

# **MS SERIES**

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AC POWER SOURCE

## **OPERATIONS MANUAL**



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3060-MS

SOLID-STATE AC POWER SOURCE/FREQUENCY CONVERTER

INSTALLATION AND OPERATION MANUAL

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MANUAL PART NO. 126350-10

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## **1.0 SCOPE**

### **1.1 MANUAL DESCRIPTION**

This manual is written to provide the information required to use the MS-Series AC Power Source effectively. This manual is an Operations Manual. Installation, operation and maintenance are principal subjects of this manual.

### **1.2 USING THIS MANUAL**

This manual primarily covers installation and operation. It is very important that the user reads Section 3, INSTALLATION and Section 4, OPERATION, prior to installing this equipment. A thorough understanding of these two sections is required to operate this equipment properly.

If questions arise while reading this manual, the user is encouraged to call Pacific Power Source Inc. Pacific maintains a toll-free number which is 1-800-854-2433 (949-251-1800 Outside the USA) or Fax 949-756-0756.

Section 5 discusses maintenance, Section 6 is for service. These sections need to be read only when such activities are required to be performed.

### 1.3 SAFETY NOTICES

The MS-Series equipment is capable of transferring very large amounts of electrical energy very quickly. This basic quality is fundamental to a high-performance power source. The warnings and cautions listed below should be observed at all times.

Warnings indicate potentially hazardous situations which, if not avoided, could result in death or serious injury. All warnings throughout this manual will be formatted as shown below.



## **WARNING**

THIS EQUIPMENT CONTAINS HIGH ENERGY, LOW IMPEDANCE CIRCUITS!! LETHAL POTENTIALS ARE CONTAINED WITHIN THE CABINET.

CARE MUST BE EXERCISED WHEN SERVICING THIS EQUIPMENT IN ORDER TO PREVENT SERIOUS OPERATOR INJURY OR EQUIPMENT DAMAGE.

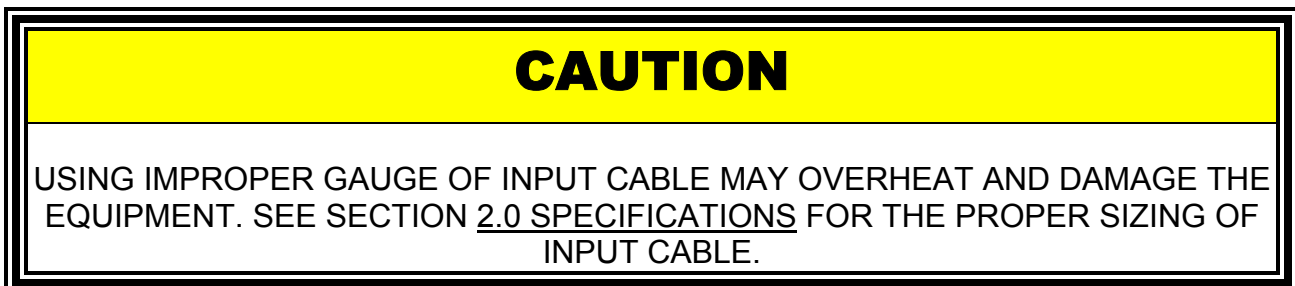
OBSERVE THE FOLLOWING WHEN SERVICE AND MAINTENANCE ARE REQUIRED:

- 1) REMOVE ALL JEWELRY FROM ARMS AND NECK WHEN SERVICING THIS EQUIPMENT. THIS PREVENTS THE POSSIBILITY OF SHORTING THROUGH THE JEWELRY AND CAUSING BURNS TO THE OPERATOR.
- 2) WEAR SAFETY GLASSES WHEN SERVICING THIS EQUIPMENT TO PREVENT EYE INJURY DUE TO FLYING PARTICLES CAUSED BY ACCIDENTAL SHORT CIRCUIT CONDITIONS.
- 3) DO NOT REMOVE ANY PANEL OR COVER WITHOUT FIRST REMOVING THE INPUT SERVICE BY OPENING ALL CIRCUIT BREAKERS.
- 4) SERVICE OTHER THAN EXTERNAL CLEANING SHOULD BE REFERRED TO PERSONNEL AUTHORIZED BY THE FACTORY TO SERVICE THIS EQUIPMENT.

Cautions indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It also may be used to alert against unsafe practices. Cautions will assume the format shown below. All cautions should be rigorously observed.



To protect equipment from damage a caution will be used as follows:



#### 1.4 GENERAL PRODUCT DESCRIPTION

The intended use of the Pacific Power Source MS-Series equipment is basic frequency or voltage conversion with manually adjustable settings. The MS-Series power sources are a family of Line-Conditioners/Frequency-Changers covering the power range from 62.5 to 750 kVA (50 - 600 kW), at power frequencies of 50 - 400 Hz. The basic 62.5 kVA / 50 kW unit is designated as the model 3060-MS. Up to 12 units can be paralleled to provide 750 kVA / 600 kW. With the optional external programmable controller it is suitable for testing applications such as sag, surge, etc.



The 3060-MS functions as a double conversion Power Source. Input AC Power is rectified to DC by a special power supply that provides low input current distortion. That DC power is then converted back to AC by a high frequency pulse-width modulated switcher, under the control of a highly stable digital oscillator.

The 3060-MS unit is designed to provide high quality output power. Output regulation and total harmonic distortion are of the order of 1% at 50 or 60Hz and 2% at 400Hz. Response time to a 100% step load change is 300 microseconds. The machine is therefore capable of delivering very high pulse current loads.

The fast response time and excellent regulation of the MS-Series are extremely important in applications where mixed or switched loads may cause power interference and load "Cross-talk".

MS Series equipment is designed for long term, continuous operation in a sheltered (no rain) environment. Because there are no batteries, it will accept a wide ambient temperature range. The equipment is efficient (about 90%), circulates little cooling air and is relatively tolerant of high dust environments.

Cabinet operation is controlled by simple, highly reliable digital logic. A microprocessor provides internal diagnostics and communicates with the operator via a 160 character digital display.

## 1.5 DEFINITIONS

The paragraphs below provide definition of common terms and components used throughout this manual as they apply to the MS-Series.

<b>Power Source</b>	All components functioning together which convert input AC power to output (isolated, conditioned, variable frequency and variable voltage) AC power to the load.
<b>Cabinet</b>	One enclosure that contains a Power Source.
<b>System</b>	One or more enclosures which make up a Paralleled Cabinet Power Source.
<b>Rectifier</b>	The component that contains the equipment and controls necessary to convert the input AC power to DC power.
<b>Inverter</b>	The component that contains the equipment and controls necessary to convert DC power from the rectifier to AC power required by the load. A high frequency pulse-width modulated switcher.
<b>Internal Control System</b>	The signal processing circuits that regulate the power conversion processes, detect fault conditions, and control the sequence of operation of the Power Source. This term may be shortened to "Control System."
<b>Operator Controls</b>	The controls which are used by the operator to monitor and operate the Power Source. They are located on the front of the cabinet exterior.
<b>Input Power</b>	Power provided by the electrical utility company, or auxiliary generator, connected to the input of the Power Source.
<b>Output Power</b>	Power provided by the Power Source to the load, connected to the output of the Power Source.

## 1.6 DETAILED DESCRIPTION

This paragraph provides a detailed description of each major sub-assembly, its purpose, and its general operation.

### 1.6.1 CABINET

The cabinet consists of a rectifier, three-phase inverter, protective devices, and accessories as required for proper operation.

### 1.6.2 RECTIFIER UNIT

The rectifier unit is a solid-state device designed to provide direct current to the inverter unit.

A 12 pulse input rectifier is used. This reduces current harmonic feedback into the input AC line to a nominal 12%rms. The rectifier also improves the input power factor so that it remains above 0.9 lagging at full load.

A dry type power transformer is used for the rectifier unit. The transformer's hottest spot winding temperature is monitored by the Diagnostic System to ensure that the transformer temperature does not exceed design limits.

The rectifier unit provides a soft start-up feature whereby when the AC power is first applied, the total initial power drawn at the input terminals will not exceed 100% of rated input power.

DC overvoltage protection is provided so that if the DC Bus voltage rises above the pre-set limit, the Power Source will shut down automatically.

DC undervoltage protection is provided so that if the DC Bus voltage drops below the pre-set limit, the Power Source will shut down automatically.

AC overvoltage protection on the AC input circuit shuts down the power source when the input voltage rises above a preset percent of input voltage.

The Low Voltage Power Supply has its own undervoltage protection to shut down the power source should the +18VDC or -18VDC fall below a preset percent of the LVPS bus voltage.

### 1.6.3 INVERTER UNIT

The inverter unit is a solid-state device that derives its power from the DC output voltage of the rectifier to provide the rated AC output within specified limits.

The output frequency of the inverter is controlled by a digital oscillator. The oscillator is adjustable over the range of 47 to 500Hz in the VAR position.

In the fixed frequency positions, the oscillator is also designed to hold the inverter output frequency to  $\pm 0.01\%$  for both steady state and transient conditions. Drift will not exceed  $\pm 0.01\%$  during a 24-hour period. Total frequency deviation, including short time fluctuations and drift, is typically within  $\pm 0.01\%$  from the specified frequency.

The inverter is capable of supporting transient overloads up to 150%, or any continuous load within its rating, without reducing the output voltage. Loads greater than 150% may cause a reduction of the output voltage.

The inverter will current limit at 150% of rated current. The inverter is capable of supplying at least 200% of rated RMS current for short circuit conditions. If the short circuit is sustained, the inverter will shut down and disconnect automatically from the output.

Each inverter output phase is independently regulated to  $\pm 0.5\%$ , with AGC enabled, such that unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance.

An output AC filter is incorporated in the inverter unit. The filter reduces the inverter output sine wave voltage harmonics to 1% RMS total and single harmonics to 0.5% RMS for linear loads at 50-60Hz.

Power semiconductors in the inverter unit are fused with fast acting fuses, so that loss of any one power semiconductor will not cause cascading failures.

In the CE version the output wiring of the inverters, after the output filters, are fused with J Class time delay fuses.

#### 1.6.4 MULTI-CABINET PARALLELED SYSTEM

Up to twelve cabinets may be paralleled together for higher power systems. Each 3060-MS is capable of operating as either a SLAVE or MASTER in multi-cabinet parallel operation. The MTBF of a single cabinet 3060-MS is quite high (approx. 5 years). Parallel system architecture is such that a failed slave unit automatically drops off-line.

A failed MASTER turns the entire system off. In this event an operator can select any other paralleled unit as the MASTER from a front panel control and restore system operation.



## 2.0 SPECIFICATIONS

This section states the electrical and mechanical specifications of the MS Series AC Power Source. General characteristics apply to all MS-Series units. Specifications specific to a particular model number (i.e. output current and power rating) are listed in the appropriate table.

### 2.1 ELECTRICAL SPECIFICATIONS

#### 2.1.1 INPUT POWER

The MS-Series equipment is intended for use on a Category II supply.

Voltage Range	480, 380, 240 or 208 VAC <sub>L-L</sub> ±15%.
Frequency Range	47-63 Hz, other frequencies available as an option.
Magnetizing Sub Cycle	100% of normal full load input, inrush current, maximum.
Power Factor	Not less than 0.9 lagging at full load.
Current	12% THD nominal. Distortion

Input Volts	Input Amps	Recommended Input Service	Taps Available
480	75	80A	Nom, -7%, -10%
380	94	100A	Nom, +5%, +10%, -4%, -8%, -17%
240	150	175A	Nom, -13%
208	170	175A	Nom, +15%, -9%

MODEL NUMBER	INPUT (KVA)	INPUT (KW)
3060-MS	62	57

**FIGURE 2.1.1 INPUT RATINGS**

<b>Input Controls</b>	Input contactors provide input ON-OFF controls. In addition, an input circuit breaker is provided that disconnects all input power from the cabinet.
<b>Protection</b>	Meets National Electrical Code Protection requirements for single phase protection, and reversed phase rotation protection.
<b>Transients</b>	Meets Institute of Electrical and Electronics Engineers 587 requirements at 4000 volts peak. Up to 150% line voltage for ½-cycle.

<b>Phase Rotation</b>	Unit will operate with any input phase rotation. There are no input phase rotation sensitive devices.
<b>Isolation</b>	An input transformer with an electrostatic shield provides isolation between the input and output of the system.
<b>Balance</b>	All three input phases are equally loaded regardless of output phase load unbalance.

### 2.1.2 OUTPUT POWER

<b>Power</b>	50 kW
<b>Volt-Amps</b>	62.5 kVA
<b>Voltage</b>	120/208 3Φ WYE May be loaded WYE or DELTA. 0-132 VAC <sub>L-N</sub> Adjustment Range, with nominal input. Other voltages available as options. Output adjustable by front panel controls.
<b>Voltage Regulation 0-100% Load Step</b>	±1% of output voltage regardless of load unbalance, with AGC enabled.
<b>Transient Voltage Regulation and Recovery</b>	The output voltage recovers from a 50% load step to within 1% of nominal in less than 150 microseconds.
<b>Harmonic Voltage Content for Linear Loads</b>	Maximum 1% RMS total, maximum 0.5% any single harmonic for linear loads 50-60Hz, 2% RMS total for 400Hz. Paralleled Systems maybe higher.
<b>Current</b>	175 amps per phase.
<b>Inverter Fault Clearing Current</b>	Greater than 200% of full load.
<b>Pulse Current</b>	Greater than 200% per phase of pulse current for driving non-linear loads.
<b>Frequency Range</b>	Selectable, crystal based frequencies at 50, 60, 400 Hz. A variable frequency oscillator is included, covering the range 47-500 Hz. In addition, provision is made for an External Oscillator input.
<b>Frequency Accuracy and Stability</b>	±0.01% typically for fixed frequencies.
<b>Frequency Drift</b>	±0.01% for fixed frequencies. (24hr period)
<b>Load Power Factor</b>	No Restrictions.
<b>Inverter Overload:</b>	<ul style="list-style-type: none"> <li>• 150% of full load for 30 seconds</li> <li>• 125% of full load for 10 minutes</li> <li>• 110% of full load for 1 hour</li> </ul>

<b>MODEL NUMBER</b>	<b>Output (KVA)</b>	<b>Output RMS (KW)</b>	<b>Output (CURRENT/Ø)</b>	<b>Output Short Circuit (CURRENT/Ø)</b>
3060-MS	62.5	50	175A	>350A

**FIGURE 2.1.3 OUTPUT RATINGS**

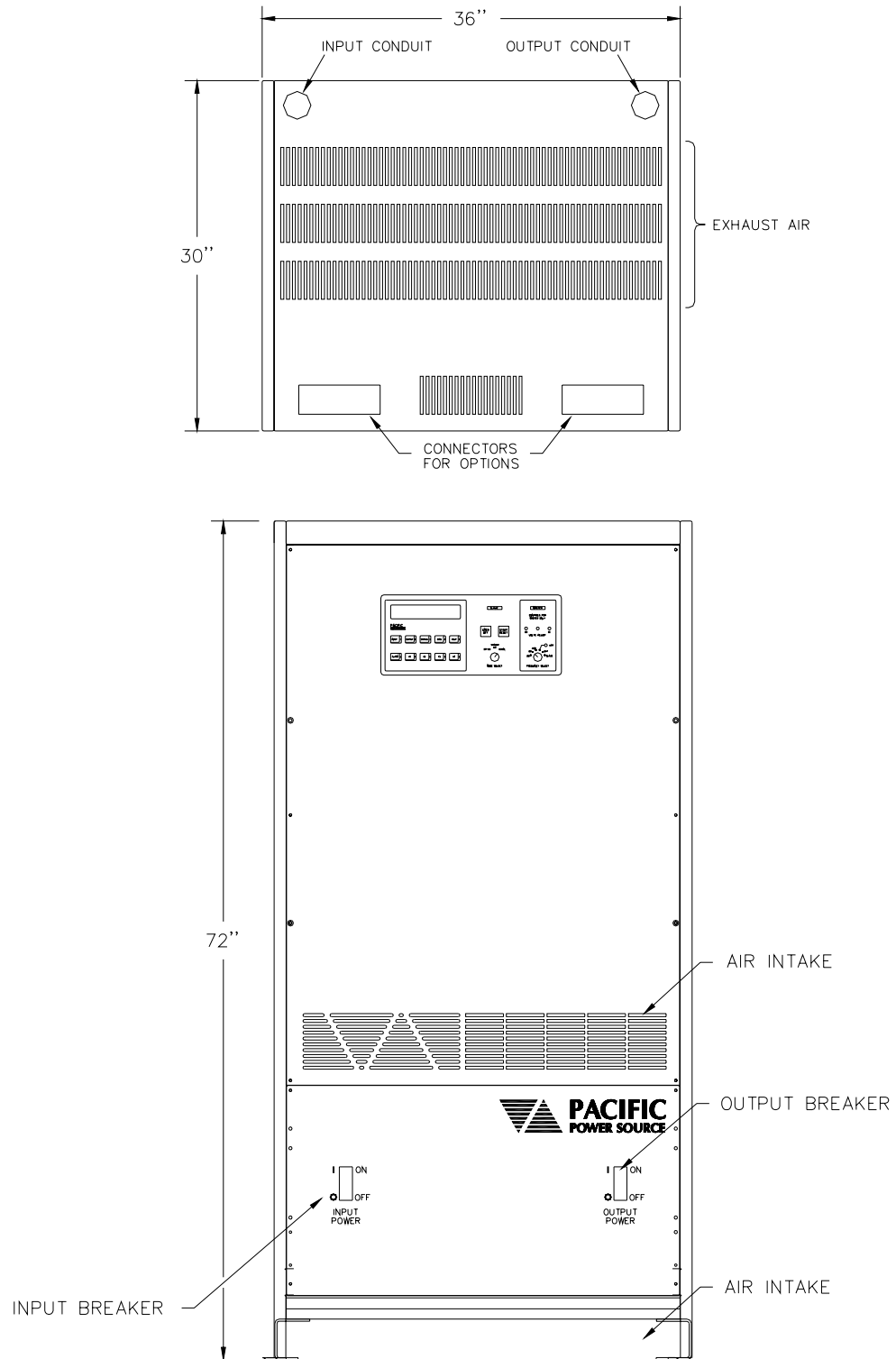
For a paralleled cabinet system multiply the above ratings by the number of cabinets in the system.

## 2.2 MECHANICAL SPECIFICATIONS

<b>Weight</b>	1550 LBS
<b>Height</b>	72"
<b>Width</b>	36"
<b>Depth</b>	30"
<b>Installation Clearance</b>	36" at front of cabinet for service, 12" top, 0" side and rear

## 2.3 ENVIRONMENTAL SPECIFICATIONS

<b>Air Flow</b>	1200 CFM bottom intake, top exhaust
<b>Noise level</b>	65dbA at 3 feet
<b>Ambient Temperature</b>	Operating 0 to 40°C Storage -10 to +70°C
<b>Relative Humidity</b> (non-condensing)	0 to 80% (standard configuration) 0 to 95% (conformally coated PCB option)
<b>Elevation</b>	Operating 6500 Ft.(1970 m) Derate to 70% at 11,500 Ft.(3480 m) Storage 40,000 Ft.(12,120 m)
<b>Heat Dissipation at 50kW, 62.5kVA load</b>	20 kBTU/HR
<b>Pollution Environment</b>	Degree 2 or better Indoor Use Only



**FIGURE 2.2 OUTLINE DRAWING**

### 3.0 INSTALLATION

This section describes the installation of an MS-Series AC Power Source. The information required to properly install MS equipment is provided in this section. A thorough understanding of this material is mandatory.

Should a question arise regarding the installation of this equipment, the user is encouraged to call Pacific Power Source, toll free in the USA at 1-800-854-2433 or 949-251-1800 internationally.

The installation of an MS Power Source consists of the following steps:

1. **Planning the job.** (Refer to paragraph 3.1)
2. **Uncrating and Moving the system.** (Refer to paragraph 3.2)
3. **Changing Input Voltage, if required.** (Refer to paragraph 3.3)
4. **Setting the cabinet into place.** (Refer to paragraph 3.4)
5. **Making Input Connections.** (Refer to paragraph 3.6)
6. **Making Output Connections.** (Refer to paragraph 3.7)
7. **Multiple Cabinet Paralleled Systems.** (Refer to paragraph 3.8)
8. **Inspecting the Installation.** (Refer to paragraph 3.9)

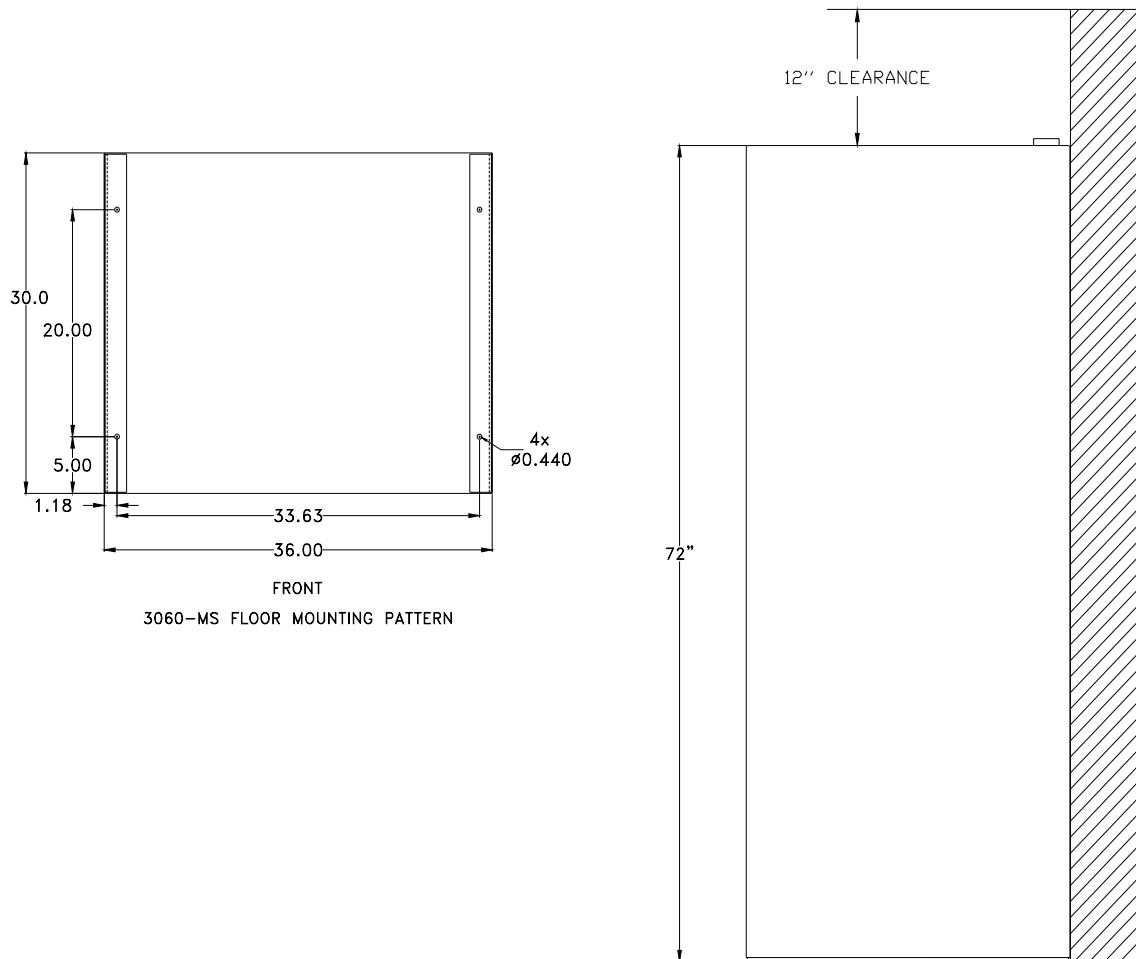
#### 3.1 PLANNING THE JOB

The main objective in planning the job is to determine the hardware required to install the MS-Series Power Source. Proper consideration of the items below will allow the installation to proceed in an orderly manner.

The first step in planning the job is to determine the size of power source required to service the load. In normal situations the load should not exceed 80% of the power source's full load ratings. This margin allows the user to add future loads to the Power Source without sacrificing surge and overload capabilities.

After a particular model has been selected, location of the Power Source, input and output wiring and environmental conditions must be considered. Table 3.1, Environmental Survey Checklist, is provided to verify environmental conditions. Be sure to refer to the clearances required for ventilation in Figure 3.1 for planning the mechanical installation.

The cabinet should be placed as close as possible to the load to minimize output wiring lengths. This is done to reduce distribution losses between the load and power source. Shorter output wiring will provide higher quality power to the load. If there is a choice between shorter power source input or output wiring, choose shorter output wiring. Final equipment location must maintain the minimum physical clearances as shown in Figure 3.1 Installation Detail.



**FIGURE 3.1 INSTALLATION DETAIL – (MECHANICAL CLEARANCES)**

**CHECK AT RIGHT WHEN CONFIRMED**

1. Ambient temperature between 0-40 degrees Centigrade. \_\_\_\_\_
2. Cooling and air exchange rates in the room adequate to support the heat load. \_\_\_\_\_
3. A minimum of 12" above the Cabinet for exhaust. \_\_\_\_\_
4. Unrestricted air intake at the lower front and rear of the cabinet. (Exception: Forced air intake from raised floor installations requires sealing off of the lower front and rear areas. Consult factory.) \_\_\_\_\_
5. A minimum of 24" in front of the Cabinet for service. \_\_\_\_\_
6. Altitude of installation does not exceed 6500 feet. Altitudes in excess of 6500 feet require the derating of maximum operating levels. \_\_\_\_\_
7. Relative humidity does not exceed 80% (95% with conformal coat PCB option) non-condensing. It is suggested that equipment not be located directly under cooling equipment due to the danger of condensing vapor. \_\_\_\_\_

**TABLE 3.1 ENVIRONMENTAL SURVEY CHECKLIST**

### 3.2 MOVING, UNCRATING, AND INSPECTION

Unless specified otherwise, all Pacific MS-Series cabinets will be shipped in one wooden crate, with a crated weight between 1,700-1,800 lbs depending upon the model and options selected. Dimensions and center of gravity can be seen in figure 3.2, Crating and Moving Outline drawing. The weight will be marked on all sides for safe handling. The crate is constructed of wood and designed to be moved with a forklift or hand truck of adequate capacity.

Upon receiving the equipment, remove the packing list. Separate and remove the top then the sides of the crate setting these aside for the moment. Inspect all equipment for signs of damage in shipping. If any damage has occurred, contact the shipper and the Pacific factory for instructions. If the cabinet is to be returned, it must be shipped back in the original crate.

If no signs of damage are evident, the equipment may be removed from the pallet. A forklift is required to lift the cabinets off the pallets. Do not attempt to "rock" or slide them off as damage may occur to the equipment or injury may occur to personnel.

## CAUTION

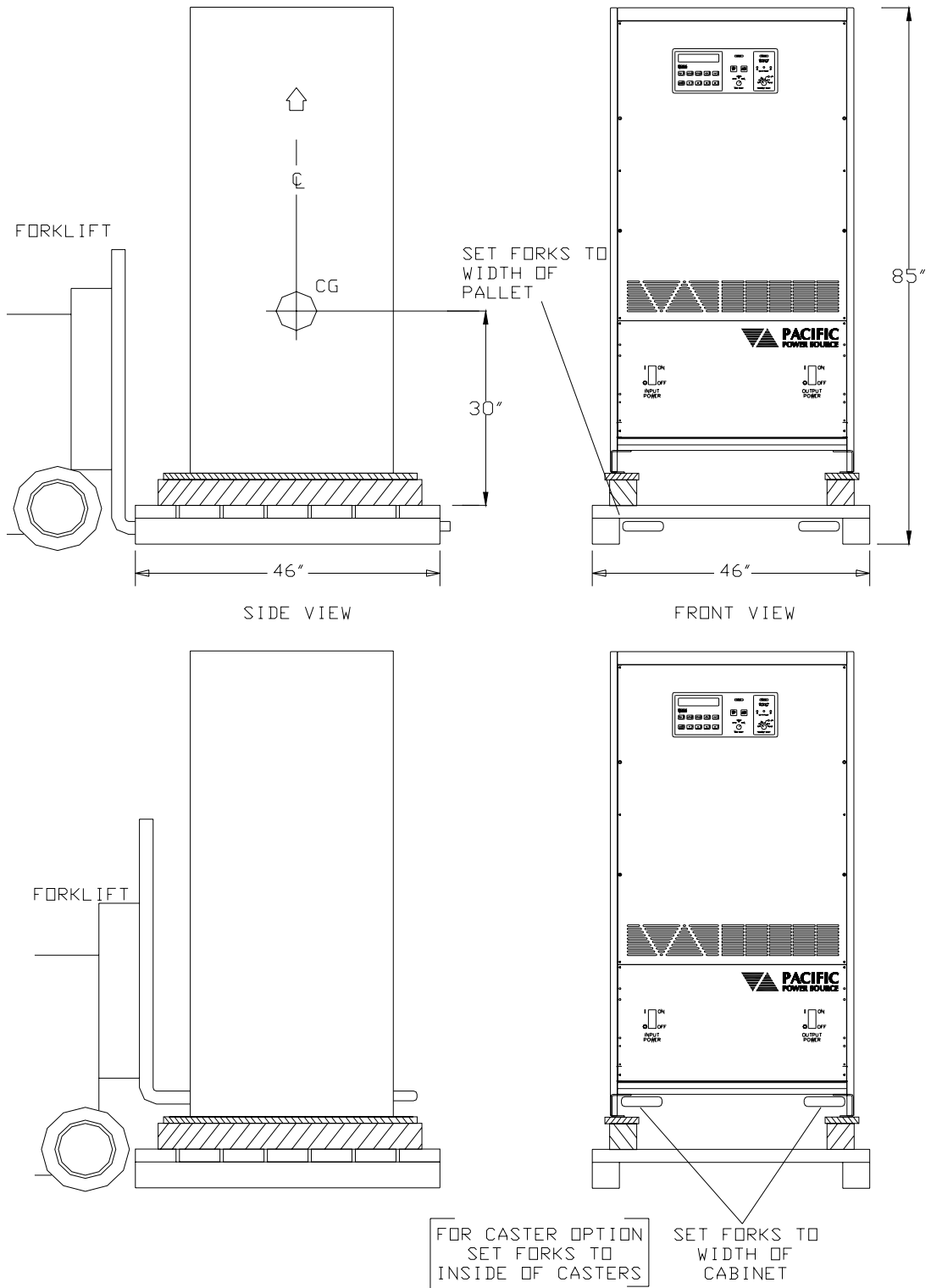
TO AVOID DAMAGE TO THE EQUIPMENT, LIFTING FORKS MUST EXTEND COMPLETELY THROUGH THE LIFTING CHANNEL UNDER THE CABINET AS SHOWN IN FIGURE 3.2, CRATING AND MOVING OUTLINE DRAWING.



## WARNING

**TIP OVER HAZARD.**  
USE CAUTION WHEN MOVING UNITS  
EQUIPPED WITH THE CASTER  
OPTION. THE CENTER OF GRAVITY IS  
RAISED BY 4" AND THE BASE IS  
SMALLER.





**FIGURE 3.2 CRATING AND MOVING OUTLINE DRAWING**

### 3.3 CHANGING INPUT VOLTAGE

This paragraph states the procedure to be used when changing input voltage. All voltages are line to line.

Configure the machine for the correct input voltage prior to installing.


To change input voltage, the input circuit breaker and fuses must be changed. The input transformer, T1, and LVPS transformer, T2, must be reconnected to the correct taps. See figure 3.3.1 through figure 3.3.4.

