

# Instruction Manual

## MONOBLOCK® SERIES XRB80HR

### High Voltage X-Ray Generator

MODEL :  
SERIAL# :  
DATE :

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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.



### SERVICING SAFETY

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

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

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

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

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# WICHTIGE SICHERHEITSHINWEISE

## SICHERHEIT

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

Das Hochspannungsnetzteil muß immer geerdet sein.

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

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

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



## SERVICESICHERHEIT

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

Reparaturen dürfen nur von qualifiziertem, eingewiesenem Personal ausgeführt werden.

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

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

## PRECAUTIONS IMPORTANTES POUR VOTRE SECURITE

### CONSIGNES DE SÉCURITÉ

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

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

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

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

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



### CONSIGNES DE SÉCURITÉ EN CAS DE REPARATION

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

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

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

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

## IMPORTANTI PRECAUZIONI DI SICUREZZA

### SICUREZZA

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

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



### SICUREZZA NELLA MANUTENZIONE.

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

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# Chapter 1

## INTRODUCTION

### 1.1 Description of the XRB80HR MONOBLOCK® Series

The XRB80HR (high reliability) Monoblock® X-ray source is designed for OEM applications powering its internal Bipolar X-ray tube up to 80kV at 100W. It is a complete integrated system consisting of a high voltage power supply (HVPS), filament supply, X-ray tube and oil encapsulant which provides the required high voltage insulation in one compact enclosure. The combination of proprietary control system and protection circuitry. Additional advantages are the elimination of high voltage cables and low leakage X-ray radiation.

Power factor corrected input regulator is utilized to improve overall reduction in harmonic emissions and EMI. The output provides a regulated +390VDC to downstream switching circuitry enabling optimal performance and efficiency.

The XRB80HR MONOBLOCK® Series incorporates remote programming, monitoring, and fault indicators including 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 external fan is required. A 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 XRB80HR is available either with fan shaped (standard) or (optional) cone shaped beam geometries. Proprietary emission control circuitry provides excellent regulation of X-ray tube current, along with outstanding stability performance. The XRB80HR is designed for long field life.

## 1.2 Operating Features

The XRB80HR MONOBLOCK® Series incorporates several standard features designed to optimize user satisfaction and safety.

- **INTERNAL FAULT PROTECTION:** The XRB80HR MONOBLOCK® Series continually monitors internal circuits critical to the proper operation of the power supply. In the event that one of these circuits does not function correctly, the fault detection circuit latches the appropriate fault on the front cover display and turns off the output.

- **LED FAULT/STATUS INDICATORS:**

Indicators are located on the cover of Inverter/Control Assembly and are provided to give the user complete indication of system operation and fault conditions.

POWER	OVERVOLTAGE (OV)
ARC FLT	UNDERVOLTAGE (UV)
OVERTEMP (OT)	OVER CURRENT (OC)
UNDER CURRENT (UC)	X-RAY ON
OVER POWER (OP)	

- **WATCHDOG OPERATION:** The HVPS employs an internal watchdog timer to discontinue X-ray operation in instances where the host computer has lost communication and control of the HVPS system for a period greater than ten second. This feature is enabled via RS-232 host command.
- **LOCAL MONITORS:** provides Local analog monitors for the output voltage and current via analog voltage outputs on J2 on the front cover.
- **REMOTE PROGRAMMING:** Allows remote adjustment of the output voltage and current via RS-232 digital interface port at J3 on the front cover. All program values default to zero upon power up.
- **REMOTE MONITORS:** Provides remote monitors of the output voltage, output current and Filament current via RS-232 digital interface port at J3 on the front cover.
- **X-RAY ENABLE CONTROL:** Provides control of X-ray ON and X-ray OFF via RS-232 communication or analog enable via J2-15 (connect to J2-13).
- **EXTERNAL INTERLOCK:** The X-ray cannot be enabled unless the external interlock is closed by connecting J2-11 to J2-12. During high voltage operation, opening the interlock circuit will cause the

High Voltage to be disabled. Interlock status indication via RS-232 interface at J3.

### IMPORTANT

**This control signal is not a safety interlock and should not be used for protection from X-ray generation for safety purposes.**

- **HV ON LAMP RELAY:** When X-ray ON command is enabled a NO and a NC relay contact closure will occur at connector J2. Refer to pin assignments datasheet SHV#128118-001 and specification for contact ratings.
- **OIL TEMPERATURE MONITOR:** Provides remote oil temperature monitor via RS-232 digital interface port at J3 on front cover.
- **PS Fault Indication:** PS Faults an open collector output on J2-1, indicates that a faults has occurred. High = no faults.
- **X-ray On Indication:** X-ray On Signal is an open collector output on J2-14, indicates that a faults has occurred. High = X-ray off



## 1.3 System Status and Fault Diagnostic Display

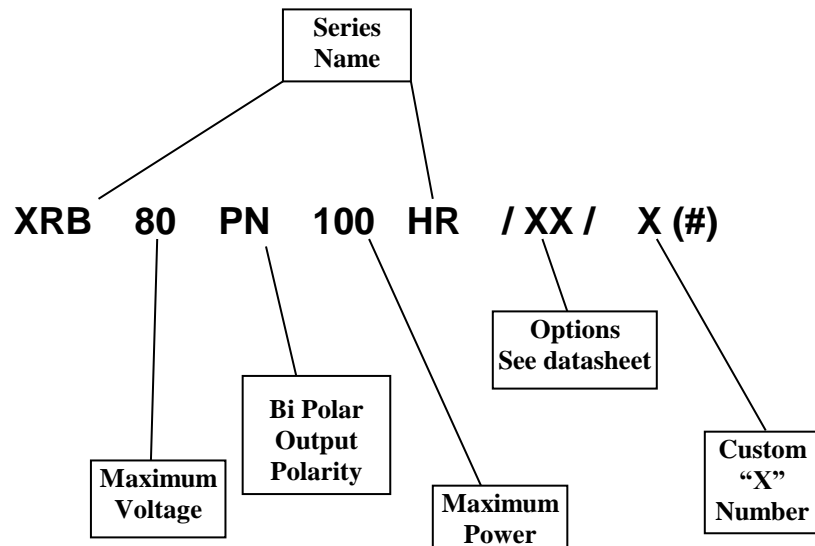
If a fault occurs, the power supply will revert to the POWER DOWN mode indicated by extinguishing of X-ray ON led and via RS-232 as HV OFF. To reset a fault, a clear command or X-ray ON command must be sent via RS-232.

