INSTRUCTION MANUAL FOR

10KW-15KW-20KW

POWER SUPPLY

83-481-018 Revision D

LAMBDA EMI

405 ESSEX ROAD, NEPTUNE, NJ 07753

TEL: (732) 922-9300
FAX: (732) 922-9334

FIVE YEAR WARRANTY

Lambda Americas, Inc. (405 Essex Road, Neptune, N.J. 07753), warrants that the unit is free from defects in material or workmanship for a period of FIVE YEARS from the date of initial shipment. Lambda Americas will service and, at its option, repair or replace parts which prove to be defective. This will be done free of charge during the stated warranty period. This warranty excludes defects resulting from misuse, unauthorized modification, operation outside the environmental or safety specifications of the power supply, or improper site preparation or maintenance. The customer shall contact Lambda Americas, for warranty service or repair as described in the RETURNING EQUIPMENT section. The customer shall prepay shipping charges. If the unit is covered under the foregoing warranty, then Lambda Americas shall pay the return shipping charges.

The "WARRANTY", "CLAIM FOR DAMAGE IN SHIPMENT", and "RETURNING EQUIPMENT" information applies to equipment purchased directly from Lambda Americas. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

THIS LIMITED WARRANTY IS IN LIEU OF, AND LAMBDA AMERICAS DISCLAIMS AND EXCLUDES, ALL OTHER WARRANTIES, STATUTORY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OF CONFORMITY TO MODELS OR SAMPLES.

CERTIFICATION

All test and measuring equipment used by Lambda Americas for Final Acceptance Testing are traceable to primary standards certified by the National Institute of Standards and Technology.

LETHAL VOLTAGES PRESENT!

All power supplies contain hazardous voltage and energy. The power supply must only be operated by qualified personnel who have read this operator's manual and are familiar with the operation, hazards and application of the power supply. Proper care and judgment must always be observed.

1. Before connecting input AC power, ensure all covers are in place and securely fastened. Ensure the required safety ground to chassis is installed and sufficient cooling is supplied.
2. Proper grounding from the input AC power is required to reduce the risk of electric shock, and to comply with safety agency and code requirements.
3. Use extreme caution when connecting input AC power. Only apply the input voltage specified on the rating label.
4. Use extreme caution when connecting any high voltage cables. Never handle any output cables when the power supply is operating.
5. After a power supply is switched OFF, its output section will retain a charge which may be lethal. Allow sufficient time for self-discharge before handling anything connected to the output. The discharge time specified in the Safety Notes does *NOT* include extra time required to discharge the energy stored in the user's load.
6. When user serviceable fuses are present, always replace fuses with the same type and Volt/Amp rating.
7. Never attempt to operate the power supply in any manner not described in this manual.
8. Never remove DANGER or WARNING labels from the power supply. Replace lost or damaged labels immediately. Contact Lambda Americas Customer Service for replacement labels.
9. The power supply may be serviced only by Lambda Americas factory qualified service personnel. Breaking the warranty seal will void the warranty. Prior to opening the power supply, contact Lambda Americas Customer Service for a written Service Waiver and a replacement warranty seal.

LAMBDA

MANUFACTURER'S PRODUCT DECLARATION

INTENDED PURPOSE (USE)

The Power Supplies described by this manual are defined by Lambda Americas as a component for use in the composition of an apparatus as defined in Article 1 (1) of the EMC Directive (89/336/EEC). These products, as individual components, do not perform in themselves a direct function for the user of the end product. They are not intended to be placed on the market with a direct function to a final user! As such, the products described by this manual are not subject to the provisions of the EMC Directive (89/336/EEC, with amendment 92/31/EEC).

The products described by this manual are intended for incorporation into a final product by a professional assembler. It is the responsibility of the assembler to ensure that the final apparatus or system incorporating our products complies with all relevant EMC standards for that final product.

OPERATING ENVIRONMENT

The operating environment as defined by Lambda Americas, for the products described by this manual is stated as follows:

The Power Supplies described by this manual are intended for use in a protected industrial environment or in proximity to industrial power installations. These locations are often referred to as industrial locations containing establishments that are not connected to the low voltage public mains network.

Industrial locations are characterized by the existence of one or more of the following conditions:

1) industrial, scientific and medical (ISM) apparatus are present;
2) heavy inductive or capacitive loads are frequently switched;
3) currents and associated magnetic fields are high;
4) location supplied by their own transformer.

These components are not intended for connection to a public mains network, but are intended to be connected to a power network supplied from a high or medium-voltage transformer dedicated for the supply of an installation feeding manufacturing or similar operations. They are suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

LAMBDA

Description of symbols used in product labeling

SYMBOL	PUBLICATION	DESCRIPTION
	EC Council Directive 93/68/EEC	European Community Conformity Assessment Product Mark
	IEC 348	Attention, consult Accompanying documents
	IEC 60417-1-5036	Dangerous voltage
	IEC 60417-1-5019	Protective earth (e.g. power line earth ground)
	IEC 60417-1-5017	Functional earth (e.g. chassis ground)
	IEC 60417-1-5134	Electrostatic Discharge (ESD) Sensitive Device

ELECTRICAL STANDARDS

All company primary standards are either certified or are traceable to certification by the National Institute of Standards and Technology.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspection before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals damage in any way, a claim should be filed with the carrier. A full report of damage should be obtained by the claim agent and this report should be forwarded to us. We will then provide a disposition of the equipment and arrange for repair or replacement.

When referring to this equipment, always include the model and serial numbers.

The "WARRANTY", "CLAIM FOR DAMAGE IN SHIPMENT", and "RETURNING EQUIPMENT" information applies to equipment purchased directly from Lambda EMI. End users receiving equipment from a third party should consult the appropriate service organization for assistance with these issues.

RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps shall be taken.

1. Notify Lambda Americas at 732-918-6888 or service@lambda.com. Give a full description of the difficulty including the model and serial number of the unit in question. Upon receipt of this information, we will assign a Return Material Authorization (RMA) number and provide shipping instructions.
2. The customer shall prepay shipping charges. Equipment returned to us must be packed in a manner to reach us without damage. The shipping container must be marked with the RMA number in an area approximate to the shipping label with numbers that are easy to read. All returned units that do not show the RMA number on the outside of the container will be refused.

   If the equipment is repaired within the warrantee agreement, than Lambda EMI shall pay for the return shipping to the customer.
3. For non-warranty repairs, we will submit a cost estimate for your approval prior to proceeding. The customer shall pay return shipping charges.

MECHANICAL INSTALLATION

Most power supplies are heavy and, when rack mounted, they should be supported by rails along the sides of the supply from front to rear. The rails must adequately support the unit and not block airflow. Do not support the power supply from the front panel only.

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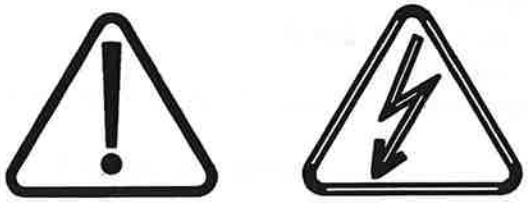
1 GENERAL INFORMATION

1.1 INTRODUCTION

This series of high frequency switching power supplies is designed to operate as a source of constant current/constant voltage power with automatic crossover. The ESS series exhibits excellent transient response, excellent regulation, high efficiency, low ripple and low noise.



1.2 SAFETY PRECAUTIONS

All EMI power supplies are designed for safe operation. This instrument received comprehensive mechanical and electrical inspection prior to shipment. Nevertheless, certain safety precautions must be observed. Only technically competent personnel familiar with the principles of electrical safety should operate this supply. To prevent fire or shock hazard, the power supply should not be exposed to water or moisture. Electrical safety should be maintained at all times. Lethal voltages develop within the power supply's enclosure whenever it is energized. Therefore, the power supply must always be unplugged prior to removing the cover. If the input to the power supply is hard-wired, the circuit breaker must be secured and the line fuses removed. Of course, dangers are inherent in high voltage equipment. However, a power supply with a low voltage output is also potentially dangerous considering the amount of energy (current) the supply is capable of delivering. **In addition to the steady state energy available, power supplies are typically terminated by very large Capacitors, which can deliver huge surge currents capable of vaporizing Metallic objects such as screwdrivers or jewelry. This could result in Molten metal being sprayed. Proper care and judgement must Always be observed.**

1) Ensure all covers are in place and securely fastened and the required grounding is supplied before connecting input AC power.
2) Proper grounding from the input Ac power is required to reduce the risk of electric shock.
3) Use extreme caution when connecting input AC power and never apply the incorrect input power.
4) Use extreme caution when connecting the high voltage output cable including the separate ground connecting the supply to the load.
5) **Ensure all load capacitors are completely discharged prior to connection. Never handle the output cable when the power supply is operating.**

6) Always replace fuses with the same type and Volt/Amp ratings.
7) Never attempt to operate the power supply in any manner not described in this manual.
8) Never remove DANGER or WARNING labels from the power supply, and replace the lost or damaged labels immediately.
9) The power supply should only be serviced by EMI factory qualified personnel.

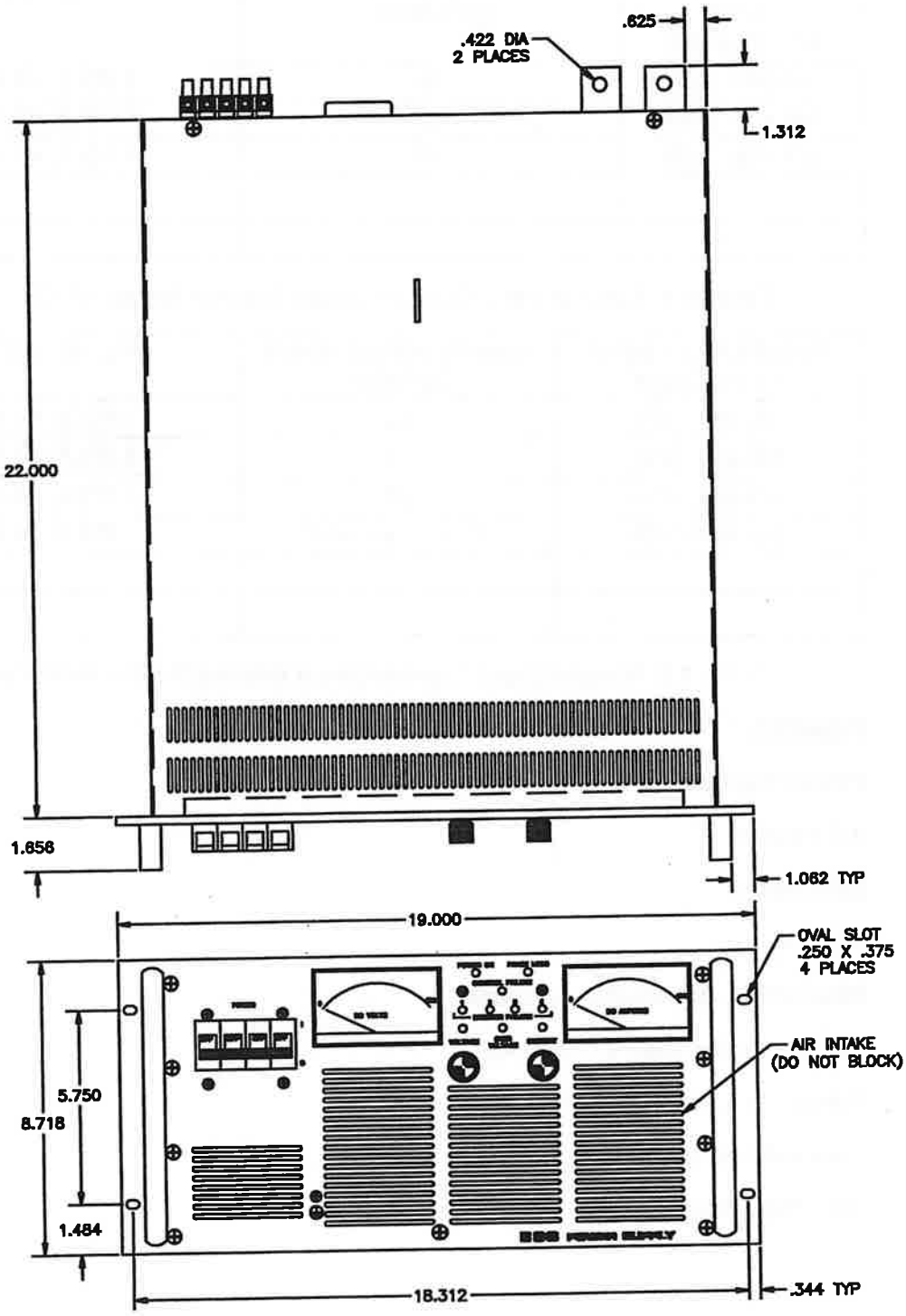


FIGURE A

1.3 SPECIFICATIONS

This series of high frequency switching power supplies is designed to operate as a source of constant current/constant voltage power with automatic crossover.

AC Input

PHASE THREE INPUT AC VOLTAGE	10KW NOMINAL INPUT CURRENT	CIRCUIT BREAKER
190-250 (220)	35	3 POLE, 40 Amps
342-418 (380)	20	4 POLE, 40 Amps
375-456 (415)	19	4 POLE, 40 Amps

Table 1.1: Nominal Input Current/ Circuit Breaker for the 10 KW series.

PHASE THREE INPUT AC VOLTAGE	15KW NOMINAL INPUT CURRENT	CIRCUIT BREAKER
190-250 (220)	52	3 POLE, 60 Amps
342-418 (380)	28	4 POLE, 40 Amps
375-456 (415)	27	4 POLE, 40 Amps
342-418 (380)	43 (15KW-20KW)	4 POLE, 50 Amps

Table 1.2: Nominal Input Current/Circuit Breaker for the 15 KW series.

GENERAL:

Power Factor:

0.9 Passive

Efficiency:

85-91%

Dielectric withstanding voltage:

Primary to Secondary: 2500 VDC

Primary to Case: 2500 VDC

Secondary to Case: 1500 VDC*

(Sensing removed)

Operating Temperature:

All ESS power supplies are capable of continuous duty performance within their specifications in ambient temperature between 0 °C and 50 °C. Units may be safely stored at temperatures of -55 °C to 85 °C.

Humidity:

95% non-condensing

TRANSIENT RESPONSE:

For a 30% load step below 20V, the transient response is 650 μS. For units above 20V, use Vmax/20 x 650μS for transient response.

Dimensions:

Rack mount standard - 19" (see Figure A)

Weight:

105 Lbs. (48kg)

STABILITY:

Maximum Deviation in either voltage or current mode for an eight (8) hour period is up to 0.05% under conditions of constant line, load and temperature.

TEMPERATURE COEFFICIENT:

The output voltage temperature coefficient is 0.02% per 1°C of rated output voltage. The output current temperature coefficient is 0.03% per 1°C of the rated output current.

REGULATION:

Constant Voltage Mode :

An output current load change of 100% will cause an output voltage variation of less than 0.1%.

Constant Current Mode :

An output voltage load change of 100% will cause an output current change variation of less than 0.1%.

VOLTS	AMPS	LINE	LOAD	RIPPLE$_{P-P}$	MODEL
160	62	0.1%	0.1%	75mV	ESS 162-62
330	33	0.1%	0.1%	125mV	ESS 330-33

Table 1.3: Regulation 10KW

160	93	0.1%	0.1%	75mV	ESS 160-93
330	45	0.1%	0.1%	75 mV	ESS 330-45
400	37.5	0.1%	0.1%	300 mV	ESS 400-37.5
424	37.5-50	0.1%	0.1%	300 mV	ESS 424-37.5-50

Table 1.4: Regulation 15KW-20KW

ISOLATION (HI-POT):

The input line terminals must be shorted together when Hi-Pot potentials are applied. This will eliminate the possibility of internal damage to the power supply. Also, the output terminals should be shorted together. A short should be applied momentarily between the terminals (input, output, and chassis ground), to discharge high potential that may still exist after Hi-Pot test.

