

# Instruction Manual

## EPM/SMS SERIES

### High Voltage Power Supply

MODEL :  
SERIAL# :  
DATE :

**SPELLMAN  
HIGH VOLTAGE ELECTRONICS  
CORPORATION**

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Spellman's SMS Series is based on a resonant flyback circuit that provides over 80% efficiency and high pulse current capability. Featuring voltage and current regulation with automatic crossover, The SMS is arc and short circuit protected making it ideal for a variety of applications.

**TYPICAL APPLICATIONS**

- CRT Testing
- Detector Arrays
- Electrophoresis
- X-ray Analysis
- Cable Testing

**SPECIFICATIONS**

**Input:**

+24Vdc ±10%

**Output:**

10 models from 1kV to 60kV. Positive or negative polarity outputs.

**Voltage Regulation:**

**Load:**

Static: 0.01% of output voltage no load to full load.  
Dynamic: 10V/100µA

Line: ±0.01% for ±10% change in input voltage.

**Current Regulation:**

Load: 0.1% of output current from 0 to rated voltage.  
Line: 0.05% of rated current over specified input range.

**Ripple:**

0.1% p-p of maximum output voltage.

**Dimensions:**

3"H x 5"W x 9"D (7.6cm x 12.7cm x 23.0cm).

**Input Connector:**

12 pin AMP Metri-Mate

**Output Cable:**

18"±1" (45.7cm) of UL® approved high voltage wire.

**Voltage Stability:**

0.02% per 8 hours.

**Voltage Temperature Coefficient:**

0.01% per °C, voltage or current regulated.

**Regulatory Approvals:**

Compliant to 2004/108/EC, the EMC Directive and 2006/95/EC, the Low Voltage Directive.

- **OUTPUT VOLTAGES FROM 1KV TO 60KV**
- **LOW STORED ENERGY**
- **TEST POINTS FOR OUTPUT CURRENT AND VOLTAGE**
- **INHIBIT CONTROL OF OUTPUT VIA TTL SIGNAL**
- **OEM CUSTOMIZATION AVAILABLE**

[www.spellmanhv.com/manuals/SMS](http://www.spellmanhv.com/manuals/SMS)

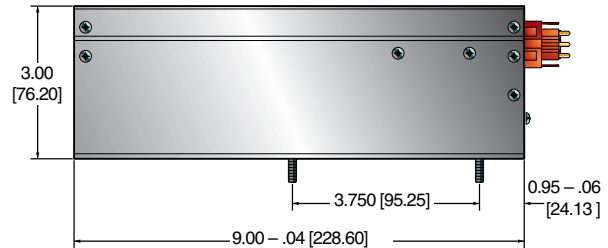
**SMS SELECTION TABLE**

Maximum Rating kV	mA	Model Number
1	60	SMS 1*60
3	20	SMS 3*60
5	12	SMS 5*60
10	6	SMS 10*60
15	4	SMS 15*60
20	3	SMS 20*60
30	2	SMS 30*60
40	1.5	SMS 40*60
50	1.2	SMS 50*60
60	1.0	SMS 60*60

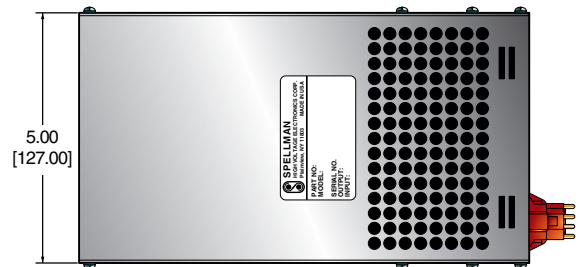
\*Specify "P" for positive polarity or "N" for negative polarity.

DIMENSIONS: in.[mm]

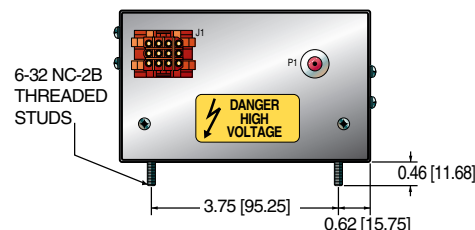
**SIDE VIEW**



**TOP VIEW**



**BACK VIEW**



**CONNECTOR 12 PIN**

J1	SIGNAL
1	Ground
2	+24Vdc
3	High Voltage Enable/Inhibit
4	Voltage Test Point: 10V±2%=0 to Rated Output
5	Current Test Point: 10V±2%=0 to Rated Output
6	Voltage Programming
7	Current Programming
8	+10Vdc Reference
9	Program and Test Point Return
10-12	Spare



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128015-001 REV.G

Spellman High Voltage is an ISO 9001:2000 and ISO 14001:2004 registered company

## IMPORTANT SAFETY PRECAUTIONS

### 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 grounded.

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

Allow five minutes for discharge of internal capacitance of the 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 by qualified personnel aware of the electrical hazards.

**WARNING** note 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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# WICHTIGE SICHERHEITSHINWEISE

## SICHERHEIT

DIESES HOCHSPANNUNGSNETZTEIL ERZEUGT LEBENSGEFÄHRLICHE HOCHSPANNUNG.  
SEIN SIE SEHR VORSICHTIG BEI DER ARBEIT MIT DIESEM GERÄT.

Das Hochspannungsnetzteil muß immer geerdet sein.

Berühren Sie die Stecker des Netzteiles nur, wenn das Gerät ausgeschaltet ist und die elektrischen Kapazitäten des Netzteiles und der angeschlossenen Last entladen sind.

Die internen Kapazitäten des Hochspannungsnetzteiles benötigen ca. 5 Minuten, um sich zu entladen.

Erden Sie sich nicht, und arbeiten Sie nicht in feuchter oder nasser Umgebung.

## SERVICESICHERHEIT

Notwendige Reparaturen können es erforderlich machen, den Gehäusedeckel während des Betriebes zu entfernen.

Reparaturen dürfen nur von qualifiziertem, eingewiesenem Personal ausgeführt werden.

“WARNING” im folgenden Text weist auf gefährliche Operationen hin, die zu Verletzungen oder zum Tod führen können.

“CAUTION” im folgenden Text weist auf Prozeduren hin, die genauestens befolgt werden müssen, um eventuelle Beschädigungen des Gerätes zu vermeiden.

# PRECAUTIONS IMPORTANTES POUR VOTRE SECURITE

## CONSIGNES DE SÉCURITÉ

CETTE ALIMENTATION GÉNÈRE DES TENSIONS QUI SONT DANGEUREUSES ET PEUVENT ÊTRE FATALES.  
SOYEZ EXTRÊMEMENT VIGILANTS LORSQUE VOUS UTILISEZ CET ÉQUIPEMENT.

Les alimentations haute tension doivent toujours être mises à la masse.

Ne touchez pas les connectiques sans que l'équipement soit éteint et que la capacité à la fois de la charge et de l'alimentation soient déchargées.

Prévoyez 5 minutes pour la décharge de la capacité interne de l'alimentation.

Ne vous mettez pas à la masse, ou ne travaillez pas sous conditions mouillées ou humides.

## CONSIGNES DE SÉCURITÉ EN CAS DE REPARATION

La maintenance peut nécessiter l'enlèvement du couvercle lorsque l'alimentation est encore allumée.

Les réparations doivent être effectuées par une personne qualifiée et connaissant les risques électriques.

Dans le manuel, les notes marquées « **WARNING** » attire l'attention sur les risques lors de la manipulation de ces équipements, qui peuvent entraîner de possibles blessures voire la mort.

Dans le manuel, les notes marquées « **CAUTION** » indiquent les procédures qui doivent être suivies afin d'éviter d'éventuels dommages sur l'équipement.

## IMPORTANTI PRECAUZIONI DI SICUREZZA

### SICUREZZA

QUESTO ALIMENTATORE GENERA TENSIONI CHE SONO PERICOLOSE E POTREBBERO ESSERE MORTALI.  
PONI ESTREMA CAUTELA QUANDO OPERI CON QUESTO APPARECCHIO.

- Gli alimentatori ad alta tensione devono sempre essere collegati ad un impianto di terra.
- Non toccare le connessioni a meno che l'apparecchio sia stato spento e la capacità interna del carico e dell'alimentatore stesso siano scariche.
- Attendere cinque minuti per permettere la scarica della capacità interna dell'alimentatore ad alta tensione.
- Non mettere a terra il proprio corpo oppure operare in ambienti bagnati o saturi d'umidità.

### SICUREZZA NELLA MANUTENZIONE.

- Manutenzione potrebbe essere richiesta, rimuovendo la copertura con apparecchio acceso.
- La manutenzione deve essere svolta da personale qualificato, coscio dei rischi elettrici.
- Attenzione alle **AVVERTENZE** contenute nel manuale, che richiamano all'attenzione ai rischi quando si opera con tali unità e che potrebbero causare possibili ferite o morte.
- Le note di **CAUTELA** contenute nel manuale, indicano le procedure da seguire per evitare possibili danni all'apparecchio.

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# Chapter 1

## INTRODUCTION

### 1.1 Description Of The EPM/SMS Series

The EPM/SMS series of high voltage power supplies provides very well regulated, low ripple high voltage in a highly efficient, compact design. The dramatically reduced size of these modules compared to traditional high voltage modules, is obtained by a state of the art off-line resonant converter. The resonant converter utilizes a unique control scheme, which allows constant frequency operation while maintaining high efficiency. High operating frequency allows for very low ripple and excellent dynamic response capabilities.

The DC output voltage and current are controllable over the full range of operation. Monitoring and control signals are provided for simple, yet flexible control of the power supply. The EPM/SMS series operates from 24VAC  $\pm 10\%$  or 28Vdc  $\pm 10\%$  (The user should specify the input voltage at the time of order). The EPM series operates at 30W continuous and the SMS series operates at 60W continuous. Neither series requires forced air cooling. The ambient temperature must be kept below the maximum rating as specified in 1.2. Consult Spellman Sales Department for higher power capabilities of the EPM/SMS series.

