS SHOULD BE ADJUSTED WITH INSULATED HANDLE SCREWDRIVERS. IMPROPER USE OF GROUNDED TEST EQUIPMENT MAY DAMAGE THE INVERTER. ENSURE THAT TEST EQUIPMENT, SUCH AS DIFFERENTIAL OSCILLOSCOPE, IS CONNECTED PROPERLY TO AVOID GROUNDING THE INVERTER. THE DC BUS REMAINS CHARGED FOR SEVERAL MINUTES AFTER POWER IS REMOVED.

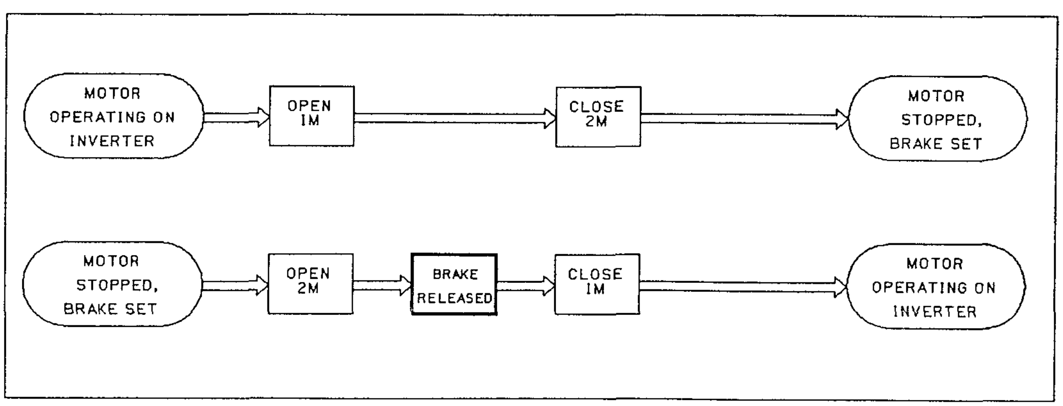
b. When the power is on, high voltage is applied to the Main Control printed circuit board.

Prior to connecting or disconnecting test equipment, follow the steps listed below:

1. Disconnect all input power.

2. Wait at least 5 minutes.

TD.I.4U6.FIGF.2



CORRECT SWITCHING SEQUENCE OF OPERATION

Table 3.1. Adjustment Potentiometers

DESIG-NATION	SYMBOL	FUNCTION	RESPONSE WHEN TURNED CLOCKWISE	FACTORY SETTING	PARAGRAPH
1RH	FM	Remote Frequency Meter calibration	Meter deflection increases	1mA @ 80HZ	3.3.1.1
2RH	FRQ	Output frequency gain	Maximum output frequency decreases	80HZ (0.75-40HP only) 60HZ all others	3.3.1.2
3RH	V-BS	Output voltage bias (voltage boost)	Minimum output voltage increases	3% of rated output @ 0.5HZ	3.1.1.2
4RH	V-GN	Output voltage gain	Lower volts/ HZ ratio	Rated out-put @ 60HZ	3.3.1.2
5RH	I-BS	Current input bias	More offset	0% at 4mA	*
6RH	I-GN	Current input gain	Less gain	100% at 20mA	*
7RH	ACC	Acceleration time	Acceleration time decreases	Approx. 20 Sec.	*
8RH	DEC	Deceleration time	Deceleration time decreases	Approx. 20 Sec.	*
9RH	UL	Upper Limit (max. freq.)	Max. frequency increases	80HZ	*
10RH	LL	Lower Limit (min. freq.)	Min. frequency increases	0HZ	*

*Adjusted during initial start-up - see Instruction Sheet 02Y00025-0220.

3. Remove the front cover and check that the "CHARGE" LED is extinguished.

<u>CAUTION</u>

THE "CHARGE" LED BEING ILLUMINATED IMPLIES THAT HAZARDOUS DC BUS CAPACITOR POTENTIAL STILL EXISTS. AS AN ADDED SAFETY MEASURE, AFTER THE "CHARGE" LED EXTINGUISHES, VERIFY THAT THERE IS NO LONGER A CHARGE BY MEASURING THE POTENTIAL ACROSS CAPACITOR C1 WITH A VOLTMETER.

c. DO NOT GROUND ANY TEST INSTRUMENTS when connecting, and ensure the input impedance of these devices is 1M ohms or greater.

d. Small-scale precision type variable resistors (potentiometers) are used. Use a well insulated thin blade screwdriver.

e. Misadjustment of 2RH thru 4RH will adversely affect drive performance.

NOTE

Adjust only the potentiometers which are described in this manual.

3.3.1.1 1RH -- Remote Frequency Meter adjustment. If a remote frequency meter is used, calibrate according to the following procedure.

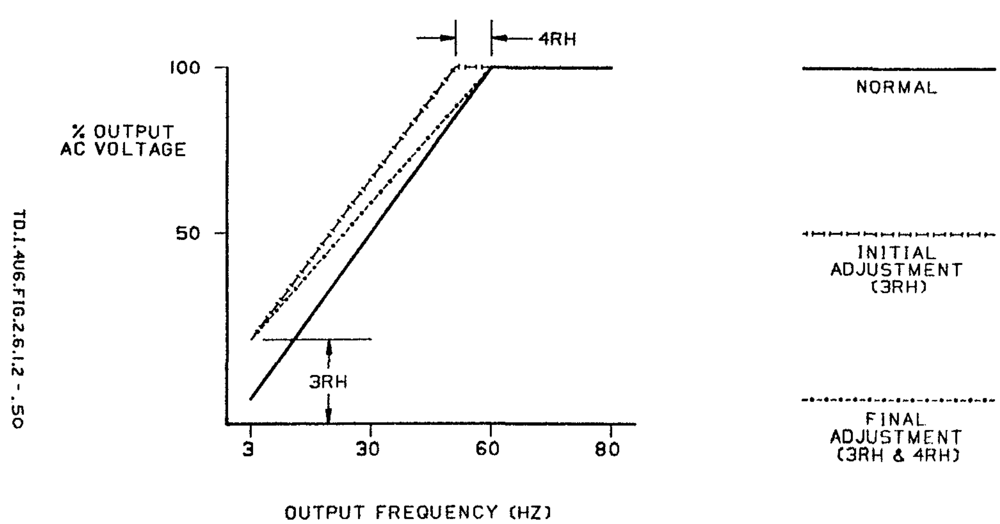
a. Zero adjust meter before applying power.

b. The meter will deflect slightly in the negative direction when the power is first turned on.

c. Adjust 1RH until the remote meter agrees with the frequency indicated on the digital FREQ./FAULT display.

3.3.1.2 2RH, 3RH, 4RH -- Voltage boost and volts/hertz adjustment. 2RH and 4RH adjust the inverter output voltage with respect to frequency. Collectively, they are commonly referred to as the volts/hertz adjustments. IF READJUSTMENT IS NECESSARY, CONTACT LOUIS ALLIS DISTRICT OFFICE FOR ASSISTANCE. Note that any readjustment of 2RH will require readjustmemt of 4RH for the same volts/hertz, and vice versa.

Motor stalling or rough running at low speeds can be corrected with V-BS (3RH). Voltage boost provides more voltage at low frequencies. Care should be taken when adjusting 3RH; too much voltage boost can heat up the motor and cause overcurrent tripping. Whenever 3RH is adjusted, 4RH (V-GN) must be readjusted to vary the V/F ratio (slope) so that maximum voltage occurs at 60HZ. Because both adjustments interact, several adjustments are necessary to get the proper V/HZ ratio. The following is a graphical representation of the adjustment procedure.



3.3.2 Jumper Connections.

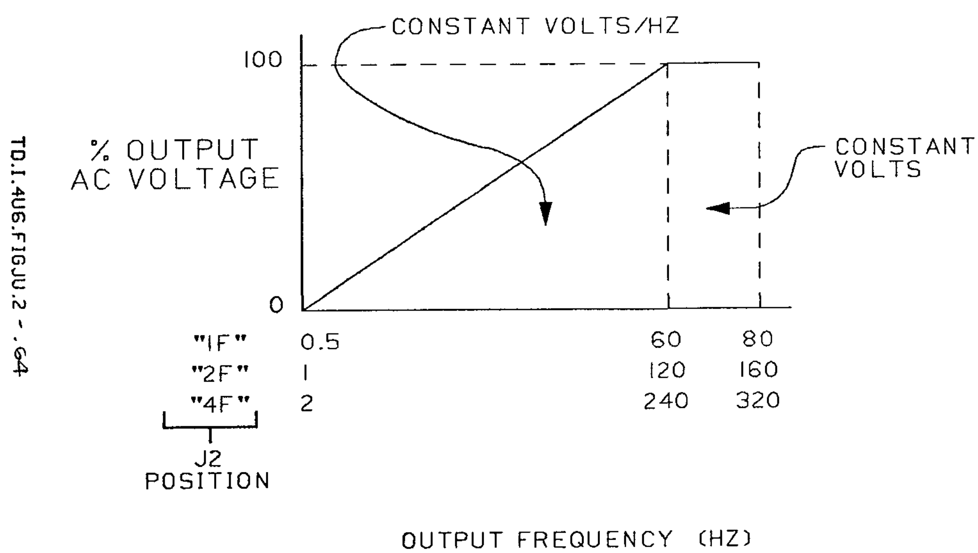
NOTE

Jumper locations are shown in Figure 6-4.

Jumper J2 is used to extend maximum inverter output frequency. With J2 in the "1F" position, maximum output frequency is 80HZ. With J2 in the "2F" position, maximum output frequency is 160HZ (doubled); with J2 in the "4F" position, maximum output frequency is 320HZ (quadrupled). Maximum frequencies and volts/hertz profiles for each jumper position are shown below.

Jumper J3 is factory positioned for 60HZ output frequency (U.S), and SHOULD NOT be changed.

Solid wire jumper J5 must remain intact if the inverter does not have the dynamic braking option added.



