

## IMPORTANT SAFETY PRECAUTIONS

### SAFETY

THIS POWER SUPPLY GENERATES VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL.  
OBSERVE EXTREME CAUTION WHEN WORKING WITH THIS EQUIPMENT.

High voltage power supplies must always be grounded.

Do not touch connections unless the equipment is off and the Capacitance of both the load and power supply is discharged.

Allow five minutes for discharge of internal capacitance of the power supply.

Do not ground yourself or work under wet or damp conditions.

### SERVICING SAFETY

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

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

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

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

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

# WICHTIGE SICHERHEITSHINWEISE

## SICHERHEIT

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

Das Hochspannungsnetzteil muß immer geerdet sein.

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

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

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

## SERVICESICHERHEIT

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

Reparaturen dürfen nur von qualifiziertem, eingewiesenem Personal ausgeführt werden.

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

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

# PRECAUTIONS IMPORTANTES POUR VOTRE SECURITE

## CONSIGNES DE SÉCURITÉ

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

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

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

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

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

## CONSIGNES DE SÉCURITÉ EN CAS DE REPARATION

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

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

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

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

## IMPORTANTI PRECAUZIONI DI SICUREZZA

### SICUREZZA

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

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

### SICUREZZA NELLA MANUTENZIONE.

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

# SPELLMAN HIGH VOLTAGE XRV SUBSYSTEM INSTALLATION MANUAL



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# XRV Subsystem Installation Manual:

## General Safety

It intent of this manual to identify and safely execute the installation of the XRV Generator and subsystem components. "Caution" and "Warning" labels used throughout this manual to highlight critical areas of the installation and operation of this equipment. Installation, maintenance and operation should only be handled by qualified personnel. Failure to follow these guidelines may result in hazardous operating conditions.

## Personal Safety

It is the responsibility that the individual operating this equipment do so in a safe non-hazardous manner. Training is required on a regular basis to prevent personal injury. It is extremely important to monitor X-ray levels applying the use of dosimeters or alternate electronic measuring devices within normal standard guidelines. Radiation measuring equipment requires calibration on a regular basis to prevent personal injury. Do not use this equipment in an unsafe manner or for anything other than the intended use. Contact Spellman High Voltage regarding questions about the safe operation or installation of this equipment.

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> The equipment described within this manual can produce lethal voltages and radiation. It is recommended that only experienced personnel install, maintain and operate this equipment. Special attention should be given to this manual to avoid personal injury to the user or surrounding personnel. It is recommended that this manual is reviewed in its entirety before installing or operating this equipment.</p>

## X-Ray Tube Overview:

There are numerous X-ray tubes available depending on the user application. The tube requirement is normally the first component selected for a specific application before any of the other subsystem requirements. There are two basic types of x-ray tubes. One type is called a single ended or “Unipolar” while the other is a double ended or “Bipolar”. The single ended tube only requires one high voltage source and a filament supply in order to emit X-rays. The source voltage is usually negative with respect to earth ground.

External cooling may be required during operation of the tube depending on the level of power output. Single ended tubes are cooled by water circulation systems specially designed to remove heat from the anode during operation. The circulation system consists of a water reservoir tank, pump, hoses and a fan circulating over a radiator that is very similar to an automobile cooling system. The hoses from the cooling system connect to the grounded side of the tube. The tube may have special fittings and will identify the water input and output side. The flow rate and capacity of the cooling system will generally rely on the recommendations of the tube manufacturer and operating power level. On higher power tubes, a chiller subsystem may be required. The chiller utilizes a compressor and pump to maintain lower water temperatures for higher wattage tubes. Both systems measure the input temperature with respect to output temperature of the water and employ an interlock system to remove high voltage on the X-ray tube preventing damage. Various Coolers and Chillers are available with the XRV Sub-System and are described later in this manual.

Standard single ended tube operating voltages range from 75kV to a maximum of 225kV and may be purchased through Spellman as part of the XRV Sub-System.

Higher voltage tubes are double-ended or “Bipolar” meaning a negative and a positive high voltage source is required for operation. The tube operates in a similar fashion as the single ended tube with the exception that the anode is at high voltage potential in addition to the cathode instead of being at ground potential. Ground potential is located in the center of the tube rather than at one end. Bipolar tubes require two X-ray generators as opposed to one.

Bipolar X-ray tubes require oil cooling as opposed to water -cooled systems. The oil serves as an electrical insulation medium internal to the tube in addition to cooling the anode. Oil cooled systems use a heat exchanger (oil to water) that is isolated from the oil circulation flowing through the tube. As with water-cooled systems, the manufacturer will specify the heat removal capacity and flow rates. These can be compared with the recommendations for X-ray tube thermal management set by the tube manufacturer. Like the water-cooled system, these systems employ the use of thermal interlocks terminating high voltage if the tube begins to overheat.

## X-Ray Tubes:

	 <b>WARNING</b>
<p><b>Warning: Potential Hazard!</b> It is imperative that the user follow the necessary safety precautions when operating any X-ray equipment. Extreme care must be taken during the installation and placement of the X-ray tube. Radiation emission must be contained within a suitable lead enclosure and configured to prevent unauthorized access when in use. Dosimeters or electronic radiation measuring devices are recommended to monitor radiation levels outside of the enclosure. Failure to follow the necessary guidelines for X-ray operation and containment may cause harm to personnel or be lethal once exposed.</p>	

Various Unipolar or Bipolar metal ceramic X-ray tubes manufactured by Comet and Varian are available for the XRV Subsystem. Contact Spellman High Voltage Corp. for more information.



Comet  
Unipolar X-ray tube



Varian  
Bipolar X-ray tube

## X-Ray Tube Data Sheets:

kV	Comet	Varian
<b>160</b>	<a href="#">MXR-160HP/11</a> <a href="#">MXR-160/22</a> <a href="#">MXR-225HP/11 FB</a> <a href="#">MXR-161</a> <a href="#">MXR-160HP/20</a> <a href="#">MXRP-160C</a> <a href="#">MXR-160/20</a> <a href="#">MXR-165</a> <a href="#">MXR-160/21</a>	<a href="#">HPC-160FB</a> <a href="#">NDI-160/21</a> <a href="#">HPX-160/20</a> <a href="#">NDI-160/22</a> <a href="#">HPX-160/11</a> <a href="#">NDI-161</a> <a href="#">NDI-160/01</a> <a href="#">NDI-160/20</a>
<b>225</b>	<a href="#">MXR-225HP/11</a> <a href="#">MXR-225/26</a> <a href="#">MXR-225HP/11 FB</a> <a href="#">MXR-225/21</a> <a href="#">MXR-225/22</a> <a href="#">MXR-226</a>	<a href="#">HPC-225FB</a> <a href="#">NDI-225/22</a> <a href="#">HPX-225-11</a> <a href="#">NDI-225/FB</a> <a href="#">NDI-225/01</a> <a href="#">NDI-226</a> <a href="#">NDI-225/20</a> <a href="#">NDI-225/21</a>
<b>320</b>	<a href="#">MXR-320HP/11</a> <a href="#">MXR-321</a> <a href="#">MXR-320HP/11 FB</a> <a href="#">MXR-322</a> <a href="#">MXR-320/23</a> <a href="#">MXR-320/23AX</a> <a href="#">MXR-320/23-90</a> <a href="#">MXR-320/26AX</a> <a href="#">MXR-320/26</a> <a href="#">MXR-320HP/11AX</a> <a href="#">MXR-320/26-90</a>	<a href="#">HPX-320-11</a> <a href="#">NDI-320</a> <a href="#">NDI-320/23</a> <a href="#">NDI-320/26</a> <a href="#">NDI-321</a>
<b>350</b>	<a href="#">MXR-350/23</a> <a href="#">MXR-350/23-90</a> <a href="#">MXR-350/26</a> <a href="#">MXR-350/26-90</a> <a href="#">MXR-351</a>	<a href="#">NDI-350</a> <a href="#">NDI-350/23</a> <a href="#">NDI-350/26</a>
<b>450</b>	<a href="#">MXR-451HP/11</a> <a href="#">MXR-451/26</a> <a href="#">MXR-452/Y</a>	<a href="#">HPX-450-11</a> <a href="#">NDI-451</a> <a href="#">NDI-451 Be</a> <a href="#">NDI-452</a>

For Comet X-ray Tube Specifications: [www.comet-xray.com](http://www.comet-xray.com)

For Varian X-ray Tube Specifications: [www.vareximaging.com](http://www.vareximaging.com)

## XRV Subsystem Overview:

### XRV Generator:

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> The XRV Generator is capable of developing extreme high voltages. It is the responsibility of the user to observe safety procedures and guidelines set forth in this manual. Extreme caution must be exercised when installing, maintaining or operating this equipment. A basic knowledge of high voltage safety is required. The XRVGenerator should never be operated without the high voltage cable connections or adequate grounding. Personal protection devices such as grounding rods and fail safe interlocks should be used to prevent a hazard condition. Failure to follow these guidelines may result in injury or death.</p>

The XRV Generator is available in several configurations for various X-ray tube requirements. The generators are assembled in a compact chassis allowing for a minimum amount of space required for installation but providing for the utmost safety. Military style circular connectors for the main and auxiliary power input offers integration flexibility and safety. Additionally, the user has the option of an analog, com port, Ethernet or a USB connection for local or remote operation. The Ethernet connection is extremely useful when operating the supply remotely or in the unlikely event the generator requires evaluation by Spellman High Voltage personnel. Utilization of this feature can save the customer hours of downtime especially when assistance is required from a long distance.

An integrated microprocessor and resistor feedback network constantly measure and adjust the output voltage and current to provide a stable highly regulated source. Models range from 1800 watts to 6000 watts of output power. A simple to use Graphical User Interface (GUI) or selectable analog control provides for safe operation and customer integration. The GUI software supplied with each model of the XRV generator can be custom programmed when placing an order for specific applications. Likewise, the analog interface allows the user to integrate unique controls and monitoring equipment. A 25 pin subminiature “D” connector (supplied with each XRV) is standard for interlock connections and user controls. The GUI software can also serve as a remote monitor during analog operation.

A single ended or “Unipolar” X-ray tube requires a single XRV Generator. The XRV model will depend on the X-ray tube selected. For example, a 160kV “Unipolar” tube operating at 3 kilowatts or less would most likely use a standard XRV model XRV-160N-3000. The output voltage of the generator would be negative with respect to ground due to the operating specifications of the X-ray tube. Additionally, an isolated DC supply is included to power a large or small filament connection within the X-ray tube. The DC filament current is adjustable via the software provided or analog input selection. Specific filament voltage and current requirements are available upon request.

## XRV Generator:

A double ended or “Bipolar” X-ray tube requires two separate XRV Generators. One Generator has a negative output with respect to ground while the other has a positive output with respect to ground. The software provided or analog selection allows for the operation of both the positive and negative outputs simultaneously with a minimal amount of imbalance. There are several models of the XRV Generator available. These are listed below.

### MODEL SELECTION TABLE

MODEL	VOLTAGE	POWER	POLARITY
XRV160*1800	160kV	1.8kW	Pos or Neg
XRV160*3000	160kV	3.0kW	Pos or Neg
XRV160*4000	160kV	4.0kW	Pos or Neg
XRV160*6000 / 208V 3 $\phi$	160kV	6.0kW	Pos or Neg
XRV160*6000 / 400V 3 $\phi$	160kV	6.0kW	Pos or Neg
XRV225*1800	225kV	1.8kW	Pos or Neg
XRV225*3000	225kV	3.0kW	Pos or Neg
XRV225*4000	225kV	4.0kW	Pos or Neg
XRV225*6000 / 208V 3 $\phi$	225kV	6.0kW	Pos or Neg
XRV225*6000 / 400V 3 $\phi$	225kV	6.0kW	Pos or Neg
XRV320P&N4500	$\pm$ 160kV	4.5kW	Bipolar
XRV350P&N4500	$\pm$ 175kV	4.5kW	Bipolar
XRV450P&N1800	$\pm$ 225kV	1.8kW	Bipolar
XRV450P&N4500	$\pm$ 225kV	4.5kW	Bipolar

\* Specify P for positive and N for negative polarity. Positive polarity models do not have integrated filament power supplies. Specify input voltage 208 or 400 volt 3 phase for 6.0kW models. Contact Spellman for custom output/power models.

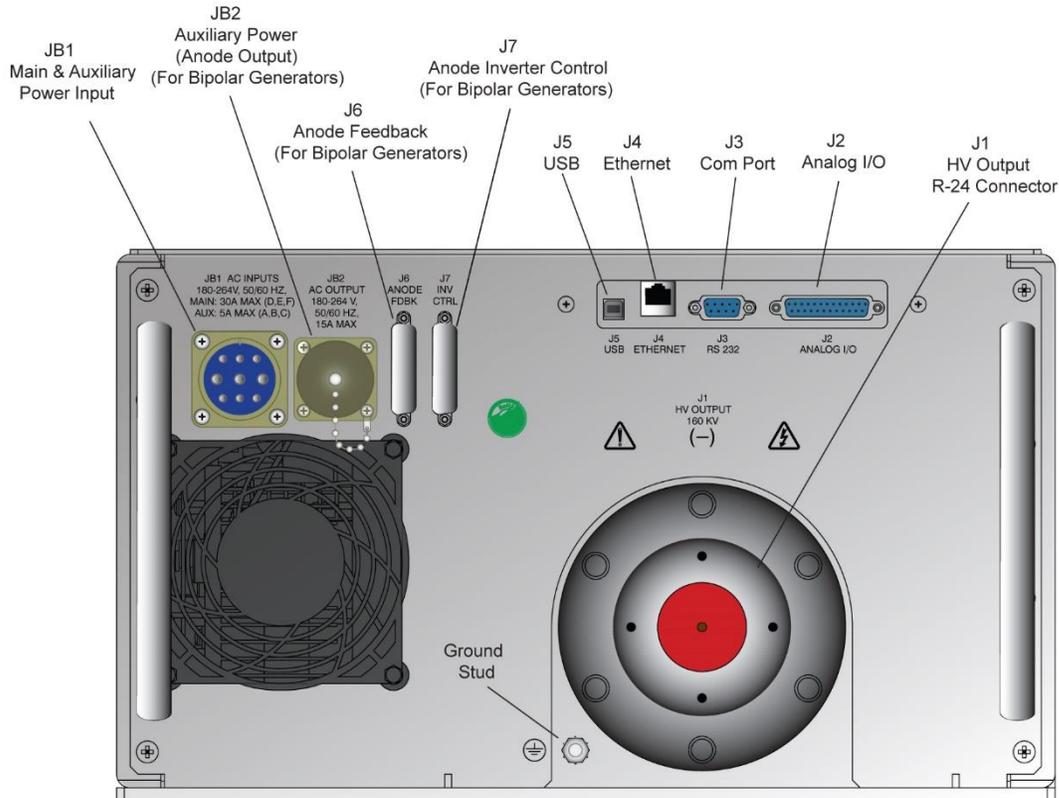
## XRV 160kV Overview:



### XRV160kV Rear Panel

The 160kV XRV Generator measures a compact 7.16" W x 10.09" x H 24" D (excluding handles). The rear of the chassis has all of the necessary connectors for power input, controls, monitoring, and kV output. Each connector on the rear panel is clearly marked for installation purposes. The main and auxiliary input includes an Amphenol style mating connector with an additional DB-25 pin connector for the I/O analog connection. The high voltage output mates with a standard R-24 type connector. These are available from Spellman

High Voltage Corp. in different lengths and configurations for installation of the X-ray tube. Standard Graphical User Interface (GUI) software is included with the XRV 160 Generator. A personal PC is required for installation. The user has the option of connection to a USB, Ethernet or Com Port. The control and monitoring of the XRV160 also includes an analog I/O connector for custom configurations. An additional optional touch screen controller (XRVC) is also available from Spellman High Voltage Corp..



XRV160 Rear Panel Connections  
4kW Units

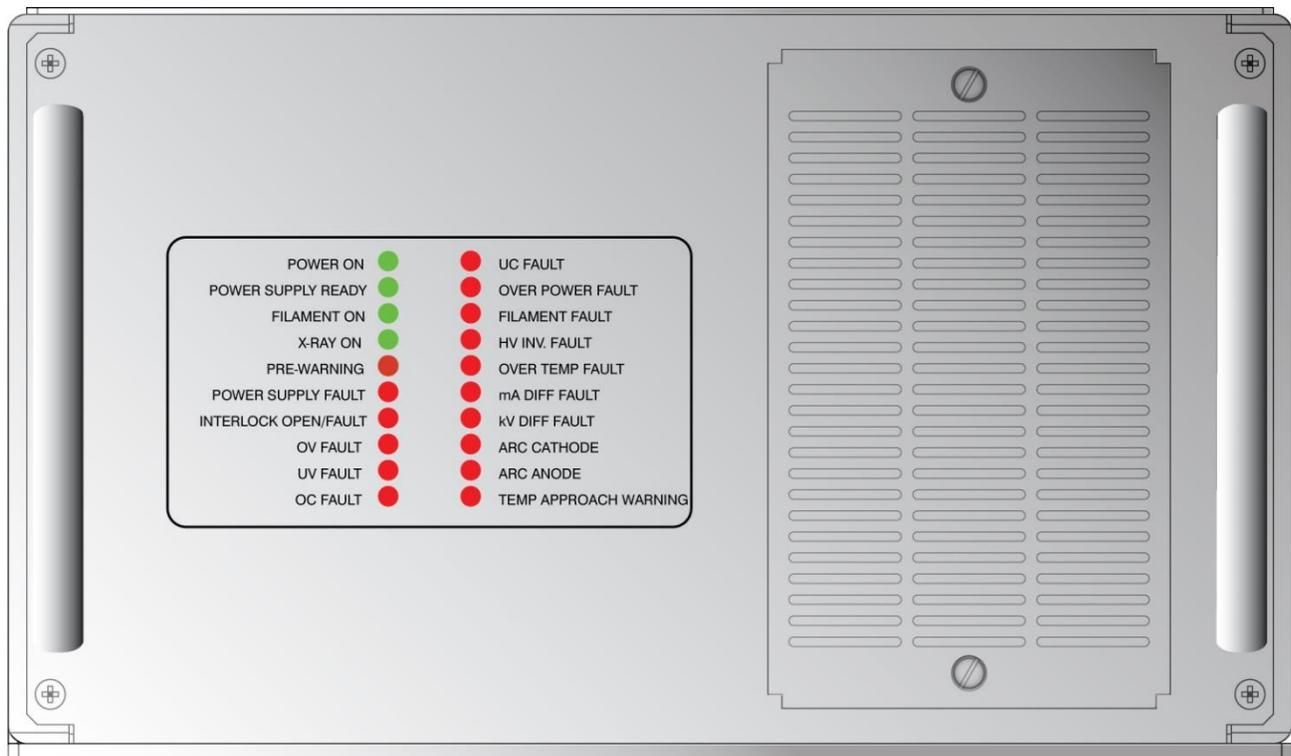
## XRV 160kV Overview :



## XRV160 (Front Panel)

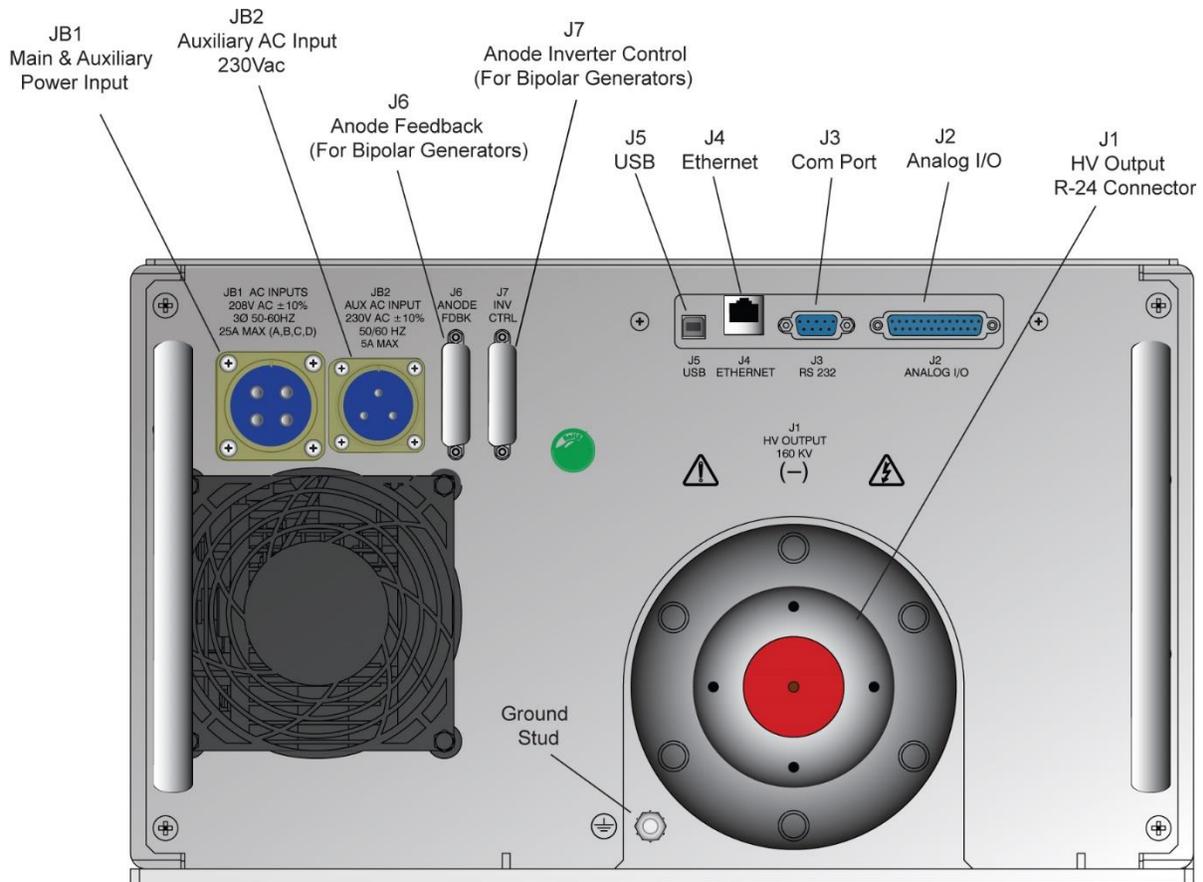
The XRV160 front panel uses LED Indicators that show the status of the Generator. Green Indicators signify normal operational mode while red indicators signify a fault condition. A fault or red indication prevents high voltage operation. Fault conditions are “latched” meaning that a reset must be employed before re-starting the generator. Once the fault clears, the red indicator will extinguish. Additionally, fault status and ready conditions are monitored from the I/O connector on the rear panel and the GUI Interface software. A removable air filter keeps dust and dirt from entering the chassis.

## XRV160 Front Panel Indicators



## XRV 160kV Overview:

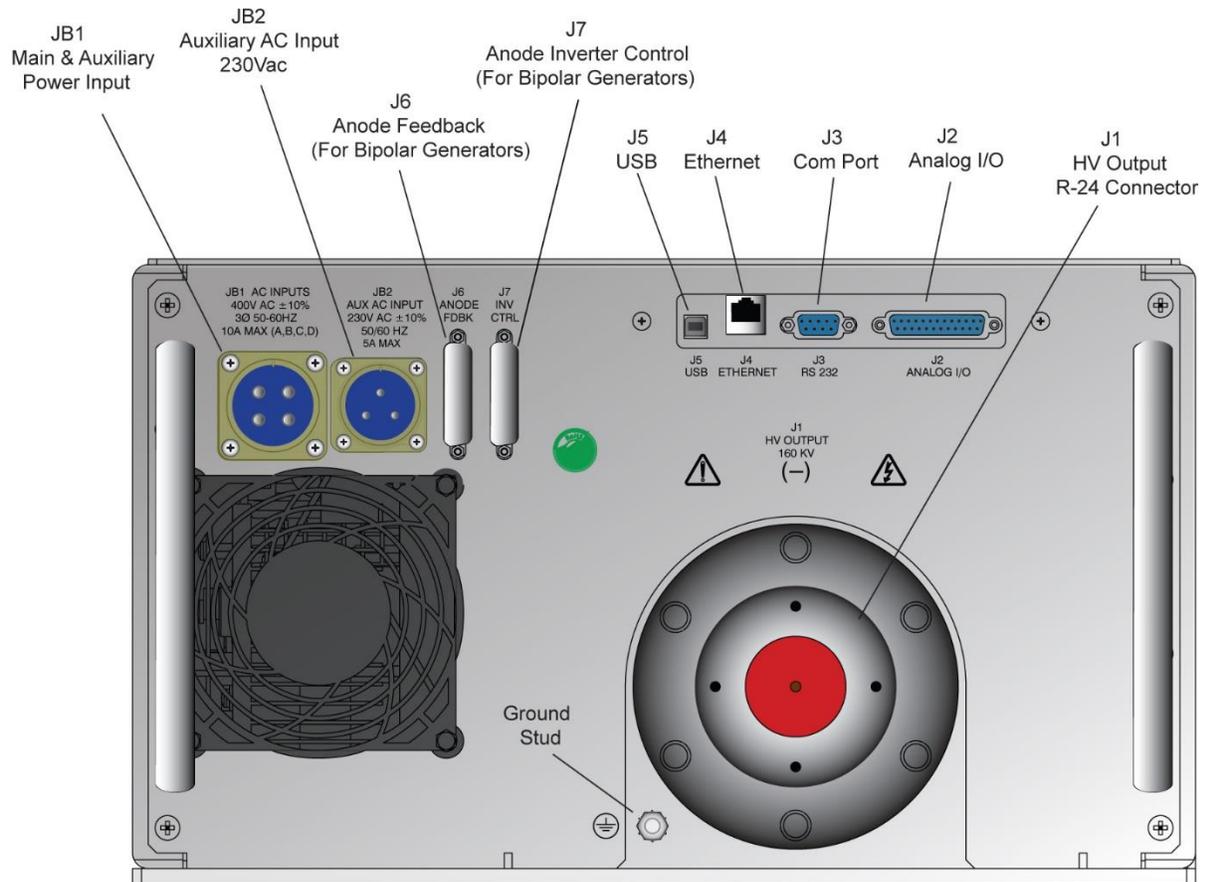
The 160kV XRV is additionally available in a 6kW version. The 6kW version uses a 208 Vac 3 $\phi$  power input or a 400Vac 3 $\phi$  power input. The chassis overall size is the same as the 4kW version. The only difference between the 6kW version and the 4kW version is the power input connections. Two connectors separate the Mains from the auxiliary power input. Amphenol style power mating connectors are included with all XRV models.



XR V160 (6kW) Rear Panel Connections

208Vac 3 $\phi$  Input

## XRV 160kV Overview:



XRV160 (6kW) Rear Panel Connections

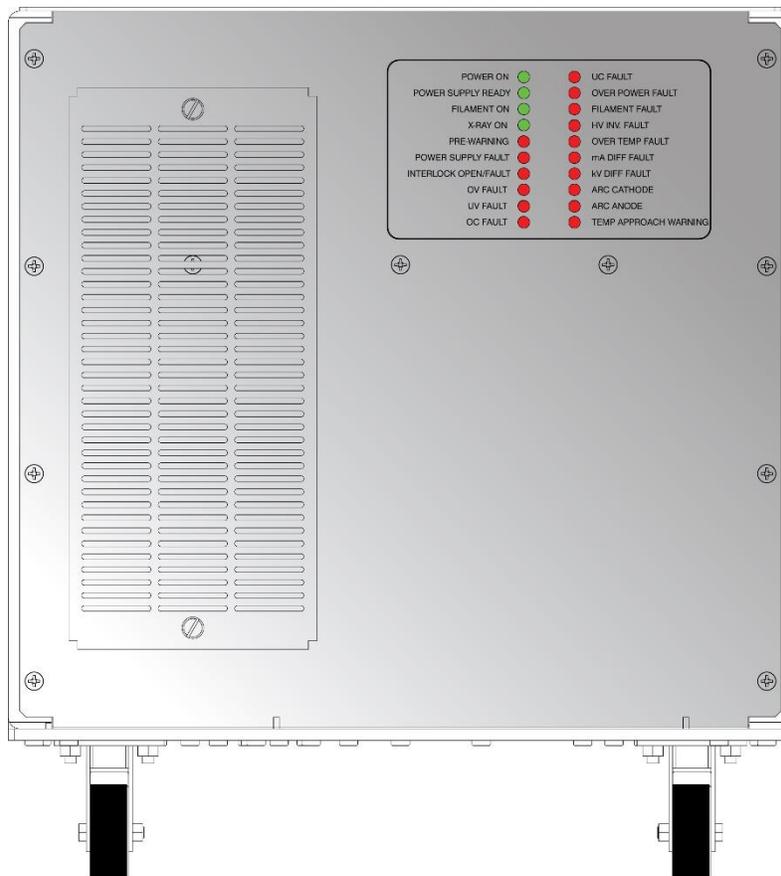
400Vac 3Ø Input

## XRV225kV Overview:



## XRV225 (Front Panel)

The XRV225 front panel uses the same LED Indicators as the XRV160 showing the status of the Generator. Green Indicators signify normal operational mode while red indicators signify a fault condition. A fault or red indication prevents high voltage operation. Fault conditions are “latched” meaning that a reset must be employed before re-starting the generator. Once the fault clears, the red indicator will extinguish. Additionally, fault status and ready conditions are monitored from the I/O connector on the rear panel and the GUI Interface software. A removable air filter keeps dust and dirt from entering the chassis.



**XRV225 Front Panel Indicators**

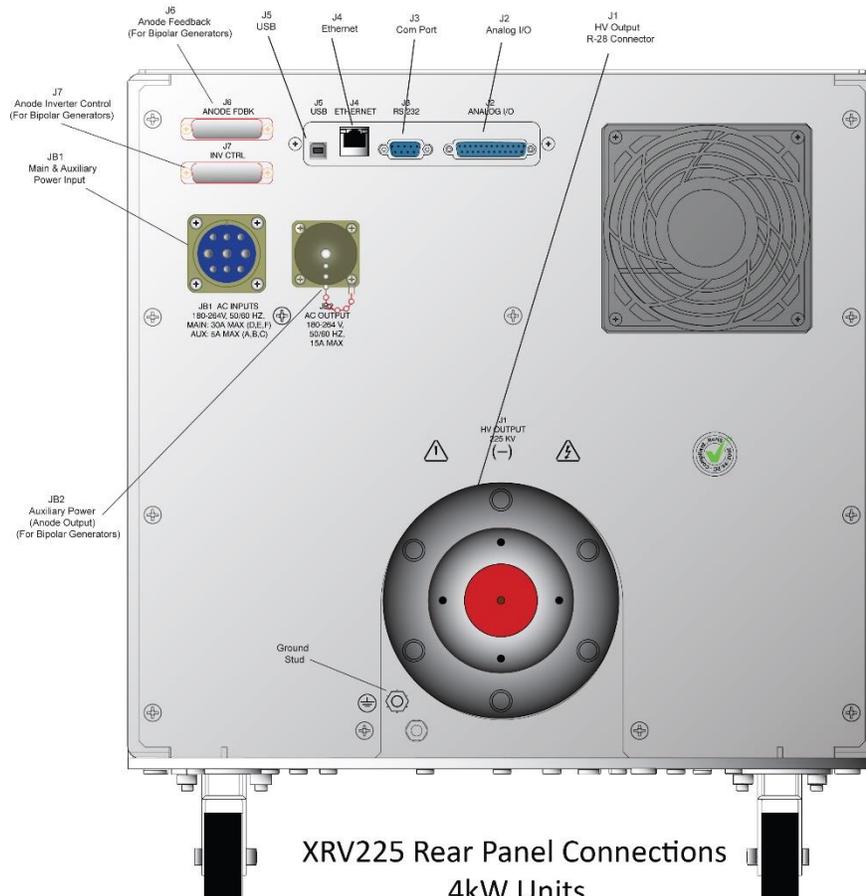
## XR225kV Overview:



### XR225kV (Rear Panel)

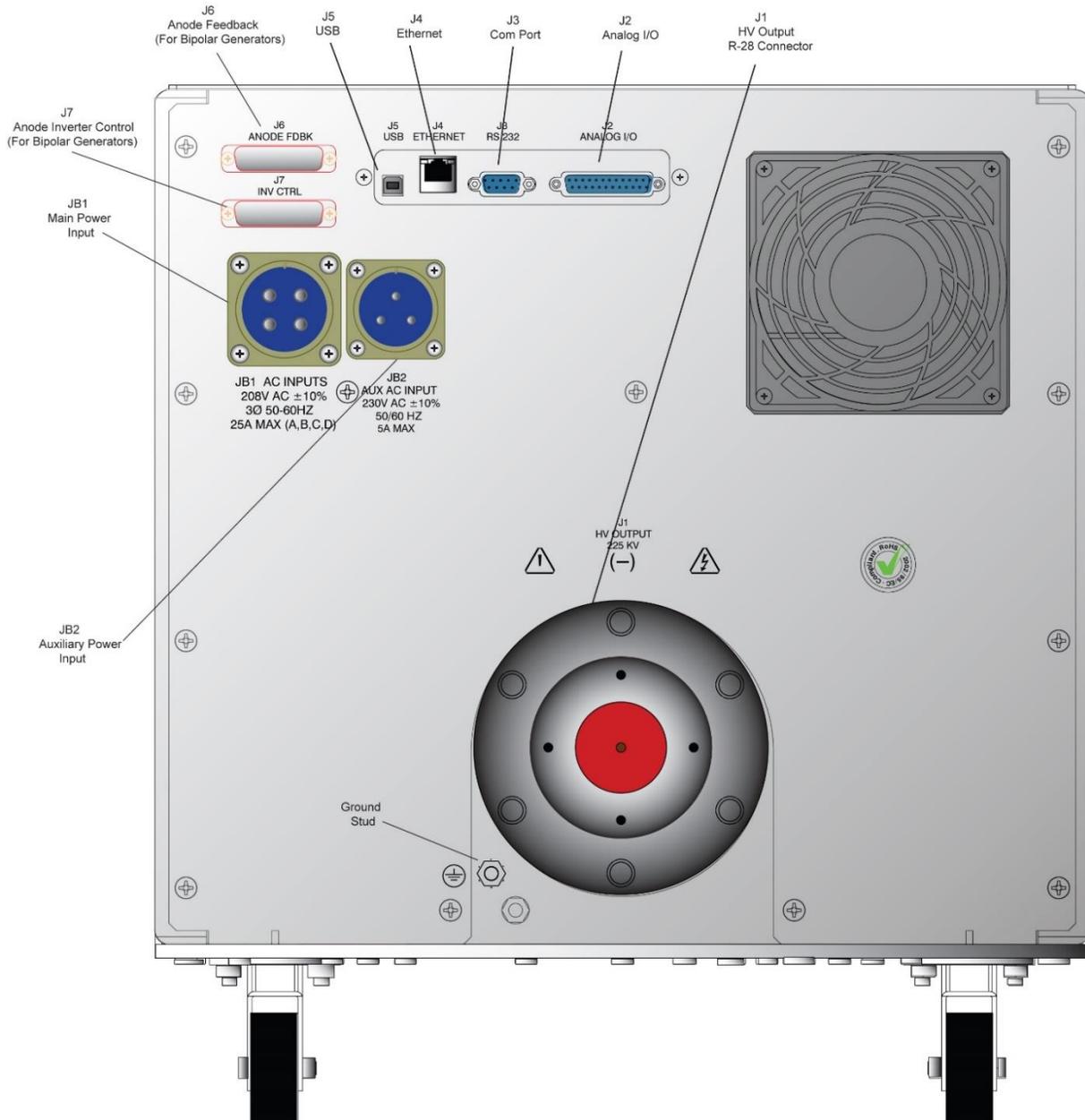
The 225kV XR225kV Generator measures a compact 17" W x 18.90" (including castors) x H 30.72" D (excluding cable well). The assembly includes lockable castors for easy moving. The rear of the chassis has all of the necessary connectors for power input, controls, monitoring, and kV output. Each connector on the rear panel clearly marked for installation purposes. The main and auxiliary input includes an Amphenol style mating connector with an additional DB-25 pin connector for the I/O analog connection. The high voltage output mates with a standard R-28 type connector. These are available from Spellman High Voltage Corp. in different lengths and configurations for installation of the X-ray tube. Standard Graphical User Interface (GUI) software is included with the XR225 Generator. A personal PC is required for installation. The user has the option of connection to a USB, Ethernet or Com Port. The control and monitoring of the XR225 also includes an analog I/O connector for custom configurations. An additional optional touch screen controller (XRVC) is also available from Spellman High Voltage Corp..

configurations for installation of the X-ray tube. Standard Graphical User Interface (GUI) software is included with the XR225 Generator. A personal PC is required for installation. The user has the option of connection to a USB, Ethernet or Com Port. The control and monitoring of the XR225 also includes an analog I/O connector for custom configurations. An additional optional touch screen controller (XRVC) is also available from Spellman High Voltage Corp..



