Spellman

High Voltage Electronics Corporation

Advancing High Voltage Technology for Tomorrow's Applications

Instructional Manual

RHR SERIES

High Voltage Power Supply

Model:	RHR30PN30
Serial #:	
Date:	05/01/00

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SAFETY

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.

OBSERVE EXTREME CAUTION WHEN WORKING WITH THIS EQUIPMENT.

High voltage power supplies must always be properly grounded.

Do not touch connections unless equipment is off
and the capacitance of both load and power supply is discharged.

Allow two minutes for discharge of internal capacitance of power supply.

Do not ground yourself or work under wet or damp conditions.

SERVICING SAFETY

Maintenance may require removing the instrument cover with the power on.

Servicing should be done only by qualified personnel aware of the electrical hazards.

WARNING notes in the text call attention to hazards in operation of these units
that could lead to possible injury or death.

CAUTION notes in the text indicate procedures to be followed
to avoid possible damage to equipment.

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Chapter 1

INTRODUCTION

1.1 DESCRIPTION OF THE RHR SERIES

The Spellman RHR series of high voltage power supplies provides continuously adjustable, well-regulated high voltage direct current. The DC output voltage is continuously adjustable from zero to the maximum rated voltage via a front panel ten turn locking potentiometer. All models are protected against damage from overload, short circuit, and arc over. These high voltage power supplies have 0.01% regulation, 0.02% ripple, and rapid recovery from line and load transients. Units can be ordered with positive (P), negative (N), or reversible (PN) polarity high voltage output. The supplies operate from a standard 115 Volt AC line and are fan cooled. Other line voltages are available. Additional options are listed in Table 1.1 and described in Section 5. Custom designed units to meet special needs are also available.

The RHR series is an all silicon solid state design employing a high frequency sine wave oscillator which is rectified to produce high voltage DC output. The units produce low conducted and radiated EMI. Standard units have current limit protection at 110% of the rated current.

A three year warranty applies to standard RHR units and a one year warranty to custom RHR units.

1.2 RHR SPECIFICATIONS

Output Voltage: Continuously adjustable over the entire range from zero to rated voltage by means of a ten-turn potentiometer which gives resolution of 500 ppm. Finer resolution is available on special order.

Input Voltage: 105-125 Volts AC, 50-60 Hz, single phase. Other input Voltages are available on request. See Section 5-17.

Load Regulation: 0.01% +1 Volt, for full load change.

Line Regulation: ±0.01% +1 Volt, for ±10% change.

Ripple: 0.02% + 2 volts RMS; 0.1% RMS on 100 KV models and above.

Polarity: Positive, Negative, and Reversible polarity with respect to ground are available.

Stability: 0.02% + 2 volts per hour.
0.05% + 5 volts per eight hours.

Temperature Coefficient (per °C):
0.02% + 2 volts

Temperature Range:
Operating: -20°C to +55°C.
Storage: -40°C to +85°C.

Controls: AC ON Toggle Switch. AC ON Indicator. Output adjustment is a ten-turn potentiometer with locking read-out dial.

Metering: Single range voltmeter, 2% accuracy. Single range ammeter, 2% accuracy.

Output Cable: All models up to 120 KV DC are provided with a ten foot shielded high voltage output cable. The cables are designed with a plug arrangement so that they can be easily removed from the mating receptacle located on the rear of the power supply.

Current Limit: The Current Limit feature is standard on all models. This feature automatically limits the load current to approximately 110% of the rated load regardless of the overload imposed upon the power supply. The power supply continues to operate under an overload condition, including a short circuit, by automatically reducing the output voltage as required to maintain the current limit. The unit is self-restoring to its normal operating level when the overload condition is removed.

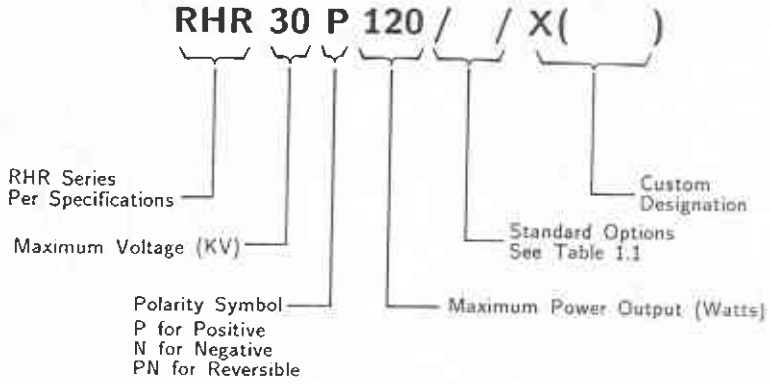
1.3 OPTIONS

The options available are listed in Table 1.1. See Section 5 for more information on these options along with operating and set-up instructions. With few exceptions, these options and modifications can be retrofitted to your power supply at the factory in a short time. For price and retrofit arrangements, contact the Spellman Sales Department.

1.4 INTERPRETING THE MODEL NUMBER

The model number of the power supply describes its capabilities. After the series name is (1) the maximum voltage (in KV), (2) the polarity of the unit - positive (P), negative (N), or reversible (PN), (3) the maximum output (in watts), and (4) the option codes for all options that are included. Custom units have an X number after the option codes.

HOW TO READ THE MODEL NUMBER:



CODE	OPTION	FUNCTION
CL(x)	Current Limit	CL(x) automatically limits load current to x milliamps. Output restores to normal operation when overload is removed. 110% current limit is standard on all units. The option code is needed only for other limits.
ACP	Adjustable Current Protection	ACP provides a one-turn front panel pot to continuously adjust current limit.
OL,OL(x)	Overload Tripout	When current exceeds 110% of rated load (if OL) or x milliamps (if OL(x)), high voltage output shuts off. Unit must be manually reset with front panel power switch.
OL/ACP	Adjustable Overload Tripout	Units equipped with both OL and ACP allow the user to set the current trip point with a front panel pot. Unit must be manually reset with front panel power switch.
CR	Current Regulation	This option provides both current and voltage regulation with automatic crossover. Output current is adjustable from 0 to rated load with a 10-turn front panel pot. Units that have remote programming will allow remote current control.
RVC,RVC(V)	Remote Voltage Programming	High voltage output can be controlled by an external low voltage DC signal. 0 to 6 VDC programming gives 0 to full rated voltage output. 0 to V volts programming available, for V between 6 and 250 VDC.
RC	Remote Resistance Programming	High voltage output can be controlled by an external potentiometer.
TP	Remote Monitor Terminals (Test Points)	Remote monitoring of voltage and current is provided at BNC connectors on the rear of the unit. Voltage scale: 1 volt = full output voltage. Current scale: 0.1 volts = 1 milliAmp. Other scales available.
GR	Ground Reference	Allows ground referencing of external programming when using Remote Voltage Programming (RVC) or Remote Monitor Terminals (TP).
F(KV)	Focus Tap	An additional high voltage output of up to 30 KV DC, with a separate front panel control, is built into the power supply. Units with remote programming will also have remote focus voltage control. Multiple focus taps are available.
RCP	Remote Control Panel	A remote control panel is supplied with 15 feet of shielded interconnection cable. Other lengths of interconnection cable are available. RCP is standard on all units over 120 KV DC output.
BPM/BPS	Bi-polar Operation	Any model power supply can be used as a master for tracking control of the equivalent opposite polarity model.
FG	Floating Ground	This option isolates the common ground of the power supply with respect to chassis (earth) ground by 80 volts maximum. The floating ground connection is provided on a 5 way binding post on the rear of the unit.
FGLL	Floating Ground - Low Leakage	Same as FG option, except maximum leakage current through floating ground monitor is 10 nanoAmperes.
TLC	True Load Current	Provides a very accurate reading of load current by eliminating the 100 microAmp offset from the internal voltage divider.
SS,SS(x)	Slow Start	The output voltage of the power supply rises gradually after turn on to operating voltage. A specific rise time (x) can be specified in seconds.
IC EI	Inhibit Circuit External Interlock	A 5V DC signal is required to enable the high voltage output. Interlock connections are provided for connection to an external switch. The unit will not operate unless the interlock circuit is closed.
EAR	External Alarm Relay	Rear panel relay contacts are closed whenever unit is in current limit (CL) or overload tripout (OL) mode.
(xxx)	Alternate Input Voltage	115 volts input is standard. 100V, 220V, and other input voltages available.
FPR	Front Panel Reversibility	A front panel switch is provided to switch output voltage polarity on units with output between 0 and 25KV.
LL(ft)	Extra Length Output Cable	Standard output cable is 10 feet of shielded high voltage cable. Other lengths may be ordered.
C	Bench Cabinet	A bench size 22" by 18" cabinet with carrying handles (blue with gray). Height varies with unit ordered.

Table 1-1
Options for RHR Power Supplies

Chapter 2

INSPECTION & INSTALLATION

Initial inspection and preliminary checkout procedures are recommended. For safe operation, please follow the step-by-step procedures described in this chapter and in Chapter 3, Operating Instructions.

2.1 INITIAL INSPECTION

Inspect the package exterior for evidence of damage due to handling in transit. Notify the carrier and Spellman immediately if damage is evident. Do not destroy or remove any of the packing material used in a damaged shipment.

After unpacking, inspect the panel and chassis for visible damage.

Fill out and mail the Warranty Registration card accompanying the unit. Standard Spellman RHR high voltage power supplies and components are covered by a three year warranty. Custom and special order models (with an X suffix in the model number) have a one year warranty.

2.2 MECHANICAL INSTALLATION

Units in the RHR series have front panel holes for standard EIA rack mounting. The rack must allow rear access for cable connections. Units are fully enclosed and are suitable for bench or table top operation.

Standard unit dimensions are shown in Figures 2.1 and 2.2. Higher power units (200 to 500 Watts) are supplied as two or three separate chassis. See Figures 2.3 and 2.4.

