Spellman’s XRB011 Series of Monoblock® X-Ray sources are designed for OEM applications powering its internal X-Ray tube up to 80kV at 20 watts and 80kV at 50 watts. Features like 24Vdc input voltage, small package size, standard analog interface and RS-232/Ethernet digital interface simplify integrating the XRB011 into your X-Ray system. Proprietary emission control circuitry provides excellent regulation of X-Ray tube current, along with outstanding stability and performance.

**TYPICAL APPLICATIONS**
Medical X-Ray: Extremity and specimen radiography
Pulsed Fluoroscopy (contact Spellman sales)
Industrial X-ray: Component inspection and Non-Destructive Testing

**SPECIFICATIONS**

**Input Voltage:**
- 20W: 24Vdc @ 2.5 Amps
- 50W: 24Vdc @ 4 Amps

**X-Ray Tube Voltage:**
Nominal X-Ray tube voltage is adjustable between 35kV to 80kV

**X-Ray Tube Current:**
- 20W: 0-250μA over specified tube voltage range
- 50W: 0-700μA over specified tube voltage range

**X-Ray Tube Power:**
- 20/50 watts, maximum continuous

**Voltage Regulation:**
- Line: ±0.5% for a ±1V change of nominal input line voltage
- Load: ±0.1% for a load change of 25μA to maximum rated current

**Voltage Accuracy:**
- Voltage measured across the X-Ray tube is within ±1% of the programmed value

**Voltage Risetime:**
- Ramp time shall be ≤250mS from 10% to 90% of maximum rated output voltage

**Over Voltage Fault:**
An overvoltage (OV) fault is detected when the output voltage exceeds 82kV. The high voltage output will be disabled. Toggling the X-Ray ON Command OFF and ON will reset the fault.

**Voltage Ripple:**
≤1% peak to peak

**Voltage Temperature Coefficient:**
≤100ppm/°C

**Current Regulation:**
- Line: ±0.5% for a ±1V change of nominal input line voltage
- Load: ±0.5% for a voltage change of 35kV to 80kV

**Current Accuracy:**
- Current measured through the X-Ray tube is within 2.5% of the programmed value

**Current Temperature Coefficient:**
≤100ppm/°C

**Over Current Fault:**
An overcurrent (OC) fault is detected when the emission current exceeds 275μA (20W model) and 710μA (50W model). Toggling the X-Ray ON Command OFF and ON will reset the fault.

**Arc Intervention:**
One arc fault. The high voltage output will be disabled. Toggling the X-Ray ON command OFF and ON will reset the fault.

**Filament Configuration:**
High Frequency Ac filament drives reference to cathode potential of the X-Ray tube. Closed loop filamentary emission control circuit regulates filament current to provide desired X-Ray tube emission current.

**X-Ray Characteristics:**
- Tube Type: Micro focus tube
- Focal Spot: 0.033mm Nominal. (IEC 336)
- Beam Filter: Ultem 0.060˝ (1.5mm)
  - Oil 0.175˝ (4.4mm)
- Beam Geometry: 40° cone

**Analog Interface:**
Ground referenced 10kV/volt, 25μA/volt (20W model) and 70μA/volt (50W model) for programming and monitoring analog interface signals. Open collector, active low digital signal interface. Internal jumper is needed to be configured for analog interface.
Digital Interface:
- RS-232: standard
- Ethernet: optional

Control Software:
- A demo GUI is available for engineering evaluations

Interlock/Signals:
- A hardware interlock functions in both analog and digital programming modes.

Operating Temperature:
- 0°C to +40°C

Storage Temperature:
- -20°C to +70°C

Humidity:
- 10% to 95% relative humidity, non-condensing

Cooling:
- 50W option: Customer provided, external cooling fan, 50cfm, minimum

Analogue Interface and Input Line Connector:
- 25 pin D connector, male

Digital Interface Connector:
- RS-232: 9 pin D connector, male
- Ethernet: RJ45 connector

Grounding Point:
- 6-32 ground stud provided on chassis

Dimensions:
- 20W: 5.81"W X 5.0"H X 10.81"D
  (147.57mm X 127mm X 274.57mm)
- 50W: 6.00"W X 5.0"H X 10.81"D
  (152.4mm X 127mm X 274.57mm)

Weight:
- 20W: 18lbs (8.165kg)
- 50W: 20lbs (9.072kg)

Orientation:
- Can be mounted in any orientation.

X-Ray Leakage:
- Less than 50mR/hr at 1 meter

Regulatory Approvals:
20W Model

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XRB011-80PN20</td>
<td>80kV, 250uA, 20W, Analog Interface, RS-232</td>
</tr>
<tr>
<td>XRB011-80PN20E</td>
<td>80kV, 250uA, 20W, Analog Interface, RS-232, Ethernet</td>
</tr>
<tr>
<td>XRB011-80PN20A</td>
<td>80kV, 250uA, 20W, Analog Interface</td>
</tr>
</tbody>
</table>

**DIMENSIONS: in.[mm]**

**FRONT VIEW**

**SIDE VIEW**

**TOP VIEW**
50W Model

ORDERING INFORMATION

- XRB011-80PN50 80kV, 700uA, 50W, Analog Interface, RS-232
- XRB011-80PN50E 80kV, 700uA, 50W, Analog Interface, RS-232, Ethernet
- XRB011-80PN50A 80kV, 700uA, 50W, Analog Interface

XRB011
50W Model
DIMENSIONS: in.[mm]

FINE STEPPING

1.25 [31.75]

40°

4.99 [126.74]

0.37 [9.39]

9.26 [234.95]

10.81 [274.57]

0.79 [20.06]

4X 0.238 [6.04]

4X 4-32 TAP

7.31 [185.67]

4.91 [124.71]

1.50 [38.1]

0.25 [6.35]

5.31 [134.67]

2.66 [67.66]
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.