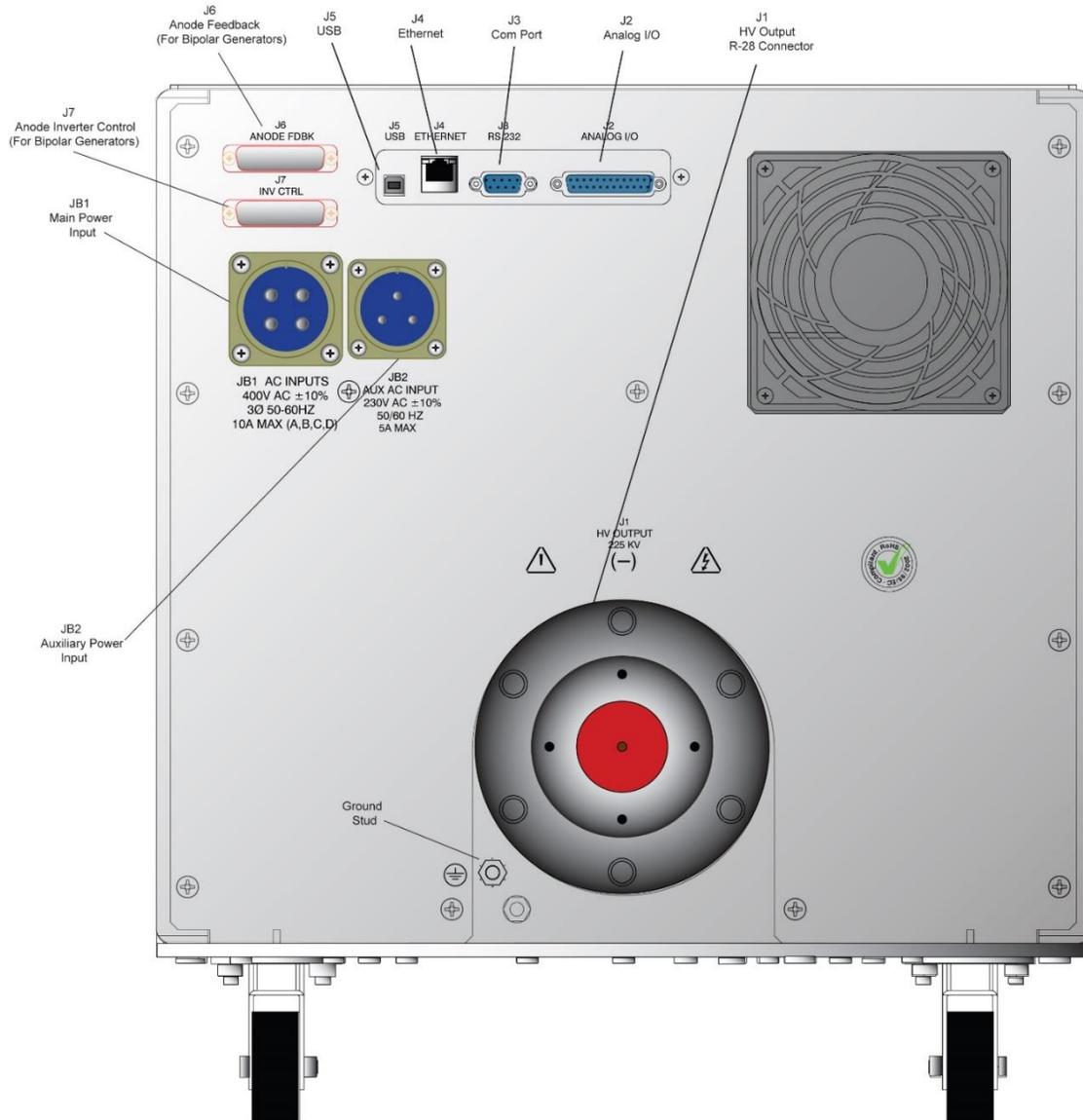
## XR225kV Overview:

The 225kV XRV is additionally available in a 6kW version. The 6kW version uses a 208 Vac 3Ø power input or a 400Vac 3Ø power input. The chassis overall size is the same as the 4kW version. The only difference between the 6kW version and the 4kW version is the power input connections. Two connectors separate the Mains from the auxiliary power input. Amphenol style power mating connectors are included with all XRV models.



**XR225kV 208Vac 3Ø 6kW Unit**

# XRV225kV Overview:



**XRV225 400Vac 3Ø 6kW Unit**

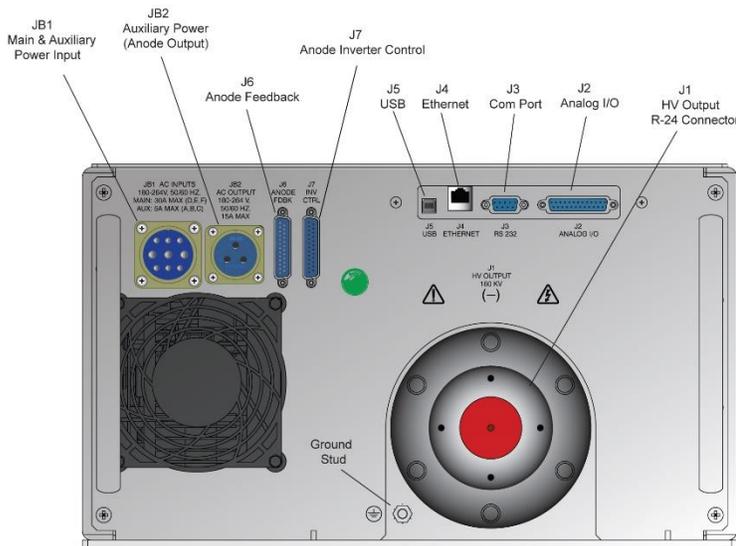
## XR320 and XR350 Overview:



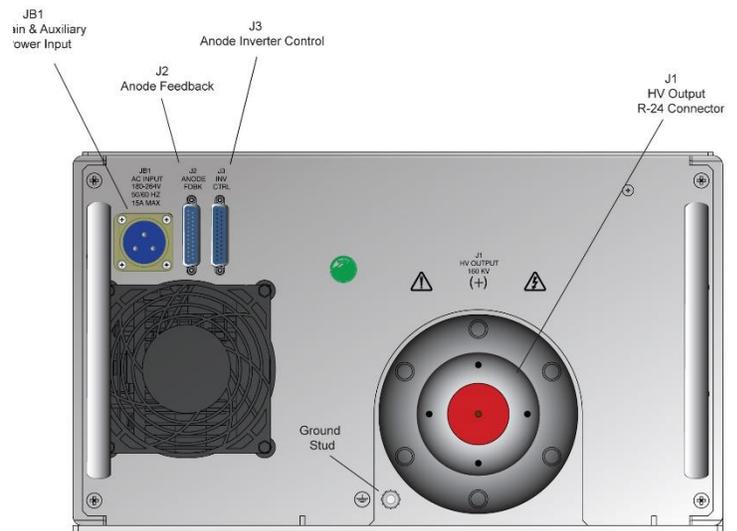
## XR320 and XR350 (Rear Panels)

The 320kV and 350kV XRV Generators are specifically designed to operate bipolar x-ray tubes. The X-ray tube requires a negative kV generator (cathode) which includes a filament supply and a positive kV output (anode) generator. Each generator on the 320kV system has a maximum voltage of 160kV. One is positive 160kV with respect to ground while the other is negative 160kV with respect to ground. Likewise, the 350kV model has a maximum of 175kV each with respect to ground. Each generator measures 7.16" W x 10.09" x H 24" D (excluding handles). The rear of the chassis has all of the necessary connectors for power input, controls, monitoring, and kV output. Each connector on the rear panel is clearly marked for installation purposes.

An interconnect cable on the cathode side supplies auxiliary power to the anode generator. Two additional 25 pin DB style cables interface the anode generator feedback and inverter signals to the main control board residing in the cathode generator supply. The mains input on the cathode generator includes an Amphenol style mating connector and an additional DB-25 pin connector for the user I/O analog control. Both the cathode and anode kV outputs mate with a standard R-24 type connector. These are available from Spellman High Voltage Corp. in different lengths and configurations for installation of the X-ray tube. Standard Graphical User Interface (GUI) software is included with the XR320 or XR350 Generator. A personal PC is required for installation. The user has the option of connection to a USB, Ethernet or Com Port. The control and monitoring of the XR320 and XR350 also includes an analog I/O connector for custom configurations. An additional optional touch screen controller (XRVC) is also available from Spellman High Voltage Corp



XR320 and XR350 Cathode Rear Panel Connections



XR320 and XR350 Anode Rear Panel Connections

## XRV320 and XRV350 Overview :

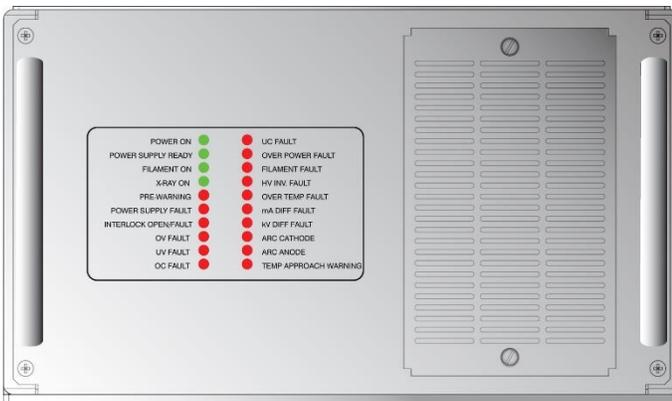


generator. Additionally, fault status and ready conditions are monitored from the I/O connector on the rear panel and the GUI Interface software. A removable air filter keeps dust and dirt from entering the chassis.

## XRV320 and XRV350 (Front Panels)

The cathode (negative) generator front panel of the XRV320 and XRV350 models use the same LED Indicators as the unipolar XRV160 showing the status of the Generator. Green Indicators signify normal operational mode while red indicators signify a fault condition. A fault or red indication prevents high voltage operation. Fault conditions are “latched” meaning that a reset must be employed before re-starting the generator. Once the fault clears, the red indicator will extinguish. The anode (positive) generator does not have any indicators since all of the monitoring and fault status indicators originate from the control board within the cathode (negative)

## Front Panel Detail



**XRV320 and XRV350 Cathode**



**XRV320 and XRV350 Anode**

## XRV450 Overview :

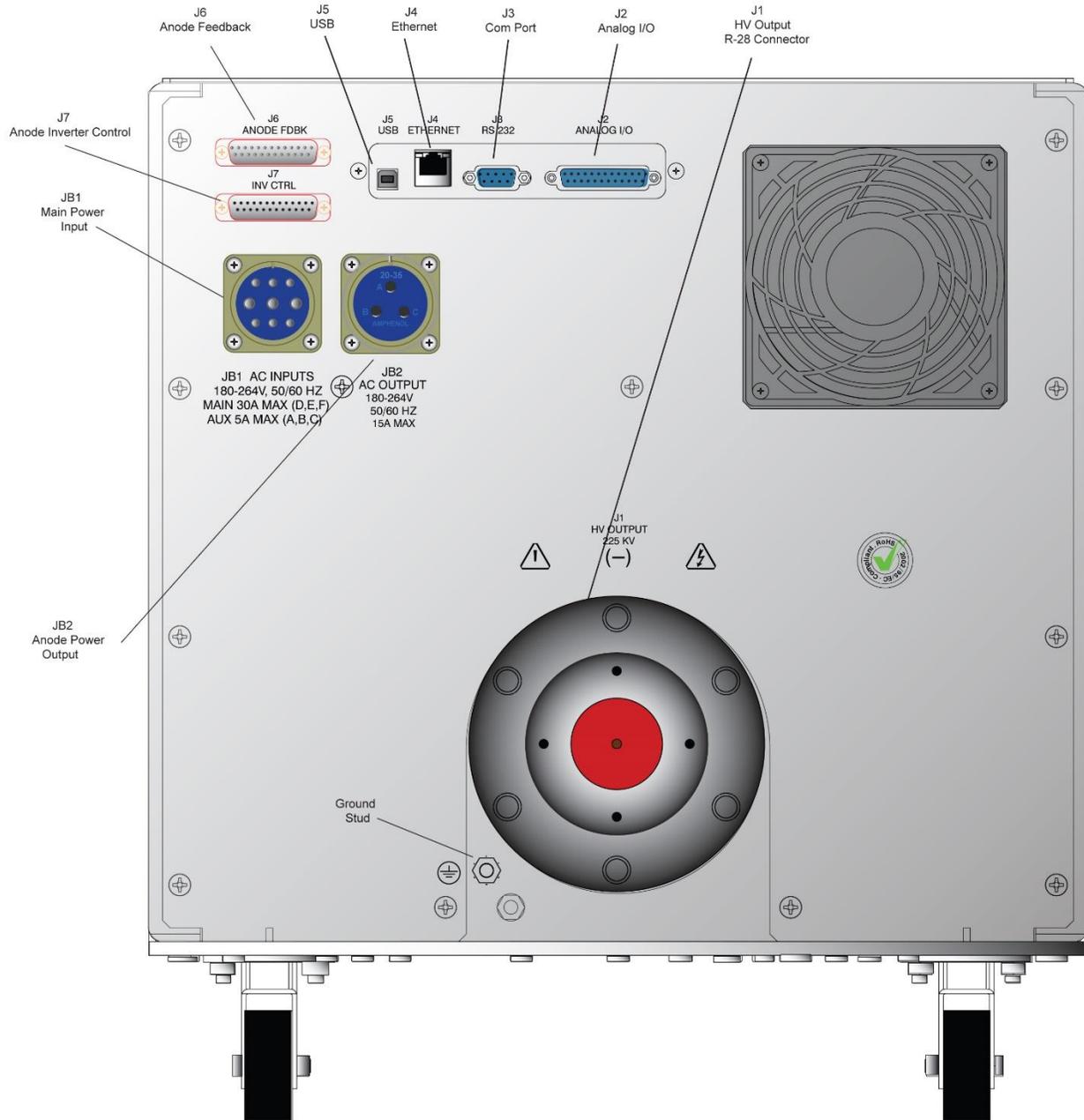
### XRV450 (Rear Panels)



The 450kV Generator is specifically designed to operate with bipolar x-ray tubes. The X-ray tube requires a negative kV generator (cathode) which includes a filament supply and a positive kV output (anode) generator. Each generator on the 450kV system has a maximum voltage of 225kV. One is positive 225kV with respect to ground while the other is negative 225kV with respect to ground. Each generator measures 17" W x 18.90" (including castors) x H 30.72" D (excluding cable well). The rear of each chassis has all of the necessary connectors for power input, controls, monitoring,

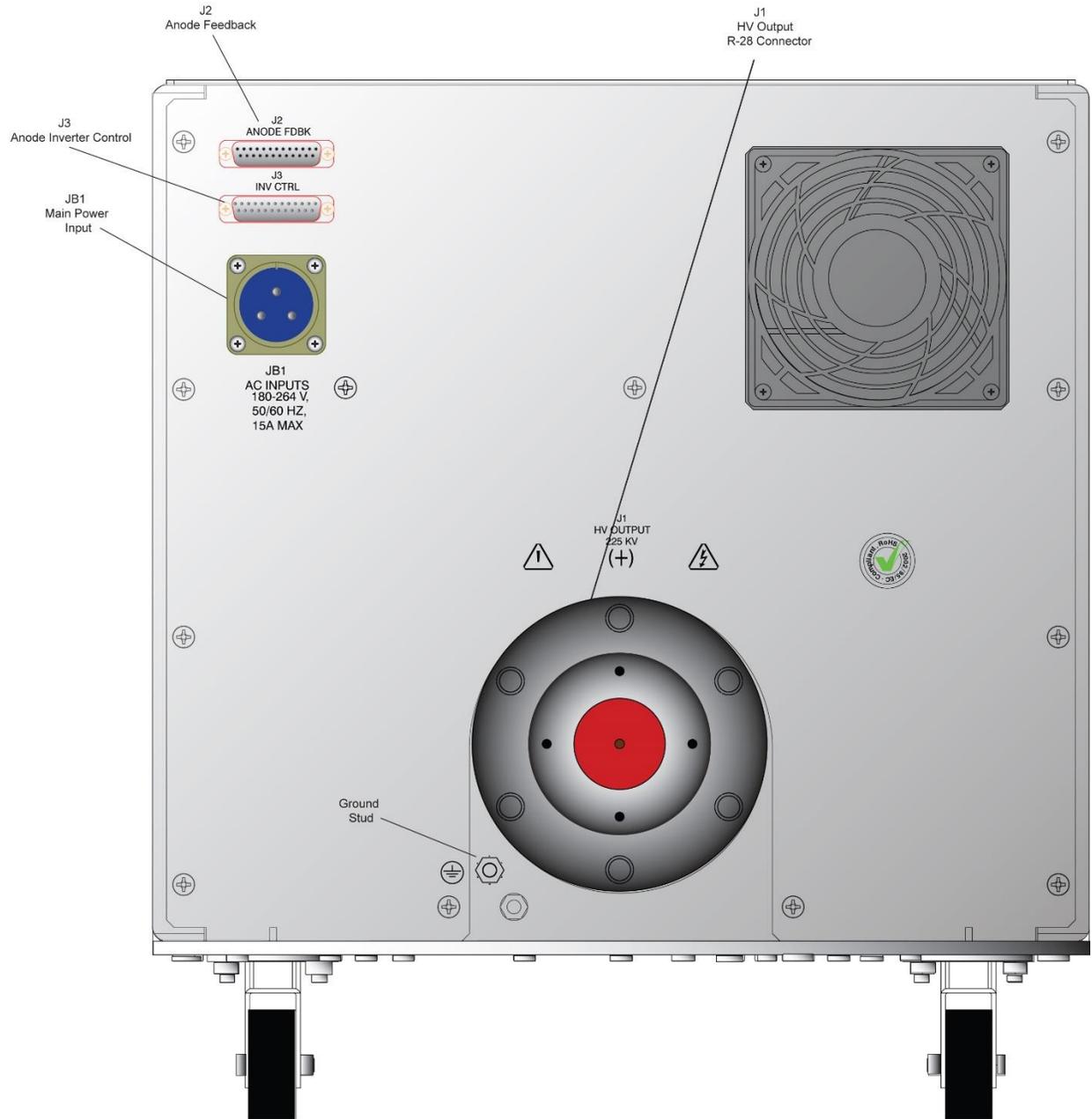
and kV output. Each connector on the rear panel is clearly marked for installation purposes. An interconnect cable on the cathode side supplies auxiliary power to the anode generator. Two additional 25 pin DB style cables interface the anode generator feedback and inverter signals to the main control board residing in the cathode generator supply. The mains input on the cathode generator includes an Amphenol style mating connector and an additional DB-25 pin connector for the user I/O analog control. Both the cathode and anode kV outputs mate with a standard R-28 type connector. These are available from Spellman High Voltage Corp. in different lengths and configurations for installation of the X-ray tube. Standard Graphical User Interface (GUI) software is included with the XRV 450 Generator. A personal PC is required for installation. The user has the option of connection to a USB, Ethernet or Com Port. The control and monitoring of the XRV450 also includes an analog I/O connector for custom configurations. An additional optional touch screen controller (XRVC) is also available from Spellman High Voltage Corp..

## XR450 Overview :



**XR450 Bipolar Cathode Generator**

## XRV450 Overview :



**XRV450 Bipolar Anode Generator**

## XRV450 Overview :

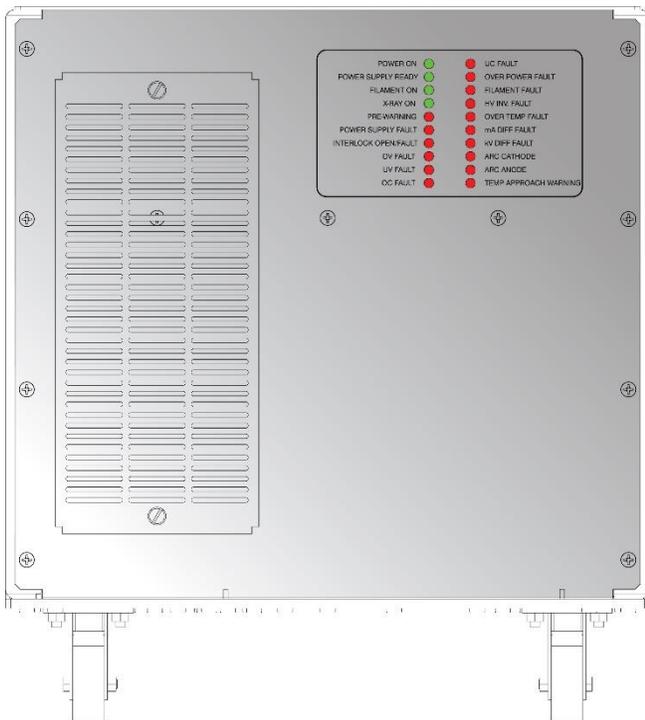


### XRV450 (Front Panels)

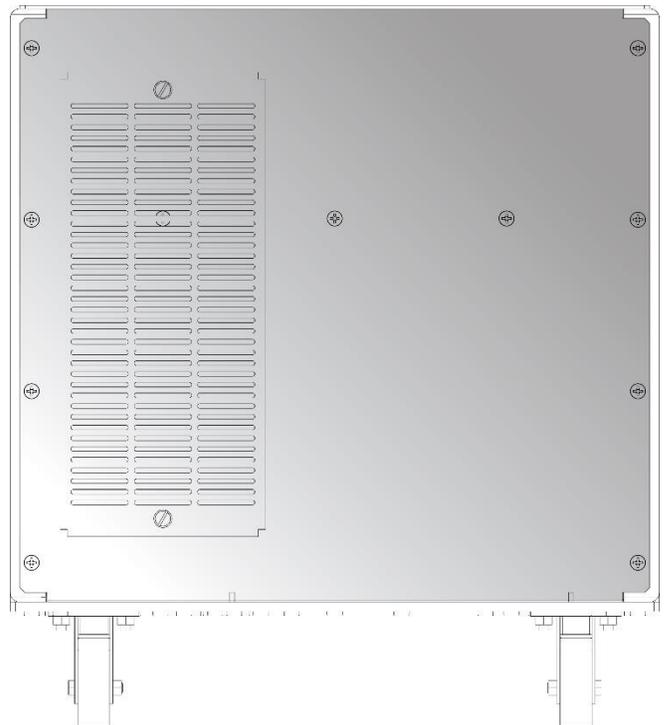
The cathode (negative) generator front panel of the XRV450 model uses the same LED Indicators as the unipolar XRV225 showing the status of the Generator. Green Indicators signify normal operational mode while red indicators signify a fault condition. A fault or red indication prevents high voltage operation. Fault conditions are “latched” meaning that a reset must be employed before re-

starting the generator. Once the fault clears, the red indicator will extinguish. The anode (positive) generator does not have any indicators since all of the monitoring and fault status indicators originate from the control board within the cathode (negative) generator. Additionally, fault status and ready conditions are monitored from the I/O connector on the rear panel and the GUI Interface software. A removable air filter keeps dust and dirt from entering the chassis.

### Front Panel Detail



**XRV450 Cathode**



**XRV450 Anode**

## I/O System Interface Box Overview:



The XRV I/O System Interface Box provides easy integration of the XRV Generator, XRV Touch Screen Controller and Cooler/Chiller unit. The interface box is enclosed in a 19" x 5.21" x 18" deep rack mountable chassis and includes all the necessary cables for a complete system setup and operation.

Power distribution includes a maximum 230Vac @ 4kW XRV High Voltage Generator and encompasses all the necessary X-ray safety requirements meeting international standards. The XRV I/O Box accommodates a variety of interface options that are best suited for user requirements and mounting

configurations.

There are several models of the XRV I/O Box. These are capable of integrating different optional accessories ranging from an XRV Touch Screen Controller to a "bare bones" setup allowing the user to operate the XRV High Voltage Generator via connection to a personal PC. The user may also choose the analog I/O interface control and monitoring as without the use of a personal PC. There are several models of the I/O Interface Box for use with the 230Vac, 4kW XRV Generators. Other models for use with high power Generators will be available in the near future.

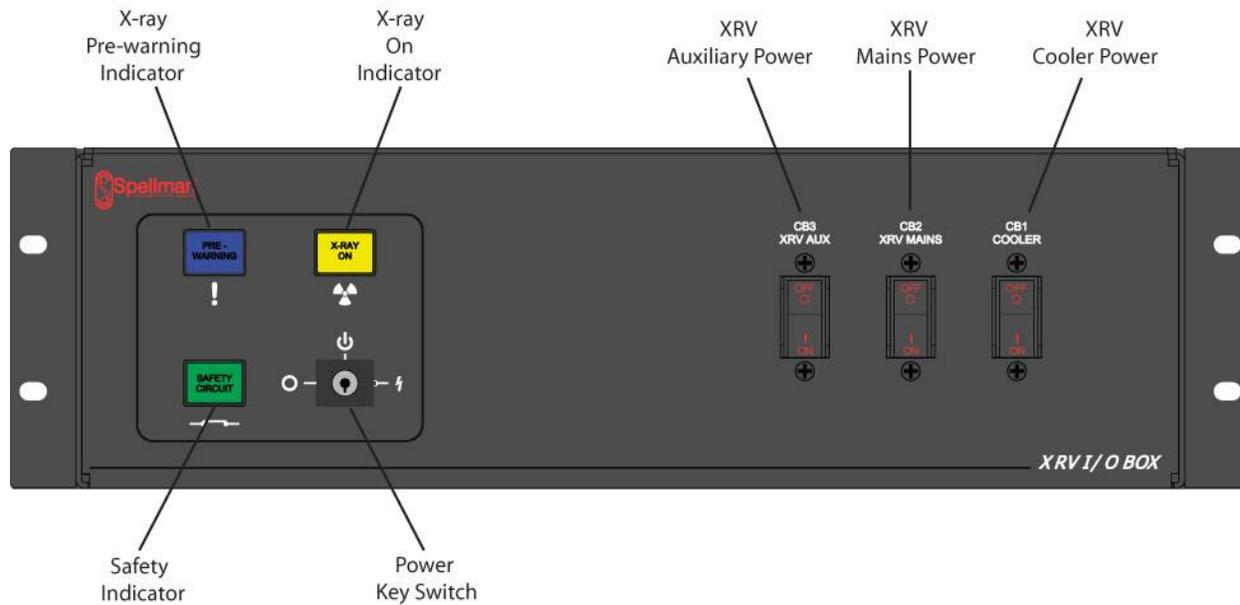
XRV I/O Box Models:

### XRV I/O BOX SELECTION TABLE

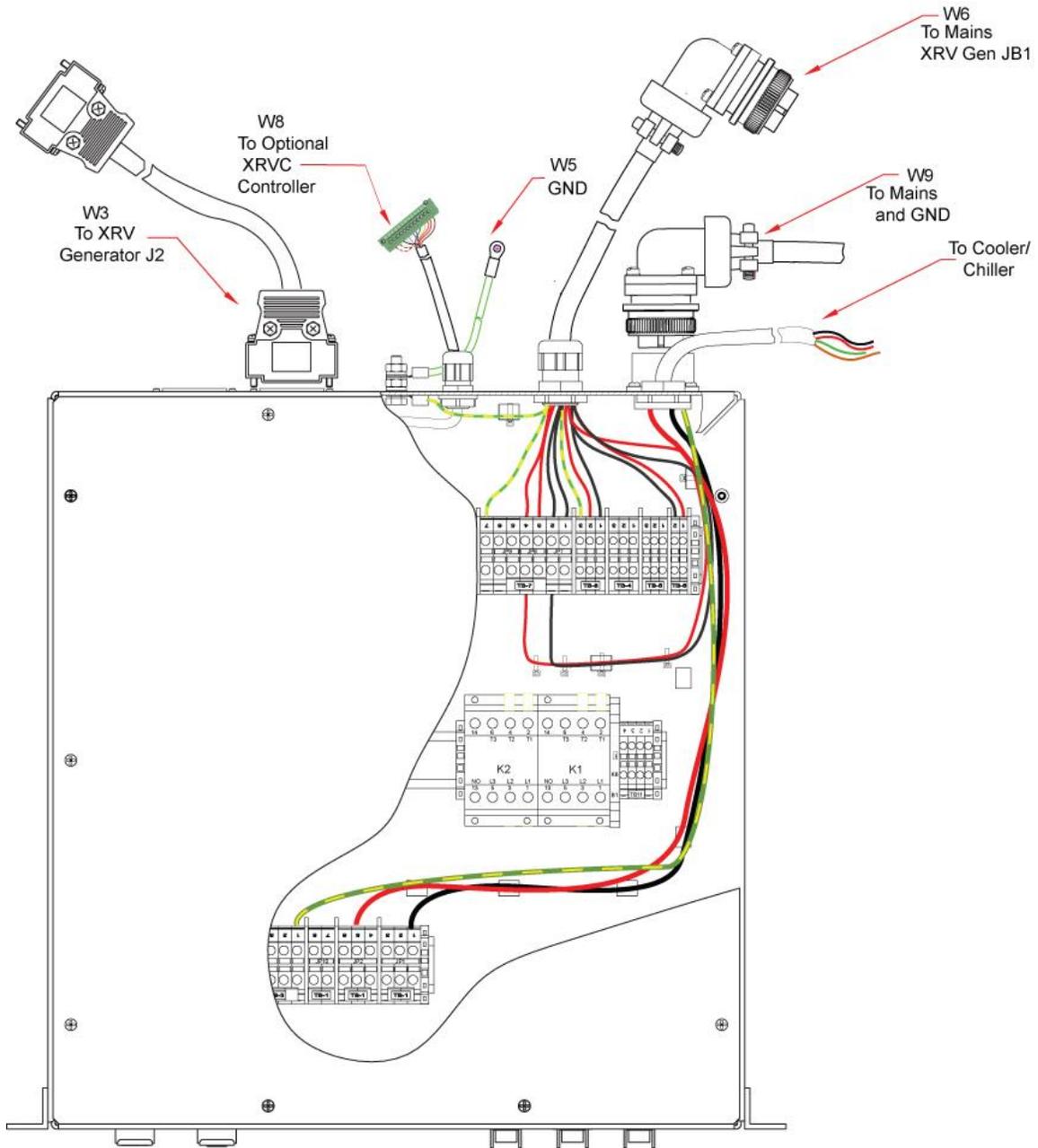
MODEL NUMBER	DESCRIPTION
XRV-9-1	Rack mount without XRV controller
XRV-9-2	Rack mount with XRV controller
XRV-9-3	Wall mount without XRV controller
XRV-9-4	Wall mount with XRV controller
XRV-9-5	Rack mount without XRV controller with optional safety relay for interlocks
XRV-9-6	Rack mount with XRV controller with optional safety relay for interlocks

## I/O System Interface Box Overview:

### I/O System Interface Box Front Panel Detail



## I/O System Interface Box Overview:



## I/O System Interface Box Rear Panel Connections Detail

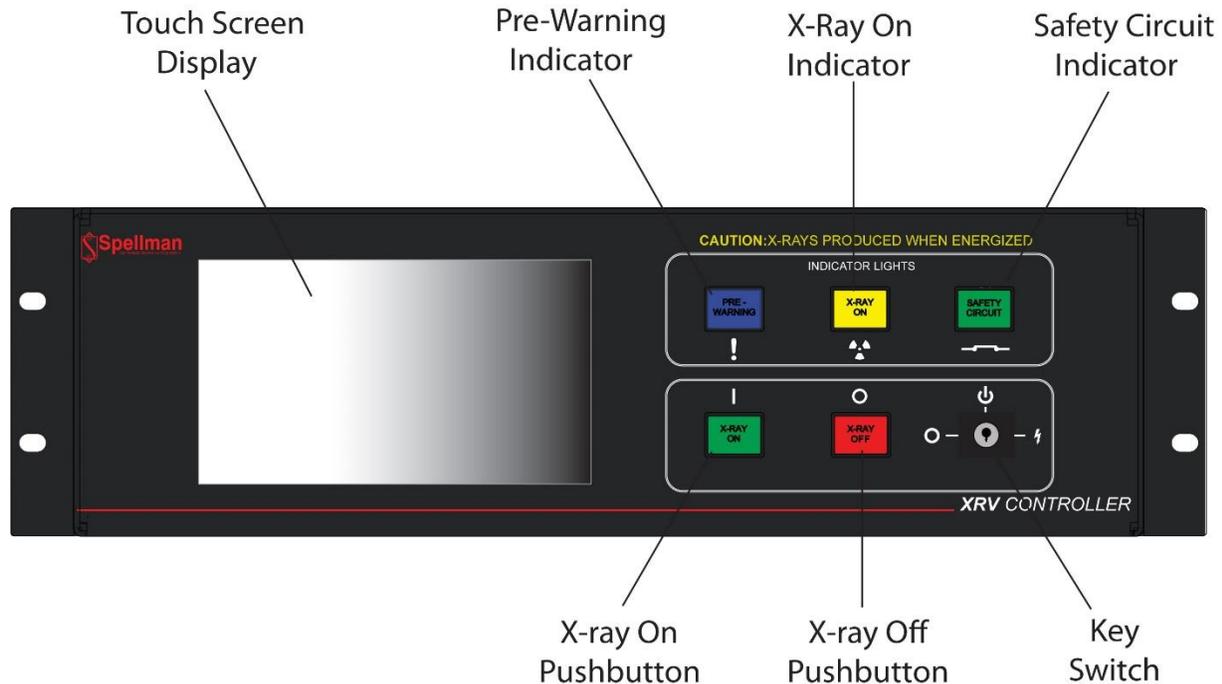
## XRVC Controller Overview:



The XRVC Controller uses an embedded computing system that runs a custom graphical user interface (GUI) and allows the user to configure custom X-ray tube profiles for any of the Spellman XRV series. The unit, housed in a 19"W x 5.25" H x 13" D (ex. connectors) features a 7" touch screen, RS-232 serial ports, 10/100/1000Mbit Ethernet and a 160GB hard drive. The Intel Atom N270 CPU processor runs at an impressive 1.6GHz and includes 1GB of static Ram. The user has the ability to create, save and load customized profiles for use within the operating capabilities of the XRV

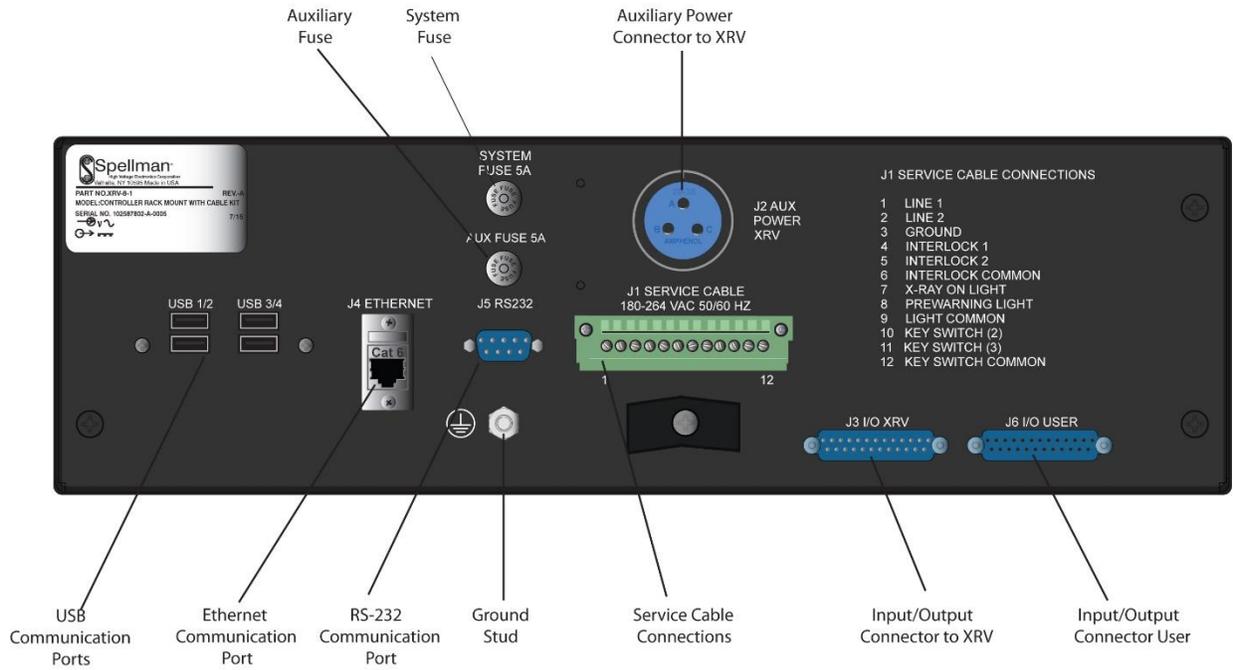
Generators. The intuitive, touch-centric, menu driven system allows ease of use with little or no learning curve. Communication settings are stored after only one system configuration session. Parameter settings on supported X-ray tubes may be automatically uploaded to the XRVC within the recommended manufacturer guidelines. A comprehensive status and control screen continuously monitors information on all critical operation parameters. An integrated on screen keyboard eliminates the need for an external keyboard. The input voltage is 180-264Vac, 50/60Hz easily integrating with the Spellman I/O System Interface Box.