The standard warranty applies to the EPM/SMS series modules. Consult factory about the warranty for custom modules.

### 1.2 EPM/SMS Specifications

- **Output Control:** Voltage and current are externally programmable over the entire range from zero to maximum rating via 0-10VDC reference or potentiometer. (Other scale factors for control and monitoring can be provided i.e. 1 volt per 10KV, 1 volt per 10mA etc.).
- **Input**
  - Voltage: 28Vdc  $\pm 10\%$ , 28Vdc  $\pm 10\%$  optional. (Consult the factory for other input voltages.)
  - Current: 5A max. on SMS models, 3A max. on EPM models.
- **Voltage Regulation:**
  - Load Regulation:** 0.01% of full voltage for a no load to full load change.
  - Line Regulation:**  $\pm 0.01\%$  of full voltage over the specified input voltage range.
- **Current Regulation:**
  - Load Regulation:** 0.05%  $\pm 25\mu\text{A}$  from 0 voltage to full voltage.
  - Line Regulation:**  $\pm 0.01\%$  of full current over the specified input voltage range.
- **Ripple:**
  - 0.1% p-p of output voltage.
- **Polarity:**
  - Positive or Negative polarity with respect to ground. (Specify at time of ordering).
- **Stability:**
  - 0.01% per hour after 1/2 hour warm up.
- **Temperature Coefficient:**
  - 100 ppm per  $^{\circ}\text{C}$ .
- **Temperature:**
  - Operating:  $-20^{\circ}\text{C}$  to  $-40^{\circ}\text{C}$
  - Storage:  $-40^{\circ}\text{C}$  to  $+80^{\circ}$
- **Monitoring:**
  - 0 to 10VDC corresponding to 0 to 100% of output voltage
  - 0 to 10VDC corresponding to 0 to 100% of output current. (Other scale factors available).
- **Control:**
  - Control signal for high voltage enable/disable.
- **Environmental:**
  - Indoor use
  - Altitude up to 2000 meters
  - 80% max. rel. humidity for temperatures up to  $31^{\circ}\text{C}$ , decreasing linearly to 50% rel. humidity at  $40^{\circ}\text{C}$ .
  - Pollution degree 2 (IEC664)

## IMPORTANT

**This control signal is not a safety interlock and should not be used for protection from high voltage generation for safety purposes.**

### 1.3 Standard Features

The EPM/SMS series incorporates several standard features designed to optimize user operation.

**Slow Start:** Provides a gradual increase in high voltage output until the maximum set point is reached. Various slow start times can be accommodated. Consult the Spellman's Sales Department for information on slow start options. (The slow start time will be a function of set point, input voltage and load conditions).

**Overvoltage Protection:** SMS series only. An overvoltage protection circuit monitors the output for excessive voltage generation. Overvoltage conditions can be caused by an excessive input program signal or an internal defect in the control circuits. If an overvoltage condition is detected, the power supply is latched off until input power is reset.

#### 1.3.1 Remote Operating Features

**Remote Programming:** Allows remote adjustment of the output voltage and current via an external voltage source.

**Remote Monitor:** Allows remote monitoring of the output voltage and current.

**High Voltage Enable/Disable:** Allows remote ON/OFF control of the high voltage.

**+10VDC Reference:** A +10VDC reference is provided for remote programming via a potentiometer or resistive divider.

### 1.4 Options

The options available are listed in Table 1.1. See section 5 for more information on the options along with operating and set-up instructions. With few exceptions, these options can be retrofitted to your power supply at

the factory in a short time. For price and retrofit arrangements, contact the Spellman Sales Department.

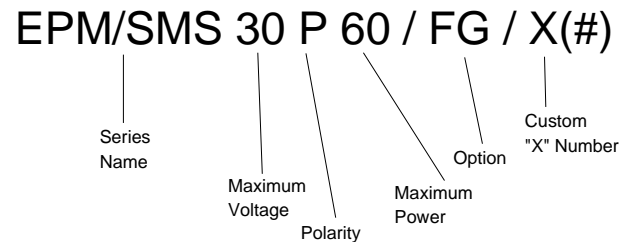
CODE DESCRIPTION	
• <b>FG</b>	Floating Ground
• <b>24</b>	24Vdc Input
• <b>NSS</b>	No Slow Start
• <b>LL(X)</b>	Extra Length Output Cable
•	Output Connector

**Table 1.1 Options**

### 1.5 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 output – positive (P), negative (N).
- (3) The maximum output (in watts).
- (4) The option code for all options that are included.
- (5) Custom "X" number representing details listed in a separate specification control drawing.



# Chapter 2

## Inspection and Installation

**I**nitial inspection and preliminary checkout procedures are recommended. For safe operation, please follow the step-by-step procedures described 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 EPM/SMS high voltage power supplies and components are covered by warranty. Custom and special order models (with an X suffix in the model number) are also covered by warranty.

### 2.2 Mechanical Installation

The EPM/SMS series module power supplies are designed for installation into existing or newly developed OEM equipment. The power supply can also easily fit into bench top applications or test set requirements. Standard unit dimensions are shown in Figure 2.1

For custom mounting requirements or specific package size requirements consult Spellman's Sales Department. Spellman has many package designs available, or can design a specific enclosure for your requirements.

The EPM/SMS series utilizes solid encapsulations for corona free operation. No periodic maintenance is required. Lower voltage units (under 6KV) utilize air insulation. Due to conservative voltage spacing design, periodic maintenance is not required

PIN	FUNCTION
1	Ground
2	+28Vdc
3	High Voltage Enable/Inhibit
4	Voltage Test Point: $10V \pm 2\% = 0$ to Rated Output
5	Current Test Point: $10V \pm 2\% = 0$ to Rated Output
6	Voltage Programming
7	Current Programming
8	+10.24Vdc Reference
9	Program and Test Point Return

Note: If Enable/Inhibit is not used, connect Pin 3 to Pin 8.

### Remote Programming:

Permits remote adjustment of the output voltage and current via an external voltage source. By adjusting the voltage source from 0V to 10V the desired output may be selected.

### Remote Monitor:

Test points, pins 4 and 5 of the input connector, monitor voltage and current outputs. The output polarity is positive from 0V to 10V equal to 0 to 100% of the output  $\pm 0.5\%$ . Output impedance is 1k Ohms.

### High Voltage Enable/Inhibit:

Control signal which allows the user to inhibit the power supply output without switching the HIGH VOLTAGE OFF. See Figures 3.7A and 3.7B.

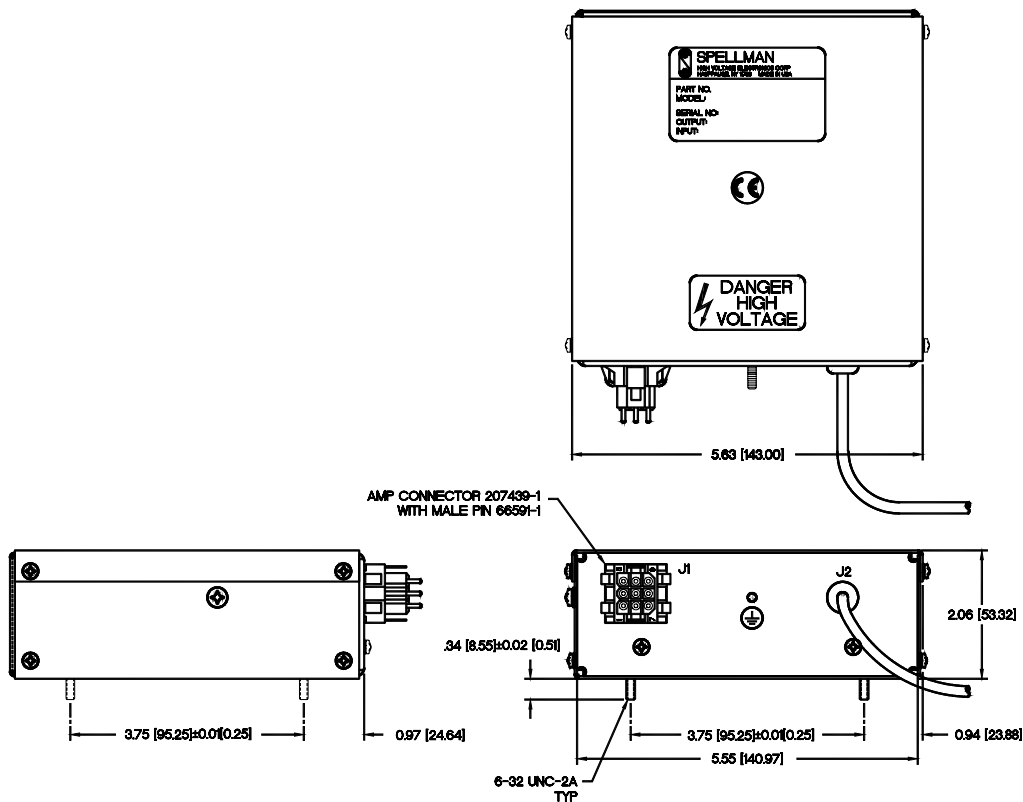


Figure 2.1 EPM Module Dimensions

PIN	FUNCTION
1	Ground
2	+28Vdc
3	High Voltage Enable/Inhibit
4	Voltage Test Point: $10V \pm 2\% = 0$ to Rated Output
5	Current Test Point: $10V \pm 2\% = 0$ to Rated Output
6	Voltage Programming
7	Current Programming
8	+10.24Vdc Reference
9	Program and Test Point Return
10	Not Used
11	Not Used
12	Not Used

