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68820-M

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1000 WATT ARC LAMP POWER SUPPLY

MODEL 68820

Please read these instructions completely before operating this equipment. If there are any questions or problems regarding the use of this equipment, please contact: ORIEL INSTRUMENTS - or - the representative from whom this equipment was purchased.

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WARRANTY AND RETURNS

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I. INTRODUCTION

The Oriel Model 68820 is one of a series of constant wattage switched-mode arc lamp supplies. Its intended use is to operate 400 to 1000 watt arc lamps whose operating voltage and current ranges are between 15 - 40 volts and 20 - 50 amperes such as the following arc lamps.

The following Oriel arc lamps may be operated with the model 68820 Arc Lamp Power Supply:

MODEL NO.	DESCRIPTION	DC VOLTAGE (V)	DC CURRENT (A)
XENON ARC LAMPS			
6261	450 Xe	18	25
6262	UV450 Xe	18	25
6265	500 Xe	14-20	25-35
6269	1000 Xe	23	44
MERCURY AND MERCURY-XENON ARC LAMPS			
6239	1000 HgXe	30-38	26-33
6295	1000 HgXe(Ozone Free)	30-38	26-33
6287	1000 Hg	30-38	26-33

TABLE I.1

The power converters in these units are switched at a relatively high frequency (20 - 25 kHz). This technique yields several advantages. The high frequency ripple is easier to filter, the power components (transistor and choke) are smaller and lighter and efficiency is greatly improved. Also, the high frequency transient response is improved allowing for externally controlled lamp intensity modulation.

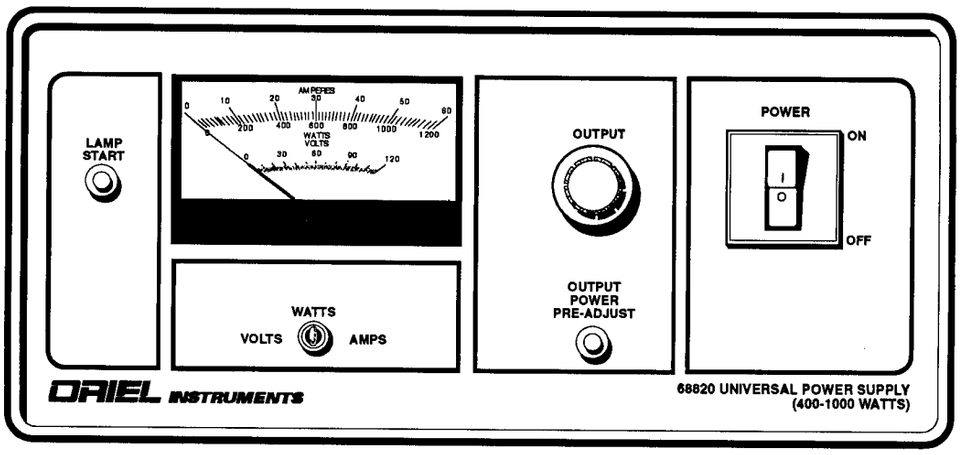
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The list of features for these units is extensive, including such items as:

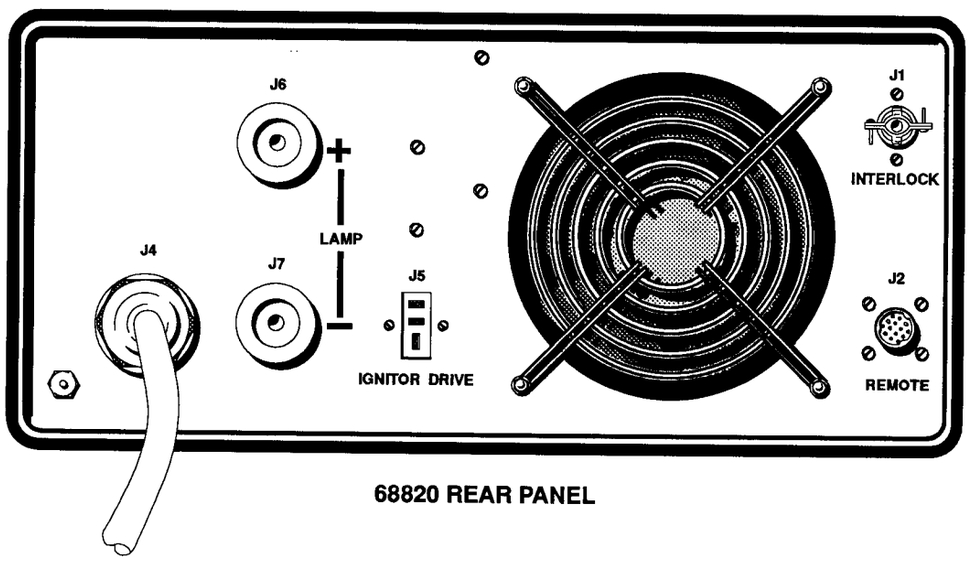
- Operation from 190 - 260 VAC, 50/60 Hz.
- Setting of lamp power prior to ignition
- Output regulation on lamp power (voltage x current)
- Direct power metering with voltage and current reading available on demand
- Intensity controller option available
- Remote metering signals are available at a rear panel connector

The packaging of this supply was done with ease of maintenance in mind. With the exception of large power components, all circuitry is located on three easily removable printed circuit cards. All internal calibration potentiometers are located at the left of the unit and are readily accessible with the top cover removed.