### XRVC Controller Front Panel Detail



# XRVC Controller Overview:

## XRVC Controller Rear Panel Detail

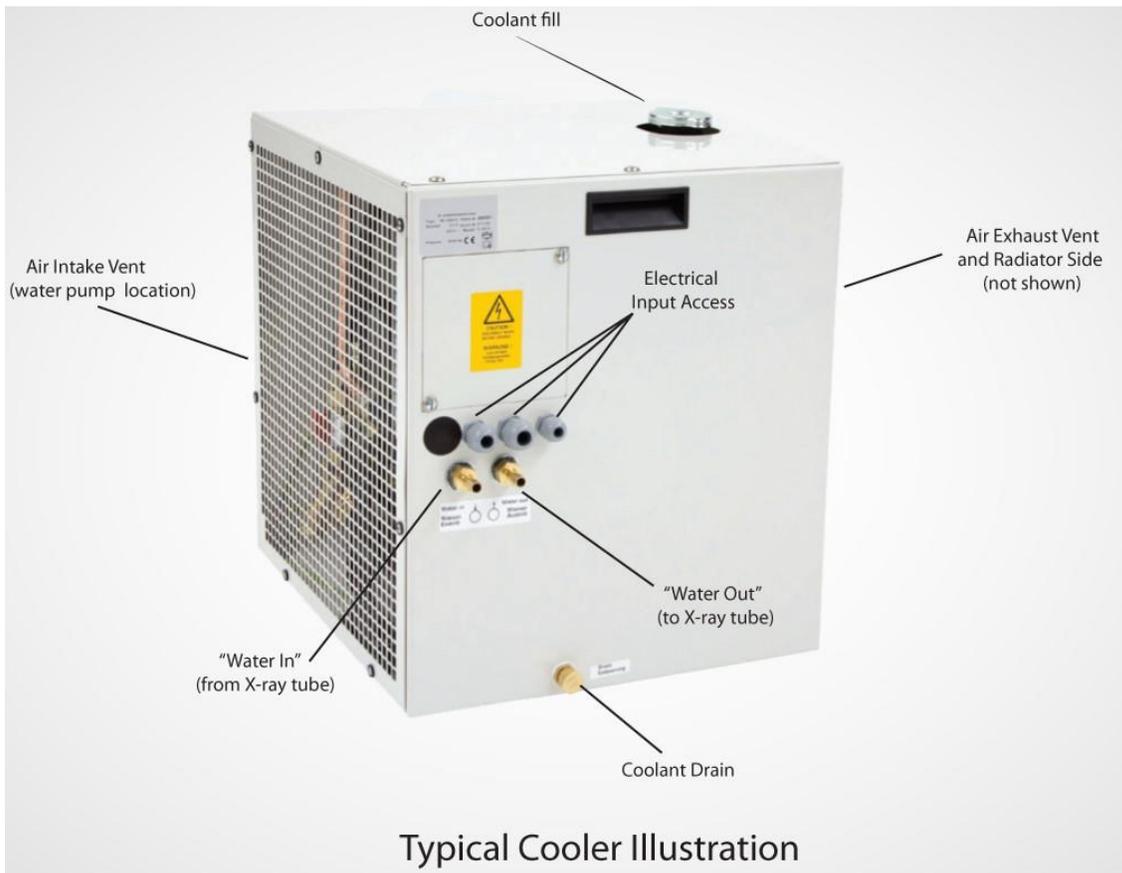


## XRV Coolers and Chillers Overview:



The X-ray tube will generate a substantial amount of heat during operation. It is important to remove as much heat as possible to avoid damage to the X-ray tube. Various coolers remove heat from a closed circulated water system flowing through the X-ray tube at ground potential. The unipolar X-ray tube normally specifies the water flow rate and ambient conditions required to prevent damage to the tube. The capacity of the cooler to remove heat through a water to air heat exchanger depends on the difference between the ambient temperature and the water outlet temperature. The coolant used could be either plain water or a mixture of water and glycol usually specified by the

manufacturer. The inlet and outlet hose connections are specifically marked for correct flow through the tube. A thermal switch monitors the outlet water temperature. If the outlet temperature exceeds the recommended operating temperature, the switch will activate opening an interlock chain removing power from the Generator. For optimal performance of the cooler, it is important not to obstruct or restrict the air flowing through the vents. The ambient air temperature should be maintained according to the manufacturers' recommendations.



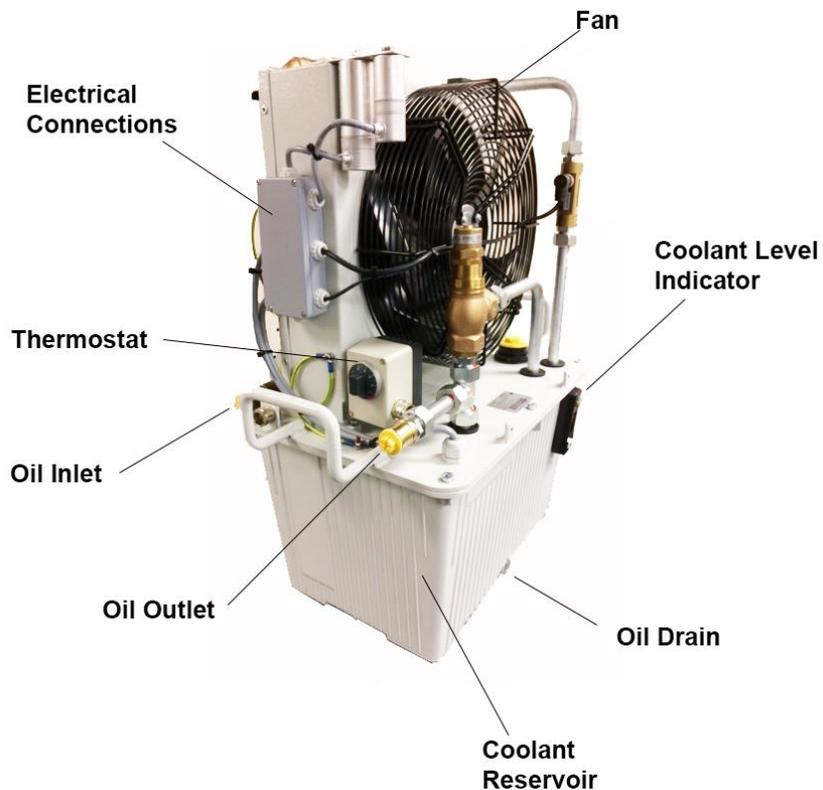
## XRV Coolers and Chillers Overview:



Chillers may be used with either Unipolar or Bipolar X-ray tubes. The tube power and ambient temperature will determine if a chiller is required in order to cool the X-ray tube. Chillers are much like air conditioners whereas a compressor lowers the temperature of the water or oil within a closed loop system. Oil coolant is used with a Bipolar tube since the Anode section of the X-ray tube “Floats” at high voltage potential and an insulation medium must be used to cool it and provide isolation to ground. An internal thermostat maintains the temperature. It constantly compares the water/oil that returns from the X-ray tube to the water/oil supplied to the X-ray tube. If the difference is too great, the chiller will provide an interlock signal (usually a dry contact switch) to shut down the high voltage generator and prevent any damage to the X-ray tube.

Adequate clearance is necessary when installing a chiller to allow the flow of air through the venting system.

Typical Chiller Illustration

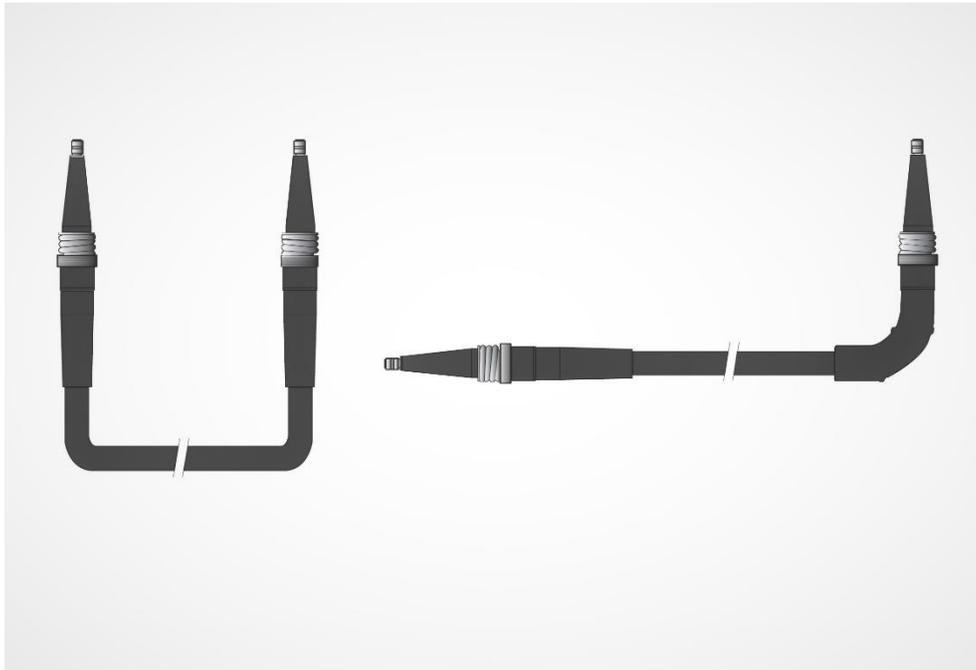


## XRV R24 and R28 HV Cables Overview:



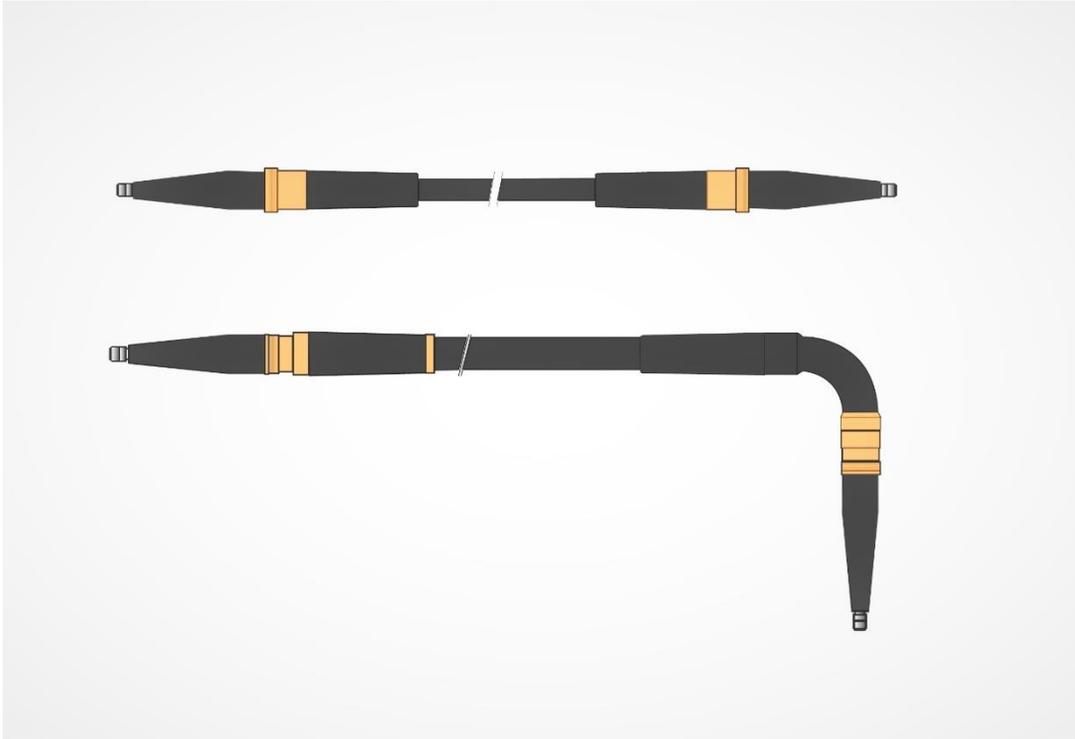
The X-ray tube and the XRV Generator uses a specific type of receptacle for the high voltage connection. The receptacles mate with an R24 or R28 high voltage cable. The R24 Cable is for systems with an output voltage of 160kV or less while the R28 Cable are designed for systems with voltages as high as 225kV. The conical shaped cable plugs ,designed to reduce voltage stress on the connections use silicone grease to fill any air voids and avoid high voltage arcing. The cables are available in various lengths, straight or right angle spring and non-spring loaded connectors. Flanges are specially designed to apply the

right amount of contact force and keep the connector securely in place. A special gapping tool adjusts the flange to cable well spacing making sure the male conical connector is the correct length for the cable well depth. Typical Cables and Flanges are shown below.

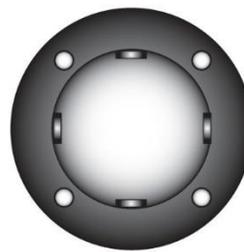
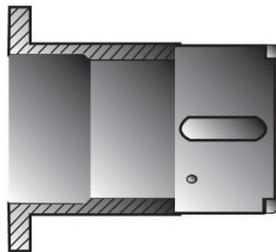
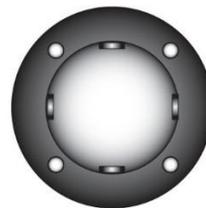
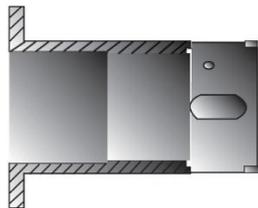


**Spring Loaded R24 and R28 Type Cables**

## XRV R24 and R28 HV Cables Overview:



### Standard Type R24 and R28 Type Cables



### R24 and R28 Type Cable Flanges

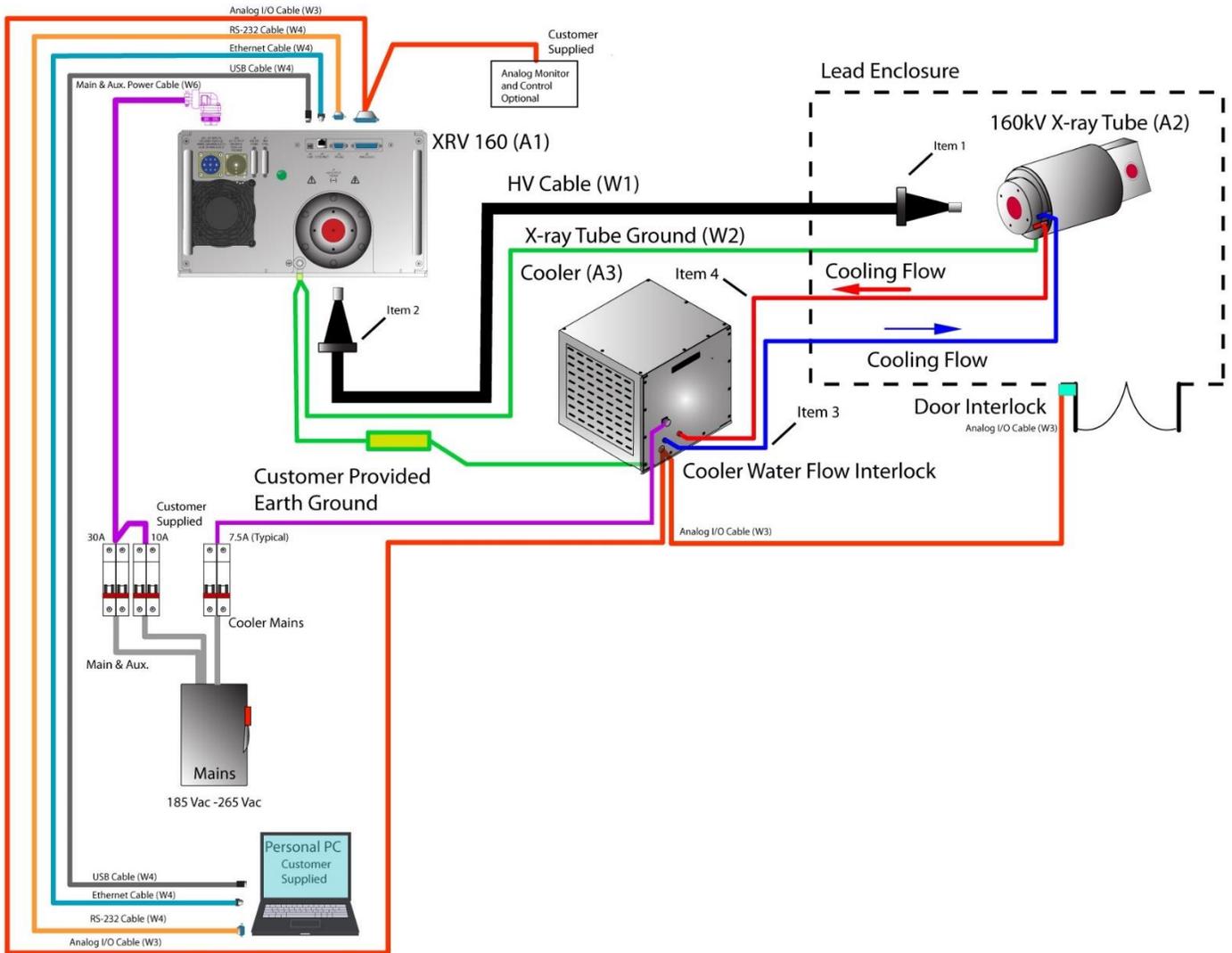
## XRV Setup and Installation:

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> It is imperative that the user follow the necessary safety precautions when operating any X-ray equipment. Extreme care must be taken during the installation and placement of the X-ray tube. Radiation emission must be contained within a suitable lead enclosure and configured to prevent unauthorized access when in use. Dosimeters or electronic radiation measuring devices are recommended to monitor radiation levels outside of the enclosure. Failure to follow the necessary guidelines for X-ray operation and containment may cause harm to personnel or be lethal once exposed.</p>

	 <b>DANGER</b>
	<p><b>Danger: High Voltage!</b> The XRV Generator is capable of developing extreme high voltages. It is the responsibility of the user to observe safety procedures and guidelines set forth in this manual. Extreme caution must be exercised when installing, maintaining or operating this equipment. Installation personnel must comply with all safety regulations when installing this equipment. It is prohibited to allow unqualified personnel to install, operate or maintain this equipment. Failure to follow these guidelines may result in injury or death.</p>

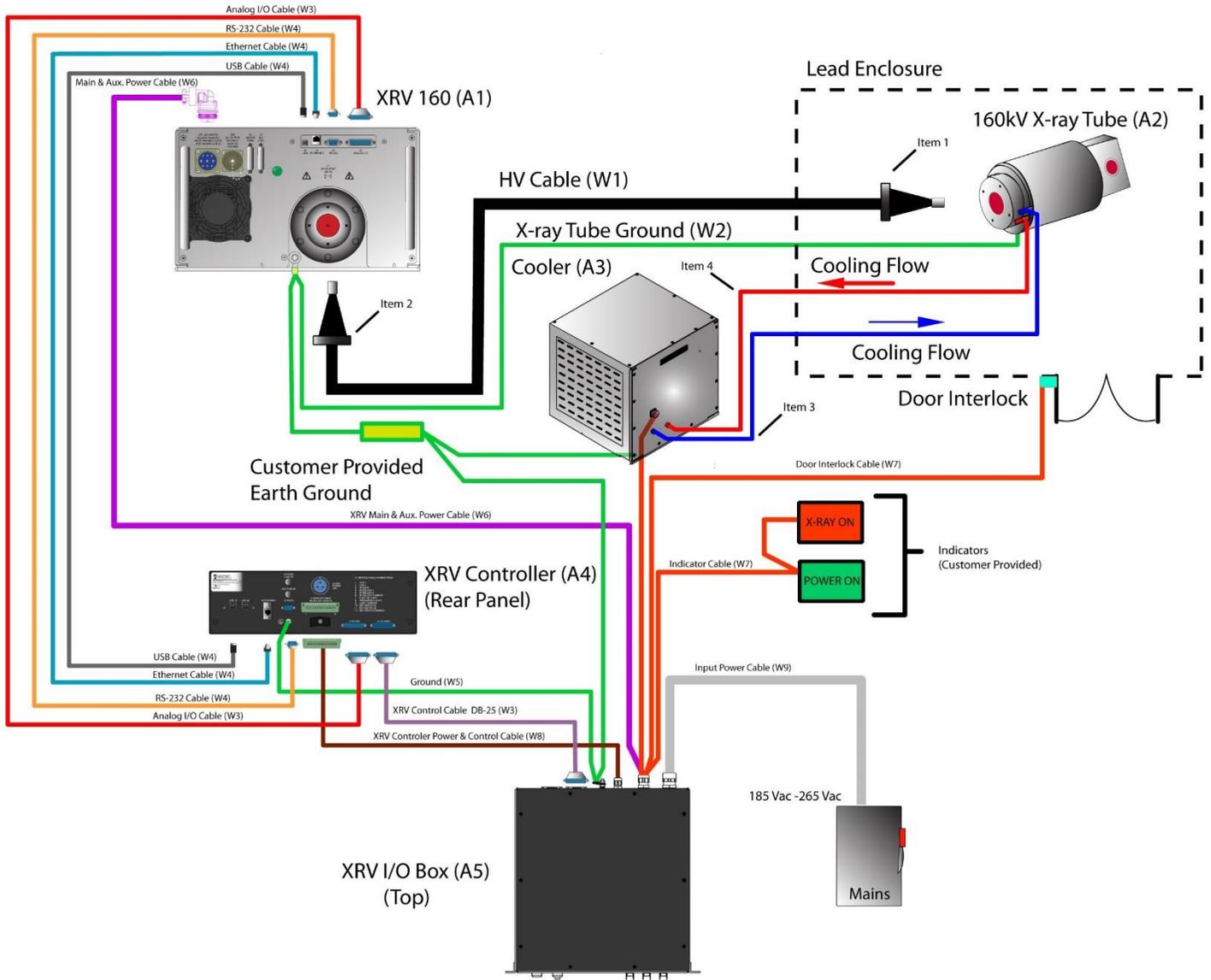
There are several installation configurations available for the XRV Subsystem. The most economical system employs the use of a single ended X-ray tube, the XRV Generator, Personal PC, X-ray Cable, Input Power / Communication Cables and Water Cooler/ Chiller. The XRV Generator includes ready to install software that can be loaded into the user's personal PC. A minimal setup for a standard Unipolar subsystem is illustrated on the following page. The user must provide a personal PC for installing the included software or elect to interface their own controls via the I/O from J2 (25 Pin subminiature D connector) on the rear of the XRV Generator. Information regarding the I/O connector will be covered later in this manual. It is imperative the installer follow all safety regulations and codes for installing this equipment. Details such as input power requirements, wire sizing, and physical placement of each component is critical for safe and trouble free operation. Do not install power wires or high voltage cables in high traffic areas where they could be damaged by heavy equipment. Wire lengths should be considered for voltage drops and thermal management. The X-ray tube

# XRV Unipolar System Diagram



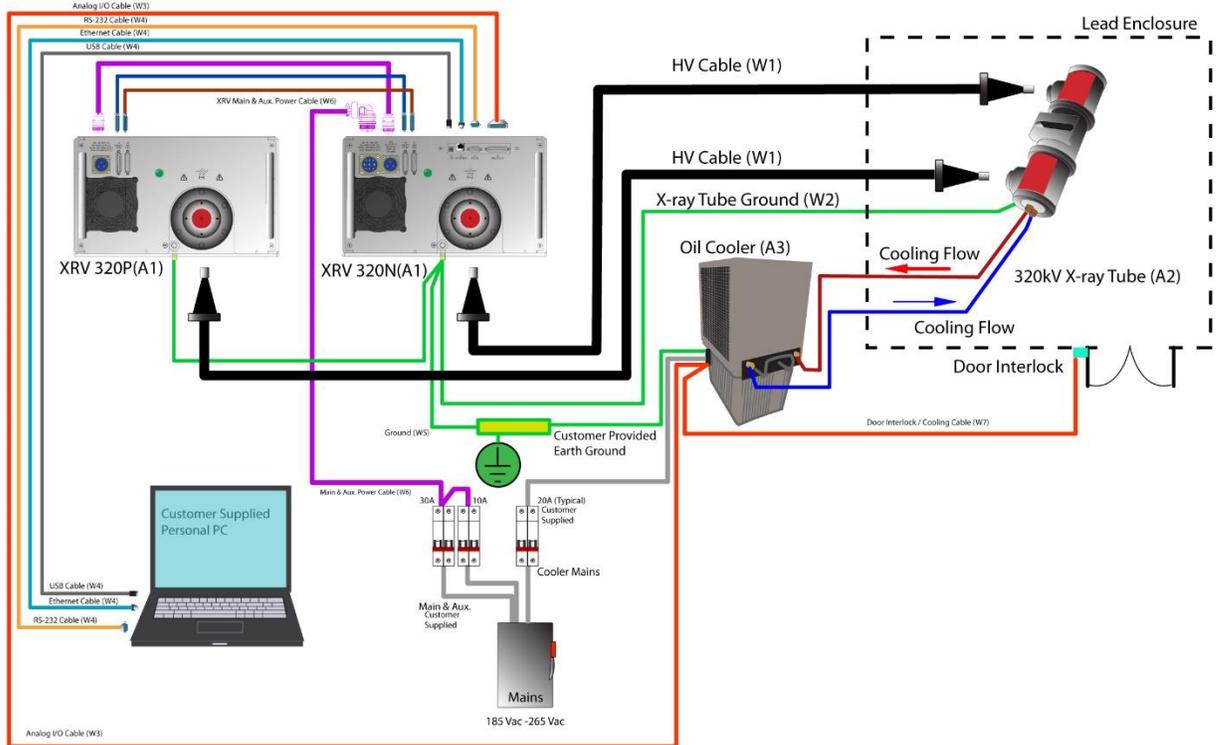
Typical Unipolar System (Minimal Requirements)

# XRV Unipolar System Diagram



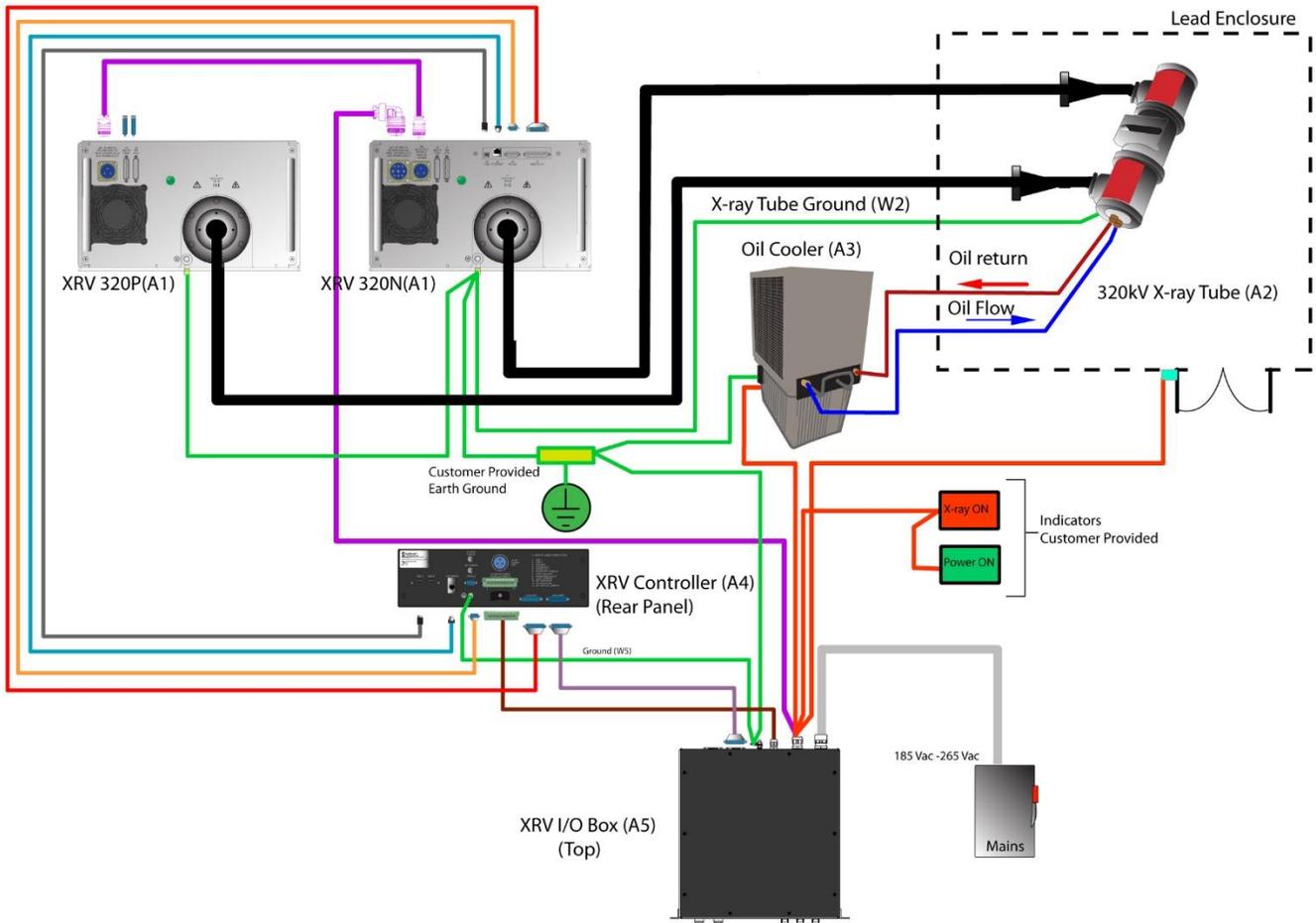
Typical Unipolar System with Additional Controller and I/O Box

# XRV Bipolar System Diagram



Typical Bipolar System (Minimal Requirements)

# XRV Bipolar System Diagram



Typical Bipolar System with Additional Controller and I/O Box

## Unpacking Generator:

	 <b>CAUTION</b>
	<p><b>Caution: Potential Hazard!</b>            Caution must be exercised when unpacking the XRV Generator and System components to avoid damage and personal injury. The XRV Generator must be lifted out of the crate by a minimum of two people or by means of a mechanical lift with sling. Do not use tools that can puncture the wooden crates. Care must be taken not to scratch the finish on the generator or components. Report any damage regarding the shipping container or system components to Spellman High Voltage immediately. Record any damage in writing and photographs. Do not attempt to connect the system without the consent from Spellman High Voltage if damage is apparent to avoid warranty issues.</p>

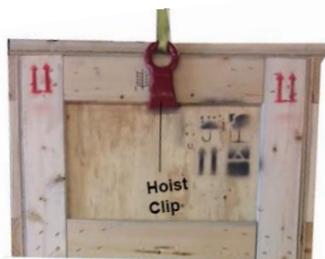
The XRV Generator and subsystem components are shipped in padded containers to avoid damage during shipment. All of the containers will have an indication that shows the correct orientation for shipment and unpacking. The XRV Generator is surrounded within a foam padding to protect it from shock and vibration during shipment. There are 6 bolts on the surrounding bottom of the crate that need to be loosened in order to remove the XRV Generator. Do not remove the 4 bolts from the top of the crate. Once the bolts are loosened, the top can be removed. Two people can lift the top of the crate evenly from either end or a hoist and strap may be used instead. Visually inspect the XRV Generator for any signs of damage once the top is removed. Report any damage to Spellman High Voltage. Include any photos and a verbal description. The crate should not be exposed to moisture or extreme temperatures.