See Section 3.2 for installation instructions for units with reversible polarity

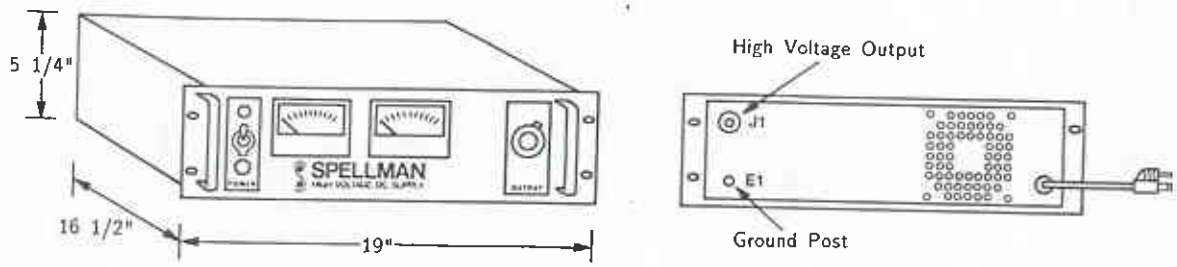


Figure 2-1
Dimensions of Units 5 to 60 KV, up to 150 Watts

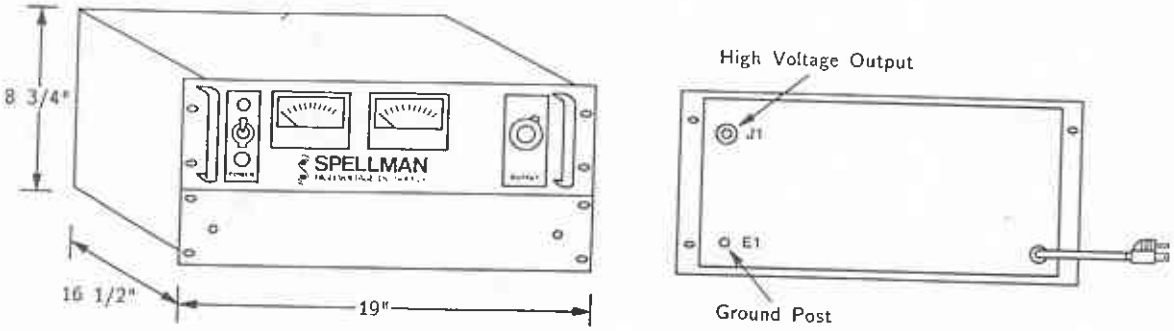


Figure 2-2
Dimensions of Units 80 to 100 KV, up to 150 Watts

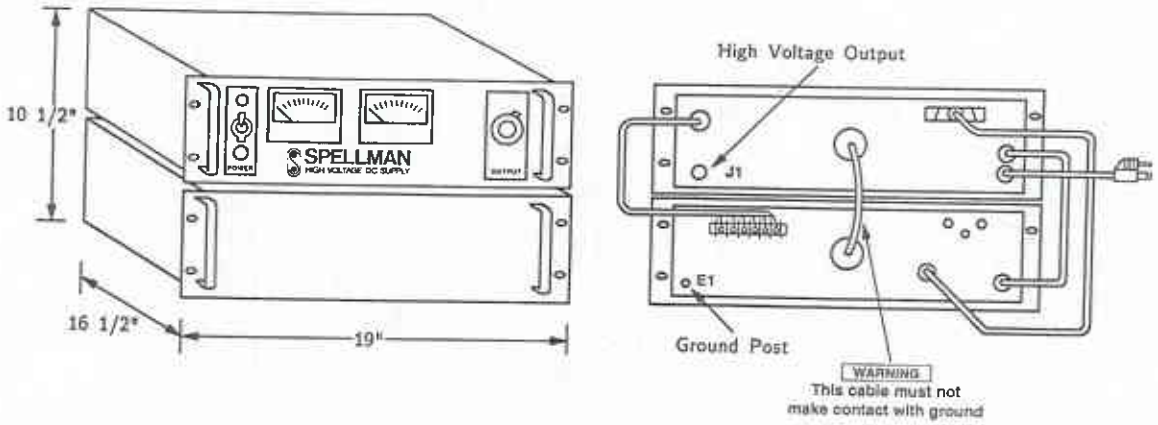


Figure 2-3
Dimensions of 200W to 250W Units

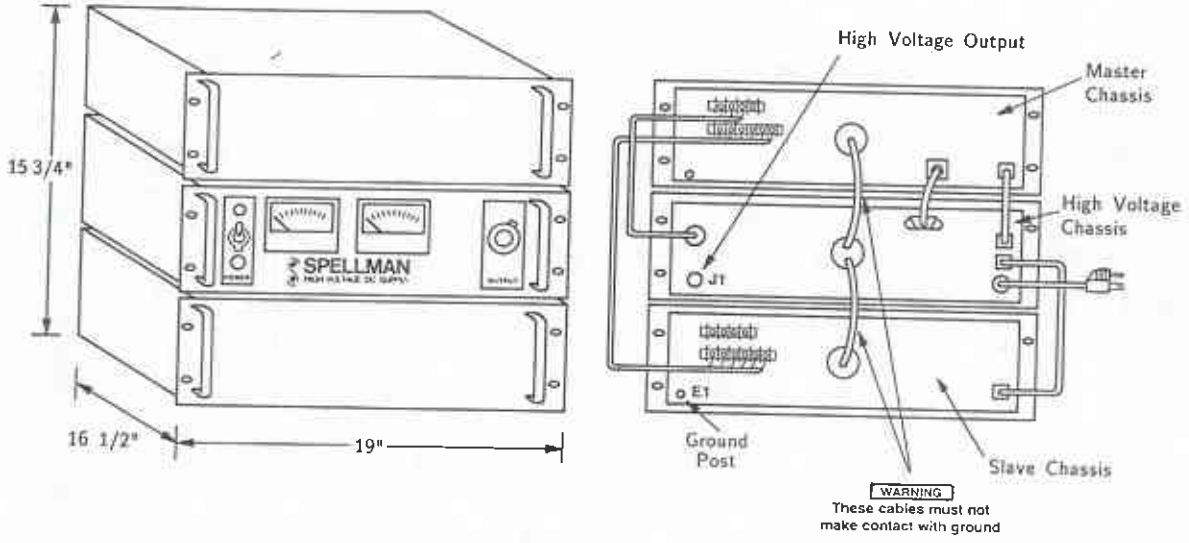


Figure 2-4
Dimensions of 300W to 500W Units

2.3 SEPARATE AIR MULTIPLIER STACKS

Units with maximum rated output greater than 120 KV come with a separate high voltage air multiplier stack (Figure 2.5). A remote control panel is standard on power supplies over 120 KV. Units up to 150 Watts have one 5 1/4" chassis. Units above 150 Watts have two 5 1/4" chassis.

Connect the high frequency high voltage output on the top or back of the driver to the base of the stack, using the high voltage cable provided. Connect the grounding screw on the base of the stack to the ground binding post on the rear of the power supply chassis. The high voltage output connection is made at the toroid at the top of the stack. No high voltage output cable is provided with these units. Consult factory for specific installation instructions.

WARNING

High voltage stacks should always be installed in enclosed safety areas to prevent injury to personnel. The recommended safety clearance is approximately one foot per 50 KV.

2.4 REMOTE CONTROL PANEL

A remote control panel is standard on units over 120 KV. A remote control panel is available as an option (RCP) on all models. The remote control panel is similar to a standard front panel and includes all operational controls and meters.

The remote control panel should be securely mounted using four screws. There must be a clearance of 2 inches behind the panel for the instrumentation. Connect the 15 foot interconnection cable to the connector on the rear of the power supply chassis. The unit is plugged into the AC line directly from the remote panel.

2.5 CONTROLS AND CONNECTORS

Standard front and rear panel controls and connectors are shown in Figure 2.6. Units with options may have additional controls and connectors. The options are described in Section 5.

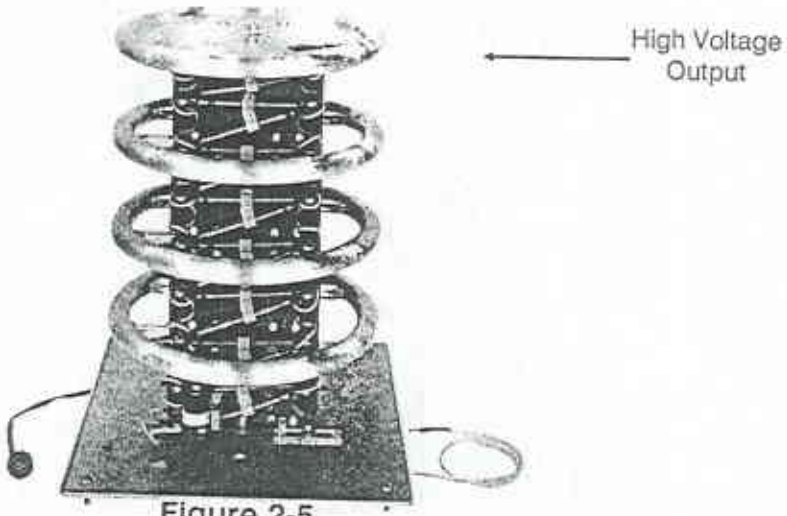
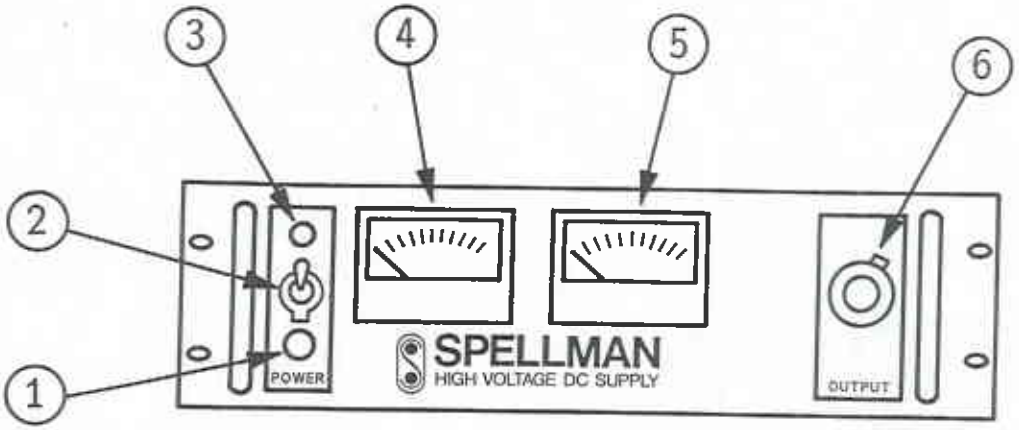
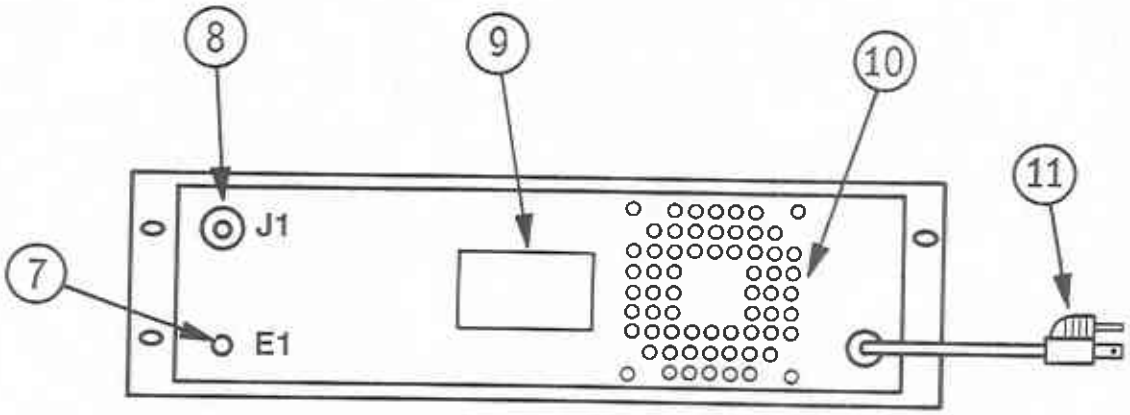