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68820 FRONT PANEL



68820 REAR PANEL

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II. SPECIFICATIONS

AC Power Input	190 - 260 VAC, 50/60 Hz.
DC Power Output	1200 watts maximum, 50 amperes maximum
Ripple with Ohmic Load	<0.4%RMS (40Hz to 20kHz)
Light Ripple (50/60 Hz)	< 1.0% P-P Typical
Pre-adjust Accuracy	± 2%
Power Meter Accuracy	± 1%
Stability (after 10 minute warm-up	± 0.2%
Line Regulation	± 1.0% (over total voltage excursion)
Output Current Limit	55 amperes (± 1.0)
Output Voltage	Pre-ignition, 70 VDC nominal (unloaded); 40 VDC maximum (loaded)
Boost Voltage	150 - 200 volts, applied only on lamp start

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III. CONTROLS AND FUNCTIONS

FRONT PANEL

Output Pre-adjust Switch	Momentary pushbutton switch. When depressed causes the meter to display lamp power setting prior to ignition.
Meter	Has three scales - Watts, Amperes and Volts
Watts/Volts/Amperes Switch	Three position toggle switch, spring-loaded to center position. In the center position causes the Meter to display lamp power. In the left position causes the Meter to display lamp voltage. In the right position causes the Meter to display lamp current.
Output Potentiometer	Ten turn potentiometer with friction lock. Sets lamp power.
Lamp Start Switch	Momentary push button switch. Used to ignite lamp. Ignition occurs when pressed.
Power Switch	Rocker switch. Used to apply power to the unit. Includes a "Power On" indicator lamp and the circuit breaker for the power supply.

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REAR PANEL

J1-Interlock Connector * Cinch/Jones #P302-CCT	Two pin connector for interlock cable from the lamp housing
J2-Remote Connector * Viking # TKP12-103	Pin 1 Photofeedback Control Input (12 volts max.) 2 Reference (Buffered Output Control setting) output 3 Common (ground) 4 N/C 5 Remote Start 6 N/C 7 Remote Start 8 N/C 9 Remote Meter Power Output 10 Remote Meter Current Output 11 Remote Meter Voltage Output 12 Remote Meter Common Output
J4-AC Input Connector	Three pin (grounded) power input connector
J5-Ignitor Drive Connector * Cinch/Jones #P303-CCT	Three pin (grounded) connector providing 100V P/P, 35kHz ignitor drive signals for time that the start switch is pressed
J6-Lamp + Connector *Amphenol	One pin connector providing positive voltage to the lamp anode
J7-Lamp - Connector *Amphenol #PL-259	One pin connector providing negative voltage to the lamp cathode. This is a grounded output.

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IV. SET-UP AND USE

SAFETY

There are two major areas of concern pertaining to personal safety when using this piece of equipment. The first has to do with the power supply itself and the second has to do with the lamp powered by the supply.

POWER SUPPLY

- Switch the power off and wait at least three minutes before making any connections to the rear panel. There may be dangerous voltage levels present when the power supply is on, and up to three minutes after the power supply is shut off.
- Do not ground the "+" output (J6) when the power supply is on. This may cause a spark and may damage the power supply.
- If this power supply is used with an Oriel Model 68705 stand-alone ignitor, an additional danger exists at the output of the ignitor. Always connect the cables with power off. When the "LAMP START" button is depressed, high voltage pulses of up to 30kV will be generated at the output of the ignitor. This voltage could become lethal for any person coming in contact with it.

ARC LAMP

Because of the nature of the high pressure lamps used with this supply and because of the high degree of shortwave ultraviolet radiation produced, there are several precautions that should be observed while working with these lamps. They are:

a. Read and become thoroughly familiar with any manufacturer's information supplied with individual lamps.

b. Do not look at any direct, specular (mirror) or diffuse reflections of the lamp's output beam, even for short periods of time, without the use of protective glasses or goggles.

c. Wear appropriate goggles or other protective devices when directly observing illuminated lamps.

d. Handle the lamps with extreme care. Avoid fingerprints or other contaminants which could weaken the quartz envelope.

IF OZONE FREE LAMPS ARE NOT USED, PROVIDE ENOUGH VENTILATION TO PREVENT OZONE BUILD-UP.

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INSTALLATION

Installation of the 68820 is straightforward and should not present any particular problem.

> ***< < < CAUTION > > >***
> ***BE CERTAIN THAT THE 115/230 LINE VOLTAGE SWITCH IS IN THE CORRECT POSITION BEFORE PLUGGING IN THE POWER CORD.***
> ***AVOID BLOCKING THE AIR EXHAUST PORTS AT THE SIDES AND THE AIR INTAKE FAN AT THE REAR OF THE UNIT.***

The two-wire safety interlock cable from the lamp housing should be connected to J1 on the rear panel. If the lamp housing does not have a safety interlock cable, a jumper connector must be plugged in at J1 or the power supply will not generate an output.

*Note: If the interlock system is open, the **POWER** indicator will illuminate and the fan will be driven but no pre-ignition pulses will occur after depressing the LAMP START switch. There won't be any open circuit voltage present.*

OPERATIONS

For Xenon Lamps

a. Turn on the front panel POWER switch. The POWER indicator should illuminate and the cooling fan should turn.

b. Before igniting, depress the OUTPUT PRE-ADJUST button and adjust the OUTPUT control for the desired lamp wattage as indicated on the meter. Push the meter switch to the VOLTS position and verify that a pre-ignition voltage of approximately 70 volts is available.

c. Depress the LAMP START switch for several seconds. The voltage is boosted to 150V, though you may not see this value reached if the lamp ignites. The lamp should ignite and the lamp power should regulate at the Pre-adjust level (± 2%). Adjust the OUTPUT control for the proper output power to the arc lamp, if necessary.

d. If the lamp does not ignite immediately, repeat the ignition procedure. If the lamp does not ignite after a few attempts, see the end of this section.