Input - Output	Input -Chassis	Output - Chassis
2500 Vdc	2500 Vdc	1500 Vdc

Table 1.5: Isolation Test

NOTE: DC Sensing and output RFI caps removed

1.4 DESCRIPTION

REMOTE START/STOP/INTERLOCK:

All ESS models are capable of being remotely started or stopped by means of an external AC or DC voltage source. NOTE: When remote is OFF or interlock is open, control failure LED will be ON, this is normal.

PROGRAMMING:

The ESS series of power supplies will respond either to the setting of the front panel controls or to an external control signal. This control signal may be in the form of either a resistance, a current, or a voltage. Full scale output is signaled by 5000 ohms, by 5 Vdc, or 1mA.

REMOTE SENSING:

Separate sense and power terminals are provided to enable specified regulation directly at the terminals of the load. This feature provides automatic compensation for the voltage drop in the power distribution system.

CONTROLS:

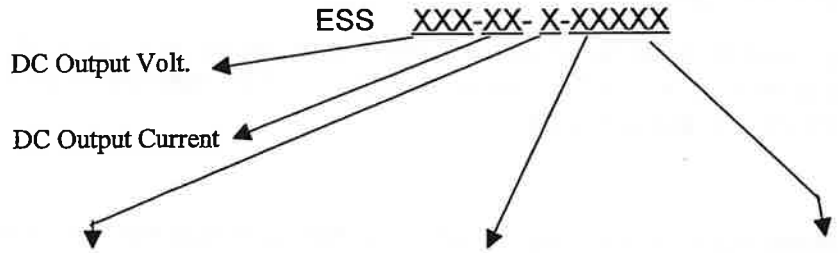
All ESS models are provided with a UL listed circuit breaker which combines primary circuit protection with on/off control. Output voltage is adjusted by the 10 turn, front panel mounted, control. Current adjustment is via a 10 turn potentiometer located on the front panel. Simultaneous indication of output current and voltage is provided by front panel meters. The voltmeter is connected across the sense terminals so that the meter will read either the voltage at the load or the voltage at the power supply terminals, depending on whether local or remote sense is selected.

OVERVOLTAGE:

Overvoltage protection, adjustable from the front panel is standard on all ESS models. This circuit will power down the power supply output to protect the load when the output voltage reaches the OVP set value. This protection is effective regardless of the cause of the overvoltage. Events which will trigger the OVP include, but are not limited to the OVP knob being turned inadvertently, broken remote sense lead, voltage applied from external source, and servo failure in the power supply.

1.5 INPUT VOLTAGE

The following chart explains the model number for the ESS power supply series.



AC INPUT VOLTS		PANEL METERS		FEATURES	
2	220 Vac 50/60 Hz 3 PHASE ±10%	OMIT	ANALOG METERS	LB	LOCK BUSHING
8	380 Vac 50/60 Hz 3 PHASE ±10%	D	DIGITAL METERS		
9	415 Vac 50/60 Hz 3 PHASE ±10%			TP	TEST POINTS
14	380-415 Vac ±10% 50/60 Hz 3 PHASE				

Table 1.6: Model Number

The input Voltage for the ESS is determined by the option number. The options are:

- ↓ 2= 190-253 Vac Three Phase 4 Wires 50-60 Hz.
- ↓ 3= 190-253 Vac Three Phase 4 Wires 400 Hz.
- ↓ 8= 342-418 Vac Three Phase 5 Wires 50-60 Hz.
- ↓ 9= 373-456 Vac Three Phase 5 Wires 50-60 Hz.
- ↓ 4= 380-415 Vac Three Phase 5 Wires 50-60 Hz.

For nominal input voltages of 380 Vac and higher, a Wye connection of the input is required in order to provide a neutral connection. Refer to the following diagram below. EMI provides two auto transformers (28-004-890-2 set type or 28-004-952-1 set type) for delta to Wye conversion.

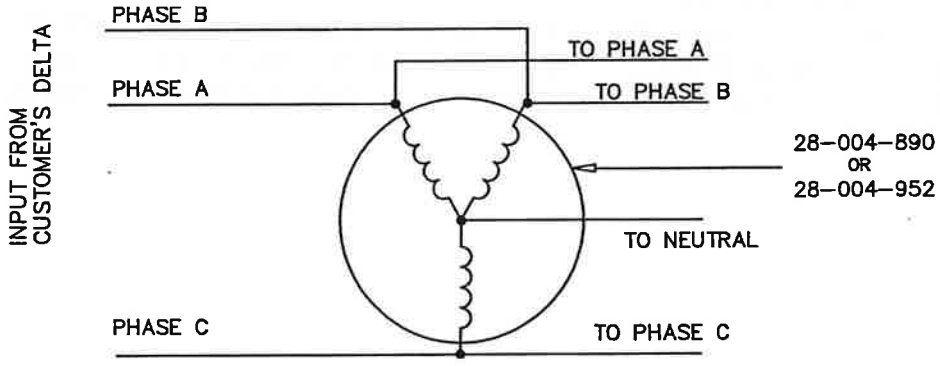


FIGURE 1.1: Delta to Wye Conversion

Phase rotation sequence need not be observed when connecting the power lines to the input terminals of the power supply. A neutral connection (marked N) is required for the 380, 415 and 480 VAC. For safety, the chassis ground terminal should be connected to earth ground. The input wires must be of the proper gauge size to minimize impedance. The wiring of the AC input connector is dependent upon the rated input voltage of the power supply. Refer to the below table for the appropriate connections.

PIN	195-253 Vac CONNECTIONS	342-418, 373-456 Vac CONNECTIONS
L1	PHASE A	PHASE A
L2	PHASE B	PHASE B
L3	PHASE C	PHASE C
N	SPARE	NEUTRAL
G	GROUND	GROUND

Table 1.7: AC Input Configuration

Both POS and NEG output terminals are floating (not connected to ground). Either may be grounded or operated at any voltage less than 600 VDC with respect to chassis ground.

1.6 RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps should be taken.

1) Notify Electronic Measurements, Inc., at telephone number (908)-922-9300. Give a full description of the difficulty, including the model and serial number of the unit in question. Upon receipt of this information, EMI will assign a Return Material Authorization number (RMA) and provide shipping instructions.

2) Equipment returned to EMI must be packed in such a manner as to arrive without incurring any damage. The shipping container must be marked with the RMA number in legible numbers near the shipping label. Any returned unit must have its RMA number clearly displayed on the outside of the container in order to be accepted.

3) For non-warranty repairs, EMI will submit a cost estimate for the customer's approval prior to proceeding.

1.7 CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspection before shipment. Immediately upon receipt from the carrier, and prior to operation, this instrument should be visually inspected for any damage that may have been incurred during shipment.

If such inspection reveals internal or external damage in any way, a claim should be filed with the carrier. A full report of the damage should be furnished to the claim agent and forwarded to Electronic Measurement, Inc., noting the model and serial number of the equipment. EMI will determine the proper course of action and arrange for repair or replacement.

2 INSPECTION AND INSTALLATION

2.1 UNPACKING

Carefully open the top of the box and remove the packing material. The supply can then be lifted from the box. This power supply is intended for rack mounting. The blades of the forklift must extend fully under the base of the power supply. Both sides must be supported. The power supply may be hoisted with a suitable sling, using the specially provided side brackets for this purpose.

2.2 VISUAL INSPECTION

Immediately inspect the power supply for any shipping damage. Verify the following:

A) Check the operation (knobs should rotate smoothly) of the front panel controls.

B) Verify that the circuit breaker latches in the ON and OFF positions.

C) Confirm that there are no dents or scratches on the panel surfaces.

D) Check front panel meters and LEDs for any broken or cracked glass.

If any damage is found, follow the "Claim for Damage in Shipment" instructions in Section 1.7.

2.3 LOCATION

Make sure that adjacent equipment does not block air intake or exhaust openings of the power supply. Air enters at the front panel and is forced out of the rear panel. This power supply is intended for rack mounting. A conventional 19-inch rack panel can be used.

2.4 ELECTRICAL INSTALLATION

Except for test purposes, this power supply should not be operated with covers removed. Please refer to safety precautions detailed in section 1.2. After the supply has been installed in a location with sufficient space for ventilation, the appropriate AC input can be applied. Refer to Section 1.5 (OPTION) for the required AC input voltage and wiring configuration of the AC input connector.

2.5 ELECTRICAL INSPECTION

To ensure that no internal damage was incurred during shipment, a preliminary test should be performed as follows:

A) Rotate Voltage and Current knobs completely counter clockwise.

B) Apply appropriate AC input power to the supply. With no load connected to the output terminals, flip ON the circuit breaker of the supply. The internal fans should start immediately. The power supply should turn on after an approximate ten second delay. The status of the indicators is as follows:

POWER ON indicator is glowing.

PHASE LOSS indicator is off

CONTROL FAILURE indicator is on (Will turn off as control is achieved)

INVERTER FAILURE indicators are off

OVER VOLTAGE indicator is off

C) Rotate the current knob clockwise. The Current indicator should glow.

D) Rotate the voltage knob completely clockwise. The front panel's voltmeter should display the maximum output voltage of the supply. The voltage indicator should glow.

E) Rotate the current knob completely counter clockwise; the output voltage should drop to zero.

F) Rotate the current knob clockwise. The output voltage should rise to its original value. Rotate the OVP potentiometer counter clockwise. The output voltage should drop to zero volts. Readjust OVP to original setting.

G) Since the OVP circuitry latches on itself, rotate the OVP potentiometer completely clockwise. Flip the circuit breaker OFF and then ON to disable the OVP. The voltmeter should display the output voltage.

H) Rotate the voltage knob completely counter clockwise and monitor the front panel voltmeter. The output voltage should gradually decrease to zero. Rotate the current knob completely counter clockwise. Flip OFF the circuit breaker of the supply.

I) Apply a short wire that sustains full output current across the output terminals of the supply. Make sure that the short can sustain the maximum output current of the supply. **NOTE:** 15KW-20KW power supplies are checked out at full voltage output. Avoid short circuit operation when in 20KW mode.

J) Flip ON the circuit breaker of the supply. Rotate the voltage knob clockwise. Rotate the current knob completely clockwise. The front panel ammeter should display the maximum output current of the supply. The current indicator should glow.

K) Rotate Voltage knob completely counter clockwise. The output current should drop to zero. Rotate current knob completely counter clockwise. Flip OFF circuit breaker.

If any inconsistency from the above test procedure is noted, please do not hesitate to call EMI for assistance.

3 OPERATING INSTRUCTIONS

3.1 CONTROLS, INDICATORS (LEDS) AND CONNECTORS

This section gives a brief description of the controls and indicators and also describes the different operational methods of the ESS power supply. Refer to figures 3.1 and 3.2.

REFERENCE NUMBER	CONTROL/INDICATOR	FUNCTION
1	POWER ON LED	When glowing, indicates that the supply is on and in the Normal Operation Mode.
2	Phase Loss LED	When glowing, indicates that Low Line or Phase Loss or both has occurred.
3	Inverter Failure LEDs	Four LEDs corresponding to four inverters. The number of the LED that glows indicates which inverter has failed.
4	Current LED	Indicates constant current mode.
5	Overvoltage LED	Indicates supply has exceeded the voltage that was set by the OVP Control.
6	Voltage LED	Indicates that the supply is in the constant Voltage mode.
7	Circuit Breaker	Connects and disconnects AC input to supply.
8	Voltmeter	Displays output voltage of power supply.
9	Ammeter	Displays output current of power supply.
10	Control Failure LED	Indicates system failure in the supply. NOTE: will go out when supply has soft started and is on when remote is turned off.
11	Voltage control	Adjust the output voltage from zero to full scale.
12	Current Control	Adjust the output current from zero to full scale.

Table 3.1: Front Panel Controls and LED's

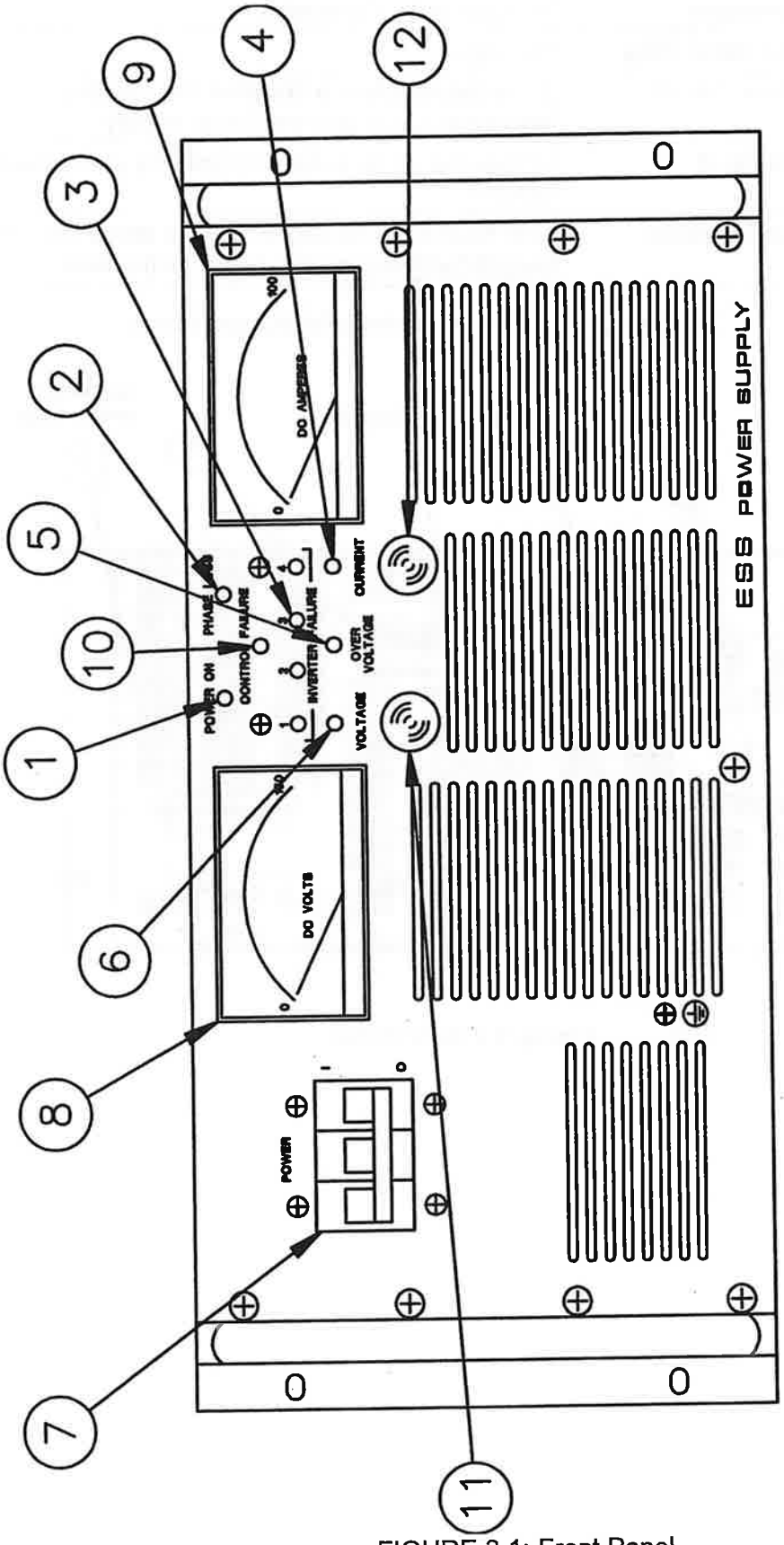


FIGURE 3.1: Front Panel

REFERENCE NUMBER	CONTROL/INDICATOR	FUNCTION
1	J1 Connector	Programming Connector
2	TB1 Terminal Strip	AC Input
3	J2 PSync Circuit	Provides interfacing between the external synchronization and the power supply
4	Ground Stud	Allows the panel to be conveniently connected to ground.
5	Output Terminals	The load is connected to these 2 terminals. The output terminals supply power to the load.