### Remote Programming:

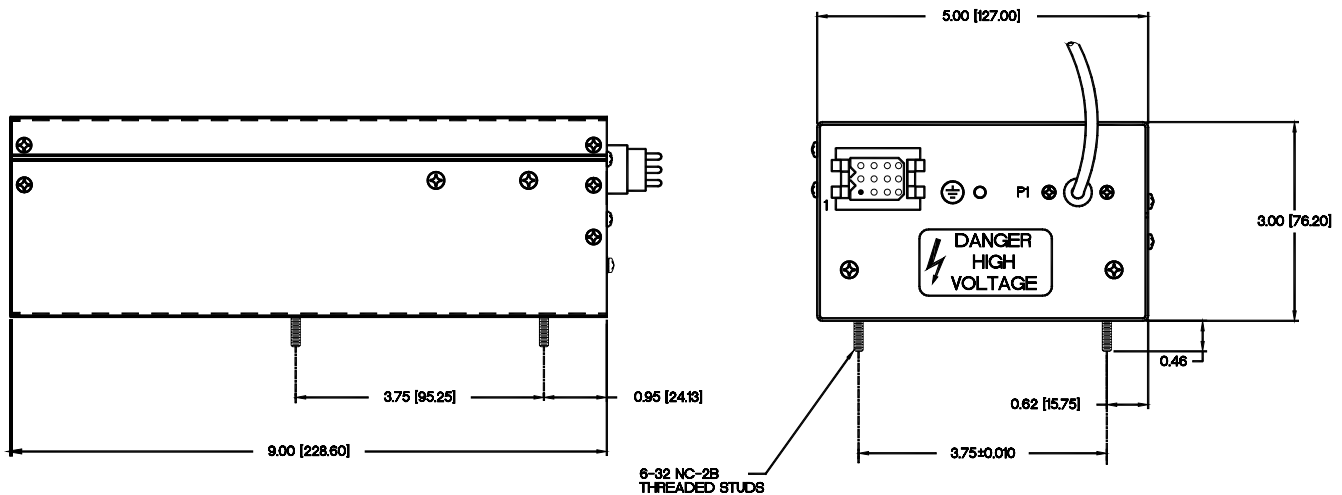
Permits remote adjustment of the output voltage and current via an external voltage source. By adjusting the voltage source from 0V to 10V the desired output may be selected.

### Remote Monitor:

Test points, pins 4 and 5 of the input connector, monitor voltage and current outputs. The output polarity is positive from 0V to 10V equal to 0 to 100% of the output  $\pm 0.5\%$ . Output impedance is 1k Ohms.

### High Voltage Enable/Inhibit:

Control signal which allows the user to inhibit the power supply output without switching the HIGH VOLTAGE OFF. See Figures 3.4A and 3.4B.



**Figure 2.2 SMS Module Dimensions**

## 2.3 Installation Instructions

The following are installation instructions for the below listed models. They are approved in accordance with EN60950:1993/AM1:1993/AM2:1993 and EN61010-1:1993. If installed in information technology equipment, the installation must comply with the above standard.

- The unit must be fused by an external 5A fuse.
- The unit is convection cooled.
- The maximum permitted temperature of the air surrounding the power supply is 40°C.
- The chassis of the power supply should be suitably connected to Protective Earth.

Model	Output Voltage	Output Power
SMS20X60	20kV/3mA	60W
SMS30X60	30kV/2mA	60W
SMS40X60	40kV/1.5mA	60W
SMS50X60	50kV/1.2mA	60W
SMS60X60	60kV/1mA	60W

**Table 2.1**

**Output Voltage and Current Ratings for  
24Vdc or 28Vdc /5A Models**

Dieses Gerat ist zugelassen gemaess EN60950:1993/AM1:1993/AM2:1993 and EN61010-1:1993. Im falle das diesses Gerat in Informationstechnik-einrichtung eingegaut werden soll, die installation muss gemaess den obengenannten Norn erfolgen.

- Das Garaet muss externe fliken Sicherungen Gesichert sein: 5A
- Kuehlung ohne Luefter.
- Maximale zugelassene Lufttemperatue un den Schaltnetztei: 40°C.
- Eine angemessene Verbindung zwischen den Metallrahmen des Netzteiles und Schutzerde muss erstellt sein.

Model	Ausgaenge	Output Power
SMS20X60	20kV/3mA	60W
SMS30X60	30kV/2mA	60W
SMS40X60	40kV/1.5mA	60W
SMS50X60	50kV/1.2mA	60W
SMS60X60	60kV/1mA	60W

**Table 2.1**

**Nennwerte  
24Vdc oder 28Vdc /5A**

# 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 connecting the power supply to the AC line, follow this step-by-step procedure.**

**Do not connect the power supply to the AC line until Step G is reached.**

**Failure to follow these procedures may void the warranty.**

A) Insure that the high voltage cable is properly terminated to the load. Insure that all circuits connected to the high voltage output are safely interlocked against accidental contact. Insure external load is discharged.

B) Check the input voltage rating on the serial nameplate of the supply and make certain that this is the rating of the available power source. EPM/SMS modules operate on 28Vdc unless ordered with a different input voltage option. External fusing is required for the DC input power. For the EPM/SMS series a 3A type fuse shall be used. The SMS series uses a 5A fuse.

C) **PROPER GROUNDING TECHNIQUE:** The chassis of high voltage power supplies must be grounded, preferably to a water system ground using copper pipe or other earth ground. See Figure 3.1 for a typical operating setup. The return line from the load should be connected to the power supply chassis. Using a separate external ground at the load is not recommended.

D) **Options Note:** See section 5 for hook up and operating instructions for the options on your unit. Custom models may also require set up changes.

E) **Hook-up:** Connect control and monitoring connections as described in this manual.

F) For initial turn-on, program the voltage and current for zero output. Connect the enable/disable signal to disable, open the interlock.

G) The DC input power may now be connected.

H) Enable the power supply via the enable/disable logic signal.

I) Slowly program the output voltage and current to desired level. Monitor the output voltage and current via the monitoring test points. Note equipment operation is normal, i.e. Load is behaving as predicted.

J) To turn high voltage off, use the enable/disable signal. If equipment is to be kept off for extended periods, disconnect power supply from the DC INPUT source.

**Note:** (SMS ONLY) If an over voltage condition occurs, the power supply will latch off. To reset the power supply, remove the line voltage and reconnect.

#### 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 VOLTAGE MONITOR ON THE POWER SUPPLY FRONT PANEL DOES NOT READ THE OUTPUT VOLTAGE WHEN THE POWER IS TURNED OFF, EVEN IF A CHARGE STILL EXISTS ON THE LOAD.**

#### CAUTION

**ALWAYS OPERATE THE UNIT WITH THE COVER ON. DO NOT ATTEMPT TO ACCESS OR REPAIR ANY INTERNAL CIRCUITS. DANGEROUS AND LETHAL VOLTAGES ARE GENERATED INSIDE THE MODULE.**

## 3.2 Standard Features

A note on remote interface circuitry and remote signal grounding: whenever possible, electrical isolation should be provided when interfacing with any high voltage power supply. For enable/disable signal connections, an isolated relay or optocoupler should be used. If possible, analog programming and monitoring signals should be isolated via analog isolation amplifiers. Spellman application engineers are available to assist in interface circuitry design. All interface cables should be properly shielded. All power supply signals should be referenced to the power supplies signal ground or power supply chassis ground

**REMOTE PROGRAMMING:** Allows remote adjustment of the output voltage and current via an external voltage source. A 0 to 10VDC signal is supplied to Pin 6 of the control input connector for voltage programming. A 0 to 10 VDC signal is supplied to Pin 7 of the control input connector for current programming. Programming signals should be referenced to Pin 9 of the control input connector signal ground. By adjusting the voltage source from 0 volts (zero output) to 10 volts (full rated output) the desired output can be selected. See Figure 3.2A and 3.5B for wiring diagram and specifications.

An alternate method of controlling the output remotely is by using external resistance such as a potentiometer or a resistor network. See Figure 3.2B and 3.5B for wiring diagram.

**Remote Monitoring:** Test points are made available for monitoring the voltage and current output. The test points are always positive regardless of the output polarity, where zero (0) to 10 (10) volts equals 0-100% of the output. See Figure 3.3 and 3.6 for test point wiring.

**Enable/Disable Control:** Remote control of the high voltage on and high voltage off can be done via the enable/disable control. See Figure 3.4 and 3.7 for recommended interface circuits.

