Instruction Manual

XRB011

SPELLMAN
HIGH VOLTAGE ELECTRONICS
CORPORATION
One Commerce Park
Valhalla, New York, 10595

+1(914) 686-3600* FAX: +1(914) 686-5424*
E-mail: **sales@spellmanhv.com**
Website: www.spellmanhv.com

USA EUROPE JAPAN MEXICO

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.

XRB011 SERVICE AND INSTALLATION MANUAL

XRB011 INTRODUCTION **1➢**

INSTALLATION **2➢**

INTERFACING **3➢**

TROUBLESHOOTING **4➢**

SCHEMATICS (Simplified Diagram) **5➢**

CHAPTER 1

XRB011 INTRODUCTION

CONTENTS:

1.1 XRB011 DESCRIPTION 3
1.2 TECHNICAL SPECIFICATIONS 3
1.2.1 Generator Hardware Specifications *3*
1.2.2 Generator Control Modes / Application Features *3*
1.2.3 Power Supply Requirements *3*
1.2.4 Environment Requirements *4*
1.2.5 Mechanical *4*
1.3 THEORY OF OPERATION 7
1.3.1 Function Overview *7*
1.3.2 Input Line Power *7*
1.3.3 HV Inverter *7*
1.3.4 High Voltage Transformer *7*
1.3.5 High Voltage Assembly *7*
1.3.6 System Control PWB *7*
1.3.7 Filament Power *8*
1.3.8 High Voltage Interlock *8*
1.4 SAFETY 9
1.4.1 Safety and Warning Symbols *9*

1.1 XRB011 DESCRIPTION

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

The XRB011 incorporates local and remote programming, monitoring, and fault indicators including safety interlock. The X-ray source is a sealed unit containing a HVPS and an X-ray tube. The insulating oil provides electrical insulation for the high voltage sections of the power supply and the X-ray tube in a sealed tank. The oil also functions as a coolant to carry heat away from the tube. Convection cooling augmented by customer provided minimum 50cfm external fan is required for the 20W, 50W option. A rubber bellows in the tank of the X-ray source compensates for the expansion of the oil as the oil temperature varies with operating conditions thereby eliminating the need for bulky overflow tank.

.

1.2 TECHNICAL SPECIFICATIONS

1.2.1 Generator Hardware Specifications

kVp range:	35 to 80 kVp output capability
kVp steps:	Continuous with 12 bits resolution
kVp accuracy:	<=1% (measured after kVp rises to the peak level)
Ripple (kV):	<= 1% Peak to Peak
Settling time:	< 10ms to within 95% of the programmed voltage
Reproducibility:	<0.5%
Temperature Coefficient:	<=100ppm/ ℃
Time range:	XRB011 is specified as a Continuous operation.
mA :	250µA maximum for 20W option 700µA maximum for 50W option
mA accuracy:	<2.5% (measured after mA rises to stable DC level)
mA range	0 to 250 µA for 20W option 0 to 700 µA for 50W option
Reproducibility:	<0.5%

1.2.2 Generator Control Modes / Application Features

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

1.2.3 Power Supply Requirements

Single Phase

Line Voltage $24V_{DC}\pm1V_{DC}$, 2.5A (20W option). 4A (50W option)

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

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

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

Mains Voltage	Minimum Recommended	Minimum Recommended Ground Wire Size	Apparent Mains Resistance
24VDC J1-1 J1-2 J1-3	 #20 AWG (0.52 mm^2) #20 AWG (0.52 mm^2) #20 AWG (0.52 mm^2)		 0.033 Ω 0.033 Ω 0.033 Ω
24V RETURN J1-5 J1-6 J1-7		 #20 AWG (0.52 mm2) #20 AWG (0.52 mm2) #20 AWG (0.52 mm2)	 0.033 Ω 0.033 Ω 0.033 Ω

1.2.4 Environment Requirements

Operating Environment

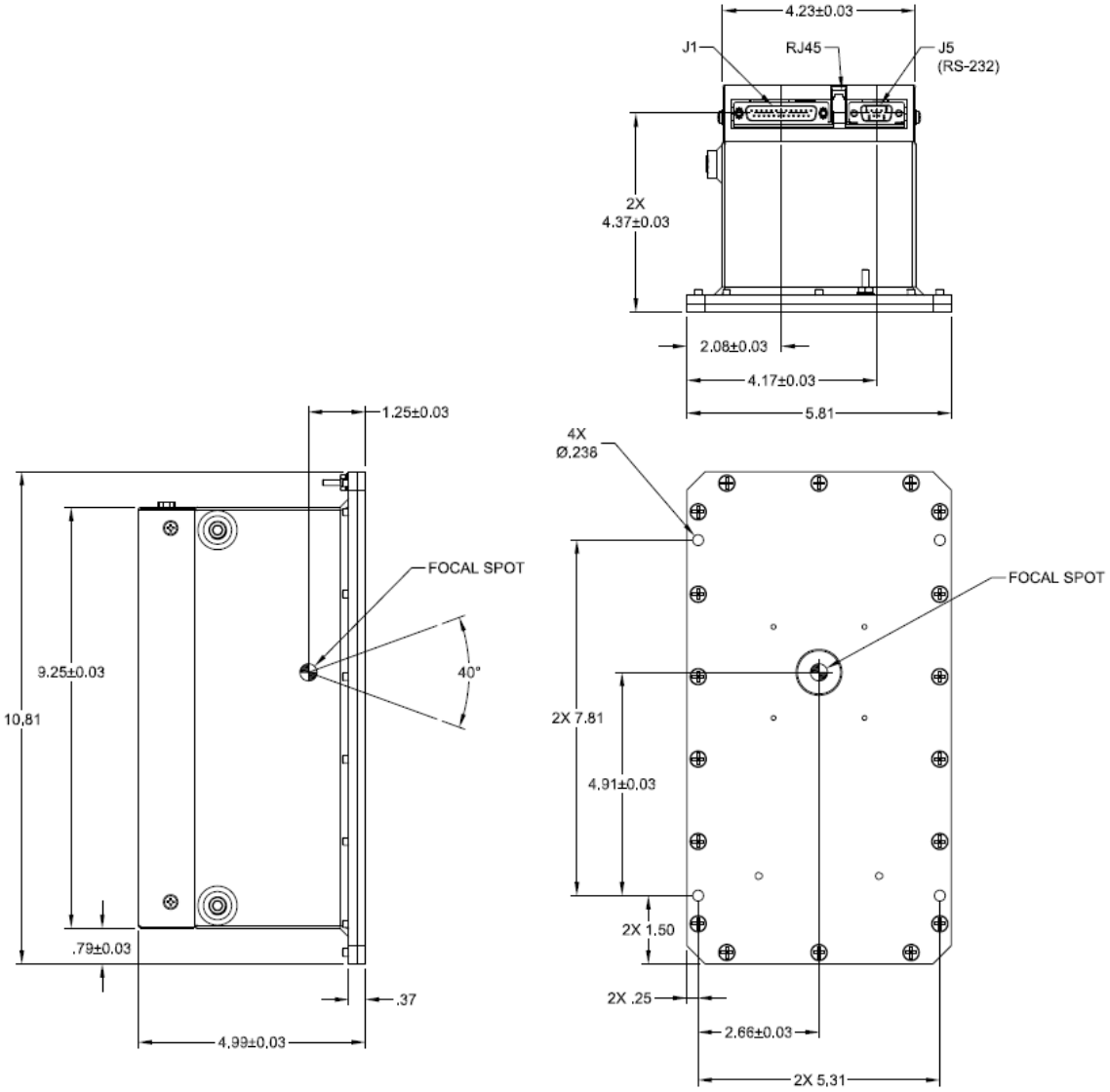
Operating Temperature	0 to 40 °C (32 to 104 °F).
Relative Humidity	10 to 95%, non-condensing.
Atmospheric pressure range	500 to 1060 hPa (375 to 795 mm Hg).

TRANSPORT AND STORAGE

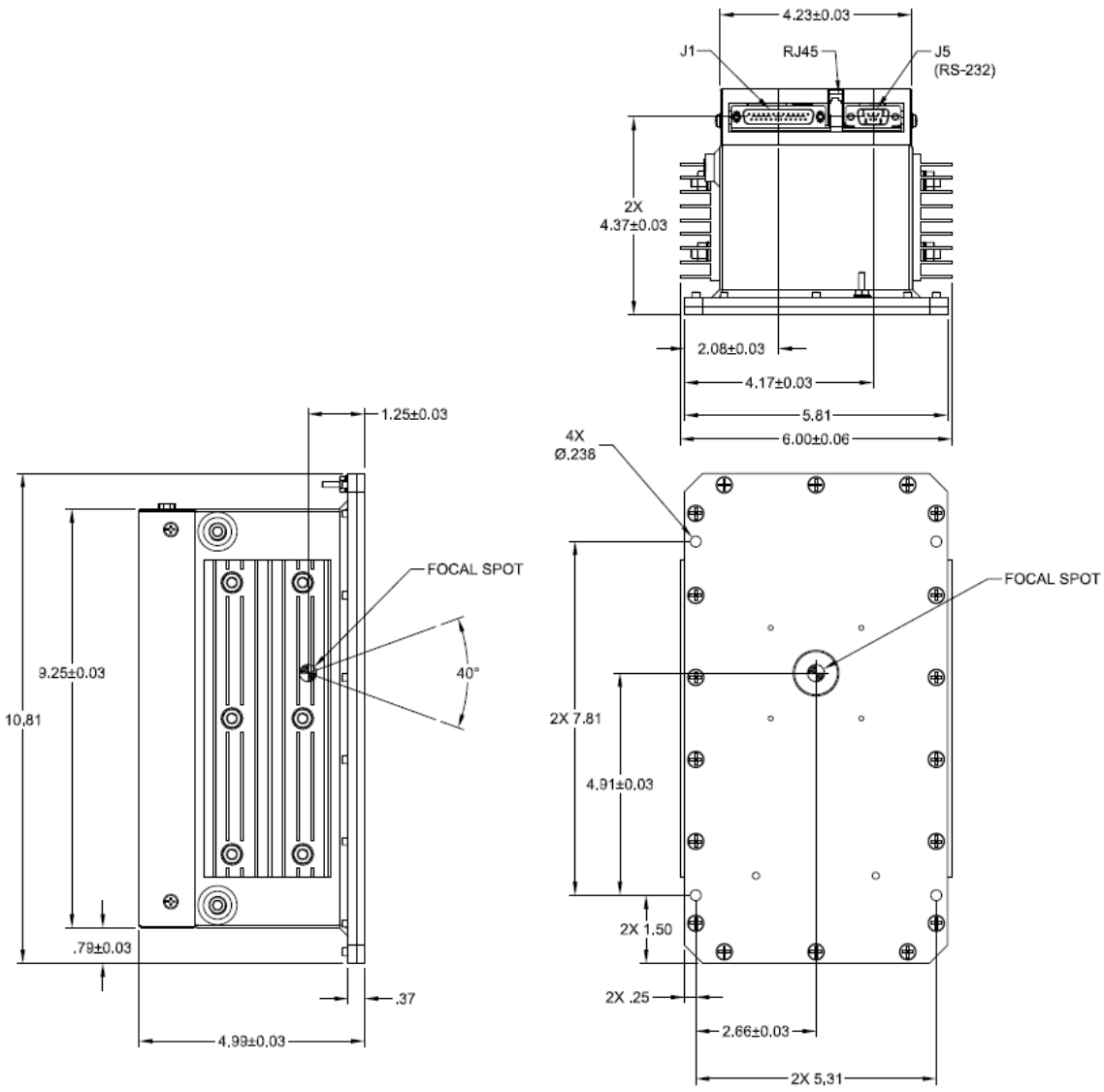
Ambient temperature range	-20 to 70 °C (-4 to 158 °F).
Relative humidity	5 to 95%, non-condensing.
Atmospheric pressure range	500 to 1060 hPa (375 to 795 mm Hg).

1.2.5 Mechanical

20W OPTION


4.23±0.03
J1
RJ45
J5
(RS-232)
2X
4.37±0.03
2.08±0.03
4.17±0.03
5.81
1.25±0.03
FOCAL SPOT
40°
9.25±0.03
10,81
.79±0.03
.37
4.99±0.03
4X
Ø.236
FOCAL SPOT
2X 7.81
4.91±0.03
2X 1.50
2X .25
2.66±0.03
2X 5.31

50W OPTION


4.23±0.03
J1
RJ45
J5
(RS-232)
2X
4.37±0.03
2.08±0.03
4.17±0.03
5.81
6.00±0.06
1.25±0.03
4X
Ø.238
FOCAL SPOT
FOCAL SPOT
40°
9.25±0.03
10,81
2X 7.81
4.91±0.03
.79±0.03
2X 1.50
.37
2X .25
4.99±0.03
2.66±0.03
2X 5,31

1.3 THEORY OF OPERATION

1.3.1 Function Overview

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

The XRB011 MONOBLOCK Series incorporates local and remote programming, monitoring, and fault indicators including safety interlock. The X-ray source is a sealed unit containing a HVPS and an X-ray tube. The insulating oil provides electrical insulation for the high voltage sections of the power supply and the X-ray tube in a sealed tank. The oil also functions as a coolant to carry heat away from the tube. Convection cooling augmented by customer provided minimum 50cfm external fan is required for the 20W, 50W option. A rubber bellows in the tank of the X-ray source compensates for the expansion of the oil as the oil temperature varies with operating conditions thereby eliminating the need for bulky overflow tank.