Table 3.2: Rear Panel Controls And Connections

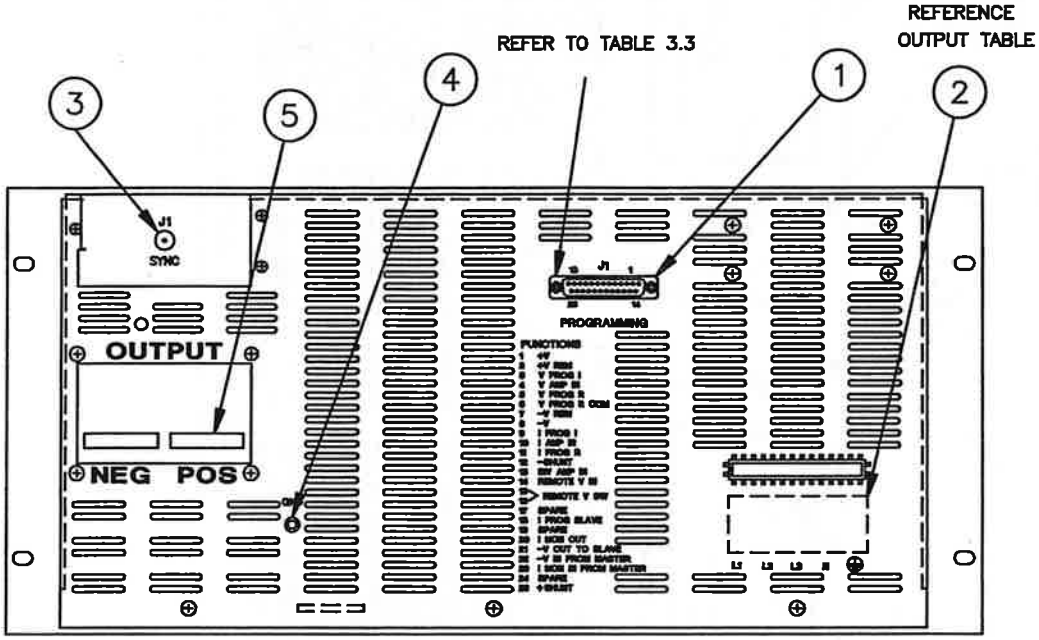


Figure 3.2 Rear Panel

3.2 GENERAL OPERATION

When shipped from the factory, each supply is configured for constant voltage, constant current and local sensing operation. This is the default or typical operating mode of the supply. All performance specifications, unless otherwise stated, are defined in this configuration. The voltage and current controls set the boundary limits for the load voltage and current respectively. The relationship between the control settings and the load resistance determines whether the power supply operates in constant voltage or constant current mode. Automatic crossover between modes depends on the following:

►The load connected to the output terminals of the power supply R_L .

►The front panel voltage control setting Vset.

►The front panel current control setting Iset .

Constant Voltage Mode: The power supply will operate in this mode whenever the current demanded by the load is less than that defined by front panel current control. In this mode, the output voltage of the power supply is set by the front panel voltage control. The output current is determined by the load and the Vset.

Constant Current Mode: The power supply will operate in this mode whenever the current demanded by the load is greater than that defined by front panel current control. In this mode, the output current of the power supply is set by the front panel current control. The output voltage is determined by the load and Iset.

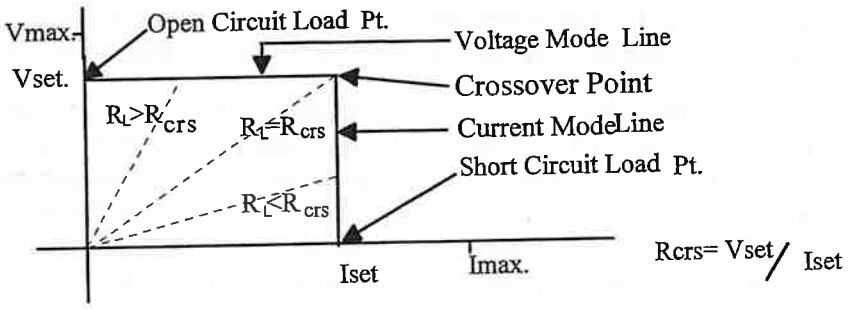


FIGURE 3.3A : Operating Modes

The front panel provides all controls and indicators necessary to operate the power supply.

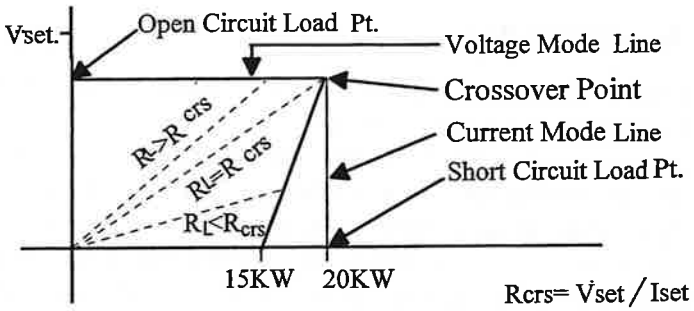


FIGURE 3.3B: Operating Modes 15KW-20KW

The front panel provides all controls and indicators necessary to operate power supply.

3.3 OVERVOLTAGE PROTECTION

An adjustable internal overvoltage protection (OVP) circuit trips between 0% and 110% of output. When the circuit is tripped, the front panel Overvoltage LED will glow, and the OVP circuitry will latch on. To reset the OVP circuit, rotate the OVP potentiometer completely clockwise, and flip the circuit breaker to the OFF and then to the ON position.

3.4 CONNECTING THE LOAD

Ensure that the power supply is off and disconnected from the input power and that all load capacitors are discharged and shorted to ground before making any connections. Never handle the HV cable during operation.

Each resistive load must be connected to the power supply output terminals using separate pairs of connecting wires. Make sure that the connecting wires are of suitable gauge to sustain maximum rated current. Separate pairs of wires minimize mutual coupling effects between loads and maintain the low output impedance of the power supply. Each pair of connecting wires must be as short as possible. If strong AC or RF fields are present, the connecting wires should be twisted or shielded. If a shield is used, connect the supply end of the shield to earth ground. Do not terminate the shield at the load end.

3.5 MODES OF OPERATION

A 25 Sub-D female Connector (J1) is used for configuring the operating mode of the power supply. Depending on the configuration of the J1 programming connector, an external resistance, voltage or current can be used to control the power supply in the remote operation mode. Remote programming can be applied to either voltage channel (voltage regulation circuit) or current channel (current regulation circuit). If strong AC or RF fields are present, use a twisted pair or shielded cable to connect the remote terminals of J1 to the programming source. The following table provides a description of the J1 connector.

PIN	PIN DESCRIPTION
1	+V
2	+V REMOTE
3	V PROG I
4	V AMP IN
5	V PROG R
6	V PROG R COM
7	-V REMOTE
8	-V
9	I PROG I
10	I AMP IN
11	I PROG R
12	-SHUNT
13	INV AMP IN
14	REMOTE V IN
15	REMOTE V SW
16	REMOTE V SW
17	OVP M/S IN
18	I PROG SLAVE
19	V MONITOR
20	I MONITOR OUT
21	-V OUT TO SLAVE
22	-V IN FROM MASTER
23	I MON IN FROM MASTER
24	OVP M/S OUT
25	+ SHUNT

Table 3.3: Prgramming J1 Connector.

3.5.1 NORMAL OPERATION MODE

In the Normal Operation mode, the power supply is controlled by the front panel potentiometers. The supply is configured for constant voltage, constant current and local sensing. When shipped from the factory, the supply is configured for this mode. Figure 3.4 illustrates the configuration of J1 for the Normal Operating mode.

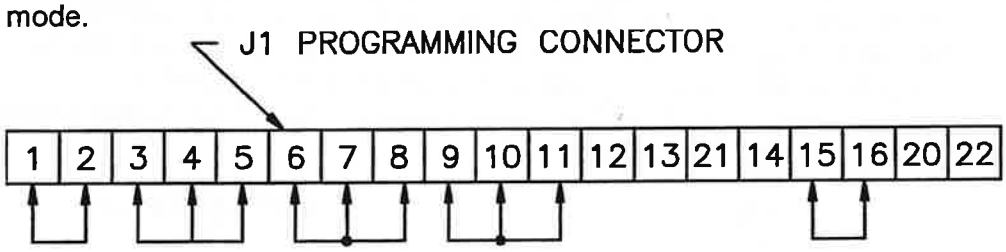


FIGURE 3.4: Normal Operation Mode

CAUTION: IF THE REMOTE PROGRAMMING RESISTOR OPENS, THE LOAD VOLTAGE OR LOAD CURRENT CAN INCREASE TO THE MAXIMUM RATING OF THE POWER SUPPLY. THEREFORE, USE MAKE-BEFORE-BREAK SWITCH CONTACTS BETWEEN EXTERNAL PROGRAMMING SOURCE AND THE PROGRAMMING J1 CONNECTOR.

3.5.2 REMOTE PROGRAMMING BY EXTERNAL RESISTANCE

Voltage Channel

A 5000 ohm potentiometer programs the supply output voltage from zero to full rated voltage. Front panel Voltage control is disabled. Front panel Current control remains active.

$$= \frac{\textit{Desired Output Voltage}}{\textit{Full Rate} = d\ \textit{Output Voltage}} \times 5000\ \textit{ohms}$$

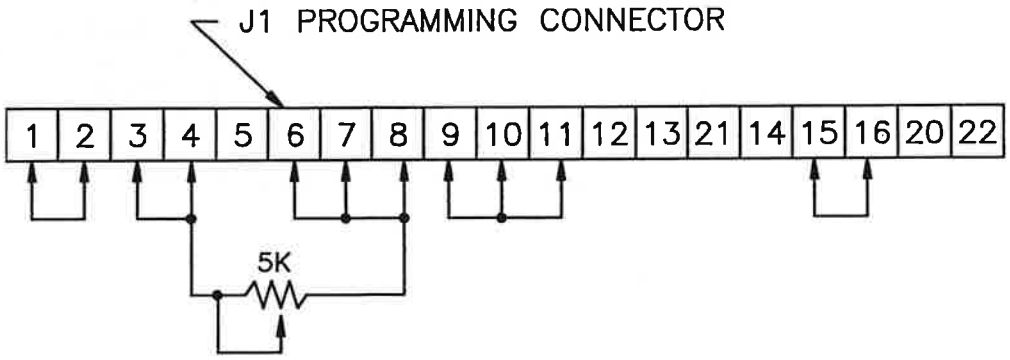


FIGURE 3.5: Remote Programming By External Resistance For Constant Voltage

Current Channel

A 5000 ohm potentionmeter programs the supply output current from zero to full rated current.Front Panel Current control is disabled. Front panel Voltage control remains active.

$$= \frac{\textit{Desired Output Current}}{\textit{Full Rated OutputCurrent}} \times 5000\ \textit{ohms}$$

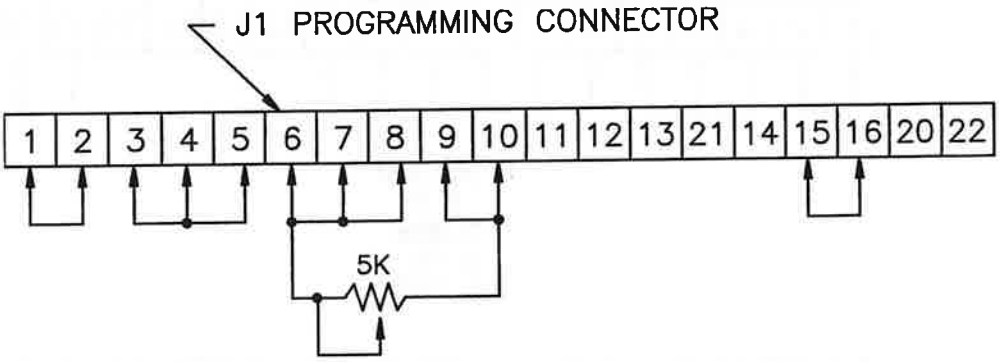


FIGURE 3.6: Remote Programming By External Resistance For Constant Current.

3.5.3 REMOTE PROGRAMMING BY EXTERNAL VOLTAGE

Voltage Channel

A 0 to 5 Vdc variable power supply programs the supply output from zero to full rated voltage. Front panel Voltage control is disabled. Front panel Current control remains active.

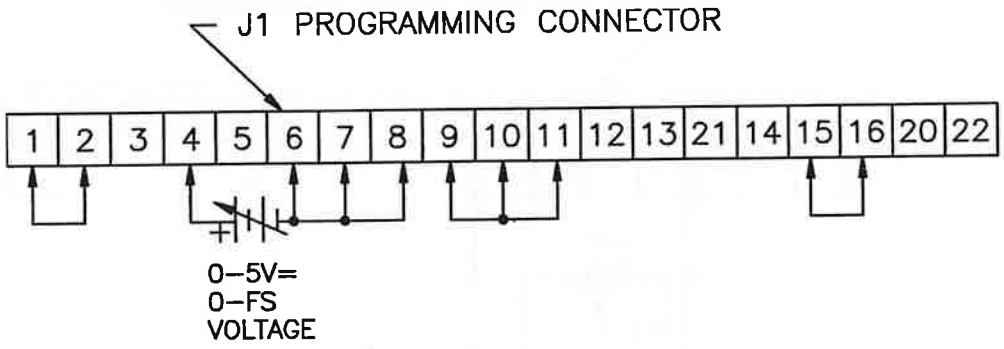


FIGURE 3.7: Remote Programming By External Voltage For Constant Voltage

Current Channel

A 0 to 5 Vdc variable power supply programs the supply output from zero to full rated current. Front panel CURRENT control is disabled. Front panel Voltage control remains active.

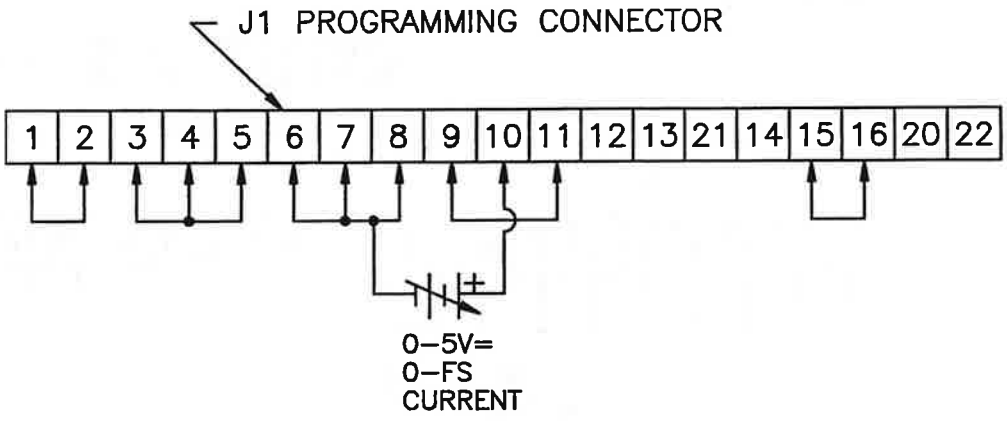


FIGURE 3.8: Remote Programming By External Voltage For Constant Current.