Each mainframe, dependent upon model number, will require the following Input Circuit Breaker and Fuses:

<u>Input Volts</u>	<u>CB1</u>	<u>F1, F2, F3</u>
480	80 A (P/N 716016)	1 A (P/N 712043)
380	100 A (P/N 716049)	1½ A (P/N 712045)
380 [CE]	100 A (P/N 716084)	1½ A (P/N 712045)
240	175 A (P/N 716057)	2 A (P/N 712044)
208	175 A (P/N 716057)	2 A (P/N 712044)

If a non-standard input is required the machine may be configured for any of the following:

<u>INPUT VOLTAGE</u>	<u>INPUT TAPS</u>	<u>CONNECT TAPS</u>	<u>Fig.</u>	
480	480	1,8	4-5	3.3.1
480-7%	448	1,8	3-5	
480-10%	430	2,8	4-5	
380+10%	416	1,7	3-5	3.3.2
380+5%	398	1,8	3-6	
380	380	2,8	4-6	
380-4%	366	2,7	3-5	
380-8%	348	2,8	3-6	
380-17%	316	2,7	3-6	
240	240	1,8	1-5,4-8	3.3.3
240-13%	208	1,7	1-5,3-7	
208+15%	240	1,8	1-5,4-8	3.3.4
208	208	1,7	1-5,3-7	
208-9%	190	2,8	2-6,4-8	

	<b>WARNING</b>
	<b>ELECTROCUTION HAZARD.</b>  OPENING INPUT CONTACTOR DOES NOT REMOVE INPUT VOLTAGE FROM INPUT TRANSFORMER. OPEN THE INPUT CIRCUIT BREAKER.

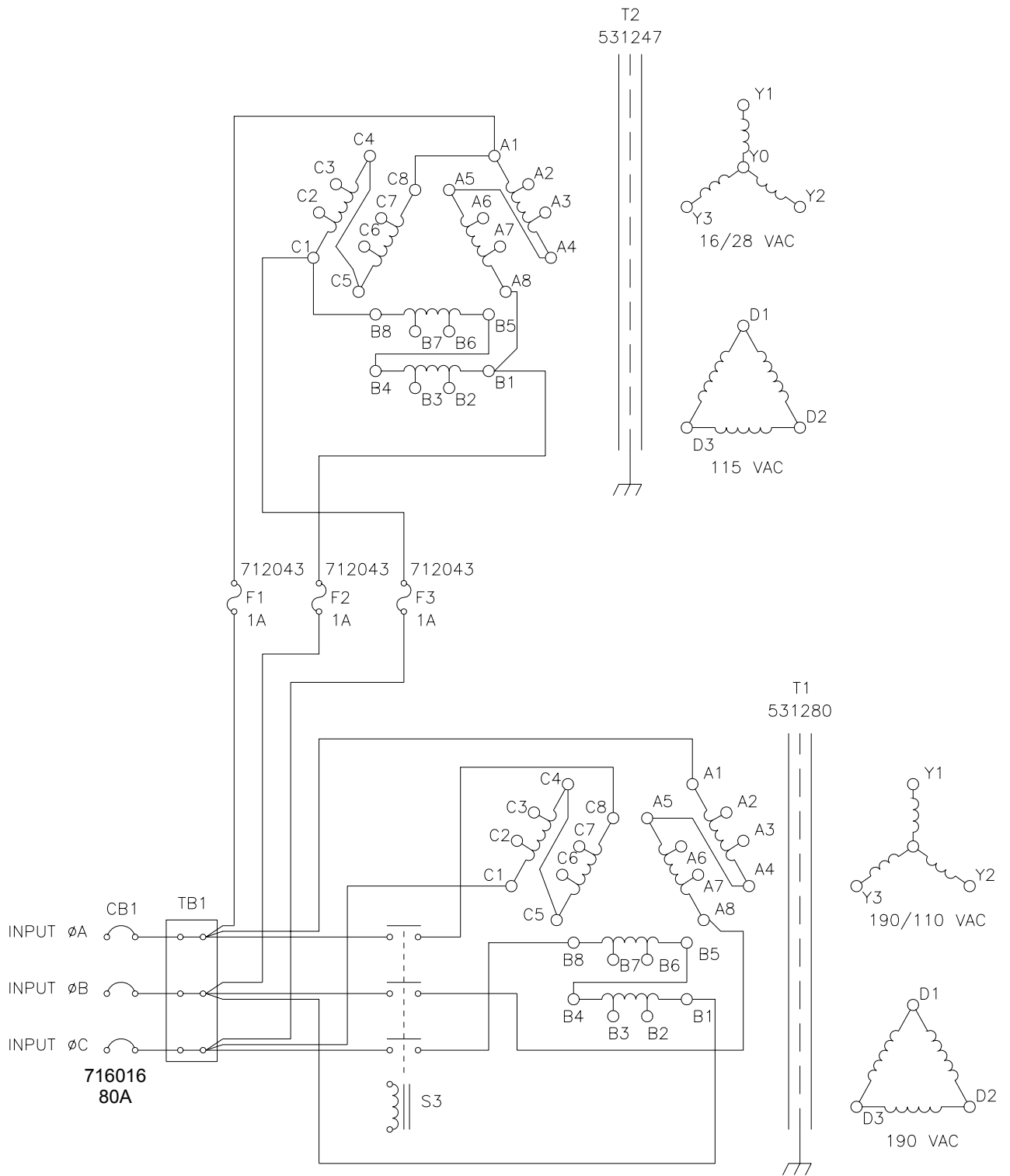
**CHANGING INPUT VOLTAGE**

- STEP 1: Verify no input power is connected.  
Open Input Circuit Breaker.
- STEP 2: Remove front covers.  
Remove sub-panels.  
Remove rear panel.
- STEP 3: Remove old CB1, the input circuit breaker.  
Install new CB1 with correct amperage for new input voltage.
- STEP 4: Remove old F1, F2 and F3, the input fuses.  
Install new fuses with correct amperage for new input voltage.
- STEP 5: Rewire T1 AND T2 as per figure 3.3.1 or 3.3.2 or 3.3.3 or 3.3.4 as required.

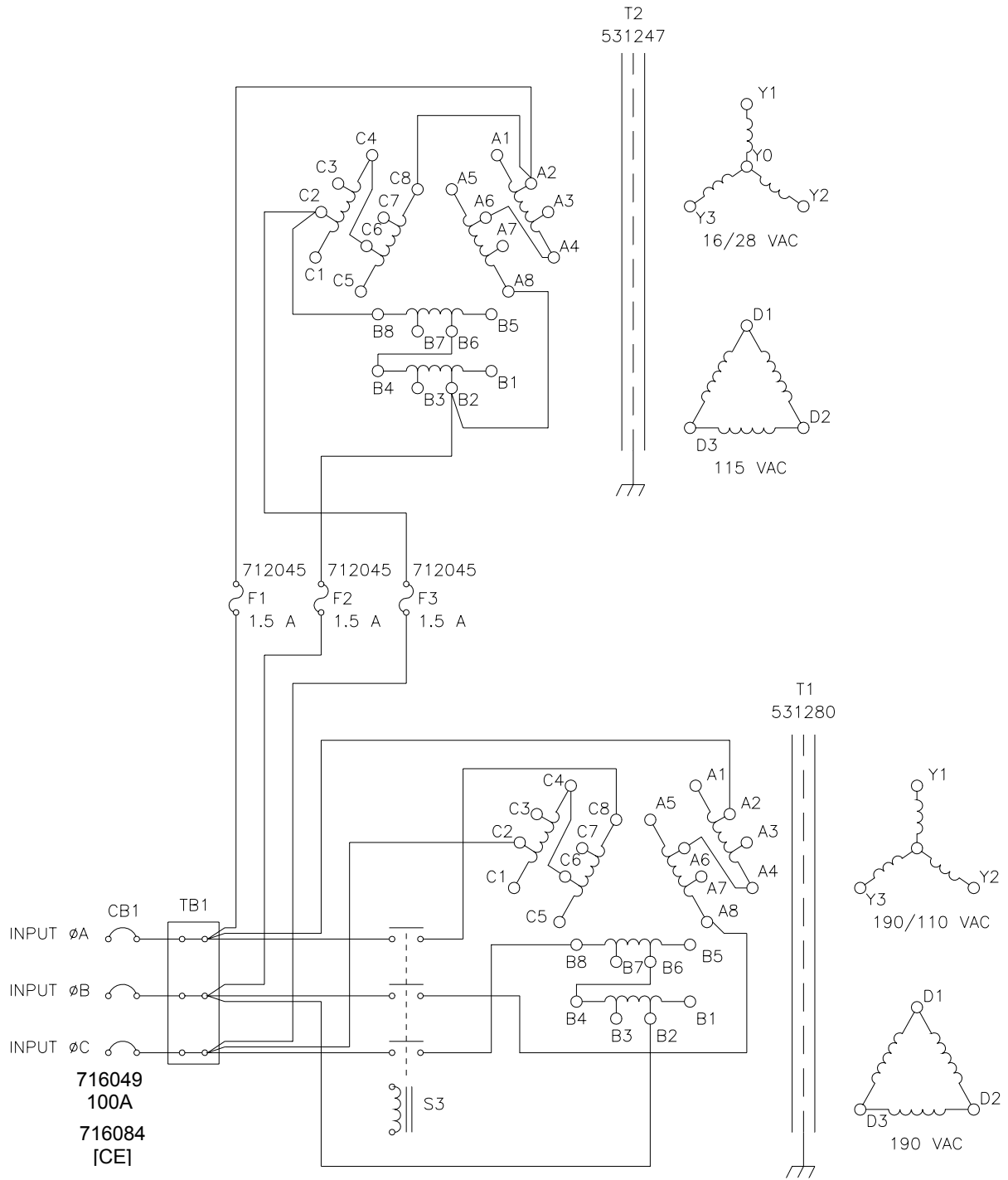
**CAUTION**

DAMAGE TO THE EQUIPMENT MAY RESULT IF INCORRECTLY WIRED. VERIFY CONNECTIONS ARE MADE TO PROPER TAPS.

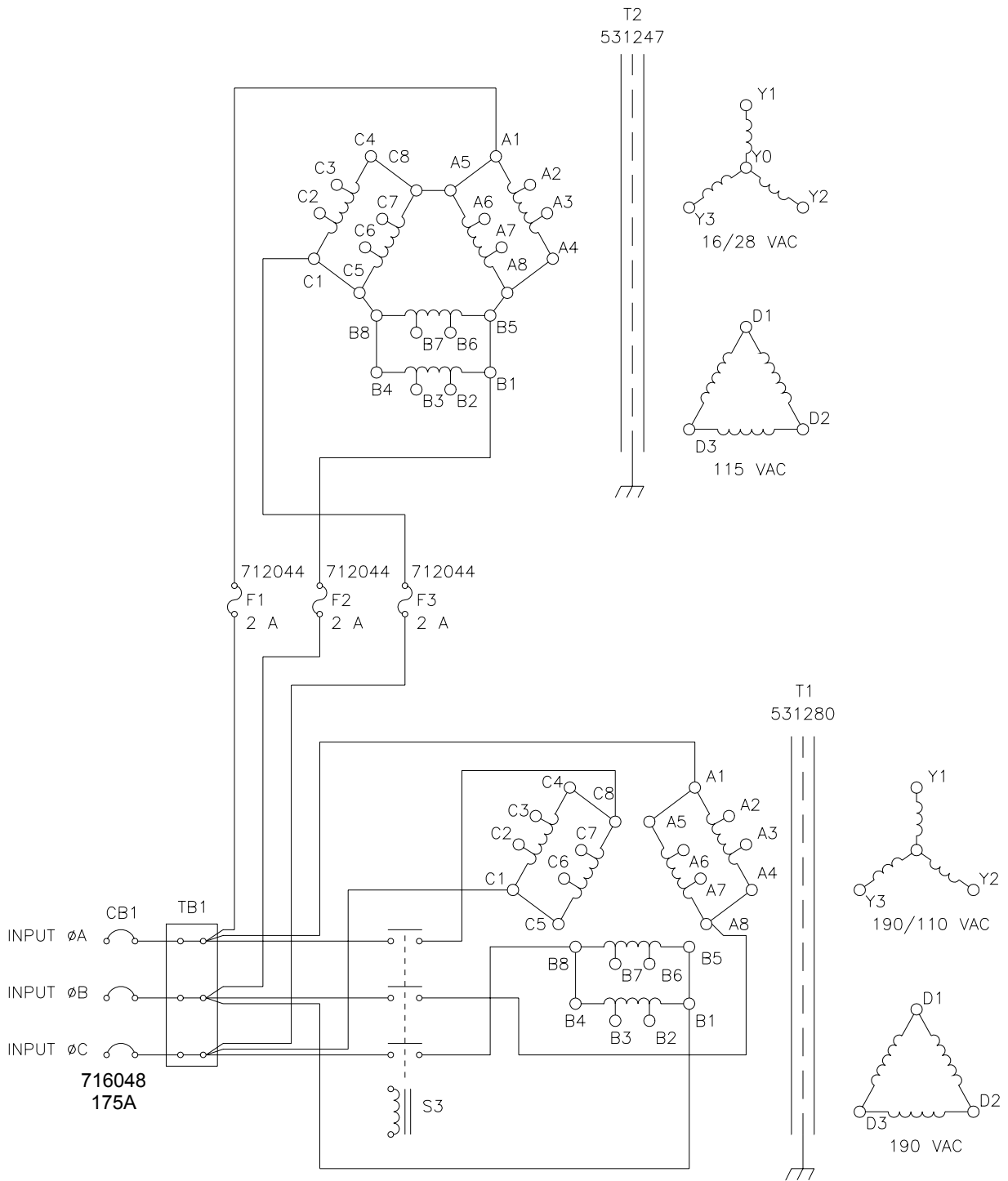
- STEP 6: Reinstall front covers.  
Reinstall sub-panels.  
Reinstall rear panel.
- STEP 7: Go to section 4.3.1 for first time operation.



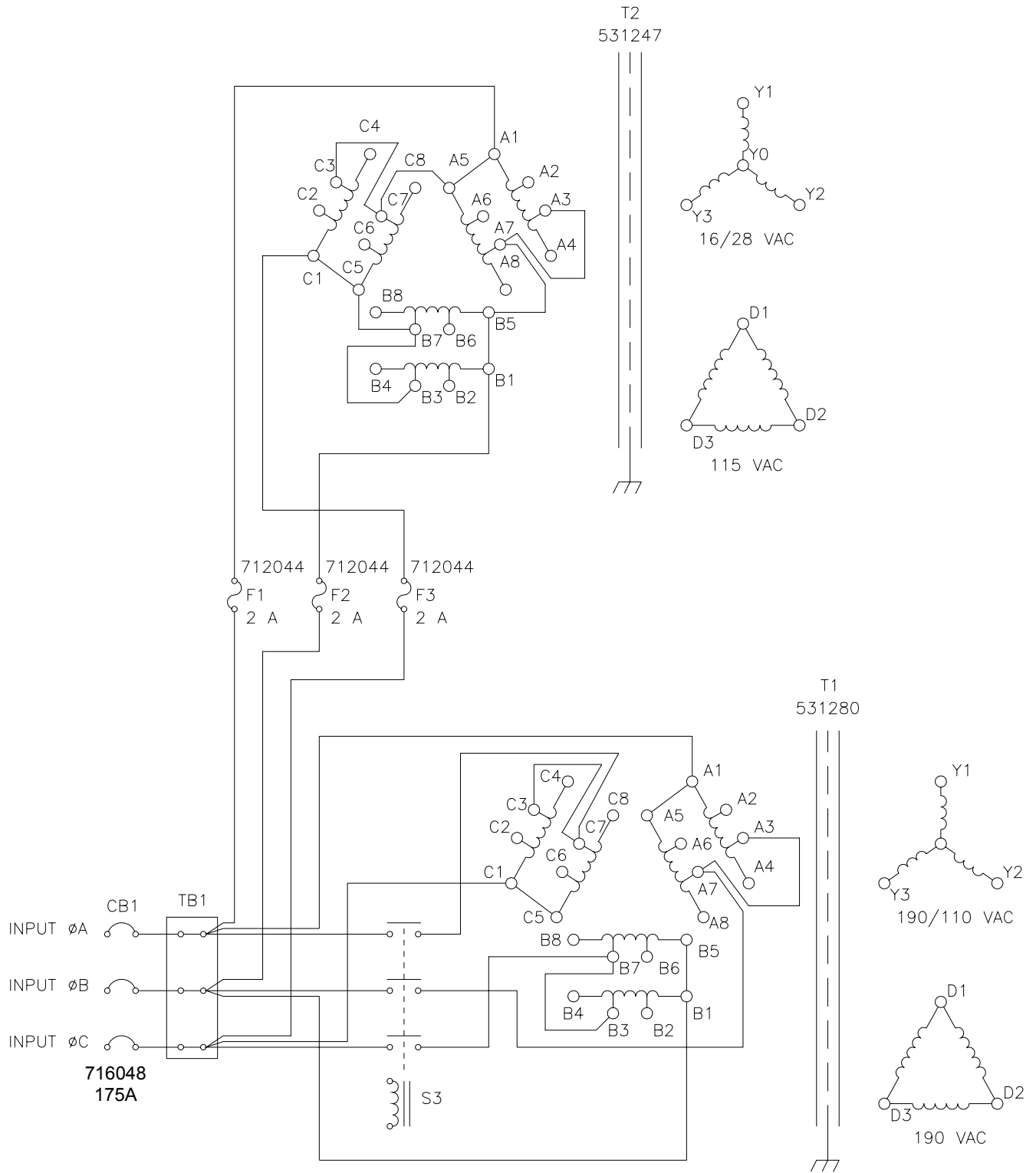
**FIGURE 3.3.1 480 V INPUT CONFIGURATION**



**FIGURE 3.3.2 380 V INPUT CONFIGURATION**



**FIGURE 3.3.3 240 V INPUT CONFIGURATION**



**FIGURE 3.3.4 208 V INPUT CONFIGURATION**

### 3.4 SETTING THE CABINET INTO PLACE

Depending on the site, it may be advisable to rough-in the input and output wiring prior to moving the cabinet into place. This is best evaluated by the installation team and they should proceed appropriately. Observe clearances as shown in Figure 3.1.

### 3.5 SAFETY GROUNDING / EARTHING

Prior to any input power connections the safety ground or earth ground must be connected. Observe minimum wire sizes as stated in TABLE 3.6.1

### 3.6 CONNECTING THE INPUT SERVICE

## NOTE

IT IS THE USER'S RESPONSIBILITY TO MEET ALL APPLICABLE LOCAL AND NATIONAL CODE REQUIREMENTS WHEN INSTALLING THIS EQUIPMENT.



## WARNING

### ELECTROCUTION HAZARD.

LETHAL VOLTAGES PRESENT AT INPUT OF MACHINE. REFER CONNECTION TO A QUALIFIED ELECTRICIAN.

This paragraph states the procedure to be used when connecting the input service. Certain requirements relating to safety are also stated and should be followed rigorously.

The 480 Delta, 60 Hz. voltage form is the standard input of the MS-Series equipment. Each mainframe, dependent upon model number, will draw the following load currents:



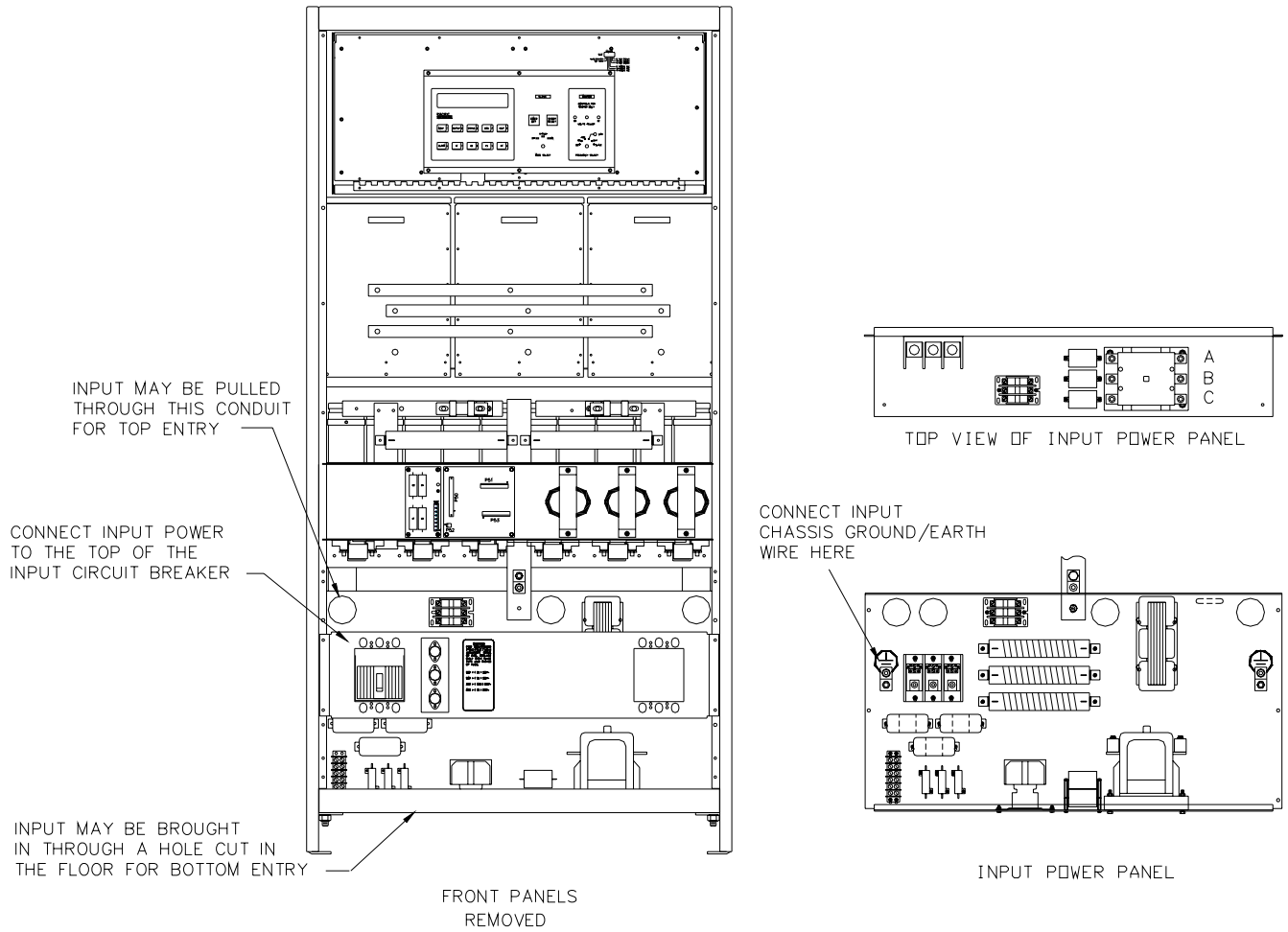
MODEL NUMBER 3060-MS					
INPUT VOLTAGE	FORM	100% LOAD	RECOMMENDED INPUT SVC.	MINIMUM INPUT WIRE SIZE@75°C (167°F) (COPPER CONDUCTOR)	
				AWG	mm <sup>2</sup>
480	DELTA	75A	80A	3	35
380	DELTA	94A	100A	2	35
240	DELTA	150A	175A	1/0	70
208	DELTA	170A	175A	2/0	70
ALL	N/A	N/A	SAFETY GROUND / EARTH	2/0	70

**TABLE 3.6.1 INSTALLATION WIRING**

Input connections to the MS-Series AC Power Source are made at the Circuit Breaker labeled "INPUT POWER." Refer to figure 3.6 AND 3.6.1 for location and orientation of terminals.

The input terminals are compression type. It is very important that the connections are clean and properly tightened. Torque input connector set screws to 55 lb-in [120 lb-in for the CE option].

The MS-Series is not sensitive to input phase sequence.



**FIGURE 3.6 INPUT TERMINAL DETAIL**

CUSTOMER INPUT WIRING PHASE A,B,C  
(INPUT IS NOT PHASE ROTATION SENSITIVE)



**FIGURE 3.6.1 CUSTOMER INPUT WIRING DETAIL**



### 3.7 CONNECTING THE OUTPUT SERVICE

This paragraph states the procedure to be used when connecting the output service. Certain requirements relating to safety are also stated and should be followed rigorously.

The standard output form of the MS-Series is 120/208Y, 50, 60, 400 Hz or Variable frequency. Phase sequence of the output is ABC. Maximum output current, dependent upon model number, is summarized below:

MODEL NUMBER	Output (KVA)	Output RMS (KW)	Output (CURRENT/Ø)	Output Short Circuit (CURRENT/Ø)
3060-MS	62.5	50	175A	>350A

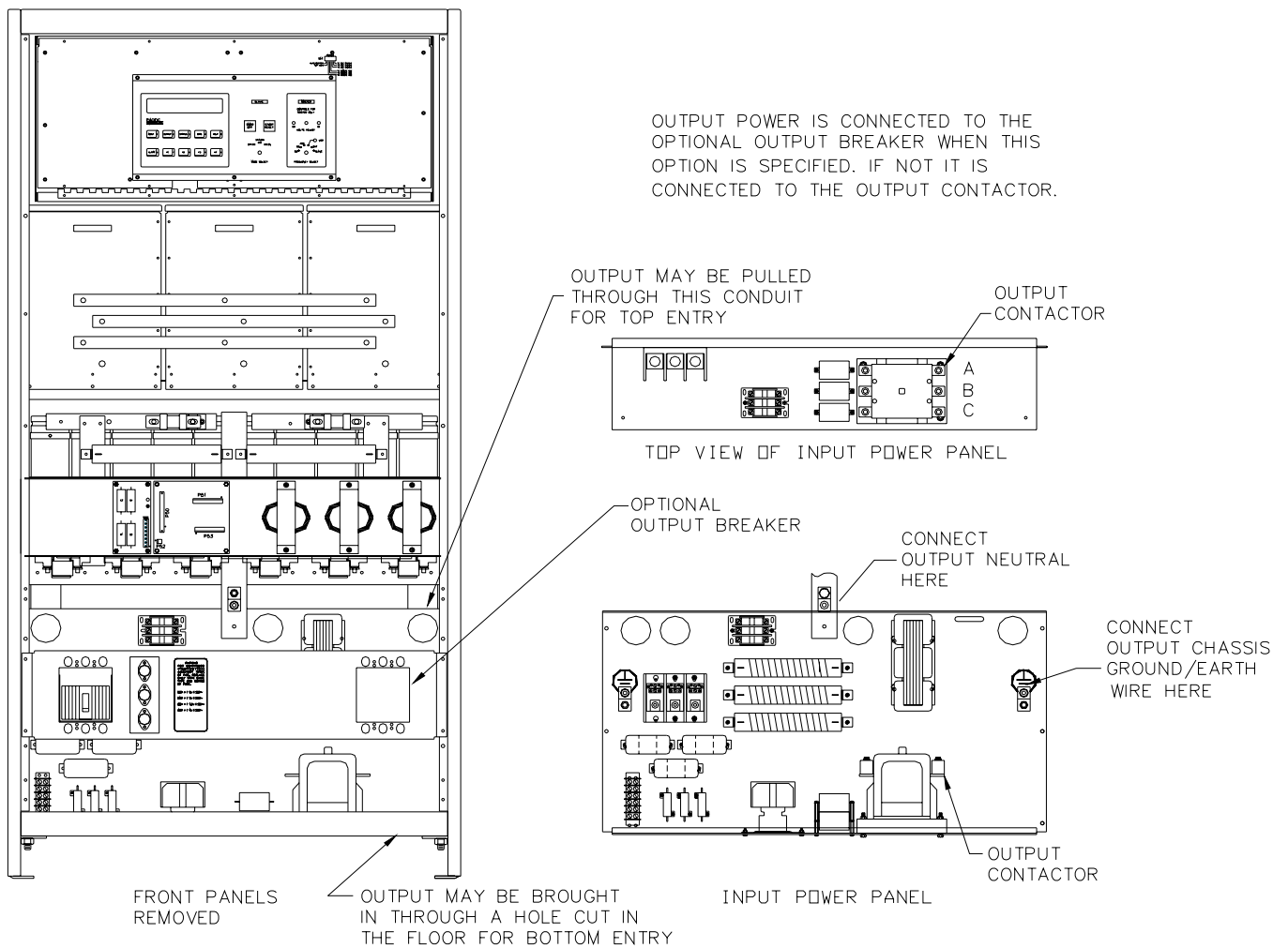
The CE option incorporates output fuses F12-F14 in the mainframe cabinet. (No output fuses are provided within the Cabinet in the standard configuration.)

	 <b>WARNING</b>
	<b>ELECTROCUTION HAZARD</b> LETHAL VOLTAGES PRESENT AT OUTPUT OF MACHINE REFER CONNECTION TO A QUALIFIED ELECTRICIAN.

Output connections from the MS-Series AC Power Source are made at the output breaker labeled "OUTPUT POWER". Refer to figures 3.7, 3.7.1, 3.7.2 for location and orientation of terminals.

The output terminals are compression type. It is very important that the connections are clean and properly tightened. Torque output connector set screws to 150 in/lbs.

**NOTE**  
 IT IS THE USER'S RESPONSIBILITY TO MEET ALL APPLICABLE LOCAL AND NATIONAL CODE REQUIREMENTS WHEN INSTALLING THIS EQUIPMENT.

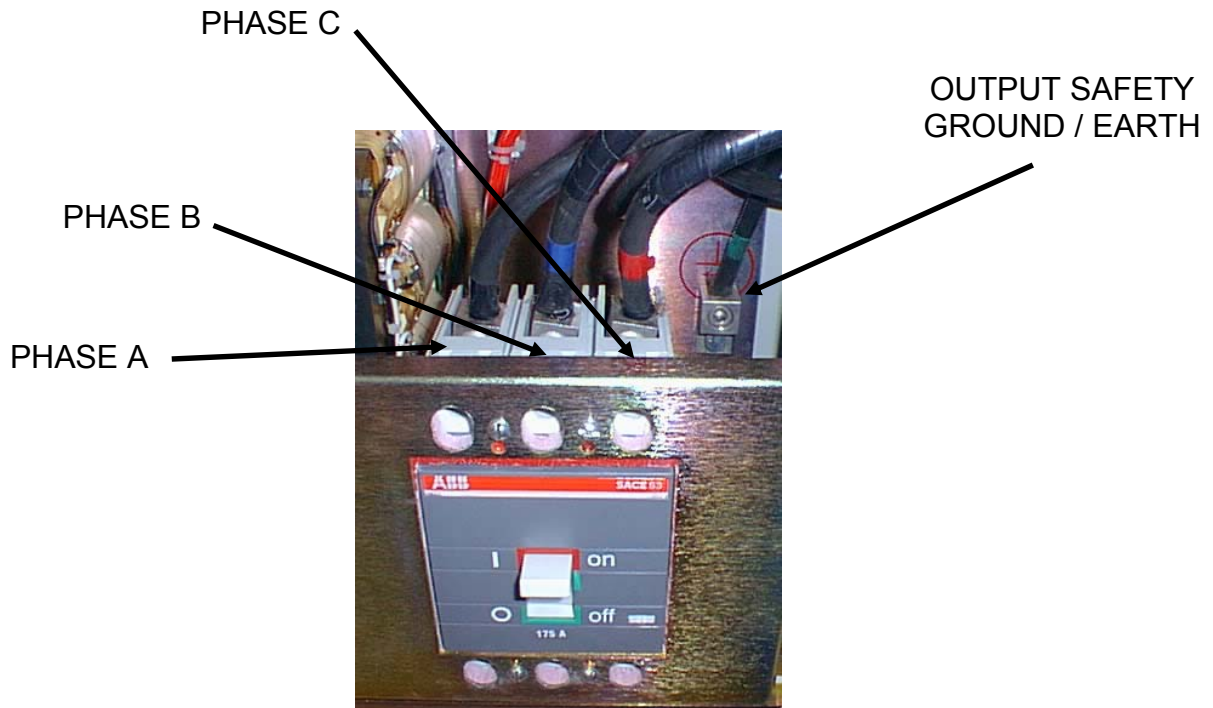


**FIGURE 3.7 OUTPUT TERMINAL DETAIL**

SYSTEM NEUTRAL CONNECTION



**FIGURE 3.7.1 OUTPUT CONTACTOR (CUSTOMER LOAD WIRING DETAIL)**



**FIGURE 3.7.2 OPTIONAL OUTPUT CIRCUIT BREAKER (CUSTOMER LOAD WIRING DETAIL)**

### 3.8 MULTIPLE CABINET SYSTEM

This paragraph states the procedure to be used when connecting the two or more cabinets in parallel to make a Multiple Cabinet System.

