Surface Analysis | Vacuum Components | SPECS® | Surface Analysis | Computer Technology

XRC 1000

X-ray Source Control

High Voltage Supply

1.1

User Manual for XRC 1000.

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Introduction

1.1 Application, capability

The X-Ray source control XRC 1000 is a new power supply for high-intensity twin anode X-ray sources optimized for XPS (ESCA) experiments in order to produce low energy X-ray quanta. Additionally, the supply can be used to control a X-ray monochromator.

The standard XRC 1000 supports a twin anode x-ray source, i.e. it is designed to supply two filaments and ensures continuous operation powers of 1000 W. SPECS offers analog / digital interfaces for complete remote control and the capability of soft start.

The SPECS power supply XRC 1000 operating normally with the x-ray source XR-50 and the cooling control unit CCX 50. The user manual for x-ray source is normally attached to these instructions. The water cooling unit has no special manual and is described at the necessary parts of the source and the supply manual.

This manual describes the installation of the XRC 1000, the initial commissioning, the normal operation, and the trouble shooting.

1.2 Safety Hints

Attention!

Beware! Lethal high voltage up to 15 kV is applied to the X-ray source. Hazardous voltages are present, therefore only persons with the appropriate training are allowed to carry out the installation, adjustment and repair works.

All national, federal, state, and company or department internal regulations, restrictions, codes, and rules for protection against radiation sources have to be observed during installation and operation of the X-ray source at its site!
Consult your safety inspector in case of a primary installation and in case of any doubt. The users are responsible for a correct labelling of the source and its power

supplies, and providing safety instructions in their mother language, if requested by the law!

Before any electric or electronic operations please consult „SPECS Safety Instructions“ and follow them strictly.

Some tests which might have to be carried out according to this manual are hazardous. These parts are indicated by a warning label:

!!Attention!!

The tests described in the following have to be performed at connectors of the electronics not plugged into the source. Hazardous voltages are present, therefore only persons with the appropriate training are allowed to do the job.

Perform the measurements only with special insulated tools released for voltages higher than 20 kV.

1.3 Soft X-ray Radiation Protection

Supplementary to the regulations, restrictions, codes, and rules for protection against radiation which have to be observed by the law at the operational site of the XRC 1000 and x-ray sources SPECS recommend the following hints:

- Cover all window flanges additionally by X-ray protection lead glass or use window flanges with lead glass are useful but normally not necessary.
- All flanges of the chamber attached to the x-ray source have to be closed by blank flanges or compact UHV components made by stainless steel. If larger components of other materials (e.g. glass) are installed consult your safety inspector for suitable measures!
- Pregnant women should announce their situation to the superior or safety inspector!

Note:

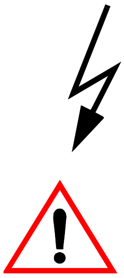
Using acceleration voltage beneath 20kV the local dose performance of <0.1 μSv/h will not be obtained or exceeded anywhere at the source within a distance of 0.1m. Note that the source runs in vacuum only, i.e. if the plant itself is not passing the radiation, working with access trough a whole (open flange) is not possible.
Normally stainless steal chambers and components as well as sight classes >1.5mm thickness (DN16CF windows) are not permeable for this kind of radiation because of the similar wall thickness like the source body.

1.4 Vacuum Conditions

The XRC 1000 could work satisfactorily in the pressure range of the x-ray source below 1 x 10^{-5} mbar. Nevertheless, better vacuum conditions in the 10^{-8} mbar range or better are strongly recommended to prevent contamination of the volume around the anode. Good vacuum conditions will prevent oxidation of the filaments while in use, ensure a longer lifetime of anode and window, reduce the risk of spark-over between the anode and grounded parts, and enables a longer availability of the X-ray source at full intensity.