3.5.4 REMOTE PROGRAMMING BY EXTERNAL CURRENT

Voltage Channel

A 0 to 1 mA Variable Current Source programs the supply output from zero to full rated voltage. The curent source is placed in parrallel with a 5000 ohm variable resistor. Front panel Voltage control is disabled. Front panel Current control remains active.

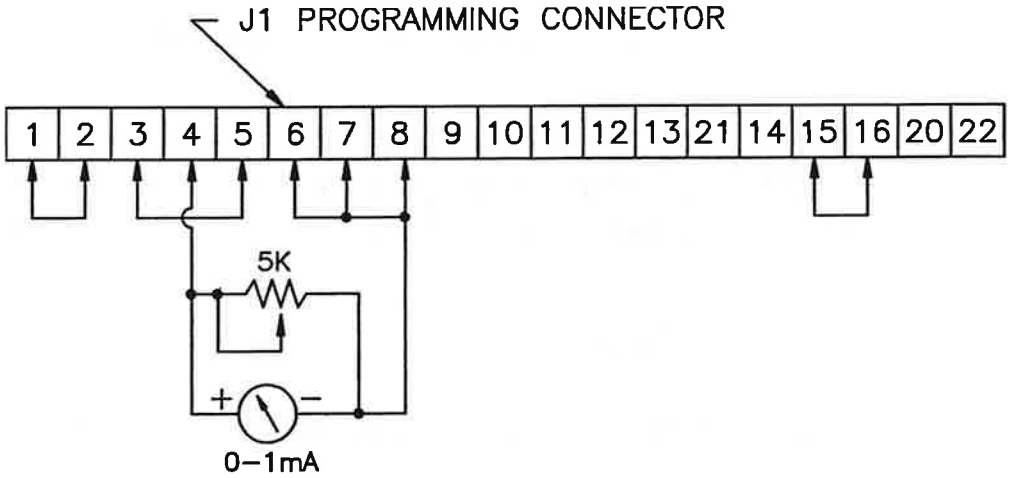


FIGURE 3.9: Remote Programming By External Current For Constant Voltage.

Current Channel

A 0 to 1 mA variable current source programs the supply output from zero to full rated current. The current source is placed in parallel with a 5000 ohm variable resistor. Front panel current control is disabled. Front panel Voltage control remains active.

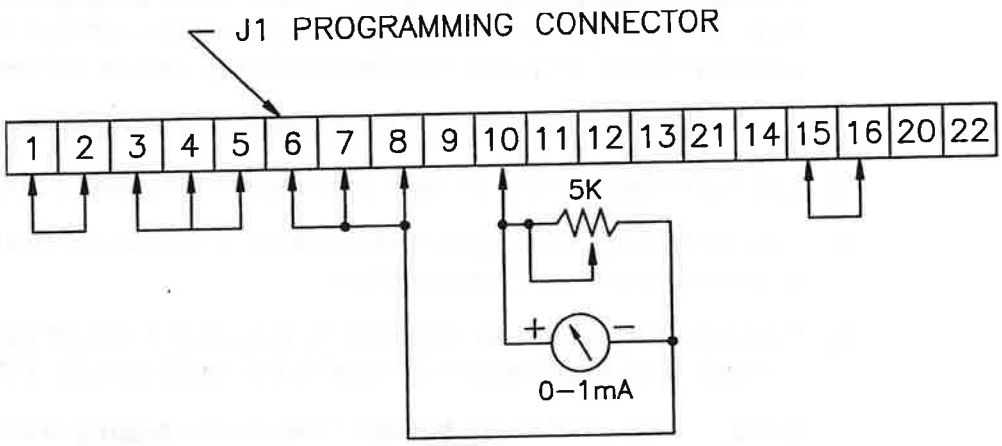


FIGURE 3.10: Remote Programming By External Current For Constant Current.

3.6 REMOTE SENSING

In applications where the voltage drop across the wires connecting the load cannot be ignored, the output voltage can be sensed directly across the load. The front panel voltmeter indicates the voltage directly at the power supply. Remote sensing minimizes the effect of the power distribution system on the load voltage and current. With remote sensing, the maximum output voltage of the power supplys equals the rated output voltage, minus the total voltage drop across the connecting wires. Figure 3.11illustrates the strapping and connections required for remote sensing. Note that the sensing wires are polarized. For voltages greater then 150 Vdc, connect an external resistance (1K Ω per volt for each volt above 150) between the + sense line and pin 2. Refer to the A100 board schematic.

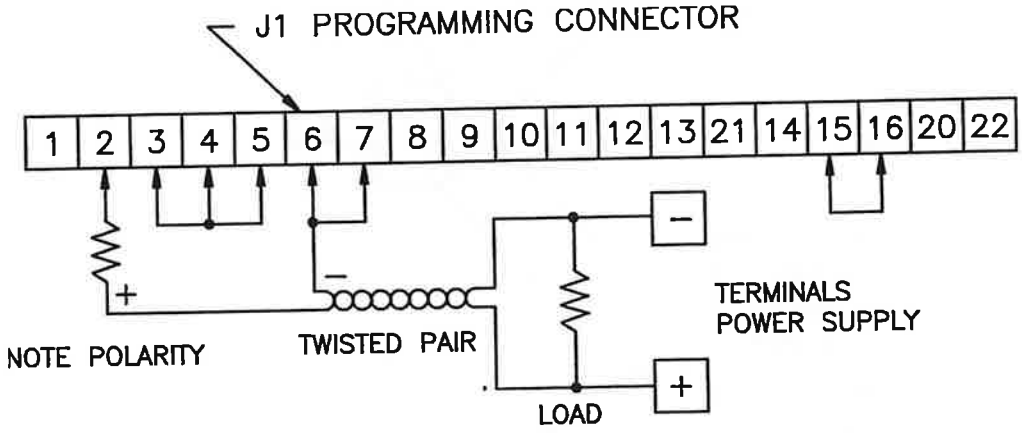


FIGURE 3.11: Remote Sensing

3.7 PARALLEL OPERATION

NOTE: Electronic Measurements does not recommend connecting more than two ESS power supplies in parallel. Contact the factory before connecting three or more supplies in parallel.

1) The J1 Programming Connector should be configured for the Normal Operation mode before connecting the two power supplies in parallel. Refer to Figure 3.4 for the Normal Operation mode configuration. **Caution: Verify that step 1 is done properly before proceeding.**

2) Advance the Current control of each supply one half turn clockwise.

3) Use the Voltage control on each unit to set the required output voltage.

4) Turn off both power supplies and rotate each Current control to its maximum counterclockwise position.

5) Connect each positive load terminal to the positive side of the load. Connect each negative load terminal to the negative side of the load.

   NOTE: Individual leads between the power supply and load must be equal in length and of sufficient gauge to provide a low impedance.

6) Turn both power supplies on.

7) Advance each Current control to maximum clockwise position.

8) Use the Voltage controls to ensure that each power supply delivers approximately the same load current.

9) Slowly adjust each Current control to limit supply output current just above the value required by the load.

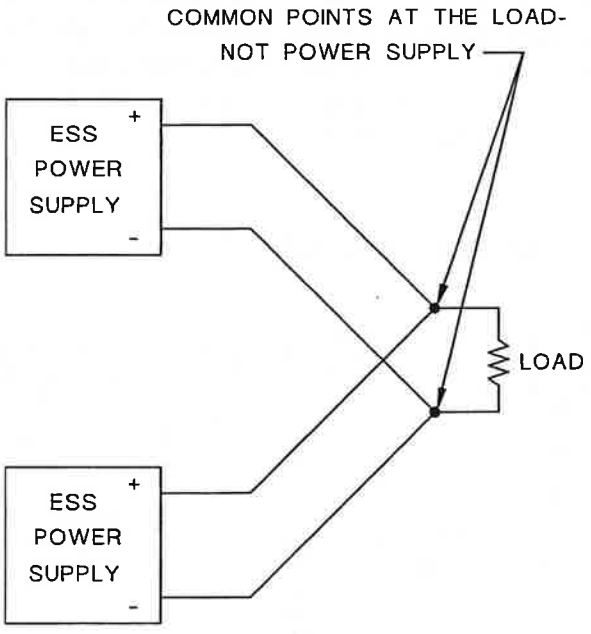


FIGURE 3.12: Parallel Operation

3.7.1 PARALLEL OPERATION IN MASTER/ SLAVE CONFIGURATION

A) Maintain the same connections used for parallel operation (Figure 3.12). Adjust the strapping of each (master and slave supply) J1 programming connector as shown in Figure 3.13. The power supply designated master controls the voltage and current output of the slave supply.

B) Figure 3.14 for Master/Slave with OVP Master/Slave. In this configuration both Master and Slave will shut down with an OVP Function.

Advance the Voltage and Current controls of the slave supply to maximum clockwise position. Use the Voltage and Current controls of the master supply to set load voltage and current.

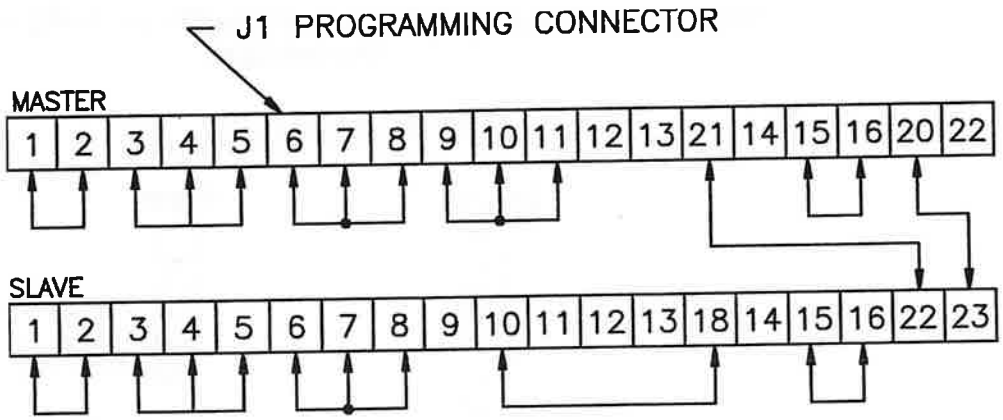


FIGURE 3.13: Parallel Operations in Masters/Slave Configuration.

NOTE: The Slave power supply should be set at 1% to 5% higher in the voltage channel than the master, (otherwise the master will lose control of the slave and the slave will seek the voltage setting of the front panel setting).

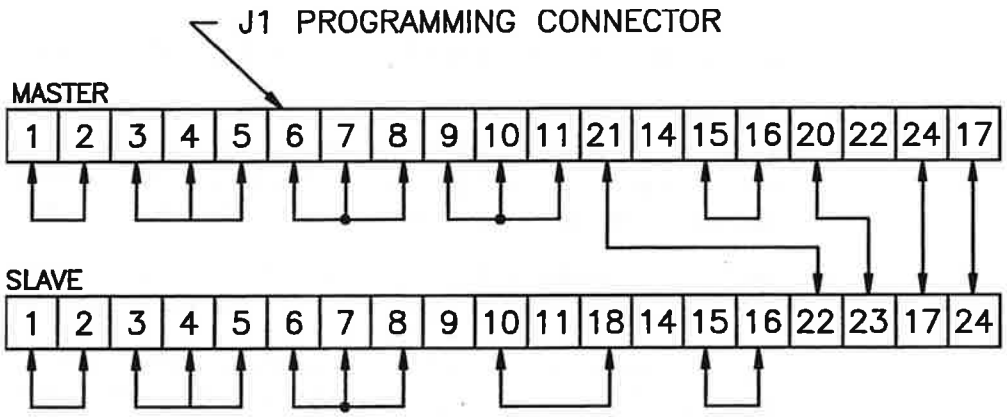


FIGURE 3.14: Paralled Operation in Master/Slave Configuration with OVP Master/Slave.

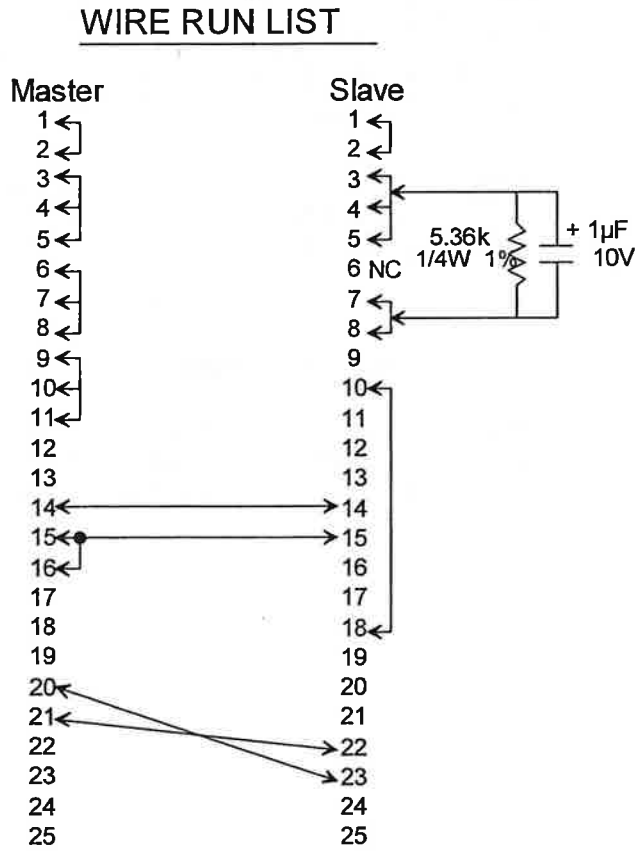


FIGURE 3.15: Master/Slave Alternate Hookup For 424-37-8-0895-1(Typical 15KW-20KW Sets)

3.8 SERIES OPERATION

NOTE: Electronic Measurements, Inc. does not recommend more than two ESS power supplies connected in series. Contact the factory before connecting three or more supplies in series.

Two ESS supplies are connected in series by connecting the negative output terminal of one supply directly to the positive output terminal of the second supply. Voltage and Current controls of each supply are adjusted independently. Total output or load voltage equals the sum of the individual supply outputs. Although the supply output terminals are floating, the maximum voltage at any one terminal must not exceed 600 volts with respect to chassis ground.

NOTE: Individual leads between the power supply and load must be equal in length and of sufficient gauge to provide a low impedance. The leads between output terminals of the supply must be of equal gauge.

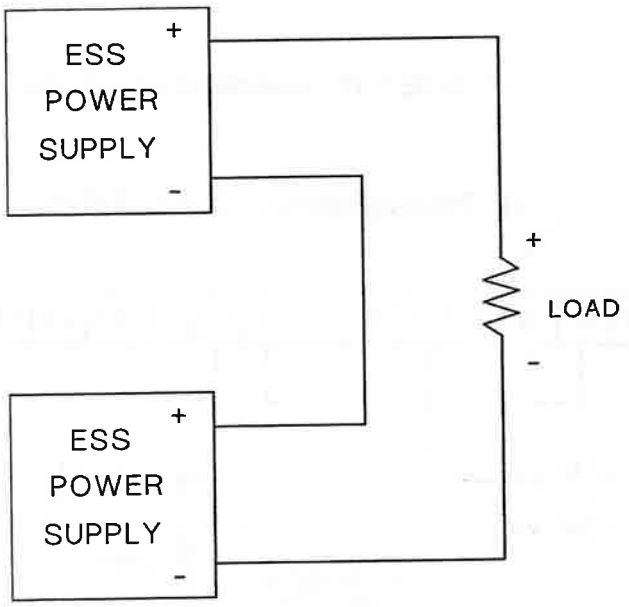


FIGURE 3.16: Series Operation

3.9 REMOTE METERS

If strong AC or RF fields are present, remote meter leads should be shielded. Connect the supply end of the shield to J1-25. Do not terminate the load side of the shield.