Figure 2-5
Typical Air Multiplier Stack



Front View



Rear View

Front Panel

1. Fuse
2. ON/OFF Switch
3. Pilot Light
4. Ammeter
5. Voltmeter
6. High Voltage Control Knob

Rear panel

7. Ground Binding Post E1
8. High Voltage Output Connector J1
9. Model and Serial No. plate
10. Fan Vent (do not obstruct)
11. AC line cord

Optional controls and connectors not shown in the photographs above may include:

BNC connectors for TP option
BNC connectors for BPM/BPS and IC
Focus Voltage Output Connector
Terminal Block for RVC and RC option
Remote Control Panel Connector
Five Way Binding Post for FG option

Figure 2-6
Controls and Connectors

Chapter 3

OPERATING INSTRUCTIONS

3.1 OPERATION

WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL.

PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.

IMPORTANT

BEFORE PLUGGING IN THE POWER SUPPLY, FOLLOW THIS STEP BY STEP PROCEDURE.

DO NOT CONNECT THE POWER SUPPLY TO THE AC LINE UNTIL STEP H IS REACHED.

Failure to follow these procedures may void the warranty.

A) Set the POWER switch to the OFF position.

B) Check the input voltage rating on the nameplate of the supply and make certain that this is the rating of the available power source. Spellman RHR units operate on 115 VAC, unless ordered with a different input voltage.

C) **PROPER GROUNDING TECHNIQUE:** The chassis of high voltage power supplies must be grounded, preferably to a water system ground or other earth ground using the ground binding post at the rear of the unit. See Figure 3.1 for a typical operating set-up.

The return line from the load should be connected to the ground binding post on the rear of the power supply. Using a separate external ground at the load is not recommended.

A three prong grounded wire is provided for connecting to the AC supply. If a grounded receptacle is not available, use an adapter and connect the third wire to a good ground.

D) Attach the output cable to the load.

E) On models up to 120 KV, plug the high-voltage output cable provided with the unit into the rear of the supply and hand tighten the knurled collar.

Models rated over 120 KV have a separate air multiplier stack (Section 3.3) and a remote control panel (Section 2.4).

F) **OPTIONS NOTE:** See Section 5 for hook-up and operating instructions for the options on your unit. Options RVC, RC, F, TP, BPM/BPS, FG, IC, and EI require special wiring or set-up considerations. Custom models may also require set-up changes.

G) For initial turn-on, rotate the OUTPUT VOLTAGE control fully counter-clockwise to the zero voltage position.

H) The input power cable may now be plugged into the AC power line.

I) Turn POWER switch ON. The pilot light should light up.

J) Rotate the OUTPUT VOLTAGE control clockwise until the voltmeter indicates the desired output voltage.

WARNING

AFTER TURNOFF, DO NOT HANDLE THE LOAD UNTIL THE CAPACITANCE HAS BEEN DISCHARGED!

LOAD CAPACITANCE MAY BE DISCHARGED BY SHORTING TO GROUND.

WARNING

The voltmeter on the power supply front panel does not read the output voltage when the unit is turned off, even if a charge still exists on the load.

CAUTION

Always operate the unit with the cover on.

A fan maintains safe operating temperature in the power supply by drawing air over the circuit components. The cover must be on in order to direct the air flow over the areas that need cooling. In operation the unit must be placed so that the air intake and the fan exhaust are clear of any obstruction that might impede the flow of air.

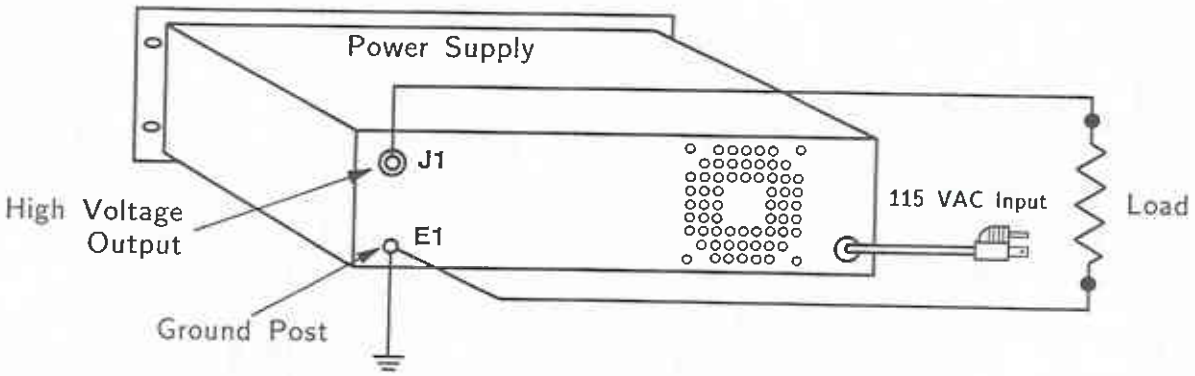


Figure 3-1
Typical Operating Setup

3.2 REVERSIBLE POLARITY

Reversible polarity units are indicated by a PN in the model number.

3.2.1 Models up to 30 KV and 120 Watts

WARNING

TURN POWER OFF BEFORE CHANGING POLARITY!!

Be sure internal and load capacitance are discharged.

On models up to 30 KV and 120 Watts, polarity is reversed inside the chassis (Figure 3.2). Open the top cover. The operating polarity is identified by appropriate labels on the high voltage assembly. The high voltage assembly (1) is fastened to the chassis with heavy duty retaining clips (2). For shipping purposes, this assembly is secured to the clips by plastic cable ties (3). These ties must be removed before reversing the polarity. [During transportation, these ties must be reinstalled to hold the reversing high voltage assembly in place.] Unsnap the connectors (4) from the two ends of the assembly, lift the assembly out of the lower retainer clip, and finally pull it away from the upper clip. The assembly should now be free. Turn the assembly over and replace it in the retainer clips. Attach it by reversing the procedure used for removal. Snap the high voltage connectors back onto the assembly and screw the cover back down onto the unit.

CAUTION

Never operate the power supply for more than five minutes without the cover in place. This is important for proper cooling.

If the Front Panel Reversibility (FPR) option is selected, an optional front panel switch is provided to switch the output polarity through a high voltage relay. (This option is available only for models up to 25 KV).

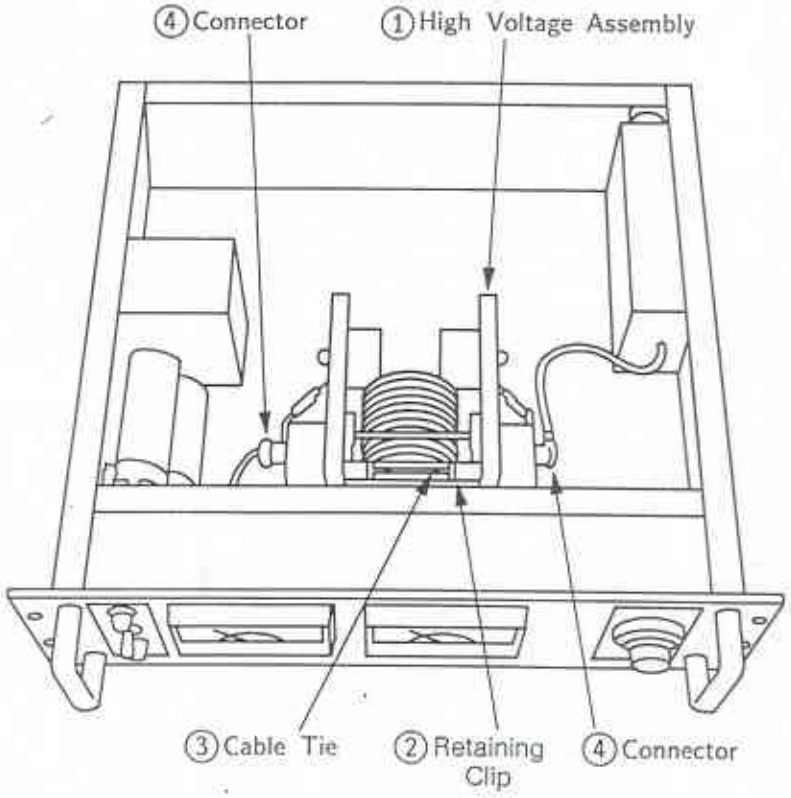


Figure 3-2
Reversing Polarity in Low Power Units

3.2.2 Models 40 to 100 KV, 0 to 150 Watts

WARNING

TURN POWER OFF BEFORE CHANGING POLARITY!!

Be sure internal and load capacitance are discharged.

