Instruction Manual

MONOBLOCK® SERIES XRBHR/XRBD

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.

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 EXTRÊMENT 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 QUESO APPARECCHIO.

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

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

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

Non mettere a terra il proprio corpo oppure operare in ambienti bagnati o 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 XRBHR/XRBD MONOBLOCK® Series

The XRBHR (high reliability) and XRBD Monoblock® X-ray source are designed for OEM applications. The XRBHR/XRBD Monoblock® series is equipped with an internal Bipolar X-Ray tube designed for use at voltages up to 80k, 100kVor 160kV at power levels up to 100W, 210W, 350W or 500W. It is a complete integrated system consisting of a high voltage power supply (HVPS) with proprietary control and protection circuitry as well as a filament supply, X-ray tube and oil encapsulant in one compact enclosure. Additional advantages are the elimination of high voltage cables and low leakage X-ray radiation.

A 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 XRBHR/XRBD MONOBLOCK® Series incorporates remote programming, monitoring, and fault indicators including interlock.

The X-ray source is a sealed unit containing the HVPS, X-ray tube and insulating oil. The insulating oil provides electrical insulation for the high voltage components and the X-ray tube. The oil also functions as a coolant to carry heat away from the tube. The cooling system requirements are outlined in Chapter 3 and in the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001. A bellows internal to the X-ray source compensates for the expansion of the oil as the oil temperature varies thereby eliminating the need for a bulky overflow tank.

The XRBHR/XRBD is available with either a fan or cone shape beam geometry. Proprietary emission control circuitry provides excellent regulation of X-ray tube current, along with outstanding stability performance. The XRBHR is designed for long field life and comes with a three-year warranty for standard units.

1.2 Operating Features

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

- **INTERNAL FAULT PROTECTION**: The XRBHR/XRBD 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 X-ray output.
- **LED FAULT/STATUS INDICATORS**:

  Indicators are located on the cover of the Control /Inverter Assembly and are provided to give the user a 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**

- **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 Monoblock® for a period greater than three seconds. This feature is may be enabled or disabled via RS-232 or Ethernet host command and will default to enable at system turn on.
- **LOCAL MONITORS**: Provides local analog monitors for the X-ray tube voltage and current via the analog interface connector on the front cover of the control assembly. Reference XRBHR data sheet SHV#128132-001or XRBD data sheet SHV#128146-001.
- **REMOTE PROGRAMMING**: Allows remote adjustment of the output voltage and current via RS-232 or Ethernet interface. All program values default to zero at system turn on.
- **REMOTE MONITORS**: Provides remote monitors such as output voltage, output current and operating temperature via RS-232 or Ethernet interface. See the Communication Interface document SHV#101501-695 for a full description of features and commands.
- **EXTERNAL INTERLOCK:** The X-ray cannot be enabled unless the 24VDC has been applied to pins 1 and 2 of the analog interface connector as outlined in the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001. During high voltage operation, opening the interlock circuit will cause the high voltage to be disabled.

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 RELAY:** When X-ray ON is enabled a N.O. and a N.C. relay contact closure will occur. Refer to the XRBHR datasheet SHV#128132-001 or XRBD data sheet SHV#128146-001 for pin assignments and contact ratings.
- **OIL TEMPERATURE MONITOR:** Provides remote oil temperature monitoring via RS-232 or Ethernet interface.
- **FAULT SIGNAL:** The Fault Signal is an open collector output that indicates that a fault has occurred. The connection can be accessed at pin 7 of the analog interface connector. High = no faults.

1.3 System Status and Fault Diagnostic Display

If a fault occurs, the power supply will react as described and the fault will be reported via RS-232 or Ethernet. To reset a fault, a clear command must be sent via RS-232 or Ethernet.

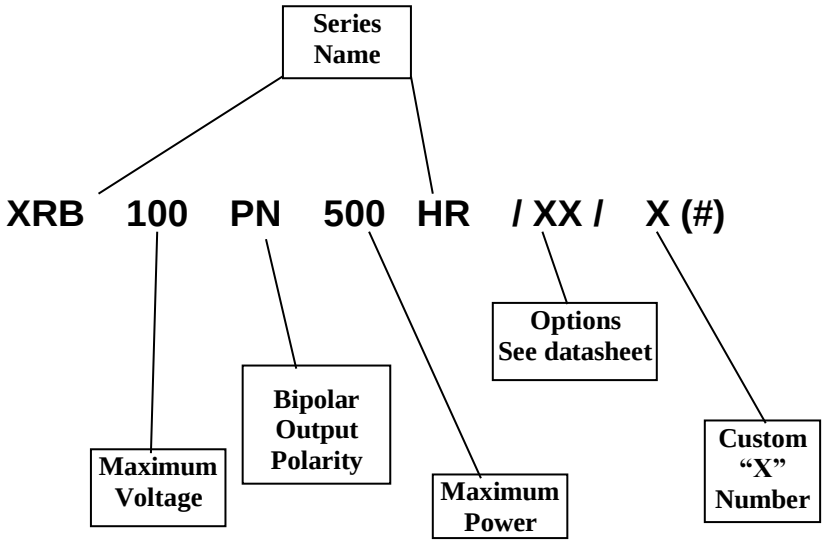
- **POWER ON LED:** When input power is applied to the unit it is indicated by the POWER LED on the control cover being illuminated.
- **X-ray ON LED:** When the high voltage status is "On" state it is indicated by X-RAY ON LED status on the control cover.
- **EXTERNAL INTERLOCK FAULT:** Indicates that the high voltage supply is inhibited by external interlock protection circuitry. This fault is reported solely via RS-232 or Ethernet communication as (ARG 9) Interlock.
- **OVER VOLTAGE:** Indicates the over voltage protection circuitry has caused the high voltage power supply to turn off. The over voltage protection is internally set to turn off the high voltage to the X-ray tube if the X-ray tube voltage is 10% greater than the set point or at 10% greater than the maximum rated voltage. This fault is indicated by OV LED on the control cover and via RS-232 or Ethernet as (ARG 6), High Voltage.
- **UNDER VOLTAGE:** Indicates the under voltage protection circuitry has caused the high voltage power supply to turn off. The under voltage protection is internally set to turn off the high voltage to the X-ray tube if the X-ray tube voltage is 10% less than the set point. This fault is indicated by illumination of UV LED on the control cover and via RS-232 or Ethernet as (ARG 5) Low Voltage.
- **OVER CURRENT:** Indicates the over current protection circuitry has caused the high voltage power supply to turn off. The over current protection is internally set to turn off the high voltage to the X-ray tube if the X-ray tube emission current is 18% greater than the set point or at 10% greater than the maximum rated emission current. This fault is indicated by illumination of OC LED status on the control cover and via RS-232 or Ethernet as (ARG 3) High Current.
- **UNDER CURRENT:** Indicates the X-ray tube emission current is less the setpoint. This fault occurs when the emission current is 18% less than the programmed emission current. This fault **does not** shutdown the high voltage power supply, it is indicated by illumination of UC LED on the control cover and via RS-232 or Ethernet as (ARG 4) Low Current.
- **ARC FAULT**: Indicates that an arc has occurred. When a single arc occurs, the event will be indicated by illumination of the ARC LED on the control cover and via RS-232 or Ethernet as (ARG 2) ARC. Both the ARC LED and the digital flag will be reported for 30 seconds.