- **EXTERNAL INTERLOCK FAULT:** Indicates that the high voltage supply is inhibited by external interlock protection circuitry solely via RS-232 communication as (ARG 8) Open Interlock.
- **OVERVOLTAGE:** Indicates the over voltage protection circuitry has caused the high voltage to turn off. Over voltage protection is internally set to 88kv. This fault is indicated by OV led status on the front cover and via RS-232 as (ARG 3), Over Voltage.
- **OVER CURRENT FAULT:** Indicates the output current has exceeded 2.20ma 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 illumination of OC led status on the front cover and via RS-232 as (ARG 5) Over Current.
- **ARC FAULT:** On the standard unit indicates that an arc has occurred. This fault is indicated by momentary (~ 1 sec) illumination of ARC FLT led status on front cover and via RS-232 as (ARG 1) Arc. Occurrences of four arcs with in a period of ten seconds will shutdown the high voltage. This fault is indicated by illumination of ARC FLT led status on front cover and via RS-232 as (ARG 1) Arc.
- **UNDER VOLTAGE:** Indicates a failure in the voltage regulation circuitry. 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 illumination of UV led status on the front cover and via RS-232 as (ARG 4) Under Voltage.
- **UNDER CURRENT:** Indicates failure in the current regulation circuitry. This fault occurs when the allowable percentage of error between actual and programmed emission currents is exceeded, due to the actual emission current being less than the programmed level. This fault **does not** shutdown the HV, it is indicated by illumination of UC led status on front cover and via RS-232 as (ARG 6) Under Current.
- **OVER TEMPERATURE:** Indicates that the internal oil temperature has exceeded 66 deg C. This could be either caused by a failure in the customer supplied cooling fan that would cause the oil temperature to exceed 65 deg C or the ambient temperature has exceeded 40 deg C, resulting in shutdown of HV. This fault is indicated by OT led status on the front cover and via RS-232 as (ARG 6) Over Temperature.
- **POWER ON LED:** When input power is applied to the unit it is indicated by the POWER led being illuminated.
- **X-ray On LED:** when the high voltage status is "On" state it is indicated by X-RAY ON led status on the front cover.
- **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 5) Watchdog Timeout. See digital manual for details.
- **OVER POWER FAULT:** Indicates the output power has exceeded 107watts. This fault is indicated by the illumination of both the UC and OC led status on the front cover an, OP fault via RS-232 as (ARG 9) Over Power.

## 1.4 Interpreting the Model Number

The model number of the power supply describes its capabilities. After the series name is:

1. Maximum voltage (in kV).
2. Polarity of the unit: (PN) Bi Polar
3. The maximum output (in watts).
4. Options
5. Custom model number



**XRB80PN100HR**

# Chapter 2

## INSPECTION & INSTALLATION

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

### 2.1 Initial Inspection

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

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

Fill out and mail the Warranty Registration card accompanying the unit. Standard Spellman XRB80HR

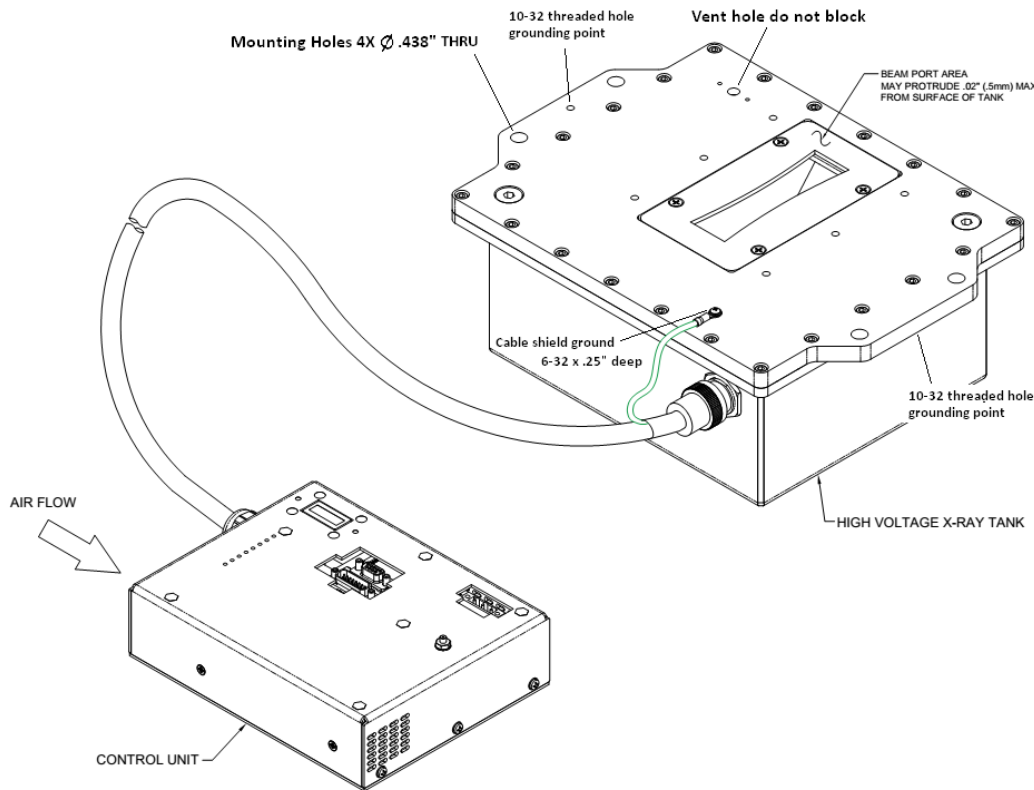
MONOBLOCK® Series high voltage power supplies and components are covered by warranty.