On models generating 40 to 100 KV, 0 to 150 Watts, the polarity is reversed by interchanging the leads in the plug-receptacle unit located at the high voltage assembly in the front of the unit. Remove the lower front panel to gain access to the leads (see Figure 3.3). The plugs are identified so that polarity is easily determined.

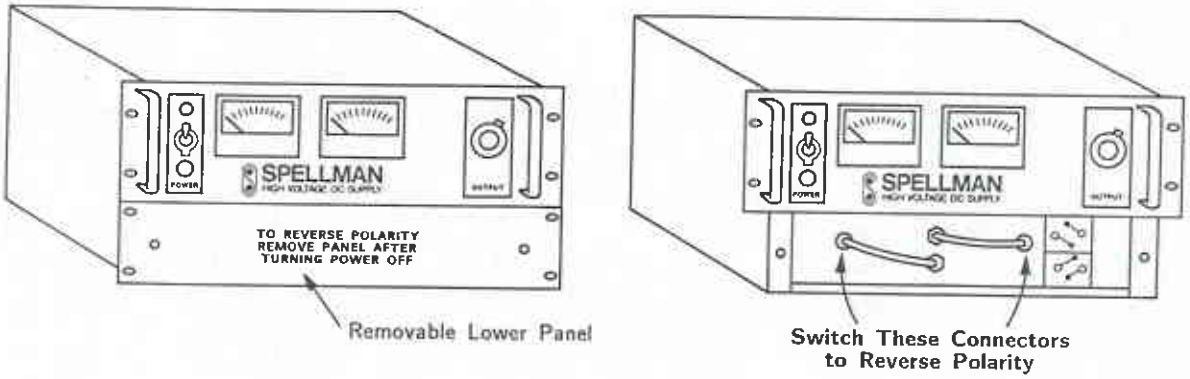


Figure 3-3
Reversing Polarity via Removable Front Panel

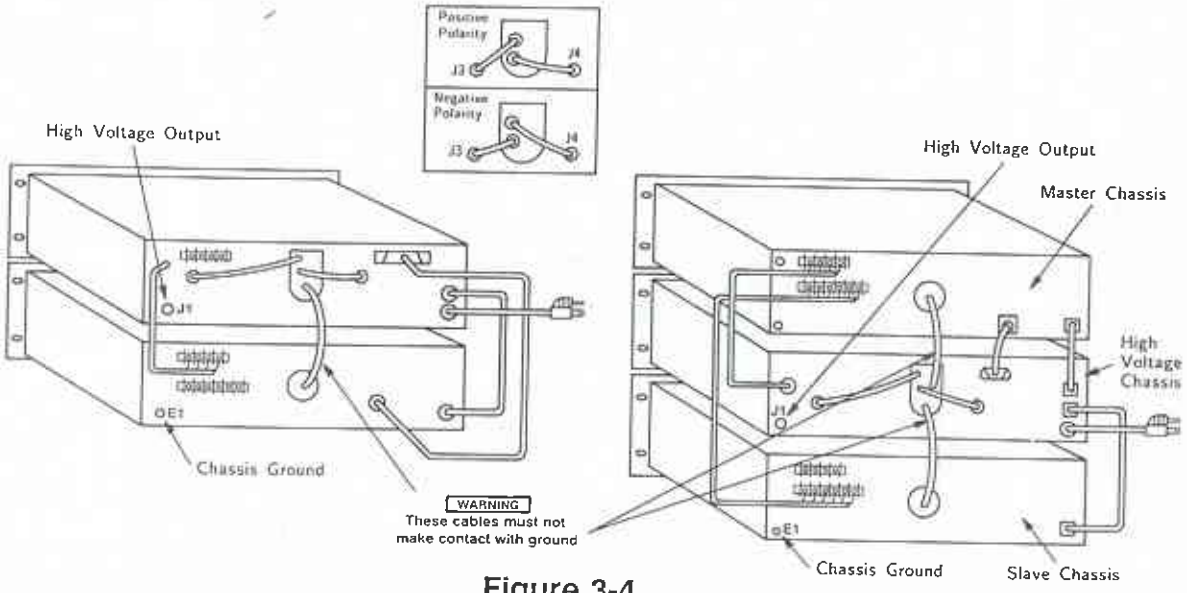


Figure 3-4
Reversing Polarity by Plug Exchange - 200 Watt to 500 Watt Units

3.2.3 Models over 200 Watts, 10 to 100 KV

WARNING

TURN POWER OFF BEFORE CHANGING POLARITY!!

Be sure internal and load capacitance are discharged.

On 200 to 500 Watt units generating from 10 to 100 KV, the polarity is reversed by interchanging the leads on the rear of the chassis. This is shown in Figure 3.4.

3.2.4 Reversible Polarity Units with Air Multiplier Stack

WARNING

TURN POWER OFF BEFORE CHANGING POLARITY!!

Be sure internal and load capacitance are discharged.

Reversible polarity units generating 150 KV or more must have two separate air multiplier stacks, one for positive polarity and one for negative polarity. To switch polarity, replace the stack in use with another stack of the desired polarity.

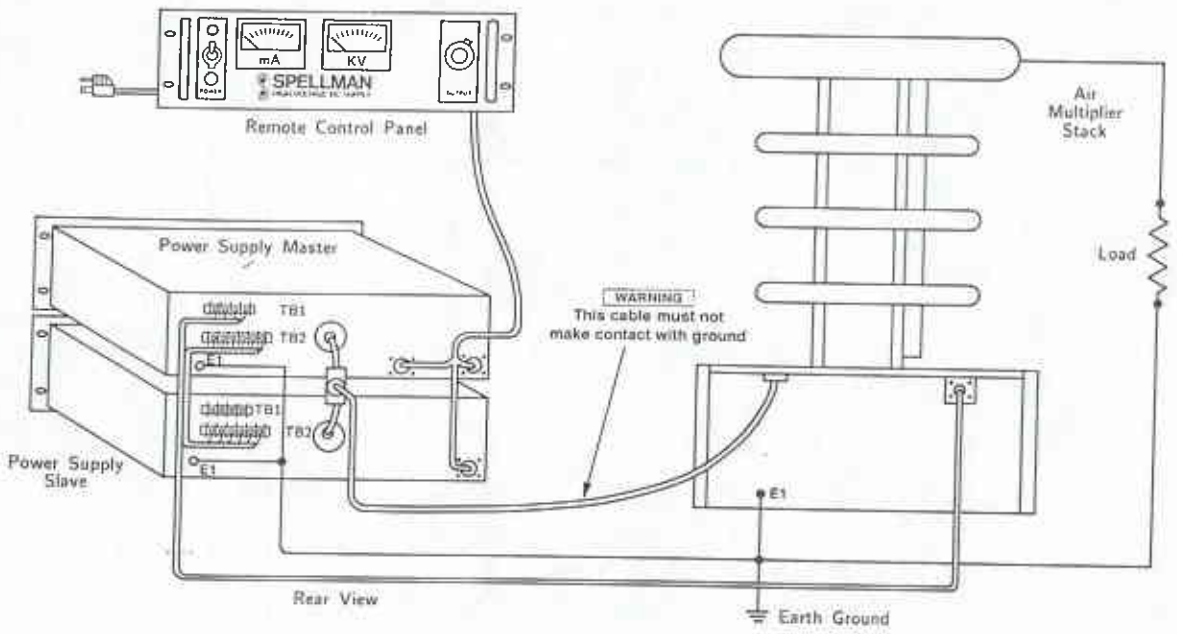


Figure 3-5
Operating Setup with Separate Air Multiplier Stack

3.3 SEPARATE AIR MULTIPLIER STACK

For models rated over 120 KV, the high voltage DC output is at the top toroid of the air multiplier stack (Figure 3.5). No output cable is provided. Connection to the toroid can be made by a safe, appropriate method of the user's choice using good high voltage practices. Consult the factory for specific installation instructions.

WARNING

High voltage stacks should always be installed in enclosed safety areas to prevent injury to personnel. The recommended safety clearance is approximately one foot per 50 KV.

For safety, the External Interlock option (EI) is recommended to shut off the high voltage output when personnel enter the area where high voltage is generated.

Installation

A) A separate ground binding post is provided on the stack. Attach both the ground return from the load and the ground from the power supply to this post.

B) Connect the interconnection cable from the rear or top of the power supply to the base of the stack with the cable provided. **THIS CABLE MUST NOT MAKE CONTACT WITH GROUND!!**

C) Connect the signal cable from the rear of the rack to the mating connector underneath the base of the stack.

Chapter 4

PRINCIPLES OF OPERATION

This section gives a basic discussion of the principles of operation of the RHR power supply. A general analysis of system functions is given first. The function of each section is then described in detail. Schematic diagrams are included at the rear of the manual.

4.1 BASIC OPERATION PRINCIPLES

RHR power supplies employ a proven solid state RF high voltage circuit for an optimum combination of electrical performance, reliability and economy. A block diagram of the power supply is shown in Figure 4.1. The AC input is rectified, filtered, and fed to a Class C RF oscillator circuit employing silicon power transistors. The feedback loop that controls the driver, and therefore the output voltage, contains a series pass stage controlled by the output of a differential amplifier. The input signal to the operational amplifier is the difference between a stable reference voltage and an accurately determined sample of the DC output voltage. The output of the RF oscillator is rectified and filtered in a solid-state voltage multiplier (a doubler, quadrupler, etc., depending on the output voltage rating).

4.2 CIRCUIT DESCRIPTION

AC Input, Transformer, Rectifier

AC power is applied through an EMI filter to a step down transformer to produce approximately 27 volts AC. This AC voltage is full wave rectified and filtered to provide a 30 volt DC source. To provide a bias, Vcc, for the control circuitry, the DC is regulated to 18 volts.

Power RF Oscillator

The RHR employs a high frequency modified Hartley sine wave oscillator as an inverter. This oscillator consists of multiple power transistors in parallel to provide the required power handling capability. In the simplified diagram of the oscillator (Figure 4.2), Q1 is the oscillator transistor and Q2 is the series

regulator transistor. The transformer T2 steps up the output to a high voltage and the feedback winding develops 180° phase shifted voltage which is fed back to Q1 to sustain oscillation. Components R_B and C_B provide proper base drive characteristics and R_D provides start-up current upon turn on. The high voltage output circuit resonates to maximize the output voltage. The resonant frequency in the RHR is determined by the secondary windings of the transformer. Capacitors are added across one of the secondary windings to optimize operation at the resonant frequency, which is typically 30 kHz. The series regulator Q2 varies the voltage applied across the oscillator and therefore varies the output. The RHR oscillator has base clamps and collector clamps to protect the oscillator transistors against over-voltage.