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

1.3.2 Input Line Power

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

1.3.3 HV Inverter

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

1.3.4 High Voltage Transformer

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

1.3.5 High Voltage Assembly

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

1.3.6 System Control PWB

Control of the generator utilizes sophisticated analog and digital circuitry resulting in fast and accurate control, protection and signaling to the user.
This generator is based on advanced PWM control utilizing the specific integrated circuit. Analog signals are digitized in A/D converter and processed within DSP circuits to provide maximum accuracy and reliability.
All feedback signals are sent to the user interface through digital and D/A circuits where switching is possible between feedback and program signals. This allows the user to preset the desired output before energizing high voltage.
All program voltages are typically ramped up to set level by the digital ramp generator.

A-D and D-A converters and drivers provide system Fault Control and Indication. User interface is processed on this PWB as well, providing isolated relay coils, opt couplers and open collectors contact.

1.3.7 Filament Power

The filament inverter provides the filament power for the X-ray tube. The filament inverter is a high frequency, series resonant inverter. The inverter provides ac current to the primary of the filament isolation transformer. The filament isolation transformer secondary is connected to the filament tube. The filament power is 2.25Vac/1.7Aac.
See Figure 1.2 for a simplified diagram of the X-RAY tube connection and current sensing circuits. The filament circuitry also provides a variety of control, diagnostic and protection functions.

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

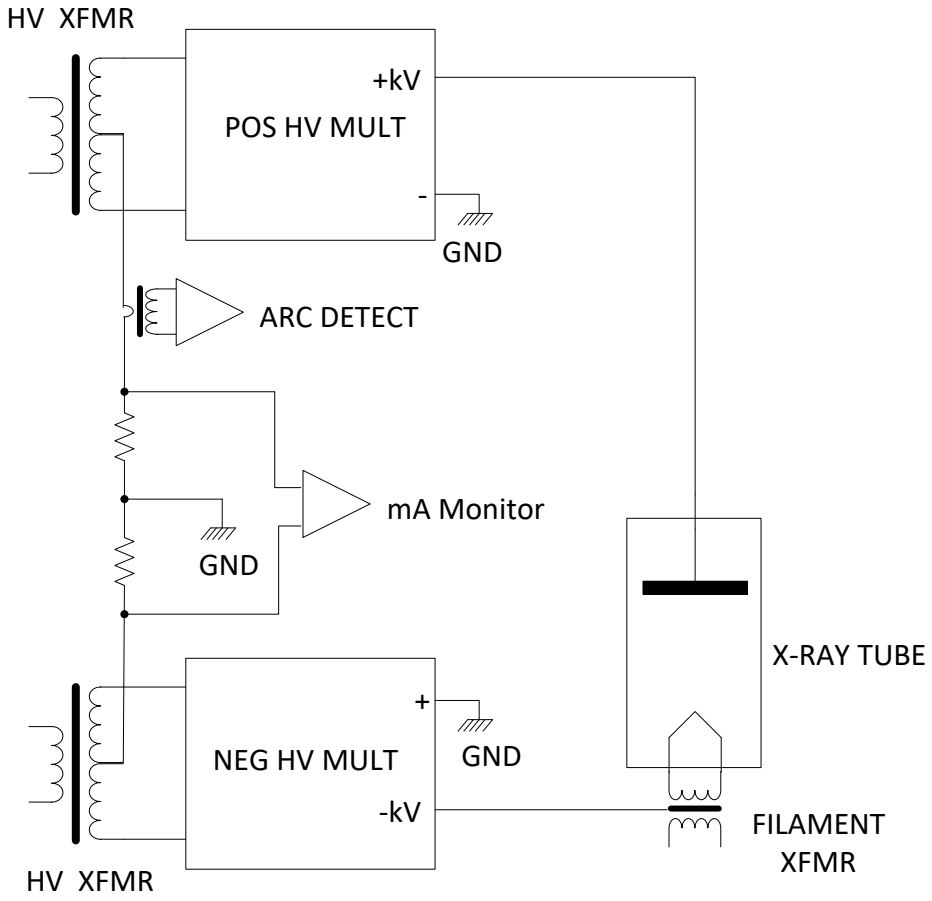


Figure 1.2 Simplified schematic of X-RAY tube connection

1.3.8 High Voltage Interlock

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

1.4 SAFETY

1.4.1 Safety and Warning Symbols

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

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

	"CAUTION" symbol used to indicate a potential hazard to operators, service personnel or to the equipment.
	"CAUTION" symbol used to indicate an X-RAY RADIATION EXPOSURE, is hazard to operators, service personnel or to the equipment.
	Protective Earth IEC 60417-5017

CHAPTER 2

INSTALLATION

CONTENTS:

2.1 INTRODUCTION 11
2.2 UNPACKING 11
2.3 OVERALL CONNECTIONS 12
2.4 INPUT POWER VOLTAGE 13
2.5 CABLE CONNECTION ILLUSTRATION 13
2.5.1 MULTI INTERFACE CABLE CONNECTIONS 13
2.5.1 Pin Layout of the Multi interface 14
2.5.2 GROUND CONNECTION 14
2.5.3 CHASSIS GROUND 15
2.5.4 X-RAY PORT 15
2.6 FINAL CHECKS 15

2.1 INTRODUCTION

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

2.2 UNPACKING

WARNING: ***THE XRB011MONOBLOK WEIGHS APPROXIMATELY 20 POUNDS (9.07 KG) IN ITS SHIPPING CONTAINER.***

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

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

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

3. Set aside the cardboard pack(s).

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

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

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

2.3 OVERALL CONNECTIONS

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

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

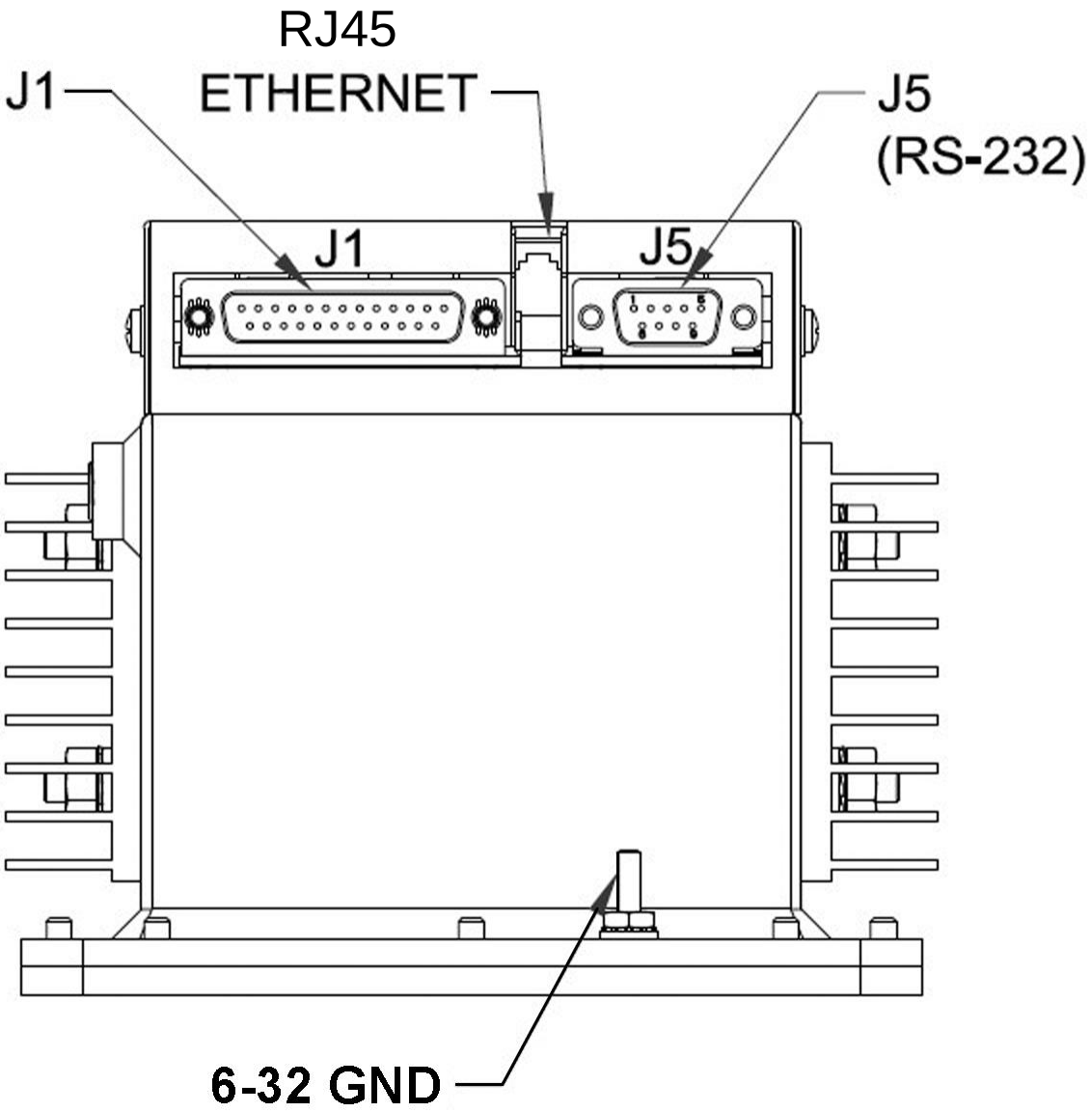


Figure 2-1: XRB011 I/O location

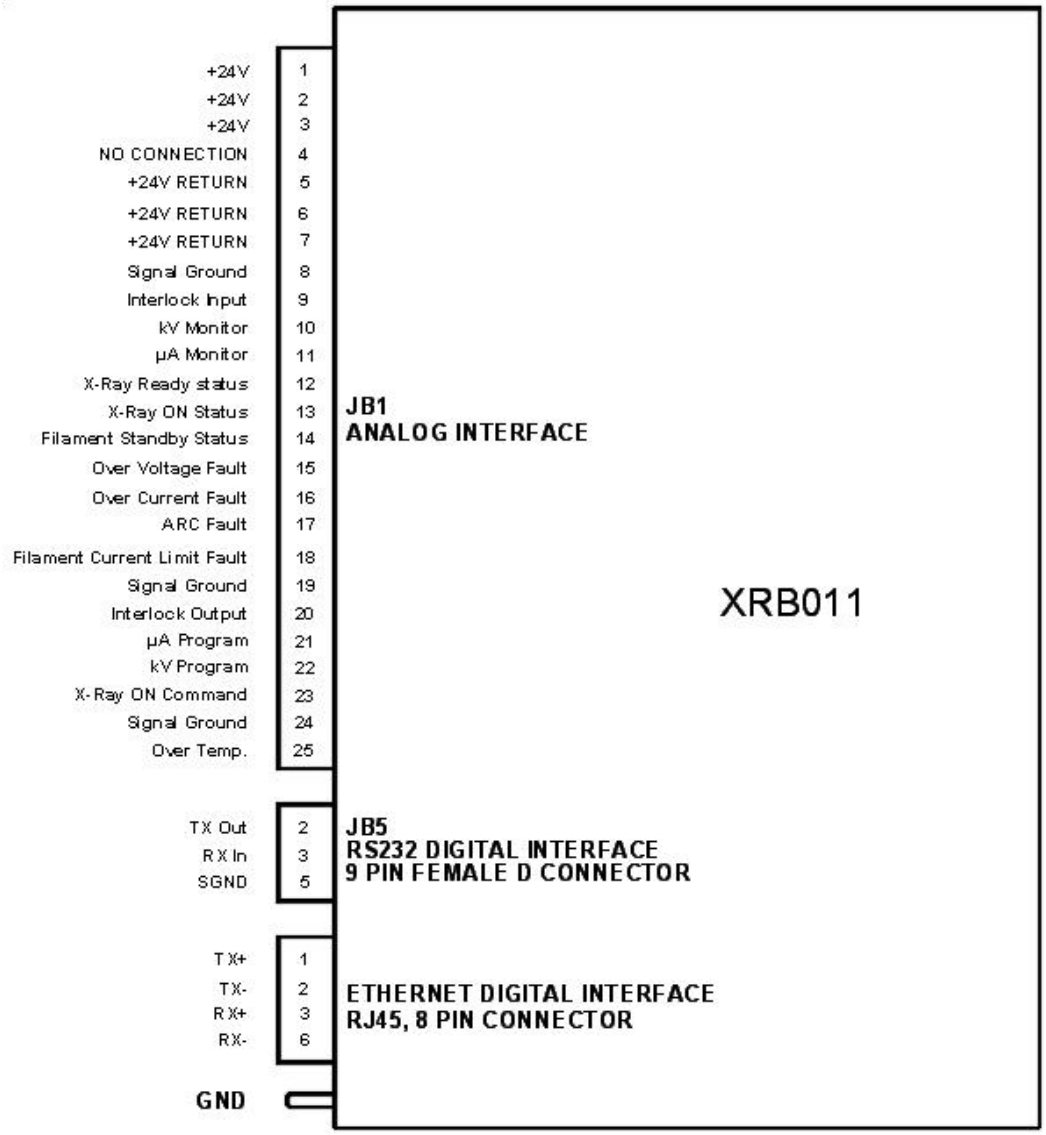


Figure 2-2: Overall connection

2.4 INPUT POWER VOLTAGE

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

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

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

2.5 CABLE CONNECTION ILLUSTRATION

2.5.1 MULTI INTERFACE CABLE CONNECTIONS

Multi Interface connections include digital I/O, serial communication, and interlock. Operator must verify and connect every signal properly though some of them are optional, before initiating power-up and basic test.