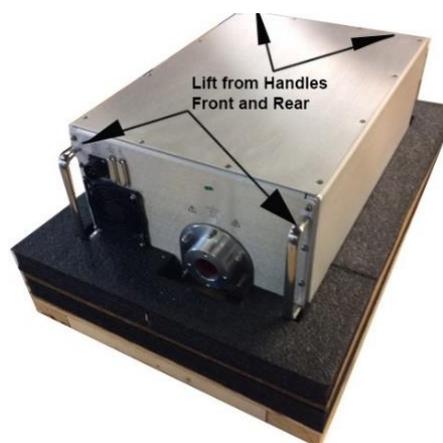
XRV 160  
Generator Crate



Loosen 6 Bolts on Bottom  
of Generator Crate



XRV 160 Generator



Lift Generator  
from Handles

## Unpacking Generator:

In addition to the XRV Generator, there will be several accessories. The 4kw unipolar models include a CD/DVD program setup, Interlock bypass subminiature D connector and a Main Power Connector. The 6kW unipolar generator includes an additional Auxiliary Power Connector. The 4kW bipolar generator includes an interconnect power cable and 2 additional subminiature D cables for the feedback and inverter control for the additional positive polarity generator. Additional subsystem components such as the X-ray tube, Cooler/Chiller



Mains & Aux 1.8kW-4kW

P/N 105808-434 Conn.  
P/N 105808-440 Clamp



Mains

6kW

Aux

P/N 105808-654 (4) Pin Conn. (6kW)  
P/N 105808-440 Clamp  
P/N 105808-441 (3) Pin Conn. (6Kw)  
P/N 105808-440 Clamp



P/N 203373-001 25 Pin  
Subminiature D



P/N SWD0026-009  
Software



P/N 304747-001  
(Bipolar XRV Only)



P/N PNC4002A  
(Bipolar XRV Only)



P/N PNC4002A  
(Bipolar XRV Only)

## XRV Generator Installation:

	 <b>DANGER</b>
	<p><b>Danger: High Voltage!</b> The XRV Generator is capable of developing extreme high voltages. It is the responsibility of the user to observe safety procedures and guidelines set forth in this manual. Extreme caution must be exercised when installing, maintaining or operating this equipment. Installation personnel must comply with all safety regulations when installing this equipment. It is prohibited to allow unqualified personnel to install, operate or maintain this equipment. Failure to follow these guidelines may result in injury or death.</p>

### General:

Locate the XRV Generator in an area where there is limited access and in close proximity to the X-ray tube load. The Generator must have adequate clearance for the intake air filter and exhaust fan. Make sure the area is a dry and dust free location. The X-ray tube load must be located within an interlocked secure lead shielded enclosure that prevents unauthorized access when in use. Typical distances from the X-ray tube to the Generator range from 5 meters to 20 meters depending on the length of the high voltage cable. Installation and maintenance of the high voltage cable is extremely important to prevent damage to both the X-ray tube and XRV Generator cable sockets. Locate the high voltage cables away from high traffic areas and the input power cables. Use a minimum of #6 copper grounding wire and #6 ring lugs when grounding any of the subsystem components. Make sure to use the proper crimping tool for the ring lug used. Keep the ground distances as short as possible from the XRV Generator and earth ground. Review the label on the rear of the XRV Generator to for the correct installation of the input voltage. Incorrect input voltage will damage the XRV Generator.

	 <b>CAUTION</b>
	<p><b>Caution: Potential Hazard!</b> It is recommended that only experienced personnel proceed with the following installation. Review the complete installation before proceeding. Failure to do so may cause damage to the equipment or personal injury.</p>



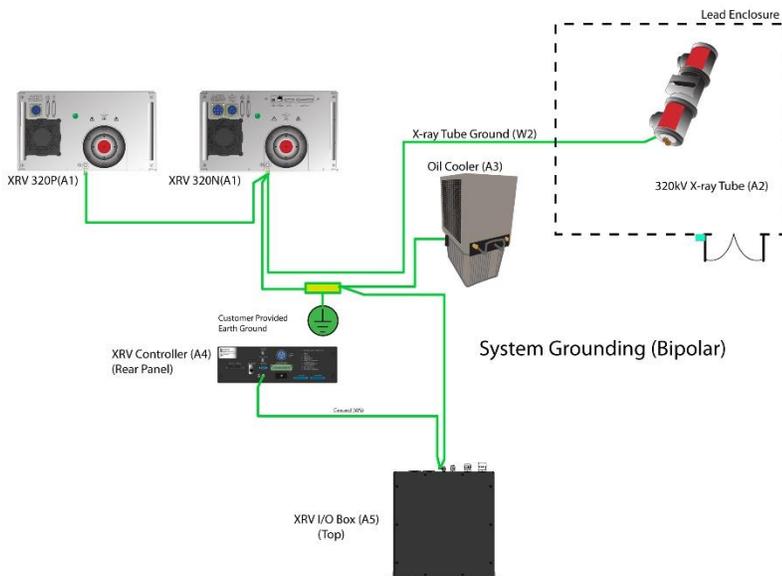
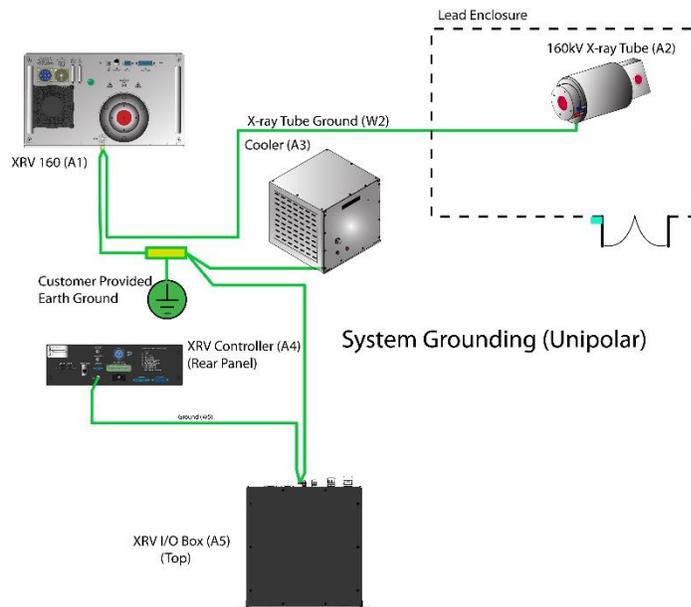
### System Grounding:

All of the subsystem components are required to be connected earth ground. Install all of the system components in the desired location. Cabling should be as short as possible Use a minimum of #6 AWG insulated copper stranded wire for the XRV Generator, X-ray tube, cooler/chiller, I/O Box and Controller. Strip and crimp the wire on to a #6 Ring Lug using the proper crimping tool. Ensure that the crimp is tight and does not pull out of the lug. Remove the ground connection nut from the X-ray tube and place the ring lug over the threaded connection. Replace the nut and torque to the manufacturer's specification. Connect the opposite end of the wire to the rear panel ground of the XRV Generator

## System Grounding:

ground. Strip and crimp #6 ring lugs on another #6 AWG wire to connect from the XRV generator to earth ground. Keep this wire as short as possible.

If the Generator is a bipolar model, a ground wire with lugs (supplied) connect between the Anode (Positive Generator) and the Cathode (Negative Generator) chassis ground. If the system includes the I/O Subsystem Box and the Controller, connect the Controller ground using #6 AWG wire and appropriate ring lugs to the I/O Subsystem. Run another ground from the I/O Subsystem Box ground lug to earth ground. The grounding system should look like the following diagram for a unipolar system.



## High Voltage Cable Installation:

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> Extreme care and caution must be exercised when installing the high voltage cables. Improper installation will cause degradation of the cable and receptacles caused by arcing. Excessive dirt, improperly greased or incorrect insertion force on the connectors will cause high voltage breakdowns. A basic knowledge of high voltage safety is required. The XRV Generator should never be operated without the high voltage cable connections or adequate grounding. High voltage cables must be installed by trained personnel. Failure to follow these guidelines may result in injury or death.</p>

### General:

Two types of high voltage cable connectors used for connecting the XRV Generator to the X-ray tube. They are either spring-loaded or non-spring loaded. The maximum high voltage for the XRV generator and X-ray tube dictates either an R-24 or R-28 type cable. An R-24 high voltage cable is used on the 160kV XRV Generator while the R-28 is used on the 225kV models. The X-ray tube specifies what type of cable plug it requires. Spring-loaded connectors are the preferred choice since they are adjusted for the right amount of force when connecting to the receptacle. Gapping tools measure the correct spacing of the flange when inserting the plug into the high voltage receptacle. Non-spring loaded cables are still used but require increased maintenance and special attention when installing.



### Non-spring loaded cable installation:

Several steps are required when installing a non-spring loaded high voltage cable. The first step is to ensure that the cable plugs and receptacles are free from dirt or damage that could cause high voltage breakdown. It is important to clean both the cable plug and receptacle prior to installation. While wearing nitrile powder free examination gloves, use a clean lint free cloth such as Kimtech Science Delicate Task Wipes, remove any dust or dirt from the cable plug and cable receptacle.



Lint Free Wipes



Nitrile Gloves



Dow Corning #4 Silicone Compound

## Cleaning Cable Plug:

While supporting the cable with one hand, apply a small bead of the Dow Corning #4 silicone compound to opposite sides of the cable plug to opposite sides of the cable plug. Spread the compound with your finger evenly over the entire rubber cone surface of the plug. Using another clean lint free wipe, remove the applied silicone from the cable plug. Do not use alcohol to clean the cable plug, as this will dry out the rubber cone. Repeat for the opposite side and place in a clean area.



Wipe cable end with dry lint free cloth



Apply 2 beads of silicone compound



Spread compound evenly with finger



Remove compound with new cloth

## Cable Receptacle Cleaning:

	 <b>CAUTION</b>
	<p><b>Caution: Potential Hazard!</b>            High voltage cables may retain an electrical charge. Discharge the connections to the shield before handling. Use extreme care when handling high voltage components to avoid contamination with dirt, water, oil, sweat etc.. Contamination will cause high voltage failures. Use only approved plugs and receptacles for high voltage connections. Do not use solvents to clean high voltage components. Wear clean talc free nitrile gloves while handling high voltage components.</p>

Inspect the cable receptacle in both the XRV Generator and X-ray tube for any dirt or foreign debris. Wrap a lint free cloth around a “foam” glass cleaning brush and insert gently into the cable receptacle. The foam brush should have 1/8” clearance on the inner circumference of the cable receptacle. While holding the cloth, rotate the foam brush several times and remove from the receptacle. Inspect the receptacle for debris. Repeat if necessary.



Obtain a foam glass cleaning brush



Wrap a lint free clean cloth around foam brush



Insert into HV receptacle and rotate



Remove and discard cloth

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b>            Non-spring loaded high voltage cables must be checked and <b>re-installed after 24 hours</b>. Repeat the cleaning, gapping, greasing and installation procedure for both the X-ray tube and XRV Generator. Failure to do so may cause premature breakdown of the cables and receptacles. <b>Maintenance is required every 3-6 months</b> depending on use. Repeat the complete procedure for maintenance schedules.</p>

## Non-spring loaded HV cable installation:

### High Voltage Cable Installation (X-ray Tube):

Wear nitrile gloves and obtain an X-ray tube cable flange. Wipe the flange with a lint free cloth and place over a clean high voltage cable plug. (One cable flange will fit the X-ray tube and the other will fit the XRV Generator). Rotate the flange counter clockwise on to the cable threads until it stops. Do not cross thread the assembly. Insert the clean dry connector into the high voltage cable receptacle of the X-ray tube with a small amount of force. Adjust the cable flange by rotating it clockwise until the flange is approximately 1/2 inch from the X-ray tube mounting surface. Insert the gapping tool (5.5m – 6mm) between the tube mounting surface and the flange. Rotate the flange until it is snug against the gapping tool. Remove the gapping tool and rotate the flange slightly to align the mounting holes with the x-ray tube holes. Tighten the grub screws of the cable flange to prevent any further rotation and remove the plug from the receptacle. Apply 2 thin beads on opposite sides of the rubber cone. Distribute a thin coat of silicone evenly on the entire cone. Finish the distribution by spreading in a circular fashion around the circumference of the cone. Do not apply any silicone to the metal tip. If the silicone gets on the metal tip, use a clean dry lint free cloth to remove it. Insert the HV cable plug into the receptacle until it seats properly. Use the correct hardware and torque as per manufacturer specifications to tighten the cable flange screws, alternating between the opposite placed screws.



Obtain flange and HV cable



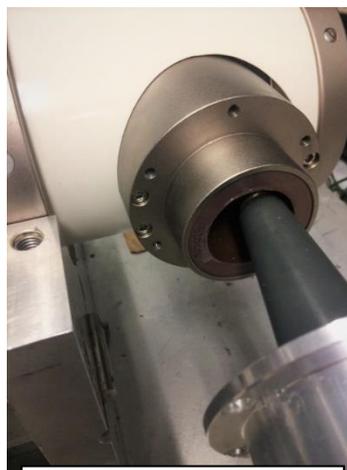
Place flange over cable plug



Thread flange on cable plug



Gapping tool for R24 & R28 Cable



Insert dry HV cable plug into X-ray tube



Measure distance with gapping tool

## High Voltage Cable Installation (X-ray Tube):



Tighten grub screws



Apply 2 beads of silicone compound



Spread compound evenly with finger



Insert HV cable plug in tube receptacle



Tighten cable flange screws

## High Voltage Cable Installation (XRV Generator):

Repeat the assembly procedure as previously described on the opposite end of the high voltage cable plug. The only notable difference is that the gapping tool will sit flush against the high voltage cable receptacle when adjusting the flange. The tube receptacle has a collar that the flange fits over, while the XRV Generator flange will sit flush against the receptacle.



Insert dry HV cable plug in XRV receptacle



Adjust flange with gapping tool



Tighten grub screws



Apply 2 beads of silicone compound



Spread compound evenly with finger



Insert HV plug in XRV & tighten flange screws

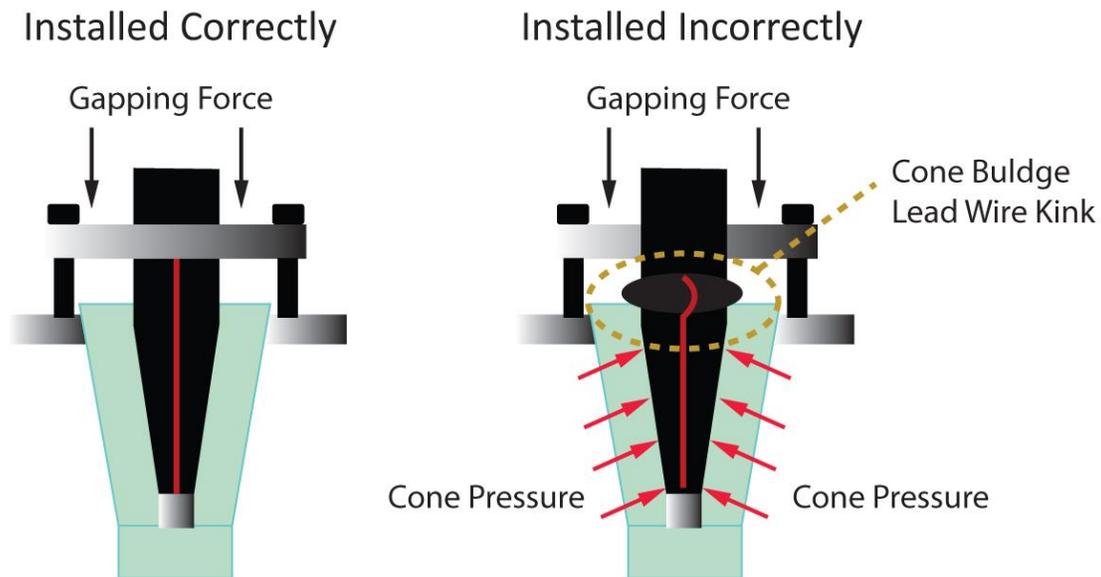
Gapping Distance	R24	R28
Standard New Cable	5.5mm - 6mm	5.5mm - 6mm
Cable Used Longer Than 3 Months	4.5mm	4.5mm
Spring Loaded Cables	6mm - 7mm	6mm - 7mm
Grease Amount Applied	2 x 2cm Lines	2 x 2cm Lines

High Voltage Cable Gapping Distances:

## Standard High Voltage Cable Installation Problems:

High voltage arcing and failures can result from improperly gapped standard cables. Too much force on a cable will cause the cone to bulge and deform creating voids within the receptacle. Another issue involves stressing the filament and common connections resulting in breakdown. Never try to reuse a kinked or bulging cable. Over application of silicone grease will also create voids and high voltage arcing.

## Standard Cable



## Spring Loaded High Voltage Cable Installation:

Clean the spring-loaded cables and high voltage receptacles prior to insertion. Refer to the cleaning procedures in the non-spring loaded section of this manual.

Wear nitrile gloves and obtain an X-ray tube cable flange. Wipe the flange with a lint free cloth and place over a clean spring-loaded high voltage cable plug. (One cable flange will fit the X-ray tube and the other will fit the XRV Generator). Rotate the flange counter clockwise on to the cable threads until it stops. Do not cross thread the assembly. Insert the clean dry connector into the high voltage cable receptacle of the X-ray tube with a small amount of force. Make sure the contact head of the cable fully inserts while checking the gap. Refer to the **“High Voltage Cable Gapping Distances”** table for the correct gap measurement. Use a gapping tool if available. When the desired gap has been set, rotate the cable flange slightly so that the holes line up with the receptacle holes. Tighten the grub screws on the cable flange so that it restricts it from rotating. Remove the cable plug and apply 2 thin beads on opposite sides of the rubber cone. Distribute a thin coat of silicone evenly on the entire cone. Finish the distribution by spreading in a circular fashion around the circumference of the cone. Do not apply any silicone to the metal tip. If the silicone gets on the metal tip, use a clean dry lint free cloth to remove it.

Place the connector carefully into the X-ray tube receptacle without scraping any of the silicone from the cone. Tighten the cable flange screws, alternating between the opposing placed screws.

### Spring Loaded High Voltage Cable Installation:

If a cable flange with a window is used, verify the correct compression was achieved by verifying 2 rings are visible through the cable flange window. If not, reset the gapping distance until 2 rings are visible (approx. 5.5mm displacement). Repeat this installation for the XRV Generator side of the cable.



Insert dry HV cable plug into X-ray tube



Adjust flange for proper gapping



Tighten grub screws



Apply 2 beads of silicone



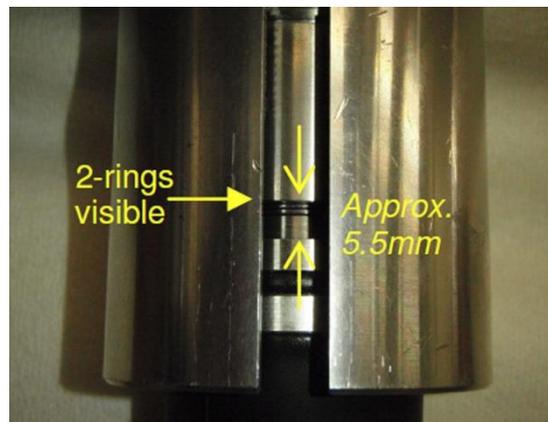
Spread compound evenly with finger



Insert HV cable plug in tube receptacle

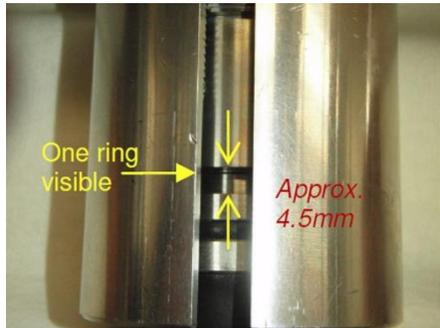


Tighten cable flange screws

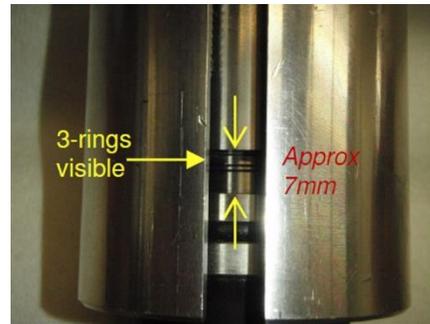


Correct Gapping

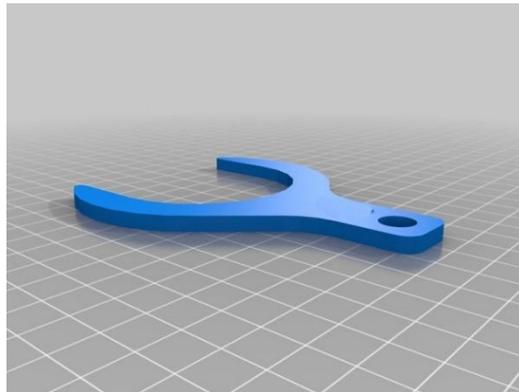
## Spring Loaded High Voltage Cable Installation:



Under gapped

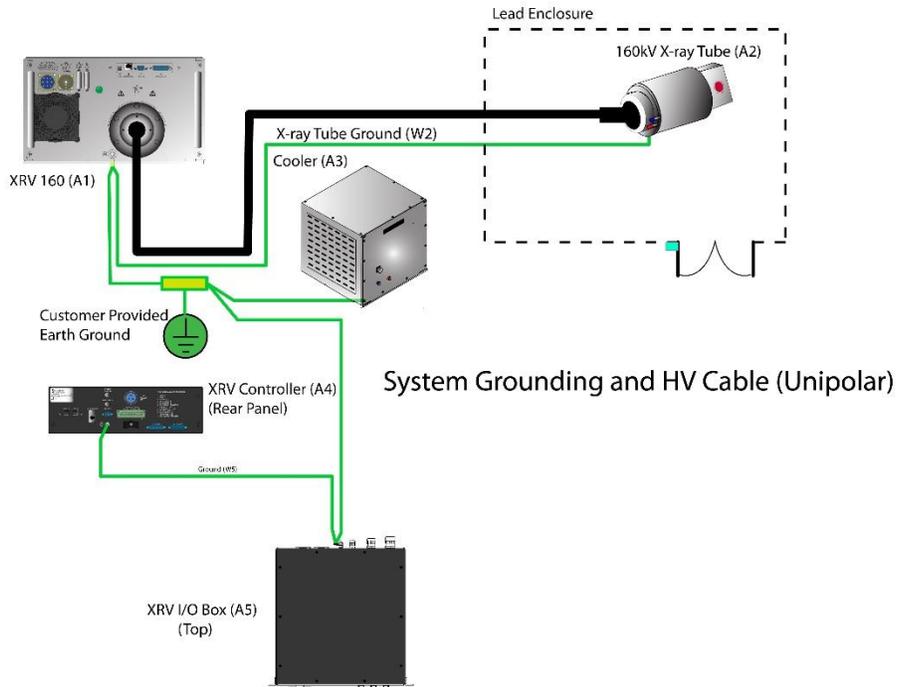


Over gapped

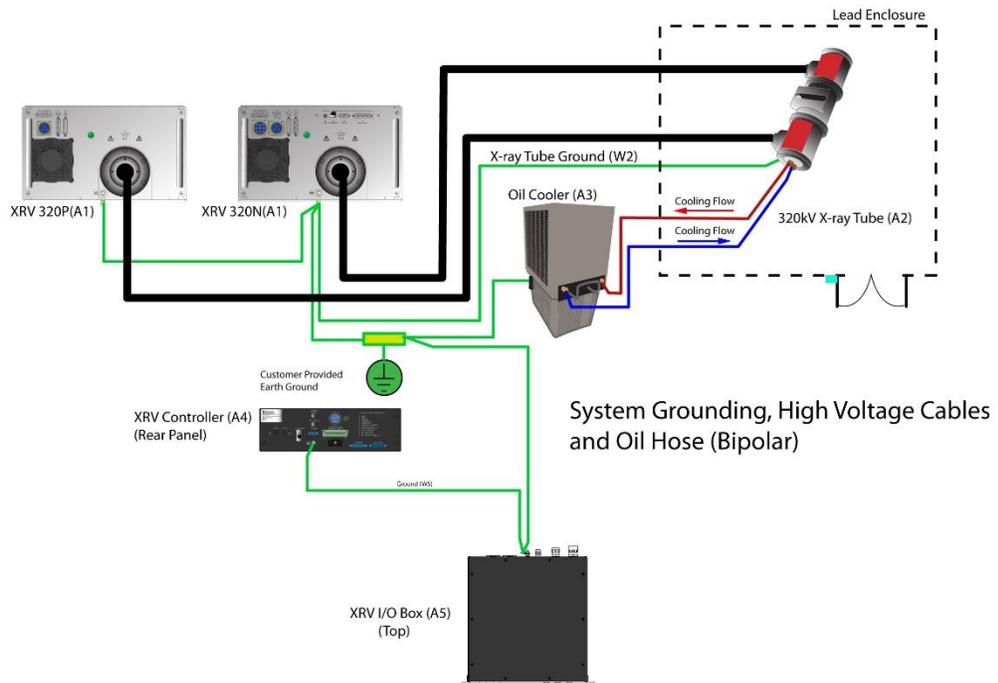


Typical gapping tool for  
spring loaded cables

## System Grounding Detail and HV Cable Connections:



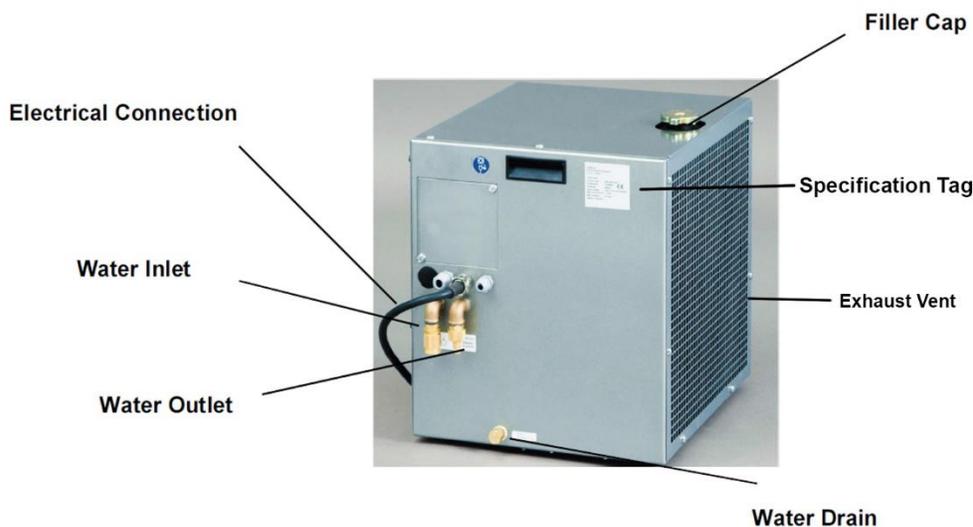
System Grounding and HV Cable (Unipolar)



System Grounding, High Voltage Cables and Oil Hose (Bipolar)

## Cooler/Chiller Connections:

The X-ray tube requires cooling to prevent damage. Single ended or unipolar tubes require a water circulation system in order to cool the tube while a double ended or bipolar x-ray tube requires a chiller and oil cooling. Depending on the power rating for the X-ray tube, the manufacturer will recommend a specific flow rate and the cooling medium for the tube. A typical cooler will have a water fill cap, water drain plug, water inlet and outlet flow connections, power input connections and interlock connections. A typical cooler is illustrated below.



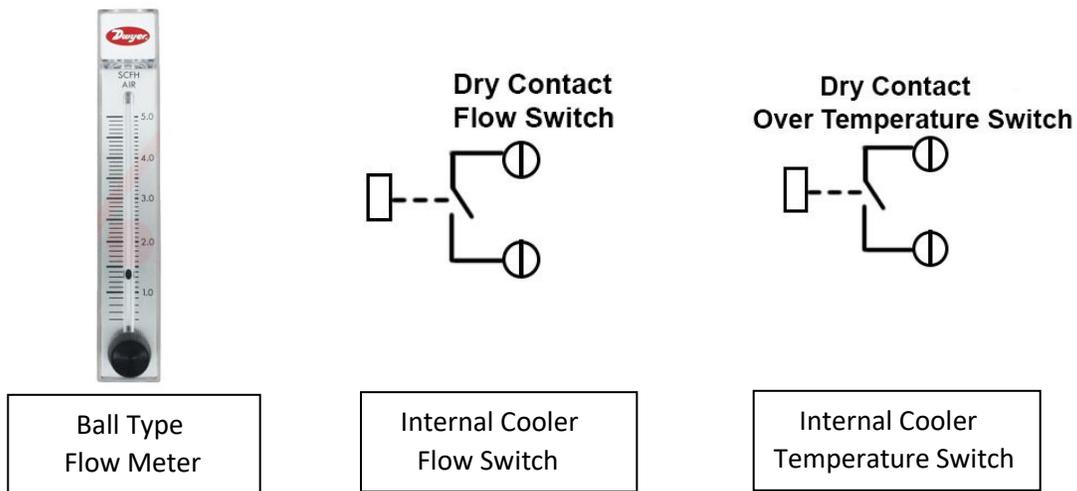
In some environments it may be necessary to mix glycol with the water in order to prevent freezing should the ambient temperature drop. Allow sufficient space for the unit when installing for air circulation. The manufacturer normally recommends the minimum distance required and the mixture for glycol to water for specific temperature ranges. The water outlet connection is water that flows to the x-ray tube anode while the water inlet connection returns from the X-ray tube anode. Although the cooler may provide temperature indicators and over temperature switches, it is important for the correct water flow configuration from the tube to the cooler. Failure to do so may result in overheating and tube damage. Below is a typical symbol for inlet and outlet water connections.

Inlet:  $\downarrow$   $\bigcirc$ ; Outlet:  $\uparrow$   $\bigcirc$

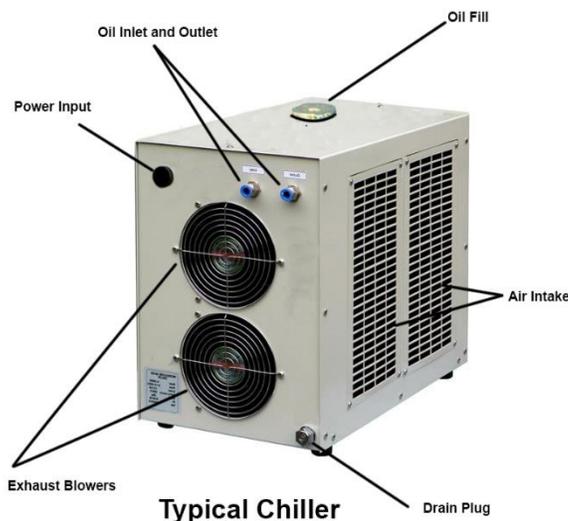
Various hose connections may be used for the water connections. Some are quick disconnecting while others either use threads or hose clamps. Consult Spellman High Voltage when ordering the cooler for more information regarding connectors. If the I/O Box is purchased with the sub-system, a circuit breaker will be provided for the cooler. If the I/O Box is not a part of the sub-system, then the user will be responsible for the correct breaker installation. Typically a cooler will require a 7.5 Amp. double pole breaker. Consult Spellman High Voltage for sizing the breaker.

## Cooler/Chiller Connections:

The cooler may or may not include a water flow indicator. Typically, water flow may be rated in liters per minute or gallons per minute depending on the tube size and specifications. It is important to check the water flow with a meter to ensure the tube has adequate cooling. Digital or traditional ball type meters may be permanently installed for verification. An internal flow and over temperature switch is provided with a dry set of contacts that can be integrated with the XRV Generator that will turn off the high voltage if the water flow is insufficient or temperature is too high.



The bipolar tube uses oil since the anode is at high voltage potential and must be isolated from ground. Oil is circulated by a pump and cooled using a refrigerant compressor. Oil flow rates and chiller sizing is dictated by the power dissipated by the tube. The manufacturer of the tube generally recommends flow rates and compressor size. If the I/O Box interface is used, a circuit breaker is included for the chiller. If the user chooses not to include the I/O Box assembly, the circuit breaker needs to be sized to handle the in-rush current when the compressor turns on. Generally a 20 Amp. suffices. Consult the manufacturer when selecting a chiller for air flow.