SECTION 4. FUNCTIONAL DESCRIPTION

4.1 OPERATION

The Lancer JR. provides a simulated Pulse Width Modulated (PWM) AC that varies the speed of the motor. A power transistor inverter used with the microprocessor controlled regulator accomplishes the conversion.

The speed listed on the motor nameplate is the top (or base) no-load speed attainable by that motor at 60HZ, rated maximum motor voltage. Slower speeds (below base speed) are produced by reducing both the voltage and the frequency of the inverter output to the motor.

Figure 4-1 shows the voltage varying with the frequency until base speed (60HZ). Above base speed the voltage remains constant while frequency varies.

TD I 4U6.FIG3.I - .75 x 64

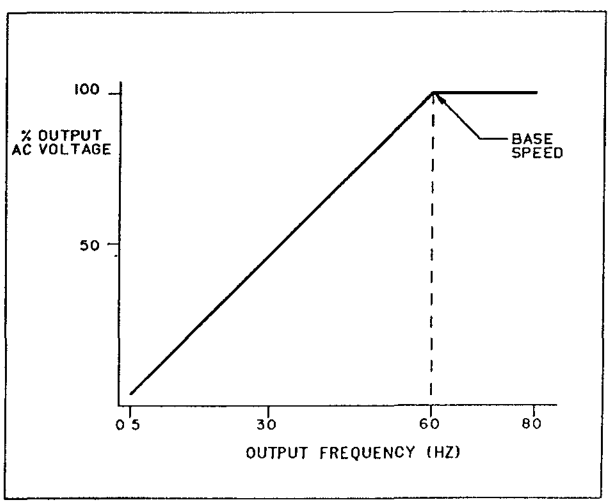


Figure 4-1.

PWM (Pulse Width Modulated) inverters change the incoming power to DC and then pulse the DC into the motor leads to simulate AC. Figure 4-2 shows a representation of the inverter output voltage waveform. An AC waveform is superimposed on the PWM waveform for illustration.

TD.I.4U6.FIG3.2

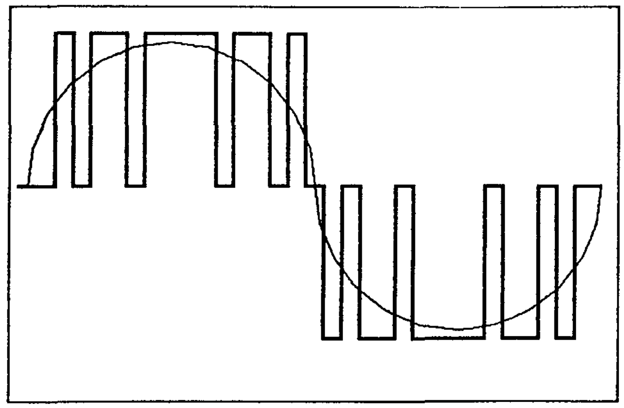


Figure 4-2.

Pulse width is decreased for lower RMS voltage and increased for higher voltage. Lower frequencies have a greater number of pulses in one cycle. As the frequency increases, the microprocessor selects the optimum number of pulses per waveform to keep motor heating to a minimum.

Figure 4-8 is a block diagram of the Lancer JR. inverter. The figure is divided into two parts; the MAIN CIRCUIT which handles the input and output power, and the CONTROL CIRCUIT which senses input information to direct the Main Circuit transistor firing.

4.1.1 Main Circuit

Input 3-phase AC is rectified by two single-phase full-wave bridges as shown in Figure 4-3 and 4-4. The rectified power is then fed to the DC bus.

Resistor R1 and contactor MS1 provide a soft charge to filter capacitor C1 when power is initially applied. C1 smooths AC ripple on the DC bus.

Diode D21 and transistor GTR7 suppress voltage spikes caused by switching of the power transistors.

FU2 is a DC semiconductor fuse sized to protect the DC bus from overcurrent. Bus currents over 240% of rated will blow the fuse.

HCT is a Hall-Effect current transformer detecting bus current. In 208/230V units rated below 3 horsepower, HCT is a component on the Base Drive PCB, sized for the HP rating. HCT, shown in Figure 4-5, is identical for all other inverters. Current scaling for proper feedback on different size units is accomplished by changing the number of turns of wire around the core, and by adjustments GIN and OFS. These factory-sealed potentiometers should never be readjusted.

Each of the transistors located in the Main Circuit can be described as a N-P-N power Darlington configuration. Inherent characteristics of these devices include high gain and fast switching speeds. Switching of the transistors is controlled by the Control Circuit.

Line-to-line output waveforms are illustrated in Figure 4-6. Proper 120° phase shift between output leads stays constant over the entire frequency range.

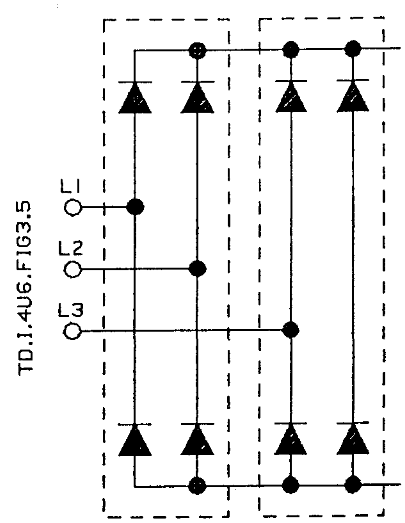


Figure 4-4

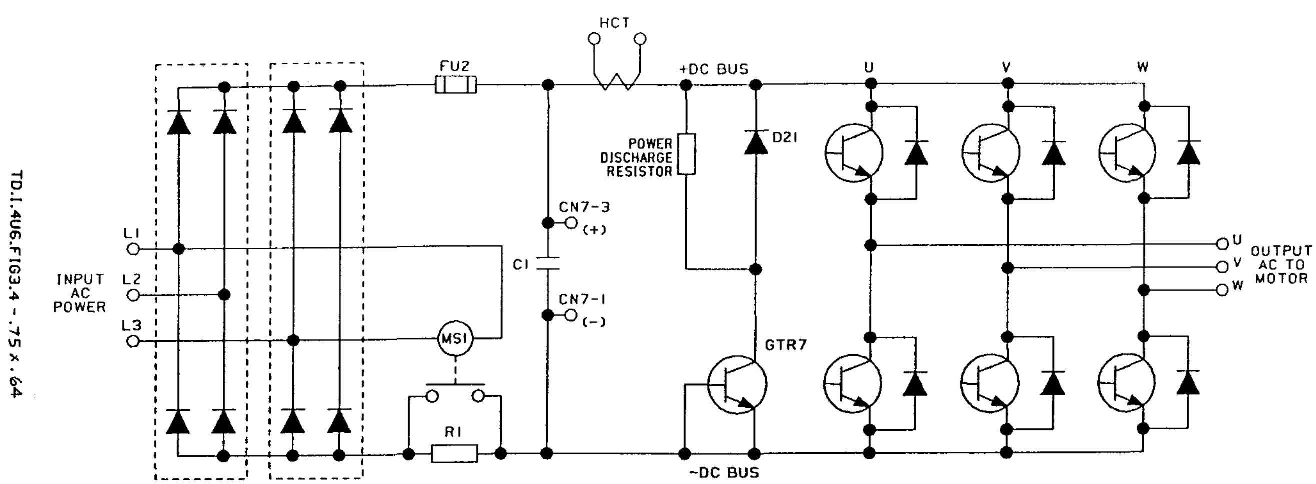


Figure 4-3

4U6.FIG3.6 -.75

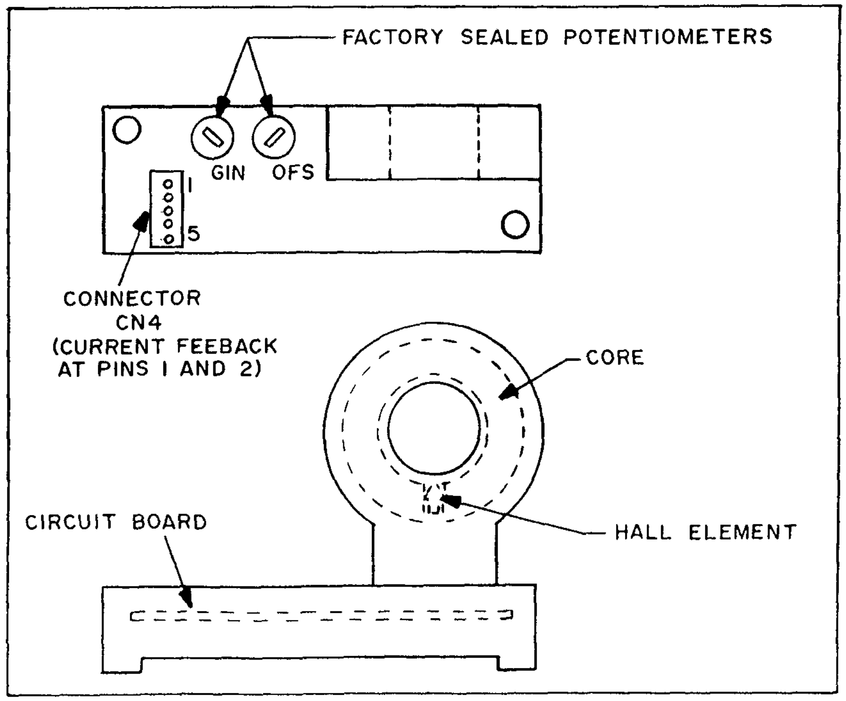


Figure 4-5.