### WARNING

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





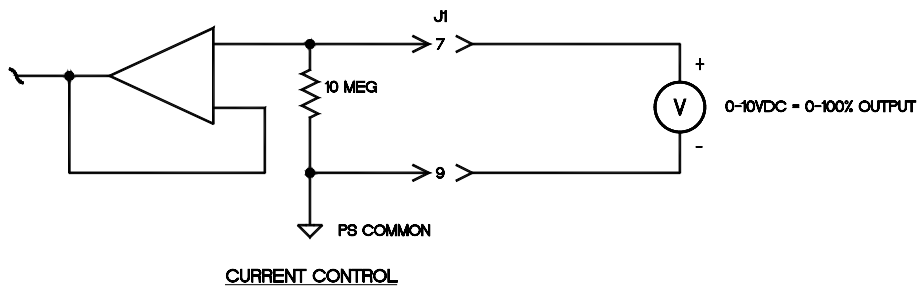
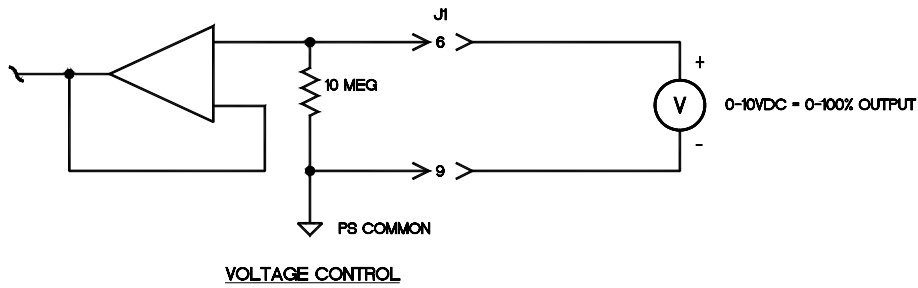


Figure 3.2A SMS Remote Programming Via Voltage Source

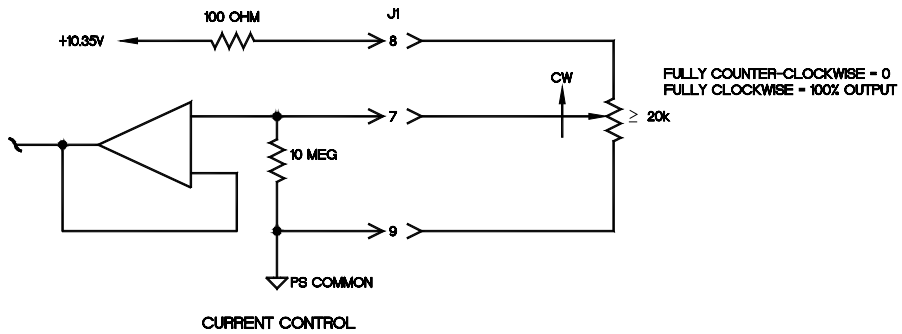
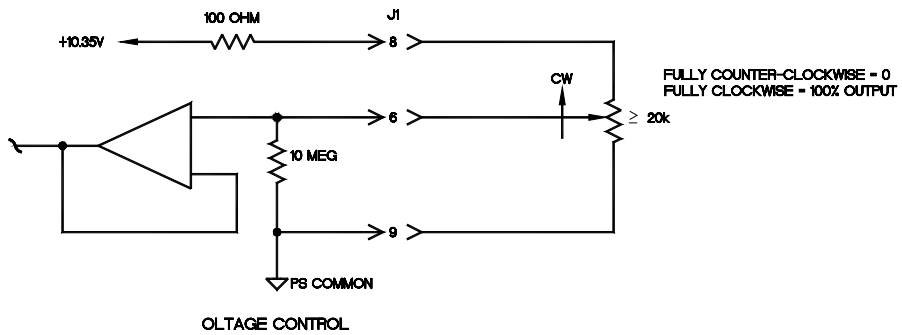