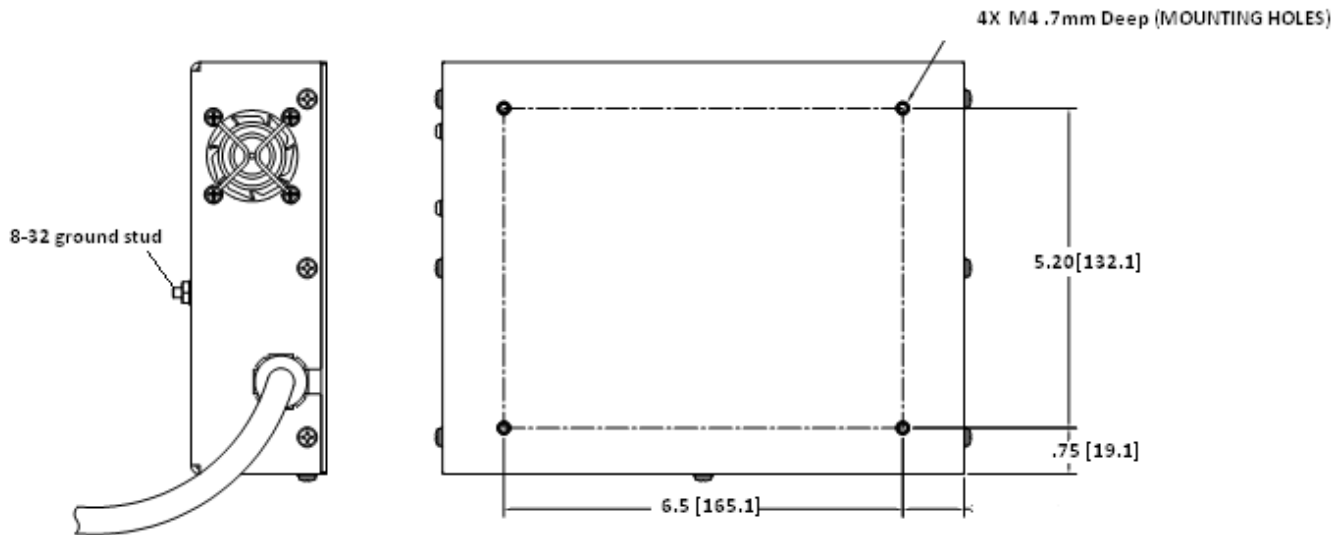
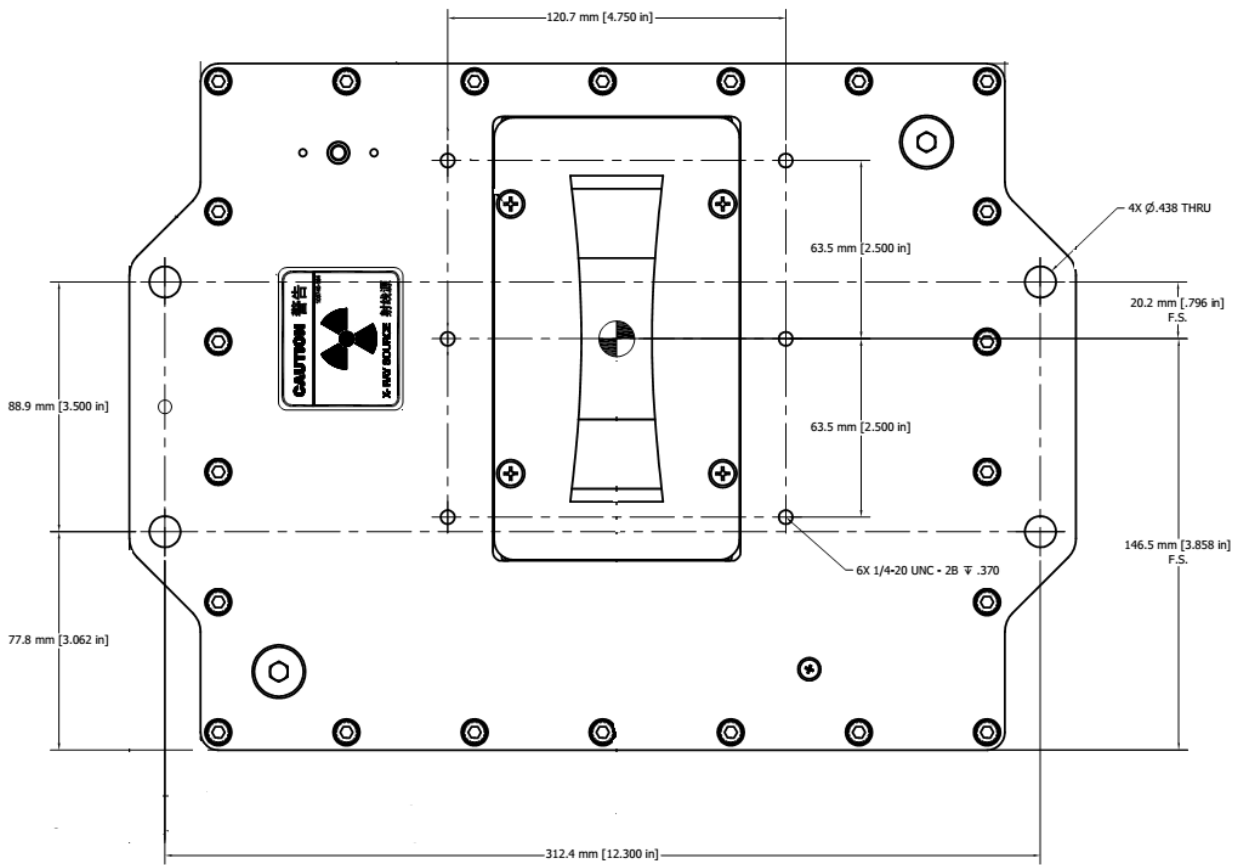
### 2.2 Installation

The unit can be mounted in any position. Four, .438" thru mounting holes are provided on the Tank flanges shown below. For Exit port collimation mounting six ¼ -20 UNC 2B holes .370" deep are provided.

The Control assemble has four, M4 threaded holes .7mm deep.

Do not block the vent holes in the top cover as indicated.





# Chapter 3

## OPERATING INSTRUCTIONS

### 3.1 Operation

**WARNING**

**THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL.**

**PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.**



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

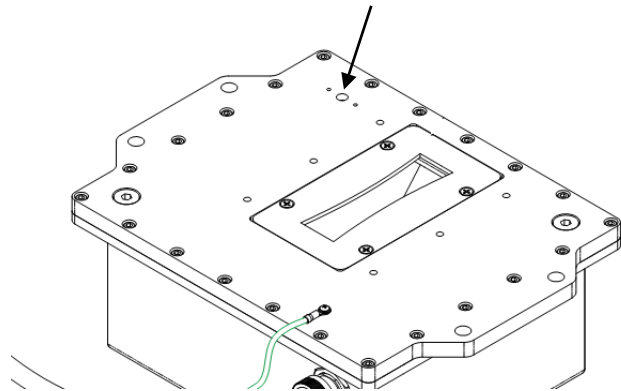
Failure to follow these procedures may void the warranty.

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 XRB80HR MONOBLOCK® XRB80PN100HR operates on 90-264VAC, single phase 50 or 60Hz.

#### **Bellow Vent hole:**

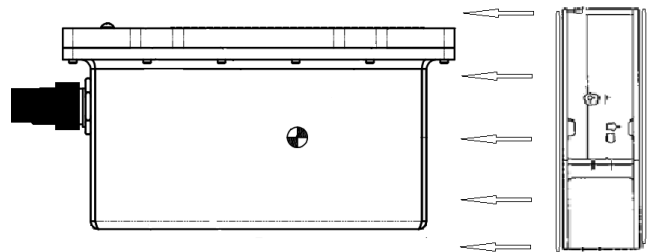
Do not block or insert anything into the vent hole located on top cover as shown. This hole provide venting for the internal bellows that is used to compensate for the expansion of the oil as the oil temperature varies.

**Do not block vent holes on the cover**



#### **Cooling:**

A customer supplied 250 CFM fan should be used to maintain safe operating temperature for XRB80HR MONOBLOCK® X-ray generator. The air flow should be direct at side wall (opposite the interface connector) and across both the top and the bottom of the tank as shown below. During operation the internal oil temperature should be below 55 deg C and should not exceed 65 deg C. See below Figure for fan location.