TD.1.4X.FIG3.8-.64

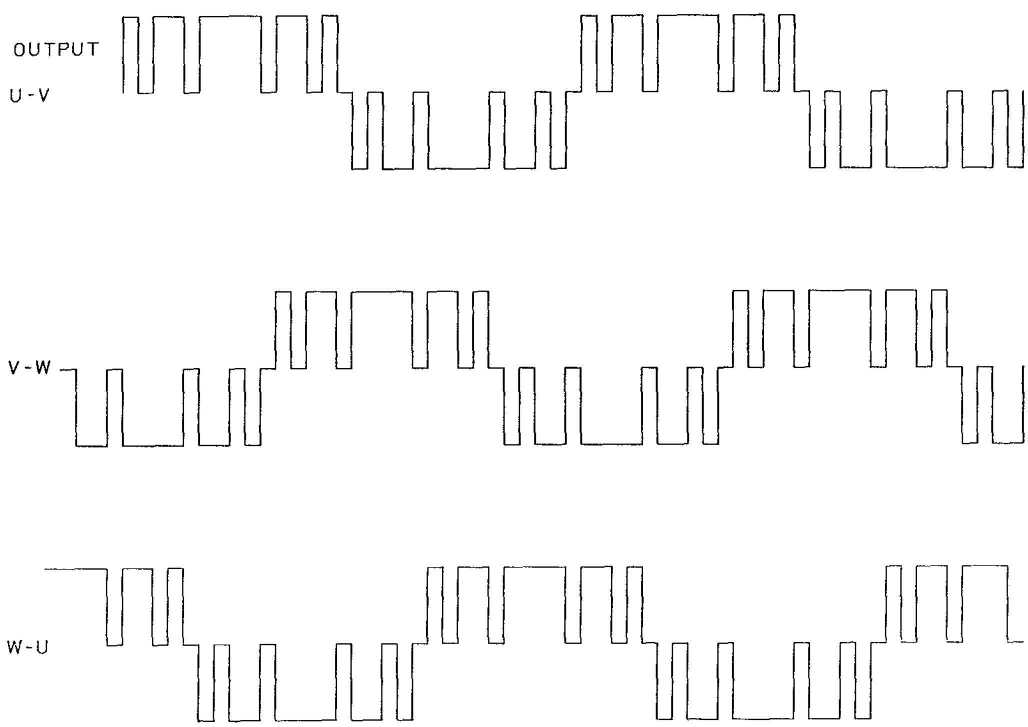


Figure 4-6.

TD.I.4U6.FIG.3.9 - .94

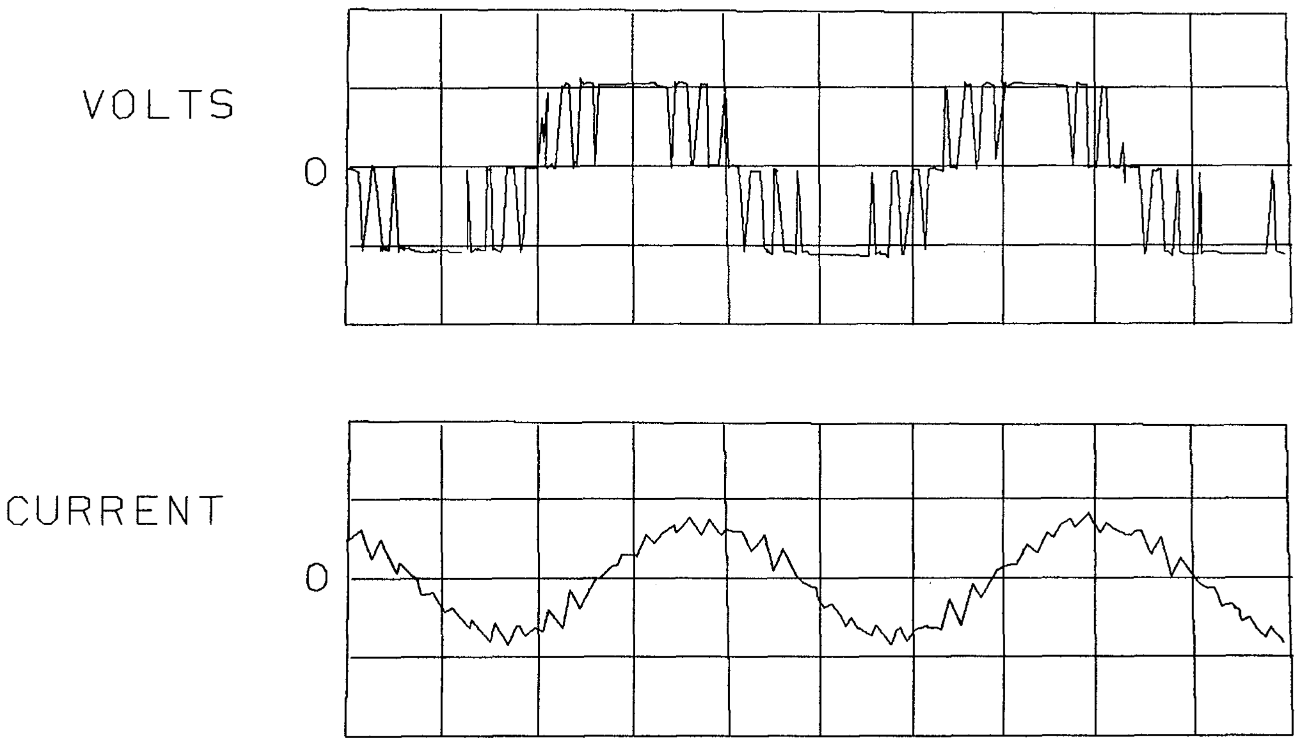


Figure 4-7.

Typical motor voltage and current at 60HZ (full load) is shown in Figure 4-7. Note that although the voltage is pulse-width-modulated (PWM), the current waveform is sinusoidal. Note also that voltage is leading current, typical in induction motors.

4.1.2 <u>Control Circuit</u>

The Control Circuit (see Figure 4-8) consists of the Control Circuit PCB, the Main Circuit PCB (0.75-2HP, 230V) or Base Drive PCB, and associated components. It accepts operator information and outputs base signals to control the transistors. The following is a description of Control Circuit functions.