1.5 Special Hints

The XRC 1000 generates high voltages up to 15 kV being dangerous to life! You have to follow the safety hints given below:



- The XRC 1000 accepts line voltages of 90 - 260 VAC.
- Use only original cables, connectors, and flexible conduits from SPECS. Make sure that all cables and water lines are free of mechanical or electrical defects. In case of doubt the cable or the water line has to be replaced by an original SPECS part.
- Please connect the X-ray source only with HF low impedance cable to the power supply ground screw. Large contact areas are important. A proper connection will protect the sensitive electronic units of your system and in your neighborhood.
- Never run the X-ray source without grounding cable or loosen ground connection!
- All shields for interlock, remote and other connections must be grounded with a proper HF performance, too!
- Operate the XRC 1000 only in case of a fully closed protection cover at the x-ray source and properly fixed cable conduit for HV and water supply! Open slits and holes could be a danger for life and violate the regulations regarding X-ray protection!
- Do not operate the X-ray source if your system pressure is above 10^{-6} mbar!
- Do not operate the X-ray source without cooling water for anode. Cooling the housing jacket limits the temperature increase of an irradiated sample during continuous operation.
- Before switching on the power units, the electrical and mechanical installation has to be completed. The interlocks for vacuum, water, and HV guard have to be correctly activated and tested for safe and proper functioning.
- Never short the HV guard and water interlock system!
- Never operate the power supplies with removed housing parts!
- Connect the x-ray source only when the power supply has been turned off!
- After switching off the power unit the operator has to wait at least 3 minutes before opening any connections, the power supplies or the X-ray source protection cover.

- In case of wetting the XRC 1000 by cooling water, a complete drying of the modules, the protection cover and the cables is strongly recommended. The usage of a fan can support the operation.
- Never run a wet XRC 1000 unit or wet inner parts of the other x-ray source parts!
- In case of operating the XRC 1000 with other equipment than delivered by SPECS, you may loosen your warranty. In case of doubt please contact the SPECS service department.

Chapter

2

Items and Connections

2.1 Items of the XRC 1000 Package

The XRC 1000 electronics package consists of:

1. power supply XRC 1000.
2. HV cable (normally mount at CCX 50 cooling unit)
3. Filament cable
4. Vacuum interlock plug, see “Interlocks” on page 18
   (The short circuit of pin 1 and 2 is necessary for HV on!
   Please check the check/modify the delivered plug, if not used as vacuum interlock!)
5. HV guard cable
6. Water interlock cable
7. Screen cable (connection to the water cooling unit, not shown her)