  Occurrences of four arcs within a period of ten seconds will turn off the high voltage. This fault is indicated by illumination of ARC FLT LED on control cover and via RS-232 or Ethernet as (ARG 2) Arc.
- **OVER TEMPERATURE:** Indicates the over temperature protection circuitry has caused the high voltage power supply to turn off. The over temperature protection is internally set to turn off the high voltage to the X-ray tube if the internal oil temperature has exceeded 65 degrees C. This fault is indicated by the OT LED status on the control cover and via RS-232 or Ethernet as (ARG 1) Temperature.
- **TEMPERATURE WARNING:** Indicates the oil temperature inside the Monoblock is greater than 58 degrees C. This fault **does not** shutdown the high voltage power supply. The warning is indicated by flashing the OT LED status on the control cover and via RS-232 or Ethernet as (ARG 11) Temperature Warning.
- **POWER LIMIT FAULT**: Indicates the output power has exceeded maximum rated power of the Monoblock® causing the high voltage power supply to turn off. This fault is reported solely via RS-232 or Ethernet communication as (ARG 8) Power.
- **WATCHDOG TIMER:** Indicates the host computer has lost communication and with the Monoblock® for a period greater than 3 seconds. This feature is enabled on by default. This fault is reported solely via RS-232 or Ethernet communication as (ARG 7) Watchdog.

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) Bipolar
3. The maximum output (in Watts).
4. Options
5. Custom model number



XRB100PN500HR

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 Monoblock and control assembly for any visible signs of damage.

The Monoblock and control assembly are paired together as a system. Verify that the serial number located on the Monoblock label is also reference on the control assembly label and vice versa. It is important that the serial number pair of Monoblock and control assembly are installed and operated as a pair for normal operation. If for any reason it becomes necessary to return the system both the Monoblock and control assembly should be returned together.

The Spellman XRBHR/XRBD MONOBLOCK® Series of X-ray source and components are covered by warranty.

2.2 Installation

Reference the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001and outline drawing SHV# 408644-001for dimensions.

The unit can be mounted in any position. Four, M8x1.25 threaded mounting holes are provided on the top and bottom of the Monoblock®. Threaded M6x1 holes are also provided for exit port collimation mounting.

The Control assemble has four, M5 threaded holes 10mm deep.

Do not block the vent holes in the top cover as indicated on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001.

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.

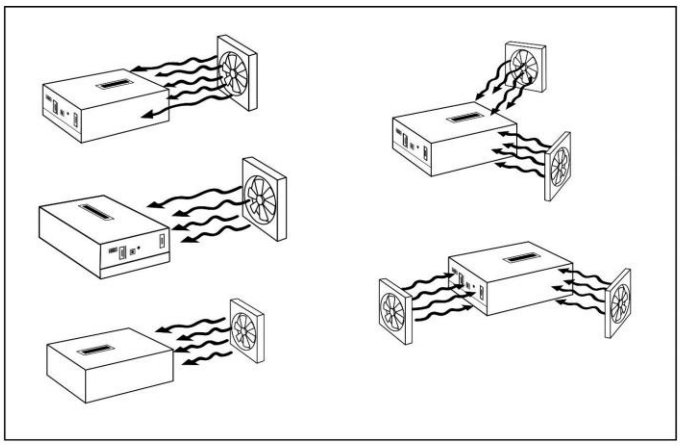
Check the input voltage rating on the nameplate of the supply and make certain that this is the rating of the available power source. The Spellman XRBHR/XRBD MONOBLOCK® operates on 90-264VAC, single phase 50 or 60Hz.

Bellow Vent hole:

Do not block or insert anything into the vent hole located on top cover as indicated on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001. This hole provides venting for the internal bellows that allows for the expansion and contraction of the insulating oil as temperature varies.

Cooling:

For convection/forced air cooled models:
The Monoblock® is designed to operate in an ambient temperature of 0-40 degrees C. For maximum performance and reliability, it is important that sufficient cooling is provided to maintain the oil temperature of the Monoblock® at or below 55 degrees C. Convection cooling may be sufficient. However, in some applications an external cooling fan (to be provided by the user) may be necessary to maintain the oil temperature of the Monoblock® at or below 55 degrees C. Please see below for suggest fan placement.



For models with an integrated cooling system:
Models equipped with an integrated cooling system are designed to operate in an ambient temperature of 0-40 degrees C. For maximum performance and reliability, it is important that the ambient operating temperature of the Monoblock® is maintained at or below 40 degrees C. Preventative maintenance is recommended in order to keep the fans and heat exchanger free from dust and debris.

BEFORE CONNECTING THE MONOBLOCK® TO THE AC LINE, FOLLOW THIS PROCEDURE.

1) PROPER GROUNDING TECHNIQUES: The Monoblock® must be grounded, by making a ground connection to the M5 threaded hole on the tank flange. The control assembly must also be grounded using the M5 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) Connect the control cable to the Monoblock® and secure the cable ground to the Monoblock® using the M5 threaded hole on the tank flange.