Figure 3.2B SMS Remote Programming Via External Resistance

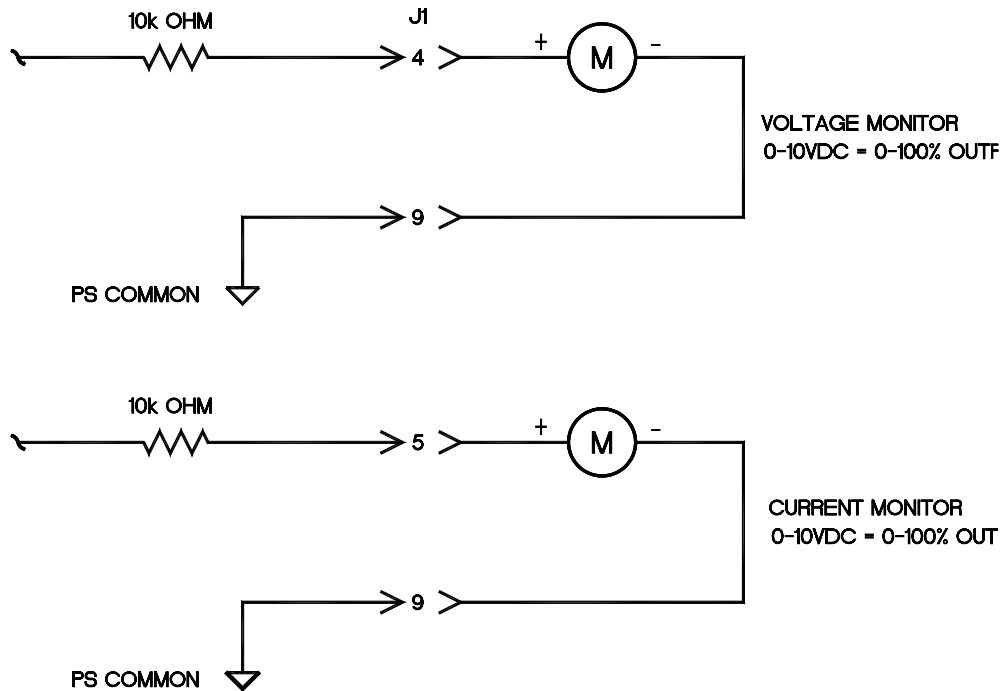


Figure 3.3 SMS Remote Monitoring

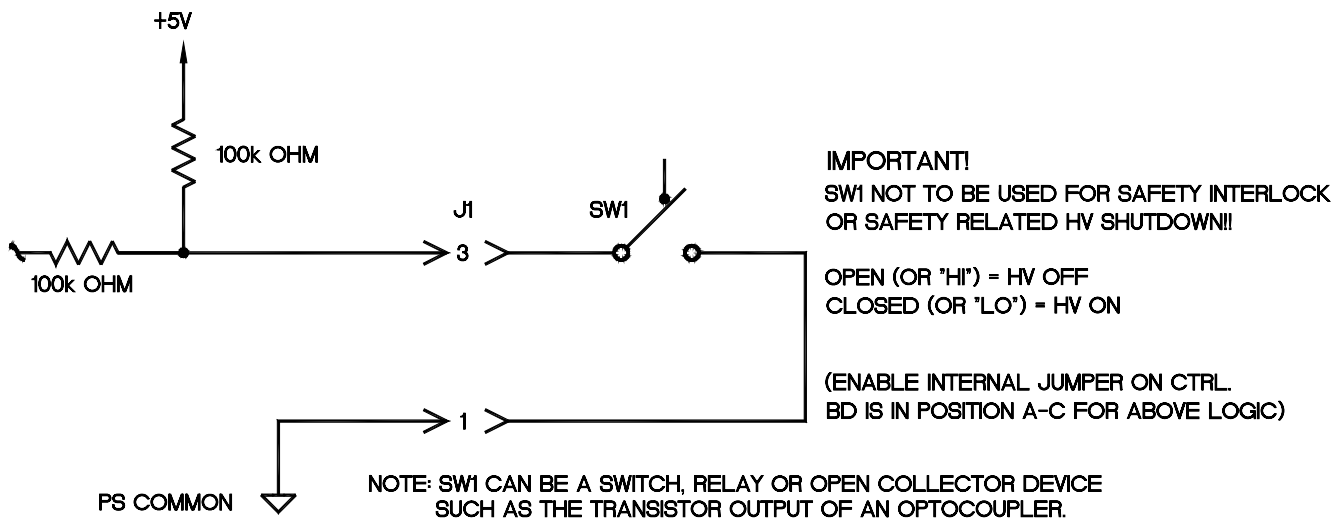


Figure 3.4A SMS HV ON/OFF Enable (Low) Control

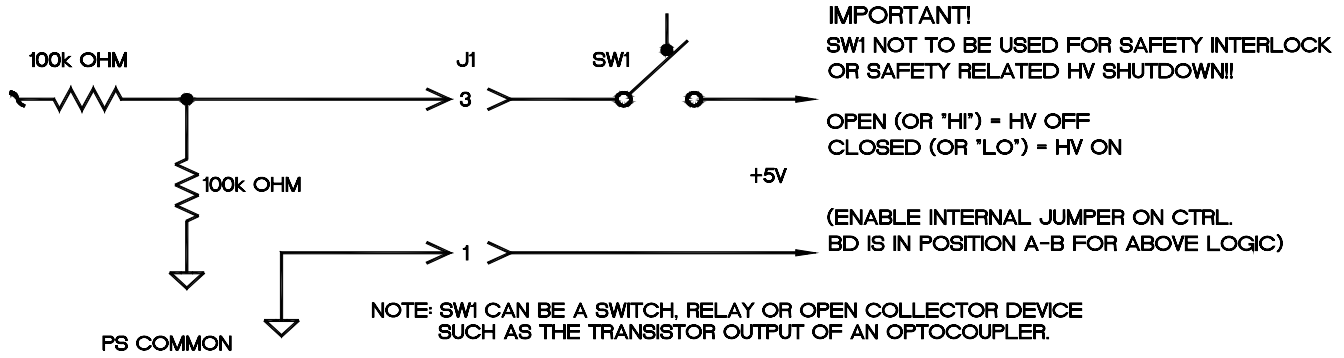


Figure 3.4B SMS HV ON/OFF Enable (Hi) Control

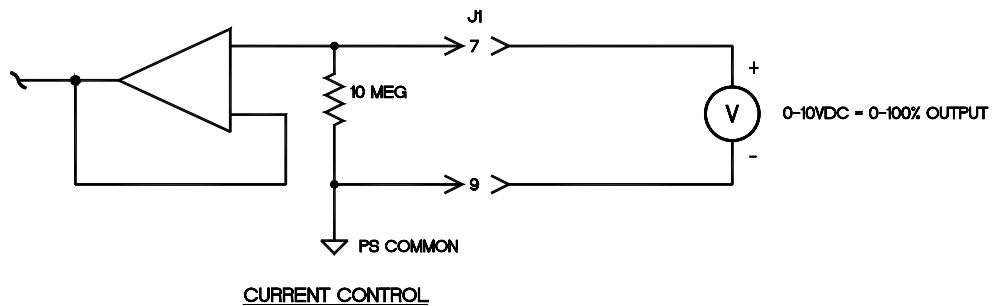
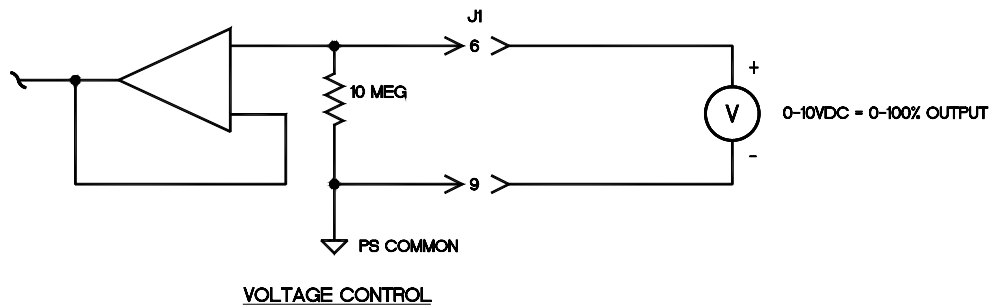
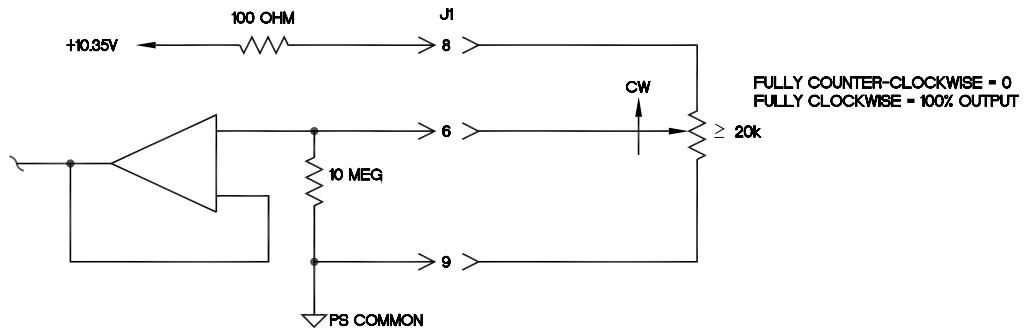
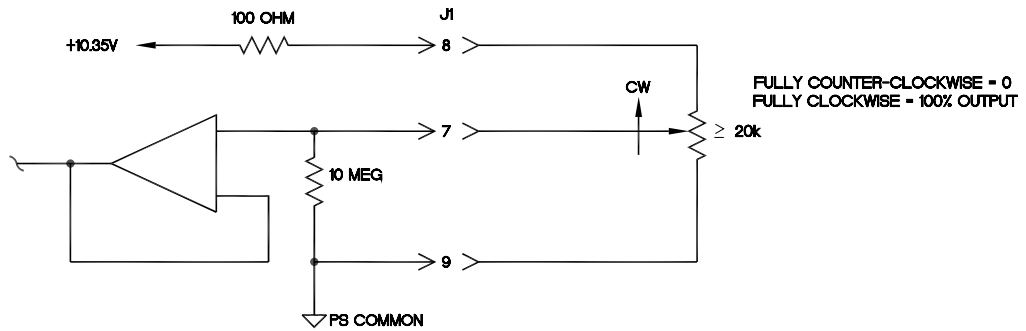


Figure 3.5A EPM Remote Programming Via Voltage Source



VOLTAGE CONTROL



CURRENT CONTROL

Figure 3.5B EPM Remote Programming Via External Resistance

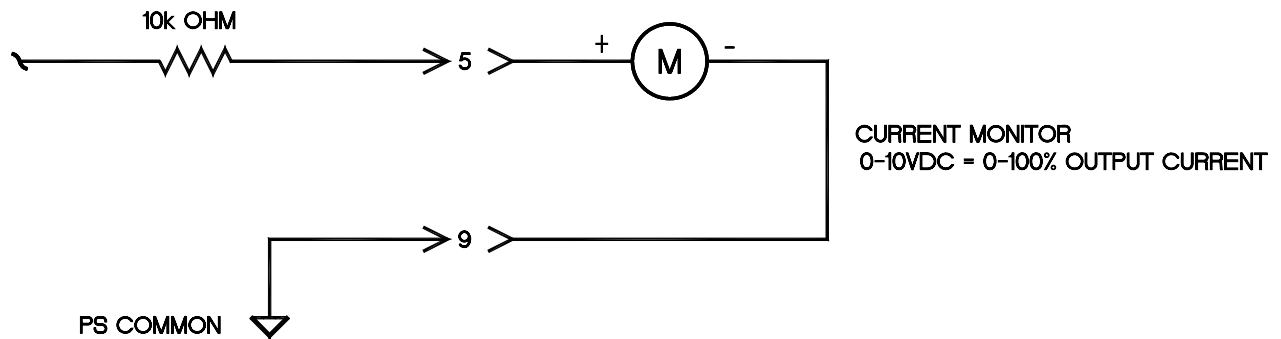
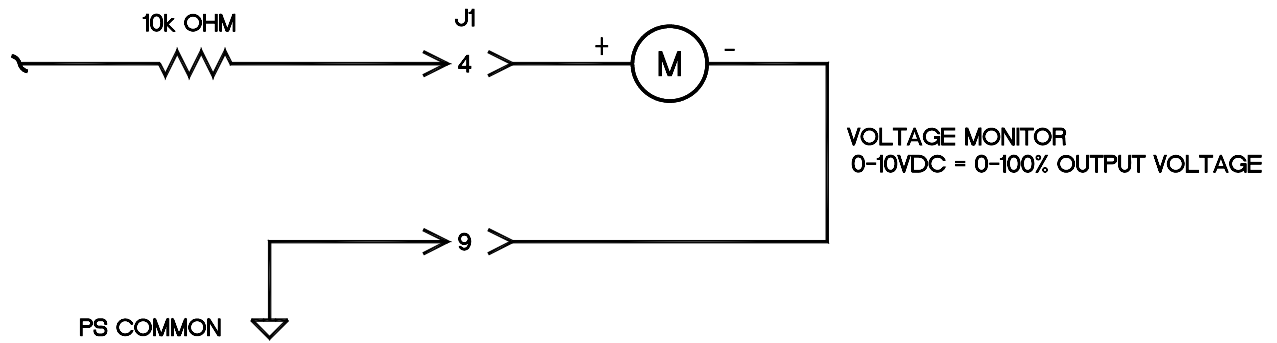
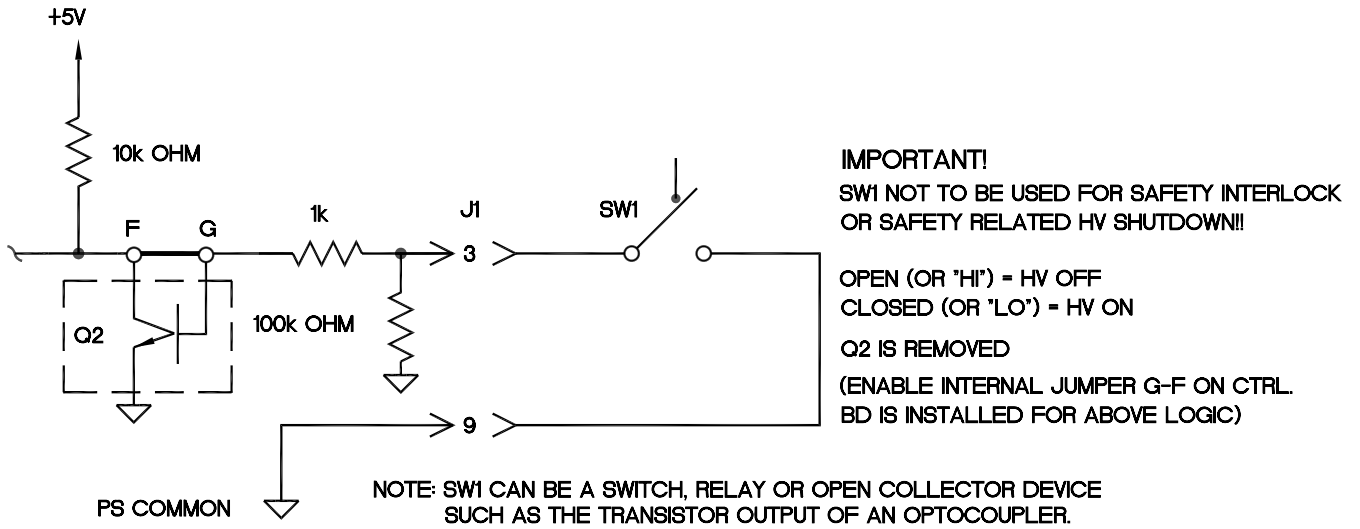
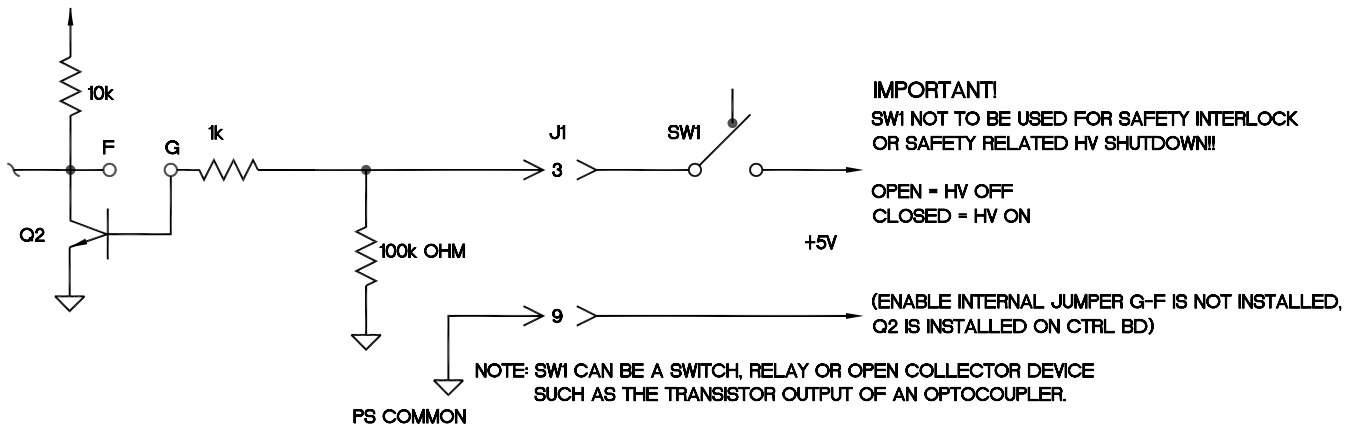


Figure 3.6 EPM Remote Monitoring



**Figure 3.7A EPM HV ON/OFF Enable (Low) Control**



**Figure 3.7B EPM HV ON/OFF Enable (Hi) Control**

# Chapter 4

## PRINCIPLES OF OPERATION

The EPM/SMS Series of high voltage power supplies utilizes sophisticated power conversion technology.