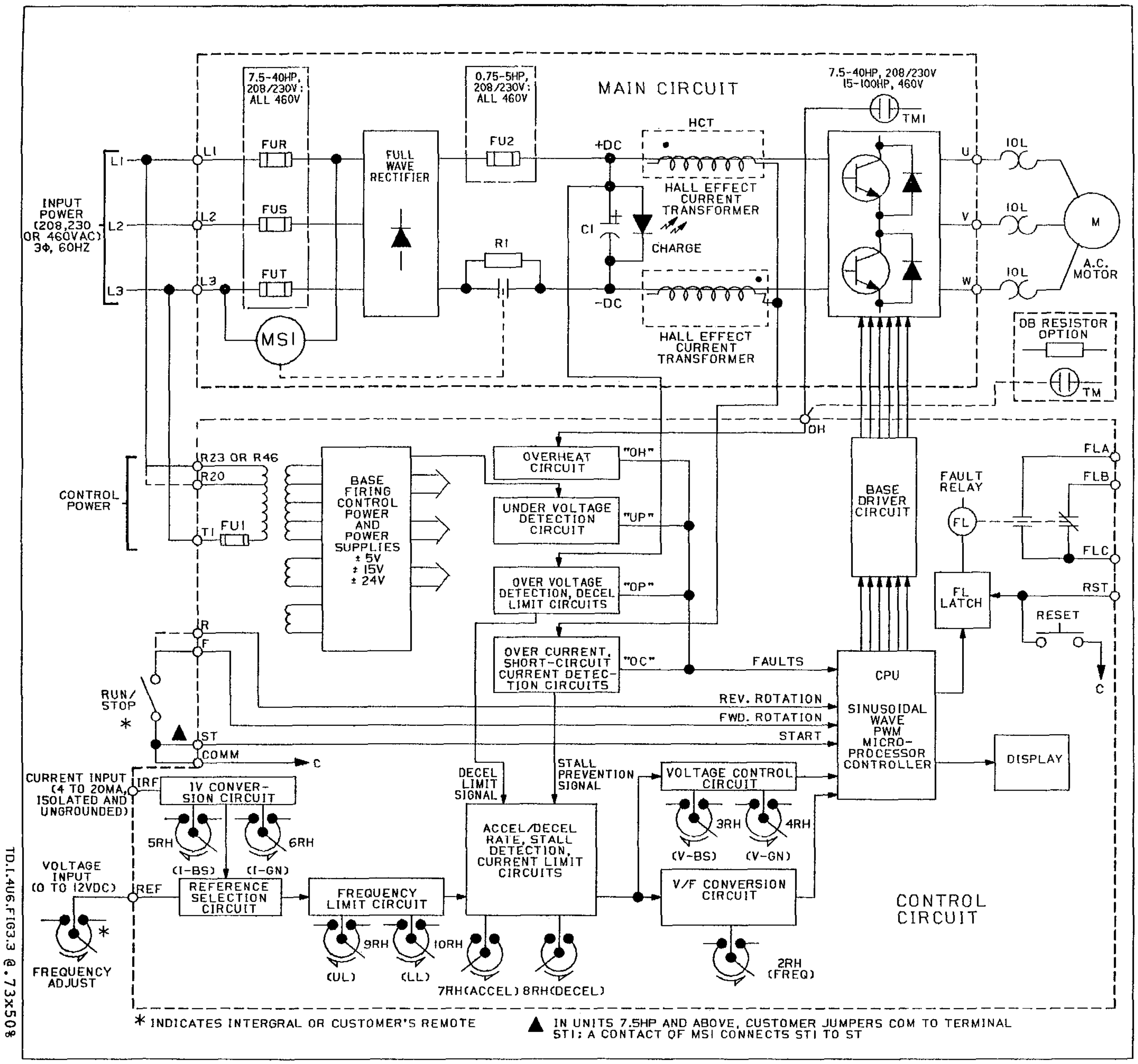

MAIN CIRCUIT
7.5-40HP, 208/230V; ALL 460V
0.75-5HP, 208/230V; ALL 460V
7.5-40HP, 208/230V 15-100HP, 460V
INPUT POWER (208,230 OR 460VAC) 3Φ, 60HZ
FUR
FUS
FUT
FULL WAVE RECTIFIER
FU2
R1
MSI
+DC
-DC
C1
CHARGE
HCT
HALL EFFECT CURRENT TRANSFORMER
TM1
IOL
A.C. MOTOR
DB RESISTOR OPTION
TM
CONTROL POWER
R23 OR R46
R20
FU1
BASE FIRING CONTROL POWER AND POWER SUPPLIES ± 5V ± 15V ± 24V
OVERHEAT CIRCUIT
UNDER VOLTAGE DETECTION CIRCUIT
OVER VOLTAGE DETECTION, DECEL LIMIT CIRCUITS
OVER CURRENT, SHORT-CIRCUIT CURRENT DETECTION CIRCUITS
"OH"
"UP"
"OP"
"OC"
BASE DRIVER CIRCUIT
FAULT RELAY
FL LATCH
RESET
FLA
FLB
FLC
RST
FAULTS
REV. ROTATION
FWD. ROTATION
START
CPU
SINUSOIDAL WAVE PWM MICRO-PROCESSOR CONTROLLER
DISPLAY
RUN/STOP
ST
COMM
CURRENT INPUT (4 TO 20MA, ISOLATED AND UNGROUNDED)
IRF
IV CONVERSION CIRCUIT
5RH
6RH
(I-BS)
(I-GN)
VOLTAGE INPUT (0 TO 12VDC)
REF
REFERENCE SELECTION CIRCUIT
FREQUENCY LIMIT CIRCUIT
FREQUENCY ADJUST
9RH
10RH
(UL)
(LL)
DECEL LIMIT SIGNAL
STALL PREVENTION SIGNAL
ACCEL/DECEL RATE, STALL DETECTION, CURRENT LIMIT CIRCUITS
7RH(ACCEL) 8RH(DECEL)
VOLTAGE CONTROL CIRCUIT
3RH
4RH
(V-BS)
(V-GN)
V/F CONVERSION CIRCUIT
2RH (FREQ)
CONTROL CIRCUIT
* INDICATES INTERGRAL OR CUSTOMER'S REMOTE
▲ IN UNITS 7.5HP AND ABOVE, CUSTOMER JUMPERS COM TO TERMINAL ST1; A CONTACT OF MSI CONNECTS ST1 TO ST
TD.I.4U6.FIG3.3 @.73x50%

Figure 4-8.

Speed (frequency) reference input to the Control Circuit is either voltage from the integral or remote FREQUENCY ADJUST pot (0-12VDC, at terminal REF) or current (4-20mA, at terminal IRF). Current input (for "Auto" mode operation) is converted to a voltage signal by the IV (current to voltage) Conversion Circuit, with zero bias and max gain adjusted by 5RH and 6RH, respectively. When a voltage greater than 0VDC is present at terminal REF (i.e. "Manual" mode operation selected), the Reference Select Circuit disables "Auto" speed reference (current) input.

The Frequency Limit Circuit establishes the minimum output frequency and maximum output frequency of the inverter, at the low end and high end of the speed reference input. These limits, set by adjustments of 10RH and 9RH, respectively, are factory set for 0.5-80HZ (0.75-40HP) or 0.5-60HZ (50-100HP).

The speed reference voltage passes through the Accel/Decel Rate circuit to become the Frequency Reference signal. The accel time (ramp) of the Frequency Reference signal is controlled by the setting of 7RH. When there is a decrease in the speed reference input, the decel time (ramp) of the Frequency Reference signal is controlled by the setting of 8RH. Standard range of adjustment for accel and decel ramp time is 1 to 20 seconds. If an application requires longer or shorter ramp time, the Main Control PCB must be specially modified.

The Voltage Control Circuit establishes the ratio of output voltage to frequency between minimum frequency and rated (base) frequency. Adjustment pot 3RH is factory set for 3% of rated voltage at minimum frequency (0.5HZ), and 4RH is factory set for 100% voltage at 60HZ. At frequencies between 60HZ and 80HZ (0.75-40HP only), the output voltage remains constant. An analog to digital conversion chip converts the Frequency Reference voltage to a 7-bit code suitable for input to the CPU.

The V/F (Voltage/Frequency) Conversion Circuit uses a voltage-to-frequency converter chip to produce a pulse train input to the CPU with a frequency proportional to the magnitude of the Frequency Reference signal. (See Table 6.3).

When power is applied to the inverter, circuit common (terminal COM) connected to terminal ST establishes one of the signals needed to enable transistor firing. When the integral or remote RUN-STOP switch is closed, terminal F (Forward) or R (Reverse) is connected to terminal COM, and the appropriate Rotation signal is inputted to the CPU. The CPU produces a CPU-Run signal to enable transistor firing, and generates base control signals in the proper sequence to produce the desired direction of rotation of the motor. The Base Driver Circuit isolates and amplifies the signals, and applies them to the transistors in the Main Circuit.

When thermostat TM1 on the heat sink in the Main Circuit (or thermostat TM in Dynamic Braking Resistor modification, if installed) senses an operating temperature above 90°C, its contact closes, connecting +24V to terminal OH. The Overheat Circuit then sends a signal to the CPU to energize the Fault relay and produce a fault display.

The Under Voltage Detection Circuit monitors voltage across a secondary transformer winding in the Control Power Circuit. When the magnitude of the voltage falls below a factory-set trip point (equivalent to 85% of rated supply voltage), the circuit sends a signal to the CPU to energize the Fault relay and produce a fault display.

The Over Voltage Detection/Decel Limit Circuit monitors the magnitude and polarity of voltage on the DC bus, and:

a. When forward (motoring) bus voltage exceeds a facotry-set trip point (based on HP rating), the circuit sends a signal to the CPU to energize the Fault relay and produce a fault display.

b. When reverse (regenerating) bus voltage exceeds 125% of rated voltage, the circuit sends a limit signal to the Decel Control Circuit to phase back the decel ramp until bus voltage decreases. There is no fault indication for this function.

NOTE

If the inverter has the Dynamic Braking (DB) Resistor modification installed, decelerating bus voltage is directed through the DB resistors and the Decel Limit circuit is disabled.

The Over Current, Stall Detection and Short-Circuit Current Detection Circuits monitor DC bus current from the HCT, and:

a. If bus current rises to 163%, the Stall Detection Circuit and Current Limit Circuit phase back voltage and current until current decreases. There is no fault indication for this function.

b. If bus current rises to 190%, the Over Current Detection Circuit sends a signal to the CPU to energize the Fault relay and produce a fault display.

When the inverter has been shut down by a fault condition, while power is still applied, the fault is annunciated on the FREQ./FAULT display (See Table 4.1). If the fault was due to a transient condition, pressing the RESET push button on the Control Circuit PCB (or customer's remote FAULT RESET push button) will reset the Fault relay, enabling the inverter to restart. If trouble- shooting and repair require removal of input power, the Fault relay is automatically reset when power is re-applied.

4.2 FREQUENCY/FAULT INDICATOR

Normal operating status and fault status are displayed on the three-digit seven-segment LED FREQ./FAULT display.

Table 4-1. Operating Status And Fault Status

DISPLAY MODE	DESCRIPTION	DISPLAY
Inverter Operating Status	Normal operating condition display, when the drive is in Stop condition: DRIVE RUN-STOP switch on the Operators Control Panel, or remote RUN/STOP switch, is in the "STOP" position.	OFF
	Normal operating condition display, when the drive is in Run Condition (DRIVE RUN-STOP switch on the Operators Control Panel, or remote RUN/STOP switch, is in the "RUN" position) and the integral or remote FREQ. ADJ. potentiometer is fully counterclockwise (CCW).	LS
Inverter Output Frequency	J2 in "1F" position. Display resolution: 0.1HZ	80.0
	J2 in "2F" position. Display resolution: 1HZ.	160
	J2 in "4F" position. Display resolution: 1HZ.	320
Inverter Fault Status	Indicates an input underpotential condition.	UP
	Indicates a DC bus overpotential condition.	OP
	Indicates an overcurrent condition.	OC
	Indicates a heat sink overtemperature condition. (208/230V, 7.5 - 40HP; 460V, 15-100HP only).	OH

SECTION 5. MAINTENANCE

5.1 GENERAL

Prior to performing any maintenance, follow the steps listed below.

1. Disconnect all input power.

2. Wait at least 5 minutes.

3. Remove the front cover and check that the "CHARGE" LED is extinguished.

CAUTION

THE "CHARGE" LED BEING ILLUMINATED IMPLIES THAT HAZARDOUS DC BUS CAPACITOR POTENTIAL STILL EXISTS. AS AN ADDED SAFETGY MEASURE, AFTER THE "CHARGE" LED EXTINGUISHES, VERIFY THATG THERE IS NO LONGER A CHARGE BY MEASURING THE POTENTIAL ACROSS CAPACITOR C1 WITH A VOLTMETER.

Once the Lancer JR. has been properly adjusted and placed into operation, only a routine dusting is required to ensure that the vents, PCBs and inverter interior are dust free. A dusty environment will require dusting more often than a relatively clean environment.

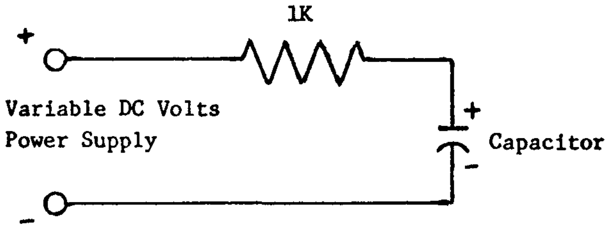
NOTE

If the inverter has been unused for more than six months, capacitor C1 must be reconditioned (reformed) as described below.

5.2 ELECTROLYTIC CAPACITOR REFORMING

Electrolytic capacitors stored more than six months must be reformed and their leakage current determined. Each capacitor must be treated separately, not in banks. This applies not only to the larger capacitors, but also to the smaller electrolytics on the PCBs.