WARNING

3) ENSURE THAT THE EXIT PORT IS PROPERLY MATED TO THE 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 XRBHR/XRBD 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 XRBHR/XRBD MONOBLOCK®.

3.2 Signal and Power Interface Connections

1) Connect Ground wires as suggested above.

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

3) Connect 90 - 264VAC line to the AC input connector. Reference power and interface connections located on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001. Make sure AC line voltage is OFF when connecting to the unit.

4) Connect 24VDC to pins 1 and 2 of the heat dissipation unit. It is critical that power is supplied to the heat dissipation unit to ensure proper operation of the Monoblock. Reference DC input for heat dissipation unit located on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001.

5) Apply the 24VDC external Interlock by connecting 24VDC to pins 1 and 2 of the analog interface connector. Reference analog interface located on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001.

6) Determine unit's idle time and refer to Appendix A for the recommended seasoning schedule. Also reference paragraph 4.5.21 and 4.5.28 of the Communications Interface document SHV#101501-695.

3.3 Analog monitors

1) The X-ray tube voltage can be monitored by measuring the voltage at pins 4 and 5 of the analog interface connector. Reference analog interface located on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001.

2) The emission current can be monitored by measuring the voltage at pins 6 and 5 of the analog interface connector. Reference analog interface located on the XRBHR data sheet SHV#128132-001 or XRBD data sheet SHV#128146-001.

3.4 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 the GUI. For instruction on GUI operation, see the "Monoblock® X User Manual.

3.5 X-ray Tube Seasoning Process

Caution: To prevent premature degradation of the X-ray tube, it is highly recommended to season the X-ray tube if the unit has been idle for greater than 24 hours. Please refer to Appendix A for the recommended seasoning schedule. Also reference paragraph 4.5.21 and 4.5.28 of the Communications Interface document SHV#101501-695.

Chapter 4

Diagnostics

4.1

Fault/Symptom	Possible Cause
Over Voltage fault resulting in shutdown of the high voltage power supply.	kV programming set greater than maximum specified kV.
Under Voltage fault resulting in shutdown of the high voltage power supply.	AC input voltage lower than minimum specified.
Over Current fault resulting in shutdown of the high voltage power supply.	mA programming greater than maximum specified mA.
Under Current fault	kV programming is less than 35kV or AC input voltage below spec.
Over Temperature fault resulting in shutdown of the high voltage power supply.	Internal oil temperature is above 65 degrees C. May be caused by operation at ambient temperature greater than 40°C or failure of a pump/cooling fan. Check that the fans and pump are operational and that there are no obstructions.
Temperature Warning fault	Indicates the oil temperature is greater than 58 degrees C. Verify that the ambient temperature is less than 40°C. Check that the fans and pump are operational and that there are no obstructions.
ARC fault resulting in the ARC fault being reported for 30 seconds while the high voltage power supply remains on.	Occurrence of tube arc. If the arcing becomes regular the X-ray tube may require additional warm up or seasoning.
ARC fault resulting in shutdown of the high voltage power supply.	At least four arcs occurred in a ten second period. The X-ray tube may require additional seasoning. Season the X-ray tube following the 14-30 days seasoning protocol. If problem continues contact Spellman service department.
Overpower fault	The unit has exceeded the maximum rated power.
Interlock fault resulting in shutdown or failure to turn on the high voltage power supply.	Verify the 24VDC interlock enable signal is present at pins 1 and 2 of the analog interface connector.

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 Service Validation Order number is needed for all returns. This SVO number should be marked clearly on the outside of the shipping container. Packages received without an SVO 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 SVO 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

Appendix A
X-ray Tube Seasoning Tables

X-RAY TUBE RE-SEASONING PROCESS
for
XRB80PN210HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	85	80	80	80	70	60	50	40
Current (mA)	0.35	0.65	0.90	1.2	1.5	1.8	2.2	2.6	3.0	3.5	4.2	5.2
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB80PN350HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	80	80	80	85	70	55	50	40
Current (mA)	0.35	0.75	1.5	2.25	3.0	3.5	4.4	4.0	5.0	6.0	7.0	8.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB80PN500HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	80	80	80	80	85	80	70	60
Current (mA)	0.35	0.75	1.5	2.25	3.0	3.5	4.0	4.5	5.5	6.25	7.0	8.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB100PN100HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	90	100	105	80	75	65	55	50
Current (mA)	0.4	0.6	0.7	0.8	0.9	1.0	2.0	1.25	1.3	1.5	1.8	2.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB100PN210HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	90	100	105	80	75	65	55	50
Current (mA)	0.35	0.65	0.90	1.2	1.5	1.8	2.0	2.5	2.8	3.2	3.8	4.2
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB100PN350HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	90	100	105	80	75	65	55	50
Current (mA)	0.35	0.75	1.5	2.25	3.0	3.5	3.33	4.37	4.66	5.38	6.36	7.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS
for
XRB100PN500HR

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step11	Step12
Voltage (kV)	50	60	70	80	90	100	105	100	100	100	100	100
Current (mA)	0.35	0.65	0.90	1.2	1.5	1.8	2.2	2.6	3.0	3.5	4.2	5.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS

For

XRBD160PN100

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step 11	Step 12
Voltage (kV)	80	90	100	110	120	130	140	150	160	165	125	100
Current (mA)	0.25	0.27	0.3	0.35	0.4	0.475	0.55	0.65	0.625	0.6	1.5	1.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS

For

XRBD160PN210

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step 11	Step 12
Voltage (kV)	80	90	100	110	120	130	140	150	160	165	140	100
Current (mA)	0.3	0.45	0.55	0.65	0.75	0.85	1.0	1.1	1.25	1.25	1.5	2.1
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS

For

XRBD160PN350

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step 11	Step 12
Voltage (kV)	80	90	100	110	120	130	140	150	160	165	155	100
Current (mA)	0.3	0.6	0.9	1.2	1.5	1.8	2.0	2.3	2.2	2.1	3.0	3.5
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

X-RAY TUBE RE-SEASONING PROCESS

For

XRBD160PN500

Parameters	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10	Step 11	Step 12
Voltage (kV)	80	90	100	110	120	130	140	150	160	160	165	125
Current (mA)	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.0	4.0
For units with idle time greater than 30 days	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min	20 min
For units with idle time of 14-30 days	5 min	5 min	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 7-14 days	60 sec	60 sec	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 1-7 days	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec	30 sec

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

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

Spellman®
High Voltage Electronics Corporation

XRB SMART CONTROL COMMUNICATIONS INTERFACE

USA CHINA EUROPE JAPAN MEXICO

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WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL. SEE THE XRBHR/XRBD OWNERS MANUAL FOR PROPER GROUNDING TECHNIQUE AND SAFETY PRECAUTIONS BEFORE APPLING AC INPUT POWER TO THE MONOBIOCK®.