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For Mercury (Xenon) Lamps

a. Turn on the front panel POWER switch. The POWER indicator should illuminate and the cooling fan should turn.

b. Before igniting, depress the OUTPUT PRE-ADJUST button and adjust the OUTPUT control for the desired lamp wattage as indicate on the meter. Push the meter switch to the VOLTS position and verify that a pre-ignition voltage of approximately 70 volts is available.

c. Depress the LAMP START switch for several seconds. The voltage is boosted to 150V, though you may not see this value reached if the lamp ignites. The lamp should ignite and the lamp current should go immediately to the OVER-CURRENT limit.

d. Immediately after a proper ignition, the lamp power will be less than the pre-set wattage until the lamp begins to warm up. First the power will climb to the pre-set wattage and then the lamp current will slowly fall to its final value. Since the Output Pre-adjust is only accurate to ± 2%, it may be necessary to re-adjust the OUTPUT control for the proper output power to the arc lamp.

e. If the lamp does not ignite immediately, repeat the ignition procedure. If the lamp does not ignite after a few attempts, see the last paragraph in this section.

For Mercury Lamps

a. Turn on the front panel POWER switch. The POWER indicator should illuminate and the cooling fan should turn.

b. Before igniting, depress the OUTPUT PRE-ADJUST button and adjust the OUTPUT control for the desired lamp wattage as indicated on the meter. Push the meter switch to the VOLTS position and verify that a pre-ignition voltage of approximately 70 volts is available.

c. Depress the LAMP START switch for several seconds. The voltage is boosted to 150V, though you may not see this value reached if the lamp ignites. The lamp should ignite and the lamp current should go immediately to the over-current limit.

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d. Immediately after ignition the lamp power will be less than that selected in step b. As the lamp begins to warm up the voltage and power will rise, but current will remain at the limit until the Pre-adjust level (± 2%) is reached. At this point the power should hold constant and the lamp current should begin to fall at a fairly rapid rate.

   Final lamp current is typically 27 amperes for Model 6287 (1000W).

e. If the lamp ignites but the lamp current does not fall to a reasonable value (or wattage does not climb to the pre-adjust level), check that there is not too much cooling on the lamp.

   If the lamp does not ignite immediately, repeat the ignition procedure.

IF THE LAMP DOES NOT IGNITE AFTER A FEW ATTEMPTS, PLEASE CHECK THE FOLLOWING:

a. All lamp connections and connectors should be tight and of the correct polarity.

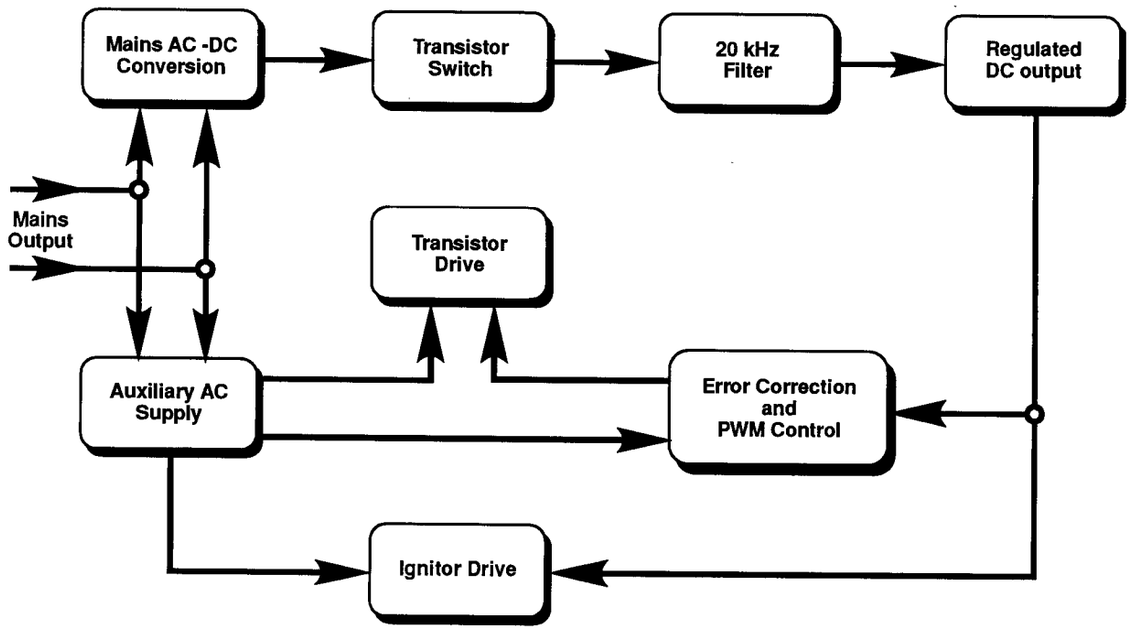
b. All exposed metal surfaces in electrical contact with either lamp terminal, such as support clamps, holders, terminal lugs, etc., should be at least 3/4 of an inch from any grounded metal surface to prevent arcing when the ignitor is in operation.

c. The LAMP START button must be pressed to apply power to the ignitor drive circuit.

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V. CIRCUIT DESCRIPTION

OVERVIEW OF THE ORIEL MODEL 68820 ARC LAMP POWER SUPPLY



The Oriel Model 68820 Power Supply is a DC-DC converter. It is a step down switching regulator operating at 20 kHz. Please refer to Figure V.1 for the block diagram of this supply.

The input mains voltage is transformer coupled, rectified to produce pulsating DC and filtered. The PWM then turns the power switch on and off at a 20 kHz rate. These high frequency pulses of current are filtered to provide a DC output to the arc lamp. Control of power output is done by the regulator board which senses output voltage and current, multiplies them and then compares the result to a reference voltage. Any deviation is an error and the control IC will adjust the PW to minimize the error of the output power. The result is a constant power output to the arc lamp.

A detailed circuit description is given on the following pages. Please refer to schematic number 68820-4-1001 and Figure V.2 when reading this section.