**BEFORE CONNECTING THE POWER SUPPLY TO THE AC LINE, FOLLOW THIS PROCEDURE.**

**1) PROPER GROUNDING TECHNIQUES:** The Tank of the X-ray Generator must be grounded, by using the ground connected to the provided 10-32 threaded hole on the tank cover. The Controller of the X-ray Generator must be grounded, by using the ground connected to the provided ground stud located on the cover of the Control Assembly.

Note: For optimal EMC results the Tank and Controller should be mounted to the same ground plane, if not a ground wire (preferably a braided wire) should be connected between the tank and the controller.

2) Plug Controller interface cable into the Tank of the X-Ray Generator. Connect interface cable Ground shield wire to the Tank with provided 6-32 threaded hole.

**WARNING**

**3) 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 XRB80PN100HR is capable of producing Lethal Voltages and X-ray Radiation. Only proceed with operation of the HVPS after**

- a) consulting with the Manufacturer and verification of X-ray setup for the proper precautions.
- b) 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 XRB80HR MONOBLOCK®.**

### **3.2 Signal and Power Interface Connections**

1) Connect Ground wire to the stud located on the cover of the Control Assembly marked Ground.

2) Connect digital signal interface RS-232 communication cable from the host computer to the J3 connector on Control Assembly.

3) Close external Interlock by connecting J2-11 to J2-12 through a dry contact. See Figure 3.1 for wiring diagram and specifications.

4) Connect 90 - 264VAC line to J1 use Phoenix contact connector block # 1805990(not provided) Pin 1= earth Pin 2 =Line and Pins 3= Neutral. Make sure AC line voltage is OFF when connecting to the unit.

5) Determine unit's idle time and refer to Table 2 for seasoning procedure. If in doubt, use the longest seasoning schedule.

### **3.3 Analog monitors**

1) Monitor kV output by measuring J2-8(reference to signal ground J2-10), 0-9.00v (0-80kV).

2) Monitor ma output by measuring J2-6 (reference to signal ground J2-10), 0-9.00V (0-2.00mA)

See Figure 3.3 for wiring diagram and specifications.

### **3.4 Local Mode (Analog enable)**

1) In local mode, to enable X-ray On connect J2-13 to J2-15 through a dry contact. The external interlock must also be close for the X-ray to enable. This feature is disable after Digital enable command is sent.

See Figure 3.4 for wiring diagram and specifications.

### **3.5 Remote Mode (Digital control)**

#### **G.U.I and operation instruction**

1) Install the G.U.I software to the host computer (See CD with GUI).

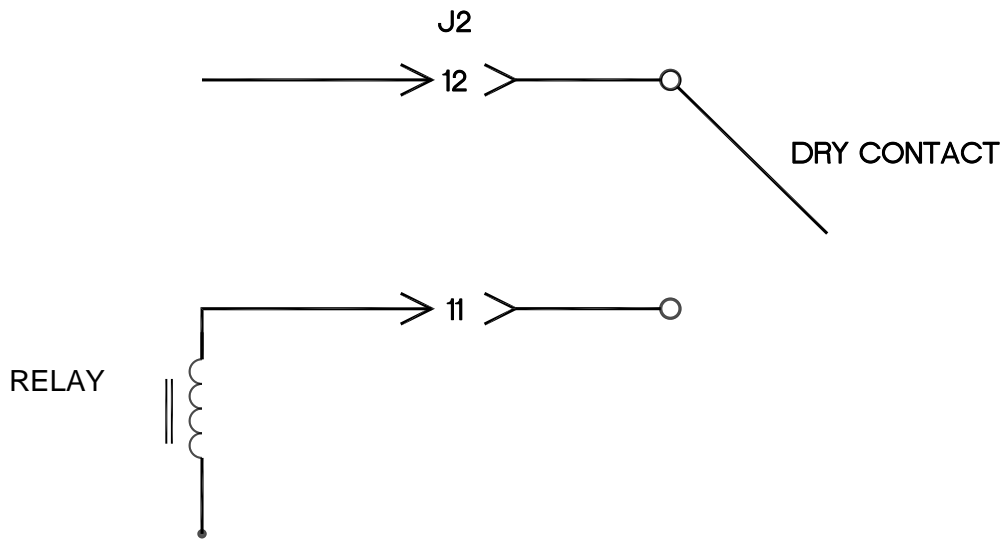
2) Start the G.U.I.

3) Read agreement then click AGREE.

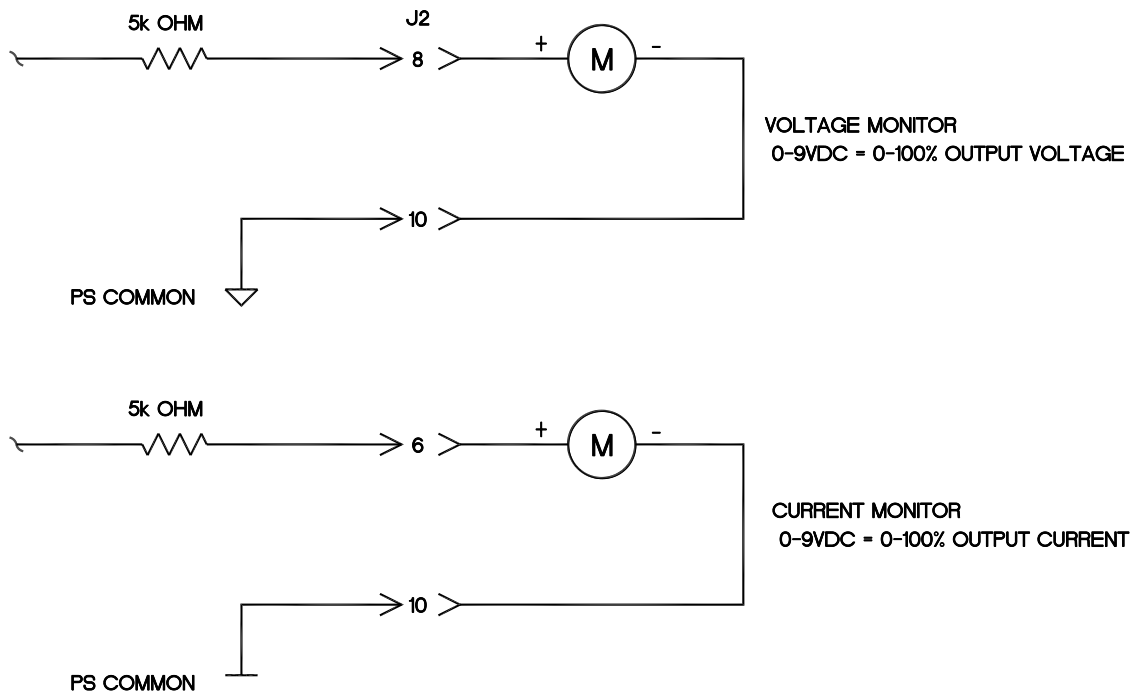
4) Operate the unit using GUI. For instruction on GUI operation, see the "XRB80HR GUI INSTRUCTION" document provided on with the GUI on the CD.