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

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 for the XRBHR, XRBD and SMART Control.

2.0 FUNCTIONAL DESCRIPTION

The XRB provides two types of digital communications interface:

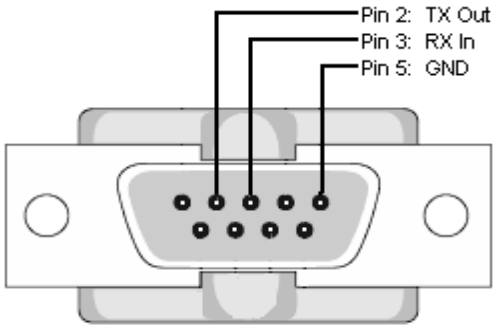
- RS-232
- Ethernet

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



SIC Serial Port: DB-9 Male

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

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

3.2 RS-232 CABLING

A standard shielded RS-232 cable should be 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

3.3 ETHERNET INTERFACE

The Ethernet interface has the following attributes:

- IP Port - 50001
- IP Address 192.168.1.4, set as default. See Appendix B for instructions to change the IP address.

4.0 COMMANDS

4.1 INTERFACE PROTOCOL

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

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 ID	= 3 - 4 ALPHA ASCII characters representing the command
<SP>	= 1 ASCII 0x20 character
<ARG>	= Command Argument
;	= 1 ASCII semicolon character 0x3B
<CSUM>	= Checksum (RS-232 only, see section 4.3 for details)
<CR>	= Carriage return character 0x0D.
<LF>	= Line feed character 0x0A

4.2 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.

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4.3 CHECKSUMS

The checksum is used for RS-232 communication only and 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 Calulate Example for VREF command:

VREF<SP>1000; = 0x24F *total sum in Hex*.
= 0x31 *(0x100 – total sum) AND with 0x7F.*
= 0x71 *OR with 0x40.*

CheckSum = 0x71.

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4.4 COMMAND OVERVIEW

XRB commands

Command Name	<CMD>	<ARG>
Program kV	VREF	1-4 ASCII
Program mA	IREF	1-4 ASCII
Request kV Setpoint	VSET	None
Request mA Setpoint	ISET	None
Request kV Monitor	VMON	None
Request mA Monitor	IMON	None
Request Temperature Monitor	TMON	None
Request Filament Monitor	FMON	None
Enable Comm Watchdog	WDTE	1 ASCII
Tickle Comm Watchdog	WDTT	None
Request Faults	FLT	None
Reset Faults	CLR	None
Turn X-ray Off/On	ENBL	1 ASCII
Request X-ray Status	STAT	None
Request Firmware Version	FREV	None
Request Model Number	GETX	None
Request Serial Number	SNUG	None
Request Date and Time	138	None
Request High Voltage on Time	HVON	None
Request Total High Voltage Off Time	HVOF	None
Request Idle Time	IDLT	None
Request Unit Off Time	OFTM	None
Request Tube Time Stamp	RTTS	None
Program Seasoning Timestamp	PSTS	None
Save Custom Seasoning Data	SCSD	2 + column data
Start Seasoning	STS	None
Stop Seasoning	STPS	None
Request Seasoning State	RSS	None
Request Recommended Profile Type	RRPT	None
Request Seasoning Table Column	RSTC	2
Set Baud Rate	SBR	1

4.5 XRB COMMANDS

4.5.1 Program kV

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

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

Where:
<ARG> = the voltage setpoint in tenths of a kV (.1 kV), in ASCII format

Example:
<STX>VREF<SP>643;<CSUM><CR><LF>
programs the kV to be 64.3 kV.

Response:
None

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4.5.2 Program mA

Description:
The host requests that the firmware change the mA setpoint.

Syntax:
<STX>IREF<SP><ARG>;<CSUM><CR><LF>

Where:
<ARG> = the current setpoint in thousandths of a mA (.001 mA), in ASCII format.

Example:
<STX>IREF<SP>500;<CSUM><CR><LF>
programs the current to be .500 mA.

Response:
None

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4.5.3 Request kV Setpoint

Description:
The host requests that the firmware report kV setpoint.

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

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

Where:
<ARG> = the voltage in tenths of a kV (.1 kV), in ASCII format.

Example:
<STX>1000;<CSUM><CR><LF>
is a voltage setpoint reading of 100.0 kV.

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4.5.4 Request mA Setpoint

Description:
The host requests that the firmware report mA setpoint.

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

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

Where:
<ARG> = the current setpoint in thousandths of a mA (.001 mA), in ASCII format.

Example:
<STX>600;<CSUM><CR><LF>
is a current setpoint reading of .600 mA.

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4.5.5 Request kV Monitor

Description:
The host requests that the firmware report kV monitor.

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

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

Where:
<ARG> = the voltage in tenths of a kV (.1 kV), in ASCII format.

Example:
<STX>1000;<CSUM><CR><LF>
is a voltage readback of 100.0 kV.

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4.5.6 Request mA Monitor

Description:
The host requests that the firmware report mA monitor.

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

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

Where:
<ARG> = the current readback in thousandths of a mA (.001 mA), in ASCII format.

Example:
<STX>700;<CSUM><CR><LF>
is a current setpoint reading of .700 mA.

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4.5.7 Request Temperature Monitor

Description:
The host requests that the firmware report the tank temperature.

Syntax:
<STX>TMON;<CSUM><CR><LF>

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

Where:
<ARG> = tenths of a degree Celsius.

Example:
<STX>556;<CSUM><CR><LF>
is 55.6 C.

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4.5.8 Request Filament Monitor

Description:
The host requests that the firmware report the filament monitor.