CAUTION
X-RAY SOURCE

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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This information contained in this publication is derived in part from proprietary and patent data. This information has been prepared for the express purpose of assisting operating and maintenance personnel in the efficient use of the model described herein, and publication of this information does not convey any right to reproduce it or to use it for any purpose other than in connection with installation, operation, and maintenance of the equipment described.
**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.
CONSIGNES DE SÉCURITÉ

Cette alimentation génère des tensions qui sont dangereuses et peuvent être fatales. Soyez extrêmement vigilants lorsque vous utilisez cet équipement.

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

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

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

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

CONSIGNES DE SÉCURITÉ EN CAS DE REPARATION

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

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

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

Dans le manuel, les notes marquées « CAUTION » indiquent les procédures qui doivent être suivies afin d’éviter d’éventuels dommages sur l’équipement.
IMPORTANTI PRECAUZIONI DI SICUREZZA

SICUREZZA

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

Gli alimentatori ad alta tensione devono sempre essere collegati ad un impianto di terra.

Non toccare le connessioni a meno che l'apparecchio sia stato spento e la capacità interna del carico e dell'alimentatore stesso siano scariche.

Attendere cinque minuti per permettere la scarica della capacità interna dell'alimentatore ad alta tensione.

Non mettere a terra il proprio corpo oppure operare in ambienti bagnati o saturi d'umidità.

SICUREZZA NELLA MANUTENZIONE

Manutenzione potrebbe essere richiesta, rimuovendo la copertura con apparecchio acceso.

La manutenzione deve essere svolta da personale qualificato, cosciente 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.
CHAPTER 1

XRB011 INTRODUCTION

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  1.2.1 Generator Hardware Specifications .......................................................................................................................... 3
  1.2.2 Generator Control Modes / Application Features ..................................................................................................... 3
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1.4 SAFETY ................................................................................................................................................................................. 9
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1.1 XRB011 DESCRIPTION

The XRB011 MONOBLOCK® is a complete integrated system consisting of a high voltage power supply (HVPS), filament supply, X-ray tube and oil encapsulant which provide the required high voltage insulation in one compact enclosure. The combination of proprietary control system and protection circuitry enables the supplies to operate under arcing and extreme transient conditions without damage or interruptions. Additional advantages are the elimination of high voltage cables and extremely low leakage X-ray radiation.

The XRB011 incorporates local and remote programming, monitoring, and fault indicators including safety interlock. The X-ray source is a sealed unit containing a HVPS and an X-ray tube. The insulating oil provides electrical insulation for the high voltage sections of the power supply and the X-ray tube in a sealed tank. The oil also functions as a coolant to carry heat away from the tube. Convection cooling augmented by customer provided minimum 50cfm external fan is required for the 50W option. A rubber bellows in the tank of the X-ray source compensates for the expansion of the oil as the oil temperature varies with operating conditions thereby eliminating the need for bulky overflow tank.

1.2 TECHNICAL SPECIFICATIONS

1.2.1 Generator Hardware Specifications

- **kVp range:** 35 to 80 kVp output capability
- **kVp steps:** Continuous with 12 bits resolution
- **kVp accuracy:** <=1% (measured after kVp rises to the peak level)
- **Ripple (kV):** <= 1% Peak to Peak
- **Settling time:** < 10ms to within 95% of the programmed voltage
- **Reproducibility:** <0.5%
- **Stability:** <=0.01% per 8 hours
- **Temperature Coefficient:** <=100ppm/ °C
- **Time range:** XRB011 is specified as a Continuous operation.

- **mA :** 250µA maximum for 20W option
- **mA range:** 0 to 250 µA for 20W option
- **mA accuracy:** <2.5% (measured after mA rises to stable DC level)
- **mA range:** 0 to 700 µA for 50W option
- **Reproducibility:** <0.5%

1.2.2 Generator Control Modes / Application Features

- Manual Operating Mode – 2 Parameters Mode (kV, mA)
- System Communication Protocol / Fault & Error Management
  See details in the Serial Communication Protocol Specifications

1.2.3 Power Supply Requirements

**Single Phase**
Line Voltage  
24Vdc±1Vdc; 2.5A (20W option). 4A (50W option)

The following table defines the power line requirements for the generators.