### **3.6 X-ray Tube Seasoning Process**

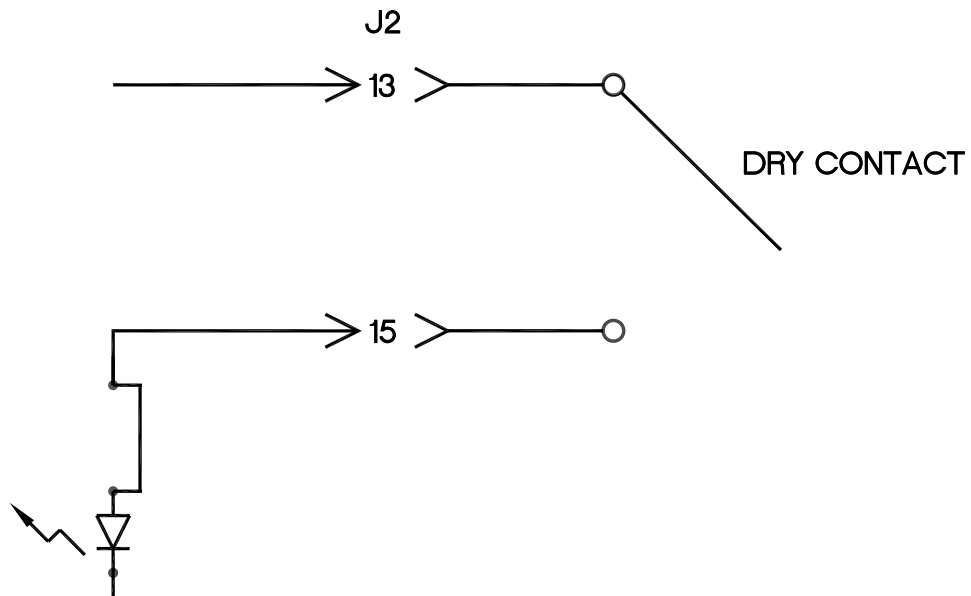
**Caution:** To prevent premature degradation of the X-ray tube, it is highly recommended to run the seasoning process if the unit has not been turned on for more than 3 days. See Table 2.



**Figure 3.1 Interlock Logic Control**



**Figure 3.3 Remote Monitoring**



**Figure 3.4 Local Enable Logic Control**



# Chapter 4

## Diagnostics

Fault/Symptom	Possible Cause
OV led illuminated and Over voltage fault at RS-232 resulting in HV Status Off.	kV programming set greater than 80kV.
UV led illuminated and Under Voltage fault at RS-232 resulting in HV Status Off.	AC input voltage lower than minimum specified.
OC led illuminated and Over Current fault at RS-232 resulting in HV Status Off.	mA programming greater than 2.00mA.
UC led illuminated and Under current fault at RS-232 resulting in HV Status Off.	kV programming is less than 35kV or AC input voltage below spec.
OT led illuminated and Over temperature fault at RS-232 resulting in HV Status Off.	Internal oil temperature is above 65 deg C, could be caused by operation at ambient temperature greater than 40°C or failure of a customer supplied cooling fan.
ARC FLT led momentarily illuminated and a momentary Arc fault at RS-232 resulting in HV Status staying ON.	Occurrence of tube arc. Refer to tube re-seasoning procedure Table 2 and idle times.
ARC FLT led illuminated and Arc fault at RS-232 resulting in HV Status OFF	At least four arcs occurred in a ten second period 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.
Over Power	Kv and ma programming exceeded 107W.Reduce programming $\leq 100W$ .
Unit will not Enable	Interlock open and/or tank to controller interface cable unplugged.

**TABLE 1**

# Chapter 5

## FACTORY SERVICE

### 5.1 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 5.2. The customer shall pay for shipping to and from Spellman.

### 5.2 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.

### 5.3 Ordering Options and Modifications

Many of the options can be retrofitted into Spellman's power supplies by our factory. For prices and arrangements, contact the Spellman Sales Department.

### 5.4 Shipping Instructions

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

All correspondence and phone calls should be directed to:

**Spellman High Voltage Electronics Corp.**

475 Wireless Boulevard

Hauppauge, New York 11788

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

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

# RE-SEASONING PROCESS

for

## XRB80PN100HR

<b>Parameters</b>	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10
<b>Voltage (kV)</b>	40	45	50	55	60	65	70	70	75	80
<b>Current (uA)</b>	250	400	550	700	850	1000	1150	1250	1250	1250
For units with idle time >3 months	5 min	5 min	5 min	5 min	5 min	5 min	5 min	5 min	5 min	5 min
For units with idle time of 1-3 months	60 sec	60 sec	60 sec	60 sec	60 sec	60 sec	60 sec	60 sec	60 sec	60 sec
For units with idle time of 2-30 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec
Daily turn on	3 sec	3 sec	3 sec	3 sec	3 sec	3 sec	3 sec	3 sec	3 sec	3 sec

**TABLE 2**

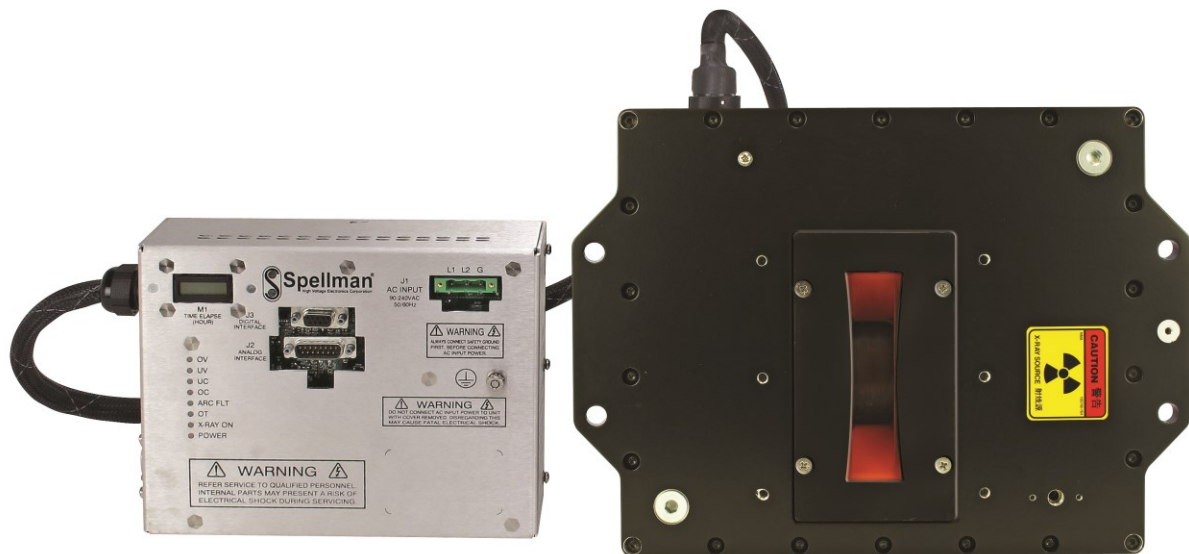
To obtain information on Spellman's product warranty please visit our website at:

<http://www.spellmanhv.com/en/About/Warranty.aspx>



## XRB80HR Digital Interface

Serial – RS-232



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118170-001 REV A

**USA CHINA EUROPE JAPAN MEXICO**

## Changes

REVISION	DATE	DESCRIPTION
1	10/13/16	Draft version
2	4/13/17	Update Photo & remove 5.7

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## WARNING

**THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL. SEE 80kv MONOBLOCK OWNERS MANUAL FOR PROPER GROUNDING TECHNIQUE AND SAFETY PRECAUTIONS BEFORE APPLYING AC INPUT POWER TO THE XRB UNIT.**

TO PREVENT DAMAGE TO THE HOST COMPUTER THE COMPUTER SHOULD BE GROUNDED TO THE SAME GROUND AS THE UUT.