A remote voltmeter is connected between J1-2 (positive) and J1-7 (negative). The voltmeter reads the voltage at the load in conjunction with remote sensing. To read voltage at the supply output terminals, connect the voltmeter across J1-1 (positive) and J1-8 (negative).

Figure 3.17 illustrates a remote voltmeter that indicates voltage across the output terminals of the power supply. Remote sensing is not used. Figure 3.17 illustrates a remote voltmeter that indicates voltage across the load.

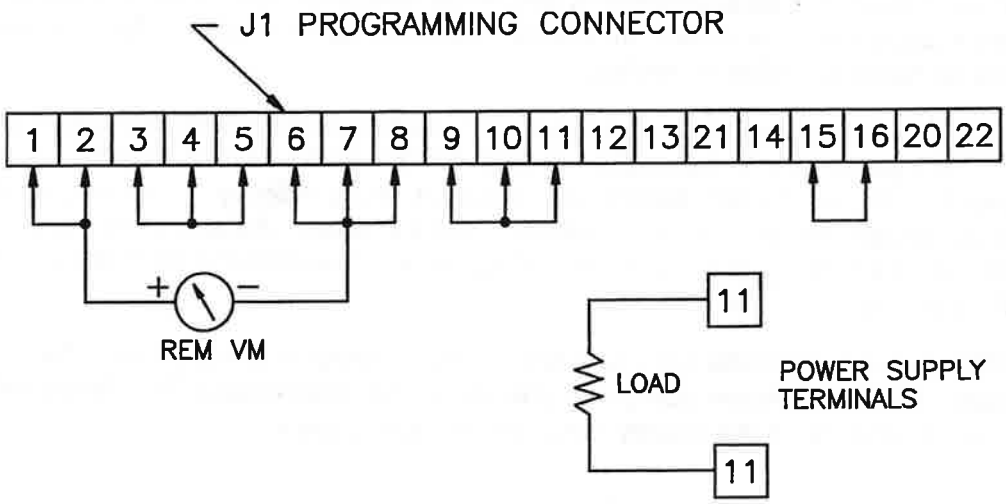


FIGURE 3.17 : Remote Meters Across Output.

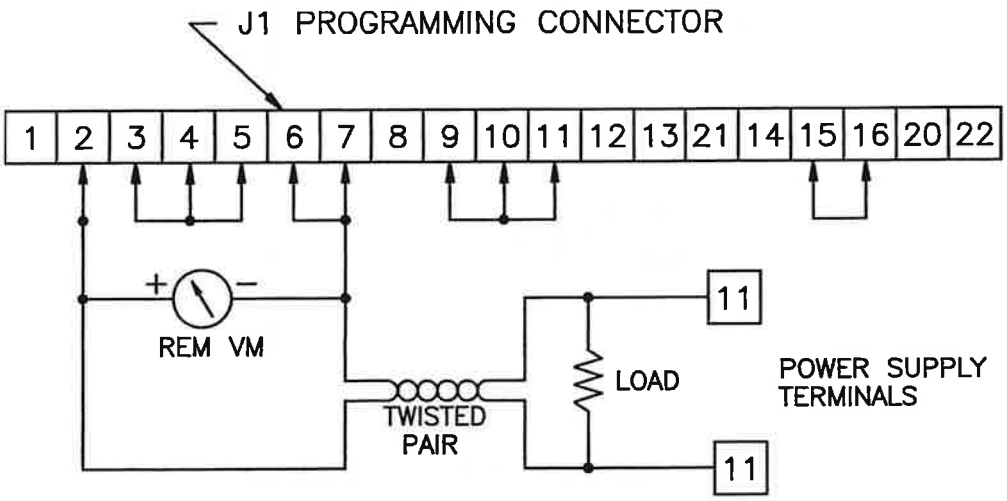


FIGURE 3.18 Remote Meter Across Load.

A) To measure load current, use a remote millivolt meter (100 mV full scale sensitivity), calibrated in amperes. Connect the meter across J1-12 (negative) and J1-13 (positive). The power supply generates 100 mV across J1 pins 12 and 25 at full rated output current. See Figure 3.19.

B) Connect 0-5 Vdc meter from J1-20(+) to J1-8 (-V). A full rate current, will generate 5 Vdc. See Figure 3.19.

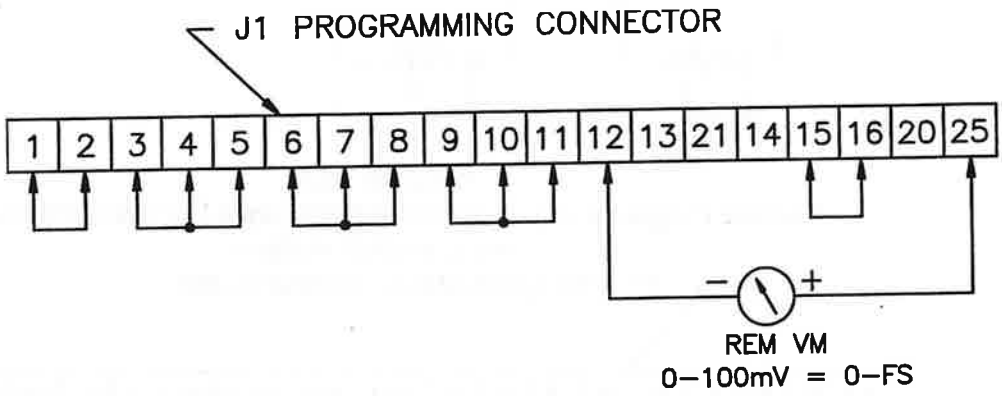


FIGURE 3.19: Remote Across Shunts

Use a higher sensitivity meter movement with a series calibration resistor to compensate for IR drops generated across long remote leads.

3.10 VOLTAGE AND CURRENT MONITOR, 0-5VDC OUTPUT

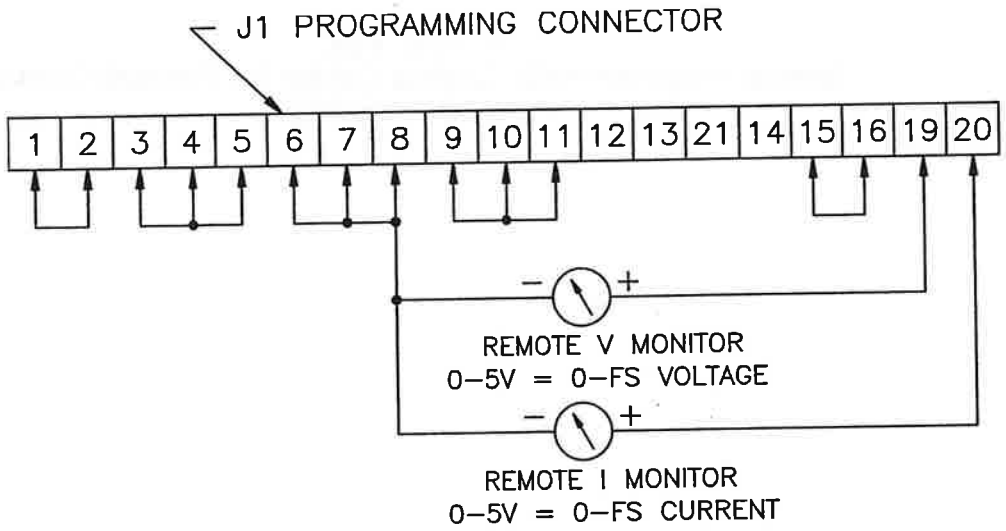


FIGURE 3.20: Voltage and Current Monitor.

3.10.1 REMOTE PROGRAMMING BOTH VOLTAGE AND CURRENT

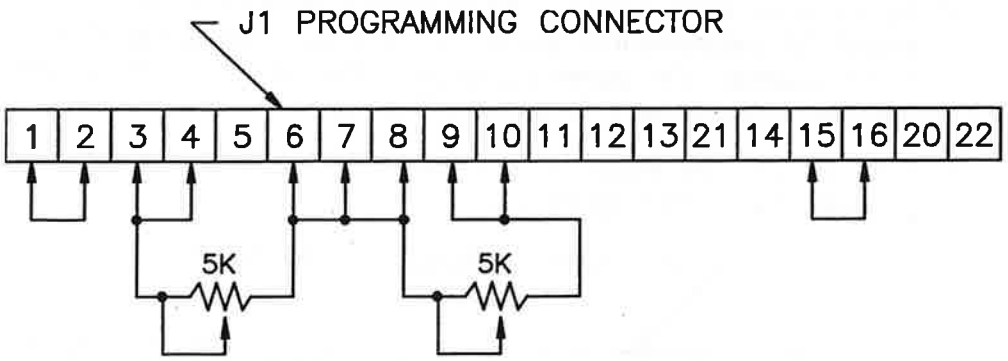


FIGURE 3.21:
Remote Programming By External Resistance For Constant Current and Constant Voltage.

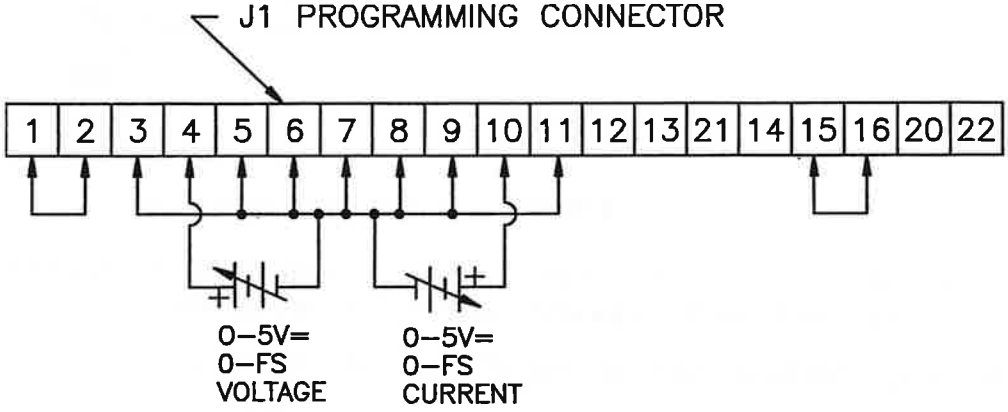


FIGURE 3.22:
Remote Programming By External Voltage For Constant Current and Constant Voltage.

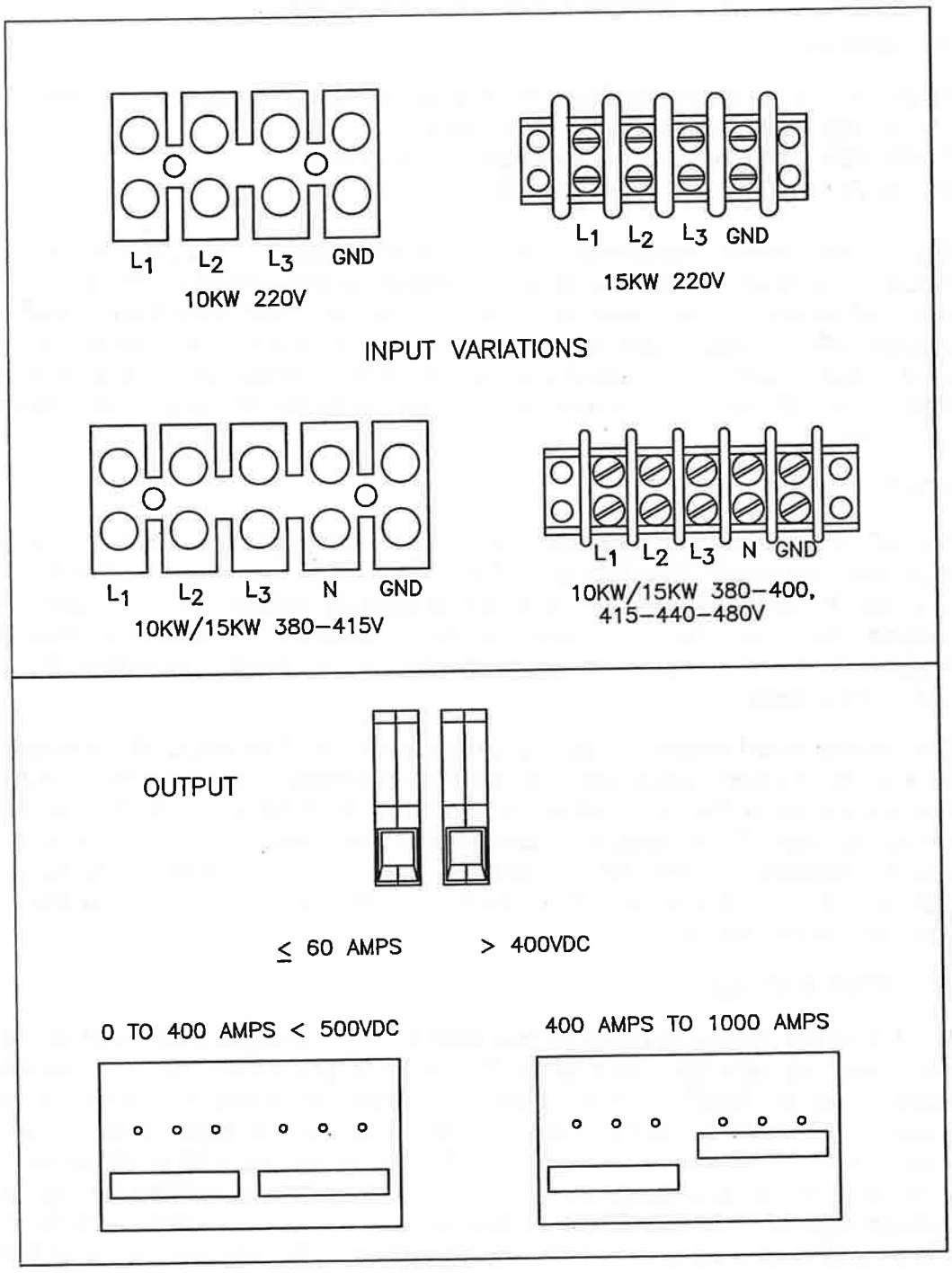


FIGURE 3.23: Rear Panel Reference.

4 THEORY OF OPERATION

4.1 REFERENCE

01-481-XXX Main schematic 220, 380, 415 Vac input (XXX depends on model).
01-000-360 A200 Inverter Board. All models.
01-000-635 A100 Board Schematic 220, 380, 415 VAC.
01-000-701 A100 Board Schematic 220, 380, 415 VAC.

The 220 Vac version works with 3 phase four wire systems. The Input AC is rectified by CR1. A raw DC bus is created with a parallel combination of C1 and C2. Refer to main schematic. The power is processed by four high frequency transformers coupled with full bridge buck converters. The raw DC bus is connected to the input of a full bridge inverter. The output from the bridge is controlled by the duty cycle of the PWM. For 220 Vac input, all four modules are connected to the parallel combination of C1 and C2.

4.2 POWER FLOW

The AC power enters through TB1 on the rear of the unit and passes through the A300 line filter board. The load side of the line filter is connected to a circuit breaker. The raw DC bus is created by the series or parallel combination of C1 and C2. L1 controls the peak charging current which is inherent in capacitive input filters. Additionally, L1 also increases the conduction angle, thereby improving the power factor of the system.