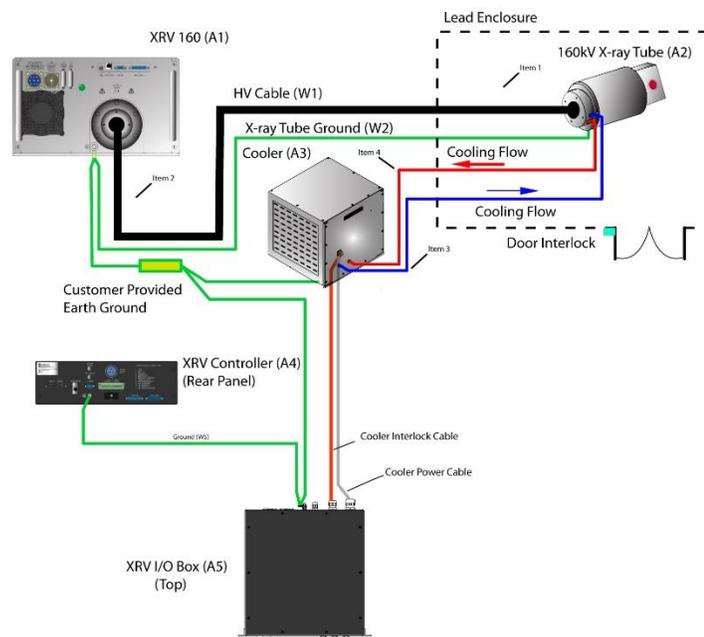
breaker for motors will Spellman High Voltage breaker size for the chiller space surrounding the

## Cooler/Chiller Connections:

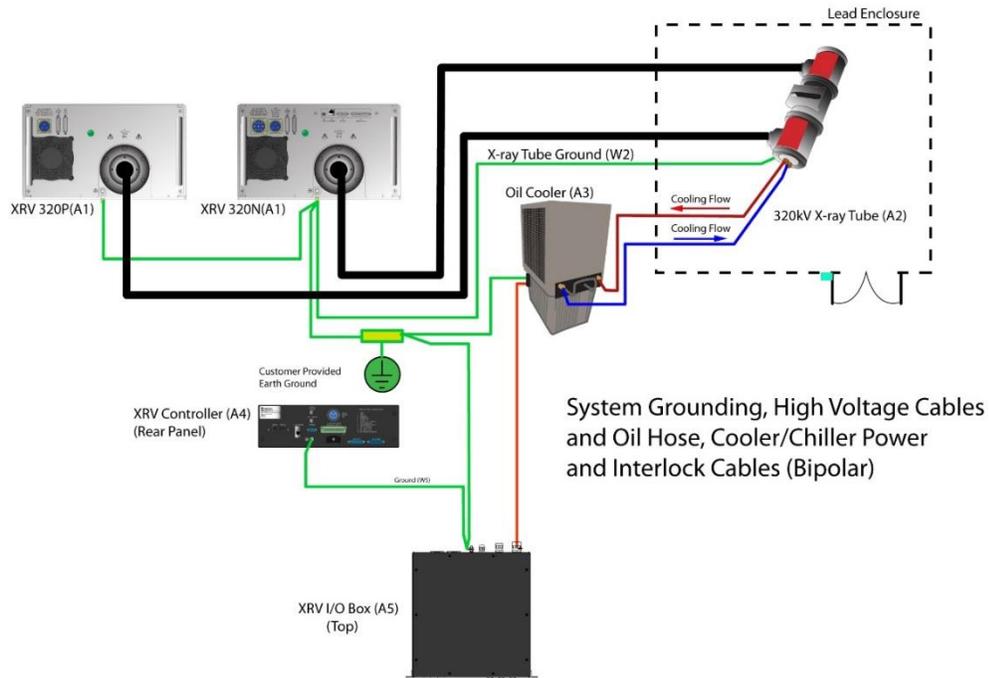


	<b>CAUTION</b>
	<p><b>Caution: Potential Hazard!</b>                  Inadequate cooling flow or undersized cooling systems will result in X-ray tube overheating and cause damage. Abide by the tube manufacturer's recommended wattage handling, dissipation and flow capacity ratings.</p>

## Cooler/Chiller Connections: (Complete System)



## Cooler/Chiller Connections: (Complete System)



	<p><b>⚡ WARNING</b></p>
	<p><b>Warning: Potential Hazard!</b> It is imperative that the power from oil coolers/chillers be removed prior to disconnecting the high voltage cables. If the dielectric of the oil is very high, a potential static charge of several thousand volts may develop on the cable due to circulating oil on the anode side of the tube.</p> <p>Allow 5 minutes for the static charge to dissipate on the high voltage cable once the cooler/chiller power is removed.</p> <p>Avoid coming into contact with the tip of the high voltage cable once it is removed. <b>Always ground the tip of the cable to earth ground before handling to avoid injury.</b></p>

## Interlock, Communication Connections (Unipolar Basic):

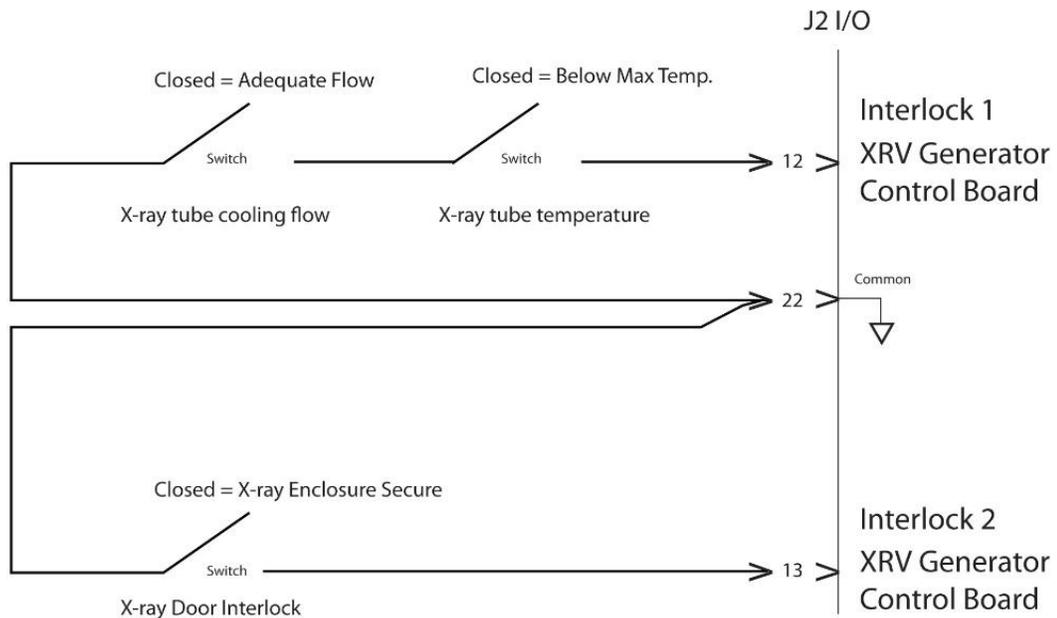
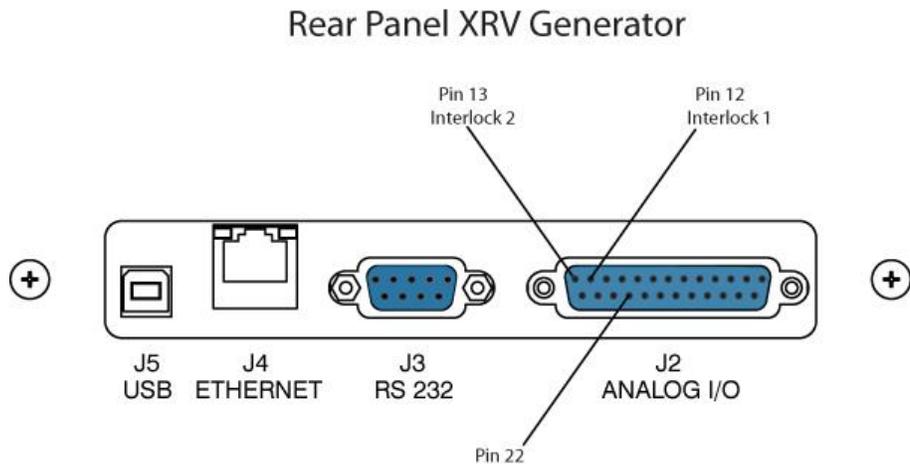
The minimal requirements for the user include the XRV Generator/s, High Voltage Cable and Flanges, Cooling or Chiller, Personal Computer and the X-ray tube. All other requirements such as a lead enclosure, circuit breakers, grounding equipment, interlock switches, safety monitoring and grounding devices are the responsibility of the user. The input power cables should be the last connections installed.

The XRV Generator I/O connector has provisions for safety interlock circuitry that will terminate high voltage. A safety interlock chain is comprised of normally pen switches or contacts that close in a series circuit in order to enable high voltage operation. If the user wishes to enable high voltage but one or

more safety interlocks are open, the high voltage is inhibited until the interlock is satisfied. Interlocks may be latching or non-latching. Latched interlocks occur after high voltage is on and the user must

### Interlock, Communication Connections (Unipolar Basic):

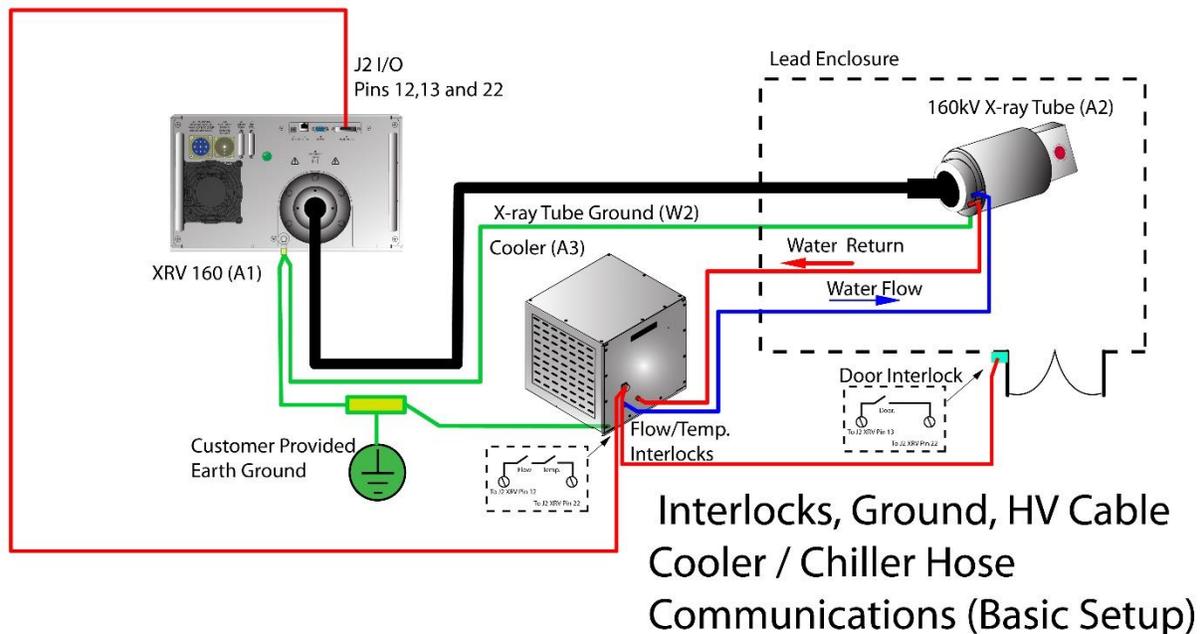
initiate a “fault reset” to clear the condition. If the fault condition still exists, the high voltage is unable to be enabled until the fault is cleared and a reset is initiated. Some common interlocks include x-ray chamber access, chiller/cooler water flow, chiller / cooler water temperature and ambient temperature.



**Typical Interlock Connections**

## Interlock, Communication Connections (Unipolar Basic):

The cooler or chiller will normally provide a thermal switch and a flow switch having a dry set of contacts. This can be used to remove high voltage from the tube. An access interlock switch must be used on the lead enclosure door to prevent high voltage operation when opened.



The next step is to choose the type of communication used for the control of the XRV Generator. There are three communication interface options including a Com Port RS-232, Ethernet Connection, and USB connection. The most commonly used is the RS-232 Com Port Connection. The connection consists of a customer supplied cable and the XRV Generator communication software selection.



RS-232 Cable

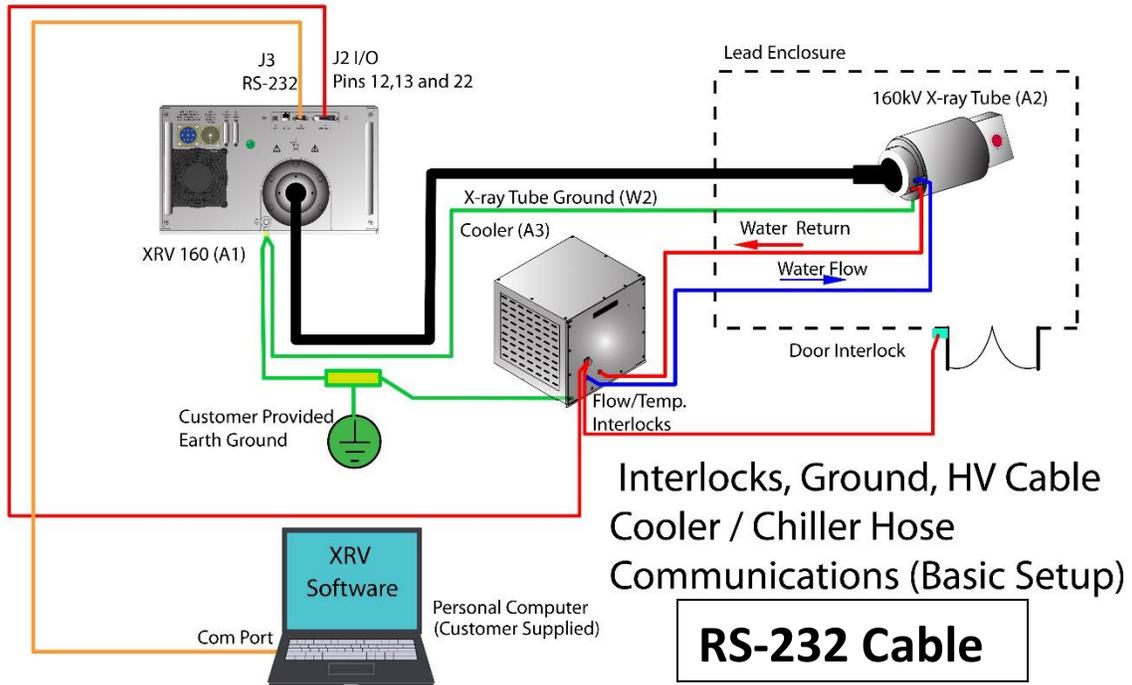


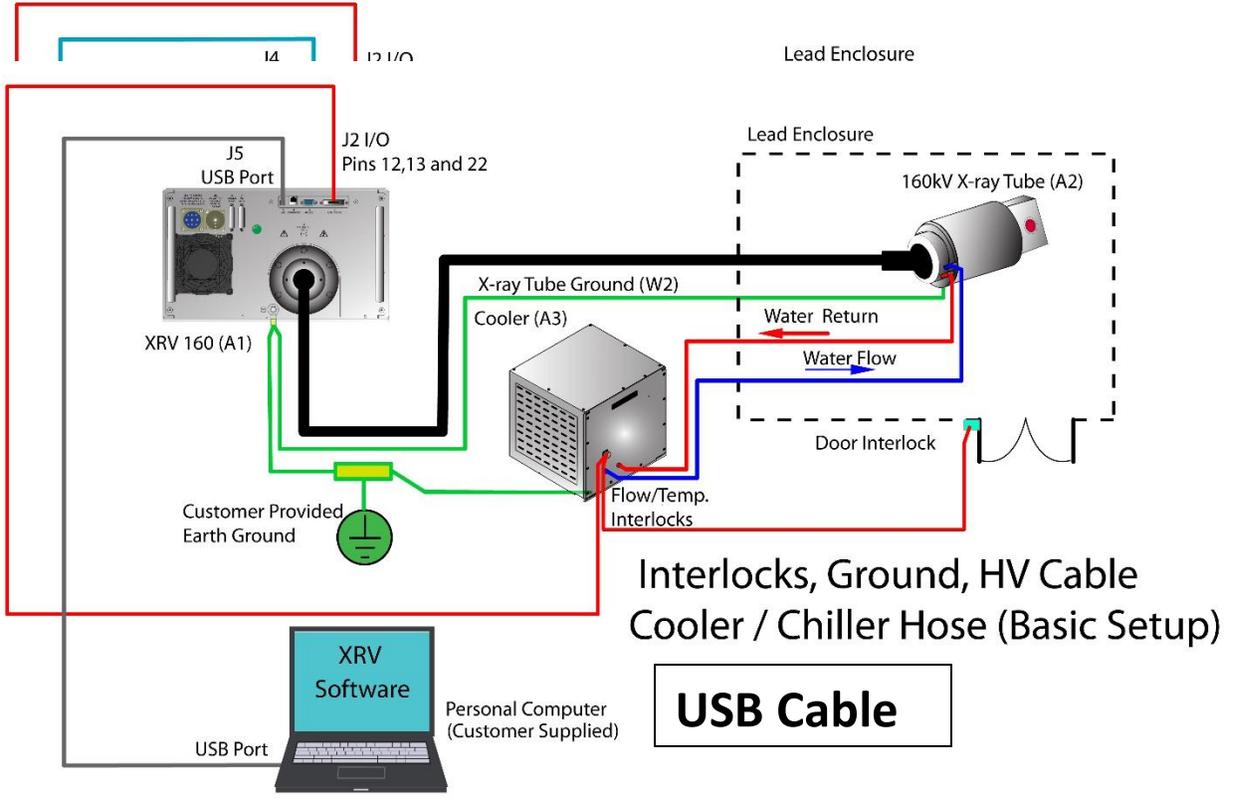
Ethernet Cable



USB Cable

## Interlock, Communication Connections (Unipolar Basic):



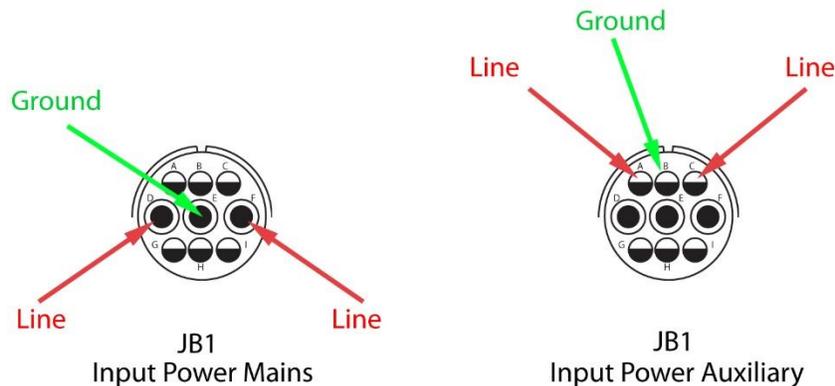


**Interlock, Communication Connections (Unipolar Basic):**

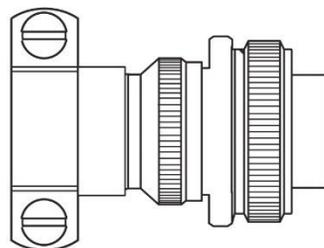
## Power Connections (Unipolar Basic):

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b>          It is the responsibility of the user to observe safety procedures and guidelines set forth in this manual. Exercise extreme caution when connecting power cables or switchgear. The XRV Generator should never be operated without the high voltage cable connections or adequate grounding. Personal protection devices such as grounding rods and fail safe interlocks should be used to prevent a hazard condition. Failure to follow these guidelines may result in injury or death. Power cables and switchgear should only be installed by qualified personnel.</p>

Amphenol style connectors are included with the XRV Generator for connecting power to the unit. There are two types of connectors. Up to 4 kilowatt generators use an Amphenol MS3106A-24-11S straight connector for connecting input power. The 6 kilowatt generator requires a 3 phase input and uses two separate connectors. One connector is for the Mains Input and the remaining is for the Auxiliary Input.



4kW Input Power Max

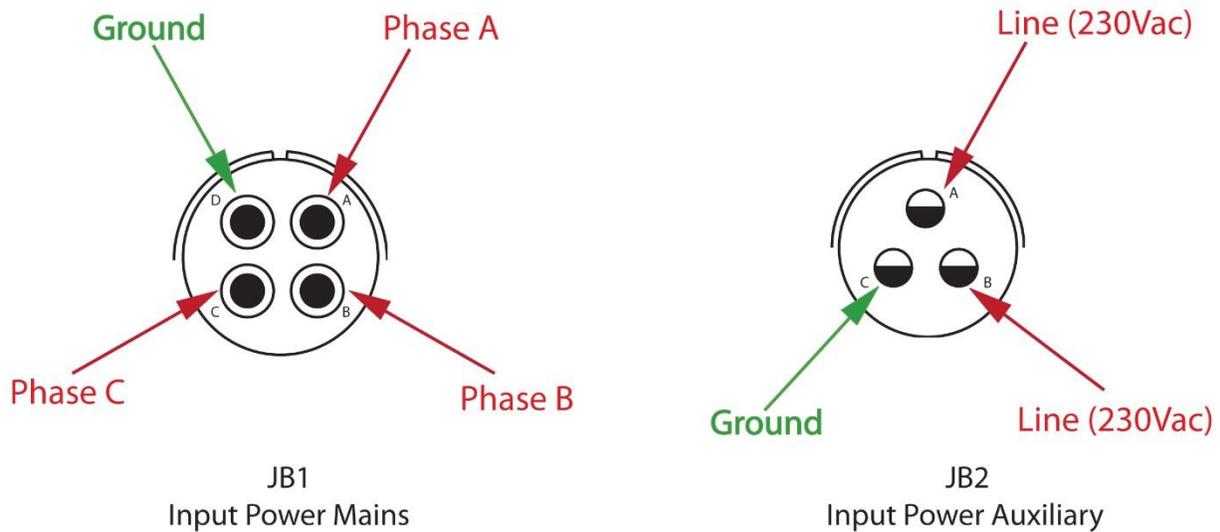


**MS-3106A-24-11S  
 Connector & Clamp**

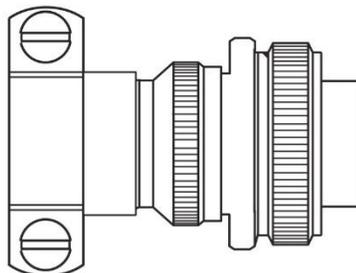
## Power Connections (Unipolar Basic):

Use stranded copper wire #8 AWG for the Input power Mains and Ground connection. Use stranded copper wire #12 AWG for the Auxiliary Line, Neutral and Ground connection. Input power requirements for the 4kW Generators are 180Vac to 264Vac  $\pm$  10%, 30A maximum for Mains and 5A maximum for Auxiliary.

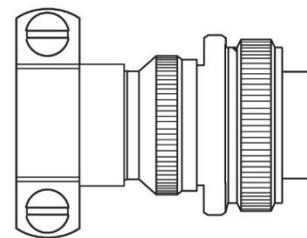
The 6 kilowatt generator uses an MS3106A-24-22S style connector for the Mains Input and an MS3106-20-3S style connector for the Auxiliary Power Input. The 6kW generators require 3 Phase 208Vac  $\pm$ 10%, 30A maximum input or 400Vac  $\pm$ 10%, 15A Max. Input. The input power is selected when placing the order for the XRV Generator. The Auxiliary Power Input requires a separate 230 Vac  $\pm$ 10%, 5A maximum source. Use #10 AWG copper stranded wire for each phase and ground on the Input Power Mains JB-1. Use #12 AWG copper stranded wire for each line and ground on the Input Power Auxiliary JB-2.



6kW Input Power Connectors



MS-3106A-24-22S



MS-3106A-20-3S

## Power Connections (Unipolar Basic):

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> Assembly and handling of input power connections, breakers, and interconnects should only be carried out by qualified personnel. It is important for installation workers and maintenance to observe safety regulations and have proper training to avoid hazardous conditions or injury. Use only recommended wire size, connectors and breakers. A basic knowledge and expertise of soldering is required. Do not connect power source or energize system until all connections are installed and it is safe to do so. Failure to follow these guidelines may result in injury or death.</p>



4kW Input Power  
Connector



6kW Input Power  
Connectors

The input power connectors are required to have soldered connections. Avoid shorts or loose wiring when assembling. Use an ohmmeter to check for shorted connections. Use the appropriate size wire for each connection. Input power wires should be run neat and as short as possible. Avoid high traffic areas or places where they are easily damaged by other equipment. When assembling, remove the clamp and shell to expose the pin cups. Remove the insulation from one end of the wire (approximately 3/8") so the bare wire will touch the bottom of the solder cup and be level with the top. Use the appropriate wire size according to the connector specification. Slide a 1-1/4 inch piece of shrink tubing over the wire insulation for the final step. Using a soldering iron, tin the stranded wire from the tip up to the insulation. Place the wire straight into the pin cup so that the tip rests on the bottom and apply the soldering iron to the outside of the cup. Insert the solder into the cup and apply until it almost fills to the top. Let the connection and wire cool. Check for cold solder joints or solder bridges. Slide the shrink tubing down over the cup pin and heat the tubing with a heat gun so that it fits snugly over the wire and cup. Repeat the procedure for the remaining connections. Check each connection so that it is secure and not touching any other connections. Slide down the cover and ring clamp with the rubber shroud toward the connector and tighten. Secure the wire clamp by tightening the two screws.

## Power Connections (Unipolar Basic):



Strip and Tin  
Appropriate Size Wire



Insert Wire into Pin Cup  
and Apply Solder



Slide Shrink Tubing Over  
Solder Cup and Apply Heat



Shrink Tubing Over  
Soldered Connections

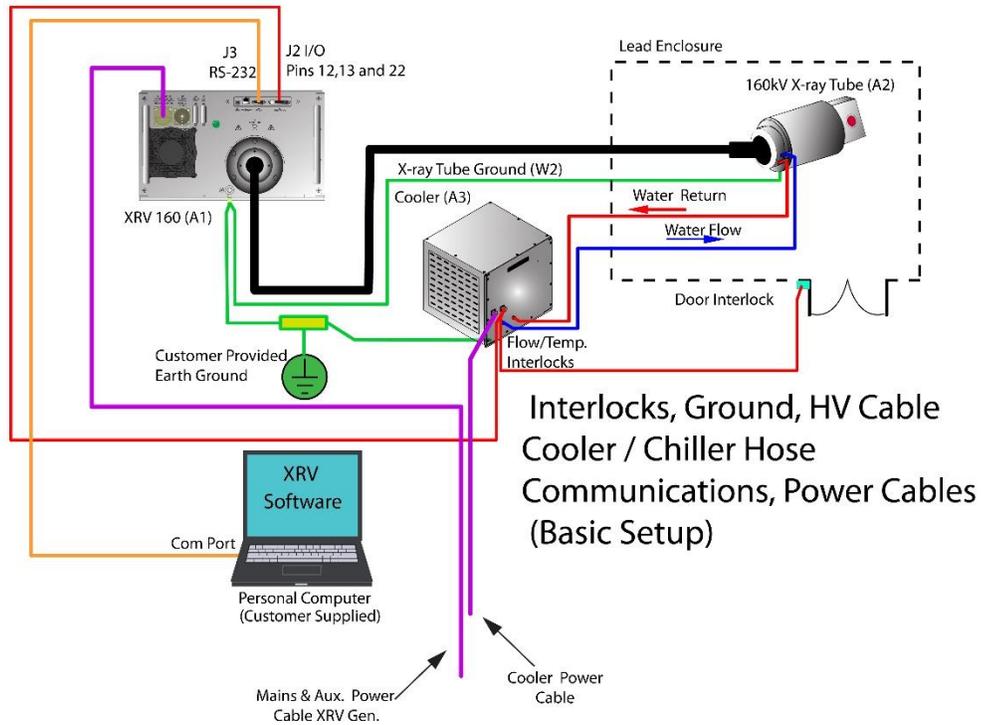


Completed XRV Cable, Clamp  
and Rubber Shroud

The input power connections for the 6 kilowatt XRV Generator is the same procedure as above with the exception of the additional connector and different wire size. Check all power connections to the XRV Generator before any connections to the mains and auxiliary power source.

**Note: The cooler / chiller system will have instructions on cable sizing for power connections and interlock connections.**

## Power Connections (Unipolar Basic):



## Power Source Connections (Unipolar Basic):

A single phase 208 Vac, 60 Ampere power source is required for the 4 kilowatt XRV Generator. Use a circuit breaker rated for 30 amperes for protection on the mains input and a circuit breaker rated for 10 amperes on the auxiliary input. Typically a 7.5 amp. breaker is used for the cooler and a 20 amp. breaker for a chiller. Consult the cooler or chiller manual for circuit breaker sizing. Consult Spellman High Voltage for input voltage options.

	 <b>WARNING</b>
	<p><b>Danger: Dangerous Voltages</b>            Incorrect wiring or connections to the Mains or Auxiliary AC voltage will result in damage to the system or personal injury. Always use appropriate sized circuit breakers or fuses when connecting. Check for loose wiring or shorted connections prior to applying power. Only qualified personnel should install Mains and Auxilliary connections.</p>

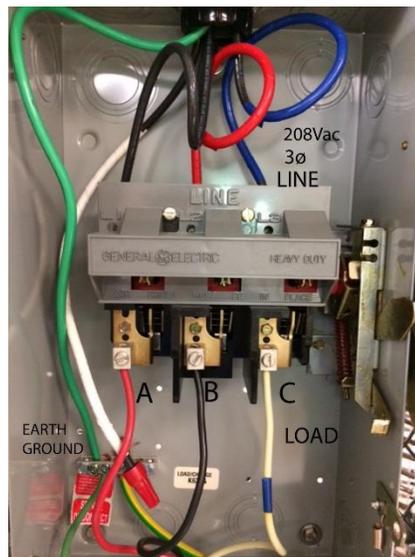
## Power Source Connections (Unipolar Basic):

The circuit breakers should be located on a panel in an accessible area. It is recommended but not necessary to have an emergency stop switch that will interrupt all the input power sources to the generator and subsystem.



Emergency Stop Switch

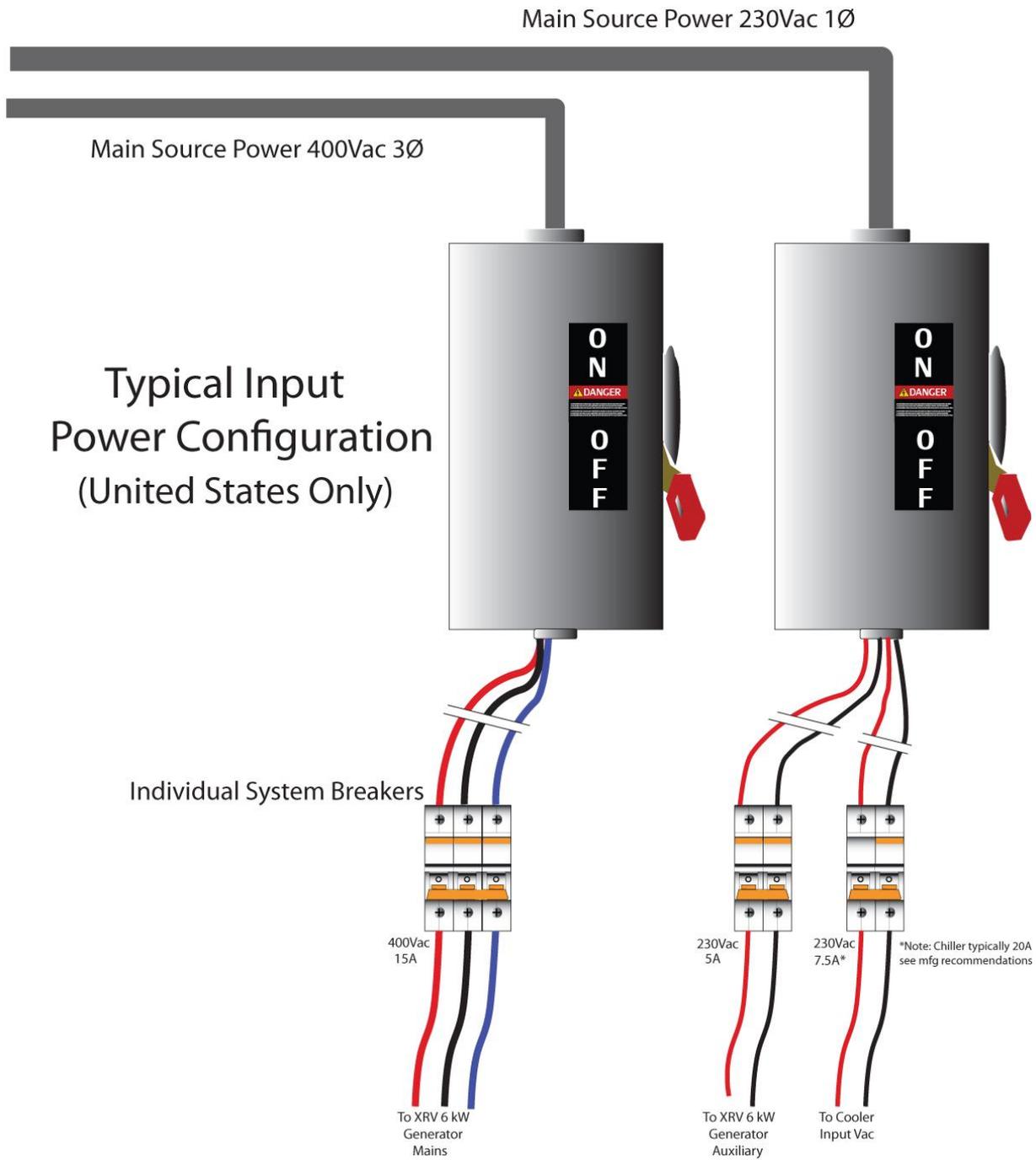
Verify that the ground buss bar in the main breaker panel connects to earth ground. Connect the mains and auxiliary cable from the XRV generator and the cooler or chiller to the load side of the circuit breakers.