The interlock, serial communication and exposure buttons interface shall be made available via a multi signal cable. Refer to *-* for a schematic of isolation and signal direction.

2.5.1 Pin Layout of the Multi interface

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

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

Table 2-3 Pin layout of multi signal connector

Refer to chapter 3 for detailed requirements and function descriptions.

2.5.2 GROUND CONNECTION

NOTE: THE INSTALLER SHOULD ENSURE THAT ALL CABLE CONNECTIONS TO THE GENERATOR ARE SECURE, AND ALL CABLES EXTERNAL TO THE GENERATOR ARE ADEQUATELY PROTECTED AGAINST ACCIDENTAL DISCONNECTION.

2.5.3 CHASSIS GROUND

The chassis of the XRB011 MONOBLOCK must be grounded to the local earth ground and also to the tube housing ground.

2.5.4 X-RAY PORT

WARNING

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

X-ray Safety Procedures must be followed when testing this unit. The XRB011 is capable of producing Lethal Voltages and X-ray Radiation. Only proceed with operation of the HVPS after

- Consulting with the Manufacturer and verification of X-Ray setup for the proper precautions.
- Reading this entire document.

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

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

2.6 FINAL CHECKS

The room interface connections may now be completed. Before power on, user needs to check the items as below finally.

- When finished all wiring, check that all connections are tight and secure.
- Check that all cables are dressed neatly outside the cabinet, and secured as necessary.
- Check the ground connection again.

WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL.

PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.

WARNING X-RAY RADIATION EXPOSURE IS HAZARDOUS

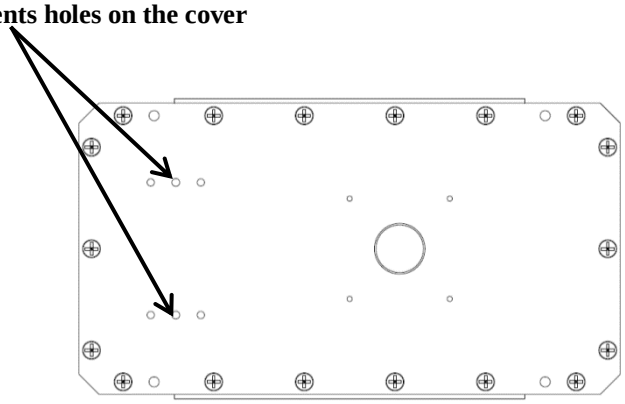
Failure to follow these procedures may void the warranty.

Check the input voltage rating on the nameplate of the supply and make certain that this is the rating of the available power source. Spellman MONOBLOCK® XRB011 operates on 24VDC±1VDC

Bellows Vent holes:

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

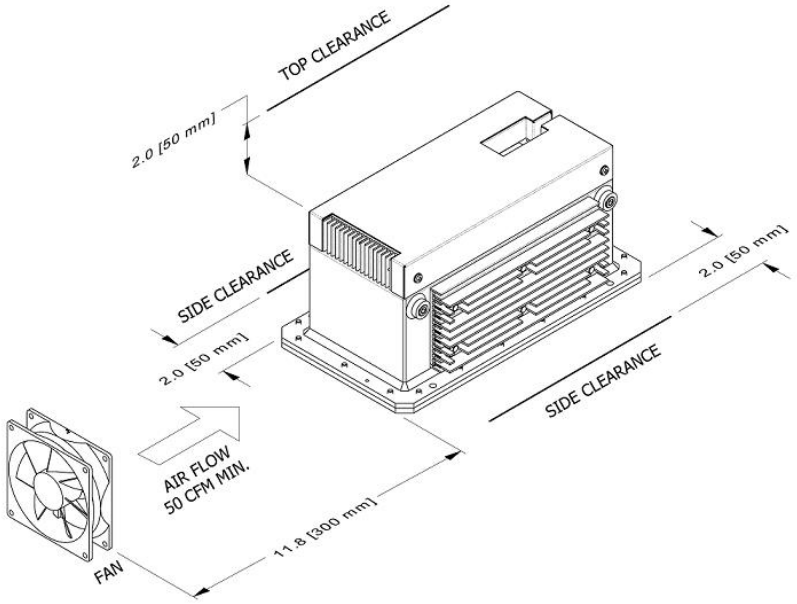
Do not block any vents holes on the cover



Cooling:

A customer supplied minimum 50 CFM fan should be used for the 20W, 50W option to maintain safe operating temperature for MONOBLOCK® X-ray generator. The air flow should be direct at the heat sink on the side of the unit and at the side of the control board compartment. During operation the internal oil temperature should be below 60C and should not exceed 65C. See below Figure for fan location.

FAN



CHAPTER 3

INTERFACING

3.1 INTRODUCTION 18
3.2 LOCAL PROGRAMMING MODE 18
3.3 LOCAL MONITORS 18
3.5 REMOTE PROGRAMMING MODE 18
3.6 REMOTE MONITORS 18
3.7 XRAY ON COMMAND 18
3.8 EXTERNAL INTERLOCK 18
3.9 SYSTEM STATUS AND FAULT DIAGNOSTIC DISPLAY 18
3.10 REMOTE MODE (DIGITAL CONTROL) 19
3.11 CONNECTOR STYLE AND PIN LAYOUT 20
3.12 SERIAL COMMUNICATION INTERFACE 21
3.13 RECOMMENDED INTERFACE CIRCUITS (LOCAL MODE, ANALOG INTERFACE) 22
3.14 RECOMMENDED INTERFACE CIRCUITS (REMODE MODE, DIGITAL INTERFACE) 23

3.1 INTRODUCTION

This Chapter describes the interfacing of the XRB011 MONOBLOCK to the customer system control side, especially with the serial communication, exposure control switch. Also, exposure mode is introduced with the timing sequence described as well.

3.2 LOCAL PROGRAMMING MODE

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

3.3 LOCAL MONITORS

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

3.5 REMOTE PROGRAMMING MODE

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

3.6 REMOTE MONITORS

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

3.7 XRAY ON COMMAND

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

3.8 EXTERNAL INTERLOCK

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

3.9 SYSTEM STATUS AND FAULT DIAGNOSTIC DISPLAY

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

All fault and status outputs are open collector (Normally off), and are intended to drive an LED or diode of an opto-coupler with 24V@10mA max

- **EXTERNAL INTERLOCK FAULT:** Indicates the EXTERNAL INTERLOCK connection is not in closed position. The fault is indicated by INTLK OPEN via RS-232 or Ethernet as (ARG 9). Analog output signal (J1-20) is active low (Low = interlock is closed, High = interlock is open)

- **X-RAY READY STATUS:** Indicates that there are no faults and the interlock is closed. The status is indicated by NO FAULT (X-RAY READY) via RS-232 or Ethernet as (ARG 0). Analog output signal (J1-12) is active low.
- **X-RAY ON STATUS:** Indicates that the X-RAY is ON or OFF. This status is indicated by via RS-232or Ethernet as X-RAY ON (ARG 1), X-RAY OFF (ARG 0). Analog output signal (J1-13) is active low (Low X-RAY is on, High=X-RAY is off).
- **OVERVOLTAGE FAULT:** Indicates the over voltage protection circuitry has caused the high voltage to turn off. Over voltage protection is internally set to 82kV. This fault is indicated by High kV via RS-232 or Ethernet as (ARG 6), Over Voltage. Analog output signal (J1-15) is active low.
- **OVER CURRENT FAULT:** Indicates the output current has exceeded 275µA (20W option), 710µA (50W option) or if the allowable percentage of error between actual and programmed emission currents is exceeded resulting in the HV to be turned off. This fault is indicated by High mA via RS-232or Ethernet as (ARG 3). Analog output signal (J1-16) is active low.
- **ARC FAULT**: Indicates that an arc has occurred. Occurrences of one arc will shutdown the high voltage and latched. This fault is indicated by ARC FAULT via RS-232 or Ethernet as (ARG 2). Analog output signal (J1-17) active low.
- **UNDER VOLTAGE FAULT:** Indicates a failure in the voltage regulation circuitry less than <35kV. This fault occurs when there is a lack of output power to maintain regulation and will result in shutdown of the HV. This fault is indicated by via RS-232 or Ethernet as (ARG 4). There is no analog output signal.
- **FILAMENT CURRENT LIMIT FAULT:** Indicates the filament current exceeded the safe operating current of the X-Ray tube. This fault is indicated by FILAMENT LIMIT via RS-232 or Ethernet as (ARG 10). Analog output signal (J1- 18) is active low.
- **FILAMENT STANDBY STATUS:** Indicates the X-RAY is off and the filament current is in standby mode. This status is indicated by FILAMENT STANDBY via RS-232 or Ethernet as (ARG 11). Analog output signal (J1-14) is active low.
- **WATCHDOG TIMER:** Indicates the host computer has lost communication and with the HVPS system for a period greater than ten second. This feature is enabled via RS-232 host command. This fault is indicated via RS-232 as (ARG 7) Watchdog Time- out. See digital manual for details.
- **OVER TEMPERATURE:** Indicates that the internal oil temperature has exceeded 65 degree C.

3.10 REMOTE MODE (DIGITAL CONTROL)

-
- G.U.I Installation software will be provided up on request.
- Start the G.U.I.
- Read agreement then click AGREES...

3.11 J1 CONNECTOR STYLE AND PIN LAYOUT

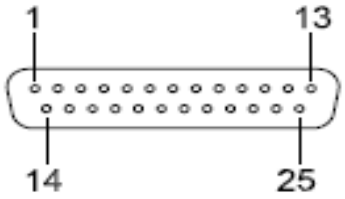


Figure 3-1 multi signal interface connector

ANALOG INTERFACE J1 25 PIN MALE CONNECTOR		
PIN	**SIGNAL**	**PARAMETERS**
1	+24V	+24Vdc±1Vdc @ 4A
2	+24V	+24Vdc±1Vdc @ 4A
3	+24V	+24Vdc±1Vdc @ 4A
4	NC	No connection
5	+24V RETURN	+24V RETURN
6	+24V RETURN	+24V RETURN
7	+24V RETURN	+24V RETURN
8	Signal Ground	Signal Ground
9	Interlock Input	Input, Active low, Interlock is low safe to enable high voltage. Connect to +24V Return
10	kV Monitor	Output, 0 to 8V = 0 to rated output voltage. Zout=100Ω
11	µA Monitor	Output, 0 to 10V = 0 to rated output current. Zout=100Ω
12	X-Ray Ready status	Output, Active Low, Open Collector, 24Vdc @ 10mA max
13	X-Ray ON status	Output, Active Low, Open Collector, 24Vdc @ 10mA max
14	Filament Standby status	Output, Active Low, Open Collector, 24Vdc @ 10mA max
15	Over Voltage Fault	Output, Active Low, Open Collector, 24Vdc @ 10mA max
16	Over Current Fault	Output, Active Low, Open Collector, 24Vdc @ 10mA max
17	ARC Fault	Output, Active Low, Open Collector, 24Vdc @ 10mA max
18	Filament Current Limit Fault	Output, Active Low, Open Collector, 24Vdc @ 10mA max
19	Signal Ground	Signal Ground
20	Interlock Output	Output, Active Low, Open Collector, 24Vdc @ 10mA max
21	µA Program	Input, 0 to 10V = 0 to rated output current. Zin=10kΩ
22	kV Program	Input, 0 to 8V = 0 to rated output voltage. Zin=10kΩ
23	X-Ray ON Command	Input, Active low, Low (short)=X-Ray ON High (open)=X-Ray OFF Internal pull up resistor to +15V
24	Signal Ground	Signal Ground
25	Over Temp.	Output, Active Low, Open Collector, 24Vdc @ 10mA max

Table 3-2 Pin layout of multi signal interface

3.12 SERIAL COMMUNICATION INTERFACE

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

RS232 DIGITAL INTERFACE
J5 9 PIN FEMALE D CONNECTOR

PIN	SIGNAL	PARAMETERS
1	NC	No connection
2	TX Out	Transmit Data
3	RX In	Receive Data
4	NC	No connection
5	SGND	Signal Ground
6	NC	No connection
7	NC	No connection
8	NC	No connection
9	NC	No connection