To reform an aluminum electrolytic capacitor, connect it in series with a variable DC power supply and a 1000 ohm (1K) resistor, as shown below.

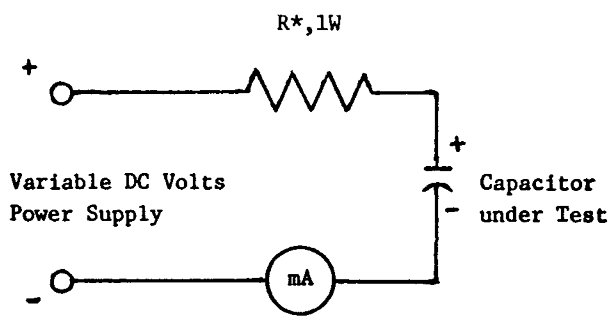


Over a period of one minute, slowly build up the DC voltage to apply the full rated voltage across the series system of resistor and capacitor. Keep voltage applied for 30 minutes; then disconnect the system without discharging the capacitor. Wait at least 24 hours before performing leakage current test.

5.2.1 Leakage Current Test

After the reforming circuit has been disconnected for at least 24 hours, perform the following test.

Connect the capacitor in a test circuit as shown below.



*R (in ohms) = not less than rated voltage of capacitor (in DC volts); (e.g., for a capacitor rated 500 VDC, use a 500 ohm, 1W resistor).

Over a period of one minute, build up the DC voltage to apply the full rated voltage across the series system of resistor, capacitor, and milliameter. Observe the leakage current for ten minutes, and record the highest value.

RATED DC VOLTAGE	K	X
3	0.0003	+.1
6	0.0005	+.1
10	0.0007	+.1
15	0.001	+.1
25	0.002	+.1
50	0.004	+.1
150	0.010	+.2
250	0.013	+.25
300	0.015	+.25
350	0.015	+.25
400	0.02	+.25
450	0.02	+.3

Use the following formula, with values from the chart above, to calculate the maximum allowable leakage current.

Max Leakage Current (mA) = (Capacitor ufd x K) + X.

Example: for a 50 WVDC 150 ufd capacitor:

Max Leakage Current
= (150 x .004) +0.1
= 0.6 + 0.1
= 0.7 mA

If the measured leakage current exceeds the calculated maximum allowable leakage current, the capacitor must be replaced before the inverter is put into service.

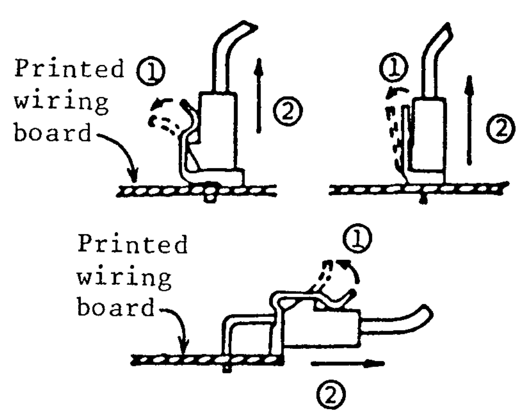
5.3 PCB REPLACEMENT

Important

Replacement PCB pot, switch and jumper settings must match those of PCB being replaced.

To remove the Main Control PCB follow the steps below:

1. Remove all connectors on the PCB. Release the stopper, ①, and pull the connector, ②, out carefully. DO NOT pull on the wire!



2. Release PCB from the locking supports located at the four corners.

3. Remove PCB.

To install the Main Control PCB:

1. Align the PCB with the locking supports and push gently until seated.

2. Connect the connectors.

   a. Match the connector numbers with the connectors on the PCB.

   b Match the arrow on the connector with the arrow on the PCB.

   c. Push the stopper back and gently push the connector onto its pins.

   d. Release the stopper so it latches the connector.

NOTE

Removal and replacement of the Base Drive PCB is the same as for the Main Control PCB except in some models the connector on the Base Drive PCB is difficult to access. If this is the case, remove the locking support and lift the circuit board so that the connector can be accessed easily before removing.

5.4 POWER TRANSISTOR REPLACEMENT

When replacing a power transistor:

1. Number the connecting wires to ensure proper reconnection.

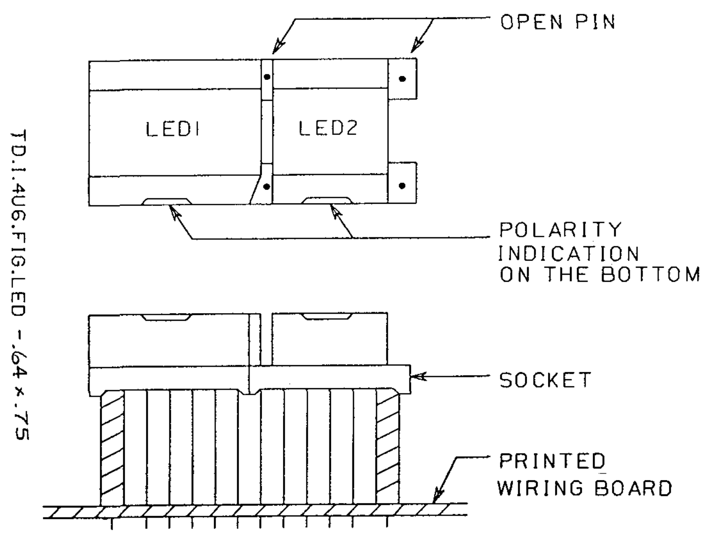
2. Apply a thin coat of a heat-conductive silicone compound to the transistor surface which will contact the heat sink.

3. Tighten the power transistor uniformly on the right and left.

5.5 LED INDICATOR REPLACEMENT

The LED indicator is plugged in a socket, as shown below, and can be easily replaced, but it should not be replaced without eliminating all other causes of failure.

If it must be replaced, the location and polarity must be checked carefully.



SECTION 6. TROUBLESHOOTING

6.1 GENERAL

Troubleshooting consists of a logical series of operational checks and observations designed to localize a fault to a printed circuit board or major circuit area. Table 6.1 lists fault indications, causes and corrective actions. Table 6.3 lists test points and their associated waveforms.

Due to the PWM nature of the inverter output signal, conventional instrumentation may not provide meaningful information. For best results, comply with the test equipment recommendations outlined below.

MEASUREMENT	INSTRUMENT TYPE	LOCATION
Output voltage	Rectifier type analog voltmeter	Output terminals U, V, W
Current	Moving-iron type + CT	Each phase of motor and inverter
Power	Electrodynamometer	Input to inverter

Prior to connecting or disconnecting troubleshooting equipment, follow the steps listed below:

1. Disconnect all input power.
2. Wait at least 5 minutes.
3. Remove the front cover and check that the "CHARGE" LED is extinguished.

CAUTION

THE "CHARGE" LED BEING ILLUMINATED IMPLIES THAT HAZARDOUS DC BUS CAPACITOR POTENTIAL STILL EXISTS. AS AN ADDED SAFETY MEASURE, AFTER THE "CHARGE" LED EXTINGUISHES, VERIFY THAT THERE IS NO LONGER A CHARGE BY MEASURING THE POTENTIAL ACROSS CAPACITOR C1 WITH A VOLTMETER.

6.1.1 Inverter Fault Diagnosis

Table 6.1 summarizes inverter faults and corrective actions. If the fault persists after corrective action has been taken, do not attempt repeated restarts. Damage to the inverter may result. Ensure that the DC bus "CHARGE" LED is extinguished before performing inspection.

Table 6.1. Inverter Fault Diagnosis

FAULT DISPLAY OR INDICATION	PROBABLE CAUSE	ACTION
OC (Overcurrent)	Inverter capacity does not match the motor rating.	Ensure that inverter and motor ratings are compatible.
	Short circuit or ground fault of motor circuit.	Isolate the cause and repair.
	Overload or abrupt load variations.	Decrease load.
	Acceleration or deceleration time is too short.	Readjust 7RH or 8RH as required.
	Shorted inverter transistor.	Replace transistor module.
OP (DC bus over-potential)	Input power source voltage too high.	Decrease or add a stepdown transformer.
	Deceleration time is too short.	Readjust 8RH. Extend LAC time with additional cap C18 (See Note 2). Add dynamic braking option.
	Improper volts/hz setting.	Readjust 2RH, 3RH, & 4RH.
UP (input under-potential)	Input power source voltage too low.	Check for problem at source; increase or add a step-up transformer.
OH (heat sink over-temperature)	Inverter heat sink over-heating. (7.5-40HP, 208/230V; 15-100HP, 460V only)	Decrease load, readjust 8RH.
	Overheating of Dynamic Braking (DB) resistors (if installed).	Refer to Dynamic Braking Resistor instruction sheet.

Table 6.1. Inverter Fault Diagnosis (Continued)

FAULT DISPLAY OR INDICATION	PROBABLE CAUSE	ACTION
DC Bus Fuse (FU2) Blown	Failure of inverter Main Circuit, bad Power Transistor, main rectifier diode, or capacitor C1. (See Note 3).	Repair as required, and replace fuse.
Control Circuit Fuse (FU1) Blown	Control Circuit transformer or component failure.	Repair as required, and replace fuse.

1/ Inverter protection in the event of a motor ground fault cannot be guaranteed. If this should occur, inverter transistors may be damaged. Display will indicate "OC" if a device is indeed shorted, and an inverter fault reset is attempted.

2/ Contact nearest Louis Allis District Office for assistance in proper sizing and installation of required capacitor.

3/ Transient increases in power supply voltage may cause the Main Circuit fuse to blow. If this is the case, additional impedance can be added at the input power side to limit the large initial charge current into the Main Circuit capacitor upon application of power. Contact nearest Louis Allis District Office for assistance.

6.2 MAIN CIRCUIT TROUBLESHOOTING

Inverter overcurrent tripping (OC), an open bus fuse (FU2), or heat sink overtemperature (OH) faults, are indications of possible Main Circuit problems.

Input fuse blowing or circuit breaker tripping are indications the input bridge rectifier is shorted.