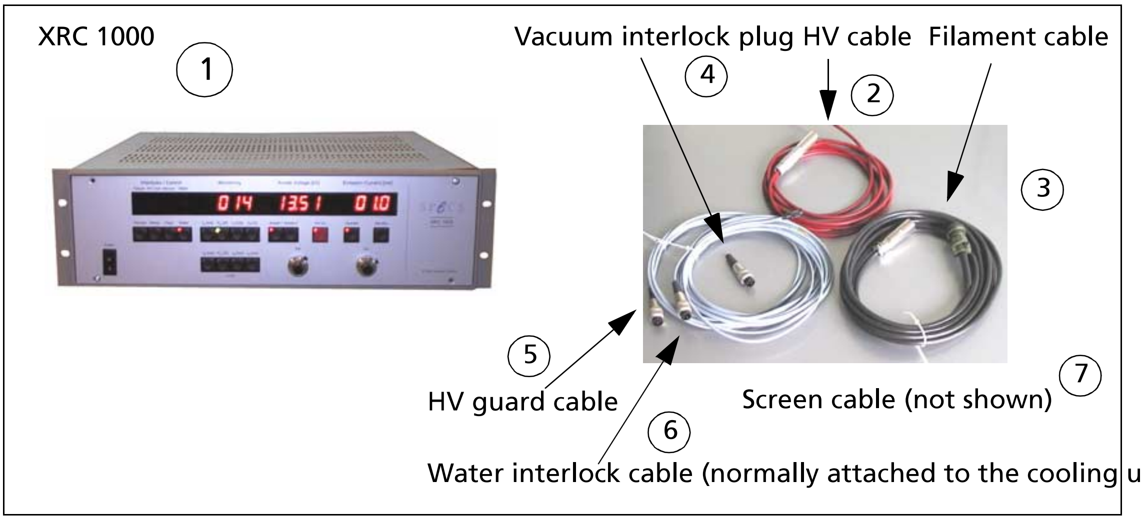


Figure 1 Items of the XRC 1000 package

2.2 Electrical Connection

1. The high voltage unit has to be connected directly to the mains supply (90 - 260 V, 50 - 60 Hz, 1300VA).
2. The high voltage line between the cooling unit and further to the anode is the most critical connection. A careful installation is necessary.
3. The high voltage connection between the Cooling Control Unit / Anode of the x-ray source and the X-Ray source control has to be fixed with traction reliefs on both sides.
4. Check that the X-ray source (or system) is connected with a low impedance cable to the power supply ground (mostly the ground screw at the cooling unit as the central ground potential). Large contact areas are important. Such a connection will be evident to protect the sensitive electronic units of your system.
5. The screen of the high voltage cable has to be connected with the back side of the cover plate of the source.
   A perfect screen of the high voltage cable protects your life, your additional electronic equipment and the x-ray source.
6. The safety interlock for the cooling water (Cooling Control Unit CCX 50,'Water' interlock), the safety HV-cover switch of the X-ray source and the vacuum interlock have to be plugged into the respective sockets („WATER“, „HV-GUARD“ and „VACUUM“) at the rear panel of the X-ray power supply. If no vacuum interlock is used pin 1 and pin 2 should be short circuit (see “Interlocks” on page 18!
7. The water cooling unit has to be connected.

The standard supplies for the X-ray source consists of two 19“-rack modules:

- the high voltage power & emission regulation unit XRC 1000 and
- the Cooling Control Unit CCX 50

Attention

Mind the safety hints given on page 1!!!
Warning: It will take 3 minutes before all high voltages are absent. So wait at least 3 minutes before disconnecting any cables from the power supply or the X-ray source.

Usual connections with XR-50 x-ray source and CCX 50 cooling control unit are shown in figure 2.