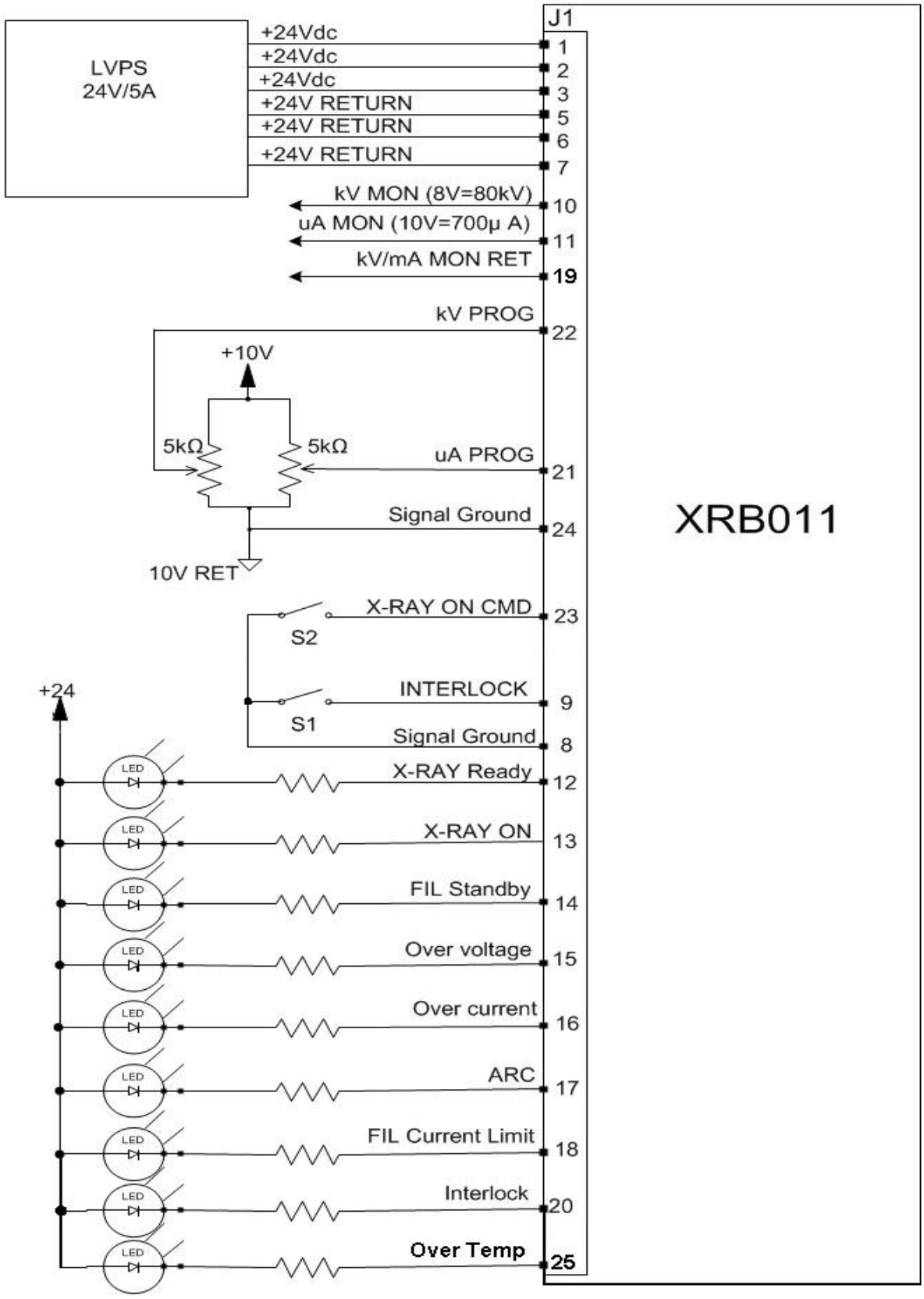
ETHERNET DIGITAL INTERFACE (OPTIONAL)
RJ45 8 PIN CONNECTOR

PIN	SIGNAL	PARAMETERS
1	TX+	Transmit Data +
2	TX -t	Transmit Data -
3	RX +	Receive Data +
4	NC	No connection
5	NC	No connection
6	RX-	Receive Data -
7	NC	No connection
8	NC	No connection

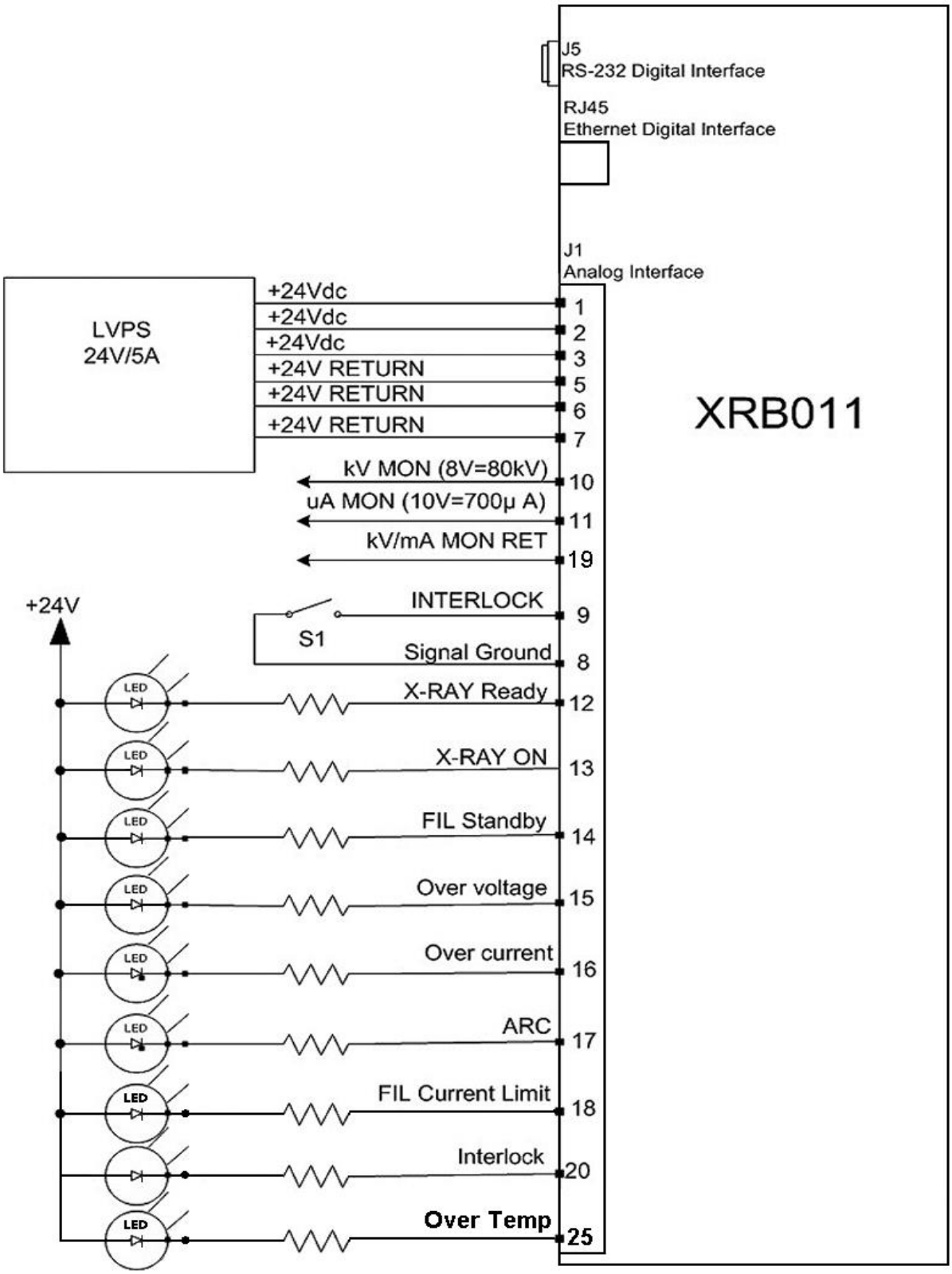
User should connect a straight type RS232 cable properly with system side such as PC. Twisted wires are preferable to enhance the EMC performance.

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

3.13 RECOMMENDED INTERFACE CIRCUITS (LOCAL MODE, ANALOG INTERFACE)



3.14 RECOMMENDED INTERFACE CIRCUITS (REMODE MODE, DIGITAL INTERFACE)



Monitors and Fault LED's are optional

CHAPTER 4

TROUBLE SHOOTING

CONTENTS:

4.1 INTRODUCTION..... 25
4.2 STATUS AND ERROR CODES 25
4.2.1 Status Messages 25

TABLE 1 – GUIDANCE AND MANUFACTURER'S DECLARATION 25
ELECTROMAGNETIC EMISSIONS – FOR ALL ME EQUIPMENT AND ME SYSTEMS 25

TABLE 2 – GUIDANCE AND MANUFACTURER'S DECLARATION
ELECTROMAGNETIC EMISSIONS – FOR ALL ME EQUIPMENT AND ME SYSTEMS 26

TABLE 3 – GUIDANCE AND MANUFACTURER'S DECLARATION
ELECTROMAGNETIC IMMUNITY – FOR ME EQUIPMENT AND ME SYSTEMS THAT ARE NOT LIFE-SUPPORING 26

TABLE 4 – RECOMMENDED SEPARATION DISTANCES BETWEEN PORTABLE AND MOBILE RF COMMUNICATIONS EQUIPMENT
AND THE ME EQUIPMENT OR ME SYSTEM – FOR ME EQUIPMENT AND ME SYSTEMS THAT ARE NOT LIFE-..... 27

4.1 INTRODUCTION

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

4.2 STATUS AND ERROR CODES

4.2.1 Status Messages

Fault/Symptom	Possible Cause
OV led illuminated and Over voltage fault at RS-232 resulting in HV Status Off.	kV programming set greater than 82kV.
UV led illuminated and Under Voltage fault at RS-232 resulting in HV Status Off.	kV programming set less than 35kV.
OC led illuminated and Over Current fault at RS-232 resulting in HV Status Off.	mA programming greater than 275µA (20W option) 710µA (50W option)
UC led illuminated and Under Current fault at RS-232 resulting in no emission, HV Status Off.	Occurrence of filament of the tube breaks open.
ARC FLT led illuminated and Arc fault at RS-232 resulting in HV Status OFF	Occurrence of tube arc causing shutdown. Clear fault and send X-ray command. Refer to tube re-seasoning procedure Table 2 and idle times. If problem continues contact Spellman service department.
Unit will not Enable	Interlock open
OT led illuminated and Over Temp fault at RS-232 resulting in HV Status Off.	Tank oil temperature has exceeded 65 degrees C

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

Guidance and manufacturer's declaration – electromagnetic emissions		
The XRB011 is intended for use in the electromagnetic environment specified below. The customer or the user of the XRB011 should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment – guidance**
RF emissions CISPR 11	Group 2	The XRB011 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The XRB011 is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not applicable	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Not applicable	

TABLE 2 – GUIDANCE AND MANUFACTURER'S DECLARATION – ELECTROMAGNETIC EMISSIONS – FOR ALL ME EQUIPMENT AND ME SYSTEMS

Guidance and manufacturer's declaration – electromagnetic immunity			
The XRB011 is intended for use in the electromagnetic environment specified below. The customer or the user of the XRB011 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment – guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	Not applicable	Not applicable	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	Not applicable	Not applicable	Mains power quality should be that of a typical commercial or hospital environment. If the user of the XRB011 requires continued operation during power mains interruptions, it is recommended that the XRB011 be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE *U*T is the A.C. mains voltage prior to application of the test level.			

TABLE 3 – GUIDANCE AND MANUFACTURER'S DECLARATION – ELECTROMAGNETIC IMMUNITY – FOR ME EQUIPMENT AND ME SYSTEMS THAT ARE NOT LIFE-SUPPORING

Guidance and manufacturer's declaration – electromagnetic immunity			
The XRB011 is intended for use in the electromagnetic environment specified below. The customer or the user of the XRB011 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment – guidance**
			Portable and mobile RF communications equipment should be used no closer to any part of the XRB011, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.

			Recommended separation distance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	$d = 1.17 \sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.17 \sqrt{P}$ 80 MHz to 800 MHz $d = 2.33 \sqrt{P}$ 800 MHz to 2.5 GHz Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,[a] should be less than the compliance level in each frequency range.[b] Interference may occur in the vicinity of equipment marked with the following symbol: 

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

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

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

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

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

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

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

Rated maximum output power of transmitter W	**Separation distance according to frequency of transmitter** m		
	150 kHz to 80 MHz $d = 1.17 \sqrt{P}$	**80 MHz to 800 MHz** $d = 1.17 \sqrt{P}$	**800 MHz to 2,5 GHz** $d = 2.33 \sqrt{P}$
0.01	0.117	0.117	0.233
0.1	0.370	0.370	0.737

1	1.17	1.17	2.33
10	3.70	3.70	7.37
100	11.7	11.7	23.3

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

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

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

CHAPTER 5

SCHEMATICS

CONTENTS:

5.1 INTRODUCTION 30
5.2 FUNCTIONAL SCHEMATIC INDEX 30

5.1 INTRODUCTION

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

5.2 FUNCTIONAL SCHEMATIC INDEX

The following functional schematics are not included in this manual.

DESCRIPTION	DRAWING NUMBER #
Block diagram Schematic	441431-001
Control Board Schematic	441434-001

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

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

XRB011 Digital Interface

Serial RS-232 - Ethernet

118150-001 REV. B

Changes

REVISION	DATE	DESCRIPTION
1	09/18/13	Draft version
2	04/18/14	Added Ramp Time command description Added User Configuration command.
3	05/14/14	Deleted mA Low fault, changed HV to X-RAY, Update status table.
4	03/28/16	Added Over temperature fault to command 22.

