Instruction Manual

EVA SERIES

High Voltage Power Supply

MODEL:
SERIAL#:
DATE:

SPELLMAN
HIGH VOLTAGE ELECTRONICS CORPORATION
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Spellman’s new EVA Series of rack mountable high voltage power supplies are specifically designed for demanding electron beam coating applications. A full featured front panel allows easy local control, while an extensive analog interface provides comprehensive remote capability. The included Ethernet and RS-232 digital interfaces simplify integrating the EVA into your system design.

The EVA’s robust IGBT inverter design is inherently fault tolerant. The proprietary low capacitance, low stored energy high voltage output section is ideal for dynamic load and fault conditions encountered in e beam applications. Fast arc recovery times (< 2ms) allows the output voltage to quickly recover minimizing process interruptions. Many operational parameters can be configured by the user to suit their particular requirements via the provided graphical user interface (GUI).

An optional filament gun supply is available. The EVA can support one, two or three filament gun supply channels providing unprecedented flexibility and cost effectiveness.

### HARDWARE BASED OPTIONS

- **3PH**: 180-264Vac Three Phase Input
- **1PH**: 180-264Vac Single Phase Input (3kW & 6kW only)
- **400VAC**: 360-528Vac, Three Phase Input (12kW only)
- **LL(X)**: High Voltage Cable Length
- **HV2**: Two High Voltage Output Connectors
- **HV3**: Three High Voltage Output Connectors
- **FIL1**: Filament Gun Supply—One Channel
- **FIL2**: Filament Gun Supply—Two Channels
- **FIL3**: Filament Gun Supply—Three Channels
- **HPF**: 50 Amp Filament Supply

### SOFTWARE CONFIGURABLE FEATURES

- Adjustable Overload Trip
- Arc Trip Count
- Arc Quench Time
- Arc Reramp Time
- Arc Window Time

### 3/6/12KW HV SPECIFICATIONS

**Input Voltage:** (must be specified at time of order)
- Option 3PH: 180-264Vac, 50/60Hz, three phase, 90% efficiency, 0.85 power factor
- Option 1PH: 180-264Vac 50/60Hz, single phase, 90% efficiency, 0.65 power factor (3kW & 6kW only)
- Option 400VAC: 360-528Vac 50/60Hz, three phase, 90% efficiency, 0.85 power factor (12kW only)

**Input Current:**
- Option 3PH: 180-264Vac, 50/60Hz, three phase
  - 3kW—13 amps, maximum
  - 6kW—25 amps, maximum
  - 12kW—50 amps, maximum
- Option 1PH: 180-264Vac, 50/60Hz, single phase
  - 3kW—29 amps, maximum
  - 6kW—57 amps, maximum
- Option 400VAC: 360-528Vac, 50/60 Hz, three phase, 12kW—25 amps, maximum

**Output Voltage:**
- 5kV @ 600mA, negative polarity. 3kW maximum.
- 10kV @ 600mA, negative polarity. 6kW maximum.
- 10kV @ 1200mA, negative polarity. 12kW maximum.

**Local Output Controls:**
- Voltage is continuously adjustable over entire range via a 10 turn potentiometer.

**Voltage Regulation:**
- Load: 0.05% of full voltage +500mV for full load change.
- Line: 0.05% of full voltage +500mV over specified input range.

**Ripple:**
- <1% p-p Vrms

**Stability:**
- 0.02% hr. after 1 hour warm-up.

**Temperature Coefficient:**
- 100ppm/°C.

**Environmental:**
- **Temperature Range:**
  - Operating: 0°C to 40°C
  - Storage: -40°C to 85°C
- **Humidity:**
  - 10% to 90% RH, non-condensing.

**Cooling:**
- Forced air; inlet through side panels, outlet at rear panel

**Metering:**
- Front panel digital voltage and current meters, 3.5 digit, accurate to within 1%.
3/6/12KW HV SPECIFICATIONS

System Status Display:
“Dead Front” type indicators provide status of up to 12 system parameters including voltage regulation, fault conditions and circuit control.

Input Power Connector:
A 6 foot (1.8 meter) long captive line cord will be provided.

Analog Interface Connector:
50 pin female D connector

High Voltage Output Cable:
10 ft (3.05m) shielded high voltage cable, removable at rear panel.

Dimensions:
3kW/6kW Units: 5.25”(3U)H x 19” W x 21” D (133mm x 482mm x 533mm)
12kW Units: 10.5”(6U)H x 19” W x 21” D (266mm x 482mm x 533mm)

Weight:
3kW/6kW Units: 46 pounds (20.87kg)
12kW Units: 90 pounds (40.82kg)

Regulatory Approvals:
2004/108/EC, the EMC Directive and 2006/95/EC, the Low Voltage Directive, approval pending.

Digital Interface
The EVA features a standard RS-232 and Ethernet digital interface, simplifying power supply communication requirements saving the user time and money, while enhancing functionality and overall capability. Spellman provides a GUI allowing customization of operational features while also providing basic power supply functionality and control via a sample simulated front panel.

Arc Intervention
Spellman’s EVA power supplies sense arc events via a fast acting current sense transformer. The arc intervention circuitry prevents power supply damage from continuous, long term arcing. Customers can change arc intervention parameters (Arc Count, Arc Quench, Reramp Time, and Window Time) within preset limits via the provided GUI. Customized units can be configured for unique arc prone environments, contact Spellman for details.

Additional High Voltage Output Connectors
Spellman’s EVA is designed to provide 1, 2 or 3 parallel configured high voltage output connectors. The standard unit provides one high voltage output connector. If you intend to use the EVA in a multi channel application but want to utilize your own filament power supply, this factory installed option provides the additional high voltage connections required. Hardware Option HV2 provides two high voltage output connectors, while Hardware Option HV3 provides three high voltage output connectors.

Optional Beam Controller (Filament Power Supply) and Gun Output Box

Multiple beam control units can be provided, allowing 1, 2 or 3 separate electron guns to be independently operated.

Each beam control unit consists of a beam controller and a gun output box. The beam controller is a 1U rack-mounted chassis containing the filament power, control and emission regulation circuitry. The gun output box contains the high frequency filament transformer which is referenced to the high voltage output potential. This box should be mounted close to the electron gun to minimize the length of the high current filament connections. The box also contains electron gun emission current monitoring circuitry and provides a feedback signal used to regulate the electron gun emission current.

Each beam control channel, if operated alone, can utilize 0 to 100% of the rated emission current capacity. When two or three beam control channels are used at the same time, the total system emission current capacity remains the same. Individual channel programming must be done such that the total current does not exceed the system’s total emission current available.

BEAM CONTROLLER SPECIFICATIONS

Input Voltage:
180-264 Vac, 50/60Hz, single phase, 7.5 amps maximum

Output Voltage/Current:
0-12Vrms at = 30kHz, 0-35 amps. An optional 50 amp filament (HPF) is available.

Metering:
Front panel digital filament current and emission current meters, 3.5 digit, accurate to within 1%.

System Status Display:
“Dead Front” type indicators provide status of up to 12 system operations including voltage regulation, fault conditions and circuit control.

Input Power Connector:
A 6 foot (1.8 m) long IEC320 Cord Set will be provided.
BEAM CONTROLLER SPECIFICATIONS

Analog Interface Connector:
Male 25 pin D connector

Filament Output Connections: (gun drive cable)
The secondary leads of the filament power transformer exiting the gun output box are 36" (91.44cm) long. The cover of this box is interlocked for safety purposes.

Environmental:
Temperature Range:
Operating: 0˚C to 40˚C
Storage: -40˚C to 85˚C
Humidity:
10% to 90% RH, non-condensing.

Cooling:
Forced air; inlet through side panels, outlet at rear panel.

Dimensions:
Beam Controller:
1.75"H (1U) x 15” W x 19”D (4.45 x 48.3 x 38.1cm)
Gun Output Box:
4"H x 6.25"W x 10”D (10.2 x 15.9 x 25.4cm)

Weight:
Beam Controller:
18 pounds (8.1kg)
Gun Output Box:
6 pounds (2.7kg)

Emission current is programmed locally (front panel adjustment) or remotely (0-10Vdc = 0-100% of rated current) via each beam controller. Filament Limit Set Point, Filament PreHeat Set Point, and Automatic Filament PreHeat functionality are provided.

EVA MODEL CONFIGURATION

Ordering:
EVA5N3/1PH 3 kilowatt unit, single phase
EVA10N6/3PH 6 kilowatt unit, three phase
EVA10N12/400VAC 12 kilowatt unit, 360-528Vac

Note: Input voltage must be specified at time of order. EVA model number must contain input voltage option code to be valid.