**NOTE: THE FOLLOWING TABLE CONTAINS RECOMMENDED VALUES FOR THE 24V INPUT POWER.**

**A POOR QUALITY INPUT LINE MAY RESULT IN THE INSTALLER HAVING TO DERATE THE GENERATOR’S MAXIMUM POWER.**

<table>
<thead>
<tr>
<th>Mains Voltage</th>
<th>Minimum Recommended</th>
<th>Minimum Recommended Ground Wire Size</th>
<th>Apparent Mains Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>24VDC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J1-1</td>
<td>#20 AWG (0.52 mm²)</td>
<td></td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>J1-2</td>
<td>#20 AWG (0.52 mm²)</td>
<td></td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>J1-3</td>
<td>#20 AWG (0.52 mm²)</td>
<td></td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>24V RETURN</td>
<td></td>
<td>#20 AWG (0.52 mm²)</td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>J1-5</td>
<td></td>
<td>#20 AWG (0.52 mm²)</td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>J1-6</td>
<td></td>
<td>#20 AWG (0.52 mm²)</td>
<td>0.033 Ω</td>
</tr>
<tr>
<td>J1-7</td>
<td></td>
<td>#20 AWG (0.52 mm²)</td>
<td>0.033 Ω</td>
</tr>
</tbody>
</table>

**1.2.4 Environment Requirements**

**Operating Environment**
- Operating Temperature: 0 to 40 °C (32 to 104 °F).
- Relative Humidity: 10 to 95%, non-condensing.
- Atmospheric pressure range: 500 to 1060 hPa (375 to 795 mm Hg).

**TRANSPORT AND STORAGE**
- Ambient temperature range: -20 to 70 °C (-4 to 158 °F).
- Relative humidity: 5 to 95%, non-condensing.
- Atmospheric pressure range: 500 to 1060 hPa (375 to 795 mm Hg).
1.2.5 Mechanical

20W OPTION
50W OPTION
1.3 THEORY OF OPERATION

1.3.1 Function Overview
The XRB011 MONOBLOCK Series is a complete integrated system consisting of a high voltage power supply (HVPS), filament supply, X-ray tube and oil encapsulant which provide the required high voltage insulation in one compact enclosure. The combination of proprietary control system and protection circuitry enables the supplies to operate under arcing and extreme transient conditions without damage or interruptions. Additional advantages are the elimination of high voltage cables and extremely low leakage X-ray radiation.

The XRB011 MONOBLOCK Series incorporates local and remote programming, monitoring, and fault indicators including safety interlock. The X-ray source is a sealed unit containing a HVPS and an X-ray tube. The insulating oil provides electrical insulation for the high voltage sections of the power supply and the X-ray tube in a sealed tank. The oil also functions as a coolant to carry heat away from the tube. Convection cooling augmented by customer provided minimum 50cfm external fan is required for the 50W option. A rubber bellows in the tank of the X-ray source compensates for the expansion of the oil as the oil temperature varies with operating conditions thereby eliminating the need for bulky overflow tank.

The XRB011 MONOBLOCK is basically a DC to DC power converter. Within the generator, conversions of DC to DC, then to high frequency AC, then to high voltage DC take place. By reviewing further the sub-assemblies, a basic understanding of the process can be gained.

1.3.2 Input Line Power
The Input DC voltage provides the voltage for the high voltage inverter and the filament supply. The line input voltage can vary from 23V up to 25V within the series.

1.3.3 HV Inverter
The inverter is a “Push-Pull” topology. Voltage mode control is used for driving the inverter. Two MOSFET transistors are used as switches in the HV inverter. These MOSFET provide high frequency switching to control the primary current flow in the high voltage transformer. Circuits on the Control board provide the gate control of the switches. The PWM IC generates gate drive control signals.

1.3.4 High Voltage Transformer
The output of the High Frequency Quasi-resonant Inverter is connected to the primary of the High Voltage Transformer. The High Voltage Transformer is a step up type. Typical secondary voltage is in the range of 5.7kV depending upon output voltage ratings.

1.3.5 High Voltage Assembly
The High Voltage Assembly circuitry typically consists of two high voltage multipliers to generate ±40kV. The high voltage section is a bipolar ground-referenced supply. The multiplier is a standard diode-capacitor multiplier with seven stages of voltage multiplication and the divider is a precision resistance divider string. Each supply is capable of generating 40 kV. A high bandwidth resistive/capacitive divider provides voltage feedback for regulation and monitoring. A sense resistor connected at the low voltage end of the High Voltage Rectifier provides current feedback for regulation and monitoring.

1.3.6 System Control PWB
Control of the generator utilizes sophisticated analog and digital circuitry resulting in fast and accurate control, protection and signaling to the user. This generator is based on advanced PWM control utilizing the specific integrated circuit. Analog signals are digitized in A/D converter and processed within DSP circuits to provide maximum accuracy and reliability. All feedback signals are sent to the user interface through digital and D/A circuits where switching is possible between feedback and program signals. This allows the user to preset the desired output before energizing high voltage. All program voltages are typically ramped up to set level by the digital ramp generator.
A-D and D-A converters and drivers provide system Fault Control and Indication. User interface is processed on this PWB as well, providing isolated relay coils, opt couplers and open collectors contact.

1.3.7 Filament Power

The filament inverter provides the filament power for the X-ray tube. The filament inverter is a high frequency, series resonant inverter. The inverter provides ac current to the primary of the filament isolation transformer. The filament isolation transformer secondary is connected to the filament tube. The filament power is 2.25Vac/1.7Aac.

See Figure 1.2 for a simplified diagram of the X-RAY tube connection and current sensing circuits. The filament circuitry also provides a variety of control, diagnostic and protection functions.

If any abnormal condition appears, monitoring circuitry will shut down the unit.

![Figure 1.2 Simplified schematic of X-RAY tube connection](image)

1.3.8 High Voltage Interlock

The XRB011 is equipped with safety interlocks for user personnel and equipment protection. An open interlock circuit inhibits operation of the XRB011 MONOBLOCK.
### 1.4 SAFETY

#### 1.4.1 Safety and Warning Symbols

**WARNING:** THIS X-RAY UNIT MAY BE DANGEROUS TO OPERATOR UNLESS SAFE EXPOSURE FACTORS AND OPERATING INSTRUCTIONS ARE OBSERVED.