Proceed with installation of each cabinet as single cabinet power sources. Place each cabinet next to each other. No side clearance is necessary. Connect the input wiring to each cabinet. See figure 3.8.1 for a Multiple Cabinet System Outline.

A paralleling cable PN (126088) is required between each cabinet of the paralleled system. Connect one cable from Cabinet #1-P2 to Cabinet #2-P1. Connect another cable from Cabinet #2-P2 to Cabinet #3-P1. Connect as many paralleling cables (up to eleven for a twelve cabinet system) as needed. This paralleling cable contains all of the control signals necessary to operate the Multiple Cabinet System.

All five output wires (Chassis, Neutral, Phase A, Phase B and Phase C) from each cabinet need to be paralleled. For three or more cabinets in parallel an Output Load Center is recommended. Each output wire from each Cabinet to the Output Load Center **MUST BE THE SAME LENGTH AND AWG**. Refer to figure 3.8.2 for Multiple Cabinet System Wiring.

For three or more cabinets in parallel an Output Load Center is **REQUIRED**. The Output Load Center must contain **INDIVIDUAL CIRCUIT BREAKERS**, one for each cabinet. The circuit breaker must be sized for the individual cabinet's output voltage and frequency. Pacific Power's Part Number 716048, a 175 Amp Circuit Breaker may be used for standard 120/208 volt direct coupled output. Refer to modification or option documentation for other output voltage forms and frequencies.

## **CAUTION**

WHEN THREE OR MORE CABINETS ARE CONNECTED IN PARALLEL, A PARALLELING / OUTPUT LOAD CENTER WITH INDIVIDUAL CIRCUIT BREAKERS FOR EACH CABINET MUST BE INSTALLED TO PROTECT OUTPUT WIRING AND CABINETS.

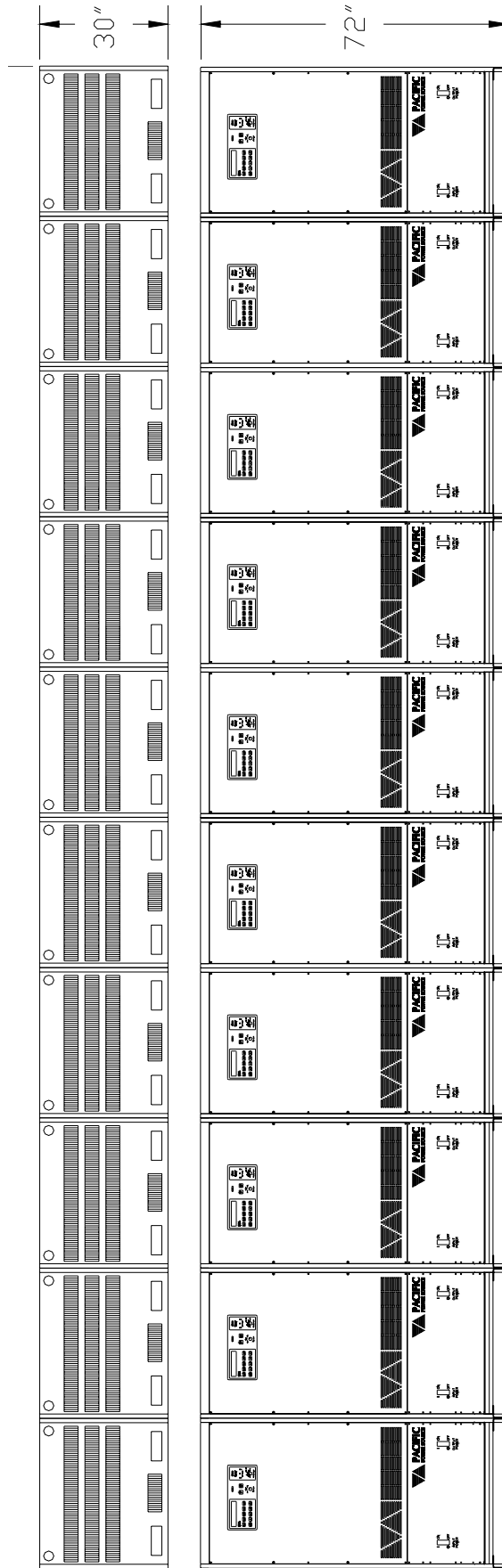
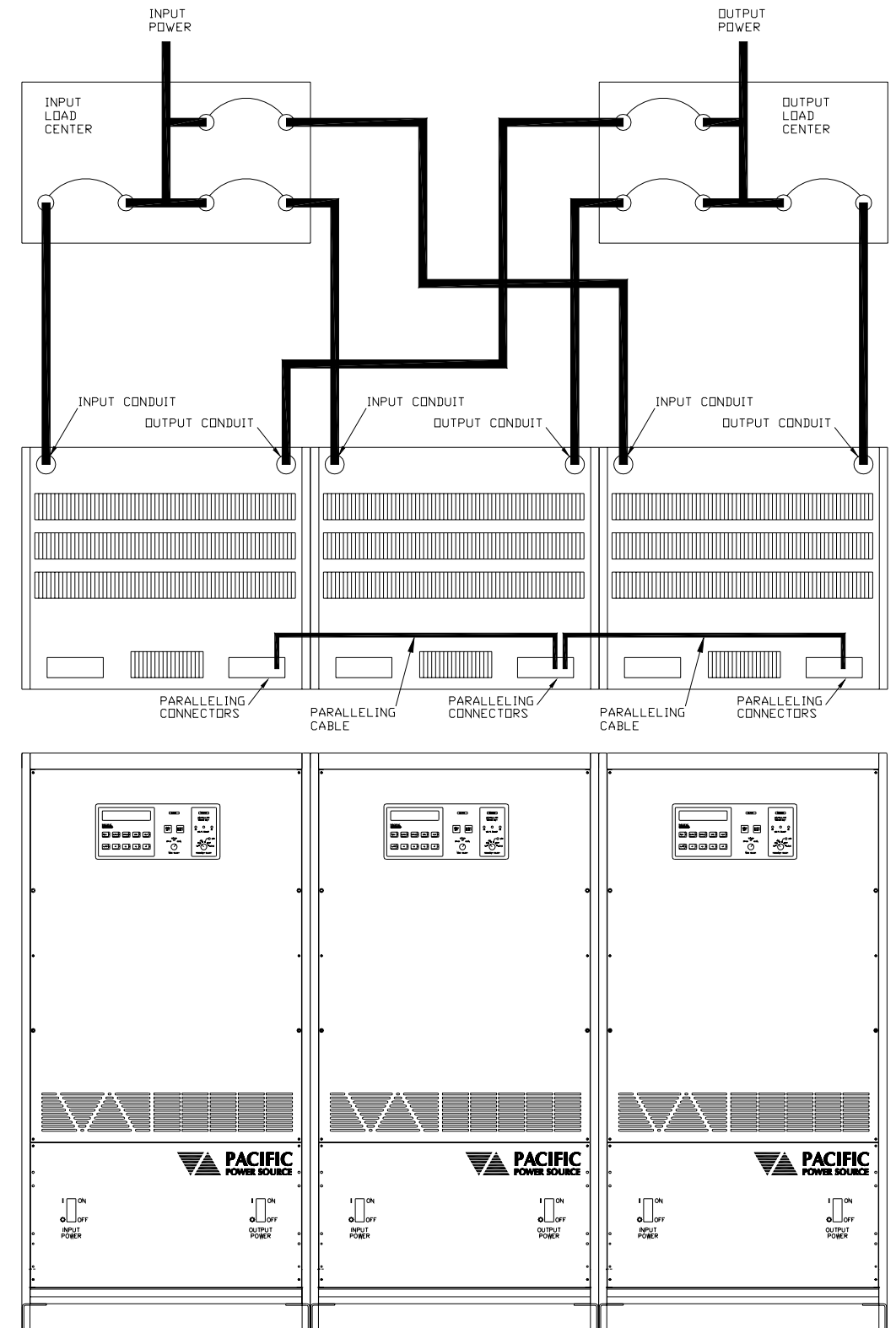


FIGURE 3.8.1 MULTIPLE CABINET SYSTEM OUTLINE





**FIGURE 3.8.2 MULTIPLE CABINET SYSTEM WIRING**

### 3.9 ELECTRICAL SURVEY CHECKLIST

This paragraph provides a comprehensive checklist to be performed prior to first time power-up of the MS-Series Power Source.

All work must be performed in accordance with applicable local, state, and national electrical codes. In the event of conflict between this document and the aforementioned codes, the codes shall be observed. It is requested that in the event of conflict, the factory be notified.

#### **CHECK AT RIGHT WHEN CONFIRMED:**

1. Check input service, voltage and frequency, with the service listed on the Cabinet Identification Plate on the upper rear of the cabinet. \_\_\_\_\_
2. Check input service ratings. Circuit breakers and wiring to be sized in accordance with currents listed in Section 3.0. Circuit breaker time-overload curves should be compatible with published curves on the Cabinet. \_\_\_\_\_
3. Safety wiring should be sized in accordance with currents listed in Section 3.6. Ground for the Cabinet shall be connected to the Cabinet from the building ground. \_\_\_\_\_
4. All power input and output wiring shall be run in individual conduits. All control wiring shall be contained in separate conduit runs. \_\_\_\_\_
5. Only one neutral point is to be used by the cabinet. Input neutral is not connected and is not required. Output neutral shall be connected at the output neutral terminal. Refer to Figure 3.5. \_\_\_\_\_
6. Verify that all pressure terminations are tightened per specifications listed in Section 3.6 and 3.7. \_\_\_\_\_

**FIGURE 3.9 ELECTRICAL SURVEY CHECKLIST**

## 4.0 OPERATION

This section provides the information required to operate the MS-Series AC Power Source.

### 4.1 INSPECTION OF INSTALLATION

Inspection of the installation is a very important step in the operation of the MS-Series AC Power Source. This is done as a safety measure to prevent injury to personnel or damage to equipment. Anytime the cabinet is first turned on, the wiring and distribution system should be checked. Input and output wiring should be examined carefully.

Solid-state power sources are capable of delivering tremendous amounts of energy. This is by design and the primary mission of the power source. Make sure that the loads attached match the output voltage and frequency of the Power Source.

First time operation requires a more in depth inspection than would otherwise be indicated. Specific items to check on first time turn on are:

1. Proper input voltage brought into the Power Source.
2. Input connections properly tightened. No nicked or damaged wires, etc.
3. Output connections made properly. Also, are loads attached of the proper voltage and frequency rating.

The operator should refer to Section 3.0, Installation, if there is any doubt regarding the above statements.

### 4.2 INSTALLATION RECORD

During first time operation, the Power Source Installation Record, Table 4.2, should be completed. This information will record initial operating parameters as well as providing the beginning of the maintenance and service record.

After installation of the Power Source, and if commissioning service has been contracted, contact the Pacific Power Source factory for check-out and initial turn-on. Two weeks should be allowed in scheduling personnel, with a maximum of two days normally required on site. The first half of the Installation Record should be completed prior to the arrival of factory personnel. The second half will be recorded by factory personnel during the commissioning field service.

If a factory visit has not been contracted, the following record should be completed by properly trained personnel only.

**TABLE 4.2 INSTALLATION RECORD**

**1.0 Cabinet and Site Information (Paragraph 4.1, 4.2)**

Model Number \_\_\_\_\_

Serial Number \_\_\_\_\_

Purchase Order# \_\_\_\_\_

Work Order# \_\_\_\_\_

Modification Numbers \_\_\_\_\_

Customer Name \_\_\_\_\_

Technical Contact \_\_\_\_\_

	Name	Title
--	------	-------

Phone Number \_\_\_\_\_ Ext. \_\_\_\_\_

Site Address \_\_\_\_\_

Test Technician \_\_\_\_\_

Date \_\_\_\_\_

Comments on Installation:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**TABLE 4.2 INSTALLATION RECORD (cont.)****2.0 Technical Record** (Paragraph 4.1)

<u>Parameter</u>	<u>Phase A</u>		<u>Phase B</u>		<u>Phase C</u>	
Input Voltage (L-L)	_____	_____	_____	_____	_____	_____
Input Current	_____	_____	_____	_____	_____	_____
Output Voltage	_____	_____	_____	_____	_____	_____
Output Current	_____	_____	_____	_____	_____	_____
Output kVA	_____	_____	_____	_____	_____	_____
Percent Load	_____	_____	_____	_____	_____	_____
Output Frequency	_____	_____	_____	_____	_____	_____

<u>Dip Switch</u>	<u>Switch Position Number</u>							
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>
Control PCB – S14	_____	_____	_____	_____	_____	_____	_____	_____
Display PCB – S41	_____	_____	_____	_____	_____	_____	_____	_____
Display PCB – S42	_____	_____	_____	_____	_____	_____	_____	_____

**TABLE 4.2 - INSTALLATION RECORD****4.3 DESCRIPTION OF CONTROLS AND INDICATORS**

The controls and indicators for the MS-Series equipment are located on the front panel of the Power Source cabinet.

As shown in figure 4.3 the Front Panel is divided into 3 basic regions:

- LCD and Interrogation Section.** Used to solicit Power Source parametric values.(Refer to paragraph 4.3.1)
- Mode Select, Emer Off, and Start/Reset switches.** Used to control the operational state of the Power Source (Refer to paragraph 4.3.2).
- Frequency Select and Volts Adjust.** Used to control the Internal Oscillator and select Master or Slave operation in Parallel Systems (Refer to paragraph 4.3.3).

This section is divided into the referenced subparagraphs which discuss each of the above in detail.

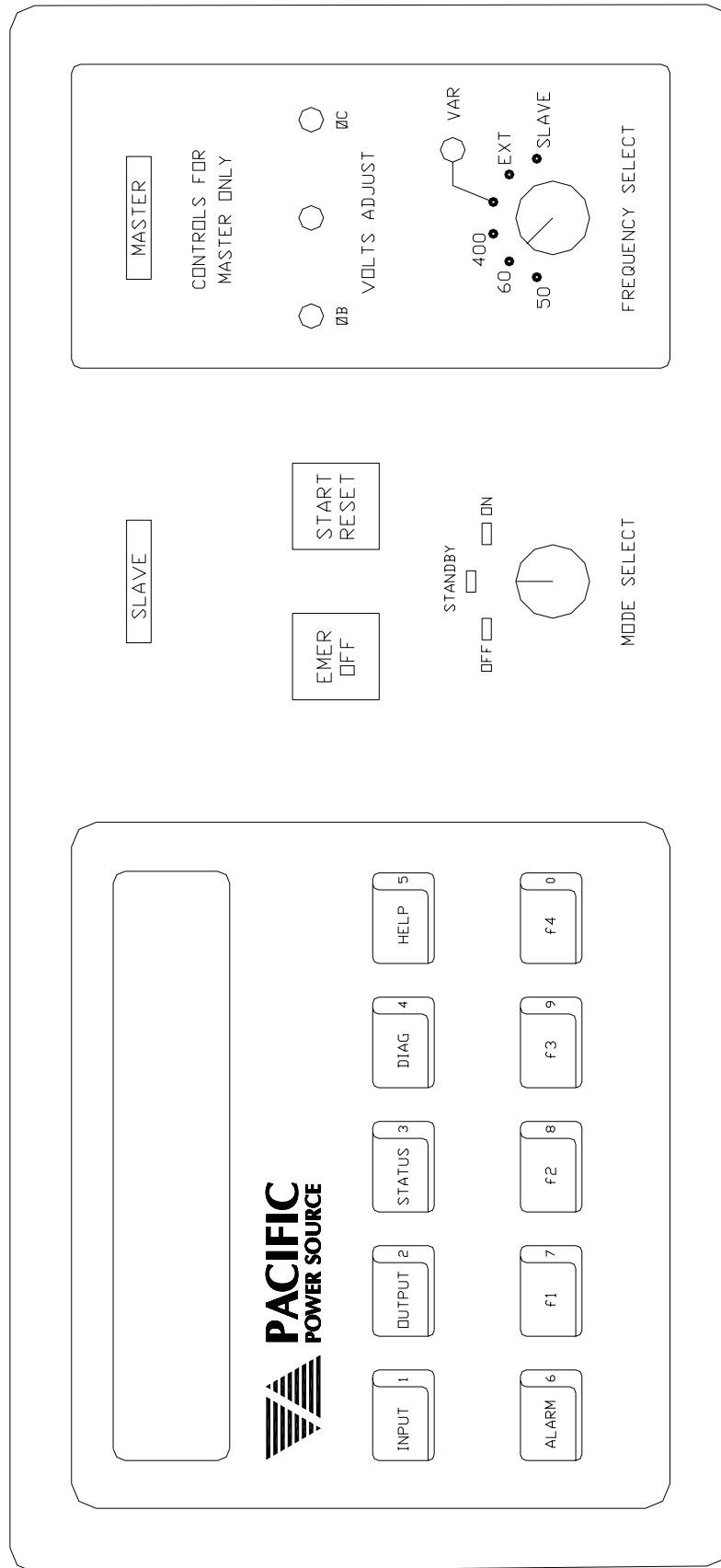
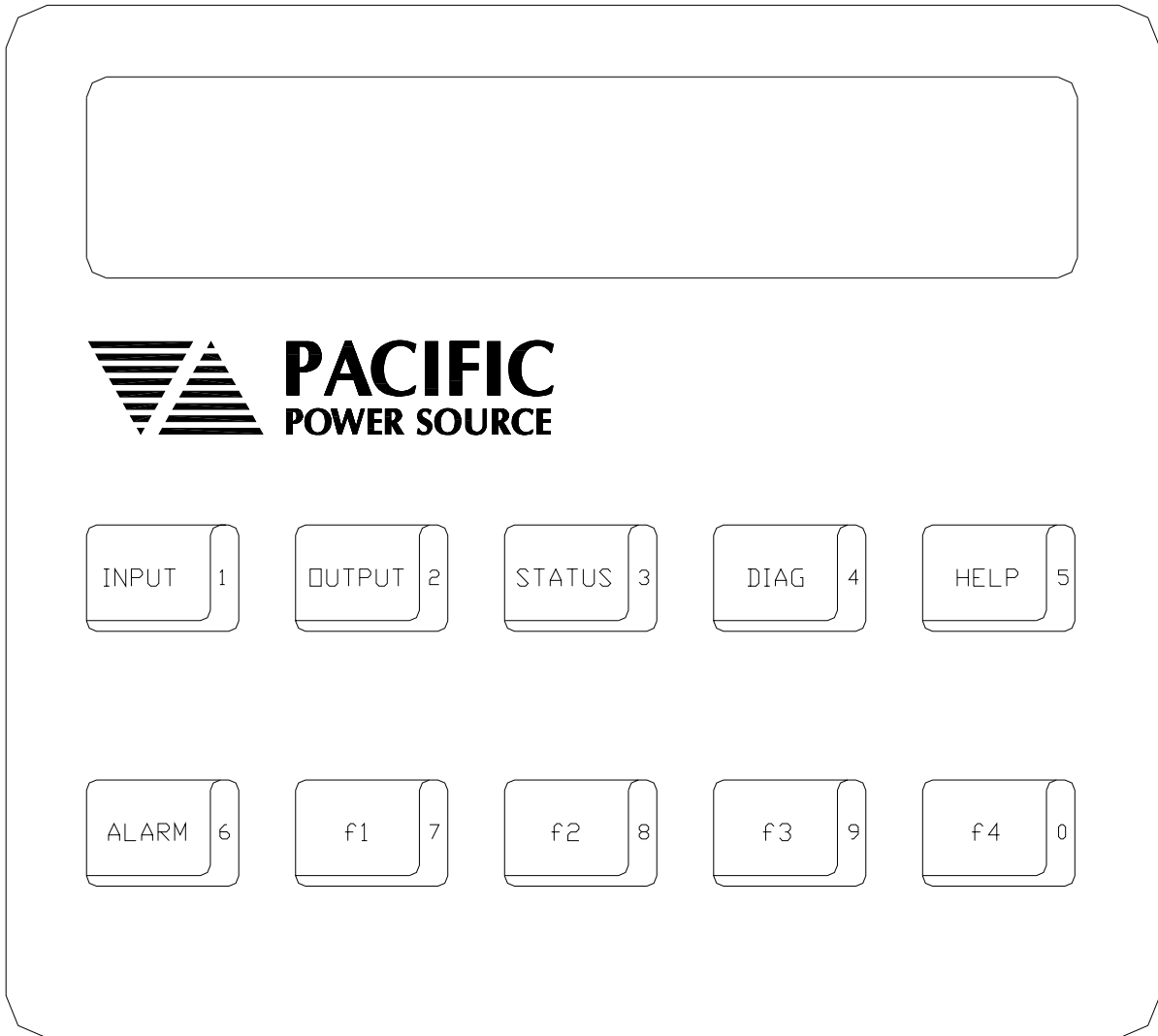


FIGURE 4.3 MS-SERIES FRONT PANEL



**FIGURE 4.3.1 LCD AND INTERROGATION SWITCHES**

### 4.3.1 LCD AND INTERROGATION SWITCHES

This paragraph provides a detailed description of each Power Source message, how it is obtained, and its meaning.

A four line, 160 character display provides the communication interface between the Power Source and the operator.

#### 4.3.1.1 INPUT KEY

The INPUT Key is used to display the current status of all Power Source input power parameters. It may be pressed at any time power is applied to the cabinet.

When the INPUT Key is depressed, message I1 will be displayed. NORMAL indicates Input Power is acceptable and ABNORMAL indicates Input Power is not acceptable. FREQ displays Input Frequency. V displays Input Volts Phase to Neutral and Phase to Phase. A displays Input Amps for each phase. kW displays Input Kilowatts for each phase and kVA displays Input Kilo-Volt-Amps for each phase.

I1: INPUT	V	XXX/XXX	XXX/XXX	XXX/XXX
(AB)NORMAL	A	XXX	XXX	XXX
	KW	XX.X	XX.X	XX.X
FREQ=XXX.X	kVA	XX.X	XX.X	XX.X

#### 4.3.1.2 OUTPUT KEY

The OUTPUT Key is used to display the current status of all Power Source output power parameters. It may be pressed at any time power is applied to the cabinet.

When the OUTPUT then f1 keys are depressed, message O1 will be displayed showing Single Cabinet Efficiency and output Frequency. Single Cabinet output volts (Phase to Neutral and Phase to Phase,) Amps, kW and kVA information are displayed for each phase.

O1: CABINET	V	XXX/XXX	XXX/XXX	XXX/XXX
OUTPUT	A	XXX	XXX	XXX
EFF=XX%	kW	XX.X	XX.X	XX.X
FREQ=XXX.X	kVA	XX.X	XX.X	XX.X

When the OUTPUT then f2 keys are depressed, message O2 will be displayed showing Single Cabinet output Frequency. Single Cabinet output volts (Phase to Neutral and Phase to Phase,) %I-PEAK (percentage of maximum peak amps,)



%kVA (percentage of maximum kVA,) and %kW (percentage of maximum kW) information are displayed for each phase.

O2: CABINET V	XXX/XXX	XXX/XXX	XXX/XXX
OUTPUT %I-PEAK	XXX	XXX	XXX
%kVA	XXX	XXX	XXX
FREQ=XXX.X %kW	XXX	XXX	XXX

When the OUTPUT then f3 keys are depressed, message O3 will be displayed showing Multiple Cabinet System output Frequency. Multiple Cabinet output volts (Phase to Neutral and Phase to Phase,) Amps, kW and kVA information are displayed for each phase.

O3: SYSTEM V	XXX/XXX	XXX/XXX	XXX/XXX
SUMMARY A	XXXX	XXXX	XXXX
OUTPUT kW	XXX	XXX	XXX
FREQ=XXX.X kVA	XXX	XXX	XXX

When the OUTPUT then f4 keys are depressed, message O4 will be displayed showing Remote Sense Frequency. Remote Sense output volts (Phase to Neutral and Phase to Phase,) Amps, kW and kVA information are displayed for each phase.

O4: REMOTE V	XXX/XXX	XXX/XXX	XXX/XXX
OUTPUT A	XXXX	XXXX	XXXX
KW	XXX	XXX	XXX
FREQ=XXX.X kVA	XXX	XXX	XXX

If an OUTPUT display is already active, it is not necessary to press the OUTPUT key each time to view another message. Simply pressing another f1-f4 key shall display the corresponding message.

#### 4.3.1.3 STATUS KEY

The STATUS key is used to display the operating status of the Power Source. This key may be pressed at any time power is applied to the cabinet. Based on internal sense circuits one of the following messages may be displayed.

- S1 Displayed when the Power Source is in an Emergency Off state. The EMER OFF lamp shall be lit.

S1: CAB EMER OFF- WARNING - NO OUTPUT PRESS DIAG KEY
---

- S2 Displayed when the Power Source is in the Normal Off state. The OFF lamp shall be lit.

```
S2: CAB IS OFF – READY FOR OPERATION
```

- S3 Displayed when the Power Source is in the Standby state. The STANDBY lamp shall be lit.

```
S3: CAB IS STBY - READY FOR OPERATION
```

- S4 Displayed when the Power Source is in the Normal ON state. The ON lamp shall be lit. Output Frequency and %LOAD (the highest of any percent load as described in the Output O2 message) is displayed. Single Cabinet output volts (Phase to Neutral and Phase to Phase,) Amps information are displayed for each phase.

```
S4: CAB IS ON - OPERATION NORMAL
      V  XXX/XXX  XXX/XXX  XXX/XXX
      A   XXX     XXX     XXX
FREQ=XXX.X %LOAD XXX
```

- S5 Displayed when the Power Source is OVERLOADED. The Power Source is overloaded when %LOAD is greater than 100%. The ON lamp shall be lit. Output Frequency and %LOAD (the highest of any percent load as described in the Output O2 message) is displayed. Single Cabinet output volts (Phase to Neutral and Phase to Phase,) Amps information are displayed for each phase.

```
S5: CAB IS ON - WARNING - OVERLOAD
      V  XXX/XXX  XXX/XXX  XXX/XXX
      A   XXX     XXX     XXX
FREQ=XXX.X %LOAD XXX
```

- S6 Displayed when the Power Source is in an Emergency Off state caused by an OVERTEMP condition. The EMER OFF lamp shall be lit.

```
S6: CAB IS EMER OFF-WARNING-OVERTEMP
      V  XXX/XXX  XXX/XXX  XXX/XXX
      A   XXX     XXX     XXX
FREQ=XXX.X %LOAD XXX
```

- S7 Displayed when the Power Source is in an Alarm condition caused by an OUTPUT UNDER VOLTAGE.

S7: CAB IS ON - WARNING UNDER VOLTAGE			
V	XXX/XXX	XXX/XXX	XXX/XXX
A	XXX	XXX	XXX
FREQ=XXX.X %LOAD XXX			

- S8 Displayed when the Power Source is in an Alarm condition caused by an OUTPUT OVER VOLTAGE.

S8: CAB IS ON - WARNING OVER VOLTAGE			
V	XXX/XXX	XXX/XXX	XXX/XXX
A	XXX	XXX	XXX
FREQ=XXX.X %LOAD XXX			

- S9 Displayed when the Power Source is in an Alarm condition caused by an OUTPUT UNDER FREQUENCY.

S9: CAB IS ON - WARNING UNDER FREQUENCY			
V	XXX/XXX	XXX/XXX	XXX/XXX
A	XXX	XXX	XXX
FREQ=XXX.X %LOAD XXX			

- S10 Displayed when the Power Source is in an Alarm condition caused by an OUTPUT OVER FREQUENCY.

S10: CAB IS ON - WARNING OVER FREQUENCY			
V	XXX/XXX	XXX/XXX	XXX/XXX
A	XXX	XXX	XXX
FREQ=XXX.X %LOAD XXX			

## 4.3.1.4 DIAGNOSTIC KEY

The Diagnostic (DIAG) key is dual purpose. First, by saving the cause of the Emergency Off state, an audit trail is provided for trouble shooting purposes. Second, technical operating parameters are displayed and recorded for determining Power Source operational status.

When the DIAG then f1 keys are depressed the cause of the Emergency Off state is displayed.

D1: DIAGNOSTIC                      NO EMERGENCY OFF

OR

D1: DIAGNOSTIC                      EMERGENCY OFF CAUSED BY  
 MASTER EMERGENCY OFF  
 SUSTAINED OVERLOAD  
 INVERTER FAULT  
 EMER OFF BUTTON  
 TRANSFORMER OVERTEMP  
 INVERTER OVERTEMP  
 LVPS FAULT  
 Bus VOLTAGE > 240 VDC  
 EXTERNAL EMERGENCY OFF  
 NO MASTER ON LINE

When the DIAG then f2 keys are pressed the input transformer temperature in degrees C and inverter temperature status (OK/Not OK) are displayed.

D2: DIAGNOSTIC	TEMPERATURE DATA
	XFMR: XXX DEG C
	INV: OK

When the DIAG then f3 keys are pressed the internal High and Low Voltage are displayed.

D3: DIAGNOSTIC	INTERNAL VOLTAGES
	BUS              LVPS
+XXX VDC	+XX.X VDC
XXX VDC	XX.X VDC

When the DIAG then f4 keys are pressed the digital inputs to the Display PCB are displayed.

D4: PORT # 2	PORT # 3	PORT # 4	PORT # 5
PWR	XXXXXXXX	XXXXXXXX	XXXXXXXX
EMER	XXXXXXXX	XXXXXXXX	XXXXXXXX
NOW	XXXXXXXX	XXXXXXXX	XXXXXXXX

This display shows the status of all of the 32 digital inputs to the Display PCB at the last PWR down (when the + 18 VDC fell below 12.3VDC,) the last EMER off (when Q6 went hi) and NOW (present real time.)

<u>BIT</u>	<u>PORT # 2</u>	<u>PORT # 3</u>
7	KYBD f3	ML
6	KYBD f4	INV OVERTEMP
5	MASTER EMER OFF	EMER OFF SW
4	XFMR OVERTEMP	SUSTAINED O/L
3	LVPS FAULT	INPUT LINE FAULT
2	LS	Q6
1	C0	VDC > 240
0	LM	EXT EMER OFF

<u>BIT</u>	<u>PORT # 4</u>	<u>PORT # 5</u>
7	VDC > 160	SPARE
6	INV FAULT	MOD ENABLE
5	S3 CLOSE COMM	SPARE
4	SPARE	SPARE
3	S5 CLOSE COMM	INV TEST OK
2	S7 CLOSE COMM	SPARE
1	C2	INV O/L
0	POLARITY	SPARE

If a DIAGNOSTIC display is already active, it is not necessary to press the DIAG key each time to view another message. Simply pressing another f1-f4 key shall display the corresponding message.

#### 4.3.1.5 HELP KEY

The HELP key is provided to direct the operator with the proper course of action to turn on and operate the machine. Six different help messages are available for display. If the HELP key is pressed the first applicable message, H1 through H6, is displayed.

H1     Displayed when the Input Voltage is not within acceptable range.

H1: INPUT SERVICE IS NOT CORRECT. CHECK ALL THREE INPUT PHASES FOR PROPER VOLTAGE.
--

- H2 Displayed when the cabinet is in an Emergency Off State. Instructs the user to press the DIAG then f1 keys to determine the cause of the FAULT. Instructs the user to press the START/RESET to clear the FAULT. Instructs the user that service is required if the fault cannot be cleared.

H2: CABINET IS IN EMERGENCY OFF STATE.  
PRESS DIAG KEY TO DETERMINE FAULT.  
TO CLEAR FAULT PRESS START/RESET.  
IF FAULT REMAINS, SERVICE IS REQUIRED.

- H3 Displayed when the cabinet is in a Normal Off State. Instructs the user how to place the cabinet in the Standby state by rotating the MODE SELECT switch to the STANDBY position and pressing the START/RESET button. This will charge up the internal high voltage dc power supplies and start the inverter operating.