Multiplier Filter

The output of the high voltage transformer is applied to a half wave Cockcroft-Walton multiplier to rectify and step up the voltage. Its DC output is filtered to reduce ripple and fed to the output connector through a series limiting resistor to limit peak discharge current upon arc-over. In units above 120 KV a separate air multiplier stack is used.

Reference Voltage

A stable reference voltage is derived from Vcc through a zener regulator. This reference is applied to a multi-turn front panel potentiometer for precise adjustment of the output high voltage.

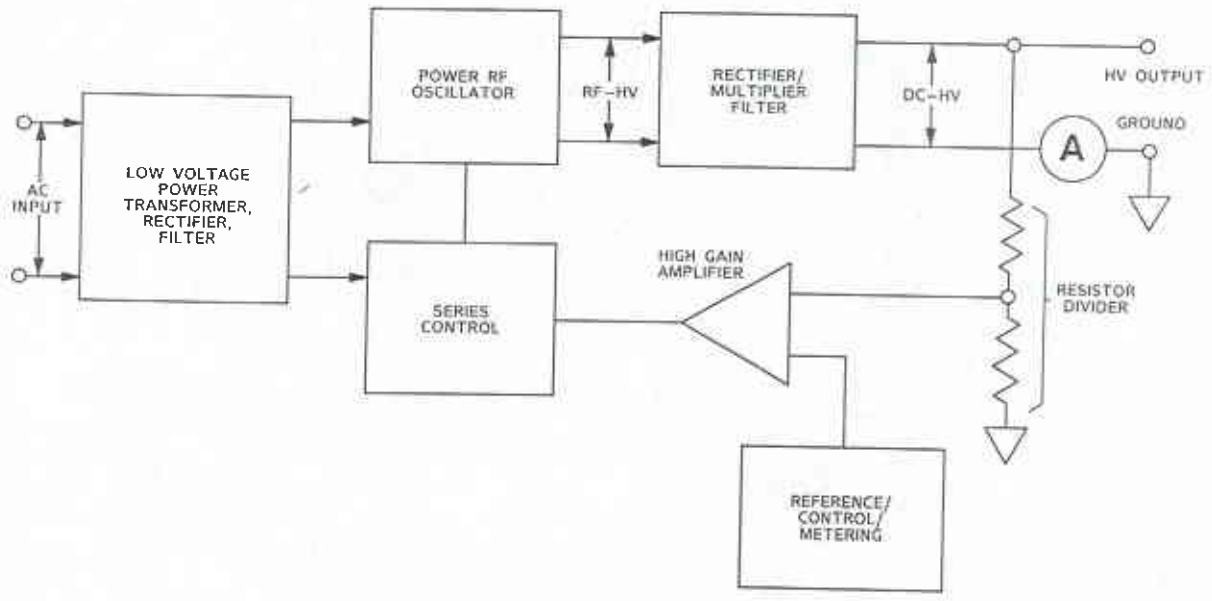


Figure 4-1
Block Diagram of the Power Supply

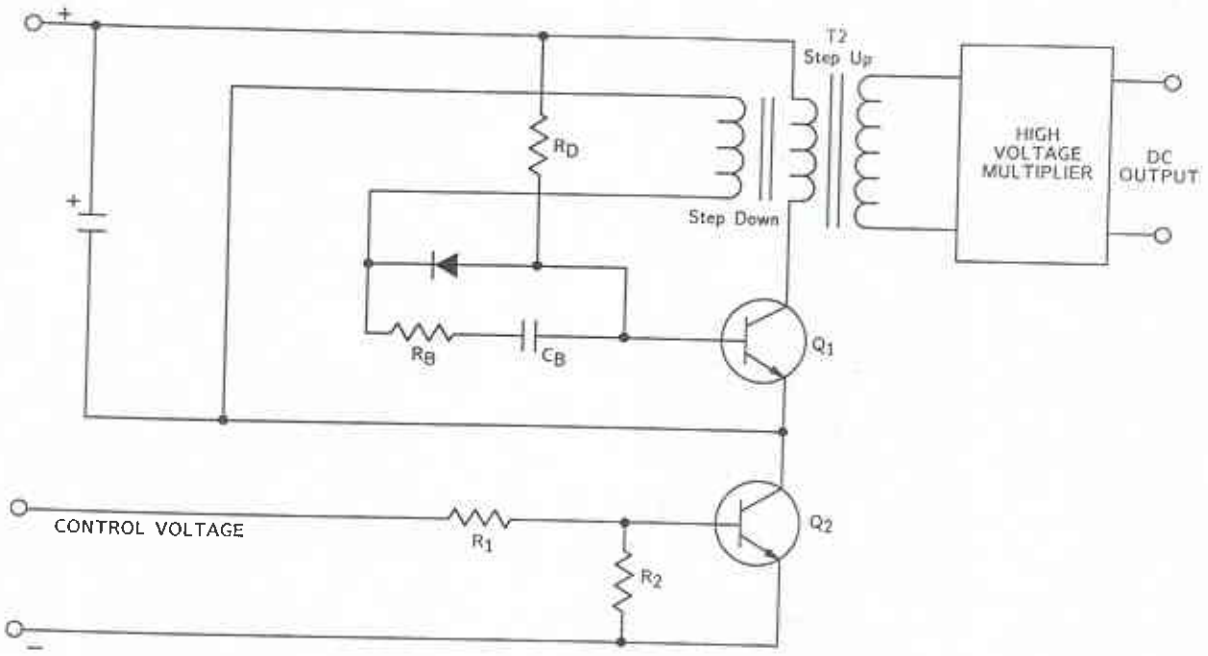


Figure 4-2
Simplified Diagram of a Sine Wave Oscillator

Feedback Loop

Current and voltage control and regulation are maintained by feedback loop techniques. The high voltage resistor divider across the high voltage output provides a low voltage signal proportional to the DC high voltage. This signal is applied through steering diodes to an error amplifier. The other input to the error amplifier is the adjustable reference voltage. The steering diodes and their associated circuitry automatically sense the polarity of the output voltage to provide the proper feedback signal. The output of the error amplifier drives the series regulator which controls the output voltage.

Overload Protection

A resistor on the return side of the multiplier senses the output current through a bridge. The output current is compared to a reference to limit the output current when it exceeds the preset value.

Chapter 5

OPTIONS

The options available for this power supply are described in this section. Interface diagrams are shown where required. Applications and ordering notes are included. Options are specified by including the option code in the model number as described in Section 1.3.

5.1 CURRENT LIMIT/ ADJUSTABLE CURRENT PROTECTION CL(x), ACP

Current Limit (CL) automatically limits the load current to a preset limit regardless of the overload imposed upon the power supply. Adjustable Current Protection (ACP) provides a single turn front panel pot to continuously adjust current limit. The power supply continues to operate at any overload condition including a short circuit by automatically reducing the output voltage as required to not exceed the current limit. The unit is self-restoring to its normal operating level when the overload condition is removed. Note: This is only a protection circuit; it is not intended for normal operation at the current limit condition.

Application: The Current Limit feature is important when the load is erratic and can exceed the power supply rating frequently. In such situations, the need to repeatedly reset the power supply that occurs with the Overload Tripout option (described in Section 5.2) can be an annoyance. A typical example of this situation is a CRT which experiences occasional arc-overs. When the arc occurs, the Current Limit circuit forces the output voltage to drop rapidly (depending on the load impedance). This helps the arc to extinguish and permits the power supply to regain its normal operating level.

Current Limit also provides essentially constant current charging in capacitive load applications.

Ordering: Current Limit is factory set at typically 110% of rated load on all RHR models. The option CL(x) allows selection of a current limit level less than the power supply rated current. The current limit in milliAmperes is

specified in parentheses following the CL; i.e. CL(5) denotes a 5 ma limit.

5.2 OVERLOAD TRIPOUT/ ADJUSTABLE OVERLOAD TRIPOUT OL,OL(x),OL/ACP

The overload tripout protection feature rapidly shuts down the high voltage output when the load current exceeds 110% of the rated load (or x milliAmps, if a level less than the rated load is chosen as an option). A fast acting latching circuit removes power to the oscillator, thereby turning off the high voltage. The power supply must be manually reset by OFF-ON operation of the main power switch. When overload tripout is provided, it replaces the standard current limit feature. Units equipped with OL and ACP allow the user to set the trip point with a single turn front panel potentiometer.

Application: This protection provides the utmost in safety for personnel, load, and power supply. The trip-out is sensitive and rapid, and will turn off the supply even for short duration arcs in the load. This option should be selected in any situation where the inconvenience of having to reset the supply due to occasional load arc-overs or high current pulses is acceptable.

Ordering: Suffix letters OL appear in the model number when this option is provided. If an overload trip-out level less than the power supply rated current is desired, this limit in milliAmperes is specified in parentheses following OL; i.e. OL(5) denotes a 5 ma tripout level.

5.3 CURRENT REGULATION CR

The current regulation option provides both current and voltage regulation with automatic crossover. The power supply will operate safely into any load between open and short circuit. Output current is adjustable from zero to the rated current over the full voltage range. A front panel 10-turn locking potentiometer for current adjustment provides resolution of 500 ppm. A single-turn pot controls the output voltage. A ten-turn pot for voltage control is available upon request. CR units that have remote programming of output voltage (Sections 5.4.2 and 5.6.2) will also allow remote programming of the output current.

Current regulation is +0.1% for any current setting between 25% and 100% of the rated maximum current for a voltage range from 10% to 100% of the rated voltage. Voltage regulation is +0.05% for line and load variations and ripple is 0.1% rms of output voltage.

Application: This type of unit is particularly suitable for gas laser excitation since the supply can provide a relatively high open circuit voltage for starting the plasma discharge, yet once the arc has formed, the supply automatically operates in a constant current mode at any preset level.