Table Of Contents

1.0 SCOPE 5
2.0 FUNCTIONAL DESCRIPTION 5
3.0 RS232 5
3.1 RS232 INTERFACE 5
3.2 RS-232 CABLING 6
3.3 Programming the RS-232 Interface 7
3.3.1 Enabling Communications Objects in Visual Basic for RS-232 7
3.3.2 Configuring Communications in Visual Basic for RS-232 7
3.4 SERIAL INTERFACE PROTOCOL 8
3.4.1 COMMAND ARGUMENTS 8
3.4.2 CHECKSUMS 8
3.4.3 COMMAND OVERVIEW 11
3.4.4 RESPONSE OVERVIEW 12
3.4.5 COMMANDS DESCRIPTION 13
3.4.6 SERIAL COMMAND HANDLING 29
4.0 ETHERNET 30
4.1 ETHERNET INTERFACE 30
4.2 ETHERNET CABLING 30
4.3 ETHERNET WEB SERVER 32
4.3.1 Diagnostic Web Server 32
4.3.2 Web Pages 32
4.4 Direct Connection between the DXM and a Computer 39
4.5 Configuring the Computer for Direct Ethernet Connection 39
4.6 Testing a Direct Connection 42
4.7 Configuring the XRB011 For a Local Area Network (LAN) 43
4.8 Configuring the Network Settings from the Monitor and Configure Applet 43
4.9 Enabling Communications Objects in Visual Basic for Ethernet Communications 45
4.10 Configuring Communications in Visual Basic for Ethernet 45
4.11 TCP/IP FORMAT 47
4.12 COMMAND ARGUMENTS 48
4.13 COMMAND OVERVIEW 49
4.14 RESPONSE OVERVIEW 50
4.15 COMMANDS DESCRIPTION 51
4.15.1 Set KV <10> 51
4.15.2 Set MA <11> 52
4.15.3 Request KV Set point <14> 53
4.15.4 Request MA Set point <15> 54
4.15.5 Request Status <22> 55
4.15.6 Request Firmware Version <23> 56
4.15.7 Request Model Number <26> 57
4.15.8 Tickle Watchdog <27> 58
4.15.9 Enable Watchdog <28> 59

4.15.12 Reset Faults <52> 62
4.15.13 Get KV Monitor <60> 63
4.15.14 Get MA monitor <61> 64
4.15.15 Get X-RAY Status <98> 65
4.15.16 Turn High X-RAY On/Off <99> 66

WARNING

THIS EQUIPMENT GENERATES DANGEROUS VOLTAGES THAT MAY BE FATAL. PROPER GROUNDING OF ALL HIGH VOLTAGE EQUIPMENT IS ESSENTIAL.SEE 80kv MONOBIOCK OWNERS MANUAL FOR PROPER GROUNDING TECHNIQUE AND SAFETY PRECAUTIONS BEFORE APPLING 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 460162.

2.0 FUNCTIONAL DESCRIPTION

The XRB provides 2 types of digital communications interface:

- RS-232 on J3
- Ethernet

3.0 RS232

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

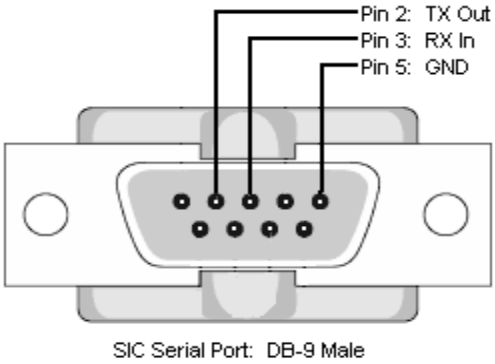


Figure 1 – J3, RS-232 DB-9M pinout (front view)

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

3.2 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

3.3 Programming the RS-232 Interface

This section details how to create software to control the XRB011 serial interface.
The RS-232 interface makes use of a standard 'command/response' communications protocol. See section 3.4 for a description of the serial interface protocol.

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

3.3.1 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 interface 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.

3.3.2 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
```

3.4 SERIAL INTERFACE PROTOCOL

Serial communications will use the following data format::

<STX><CMD><,>ARG><,><CS><ETX>

Where:

<STX>	= 1 ASCII 0x02 Start of Text character
<CMD>	= 2 ASCII characters representing the command ID
<,>	= 1 ASCII 0x2C character
<ARG>	= Command Argument
<,>	= 1 ASCII 0x2C character
<CS>	= Checksum
<ETX>	= 1 ASCII 0x03 End of Text character

3.4.1 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.

3.4.2 CHECKSUMS

The checksum is computed as follows:

- Add the <CMD>, <,>, and <ARG>, and <,> bytes into a 16 bit (or larger) word. The bytes are added as unsigned integers.
- Take the 2’s complement (negate it).
- 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.

Here is another example, this time for command 22 (Request Status) which has no arguments.
The original message with a placeholder for checksum is:

<STX>22,<CS><ETX>

First, you add up all the characters starting with the '2' in the command number to the comma before the checksum with their ASCII values (in hexadecimal):

0x32 + 0x32 + 0x2C = 0x90
Next, you then take the two's complement of that number by negating it, by subtracting it from 0x100 (decimal 256), and only retain the lowest 7 bits by bitwise ANDing the results with 0x7F:

This combines the steps of getting the twos complement, truncating the result to 8 bits and clearing the 8th bit.

(0x100 – 0x90) & 0x7F = 0x70

Finally, bitwise OR the result with 0x40:

0x70 | 0x40 = 0x70
The checksum byte is 0x70 (Decimal 112, ASCII: p)

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                 'Twos Complement
CSb2 = 63 And (CSb1)
CSb3 = 64 Or (CSb2)        'OR 0x40
 CSb$ = Chr(Val("&H" & (Hex(CSb3))))
```

```
ProcessOutputString = Chr(2) & outputString & CSb$ & Chr(3)

End Function
```

Here is an example of an actual Checksum calculation for command 10 (Program kV set point)
The original message with a placeholder for the checksum is

<STX>10,4095,<CS><ETX>

First, you add up all the characters starting with the '1' in the command number, to the comma before the checksum with their ASCII values (in hexadecimal):
0x31 + 0x30 + 0x2C + 0x34 + 0x30 + 0x39 + 0x35 + 0x2C = 0x18B
Next, you then take the two's complement of that number by negating it, by subtracting it from 0x100 (decimal 256), and only retain the lowest 7 bits by bitwise ANDing the results with 0x7F. :
This combines the steps of getting the twos complement, truncating the result to 8 bits and clearing the 8th bit.

(0x100 – 0x18B) & 0x7F = 0x75
Finally, bitwise OR the result with 0x40:

0x75 | 0x40 = 0x75
The checksum byte is 0x75 (Decimal 117, ASCII: u)

3.4.3 COMMAND OVERVIEW

Command Name	<CMD>	<ARG>	RANGE
Set KV	10	1-4 ASCII	0-Max KV
Set MA	11	1-4 ASCII	0-Max mA
Request KV Set-point	14	None	
Request MA Set-point	15	None	-
Request Status	22	None	-
Request Software Version	23	None	-
Request Model Number	26	None	-
Tickle Watchdog	27	None	-
Enable Watchdog	28	1-2 ASCII	1-10
Ramp Time	29	1-4 ASCII	1 - 1000
User Configuration	31	4 ASCII	-
Reset Faults	52	None	-
Get KV monitor	60	None	-
Get MA monitor	61	None	-
Get X-RAY Status	98	None	-
Turn X-RAY ON/OFF	99	1 ASCII	0 or 1

3.4.4 RESPONSE OVERVIEW

The command responses will follow the same format as outlined above in section 2.1. This list is comprised of Commands with complex responses only. Commands using a simple response will use the <$> character (ASCII 0x24) as a “Success” response or a single character error code. These responses will be eight ASCII characters in length.

Response Name	<CMD>	<ARG>
Request KV Setpoint	14	1-3 ASCII
Request MA Setpoint	15	1-3 ASCII
Request Status	22	3 ASCII
Request DSP Software Version	23	11 ASCII
Request Model number	26	5 ASCII
Get KV monitor	60	1-3 ASCII
Get MA monitor	61	1-3 ASCII
Get X-RAY Status	98	1 ASCII

3.4.5 COMMANDS DESCRIPTION

3.4.5.1 Set KV <10>

Description:
The host requests that the firmware change the KV set point.

Direction:
Host to supply

Syntax:
<STX><10><,><ARG><,><CS><ETX>

Where:
<ARG> = Value of KV in ASCII format. Units are tenths of KV. Example, for 80KV, enter 800.

Example:
<STX>10,800,<CS><ETX>

Response:
<STX><10><,><$><,><CS><ETX> or
<STX><10><,><ARG><,><CS><ETX>

where <ARG> = error code
Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.2 Set MA <11>

Description:
The host requests that the firmware change the MA set point.

Direction:
Host to supply

Syntax:
<STX><11><,><ARG><,><CS><ETX>

Where:
<ARG> = Value of mA in ASCII format. Units are micro amps. Example,
For 0.2 mA, enter 200.

Example:
<STX>11,200,<CS><ETX>

Response:

<STX><11><,><$><,><CS><ETX>
<STX><11><,><ARG><,><CS><ETX>

where <ARG> = error code
Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.3 Request KV Set point <14>

Description:
The host requests the KV set point.

Direction:
Host to supply

Syntax:
<STX><14><,><ETX>

Example:
<STX>14,<ETX>

Response:

<STX><14><,><ARG><,><ETX>
Where <ARG> = number in ASCII format representing un-scaled KV set point. Units are tenths of KV.

3.4.5.4 Request MA Set point <15>

Description:
The host requests that the firmware send the MA set point.

Direction:
Host to supply

Syntax:
<STX><15><,><ETX>

Example:
<STX>15,<ETX>

Response:

<STX><15><,><ARG><,><ETX>
Where <ARG> = = number in ASCII format representing un-scaled mA set point. Units are micro amps.

3.4.5.5 Request Status <22>

Description:
The host requests that the firmware sends the power supply status. The power supply sends a three digits code representing a specific status condition. A description of these characters is shown in the table below.

Direction:
Host to supply

Syntax:
<STX><22><,><CS><ETX>

Example:
<STX>22,<CS><ETX>

Response:
<STX><22><,><ARG><,><CS><ETX>

Arg	Name	Description
000	No Fault (X-RAY Ready)	It indicates thet the Monoblock is ready to produce X-RAY
001	Over Temperature	It indicates oil tank over temperature
002	Arc Fault	It indicates that an arc event was detected
003	High mA	The mA output is higher than allowed threshold
005	Low kV	The kV output is lower than threshold
006	High kV	The kV output is higher than allowed theshold
007	Watchdog	Watchdog timer expired while X-Rays were on
009	Interlock Open	Interlock is not satisfied
010	Filament Limit	Indicates filament overcurrent
011	Filament Standby	Filament status

Example:
<STX>22,000,<CS><ETX>

3.4.5.6 Request Firmware Version <23>

Description:
The host requests that the firmware sends the DSP firmware version.

Direction:
Host to supply

Syntax:
<STX><23><,><CS><ETX>

Example:
<STX>23,<CS><STX>

Response:
<STX><23><,>< ARG><,><CS><ETX>

Where:
<ARG> consists of eleven ASCII characters representing the current firmware part number/version. The format is SWMNNNN-NNN, where N is a numeric character.
Example:
<STX>23,SWM0584-001,<CS><ETX>

3.4.5.7 Request Model Number <26>

Description:
The host requests that the firmware sends the unit model number

Direction:
Host to supply

Syntax:
<STX><26><,><CS><ETX>

Example:
<STX>26,<CS><ETX>

Response:
<STX><26><,><ARG><,><CS><ETX>

Where:
<ARG> consists of five ASCII characters representing the model number. The format is XNNNN, where N is a numeric character.

Example:
<STX>26,X4618,<CS><ETX>

3.4.5.8 Tickle Watchdog <27>

Description:
This command is used to reset the Watchdog timer to prevent a watchdog time out fault condition.

Direction:
Host to supply

Syntax:
<STX><27><,><CS><ETX>

Response:
<STX><27><,><ARG><,><CS><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.9 Enable Watchdog <28>

Description:
It enables the communication watchdog and sets the timeout delay. If no message is received during the timeout period, high voltage will be shut down and a watchdog fault will be declared. Enter timeout delays from 1 to 10 seconds. A value of zero disables the watchdog operation.
The default timeout is 5 seconds. This command is password protected and the userconfig command must be sent first.

Direction:
Host to supply

Syntax:
<STX><28><,><ARG><,><CS><ETX>
Where <ARG> = 1-10 seconds

Response:
<STX><28><,><ARG><,><CS><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.10 Set Ramp Time <29>

Description:
It sets the KV and uA ramp time to full scale value. Units are milli-seconds. Recommended range is 1 to 1000 milliseconds. Default value is 250 milliseconds. This command is password protected and the userconfig command must be sent first.

Direction:
Host to supply

Syntax:
<STX><29><,><ARG><,><CS><ETX>
Where <ARG> = 1-1000 milliseconds

Response:
<STX><29><,><ARG><,><CS><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.11 Enter User Configuration <31>

Description:
It allows users change following settings: Ramp Time and Watchdog time out. A password must be sent in order for the firmware to allow modification of these values. The password is ‘4343’.