H3: SYSTEM IS IN NORMAL OFF STATE.  
TO PLACE IN STANDBY, ROTATE THE  
MODE SELECT SWITCH TO STANDBY AND  
PRESS START/RESET.

- H4 Displayed when the cabinet is in the Standby State. The cabinet is ready to deliver output power but the output contactor is open. Instructs the user to rotate the MODE SELECT switch to the ON position to turn on the output contactor.

H4: SYSTEM IS IN STANDBY STATE.  
TO TURN ON THE OUTPUT, ROTATE  
THE MODE SELECT SWITCH TO ON.

- H5 Displayed when the cabinet is in the On State. The cabinet's output terminals are energized. The output contactor is closed. Instructs the user to press a button to read metering information.

H5: SYSTEM IS IN ON STATE.  
TO READ METERING INFORMATION  
PRESS THE ASSOCIATED BUTTON.

- H6 Displayed when the cabinet is in the Alarm State. Instructs the user to press the STATUS button to determine the cause of the alarm. Instructs the user to press the ALARM button to silence the audible alarm.

<p>H6: SYSTEM IS IN ALARM STATE. PRESS STATUS TO DETERMINE CAUSE OF ALARM. PRESS ALARM TO SILENCE.</p>
--

#### 4.3.1.6 ALARM KEY

Whenever ALARM is pressed message A1 appears. It remains displayed until some other button is pressed. Pressing ALARM momentarily there after has no effect. Pressing and holding ALARM for 2+ seconds shall cause the ALARM buzzer to change state between ENABLED and DISABLED (display text changes accordingly).

<p>A1: ALARM DISABLED- PRESS AND HOLD ALARM TO ENABLE. USE f1 f2 f3 f4 BUTTONS TO CHANGE LIMITS</p>	<p>f1&gt; OV XXX f2&gt; UV XXX f3&gt; OF XXX f4&gt; UF XXX</p>
---	--

Whenever message A1 is displayed, limits are subject to change by use of f1 through f4 buttons.

First press and hold of f1 causes OV to increase at about 5 volts per second. Second press and hold causes OV to decrease at about 5 volts per second. Similarly for f2, f3 and f4.

If ALARM is ENABLED and any parameter exceeds its limit the ALARM BUZZER shall sound. When parameter returns to limits buzzer shall extinguish.

When RAM is cleared, ALARM system shall be DISABLED and limits shall be:

OV 132  
UV 108  
OF 440  
UF 47

This feature monitors CABINET PARAMETERS ONLY. No system or remote parameters are monitored. The alarm shall NOT sound if enabled and the output contactor is open.

#### 4.3.1.7 SPECIAL KEY COMBINATIONS

INPUT/  
STATUS/  
HELP:                      Pressed simultaneously shall cause a software reset of the display CPU.

OUTPUT/  
DIAG/  
ALARM:                      Pressed simultaneously shall clear the RAM.

#### 4.3.2 MODE SELECT, EMERGENCY OFF, AND ON-RESET SWITCHES

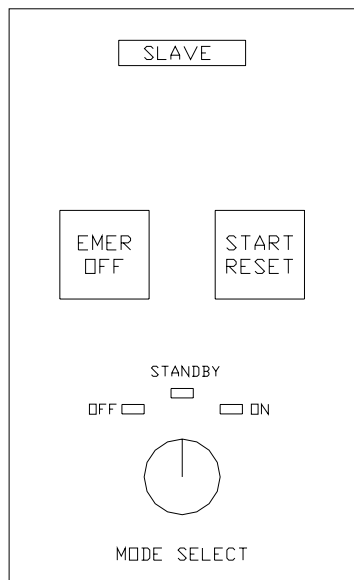
As the name implies, these switches control the operational mode of the Power Source. The operator must be fully familiar with these switches and their function prior to operating the Power Source.

##### 4.3.2.1 MODE SELECT SWITCH

During normal operation of the MS, control of the cabinet is through the MODE SELECT switch. The design of the switch is such that only one Mode Position can occur at any time. The three available switch positions are defined as follows:

OFF	The cabinet is shut off. No power is supplied to the load. A red LED next to the OFF position is lighted when there is no power applied to the output and diagnostic checks are OK.
STANDBY	The cabinet is in the Standby State. The internal high voltage power supplies are energized. The inverter is operating. The cabinet is ready to deliver output power but the output contactor is open. A red LED next to the STANDBY position is lighted.
ON	The output terminals are energized. The output contactor is closed and supplying power to the load. A red LED next to the ON position is lighted.





**FIGURE 4.3.2 MODE SELECT, EMER OFF, AND START/RESET**

#### 4.3.2.2 EMERGENCY OFF AND START/RESET SWITCHES

During normal operation of the Power Source, return to the OFF state is accomplished through the use of the Mode Select Switch. In the event of an emergency, the EMER OFF button may be used to cause an immediate shutdown of the cabinet. Manual reset of the Mode Select switch to the OFF position, and pushing the START/RESET switch is required before the cabinet can be brought back on line.

Two off lamps are used to indicate the Off states. The Emergency Off state is indicated by a lamp that illuminates the EMER OFF push button. A lamp next to the OFF text on the Mode Select switch indicates that the cabinet is in the Normal Off State. The Normal Off state lamp is inhibited from being ON when an EMERGENCY OFF condition exists.

When power is first applied during turn-on, the cabinet is automatically set to the Off state. If the cabinet is in the Emergency Off state the operator must switch the MODE SELECT switch to OFF and press START/RESET to reset the cabinet. The operator may then proceed to Power Source operation.

### 4.3.3 FREQUENCY SELECT SWITCH AND VOLTS ADJUST

These switches also control the operation of the Power Source. The operator must be fully familiar with these switches and their function prior to operating the Power Source.

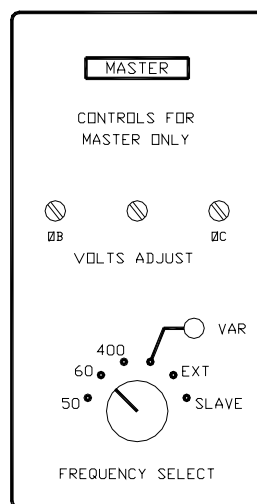
#### 4.3.3.1 FREQUENCY SELECT SWITCH

The primary of the Frequency Select Switch is to control the internal Oscillator. It also is used to determine whether the cabinet is a MASTER or SLAVE.

50, 60 and 400	These are fixed, crystal controlled frequencies for the internal oscillator.
VAR	This is a 47 to 500 Hz variable frequency control for the internal oscillator.
EXT	This selects an external oscillator input for the Power Source.
SLAVE	In this position this cabinet is a SLAVE to another master in a Multiple Cabinet System. One and only one cabinet may be MASTER in a Multiple Cabinet System. The MASTER Frequency shall control the entire Multiple Cabinet System.

#### 4.3.3.2 VOLTAGE ADJUST CONTROLS

The Voltage Adjust Controls control the internal Oscillator output voltage. The center control is for all three output phases. ØB and ØC are for Phase B and Phase C trim adjustments only. These controls only work if the cabinet is a master and the internal oscillator is selected.



**FIGURE 4.3.3 FREQUENCY SELECT AND VOLTS ADJUST**

#### 4.4 OPERATING PROCEDURES

This paragraph describes Power Source modes of operation and the various operating procedures to be used in operating the MS-Series Power Source.



## CAUTION

BEFORE APPLYING POWER OF ANY KIND TO THE POWER SOURCE, READ SECTION 4.0 OF THIS MANUAL ENTIRELY AND DO NOT PROCEED UNTIL ITS CONTENTS ARE FULLY UNDERSTOOD.

This section is divided into four sub-paragraphs:

1. Power Source Modes of Operation  
Provides definition of Power Source operational states.
2. First Time Turn-On Procedure  
To be performed at initial turn-on or when service has been performed.
3. Normal Shut-Down Procedure  
To be performed when Power Source power is secured for load maintenance.
4. Emergency Shutdown Procedure  
Action taken to secure Power Source output power in emergency situations.

Operation of the MS-Series Power Source has been designed to be simple and straightforward. This is done for several reasons the primary reason being safety. The addition of an Emergency Off Switch allows for quick action in the case of an emergency.

**It cannot be stressed too many times that Solid-State Power Sources are capable of delivering tremendous amounts of energy.** Things happen quickly when something goes wrong. However, good habits and a methodical approach, when operating this equipment will, avoid most hazards.

#### 4.4.1 MODES OF OPERATION

There are six possible modes of operation:

1. Off State
2. Stand By State
3. On State
4. Emergency Off State
5. Slave State
6. Auto Re-Start

These states are achieved as described below:

##### **OFF STATE**

The OFF state is achieved by rotating the Mode Select Switch to Off. If the EMER OFF switch is illuminated, pressing START/RESET is also required to change the state from EMER OFF to normal OFF.

OFF causes the machine to be dead except for the low voltage power supply. OFF shall be achieved if the following are true:

- A) The EMER OFF lamp is off.
- B) The OFF lamp is on.
- C) The STANDBY lamp is off.
- D) The ON lamp is off.

##### **STANDBY STATE**

STANDBY is when the input contactor is closed and the machine is ready to deliver power to a load but the output contactor is open. The STANDBY lamp is on. Observe the following start sequence to achieve STANDBY:

- A) The EMER OFF lamp is off.
- B) The OFF lamp is on.
- C) The MODE SELECT switch is rotated to STANDBY.
- D) The START/RESET button is pushed.
- E) The slow turn on contactor is closed and the modulator is enabled.
- F) The main input contactor closes.
- G) The slow input contactor opens. The machine is now in STANDBY mode.

**ON STATE**

ON is when the output contactor is closed and the machine is ready to deliver power to a load. The ON lamp is on. Observe the following sequence to achieve ON:

- A) The STANDBY lamp is on.
- B) The MODE SELECT switch is rotated to ON. The machine is now in ON mode.

OR

- A) The EMER OFF lamp is off.
- B) The MODE SELECT switch is in the ON position and the START/RESET switch is pressed. The machine shall go to STANDBY mode and then to ON mode.

**EMER OFF STATE**

EMER OFF causes the machine to be dead except for the low voltage power supply. The EMER OFF push button shall be lit. The following shall cause an EMER OFF:

- A) EMER OFF BUTTON, the EMER OFF push button has been pressed.
- B) MASTER EMERGENCY OFF, The Master Cabinet is in an EMERGENCY OFF STATE and this machine is a SLAVE.
- C) INPUT LINE FAULT, the input power is not within limits.
- D) LVPS FAULT, one of the low voltage power supplies has failed.
- E) BUS VOLTAGE > 240 VDC, one of the high voltage power supplies has exceeded 240 VDC.
- F) INVERTER FAULT, one of the inverters has failed.
- G) INVERTER OVERTEMP, one of the inverters is too hot.
- H) TRANSFORMER OVERTEMP, the large input transformer has overheated.
- I) SUSTAINED OVERLOAD, the power source has been in current limit for a long time.
- J) EXTERNAL EMERGENCY OFF, an external signal has caused an emergency off.

**SLAVE STATE**

SLAVE causes the machine to act as a slave in a multi cabinet system. The machine is a SLAVE if the FREQUENCY SELECT switch is rotated to SLAVE, and a MASTER if in any other position. The SLAVE lamp and either EMER OFF, OFF, STANDBY or ON lamps shall be lit. The control mode shall be determined by the following table:

	<b>MASTER (Mode Switch Position)</b>	<b>OFF</b>	<b>STANDBY</b>	<b>ON</b>
<b>SLAVE (Mode Switch Position)</b>	<b>OFF</b>	<i>OFF</i>	<i>OFF</i>	<i>OFF</i>
	<b>STANDBY</b>	<i>OFF</i>	<i>STANDBY</i>	<i>STANDBY</i>
	<b>ON</b>	<i>OFF</i>	<i>STANDBY</i>	<i>ON</i>

**FIGURE 4.4.1 SLAVE CONTROL MODE**

**AUTO RE-START**

If AUTO RE-START is enabled, the Power Source shall start AUTOMATICALLY when input power is applied. The Power Source shall attain the mode as selected by the MODE SELECT switch if all internal diagnostics check out ok.



## **WARNING**

**IF AUTO RE-START IS ENABLED, THE OUTPUT TERMINALS OF POWER SOURCE MAY BE ENERGIZED AUTOMATICALLY WHEN INPUT POWER IS APPLIED**

#### 4.4.2 FIRST TIME OPERATION

This procedure is to be used to turn on a one Cabinet Power Source for the first time, or when service has been performed. Proceed as follows:

---

##### **FIRST TIME OPERATION**

---

- STEP 1: Verify the AUTO RE-START option has been disabled by switching S14-1 OFF (refer to Section 4.5.2, Figure 4.5.2.)
- STEP 2: Inspect the installation. Verify that the wiring is correct (refer to Section 3.0, figure 3.6, and figure 3.7.) If this is first time turn-up operation, complete Table 4.2, (Installation Record) as operation proceeds.
- STEP 3: Open main breakers of output distribution system. No load should be connected to cabinet at this point.
- STEP 4: Close input power circuit breaker. The OFF lamp on the Power Source Mode Select switch should illuminate.

If this lamp does not light the EMER OFF lamp should be on. Press the DIAG then f1 keys to determine the cause of the EMERGENCY OFF. If the EMERGENCY OFF is caused by INPUT LINE FAULT, check the input power by pressing the INPUT key on the front panel. ABNORMAL will be indicate if the input power is not within limits and NORMAL if input power is within limits. Correct the fault, if any, and proceed.

Rotate the Mode Select Switch to OFF and press START/RESET. The EMER OFF indicator will go out.

- STEP 5: Place the cabinet in the STANDBY state by rotating the Mode Select Switch to STANDBY and pressing the START/RESET button. The STANDBY lamp will illuminate. The high voltage power supplies are now energized and the inverters are producing voltage. The output contactor is open. Cabinet output voltages and frequency may be checked by pressing the OUTPUT then f1 keys on the front panel.
- STEP 6: If inverter voltage is not at desired levels, it may be changed by adjusting the VOLTS ADJUST controls on the front panel. The center VOLTS ADJUST control adjusts all three outputs simultaneously. ØB and ØC are trim adjustments.
- Frequency may be changed by using the FREQUENCY SELECT switch. 50, 60, and 400Hz are fixed crystal stabilized frequencies. The VAR position is variable from 47 to 500Hz. The EXT position allows external oscillator input on connector J6. The SLAVE position makes this cabinet a slave.
- STEP 7: Place the cabinet in the ON State by rotating the Mode Select Switch to ON. The internal output contactor is now closed, and the cabinet is ready to deliver load power. Cabinet output voltages may be checked by pressing the OUTPUT then f2 keys on the front panel.
- STEP 8: Close main breakers of the output distribution system. Monitor output voltages. The output voltage should not change as load is applied.
-

### 4.4.3 PARALLEL CABINET OPERATION

This procedure is to be used to turn on the Paralleled Cabinet System for the first time, or when service has been performed on a cabinet. Proceed as follows:

---

#### **PARALLEL CABINET OPERATION**

---

- STEP 1: Inspect the installation. Verify that the wiring is correct (refer to Section 3.8, figure 3.8.2). Open all Circuit Breakers in the Output Load Center.
- STEP 2: Rotate the MODE SELECT switch to the OFF position for each Cabinet in the System. Rotate the FREQUENCY SELECT switch to the SLAVE position for each Cabinet in the system. This should cause an EMER OFF in ALL Cabinets.
- STEP 3: Select ONE Cabinet to be MASTER. Operate the ONE MASTER Cabinet as a Single Cabinet Power Source as described in section 4.4.2.
- STEP 4: Verify operation of each Cabinet individually as described in steps 2 and 3 above.
- STEP 5: Rotate the MODE SELECT switch to OFF for all Cabinets. Select ONE Cabinet, in the middle of the System, to be MASTER. Select all other Cabinets to be slaves. Disconnect any load from the output of the system. Close all of the Circuit Breakers at the Output Load Center. Press OUTPUT then f1 keys on all Cabinets in the system to monitor each Cabinet's output voltages and currents.
- STEP 6: On the MASTER, turn the Volts Adjust down to 0 VAC. Rotate the MODE SELECT to ON and press START/RESET. Select one and only one SLAVE. Rotate its MODE SELECT to ON, and press START/RESET. Verify the MASTER and SLAVE output currents are less than 10 amps.
- STEP 7: On the MASTER, turn the Volts Adjust up to 120 VAC. Verify the MASTER and SLAVE output currents are less than 10 amps. If output currents are large, check for miswires.
- STEP 8: Verify operation of each SLAVE individually as described in steps 6 and 7 above.
- STEP 9: Turn ON all Cabinets in the system. On the MASTER, rotate the MODE SELECT switch to standby and verify all cabinets go to STANDBY. On the MASTER, press EMER OFF and observe all Cabinet go to EMER OFF.
- STEP 10: Connect the load. Bring up the MASTER, then all Cabinets to the STANDBY state. Leave the MASTER in the STANDBY state. Rotate the MODE SELECT switch to ON for all the SLAVES. Rotate the MASTER MODE SELECT to ON. Verify all Cabinet output currents are  $\pm 10\%$  of each other. The system is now fully operational.
-



#### 4.4.4 NORMAL SHUTDOWN PROCEDURE

This procedure describes how to place the Power Source into the normal Off state. One of two conditions may be desired when turning off the Power Source:

1. Secure power from the Power Source. Turn off high voltage power supplies, inverters and output to the load. Control circuits shall remain active.
2. Secure all power; no power applied to either the Power Source or the Load.

To secure power from the Power Source proceed as follows:

**To secure power from the Power Source proceed as follows:**

---

STEP 1: Turn off all loads and open output circuit breaker if provided.

STEP 2: Rotate the Mode Select Switch to the OFF position. Verify that the OFF lamp is lit. Verify that the STANDBY and ON lamps are extinguished.

---

To secure all power to and from the Power Source proceed as follows:

**To secure all power to and from the Power Source proceed as follows:**

---

STEP 1: Turn off all loads and open output circuit breaker if provided.

STEP 2: Rotate the Mode Select Switch to the OFF position.

STEP 3: Open the input power circuit breaker. This removes all power to and from the cabinet.

---

#### 4.4.5 EMERGENCY SHUTDOWN PROCEDURE

Emergency shutdown is accomplished by depressing the EMER OFF Switch at any time.

The principle function of the Emergency Off state is to open the input and output contactors in the event of internal Power Source failure.

A secondary purpose is to protect against overheating of the inverter or input transformer in the event of excessive load current for extended time (an unlikely occurrence due to conservative thermal design.)

A third function is to give the operator a quick "Turn Off" means in the event of an emergency - since pressing EMER OFF is slightly faster than rotating the Mode Select Switch to Off.

The Emergency Off state can only be removed by rotating the Mode Select Switch to Off and pressing START/RESET. The EMER OFF lamp will extinguish and the cabinet will be in a normal Off state.

#### 4.5 SETUP SWITCHES

This paragraph describes the PC mounted dip switches contained within the MS-Series AC Power Source, their purpose and location.

Every effort has been made to simplify the Power Source design and its maintenance. To this end, many common components are used throughout the product family. To maintain commonality within the product family, logic switches are used to convey certain operating characteristics to the cabinet. These switches are summarized as follows:

1. Display PCB, Paragraph 4.5.1

S41: Machine ID and Baud Rate  
S42: For testing and future use.

2. Control PCB, Paragraph 4.5.2

S14: Auto restart and AGC control.

Refer to Figure 4.5, Cabinet Assembly Drawing, for PC Board location.

## CAUTION

ALL CABINET SWITCHES ARE FACTORY PRESET.  
CHANGING ANY SWITCH POSITION, WITHOUT PROPERLY IDENTIFYING ITS  
LOCATION AND PURPOSE, MAY CAUSE SERIOUS EQUIPMENT DAMAGE.



## WARNING

IF **AUTO RE-START** IS ENABLED, THE OUTPUT TERMINALS OF POWER SOURCE  
MAY BE ENERGIZED **AUTOMATICALLY** WHEN INPUT POWER IS APPLIED

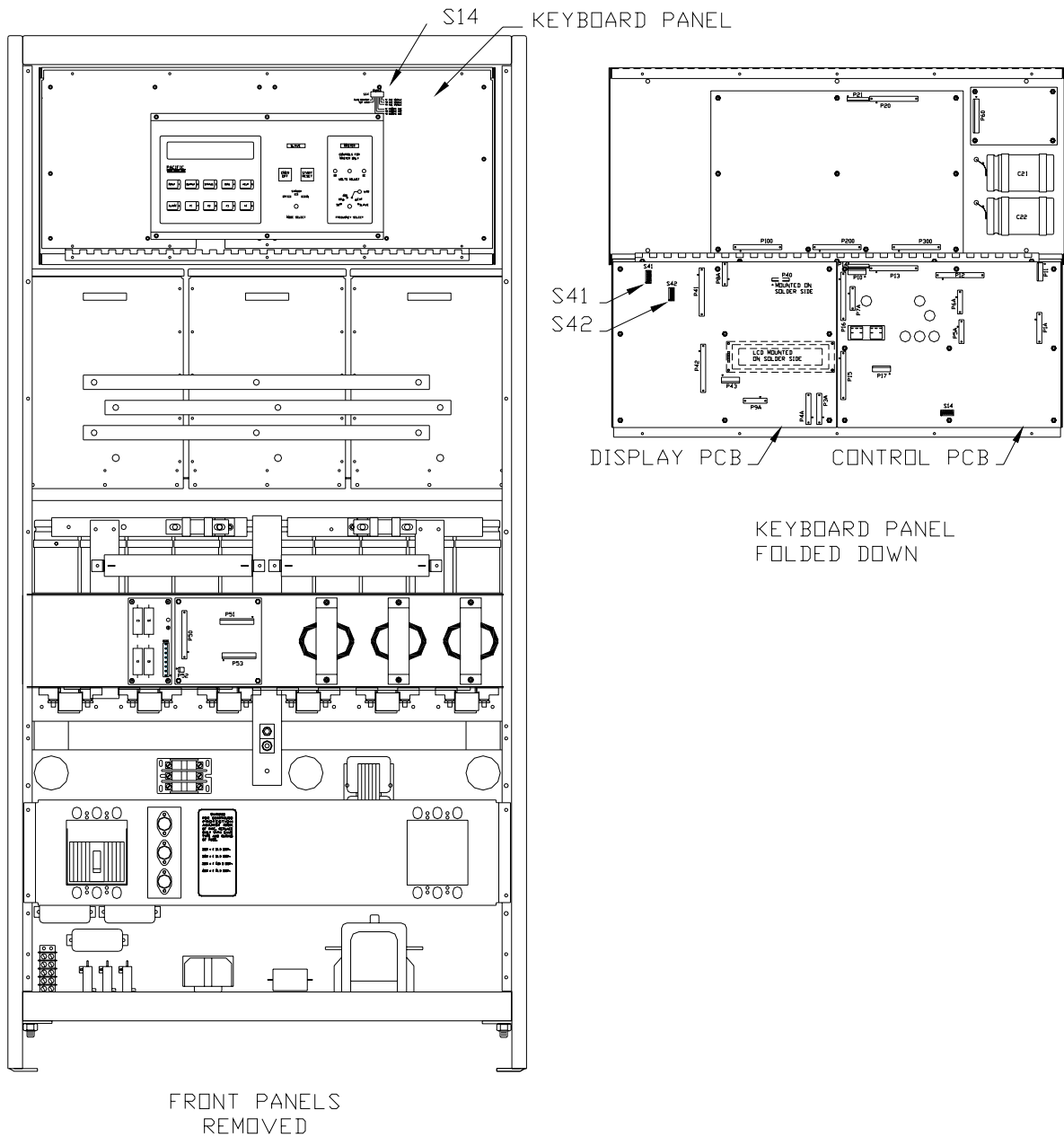


FIGURE 4.5 CABINET ASSEMBLY

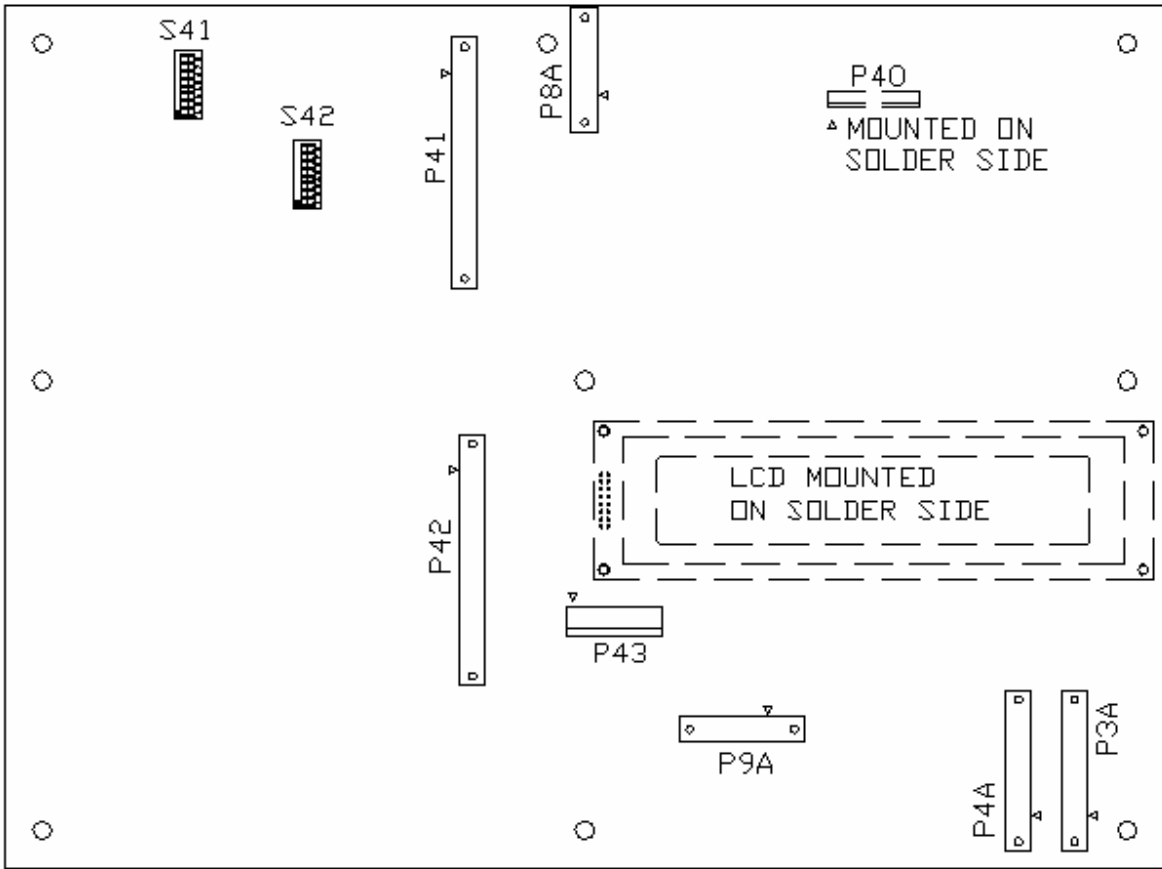
## 4.5.1 DISPLAY PCB (126072)

Refer to figure 4.5.1, Display PCB. Two switches are located on this assembly. Switch S42 is for testing and future use. Switch S41 provides the following configuration information to the Power Source:

<b><u>S41-1</u></b>	<b><u>S41-2</u></b>	<b><u>Machine Size</u></b>
OFF	OFF	62.5kVA
OFF	ON	Undefined
ON	OFF	Undefined
ON	ON	Undefined
<b><u>S41-3</u></b>		<b><u>Undefined</u></b>
<b><u>S41-4</u></b>		<b><u>Undefined</u></b>
<b><u>S41-5</u></b>	<b><u>S41-6</u></b>	<b><u>Serial Port "A" Baud Rate</u></b>
OFF	OFF	300
OFF	ON	1200
ON	OFF	2400
ON	ON	9600
<b><u>S41-7</u></b>	<b><u>S41-8</u></b>	<b><u>Serial Port "B" Baud Rate</u></b>
OFF	OFF	300
OFF	ON	1200
ON	OFF	2400
ON	ON	9600

Normal Shipping Configuration is as follows:

S41-1	OFF	62.5kVA Machine
S41-2	OFF	62.5kVA Machine
S41-3	OFF	Undefined
S41-4	OFF	Undefined
S41-5	OFF	1200 Baud Serial Port A
S41-6	ON	1200 Baud Serial Port A
S41-7	OFF	1200 Baud Serial Port B
S41-8	ON	1200 Baud Serial Port B
S42-ALL	OFF	Undefined



**FIGURE 4.5.1      DISPLAY PCB ASSY., 126072**

## 4.5.2 CONTROL PCB (126070)

Refer to figure 4.5.2, Control PCB. One switch is located on this assembly. Switch S14 provides for enabling of the auto restart option and local or remote AGC (automatic gain control.)