Sample Options:
EVA10N6/1PH/HV2 Single Phase Input & 2 HV Connectors
EVA10N12/400VAC/FIL3 360-528Vac Input & 3 Gun Supplies

The signal cable connecting the high voltage power supply to the beam controller is 39.4" (1m) long. A captive but field replaceable 10 foot (3.05m) long high voltage cable is provided to connect each beam control output box to the high voltage power supply.
**HV POWER SUPPLY INTERFACE—50 PIN FEMALE D CONNECTOR**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply Common</td>
<td>Power Supply Ground</td>
</tr>
<tr>
<td>2</td>
<td>Reset/HV Inhibit</td>
<td>Normally open, Low = Reset/Inhibit</td>
</tr>
<tr>
<td>3</td>
<td>External Interlock</td>
<td>+24Vdc @ open, &lt;25mA @ closed</td>
</tr>
<tr>
<td>4</td>
<td>External Interlock Return</td>
<td>Return for External Interlock</td>
</tr>
<tr>
<td>5</td>
<td>mA Test Point</td>
<td>0-10Vdc = 0-100% rated output, Zout= 1KΩ, 1%</td>
</tr>
<tr>
<td>6</td>
<td>kV Test Point</td>
<td>0-10Vdc = 0-100% rated output, Zout= 1KΩ, 1%</td>
</tr>
<tr>
<td>7</td>
<td>+10Vdc Reference Output</td>
<td>+10Vdc @ 1mA</td>
</tr>
<tr>
<td>8</td>
<td>mA Program Input</td>
<td>0-10Vdc = 0-100% rated output, Zin&gt;10MΩ</td>
</tr>
<tr>
<td>9</td>
<td>Local mA Program Output</td>
<td>0-10Vdc = 0-100% rated output, front panel pot</td>
</tr>
<tr>
<td>10</td>
<td>kV Program Input</td>
<td>0-10Vdc = 0-100% rated output, Zin&gt;10MΩ</td>
</tr>
<tr>
<td>11</td>
<td>Local kV Program Output</td>
<td>0-10Vdc = 0-100% rated output, front panel pot</td>
</tr>
<tr>
<td>12</td>
<td>Remote Power On Output</td>
<td>+24Vdc @ open, &lt;25mA @ closed</td>
</tr>
<tr>
<td>13</td>
<td>Remote Power On Return</td>
<td>Return for Remote Power On</td>
</tr>
<tr>
<td>14</td>
<td>Remote HV Off</td>
<td>+24Vdc @ open, &lt;25mA @ closed, connect to pin15 for front panel operation</td>
</tr>
<tr>
<td>15</td>
<td>Remote HV Off/On Common</td>
<td>HV On/Off Common</td>
</tr>
<tr>
<td>16</td>
<td>Remote HV On</td>
<td>+24Vdc @ open, &lt;25mA @ closed, momentarily connect to pin 15 enable high voltage</td>
</tr>
<tr>
<td>17</td>
<td>HV Off Indicator</td>
<td>+24Vdc @ 25mA = HV Off</td>
</tr>
<tr>
<td>18</td>
<td>HV On Indicator</td>
<td>+24Vdc @ 25mA = HV On</td>
</tr>
<tr>
<td>19</td>
<td>Power Supply Common</td>
<td>Supply Ground</td>
</tr>
<tr>
<td>20</td>
<td>+24Vdc Output</td>
<td>+24Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>21</td>
<td>Voltage Mode Status</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>22</td>
<td>Current Mode Status</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>23</td>
<td>Power Mode Status</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>24</td>
<td>Interlock Closed Status</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>25</td>
<td>Power Test Point</td>
<td>0-10Vdc = 0-100% rated output, Zout= 5KΩ, 1%</td>
</tr>
<tr>
<td>26</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Remote Overvoltage Adjust</td>
<td>0-10Vdc = 0-100% rated output</td>
</tr>
<tr>
<td>29</td>
<td>Over Power Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>30</td>
<td>Over Voltage Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>31</td>
<td>Over Current Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>32</td>
<td>System Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>33</td>
<td>RGLT Error Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>34</td>
<td>Arc</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>35</td>
<td>Over Temp Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>36</td>
<td>AC Fault</td>
<td>Open Collector, Low = Active</td>
</tr>
<tr>
<td>37</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Remote Power Program Input</td>
<td>0-10Vdc = 0-100% rated output, Zin&gt;10MΩ</td>
</tr>
<tr>
<td>43</td>
<td>Local Power Program Output</td>
<td>0-10Vdc = 0-100% rated output, internal pot</td>
</tr>
<tr>
<td>44</td>
<td>+5Vdc Output</td>
<td>+5Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>45</td>
<td>+15Vdc Output</td>
<td>+15Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>46</td>
<td>-15Vdc Output</td>
<td>-15Vdc @ 10mA, maximum</td>
</tr>
<tr>
<td>47</td>
<td>RS232 1x</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>RS232 Rx</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>RS232 GND</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Power Supply Common</td>
<td>Power Supply Ground</td>
</tr>
</tbody>
</table>

**BEAM CONTROLLER INTERFACE—25 PIN FEMALE D CONNECTOR**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>SIGNAL PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply Common</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>2</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>External Interlock</td>
<td>+15Vdc at Open, &lt;15mA @ Closed</td>
</tr>
<tr>
<td>4</td>
<td>External Interlock Return</td>
<td>Return for Interlock</td>
</tr>
<tr>
<td>5</td>
<td>Filament Current Test Point</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>6</td>
<td>Beam Current Test Point</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>7</td>
<td>+10Vdc Reference</td>
<td>+10Vdc, 1mA Max</td>
</tr>
<tr>
<td>8</td>
<td>Filament Limit Program Input</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>9</td>
<td>Local Filament Limit Program</td>
<td>Front panel potentiometer wiper</td>
</tr>
<tr>
<td>10</td>
<td>Beam Current Program Input</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>11</td>
<td>Local Beam Current Program</td>
<td>Front panel potentiometer wiper</td>
</tr>
<tr>
<td>12</td>
<td>Filament Preheat Program In</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>13</td>
<td>Local Fil. Preheat Program</td>
<td>Internal potentiometer</td>
</tr>
<tr>
<td>14</td>
<td>Beam Off</td>
<td>+15Vdc at Open, &lt;25mA @ Closed</td>
</tr>
<tr>
<td>15</td>
<td>Beam On/Off Common</td>
<td>Connect together for FP operation</td>
</tr>
<tr>
<td>16</td>
<td>Beam On</td>
<td>Momentarily connect to pin 15 = Beam On</td>
</tr>
<tr>
<td>17</td>
<td>Remote Beam Off Indicator</td>
<td>0=Beam On, +15V, 10mA Max=Beam Off</td>
</tr>
<tr>
<td>18</td>
<td>Remote Beam On Indicator</td>
<td>0=Beam Off, +15V, 10mA Max=Beam On</td>
</tr>
<tr>
<td>19</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Remote PS Fault</td>
<td>0 = Fault, +15Vdc @ 0.1mA = No Fault</td>
</tr>
<tr>
<td>23</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Power Supply Common</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>25</td>
<td>Shield Return</td>
<td>Chassis Ground</td>
</tr>
</tbody>
</table>
DIMENSIONS: in.[mm]

6U 12kW Power Supply

FRONT VIEW

TOP VIEW

BACK VIEW

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**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.

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**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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118004-001 REV. B
## 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.*

<table>
<thead>
<tr>
<th>Les alimentations haute tension doivent toujours être mises à la masse.</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
<tr>
<td>Prévoyez 5 minutes pour la décharge de la capacité interne de l’alimentation.</td>
</tr>
<tr>
<td>Ne vous mettez pas à la masse, ou ne travaillez pas sous conditions mouillées ou humides.</td>
</tr>
</tbody>
</table>

### 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 QUESO 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 satiri 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
EVA HIGH VOLTAGE POWER SUPPLY INTRODUCTION

1.1 Description of the EVA Series

The EVA Series of high voltage power supplies provides very well regulated, low ripple high voltage in a highly efficient, compact design, specifically for electron beam coating applications. Extremely stable output voltage and digitally configurable arc intervention circuitry result in significant performance improvements over previously available technology.

All of these advancements are possible only by Spellman’s long history in high voltage power conversion technology. This series of power supplies utilizes extremely advanced quasi-resonant PWM conversion techniques, along with sophisticated digital technology. Custom units to meet special requirements and specific applications can also be provided.

1.2 Standard Features

The EVA Series incorporates several standard features and software configurable items designed to optimize user utility, satisfaction and safety.

**FRONT PANEL CONTROL POWER/HIGH VOLTAGE ON/HIGH VOLTAGE OFF SWITCHES:** These intuitive front panel controls allow the user to easily turn the unit on and enable/disable the generation of high voltage.

**FRONT PANEL POTENTIOMETER:** A ten turn potentiometer is provided for easy programming of the desired voltage regulation value.

**FRONT PANEL INDICATOR LAMPS:** CONTROL POWER ON, HIGH VOLTAGE OFF and HIGH VOLTAGE ON indicators are integral with the control switches and equipped with dual lamps for redundancy and safety.

**FRONT PANEL DIGITAL METERS:** 3.5 digit meters are provided to view the output voltage and current. A convenient Preset View Feature is provided: If the HIGH VOLTAGE OFF button is depressed and held in, the present voltage and current programming values will be displayed in actual kV and mA on the front panel meters.

**ETHERNET AND RS-232 INTERFACE:** DSP based SMT circuitry provides both Ethernet and RS-232 digital interfacing capability simplifying the integration of the EVA into your system design. A VB GUI is provided for the RS-232 and Ethernet.
**SLOW START RAMP TIME:** This feature provides a gradual increase of high voltage until the preset operating point is reached. The slow start time is factory set for six seconds. Other slow start times can be software configured using the digital interface.

**ARC QUENCH/ARC RERAMP/ARC TRIP:** These features allow the user to tailor the power supply to meet specific needs in dynamic load applications. The standard configuration is if an arc occurs, the output is inhibited for approximately one millisecond (Arc Quench), and then the output is ramped up to the preset level in two milliseconds via the Arc ReRamp time period. If 25 arcs occur in a five second time period the unit will shut down displaying an “ARC” Fault (Arc Trip). Short term arcing = 5 arcs/second. A real time Arc Rate Limiter calculates the average arcing rate, if 50 arcs occur in a 30 second average time period the unit will shut down displaying an Arc fault. Long term arcing = 1.67 arcs/second. See Chapter 3 for operating details and information for user customization for these parameters via the software and the digital interface.