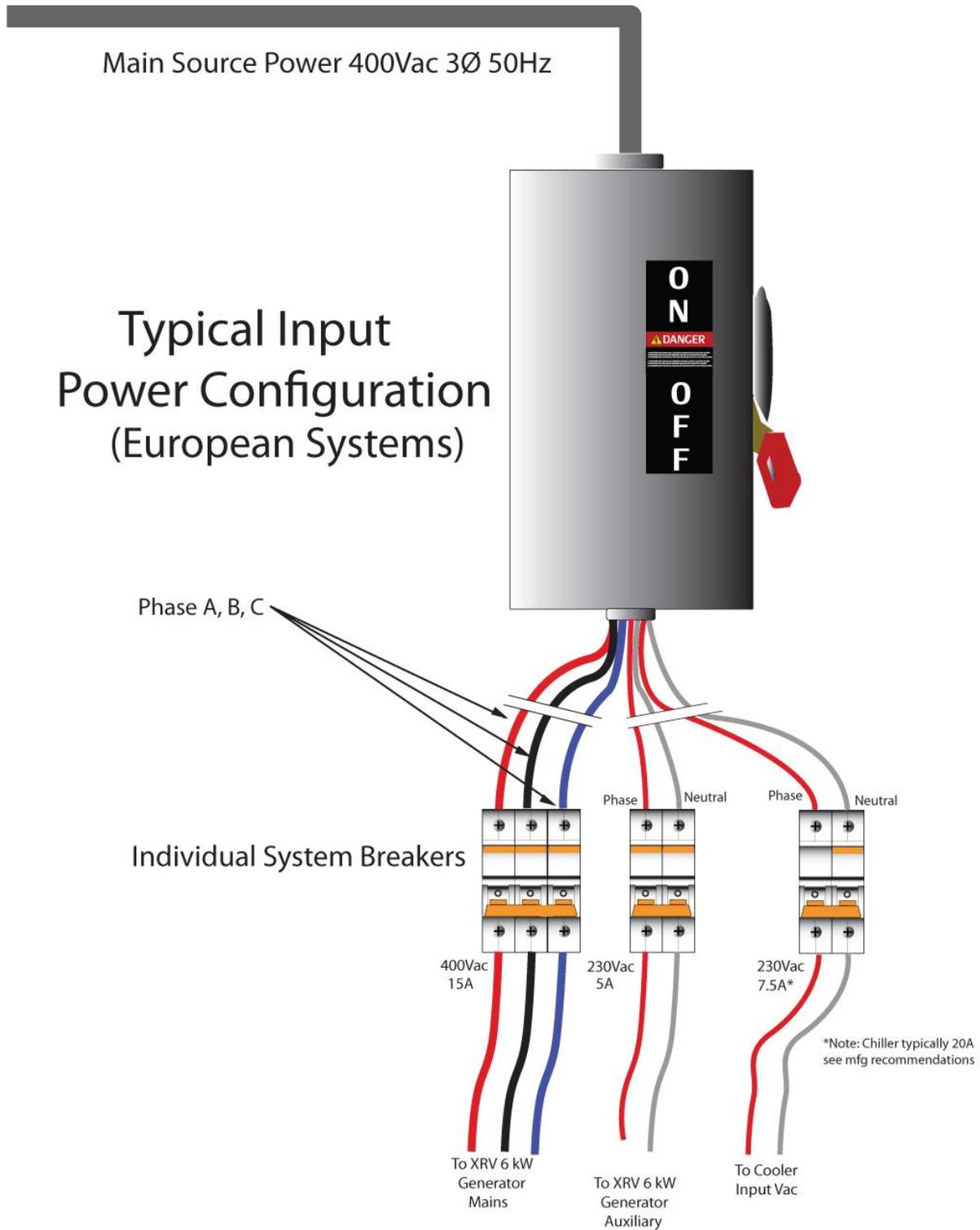
Typical 208 Vac 3Ø Breaker Box



## Power Source Connections (Unipolar Basic):



## Power Source Connections (Unipolar Basic):



## Power & Feedback Connections (Bipolar Basic):

The power connections for bipolar XRV Generators are identically the same as the unipolar XRV Generators with the exception of an added chassis and three interconnect cables. Follow the procedure for the unipolar generators but include the following cables and additional chassis ground. See page 35 for system diagram.



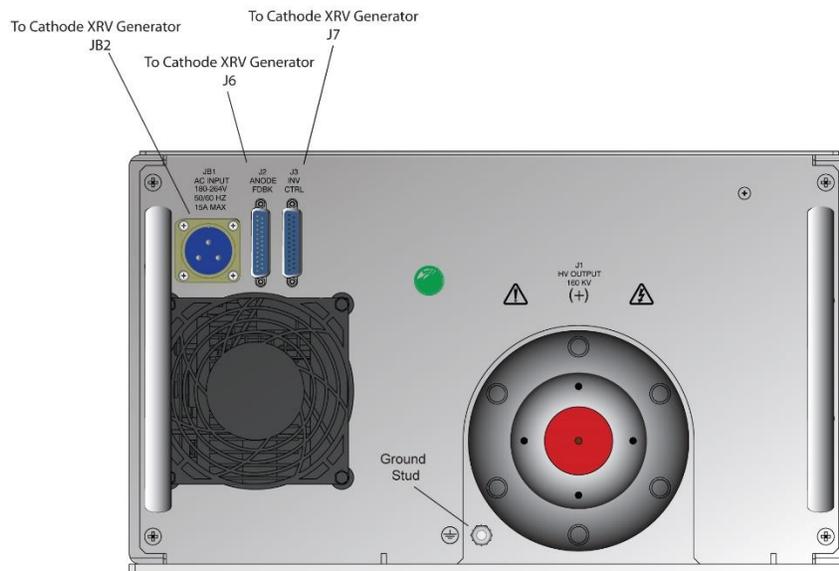
JB1 to JB2 Anode to Cathode Power Cable



J2 to J6 Anode to Cathode Feedback Cable



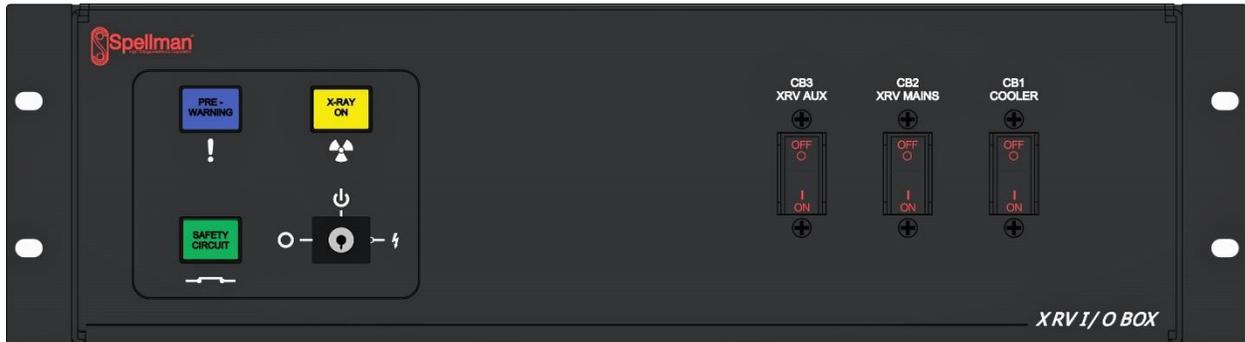
J3 to J7 Anode to Cathode Inverter Control Cable



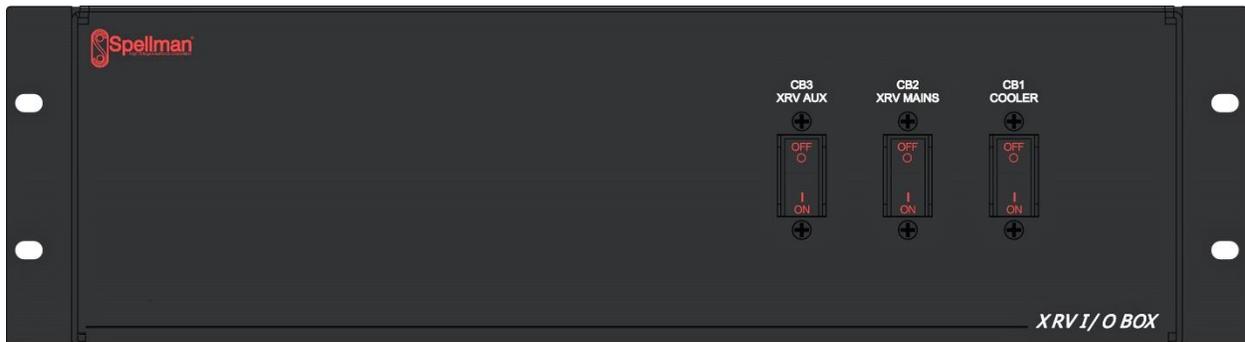
Anode Power & Feedback Connections

## Power Connections (I/O System Interface Box):

The I/O Box offers a convenient method to connect the input power, the XRVC Controller, XRV Generator and Cooler/Chiller and associated interlock circuits. If the I/O System Interface Box is used without the XRVC Controller, it will include a key switch and 3 status indicators on the left side of the front panel. If the XRVC Controller is used, then the left side of the panel will be blank.



I/O Box Configuration without  
Optional XRVC Controller

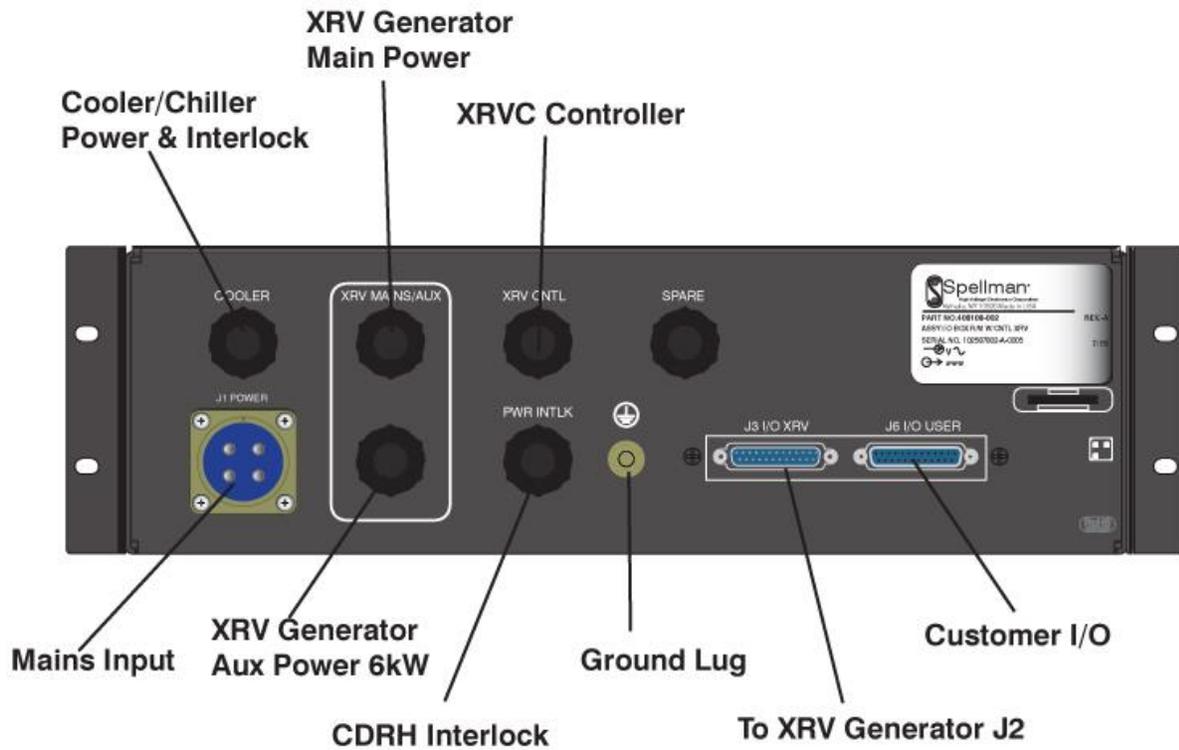


I/O Box Configuration with  
Optional XRVC Controller

Both I/O Boxes include an Amphenol style connector on the rear panel for input power connections. The circular connector can be either supplied as a separate piece or with the user specified cable length. If the user decides to install the cable, use #8 AWG copper stranded wire soldered to the Amphenol mating connector.

	 <b>WARNING</b>
	<p><b>Danger: Dangerous Voltages</b>            Incorrect wiring or connections to the Mains or Auxiliary AC voltage will result in damage to the system or personal injury. Always use appropriate sized circuit breakers or fuses when connecting. Check for loose wiring or shorted connections prior to applying power. Only qualified personnel should install Mains and Auxilliary connections.</p>

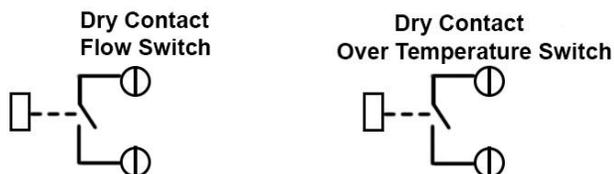
## Power Connections (I/O System Interface Box):



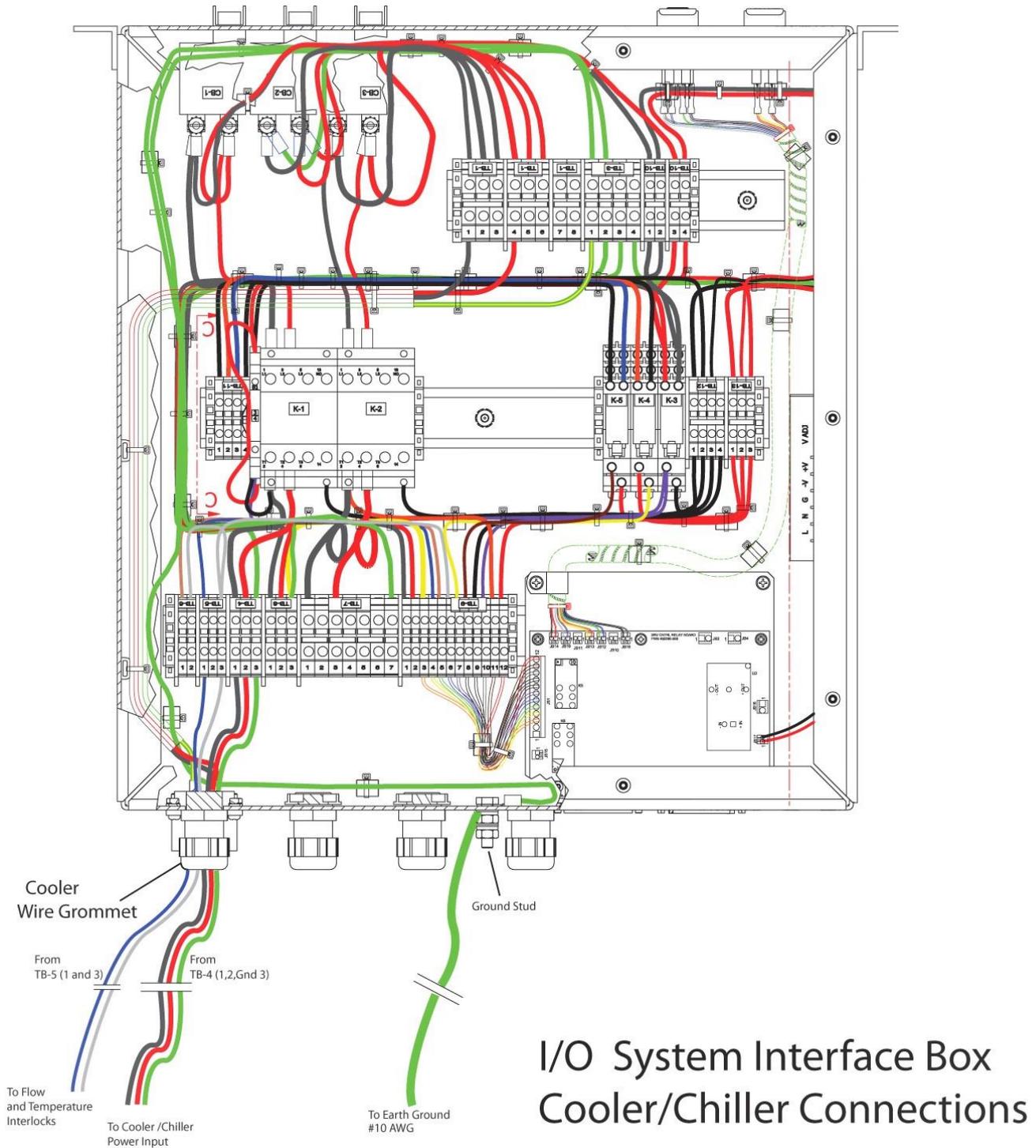
**Note: Included cables with the I/O Box not shown for the Generator Power, or XRVC Controller**

Connect the ground lug on the rear panel to earth ground. Use a minimum of #6 AWG copper stranded wire. Remove the top cover of the I/O Box for the Chiller or Cooler Interlock and power cable installation. The Chiller or Cooler includes instructions for sizing the input power wire and detailing water or oil flow and thermal interlock connections. Remove the top of the I/O Box and locate TB-4 and TB-5. Route the input power wires from the Cooler or Chiller through the “Cooler” wire grommet and connect to TB-4 Terminals 1, 2 and 3. Make sure that #3 is the ground connection from the Cooler or Chiller. The Cooler or Chiller voltage is normally 230Vac single phase. Consult the manufacturer for additional information. Connect the interlock switches for temperature and coolant flow from the Cooler or Chiller through the “Cooler” grommet to TB-5, Terminals 1 and 3. **Refer to cutout of I/O Box diagram for connection locations.**

### Interlock Switches Cooler/Chiller

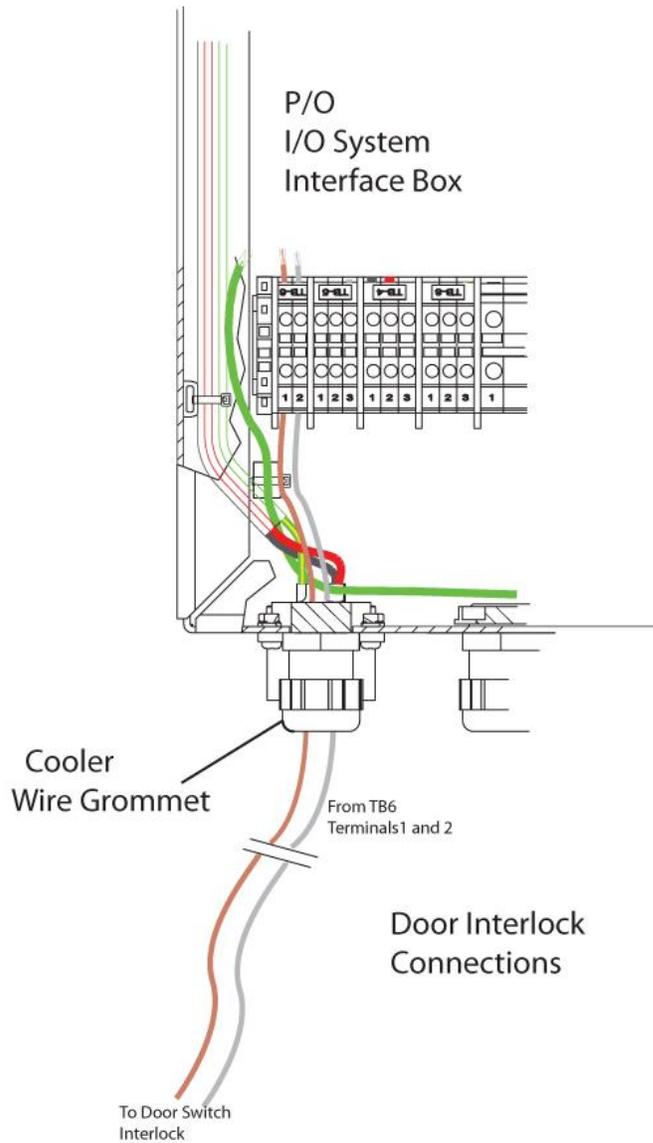


## Power Connections (I/O System Interface Box):



## Power Connections (I/O System Interface Box):

The I/O Box also includes an additional door interlock that may be used to interrupt power to the XRV Generator in the event of unauthorized access to the X-ray chamber or other restricted areas. The interlock connection is located on TB6 terminals 1 and 2. Use #16 AWG copper wire for the connections.

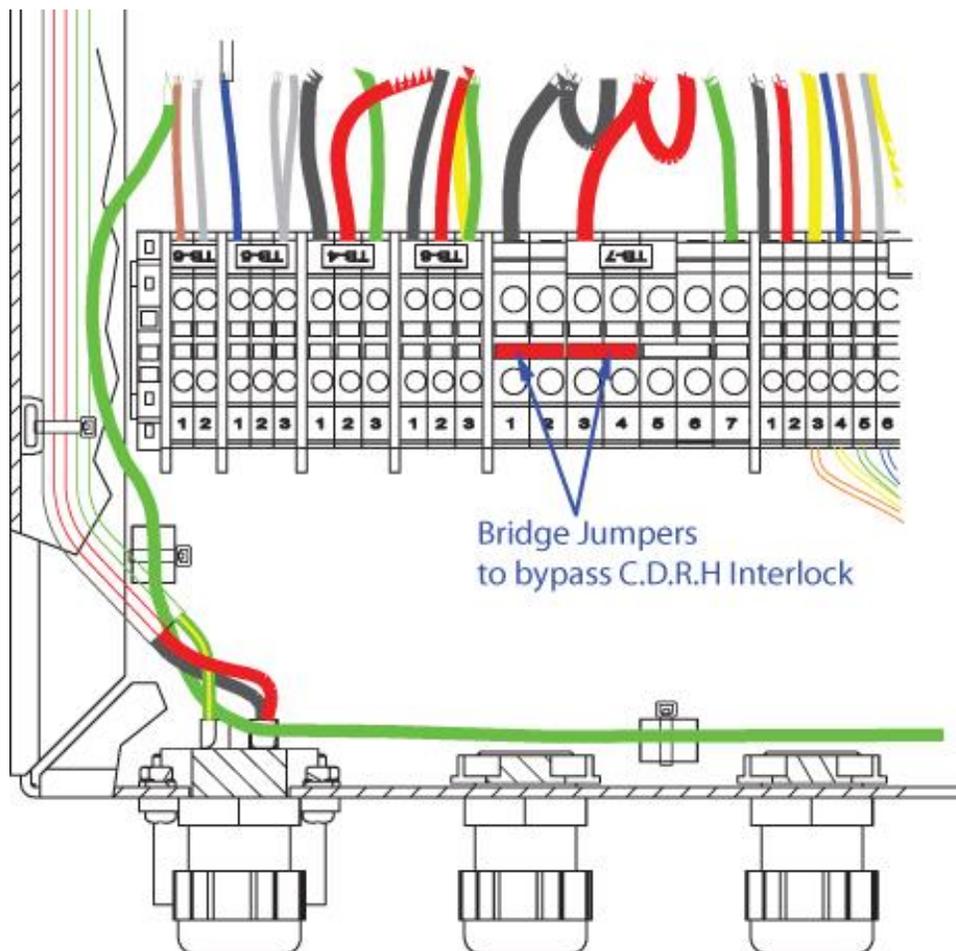


## Power Connections (I/O System Interface Box):

If a Door Power Interlock is used, remove the bridge jumper on TB7 terminals 1 and 2 and terminals 3 and 4. The Power Interlock is designed for use with C.D.R.H. requirements that are mounted to an x-ray cabinet and door to provide the required disconnection of the input voltage independent of any moving parts other than the door.

**WARNING**

**Warning: Dangerous Voltages**  
Do not attempt to remove the top cover of the I/O Box with the input power applied. Do not remove or replace C.D.R.H. jumpers or interlock connections with the main power energized. Failure to remove power from the input connections may result in personal injury or death. Installation and maintenance should only be carried out by qualified personnel.



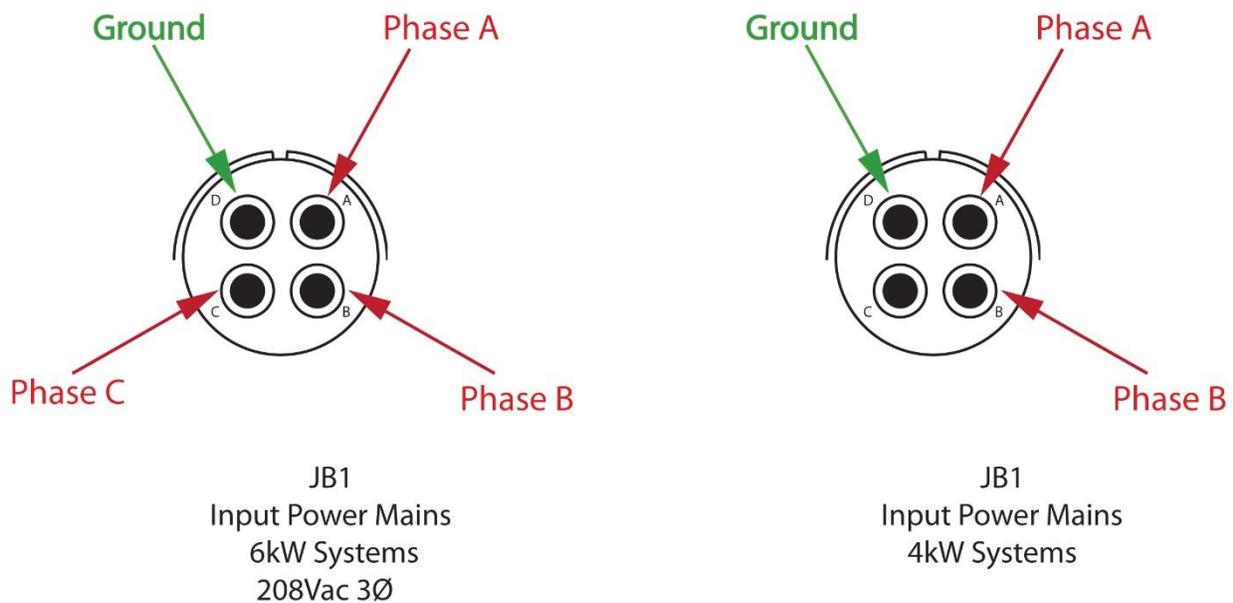
**C.D.R.H. Bridge Jumper Location TB-7**

## Main Input Power Connections (I/O System Interface Box):

The main input power connections will depend on the power rating of the XRV Generator. A 4kW XRV Generator will require a single phase 180Vac to 264Vac source while the 6kW XRV Generator requires a 3 phase 208Vac +/-10% Input. The input voltage requirement for the 6kW units must be specified by the user when purchased. If the user installs the input power cables, the appropriate wire size must be used. Recommended wire for the 4kW generators and below is copper stranded #8 AWG. The wire size for the 6kW 3 phase systems is #10AWG due to the higher current draw on the input line. With the exception of the Cooler/Chiller and Power Door Interlock connections, all of the cabling and connectors are provided with the I/O System Interface Box to easily connect all of the subsystem components.

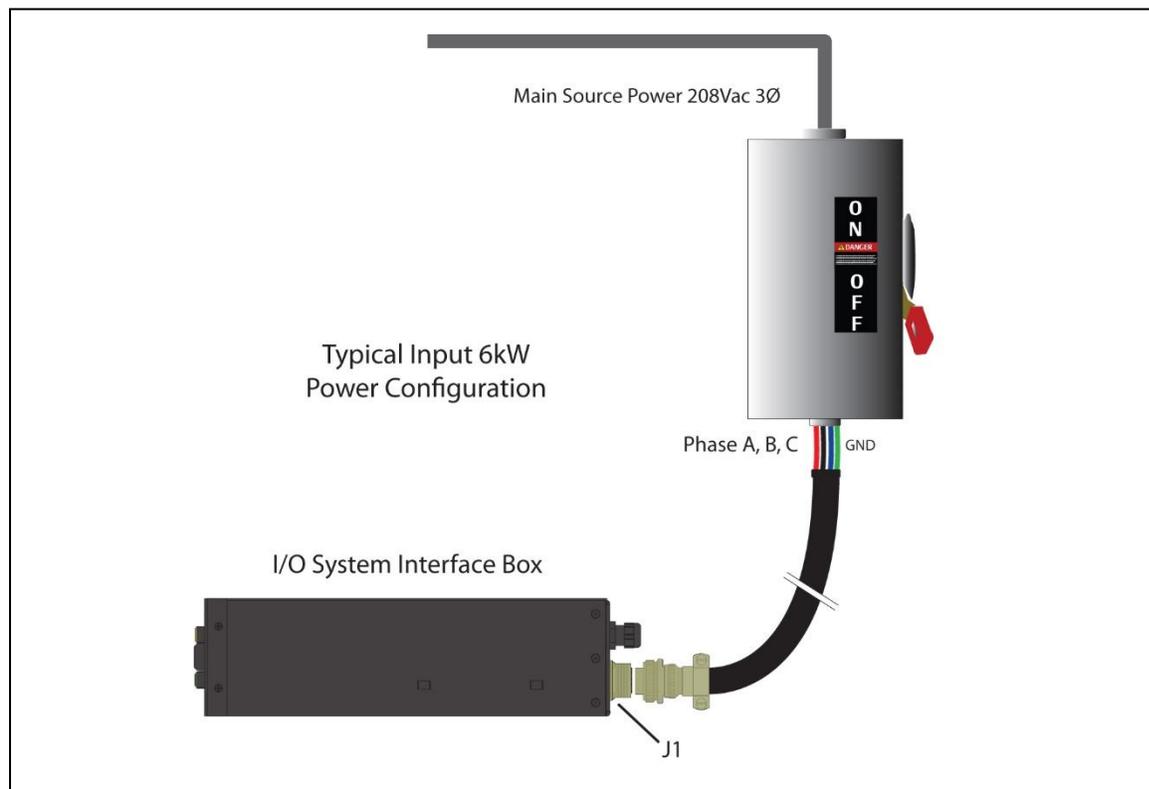
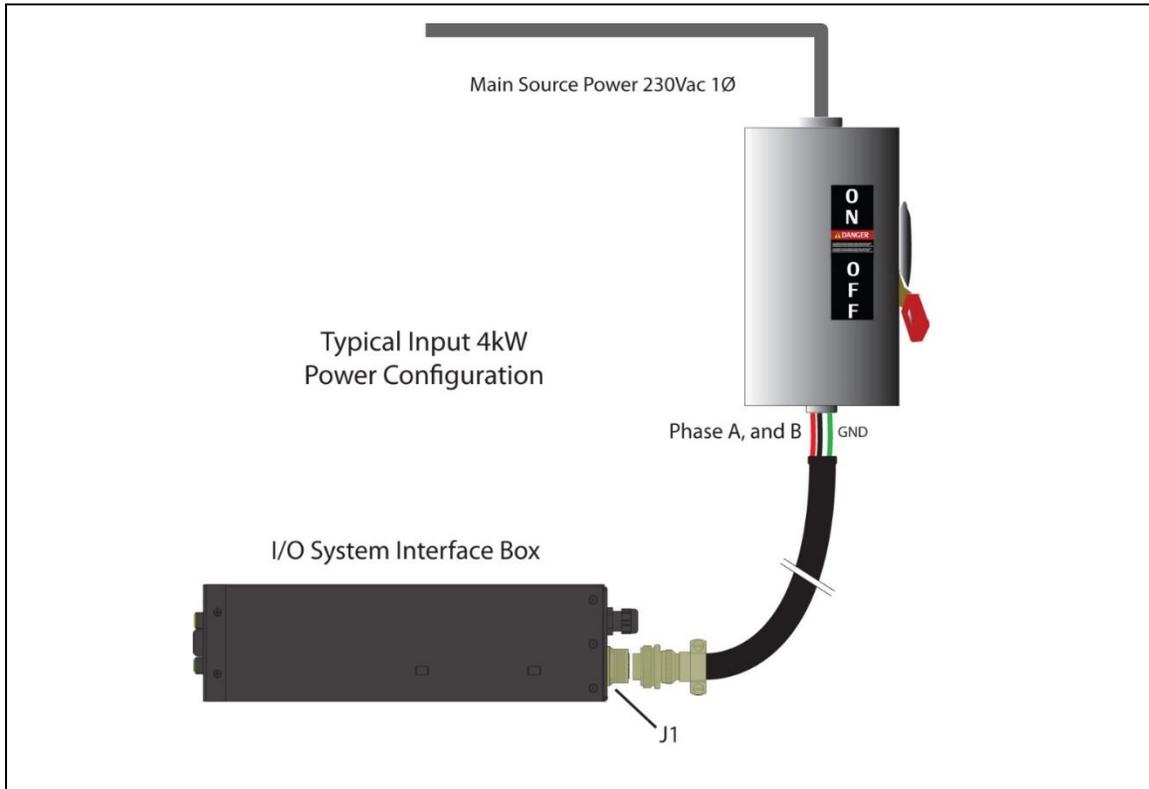
**Note: Although a 3 phase 400Vac system can be selected, the I/O Subsystem Box for that voltage is not available at this time.**

### I/O System Interface Box Input Power Connections

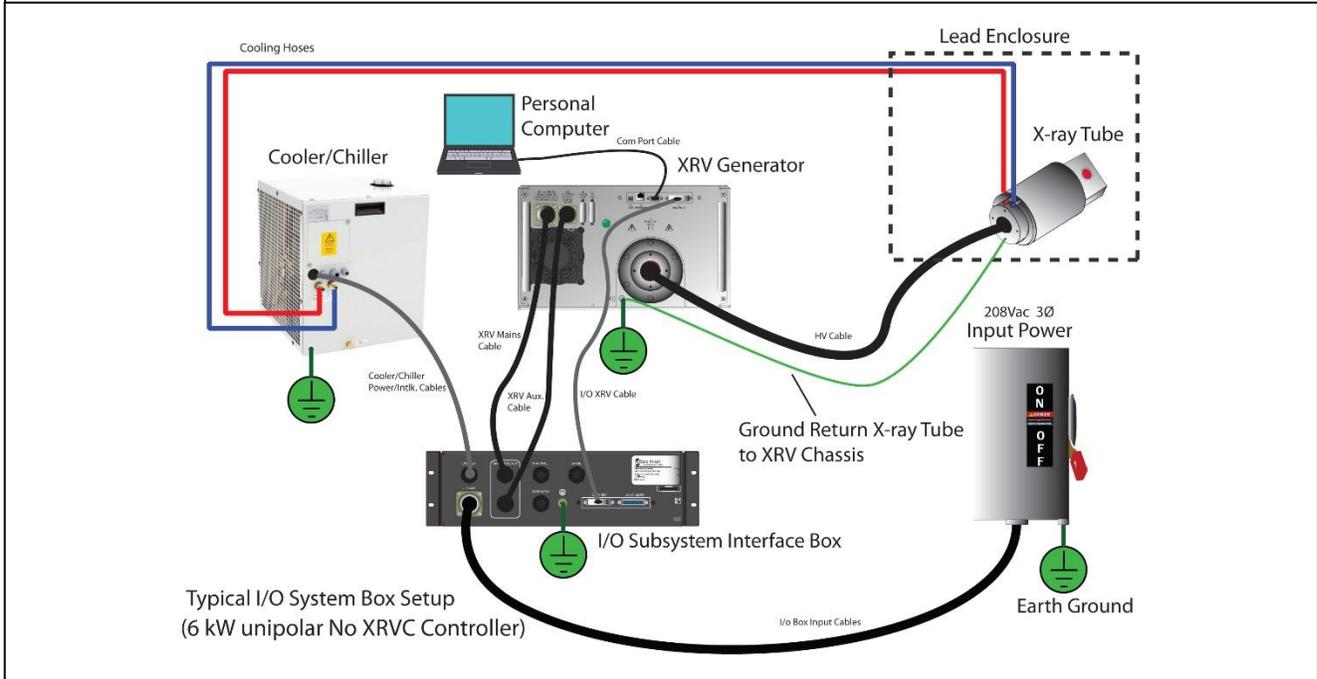
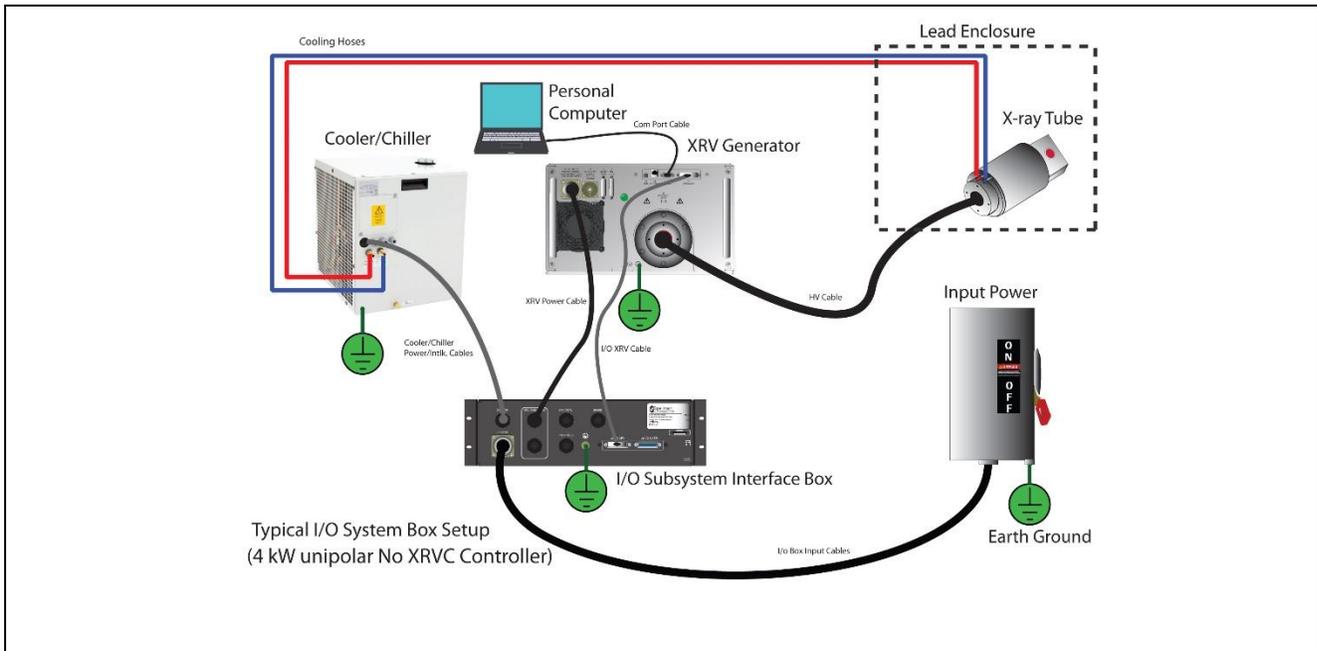