Switch S14 assignments are as follows:

<b>S14-1</b>	<b>Auto Restart</b>	<b>Normal Configuration as Shipped</b>
OFF	OFF	OFF
ON	ON	
<b>S14-2</b>	<b>Undefined</b>	OFF
<b>S14-3</b>	<b>Phase A AGC</b>	
OFF	LOCAL	OFF
ON	REMOTE	
<b>S14-4</b>	<b>Phase B AGC</b>	
OFF	LOCAL	OFF
ON	REMOTE	
<b>S14-5</b>	<b>Phase C AGC</b>	
OFF	LOCAL	OFF
ON	REMOTE	
<b>S14-6</b>	<b>Phase A AGC</b>	
OFF	DISABLED	
ON	ENABLED	ON
<b>S14-7</b>	<b>Phase B AGC</b>	
OFF	DISABLED	
ON	ENABLED	ON
<b>S14-8</b>	<b>Phase C AGC</b>	
OFF	DISABLED	
ON	ENABLED	ON



## WARNING

IF **AUTO RE-START** IS ENABLED, THE OUTPUT TERMINALS OF POWER SOURCE MAY BE ENERGIZED **AUTOMATICALLY** WHEN INPUT POWER IS APPLIED

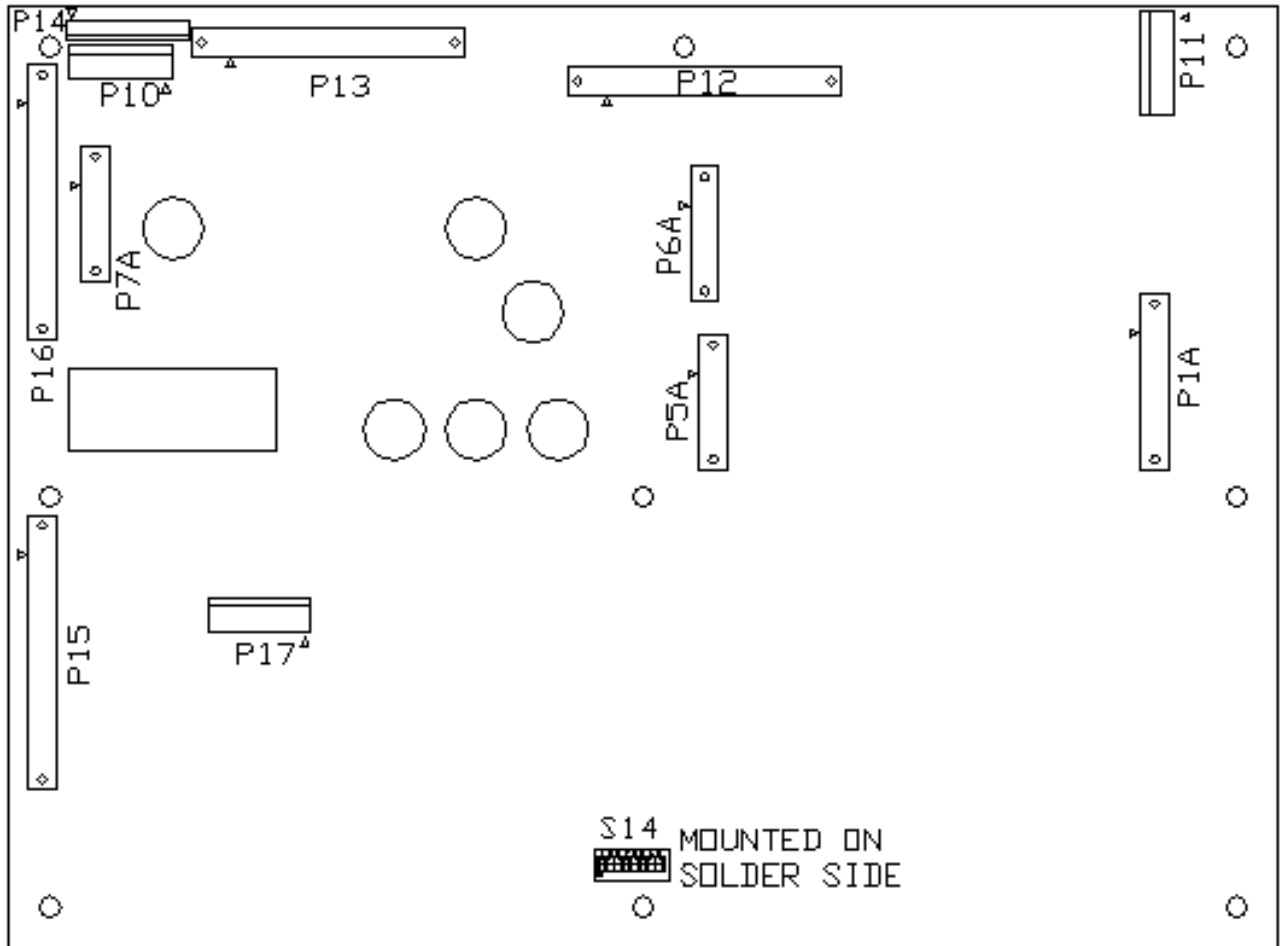


FIGURE 4.5.2 CONTROL PCB ASSY., 126070

#### 4.6 FEATURE CONNECTORS

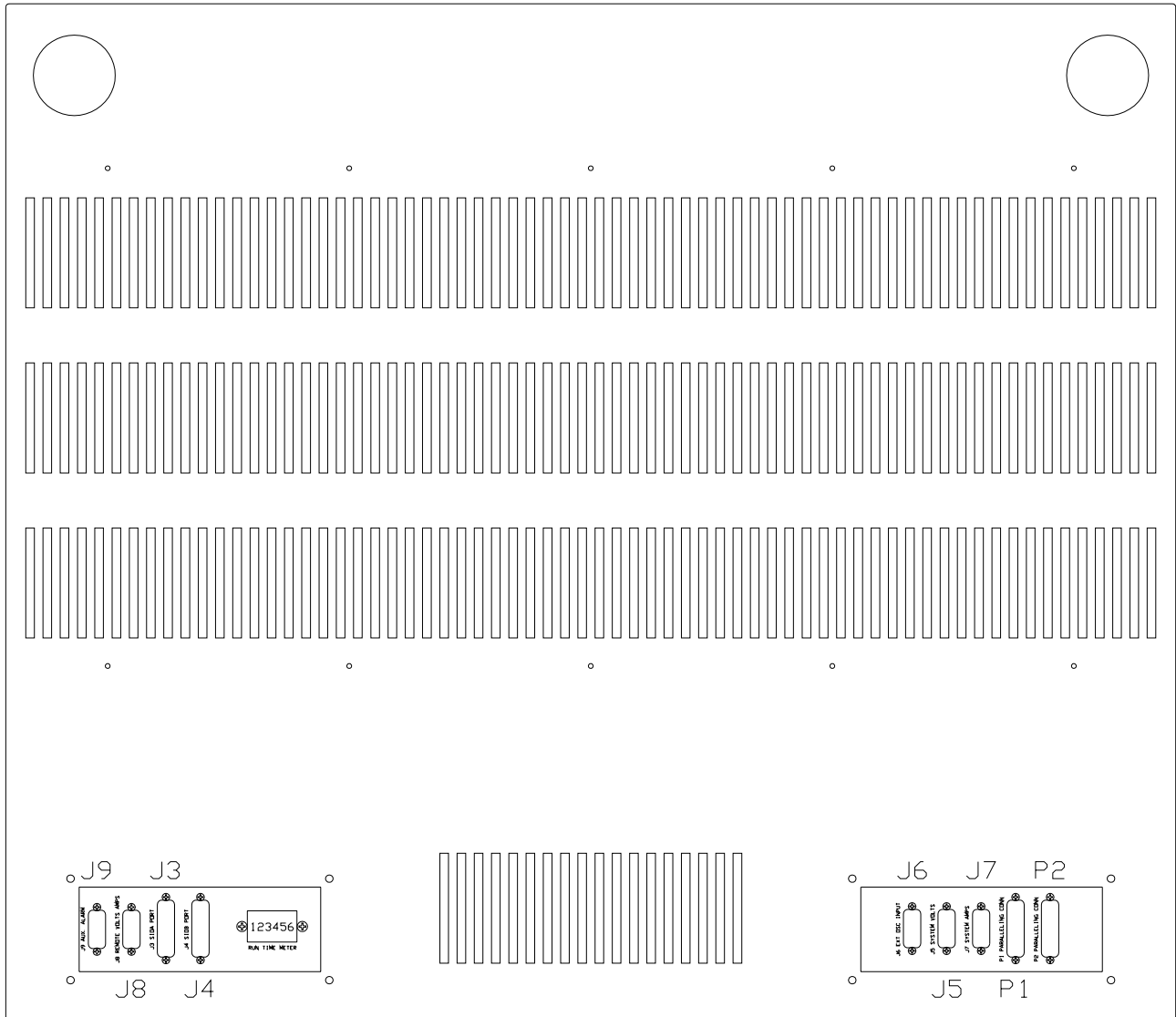
This paragraph describes the Feature Connectors contained within the MS-Series AC Power Source, their purpose, location, and pin numbers. The use of these connectors is optional. Refer to figure 4.6 for location of these connectors.

##### 4.6.1 P1, P2 PARALLELING

These are used for Paralleling cabinets in multiple cabinet systems. They are DB25P type. Pin numbers are as follows:

<b><u>Pin#</u></b>	<b><u>Description</u></b>
1	ØA (Error Signal)
2	ØB (Error Signal)
3	ØC (Error Signal)
4	Common (Error Signal)
5	Triangle Wave Sync
6	Master on line
7	Remote mode 0
8	Remote mode 2
9	Remote Emer Off
10	Remote Start
11	ØA System Amps
12	ØB System Amps
13	ØC System Amps
14-17	Gnd
18	+12VDC
19	Ext Emer Off
20-22	No Connection
23-25	Gnd





**FIGURE 4.6 CABINET TOP VIEW - FEATURE CONNECTOR DETAIL**

#### 4.6.2 J3 AND J4 SERIAL I/O

This paragraph describes the Serial Ports available on the MS-Series Power Source.

The MS Series Power Source is provided with Dual Serial Communication Ports designated COM A and COM B. These output are RS-232-C Ports with bi-directional logic. Power Source status is stored in an internal register and transmitted through these ports when interrogated.

#### **PHYSICAL CONFIGURATION**

Refer to Figure 4.6. J3, or COM A, is a female, DB-25 socket. This socket is a Data Communications Equipment (DCE) Port configured to be interfaced with a Data Terminal Equipment (DTE) device such as a "dumb" terminal, or PC set up as a DTE.

J4, or COM B, is a DTE port configured to be interfaced with a DCE device such as a modem. A female, DB-25 socket is also provided for this port.

#### **BAUD RATE**

The Baud Rates for data transmission are 300, 1200, 2400 or 9600 as selected by switch S41 on the Display PCB Assembly. (Refer to Figure 4.5.1.)

#### **COMMUNICATION DATA FORMAT**

Data is transferred as an 8 bit word with 1 Start, 1 Stop, and no Parity bit.

#### **DATA TRANSMISSION**

Serial Port design is such that no "Handshaking" is required in hardware or software. Due to this fact, data transmitted to the MS must be limited to 5 characters per second. Data bursts are sent from the MS in approximately 200ms increments.

Refer to Table 4.6.2. Hardware handshaking signals, (i.e. TXDA, CTSA, DCDA, etc) are provided for operator convenience. The MS requires only 3 lines: Receive, Transmit and Ground.

PORT	PIN	MNEMONIC	DESCRIPTION
<b>COM A</b>	2	RXDA	RECEIVE DATA PORT A
	3	TXDA	TRANSMIT DATA PORT A
	4	CTSA	CLEAR TO SEND PORT A
	20	DCDA	DATA CARRIER DETECT PORT A
	8	DSRA	DATA SET READY PORT A
	5	RTSA	REQUEST TO SEND PORT A
	7	GRD	GROUND PORT A
<b>COM B</b>	4	RTSB	REQUEST TO SEND PORT B
	20	DTRB	DATA TERMINAL READY PORT B
	2	TXDB	TRANSMIT DATA PORT B
	3	RXDB	RECEIVE DATA PORT B
	8	DCDB	DATA CARRIER DETECT PORT B
	5	CTSB	CLEAR TO SEND PORT B
	7	GRD	GROUND

TABLE 4.6.2 SERIAL I/O CONNECTIONS

With the serial port, it is possible to obtain all Front Panel Display information described in section 4.3.1.

This paragraph provides the syntax and a brief description of all MS recognized commands. Section 4.3.1 should be reviewed for detailed descriptions of returned messages.

<u>Command</u>	<u>Command Type</u>	<u>Information Type</u>
I1 <RET>	Input Screen #1	VLN, VLL, Amps, kW, kVA, Frequency, Input NORMAL OR ABNORMAL.
O1 <RET>	Output Screen #1	CABINET VLN, VLL, Amps, kW, kVA, Frequency, Efficiency.
O2 <RET>	Output Screen #2	CABINET VLN, VLL, %Peak Current, %kVA, %kW, Frequency.
O3 <RET>	Output Screen #3	SYSTEM VLN, VLL, Amps, kW, kVA, Frequency.
O4 <RET>	Output Screen #4	REMOTE VLN, VLL, Amps, kW, kVA, Frequency.
S <RET>	Status Screen	Varies
D1 <RET>	Diag. Screen #1	Cause of Emergency Off.

<u>Command</u>	<u>Command Type</u>	<u>Information Type</u>
D2 <RET>	Diag. Screen #2	Temperature Data
D3 <RET>	Diag. Screen #3	Internal Voltages
D4 <RET>	Diag. Screen #4	Binary Ports 2-5
H <RET>	Help Screen	Varies
ST <RET>	Reset Display CPU	<Same as pressing Input Status and Help keys>
Q <RET>	Alarm Silence	<Same as Alarm Key>
R <RET>		Continuously Repeat Last Command. Use <SPACE BAR> <RET> to stop.

#### 4.6.3 J6 EXTERNAL OSCILLATOR

This is an External Oscillator Input. This connector is a DA15S type. If the Frequency Select Switch is rotated to the EXT position and the cabinet is ON, inputs applied to J6 are amplified 25 times at the output terminals.

Example: 4.80 VAC, 60 Hz input at J6 equals  
120 VAC, 60 Hz at the output contactor.

Pin Numbers are as follows:

7	Ext Phase A Oscillator Input
15	Ext Phase B Oscillator Input
8	Ext Phase C Oscillator Input
10	Gnd

#### 4.6.4 J5 AND J7 SYSTEM METERING OUTPUTS

J5 is a System Volts output signal connector. System Volts are divided down by 25 to 1 and sent to this connector. This connector is a DA15S type.

Example: 120 VAC, 60 Hz at the output contactor equals  
4.80 VAC, 60 Hz at J5.

Pin Numbers are as follows:

1	Phase A System Volts Output
11	Phase B System Volts Output
8	Phase C System Volts Output
2,7,12	Gnd

J7 is a System Amps output signal connector. System Amps are divided down by 400 to 1 and sent to this connector. This connector is a DA15S type.

Example: 400 AAC, 60 Hz total system output equals  
1.00 VAC, 60 Hz at J7.

Pin Numbers are as follows:

2	Phase A System Amps Output
7	Phase B System Amps Output
11	Phase C System Amps Output
1,8,12	Gnd

#### 4.6.5 J8 REMOTE METERING INPUTS

J8 is a Remote Metering Input signal connector. Remote Volts are divided down by 100 to 1 and sent to this connector. Remote Amps are divided down by 400 to 1 and sent to this connector. This connector is a DA15S type.

Example: 120 VAC, 60 Hz at the remote location equals  
1.20 VAC, 60 Hz at J8.

Example: 400 AAC, 60 Hz at the remote location equals  
1.00 VAC, 60 Hz at J8.

Pin Numbers are as follows:

1	Phase A Remote Volts Input
2	Phase B Remote Volts Input
3	Phase C Remote Volts Input
4	Phase A Remote Amps Input
5	Phase B Remote Amps Input
6	Phase C Remote Amps Input
7	Neut Remote Amps Input
8	Gnd

#### 4.6.6 J9 AUXILIARY ALARM OUTPUTS

This connector alerts the user to conditions that cause alarm status in the cabinet. These are digital 0 to +5 VDC outputs designed to operate small relays which the user may utilize to operate remote lights and buzzers. This connector is a DA15S type.

Pin Numbers are as follows:

1	Overload
2	Over/Under Voltage
3	Audible Alarm at Cabinet
4	Undefined
5	No connection
6	No connection
7	-18 VDC
8	Gnd
9	Overtemp
10	Over/Under Frequency
11	Undefined
12	Undefined
13	No connection
14	No connection
15	+18 VDC

Refer to section 4.3.1.6 for information on setting ALARM parameter limits. Disabling ALARM at the cabinet will be reflected here as no output on pin 3 during an ALARM condition.

## 5.0 MAINTENANCE

The MS-Series equipment has been designed so that maintenance is kept to an absolute minimum. This section describes the maintenance requirements of this equipment. Paragraph 5.1 describes the maintenance required by the Power Source. If there are any questions please call Pacific Power Source, Inc. at 800-854-2433 (in the United States. For international support dial 1-949-251-1800)

### 5.1 MAINTENANCE SCHEDULE

Routine maintenance of the MS equipment consists of the steps below. Pacific recommends the use of a maintenance checklist of the form shown in FIGURE 5.1.3. This helps to guarantee regular performance of maintenance. Additionally, equipment history is created. This is sometimes helpful when servicing the equipment, particularly when attempting to solve an application type problem.

#### MAINTENANCE PROCEDURES (Refer to FIGURE 5.1.3)

The following procedure is recommended to be performed at 3 month intervals.

- STEP 1: Record cabinet input data by pressing the INPUT key on the front panel display.
- STEP 2: Record cabinet output data by pressing the OUTPUT then f1 and f2 keys on the front panel display.
- STEP 3: Record the current Status message by pressing the STATUS key on the front panel display.
- STEP 4: Record Diagnostic messages by pressing the DIAGNOSTIC then f1 then f2 then f3 and f4 keys on the front panel display.
- STEP 5: Inspect the cabinet carefully. Listen for noisy fan bearings, etc.
- STEP 6: Turn the unit off and inspect the inside of the cabinet
- STEP 7: Clean the Inverter Air Filters by, first, removing the back panel of the power source (FIGURE 5.1.1). Then use a vacuum cleaner and a soft brush on the underside of each inverter (FIGURE 5.1.2) to clean each of the two filters per inverter. (If rear access is not available then remove the inverters per section 6.5.1. Clean and replace.)
- STEP 8: Clean the outside of the machine. Make comments as appropriate in the maintenance log.
- STEP 9: Turn the unit back on.

#### TABLE 5.1.1 6 MONTH MAINTENANCE CYCLE



**FIGURE 5.1.1 REAR OF MS-SERIES CABINET – BACK PANEL REMOVED**



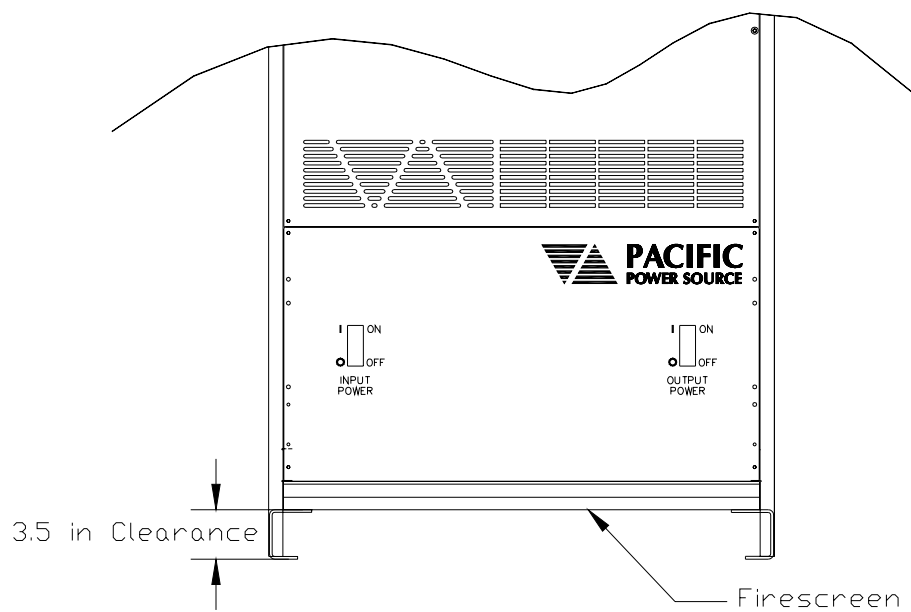
**FIGURE 5.1.2 UNDERSIDE OF MS-SERIES INVERTERS**



The following procedure is recommended to be performed at 4 to 6 week intervals (for CE versions).

- STEP 1: Clean the fire screen underneath the bottom of the MS using a vacuum cleaner with a brush attachment

**TABLE 5.1.24-6 WEEK MAINTENANCE CYCLE**



**FIGURE 5.1.3 FIRESCREEN LOCATION FOR CLEANING**

**MS-SERIES MAINTENANCE LOG**

EQUIPMENT MODEL NO. \_\_\_\_\_

EQUIPMENT SERIAL NO. \_\_\_\_\_

DATE: \_\_\_\_\_ TECHNICIAN: \_\_\_\_\_

**1. CABINET DATA**

I1: INPUT	V	_____ / _____	_____ / _____	_____ / _____
NORMAL	A	_____	_____	_____
	kW	_____	_____	_____
FREQ=	kVA	_____	_____	_____
O1: CABINET	V	_____ / _____	_____ / _____	_____ / _____
OUTPUT	A	_____	_____	_____
EFF _____ %	kW	_____	_____	_____
FREQ _____	KVA	_____	_____	_____
O2: CABINET	V	_____ / _____	_____ / _____	_____ / _____
OUTPUT	%I-PEAK	_____	_____	_____
	%kVA	_____	_____	_____
FREQ _____	%kW	_____	_____	_____
O3: SYSTEM	V	_____ / _____	_____ / _____	_____ / _____
SUMMARY	A	_____	_____	_____
OUTPUT	KW	_____	_____	_____
FREQ _____	KVA	_____	_____	_____
O4: REMOTE	V	_____ / _____	_____ / _____	_____ / _____
OUTPUT	A	_____	_____	_____
	KW	_____	_____	_____
FREQ _____	KVA	_____	_____	_____

**FIGURE 5.1.4 MS-SERIES MAINTENANCE LOG**

MS-SERIES MAINTENANCE LOG (cont)

**2. STATUS INFORMATION**

S \_\_\_\_\_ : CAB \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**3. DIAGNOSTIC INFORMATION**

D1: DIAGNOSTIC \_\_\_\_\_  
 \_\_\_\_\_

D2: DIAGNOSTIC

TEMPERATURE DATA	
XFMR:	DEG C
INV:	DEG C

D3: DIAGNOSTIC

INTERNAL VOLTAGES			
BUS		LVPS	
+	VDC	+	VDC
-	VDC	-	VDC

D4:

	Port # 2	Port # 3	Port # 4	Port # 5
PWR				
EMER				
NOW				

**COMMENTS/APPEARANCE**

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## 6.0 SERVICE

The MS-Series equipment has been designed using a subassembly concept. This design feature allows for service via the assembly exchange approach. The service procedures described in this section will isolate a problem to the replaceable assembly or component level as appropriate. Printed circuit board assemblies are considered to be replacement items. Mainframe components such as contactors, diode bridges, filter capacitors, etc. are considered replaceable components.

For factory assistance call Pacific Power Source, Inc. at 800-854-2433 (in the United States. For international support dial 1-949-251-1800)

This section is organized as follows:

Paragraph 6.1	Provides a brief description of each assembly.
Paragraph 6.2	Provides the theory of operation required to troubleshoot the system.
Paragraph 0	Provides step-by-step troubleshooting procedures.
Paragraph 6.4	This section contains schematic diagrams for the LVPS, Input Power, DC Power Supply and Inverter assemblies.
Paragraph 6.5	Provides procedures for replacing defective assemblies.
Paragraph 6.6	Provides procedures for replacing defective components.
Paragraph 6.7	Provides instructions for returning assemblies for repair.

### 6.1 DESCRIPTION

#### 6.1.1 MAINFRAME DESCRIPTION

This paragraph describes the various assemblies and components of the Mainframe. Each assembly's and component's function is described below. The part numbers listed are to be used when ordering spare assemblies and components. Refer to Figure 6.1.1 for the location of the assemblies and components following.

1. **MAINFRAME ASSEMBLY (P/N 126000)**  
The top assembly. The mainframe assembly contains the main cabinet sheet metal, input transformer and input and output power contactors.
2. **POWER SUPPLY PANEL ASSEMBLY (P/N 126100)**  
A  $\pm 200$  VDC power supply for the inverter assemblies. This assembly is not field replaceable, but components such as fuses, filter capacitors and rectifier diodes are field replaceable.
3. **DISCHARGE PCB ASSEMBLY (P/N 126075)**  
This PCB assembly contains a transistor switch which is used to switch a load into the high voltage DC supply. This switch is active during shutdown sequences so that the DC voltages are brought to safe levels, less than 48 VDC. This board also contains signal conditioning circuits that scale down high voltages to low voltages which are required for the control and display PCB's. [In the CE Option a High Voltage DC blocking PCB Assembly (P/N 126370) is mounted next to the Discharge PCB Assembly.]
4. **COMPONENTS**
  - R4 and R5, Discharge Resistors (P/N 769990-056)
  - S3, Input Contactor (P/N 717026)
  - S7, Slow Start Input Contactor (P/N 717005)
  - CB1, Input Circuit Breaker:
    - 480 VAC Input: 80A (P/N 716016)
    - 380 VAC Input: 100A STD (P/N 716049), 100A CE (P/N 716084)
    - 240 VAC Input: 175A (P/N 716048)
    - 208 VAC Input: 175A (P/N 716048)
  - F1-3, LVPS Fuses
    - 480 VAC Input: 1A@500V (P/N 712043)
    - 380 VAC Input: 1A@500V (P/N 712045)
    - 240 VAC Input: 2A@500V (P/N 712044)
    - 208 VAC Input: 2A@500V (P/N 712044)
  - CB2, Output Circuit Breaker Option
    - STD (P/N 716048), CE (716083)
  - CT11-13, Input CT's (P/N 731029)
  - C10-15, Filter Caps (P/N 720096-10)
  - R1-3, Slow turn on resistors (P/N 769990-037)
  - S5, Output Contactor (P/N 717029)
  - BR1-6, Diode Bridges (P/N 743009)
  - C30-39, Power Supply Caps (P/N 720219-12)
  - F10 and F11, DC fuses 300A@500V (P/N 712042)
  - F4-9, AC fuses 150A@250V (P/N 712063)
  - T2, 3 $\Phi$  LVPS Transformer (P/N 531247)
  - T1, 3 $\Phi$  Input Transformer (P/N 531246)
  - F12-14, AC Fuses 200A@600V Slow Blow (P/N 712065)

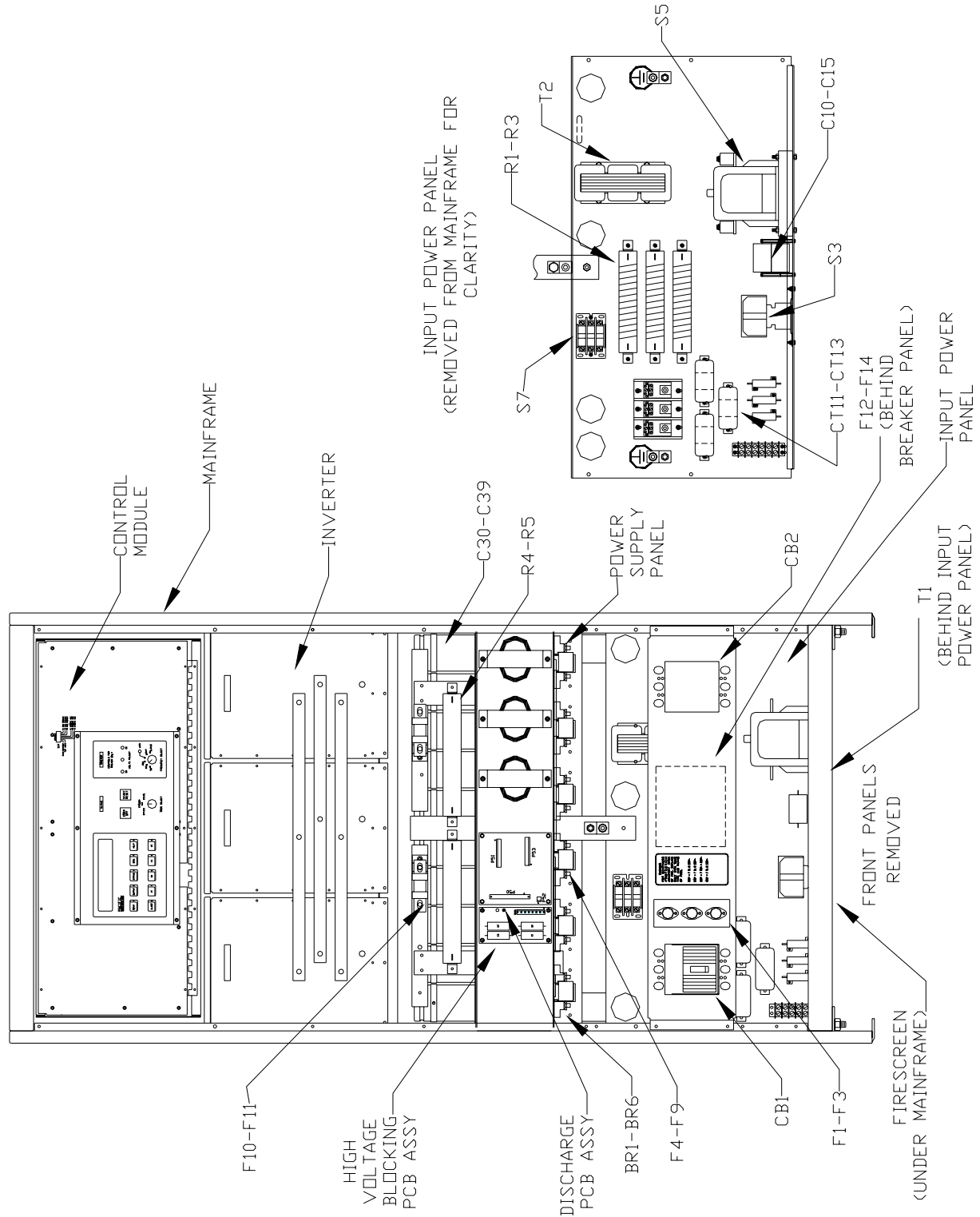


FIGURE 6.1.1 MAINFRAME

### 6.1.2 CONTROL MODULE DESCRIPTION

This paragraph describes the various assemblies and components of the Control Module. Each assembly's and component's function is described below. The numbers listed are to be used when ordering spare assemblies and components. Refer to Figure 6.1.2 for the location of the assemblies and components listed below.

1. **CONTROL PCB ASSEMBLY (P/N 126070)**

A PCB assembly which contains logic, comparator and oscillator circuits. This board determines the state of the system and controls the system. This assembly also contains the local oscillator which develops the output waveform. This is a crystal referenced oscillator. The output is a digitally synthesized sine wave.

2. **MODULATOR PCB ASSEMBLY (P/N 126071)**

This PCB assembly receives the output of the oscillator and produces the signals required to drive the inverter assemblies.

3. **DISPLAY PCB ASSEMBLY (P/N 126072)**

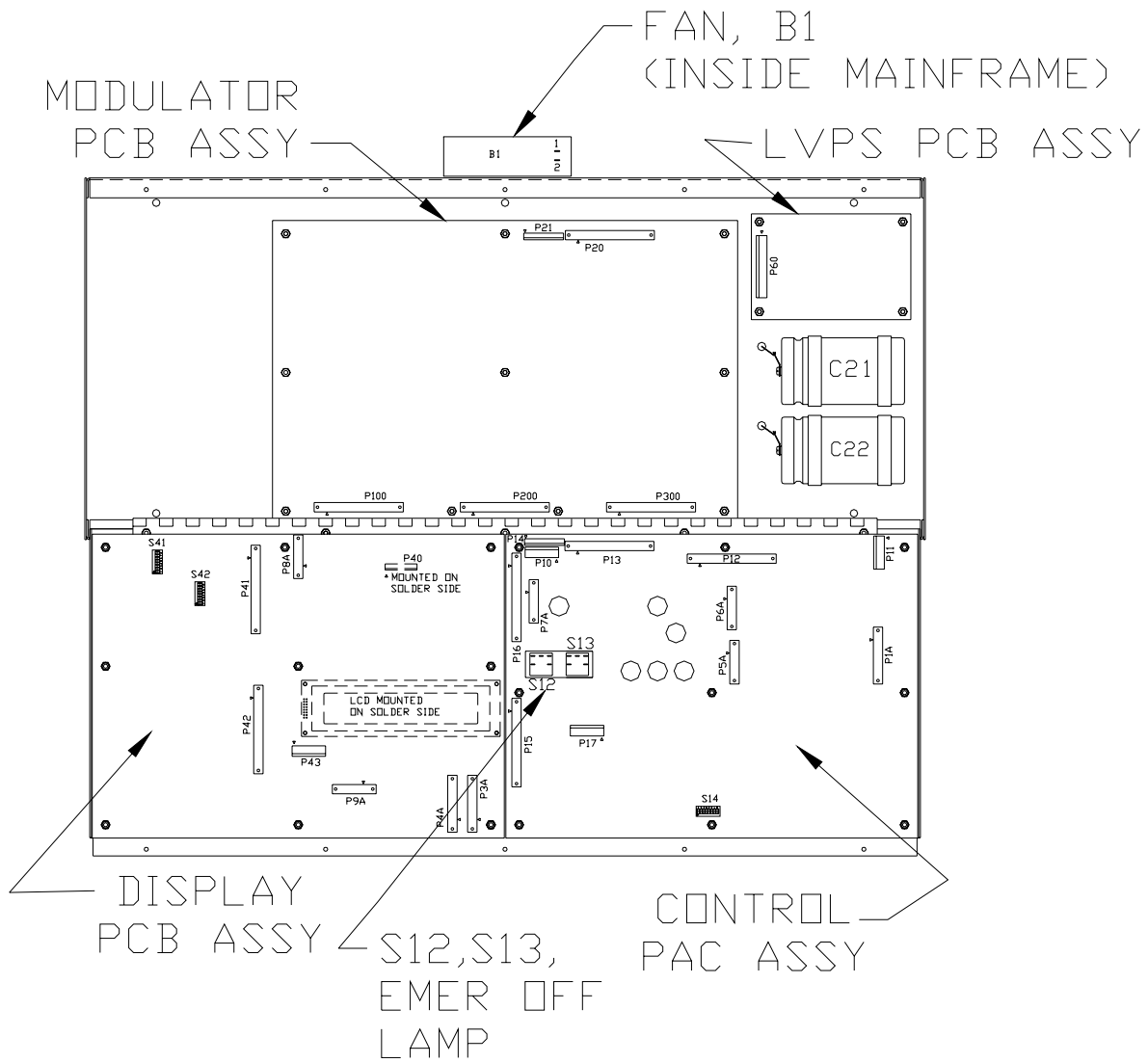
This PCB assembly is mounted to the front panel and contains a CPU which drives an LCD for metering, status, diagnostics and alarms. Two RS232 serial ports are also available for a remote terminal or modem.