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

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

Where:
<ARG> = 0-32767

Example:
<STX>12481;<CSUM><CR><LF>

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4.5.9 Enable Communication Watchdog

Description:
The host requests that the firmware to enable communication watchdog.

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

Where:
<ARG of 1> = Enable Watchdog, <ARG of 0> = Disable Watchdog

Example:
<STX>WDTE<SP>1;<CSUM><CR><LF>
enables the watchdog timer

Response:
None

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4.5.10 Tickle Communication Watchdog

Description:
The host requests that the firmware reset communication watchdog timer.

Direction:
Host to supply

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

Response:
None

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4.5.11 Request Faults

Description:
The host requests that the firmware report the fault status. One code is returned. The fault that is returned is based on priority if more than one fault is set. The order is shutdown faults, then arc fault, under current, and preventative maintenance. See Appendix A for fault cause and effect.

Syntax:
<STX>FLT;<CSUM><CR><LF>

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

Where:
<ARG> 0 = No Fault
1 = Temperature
2 = Arc
3 = High Current
4 = Low Current
5 = Low Voltage
6 = High Voltage
7 = Watchdog
8 = Power
9 = Interlock
11 = Temperature Warning
43 = Preventative Maintenance. Issued if either there are more than 15,000 hours of high voltage time on the X-ray tube, or if four years have elapsed since the X-ray tube was factory installed. This is a non-shutdown fault.

Example:
<STX>6;<CSUM><CR><LF>
is a High Voltage fault.

4.5.12 Reset Faults

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

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

Response:
None

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4.5.13 Turn X-RAY On/Off

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

Where:
<ARG of '1'> = XRAY On, <ARG of '0'> = XRAY Off (in ASCII format, where '1' is equal to 49 in decimal).

Example:
<STX>ENBL<SP>1;<CSUM><CR><LF> will turn on X-rays.

Response:
None

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4.5.14 Request X-RAY Status

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

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

Where <ARG of '1'> = XRAY On, <ARG of '0'> = XRAY Off (in ASCII format, where '1' is equal to 49 in decimal).

Example:
<STX>1;<CSUM><CR><LF>
is returned for X-rays on.

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4.5.15 Request Firmware Version

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

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

Where:
<ARG> consists of ASCII characters representing the current firmware part number/version.

Example:
<STX>22435;<CSUM><CR><LF>

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4.5.16 Request Model Number

Syntax:
<STX>GETX;<CSUM><CR><LF>

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

Where:
<ARG> consists of ASCII characters representing the model number.

Example:
<STX>X4321;<CSUM><CR><LF>

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4.5.17 Request Serial Number

Syntax:
<STX>SNUG;<CSUM><CR><LF>

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

Where:
<ARG> consists of 16 ASCII characters representing the unit's serial number.

Example:
<STX>123456789ABCDEFG;<CSUM><CR><LF>

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4.5.18 Request Date and Time

Description:
Returns the Date-Time from the Real-Time Clock using 24-hour clock format.

Syntax:
<STX>138,<CSUM><ETX>

Response:
<STX>138,M(M),D(D),YY,h(h),m(m),s(s),<CSUM><ETX>

Example:
<STX>138,5,23,18,14,43,27,<CSUM><ETX>
for 5/23/18 14:43:27 (May 23rd, 2018)

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4.5.19 Request High Voltage On-Time

Description:
Returns the number of hours that the high voltage has been on since tube was last factory installed or replaced.

Syntax:
`<STX>HVON;<CSUM><CR><LF>`

Response:
`<STX><ARG1>,<ARG2>;<CSUM><CR><LF>`

Where:
`ARG1` equals the hours and `ARG2` equals the remaining hundredths of hours that the high voltage has been on.

Example:
`<STX>78,97;<CSUM><CR><LF>`
means that high voltage has been on for 78.97 hours.

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4.5.20 Request Total High Voltage Off Time

Description:
Returns the total amount of time that high voltage has been off since the tube was last seasoned. This off time includes time when the power supply was turned off and the time where the supply is on but x-rays (and thus high voltage) were off (that is, the supply is in idle).

Syntax:
`<STX>HVOF;<CSUM><CR><LF>`

Response:
`<STX><ARG1>,<ARG2>;<CSUM><CR><LF>`

Where:
`ARG1` equals the hours and `ARG2` equals the remaining hundredths of hours that the high voltage has been off.

Example:
`<STX>163,27;<CSUM><CR><LF>`
means that high voltage has been off for 163.27 hours

4.5.21 Request Idle Time

Description:
Returns the amount of time the power supply has been in an idle state since the tube was last seasoned.

Syntax:
<STX>IDLT;<CSUM><CR><LF>

Response:
<STX><ARG1>,<ARG2>;<CSUM><CR><LF>

Where:
ARG1 equals the hours and ARG2 equals the remaining hundredths of hours that the supply has been in an idle state (that is, the power supply is on but high voltage is off).

Example:
<STX>78,97;<CSUM><CR><LF>
means that power supply has been in an idle state for 78.97 hours.

4.5.22 Request Unit Off Time

Description:
Returns the amount of time the power supply itself has been off since the last seasoning has been performed.

Syntax:
`<STX>OFTM;<CSUM><CR><LF>`

Response:
`<STX><ARG1>,<ARG2>;<CSUM><CR><LF>`

Where:
`ARG1` equals the hours and `ARG2` equals the remaining hundredths of hours that the supply has been off.

Example:
`<STX>78,5;<CSUM><CR><LF>`
means that power supply has been off for 78.05 hours.

4.5.23 Request Tube Time Stamp

Description:
Returns the date and time the X-ray tube was factory installed in the Monoblock. This date and time is used to calculate the Preventative Maintenance notification (code 43). See paragraph 4.5.11 Request Faults.

Syntax:
<STX>RTTS;<CSUM><CR><LF>

Response:
<STX>M(M),D(D),YY,h(h),m(m),s(s);<CSUM><CR><LF>

Example:
<STX>5,23,18,14,43,27;<CR><LF>
for 5/23/18 14:43:27 (May 23rd, 2018).

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4.5.24 Program Seasoning Timestamp

Description:
Uses the Real-Time Clock's time to save the seasoning timestamp.