Advanced analog and power conversion techniques are used in the EPM/SMS series. The intention of the Principles of Operation is to introduce the basic function blocks of the EPM/SMS series power supply. For details on a specific circuit, consult Spellman's Engineering Department.

The EPM/SMS series power supply is basically an DC to DC power converter. Within the power supply, conversions of DC to high frequency AC, then to high voltage DC take place.

Typical EPM/SMS series power supplies comprise a few basic building blocks. These are: 1) High frequency quasi-resonant inverter, 2) High voltage transformer and rectifier circuits, and 3) Control and monitoring circuits. The following is a brief description of each building block.

### WARNING

**The energy levels used and generated by the power supply can be lethal! Do not attempt to operate the power supply unless the user has a sufficient knowledge of the dangers and hazards of working with high voltage. Do not attempt to approach or touch any internal or external circuits or components that are connected or have been connected to the power supply. Be certain to discharge any stored energy that may be present before and after the power supply is used. Consult IEEE recommended practices for safety in high voltage testing #510-1983.**

### 4.1 High Frequency Inverter

The EPM/SMS series uses a resonant converter operating in a zero current switching, resonant flyback and forward converter topology. MOSFET transistors switch DC voltage to the resonant circuit. Typical operating frequency is in the range of 30-35KHz depending on model. Control of the resonant circuit output is done by the low voltage control circuits. The resonant circuitry consists of a resonant inductor and step-up transformer.

### 4.2 High Voltage Circuits

The high voltage transformer is a step-up type. The secondary of the high voltage transformer is connected to the high voltage rectifier circuit. The rectifier circuit will vary depending upon the rated output voltage. For lower output voltage, a full bridge or doubler circuit is used. For higher voltages, a half wave Cockroft-Walton multiplier is used. A feedback signal is generated by the high voltage resistor divider. This feedback signal is sent to control circuits to provide voltage regulation and monitoring. A current sense resistor is connected at the low voltage end of the rectifier circuit. The circuit sense signal is sent to the control circuits to provide current regulation and monitoring.

In the SMS series, an auxiliary voltage sense signal is generated by the overvoltage protection feedback resistor. This is used to provide overvoltage protection.

The high voltage rectifier output is connected to an R-C type filter to reduce high frequency ripple components. The filter is then connected to the output limiting resistors. These resistors limit the peak surge current in the event an arc or discharge occurring. The limiting resistor output is connected to the output cable or connector provided.

### 4.3 Control Circuits

Control circuits are used for regulation, monitoring, pulse-width, control, slow-start and inhibit control. Feedback signals are calibrated and buffered via general purpose OP-AMPS. Pulse width control is accomplished by a typical PWM type control I.C. Logic enable/disable is provided by a logic gate I.C. Regulators generate +/- 15V and 10VDC.

### 4.4 Options

Due to the variations of models and options provided in the EPM/SMS series, details of actual circuits used may differ slightly from above descriptions. Consult Spellman's Engineering Department for questions regarding the principles of operations for the EPM/SMS.

# Chapter 5

## OPTIONS

The options available for this power supply are described in this section. Interface diagrams are shown where required. Options are specified by including the option code in the model number as described in Section 1.4.

### 5.1 Floating Ground **FG**

The floating ground option allows isolation of the power supply common from chassis ground. A typical application for FG is for connection of an external meter or circuit into the FG signal point. This circuit can monitor actual current flow at a low voltage level. See Figure 5.1 for typical connection to the floating ground terminal.

#### IMPORTANT

**The power supply common must be connected to chassis ground through a low impedance circuit. The power supply common is clamped to chassis ground using a power zener diode. This diode is not intended to clamp under continuous operation. On higher current units the power dissipation within the zener diode can be excessive if allowed to clamp.**

### 5.2 24Vdc **24**

EPM/SMS series power supplies with the 24Vdc input option will operate from an input voltage of 24Vdc±10%

### 5.3 No Slow Start **NSS**

The no slow start option causes the output voltage of the power supply to rise (within 500 msec) to the rated voltage upon Power Up.

### 5.4 Non-Standard Slow Start **SS(x)**

The non-standard slow start option allows the gradual rise time of the output voltage to be different from the standard of six seconds. To order the option, place the time desired in seconds after the suffix letter; i.e. SS(10) denotes a 10 second rise time.

### 5.5 Extra Length Output Cable **LL(ft)**

Standard output cable is 18" long. Other lengths may be specified.

### 5.6 Custom Designed Models **X(#)**

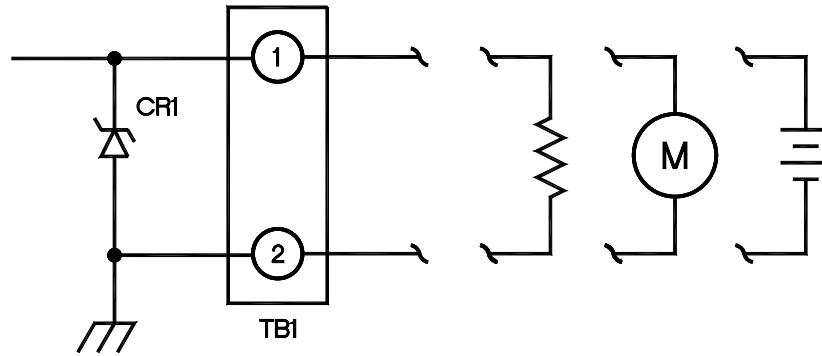
Units built to customer specifications are assigned an X number by the factory. If this unit is an X model, specification control sheet is added at the end of this instruction manual.

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



To internal high voltage return circuits.

Pin 2 internally connected to power supply chassis.



CR1- Polarity dependent on output voltage polarity. Zener voltage is 15V standard. Up to 50V is available. Consult factory.

**IMPORTANT:** Power dissipation in CR1 should not exceed 1W. This can be accomplished by keeping chassis and power ground voltage below Zener voltage. CR1 is for safety and transient protection only, and is not designed for continuous clamping.

**Figure 5.1 Floating Ground Interface Circuit**

# Chapter 6

## MAINTENANCE

This section describes periodic servicing 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

The EPM/SMS series does not require periodic maintenance or servicing.

### 6.2 Performance Test

### WARNING

**HIGH VOLTAGE IS DANGEROUS. ONLY QUALIFIED PERSONNEL SHOULD PERFORM THESE TESTS.**

High voltage test procedures are described in Bulletin STP-783, Standard Test Procedures for High Voltage Power Supplies. Copies 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. All test components must be rated for operating voltage.

### 6.3 High Voltage Dividers

High voltage dividers for precise measurements 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.

# Chapter 7

## REPLACEMENT PARTS

### 7.1 Replacement Parts

**S**Pellman provides parts and assemblies for its high voltage power supplies but recommends that only qualified personnel perform the repair. 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.

### 7.2 Correspondence And Ordering Spare Parts

Each 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.

When ordering spare parts, please specify the part's description, the part's reference designation or part number, and the model and serial number of the unit.

# 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 procedures described in Section 8.2. The customer shall pay for 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 the rear of the power supply, and the purchase order number for the repair. A Return Material Authorization Code Number (RMA Number) is needed 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. The Customer shall pay for 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 the Spellman 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

TEL: (631) 630-3000 FAX: (631) 435-1620

E-Mail: [sales@Spellmanhv.com](mailto:sales@Spellmanhv.com)

<http://www.spellmanhv.com>

# SPELLMAN HIGH VOLTAGE ELECTRONICS

## WARRANTY

**Spellman** High Voltage Electronics ("**Spellman**") warrants that all power supplies it manufactures will be free from defects in materials and factory workmanship, and agrees to repair or replace, without charge, any power supply that under normal use, operating conditions and maintenance reveals during the warranty period a defect in materials or factory workmanship. The warranty period is twelve (12) months from the date of shipment of the power supply. With respect to standard SL power supplies (not customized) the warranty period is thirty-six (36) months from the date of shipment of the power supply.

This warranty does not apply to any power supply that has been:

- Disassembled, altered, tampered, repaired or worked on by persons unauthorized by **Spellman**;
- subjected to misuse, negligent handling, or accident not caused by the power supply;
- installed, connected, adjusted, or used other than in accordance with the original intended application and/or instructions furnished by **Spellman**.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING THOSE OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

The buyer's sole remedy for a claimed breach of this warranty, and **Spellman's** sole liability is limited, at **Spellman's** discretion, to a refund of the purchase price or the repair or replacement of the power supply at **Spellman's** cost. The buyer will be responsible for shipping charges to and from **Spellman's** plant. The buyer will not be entitled to make claim for, or recover, any anticipatory profits, or incidental, special or consequential damages resulting from, or in any way relating to, an alleged breach of this warranty.