Figure 6-1 depicts a method for checking the power transistors for a short (most common failure). Input diodes may be checked in the same manner at terminals L1, L2, and L3. A shorted device will exhibit low resistance (0-10 ohms).

WARNING

IN-CIRCUIT OHMMETER CHECKS MUST BE PERFORMED WITH POWER OFF AND DC BUS DISCHARGED.

NOTE

A shorted device in a bridge configuration has probably overstressed other devices in that bridge. The entire module must be replaced.

These tests may not determine the true condition of a transistor or diode. When readings fall into the questionable or fault areas, do not replace the device until a comparison test is made with a known good device or similar device(s) in the same circuit. Always use the same meter when performing comparison tests.

Table 6.2 shows transistor module outline and equivalent circuit according to the inverter HP rating.

4U6.FIG4.1 - .75

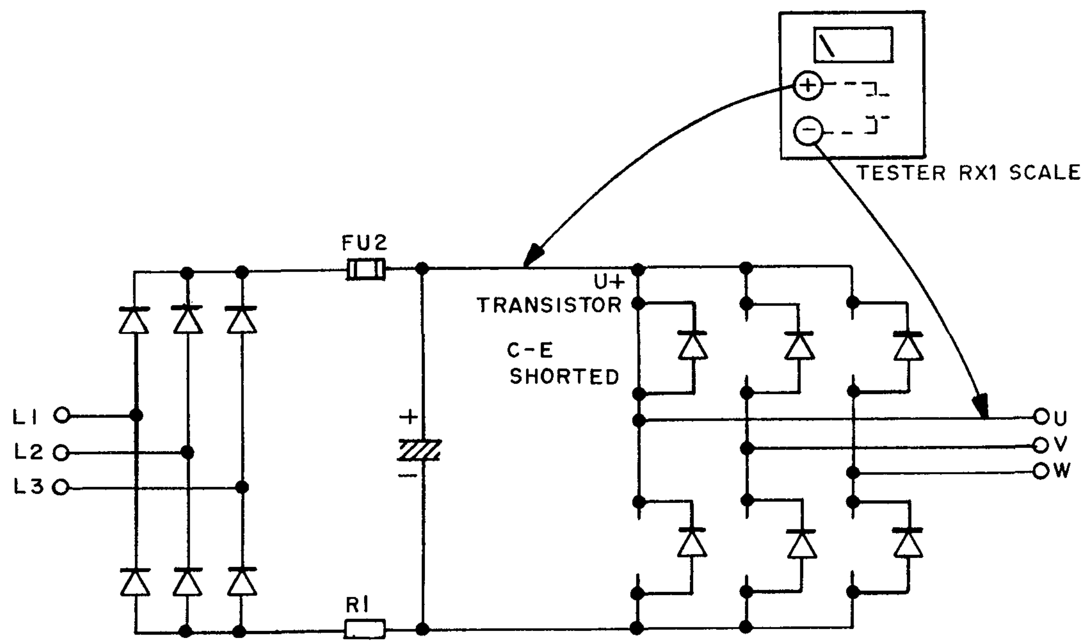


Figure 6-1. Transistor Test Procedure

Table 6.2. Transistor Modules

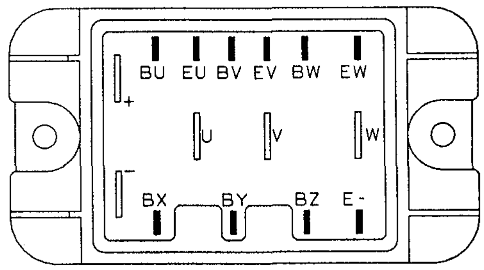
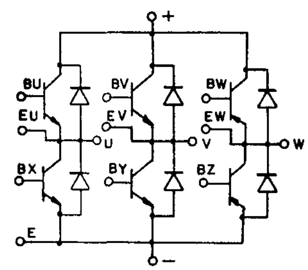
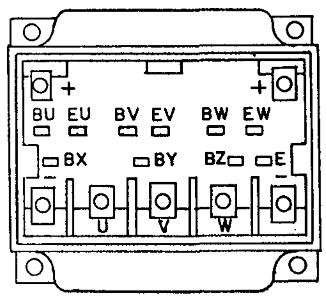
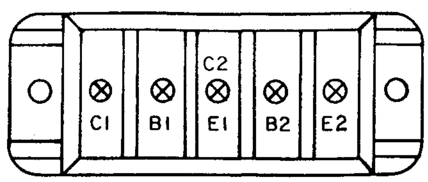
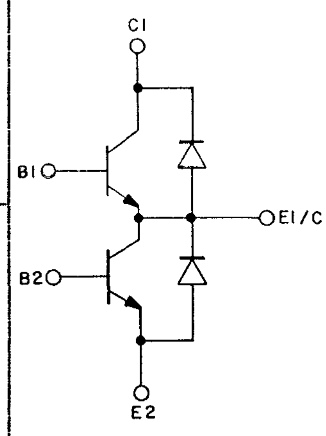
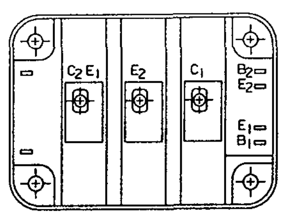
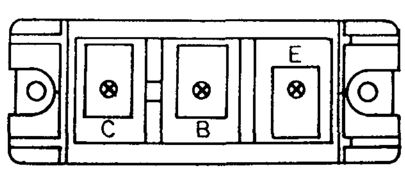
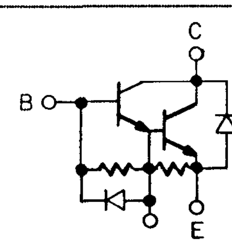
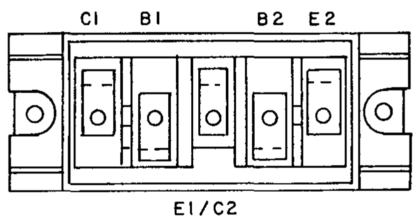
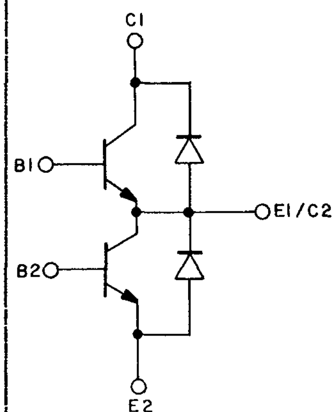
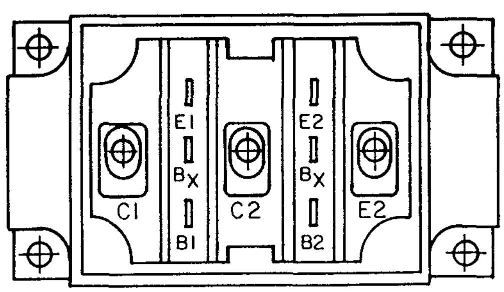
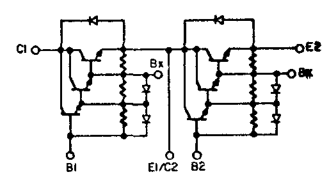
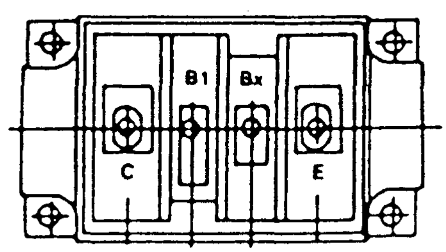
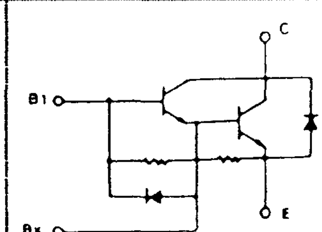
(208/230 VAC UNITS)			
HP RATING	MODULE PART NUMBER	ELECTRICAL CONNECTION DIAGRAM	SCHEMATIC DIAGRAM
0.75 1	MG15G62L1		
2	MG20G6EL1		
3	MG30C6EL1		
5	MG50C6EL1		
7	MC75H2CL1		
10	MG100H2CL1		
15 20	QM150DY-H		
25 30 40	MG200H1AL2		

Table 6.2. Transistor Modules (Continued)

(460 VAC UNITS)			
HP RATING	MODULE PART NUMBER	ELECTRICAL CONNECTION DIAGRAM	SCHEMATIC DIAGRAM
1 2 3	MG25M2CK2		
5 7.5 10	MG50M2CK2		
15	MG75M2CK1		
20 25 30	MG150M2CK1		
40 thru 100	MG300N1FK1		

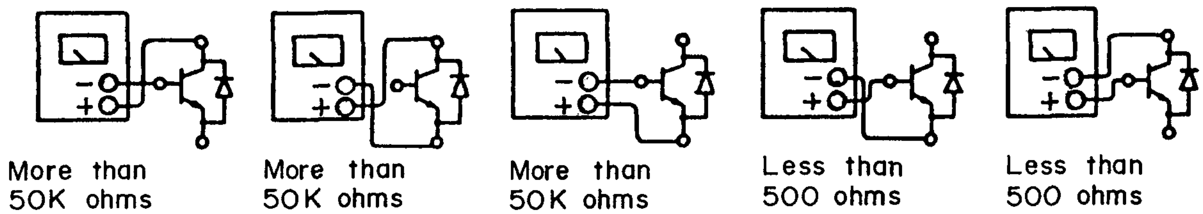


Figure 6-2. Ohmmeter Readings

Figure 6-2 shows correct ohmmeter readings for a good transistor.

Check the polarity of the internal battery at the ohmmeter terminals, and measure the resistance with the above polarity.

The ohmmeter should be on R x 1K scale. If a reading is in doubt, compare with a known good transistor.