Direction:
Host to supply

Syntax:
<STX><31><,><ARG><,><CS><ETX>
Where <ARG> = 4343

Response:
<STX><31><,><ARG><,><CS><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.12 Reset Faults <52>

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

Direction:
Host to supply

Syntax:
<STX><52><,><CS><ETX>

Example:
<STX>52,<CS><ETX>

Response:
<STX><52><,><ARG><,><CS><ETX>

Where ARG = $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

3.4.5.13 Get KV Monitor <60>

Description:
The host requests that the firmware report the monitored KV.

Direction:
Host to supply

Syntax:
<STX><60><,><CS><ETX>

Response:
<STX><60><,><ARG><,><CS><ETX>

Where:
<ARG> = 1-3 digits number in ASCII format representing un-scaled KV value. Units are tenths of KV.

Example:

For 80KV feedback:

<STX>60,800,<ETX>

3.4.5.14 Get MA monitor <61>

Description:
The host requests that the firmware report the monitored MA.

Direction:
Host to supply

Syntax:
<STX><61><,><CS><ETX>

Response:
<STX><61><,><ARG><,><CS><ETX>

Where:
<ARG> = 1-3 digits number in ASCII format representing un-scaled mA value in units of micro amps.

Example:

For 0.2 mA

<STX>61,200,<ETX>

3.4.5.15 Get X-RAY Status <98>

Description:
The host requests the current X-RAY status.

Direction:
Host to supply

Syntax:
<STX><98><,><ARG><,><CS><ETX>

Where:
<ARG> 1 = X-RAY is on.
0 = X-RAY is off in ASCII format

Example:
<STX>98,<CS><ETX>

Response:
<STX><98><,><1><,><CS><ETX>

3.4.5.16 Turn X-RAY ON/OFF <99>

Description:
The host requests that the firmware to turn on or off High Voltage.

Direction:
Host to supply

Syntax:
<STX><99><,><ARG><,><CS><ETX>

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

Example:
<STX>99,1,<CS><ETX>

Response:
<STX><99><,><ARG><,><CS><ETX>

Where ARG = $ or error code.

Error Codes:

3.4.6 SERIAL COMMAND HANDLING

3.4.6.1 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.

3.4.6.2 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.

3.4.6.3 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.

4.0 ETHERNET

4.1 ETHERNET INTERFACE

The Ethernet interface has the following attributes:

- 10/100-Base-T
- IP address can be set by the system integrator
- Network Mask can be set by the system integrator
- TCP Port Number can be set by the system integrator
- RJ-45 connector
- Network attachment via Crossover and Standard Ethernet cables.
- Supported Operating Systems: Windows 98 2ED, Windows 2000 (SP2), Windows NT (SP6), Windows XP Professional

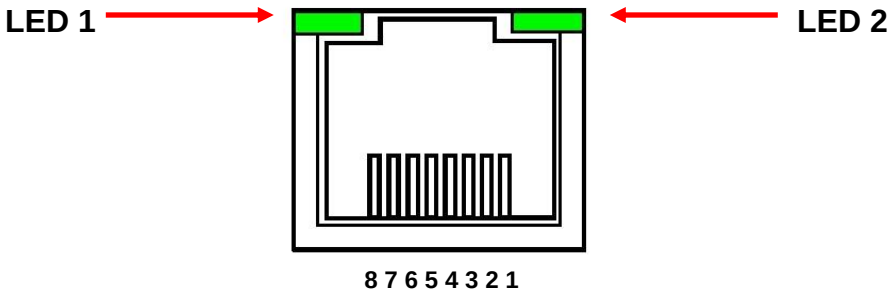


Figure 2 – Ethernet RJ45 Jack (front view)

PIN	DESCRIPTION
1	TX+
2	TX-
3	RX+
4	-
5	-
6	RX-
7	-
8	-

The Ethernet RJ-45 has two LED indicators, as shown in Figure 2. The left LED, LED1 indicates that the network processor has a valid network link. The right LED, LED2 indicates network activity.

4.2 ETHERNET CABLING

Shielded Category 5 (CAT5) Ethernet patch cables are used to connect the XRB011 to the host computer. There are two ways to connect to the XRB011 board via Ethernet: the first is to directly cable between the host

and the XRB011 board, and the second is through the use of a switch, hub, or network.

A direct connection requires a non-standard cable where the wires are not run straight through. Please refer to the two cable ends shown below in figure 4.

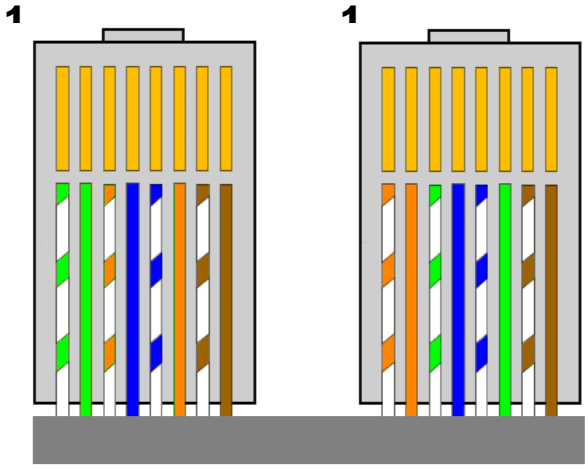


Figure 4 – Crossover Cable for Direct Connection

A standard connection through a hub, switch, or network uses a standard CAT5 patch cable. Please refer to the two cable ends shown below in figure 5.

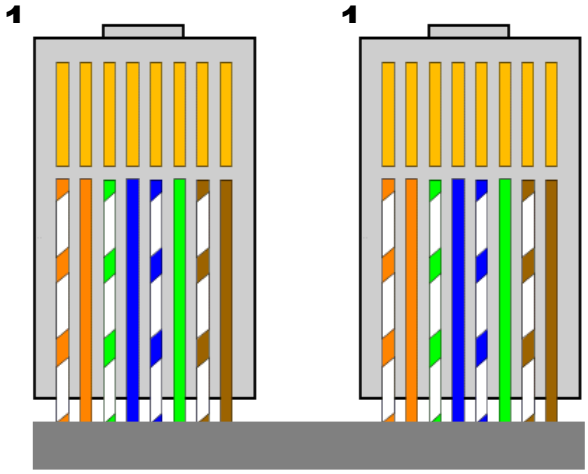


Figure 5 – Standard Straight Through Cable – Standard CAT5 Patch

4.3 ETHERNET WEB SERVER

The XRB contains a generic embedded diagnostic web server that can be accessed through any standard web browser by browsing to the XRB011's default IP address 192.168.1.4

The Ethernet interface communicates using the following protocols:

- TCP/IP
- HTTP
- TFTP
- FTP

4.3.1 Diagnostic Web Server

The diagnostic web server can be used to configure the XRB011 network settings from a web browser. The application consists of three web pages; a page displaying contact information, a license agreement, and a monitoring and control applet that is at the heart of this application. The Web Server application for the DXM power supply is presented as an example in the following pages.

Note: The XRB011 cannot be controller nor monitored using this embedded web browser. You can only change the Network Settings.

4.3.2 Web Pages

4.3.2.1 Web Page 1: Contact Information Page

Figure 9 displays a picture of the DXM unit and information on how to contact Spellman High Voltage Electronics Corporation. By clicking on the picture of the DXM or on the button labeled "Click Here to Monitor and Control" one can move on to the next screen, the license agreement.

Figure 9 - Web Page 1- Contact Information

4.3.2.2 Web Page 2: License Agreement Page

Figure 10 displays the license agreement. Here the user can either agree or disagree with the Spellman license agreement. Click on “I Accept” to continue on to the applet.

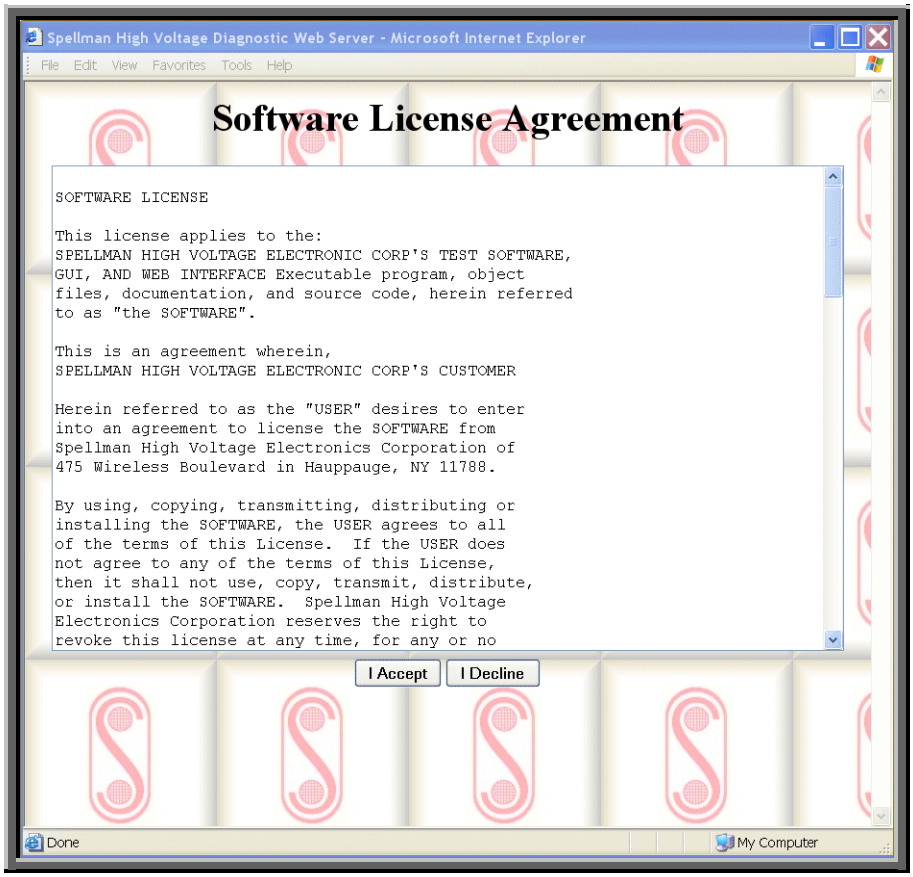


Figure 10 - Web Page 2 – License Agreement

4.3.2.3 Web Page 3 - Monitor and Control Applet

The Monitor and Control Applet is a java “applet” (“small java application” specifically written to be embedded in a web page and invoked from a browser) that requires an Internet browser with an installed JVM (Java Virtual Machine). The Default username and password for the applet is: Username: admin, Password: SHV Applet. We have tested under Internet Explorer 5 and 6, Microsoft JVM 5 and Sun JVM versions 1.4.1 and 1.4.2.

Figure 11 displays an example of an embedded monitor and control application.

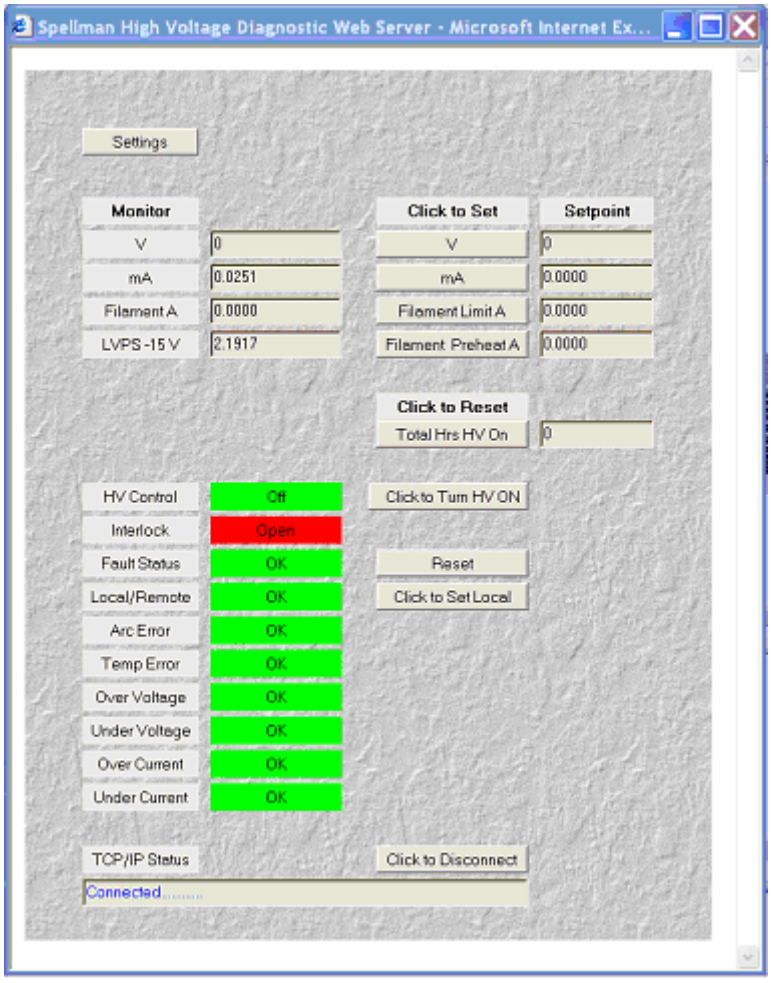


Figure 11 - Control and Monitor Applet

Broadly one can view the screen as a “left” and a “right” with the left half containing status values (read backs) read from the DXM and the right half containing the values that are configurable by the user. Notice that

the top of the right half contains the label “Click to Set”. For any configurable setting you click on the button to the left of the setting, which brings up the program set point screen. For example, click on the button labeled, ‘V’ to set the output voltage set point. Refer to figure 12.