The inverter board consists of four full bridge inverters. The output of the inverter is a 33 Khz PWM square wave, which is fed to the primary of transformers T1A to T1D. The secondary of the transformers is connected to a full wave rectifier and an LC averaging filter. Each module is connected to the output bus bar. The output has preload resistors mounted on the heatsink assembly. The output filter consists of L2A-2D, L3, C7, C8, C9, and C10. An RC snubber is used to minimize the voltage spike across the diodes.

4.3 INVERTER MODULE

The full bridge inverter consists of four IGBTs. T1 is designed such that Q1 and Q4 are turned on simultaneously while Q2 and Q3 are turned off. T2 senses the switching of the IGBTs and the switching of the HF power transformer's primary current. CR9, CR10, CR11, and CR12 rectify the signal from T2 and generate a voltage across the burden resistor R14. The signal across R14 is connected to the A100 card for control purposes. C5 snubs the spikes generated by the primary leakage inductance of the HF power transformer. CR2, CR4, CR6 and CR8 are the anti-parallel diodes across the switches. The RC snubber across the device limits the dv/dt so that latching of the IGBTs is prevented. L1, C13 and C14 form a bypass circuit which delivers the entire pulse current of the inverter, thereby reducing the area of high frequency pulse current. The signal from TS1 shuts the PWM down in case of over heating. The A100 board controls steady state volt-second balance across the high frequency power transformer to prevent saturation of T1.

4.4 SIGNAL FLOW

A100 BOARD: This board generates ± 15 volts and +5 volts for "Housekeeping" purposes. Other functions of the A100 control board:

1) Reference Generation
2) CC/CV Control
3) Control of PWM
4) Supervisory Functions
5) Over current protection

4.5 REFERENCE GENERATION

Separate constant current references are provided for voltage and current channels. The collector current of Q1 drives the voltage channel. The collector current of Q2 drives the current channel. The current sources are referenced by U6, a highly stable voltage source. The current through the sources is adjustable by R6 and R8. The current sources are factory adjusted to 1 mA, and terminate at J1-3 and J1-9 on rear panel programming connector.

4.6 ERROR AMPLIFIERS

Constant voltage control and error amplification are implemented by U7. The reference (0-5 Volts) is connected to the non-inverting terminal of U7. An attenuated version of the output voltage is connected to the inverting terminal of U7. A voltage of 0 to 5 volts across R136 is the equivalent of 0 to 100% of the output voltage. The output of the voltage channel amplifier can be measured at A1. It should be -0.7 volts for the shutdown condition and 6 volts for maximum duty cycle. The offset null is adjusted by R15. Constant current is implemented by U8 and U9. The references are connected to the non inverting inputs of U9.

The output current is sensed by shunt R12 mounted in the power supply. The output of the current channel can be measured at B1. It should be -0.7 volts shutdown or 6 volts voltage and current channels are "ORed" via diodes CR41 and CR31, and thus provides automatic crossover from current to voltage control and vice versa.

4.7 PULSE WIDTH MODULATOR

The "core" of the A100 board is the four UC 3825 controllers. U15, U16, U17 and U18 are synchronized by the clock consisting of U4, U20, U21, U22, U23, and output drivers U22A-B, which comprise the sync needed to control the point at which the oscillator ramp begins.

All error amplifiers of U15, U16, U17 and U18 have a unity gain. Their inputs are tied together and receive their signal from U7 and U9. Q4, Q6, Q8, and Q10 isolate the clock signal from the oscillators to provide slope compensation for U15, U16, U17, and U18.

Signals are fed through diodes CR62, CR70, CR 63 and CR71 to pin 7. At pin 7, the clock signal and the current signal are combined. C54, C64, C74 and C84 block DC from Q4, Q6, Q8 and Q10 from appearing on pin 7 of each PWM. The duty cycle of the PWM is controlled by comparing the output of the error amplifiers (U15, U16, U17 and U18) to the ramp of the oscillator and the current sense signal of the high frequency transformers.

Q5, Q9, Q7 and Q11 make up the soft start. When their bases are pulled low or their emitters are pulled low, the PWM shuts down. When the bases or the emitters are released, the PWMS will slowly widen pulse width and then are controlled by error amps.

4.8 SUPERVISORY FUNCTIONS

U14, U11, and U12 and the associated components form the supervisory circuit. These functions include: undervoltage lockout, phase loss detection, overvoltage protection, control failure, inrush current suppression, mode detect and over temperature lockout. Inrush current limitation and mode detection are implemented by U12. The other functions are implemented by the power supply's supervisor chip U14 (UC3544).

4.9 REMOTE TURN ON CIRCUIT

This feature allows the user to control the power supply from a remote location with a 12-24 Vdc, 24-115 Vac or a dry contact closure. U4 provides isolation from the power supply ground. When using a dry contact closure, the power is supplied by the bias transformer, rectified on the A100 board, and then routed to J14, J16 and R47.

4.10 INRUSH CURRENT LIMITING CIRCUIT

The soft start is controlled by the A100 board and works in conjunction with the K1 that is on the input rectifier assembly. When power is applied to the supply, the output of U12 is low. The input bus capacitors are charged via K1 with a resistor to limit the inrush current. After the elapsed time, which is determined by R47, R49 and C42, the output of U12 switches to high closing both relays (K1). The soft start pins of U15, U16, U17, and U18 go high enabling the PWMs.

4.11 MODE DETECT

The output of the voltage channel and current channel are compared by the second op-amp of U12. The output of the comparator switches between plus and minus 15 volts depending on the magnitude of its input signal. If the output is positive, the voltage LED on the front panel lights; if it is negative the current LED lights.

4.12 THERMAL SHUTDOWN

The heatsinks' temperature is sensed by individual thermostats wired in parallel. The thermostats are normally open but they close when the temperature exceeds 70 degree Celsius. A closed thermostat will pull the soft start pins of U15, U16, U17, and U18 low, disabling the PWMs.

4.13 PHASE LOSS CIRCUIT

The phase loss circuit is the same for all the models, except that the 220 Vac model does not detect a neutral loss.

4.13.1 PHASE LOSS CIRCUIT For the 220 Vac

The incoming AC line is rectified (on the PCB A600 assembly) and optically coupled to the control section. The output of the opto-coupler is controlled by R1, R2, R3 and R7. The output of the opto-coupler is connected to pin 9 of U14 (on the A100 board) and is compared to the 2.5 volts reference on pin 8. For normal operation, pin 11 is high (15 volts). When a phase loss or a low line

occurs, pin 11 switches to low causing the soft start pins of U15, U16, U17, and U18 to go low, thus disabling the PWMs and turning the phase loss LED on.

4.13.2 PHASE LOSS CIRCUIT 380, 415 and 480 Vac

The incoming AC line is rectified (on the PCB A600 assembly) and optically coupled to the control section. The output of the opto-coupler, U2, is controlled by R4, R5 and R6. The output of the opto-coupler is connected to pin 9 of U14 (on the A100 board) and is compared to the 2.5 volts reference on pin 8. For normal operation, pin 11 is high (15 volts). When a phase loss or a low line occurs, pin 11 switches to low causing the soft start pins of U15, U16, U17, and U18 to go low, thus disabling the PWMs and turning the phase loss LED on. The neutral loss circuit is comprised of R1, R2, R3, R8, R9, R10, R11, CR7, CR4, CR5, C1 and U1. If the neutral line is disconnected, a voltage will develop across R11 causing U1 to disable U2. Therefore, the soft start pins of U15, U16, U17, and U18 will go low disabling the PWMs.

4.14 OVERVOLTAGE PROTECTION

This feature allows the user to control the power supply's overvoltage trip point. The overvoltage control (R16) located on the front panel controls an adjustable 2.5 volt reference which is fed to the U14 on the A100 board. An attenuator on the A100 board also couples the DC signal to U14. When the signal of the attenuator is higher than the adjustable 2.5 volt reference, U14, drives a DC signal to the A900 board. U801(SCR optocoupler) drives Q601 which crowbars the output of the power supply. At the same time U14 pulls the (SS line) low which shuts off the PWM.

4.15 PSYNC OPERATION (DEPENDS ON MODEL)

The incoming P Sync signal is optically coupled by U2 and divide by 3 by U3 and U4B. It is divided by 2 for 1 MHz Sync Modules. Then the signal is coupled by C6 to U5 which the phase lock loop IC which synchronizes the incoming signal to U6, U7, and U4 which divides it by 20 for 81 KHz models or buffers it for 1 MHz modules for the A100 board.

4.16 ENABLE ASSY A700 (DEPENDS ON MODEL)

V program is connected to S1 which is connected to U702. U702 selects whether voltage program is adjusted to 100 - 107VDC or to full output voltage by external user program optically coupled by U703 and U704. S1 overrides this function when switched to Local.

When overtemp occurs in INV #1 or INV #4 Q701 conducts sending a closure signal to J703, 4, 5. At the same time it lowers I max program to 37.5 Amps from 50 Amps. When high temp has been removed 20KW mode is reactivated.

5 MAINTENANCE

5.1 INTRODUCTION

This section provides a troubleshooting guide, module replacement procedures and a calibration procedure. The troubleshooting guide addresses the most common symptoms and their causes. The replacement procedure outlines the removal and replacement of the Field Replaceable Units (FRUs). The calibration procedure outlines the adjustment of the A100 board. Whenever any troubleshooting, replacement or calibration is done, the schematics and components listed in section 6.10 should be used for reference. Prior to removing the cover, refer to Section 1.2 Page 1 for safety warnings.

5.2 TROUBLESHOOTING GUIDE

SYMPTOMS	POSSIBLE CAUSE
No Output. Control Failure LED is on.	Remote on/off is disconnected. A100 board failure, inverter failure or neutral disconnected on 380, 414, 480 Vac input models, or OVP fired. NOTE: When remote is OFF, control failure will be ON. This is a normal condition.
Phase Loss LED is on	AC Line low or phase/ neutral is disconnected.
Supply working, but power on LED is not glowing.	Faulty Power On LED.
Supply not working and Power On LED not glowing	F1 fuse blown. Bias supply failure or fan(s) failure.
Inverter LED is glowing	Inverter failed (replace inverter), check diodes on output assembly.
Circuit Breaker trips	Input rectifier failed or inverter failed.
Unit output goes too high. Voltage and current are unadjustable.	Wires to voltage or current pots are disconnected. Voltage or current pot is broken.
OVP trips when unit Turned on	OVP pot broken or wires disconnect. OVP tripping because output is too high or adjusted too low.
Cannot reach full output	One or two inverters have failed.
High ripple	One of the output caps has failed
Overheating	One of the fans have failed or an inverter is overheating.

Table 5.1 Troubleshooting Guide

5.3 FIELD REPLACEABLE UNITS (FRUS)

This supply is comprised of several modules (assemblies). If a module fails, simply replace it with an identical one. A front panel LED will glow to indicate which module (assembly) has failed. FRUs (Modules) are replaced by removing the screws on the top cover which allows access to the modules. When ordering a FRU, please refer to its EMI number and the model number of the power supply. The table below provides a list of the modules and their EMI part numbers.

FRU	AC Input Voltage Of Supply	EMI Part Number
A200 Inverter Board10 kw 15 Kw	220-480	23-227-001 23-227-000
A100 Control Board	220, 380-415, 480	20-760-7XX, 20-928-XXX 20-760-8XX
A900 OVP Board	220-480	20-460-1XX When Installed
Main Rectifier Assembly	220 , 15KW 220, 10KW 380 415	26-330-004 26-330-002 26-330-009 26-330-010
Fan Assembly	All Models	12-481-003

Table 5.2 FRUs

DESCRIPTION	EMI P/N	COPLEY P/N	FRU NO.
ESS Supply	00-481-040	88-0026	4522-150-11231
A500 Sync Bd	12-481-014	05-0427	4522-150-11281
-002 A200 Inverter	12-481-015	05-0425	4522-150-11241
-003 A200 Inverter	12-481-016	05-0441	4522-150-14591
A100 Control Bd	12-481-017	05-0426	4522-150-11251
AC Fan Assy	12-481-003	65-0014	4522-150-10321
Input Rect. Assy	12-481-013	05-0424	4522-150-11261
A600 Phase Loss Bd	12-481-044	02-0650	4522-150-11312
A700 Enable Bd	12-481-018	05-0442	4522-150-14521

Table 5.3 Copley FRUs

DESCRIPTION	EMI P/N	COPLEY P/N	FRU NO.
ESS Supply	00-481-327	88-0009	4522-150-10282
A500 Sync Bd	12-481-004	02-0278	4522-150-10241
-000 A200 Inverter	12-481-042	02-0239	4522-150-10291
A100 Control Bd	12-481-041	02-0443	4522-150-10301
AC Fan Assy	12-481-003	65-0014	4522-150-10321
Input Rect. Assy	12-481-043	05-0164	4522-150-10311
A600 Phase Loss Bd	12-481-044	02-0650	4522-150-11312

Table 5.4 Copley FRUs

Caution: Proper ESDS (ElectroStatic Discharge Sensitivity) procedures should be adhered to whenever replacing a module or troubleshooting the power supply.

Prior to removing the top cover of the power supply, Refer to **Safety Precautions** section 1.2 of page 1. Simply loosen the screws that attach the cover to the chassis and remove the cover.

5.4 INVERTER A200

There are four inverter board assemblies in the power supply. Inverter failures are indicated on the front panel by their LEDs. To remove a module, loosen the five captive screws on the plate between inverters 1 and 2 (or inverters 3 and 4), then remove the plate. Unplug the multi-pin cable near the top and remove the screws holding the red and black wires. Lift out the module and unplug the red two pin connector. Install the new module in the reverse order. All four inverter modules are removed and installed in the same manner.

5.4.1 INVERTER A200 TEST

After the module has been replaced, the following test procedure should be done:

A) With no load connected to the output terminals of the power supply, adjust the front panel's Voltage and Current controls fully counter clockwise.

B) Apply power. Turn on the front panel CB (supply starts after a ten second delay). Turn up the current and voltage controls until the output is about 15% of Max. voltage, then adjust the load for about 20% of Max. current.

5.5 A100 CONTROL BOARD

All of the plugs (12 total) on the A100 board should be disconnected before removing the board. Unscrew and remove the six screws which hold the board to the chassis. Remove J1 which is located on the rear panel. The board should now be free of any connections and can be simply removed. Replace in the reverse order and be sure the connectors are correctly plugged back into the PCB. If unsure, mark the connectors before unplugging.

A) Rotate the front panel controls fully counter clockwise.

B) Apply AC power. Turn on the front panel CB and slowly advance the current control 1/4 turn. Slowly advance the voltage control. The output should gradually increase as the Voltage control is rotated.

5.6 FAN ASSEMBLY

The procedure for removing the fans is as follows. Unscrew the captive screws (two for each) that attach each fan to the chassis. After the base screws are loose, remove the two screws near the top which screw into the flat chassis plate where the A100 PCB is mounted. After unsoldering the wires to the AC terminal, the fan assembly can be removed. To install, follow the reverse order.

5.7 MAIN RECTIFIER ASSEMBLY

To remove the rectifier assembly, face the front panel. The chassis left side cover has to be removed. This side cover is fastened with seven screws to the chassis.

After this side is removed the rectifier assembly can be accessed. The two bottom flat head screws, hold the bracket to the chassis.

After the flat head screws are removed, the five large wires and eleven small wires must be removed before the assembly is ready for removal. Because of the large number of wires, mark each wire as it is being removed so that it can be replaced correctly. The reassembling is the reverse sequence of that used to remove the module.

A) Adjust the front panel controls fully counter clockwise.