No modification, amendment, supplement, addition, or other variation of this warranty will be binding unless it is set forth in a written instrument signed by an authorized officer of **Spellman**.

### Factory Service Procedures

For an authorization to ship contact **Spellman's** Customer Service Department. Please state the model and serial numbers, which are on the plate on the rear panel of the power supply and the reason for return. A Return Material Authorization Code Number (RMA number) is needed from **Spellman** for all returns. The RMA number should be marked clearly on the outside of the shipping container. Packages received without an RMA Number may delay return of the product. The buyer shall pay shipping costs to and from **Spellman**. Customer Service will provide the Standard Cost for out-of-warranty repairs. A purchase order for this amount is requested upon issuance of the RMA Number (in-warranty returns must also be accompanied by a "zero-value" purchase order). A more detailed estimate may be made when the power supply is received at **Spellman**. In the event that the cost of the actual repair exceeds the estimate, **Spellman** will contact the customer to authorize the repair.

### Factory Service Warranty

**Spellman** will warrant for three (3) months or balance of product warranty, whichever is longer, the repaired assembly/part/unit. If the same problem shall occur within this warranty period **Spellman** shall undertake all the work to rectify the problem with no charge and/or cost to the buyer. Should the cause of the problem be proven to have a source different from the one that has caused the previous problem and/or negligence of the buyer, **Spellman** will be entitled to be paid for the repair.

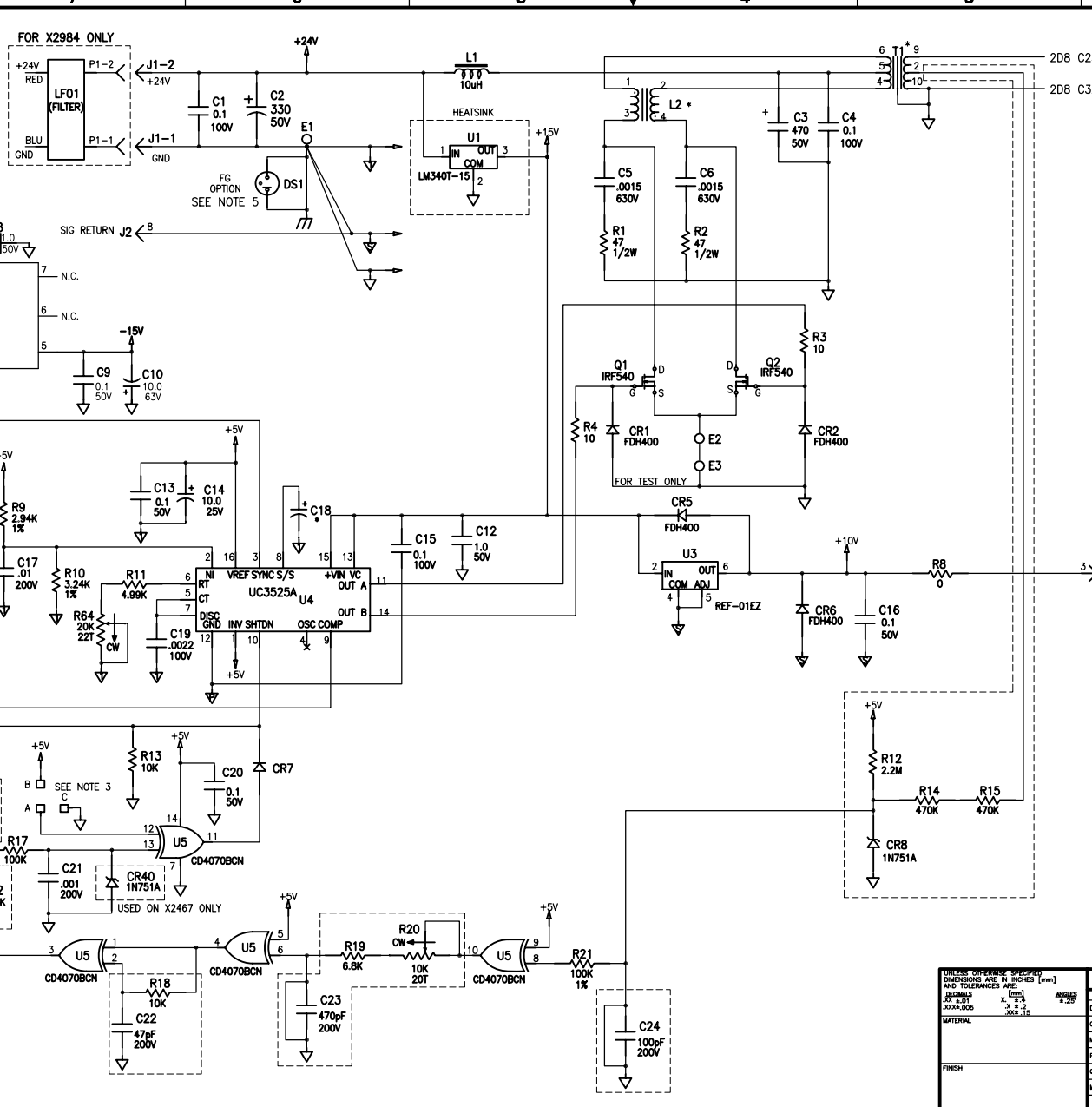
### Spellman Worldwide Service Centers

For a complete listing of **Spellman's** Global Service facilities please go to:  
<http://www.spellmanhv.com/customerservice/service.asp>