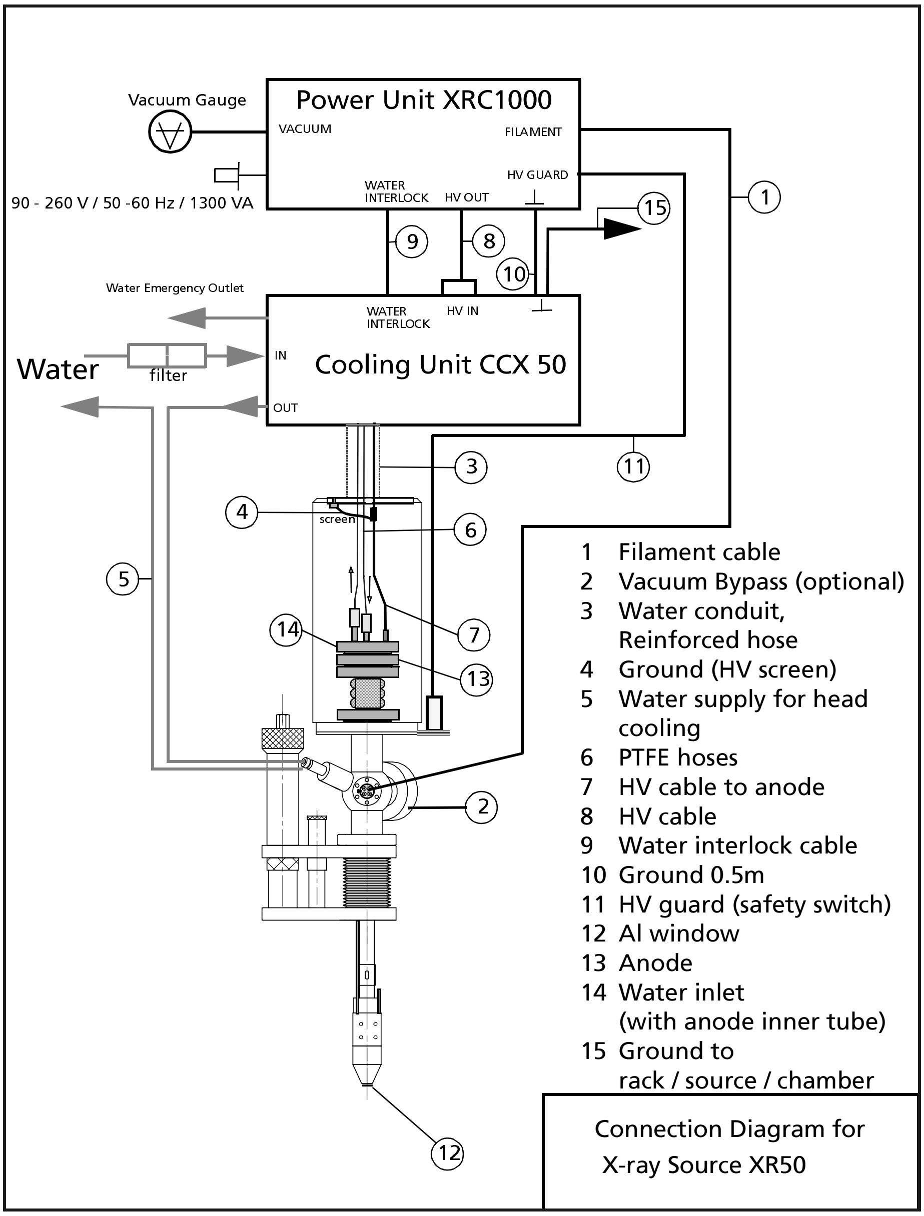


Figure 2 Connection diagram for XRC 1000 and SPECS X-ray source XR-50

Chapter

3

Electronics Description

Attention

Mind the safety hints given on page 1!!!
Beware! Lethal high voltage is applied to the water within the hoses during operation.

Warning: It will take 3 minutes before the turned off high voltage is reduced to about zero. So wait with patience at least 3 minutes before opening the protection cover and disconnecting any cables from the power supplies or the X-ray source.

This chapter deals with the electronics and operation of the X-ray Source Control XRC 1000 in conjunction with the SPECS X-ray source XR-50 and the Water Control Unit CCX 50.

The new XRC 1000 supplies all voltages and currents needed for the operation of the source XR50. This power supply is also capable of powering other X-ray sources than the XR50.

The functions and controls of the XRC 1000 can be divided into five main parts:

1. Front panel control
2. Rear panel control
3. Emission control
4. HV control
5. Remote control

The front panel provides a number of push-buttons, indicators, and displays allowing the user to control the power supply.

On the rear panel a number of sockets and status indicators are provided for interlock control, filament supply, and high voltage supply.

The emission control supplies the filament current and regulates the emission current. Two different anodes can be easily selected by push-buttons.

The HV control supplies the anode voltage up to 15kV / 66mA. The high voltage output is short circuit and arc protected.

The optional remote control allows remote control via RS232 or CAN bus. This unit is also capable of ramping the high voltage automatically, e.g. after each bake out.

Figure 3 XRC 1000 front view

Figure 4 XRC 1000 rear view

Size / Height:	19“(W) x 132mm (H, 3 chassis units) x 495mm (T) +10mm (plug)
Depth:	483 (+ 80 mm for cable plugs) x 33 x 57 mm
Weight:	18.5 kg

High Voltage:	0 - 15 kV, continuous
Emission Current:	variable, standard up to 66mA
Cathode Supply:	0 - 8 A, 0 - 10 V
Power:	1000 W[1]
Mains:	90 - 260 V, 50 - 60 Hz, 1300VA , Fuse please check page 20
Interlock:	HV Guard, Vacuum, Water
Optional	
Remote:	Refer to the remote control manual
Soft start	Variable ramp for voltage and emission current

3.1 X-ray Source Voltages and Currents

This document deals with different voltages, currents, and powers of the X-ray source. For a better understanding a block diagram is depicted below showing the source voltages and currents which are described below in details.