B) Apply AC power and turn the front panel CB on.

C) Advance the current control fully counter clockwise and slowly adjust the voltage control until system output voltage is achieved.

D) Apply full load current and the output voltage deviation should be less than 0.1% of maximum output. The unit can now be returned to service.

5.8 A900 OVP BOARD (IF INSTALLED)

A) After the board has been replaced, the operation of the board should be checked.

B) Apply AC power and turn on the CB.

C) Adjust front panel OVP control fully clockwise, as the voltage of the set increases to the front panel setting of the voltage pot on front panel, turn the OVP control pot counterclockwise until the OVP activates. After the OVP has been activated turn CB off and return OVP setting to the desired point. Turn CB back to verify that set is functioning properly.

5.9 CALIBRATION

Calibration of the A100 Board (for all models) is necessary whenever replacing the A100 Board, the voltage control, or the current control. The following is the calibration procedure for the A100 Board. Refer to schematic #01-000-478.

1) Remove cover.
2) Rotate voltage and ammeter potentiometers counter clockwise.
3) Turn power supply on.
4) Partially rotate voltage potentiometer clockwise.
5) Connect negative lead of DVM to pin 2 of U24.
6) Connect positive lead of DVM to cathode of CR31.
7) Digital meter should display 6 Vdc.
8) Rotate voltage potentiometer counter clockwise.
9) Adjust R15 until DVM displays -0.6 volts.
10) Partially rotate current potentiometer clockwise.
11) Connect positive pin of DVM to cathode of CR41 (keep negative lead of DVM at pin 2 of U24).
12) DVM should display 6 volts.
13) Rotate current potentiometer fully counter clockwise.
14) Adjust R21 until DVM displays -0.6 volts.
15) Connect positive pin of DVM to collector of Q1 (keep negative lead of DVM at pin 2 of U24).
16) Connect another DVM across output of power supply (no load is connected to output).
17) Rotate voltage potentiometer fully clockwise.

18) Voltage of collector Q1 should be 5 ± 0.01 Vdc, if not adjust R6.
19) Adjust R148 until output of power supply is equal to $V_{out\ max.}$ ± 0.1 Vdc.
20) Disconnect DVMs. Turn off circuit breaker. Connect $R_{load} \leq$ (maximum output voltage÷maximum output current) to output terminals of power supply.
21) Connect a DVM to pins 1 & 2 of J2(shunt R12). Refer to the A100 board schematic (use R25 and R26 for convenience).
22) Connect positive lead of another DVM to collector of Q2. Connect negative lead to pin 2 of U24.
23) Turn on circuit breaker. Rotate current potentiometer fully clockwise. Verify that the supply is in the current mode; the current LED should glow.
24) Voltage of collector Q2 should be 5 ± 0.01 Vdc, if not adjust R8.
25) Adjust R34 until voltage across shunt (pins 1 & 2 of internal J2) is 100 ± .01%.

5.10 SYNC BOARD A500

A) After the board has been replaced the operation of the board should be checked.

B) Apply AC power and turn ON the CB.Connect the oscilloscope probe common to TP1 and the other to TP5.

C) Sync the scope to channel 1 (TP1) and the trace should show the two wave forms to be in Sync.

Note the position of R6, and adjust 1/2 turn CW and 1/2 turn CCW. The two traces should still show synchronization. Return R6 to it's original position. This completes the test.

5.11 ENABLE BOARD A700 ASSEMBLY

A) After the board has been replaced the operation of the board should be checked with a full load.

B) Apply AC power and turn on the CB and turn the front panel controls CW.

C) Connect meter to external shunt of 100MV at 50 amps. Attach jumper from junction of R704 and R703, to collector of Q70, U701 output should go low.

D) Set external shunt for 74 MV. program external unable and set should go to max V set by front panel pot. Remove programming and set should work in local.

5.12 SCHEMATICS AND COMPONENTS

The following pages contain component charts and schematics to be used as references for any troubleshooting, replacement or calibration.

BILL NO: 20928001 REV: B U/M: EA DRAWING NO: 207607XX DRAWING REV: C
ASSY PCB A100 CONTROL ESS 330-45 220V 0856

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	12.000	NEW	JP7 , JP10 R47 , R51 R19 , R153 R50 , R159 CR71 , CR62 CR63 , CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A , JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C18
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	9.000	NEW	C6 , C25 C28 , C29 C90 , C54 C64 , C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	7.000	NEW	C5 , C19 C35 , C52 C62 , C72 C82
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C30
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	1.000	NEW	C9
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 , C55 C44 , C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	1.000	NEW	R148
0000	67001013	E	RES CF 1K 1/4W 5%	EA	1.000	NEW	R147
0000	67001030	E	RES CF 15K 1/4W 5%	EA	1.000	NEW	R134
0000	67001031	E	RES CF 150K 1/4W 5%	EA	1.000	NEW	R31

BILL 20928001 REV: B U/M: EA DRAWI O: 207607XX DRAWING REV: C
ASSY PCB A100 CONTROL ESS 330-45 220V 0856

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	12.000	NEW	JP7 ,JP10 R47 ,R51 R19 ,R153 R50 ,R159 CR71 ,CR62 CR63 ,CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C18
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	9.000	NEW	C6 ,C25 C28 ,C29 C90 ,C54 C64 ,C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	7.000	NEW	C5 ,C19 C35 ,C52 C62 ,C72 C82
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C30
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	1.000	NEW	C9
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 ,C55 C44 ,C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	1.000	NEW	R148
0000	67001013	E	RES CF 1K 1/4W 5%	EA	1.000	NEW	R147
0000	67001030	E	RES CF 15K 1/4W 5%	EA	1.000	NEW	R134
0000	67001031	E	RES CF 150K 1/4W 5%	EA	1.000	NEW	R31

BILL NO: 20928001 REV: B U/M: EA DRAWING NO: 207607XX DRAWING REV: C
ASSY PCB A100 CONTROL ESS 330-45 220V 0856

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R88 R105 ,R122
0000	67001092	E	RES CF 680K 1/4W 5%	EA	1.000	NEW	R16
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R90 R107 ,R124
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67006026	F	RES MF 20K 1/4W 1%	EA	1.000	NEW	R22
0000	67006091	F	RES MF 130K 1/4W 1%	EA	2.000	NEW	R133 ,R157
0000	67006126	F	RES MF 9.25K 1/4W 1%	EA	2.000	NEW	R60 ,R155
0000	67006141	F	RES MF 200K 1/4W 1%	EA	2.000	NEW	R151 ,R152
0000	67007014	C	RES MF 150K 1/2W 1%	EA	2.000	NEW	R61 ,R99
0000	67007075	C	RES MF 100 1/2W 1%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67007102	C	RES MF 187K 1/2W 1%	EA	2.000	NEW	R158 ,R156
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV A INITIAL RELEASE DMH 8/7/96
REV B ECO 16000 DMH 11/12/96

BILL 20928003 REV: C U/M: EA DRAWING: 207607XX DRAWING REV: B
ASSY PCB A100 CONTROL ESS 160-93-8-0856

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	13.000	NEW	JP7 ,JP10 R47 ,R50 R51 ,R156 R158 ,R159 R157 ,CR71 CR62 ,CR63 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C29
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	5.000		C28 ,C54 C64 ,C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	6.000	ECO 16128 REV C	C5 ,C10 C52 ,C72 C62 ,C82
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154009	C	CAP DECOUPLING 33PF 200V AXIAL	EA	1.000	ECO 16128 REV C	C19
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	ECO 16128 REV C	C30 ,C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C6 ,C9 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C44 ,C55 C65 ,C75
0000	63041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 ,R148
0000	67001039	E	RES CF 1.8K 1/4W 5%	EA	1.000	NEW	R22

BILL NO: 20929003 REV: C U/M: EA DRAWING NO: 207607XX DRAWING REV: B
ASSY PCB A100 CONTROL ESS 160-93-8-0856

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001051	E	RES CF 220K 1/4W 5%	EA	1.000	ECO 16128 REV C	R16
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R105 R88 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R124 ,R70
0000	67002045	D	RES CF 20K 1/2W 5%	EA	1.000	NEW	R128
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R110 R73 ,R127
0000	67006003	F	RES MF 100K 1/4W 1%	EA	2.000	NEW	R99 ,R153
0000	67006014	F	RES MF 150K 1/4W 1%	EA	1.000	NEW	R133
0000	67006041	F	RES MF 30.1K 1/4W 1%	EA	3.000	NEW	R151 ,R152 R61
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006106	F	RES MF 24.9K 1/4W 1%	EA	1.000	NEW	R60
0000	67006111	F	RES MF 154K 1/4W 1%	EA	1.000	NEW	R155
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV A RELEASE TO MFG JF 8/5/96
REV B ECO 16000 DMH 11/12/96
REV C ECO 16128 CORRECTED 2-10-97 DMH 1/22/97

BILL N 0928004 REV: B U/M: EA DRAWI): * DRAWING REV: C

ASSY PCB A100 CONTROL ESS 330-45-8-0856 W/TL

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	11.000	NEW	JP7 , JP10 R158 , R49 R51 , R50 R153 , CR71 CR62 , CR63 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A , JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	6.000	NEW	C28 , C29 C54 , C74 C64 , C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	6.000	NEW	C5 , C10 C52 , C72 C62 , C82
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154009	C	CAP DECOUPLING 33PF 200V AXIAL	EA	1.000	NEW	C19
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	2.000	NEW	C30 , C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C9 , C6 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 , C75 C44 , C55
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 , R148
0000	67001016	E	RES CF 1M 1/4W 5%	EA	1.000	NEW	R16
0000	67001044	E	RES CF 2K 1/4W 5%	EA	1.000	NEW	R22
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 , R116

BILL NO: 20928004 REV: B U/M: EA DRAWING NO: * DRAWING REV: C
ASSY PCB A100 CONTROL ESS 330-45-8-0856 W/TL

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R105 R88 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R124 ,R90
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R110 R93 ,R127
0000	67005169	E	RES MF 8.25K 1/8W 1%	EA	2.000	NEW	R60 ,R155
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006091	F	RES MF 130K 1/4W 1%	EA	2.000	NEW	R133 ,R157
0000	67006141	F	RES MF 200K 1/4W 1%	EA	2.000	NEW	R151 ,R152
0000	67007014	C	RES MF 150K 1/2W 1%	EA	2.000	NEW	R61 ,R99
0000	67007102	C	RES MF 187K 1/2W 1%	EA	2.000	NEW	R156 ,R159
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV A INITIAL RELEASE DMH 8/7/96
REV B ECO 16000 DMH 11/12/96

BILL / 20928005 REV: B U/M: EA DRAWI 'O: DRAWING REV:
ASSY PCB A100 CNTL ESS 160- 62- 2- A/D- 0962

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	13.000	NEW	JP7 ,JP10 R49 ,R50 R51 ,R156 R158 ,R159 R157 ,CR71 CR62 ,CR63 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54014004	J	CAP MICA .0022MF 500V RADIAL	EA	1.000	NEW	C7
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C29
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	5.000	NEW	C28 ,C54 C64 ,C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	8.000	NEW	C5 ,C10 C18 ,C19 C52 ,C62 C72 ,C82
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C30
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C6 ,C9 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 ,C55 C44 ,C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 ,R148
0000	67001016	E	RES CF 1M 1/4W 5%	EA	1.000	NEW	R16

BILL NO: 20928005 REV: B U/M: EA DRAWING NO: DRAWING REV:
ASSY PCB A100 CNTL ESS 160- 62- 2- A/D- 0962

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001039	E	RES CF 1.8K 1/4W 5%	EA	1.000	NEW	R22
0000	67001045	E	RES CF 20K 1/4W 5%	EA	1.000	NEW	R128
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R88 R105 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R90 R107 ,R124
0000	67002009	D	RES CF 68 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67006003	F	RES MF 100K 1/4W 1%	EA	2.000	NEW	R99 ,R153
0000	67006014	F	RES MF 150K 1/4W 1%	EA	1.000	NEW	R133
0000	67006039	F	RES MF 27.4K 1/4W 1%	EA	1.000	NEW	R60
0000	67006041	F	RES MF 30.1K 1/4W 1%	EA	3.000	NEW	R151 ,R152 R61
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006111	F	RES MF 154K 1/4W 1%	EA	1.000	NEW	R155
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK
			REV A INITIAL RELEASE DMH 8/7/96				
			REV B ECO 16000 DMH 11/12/96				

BILL N 0928006 REV: B U/M: EA DRAWI J: 207607XX DRAWING REV: C
ASSY PCB A100 ESS 424-37-8-0985-1

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	07481025	A	TEST PROCEDURE COPLEY A100 SUB ASSY	EA REF		NEW	TSTSHT
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	TO REV 2	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	9.000	NEW	JP7 ,JP10 R60 ,R51 R50 ,CR62 CR63 ,CR70 CR71
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	TO REV 2	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	TO REV 2	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54003003	M	CAP DISC .02MF 1000V RADIAL	EA	1.000	NEW	C7
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C123
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	3.000	NEW	C111 ,C28 C30
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	5.000	NEW	C29 ,C54 C74 ,C64 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	2.000	NEW	C5 ,C10
0000	54154008	C	CAP DECOUPLING 2200PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C9 ,C6 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	5.000	ENG CHG SS	C19 ,C44 C55 ,C65 C75
0000	54154016	C	CAP DECOUPLING 470PF 100V AXIAL	EA	5.000	NEW	C52 ,C62 C72 ,C82 C120
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	1.000	NEW	R148

BILL NO: 20928006 REV: B U/M: EA DRAWING NO: 207607XX DRAWING REV: C
ASSY PCB A100 E3S 424-37-8-0985-1

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001014	E	RES CF 10K 1/4W 5%	EA	1.000	NEW	R134
0000	67001019	E	RES CF 1.2K 1/4W 5%	EA	1.000	NEW	R118
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	TO REV 2	R111 ,R116
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001077	E	RES CF 470K 1/4W 5%	EA	1.000	NEW	R16
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	5.000	NEW	R22 ,R71 R105 ,R88 R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R90 ,R124
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R110 R93 ,R127
0000	67006026	F	RES MF 20K 1/4W 1%	EA	1.000	NEW	R155
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006091	F	RES MF 130K 1/4W 1%	EA	1.000	NEW	R133
0000	67006141	F	RES MF 200K 1/4W 1%	EA	4.000	NEW	R151 ,R152 R156 ,R157
0000	67006164	F	RES MF 82.5K 1/4W 1%	EA	1.000	NEW	R159
0000	67007003	C	RES MF 100K 1/2W 1%	EA	1.000	NEW	R153
0000	67007103	C	RES MF 191K 1/2W 1%	EA	2.000	NEW	R61 ,R99
0000	67008070	NR	RES MF 200K 3/4W 1%	EA	1.000	NEW	R158
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72122005	D	HEADER PC MALE 6 CKT W/LOCK .100"CTRS NYLON 94V2	EA	1.000	NEW	J14
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK
			REV 1 INITIAL RELEASE JF 4/2/96				
			REV 2 CHG 20760100 TO 20928000 AND JF 4/26/96				

BILL 20928007 REV: C U/M: EA DRAW NO: DRAWING REV:
ASSY PCB A100 CONTROL ESS 330-45-14-0856 W/TL

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	11.000	NEW	JP7 , JP10 R158 , R49 R51 , R50 R153 , CR71 CR62 , CR63 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A , JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	ECO 16000 REV B	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	6.000	NEW	C28 , C29 C54 , C74 C64 , C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	6.000	ECO 16128 REV C	C5 , C10 C52 , C72 C62 , C82
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154009	C	CAP DECOUPLING 33PF 200V AXIAL	EA	1.000	ECO 16128 REV C	C19
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	2.000	ECO 16128 REV C	C30 , C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C9 , C6 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 , C55 C44 , C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 , R148
0000	67001044	E	RES CF 2K 1/4W 5%	EA	1.000	NEW	R22
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 , R116
0000	67001051	E	RES CF 220K 1/4W 5%	EA	1.000	ECO 16128 REV C	R16