**INTERNAL FAULT PROTECTION:** The EVA series continually monitors internal circuits critical to the proper operation of the power supply. In the event that one of these circuits malfunctions, the fault detection circuit turns off the high voltage and reverts the unit to the POWER DOWN mode with the CONTROL POWER ON indicator lamp flashing slowly. The applicable fault indicator will be illuminated on the front panel diagnostic display requiring the user to clear (cycle the CONTROL POWER ON switch, cycle the AC line power or toggle the Reset/External Inhibit signal line) before high voltage can be re-enabled.

**OUTPUT CABLE:** All standard models are provided with a ten foot shielded high voltage output cable. The cable is designed so that it can be easily removed from the mating receptacle located on the rear of the chassis.

### 1.2.1 Remote Operating Features

**REMOTE PROGRAMMING:** Allows remote adjustment of the output voltage, current, power and overvoltage regulation parameters via the use of external 0-10Vdc = 0-100% rated output voltage sources.

**REMOTE MONITORS:** Allows remote monitoring of the output voltage, current and power test points where 0-10Vdc = 0-100% rated output.

**REMOTE HIGH VOLTAGE CONTROL:** Allows remote control of the HIGH VOLTAGE ON and HIGH VOLTAGE OFF functions. Signals are also provided for remote indication of HIGH VOLTAGE ON and HIGH VOLTAGE OFF status.

**REMOTE POWER ON:** Allows remote control of CONTROL POWER ON/OFF function. This feature also allows remote reset of the power supply when a SYSTEM FAULT shutdown occurs.

**RESET/EXTERNAL INHIBIT:** This circuit will reset any latched power supply faults and inhibit the high voltage output. A logic low/ground, will reset any fault(s) while inhibiting the high voltage output. A logic high/open will allow the high voltage to be enabled assuming the HIGH VOLTAGE ON switch (local or remote) cycled. NOTE: The External Inhibit circuit should NOT be used for protection against injury or for safety interlocking. See External Interlock for this type of safety control.

**EXTERNAL INTERLOCK:** Interlock connections are provided on the rear panel interface connector for connection to a customer implemented safety switch. The unit will not high voltage enable unless the interlock circuit is closed. During high voltage operation, opening the interlock circuit will cause the high voltage to shut off. This circuit should be used for safety interlock circuits. Spellman strongly recommends the use of External Interlocking for safety purposes.

### 1.2.2 System Status and Fault Diagnostic Display

“Dead Front” backlight type indicators provide system operation and fault condition information. If a fault occurs the power supply will revert to the POWER DOWN mode. This is indicated by the flashing of the CONTROL POWER ON indicator. To reset the latched fault: cycle the CONTROL POWER ON switch, cycle the AC line power or toggle the Reset/External Inhibit signal line.
VOLTAGE CONTROL: Indicates the output voltage regulator circuit is maintaining voltage regulation.

CURRENT CONTROL: Indicates the output current regulator circuit is maintaining current regulation.

HV INHIBIT: Indicates the high voltage supply is being inhibited by either the EXTERNAL INHIBIT signal line or by internal protection circuitry.

INTLK CLOSED: Indicates the EXTERNAL INTERLOCK connections are in the closed position.

INTLK OPEN: Indicates the EXTERNAL INTERLOCK connections are in the open position. This also indicates opening of internal power supply interlocks. It is not possible to enable high voltage with an open EXTERNAL INTERLOCK.

SYSTEM FAULT: Indicates an internal fault has occurred.

OVER VOLTAGE: Indicates the overvoltage protection circuitry has caused the power supply to turn off. The default setting for the overvoltage protection circuitry is internally set to 105% of rated output voltage. This level can be set to anywhere from 0-105% of rated output voltage by the user via the remote overvoltage programming capability, see Chapter 3 for more details.

OVER CURRENT: Indicates the output current has exceeded the programmed current trip level when the AOL (Adjustable Overload Trip) feature has been software configured using the digital interface.

OVER TEMP: Indicates that excessive temperature has been sensed within the chassis and internal protection circuitry has shut down the power supply.

ARC: Indicates that an arc has occurred (one second flash) or that the ARC Intervention Circuitry has shut down the power supply due to excessive arcing (latched “ARC” fault).

AC FAULT: Indicates a problem with the front end AC input circuitry and the corresponding generated inverter power buss voltages.

RGLT ERR: Indicates a failure in the voltage or current regulation circuitry. This fault usually occurs when there is a lack of output power to maintain proper regulation. Possible causes could be due to low AC input voltage (below low line parameters, or a missing phase) or a malfunction of the power supply preventing it from generating the voltage/current being requested.

1.3 Input Voltage

3PH Three Phase Input
180-264Vac, 50/60Hz three phase input voltage, available on 3kW, 6kW and 12kW units.

1PH Single Phase Input
180-264Vac, 50/60Hz single phase input voltage (3kW and 6kW units only).

400VAC 400 Volt Input
360-528Vac, 50/60Hz three phase input voltage (12kW units only).

1.4 Options

LL(X) High Voltage Cable Length
Custom length high voltage output cables, indicated in foot measurement units. Various predetermined lengths are available along with entirely custom lengths; contact Spellman Sales Department for details.

HV2 Two High Voltage Connecters
Optional two (2) high voltage output connectors that are connected in parallel for powering two beam channels with a single high voltage power supply.
HV3  Three High Voltage Connecters
Optional three (3) high voltage output connecters that are connected in parallel for powering three beam channels with a single high voltage power supply.

FIL1  Filament Gun Supply-One Channel
Optional beam controller (filament supply) and gun output box for single channel applications.

FIL2  Filament Gun Supply-Two Channels
Two optional beam controllers (filament supplies) and two gun output boxes for two channel applications.

FIL3  Filament Gun Supply-Three Channels
Three optional beam controllers (filament supplies) and three gun output boxes for three channel applications.

HPF  High Powered Filament
50 amp filament power supply.

See Section 5 for more information on these options. 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 Spellman’s Sales Department at:
sales@spellmanhv.com

1.5  Interpreting the Model Number
The model number of the power supply describes its capabilities. After the series name “EVA” is:

EVA  10  N  6 / 1PH /HV3 / X9999

- The maximum voltage in kV (5, 10)
- The polarity of the unit: Negative (N)
- The maximum output power in kilowatts (3, 6, 12)
- The selected input voltage (3PH, 1PH, 400VAC)
- The option codes for all options that are included.
- Custom units have a unique 4 digit X number after the option code(s). This X number references a unique specification control drawing that takes precedence over the standard EVA data sheet specifications.
Chapter 2
EVA HIGH VOLTAGE POWER SUPPLY INSPECTION AND INSTALLATION

Initial 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 discard any of the packing material used in a damaged shipment.

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

Standard Spellman EVA high voltage power supplies are covered by a warranty. Custom and special order models (with an X suffix in the model number) are also covered by a warranty. Check the specific warranty terms by referring to the Warranty document contained in this operator’s manual.

2.2 Input Requirements
For proper protection of the EVA power supply a circuit breaker protected, dedicated electrical service must be provided for each EVA chassis. EVA units are not phase dependent; the three AC input phase connections can be orientated in any manner with no adverse effect on power supply performance. See Table 2.1

2.3 Mechanical Installation
Units in the EVA 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 tabletop operation. It is strongly recommended to support the chassis by guides or shelves.

2.4 Airflow Requirements
EVA units (3/6/12kW) are forced air cooled, air enters the chassis via openings on the right and left side panels and air is forcibly exhausted out the rear panel via a single fan. Whatever mechanical installation is implemented airflow into and out of the unit must not be compromised. Additionally it is the responsibility of the user to assure that air entering the unit is not above the maximum ambient temperature of 40°C. Airflow volume is 100cfm for 3/6kW units and 300cfm for 12kW units.

Figure 2.1 EVA High Voltage Power Supply Airflow
### Table 2.1 Input Voltage/Current Requirements

The above maximum input current values assume a unit running at maximum power, operating at low line and taking power supply efficiency and power factor into account.

<table>
<thead>
<tr>
<th>UNIT/INPUT VOLTAGE</th>
<th>FACTORY CONFIGURATION</th>
<th>MAXIMUM INPUT CURRENT PER PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-264Vac, 3 phase, 50/60Hz</td>
<td>3PH (3kW, 6kW &amp; 12kW)</td>
<td>13 amps @ 3kW, 25 amps @ 6kW, 50 amps @ 12kW</td>
</tr>
<tr>
<td>180-264Vac, 1 phase, 50/60Hz</td>
<td>1PH (3kW &amp; 6kW only)</td>
<td>29 amps @ 3kW, 57 amps @ 6kW</td>
</tr>
<tr>
<td>360-528Vac, 3 phase, 50/60Hz</td>
<td>400VAC (12kW only)</td>
<td>25 amps</td>
</tr>
</tbody>
</table>

*Input Voltage Must Be Selected At Time of Order*

Note: 400VAC Option (360-528Vac) units do NOT have a rear panel circuit breaker. For proper protection a circuit breaker/fuse protected dedicated 30 amp, three phase electrical service must be provided for each EVA chassis.
Chapter 3
EVA HIGH VOLTAGE POWER SUPPLY OPERATING INSTRUCTIONS

3.1 Operation

WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.