4.3.2.4 Java Warning Messages

You may notice a message at the bottom of all dialog windows that are displayed from the DXM Control and Monitor Applet. The wording may vary slightly depending on the JVM version but on some the message is “Warning: Applet Window”. This message is letting you know that the dialog window was generated by an applet. The design philosophy for the JVM was for secure computing so the origins of new windows are supposed to be as obvious as possible.

4.3.2.5 Menu Item “Settings” on Applet

The user can view and set operating parameters of the applet or network configurations of the XRB011 or view firmware version information for both through the settings menu. Click on the button at the top of the Monitor and Control Applet that has the label “Settings”. This displays the settings popup menu as shown in figure 13.

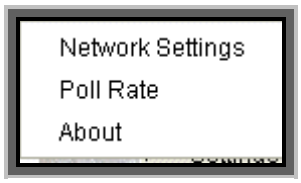


Figure 13 – Settings Pop up Menus

Notice that there are three choices. The first, “Network Settings” refers to the network settings for the network component of the XRB011 and not the Monitor and Control applet. The second option, “Poll Rate” affects refresh rate of the Monitor and Control Applet and will be discussed in the next section. In the “about” choice firmware version information is displayed, both for the Monitor and Control Applet and for the DXM hardware.

4.3.2.6 Refresh rate for monitored values

The refresh rate for the applet display of the XRB011 is dependent upon the rate of placement of status requests in the internal send queue and how fast responses are sent back from the DXM in

response to the requests. The default value for queuing responses is every 600ms and this is a configurable value in the

Settings->Poll rate screen. Please refer to figure 14.

Figure 14 - Configure Polling Rate Screen

Setting this value lower may make the screen refresh quicker. However, setting it too low may cause requests to queue up in the send queue. This may make controlling the XRB011 very slow, as control requests now must wait behind queued status requests. We recommend leaving the delay set at the default value.

4.3.2.7 Version Information

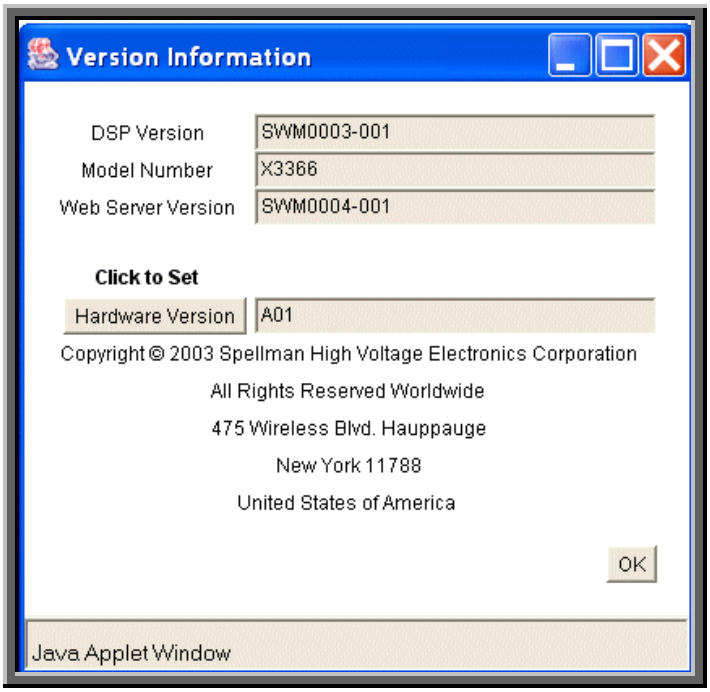


Figure 15 – Version Information

4.4 Direct Connection between the DXM and a Computer

A direct Ethernet connection between the XRB011 and the computer requires an RJ45 crossover cable. The end connectors will look identical to a “normal” RJ45 connector but the colors of some of the wires in the connectors will be “reversed”. Hold up the two ends of the RJ45 cable and look at the color of the wires from left to right. They should differ on the two connectors.

When direct connecting the XRB011 to a computer using a crossover cable over Ethernet they are essentially participating in a private network. As such you need to pick two valid IP addresses, one for each device.

The table below illustrates that not all IP addresses are actually valid IP addresses. For example, IP addresses beginning with 127 are not valid.

Class	Address Range
A	1.0.0.0-126.255.255.255
B	128.0.0.0-191.255.255.255
C	192.0.0.0-223.255.255.255

4.5 Configuring the Computer for Direct Ethernet Connection

As mentioned above both the IP Address and Subnet Mask need to be configured. In our environment computers normally are assigned IP addresses dynamically, using DHCP. We need to change this and assign the IP Address statically to the one we have selected.

Here are the steps on Windows XP. On the desktop right click on “My Network Places” and select properties at the bottom of the menu.

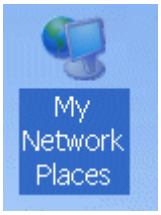


Figure 16 – Right Click on Desktop

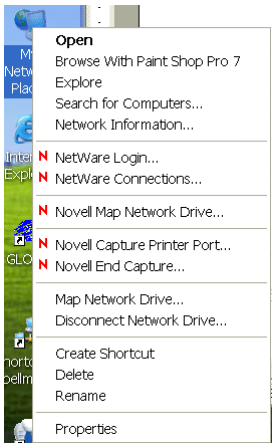


Figure 17 – Select Properties

After selecting properties you are brought up to the screen below (Figure 18). You must RIGHT CLICK and select Properties on Local Area Connection, and not double click which will display a window similar to figure 19.

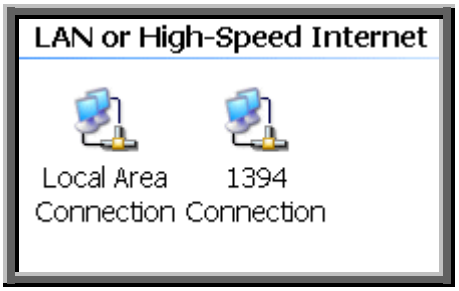


Figure 18 – Here you must Right Click and Select Properties

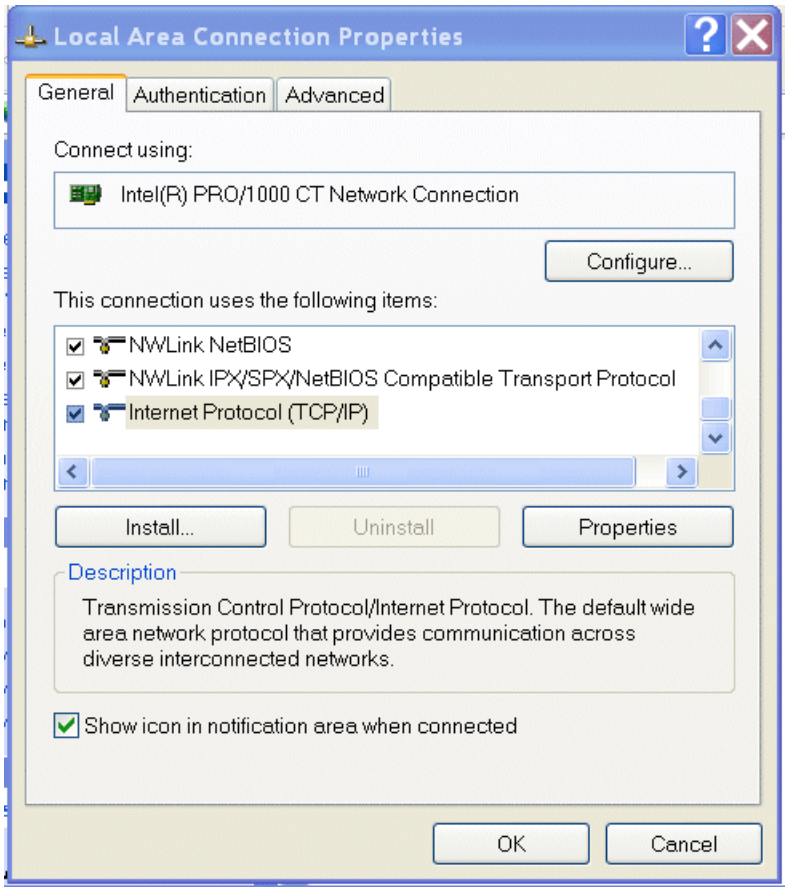


Figure 19 – Local Area Connection Properties

Now you must select “Internet Protocol (TCP/IP)” and click on the Properties button to be brought to figure 20. Lastly you must disable any firewall software you have running. If you are running a proxy server for Internet access, you must also disable the proxy client. Disabling this also requires a reboot.

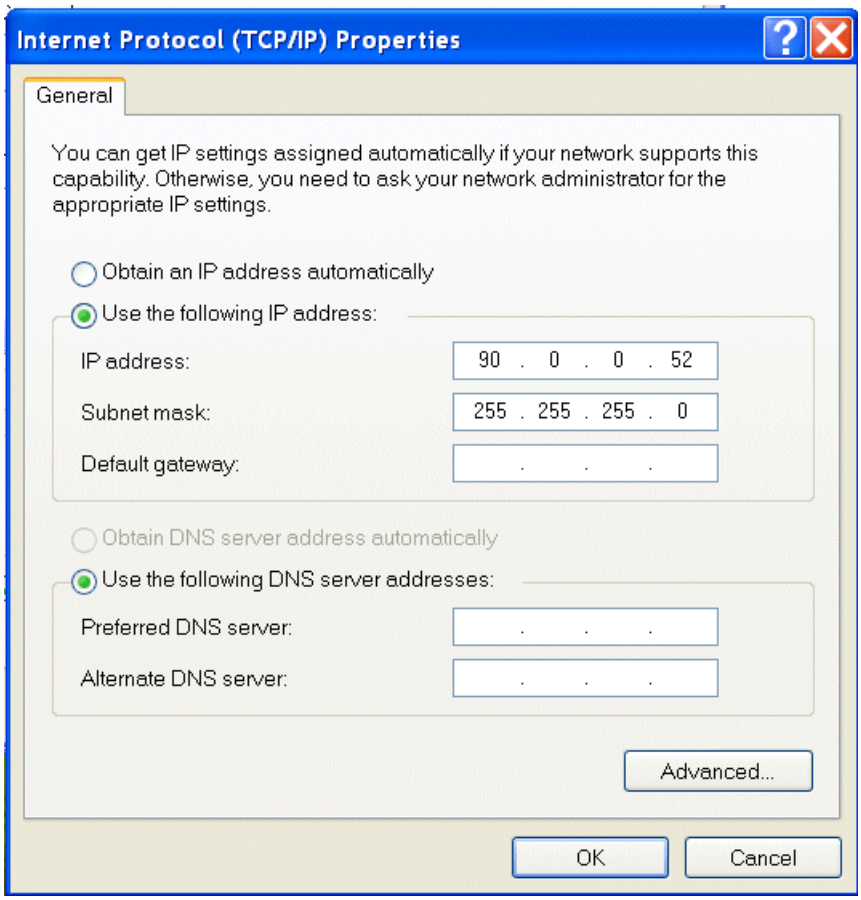


Figure 20 – TCP/IP Properties

4.6 Testing a Direct Connection

You can use the program “Ping” to test a network connection between the computer and the XRB011. “Ping” is a command line tool so we will need to bring up a command prompt. Under Windows NT, 2000 and XP the name of this command is “CMD”. Under Windows 98 the name of this command is “Command”.

To do this, click on Start->Run->Cmd

Then on the command line type

Ping <IP Address>

For example

Ping 192.168.1.4

If the XRB011 is found at the specified IP address, the Ping command will respond with a report that is similar to:

Pinging 192.168.1.4 with 32 bytes of data:

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Reply from 192.168.1.4: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.1.4:

Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),

Approximate round trip times in milli-seconds:

Minimum = 0ms, Maximum = 0ms, Average = 0ms

4.7 Configuring the XRB011 For a Local Area Network (LAN)

If you have chosen to place the XRB011 onto your local area network you will need:

- A CAT5 network patch cable to physically connect the XRB011 to the LAN
- A static IP address to assign to the XRB011.

Remember that even if the IP address you have selected is in general a valid IP address it needs to be valid for your LAN (local area network). Otherwise the device will not be accessible from an Internet browser or Ping.

4.8 Configuring the Network Settings from the Monitor and Configure Applet

The network settings are configurable from the Settings->Network Settings screen, refer to figure 21.