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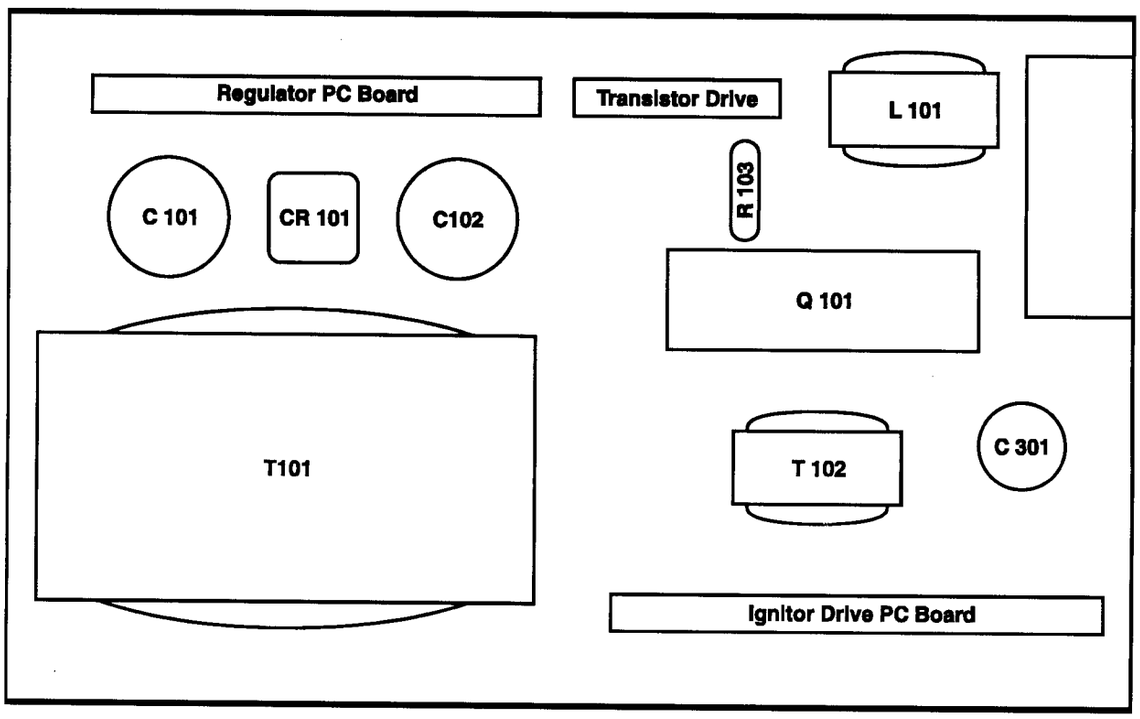


Fig. V-2 68820 Universal Power Supply Chassis Layout

MAINS AC-DC CONVERSION AND AUXILIARY POWER SUPPLY

The mains voltage is brought in via J304, at the rear panel, to the front panel power/CB switch, then to the main power transformer (T101) and to the auxiliary control panel transformer (T102). The cooling fan and connections (D) and (E) are always at 110 VAC operation.

T101 isolates and steps down the input mains so that at nominal line there will be 55 VAC on the secondary. This is rectified and filtered by CR101, C101 and C102 to provide an unregulated source of DC voltage for the main regulator circuit. At nominal line and no load, this is a 70 VDC. R101 and R102 will safely discharge C101 and C102 when the main power is off.

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The secondaries of T102 each go to the three circuit boards to provide power for the regulator PCB, the switch drive PCB, the ignitor drive and the output monitor PCB.

CR6 and C5 provide the un-regulated DC voltage for the PWM IC switches. CR7, C3, U1 and CR4, C4, U2 provide the regulated ± 15 VDC for all the ICs on the regulator PCB. The last winding of T102 provides 24 AC power for the ignitor drive and output monitoring circuit only when there is an output voltage across the output connectors (J306 and J307).

SWITCHING TRANSISTOR AND RELATED DRIVE CIRCUIT

The constant frequency variable PW output of the regulator IC is transformer coupled to this PCB by T601 and T602. Since there are two output pulses per period, they are summed by Q603 and Q604 to provide a greater than 50% adjustment of duty cycle. This summed pulse controls Q602 which turns on only when both Q603 and Q604 are off. When Q602 turns on, base drive to Q601 is removed turning the Q601 off which in turn shuts the main switching transistor off. A -5V, 1 amp reverse current is also available to assist in the rapid turn off of Q601. When Q602 is off, Q601 turns on and biases Q101 into conduction.

The variable PW controls the on time of Q101 which applies more or less current to the filter circuit thereby changing the average value of the output. During the time that Q101 is off, L101 reverses polarity and CR102 maintains current flow around the filter loop.

< < < < < CAUTION > > > > >

The +18V, +9V and -5V supplies on this PCB are referenced to the emitter of Q101. Do not connect a grounded oscilloscope probe or a grounding wire to this emitter reference. Only a safely isolated scope or meter should be connected here in order to make measurements on this PCB.

HF FILTERING

The high current constant frequency and variable PW pulses are applied to the low pass LC filter combination of L101 and C301. These components average the current pulses to provide a filtered DC output to the load.

ERROR FEEDBACK AND PWM CONTROL

PWM is performed on the regulator card. The output voltage is sensed directly by divider R27 and R33 and the load current is sensed through the paralleled current sense resistors R103 and R103a which is amplified by U3. These scaled voltage and current outputs are applied to U5 for multiplication. The output is a representation of output power and is compared with a reference set by front panel pot R201 at U7. Any deviation from the reference is amplified within U7 and modulates the PW of the output transistors of U7. This modulated signal is transformer coupled to the transistor drive board.

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The current sense signal is also amplified by U4 which then limits the maximum output current by controlling the maximum PW out of U7. As a secondary protection, the output of U4 also controls Q6 which will reduce output power by decreasing the reference level when Q6 is biased into conduction.