5.4 REMOTE VOLTAGE PROGRAMMING RVC, RVC(x)

5.4.1 RVC for High Voltage Output Control

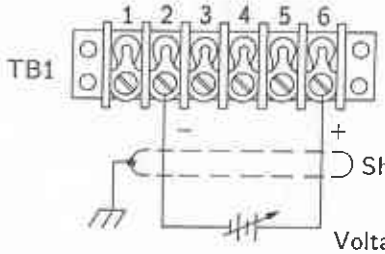
This option enables the power supply to be controlled by a floating external low voltage DC source. The output voltage is directly proportional to the DC programming voltage with linearity and proportionality of 1% of full scale. The standard ratio of programming voltage to output voltage is such that 0 to +6 volts DC controls the output from 0 to the rated high voltage output. The programming voltage polarity is positive, regardless of the output polarity of the power supply.

Connections for the programming voltage are on a barrier type terminal board on the rear of the power supply. The programming voltage is applied between terminal 6 and terminal 2 (common) (Figure 5.1). If normal usage of the front panel controls is desired, terminals 3 and 4 should be jumpered. Shielded cable should be used for all interconnections to prevent pick-

up, with the shield connected to common (terminal 2).

Note: The common of the external voltage source should not be connected to ground. For ground referenced operation, the Ground Reference (GR) option (Section 5.5) must be ordered.

Ordering: If a control voltage other than 6 volts is desired, any value desired between 5 and 250 volts DC may be specified in parentheses after the option letters; i.e. RVC(10) specifies a 0 to 10 volt programming signal.



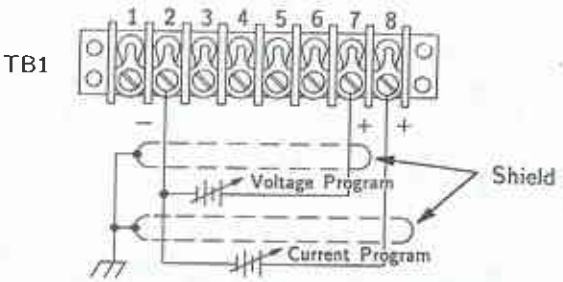
Scale Factor: 6 VDC = Full Scale (standard)
Polarity: Positive

Figure 5-1
Remote Voltage Control

5.4.2 RVC with both Output Current Control and High Voltage Output Control RVC/CR

Units that have both Current Regulation (CR) and Remote Voltage Control (RVC) will accept two floating programming voltages, one for high voltage output between terminals 7 and 2, and one for output current between terminals 8 and 2, where terminal 2 is common (Figure 5.2). Both programming voltages must be positive. The front panel potentiometers set the upper voltage limit for remote programming. For front panel output voltage control, jumper terminals 3 and 4. For front panel output current control, jumper terminals 5 and 6.

Note: The common of the external voltage source should not be connected to ground. For ground referenced operation, the Ground



Scale Factor: 6 VDC = Full Scale (standard)
Polarity: Positive

Figure 5-2
RVC for Output Current and High Voltage Output Control

Reference (GR) option (Section 5.5) must be ordered.

5.5 GROUND REFERENCE GR

This option allows ground referencing of external programming when using Remote Voltage Programming (RVC) or Remote Monitor Terminals (Test Points).

5.6 REMOTE RESISTANCE PROGRAMMING RC

5.6.1 RC for High Voltage Output Control

This option permits output voltage control by either an external potentiometer (3 terminals) or the front panel 10-turn control potentiometer. The external potentiometer is connected to the barrier type terminal block on the rear of the chassis. When wired in accordance with Figure 5.3, the front panel control sets the upper limit for remote programming. For front panel control, jumper TB1-3 to TB1-4.

A 5K ohm potentiometer is required, although fixed resistor dividers of equivalent value may be used. A shielded cable (up to 100 feet long) should be used, with the shield connected to the chassis ground post.

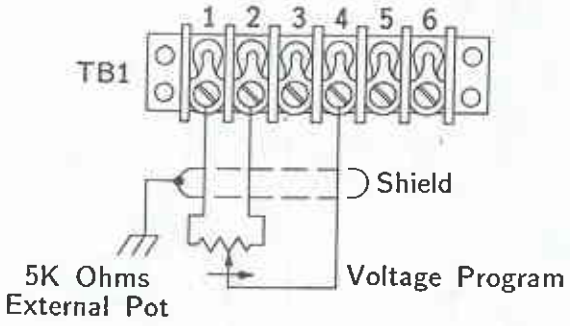


Figure 5-3
Remote Resistance Control

5.6.2 RC for both Output Current Control and High Voltage Output Control RC/CR

Units with both Current Regulation (CR) and Remote Resistance Programming (RC) allow connection of two remote potentiometers to the barrier type terminal board on the rear of the chassis to control both high voltage output and output current (Figure 5.4). If front panel control of output voltage is desired, jumper TB1-3 to TB1-4. For front panel control of output current, jumper TB1-5 to TB1-6.

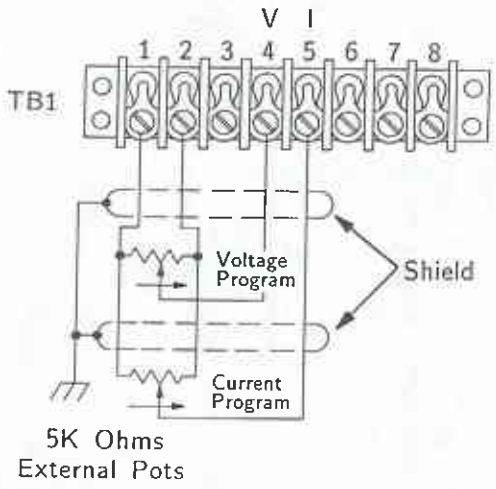


Figure 5-4
RC for Output Current and High Voltage Output Control

5.7 FOCUS TAP F(max KV)

One or more separate additional high voltage output modules up to 30 KV DC, with separate front panel potentiometer control, can be built into the power supply. Almost any Spellman DC to DC modular power supply from the RM and WRM Series may be selected. Specifications for supplementary outputs are in accordance with catalog values. Focus voltage control is provided on the front panel with a single turn potentiometer. No voltmeter for the focus voltage is provided on the power supply.

An 18" output cable with a male Alden connector is supplied with the unit for the focus voltage. It connects to a female connector on the rear of the unit. The other end of the output cable is available for the customer's connector.

Options: If the Remote Resistance Programming (RC) option is ordered for the main output, then the auxiliary output will also be programmed remotely through a remote 5K pot connected to the second terminal block TB2 as shown below. For front panel focus control, remove the remote pot and jumper TB2-3 to TB2-4. Remote Voltage Control (RVC) is not available for the focus output. For units with Test Points (TP), output focus voltage and output focus current can be metered by attaching two voltmeters to terminals 10, 11, and 12 of the terminal board on the rear of the chassis, as shown in Figure 5.5.

Operation: Connect the focus voltage cable from the load to the FOCUS output connector at the rear of the unit. A separate voltmeter can be connected to measure the focus output voltage.

Before initial turn-on, turn the focus voltage control fully counterclockwise to the zero voltage position. After turn-on, adjust the FOCUS VOLTAGE control clockwise until the desired focus voltage is obtained.

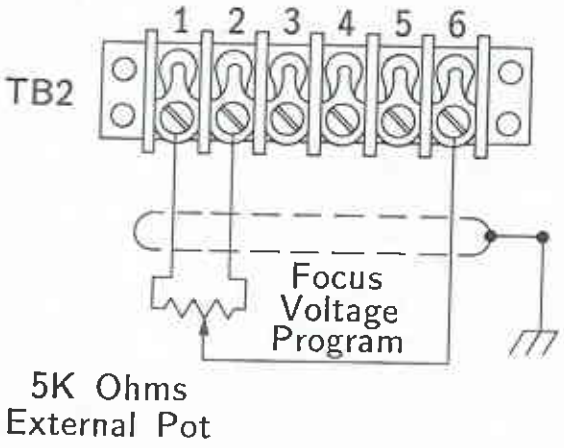


Figure 5-5
Focus Voltage with RC and TP

5.8 REMOTE MONITOR TERMINALS (TEST POINTS) TP

This option permits remote monitoring of voltage and current at BNC connectors provided on the rear of the unit (Figure 5.6). The voltage monitor circuit provides a 0 to 1 volt signal corresponding to zero to maximum rated voltage accurate to 1%. The current monitor scale factor is 100mV/mA. Other scales are available upon request.

Note: The common of the remote monitor signals should not be connected to ground. For ground referenced operation, the power supply must also include the Ground Reference (GR) option (Section 5.5).

5.9 REMOTE CONTROL PANEL RCP

Any standard model may be supplied with the control panel separate from the basic supply. The remote control panel is standard on all units with output voltages above 120 KV. The control panel is identical to a standard front panel and contains an AC power switch, fuse, pilot light, voltmeter, ammeter, and 10-turn control potentiometer. Any options that have control panel mounting can be included on the remote control panel.

The remote control panel is mounted by four screws. Two inches of clearance should be allowed behind the remote control panel for the instrumentation. The connector on the rear of the supply is readily connected to the 15 feet of shielded interconnection cable provided. Other lengths of interconnection cable are available.

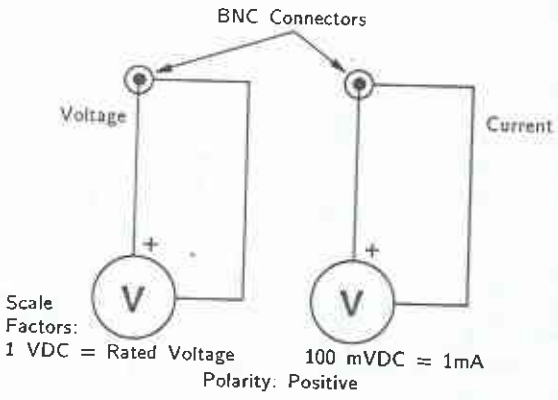


Figure 5-6
Remote Monitor Terminals
(Test Points)

5.10 BI-POLAR OPERATION BPM/BPS

Any power supply equipped with the slaved bi-polar option can be used as a master for controlling the output of the equivalent opposite polarity power supply. One control provides adjustment of both power supplies from zero to the rated output voltage. The negative polarity output tracks the positive output within ±1% from 10% to the full rated output voltage. Specifications for regulation, ripple, etc., are governed by individual unit characteristics.