WARNING

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 front panel CONTROL POWER ON switch is in the OFF position (switch bezel out).

B) Check the input voltage rating on the rear panel identification tag of the supply and make certain that this is the rating of the available power source.

C) PROPER GROUNDING TECHNIQUE: The chassis of the high voltage power supply must be adequately grounded, preferably to the local “system ground” (cold water pipe ground, electrical conduit ground, copper ground rod, etc.) using a heavy gauge copper wire securely connecting to the ¼-20 ground stud on the rear panel of the unit. See Figure 3.1 for a typical operating setup.

A heavy gauge user provided “load return” wire must be connected from the low end of the load back to the ¼-20 ground stud on the rear panel of the power supply. Using a separate external ground at the load is not recommended.

A six foot long, captive, three or four wire, unterminated line cord is provided for connecting to the AC supply.

For three phase input: BROWN, BLACK and BLUE wires are the three phase inputs, they are not phase dependent and can be connected in any manner. For single phase input: BROWN is line and BLUE is neutral. The GREEN/YELLOW or GREEN wire is for chassis safety ground connection. This is a safety ground connection and is NOT adequate for system grounding purposes.

Attach the high voltage output cable to the load.

D) Plug the high voltage output cable provided with the unit into the rear of the supply and secure appropriately.

E) 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.

F) For initial turn-on, rotate the front panel KILOVOLT control potentiometer fully counter-clockwise to the zero voltage position.

G) The input power cable may now be connected to the AC power line.

H) Depress the CONTROL POWER ON switch. The amber light inside the switch should light up. The unit is now in the HIGH VOLTAGE OFF mode. The HIGH VOLTAGE OFF light should be lit.

I) Depress and hold the green HIGH VOLTAGE OFF switch. The front panel meters will now read the preset value of the KILOVOLT control dial and the MILLIAMPERES internal preset value (100% rated current). To preset the desired level of the current and voltage during operation, depress and hold the green HIGH VOLTAGE OFF switch and rotate the control dial while noting its corresponding meter reading. Release the HIGH VOLTAGE OFF switch.

NOTE: No actual high voltage is being produced at this time.

J) Depress the red HIGH VOLTAGE ON switch. The lamps inside the switch should illuminate and the output will slow start up to the preset level output voltage and/or output current.

NOTE: The EVA series is equipped with a slow start circuit that ramps the output up to its maximum setting.
in approximately 6 seconds after the HIGH VOLTAGE ON switch is depressed.

K) To terminate the generation of output power, depress the HIGH VOLTAGE OFF switch. In the HIGH VOLTAGE OFF mode the power supply’s fault and interface circuits are still active.

L) To turn off the power supply, depress the amber CONTROL POWER ON switch to release the switch bezel to the out position. All front panel lights should extinguish.

NOTE: If a power supply fault, or system monitoring fault occurs, the power supply will revert to the POWER DOWN mode. In this mode the output power will be turned off. The CONTROL POWER ON lamp will flash indicating a SYSTEM FAULT. To reset the SYSTEM FAULT cycle the CONTROL POWER ON switch, cycle the AC line power or toggle the RESET/EXTERNAL INHIBIT signal line.

### 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 VOLTOMETER 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**

**TO ASSURE SAFETY AND PROPER COOLING ALWAYS OPERATE THE UNIT WITH THE COVER PANELS INSTALLED.**

Internal fans maintain safe operating temperatures in the power supply by drawing air over the circuit components. The covers must be on in order to direct the air flow over the areas that need cooling. In operation, the units air intake and fan exhaust paths must be clear of any obstructions that might impede the flow of air.

### 3.2 Standard Features

A general note on remote interface circuitry and remote signal grounding:

When usage applications dictate, electrical isolation may be required when interfacing with the high voltage power supply in question. For power control signals such as CONTROL POWER, EXTERNAL INTERLOCK, HIGH VOLTAGE OFF and HIGH VOLTAGE ON isolated relay contacts should be used. For status signals and control signals such as HIGH VOLTAGE ON status, HIGH VOLTAGE OFF status, EXTERNAL INHIBIT, etc. opto-isolation should be used. When usage applications dictate, analog programming and monitoring signals may require isolation via analog isolation amplifiers. All interface cables should be properly shielded. All power supply signals should be referenced to the power supplies signal ground on the rear panel interface connector.

**LOCAL/REMOTE PROGRAMMING:** Allows adjustment of the output voltage and current via the front panel/internal controls (local) or external voltage sources (remote).

**LOCAL CONTROL** - In local control (front panel control), jumpers are installed on rear panel interface connector between pin 8 and pin 9 for current control and between pin 10 and pin 11 for voltage control. This will enable the front panel potentiometer for voltage control and an internal pull up for current control.

**REMOTE CONTROL** - For remote programming, the above mentioned jumpers are removed and a positive polarity, ground referenced voltage source is applied to the pin 8 for current and pin 10 for voltage. Programming signals should be referenced to pin 1, signal ground. Scaling is such that 0-10Vdc corresponds to 0-100% rated output respectively. See Figure 3.2A for wiring diagram.

An alternate method of controlling the output remotely is by using external resistance such as a potentiometer or a resistor network. For remote control the jumpers are removed and the desired resistor configuration is installed. See Figure 3.2B for wiring diagram.
REMOTE MONITORS: Test points are made available on the rear panel interface connector for monitoring the current and voltage; pin 5 and pin 6 respectively. The test points are always positive, scaling is such that 0-10Vdc corresponds to 0-100% rated output. Test points have an output impedance of 1k ohms, ±1%. See Figure 3.3 for test point designation.

LOCAL/REMOTE CONTROL POWER/HV ON/HV OFF: Allows for command of CONTROL POWER, HIGH VOLTAGE ON and HIGH VOLTAGE OFF by either the front panel controls or external signals via the rear panel external interface connector.

LOCAL CONTROL - For local front panel switch command of the Control Power functionality a maintained connection between pin 12 and pin 13 is required. Once connected as outlined above, the front panel CONTROL POWER switch will alternate latch on/latch off with each successive pressing of the switch. For local front panel command of the HIGH VOLTAGE OFF functionality a maintained connection between pin 14 and pin 15 is required.

REMOTE CONTROL – Remote control of CONTROL POWER, HIGH VOLTAGE ON and HIGH VOLTAGE OFF can be accomplished via the rear panel interface. The CONTROL POWER is an on-off toggle contact between pins 12 and 13. With the front panel CONTROL POWER switch latched in the “ON” position, opening and closing the connection between pins 12 and pins 13 will allow remote command of the CONTROL POWER functionality. HIGH VOLTAGE OFF and HIGH VOLTAGE ON are controlled by momentary normally closed; normally open contacts, respectively between pins 14 and 15, and pins 15 and 16. See Figure 3.4 for recommended interface.

EXTERNAL INHIBIT: The External inhibit allows the user to inhibit the power supply output without putting the power supply into the HIGH VOLTAGE OFF mode. This circuit can be used to generate fast slewing output waveforms. The maximum inhibit rate should not exceed 5Hz. Consult factory for higher repetition rates or high pulse load applications. See Figure 3.5 for the recommended interface circuit.

WARNING

IT IS EXTREMELY DANGEROUS TO USE THE EXTERNAL INHIBIT TO STOP HIGH VOLTAGE GENERATION FOR THE PURPOSE OF SERVICING OR APPROACHING ANY AREA OF THE LOAD CONSIDERED UNSAFE DURING HIGH VOLTAGE OPERATION

EXTERNAL INTERLOCK: The External Interlock connections are provided on the rear panel interface connector, pin 3 and pin 4, intended for use in the connection to a customer provided and implemented external safety switch. The unit will not enable into HIGH VOLTAGE ON unless the interlock circuit is closed. If the interlock is not being used (use is highly recommended), a jumper must be installed. During high voltage operation, opening the External Interlock will cause the unit to revert to the HIGH VOLTAGE OFF mode. Subsequent closing of the interlock circuit will NOT return the unit to HIGH VOLTAGE ON mode; this must be accomplished by depressing the HIGH VOLTAGE ON switch. See Figure 3.6 for the recommended interface circuit.

ARC DETECT/ARC QUENCH/ARC COUNT: The ARC Intervention Circuitry senses dynamic arcing or discharge conditions present at the output load with a wide bandwidth current transformer coupled to the return side of the high voltage multiplier. The instant an arc is detected the generation of high voltage is electronically inhibited for 1 millisecond; this is called the ARC Quench time period. After the 1 millisecond period, the discharged high voltage output (level dependent upon arc impedance, arc duration, etc.) is ramped back up to the previous set level. This Arc ReRamp ramp time is 2 milliseconds. The ARC indicator on the front panel will illuminate for approximately 1 second after each arc has occurred. The HV INHIBIT indicator will also illuminate indicating that the output is being inhibited (ARC Quench).
The factory default Arc Count Shutdown setting of the Arc Intervention circuitry is such that if 25 arcs occur in a 5 second time period the unit will shut down into the POWER DOWN mode displaying an “ARC Fault”. This correlates to 5 arcs per second for a short timeframe. Additionally there is an Arc Rate Limiter feature. A real time averaging circuit will shut the power supply off with an ARC Fault if 50 arcs occur in a 30 second time period. This correlates to 1.67 arcs per second for a long time period. This allows the unit to operate in an arc prone environment, tolerating brief intense arcing but protect itself in the event of excessive long term arcing. ARC parameters can be modified by using the digital interface and provided GUI but changing these settings can have serious consequences.