A tertiary over current protection shuts the regulator IC if a short circuit condition exists. Resistive divider R1 and R2 bias Q2 on when a voltage exists across the output of the power supply. At the same time a portion of the amplified output of the current sense amplifier (U3) exists at the ten volt zener (CR1). When a short circuit condition exists there will not be any voltage, therefore Q2 turns off. Also, the output of U3 will be at maximum (less than 14 volts) and the zener will break down and conduct current to the gate of the SCR (Q3). Once a gate signal is present, Q3 conducts and latches thereby removing bias from Q4 which turns off. With Q2 off, the shutdown control at pin 10 of U7 goes to a high level and shuts off the outputs of the regulator IC. The only way of re-starting the power supply is to shut the main power switch (CB201) off and then turn it on again.

The interlock circuitry performs the same way via CR13 and R13. If no interlock is present, pin 10 of U7 is at a high level. When the interlock is connected at J301, CR13 is reverse biased and pin 10 of U7 is at a low state which turns on the output of the regulator IC.

IC U6 buffers the internal reference so that it can be applied to the power meter for a pre-set adjustment or for use by an external accessory via J302.

IGNITOR DRIVE AND OUTPUT MONITOR CIRCUIT

The ignitor drive PCB contains circuitry to generate the 25kHz square wave required by the ignitor. It is a self oscillating invertor which starts when relay K401 energizes at an open circuit voltage of 40 volts or more. Relay contact K401-1 is closed and the start switch is pressed to apply 24 VAC to rectifier CR401. The filtered output is used by R401 to slightly bias Q401 into conduction.

Q401 goes into conduction more and more until T401 saturates. At saturation, Q401's collector current increases at the limit set by the beta of the transistor and input voltage. This limits collector current to one ampere. Since di/dt is removed from T401, Q401 shuts off due to lack of base drive. The flyback voltage is of the correct polarity to bias Q402 into conduction and the action repeats but of opposite polarity. The result will be a two to one unregulated step up on T401's secondary. This is nominally a 100V P-P square wave @ 30 kHz. This square wave is connected to the ignitor via J401 on the rear panel.

The SENSE CIRCUIT consisting of an op-amp (U401), divider resistors and Q403 monitor the output voltage for the low voltage condition which is normal operation during the starting cycle of the arc lamp. Before starting, the lamp is at open circuit voltage. Therefore, the comparator (U401) turns on Q403 with no load applied across the output. With Q403 on, relay K401 is energized and contacts K401-1 are closed to allow the AC voltage to be connected to the ignitor drive circuit. This is also connected to a capacitive multiplier to provide the boost voltage during the start phase of the lamp.

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VI. CALIBRATION PROCEDURE

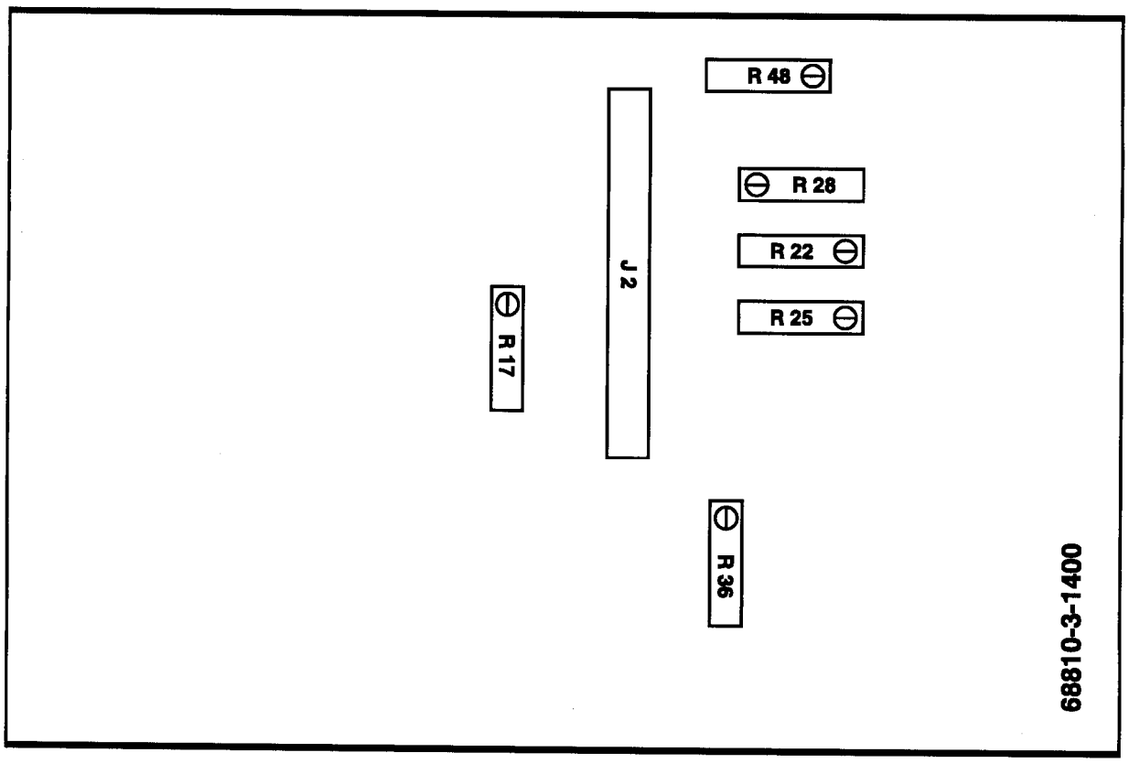


Fig. VI-1 PWM Control PC Board Potentiometer Layout

Calibration of the power supply should be performed by qualified personnel. It should be performed if the regulator PC board (68820-3-1400) is replaced. Please refer to Figure VI.1 for the adjustment potentiometer layout.