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**DESCRIPTION OF HOLES**

SYN	DESCRIPTION	QTY

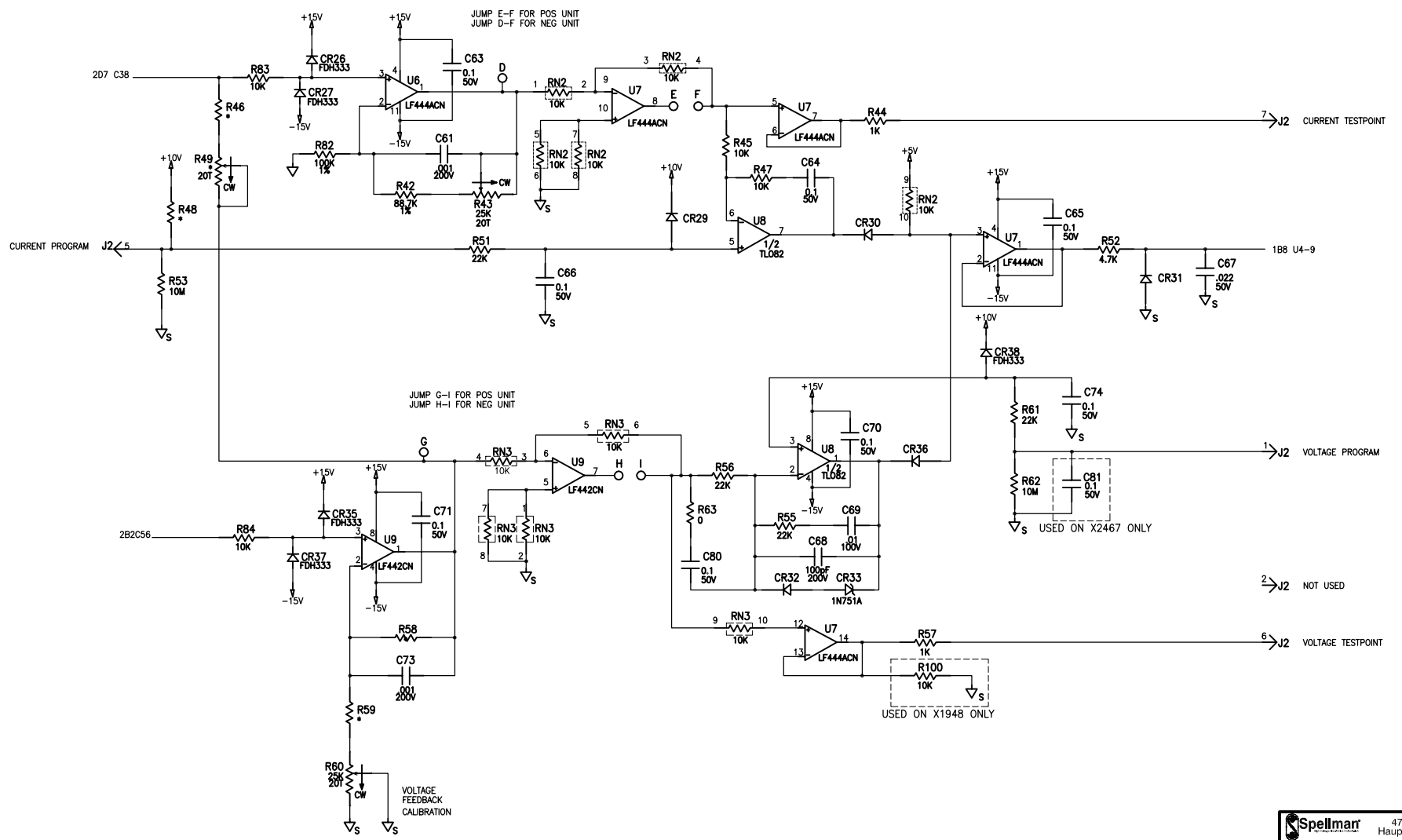


REVISIONS		DATE	DESIGN	APP'D	QUALITY	REV
A	RELEASED PER EDR 2886	1/27/92	J/A	P.H.	X.X.	X/A
B	REVISED PER ECN NO. 6324	6/16/92	J/A	P.H.	X.X.	X/A
B1	ECN 6487, B.O.M. CHANGE FOR 33KV OPTION	6/16/92	J/A	P.H.	X.X.	X/A
B2	REVISED PER ECN NO. 6560	5/24/92	J/A	P.H.	X.X.	X/A
B3	REVISED PER ECN NO. 6587,6588 SHT4 REV	10/24/92	J/A	P.H.	X.X.	X/A
B4	REVISED PER ECN NO. 6664,6737 SHT4 REV	10/27/92	J/A	P.H.	X.X.	X/A
B5	REVISED PER ECN NO. 6801 SEE SHT 4	10/27/92	J/A	P.H.	X.X.	X/A
B	REVISED PER ECN NO. 6324	1/27/92	J/A	P.H.	X.X.	X/A
B6	REVISED PER ECN NO. 6800, B.O.M. CHANGE	12/31/92	J/A	P.H.	X.X.	X/A
B7	REVISED PER ECN NO. 7032, 7211	4/23/93	J/A	P.H.	X.X.	X/A
B8	REVISED PER ECN NO. 7359	8/2/93	J/A	P.H.	X.X.	X/A
B9	REVISED PER ECN NO. 7884, REV'D 33KV TB	9/17/93	J/A	P.H.	X.X.	X/A
B10	REVISED PER ECN NO. 7517	9/30/93	J/A	P.H.	X.X.	X/A
B11	REVISED PER ECN NO. 7692, SHT 4	1/12/94	J/A	P.H.	X.X.	X/A
B12	REVISED PER ECN NO. 7890	4/19/92	J/A	P.H.	X.X.	X/A
B13	REVISED PER ECN NO. 7946	5/20/94	J/A	P.H.	X.X.	X/A
B14	REVISED PER ECN NO. 8165	8/11/94	J/A	P.H.	X.X.	X/A
B15	REVISED PER ECN NO. 8528, ADDED X2118	12/30/94	J/A	P.H.	X.X.	X/A
B16	REVISED PER ECN NO. 8699, REV'D 30KV	3/17/95	J/A	P.H.	X.X.	X/A
B17	REVISED PER ECN NO. 8793	4/14/95	J/A	P.H.	X.X.	X/A
B18	REVISED PER ECN NO. 8850	5/12/95	J/A	P.H.	X.X.	X/A
B19	REDRAW WITHOUT CHANGE	1/16/96	J/A	P.H.	X.X.	X/A
B19	REVISED PER ECN NO. 9531	4/4/96	J/A	P.H.	X.X.	X/A
B20	REVISED PER ECN NO. 11152	2/4/98	J/A	P.H.	X.X.	X/A
B21	REVISED PER ECN NO. 11415, ADDED X2715	4/10/98	J/A	P.H.	X.X.	X/A
B23	REVISED PER ECN NO. 11727	1/18/98	J/A	P.H.	X.X.	X/A
B23	REVISED PER ECN NO. 13020	1/31/00	J/A	P.H.	X.X.	X/A
B24	REVISED PER ECN NO. 13021	2/3/00	J/A	P.H.	X.X.	X/A
G	REVISED PER ECN NO. 14043	6/19/01	J/A	P.H.	X.X.	X/A
G1	REVISED PER ECN NO. 14353	6/29/01	J/A	P.H.	X.X.	X/A
H	REVISED PER ECN NO. 15045	4/28/02	J/A	P.H.	X.X.	X/A
H1	REVISED PER ECN NO. 18704	3/7/08	J/A	P.H.	X.X.	X/A
H2	REVISED PER ECN NO. 20223	4/24/07	J/A	P.H.	X.X.	X/A
H3	REVISED PER ECN NO. 20814	10/2/07	J/A	P.H.	X.X.	X/A

- NOTES:
- UNLESS OTHERWISE SPECIFIED:
    - RESISTORS ARE IN OHMS, 1/4W. ALL 1% RESISTORS ARE RN TYPE.
    - CAPACITORS ARE IN MICROFARADS.
    - DIODES ARE FDH400.
    - CAPACITOR VALUES IN THIS SECTION ARE .001/12KV, DIODES ARE H1701-12.
  - \* SEE TABLE ON SHEET 4 FOR VALUES.
  - JUMP A-B FOR ENABLE  
JUMP A-C FOR ENABLE
  - = □ OPTIONAL CIRCUITRY.
  - NOT USED IN TUV CERTIFIED MODELS.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES [mm]		APPROVALS		Spellman 475 Wireless Boulevard Hauppauge, New York 11788	
ANGLES UNLESS OTHERWISE SPECIFIED ARE 90°		BY	DATE	Schematic Diagram POWER SUPPLY SMS60 GEN3	
DRAWN	J. Janyak/JH	5/21/91	SIZE CODE IDENT NO. DRAWING NO.		
CHECKED	J. Janyak/JH	9/18/91	D 10610	440395-009	H3
MECH. DESIGN	J/A	N/A	REV		
PROJ. ENG.	P. Janyak	3/9/92	SCALE: NONE THIRD ANGLE PROJECTION SHEET 1 OF 4		
Q.A.	K. Janyak	3/6/92	DO NOT SCALE DRAWING		
MFG. ENG.	J/A	N/A	BREAK ALL SHARP EDGES & CORNERS		

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Spellman 475 Wireless Boulevard  
Hauppauge, New York 11788

**SCHMATIC DIAGRAM  
POWER SUPPLY  
SMS60 GEN3**

SIZE	CODE IDENT NO.	DRAWING NO.	REV
D	10610	440395-009	H3
SCALE: NONE	THIRD ANGLE PROJECTION	SHEET 2 OF 4	

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TABLE 1

KV OPTION												JUMPER BETWEEN			NO.OF MULT STAGES	JUMPER BETWEEN	GAP	R16	R22				
	R32	R46	R48	R49	C18	R58	R59	R80	R23-R29	C72	L2	T1	C41/C42	C44/C45						C46/C47			
01KV	SEE SCHEMATIC 440395-015																				IN	OUT	
03KV	SEE SCHEMATIC 440395-008																					IN	OUT
05KV	SEE SCHEMATIC 440395-008																				IN	OUT	
10KV	SEE SCHEMATIC 440395-011																				IN	OUT	
15KV	SEE SCHEMATIC 440395-014																		2			IN	OUT
20KV	226K,1%	133K,1%	N/U	50K,20T	10,25V	249K,1%	37.4K,1%	1.82K,1%	15K,1.0W,10%	.15,50V	302891-002	403562-001	JUMP C50 TO C42			2	CR20-C CR13-A	1M	IN	OUT			
30KV	210K,1%	115K,1%	N/U	50K,20T	10,25V	158K,1%	40.2K,1%	2.49K,1%	18K,1.0W,10%	.15,50V	302891-002	403562-001	JUMPER	JUMPER	JUMPER	3	CR20-C CR15-A	1M	IN	OUT			
40KV	210K,1%	100K,1%	N/U	50K,20T	10,25V	158K,1%	57.6K,1%	3.24K,1%	22K,1.0W,10%	.15,50V	302891-002	403562-001				4	CR20-C CR17-A	1M	IN	OUT			
50KV	210K,1%	86.6K,1%	N/U	50K,20T	10,25V	100K,1%	57.6K,1%	4.12K,1%	22K,1.0W,10%	.15,50V	302891-003	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
60KV	210K,1%	75K,1%	N/U	50K,20T	10,25V	100K,1%	57.6K,1%	5.36K,1%	27K,1.0W,10%	.15,50V	302891-003	403562-001				6	NONE REQ'D	1M	IN	OUT			
X1607A	210K,1%	86.6K,1%	22K	50K,20T	10,25V	100K,1%	57.6K,1%	2.49K,1%	47K,1.0W,10%	.15,50V	302891-002	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
X1785	210K,1%	43.2K,1%	22K	25K,20T	10,25V	2.49K,1%	4.99K,1%	5.76K,1%	22K,1.0W,10%	.15,50V	302891-001	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
33KV	255K,1%	115K,1%	N/U	50K,20T	10,25V	158K,1%	46.4K,1%	2.80K,1%	22K,1.0W,10%	.15,50V	302891-002	403562-001				4	CR20-C CR17-A	NONE	IN	OUT			
X1948	210K,1%	43.2K,1%	22K	25K,20T	10,25V	2.49K,1%	4.99K,1%	5.76K,1%	22K,1.0W,10%	.15,50V	302891-001	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
X1844	210K,1%	86.6K,1%	N/U	50K,20T	10,25V	100K,1%	57.6K,1%	4.12K,1%	22K,1.0W,10%	.15,50V	302891-004	403562-001				5	CR20-C CR19-A	1M	OUT	IN			
X2118	210K,1%	86.6K,1%	22K	50K,20T	10,25V	100K,1%	57.6K,1%	2.49K,1%	47K,1.0W,10%	.15,50V	302891-005	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
X2715	255K,1%	86.6K,1%	N/U	50K,20T	10,25V	165K,1%	88.7K,1%	4.99K,1%	22K,1.0W,10%	.15,50V	302891-003	403562-001				5	CR20-C CR19-A	1M	IN	OUT			
X2973	301K,1%	140K,1%	N/U	50K,20T	10,25V	100K,1%	88.7K,1%	1.0K,1%	10K,1.0W,5%	.15,50V	302891-002	403562-003				2	CR20-C CR13-A	1M	IN	OUT			
X3744	210K,1%	75K,1%	N/U	50K,20T	10,25V	100K,1%	88.7K,1%	5.36K,1%	27K,1.0W,10%	.15,50V	302891-003	403562-001	JUMPER	JUMPER	JUMPER	6	NONE REQ'D	1M	IN	OUT			

**Spellman** 475 Wireless Boulevard  
Hauppauge, New York 11788

**SCHEMATIC DIAGRAM  
POWER SUPPLY  
SMS60 GEN3**

SIZE	CODE IDENT NO.	DRAWING NO.	
D	10610	440395-009	H3
SCALE: NONE	THIRD ANGLE PROJECTION		SHEET 4 OF 4