The units are connected independently to loads and to ground. The two units are attached with RG58 coaxial cable with BNC connectors plugged into the rear of the units (Figure 5.7).

Ordering: The suffix BPM appears after the standard model number in the master unit. The suffix BPS appears after the model number in the opposite polarity slave unit.

5.11 FLOATING GROUND FG

The Floating Ground feature isolates the common ground of the power supply with respect to chassis (earth) ground. A five-way binding post insulated from the chassis is provided on the rear of the power supply for attachment of the low end return from the load. Insulation of 50 volts nominal (300 volts maximum) is provided for the "floating" terminal. The terminal is also bypassed to chassis ground by a one megohm resistor, a 0.047 mF capacitor, and a neon lamp. The ground binding post on the chassis must be connected to a good external ground. When the Floating Ground feature is not in use, the floating ground post should be tied to the chassis ground binding post. If the high voltage output is on an air multiplier stack, the Floating Ground binding post is on the stack.

Application: To monitor the load current with accurate instrumentation, current monitoring circuitry can be inserted between the floating ground terminal and the system ground (Figure

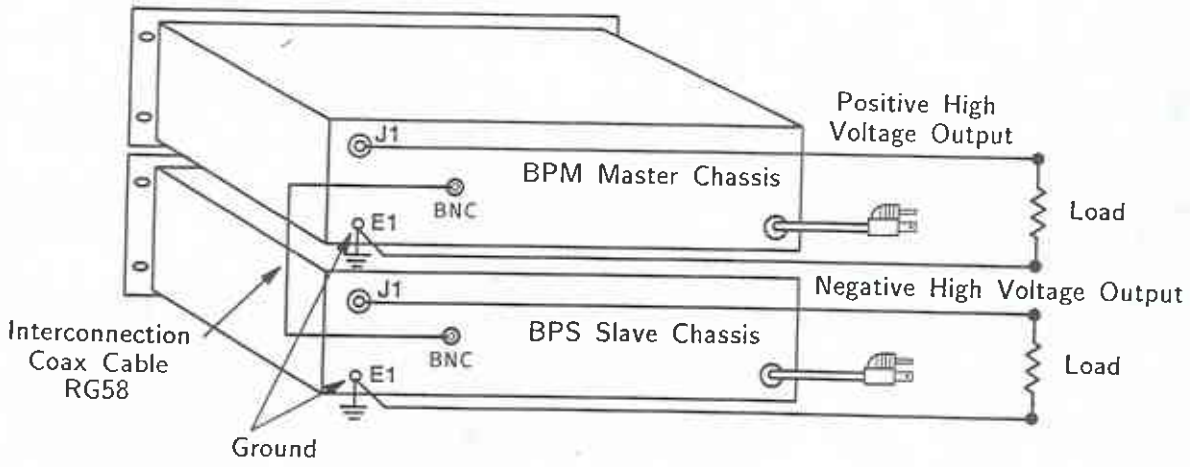


Figure 5-7
Bi-polar Operation

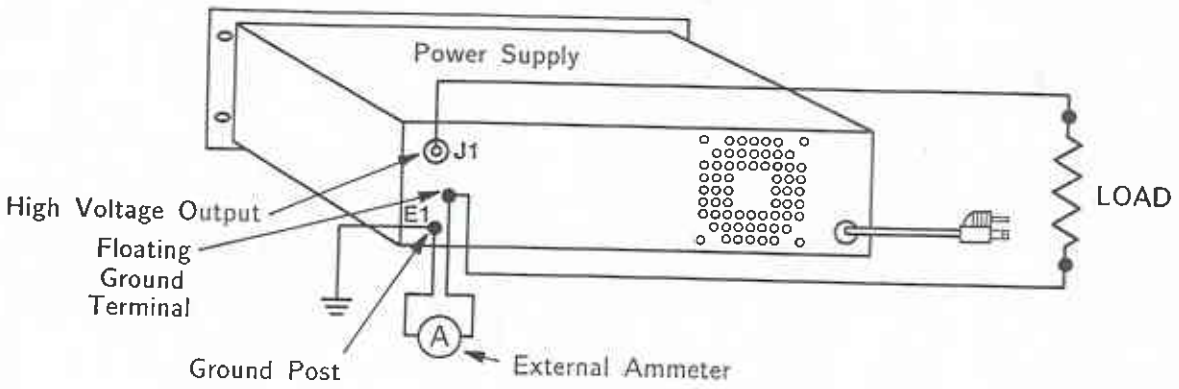


Figure 5-8
Floating Ground

5.8). This can be an appropriate milliammeter or microammeter, or a current sensing resistor which can be calibrated with a sensitive digital or high impedance differential voltmeter. It should be understood, however, that a low impedance return to ground must be provided by the user for proper operation of the power supply.

Another purpose of the Floating Ground option is to permit the user to "ground" or "return" the low end of the power supply at a point within his system which will suppress undesirable ground loop currents.

5.11.1 FLOATING GROUND - LOW LEAKAGE FGLL

This option provides the floating ground feature with a maximum leakage current through the floating ground of 10 nanoAmperes

5.12 TRUE LOAD CURRENT TLC

This option provides an accurate reading of the load current by eliminating the 100 microAmp offset in the feedback divider.

5.13 INHIBIT CIRCUIT IC

The Inhibit Circuit option requires that a separate low voltage TTL DC signal be applied to a BNC connector in order to turn the unit on. When the signal is removed, the high voltage output is turned off.

If no connections are made to the Inhibit Circuit BNC connection, the unit will be disabled.

WARNING

It is extremely dangerous to use this input to inhibit the high voltage output for the purpose of servicing or approaching any area or load considered unsafe during normal operation.

5.14 SLOW START SS, SS(x)

The Slow Start option causes the output voltage of the power supply to rise gradually to operating voltage when the unit is turned on. The time to reach the operating level is approximately proportional to the control setting. The rise time to full voltage can be specified in seconds by placing the appropriate time in parentheses after the suffix letters; i.e. SS(10) denotes a 10 second rise time.

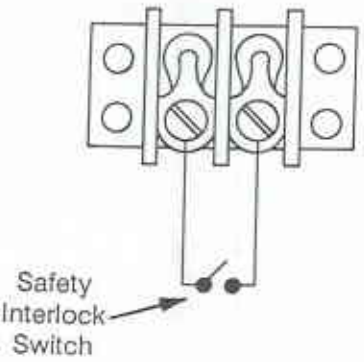
5.15 EXTERNAL INTERLOCK EI

Interlock connections are provided on a rear panel terminal board for connection to an external safety switch. The unit will not operate unless the interlock circuit is closed. The interlock connections may be jumpered when interlock feature is not used.

Application: This option may be used to give a measure of safety by turning off the high voltage output when personnel enter the area where the high voltage equipment is operated.

WARNING

115 VAC is present at the External Interlock terminal block.



NOTE: Power Supply comes with EI terminals jumpered

Figure 5-9
External Interlock

5.16 EXTERNAL ALARM RELAY EAR

On units equipped with this option, rear panel relay contacts are closed whenever the unit is operating in current limit (CL) or overload tripout (OL) mode. These contacts may be connected to a warning device or computer controller provided by the customer.

5.17 ALTERNATE INPUT VOLTAGE (V)

Standard models are wired for input of 115V AC ±10% unless otherwise specified. Other input voltages are available upon request.

For a nominal input voltage of 220 volts rms ±10%, 50-60 Hz, single phase, add the suffix (220) to the model number.

For a nominal input voltage of 100 volts rms ±10%, 50-60 Hz, single phase, add the suffix (100) to the model number.

Units that operate from power sources with frequencies up to 400 Hz can be provided.

5.18 FRONT PANEL REVERSIBILITY FPR

Units equipped with Front Panel Reversibility have a front panel switch that will switch the output voltage polarity. Front Panel Reversibility is only available for units with maximum high voltage output of 25 KV.

5.19 EXTRA LENGTH OUTPUT CABLE LL(ft)

Standard output cable is 10 feet of shielded high voltage cable. Other lengths may be specified in multiples of 10 feet.

5.20 BENCH CABINET C

A deluxe rack cabinet is available for all models. The base dimensions are 22" wide x 18" deep. The cabinet height is selected to fit the individual unit height. A two-tone blue and gray color scheme is standard. Carrying handles are located conveniently on the sides of the cabinet for easy handling.

5.21 CUSTOM DESIGNED MODELS X(#)

Units built to customer specifications are assigned an X number by the factory. If this unit is an X model, a specification control sheet is added at the end of this instruction manual.

Spellman welcomes the opportunity to tailor units to fit your requirements or to develop new products for your applications. Contact the Spellman Sales Department with your needs.

Chapter 6.

MAINTENANCE

This section describes periodic servicing, troubleshooting, and performance testing procedures.

WARNING

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.

OBSERVE EXTREME CAUTION WHEN WORKING WITH HIGH VOLTAGE

6.1 PERIODIC SERVICING

Approximately once a year (more often in high dust environments), unplug the unit and remove the top cover. Use compressed air to blow dust out of the inside of the unit. Be sure that the fan is not obstructed and spins freely. The fan has sealed bearings and does not need lubrication. Be sure to replace the top cover before operating for proper cooling. Note: Care should be taken not to damage the air core transformers.

6.2 TROUBLESHOOTING

Only qualified personnel should service or repair high voltage equipment.

A list of malfunction symptoms and a list of possible cause(s) for each symptom is given in the Troubleshooting Chart, Table 6.1. The chart does not cover every possible trouble, but it does cover many problems that can be fixed in the field.

If the power supply does not operate, check the obvious first. Make sure that the power supply is plugged in and that there is power at the socket. Check for correct line voltage. Operate the ON/OFF switch. If the pilot light is not lit, check the pilot light bulb and the line fuse. There may also be an internal fuse on the heat sink or chassis. The correct fuses are shown in Table 6.2.