**This unit is capable of producing X-ray radiation, please proceed only after proper precautions have been taken to prevent X-ray exposure.**

### 1.0 SCOPE

This document applies to the communications interfaces on the XRB, assembly 460350-001.

### 2.0 FUNCTIONAL DESCRIPTION

The XRB provides 1 type of digital communications interface:

- RS-232 on J3

### 3.0 GETTING STARTED - INTERFACE WIRING AND PIN-OUTS

#### 3.1 RS232 INTERFACE

The RS232C interface has the following attributes:

- 115K bits per second
- No Parity
- 8 Data Bits
- 1 Stop Bit
- No handshaking
- DB-9 connector as shown

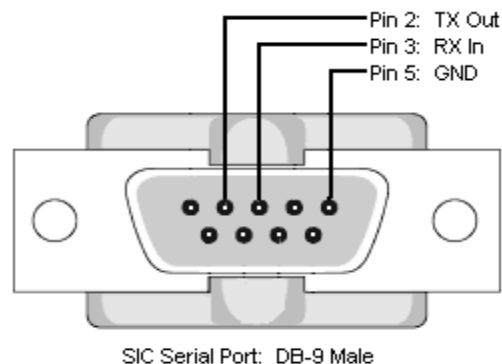


Figure 1 – J3, RS-232 DB-9M pinout (front view)



PIN	DESCRIPTION
1	-
2	Tx Out
3	Rx In
4	-
5	Ground
6	-
7	-
8	-
9	-

### 3.4 RS-232 CABLING

A standard shielded RS-232 cable is used to connect the XRB serial port to the serial port on a standard personal computer. Please refer to the following chart.

PC to XRB Board Cable Details	
PC Connector (DB-9 Female)	XRB Connector (DB-9 Male)
Pin 2: RX In	Pin 2: TX Out
Pin 3: TX Out	Pin 3: RX In
Pin 5: Ground	Pin 5: Ground

## 4.0 GETTING STARTED – SOFTWARE

The following sections detail how to create software to interface to the XRB communications interfaces.

### 4.1 RS-232

The RS-232 interface makes use of a standard ‘command/response’ communications protocol. See section 5.0 for the syntax of the serial interface protocol. The programmer should also review section 4.3 for programming considerations for the RS-232 interface.

All software that addresses the RS-232 interface must adhere to the following parameters:

- A default Baud rate of 115.2K bps
- No Parity
- 8 Data Bits
- 1 Stop Bit
- No handshaking

#### 4.1.1 Enabling Communications Objects in Visual Basic for RS-232

Communications in Microsoft Visual Basic 6.0 are directed to a control that abstracts the port. In the case of serial and USB we need Microsoft Comm Control 6.0. To enable this in your VB 6 project, go to:

##### **Project -> Components**

Then in the list make sure that Microsoft Comm Control 6.0 has a check next to it. The Comm Control Object should then appear in your toolbox. It will have an icon of a telephone and will be named: MSComm. This can be dragged and dropped into your application. You will then need to set the object’s properties.

#### 4.1.2 Configuring Communications in Visual Basic for RS-232

In order to configure the MSComm Object, first you must initialize it in the Object properties:

Settings	115200,n,8,1
Handshaking	0 – comNone

The application can be set to either default to a specific COM Port or the End User can be allowed to choose one for the particular

PC. For the “Default” scenario, include the following commands in the Form\_Load() routine:

```
MSComm1.CommPort = portNumber  
MSComm1.PortOpen = True
```

## 5.0 SERIAL COMMANDS – RS-232

### 5.1 SERIAL INTERFACE PROTOCOL

Serial communications will use the following protocol:

There are two categories of commands from the host computer to the tank.

1. Commands that have an argument.
2. Commands that do not have an argument.

The syntax of commands that have an argument is:

**<STX>CMD<SP>ARG;<CSUM><CR><LF>**

The syntax of commands that do not have an argument is:

**<STX>CMD;<CSUM><CR><LF>**

The specification of the above symbols is as follows:

<STX>	= 1 ASCII 0x02 Start of Text character
<CMD>	= 3 - 4 ALPHA ASCII characters representing the command ID
<SP>	= 1 ASCII 0x20 character
<ARG>	= Command Argument
<;>	= 1 ASCII 0x3B semicolon character 0x3B
<CSUM>	= Checksum (see section 5.3 for details)
<CR>	= Carriage return character 0x0D.
<LF>	= Line feed character 0x0A

### 5.2 COMMAND ARGUMENTS

The format of the numbers is a variable length string. To represent the number 42, the string '42', '042', or '0042' can be used. This being the case, commands and responses that carry data are variable in length.

### 5.3 CHECKSUMS

The checksum is computed as follows:

- Add the <CMD>, <;>, and <ARG> bytes excluding the <STX> byte into a 16 bit (or larger) word. The bytes are added as unsigned integers.
- Take the 2's compliment (negate it) and add the value of 1 to the resulting value.
- Truncate the result down to the eight least significant bits.
- Clear the most significant bit (bit 7) of the resultant byte, (bitwise AND with 0x7F).

- Set the next most significant bit (bit 6) of the resultant byte (bitwise OR with 0x40).

Using this method, the checksum is always a number between 0x40 and 0x7F. The checksum can never be confused with the <STX> or <ETX> control characters, since these have non-overlapping ASCII values.

If the DSP detects a checksum error, the received message is ignored – no acknowledge or data is sent back to the host. A timeout will act as an implied NACK.

CheckSum Calculate Example for VREF command:

VREF<SP>4095; = 0x260H – total sum in Hex.  
 = 0xD9FH – negate.  
 = 0xDA0H – add one.  
 = 0xA0H – truncate down to 8 least significant bits.  
 = 0x20H – clear bit 7.  
 = 0x60H – set bit 6.