NOTE: Making changes to the ARC Intervention Circuitry along with excessive arcing of the power supply can thermally overheat and damage the internal short circuit limiting assembly. Damage to the power supplies internal short circuit limiting assembly is consider misuse of the unit and repairs will not be covered under the warranty. The ARC Intervention Circuitry is incorporated and configured to protect the power supply from excessive arcing, make changes to this circuitry at your own responsibility and risk.

3.3 Digital Interface (RS-232/Ethernet)

The EVA features standard RS-232 and Ethernet digital interface capability. Please see Appendix A for complete details on functionality and operation.

Figure 3.1 Typical EVA Operating Setup

Note: The service connection to these units must be protected by an appropriately rated and circuit breaker protected power connection.
Figure 3.2A Wiring Diagram for Remote Programming via Voltage Source

Figure 3.2B Wiring Diagram for Remote Programming via External Resistance
It is recommended to use relay contacts for S1, S2 and S3. Relays should be located as close as possible to the high voltage power supply. Coils should be driven from isolated sources. Signals are at 24Vdc, 100mA max, and are only to be used for contact closure.

S1 must be closed to enable HIGH VOLTAGE ON. Momentary closure of S2 will enable HIGH VOLTAGE ON. Opening S1 will disable HIGH VOLTAGE ON and switch the unit to the HIGH VOLTAGE OFF mode.
Figure 3.5 External Inhibit Interface Circuit

Rear Panel JB1
1
2
3
4
5

Customer provided relay for control of External Inhibit Circuit

It is recommended to use relay contacts for the control of the External Interlock. The relay should be located as close as possible to the power supply. Signals are \( \approx +24\text{Vdc} @ 100\text{mA}, \) maximum, and are only to be used for contact closure.

Relay Coil for Safety External Interlock Control

All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply

JB1-3 and JB1-4 @ Open = External Interlock Open, HV Disable, No HV Enable Possible
JB1-3 and JB1-4 @ Closed = External Interlock Closed, HV Can Be Enabled

Figure 3.6 External Interlock Interface Circuit
Figure 3.7 Remote High Voltage ON and Remote High Voltage OFF Indicator

Figure 3.8 Remote Overvoltage Adjust Interface
Figure 3.9 Remote Status and Fault Indicator Interface
<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply Common</td>
<td>Power Supply Ground</td>
</tr>
<tr>
<td>2</td>
<td>Reset/HV Inhibit</td>
<td>Toggle to reset latched faults, Ground = Inhibit, Open = HIGH VOLTAGE ON</td>
</tr>
<tr>
<td>3</td>
<td>External Interlock</td>
<td>+24Vdc @ open, &lt;25mA @ closed</td>
</tr>
<tr>
<td>4</td>
<td>External Interlock Return</td>
<td>Return for External Interlock. Pins 3 and 4 must be connected to HV enable</td>
</tr>
<tr>
<td>5</td>
<td>mA Test Point</td>
<td>0-10Vdc = 0-100% rated output, Zout = 1kΩ, 1%</td>
</tr>
<tr>
<td>6</td>
<td>kV Test Point</td>
<td>0-10Vdc = 0-100% rated output, Zout = 1kΩ, 1%</td>
</tr>
<tr>
<td>7</td>
<td>+10Vdc Reference</td>
<td>+10Vdc @ 1mA</td>
</tr>
<tr>
<td>8</td>
<td>mA Program Input</td>
<td>0-10Vdc = 0-100% rated output, Zin =&gt;10MΩ, jump to pin 8 for local control</td>
</tr>
<tr>
<td>9</td>
<td>Local mA Program Output</td>
<td>0-10Vdc = 0-100% rated output, front panel potentiometer</td>
</tr>
<tr>
<td>10</td>
<td>kV Program Input</td>
<td>0-10Vdc = 0-100% rated output, Zin =&gt;10MΩ, jump to pin 11 for local control</td>
</tr>
<tr>
<td>11</td>
<td>Local kV Program Output</td>
<td>0-10Vdc = 0-100% rated output, front panel potentiometer</td>
</tr>
<tr>
<td>12</td>
<td>Remote Power On Output</td>
<td>24Vdc @ open, &lt;25mA @ closed</td>
</tr>
<tr>
<td>13</td>
<td>Remote Power On Return</td>
<td>Return for Remote Power On</td>
</tr>
<tr>
<td>14</td>
<td>Remote HV OFF</td>
<td>+24Vdc @ open, &lt;25mA @ closed, connect to pin 15 for front panel operation</td>
</tr>
<tr>
<td>15</td>
<td>Remote HV OFF/ON Common</td>
<td>Remote HV OFF/ON Common</td>
</tr>
<tr>
<td>16</td>
<td>Remote HIGH VOLTAGE ON</td>
<td>+24Vdc @ open, &lt;25mA @ closed, momentarily connect to pin 15 for HV enable</td>
</tr>
<tr>
<td>17</td>
<td>HIGH VOLTAGE OFF Indicator</td>
<td>+24Vdc @ 25mA = HIGH VOLTAGE ON</td>
</tr>
<tr>
<td>18</td>
<td>HIGH VOLTAGE ON Indicator</td>
<td>+24Vdc @ 25mA = HIGH VOLTAGE ON</td>
</tr>
<tr>
<td>19</td>
<td>Power Supply Common</td>
<td>Power Supply Ground</td>
</tr>
<tr>
<td>20</td>
<td>+24Vdc Output</td>
<td>+24Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>21</td>
<td>Voltage Mode Status</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>22</td>
<td>Current Mode Status</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>23</td>
<td>n/c</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Interlock Closed Status</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>25</td>
<td>n/c</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Remote Overvoltage Adjust</td>
<td>0-10Vdc = 0-105% rated output</td>
</tr>
<tr>
<td>29</td>
<td>n/c</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Over Voltage Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>31</td>
<td>Over Current Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>32</td>
<td>System Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>33</td>
<td>RGLT Error Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>34</td>
<td>ARC</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>35</td>
<td>Over Temp Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>36</td>
<td>AC Fault</td>
<td>Open collector, Low = Active, 35V maximum @ 10mA</td>
</tr>
<tr>
<td>37</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Short to pin 43</td>
<td>Connect pin 42 and pin 43 together in all configurations</td>
</tr>
<tr>
<td>43</td>
<td>Short to pin 42</td>
<td>Connect pin 42 and pin 43 together in all configurations</td>
</tr>
<tr>
<td>44</td>
<td>+5Vdc Output</td>
<td>+5Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>45</td>
<td>+15Vdc Output</td>
<td>+15Vdc @ 100mA, maximum</td>
</tr>
<tr>
<td>46</td>
<td>-15Vdc Output</td>
<td>-15Vdc @ 10mA, maximum</td>
</tr>
<tr>
<td>47</td>
<td>RS-232 Tx</td>
<td>RS-232 Tx</td>
</tr>
<tr>
<td>48</td>
<td>RS-232 Rx</td>
<td>RS-232 Rx</td>
</tr>
<tr>
<td>49</td>
<td>RS-232 GND</td>
<td>RS-232 GND</td>
</tr>
<tr>
<td>50</td>
<td>Power Supply Common</td>
<td>Power Supply Ground</td>
</tr>
</tbody>
</table>

= Denotes jumper connection for simplified local front panel control

**Figure 3.10 JB1 Rear Panel Interface Connector**
Chapter 4
EVA HIGH VOLTAGE POWER SUPPLY PRINCIPLES OF OPERATION

The EVA series of high voltage power supplies utilizes sophisticated power conversion technology. A variety of analog, digital and power conversion techniques are employed. This Principles of Operation will introduce the basic function blocks that comprise the EVA power supply. For details on a specific circuit, consult Spellman’s Engineering Department.

The EVA power supply is an AC to DC converter. Within the power supply, conversions of AC to DC, high frequency AC, then to high voltage DC take place. By reviewing functionality of the subassemblies, a basic understanding of the process can be gained.

**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 Line Rectification and Filtering

**WARNING**

LINE VOLTAGE IS PRESENT WHENEVER THE POWER SUPPLY IS CONNECTED TO THE INPUT LINE VOLTAGE. BE SURE TO DISCONNECT THE LINE CORD BEFORE OPENING THE UNIT. ALLOW 5 MINUTES FOR INTERNAL CAPACITANCE TO DISCHARGE BEFORE TOUCHING ANYTHING CONNECTED TO LINE REFERENCED CIRCUITRY.

Simple three/single phase rectification provides the DC buss voltage for the high frequency inverter.

An input line cord, circuit breaker, EMI Filter Assembly, contactor, inrush limiting circuitry, bridge rectifier, electrolytic capacitors, rail inductors and rail capacitors comprise the basic components required for input line rectification.

Three different input voltages are available for the EVA Series. If the user is unsure which input voltage is required for the unit on hand, check the identification tag on the rear of the power supply.

The customer provided AC power input is provided to the unit via the four conductor AC line cord. Circuit protection is provided by CB1, a fast acting magnetic trip type circuit breaker. The load side of CB1 is connected to EMI filter A2. The output of the EMI filter connects to K1, a three phase contactor. K1 provides fail-safe type disconnection of the line voltage to the power supply rectification circuits. K1’s coil is controlled by a variety of circuit conditions, which will be described later on. The load side of CB1 is also connected to low voltage power supply assembly A9, which provides various voltages for housekeeping and control circuit power.