Be particularly careful about replacing heat damaged parts. Overheating is usually only a

SYMPTOM	POSSIBLE CAUSE
No output, pilot light not lit	no input line voltage blown line fuse
No output, pilot light lit	defective control board defective high voltage feedback assembly blown internal fuse on heat sink or chassis
Fuse blows	shorted oscillator transistor defective clamp diodes (1N4937)
Output voltage low	low input line voltage unit operating in current limiting mode reduce load or adjust front panel output voltage control front panel pot set too low when using remote programming (RVC or RC)
Unit current limits	load too heavy -- load resistance too low load shorted to ground shorted high voltage assembly
Does not regulate, no voltage control	defective control board shorted regulator transistor defective high voltage assembly
Does not current limit	defective control board
Ticking noise, high voltage arcing	defective high voltage assembly
Shocks from power supply	defective ground connection
Erratic output	defective high voltage assembly defective control board defective ground connection defective load return connection open floating ground connection (FG option)

Table 6-1
Troubleshooting Chart

symptom of trouble. The actual cause of overheating should be determined or the damage may recur.

The Warranty is void if the unit is worked on by other than Spellman personnel during the warranty period.

Power Supply Rating	Front Panel Fuse	Internal Fuse
0 to 120W	5 Amp, 250V	15 Amp, 250V
150W to 250W	10 Amp, 250V	30 Amp, 250V

Table 6-2
Fuse Selection

6.3 PERFORMANCE TEST

WARNING

HIGH VOLTAGE IS DANGEROUS.

Only qualified personnel should perform these tests.

The test setup for checking the performance of your high voltage power supply is shown in Figure 6.1. High voltage test procedures are described in Spellman Bulletin STP-783, Standard Test Procedures for High Voltage Power Supplies. It can be obtained from the Spellman Customer Service Department.

Test equipment, including an oscilloscope, a high impedance voltmeter, and a high voltage divider such as the Spellman HVD-100 or HVD-200, is needed for performance tests. Be sure the power switch is OFF. Hook up the circuit as shown in Figure 6.1. Check the power supply parameters to ensure satisfactory operation.

Note: All test components must be rated for operating voltage

6.4 HIGH VOLTAGE DIVIDERS

High voltage dividers for precise measurement of output voltage with an accuracy up to 0.1% are available from Spellman. The HVD 100 is used for voltages up to 100KV. The HVD 200 measures up to 200KV. The Spellman divider is designed for use with differential voltmeters or high impedance digital voltmeters. The high input impedance is ideal for measuring high voltage low current sources, which would be overloaded by traditional lower impedance dividers.

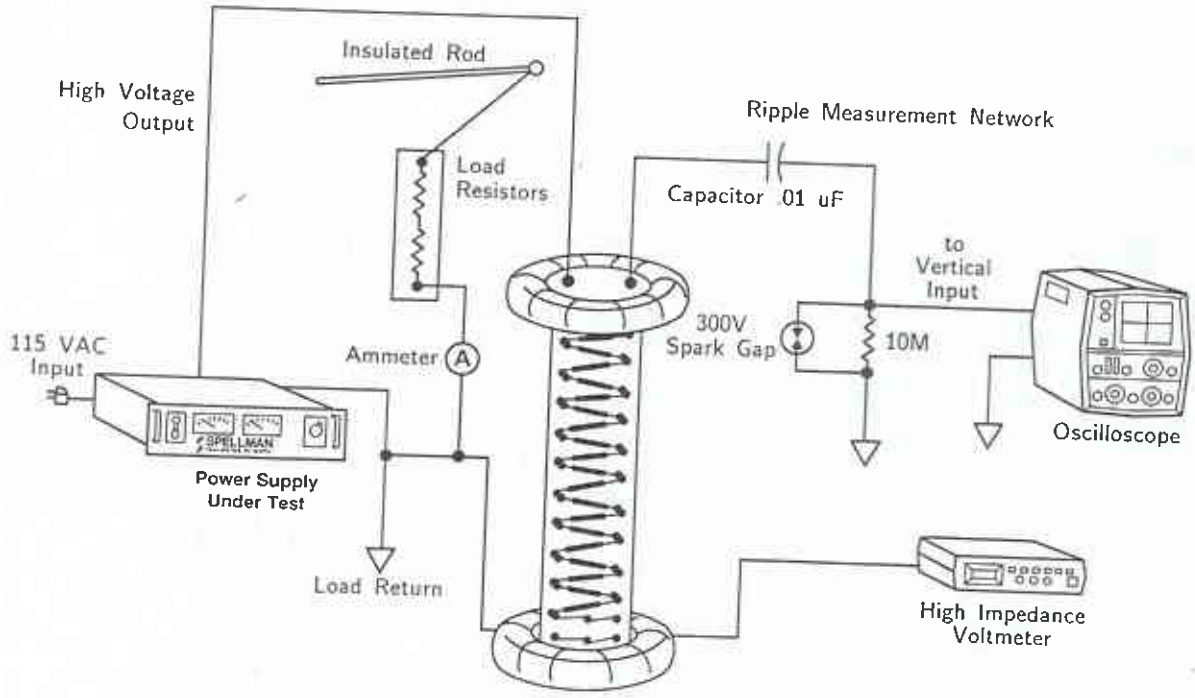


Figure 6-1
Test Set Up Diagram

Chapter 7.

REPLACEMENT PARTS

7.1 REPLACEMENT PARTS

Contact the Spellman Customer Service Department for parts lists for specific models

Spellman provides parts and subassemblies for its high voltage power supplies but recommends that only qualified personnel perform the repairs. High voltage is dangerous; even minor mistakes in repairs can have serious consequences.

When requesting parts please give the model number and serial number of the power supply. See Table 7.1 for a list of standard replacement parts.

7.2 CORRESPONDENCE AND ORDERING SPARE PARTS

Each Spellman power supply has an identification label on the rear of the chassis that bears its model and serial number.

When requesting engineering or applications information, please state the model and serial number of the power supply. If specific components or circuit sections are involved in the inquiry, it is helpful to indicate the component symbol number(s) shown on the applicable schematic diagram.

Example: "...the voltage across Capacitor C2, for Model RHR30P60 power supply, serial no. C008621."

When ordering spare parts, please specify the 9-digit Spellman part number, the component function and symbol from the schematic, and the model and serial number of the unit.

Example: "One (1) Spellman Part No. 105423-001, Capacitor C2, for Model RHR30P60 power supply, serial no. C008621."

DESCRIPTION	PART NUMBER	
Input transformer, 115 VAC	104017-003	
Oscillator transistor, 2N5039	105405-016	
Oscillator transistor, 2N3055	105405-001	
High voltage transformer, TRF10	301590-009	(1)
High voltage primary transformer TRF10P	301590-010	(2)
High voltage secondary transformer, TRF10S	301590-006	(2)
High Voltage Air Multiplier Assembly		(3)
Diode, high voltage, 15KV, 25mA	105402-008	
Bridge rectifier, PW10	105404-008	
Diode, rectifier, 1N4937	105401-037	
Filter Feedback Assembly		(3)
Output cables	100161-TAB	(4)
Fan	105730-003	
Voltmeter, KV (specify range)	105607-TAB	
Ammeter, mA (specify range)	105608-TAB	
Resistor, 0.25 ohm, 2W	105005-002	
Capacitor, ceramic, high voltage, 3600pF, 30KV	105204-017	
Capacitor, ceramic, high voltage, 3200pF, 15KV	105204-023	
Capacitor, ceramic, high voltage, 2400pF, 20KV	105204-021	
Capacitor, ceramic, high voltage, 1800pF, 30KV	105204-025	
Capacitor, ceramic, high voltage, 460pF, 30KV	105204-015	
Fuse	105721-TAB	
Amplifier assembly	401081-TAB	(3)
Oscillator chassis assembly		(3)
Interconnection cable assemblies, 250W series		
AC high voltage input cable	100414-002	
Program/monitor cable, 6"	301647-002	
Feedback cable, 12"	301620-004	
AC power cable, 18"	301624-004	
Air Multiplier Stack subassemblies		
Capacitor assembly	200296-001	
Rectifier assembly	100224-999	

Notes:

(1) For models with output 40 KV or greater.
(2) For models with output less than 40 KV.
(3) See schematics for correct part number.
(4) Depends on voltage and power. Longer lengths available.

Table 7-1
Replacement Parts List

Chapter 8

FACTORY SERVICE

8.1 WARRANTY REPAIRS

During the Warranty period, Spellman will repair all units free of charge. The Warranty is void if the unit is worked on by other than Spellman personnel. See the Warranty in the rear of this manual for more information. Follow the return procedure described in Section 8.2. Customer shall pay shipping to and from Spellman.

8.2 FACTORY SERVICE PROCEDURES

Spellman has a well-equipped factory repair department. If a unit is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached.

For all units returned for repair, please obtain an authorization to ship from the Customer Service Department either by phone or mail prior to shipping. When you call, please state the model and serial numbers which are on the plate on rear of the power supply and the purchase order number for the repair. A Return Material Authorization Code Number (RMA number) is needed from Spellman for all returns. This RMA number should be marked clearly on the outside of the shipping container. Packages received without an RMA Number will be returned to the customer. Customer shall pay shipping to and from Spellman.

A preliminary estimate for repairs will be given by phone by Customer Service. A purchase order for this amount is requested upon issuance of the RMA Number. A more detailed estimate will be made when the power supply is received at the Spellman Repair Center. In the event that repair work is extensive, Spellman will call to seek additional authorization from your company before completing the repairs.

8.3 ORDERING OPTIONS AND MODIFICATIONS

Many of the options listed in Chapter 5 can be retrofitted into Spellman power supplies by our factory. For prices and arrangements, contact our Sales Department.

8.4 SHIPPING INSTRUCTIONS

All power supplies returned to Spellman must be sent shipping prepaid. Pack the units carefully and securely in a suitable container, preferably in the original container, if available. The power supply should be surrounded by at least four inches of shock absorbing material. Please return all associated materials, i.e. high voltage output cables, interconnection cables, etc., so that we can examine and test the entire system.

All correspondence and phone calls should be directed to:

Spellman High Voltage Electronics Corp.
475 Wireless Boulevard
Hauppauge, New York 11788
(516) 435-1600 * FAX (516) 435-1620
E-Mail: sales@spellmanhv.com
http://www.spellmanhv.com