The following advisory symbols are used on the safety warning labels, and/or on circuit boards.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Exclamation Mark" /></td>
<td>“CAUTION” symbol used to indicate a potential hazard to operators, service personnel or to the equipment.</td>
</tr>
<tr>
<td><img src="image" alt="CAUTION Symbol" /></td>
<td>“CAUTION” symbol used to indicate an X-RAY RADIATION EXPOSURE, is hazard to operators, service personnel or to the equipment.</td>
</tr>
<tr>
<td><img src="image" alt="Protective Earth" /></td>
<td>Protective Earth IEC 60417-5017</td>
</tr>
</tbody>
</table>
CHAPTER 2

INSTALLATION

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2.1 INTRODUCTION

This Chapter contains instructions for unpacking the XRB011 MONOBLOCK, allowing for initial power-up and exposures.

2.2 UNPACKING

**WARNING:** THE XRB011 MONOBLOCK WEIGHS APPROXIMATELY 20 POUNDS (9.07 KG) IN ITS SHIPPING CONTAINER.

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

2. Remove the cardboard outer pack. See the cautionary note below before removing the pack.

**CAUTION:** OPEN THE CARDBOARD PACK CAREFULLY. SHARP TOOLS MAY DAMAGE THE CONTENTS.

3. Set aside the cardboard pack(s).

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

5. Keep the shipping containers. In case of shipping damage, place the unit(s) back in its shipping pack and notify the carrier and the Customer Support Department as shown on the inside cover page of this manual.

6. Fill out and mail the Warranty Registration card accompanying the unit. Spellman XRB011 MONOBLOCK is covered by warranty.
2.3 OVERALL CONNECTIONS

NOTE: THIS IS BASIC CONNECTION ILLUSTRATION FOR TESTING. MORE COMPLEX AND DEDICATED CIRCUITRY IS NEEDED IN ULTIMATE APPLICATION.

All cables should be routed away from the X-Ray port, and dressed and secured neatly in place. Cables should be cut to the correct length if possible as excess cabling may contribute to EMI/RFI problems. For those cables that cannot be cut to the correct length, try to minimize the area inside any loops of excess cable, as these loops are in effect an antenna.

Figure 2-1: XRB011 I/O location
2.4 INPUT POWER VOLTAGE

1. Check the input voltage rating on the nameplate of the supply and make certain that this is the rating of the power source to be connected.

2. Units operate on 24VDC, 2.5A (20W option), 4A (50W option).

3. **DO NOT SWITCH ON MAINS POWER AT THIS TIME.**

2.5 CABLE CONNECTION ILLUSTRATION

2.5.1 MULTI INTERFACE CABLE CONNECTIONS

Multi Interface connections include digital I/O, serial communication, and interlock. Operator must verify and connect every signal properly though some of them are optional, before initiating power-up and basic test.
The interlock, serial communication and exposure buttons interface shall be made available via a multi signal cable. Refer to **-* for a schematic of isolation and signal direction.

### 2.5.1 Pin Layout of the Multi interface

The multi signal interface shall have a female 25 pin D-Sub (J1). Twisted pairs shall be used where applicable. The pin layout is given in Table 2-3.

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+24V</td>
<td>+24V±1Vdc, @ 4A</td>
</tr>
<tr>
<td>2</td>
<td>+24V</td>
<td>+24V±1Vdc, @ 4A</td>
</tr>
<tr>
<td>3</td>
<td>+24V</td>
<td>+24V±1Vdc, @ 4A</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>5</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>6</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>7</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>8</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>9</td>
<td>Interlock Input</td>
<td>Input, Active low, Interlock is low-safe to enable high voltage. Connect to +24V Return</td>
</tr>
<tr>
<td>10</td>
<td>kV Monitor</td>
<td>Output, 0 to 8V = 0 to rated output voltage. Zout=100Ω</td>
</tr>
<tr>
<td>11</td>
<td>µA Monitor</td>
<td>Output, 0 to 10V = 0 to rated output current. Zout=100Ω</td>
</tr>
<tr>
<td>12</td>
<td>X-Ray Ready status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>13</td>
<td>X-Ray ON status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>14</td>
<td>Filament Standby status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>15</td>
<td>Over Voltage Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>16</td>
<td>Over Current Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>17</td>
<td>ARC Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>18</td>
<td>Filament Current Limit Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>19</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>20</td>
<td>Interlock Output</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>21</td>
<td>µA Program</td>
<td>Input, 0 to 10V = 0 to rated output current. Zin=10kΩ</td>
</tr>
<tr>
<td>22</td>
<td>kV Program</td>
<td>Input, 0 to 8V = 0 to rated output voltage. Zin=10kΩ</td>
</tr>
<tr>
<td>23</td>
<td>X-Ray ON Command</td>
<td>Input, Active low, Low (short)=X-Ray ON High (open)=X-Ray OFF Internal pull up resistor to +15V</td>
</tr>
<tr>
<td>24</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>25</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
</tbody>
</table>

**Table 2-3 Pin layout of multi signal connector**

Refer to chapter 3 for detailed requirements and function descriptions.