When contactor K1 is energized, voltage is applied to isolated bridge rectifier power module CR1, used for line voltage rectification. The output of CR1 is connected to aluminum electrolytic capacitors C1 and C2 for line filtering purposes. Capacitors C1 and C2 are initially charged through inrush limiting charging resistors which is located on POWER PWB – A6.

After an appropriate period of time to charge C1 and C2, relays on POWER PWB – A6 are energized to short out the inrush limiting resistors. The generated DC buss voltage is supplied to the inverter circuitry through L2, L3, L6 and L7. The inductors provide isolation for the electrolytic capacitors C1 and C2, so the inverter’s high
4.3 High Voltage Transformer

The output of the Inverter is connected to the primary of the High Voltage Transformer. The High Voltage Transformer is a step-up type. Typical secondary voltages are in the range of 1kVac to 5kVac depending upon the units specific maximum output voltage rating.

4.4 High Voltage Assembly

The High Voltage Assembly will vary depending upon the model ordered. The circuitry typically consists of full wave doubler output circuit.

Output filtering is typically provided by an L-C type filter. Voltage feedback for regulation and monitoring is provided by a high bandwidth resistive/capacitive compensated feedback divider. Current feedback for regulation and monitoring is provided by a sense resistor connected at the low voltage end of the high voltage output section.

4.5 System Control PWB

The majority of control circuits for power supply controls are located on the SYSTEM CONTROL PWB – A1. For trouble shooting and testing purposes, this board can be easily accessed by removing the screws located on the side panels near the front panel. The front panel will hinge down allowing for easy access to the SYSTEM CONTROL PWB.

4.6 Front Panel Assembly

Front Panel CONTROL POWER, HIGH VOLTAGE OFF, HIGH VOLTAGE ON, switches, voltage programming potentiometer, voltage and current digital meters, and status indications are connected to the FRONT PANEL PWB – A7. The FRONT PANEL PWB interfaces directly to the SYSTEM CONTROL PWB - A1.
Chapter 5
EVA HIGH VOLTAGE POWER SUPPLY INPUT VOLTAGE & OPTIONS

The input voltage and options available for this power supply are described in this section. An input voltage selection must be made at time of order for each EVA high voltage power supply. Options are specified by including the option code in the model number as described in Section 1.5.

5.1 180-264Vac, 3Ø Input - 3PH
This factory configures EVA units to operate from 180-264Vac, three phase, 50/60Hz input power. Available on 3kW, 6kW and 12kW units.

5.2 180-264Vac, 1Ø Input - 1PH
This option factory configures EVA units to operate from 180-264Vac, single phase, 50/60Hz input power. Available only on 3kW and 6kW units.

5.3 360-528Vac Input - 400VAC
This option factory configures the EVA units to operate from 360-528Vac, three phase, 50/60Hz input power. Available only on 12kW units.

5.4 High Voltage Cable Length - LL(X)
Custom length high voltage output cables, indicated in foot measurement units. Various predetermined lengths are available along with entirely custom lengths; contact Spellman Sales Department for details.

5.5 Two High Voltage Connecters - HV2
Optional two (2) high voltage output connectors that are connected in parallel for powering two beam channels with a single high voltage power supply.

5.6 Three High Voltage Connecters - HV3
Optional three (3) high voltage output connectors that are connected in parallel for powering three beam channels with a single high voltage power supply.

5.7 Filament Gun Supply, 1 Channel- FIL1
Optional beam controller (filament supply) and gun output box for single channel applications.

5.8 Filament Gun Supply, 2 Channel- FIL2
Optional beam controller (filament supplies) and gun output boxes for two channel applications.

5.9 Filament Gun Supply, 3 Channel- FIL3
Optional beam controller (filament supplies) and gun output boxes for three channel applications.

5.10 High Power Filament - HPF
50 amp filament power supply.

5.11 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 instructional 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 need.
Chapter 6
EVA BEAM CONTROLLER INTRODUCTION

6.1 Description of Beam Controller (Filament Power Supply)

Multiple beam control units can be provided, allowing 1, 2 or 3 separate electron guns to be independently operated from a single EVA high voltage power supply. Each beam control unit consists of a beam controller and a gun output box. The beam controller is a 1U (1.75”/44.45mm) rack-mounted chassis containing the filament power, control and emission (beam) current regulation circuitry. The gun output box contains the high frequency filament transformer which is referenced to the high voltage output potential. This box should be mounted close to the electron gun to minimize the length of the high current filament connections. The box also contains emission (beam) current monitoring circuitry and provides a feedback signal used to regulate the emission (beam) current.

Each beam control channel if operated alone can utilize 0 to 100% of the rated emission current capacity of the EVA high voltage power supply. When two or three beam control channels are used at the same time, the total system emission current capacity remains the same. Individual channel programming must be done such that the total current does not exceed the systems total emission current available.

6.2 Standard Features

The beam controller incorporates several standard features designed to optimize user utility, satisfaction and safety.

FRONT PANEL BEAM OFF/ BEAM ON SWITCHES: These intuitive front panel controls allow the user to easily enable/disable the generation of the electron beam.

FRONT PANEL INDICATOR LAMPS: BEAM ON and BEAM OFF indicators are integral with the control switches and are LED illuminated for reliability and long service life.

FRONT PANEL POTENTIOMETERS: A ten turn potentiometer is provided for easy programming of the desired emission (beam) current value. Additionally a

Figure 6.1 EVA System Block Diagram
single turn potentiometer is provided for the Filament Limit Set value.

**FRONT PANEL DIGITAL METERS:** 3.5 digit meters are provided to view the Emission (Beam) Current, Filament Limit Set value and Filament Operating Current. A convenient Preset View Feature is provided: If the BEAM OFF button is depressed and held in, the emission (beam) current programming value will be displayed in mA on the right front panel meter. Additionally, when the BEAM OFF button is depressed and held in, the Filament Limit Set value will be displayed in amps on the left front panel meter. When in the active BEAM ON condition this meter displays the operational filament current value.

**INTERNAL FAULT PROTECTION:** The beam controller continually monitors internal circuits critical to its operation. If one of these circuits malfunctions, the fault detection circuit turns off the emission (beam) current and reverts the unit to the POWER DOWN mode, where neither the BEAM ON nor the BEAM OFF indicator lamps will be illuminated. The applicable fault indicator will be illuminated on the fault diagnostic panel, requiring the user to clear (depress the BEAM OFF switch, or cycle the AC line power) before the emission (beam) current can be re-enabled.

### 6.3 Remote Operating Features

**REMOTE PROGRAMMING:** Allows remote adjustment of the Emission (beam) Current, Filament PreHeat and Filament Limit Set parameters via the use of 0-10Vdc = 0-100% rated, external voltage sources.

**REMOTE MONITOR:** Allows remote monitoring of the 0-10Vdc = 0-100% rated, Emission (beam) Current and Filament Current test points.

**REMOTE BEAM ON/OFF CONTROL:** Allows remote control of the BEAM ON and BEAM OFF functions via dry contact opens and closures. Signals are also provided for remote indication of BEAM ON and BEAM OFF status.

**EXTERNAL INTERLOCK:** Interlock connections are provided on the rear panel interface connector for connection to a safety switch. The unit will not operate unless the interlock circuit is closed. During operation, opening the interlock circuit will cause the BEAM ON to shut off. This circuit should be used for safety interlock circuits. Spellman strongly recommends the use of External Interlocking for safety purposes.

### 6.4 System Status and Fault Diagnostic Display

“Dead Front” backlight type indicators provide system operation and fault condition information. If a fault occurs the beam controller will revert to the POWER DOWN mode. This is indicated by the BEAM ON and the BEAM OFF indicator lamps both not being illuminated. The applicable fault indicator will be illuminated on the front panel requiring the user to clear (depress the BEAM OFF switch, or cycle the AC line power) before the beam can be re-enabled.

**GUN 1:** Indicates a beam controller is active in the Channel One position.

**GUN 2:** Indicates a beam controller is active in the Channel Two position.

**GUN 3:** Indicates a beam controller is active in the Channel Three position.

**INTLK CLOSED:** Indicates the EXTERNAL INTERLOCK connections are in the closed position.

**INTLK OPEN:** Indicates the EXTERNAL INTERLOCK connections are in the open position. This also indicates opening of internal power supply interlocks. It is not possible to enable BEAM ON with an open EXTERNAL INTERLOCK.
RMT CNTRL: Indicates that the programming of the unit is being accomplished by either the Ethernet or RS-232 digital interface. This feature is selectable via the rear panel DIP switch, switch position 1. See the section on Configuration for more details.

FIL LIMIT: Indicates that the beam controller is limiting the filament current at the programmed Filament Current Limit level.

OVER mA: Indicates the emission (beam) current has been actively limited to 105% of maximum rated current (as per an internal printed circuit board potentiometer setting).

FAULT 1: Not allocated.

RGLT ERR: Indicates a failure in the beam controllers regulation circuitry. This fault usually occurs when there is a lack of output power to maintain proper output regulation. Possible causes could be due to low AC input voltage (below low line parameters) or a malfunction of the power supply preventing it from generating the voltage/current being requested.

FAULT 2: Not allocated.

OVER TEMP: Indicates that excessive temperature has been sensed within the chassis and internal protection circuitry has shut down the beam controller.