CheckSum = 0x60H

The following is sample code, written in Visual Basic, for the generation of checksums:

```
Public Function ProcessOutputString(outputString As String) As String

Dim i As Integer
Dim CSb1 As Integer
Dim CSb2 As Integer
Dim CSb3 As Integer
Dim CSb$
Dim X

X = 0
For i = 1 To (Len(outputString)) 'Starting with the CMD character
X = X + Asc(Mid(outputString, i, 1)) 'adds ascii values together
Next i

CSb1 = 256 - X
CSb2 = 127 And (CSb1) 'Twos Complement
CSb3 = 64 Or (CSb2) 'OR 0x40
CSb$ = Chr(Val("&H" & (Hex(CSb3))))
ProcessOutputString = Chr(2) & outputString & CSb$ & Chr(13) & Chr(10)

End Function
```

## 5.4 COMMAND OVERVIEW

Command Name	<CMD>	<ARG>	RANGE
Program kV	VREF	1-4 ASCII	0-4095
Program mA	IREF	1-4 ASCII	0-4095
Request kV Sepoint	VSET	None	-
Request mA Sepoint	ISET	None	-
Request kV Monitor	VMON	None	-
Request mA Monitor	IMON	None	-
Request Filament Monitor	FMON	None	-
Turn XRAY On/Off	ENBL	1 ASCII	0-1
Enable Comm Watchdog	WDTE	1 ASCII	0-1
Tickle Comm Watchdog	WDTT	None	-
Reset Faults	CLR	None	-
Request Faults	FLT	None	-
Read XRAY Status	STAT	None	-
Request Software Version	FREV	None	-
Request Voltage Scaling	SLVR	None	-
Request Current Scaling	SLIR	None	-
Request Model Number	MODR	None	-
Request Hardware Version	HWVR	None	-
Request Software Build Version	SOFT	None	-
Request -15V LVPS	LVPS	None	-
Request Tank Temperature	TEMP	None	-
Program Baud Rate	BAUD	1	1-2

Serial Number Program	SNUS	16 ASCII character string	
Request Serial Number	SNUR	16 ASCII character string	

## 5.5 RESPONSE OVERVIEW

The command responses will follow the same format as outlined above in section 5.1. This list is comprised of Commands with complex responses only. Commands using a simple response will use the <;> character (ASCII 0x3B) as a “Success” response. These responses will be 5 ASCII characters in length.

Response Name	<CMD>	Response
Request kV Monitor	VMON	6-9
Request mA Monitor	IMON	6-9
Request kV Setpoint	VSET	6-9
Request mA Setpoint	ISET	6-9
Request Filament Monitor	FMON	6-9
Request Faults	FLT	13
Read XRAY Status	STAT	6
Request Software Version	FREV	16
Request Voltage Scaling	SLVR	9
Request Current Scaling	SLIR	9
Request Model Number	MODR	6-15
Request Hardware Version	HWVR	8
Request Software Build Version	SOFT	9-10
Request -15V LVPS	LVPS	6-9

Request Tank Temperature	TEMP	6-9
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## 5.6 COMMAND STRUCTURE

### 5.6.1 Program kV

Description:

The host requests that the firmware change the setpoint of kV.

Direction:

Host to supply

Syntax:

<STX><VREF><SP><ARG><;><CSUM><CR><LF>

Where:

<ARG> = 0 - 4095 in ASCII format

Example:

<STX><VREF><SP><4095><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>

See 5.6.15 for voltage scaling

## 5.6.2 Program mA

### Description:

The host requests that the firmware change the setpoint of mA.

### Direction:

Host to supply

### Syntax:

```
<STX><IREF><SP><ARG><;><CSUM><CR><LF>
```

### Where:

<ARG> = 0 - 4095 in ASCII format

### Example:

```
<STX><IREF><SP><4095><;><CSUM><CR><LF>
```

### Response:

```
<STX><;><CSUM><CR><LF>
```

See 5.6.16 for current scaling

### 5.6.3 Request kV Monitor

Description:

The host requests that the firmware report kV monitor.

Direction:

Host to supply

Syntax:

<STX><VMON><;><CSUM><CR><LF>

Example:

<STX><VMON><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX><4095><;><CSUM><CR><LF>

#### 5.6.4 Request kV Setpoint

Description:

The host requests that the firmware report kV setpoint.

Direction:

Host to supply

Syntax:

<STX><VSET><;><CSUM><CR><LF>

Example:

<STX><VSET><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX><4095><;><CSUM><CR><LF>

### 5.6.5 Request mA Setpoint

Description:

The host requests that the firmware report mA setpoint.

Direction:

Host to supply

Syntax:

<STX><ISET><;><CSUM><CR><LF>

Example:

<STX><ISET><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX><4095><;><CSUM><CR><LF>

### 5.6.6 Request mA Monitor

Description:

The host requests that the firmware report mA monitor.

Direction:

Host to supply

Syntax:

<STX><IMON><;><CSUM><CR><LF>

Example:

<STX><IMON><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX><4095><;><CSUM><CR><LF>

### 5.6.7 Request Filament Monitor

Description:

The host requests that the firmware report Filament monitor.

Direction:

Host to supply

Syntax:

<STX><FMON><;><CSUM><CR><LF>

Example:

<STX><FMON><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

Example:

<STX><4095><;><CSUM><CR><LF>

### 5.6.8 Turn XRAYs On/Off

Description:

The host requests that the firmware to turn XRAY On/Off.

Direction:

Host to supply

Syntax:

<STX><ENBL><SP><ARG><;><CSUM><CR><LF>

Where:

<ARG> 1 = XRAY On, 0 = XRAY Off in ASCII format

Example:

<STX><ENBL><SP><1><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>



### 5.6.9 Enable Commuunication Watchdog

Description:

The host requests that the firmware to enable communication watchdog.

Direction:

Host to supply

Syntax:

<STX><WDTE><SP><ARG><;><CSUM><CR><LF>

Where:

<ARG> 1 = Enable Watchdog, 0 = Disable Watchdog

Example:

<STX><WDTE><SP><1><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>

### 5.6.10 Tickle Communication Watchdog

Description:

The host requests that the firmware reset communication watchdog timer.

Direction:

Host to supply

Syntax:

<STX><WDTT><;><CSUM><CR><LF>

Example:

<STX><WDTT><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>

### 5.6.11 Reset Faults

Description:

The host requests that the firmware resets all Fault messages and indicators.

Syntax:

<STX><CLR><;><CSUM><CR><LF>

Example:

<STX><CLR><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>

## 5.6.12 Request Faults

### Description:

The host requests that the firmware report Faults.

### Direction:

Host to supply

### Syntax:

```
<STX><FLT><;><CSUM><CR><LF>
```

### Example:

```
<STX><FLT><;><CSUM><CR><LF>
```

### Response:

```
<STX><ARG1><ARG2><ARG3><ARG4><ARG5><ARG6><ARG7>  
<ARG8><ARG9><;><CSUM><CR><LF>
```

### Where:

<ARGx> 1 = Fault, 0 = No Fault in ASCII format

ARG1 = ARC

ARG2 = Over Temperature

ARG3 = Over Voltage

ARG4 = Under Voltage

ARG5 = Over Current

ARG6 = Under Current

ARG7 = Watchdog Time-out

ARG8 = Open Interlock

ARG9 = Over Power

### Example:

```
<STX><100010011><;><CSUM><CR><LF>
```

### 5.6.13 Request XRAY Status

Description:

The host requests that the firmware read the XRAY status.