Syntax:
<STX>PSTS;<CSUM><CR><LF>

Response:
Acknowledgment

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4.5.25 Save Custom Seasoning Data

Description:
Saves a custom seasoning profile of up to 25 steps.

Syntax:
<STX>SCSD <Column Index>,<Step 0>,…,<Step 25>;<CSUM><CR><LF>

Where:
Column Index is one of:
‘0’ for the kV column
‘1’ for the mA column
‘2’ for the Time column

Response:
None

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4.5.26 Start Seasoning

Syntax:
<STX>STS<SP><ARG>;<CSUM><CR><LF>

Where:
ARG is one of the following profile types:
‘0’ for the >= 1 and < 7 days profile
‘1’ for the >= 7 and < 14 days profile
‘2’ for the < 30 days profile
‘3’ for the >= 30 days profile

Response:
Acknowledgment

4.5.27 Stop Seasoning

Syntax:
<STX>STPS;<CSUM><CR><LF>

Response:
Acknowledgment

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4.5.28 Request Seasoning State

Description:
Returns the seasoning state (start state, running, stopped, or ready).

Syntax:
<STX>RSS;<CSUM><CR><LF>

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

Where:
Returns one argument in ASCII. The following character values may be returned:
‘0’ for start state (the supply is commanded to begin seasoning).
‘1’ for seasoning running,
‘2’ for seasoning stopped,
‘3’ for ready for seasoning.

Example:
<STX>1;<CSUM><CR><LF>
means that seasoning is running.

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4.5.29 Request Recommended Profile Type

Description:
Returns the seasoning profile that is recommended for the time that has elapsed since the tube was last seasoned and for how long the high voltage was off.

Syntax:
<STX>RRPT;<CSUM><CR><LF>

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

Where:
Returns one argument in ASCII. The following character values may be returned:
‘0’ for >= 1 and < 7 days
‘1’ for >= 7 and < 14 days
‘2’ for < 30 days
‘3’ for >= 30 days
“99” for None (less than one day)

Example:
<STX>1;<CSUM><CR><LF>
means that the recommended profile is the one for 7-14 days.

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4.5.30 Request Seasoning Table Column

Description:
Returns a specified column of data for a specified seasoning profile. The column is the value (either kV, mA, or Time, depending on the column that is specified) for every seasoning step.

Syntax:
<STX>RSTC<SP><Profile Type>,<Column Index>;<CSUM><CR><LF>

Response:
<STX><ARG1>,<ARG2>…<ARG25>;<CSUM><CR><LF>

Where:
Profile Type is one of:
‘0’ for >= 1 and < 7 days
‘1’ for >= 7 and < 14 days
‘2’ for < 30 days
‘3’ for >= 30 days
‘4’ for the custom profile

And

Column Index is one of:
‘0’ for the kV column
‘1’ for the mA column
‘2’ for the Time column

Returns 25 arguments in ASCII, representing each step for a particular column of the seasoning table.

Example:
<STX>RSTC 1,0;<CSUM><CR><LF>
gets column 0 (kV) of profile 1 (the profile for greater than 7 days but less than or equal to 14 days).

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4.5.31 Set Baud Rate

Description:
Changes the unit to use either 9600 or 115200 baud. This setting is saved in non-volatile FRAM so that, upon power-cycling, the unit remembers the last desired baud rate.

Syntax:
<STX>SBR<SP><ARG>;<CSUM><CR><LF>

Where:
Passing an ARG of '1' means switching to 115,200 baud rate with serial parameters of 8-N-1 (eight data bits, no parity, and one stop bit). Passing an ARG of '2' means 9600 baud rate with serial parameters of 8-E-1 (eight data bits, even parity, and one stop bit).

Response:
None

Example:
<STX>SBR<SP>2;<CSUM><CR><LF>
means the unit will use 9600 baud for all future communications, even after powering on/off, unless another SBR command is set to change it.

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5.0 COMMAND HANDLING

5.1 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.

5.2 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.

5.3 Handshaking

The only handshaking implemented on the host interface, is built into the implementation of this protocol. That is, the host must initiate all communications. If the supply receives a command that returns an acknowledgment, a “$” message is sent back to the host. 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.

Note: During the first five seconds after the application of AC line voltage serial data transmission from the Monoblock, if any, should be ignored. It is always recommended that the response from the Monoblock be verified using the checksum as outlined in paragraph 4.3.

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APPENDIX A

FAULT CAUSE AND EFFECT

High Temperature
The fault occurs when the oil temperature inside the Monoblock reaches 65^{O} C.
This fault will produce the following results:
Light the Over Temp (OT) LED
Respond to a Request Fault command with Fault #001
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’
This is a latched fault

ARC Fault
There are two ARC fault conditions:
a) When a single arc occurs, this fault will produce the following results:
Light the ARC LED for about 30 seconds
Respond to a Request Fault command with FLT # 002
This is not a latched fault and will not shutdown the unit
b) When multiple Arcs occur (4 arc events during a 10sec period), this fault will produce the following results:
Light the ARC LED
Respond to a Request Fault command with FLT # 002
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’.
This is a latched fault

High mA
There are two High mA conditions:
a) When output current exceeds 10% of max rated current
b) When output current exceeds the reference set value by 18%
This fault will produce the following results:
Light the Over Current (OC) LED
Respond to a Report Fault Command with Fault #003
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’
This is a latched fault

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Low mA
A Low mA fault occurs when the output current is below the current reference set value by 18%.
This fault will produce the following results:
Light the Under Current (UC) LED
Respond to a Report Fault Command with Fault #004
This is not a latched fault and will not shutdown the unit
This fault will remain active for as long as the output current is below the reference set value by >18%

Low kV
The fault occurs when the output voltage is below the voltage reference set value by 10%.
This fault will produce the following results:
Light the Under Voltage (UV) LED
Respond to a Report Fault Command with Fault #005
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’
This is a latched fault

High kV
There are two High kV conditions:
a) When the output voltage exceeds 10% of max rated voltage
b) When the output voltage exceeds the reference set value by 10%
This fault will produce the following results:
Light the Over Voltage (OV) LED
Respond to a Report Fault Command with Fault #006
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’.
This is a latched fault.

Watchdog
The fault occurs when the Watchdog timer expires.
This fault will produce the following results:
Respond to a Report Fault Command with Fault #007
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’.
This is a latched fault.