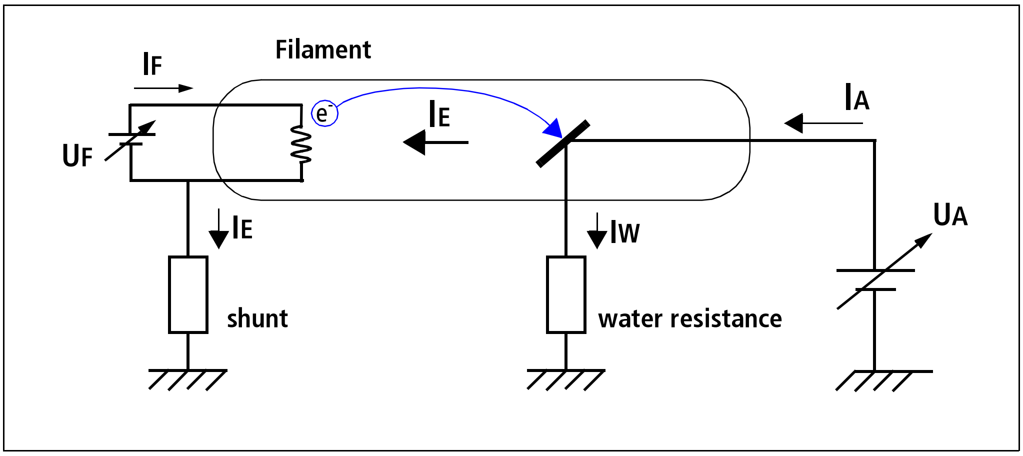


Figure 5 Block diagram of principle operation

3.1.1 Anode Voltage (U_A) and Anode Current (I_A)

The output voltage of the XRC 1000 is applied to the source anode. This voltage is called anode voltage, U_A, and can be set to a value in the range of 0 to 15kV. The output

1. The X-ray power is calculated by emission current I_E and high voltage. The total power (of the supply) is the product of anode current IA and high voltage. The anode current consists of emission current I_E and Water current I_W.
(see section 3.1 , 'X-ray Source Voltages and Currents" on page 11)

current flowing to the source anode is called anode current, I_A, and can be in the range of 0 to 66mA.

The anode current is divided into two parts, One part of the anode current, called cooling water current I_W, flows through the cooling water to ground. The other part of the anode current, called emission current I_E, flows through the source filament to ground.

3.1.2 Cooling Water Current

In case of the XR-50 cooling water is applied for anode heat sinking. The cooling water at the water output of the source has the same potential like the anode itself. Due to the water conductivity a leakage current, called cooling water current, flows through the water to ground. The amount of this current depends on the water conductivity, the length and thickness of the water hoses.

The anode net power consists of X-ray radiation and heat dissipation. The anode gross power includes in addition the voltage drop via water influx and reflux lines for the anode cooling (cooling water current, I_{water}), because usually the water cooling box is grounded.

The difference between gross and net anode power will increase as much lower the water resistance or as much higher the water conductivity.

If the difference between gross and net emission currents (so-called „water current“,I_{water}) exceed to an amount where the sum of emission power and the power loss due to the water current is larger than the maximum power of the supply, the supply will fail.
Normal values are between 2 and 10 mA for the water current at 15 kV anode voltage. If the water resistance is too large („water current“< 2 mA at 15kV), electrochemical attacks can be enforced.

Please check the hints given in your X-ray source manual!

3.1.3 Emission Current (I_E)

Due to the source filament heating, electrons are emitted and accelerated toward the anode. Thus an emission current, I_E, flows from the filament (electrons) through the anode to ground. The amount of the emission current depends on the filament current, I_F, and the acceleration voltage, U_A. The emission current flows through a shunt resistor to the ground allowing the current measurement. The emission control unit of the XRC 1000 measures the emission current and controls the filament current such that a constant emission current is achieved. The maximum emission current is internally set to 66mA.