### 2.5.2 GROUND CONNECTION

**NOTE:** THE INSTALLER SHOULD ENSURE THAT ALL CABLE CONNECTIONS TO THE GENERATOR ARE SECURE, AND ALL CABLES EXTERNAL TO THE GENERATOR ARE ADEQUATELY PROTECTED AGAINST ACCIDENTAL DISCONNECTION.
2.5.3 CHASSIS GROUND
The chassis of the XRB011 MONOBLOCK must be grounded to the local earth ground and also to the tube housing ground.

2.5.4 X-RAY PORT

**WARNING**

ENSURE THAT THE EXIT PORT IS PROPERLY MATED TO COLLIMATOR OR SATISFACTORILY SHIELDED WITH LEAD PLUG TO LIMIT EXPOSURE TO LEAKAGE RADIATION.

X-ray Safety Procedures must be followed when testing this unit. The XRB011 is capable of producing Lethal Voltages and X-ray Radiation. Only proceed with operation of the HVPS after
- Consulting with the Manufacturer and verification of X-Ray setup for the proper precautions.
- Reading this entire document.

NEVER OPERATE THIS UNIT WITH AN OPEN X-RAY EXIT PORT.

It is recommended not to allow leakage radiation exceeding 0.5mR/hr at 5cm from any surface of the MONOBLOCK.

2.6 FINAL CHECKS

The room interface connections may now be completed. Before power on, user needs to check the items as below finally.
- When finished all wiring, check that all connections are tight and secure.
- Check that all cables are dressed neatly outside the cabinet, and secured as necessary.
- Check the ground connection again.

**WARNING**

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL.

PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.

**CAUTION**

![X-Ray Source]

**WARNING** X-RAY RADIATION EXPOSURE IS HAZARDOUS

Failure to follow these procedures may void the warranty.

Check the input voltage rating on the nameplate of the supply and make certain that this is the rating of the available power source. Spellman MONOBLOCK® XRB011 operates on 24VDC±1VDC
**Bellows Vent holes:**
Do not block or insert anything into the vent holes located on top cover as shown. These two holes provide venting for the internal bellows that is used to compensate for the expansion of the oil as the oil temperature varies.

**Do not block any vents holes on the cover**

**Cooling:**
A customer supplied minimum 50 CFM fan should be used for the 50W option to maintain safe operating temperature for MONOBLOCK® X-ray generator. The air flow should be direct at the heat sink on the side of the unit and at the side of the control board compartment. During operation the internal oil temperature should be below 60°C and should not exceed 65°C. See below Figure for fan location.
CHAPTER 3

INTERFACING

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3.3 LOCAL MONITORS ............................................................................................................................................................ 18
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3.8 EXTERNAL INTERLOCK .................................................................................................................................................... 18
3.9 SYSTEM STATUS AND FAULT DIAGNOSTIC DISPLAY ................................................................................................. 18
3.10 REMOTE MODE (DIGITAL CONTROL) .......................................................................................................................... 19
3.11 CONNECTOR STYLE AND PIN LAYOUT .......................................................................................................................... 20
3.12 SERIAL COMMUNICATION INTERFACE ......................................................................................................................... 21
3.13 RECOMMENDED INTERFACE CIRCUITS (LOCAL MODE, ANALOG INTERFACE) ........................................................ 22
3.14 RECOMMENDED INTERFACE CIRCUITS (REMODE MODE, DIGITAL INTERFACE) .................................................... 23
3.1 INTRODUCTION
This Chapter describes the interfacing of the XRB011 MONOBLOCK to the customer system control side, especially with the serial communication, exposure control switch. Also, exposure mode is introduced with the timing sequence described as well.

3.2 LOCAL PROGRAMMING MODE
- Allows Local adjustment of the output voltage and current via analog voltage inputs on J1 analog interface. To operate in Local mode, position jumpers for JP11 in the 1-2. JP11 is located on the control board. Remove the cover to access JP11.
- Program kV output value by providing 0-8.00V (0-80kV) to J1-22 (reference to signal ground J1-24 or 25).
- Program µA output value by providing 0-10.00V (0-250µA for 20W option), (0-700µA for 50W option) to J1-21 (reference to signal ground J1-24 or 25).
- All program values default to zero upon power up except kV program to 3.5V (35kV)

3.3 LOCAL MONITORS
- Provides local analog monitors for the output voltage and current via analog voltage outputs on J1 analog interface.
- Monitor kV output by measuring J1-10 (reference to signal ground J1-24), 0-8.00v (0-80kV).
- Monitor µA output by measuring J1-11 (reference to signal ground J1-24 or 25), 0-10.00V (0-250µA, 20W option), (0-700µA, 50W option)

3.5 REMOTE PROGRAMMING MODE
- Allows remote adjustment of the output voltage and current via RS-232 digital interface at J5 or Ethernet digital interface RJ45.
- To operate in Remote mode, position jumper JP11 in the 2-3 position on the control board. Remove the cover to access JP11.
- All program values default to zero upon power up except kV program to 35kV.

3.6 REMOTE MONITORS
- Provides remote monitors of the output voltage and output current via RS-232 digital interface at J5 or Ethernet digital interface RJ45.

3.7 XRAY ON COMMAND
- Provides control of X-ray ON and X-ray OFF either via a dry contact connection from J1-23 to J1-19 when operating in Local Mode (analog control). In remote Mode J1-23 is not active and X-ray ON and OFF is controlled through RS-232 or Ethernet communication.
- The external interlock must also be close for the X-ray to enable.