6.5 Options

HPF High Power Filament

This option provides a 50 amp filament capable beam controller and gun output box.

BEAM CONTROLLER INSPECTION, INSTALLATION AND CONFIGURATION

Initial inspection and preliminary checkout procedures are recommended. For safe operation, please follow the step-by-step procedures described in section 6.10, Operating Instructions.

6.6 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 discard any of the packing material used in a damaged shipment. After unpacking, inspect the panel, chassis, gun output box and cables for visible damage.

Standard Spellman EVA beam controllers are covered by a warranty. Custom and special order models (with a unique 4 digit X suffix in the model number) are also covered by a warranty. Check the specific warranty terms by referring to the Warranty document contained in this operator’s manual.

6.7 Input Requirements

Each beam controller chassis operates from 180-264Vac, 50/60Hz, single phase, 7.5 amps maximum (10 amps maximum for HPF Option - 50 amp units).

Beam controller chassis have front panel holes for standard EIA rack mounting. The rack must allow rear mechanical installation access for cable connections. Units are fully enclosed and are suitable for bench or tabletop operation. It is strongly recommended to support the chassis by guides or shelves.

6.8 Airflow Requirements

Beam controllers are forced air cooled, air enters the chassis via openings on the right and left side panels and air is forcibly exhausted out the rear panel via a single fan. Whatever mechanical installation is implemented airflow into and out of the unit must not be compromised. Additionally it is the responsibility of the user to assure that air entering the unit is not above the maximum ambient temperature of 40°C. Airflow volume is 25cfm.

6.9 Configuration

Multiple beam control units can be provided, allowing 1, 2 or 3 separate electron guns to be independently operated. A rear panel accessible DIP switch configures each chassis for use in single channel or multi-channel applications. If a complete system is ordered from the factory, this configuration setting will already be done. If you are reconfiguring an existing system, or adding a beam control unit in the field the details of the configuration process are outlined below.
<table>
<thead>
<tr>
<th>Switch</th>
<th>Name</th>
<th>Programming Feature</th>
<th>Switch Position ON</th>
<th>Switch Position OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RMT CNTRL</td>
<td>Enables remote control via the provided Ethernet/RS-232 interfaces.</td>
<td>ON(down) for RMT CNTRL</td>
<td>OFF(up) for local control and remote analog control</td>
</tr>
<tr>
<td>2</td>
<td>GUN2</td>
<td>Configures the Beam Controller chassis as GUN2. Lights up the front panel GUN2 lamp. (See Note 1)</td>
<td>ON(down) for GUN2</td>
<td>OFF(up) for Single Gun and for GUN1 and GUN3 in Multi-Gun configuration</td>
</tr>
<tr>
<td>3</td>
<td>GUN3</td>
<td>Configures the Beam Controller chassis as GUN3. Lights up the front panel GUN3 lamp. (See Note 1)</td>
<td>ON(down) for GUN3</td>
<td>OFF(up) for Single Gun and for GUN1 and GUN2 in Multi-Gun configuration</td>
</tr>
<tr>
<td>4</td>
<td>SINGLE GUN</td>
<td>Selects the Emission Current feedback signal from the EVA High Voltage Chassis. For single gun configuration only.</td>
<td>ON(down) No GUN2 or GUN3 installed</td>
<td>OFF(up) for Multi-Gun configuration</td>
</tr>
<tr>
<td>5</td>
<td>MULTI-GUN</td>
<td>Selects the Emission Current feedback signal from the Gun Output Box when multiple guns are installed.</td>
<td>ON(down) on GUN1, GUN2, GUN3</td>
<td>OFF(up) for Single Gun Configuration</td>
</tr>
<tr>
<td>6</td>
<td>n/u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>n/u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>n/u</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1: The Beam Controller chassis is configured as GUN1 when the GUN2 and GUN3 selector switches are both in the OFF (up) position. The GUN1 front panel lamp will illuminate.

Table 6.1 Rear Panel DIP Switch Configuration
EVA BEAM CONTROLLER OPERATING INSTRUCTIONS

6.10 Operation

**WARNING**

**THIS EQUIPMENT’S OUTPUT IS REFRENCED TO DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.**

**WARNING**

**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 input power cable is disconnected from the rear panel IEC320 connector.

B) Check the input voltage rating on the rear panel identification tag and make certain that this is the rating of the available power source.

C) **PROPER GROUNDING TECHNIQUE:** The chassis of the high beam controller and the gun output box must be properly grounded. Connect the ground cable from the gun output box to the beam controller using the ¼-20 ground studs. Connect the ground cable from the beam controller to the EVA high voltage power supply using the ¼-20 ground studs. See Figure 6.2 for a typical operating setup.

A six foot long, detachable IEC320, three-wire, unterminated line cord is provided for connecting to the AC input supply. The BROWN wire is LINE and the BLUE wire is NEUTRAL. The GREEN wire is for chassis safety ground connection. This is a safety ground connection and is NOT adequate for system grounding purposes.

**MAKE CERTAIN THE EVA HIGH VOLTAGE POWER SUPPLY IS DISCONNECTED FROM THE AC POWER**

**SOURCE AND TURNED OFF FOR A MINIMUM OF 5 MINUTES BEFORE PROCEEDING!**

D) Plug the captive (yet field replaceable) high voltage output cable attached to the gun output box into the rear panel high voltage connector of the EVA high voltage power supply and secure properly.

E) Connect the captive two conductor filament output cable that exits the gun output box to the filament of the electron gun. Either wire can be connected to which ever terminal of the filament desired as there is no polarity orientation. Make certain the connections are secure due to the high current output (35 amp standard or optional 50 amp) of the filament power supply.

F) For initial turn-on, rotate the front panel Emission (beam) Current control potentiometer fully counter-clockwise to the zero position. Rotate the front panel Filament Limit Set control potentiometer fully counter-clockwise to the zero position.

G) The input power cable may now be connected to the AC power line.

H) Reconnect the AC power source to the EVA high voltage power supply and the EVA beam controller.

I) Depress the CONTROL POWER ON switch on the EVA high voltage power supply front panel.

J) Observe that the front panel meters are illuminated and the green BEAM OFF indicator is illuminated on the EVA beam controller chassis. Additionally observe that the front panel meters are illuminated and the green HIGH VOLTAGE OFF indicator is illuminated on the EVA high voltage power supply chassis.

K) Rotate the Filament Limit potentiometer slowly clockwise until the beam controller filament current meter displays the factory preset 10 amp preheat level. The filament is now operating at a 10 amp filament current level.

L) Depress and hold in the BEAM OFF switch. The front panel meters will now display the preset value of the Emission (beam) Current control potentiometer and the Filament Limit Set control potentiometer. To preset
the desired level of the Emission (beam) Current and Filament Limit Set continue holding in the BEAM OFF switch and rotate the applicable control dial while noting its corresponding meter reading. Release the BEAM OFF switch.

**NOTE:** No actual electron beam is being produced at this time, but the filament is operating at the preheat current levels.

**M)** Depress the HV ON switch on the EVA high voltage power supply. The red light inside the switch should illuminate and the output will slow start up to the preset level output voltage under a no load current condition.

**NOTE:** The EVA series is equipped with a slow start circuit that ramps the output up to its maximum setting in approximately 6 seconds after the HV ON switch is depressed.

**N)** Depress the BEAM ON switch on the beam controller. The red light inside the switch should illuminate and the emission (beam) current will slow start up to the preset level, as displayed on the front panel digital display.

**O)** To terminate the generation of electron beam, depress the BEAM OFF switch on the beam controller. In the BEAM OFF mode the beam controllers fault and interface circuits are still active and the filament is operating at the 10 amp preheat level. The high voltage is still operating at the present voltage level.

**P)** To turn off the EVA high voltage power supply, depress the HV OFF switch on the EVA high voltage power supply. In the HV OFF mode the EVA high voltage power supplies fault and interface circuits are still active. To fully turn off the EVA high voltage power supply and EVA beam controller push in CONTROL POWER ON switch to release the switch bezel to the out position. All front panel lights should extinguish.

**NOTE:** If a beam controller fault, or system monitoring fault occurs, the beam controller will revert to the POWER DOWN mode. This is indicated by neither the BEAM ON nor the BEAM OFF indicator lamps will be illuminated. The EVA high voltage power supply will shut down with a “GUN” fault and the CONTROL POWER ON lamp will flash. The applicable fault indicator will be illuminated on the front panel requiring the user to clear (depress the BEAM OFF switch, or cycle the AC line power). The EVA high voltage power supply fault is cleared by cycling the CONTROL POWER ON switch, cycling the AC line power or by toggling the Reset/HV Inhibit (50 pin connector pin 2) signal line.

**WARNING**

**AFTER TURN OFF, DO NOT HANDLE THE OUTPUT UNTIL THE CAPACITANCE HAS BEEN DISCHARGED! LOAD CAPACITANCE MAY BE DISCHARGED BY SHORTING TO GROUND.**

**WARNING**

**DANGER - THE VOLTOMETER ON THE EVA HIGH VOLTAGE POWER SUPPLY FRONT PANEL DOES NOT DISPLAY THE OUTPUT VOLTAGE WHEN THE POWER IS TURNED OFF, EVEN IF A CHARGE STILL EXISTS ON THE OUTPUT.**

**CAUTION**

**TO ASSURE SAFETY AND PROPER COOLING ALWAYS OPERATE THE UNIT WITH THE TOP COVER INSTALLED.**

A fan maintains safe operating temperatures in the beam controller 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 units air intake and fan exhaust paths must be clear of any obstructions that might impede the flow of air.
6.11 Standard Features

A general note on remote interface circuitry and remote signal grounding:

When usage applications dictate, electrical isolation may be required when interfacing with beam controller in question. For power control signals such as EXTERNAL INTERLOCK, BEAM OFF and BEAM ON, isolated relay contacts should be used. For status signals and control signals such as BEAM ON, BEAM OFF, etc. opto-isolation should be used. When usage applications dictate, analog programming and monitoring signals may require isolation via analog isolation amplifiers. All interface cables should be properly shielded. All power supply signals should be referenced to the power supplies signal ground on the rear panel interface connector.