3.1.4 Filament Voltage and Current

The emission control unit of the XRC 1000 supplies the filament voltage, U_F, and the filament current, I_F, and is capable of powering the filament up to 10V/8A.

3.1.5 Source Power Dissipation

The power dissipation of the X-ray source can be divided into 3 parts:

1. The anode power dissipation
2. The cooling water power dissipation
3. The filament power dissipation

The total power dissipation at the source anode is:

$$P_{total} = I_A \times U_A \qquad \textit{(EQ 1)}$$

The anode power dissipation P_A (nearly proportional to the X-ray radiation power) depends on the emission current and the anode voltage and can be calculated by the formula:

$$P_A = I_E \times U_A \text{, where } I_E = I_A - I_W \qquad \textit{(EQ 2)}$$

The water power dissipation P_W depends on the resistance of the cooling water. With the water current and the anode voltage the water power dissipation can be calculated by the formula:

$$P_W = I_W \times U_A \qquad \textit{(EQ 3)}$$

The total power that has to be delivered by the high voltage control of the XRC 1000 is:

$$P_{total} = P_A + P_W \qquad \textit{(EQ 4)}$$

The filament power dissipation depends on the filament current and the filament voltage and can be calculated by the formula:

$$P_{filament} = I_F \times U_F \qquad \textit{(EQ 5)}$$

3.2 Front Panel Control

On the front panel there are a number of push-buttons, indicators, potentiometers, and displays allowing the control of the XRC 1000. The front panel is logically divided into 5 function groups, interlocks/control, monitoring, anode voltage, emission current, and limits setting. Following each group is described in details.

3.2.1 Interlocks and Control

This function group provides 4 push-buttons with internal LED and 4 indicators.

3.2.1.1 Indicators

- Water — Lamp is on if the water interlock switch is open, e.g. if the water flow fails.
- Vacuum — Lamp is on if the vacuum interlock switch is open.
- HV Lock — Lamp is on if the source cover is not in position or if the HV connector is removed from the power supply.
- Failure — Lamp is on if the internal power supply of the XRC 1000 is not ready.

3.2.1.2 Push-buttons

- Water — Push button to switch on the cooling water circuit. LED is blinking if there is a failure within the circuit or if the interlock is not connected.
- Clear — This push-button is not used.
- Ramp — This push-button can only be used in conjunction with the optional remote interface. Upon pushing this button the high voltage and the emission current are ramped slowly. This function is usually used to start up the source automatically after each bakeout. The LED is on if ramping is in process. For more details see also the user manual of the remote interface.
- Remote — The button LED is on if the unit operates in remote mode. In this case no manual control is possible through the front panel. Upon pushing the button, the unit is released from remote control and can be manually controlled, e.g. in emergency cases.

3.2.2 Monitoring

This function group consists of one digital panel meter and 8 push-buttons with internal LED.
The digital panel meter with 3 1/2 digits and decimal points is used to show the voltages, currents, or powers selected by the push-buttons.
The upper 4 push-buttons are used to display the operational parameters. The lower 4 push-buttons in conjunction with the buttons Anode1 and Anode2 are used to display the current and power limits for anode 1 and anode 2.

The function of each push-button in the monitoring group is described below:

Operational parameters:

- I_A [mA] — Push-button to select the display of the anode current. Note that the anode current is the sum of the emission current and the cooling water current. Button LED is on if the anode current is displayed. LED is blinking if the anode current exceeds the limit of 66mA.

- P_A[W] — Push-button to select the display of the anode power. Note that the anode dissipation power depends on the emission current and anode voltage, i.e. $P_A = I_E \times U_A$ (section (EQ 2), " on page 13). Button LED is on if the anode power is displayed. LED is blinking if the anode power exceeds the user selected limit.
- I_F [A] — Push-button to select the display of the filament current. Button LED is on if the filament current is displayed. LED is blinking if the filament current exceeds the user selected limit.
- U_F [V] — Push-button to select the display of the filament voltage. Button LED is on if the filament voltage is displayed. LED is blinking if the filament voltage exceeds approx. 10V or if the filament is not connected.