4. **LVPS PCB ASSEMBLY (P/N 126074)**

This is a PCB assembly which is used to develop a regulated  $\pm 18$  VDC. This DC voltage is distributed throughout the mainframe and is used to create low voltage DC on each PCB.

5. **COMPONENTS**

C21 and C22, LVPS caps (P/N 720449-95)  
S12 and S13, Push button switches (P/N 710023)  
EMER OFF lamp (P/N 701024)  
B1, fan (P/N 703104)



**FIGURE 6.1.2 CONTROL MODULE**



### 6.1.3 INVERTER DESCRIPTION

This paragraph describes the various assemblies and components of the Inverter assembly. Each assembly's and component's function is described below. The numbers listed are to be used when ordering spare assemblies and components. Refer to Figure 6.1.3 for the location of the assemblies and components listed below. Refer to Section 6.5.1 for removal and replacement procedures.

1. **INVERTER ASSEMBLY (P/N 126200)**

A 21kVA inverter assembly which contains the power circuits that convert DC to AC and drives the output. The inverter assembly is housed in a metal case. This inverter assembly has been designed to reduce RFI/EMI.

2. **DRIVER PCB ASSEMBLY (P/N 126270)**

This PCB assembly receives control signals from the modulator, provides isolation and then drives the power transistors. This PCB is a subassembly of the inverter assembly.

3. **SNUBBER PCB ASSEMBLY (P/N 126272)**

This PCB assembly is used to snub voltage spikes on the power transistors. This PCB is a subassembly of the inverter assembly.

4. **COMPONENTS**

C11-13, Feed through cap (P/N 720545-30)

C1-8, Filter cap (P/N 720096-10)

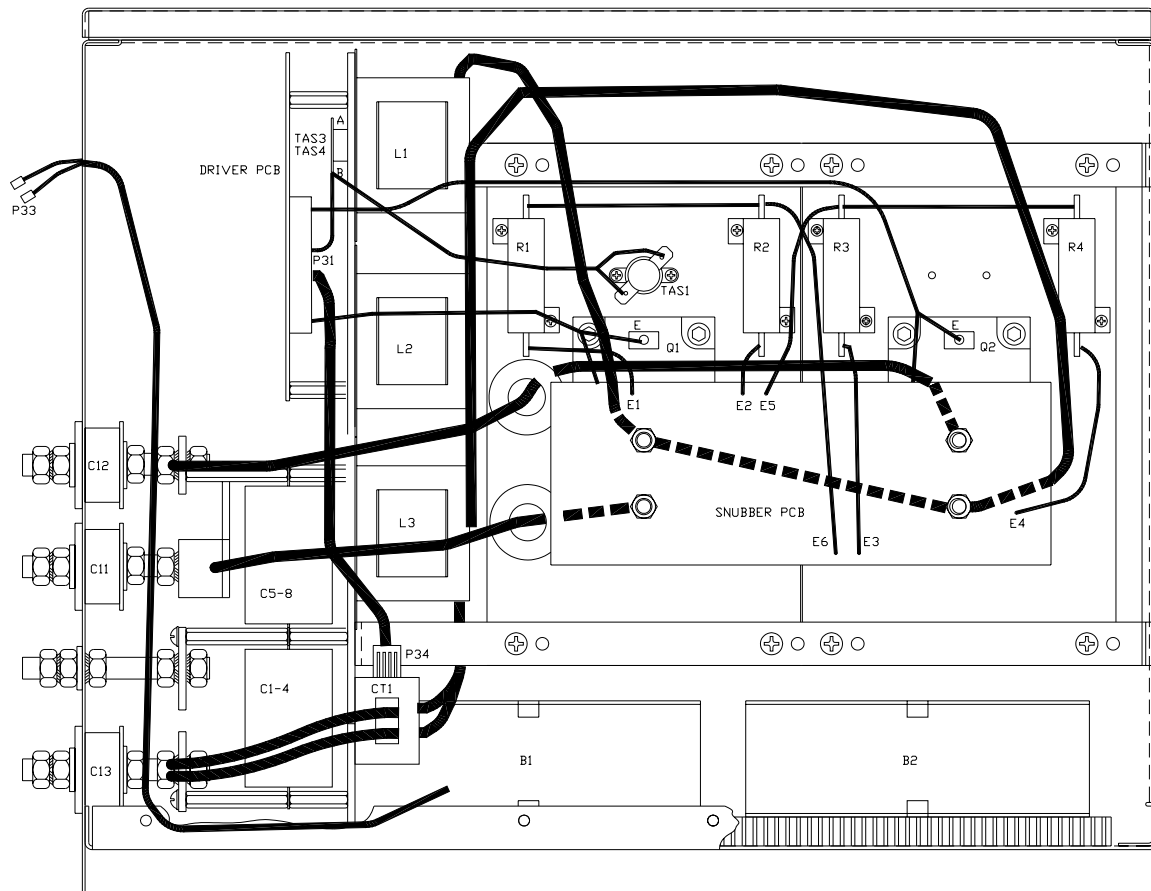
CT1, Current sensor (P/N 703130)

B1 and B2, Fan (P/N 703106)

R1-8, Snubber resistor (P/N 760180-10)

TAS1-4, Temp sensor (P/N 710039)

L1-12, Filter inductor (P/N 530014)



**FIGURE 6.1.3     INVERTER**

## 6.2 THEORY OF OPERATION

This paragraph describes the basic theory of operation for the MS-Series Power Source. The information which follows is provided as technical reference to aid troubleshooting of the equipment.

The MS-Series Power Source consists of five basic subsystems which are as follows:

1. Power Conversion Circuits (Paragraph 6.2.1)
2. System Control Circuits (Paragraph 6.2.2)
3. DC Power Supply Circuits (Paragraph 6.2.3)
4. Metering and Display Circuits (Paragraph 6.2.4)
5. Paralleling Circuits (Paragraph 6.2.5)

Each of the circuits is discussed in detail in each of the above referenced paragraphs.

When the DIAG then f4 keys are pressed the digital inputs to the Display PCB are displayed (Reference section 4.3.1.4). This display may be used to determine the state of control terms in the system.

Control Terms are defined as follows:

### **Control Term Definitions**

3 PHASE PRESENT	True when all three input phases are present.
AGC	(Automatic Gain Control) Provides better steady state regulation of the output voltage.
AUTO RESTART PULSE	Same as POWER ON RESET if selected.
C0	Control mode 0.
C2	Control mode 2.
DISCHARGE	True if S3 CLOSE COMM and S7 CLOSE COMM are false.
EMER OFF SW	True when switch is pressed. Momentary contact panel switch with integral lamp.
EMER OFF LAMP	Is lit whenever Q6 is true.
ERROR IN	Error signal to the modulator.
ERROR OUT	Error signal from the modulator.
ERROR	System Error signal from the master modulator.

**Control Term Definitions (Continued)**

EXT EMER OFF	External Emergency Off input. External contacts have shorted connector P1-18 to P1-19 together and have caused an emergency off.
IAC	Input AC Normal.
INPUT VOLTS	Line to neutral input voltage.
INPUT LINE FAULT	True when Input voltage is less than 80 % of nominal or greater than 120 % of nominal or 3 PHASE PRESENT is false.
INPUT AMPS	Input amps from current transformers.
INV OVERTEMP	One of the inverters has overheated.
INV HOLD COMM	Inverter Hold Command.
INV FAULT	Is true when INVERTER HOLD COMM and MXEN are true and INV TST OK is false. Possible shorted transistor.
INV TST OK	Inverter test OK indicates that the Inverters, 2 per phase, are switching at approximately 30 kHz and no fuses are blown. Does not test the quality of the sine wave being produced and does not care if inverter is in current limit.
INV VOLTS	Inverter output voltage. Inverter side of the output contactor.
INV AMPS	Inverter output amps.
INV O/L	Inverter is in current limit.
LM	Local Master, the FREQUENCY SELECT switch is not in the SLAVE position.
LS	Local Slave, the FREQUENCY SELECT switch is in the SLAVE position.
LVPS FAULT	Checks $\pm 12$ VDC on PCB's.
MASTER LAMP	Is lit whenever the FREQUENCY SELECT switch is not in the SLAVE position.
MASTER EMER OFF	The master cabinet is in an EMER OFF state.
ML	Master on line, at least one Cabinet is a Master.
MOD ENABLE	Modulator enable.
OAC	Output AC Normal.

OFF LAMP	Is lit if Q6, S3 CLOSE COMM and S7 CLOSE COMM are false.
ON LAMP	Is lit if S5 CLOSE COMM is true.
OSC IN	Oscillator signal.
OVER FREQUENCY	OF Condition exists if output frequency is greater than preset limit. Limit is set by the ALARM KEY.
OVER VOLTAGE	OV Condition exists if output voltage is greater than preset limit. Limit is set by the ALARM KEY.
OVERTEMP	Either INV OVERTEMP or XFMR OVERTEMP is true.
POLARITY	Polarity of the signal is being metered.
POWER ON RESET	Pulse, after 3 PHASE PRESENT is true.
Q6	Local EMER OFF state.
R0	Remote mode 0.
R2	Remote mode 2.
REMOTE VOLTS	Remote line to neutral voltage.
REMOTE SENSE	Voltage and current metering from a remote location. AGC may be selected to regulate to this point.
REMOTE START	True if the master is starting.
REMOTE AMPS	Remote amps from remote current transformers.
S3 CLOSE COMM S5 CLOSE COMM S7 CLOSE COMM	Drive signal which causes the relay to close.
SLAVE LAMP	Is lit whenever the FREQUENCY SELECT switch is in the SLAVE position.
STANDBY LAMP	Is lit if S3 CLOSE COMM or S7 CLOSE COMM is true and S5 CLOSE COMM is false.
START/RESET SW	True when switch is pressed. Momentary contact.
SUSTAINED O/L	Inverter is in current limit for more than 50% duty cycle for longer than 20 seconds.
SYSTEM AMPS	Total system output amps from all of the inverters in a paralleled system.
SYSTEM VOLTS	System output volts on the output side of the output contactor.
TRI SYNC	Triangle Wave synchronization signal.
UNDER FREQUENCY	UF Condition exists if output frequency is less than

	preset limit. Limit is set by the ALARM KEY.
UNDER VOLTAGE	UV Condition exists if output voltage is less than preset limit. Limit is set by the ALARM KEY.
VDC > 160	Term goes true when both BUSES are greater than 180 VDC. Term goes false when either Bus goes below 160 VDC.
VDC > 240	True when either Bus voltage exceeds 240 VDC.
XFMR OVERTEMP	Input Transformer has overheated.
XFMR TEMP	Analog signal from embedded thermocouple in input transformer.

### 6.2.1 THEORY OF OPERATION - POWER CONVERSION CIRCUITS

The power conversion circuits of the MS-Series power source consist of the following assemblies:

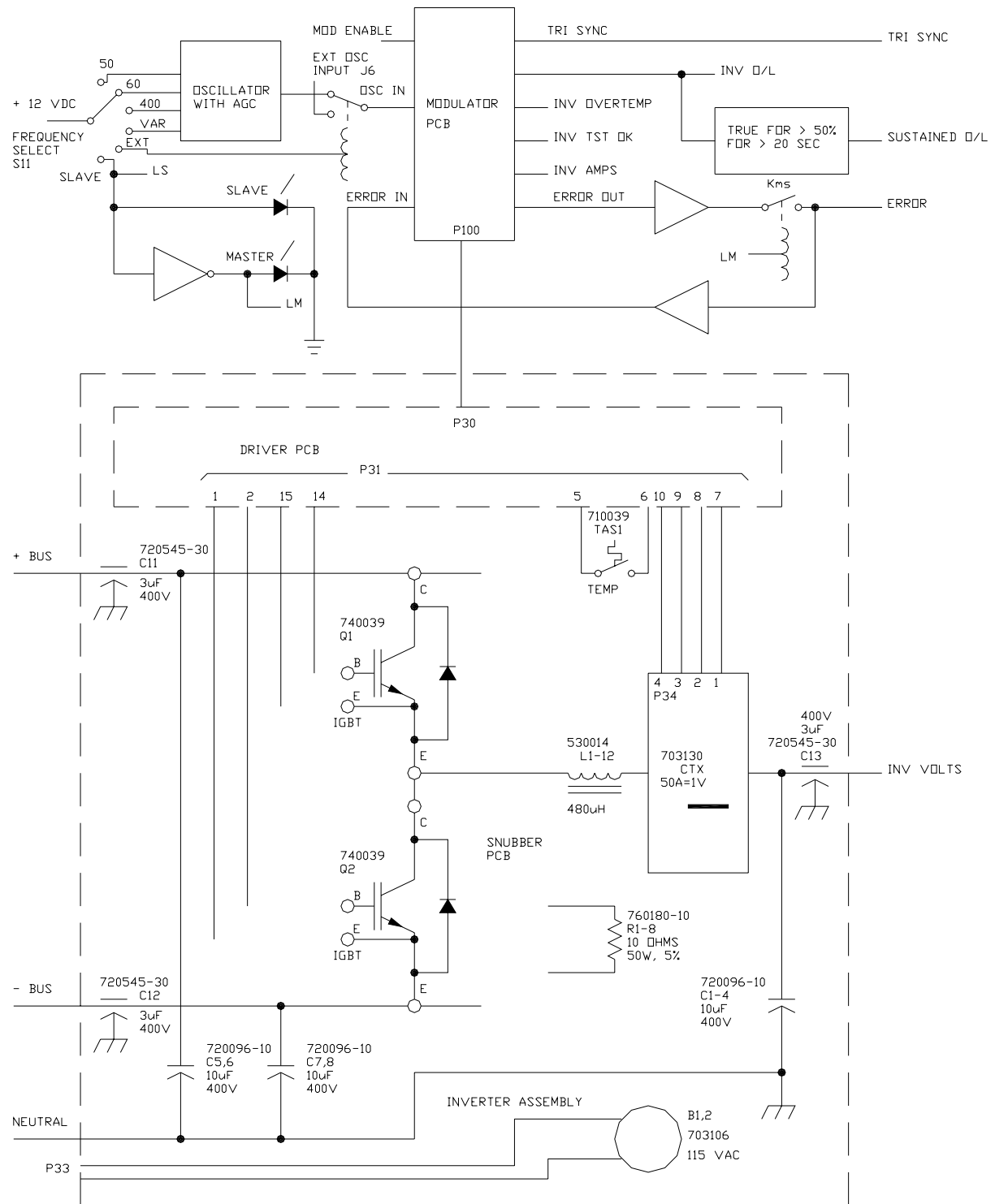
1. Control PCB which contains the Oscillator
2. Modulator PCB
3. Inverter Assemblies (3 each)

Figure 6.2.1 is a block diagram of the inverter assembly.

The oscillator generates three low level sine waves which are at the fundamental output frequency. The amplitude of these signals is 4.8 VAC<sub>rms</sub> when the output is set to 120 VAC<sub>I-n</sub>. Potentiometers R261, R262 and R263 supply DC voltage levels which control the amplitude of the appropriate oscillator outputs. Automatic Gain Control (AGC) is also provided in the oscillator for good output voltage regulation. S14 enables or disables and selects local or remote operation of AGC. When the FREQUENCY SELECT SWITCH is in the EXT or SLAVE positions, all outputs of the oscillator are disabled and will be 0 VAC.

The oscillator output is fed into the modulator PCB. The modulator takes the signal and creates a pulse width modulated digital signal required by the inverter assemblies. The modulator also receives six current signals, two from each inverter assembly, which are representative of individual inverter assemblies' output current. These signals are used to guarantee current sharing between assemblies on the same phase. The modulator develops the INV AMPS term which is used to drive the system output ammeter. The output voltage of each phase is fed back to the modulator PCB. This is done to achieve high waveform quality.

The inverter assembly uses large transistors which switch between the +/- 200 VDC power supplies as controlled by the modulator. The output of this switch is filtered to create the output sine wave.



**FIGURE 6.2.1 BLOCK DIAGRAM POWER CONVERSION CIRCUITS**

### 6.2.2 THEORY OF OPERATION - CONTROL CIRCUITS

The Control PCB is mounted to the rear of the keyboard sub-panel. The Control PCB assembly is central to the system control of an MS-Series mainframe. This PCB monitors key system parameters and either allows or prohibits operation accordingly. Figure 6.2.2 is a block diagram of the system control circuits within the mainframe.

When input power is applied and the input circuit breaker is closed the LVPS is on. At this point, the Control PCB is performing preliminary diagnostics and will light the red System Off LED on the front panel when all diagnostic tests have been passed. The INPUT LINE FAULT signal will be at -12 VDC when all input diagnostic tests have been passed.

If the machine has an internal fault the EMER OFF push button will light. After the fault has been cleared, pressing the START/RESET push button will allow normal operation.

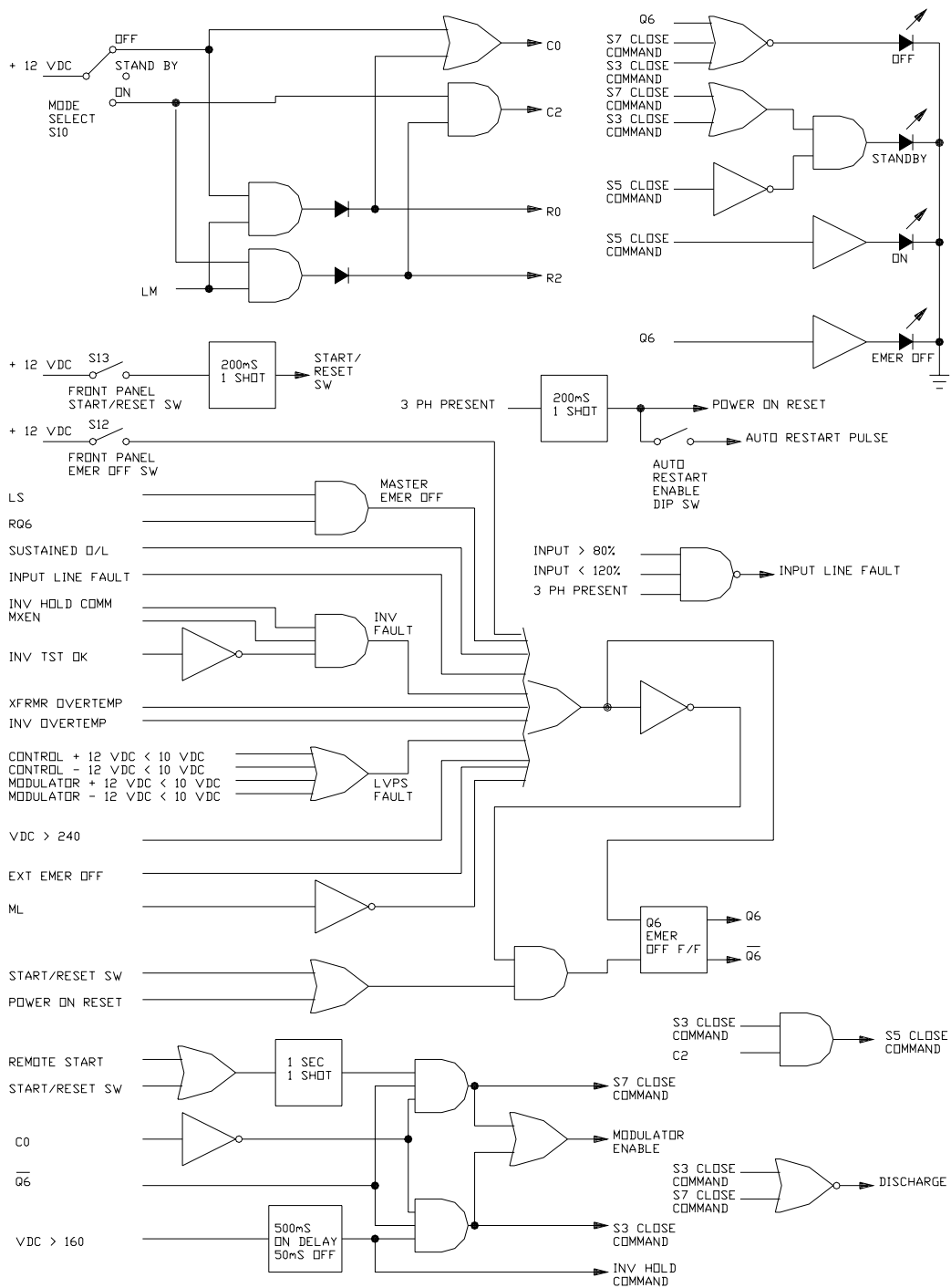
Rotating the MODE SELECT switch to STANDBY and then pressing START/RESET will turn on S7, the Slow-Turn-On Contactor. Resistors R1, R2 and R3 limit the inrush current during transformer turn on and charging of the power supply capacitors. At this point the MODULATOR ENABLE signal is high allowing the inverter to create sine waves at the output. When the power supplies have charged S3, the input power contactor, will close. Rotating the MODE SELECT switch to ON will close the output contactor, S5.

Rotating the MODE SELECT switch to OFF will open all input and output contactors and cause the Discharge PCB to become active. The Discharge PCB switches in a pair of resistors, R4 and R5, whose sole purpose is to discharge the DC supplies.

Pressing the red EMER OFF switch will open all input and output contactors and cause the Discharge PCB to become active. The emergency off flip-flop, Q6, is also set.

Figure 6.2.2 shows the various control signals used in the system. These signals are named appropriately to aid understanding.





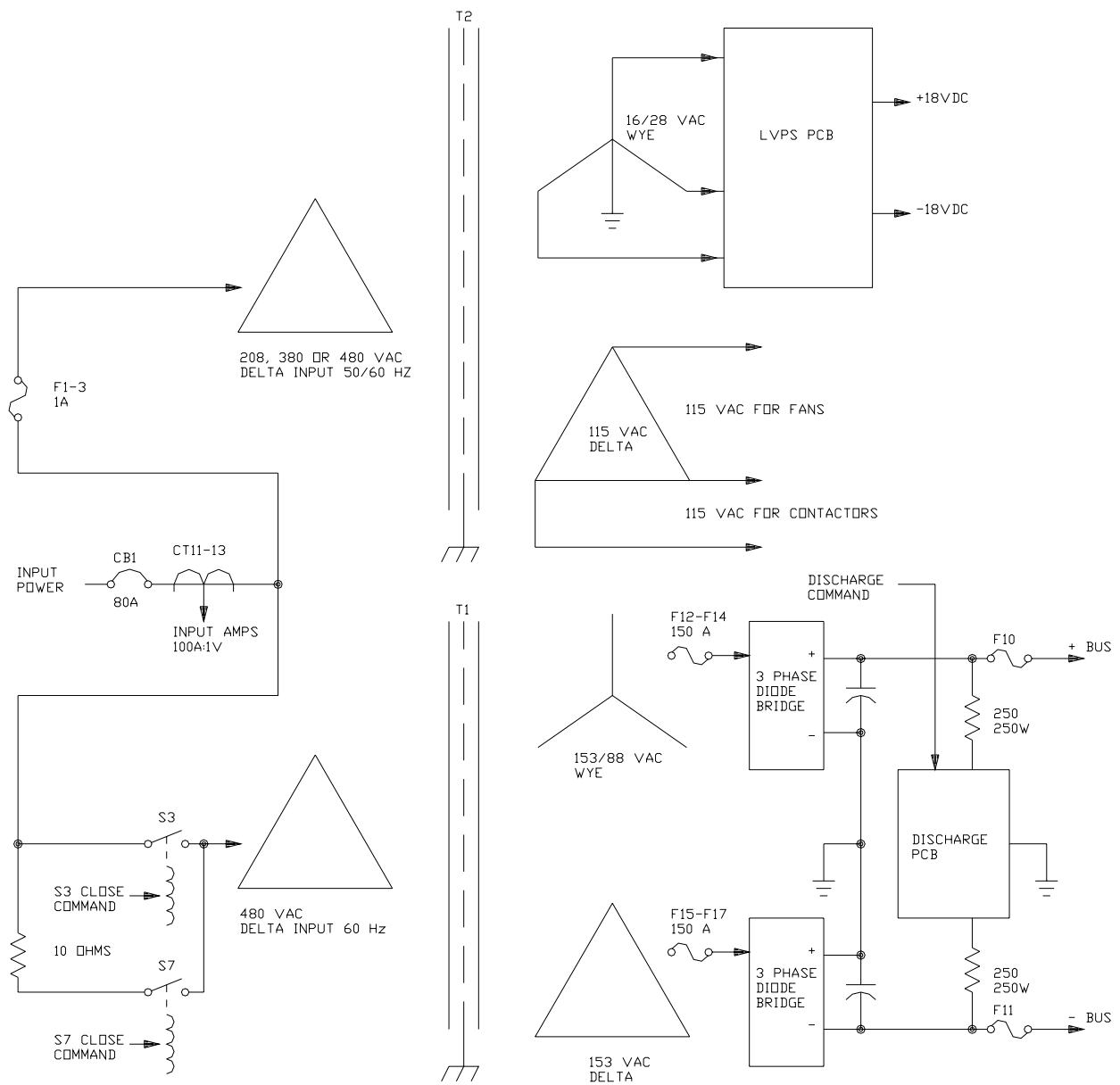
**FIGURE 6.2.2 BLOCK DIAGRAM SYSTEM CONTROL CIRCUITS**

### 6.2.3 THEORY OF OPERATION - DC POWER SUPPLY

The low voltage power supply transformer, T2, generates 3 phase 16/28 VAC for the low voltage DC power supplies and 3 phase 115 VAC for fans and contactor coils. The LVPS PCB generates a regulated  $\pm 18$  VDC from the 16/28 VAC. The Control PCB continuously monitors the  $\pm 18$  VDC Low Voltage DC supplies. If any of these become abnormal, logic circuits on the Control PCB will initiate system shutdown. Refer to Figure 6.2.3 for the block diagram of this circuit.

The main input power transformer, T1, and power supply panel assembly, which contains the rectifiers, capacitors and DC fuses, make up the main DC Power Supply Circuits. The main DC Power Supply is a bipolar supply which produces  $\pm 200$  VDC. This supply is an unregulated supply. It is actually two independent 200 VDC supplies which are stacked on top of each other. The rectifiers are configured as two, full-wave three-phase bridges. These two bridges are connected as shown and feed the capacitor assembly. The capacitors filter the bridge outputs and DC is produced. The common point of this supply is Output Neutral and is connected to the chassis. Two red LEDs, one for positive and one for negative, on the Discharge PCB indicate BUS voltages are present.

The Control PCB continuously monitors the  $\pm 200$  VDC and will shut down the system if the DC is higher than 240 VDC or lower than 160 VDC.

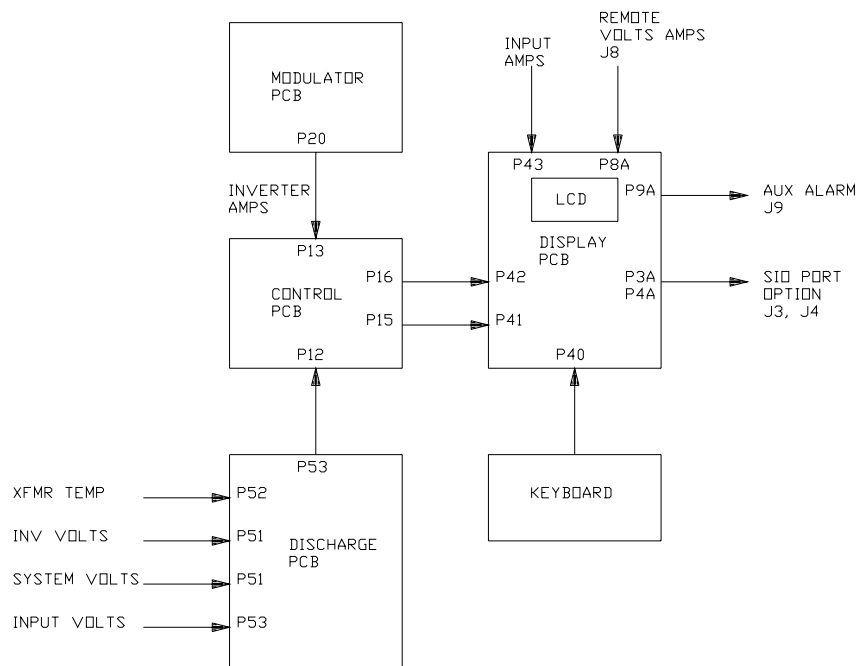


**FIGURE 6.2.3 BLOCK DIAGRAM DC POWER SUPPLY**

### 6.2.4 THEORY OF OPERATION - DISPLAY CIRCUITS

The Display PCB is mounted to the rear of the keyboard sub-panel. The metering circuits are contained on the Display PCB assembly. A CPU is used to meter and display system information on an LCD. The Discharge PCB assembly contains the resistor voltage dividers to scale down system voltages to a low level. These system voltages are sent to the Control PCB. The Control PCB provides all input signals (analog and digital), except input amps, to the Display PCB. CT11-CT13 provide the input current terms required by the Display PCB. Figure 6.2.4 is the block diagram for the meter and display portion of the MS-Series power source.

The Control PCB drives the EMER OFF, OFF, STANDBY, ON, MASTER and SLAVE lamps.



**FIGURE 6.2.4 BLOCK DIAGRAM DISPLAY CIRCUITS**

### 6.2.5 THEORY OF OPERATION - PARALLELING CIRCUITS

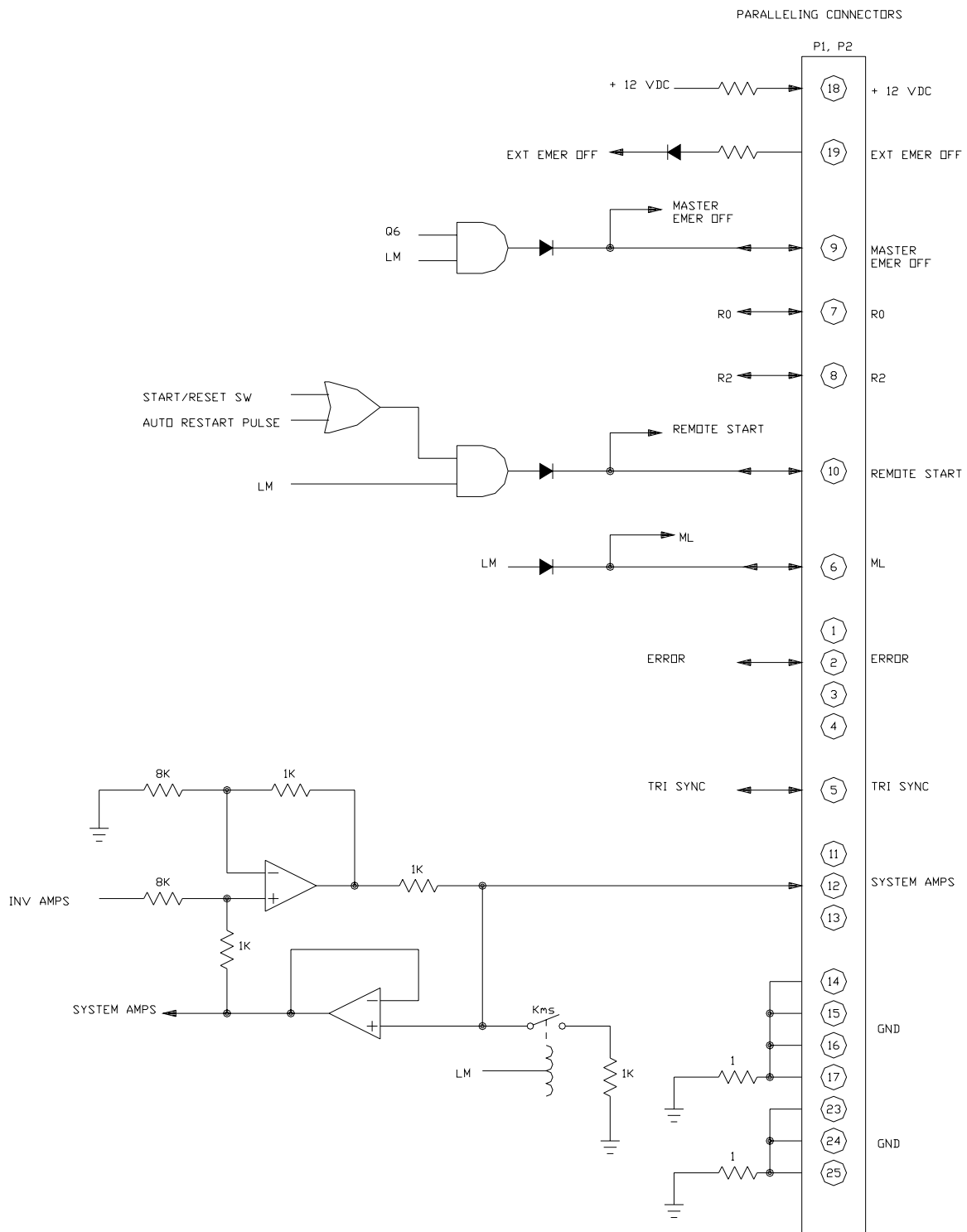
The paralleling circuits are located on the Control PCB. The Control PCB is mounted to the rear of the keyboard sub-panel. The Master Cabinet's Control PCB assembly is central to the system control of a Multi-Cabinet paralleled system. This PCB monitors key system parameters and either allows or prohibits operation accordingly. Figure 6.2.5 is a block diagram of the paralleling circuits within all cabinets of the paralleled system.