6.3 CONTROL CIRCUIT TROUBLESHOOTING

1. Disconnect all input power.

2. Wait at least 5 minutes.

3. Remove the front cover and check that the "CHARGE" LED is extinguished.

CAUTION

THE "CHARGE" LED BEING ILLUMINATED IMPLIES THAT HAZARDOUS DC BUS CAPACITOR POTENTIAL STILL EXISTS. AS AN ADDED SAFETY MEASURE, AFTER THE "CHARGE" LED EXTINGUISHES, VERIFY THAT THERE IS NO LONGER A CHARGE BY MEASURING THE POTENTIAL ACROSS CAPACITOR C1 WITH A VOLTMETER.

Control Circuit problems can be caused by miswiring. Table 6.3 shows typical waveforms associated with good operation.

Transistor failure sometimes damages the base amplifier circuit. Checking the base amplifiers after transistor replacement is a good practice:

1. Remove input voltage at terminals L1, L2 and L3, but keep control voltage applied at terminals R23 (or R20) (208/230 VAC units) or R46 (460 VAC units) and T1.

2. Run the inverter and check base pulses with an oscilloscope. the ground lead of the scope should be connected to the emitter and the probe on the base. Connectors CN5 to CN8 provide access for measurement. Check all six base amplifier voltages. Figure 6-3 shows normal levels for proper operation.

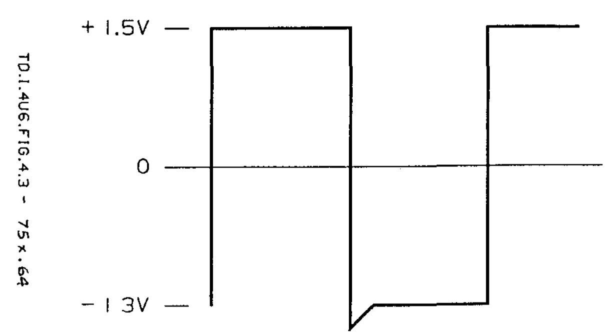


Figure 6-3. Base Pulse

Table 6.3. Control Circuit Test Points And Waveforms

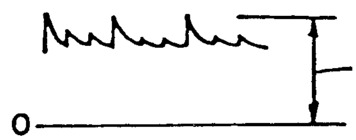
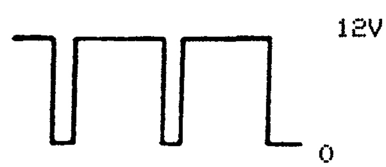
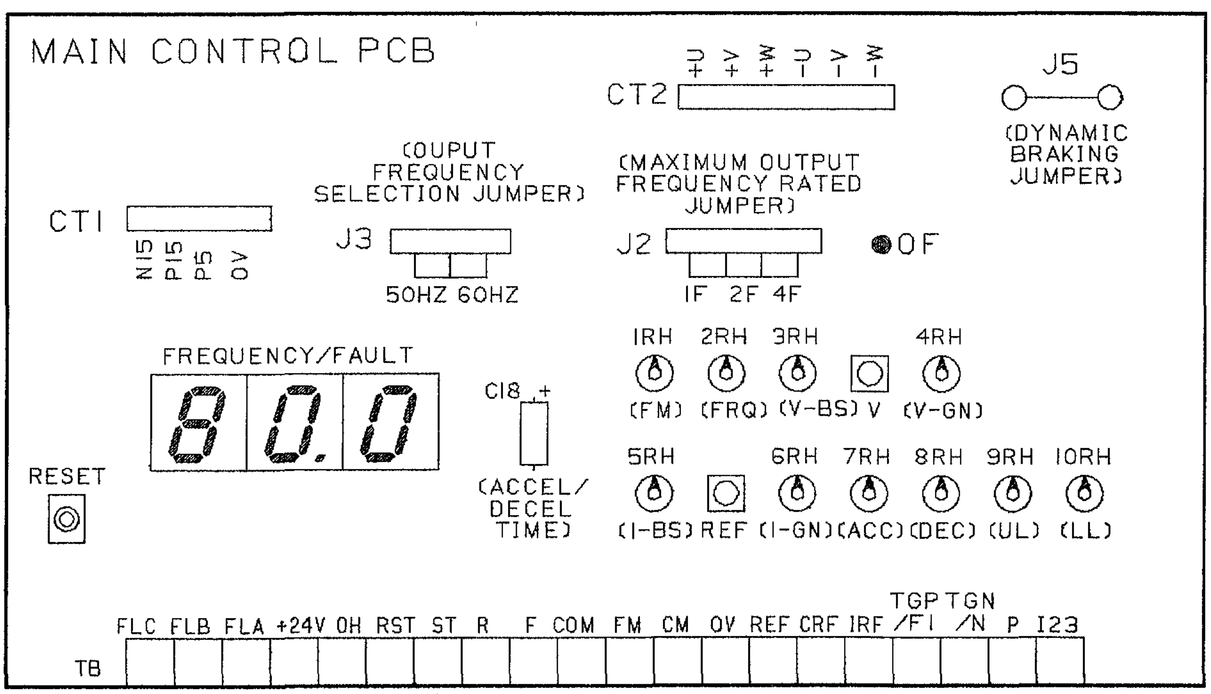
CONTROL PCB TEST POINT (FIGURE 6-4)	FUNCTION	NORMAL READING OR WAVEFORM
Connector CT2 Pin +U +V +W -U -V -W	Base Driver Circuit Input Signal	PWM Signal of Sinusoidal Wave Distribution 
Terminal CM (with respect to terminal COM)	Current Feedback Rate Signal	Waveform repeated every 60°  Approx. 3.5V (under 100% load)
Test Point OF (Open collector; Use pullup 20K ohm resistor in test lead)	F/V Converter Output Signal	J2 Pos. — Frequency 1F — 1152 x inverter freq. 2F — 576 x inverter freq. 4F — 288 x inverter freq.  Approx. 77% duty cycle.
Test Point V	A/D Converter Input Voltage Signal	Approx. 5V at this test point indicates maximum output voltage.

Table 6.3. Control Circuit Test Points And Waveforms
(Continued)

CONTROL PCB TEST POINT (FIGURE 6-4)	FUNCTION	NORMAL READING OR WAVEFORM
Connector CT1 Pin P15	Control Voltage +15 VDC	+15 VDC 0
Connector CT1 Pin N15	Control Voltage -15 VDC	0 -15 VDC
Connector CT1 Pin P5	Control Voltage +5 VDC	+5 VDC 0
Connector CT1 Pin 0	Control Voltage 0V.	0V. COMMON



TD.I.4U6.FIGJ.I

Figure 6-4

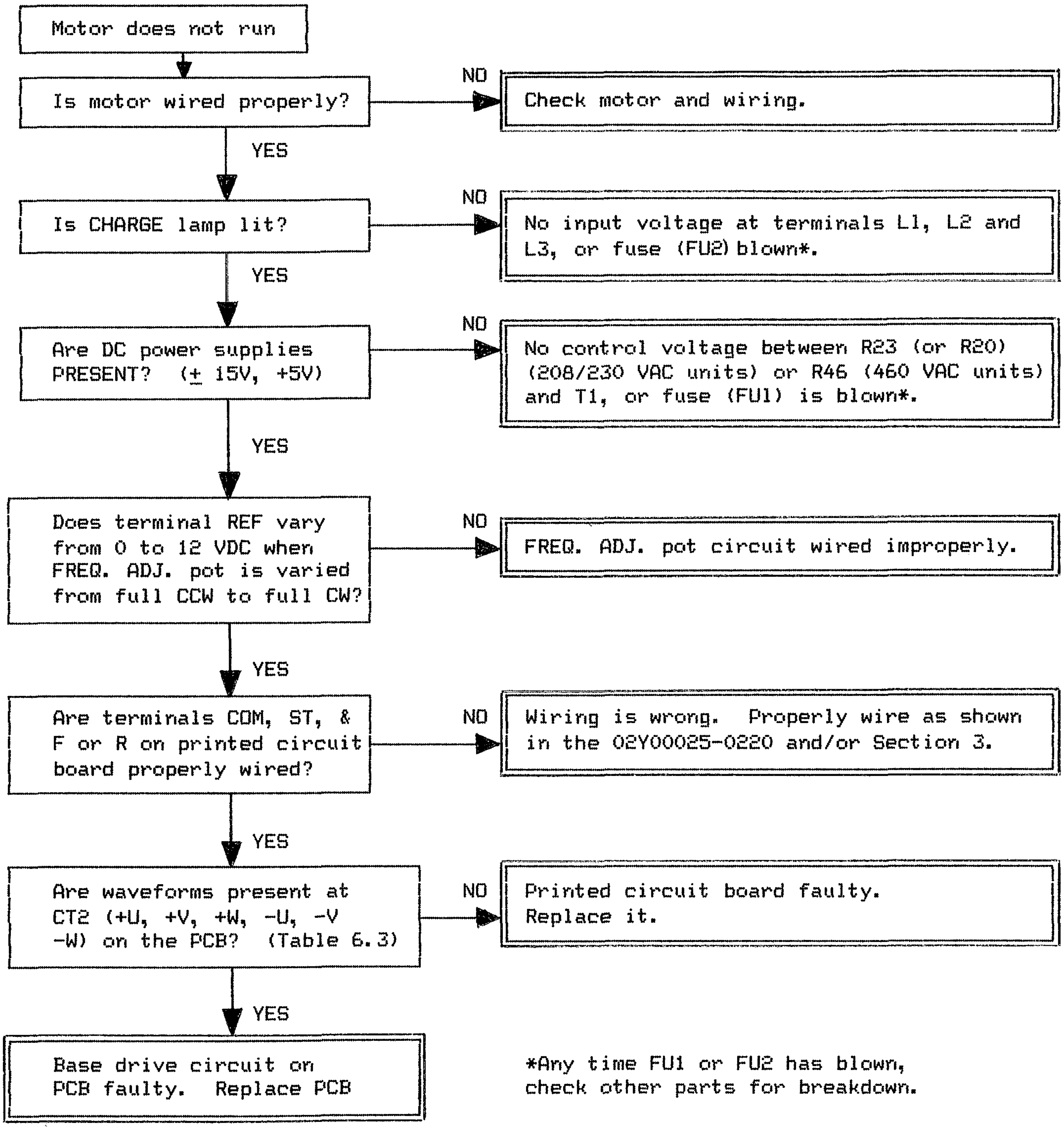


Figure 6-4. Troubleshooting Flow Chart: Motor Does Not Run

SECTION 7. SPARE PARTS

7.1 GENERAL

Louis Allis recommends the customer stock on site spare parts to minimize costly down time. Prices may be obtained from your local Louis Allis District Office.