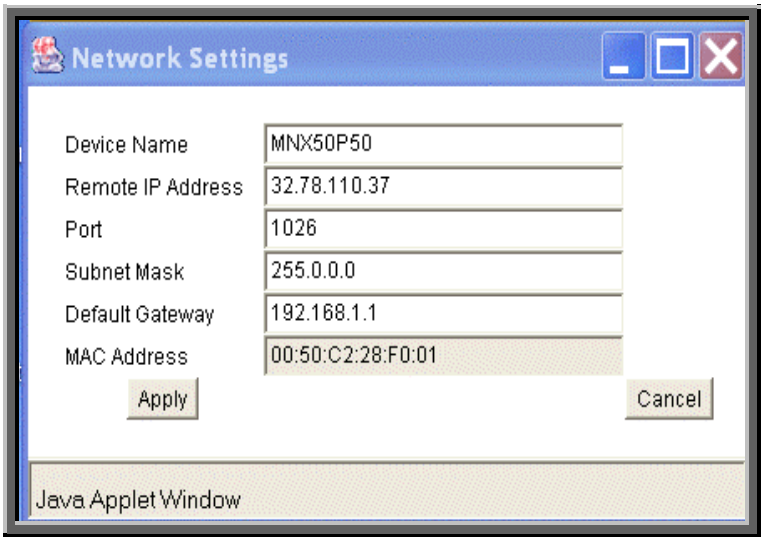


Figure 21 - Configure Network Settings

The settings that can be changed are the:

- Device Name
- IP Address
- TCP Port
- Subnet Mask
- Default Gateway

Once the Apply button is clicked on the network settings screen the network component of the XRB011 is configured, rebooted and the applet is disconnected from the XRB011. You must type the NEW IP address into a web browser to bring up a new instance of the applet to monitor and control the XRB011 after reconfiguring it. This may also require reconfiguring the host computer with the correct host IP address, subnet mask, and TCP port.

The device name does not affect the operation of the XRB011; it is simply a way for the user to differentiate multiple units on the same network.

Depending on the type of network you are attaching the XRB011 to, you may need to configure the host PC's IP address and subnet mask as shown in section 4.5. You can also test a network connection to the XRB011 by following the instructions listed in section 4.6.

4.9 Enabling Communications Objects in Visual Basic for Ethernet Communications

For Ethernet communications, we need Microsoft Winsock Control 6.0 and SP5. To enable this in your VB 6 project, go to:

Project -> Components

Once selected in your toolbox you will have an icon of two computers linked together and it will be named: Winsock.This can be dragged and dropped into your application. Then set the object's properties.

4.10 Configuring Communications in Visual Basic for Ethernet

In order to configure the Winsock Object, you must make the following initialization in the object's properties:

Protocol 0 – sckTCPProtocol

Then, in the application code, include the following commands:

```
tcpClient.RemoteHost = host
tcpClient.RemotePort = portNumber
tcpClient.Connect
```

For further information regarding the use of the above commands, please refer to your Visual Studio Help File.

Data Output Example

```
MSComm1 is both the serial and USB port. TcpClient is the
Ethernet port.

If (portType = "ethernet") Then
        tcpClient.SendData (str)
Else
        MSComm1.InBufferCount = 0
         On Error GoTo done
        MSComm1.Output = str
        done:
        tmrOpenClose.Enabled = True
End If
```

Data Input Example

```
If (portType = "ethernet") Then
```

```
Do
        DoEvents
 . . .
 . . .
        tcpClient.GetData temp$
        str = str + temp$
        Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
        On Error Resume Next
Else
        Do
        DoEvents
        If MSComm1.InBufferCount > 0 Then
                str = str & MSComm1.Input
End If
        Loop Until InStr(str, Chr(3)) Or Timer - t1 > 1
        If InStr(str, Chr(3)) > 0 Then
        tmrOpenClose.Enabled = False
        End If
End If
```

4.11 TCP/IP FORMAT

Each Ethernet command will consist of a TCP/IP header followed by the required data bytes. Figure 1.1 summarizes the TCP/IP header configuration. Please note that this functionality is provided by the software implementation of the Open Systems Interconnection (OSI) TCP/IP protocol stack, specifically the upper 4 layers.

Byte				
0	Protocol Version	Header Length	Type Of Service	Total Length
4	Packet ID		Flags	Fragmentation Offset
8	Time To Live	Protocol	Header checksum	
12	Source Address			
16	Destination Address			
20	Source Port		Destination Port	
24	Sequence Number			
28	Acknowledgement Number			
32	Data Offset	Reserved	Code Bits	Window
36	Checksum		Urgent Pointer	
40	Data Byte 1	Data Byte 2	Data Byte 3	Data Byte N

Network TCP/IP datagram header

The format of Data Bytes 1 through N are as follows:

<STX><CMD><,>ARG><,><ETX>

Where:
<STX> = 1 ASCII 0x02 Start of Text character
<CMD> = 2 ASCII characters representing the command ID
<,> = 1 ASCII 0x2C character
<ARG> = Command Argument
<,> = 1 ASCII 0x2C character
<ETX> = 1 ASCII 0x03 End of Text character

4.12 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.

4.13 COMMAND OVERVIEW

Data Byte section of the TCP/IP Datagram			
Command Name	<CMD>	<ARG>	RANGE
Set KV	10	1-3 ASCII	0-Max KV
Set MA	11	1-3 ASCII	0-Max mA
Request KV Setpoint	14	None	-
Request MA Setpoint	15	None	-
Request Status	22	None	-
Request Software Version	23	None	-
Request Model Number	26	None	-
Tickle Watchdog	27	None	-
Enable Watchdog	28	1-2 ASCII	1-10
Ramp Time	29	1-4ASCII	1-1000
User Configuration	31	4 ASCII	-
Reset Faults	52	None	-
Get KV Monitor	60	None	-
GET MA Monitor	61	None	-
Get X-RAY Status	98	None	-
Turn X-RAY ON/OFF	99	1 ASCII	0 or 1

4.14 RESPONSE OVERVIEW

The command responses will follow the same network TCP/IP header format as outlined above in section 1.1. This list is comprised of Commands with complex responses only. Commands using a simple response will use the <$> character (ASCII 0x24) as a “Success” response or a single character error code. These will be seven ASCII characters in length.

Response Name	<CMD>	<ARG>
Request KV Setpoint	14	1-3 ASCII
Request MA Setpoint	15	1-3 ASCII
Request Status	22	3 ASCII
Request DSP Software Version	23	11 ASCII
Request Model number	26	5 ASCII
Get KV monitor	60	1-3 ASCII
Get MA monitor	61	1-3 ASCII
Get X-RAY Status	98	1 ASCII

4.15 COMMANDS DESCRIPTION

4.15.1 Set KV <10>

Description:
The host requests that the firmware change the KV set point.

Direction:
Host to supply

Syntax:
<STX><10><,><ARG><,><ETX>

Where:
<ARG> = Value of KV in ASCII format. Units are tenths of KV. Example,
For 80KV, enter 800.

Example:
<STX>10,800,<ETX>

Response:
<STX><10><,><$><,><ETX> or
<STX><10><,><ARG><,><ETX>

where <ARG> = error code

Error Codes: 1 = receive error, 2 = unrecognized command

4.15.2 Set MA <11>

Description:
The host requests that the firmware change the MA set point.

Direction:
Host to supply

Syntax:
<STX><11><,><ARG><,><ETX>

Where:
<ARG> = Value of mA in ASCII format. Units are micro amps. Example,
For 0.2 mA, enter 200.

Example:
<STX>11,200,<ETX>

Response:
<STX><11><,><$><,><ETX> or
<STX><11><,><ARG><,><ETX>
where <ARG> = error code
Error Codes: 1 = receive error, 2 = unrecognized command

4.15.3 Request KV Set point <14>

Description:
The host requests KV set point.

Direction:
Host to supply

Syntax:
<STX><14><,><ETX>

Example:
<STX>14,<ETX>

Response:

<STX><14><,><ARG><,><ETX>
Where <ARG> = number in ASCII format representing un-scaled KV set point. Units are tenths of KV.

4.15.4 Request MA Set point <15>

Description:
The host requests that the firmware send the MA set point.

Direction:
Host to supply

Syntax:
<STX><15><,><ETX>

Example:
<STX>15,<ETX>

Response:

<STX><15><,><ARG><,><ETX>
where <ARG> = number in ASCII format representing un-scaled mA set point. Units are micro amps.

4.15.5 Request Status <22>

Description:
The host requests that the firmware sends the power supply status. The power supply sends a three digits code representing a specific status condition. A description of these characters is shown in the table below.

Direction:
Host to supply

Syntax:
<STX><22><,><ETX>

Example:
<STX>22,<ETX>

Response:
<STX><22><,><ARG><,><ETX>

Arg	Name	Description
000	No Fault (X-RAY Ready)	It indicates thet the Monoblock is ready to produce X-RAY
001	Over Temperature	It indicates oil tank over temperature
002	Arc Fault	It indicates that an arc event was detected
003	High mA	The mA output is higher than allowed threshold
005	Low kV	The kV output is lower than threshold
006	High kV	The kV output is higher than allowed theshold
007	Watchdog	Watchdog timer expired while X-Rays were on
009	Interlock Open	Interlock is not satisfied
010	Filament Limit	Indicates filament overcurrent
011	Filament Standby	Filament status

Example:
<STX>22,000,<ETX>

4.15.6 Request Firmware Version <23>

Description:
The host requests that the firmware sends the DSP firmware version.

Direction:
Host to supply

Syntax:
<STX><23><,><ETX>

Example:
<STX>23,<STX>

Response:
<STX><23><,>< ARG><,><ETX>

Where:
<ARG> consists of eleven ASCII characters representing the current firmware part number/version. The format is SWMNNNN-NNN, where N is a numeric character.
Example:
<STX>23,SWM0584-001,<ETX>

4.15.7 Request Model Number <26>

Description:
The host requests that the firmware sends the unit model number

Direction:
Host to supply

Syntax:
<STX><26><,><ETX>

Example:
<STX>26,<ETX>

Response:
<STX><26><,><ARG><,><ETX>

Where:
<ARG> consists of five ASCII characters representing the model number. The format is XNNNN, where N is a numeric character.

Example:
<STX>26,X4618,<ETX>

4.15.8 Tickle Watchdog <27>

Description:
This command is used to reset watchdog time out counter.

Direction:
Host to supply

Syntax:
<STX><27><,><ETX>

Response:
<STX><27><,><ARG><,><ETX>

Where ARG = $ or error code.
Error Codes: 1 = receive error, 2 = unrecognized command

4.15.9 Enable Watchdog <28>

Description:
It enables the communication watchdog and sets the timeout delay. If no message is received during the timeout period, high voltage will be shut down and a watchdog fault will be declared. Enter timeout delays from 1 to 10 seconds. A value of zero disables the watchdog operation.
The default timeout is 5 seconds. This command is password protected and the userconfig command must be sent first.

Direction:
Host to supply

Syntax:
<STX><28><,><ARG><,><ETX>
Where <ARG> = 1-10 seconds
0: Watchdog disabled

Response:
<STX><28><,><ARG><,><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

4.15.10 Set Ramp Time <29>

Description:
It sets the KV and uA ramp time to full scale value. Units are milli-seconds. Recommended range is 1 to 1000 milliseconds. Default value is 250 milliseconds. This command is password protected and the userconfig command must be sent first.

Direction:
Host to supply

Syntax:
<STX><29><,><ARG><,><ETX>
Where <ARG> = 1-1000 milliseconds

Response:
<STX><29><,><ARG><,><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

4.5.11 Enter User Configuration <31>

Description:
It allows users change following settings: Ramp Time and Watchdog time out. A password must be sent in order for the firmware to allow modification of these values. The password is ‘4343’.

Direction:
Host to supply

Syntax:
<STX><31><,><ARG><,><ETX>
Where <ARG> = 4343

Response:
<STX><31><,><ARG><,><ETX>

Where:
<ARG>= $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

4.15.12 Reset Faults <52>

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

Direction:
Host to supply

Syntax:
<STX><52><,><ETX>

Example:
<STX>52,<ETX>

Response:
<STX><52><,><ARG><,><ETX>

Where ARG = $ or error code.

Error Codes: 1 = receive error, 2 = unrecognized command

4.15.13 Get KV Monitor <60>

Description:
The host requests that the firmware report the monitored KV.

Direction:
Host to supply

Syntax:
<STX><60><,><ETX>

Response:
<STX><60><,><ARG><,><ETX>

Where:
<ARG>=1-3 digits number in ASCII format representing un-scaled KV value. Units are tenths of KV.

Example:

For 80KV feedback:

<STX>60,800,<ETX>

4.15.14 Get MA monitor <61>

Description:
The host requests that the firmware report the monitored MA.

Direction:
Host to supply

Syntax:
<STX><61><,><ETX>

Response:
<STX><61><,><ARG><,><ETX>

Where:
<ARG>= 1-3 digits number in ASCII format representing un-scaled mA value in units of micro amps.

Example:

For 0.2 mA
<STX>61,200,<ETX>

4.15.15 Get X-RAY Status <98>

Description:
The host requests the current X-RAY status.

Direction:
Host to supply

Syntax:
<STX><98><,><ARG><,><ETX>

Where:
<ARG> 1 = X-RAY is on.
0 = X-RAY is off in ASCII format

Example:
<STX>98,<ETX>

Response:
<STX><98><,><1><,><ETX>

4.15.16 Turn High X-RAY On/Off <99>

Description:
The host requests that the firmware turn on or off High Voltage.

Direction:
Host to supply

Syntax:
<STX><99><,><ARG><,><ETX>

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

Example:
<STX>99,1,<ETX>

Response:
<STX><99><,><$><,><ETX> or
<STX><99><,><ARG><,><ETX>

where <ARG> = error code

Error Codes: 1 = receive error, 2 = unrecognized command