**\*Note: 400Vac 3Ø System I/O Box Not Currently Available**

## Main Input Power Connections (I/O System Interface Box):

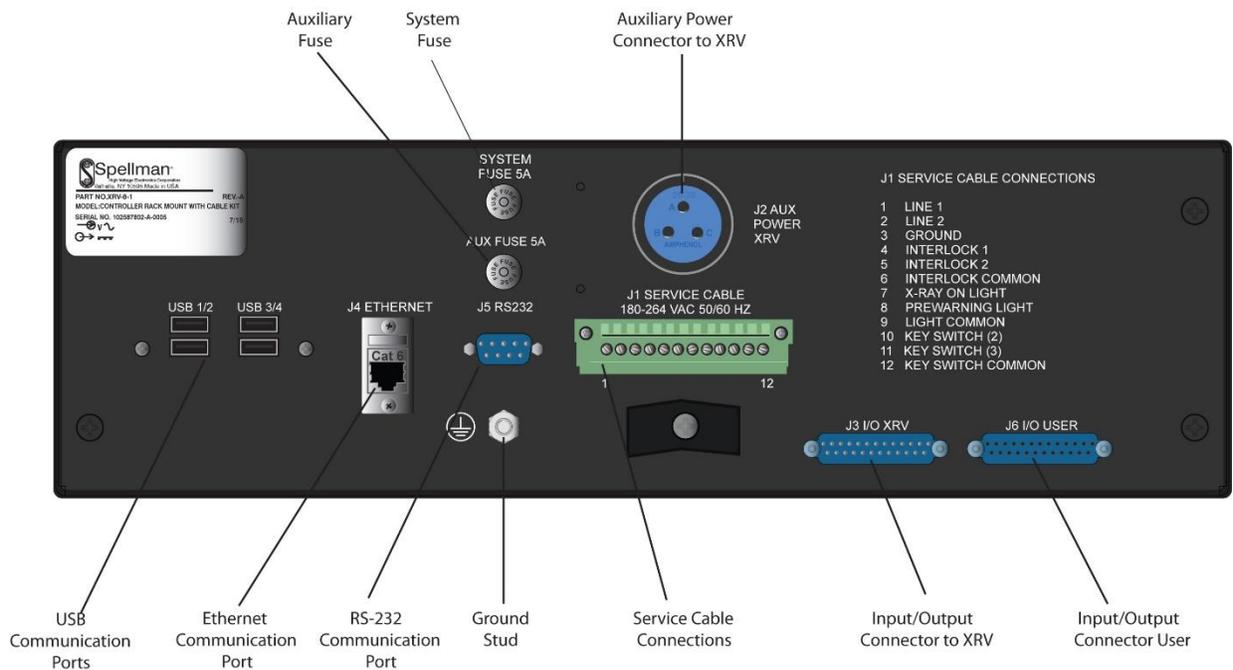


## I/O Subsystem Interface Box (System Diagram):

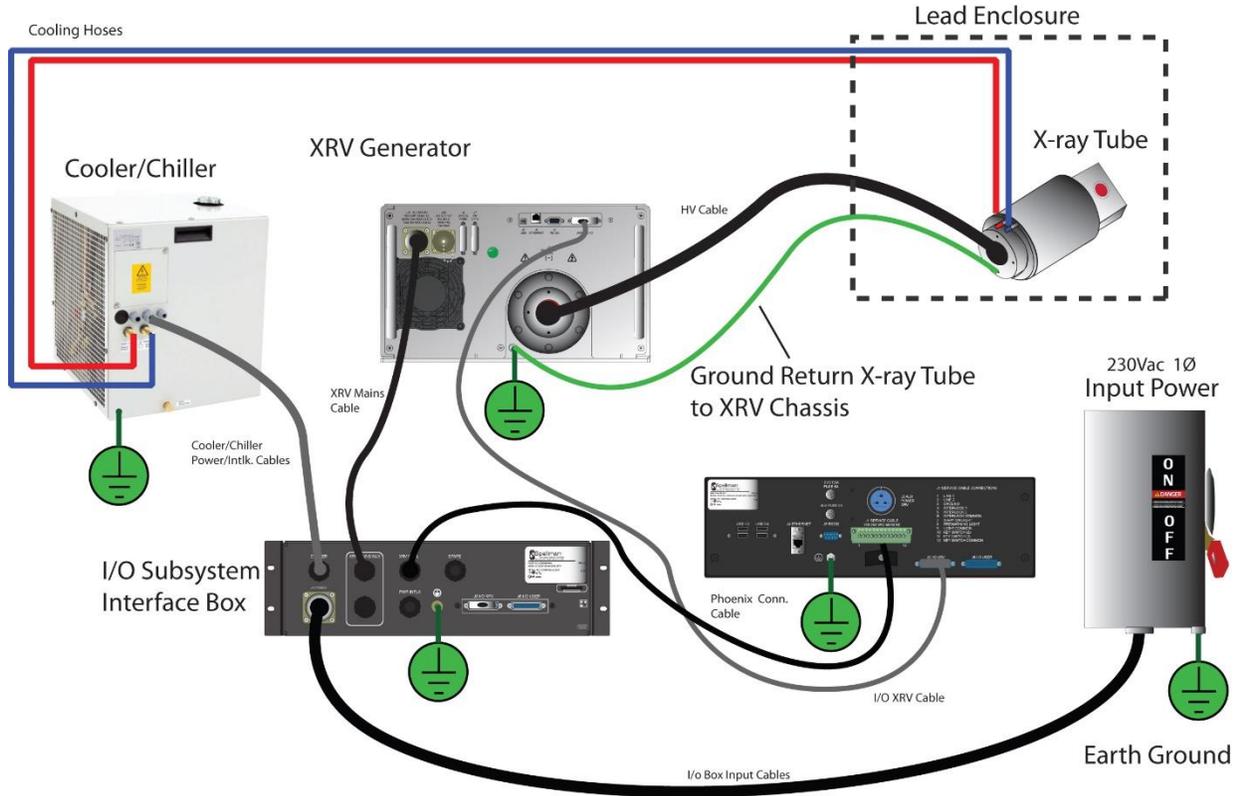


## XRVC Control Box:

The XRVC Control Box eliminates the need of having a personal PC to run and monitor the XRV Generator and subsystem components. It employs an embedded computing system that runs a custom graphical user interface (GUI) and allows the user to configure custom X-ray tube profiles for any of the Spellman XRV series. Although it can be used without the I/O System Interface Box, it is more readily integrated with it. The I/O Box includes the cables and connectors that intuitively connects to the XRVC Controller. The placement and setup is relatively quick and allows the user a plug and play system. Instructions on setting up the XRVC controller and operation are covered in the XRVC manual.

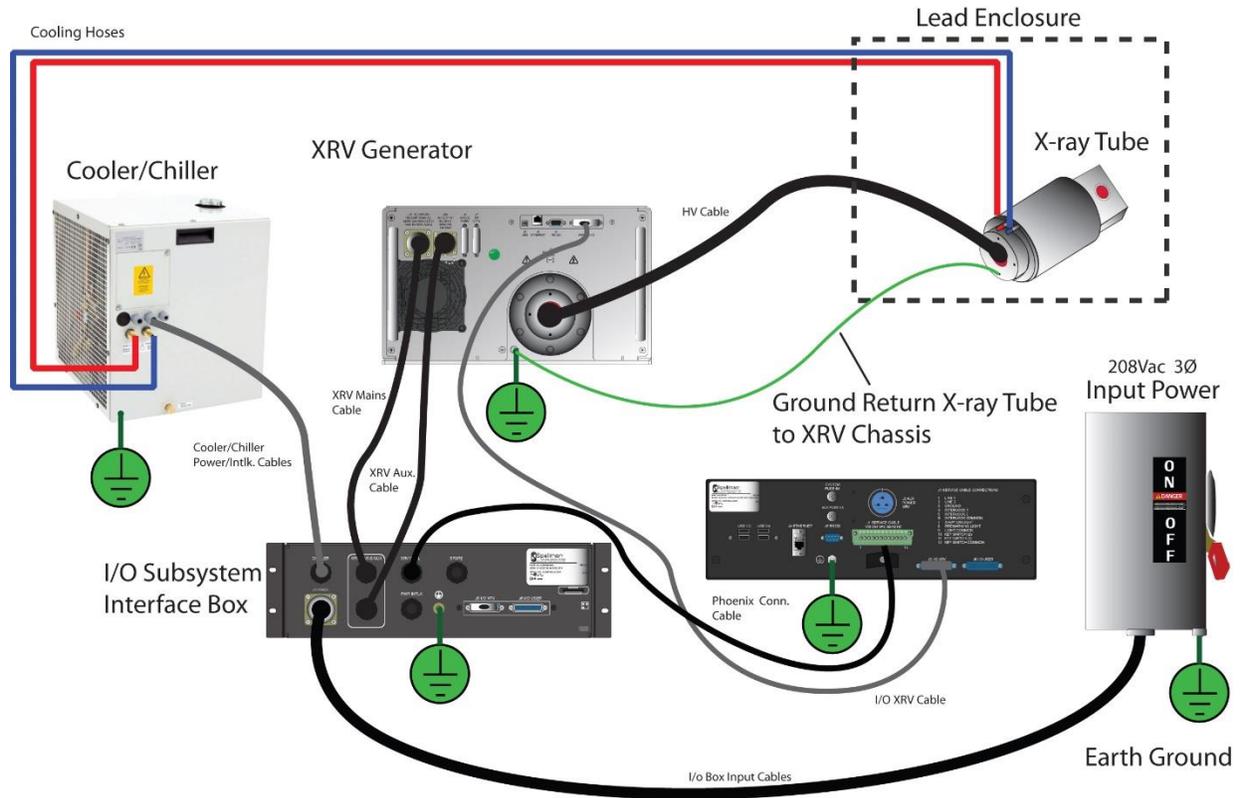


## XRVC Control Box and I/O System Box Setup:



XRVC Controller, I/O System Interface Box, Cooler/Chiller, XRVC Generator and X-Ray Tube Setup for 4kW System

## XRVC Control Box and I/O System Box Setup:



XRVC Controller, I/O System Interface Box, Cooler/Chiller, XRVC Generator and X-Ray Tube Setup for 6kW System

## GUI Installation:

The GUI is designed to control the XRV series x ray generator. It allows users to control all necessary functions of the x-ray generator from a user-friendly windows base menu. Functionality is organized into nine screens that appear as tabs within the GUI. The “Main Control” screen will generally be the used most frequently. Additional screens for seasoning, communication, user configuration and filament control provide functionality necessary to control and monitor all aspects of the XRV series power supplies.

### 1.1 System Requirements

- A computer with a male RS232 D 9 pin connector
- Windows XP, Windows 7, or Windows 10
- CD-ROM drive, USB or from Spellman website
- Color Monitor with display resolution of 1024 X 768

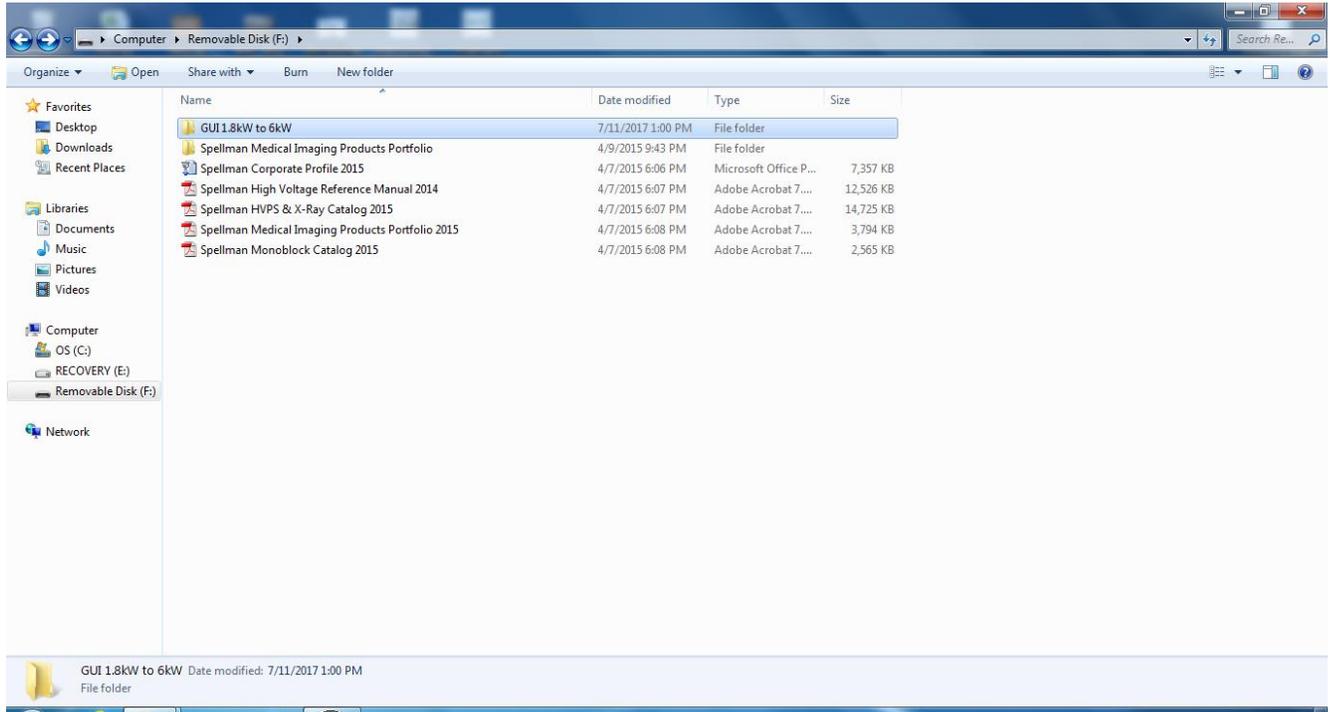
### 2.2 Installation via CD

1. Insert the XRV disk in the CD Drive
2. Click “Start” Button on screen
3. Click on “My Computer icon”
4. Click CD drive icon
5. Double-click on the XRV setup icon
6. Follow the instructions displayed on screen

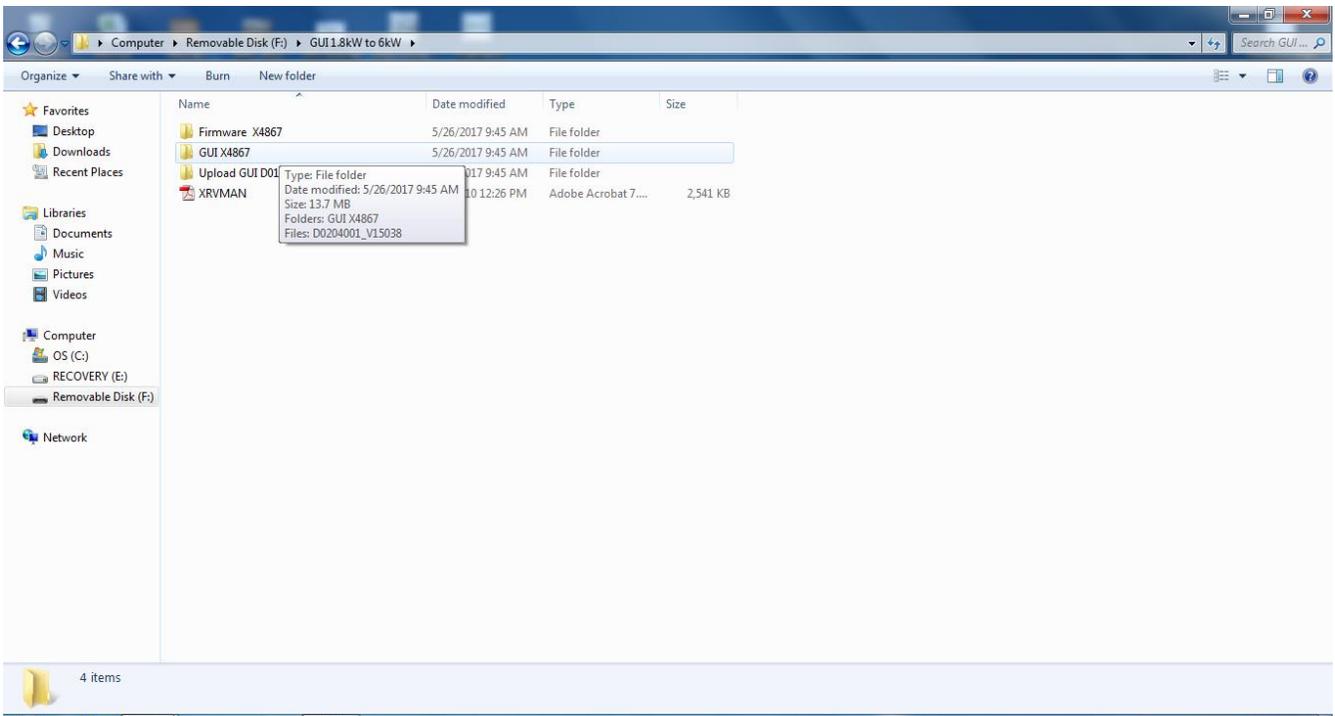
### 2.3 Installation via USB Flash Drive

1. Insert the XRV flash drive in the USB port of the computer
2. Open the GUI 1.8kW to 6kW folder
3. Open the GUI X4867 folder
4. Open the GUI X4867 subfolder
5. Open D0204001\_V15038 folder
6. Double Click Setup 1 Icon
7. Follow instructions displayed on screen

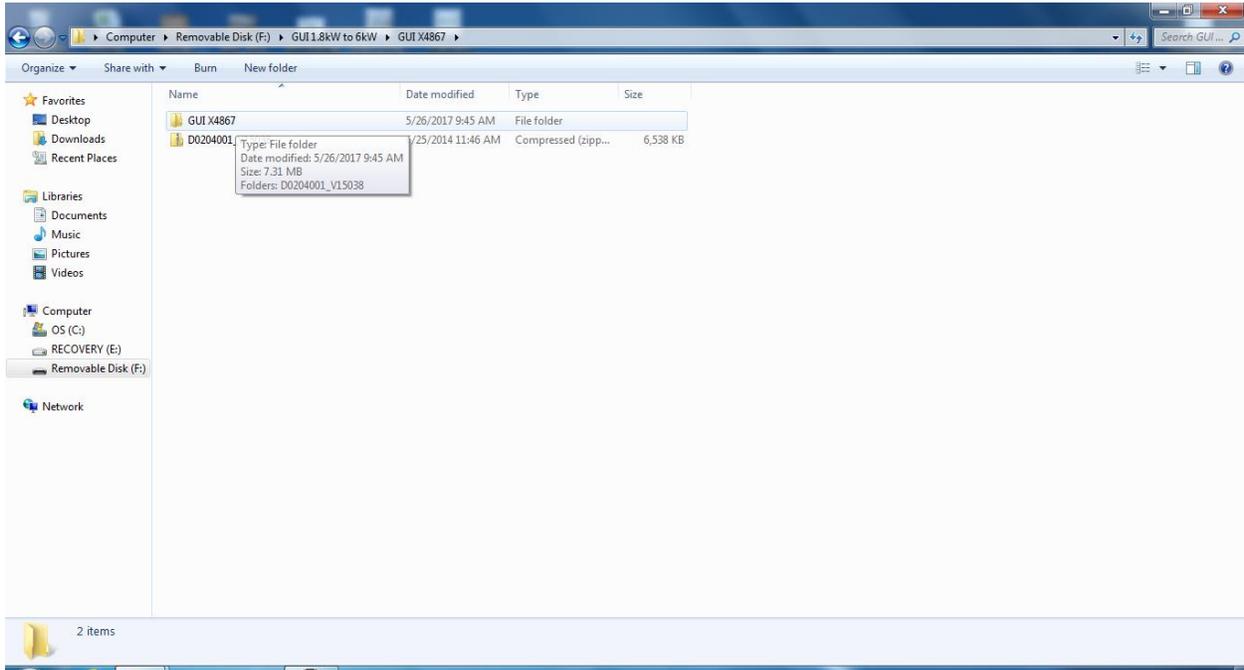
## Flash Drive USB installation Step 1



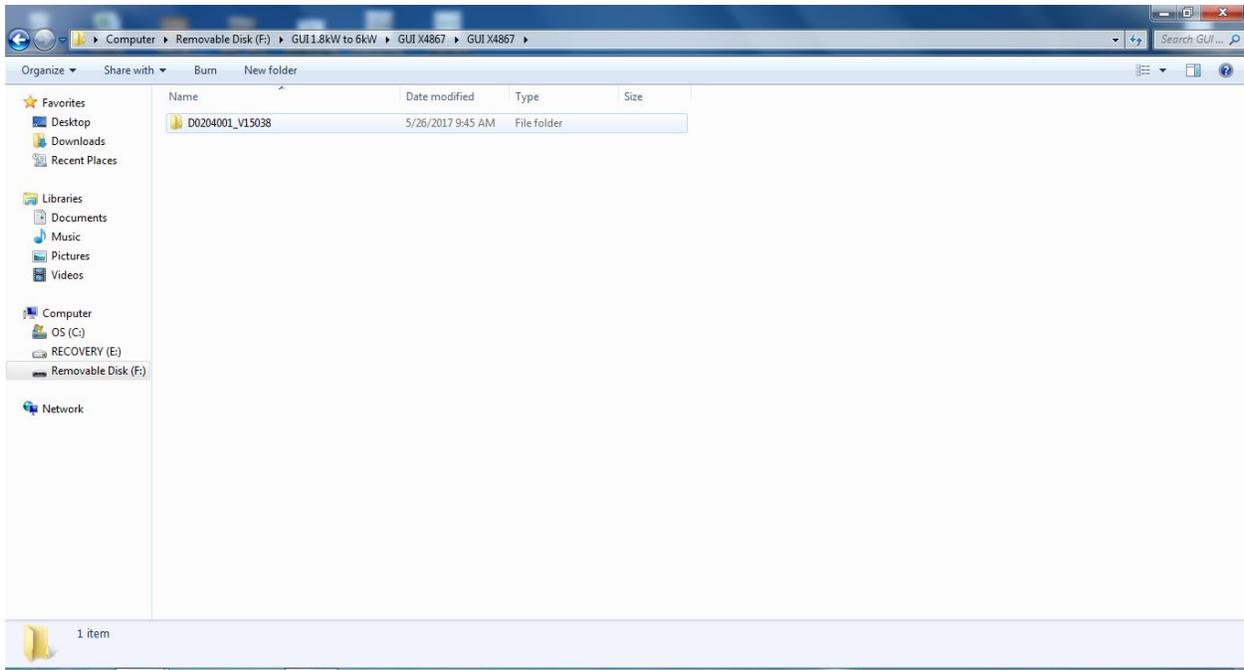
## Flash Drive USB installation Step 2



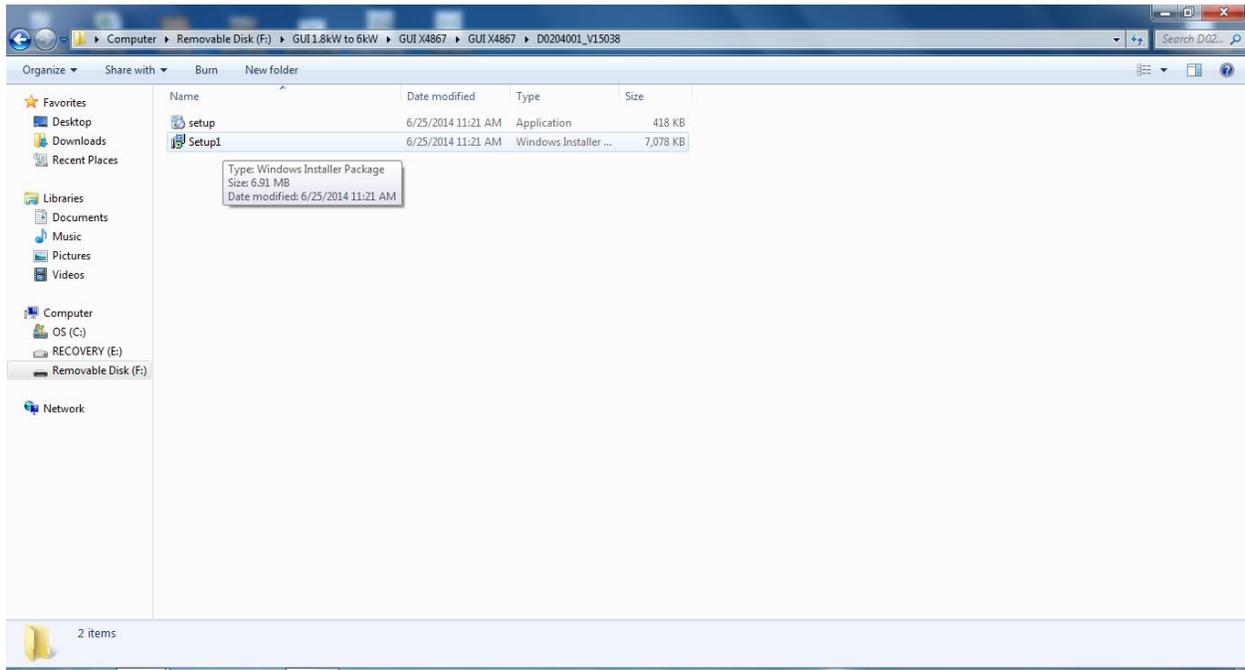
## Flash Drive USB installation Step 3



## Flash Drive USB installation Step 4

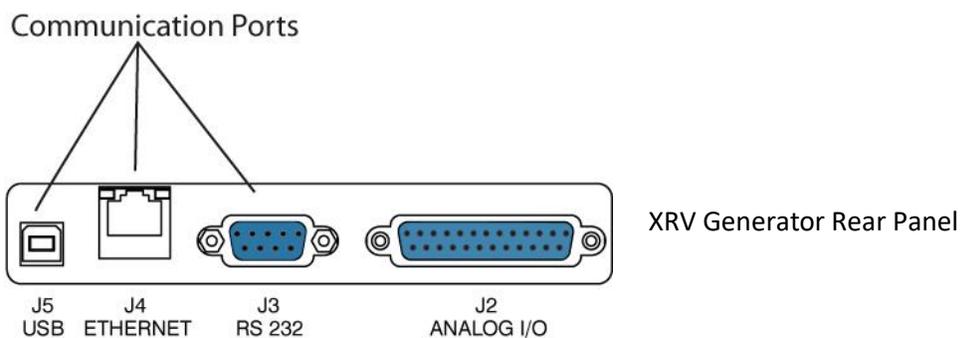


## Flash Drive USB installation Step 5



### Software Communication:

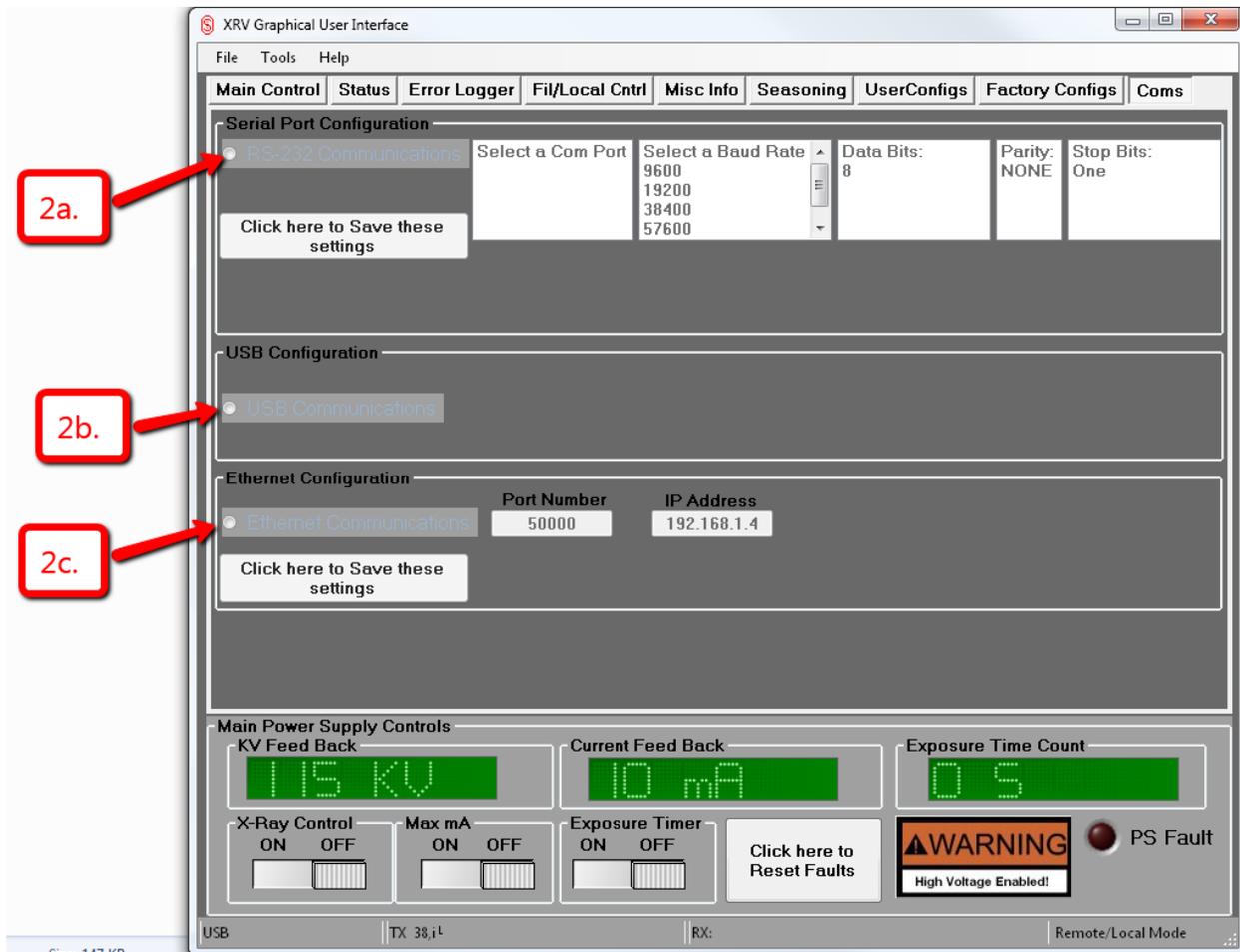
After the GUI is installed, shut down the computer. Select which type of communication cable will be used to control the XRV Generator. Connect a 9 pin com port (RS-232), Ethernet or USB from the computer to the XRV Generator J3, J4 or J5 input connector. Make sure that the appropriate interface cable is plugged in before power is applied to the computer or XRV Generator.



## Software Communication:

When the appropriate cable is connected, power up the computer and **ONLY** the auxiliary power on the XRV Generator. Do **NOT** apply power to the Mains on the generator. Launch the GUI from the computer and click on the “Coms” Tab. Select the desired communication setup as illustrated in the diagram.

**Note:** When using the XRVC control subsystem option, no software installation is necessary.



**Note:** When using the RS232 method of communication, the user must select a Com port, Baud Rate, Data Bits, Parity, and Stop Bits. When using the Ethernet method of communication, the user must select a port number and IP address. Be sure to press the “Click here to save these settings” button when finished.

## Software Communication:

Model Currently Being Controlled

Indicates whether the unit is being controlled locally or remotely

Com Port Information

Data Transmission Information

Data Receiving Information

Once communication has been set up, click on the “Main Control” tab to verify the data transmission information is transferred from the XRV Generator to the computer as shown above. For additional information regarding software installation and control, refer to Spellman High Voltage “XRV Controller Reference Guide Manual (Classic)”.

## X-Ray Tube Filament Calibration:

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b> The XRV Generator is capable of developing extreme high voltages. It is the responsibility of the user to observe safety procedures and guidelines set forth in this manual. Extreme caution must be exercised when installing, maintaining or operating this equipment. A basic knowledge of high voltage safety is required. The XRVGenerator should never be operated without the high voltage cable connections or adequate grounding. Personal protection devices such as grounding rods and fail safe interlocks should be used to prevent a hazard condition. Failure to follow these guidelines may result in injury or death.</p>

	 <b>CAUTION</b>
	<p><b>Caution: Potential Hazard!</b> It is recommended that only experienced personnel proceed with the following filament calibration procedure. Review the complete procedure before proceeding. Failure to do so may cause damage to the equipment or personal injury.</p>

The X-ray tube filament current is required to be calibrated once the initial installation is completed or if the X-ray tube was replaced. The calibration is required for both the large and small filaments. If the tube only has one filament, only the large filament will require calibration. The tube manufacturer will recommend the maximum setting for each filament. In most cases, the filament current supplied will be DC unless the user has specified an AC filament source when procuring the XRV Generator. If an AC filament source was selected, then an appropriate meter having an adequate frequency response of 25kHz or more should be used to measure the RMS current.