Table 7.1 lists parts which have a high probability of needing replacement, such as fuses and PCBs.

Table 7.2 lists parts which have a lower probability of needing replacement, but which according to economic analysis, the customer may deem necessary to stock on site.

Table 7.1. Spare Parts - High Replacement Probability

(208/230 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
CONTROL POWER FUSE	FU1	0.75 THRU 5	BUSSMAN AGC-2A 2 AMPS, 250 VAC	5
		7.5 THRU 40	BUSSMAN FGA-3A 3 AMPS, 250 VAC NON-TIME DELAY	
DC BUS FUSE	FU2	0.75	BUSSMAN ABC-8A	5
		1	BUSSMAN ABC-10A	
		2	BUSSMAN ABC-15A	
		3	BUSSMAN KLM-20A 20 AMPS, 600 VAC/500 VDC FAST ACTING	
		5	BUSSMAN KLM-30A 30 AMPS, 600 VAC/500 VDC FAST ACTING	
AC LINE FUSE	FUR FUS FUT	7.5, 10	BUSSMAN FWX-100 75 AMP, 250 VAC SEMICONDUCTOR	5

Table 7.1. Spare Parts - High Replacement Probability (Continued)

(208/230 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
AC LINE FUSE (Continued)	FUR FUS FUT	15, 20	BUSSMAN FWX-100 100 AMP, 250 VAC SEMICONDUCTOR	5
		25	BUSSMAN FWX-150 150 AMP, 250 VAC SEMICONDUCTOR	
		30	BUSSMAN FWX-175 150AMP, 250 VAC SEMICONDUCTOR	
		40	BUSSMAN FWX-200 200 AMP, 250 VAC SEMICONDUCTOR	
CONTROL CIRCUIT PCB	NA	0.75 THRU 5	ARNI-889A (OLD) ARNI-889D (NEW)	1
		7.5 THRU 40	ARNI-889B (OLD) ARNI-889E (NEW)	
MAIN CIRCUIT PCB	NA	0.75	ARNI-892A*	1
		1	ARNI-892B*	
		2	ARNI-892C*	

*ARNI-892A, B, or C has appropriate R21, HCT, GTR7, and MS1 already mounted.

Table 7.1. Spare Parts - High Replacement Probability (Continued)

(208/230 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
BASE DRIVE PCB	NA	3, 5	ARNI-891A	1
		7.5 THRU 20	ARNI-913B	
		25 THRU 40	ARNI-915B	

TABLE 7.1. Spare Parts - High Replacement Probability (Continued)

(460 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
CONTROL POWER FUSE	FU1	1 THRU 5	KTK-R-3A	1
		7.5 THRU 30	PC1-3A	
		40, 50	PC1-5A	
		60 THRU 100	PC1-10A	
DC BUS FUSE	FU2	1 THRU 5	BUSSMANN FWP20 20 AMPS, 720VAC ULTRA FAST ACTING SHORT-CIRCUIT PEAK CURRENT LIMITING SEMICONDUCTOR	1
		7.5, 10	BUSSMANN FWP40	
		15	BUSSMAN FWP60	
		20, 25	BUSSMAN FWP80	
		30	BUSSMAN FWP100	
		40, 50	BUSSMAN FWP150	
		60	BUSSMAN FWP200	
		75	BUSSMAN FWP250	
		100	BUSSMAN FWP300	

TABLE 7.1. Spare Parts - High Replacement Probability (Continued)

(460 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
AC LINE FUSE	FUR	7.5, 10	BUSSMAN FWH40	3
	FUS	15	BUSSMAN FWH60	
	FUT	20, 25	BUSSMAN FWH80	
		30	BUSSMAN FWH100	
		40, 50	BUSSMAN FWH150	
		60	BUSSMAN FWH200	
		75	BUSSMAN FWH250	
		100	BUSSMAN FWH300	
CONTROL CIRCUIT PCB	N/A	1 THRU 15	ARNI-889B (OLD) ARNI-889E (NEW)	1
		20 THRU 30	ARNI-889C (OLD) ARNI-889F (NEW)	
		40 THRU 100	ARNI-889F	
BASE DRIVE PCB	N/A	1 THRU 3	ARNI-891D	1
		5	ARNI-891E	

TABLE 7.1. Spare Parts - High Replacement Probability (Continued)

(460 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER	RECOMMENDED STOCKED QUANTITY PER DRIVE
DESCRIPTION	DESIGNATION			
BASE DRIVE PCB (Continued)	N/A	7.5, 10	ARNI-915C	1
		15	ARNI-915D	
		20, 25	ARNI-910C	
		30	ARNI-910C (OLD) ARNI-910D (NEW)	
		40, 50	ARNI-910D	
		60 THRU 100	ARNI-910E	

TABLE 7.2. Spare Parts - Low Replacement Probability

(208/230 VAC UNITS)				
PART			INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION		DESIGNATION		
RESISTOR	1 ohm	R21	3, 5	SCH30G
	4.7 ohm		7.5, 10	CRF21G
	2 ohm		15, 20	SCS0H40
	2 ohm		25 thru 40	SCH40G
INVERTER TRANSISTOR		GTR1 (6-in-1 module)	0.75, 1	MG15G6EL1
			2	MG20G6EL1
			3	MG30G6EL1
			5	MG50G6EL1
		GTR1 GTR2 GTR3 (2-in-1 module)	7.5	MG75H2CL1
			10	MG100H2CL1
			15, 20	QM150DY-H
		GTR1-GTR6 GTR1A-GTR6A	25 thru 40	MG200H1AL2

Table 7.2. Spare Parts - Low Replacement Probability (Continued)

(208/230 VAC UNITS)			
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION	DESIGNATION		
RECTIFIER MODULE	REC1 REC2	0.75 thru 2	10J4B41
		3, 5	25J4B41
	REC 1	7.5 THRU 20	100L6P41
	REC 1 - REC 3	25 THRU 40	160L2G41
COOLING FAN	FAN	7.5 THRU 20	109-008
	FAN 1, FAN 2	25 THRU 40	
CONTROL CIRCUIT TRANSFORMER	T1	0.75 THRU 2	5P3N0147P37
		3, 5	5P3N0147P38
		7.5 THRU 20	5P3N0147P40
		25 THRU 40	5P3N0147P42
THERMOSTAT	TM1	7.5 THRU 40	US-602AYTFL
AC TIMER	ACT	7.5 THRU 40	ACT-1A

TABLE 7.2. Spare Parts - Low Replacement Probability (Continued)

(208/230 VAC UNITS)			
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION	DESIGNATION		
HALL EFFECT CURRENT TRANSFORMER	HCT	0.75, 1	LC5*
		2	LC6*
		3, 5, 20	NNC-20CTS 100A/4
		25	NNC-20CTA 125A/4
		40	NNC-20CTA 185A/4

*Mounted on Main Circuit PCB - See Table 7.1.

Table 7.2. Spare Parts. Low Replacement Probability (Continued)

(460 VAC UNITS)				
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION	DESIGNATION		
RESISTOR 5.1 ohm	R21	1 THRU 5	SCH30G
20 ohm		7.5, 10	SCH40G
10 ohm		15	SCH40G
	R21, R21A	40, 50	SCH40G
3.9 ohm	R21	20 THRU 30	SCH40G
	R21, R21A	60, 100	SCHN110
6.2 ohm		75	
INVERTER TRANSISTOR	GTR1 GTR2 GTR3 (2-in-1 module)	1 THRU 3	MG25M2CK2
		5 THRU 10	MG50M2CK2
		15	MG75M2CK1
		20 THRU 30	MG150M2CK1 (OLD) MG150N2CK1 (NEW)
	GTR1-GTR6	40, 50	MG300N1FK1

Table 7.2. Spare Parts - Low Replacement Probability (Continued)

(460 VAC UNITS)			
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION	DESIGNATION		
INVERTER TRANSISTOR (Continued)	GTR1-GTR6 GTR1A-GTR6A	60 THRU 100	MG300N1FK1
RECTIFIER MODULE	REC	1 THRU 10	30U6P4
		15	50U6P41
		20 THRU 30	100U6P41
	REC1-REC3	40, 50	160U2G41
	REC1-REC3 REC1A-REC3A	60 THRU 100	
COOLING FAN	FAN	15	109-008
	FAN1,FAN2	20 THRU 30	
	FAN	40, 50	
	FAN1, FAN2	60 THRU 100	EP145D
TRANSFORMER	T1	1 THRU 5	5P3N0147P48
		7.5 THRU 15	5P3N0147P44
		20 THRU 30	5P3N0147P30

Table 7.2. Spare Parts - Low Replacement Probability (Continued)

(460 VAC UNITS)			
PART		INVERTER HP RATING	LOUIS ALLIS PART NUMBER
DESCRIPTION	DESIGNATION		
TRANSFORMER (Continued)	T1	40 THRU 50	5PN0155P23
		60 THRU 100	5P3N0155P26
THERMOSTAT	TM1	15 THRU 100	US-602AYTFL
AC TIMER	ACT	7.5 THRU 100	ACT-1A
HALL EFFECT CURRENT TRANSFORMER	HCT	1 THRU 7.5, 30	NNC-20CTA 75A/4
		10, 20	NNC-20CTA 100A/4
		15	NNC-20CTA 150A/4
		25	NNC-20CTA 65A/4
		40	NNC-20CTA 185A/4