3.8 EXTERNAL INTERLOCK
- The X-ray cannot be enabled unless the external interlock is closed by connecting J1-9 to J1-8. During high voltage operation, opening the interlock circuit will cause the High Voltage to be disabled.

3.9 SYSTEM STATUS AND FAULT DIAGNOSTIC DISPLAY
If a fault occurs, the power supply will revert to the POWER DOWN mode indicated by X-RAY READY STATUS (J1-12), RS-232 or Ethernet as HV OFF. In local mode to reset all faults, the X-RAY ON Command (J1-23) must be toggled OFF and ON. In Remote mode; to reset all faults a host command sent via RS-232 or Ethernet, Reset Faults <52>.

All fault and status outputs are open collector (Normally off), and are intended to drive an LED or diode of an optocoupler with 24V@10mA max
- EXTERNAL INTERLOCK FAULT: Indicates the EXTERNAL INTERLOCK connection is not in closed position. The fault is indicated by INTLK OPEN via RS-232 or Ethernet as (ARG 9). Analog output signal (J1-20) is active low (Low = interlock is closed, High = interlock is open)
- **X-RAY READY STATUS:** Indicates that there are no faults and the interlock is closed. The status is indicated by NO FAULT (X-RAY READY) via RS-232 or Ethernet as (ARG 0). Analog output signal (J1-12) is active low.

- **X-RAY ON STATUS:** Indicates that the X-RAY is ON or OFF. This status is indicated by via RS-232 or Ethernet as X-RAY ON (ARG 1), X-RAY OFF (ARG 0). Analog output signal (J1-13) is active low (Low X-RAY is on, High=X-RAY is off).

- **OVERVOLTAGE FAULT:** Indicates the over voltage protection circuitry has caused the high voltage to turn off. Over voltage protection is internally set to 82kV. This fault is indicated by High kV via RS-232 or Ethernet as (ARG 6), Over Voltage. Analog output signal (J1-15) is active low.

- **OVER CURRENT FAULT:** Indicates the output current has exceeded 275µA (20W option), 710µA (50W option) or if the allowable percentage of error between actual and programmed emission currents is exceeded resulting in the HV to be turned off. This fault is indicated by High mA via RS-232 or Ethernet as (ARG 3). Analog output signal (J1-16) is active low.

- **ARC FAULT:** Indicates that an arc has occurred. Occurrences of one arc will shutdown the high voltage and latched. This fault is indicated by ARC FAULT via RS-232 or Ethernet as (ARG 2). Analog output signal (J1-17) active low.

- **UNDER VOLTAGE FAULT:** Indicates a failure in the voltage regulation circuitry less than <35kV. This fault occurs when there is a lack of output power to maintain regulation and will result in shutdown of the HV. This fault is indicated by via RS-232 or Ethernet as (ARG 4). There is no analog output signal.

- **FILAMENT CURRENT LIMIT FAULT:** Indicates the filament current exceeded the safe operating current of the X-Ray tube. This fault is indicated by FILAMENT LIMIT via RS-232 or Ethernet as (ARG 10). Analog output signal (J1-18) is active low.

- **FILAMENT STANDBY STATUS:** Indicates the X-RAY is off and the filament current is in standby mode. This status is indicated by FILAMENT STANDBY via RS-232 or Ethernet as (ARG 11). Analog output signal (J1-14) is active low.

- **WATCHDOG TIMER:** Indicates the host computer has lost communication and with the HVPS system for a period greater than ten second. This feature is enabled via RS-232 host command. This fault is indicated via RS-232 as (ARG 7) Watchdog Time-out. See digital manual for details.

### 3.10 REMOTE MODE (DIGITAL CONTROL)

- G.U.I Installation software will be provided up on request.
- Start the G.U.I.
- Read agreement then click AGREES...
3.11 J1 CONNECTOR STYLE AND PIN LAYOUT

**Figure 3-1 multi signal interface connector**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+24V</td>
<td>+24Vdc±1Vdc @ 4A</td>
</tr>
<tr>
<td>2</td>
<td>+24V</td>
<td>+24Vdc±1Vdc @ 4A</td>
</tr>
<tr>
<td>3</td>
<td>+24V</td>
<td>+24Vdc±1Vdc @ 4A</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>5</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>6</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>7</td>
<td>+24V RETURN</td>
<td>+24V RETURN</td>
</tr>
<tr>
<td>8</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>9</td>
<td>Interlock Input</td>
<td>Input, Active low, Interlock is low safe to enable high voltage. Connect to +24V Return</td>
</tr>
<tr>
<td>10</td>
<td>kV Monitor</td>
<td>Output, 0 to 8V = 0 to rated output voltage. Zout=100Ω</td>
</tr>
<tr>
<td>11</td>
<td>µA Monitor</td>
<td>Output, 0 to 10V = 0 to rated output current. Zout=100Ω</td>
</tr>
<tr>
<td>12</td>
<td>X-Ray Ready status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>13</td>
<td>X-Ray ON status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>14</td>
<td>Filament Standby status</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>15</td>
<td>Over Voltage Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>16</td>
<td>Over Current Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>17</td>
<td>ARC Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>18</td>
<td>Filament Current Limit Fault</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>19</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>20</td>
<td>Interlock Output</td>
<td>Output, Active Low, Open Collector, 24Vdc @ 10mA max</td>
</tr>
<tr>
<td>21</td>
<td>µA Program</td>
<td>Input, 0 to 10V = 0 to rated output current. Zin=10kΩ</td>
</tr>
<tr>
<td>22</td>
<td>kV Program</td>
<td>Input, 0 to 8V = 0 to rated output voltage. Zin=10kΩ</td>
</tr>
<tr>
<td>23</td>
<td>X-Ray ON Command</td>
<td>Input, Active low, Low (short)=X-Ray ON High (open)=X-Ray OFF Internal pull up resistor to +15V</td>
</tr>
<tr>
<td>24</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>25</td>
<td>Signal Ground</td>
<td>Signal Ground</td>
</tr>
</tbody>
</table>