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REQUIRED TEST EQUIPMENT

60 Ampere Ammeter

200 Volt Voltmeter

0.5 Ω, 1000 watt power resistor

0.3 Ω, 1000 watt power resistor

INITIAL CONDITIONS

Before applying an AC power to the power supply, set the controls listed below to the specified settings. Please refer to Figure VI.1 for the potentiometer layout.
NOTE: The PC card mounted potentiometers are 20 turns or more, end to end.

No.	Name	Location	Setting
R201	Output Adjust	Front Panel	Full CW
R17	E Meter Adjust	Regulator Card	Full CW
R22	I Limit Adjust	Regulator Card	Full CW
R25	I Meter Adjust	Regulator Card	Full CW
R28	I Gain Adjust	Regulator Card	Full CW
R36	Multiplier Offset	Regulator Card	Full CW
F48	P Meter Adjust	Regulator Card	Full CW

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OPEN CIRCUIT TEST

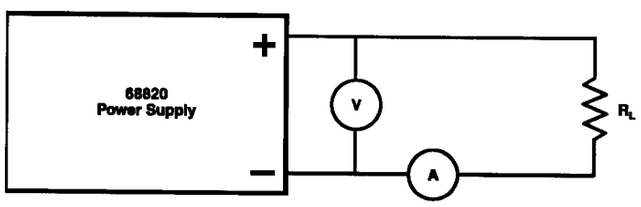
These test will insure that the proper voltages and preliminary setting will be correct.

1. Remove the interlock plug from J301 at the rear panel, plug the unit into the mains source and place the power switch on. The internal lamp in the power switch should turn on and the fan should be operating. There should not be any output voltage present.

2. Adjust R36 (Multiplier Offset) so that the power meter shows zero (0) power. Press and hold in the Output Pre-adjust switch and adjust R48 (P meter) for a full scale reading of 1200 watts. Adjust the Output Adjust (R201) potentiometer for a reading of 600 watts. Release the Output Pre-adjust switch.

3. Install the interlock plug into J301. There should be an output voltage of 70 volts DC or more. If necessary, trim R36 to display 0 output power. Shut the power supply off.

LOAD TEST AT 0.5Ω



1. Before beginning this test, connect the power supply, the meters and the load resistor as shown.

2. Turn on the power supply which should display 600 watts immediately after turn on.

3. Observe the external test meters and adjust R28 (I gain) for a true output of 600 watts.

4. Set the output to 1000 watts with the front panel Output Adjust control. Adjust R28 (I gain) for a true output of 1000 watts.

5. Set the output to 350 watts and trim R36 - MULTIPLIER ZERO - to output and display 350 watts. Continue to adjust the output, alternating between 350 and 1000 watts, trimming R36 for 350 watts and R28 for 1000 watts until the actual output is 2% of the displayed output.

6. Set the output voltage to 20 volts and adjust R17 (E meter) so that the front panel meter reads 20 volts when the volts-power-amps switch is in the volts position.

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7. Set the output current to 40 amps and adjust R25 (I meter) so that the front panel meter reads 40 amps when the volts-power-amps switch is in the amps position.

8. Set the output power to maximum and adjust R22 (I limit) so that the output power is reduced by 1.0 watt.

9. Turn the power supply off and replace the 0.5Ω resistor with the 0.37Ω resistor. Turn the power back on and adjust R22 (I limit) for a maximum output current of 55 amperes. At loads of less than 0.37Ω impedance the short circuit protection circuit disables the output. If this occurs, turn the power supply off and then on again to reset the circuit.

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VII. TROUBLESHOOTING

A careful reading of the circuit description should be done before attempting any repairs or adjustments. The information given in this section is based on prototype and reliability testing and is general in nature. Troubleshooting should be performed by qualified electronic service personnel. Careful use of test equipment or tools must be done especially when testing the high power section or the switching transistor drive PCB.

>>>>> WARNING <<<<<

Potentially lethal voltages exist in the power supply when power is applied and for a few minutes after power is removed. Extreme care should be taken when working within or near the power supply whenever the cover is removed.

If a problem exists with the power supply, a visual inspection of all components and wiring should be made. Inspect for obviously damaged or broken components before proceeding with power for testing of the power supply. Below are some items to check and their expected signals. For most of the troubleshooting, an oscilloscope is a necessary piece of test equipment. **Please exercise caution when testing the transistor drive board because it is not referenced to ground. It is referenced to the emitter of q101 and is therefore floating at the dc supply voltage.**

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LOW VOLTAGE AUXILIARY SUPPLIES

Measurement Point (referenced to ground)	Expected Signal	Probable Cause
U7-15	+ 18VDC	CR6
U7-16	+ 5VDC	U7
U6-4	- 15VDC	U2
U6-7	+ 15VDC	U1

For the next three measurements, use an isolated oscilloscope if that is the instrument being used. Use J1-2 as reference.