LOCAL/REMOTE PROGRAMMING: Allows adjustment of the Emission (beam) Current, Filament Limit Set and Filament Preheat via the front panel/internal controls (local) or external voltage sources (remote).

LOCAL CONTROL - Local programming (front panel/internal control) will enable the front panel potentiometers for Emission (beam) Current and Filament Limit Set, and an internal factory preset potentiometer to set the Filament PreHeat. This is accomplished by setting the rear panel DIP switch, switch 1 position to the OFF (up) position. A jumper should be placed between the rear panel 25 pin female D connector pins 8/9, pins 10/11 and pins 12/13 to enable local Filament Limit Set, Beam Current Program and Filament Preheat control respectively.

REMOTE CONTROL - For remote programming a positive polarity, ground referenced 0-10Vdc source is applied to the rear panel 25 pin female D connector pin 8, pin 10 and pin 12 for Filament Limit Set, Beam Current Program and Filament Preheat control respectively. Any jumpers for local control should be removed and the programming signals should be referenced to pin 1, signal ground. See Figure 6.3 for more details.

Figure 6.2 Typical Operating Setup
An alternate method of controlling the output remotely is by using external resistance such as a potentiometer or a resistor network. See Figure 6.4 for more details.

**REMOTE MONITORS:** Test points (monitors) are made available on the rear panel interface connector for monitoring the Emission (beam) Current and Filament Current; pin 6 and pin 5 respectively. The test points are always positive, scaling is such that 0-10Vdc corresponds to 0-100% rated output. Test points have an output impedance of 4.99k ohms, ±1%. See Figure 6.5 for more information.

**LOCAL/REMOTE: BEAM ON/BEAM OFF:** Allows for command of BEAM ON and BEAM OFF by either the front panel controls or external signals via the rear panel 25 pin external interface connector.

**LOCAL CONTROL -** For local front panel command of the BEAM OFF functionality a maintained connection between pin 14 and pin 15 is required.

**REMOTE CONTROL –** Remote control of BEAM ON and BEAM OFF can be accomplished via the rear panel interface. BEAM OFF and BEAM ON are controlled by momentary normally closed; normally open contacts, respectively between pins 14 and 15, and pins 15 and 16. See Figure 6.6 for more details.

**EXTERNAL INTERLOCK:** The External Interlock connections are provided on the rear panel interface connecter, pin 3 and pin 4. They are intended for use in the connection to a customer provided and implemented external safety switch. The unit will not operate unless the external interlock circuit is closed. If the interlock is not being used (use is highly recommended), a jumper must be installed. During operation, opening the external interlock will cause the unit to revert to the BEAM OFF mode. Subsequent closing of the interlock circuit will NOT return the unit to BEAM ON mode; this must be accomplished by depressing the BEAM ON switch (be it local or remote). See Figure 6.7 for more details.

**REMOTE BEAM ON/OFF INDICATORS:** Allows for the remote monitoring of BEAM ON/OFF. See Figure 6.8

---

**Figure 6.3 Remote Programming via Voltage Sources**

Voltage Source:
0 to 10Vdc = 0 to 100% Rated Output

Remote Filament Preheat Program

Remote Emission Beam Program

All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply
Figure 6.4 Remote Programming via Resistance

Rear Panel JB4

1. Power Supply Ground

2. Remote Filament Limit Set

3. Remote Emission Beam Program

4. 50k Ohm

5. 50k Ohm

6. 50k Ohm

7. +10Vdc

8. Zin = 10M ohms

9. Zin = 10M ohms

10. Zin = 10M ohms

11. Zin = 10M ohms

12. Zin = 10M ohms

Potentiometer Settings:
Fully Counterclockwise = Zero Output
Fully Clockwise = 100% of Rated Output

Remote Filament Preheat Program

All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply.

Figure 6.5 Remote Monitor Designations

Rear Panel JB4

1. Power Supply Ground

2. Filament Current Monitor

3. Emission Beam Current Monitor

4. M

5. Zout = 4.99k ohm, ±1%

6. Zout = 4.99k ohm, ±1%

Monitor signals are scaled such that 0-10Vdc = 0-100% rated output.

All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply.
All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply.

**Figure 6.6 Remote BEAM ON / BEAM OFF**

It is recommended to use relay contacts for the control of the External Interlock. The relay should be located as close as possible to the beam controller. 15Vdc @ 25mA maximum contact rating required.

All cables should be shielded with the shields returned to chassis ground of the beam controller.

**Figure 6.7 External Interlock Interface Circuit**
Figure 6.8 Remote BEAM ON /BEAM OFF Indicator

LED’s or low power relays may replace the optocouplers shown. Whatever devices employed, they should be located as close as possible to the high voltage power supply.

All cables should be shielded with the shields returned to chassis ground (E1) of the high voltage power supply.
### Table 6.2 Beam Controller 25 Pin D Remote Interface Connector

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>SIGNAL PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply Common</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>2</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>External Interlock</td>
<td>+15Vdc at Open, &lt;15mA @ Closed</td>
</tr>
<tr>
<td>4</td>
<td>External Interlock Return</td>
<td>Return for Interlock</td>
</tr>
<tr>
<td>5</td>
<td>Filament Current Test Point</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>6</td>
<td>Beam Current Test Point</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>7</td>
<td>+10Vdc Reference</td>
<td>+10Vdc, 1mA Max</td>
</tr>
<tr>
<td>8</td>
<td>Filament Limit Program Input</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>9</td>
<td>Local Filament Limit Program</td>
<td>Front panel potentiometer wiper</td>
</tr>
<tr>
<td>10</td>
<td>Beam Current Program Input</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>11</td>
<td>Local Beam Current Program</td>
<td>Front panel potentiometer wiper</td>
</tr>
<tr>
<td>12</td>
<td>Filament Preheat Program In</td>
<td>0 to 10Vdc = 0 to 100% rated output</td>
</tr>
<tr>
<td>13</td>
<td>Local Fil. Preheat Program</td>
<td>Internal potentiometer</td>
</tr>
<tr>
<td>14</td>
<td>Beam Off</td>
<td>+15Vdc at Open, &lt;25mA @ Closed</td>
</tr>
<tr>
<td>15</td>
<td>Beam On/Off Common</td>
<td>Connect together for FP operation</td>
</tr>
<tr>
<td>16</td>
<td>Beam On</td>
<td>Momentarily connect to pin 15 = Beam On</td>
</tr>
<tr>
<td>17</td>
<td>Remote Beam Off Indicator</td>
<td>0=Beam On, +15V, 10mA Max=Beam Off</td>
</tr>
<tr>
<td>18</td>
<td>Remote Beam On Indicator</td>
<td>0=Beam Off, +15V, 10mA Max=Beam On</td>
</tr>
<tr>
<td>19</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Remote PS Fault</td>
<td>0 = Fault, +15Vdc @ 0.1mA = No Fault</td>
</tr>
<tr>
<td>23</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Power Supply Common</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>25</td>
<td>Shield Return</td>
<td>Chassis Ground</td>
</tr>
</tbody>
</table>

-= Denotes jumper connection for simplified front panel operation
Chapter 7
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.

7.1 Periodic Servicing

Approximately once a year (more often in high dust environments), disconnect the power to the unit and remove the top cover. Use compressed air to blow dust out of the inside of the unit. Avoid touching or handling the high voltage assembly. 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 cover before operating for proper cooling.

Turn the chassis over and remove the bottom cover. Use compressed air to blow dust out. NOTE: On 10kV and below, an air insulated high voltage section is used. Avoid touching or handling the high voltage assembly. Be sure to replace the bottom cover before operating the unit.

7.2 Performance Test

**WARNING**

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

High voltage test procedures are described in Bulletin STP-783, available by clicking the following link Standard Test Procedures for High Voltage Power Supplies. Test equipment, including an oscilloscope, a high impedance voltmeter, and a high voltage divider (such as the Spellman HVD-100) is needed for performance tests. All test components must be rated for applicable operating voltage.

7.3 High Voltage Dividers

High voltage dividers for precise measurements of output voltage with 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 and the HVD-400 measures up to 400kV. The Spellman HVD divider is designed for use with differential voltmeters or high impedance digital voltmeters. The data sheet for Spellman's series of HVD dividers can be viewed by clicking here.
Chapter 8
REPLACEMENT PARTS

8.1 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 repairs. High voltage is dangerous; even minor mistakes in repairs can have serious consequences.

When requesting parts, please provide the complete model number and serial number of the power supply in question.

8.2 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.

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. Digital photographs can be very helpful in identify components and/or assemblies.
Chapter 9

FACTORY SERVICE

9.1 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.

9.2 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.

9.3 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.

9.4 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
www.spellmanhv.com
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