Limits:

- I_E [mA] — Push-button to select the display of the emission current limit. LED is on if the emission current limit is displayed. LED is blinking if the emission current exceeds the limit set by the user.
- P_A [W] — Push-button to select the display of the anode power limit. LED is on if the power limit is displayed. LED does not blink.
- I_M [A] — Push-button to select the display of the maximum filament current (in operate mode) set by the user. LED is on if the maximum current is displayed. LED does not blink.
- I_S [A] — Push-button to select the display of the maximum filament current (in standby mode) set by the user. LED is on if the maximum current is displayed. LED does not blink

3.2.3 Anode Voltage

This function group consists of a digital panel meter, a potentiometer, and 3 push-buttons with internal LED.
The digital panel meter with 3 1/2 digits is used to show the high voltage of the selected anode up to 15kV.
The 10-turn potentiometer is used to set the anode voltage in the range of 0 to +15kV.

The function of the three push-buttons is described below:

- Anode 1 / Anode 2 — Push-buttons to select the desired anode. Push-button LED illuminates indicating the selected anode.
- HV On — Push-button to switch on the anode high voltage. LED is on if the high voltage is turned on and the chosen value is reached. LED is blinking during change of the

voltage and if control unit can not supply the chosen high voltage, e.g. in case of current limitation.

3.2.4 Emission Current

This function group consists of a digital panel meter, a potentiometer, and 2 push-buttons with internal LED.
The digital panel meter with 3 1/2 digits is used to show the emission current up to 66mA.
The 10-turn potentiometer is used to set the emission current in the range of 0 to 66mA.

The function of the two push-buttons is given below:

- Standby — This push-button is pressed to select standby mode (LED on) or to turn the filament off (LED off).
- Operate — Push-button to select the operate mode. The control unit goes to operate mode only if standby is on, the high voltage is on, and this push-button is pressed. The operate LED illuminates and the standby LED goes off.

3.3 Limits Setting

The limit of relevant currents and powers can be set by the user through potentiometers located on the top side of the front panel printed circuit board. The potentiometers can be accessed from the top side by removing the unit cover. The figure given below depicts the position of each potentiometer.

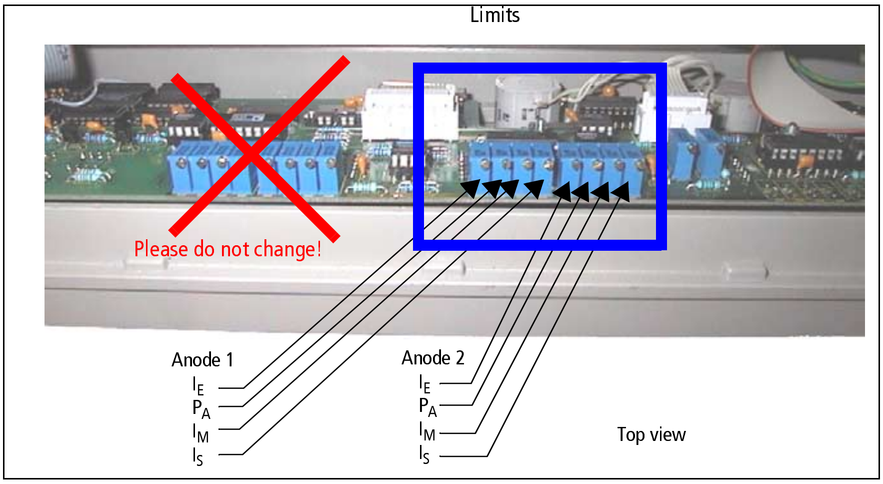


Figure 6 Limits Setting

Limits for Anode 1:

Before changing the limits make sure the high voltage is turned off and the push-button LED of Anode 1 is on. Use the push-buttons and panel meter in the function group Monitoring. Use the potentiometers for **Anode 1** (see figure 6)!