BILL NO: 20928007 REV: C U/M: EA DRAWING NO: DRAWING REV:
ASSY PCB A100 CONTROL ESS 330-45-14-0856 W/TL

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R105 R88 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R124 ,R90
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R110 R93 ,R127
0000	67005169	E	RES MF 8.25K 1/8W 1%	EA	1.000	NEW	R155
0000	67006041	F	RES MF 30.1K 1/4W 1%	EA	1.000	NEW	R60
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006091	F	RES MF 130K 1/4W 1%	EA	2.000	NEW	R133 ,R157
0000	67006141	F	RES MF 200K 1/4W 1%	EA	2.000	NEW	R151 ,R152
0000	67007014	C	RES MF 150K 1/2W 1%	EA	2.000	NEW	R61 ,R99
0000	67007102	C	RES MF 187K 1/2W 1%	EA	2.000	NEW	R156 ,R159
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV A INITIAL RELEASE DMH 8/7/96
REV B ECO 16000 DMH 11/12/96
REV C ECO 16128 DMH 1/22/97

BILL : 20928008 REV: A U/M: EA DRAWI D: 207607XX DRAWING REV: C
ASSY PCB A100 ESS 404-37.5-14-1262

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	8.000	REV 2	JP7 , JP10 R50 , CR62 CR71 , R51 CR63 , CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A , JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	REV 2	C123
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C28
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C35
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	8.000	NEW	C6 , C25 C29 , C90 C54 , C64 C74 , C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	4.000	REV 2	C5 , C10 C120 , C125
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	REV 2	C19
0000	54154008	C	CAP DECOUPLING 2200PF 100V AXIAL	EA	1.000	REV 2	C111
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	2.000	NEW	C30 , C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	1.000	NEW	C9
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C44 , C55 C65 , C75
0000	54154016	C	CAP DECOUPLING 470PF 100V AXIAL	EA	4.000	NEW	C52 , C62 C72 , C82
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001013	E	RES CF 1K 1/4W 5%	EA	1.000	NEW	R147
0000	67001030	E	RES CF 15K 1/4W 5%	EA	1.000	NEW	R134
0000	67001031	E	RES CF 150K 1/4W 5%	EA	1.000	NEW	R31

BILL NO: 20928009 REV: A U/M: EA DRAWING NO: 207607XX DRAWING REV: C
ASSY PCB A100 ESS 404-37.5-14-1262

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001051	E	RES CF 220K 1/4W 5%	EA	1.000	NEW	R16
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	5.000	REV 2	R19 ,R88 R71 ,R122 R105
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R124 ,R90
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67006002	F	RES MF 10K 1/4W 1%	EA	1.000	NEW	R22
0000	67006063	F	RES MF 69.8K 1/4W 1%	EA	1.000	REV 2	R60
0000	67006074	F	RES MF 4.02K 1/4W 1%	EA	1.000	NEW	R155
0000	67006140	F	RES MF 140K 1/4W 1%	EA	1.000	NEW	R133
0000	67006141	F	RES MF 200K 1/4W 1%	EA	3.000	NEW	R151 ,R157 R152
0000	67007003	C	RES MF 100K 1/2W 1%	EA	2.000	NEW	R159 ,R153
0000	67007014	C	RES MF 150K 1/2W 1%	EA	3.000	NEW	R158 ,R99 R61
0000	67007103	C	RES MF 191K 1/2W 1%	EA	1.000	NEW	R156
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72122005	D	HEADER PC MALE 6 CKT W/LOCK .100"CTRS NYLON 94V2	EA	1.000	NEW	J14
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV 99	PRELIM RELEASE	JF 12/11/96
REV 1	INITIAL RELEASE	JF 12/20/96
REV 2	PRODUCTION TO CHANGE	WJW 01/24/97
REV A	TOLLGATE RELEASE	WJW 01/24/97

BILL 20928009 REV: A U/M: EA DRAWI O: 207607XX DRAWING REV: C

ASSY PCB A100 CONTROL ESS 330-30-7 A/D-U

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	12.000	NEW	JP7 ,JP10 R49 ,R51 R17 ,R153 R50 ,R159 CR71 ,CR62 CR63 ,CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10715KW COPLEY BASIC	EA	1.000	NEW	A100
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54026001	R	CAP ELEC 22MF 25V RADIAL	EA	1.000	NEW	C93
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C18
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	9.000	NEW	C6 ,C25 C28 ,C29 C90 ,C54 C64 ,C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	7.000	NEW	C5 ,C19 C35 ,C52 C62 ,C72 C82
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C30
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	1.000	NEW	C9
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C65 ,C55 C44 ,C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	1.000	NEW	R148
0000	67001013	E	RES CF 1K 1/4W 5%	EA	1.000	NEW	R147
0000	67001030	E	RES CF 15K 1/4W 5%	EA	1.000	NEW	R134
0000	67001031	E	RES CF 130K 1/4W 5%	EA	1.000	NEW	R31

BILL NO: 20928009 REV: A U/M: EA DRAWING NO: 207607XX DRAWING REV: C
ASSY PCB A100 CONTROL ESS 330-30-7 A/D-U

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R88 R105 ,R122
0000	67001092	E	RES CF 680K 1/4W 5%	EA	1.000	NEW	R16
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R90 R107 ,R124
0000	67002008	D	RES CF 56 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67006026	F	RES MF 20K 1/4W 1%	EA	1.000	NEW	R22
0000	67006091	F	RES MF 130K 1/4W 1%	EA	2.000	NEW	R133 ,R157
0000	67006126	F	RES MF 8.25K 1/4W 1%	EA	2.000	NEW	R60 ,R155
0000	67006141	F	RES MF 200K 1/4W 1%	EA	2.000	NEW	R151 ,R152
0000	67007014	C	RES MF 150K 1/2W 1%	EA	2.000	NEW	R61 ,R99
0000	67007102	C	RES MF 187K 1/2W 1%	EA	2.000	NEW	R158 ,R156
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV 1 INITIAL RELEASE PER SS JF 7/3/97
REV A TO RELEASE REV 1 = REV A CMT 8/21/97

BILL 20928010 REV: A U/M: EA DRAW: ID: 207607XX DRAWING REV: D

ASSY PCB A100 CNTL ESS 160-93-2-A/D-U

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	13.000	NEW	JP7 ,JP10 R47 ,R50 R51 ,R156 R158 ,R159 R157 ,CR62 CR63 ,CR71 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C29
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	5.000	NEW	C28 ,C54 C64 ,C74 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	2.000	NEW	C5 ,C10
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154009	C	CAP DECOUPLING 33PF 200V AXIAL	EA	1.000	NEW	C19
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	2.000	NEW	C30 ,C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C6 ,C9 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C44 ,C55 C65 ,C75
0000	54154016	C	CAP DECOUPLING 470PF 100V AXIAL	EA	4.000	NEW	C52 ,C62 C72 ,C82
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 ,R148
0000	67001039	E	RES CF 1.8K 1/4W 5%	EA	1.000	NEW	R22
0000	67001045	E	RES CF 20K 1/4W 5%	EA	1.000	NEW	R128

BILL NO: 20929010 REV: A U/M: EA DRAWING NO: 207607XX DRAWING REV: D
ASSY PCB A100 CNTL ESS 160-93-2-A/D-U

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001051	E	RES CF 220K 1/4W 5%	EA	1.000	NEW	R16
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R88 R105 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R90 R107 ,R124
0000	67002005	D	RES CF 33 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67006003	F	RES MF 100K 1/4W 1%	EA	2.000	NEW	R99 ,R153
0000	67006014	F	RES MF 150K 1/4W 1%	EA	2.000	NEW	R133 ,R155
0000	67006039	F	RES MF 27.4K 1/4W 1%	EA	1.000	NEW	R60
0000	67006041	F	RES MF 30.1K 1/4W 1%	EA	3.000	NEW	R61 ,R151 R152
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK
			REV A RELEASE TO MFG JF 8/1/97				

BILL NO: 20928011 REV: B U/M: EA DRAWING : 207607XX DRAWING REV: D
ASSY PCB A100 CNTL ESS 400-37.5-7 A/D-U

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	9.000	NEW	JP7 ,JP10 R17 ,R50 R153 ,CR62 CR63 ,CR71 CR70
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	2.000	NEW	C111 ,C28
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C35
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	8.000	NEW	C6 ,C25 C27 ,C90 C54 ,C64 C74 ,C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	2.000	NEW	C5 ,C10
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	2.000	ECO 16914 REV B	C30 ,C18
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	1.000	NEW	C9
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	5.000	ECO 16914 REV B	C44 ,C55 C65 ,C75 C19
0000	54154016	C	CAP DECOUPLING 470PF 100V AXIAL	EA	4.000	NEW	C52 ,C62 C72 ,C82
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001013	E	RES CF 1K 1/4W 5%	EA	1.000	NEW	R147
0000	67001030	E	RES CF 15K 1/4W 5%	EA	1.000	NEW	R134
0000	67001031	E	RES CF 150K 1/4W 5%	EA	1.000	NEW	R31
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001051	E	RES CF 220K 1/4W 5%	EA	1.000	NEW	R16

BILL NO: 20929011 REV: B U/M: EA DRAWING NO: 207607XX DRAWING REV: D
ASSY PCB A100 CNTL ESS 400-37.5-7 A/D-U

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R88 ,R71 R122 ,R105
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R124 ,R90
0000	67002005	D	RES CF 33 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67006002	F	RES MF 10K 1/4W 1%	EA	1.000	NEW	R22
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	2.000	NEW	R49 ,R51
0000	67006074	F	RES MF 4.02K 1/4W 1%	EA	1.000	NEW	R155
0000	67006101	F	RES MF 59K 1/4W 1%	EA	1.000	NEW	R60
0000	67006140	F	RES MF 140K 1/4W 1%	EA	1.000	NEW	R133
0000	67006141	F	RES MF 200K 1/4W 1%	EA	3.000	NEW	R151 ,R157 R152
0000	67007003	C	RES MF 100K 1/2W 1%	EA	1.000	NEW	R159
0000	67007014	C	RES MF 150K 1/2W 1%	EA	3.000	NEW	R158 ,R99 R61
0000	67007103	C	RES MF 191K 1/2W 1%	EA	1.000	NEW	R156
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY	EA	REF	NEW	CHECK

REV A RELEASE TO MFG JF 8/1/97
REV B ECO 16914 CMT 10/25/97

BILL 20928012 REV: A U/M: EA DRAW ID: 207607XX DRAWING REV: D

ASSY PCB A100 CNTL ESS 160-62-B A/D-U

SEQ	PART NUMBER	REV	D E S C R I P T I O N	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	18038009	J	JUMPER WIRE INSL .200 CTRS .250 LEG 22 AWG	EA	1.000	NEW	R139
0000	18038015	J	JUMPER WIRE INSL .400 CTRS .250 LEG 22 AWG	EA	13.000	NEW	JP7 ,JP9 R49 ,R50 R51 ,R156 R158 ,R159 R157 ,CR62 CR63 ,CR70 CR71
0000	18038020	J	JUMPER WIRE INSL .500 CTRS .250 LEG 20 AWG	EA	1.000	NEW	R143
0000	20928000	B	ASSY PCB A100 CONTROL ESS 10/15KW COPLEY BASIC	EA	1.000	NEW	BASIC
0000	47085000		JUMPER LINK 100 CTRS	EA	2.000	NEW	JP13A ,JP13B
0000	54007009	E	CAP FILM .002MF 200V AXIAL	EA	1.000	NEW	C7
0000	54154001	C	CAP DECOUPLING 0.1MF 50V AXIAL	EA	1.000	NEW	C111
0000	54154002	C	CAP DECOUPLING 330PF 200V AXIAL	EA	1.000	NEW	C29
0000	54154004	C	CAP DECOUPLING 0.01MF 50V AXIAL	EA	5.000	NEW	C28 ,C54 C74 ,C84 C84
0000	54154005	C	CAP DECOUPLING 0.001MF 50V AXIAL	EA	4.000	NEW	C5 ,C10 C18 ,C19
0000	54154007	C	CAP DECOUPLING 220PF 100V AXIAL	EA	1.000	NEW	C35
0000	54154008	C	CAP DECOUPLING 2200PF 100V AXIAL	EA	4.000	NEW	C52 ,C62 C72 ,C82
0000	54154012	C	CAP DECOUPLING 4700PF 50V AXIAL	EA	1.000	NEW	C30
0000	54154013	C	CAP DECOUPLING 0.047MF 50V AXIAL	EA	3.000	NEW	C6 ,C9 C25
0000	54154014	C	CAP DECOUPLING 100PF 200V AXIAL	EA	4.000	NEW	C44 ,C55 C65 ,C75
0000	65041008	H	RELAY 0.5A 100VDC 1 FORM A DIP 14 PCB 1200 OHM	EA	1.000	NEW	K1
0000	67001001	E	RES CF 10 1/4W 5%	EA	2.000	NEW	R134 ,R148
0000	67001016	E	RES CF 1M 1/4W 5%	EA	1.000	NEW	R16

BILL NO: 20928012 REV: A U/M: EA DRAWING NO: 207607XX DRAWING REV: D
ASSY PCB A100 CNTL ESS 160-62-8 A/D-U

SEQ	PART NUMBER	REV	DESCRIPTION	U/M	QUANTITY-PER	LATEST ECO	REF-DSGN
0000	67001020	E	RES CF 12K 1/4W 5%	EA	1.000	NEW	R22
0000	67001048	E	RES CF 220 1/4W 5%	EA	2.000	NEW	R111 ,R116
0000	67001067	E	RES CF 330K 1/4W 5%	EA	1.000	NEW	R31
0000	67001076	E	RES CF 47K 1/4W 5%	EA	1.000	NEW	R146
0000	67001090	E	RES CF 6.8K 1/4W 5%	EA	4.000	NEW	R71 ,R105 R88 ,R122
0000	67001095	E	RES CF 8.2K 1/4W 5%	EA	4.000	NEW	R73 ,R107 R90 ,R124
0000	67002045	D	RES CF 20K 1/2W 5%	EA	1.000	NEW	R128
0000	67002074	D	RES CF 470 1/2W 5%	EA	1.000	NEW	R103
0000	67002120	D	RES CF 43 1/2W 5%	EA	4.000	NEW	R76 ,R93 R110 ,R127
0000	67006003	F	RES MF 100K 1/4W 1%	EA	2.000	NEW	R99 ,R153
0000	67006014	F	RES MF 150K 1/4W 1%	EA	1.000	NEW	R133
0000	67006041	F	RES MF 30.1K 1/4W 1%	EA	3.000	NEW	R151 ,R152 R61
0000	67006053	F	RES MF 4.99K 1/4W 1%	EA	1.000	NEW	R19
0000	67006106	F	RES MF 24.9K 1/4W 1%	EA	1.000	NEW	R60
0000	67006111	F	RES MF 154K 1/4W 1%	EA	1.000	NEW	R155
0000	67019079	M	RES WW 120 3W 5%	EA	2.000	NEW	R3 ,R140
0000	72049001	A	HEADER PC MALE 26 CKT KEYED DUAL INLINE .100 CTRS	EA	1.000	NEW	J11
0000	ZCN00000		E/M E.C.O. HISTORY REV A RELEASE TO MFG JF 8/1/97	EA	REF	NEW	