P1 and P2 are the paralleling connectors. Tying pin 18 and pin 19 together with isolated external contacts shall cause an external emergency off of the system.

If a cabinet is a master and in an EMER OFF state, it will cause all cabinets to be in an EMER OFF state. The master EMER OFF must be cleared first; then all slave's EMER OFF may be cleared.

When all slave cabinets have no EMER OFF and the mode select switch is in the ON position, the MASTER controls total system operation.

Each cabinet in a paralleled system generates its own inverter amps signal. This signal is summed together to create the system amps signal. System amps is total amps of the system and may be displayed at any cabinet.



**FIGURE 6.2.5 BLOCK DIAGRAM PARALLELING CIRCUITS**

## 6.3 TROUBLESHOOTING PROCEDURE

**CAUTION**

THE SERVICE PROCEDURES OUTLINED IN THIS MANUAL ARE INTENDED FOR USE ONLY BY PERSONNEL AUTHORIZED BY THE MANUFACTURER.

This paragraph outlines a detailed troubleshooting procedure for the MS-Series equipment. Read and understand section 4 of this manual prior to troubleshooting.

These procedures apply to a single cabinet system or the master cabinet of a paralleled cabinet system with all slave cabinets operating normally as a single cabinet system. Two distinct groups of procedures are provided. They are briefly described below:

1. **Performance Check** - This procedure, figure 6.3.1, is used to verify that the system is operating properly.
2. **Service Procedures** - These procedures, figures 6.3.2 through 6.3.6, are used to locate and repair problems which may require removal of input power. Do not use any of these procedures unless instructed to do so by the performance check flow chart.

The procedures make use of flow charts along with explanatory text. This will lead the technician to the defective component or assembly. PCB assemblies and power assemblies are assumed to be replacement items. No attempt is made to troubleshoot these assemblies to the component level.

**WARNING****ELECTROCUTION HAZARD.**

ALWAYS REMOVE ALL INPUT POWER FROM THE MAINFRAME PRIOR TO ATTEMPTING ANY SERVICE TO THE EQUIPMENT.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME WHEN INPUT VOLTAGE IS APPLIED TO THE INPUT TERMINALS.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.

### 6.3.1 PERFORMANCE CHECK

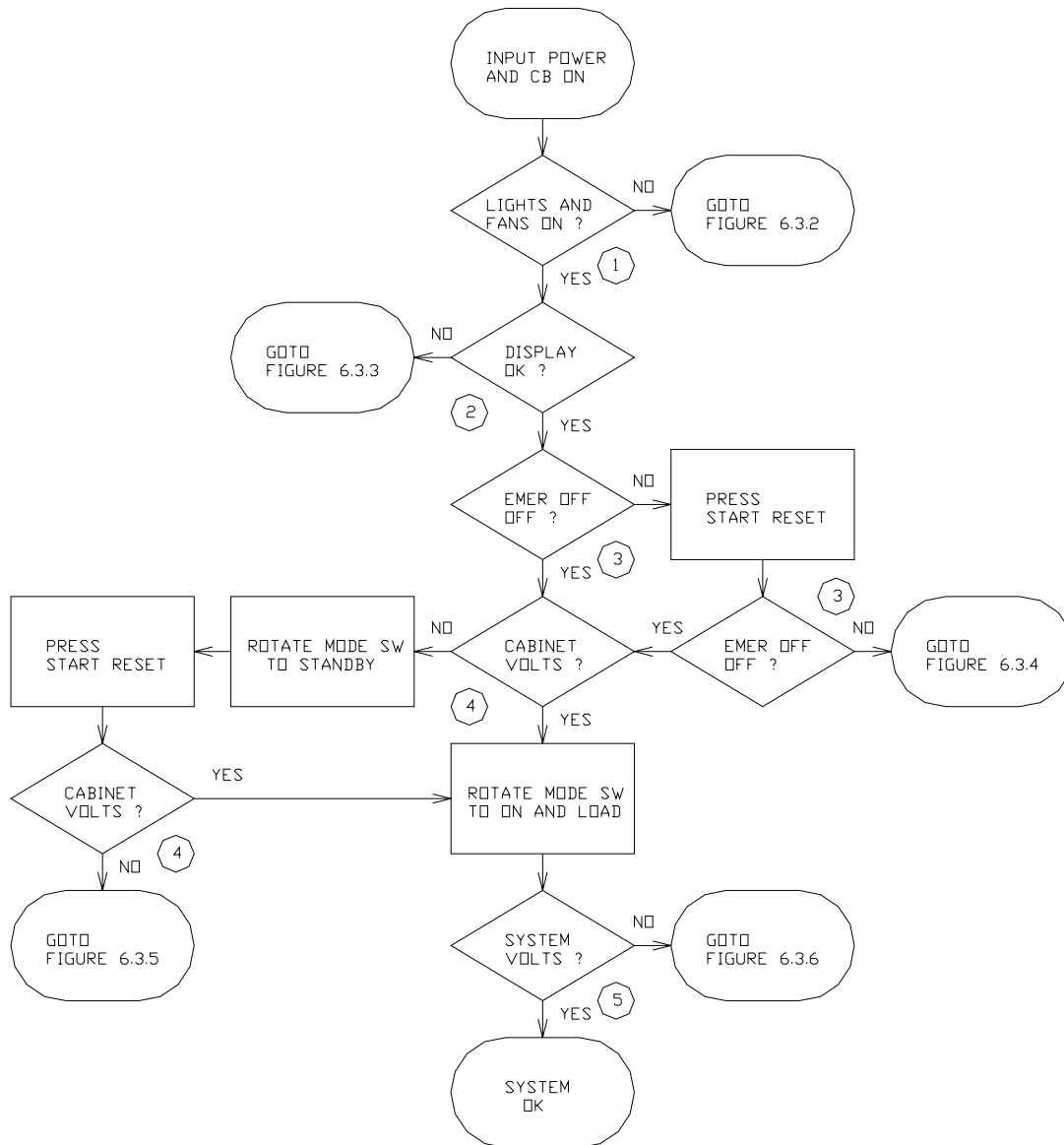
The purpose of this paragraph is to provide a quick, yet thorough procedure that allows the user to verify that the power source is operating properly. Always start with the performance check flow chart.

The numbered comments below correspond to the circled numbers on figure 6.3.1 and provide detailed instructions relative to the referenced step.

1. With input power applied and the input circuit breaker closed, some panel lights should be on and all fans should be spinning. If there are no panel lights or the fans are not spinning go to figure 6.3.2.
2. Pressing the DIAG KEY then f3 KEYS should cause the LCD to display INTERNAL VOLTAGES. Ignore BUS voltages at this time. The LVPS shall be between 15 and 20 VDC. If the LVPS was outside of this range it would cause an EMER OFF. If the display is not correct go to figure 6.3.3.
3. The EMER OFF lamp should be off. If you suspect the lamp it's self is bad press the EMER OFF button. This will cause an EMER OFF. Pressing START RESET should clear the EMER OFF. If an EMER OFF cannot be cleared go to figure 6.3.4.
4. Pressing the OUTPUT then f2 KEYS shall cause the O2 display to be active. This allows metering of inverter volts or CABINET VOLTS. Verify the power source is in STANDBY or ON mode. Verify CABINET VOLTS are OK. If not go to figure 6.3.5.



5. Pressing OUTPUT then f3 KEYS shall cause the O3 display to be active. This allows metering of SYSTEM VOLTS, the output terminals. With a load applied verify the output volts or SYSTEM VOLTS are OK. If not go to figure 6.3.6.



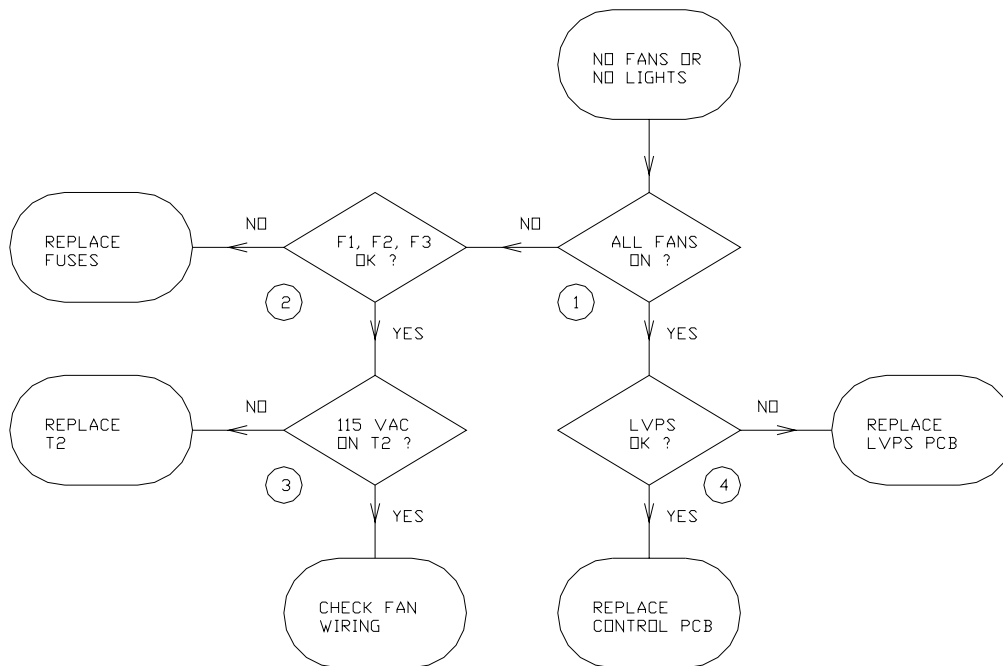
**FIGURE 6.3.1 PERFORMANCE CHECK FLOW CHART**

### 6.3.2 LVPS SERVICE PROCEDURE

The troubleshooting procedure contained in this paragraph is to be used to locate a problem within the Low Voltage Power Supply of the MS power source. Directions are given which locate a fault to the PCB level or component level as appropriate. Do not use this procedure unless instructed to do so by the performance check flow chart.

The numbered comments below correspond to the circled numbers on figure 6.3.2 and provide detailed instructions relative to the referenced step.

1. With input power applied and the input circuit breaker closed, some panel lights should be on and all fans should be spinning. If all of the fans are not spinning, check F1, F2 and F3.
2. If the fuses are not good replace them.
3. Check for 115 VAC on T2 from pins D1 to D2, D2 to D3 and D3 to D1. If input voltage is present on the primary of T2 but not on the secondary replace T2. Check for 115 VAC on P33 of each inverter assembly. P33 is the loose slip-on lugs in front of the inverter assembly. If voltage is present on P33 replace the fans. Reference figure 6.4.1 LVPS Schematic.
4. Check for 16 VAC from P60-8 to P60-1, P60-8 to P60-5 and P60-8 to P60-13, of the LVPS PCB. If input voltage is present on the primary of T2 but not on the secondary, replace T2. If 16 VAC voltage is present check for +18 VDC from P60-8 to P60-9 and -18 VDC from P60-8 to P60-7 on the LVPS PCB. If no DC voltage is present, replace the LVPS PCB. Check for +18 VDC from P10-4 to P10-7 and -18 VDC from P10-4 to P10-8 on the CONTROL PCB. If voltage is present and no LEDs are lit on the CONTROL PCB replace the CONTROL PCB. Reference figure 6.4.1 LVPS Schematic.



**FIGURE 6.3.2 LVPS FLOW CHART**

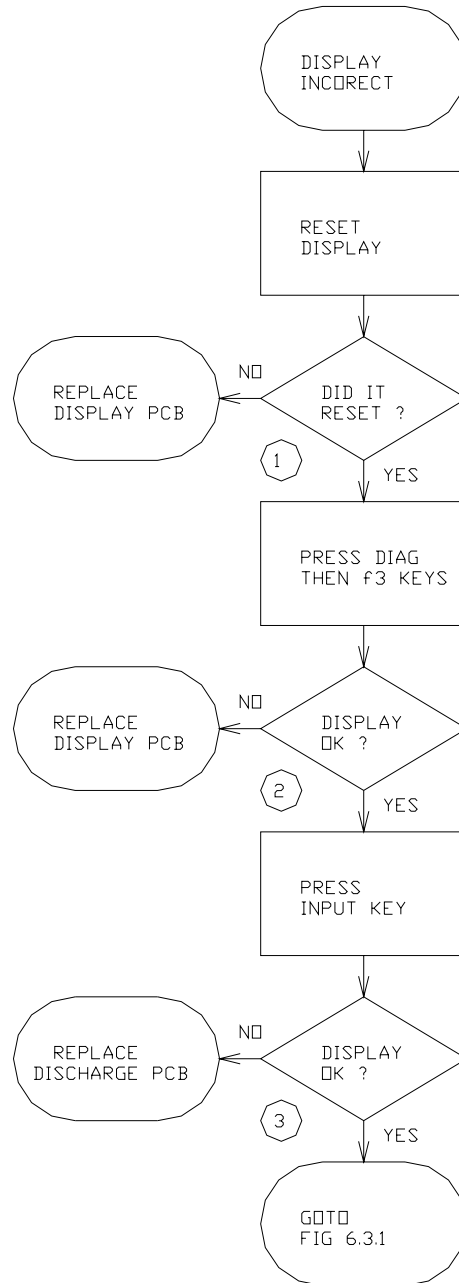
### 6.3.3 DISPLAY SERVICE PROCEDURE

The troubleshooting procedure contained in this paragraph is to be used to locate a problem within the Display Circuits of the MS power source. Directions are given which locate a fault to the PCB level or component level as appropriate. Do not use this procedure unless instructed to do so by the performance check flow chart.

The numbered comments below correspond to the circled numbers on figure 6.3.3 and provide detailed instructions relative to the referenced step.

1. Reset the Display PCB by simultaneously pressing INPUT, OUTPUT and HELP keys. If this does not cause a reset remove input power from the machine and reapply input power. If this does not reset the Display PCB, replace the Display PCB.
2. Pressing the DIAG KEY then f3 KEYS shall cause the LCD to display INTERNAL VOLTAGES. Ignore BUS voltages at this time. The LVPS shall be between 15 and 20 VDC. If the LVPS was outside of this range it would cause an EMER OFF. If the display is not correct replace the Display PCB.

3. Pressing the INPUT key should cause the LCD to display input power. If the input voltages are not within 3% of the displayed voltages, replace the Discharge PCB.



**FIGURE 6.3.3**      **DISPLAY FLOW CHART**

#### 6.3.4 EMER OFF SERVICE PROCEDURE

The troubleshooting procedure contained in this paragraph is to be used to locate the cause of an EMER OFF condition. Directions are given which locate a fault to the PCB level or component level as appropriate. Do not use this procedure unless instructed to do so by the performance check flow chart.

The numbered comments below correspond to the circled numbers on Figure 6.3.4 and provide detailed instructions relative to the referenced step.

1. Press the DIAG then f1 KEYS, the cause of the EMER OFF should be displayed. If the cause is displayed correct the fault. If the cause is not displayed press the f4 KEY to determine which bit(s), would cause an EMER OFF. If the bit is true (1), on the NOW line, this could be the cause (Reference section 4.4.1).

MASTER EMERGENCY OFF indicates that the master of the system was/is in an EMER OFF state. Reset the Master's EMER OFF.

SUSTAINED OVERLOAD indicates the machine was in an overload condition for an extended period of time and shut off. Pressing the OUTPUT then f2 KEYS displays the system load in percentages, %I-PEAK, %kVA and %kW. If any of the six fields are greater than 100% the machine is overloaded.

INPUT LINE FAULT indicates input voltage is not correct (Reference section 4.3.1.1). Apply the correct input voltage.

INVERTER FAULT indicates an inverter or modulator PCB failure. If F10 and F11 are open, power transistors in the Inverter assembly have shorted. Replace the transistors, in pair's, and the fuses.

EMER OFF BUTTON, the EMER OFF button was pushed. Press START RESET to clear.

TRANSFORMER OVERTEMP indicates the input transformer has overheated. Allow to cool by leaving the fans on. This may take several hours.

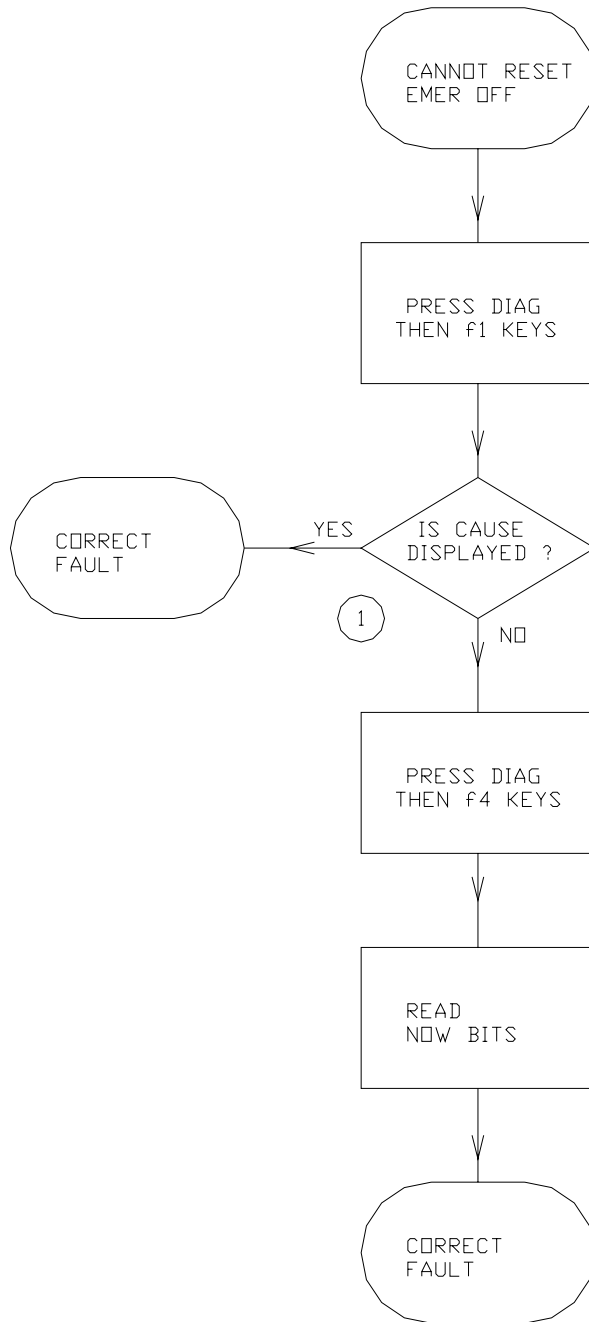
INVERTER TEMP indicates one of the inverters has overheated. A fan may have failed.

LVPS FAULT indicates the regulated  $\pm 12$  VDC on the control, modulator or driver PCB's has failed.

BUS VOLTAGE > 240 VDC indicates the input voltage is too high or the input transformer is wired wrong.

EXTERNAL EMERGENCY OFF, pin 19 of the paralleling connector has positive voltage applied.

NO MASTER ON LINE, one and only one cabinet must be a master.



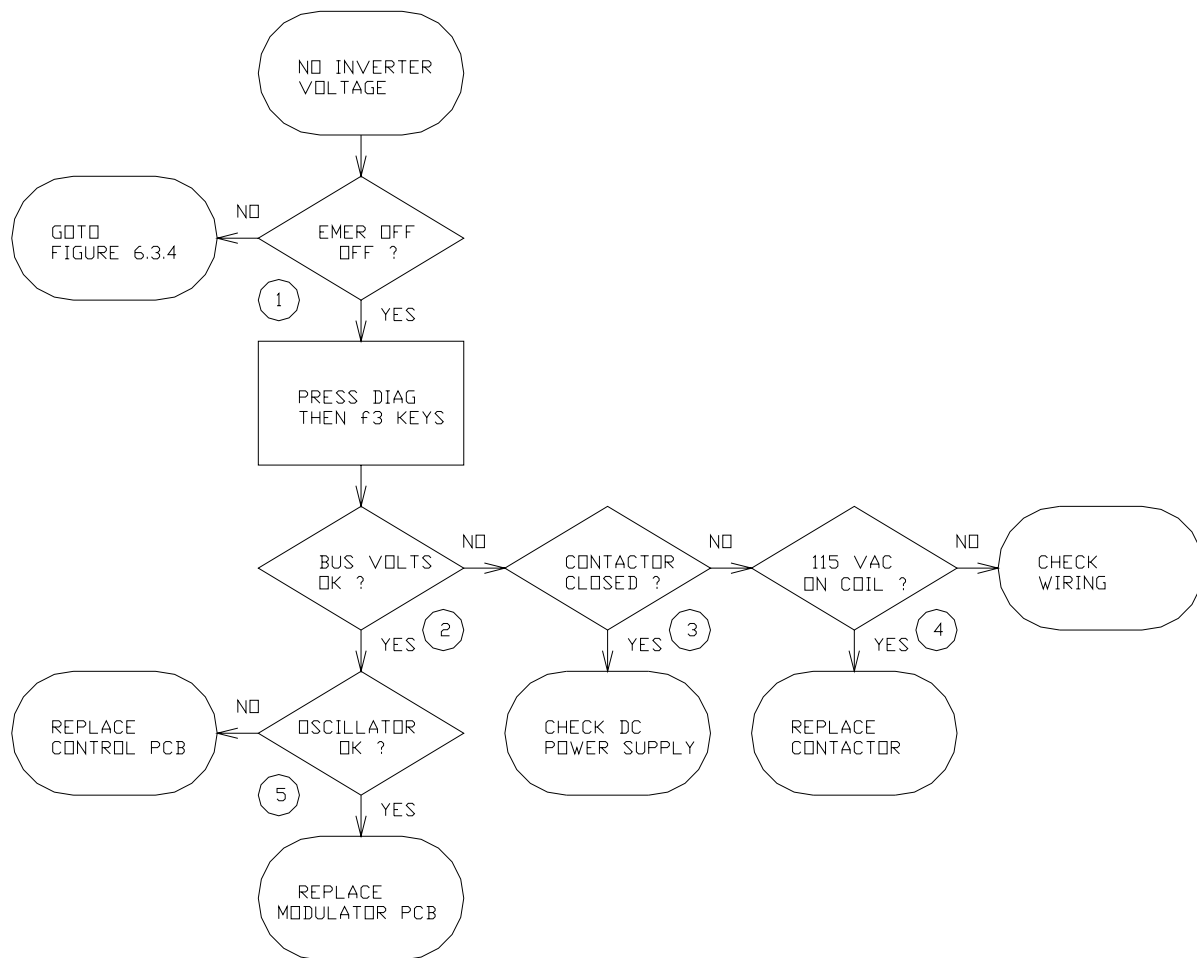
**FIGURE 6.3.4 EMER OFF FLOW CHART**

### 6.3.5 NO INVERTER VOLTS SERVICE PROCEDURE

The troubleshooting procedure contained in this paragraph is to be used to locate a problem within the Inverter circuits of the MS power source. Directions are given which locate a fault to the PCB level or component level as appropriate. Do not use this procedure unless instructed to do so by the performance check flow chart.

The numbered comments below correspond to the circled numbers on figure 6.3.5 and provide detailed instructions relative to the referenced step.

1. If an EMER OFF condition exists go to figure 6.3.4.
2. Press the DIAG then f3 keys and verify the BUS voltages are between 160 and 240 VDC. If BUS voltages are not ok check the input contactor.
3. If the input contactor, S3, is closed verify two red LEDs are lit on the Discharge PCB. If the LED's are not lit check the Input Transformer and wiring. Reference figure 6.4.2 Input Power Schematic and figure 6.4.3 DC Power Supply Schematic.
4. If the Input Contactor, S3, is open, try to close it. Rotate the MODE SELECT to STANDBY and press START RESET. This should cause the Slow Turn-on Contactor, S7, to close for one second. The Input Contactor, S3, should close before the Slow Turn-on Contactor, S7, opens. Check for 115 VAC on the coils of these contactors during the turn on sequence. If 115 VAC is present on the coil and the contactor does not close replace the contactor. If no voltage is present on the coil and the STANDBY lamp is on during the turn on sequence, check the wiring or replace the Control PCB. Reference figure 6.4.1 LVPS Schematic.
5. Verify the FREQUENCY SELECT switch is in the 50, 60, 400 or VAR positions as desired. Turn the VOLTS ADJUST pot, on the front panel, to maximum. On the Modulator PCB, verify an Oscillator signal exists of about 5 VAC on C107, C207 and C307. If no Oscillator signal is present replace the Control PCB. If an Oscillator signal is present and there is no INVERTER VOLTS replace the Modulator PCB.



**FIGURE 6.3.5 NO INVERTER VOLTS FLOW CHART**

### 6.3.6 ABNORMAL VOLTAGE SERVICE PROCEDURE

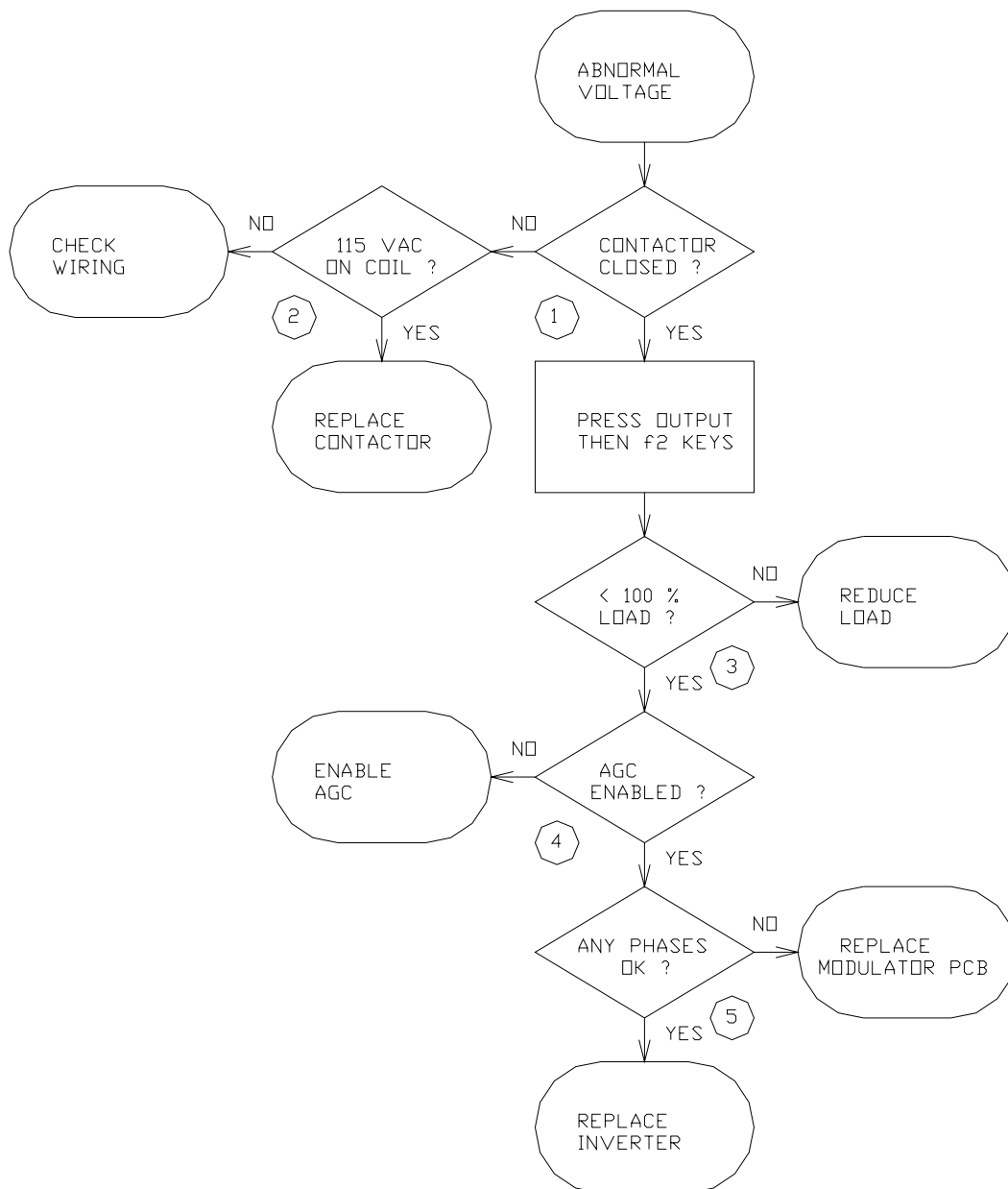
The troubleshooting procedure contained in this paragraph is to be used to locate a problem within the Inverter circuits of the MS power source. Directions are given which locate a fault to the PCB level or component level as appropriate. Do not use this procedure unless instructed to do so by the performance check flow chart.

The numbered comments below correspond to the circled numbers on figure 6.3.6 and provide detailed instructions relative to the referenced step.

1. If the Output Contactor, S5, is open, try to close it. Rotate the MODE SELECT to ON and press START RESET. This should cause the Output Contactor, S5, to close.