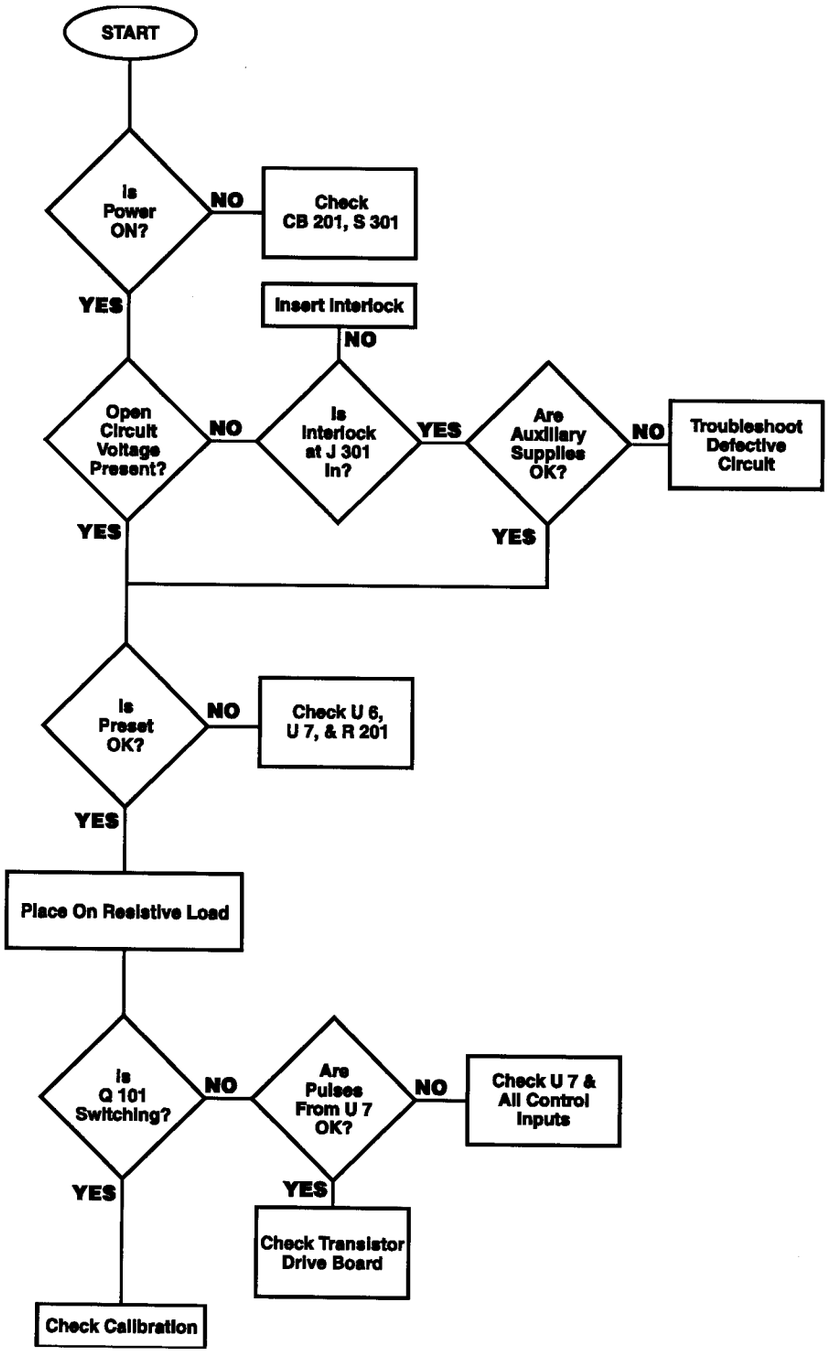
R602-Positive side	+ 18V	R602,Q601,CR601 CR605,Q602
Q602-C	+ 9V	Q601,Q602,CR601 CR605
Q604-E	- 5V	Q602,CR605,CR602 Q604,Q603

If any of the above voltages are missing, check the auxiliary power supplies transformer for the proper AC voltages.

The following flow chart, Figure VII-1, will serve as a starting point for the repair of the power supply. Please observe all cautions previously mentioned. A qualified electronics technician should perform the troubleshooting and repair.

If the lamp does not start, the ignitor drive and the ignitor should be checked for proper operation. Please refer to the related documentation for the circuit diagrams and descriptions.

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VIII. DRAWINGS

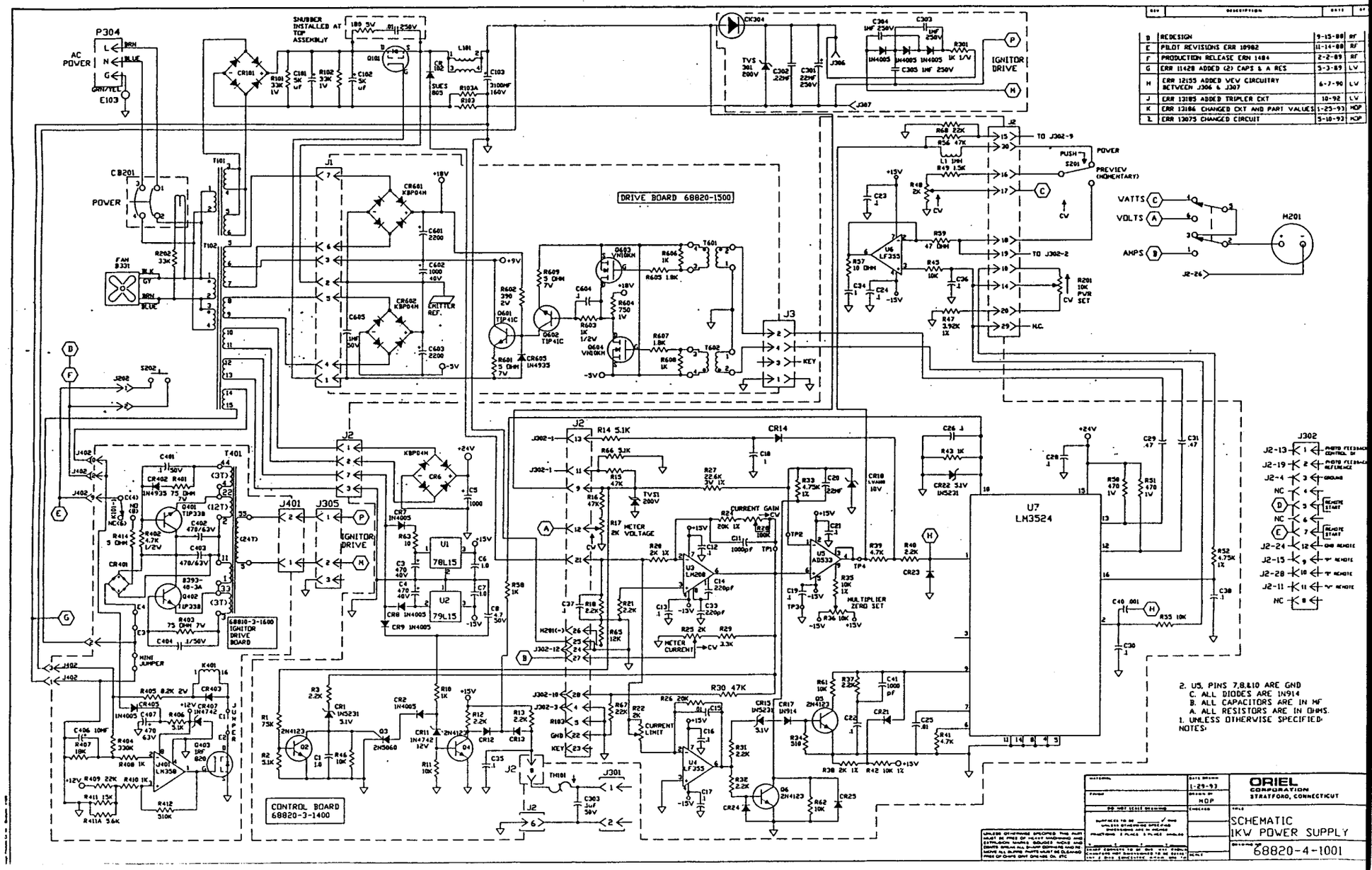
The following drawings are included with this manual:

Schematic

68820-4-1001 Power Supply

Parts Lists: available upon request.

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B	REDESIGN	9-15-88	RF
E	PILOT REVISIONS ERR 10982	11-14-88	RF
F	PRODUCTION RELEASE ERN 1484	2-2-89	RF
G	ERR 11428 ADDED (2) CAPS & A RES	5-3-89	LV
H	ERR 12155 ADDED VCV CIRCUITRY BETWEEN J306 & J307	6-7-90	LV
J	ERR 12183 ADDED TRIPLER CKT	10-92	LV
K	ERR 12184 CHANGED CKT AND PART VALUES	1-25-93	MDP
L	ERR 13075 CHANGED CIRCUIT	5-10-93	MDP

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WARRANTY AND RETURNS

WARRANTY

Oriel Instruments warrants that all goods described in this manual (except consumables such as lamps, bulbs, filters, ellipses, etc.) shall be free from defects in material and workmanship. Such defects must become apparent within the following period:

1. All products described here, except spare and repaired parts: one (1) year or 3000 hours of operation, whichever comes first, after delivery of the goods to buyer.

2. Spare parts: ninety (90) days after delivery of goods to buyer.

3. Repaired items: ninety (90) days after delivery of goods to buyer.

Oriel Instruments' liability under this warranty is limited to the adjustment, repair and/or replacement of the defective part(s). During the above listed warranty period, Oriel Instruments shall provide all materials to accomplish the repaired adjustment, repair or replacement. Oriel Instruments shall provide the labor required during the above listed warranty period to adjust, repair and/or replace the defective goods at no cost to the buyer ONLY IF the defective goods are returned, freight prepaid, to an Oriel Instruments designated facility.

Oriel Instruments shall be relieved of all obligations and liability under this warranty if:

1. The user operates the device with any accessory, equipment or part not specifically approved or manufactured or specified by Oriel Instruments unless buyer furnishes reasonable evidence that such installations were not a cause of the defect.

2. The goods are not operated or maintained in accordance with Oriel's instructions and specifications.

3. The goods have been repaired, altered or modified by other than Oriel authorized personnel.

4. Buyer does not return the defective goods, freight prepaid, to an Oriel repair facility within the applicable warranty period.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY SHALL REPLACE ALL WARRANTIES OF FITNESS AND MERCHANTABILITY. BUYER HEREBY WAIVES ALL OTHER WARRANTIES, GUARANTIES, CONDITIONS OR LIABILITIES, EXPRESSED OR IMPLIED, ARISING BY LAW OR OTHERWISE, WHETHER OR NOT OCCASIONED BY ORIEL'S NEGLIGENCE.

This warranty shall not be extended, altered or varied except by a written document signed by both parties. If any portion of this agreement is invalidated, the remainder of the agreement shall remain in full force and effect.

CONSEQUENTIAL DAMAGES -

Oriel Instruments shall not be responsible for consequential damages resulting from misfunctions or malfunctions of the goods described in this manual. Oriel's total responsibility is limited to repairing or replacing the misfunctioning or malfunctioning goods under the terms and conditions of the above described warranty.

INSURANCE -

Persons receiving goods for demonstrations, demo loan, temporary use or in any manner in which title is not transferred from Oriel, shall assume full responsibility for any and all damage to the goods while they are in their care, custody and control. If damage occurs which is unrelated to the proper and warranted use and performance of the goods, then the recipient of the goods accepts full responsibility for restoring the goods to their condition upon original delivery, and for assuming all costs and charges.

RETURNS

Before returning equipment to Oriel for repair, please call the Customer Service Department at (203) 377-8282. Have your purchase order number available before calling Oriel. The Customer Service Representative will give you a Return Material Authorization number (RMA). Having an RMA will shorten the time required for the repair, because it ensures that your equipment will be properly processed. Write the RMA on the returned equipment's box. Equipment returned without a RMA may be rejected by the Oriel Receiving Department. Equipment returned under warranty will be returned with no charge for the repair or shipping. Oriel will notify you of the cost of repairs not covered by warranty before starting out of warranty repairs.

Please return equipment in the original (or equivalent) packaging. You will be responsible for damage incurred from inadequate packaging, if the original packaging is not used.

Include the cables, connector caps and antistatic materials sent and/or used with the equipment, so that Oriel can verify correct operation of these accessories.

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