**Table 3-2 Pin layout of multi signal interface**
3.12 SERIAL COMMUNICATION INTERFACE

The serial communication is part of the Multi Signal Interface. The pin definition shows below:

**RS232 DIGITAL INTERFACE**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>2</td>
<td>TX Out</td>
<td>Transmit Data</td>
</tr>
<tr>
<td>3</td>
<td>RX In</td>
<td>Receive Data</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>5</td>
<td>SGND</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>6</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>7</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>9</td>
<td>NC</td>
<td>No connection</td>
</tr>
</tbody>
</table>

**ETHERNET DIGITAL INTERFACE (OPTIONAL)**

<table>
<thead>
<tr>
<th>PIN</th>
<th>SIGNAL</th>
<th>PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TX+</td>
<td>Transmit Data +</td>
</tr>
<tr>
<td>2</td>
<td>TX -</td>
<td>Transmit Data -</td>
</tr>
<tr>
<td>3</td>
<td>RX +</td>
<td>Receive Data +</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>6</td>
<td>RX -</td>
<td>Receive Data -</td>
</tr>
<tr>
<td>7</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>8</td>
<td>NC</td>
<td>No connection</td>
</tr>
</tbody>
</table>

User should connect a straight type RS232 cable properly with system side such as PC. Twisted wires are preferable to enhance the EMC performance.

GUI software can be used temporarily to test the XRB011 provided per request installed on the user PC. (Refer to separate document for detailed information of GUI). But user need to develop their own ultimate software based on open protocol (Refer to separate document) and design system control board to integrated XRB011 into their system with proper method (Refer to 2.6.1 NOTE the isolation requirement).
3.13 RECOMMENDED INTERFACE CIRCUITS (LOCAL MODE, ANALOG INTERFACE)

![Diagram of LVPS 24V/5A with XRB011 interface circuits]

- +24Vdc
- +24Vdc
- +24V RETURN
- +24V RETURN
- +24V RETURN
- kV MON (8V=80kV)
- μA MON (10V=700μA)
- kV/mA MON RET
- 10V RET
- 5kΩ
- 5kΩ
- Signal Ground
- +10V
- X-RAY ON CMD
- S2 Signal Ground
- INTERLOCK
- S1 Signal Ground
- X-RAY Ready
- X-RAY ON
- FIL Standby
- Over voltage
- Over current
- ARC
- FIL Current Limit
- Interlock
3.14  RECOMMENDED INTERFACE CIRCUITS (REMODE MODE, DIGITAL INTERFACE)

Monitors and Fault LED’s are optional
CHAPTER 4

TROUBLE SHOOTING

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TABLE 3 – GUIDANCE AND MANUFACTURER’S DECLARATION
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4.1 INTRODUCTION

Fault or error message will be indicated via system status indicator or serial message during abnormal operation. This Chapter contains tables of those messages and suggests actions to be taken by service personnel to correct any malfunctions that may occur.

4.2 STATUS AND ERROR CODES

4.2.1 Status Messages

<table>
<thead>
<tr>
<th>Fault/Symptom</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>OV led illuminated and Over voltage fault at RS-232 resulting in HV Status Off.</td>
<td>kV programming set greater than 82kV.</td>
</tr>
<tr>
<td>UV led illuminated and Under Voltage fault at RS-232 resulting in HV Status Off.</td>
<td>kV programming set less than 35kV.</td>
</tr>
<tr>
<td>OC led illuminated and Over Current fault at RS-232 resulting in HV Status Off.</td>
<td>mA programming greater than 275µA (20W option) 710µA (50W option)</td>
</tr>
<tr>
<td>ARC FLT led illuminated and Arc fault at RS-232 resulting in HV Status OFF</td>
<td>Occurrence of tube arc causing shutdown. Clear fault and send X-ray command. Refer to tube re-seasoning procedure Table 2 and idle times. If problem continues contact Spellman service department.</td>
</tr>
<tr>
<td>Unit will not Enable</td>
<td>Interlock open</td>
</tr>
</tbody>
</table>

TABLE 1 – GUIDANCE AND MANUFACTURER’S DECLARATION
ELECTROMAGNETIC EMISSIONS – FOR ALL ME EQUIPMENT AND ME SYSTEMS

<table>
<thead>
<tr>
<th>Emissions test</th>
<th>Compliance</th>
<th>Electromagnetic environment – guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF emissions</td>
<td>Group 2</td>
<td>The XRB011 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.</td>
</tr>
<tr>
<td>CISPR 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmonic emissions</td>
<td>Class B</td>
<td>The XRB011 is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.</td>
</tr>
<tr>
<td>IEC 61000-3-2</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Voltage fluctuations/ flicker emissions</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 2 – GUIDANCE AND MANUFACTURER’S DECLARATION – ELECTROMAGNETIC EMISSIONS – FOR ALL ME EQUIPMENT AND ME SYSTEMS