Direction:

Host to supply

Syntax:

<STX><STAT><;><CSUM><CR><LF>

Example:

<STX><STAT><;><CSUM><CR><LF>

Response:

<STX><ARG><;><CSUM><CR><LF>

Where ARG is status. A 1 indicates XRAY On. A 0 indicates XRAY Off.

Example:

<STX><1><;><CSUM><CR><LF>

#### 5.6.14 Request DSP Software Part Number/Version

Description:

The host requests that the firmware sends the DSP firmware.

Direction:

Host to supply

Syntax:

<STX><FREV><;><CSUM><CR><LF>

Example:

<STX><FREV><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG> consists of eleven ASCII characters representing the current firmware part number/version. The format is SWM9999-999.

Example:

<STX><SWM9999-999><;><CSUM><CR><LF>

### 5.6.15 Request Voltage Scaling

Description:

The host requests requests that the firmware send the current unit voltage scaling.

Direction:

Host to supply

Syntax:

<STX><SLVR><;><CSUM><CR><LF>

Example:

<STX><SLVR><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

ARG = KV scaling (8889 = 88.89 kV)

Example:

<STX><8889><;><CSUM><CR><LF>

### 5.6.16 Request Current Scaling

Description:

The host requests requests that the firmware send the current unit current scaling.

Direction:

Host to supply

Syntax:

<STX><SLIR><;><CSUM><CR><LF>

Example:

<STX><SLIR><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

ARG = mA scaling (2220 = 2.220 mA)

Example:

<STX><1388><;><CSUM><CR><LF>



### 5.6.17 Request Model Number

Description:

The host requests that the firmware sends the unit model number

Direction:

Host to supply

Syntax:

<STX><MODR><;><CSUM><CR><LF>

Example:

<STX><MODR><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG> consists of one to ten ASCII characters representing the model number. The format is XBR80N100 or CB for cone beam option

Example:

<STX><XBR80N100><;><CSUM><CR><LF>

### 5.6.18 Request Hardware Version

Description:

The host requests that the firmware sends the hardware version.

Direction:

Host to supply

Syntax:

<STX><MODR><;><CSUM><CR><LF>

Example:

<STX><MODR><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG> consists of 3 ASCII characters representing the hardware version. The format is ANN, where A is an alpha character and N is a numeric character

Example:

<STX><A01><;><CSUM><CR><LF>

### 5.6.19 Request Software Build Version

Description:

The host requests that the firmware sends the hardware version.

Direction:

Host to supply

Syntax:

<STX><SOFT><;><CSUM><CR><LF>

Example:

<STX><SOFT><;><CSUM><CR><LF>

Response:

<STX>< ARG><;><CSUM><CR><LF>

Where:

<ARG> consists of four to five ASCII characters representing the current firmware build version. The format is 12345.

Example:

<STX><12345><;><CSUM><CR><LF>

## 5.6.20 Request –15V LVPS

### Description:

The host requests that the firmware report –15V LVPS.

### Direction:

Host to supply

### Syntax:

<STX><LVPS><;><CSUM><CR><LF>

### Example:

<STX><LVPS><;><CSUM><CR><LF>

### Response:

<STX><ARG><;><CSUM><CR><LF>

### Where:

<ARG>=0-4095 in ASCII format representing unscaled value.

To convert the unscaled value to voltage, use the equation below:

x = unscaled value.

Voltage =  $-(3972 - x) * 0.006224$ .

### Example:

<STX><4095><;><CSUM><CR><LF>

### **5.6.21 Request Tank Temperature**

Description:

The host requests that the firmware sends the tank temperature.

Direction:

Host to supply

Syntax:

<STX><TEMP><;><CSUM><CR><LF>

Example:

<STX><TEMP><;><CSUM><CR><LF>

Response:

<STX><ARG><;><CSUM><CR><LF>

Where:

<ARG>=0-956 in ASCII format representing 0 – 70.036 degrees C.

Example:

<STX><956><;><CSUM><CR><LF>

## 5.6.22 Program Baud Rate Select

### Description:

The host requests that the firmware select a baud rate.

### Direction:

Host to supply

### Syntax:

<STX><BAUD><SP><ARG><;><CSUM><CR><LF>

### Where:

<ARG> = 1 in ASCII format = 115200 Baud

<ARG> = 2 in ASCII format = 9600 Baud

### Example:

<STX><BAUD><SP><1><;><CSUM><CR><LF>

### Response:

<STX><;><CSUM><CR><LF>

### 5.6.23 PROGRAM SERIAL NUMBER

Description:

After the password command (PASS) and correct password are sent, the user can program the unit serial number. Up to 16 alphanumeric characters are allowed.

Password ARG = 1212

Direction:

Host to supply

Syntax:

<STX><SNUS><SP><ARG><;><CSUM><CR><LF>

Where:

<ARG> = 16 ASCII character string.

Example:

<STX><SNUS><SP><1234-ABCDE><;><CSUM><CR><LF>

Response:

<STX><;><CSUM><CR><LF>

## 5.6.24 REQUEST SERIAL NUMBER

### Description:

The host requests that the firmware sends the current stored unit serial number. The unit always replies with 16 characters. It is up to the Host to accept valid character string.

### Direction:

Host to supply

### Syntax:

<STX><SNUR><;><CSUM><CR><LF>

### Response:

<STX>< ARG><;><CSUM><CR><LF>

### Where:

<ARG>= 16 ASCII character string.

### Example:

<STX><1234-ABCDXXXXXXXX><;><CSUM><CR><LF>



## **6.0 SERIAL COMMAND HANDLING**

**6.1 Command Time Out**The host computer should set a serial time out at approximately 100mS. This allows the DSP to process the incoming message, and transmit a response. The DSP will initiate a reply to incoming messages in approximately 1-2mS, with a worst case of 5mS.

### **6.2 Buffer Flushing**

The DSP will flush the incoming serial data buffer every time an STX is received. This provides a mechanism to clear the receive buffer of partial or corrupt messages.

### **6.3 Handshaking**

The only handshaking implemented on the host interface, is built in to the implementation of this protocol. That is, the host must initiate all communications. If the supply receives a program command, an acknowledge message is sent back to the host via the “;” message. If the host does not receive an acknowledge within the time out window, the host should consider the message lost or the device off-line.

Similarly, if the supply receives a request command, the requested data is sent back to the host. If the host does not receive the requested data within the time out window, the host should consider the message lost or the device off-line.

This essentially uses the full-duplex channel in a half-duplex communication mode.