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Power Limit
A Power Limit fault occurs the combination of KV and mA (kV multiplied by mA) exceeds the maximum rated power of the Monoblock.
This fault will produce the following results:
Respond to a Report Fault Command with Fault #008
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’.
This is a latched fault.

Interlock
The fault occurs when the X-ray Interlock Enable Signal (+24Vdc) is removed from the Monoblock.
This fault will produce the following results:
Respond to a Report Fault Command with Fault #009
Shutdown the unit
Change the status of pin 7 of the analog interface to ‘Active low’.
This is a latched fault.

Temperature Warning
The fault occurs when the oil temperature inside the Monoblock is greater than 58^{O} C.
This fault will produce the following results:
Toggle the Over Temp (OT) LED on/off
Respond to a Request Fault command with Fault #011
This is not a latched fault and will not shutdown the unit
This fault will only remain active for as long as the oil temperature inside the Monoblock is greater than58^{O} C.

Preventative Maintenance
The fault occurs when the Monoblock has been in the field for greater than 4 years or the High voltage on time is greater than 15,000 hours. When this fault occurs, it is recommended that the Monoblock is returned to Spellman High Voltage for preventative maintenance.
Respond to a Report Fault Command with Fault #043
This is not a latched fault and will not shutdown the unit.

Fault Clear
All faults can be cleared by executing a Reset Fault (CLR) command or powering down the Monoblock.

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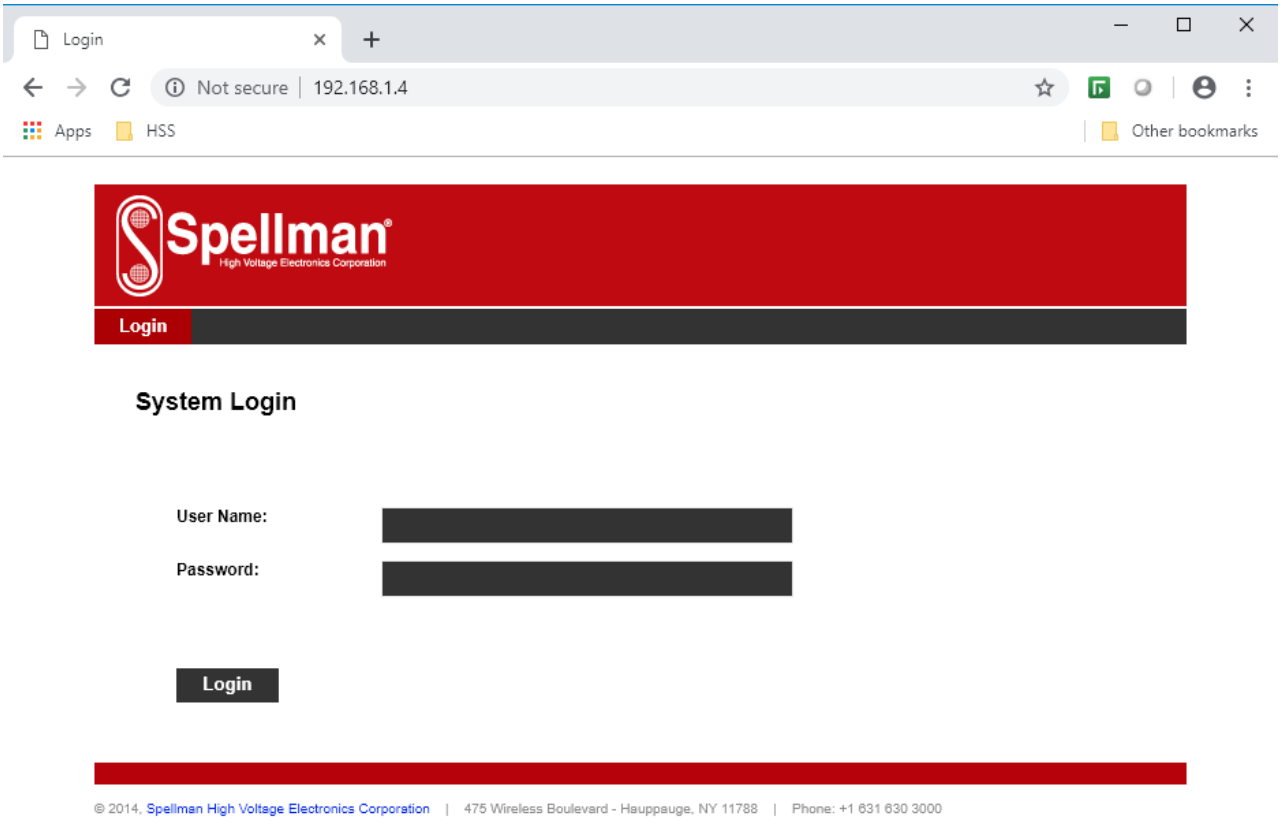
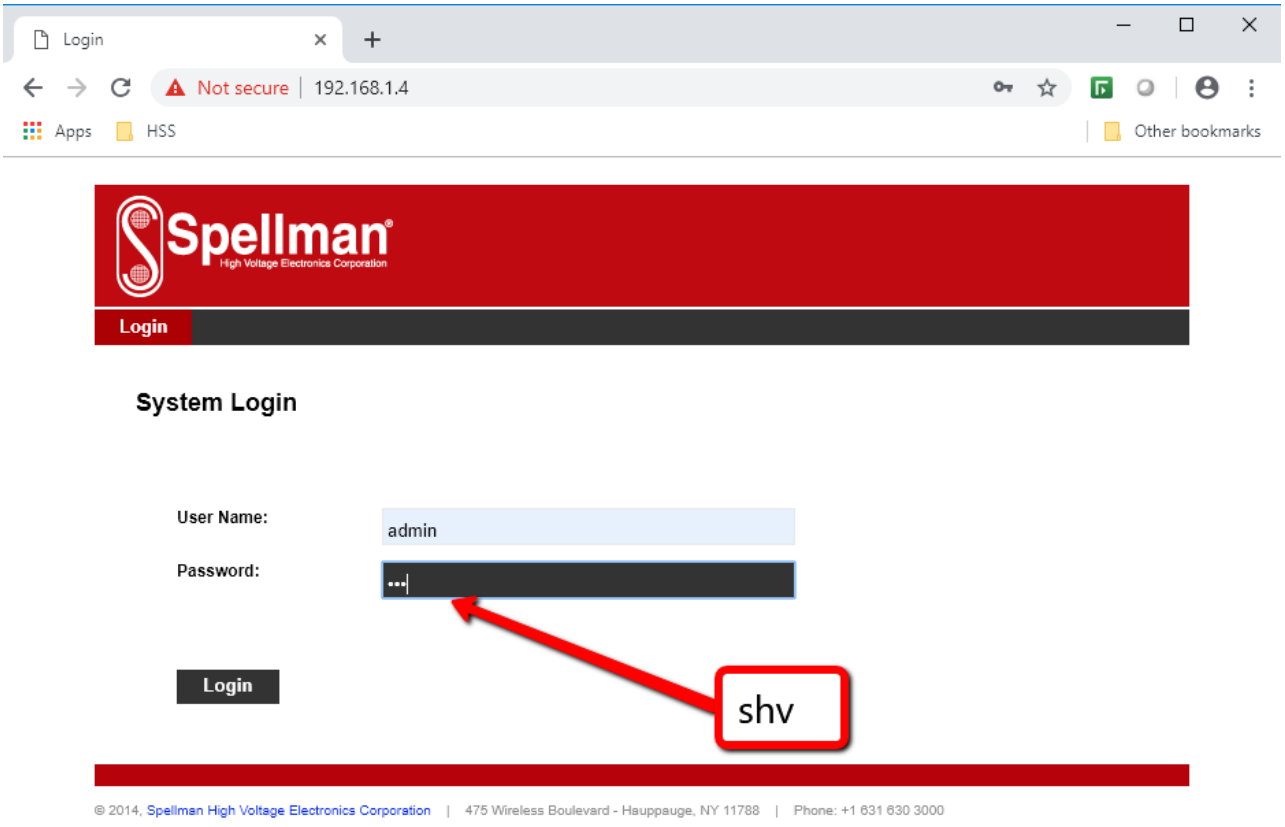
APPENDIX B