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC 60601 test level</th>
<th>Compliance level</th>
<th>Electromagnetic environment – guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge (ESD)</td>
<td>± 6 kV contact</td>
<td>± 6 kV contact</td>
<td>Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.</td>
</tr>
<tr>
<td>IEC 61000-4-2</td>
<td>± 8 kV air</td>
<td>± 8 kV air</td>
<td></td>
</tr>
<tr>
<td>Electrical fast transient/burst</td>
<td>± 2 kV for power supply lines</td>
<td>± 2 kV for power supply lines</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>IEC 61000-4-4</td>
<td>± 1 kV for input/output lines</td>
<td>± 1kV for input/output lines</td>
<td></td>
</tr>
<tr>
<td>Surge</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>IEC 61000-4-5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage dips, short interruptions</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>and voltage variations on power</td>
<td></td>
<td></td>
<td>If the user of the XRB011 requires continued operation during power mains interruptions, it is recommended that the XRB011 be powered from an uninterruptible power supply or a battery.</td>
</tr>
<tr>
<td>supply input lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEC 61000-4-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power frequency (50/60 Hz) magnetic</td>
<td>3 A/m</td>
<td>3 A/m</td>
<td>Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEC 61000-4-8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE** \( U_T \) is the A.C. mains voltage prior to application of the test level.

### TABLE 3 – GUIDANCE AND MANUFACTURER’S DECLARATION – ELECTROMAGNETIC IMMUNITY – FOR ME EQUIPMENT AND ME SYSTEMS THAT ARE NOT LIFE-SUPPORTING

<table>
<thead>
<tr>
<th>Immunity test</th>
<th>IEC 60601 test level</th>
<th>Compliance level</th>
<th>Electromagnetic environment – guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable and mobile RF communications equipment should be used no closer to any part of the XRB011, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Recommended separation distance

Conducted RF

IEC 61000-4-6
3 Vrms
150 kHz to 80 MHz

3 Vrms

\( d = 1.17 \sqrt{P} \)

Radiated RF

IEC 61000-4-3
3 V/m
80 MHz to 2.5 GHz

3 V/m

\( d = 1.17 \sqrt{P} \)

80 MHz to 800 MHz

\( d = 2.33 \sqrt{P} \)

800 MHz to 2.5 GHz

Where \( P \) is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and \( d \) is the recommended separation distance in meters (m).

Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,a should be less than the compliance level in each frequency range.b

Interference may occur in the vicinity of equipment marked with the following symbol:

NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

a Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the XRB011 is used exceeds the applicable RF compliance level above, the XRB011 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the XRB011.

b Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

TABLE 4 – RECOMMENDED SEPARATION DISTANCES BETWEEN PORTABLE AND MOBILE RF COMMUNICATIONS EQUIPMENT AND THE ME EQUIPMENT OR ME SYSTEM – FOR ME EQUIPMENT AND ME SYSTEMS THAT ARE NOT LIFE-SUPPORTING

Recommended separation distances between portable and mobile RF communications equipment and the XRB011

The XRB011 is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the XRB011 can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the XRB011 as recommended below, according to the maximum output power of the communications equipment.

<table>
<thead>
<tr>
<th>Rated maximum output power of transmitter W</th>
<th>Separation distance according to frequency of transmitter m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150 kHz to 80 MHz</td>
</tr>
<tr>
<td>0.01</td>
<td>0.117</td>
</tr>
<tr>
<td>0.1</td>
<td>0.370</td>
</tr>
</tbody>
</table>
For transmitters rated at a maximum output power not listed above, the recommended separation distance $d$ in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where $P$ is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

**NOTE 1** At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

**NOTE 2** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.17</td>
<td>1.17</td>
<td>2.33</td>
</tr>
<tr>
<td>10</td>
<td>3.70</td>
<td>3.70</td>
<td>7.37</td>
</tr>
<tr>
<td>100</td>
<td>11.7</td>
<td>11.7</td>
<td>23.3</td>
</tr>
</tbody>
</table>
CHAPTER 5

SCHEMATICS

CONTENTS:

5.1 INTRODUCTION ........................................................................................................................................................ 30
5.2 FUNCTIONAL SCHEMATIC INDEX ........................................................................................................................ 30
5.1 INTRODUCTION

This chapter contains the functional schematics for XRB011 MONOBLOCK. Each schematic represents a major function in the generator; the 2 functional schematics in this chapter represent all of the major functional blocks in this generator.

5.2 FUNCTIONAL SCHEMATIC INDEX

The following functional schematics are not included in this manual.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DRAWING NUMBER #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block diagram Schematic</td>
<td>441431-001</td>
</tr>
<tr>
<td>Control Board Schematic</td>
<td>441434-001</td>
</tr>
</tbody>
</table>
SPELLMAN HIGH VOLTAGE ELECTRONICS

WARRANTY

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

This warranty does not apply to any power supply that has been:
- Disassembled, altered, tampered, repaired or worked on by persons unauthorized by Spellman;
- Subjected to misuse, negligent handling, or accident not caused by the power supply;
- Installed, connected, adjusted, or used other than in accordance with the original intended application and/or instructions furnished by Spellman.

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

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

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

Factory Service Procedures

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

Factory Service Warranty

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

Spellman Worldwide Service Centers

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