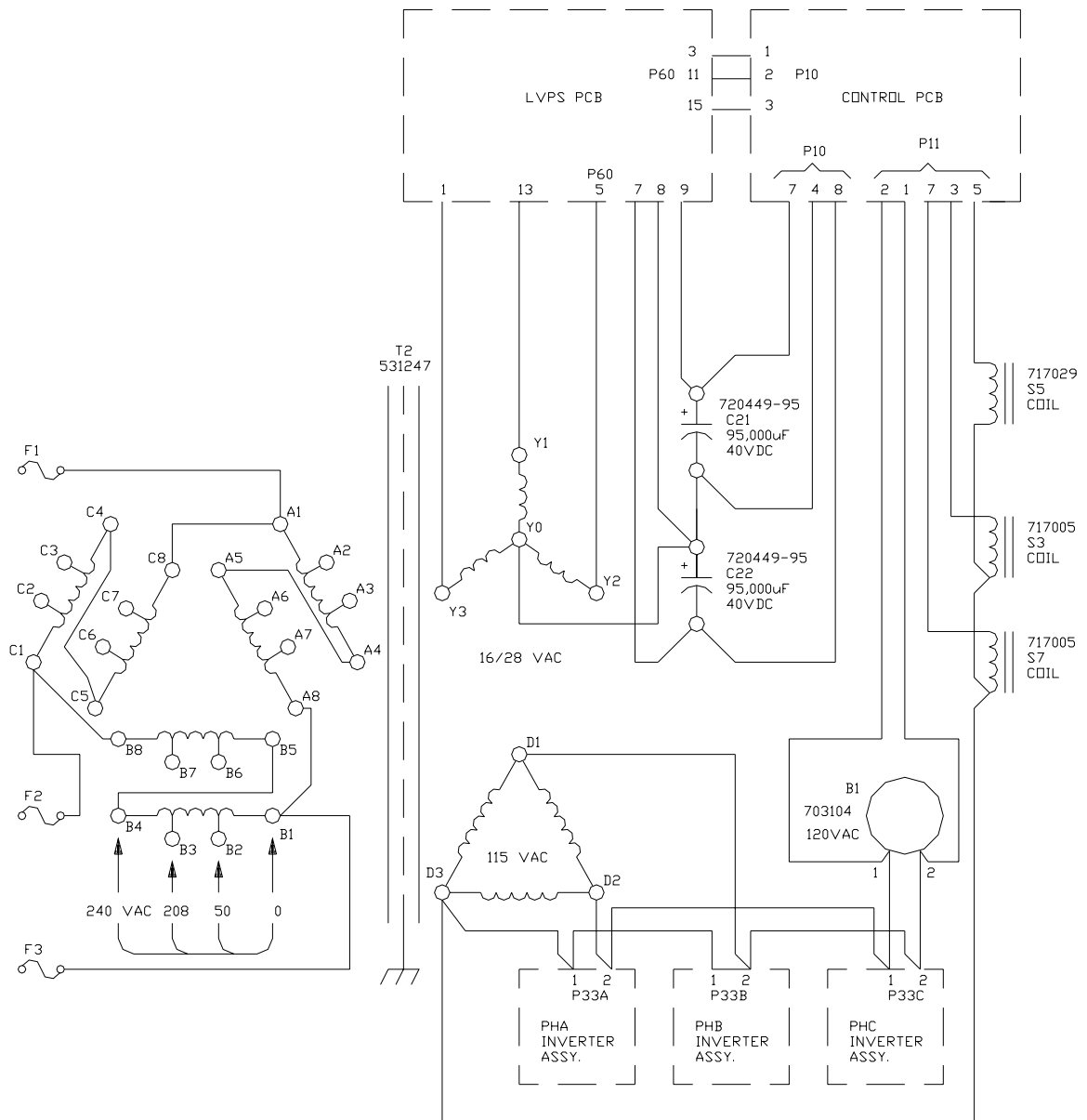
2. If the Output Contactor, S5, is not closed, check for 115 VAC on the coil. If 115 VAC is present on the coil and the contactor does not close replace the contactor. If no voltage is present on the coil and the ON lamp is on, check the wiring or replace control PCB. Reference figure 6.4.1 LVPS Schematic.
3. Pressing the OUTPUT then f2 KEYS displays the system load in percentages: %I-PEAK, %kVA and %kW. Verify that the machine is not overloaded, (all six fields are less than 100%). If any field is greater than 100% the machine is overloaded; reduce the load.
4. If voltage regulation is a problem, verify that the AGC is enabled. Switch S14-6, S14-7 and S14-8 ON. Switch S14-3, S14-4 and S14-5 OFF. Reference section 4.5.2.
5. If all three phases have the same problem replace the Modulator PCB. If only one phase has a problem swap two of the Inverters and see if the problem follows the Inverter. If the problem follows the Inverter replace that Inverter. If the problem stays on the same phase replace the Modulator PCB.



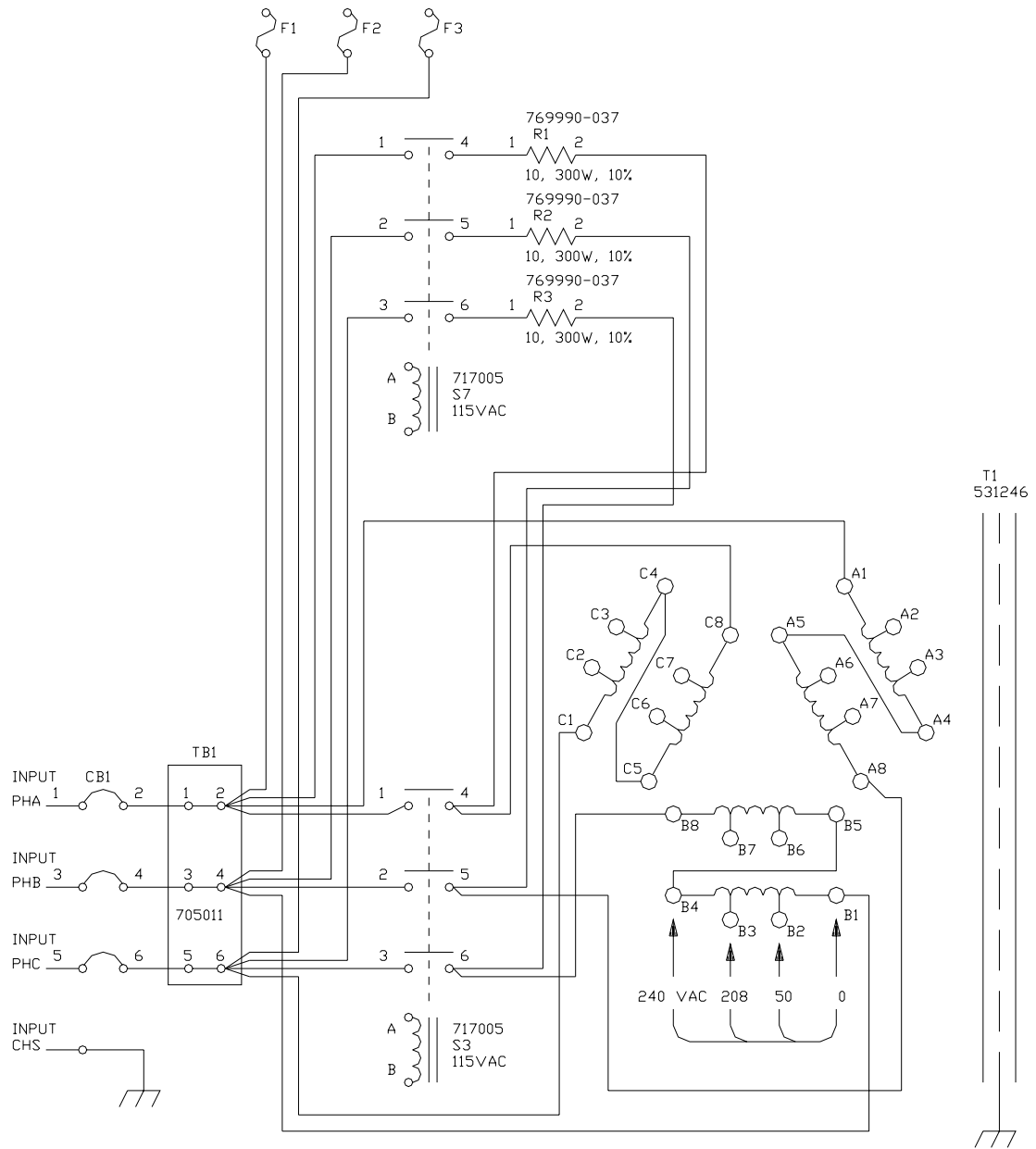
**FIGURE 6.3.6 ABNORMAL VOLTS FLOW CHART**

#### 6.4 SCHEMATIC DIAGRAMS

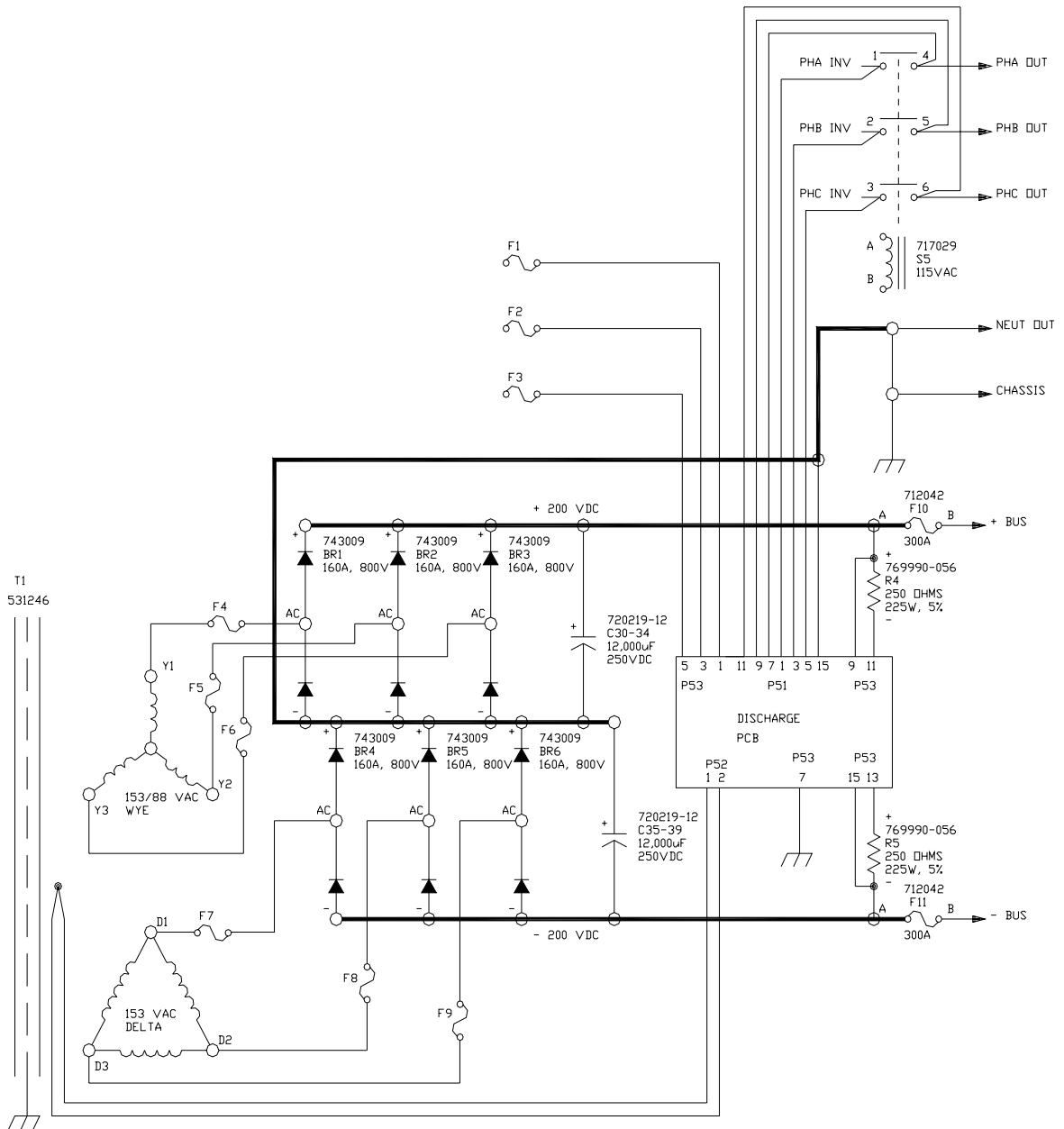
This section contains schematic diagrams for the LVPS, Input Power, DC Power Supply and Inverter assemblies.



**FIGURE 6.4.1 LVPS SCHEMATIC**



**FIGURE 6.4.2 INPUT POWER SCHEMATIC**



**FIGURE 6.4.3 DC POWER SUPPLY SCHEMATIC**

## 6.5 ASSEMBLY REPLACEMENT PROCEDURES

**CAUTION**

THE SERVICE PROCEDURES OUTLINED IN THIS MANUAL ARE INTENDED FOR USE ONLY BY PERSONNEL AUTHORIZED BY THE MANUFACTURER.

This paragraph describes the various procedures to be used to replace assemblies contained in the MS-Series mainframe.

**WARNING****ELECTROCUTION HAZARD.**

ALWAYS REMOVE ALL INPUT POWER FROM THE MAINFRAME PRIOR TO ATTEMPTING ANY SERVICE TO THE EQUIPMENT.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME WHEN INPUT VOLTAGE IS APPLIED TO THE INPUT TERMINALS.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME (ON THE DC BUS) WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.

## 6.5.1 INVERTER ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Inverter Assembly. Input power **MUST** be removed before attempting this procedure.

**Inverter Assembly Replacement**

- STEP 1: Remove input power.
- STEP 2: Remove front covers.  
Remove sub panels.
- STEP 3: Verify the red LEDs on the discharge PCB are off. With a DC voltmeter verify less than 5 VDC from each Bus bar to chassis.

### **Inverter Assembly Replacement**

---

- STEP 4: Remove five screws from the top of the keyboard sub panel.  
Fold down the keyboard sub panel.  
Disconnect ribbon cables from Modulator PCB.
- STEP 5: Remove Bus bars from the front of the inverters. Be careful not to spin the studs.  
Disconnect P33, the fan wires and push them up into the control box.  
Remove three screws at the bottom of the Inverter assembly.  
Slide Inverter assembly out of mainframe.



- STEP 6: Slide replacement Inverter assembly into mainframe.  
Reinstall three screws at the bottom of the Inverter assembly.
- STEP 7: Replace Bus bars on the front of the inverters. Align all the holes and bus bars prior to tightening. Be careful not to spin the studs.  
Reconnect P33, the fan wires.
- STEP 8: Reconnect ribbon cables from Modulator PCB.  
Fold up the keyboard sub panel.  
Replace five screws from the top of the keyboard sub panel.
- STEP 9: Replace fuses, F10 and F11 if needed.
- STEP 10: Replace sub panels.  
Replace front covers.
-

### 6.5.2 CONTROL PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Control PCB Assembly. Input power **MUST** be removed before attempting this procedure.

#### **Control PCB Assembly Replacement**

---

- STEP 1: Remove input power.
- STEP 2: Remove front covers.
- STEP 3: Remove yellow cover from top of MODE SELECT and FREQUENCY SELECT knobs.  
Loosen the 9/32" nut inside of knob.  
Remove knobs.
- STEP 4: Remove five screws from the top of the keyboard sub panel.  
Fold down the keyboard sub panel.
- STEP 5: Disconnect all cables from Control PCB.  
Remove nine nuts holding the Control PCB.  
Remove Control PCB assembly.
- STEP 6: Install Control PCB assembly.  
Install nine nuts holding the Control PCB.  
Install all cables to the Control PCB.
- STEP 7: Fold up the keyboard sub panel.  
Replace five screws from the top of the keyboard sub panel.
- STEP 8: Install knobs.  
Tighten nut inside of knob.  
Install yellow cover on top of MODE SELECT and FREQUENCY SELECT knobs. Note position of line on the yellow cover.
- STEP 9: Install front covers.
-



### 6.5.3 MODULATOR PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Modulator PCB Assembly. Input power **MUST** be removed before attempting this procedure.

#### **Modulator PCB Assembly Replacement**

---

- STEP 1: Remove input power.
  - STEP 2: Remove front covers.
  - STEP 3: Remove five screws from the top of the keyboard sub panel.  
Fold down the keyboard sub panel.
  - STEP 4: Disconnect all cables from the Modulator PCB.  
Remove ten nuts holding the Modulator PCB.  
Remove the Modulator PCB assembly.
  - STEP 5: Install Modulator PCB assembly.  
Install the nuts holding the Modulator PCB.  
Install all cables to the Modulator PCB.
  - STEP 6: Fold up the keyboard sub panel.  
Replace five screws from the top of the keyboard sub panel.
  - STEP 7: Install front covers.
-

#### 6.5.4 DISPLAY PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Display PCB Assembly. Input power **MUST** be removed before attempting this procedure.

##### **Display PCB Assembly Replacement**

---

- STEP 1: Remove input power.
  - STEP 2: Remove front covers.
  - STEP 3: Remove five screws from the top of the keyboard sub panel.  
Fold down the keyboard sub panel.
  - STEP 4: Disconnect all cables from Display PCB.  
Remove nine nuts holding the Display PCB.
  - STEP 5: Lift up Display PCB and remove keyboard connector.  
Remove Display PCB assembly.
  - STEP 6: Install keyboard connector.  
Install Display PCB assembly.  
Install nine nuts holding the Display PCB.  
Install all cables to the Display PCB.
  - STEP 7: Fold up the keyboard sub panel.  
Replace five screws from the top of the keyboard sub panel.
  - STEP 8: Install front covers.
-

### 6.5.5 LVPS PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series LVPS PCB Assembly. Input power **MUST** be removed before attempting this procedure.

#### **LVPS PCB Assembly Replacement**

---

- STEP 1: Remove input power.
  - STEP 2: Remove front covers.
  - STEP 3: Remove five screws from the top of the keyboard sub panel.  
Fold down the keyboard sub panel.
  - STEP 4: Disconnect all cables from the LVPS PCB.  
Remove four nuts holding the LVPS PCB.  
Remove the LVPS PCB assembly.
  - STEP 5: Install LVPS PCB assembly.  
Install four nuts holding the LVPS PCB.  
Install all cables to the LVPS PCB.
  - STEP 6: Fold up the keyboard sub panel.  
Replace five screws from the top of the keyboard sub panel.
  - STEP 7: Install front covers.
- 

### 6.5.6 DISCHARGE PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Discharge PCB Assembly. Input power **MUST** be removed before attempting this procedure.

#### **Discharge PCB Assembly Replacement**

---

- STEP 1: Remove input power.
- STEP 2: Remove front covers.  
Remove sub panels.



**WARNING**

**ELECTROCUTION HAZARD.**

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME (ON THE DC BUS) WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - ***EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.***

- 
- STEP 3: Verify the red LEDs on the discharge PCB are off. With a DC voltmeter verify less than 5 VDC from each Bus bar to chassis.
- STEP 4: Disconnect all cables.  
Remove four nuts holding the Discharge PCB.  
Remove the Discharge PCB assembly.
- STEP 5: Install Discharge PCB assembly.  
Install four nuts holding the Discharge PCB.  
Install all cables to the Discharge PCB.
- STEP 6: Replace sub panels.  
Replace front covers.
- 

#### 6.5.7 DRIVER PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Driver PCB Assembly. Input power MUST be removed before attempting this procedure.

##### **Driver PCB Assembly Replacement**

---

- STEP 1: Remove the Inverter assembly as described in section 6.5.1.
- STEP 2: Remove all screws holding the top screen and side covers.  
Remove top screen and side covers.
- STEP 3: Disconnect all cables.  
Remove six nuts holding the Driver PCB.  
Remove the Driver PCB assembly.
- STEP 4: Install Driver PCB assembly.  
Install six nuts holding the Driver PCB.  
Install all cables to the Driver PCB.
- STEP 5: Install top screen and side covers.  
Install all screws holding the top screen and side covers.
- STEP 6: Install the Inverter assembly as described in section 6.5.1.
- 

#### 6.5.8 SNUBBER PCB ASSEMBLY REPLACEMENT

This procedure is to be used to replace an MS-Series Snubber PCB Assembly. Input power MUST be removed before attempting this procedure.

**Snubber PCB Assembly Replacement**

- STEP 1: Remove the Inverter assembly as described in section 6.5.1.
- STEP 2: Remove all screws holding the top screen and side covers.  
Remove top screen and side covers.
- STEP 3: Un-solder and mark all resistor wires.  
Remove four nuts holding the Snubber PCB.  
Remove the Snubber PCB assembly.
- STEP 4: Install Snubber PCB assembly.  
Install four nuts holding the Snubber PCB.  
Solder resistor wires to the Snubber PCB.
- STEP 5: Install top screen and side covers.  
Install all screws holding the top screen and side covers.
- STEP 6: Install the Inverter assembly as described in section 6.5.1.

## 6.6 COMPONENT REPLACEMENT PROCEDURES

**CAUTION**

THE SERVICE PROCEDURES OUTLINED IN THIS MANUAL ARE INTENDED FOR USE ONLY BY PERSONNEL AUTHORIZED BY THE MANUFACTURER.

This procedure provides procedures which allow the user to replace various components. The following paragraphs detail the order of disassembly/assembly for particular portions of the system.

**WARNING****ELECTROCUTION HAZARD.**

ALWAYS REMOVE ALL INPUT POWER FROM THE MAINFRAME PRIOR TO ATTEMPTING ANY SERVICE TO THE EQUIPMENT.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME WHEN INPUT VOLTAGE IS APPLIED TO THE INPUT TERMINALS.

LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME (ON THE DC BUS) WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.



### 6.6.1 INPUT POWER PANEL COMPONENT REPLACEMENT

This procedure is used to replace components located on the Input Power Panel. Input power **MUST** be removed before attempting this procedure.

#### **Input Power Panel Component Replacement**

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- STEP 1: Remove input power.
- STEP 2: Remove front covers.  
Remove sub panels.

	 <b>WARNING</b>
<b>ELECTROCUTION HAZARD.</b> LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME (ON THE DC BUS) WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - <b><i>EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.</i></b>	

- STEP 3: Verify the red LEDs on the discharge PCB are off. With a DC voltmeter verify less than 5 VDC from each Bus bar to chassis.
- STEP 4: Remove the panel holding CB1, if needed, and support it in front of the machine.
- STEP 5: Disconnect the AC wires as needed. Remove screws as needed. Remove defective component.
- STEP 6: Replace defective component.  
Replace screws as needed.  
Reconnect the AC wires as needed.
- STEP 7: Reinstall the panel holding CB1.
- STEP 8: Replace sub panels.  
Replace front covers.
-

### 6.6.2 DC POWER SUPPLY COMPONENT REPLACEMENT

This procedure is used to replace components located on the Power Supply Panel assembly. Input power **MUST** be removed before attempting this procedure.

#### **DC Power Supply Component Replacement**

STEP 1: Remove input power.

STEP 2: Remove front covers. Remove sub panels.



## **WARNING**

### **ELECTROCUTION HAZARD.**

**LETHAL VOLTAGES ARE PRESENT INSIDE THE MAINFRAME (ON THE DC BUS) WHEN RED LEDS ARE LIT ON THE DISCHARGE PCB - *EVEN IF INPUT VOLTAGE IS NOT PRESENT AT THE INPUT TERMINALS.***

- STEP 3: Verify the red LEDs on the discharge PCB are off. With a DC voltmeter verify less than 5 VDC from each Bus bar to chassis.
- STEP 4: Disconnect cables to the discharge PCB.  
Disconnect output cables to the Inverters.  
Remove the panel holding the discharge PCB and support it in front of the machine.
- STEP 5: Remove Bus bars as needed.  
Disconnect the AC wires as needed.  
Remove screws as needed.  
Remove defective component.
- STEP 6: Replace defective component.  
Replace screws as needed.  
Reconnect the AC wires as needed.  
Replace Bus bars as needed.
- STEP 7: Reinstall the panel holding the discharge PCB.  
Reconnect output cables to the Inverters.  
Reconnect cables to the discharge PCB.
- STEP 8: Replace sub panels.  
Replace front covers.

### 6.6.3 INVERTER COMPONENT REPLACEMENT

This procedure is used to replace components located on the Inverter assembly. Input power **MUST** be removed before attempting this procedure.

#### **Inverter Component Replacement**

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- STEP 1: Remove Inverter assembly as described in section 6.5.1.
- STEP 2: Remove all screws holding the top screen and side covers.  
Remove top screen and side covers.
- STEP 3: Remove the Snubber PCB assembly if needed as described in section 6.5.8.
- STEP 4: Disconnect wires as needed.  
Remove screws as needed.  
Remove defective component.
- STEP 5: Replace defective component.  
Replace screws as needed.  
Reconnect wires as needed.
- STEP 6: Install the Snubber PCB assembly if needed as described in section 6.5.8.
- STEP 7: Install top screen and side covers.  
Install all screws holding the top screen and side covers.
- STEP 8: Install the Inverter assembly as described in section 6.5.1.



### 6.7 RETURNING ASSEMBLIES FOR REPAIR

Equipment requiring service or repair must be returned to the factory in Irvine, California or to a Pacific Power Source, Incorporated authorized service center. Freight must be prepaid by the shipper. IMPORTANT instructions are:

1. Call the factory (in the United States (800)854-2433; internationally +1-949-251-1800) to obtain an RMA number. This number will allow you to track your equipment at the factory.
2. Attach a tag to the equipment identifying the owner's name and address, and the name and phone number of an individual that can be contacted and the RMA number.
3. Attach the mainframe serial number from which the assembly came from and a description of the service required.
4. Pack the equipment in the original carton or crate if available. **PACK CAREFULLY TO AVOID EQUIPMENT DAMAGE IN TRANSIT. PACIFIC POWER SOURCE CORPORATION SHALL NOT BE RESPONSIBLE FOR REPAIR OF DAMAGE DUE TO IMPROPER PACKAGING AND HANDLING.**

If the equipment to be serviced is under warranty Pacific Power Source, Incorporated will repair and return the equipment, freight collect, to the original purchaser.

If the equipment to be serviced is out of warranty, Pacific Power Source, Incorporated will inspect the equipment and will contact the owner with an estimate of repairs, and will return the equipment, freight collect, to the owner.



Appendix A

**FIGURE A.1 3060-MS MAINFRAME MAINTENANCE/SERVICEABLE PARTS**

ITEM	DESCRIPTION	QTY	P/N	CKT. SYMBOL
1	KEYBOARD	1	126017	
2	MANUAL	2	126050	
3	DB25P RIBBON CABLE	1	126080	
4	DB25S RIBBON CABLE	2	126081	
5	DA15S RIBBON CABLE	5	126082	
6	50 PIN X 77" RIBBON CABLE	1	126083	
8	50 PIN X 18" RIBBON CABLE	3	126085	
9	15 PIN X 18" RIBBON CABLE	1	126086	
10	50 PIN X 24" RIBBON CABLE	2	126087	
11	LENS, RED, EMERGENCY OFF	1	510028	
12	LENS, GREEN, START/RESET	1	510029	
13	TRANSFORMER, 65 KVA, MULTI-TAP, 60Hz	1	531246	T1
14	TRANSFORMER, 1 KVA, THREE PHASE	1	531247	T2
15	POWDERED IRON E-CORE ASSEMBLY	3	532002	L11-13
16	HOURMETER, 10-50 VDC	1	700008	
17	LAMP, INCANDESCENT 28V, 0.04A, T-1 3/4 MDGT	1	701024	DS20
18	KNOB, COLLET LOCK FOR 1/8 SHAFT-BLACK	2	702123	
19	COLLET KNOB INSERT, YELLOW W/POINTER	2	702124	
20	FAN, 4 IN., 100CFM, 120VAC, 50/60HZ	1	703104	B1
21	TERMINAL BLOCK, 3 TERMINAL PRESSURE, 300A	1	705011	TB1
22	TERMINAL BD, 6 TERMINAL, DOUBLE ROW, 30A	1	705046	TB2
23	SWITCH, SPDT MOMENTARY ILLUM., 0.75SQ	2	710023	S12-13
24	FUSE 1A @ 500VDC, 13/32 X 1 1/2 480 VAC INPUT - STD	3	712043	F1-3
	FUSE 1.5A @ 500VDC, 13/32 X 1 1/2 [380 VAC INPUT / CE OPTION]	[3]	712045	F1-3
	FUSE 2A @ 500VDC, 13/32 X 1 1/2 [240/208 VAC INPUT OPTION]	[3]	712044	F1-3
25	CKT BKR, 3POLE, 80A, 480VAC (CODE U) 480VAC INPUT- STD	1	716016	CB1
	CKT BKR, 3POLE, 100A, 480VAC (CODE U) [380VAC INPUT OPTION]	[1]	716049	CB1
	CKT BKR, 3POLE, 100A, 480VAC (CODE U) [380VAC INPUT-CE OPTION]	[1]	716084	CB1
	CKT BKR, 3POLE, 175A, 480VAC (CODE U) [240/208 VAC INPUT OPTION]	[1]	716048	CB1
26	CONTACTOR, 3 POLE, 50A, 120VAC COIL	1	717005	S7
27	CONTACTOR, 3 POLE, N.O., 115VAC COIL	1	717029	S5
28	CAP., 10uF @ 400VDC, 20% POLYPROP.	6	720096-10	C10-15
29	CAP, 95000uF, 40V ALUM. ELECTROLYTIC	2	720449-95	C21-22
30	CURRENT TRANSFORMER, 300:5, 60-400HZ	3	731029	CT11-13
31	RESISTOR, 1K, 2W, 5%	2	760052-10	R21-22
32	RESISTOR, 0.6 OHM, 1%, 50W, CHASSIS MT.	3	760180-R60	R11-13
33	RESISTOR, EDGEWOUND, 10 OHM, 300W	3	769990-037	R1-3
34	RESISTOR MOUNTING BRACKET	6	769990-057	

Appendix A

**FIGURE A.1 3060-MS MAINFRAME MAINTENANCE/SERVICEABLE PARTS (CONT)**

ITEM	DESCRIPTION	QTY	P/N	CKT. SYMBOL
35	FUSE HOLDER, MODULAR STUD TYPE	18	712040	
36	FUSE 300A @ 500VDC	2	712042	F10-11
37	CAP., 12000uF, 250V ALUM. ELECTROLYTIC	10	720219-12	C30-39
38	DUAL DIODE, 160A @ 800V	6	743009	BR1-6
39	RESISTOR, 47K, 2W, 5%	10	760053-47	R30-39
40	RESISTOR, 250 OHM, 225W	2	769990-056	R4,5
41	RESISTOR MOUNTING BRACKET	4	769990-057	
42	CONTROL PCB ASSEMBLY	1	126070	
43	MODULATOR PCB ASSEMBLY	1	126071	
44	DISPLAY PCB ASSEMBLY	1	126072	
45	DISCHARGE PCB ASSEMBLY	1	126075	
46	LOW VOLTAGE PCB ASSEMBLY	1	126074	
47	INVERTER ASSEMBLY	3	126200	
48	CONTACTOR, 3 POLE, 120VAC COIL	1	717026	S3
49	CKT BKR, 3POLE, 175A, 480VAC (CODE U)	[1]	716048	CB2 [STD OUTPUT]
50	CKT BKR, 3POLE, 175A, 240VAC (CODE U)	[1]	716082	CB2 [CE OUTPUT]
51	FUSE 150A @ 250VAC (CODE U)	6	712063	F4-9
52	FUSE 200A @ 600VAC SLOW BLOW (CODE CE)	3	712065	F12-14[CE]
53	FUSE HOLDER, CLASS J, 3 POSITION	1	712067	[CE]
54	HIGH VOLTAGE BLOCKING PCB ASSEMBLY	1	126370	[CE]

NOTE: QUANTITIES IN BRACKETS [ ] ARE FOR OPTIONAL INPUT VOLTAGE AND OUTPUT BREAKER CONFIGURATIONS. REFER TO THE SETUP AND INSTALLATION SECTIONS FOR MORE INFORMATION.

**FIGURE A.2 3060-MS INVERTER ASSEMBLY MAINTENANCE/SERVICEABLE PARTS**

ITEM	DESCRIPTION	QTY	P/N	CKT. SYMBOL
1	INDUCTOR, 250uH @ 16A <sub>RMS</sub>	12	530014	L1-12
2	FAN, 6.75" DIA., 240CFM, 120V, 50/60HZ	2	703106	B1-2
3	CURRENT TRANSDUCER MODULE, 200A, 50A:1V	2	703130	CT1-2
4	THERMOSTATIC SWITCH, CLOSE @ 180 DEG.F	2	710039	TAS1-2
5	CAP., DISC, 0.05uF @ 500V, TYPE Z5U	2	720023-50	C14-15
6	CAP., 10uF, 400VDC, 20% POLYPROP	8	720096-10	C1-8
7	CAP., 3uF, 400V FEED THROUGH, MYLAR	3	720545-30	C11-13
8	TOROID CORE, 1.3 O.D. X 0.64 I. D.	6	732004	L13-18
9	TRANSISTOR, IGBT, 300A, 600V	4	740039	Q1-4
10	RESISTOR, 10 OHM, 50W, 5%, CHASSIS MOUNT	4	760180-10	R1-6
11	DRIVER PCB ASSEMBLY	1	126270	
12	SNUBBER PCB ASSEMBLY	2	126271	