CHANGING IP ADDRESS

To change the Ethernet IP address you must log into the Monoblock using your web browser and then change the address as shown below.





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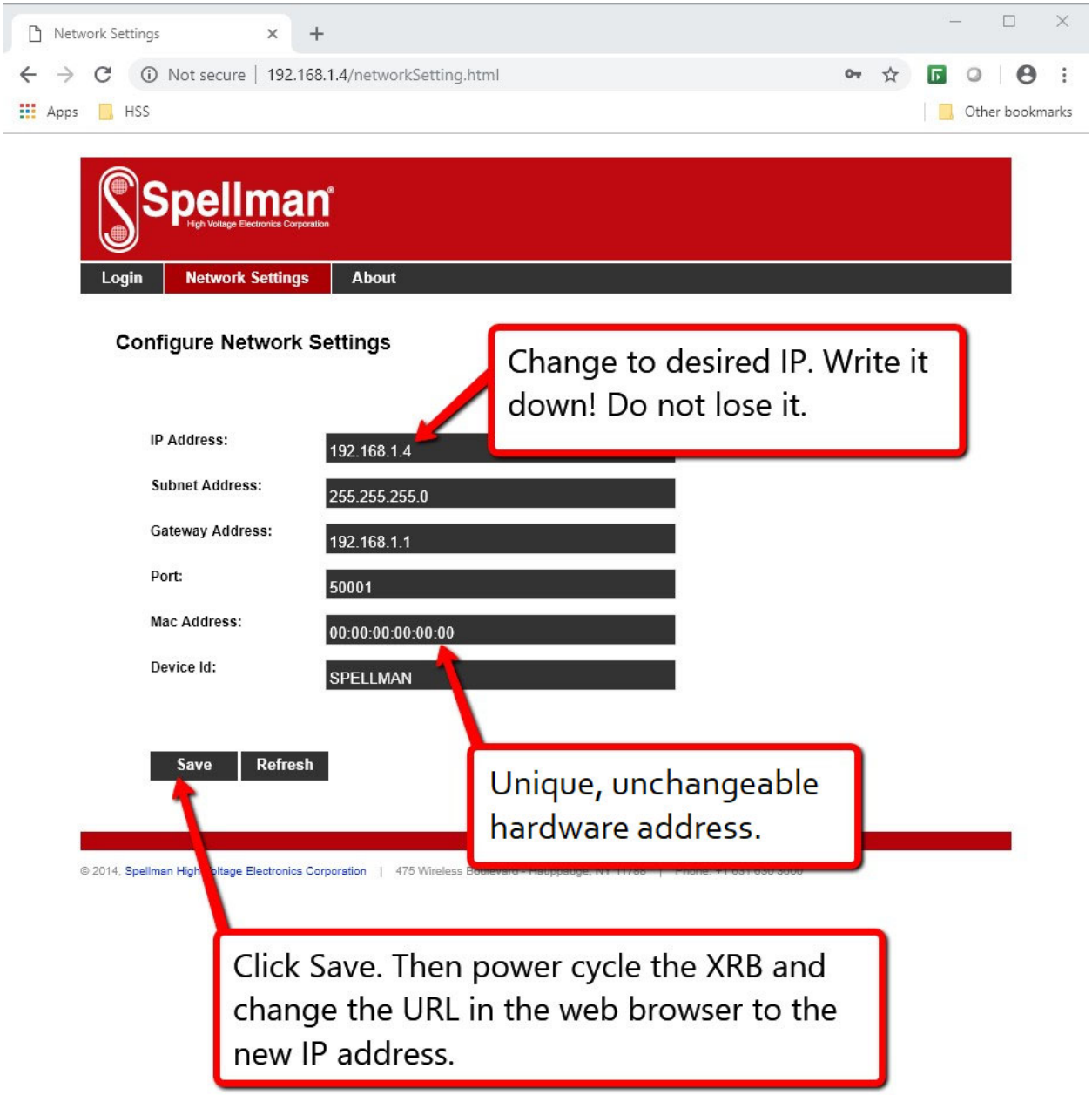

End of Document

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