Current measurements are made directly in the high voltage cable that is connected to the X-ray tube. Refer to the current limit data for small and large found in the Tube Specification Data Sheet. The filament measuring and calibration adapter is available as an accessory kit from Spellman High Voltage.

## X-Ray Tube Filament Calibration:

Test equipment required:

- 1=Measuring Adapter for high voltage socket
- 2= Measuring Adapter for high voltage cable plug
- 3= Digital Multimeter (Customer Supplied)



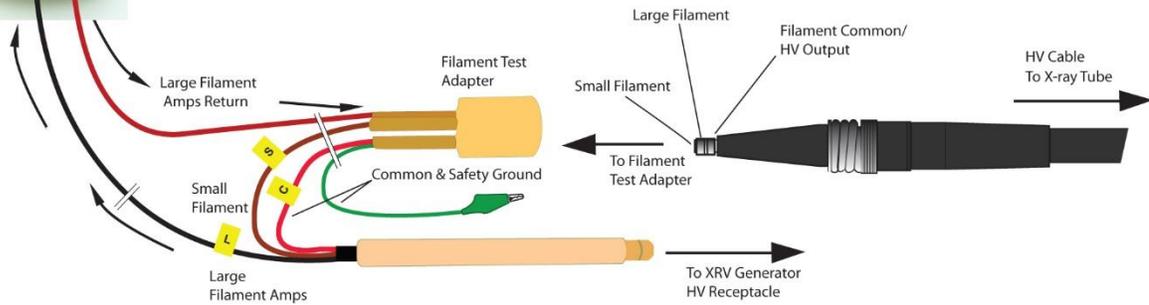
C=Common Connection, L= Large Filament Connection, S= Small Filament Connection

## X-Ray Tube Filament Calibration Setup:

Multimeter set for 10A



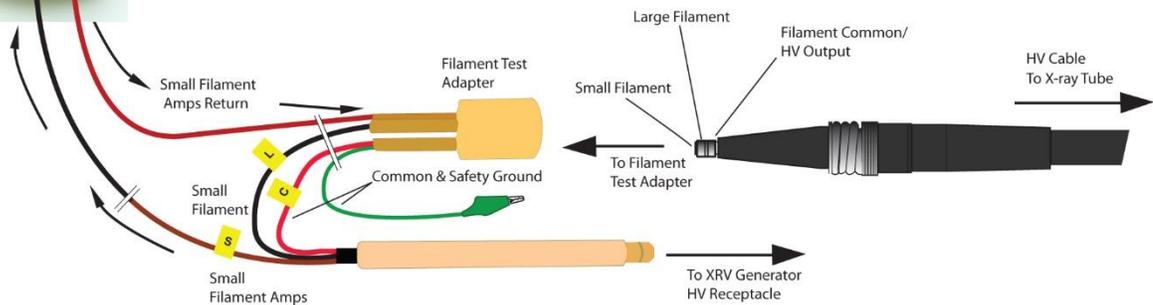
### HV Connector Large Filament Calibration Adapter Connections



Multimeter set for 10A



### HV Connector Small Filament Calibration Adapter Connections



## X-Ray Tube Filament Calibration Using GUI:

	 <b>WARNING</b>
	<p><b>Warning: Potential Hazard!</b>            Do not energize the Mains Circuit Breaker before or during the filament calibration procedure. The XRV Generator is capable of developing extreme high voltages. Use extreme caution when adjusting or calibrating the filament supplies. Failure to observe high voltage safety procedures or deviate from this procedure could result in equipment damage, personal injury or death. Only qualified personnel should be allowed to perform this procedure.</p>

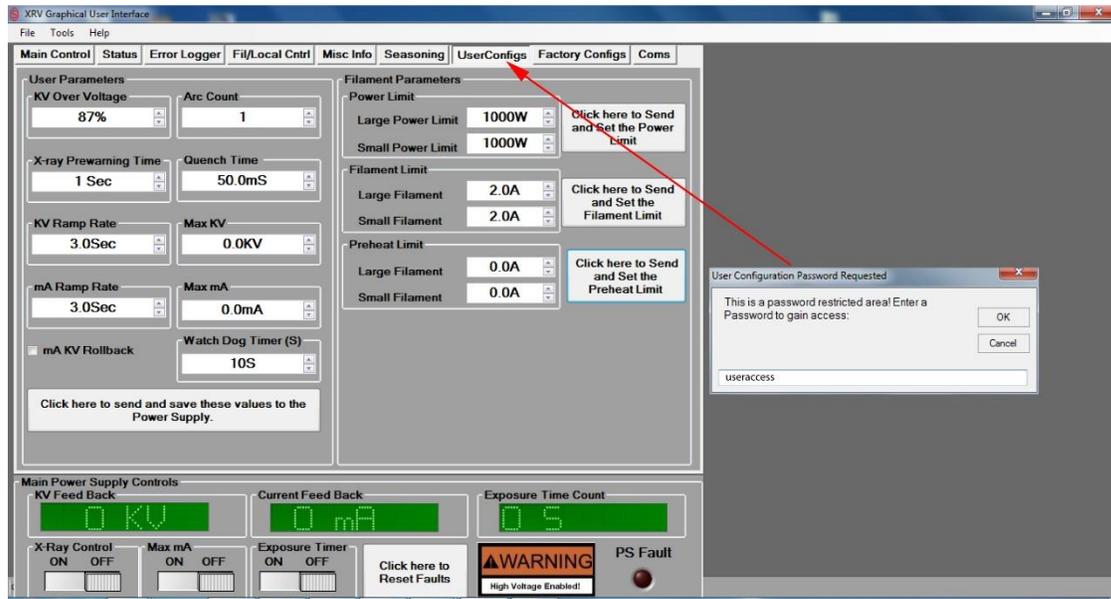
- 1) Connect the filament calibration for the large or small filament as shown in the diagram. Make sure the common is connected to earth ground.
- 2) Energize the Auxiliary circuit breaker to the XRV Generator.  
**Do Not Energize the Main Circuit Breaker!**
- 3) Launch the supplied XRV software and verify the XRV Generator is communicating with the GUI.
- 4) Refer to the manufacturer’s X-ray tube specification and verify the maximum current for the filament.



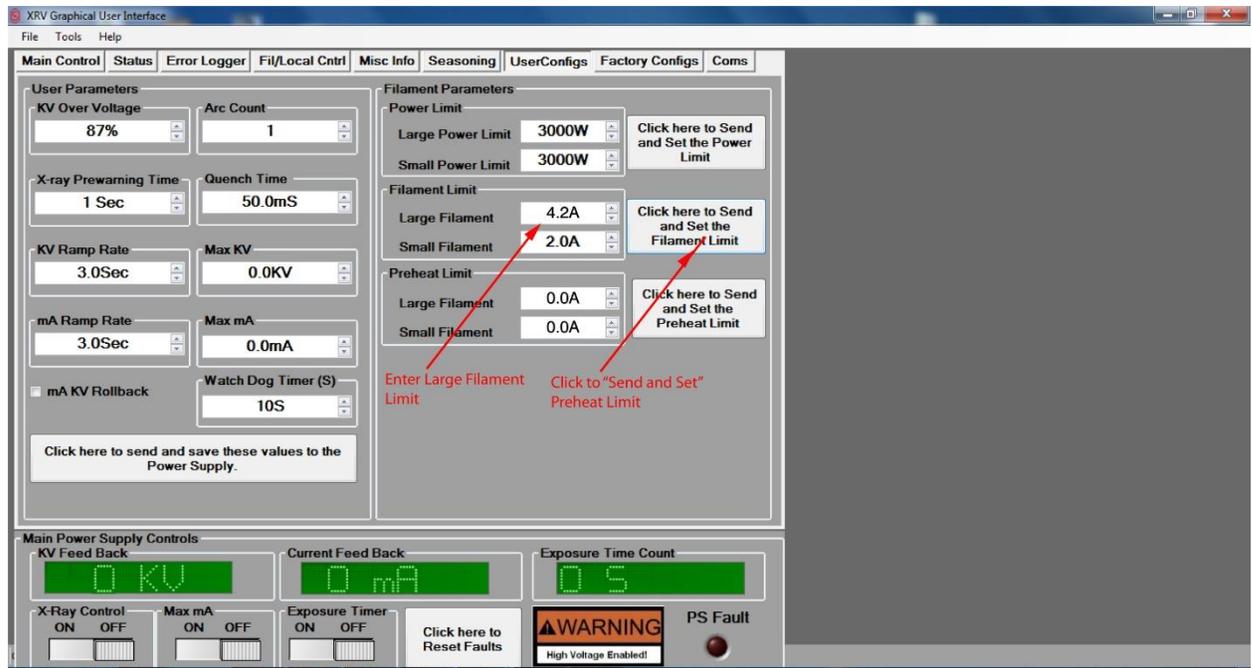
### Product Specifications

Nominal tube voltage .....	225 kV
Continuous rating .....	3000 W
Focal spot acc. EN 12543 .....	d = 75 mm
Focal spot acc. ASTM E1165-12 .....	N/A
Filament current, max. ....	4.2 A
Filament voltage, typical .....	5.5 V
Inherent filtration .....	0.8 ± 0.1 mm Be
Target material .....	W
Target angle .....	... 30°
Radiation coverage .....	40°
Leakage radiation, max. at loading factors in 1m distance .....	10 mSv/h (225 kV; 13 mA)
Weight .....	11 kg
Terminal type .....	R24
Gapping spring-loaded HV-cable .....	2 rings visible (~7 mm)
Gapping non-spring-loaded HV-cable .....	5.5 - 6 mm
Grease quantity for HV-cable terminal .....	1.2 ml

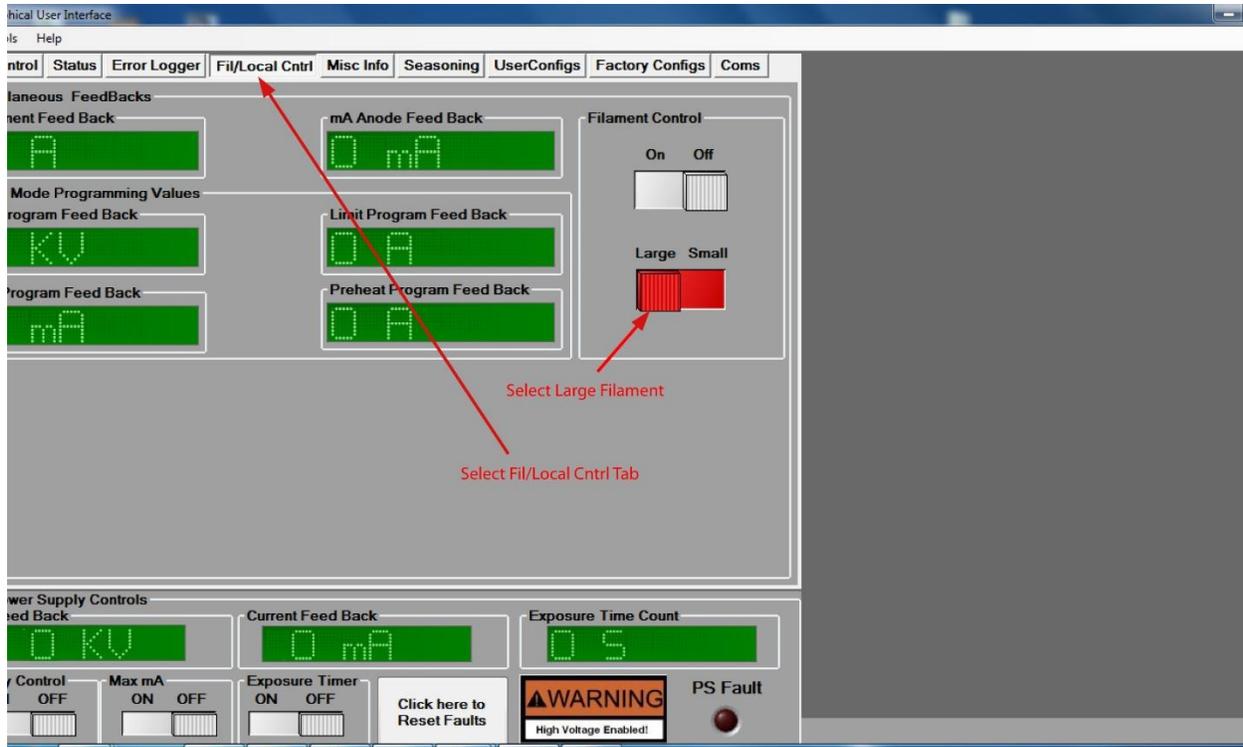
- Click on the “User Config” tab and enter “useraccess” for the password.



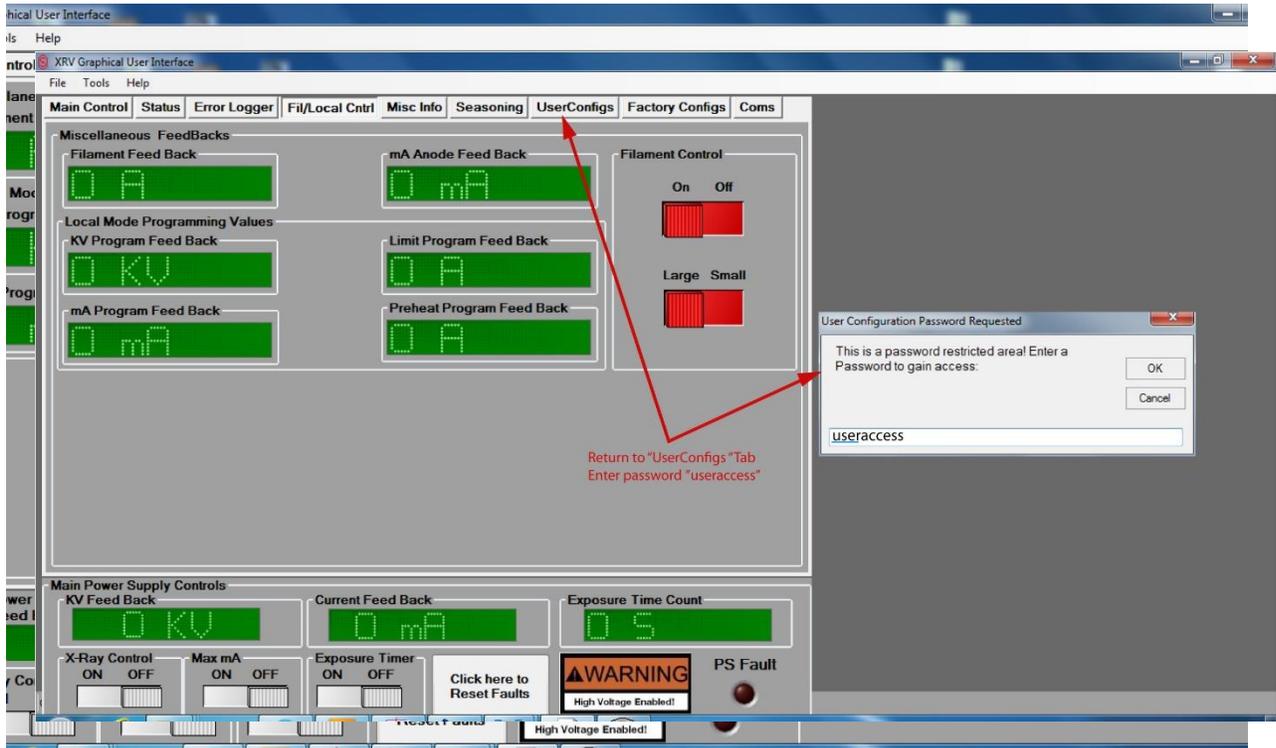
- Enter the “Large Filament Limit” current and Click to send.  
**Note: In this example, the tube only has a large filament. The “Small Filament Limit” setting can be ignored.**



7) Click on the "Fil/Local Cntrl" tab and select "Large" Filament.

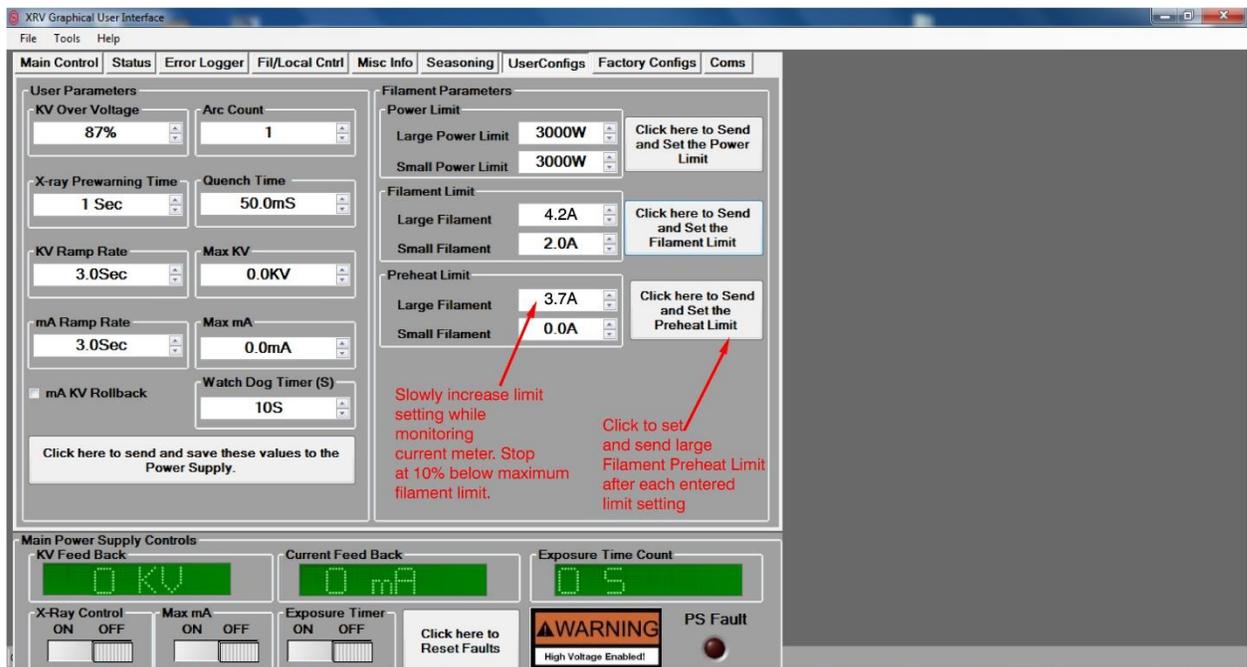


8) Select Filament "On"

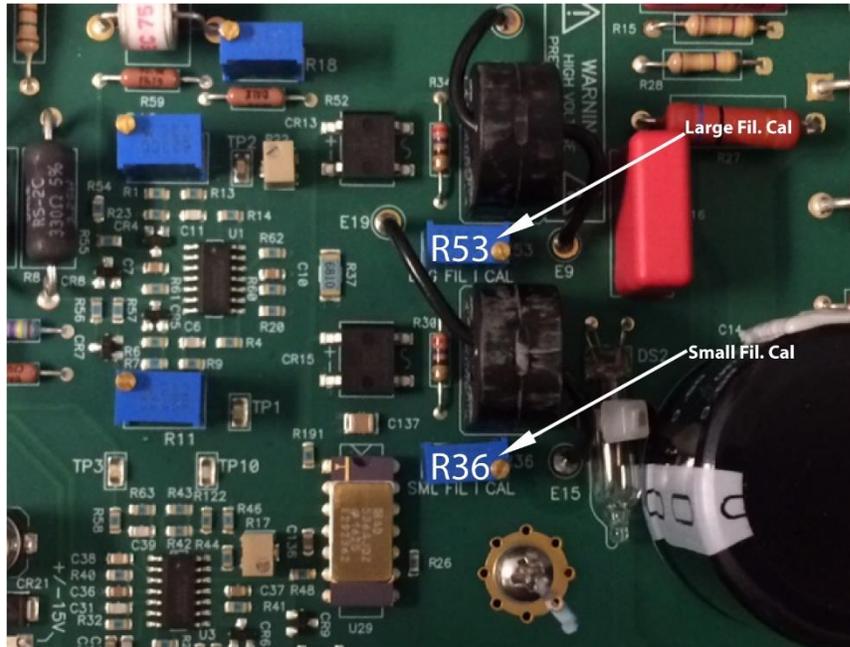


9) Return to “UserConfigs” tab and enter password.

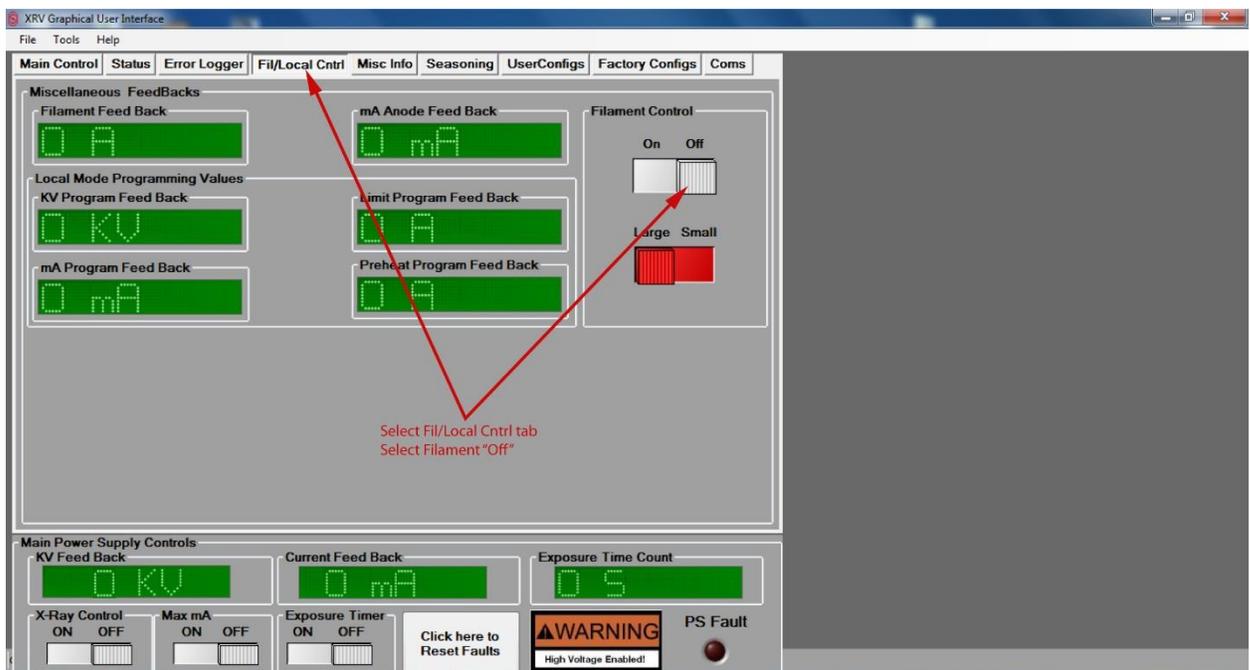
10) Starting from 0 current, slowly increase the Large Filament current Pre-heat setting while monitoring the digital multimeter. Increase the current until the multimeter reads 10% below the maximum current setting on the tube. **Do not exceed the maximum tube current!**



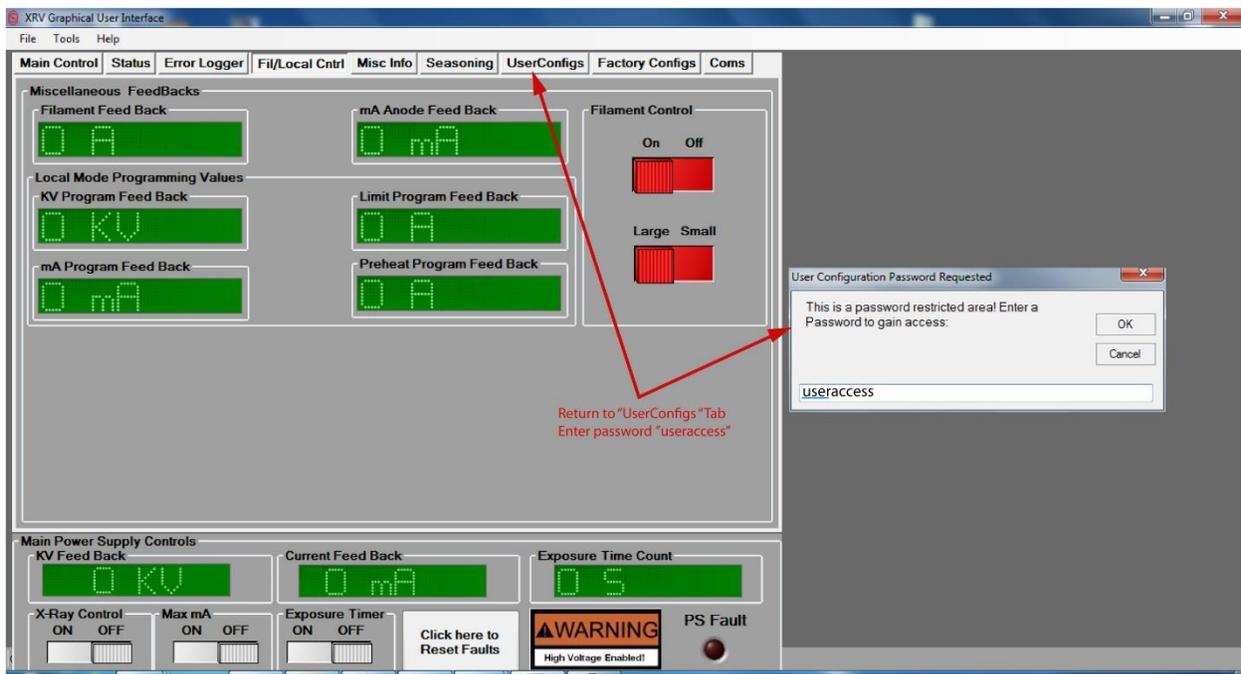
- 11) The actual filament current and the monitored current monitored by the GUI should be within 1% tolerance. If the reading is not at spec, adjust R53 (LARGE FIL I CAL) on Filament/Feedback board XRV (Part # 460158-XXX).



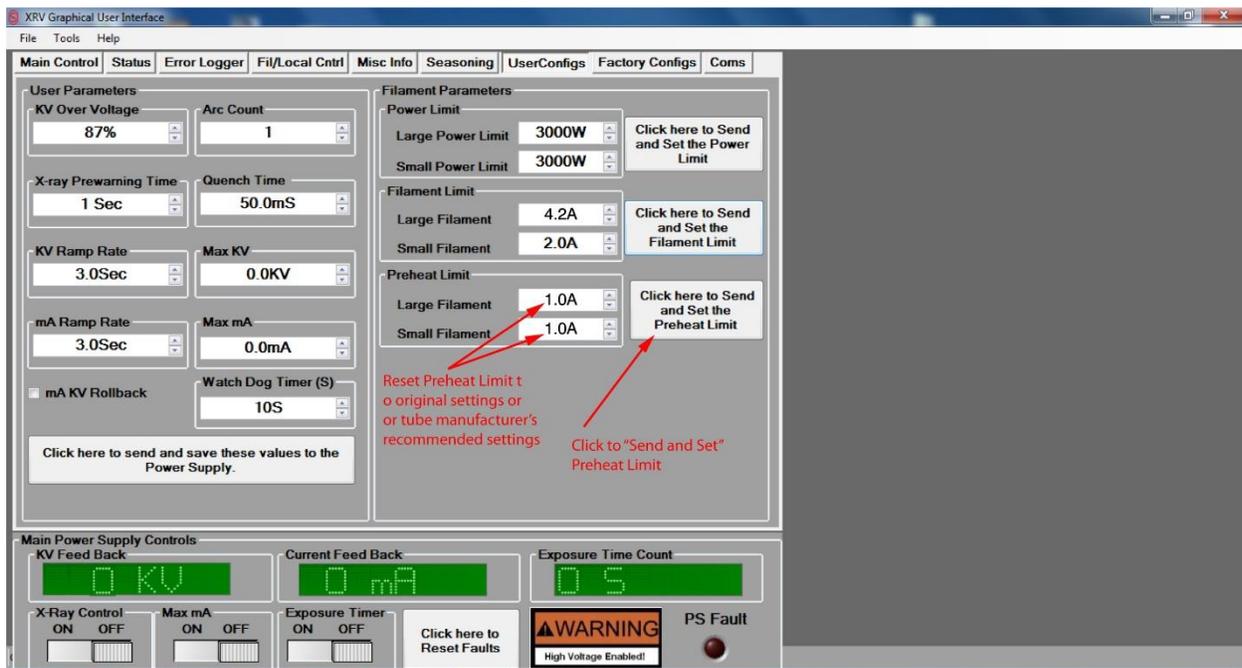
- 12) Select the “Fil/Local Cntrl” tab and select Filament Control “Off”. The Small Filament Calibration follows the same procedure as the Large Filament Calibration. Ensure the multi-meter current connections are through the small filament as referred to in the diagram. For additional information, see *Filament Calibration Procedure* in the XRV Generator Manual.



13) Return to "User Configs" and enter password.



14) Return "Preheat Settings" to original filament current settings or recommended manufacturer recommended settings. Click to save and set the preheat limit.



## Accessory Test Kits for XRV Generators:

### XRV-14-1 (R24 Dummy/Blanking Plug)



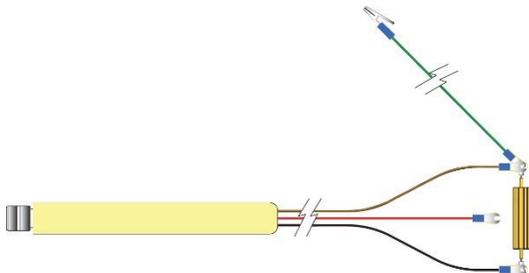
R24 test plug useful for evaluating or troubleshooting XRV160 model generators or X-ray tube functionality. The plug is inserted into the high voltage receptical and allows for operation of the XRV Generator without the X-ray tube load.

### XRV-14-2 (R28 Dummy/Blanking Plug)



R28 test plug useful for evaluating or troubleshooting XRV225 model generators or X-ray tube functionality. The plug is inserted into the high voltage receptical and allows for operation of the XRV Generator without the X-ray tube load.

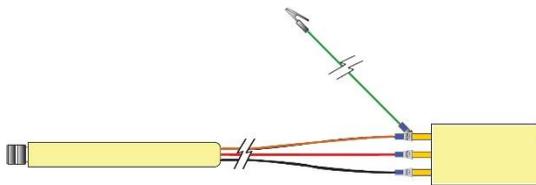
### XRV-14-3 (Filament Adapter with Resistor)



XRV filament power supply calibration tool utilizing a resistive load for filament current calibration and verification. For use with both the XRV160 and XRV225 models. Customer supplied voltmeter is required.

## Accessory Test Kits for XRV Generators:

### XRV-14-4 (Filament Measuring Adapter)



XRV X-ray tube filament calibration tool utilizing a unique adapter between the high voltage cable plug and the XRV Generator for X-ray tube filament current calibration and verification. For use with both the XRV160 and XRV225 models. Customer supplied ampere meter is required.

### XRV Sub-system Nomenclature:

XRV-1-(x)	High Voltage Power Supply (A1)
XRV-2-(x)	X-Ray Tube (A2)
XRV-3-(x)	HV Cable & GND Cable Kit (W1 & W2)
XRV-4-(x)	HV Cable Flange (Power Supply Side) (FL1)
XRV-5-(x)	HV Cable Flange (X-ray Tube Side) (FL2)
XRV-6-(x)	Cooler/Chiller (A3)
XRV-7-(x)	Cooling Hose (Item 3 & 4)
XRV-8-(x)	Controllers & Cable Kit (A4, W3, W4, W5)
XRV-9-(x)	I/O Box (A5)
XRV-10-(x)	Mains/Aux & GND Cable Kit (W6 & W10)
XRV-11-(x)	I/O Box to Door Interlock Cable (W7)
XRV-12-(x)	I/O Box to Controller Cable (W8)
XRV-13-(x)	I/O Box Input Power Cable (W9)
XRV-14-(x)	Test Kits for XRV

For a detailed list, refer to Spellman Drawing # 408216-001

## Drawing List:

### XRV Generator

DESCRIPTION	XRV160	XRV 225	XRV320	XRV450
System Diagram	441202-001	441204-001	441177-001	441178-001
Overall Drawing	407175-001	407181-001	407035-001	407034-001
Assembly Drawing Cathode	407106-001	407118-001	407106-001	407118-001
Assembly Drawing Anode	-	-	407110-001	407098-001
Fil/FDBK Bd. Assy. Cathode	460158-001	460158-001	460158-001	460158-001
Fil/FDBK Bd. Assy. Anode	-	-	460158-002	460158-002
Fil/FDBK Bd. Schematic	441170-001	441170-001	441170-001	441170-001
Inverter Module Assembly	407105-001	407000-001	407105-001	407000-001
Power Inverter Bd. Assy.	460156-002	460156-001	460156-002	460156-001
Power Inverter Bd. Sch.	441164-001	441164-001	441164-001	441164-001
System Control Assy.	460130-001	460130-001	460130-001	460130-001
System Control Bd. Sch.	441105-001	441105-001	441105-001	441105-001
Front Panel LED Display Assembly	460124-001	460124-001	460124-001	460124-001
Front Panel LED Display Schematic	340352-001	340352-001	340352-001	340352-001

### Sub-system

XRV	DESCRIPTION	DRAWING NUMBER
	XRV UNIPOLAR/BIPOLAR SYSTEM DIAGRAM SCH.	408216-001
XRV-9-1	I/O BOX,RACK MOUNT,W/O CONTROLLER SCH.	441458-001
XRV-9-2	I/O BOX,RACK MOUNT,WITH CONTROLLER SCH.	441458-002
XRV-9-5	I/O BOX,RACK MOUNT,W/O CNTL, W/SAFETY RELAY SCH.	441458-003
XRV-9-6	I/O BOX,RACK MOUNT,W/CNTL, W/SAFETY RELAY SCH.	441458-004
XRV-9-7	I/O BOX, RACK MOUNT THREE PHASE, W/O CONTROLLER SCH.	441458-001
XRV-9-8	I/O BOX, RACK MOUNT THREE PHASE, WITH CONTROLLER	441458-002
XRV-8-1	CONTROLLER, RACK MOUNT WITH CABLE KIT	441484-001
XRV-8-2	CONTROLLER, BENCH MOUNT WITH CABLE KIT	441484-001

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

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