Limits for Anode 2:

Before changing the limits make sure the high voltage is turned off and the push-button LED of Anode 2 is on. Use the push-buttons and panel meter in the function group Monitoring.
Use the potentiometers for **Anode 2** (see figure 6)!

Note: Use the limit display buttons (lower 4 push-buttons in the monitoring section of the front panel)

- Emission Current — Press the push-button **I_E[mA].** The panel meter shows the present limit of the emission current. Use the potentiometer **I_E** for setting the new limit. The limit can be set in the range of 0 to 66mA.
- Anode Power Limit — Press the push-button **P_A[W]**. The panel meter shows the present limit of the anode power. Use the potentiometer **P_A** for setting the new limit. The limit can be set in the range of 0 to 1000W.
- Operate Current — Press the push-button **I_M[A].** The panel meter shows the present limit of the filament current in operate mode. Use the potentiometer **I_M** for setting the new limit. The limit can be set in the range of 0 to 8A.

- Standby Current — Press the push-button I_M**[A]**. The panel meter shows the present limit of the filament current in standby mode. Use the potentiometer I_S for setting the new limit. The limit can be set in the range of 0 to 8A.

3.3.1 Emission Current at Standby

The limit of the standby current is usually chosen such that the emission current in standby mode is in the range of 0.1 to 2mA. Under circumstances, e.g. after a filament change, the emission current in standby mode could possibly exceeds a few milliampere and reaches very high values.

To ensure safe operation of the source, two concurrent regulation circuits are activated in standby mode. Thus two limits are used for standby mode, one for standby filament current and one for the standby emission current. These two limits are not exceeded at any time. The limit of the emission current in standby mode is factory set to 1mA.

3.4 Rear Panel Control

3.4.1 Line Voltage Input

The XRC 1000 uses a PFC-module (power factor correction module) for converting the line voltage to a DC voltage and accepts line voltages in the range of 90 V ac to 260 V ac. A 3-pole line input socket and two fuse holders are provided on the rear panel.

For line voltages in the range of 90 to 120 V ac, the PFC-module provides a maximum power of 750 W. However, the XRC 1000 can supply a maximum power of approx. 600W. In this case 10Amp slow blow fuse should be used.

For line voltage of 200 V ac, the PFC-module provides a maximum power of 1000 W. However, the XRC 1000 can supply a maximum output power of approx. 800W. In this case 6.3Amp slow blow fuse should be used.

For line voltages in the range of 220 to 260 V ac, the PFC-module provides a maximum power of 1200W. However, the XRC 1000 can supply a maximum output power of 1000 W. In this case 6.3Amp slow blow fuse should be used.

3.4.2 Interlocks

On the back panel, three sockets are provided for interlocks and cooling water control:

- HV Lock — 3-pole socket. Pin 1 is internally connected through a resistor of 5k to +5V. Pin 2 is the signal input. Pin 3 is not used. If pin 1 and 2 are connected to each other, the interlock is closed.
- Vacuum — 4-pole socket. Pin 1 is internally connected through a resistor of 5k to +5V. Pin 2 is the signal input. Pin 3 and

4 are not used. If pin 1 and 2 are connected to each other, the interlock is closed.

- Water — 6-pole socket. Pin 1 is internally connected through a resistor of 5k to +5V. Pin 2 is the signal input. Pin 3 and 4 are not used. Pin 5 is connected to ground. Pin 6 supplies +24V/1A if the water push-button is pressed. If pin 1 and 2 are connected to each other, the interlock is closed.

3.4.3 HV Output

A LEMO socket is provided on the rear panel for high voltage output. This socket includes an interlock switch inside. The high voltage is only enabled if the high voltage connector of the source is plugged in.

3.4.4 Filament Connector

On the rear panel a 6-pole socket is provided for filament supply. The pin assignment is given below:

- Pin A — Filament 2, negative electrode
- Pin B — Filament 1, negative electrode
- Pin C — Filament 1, positive electrode
- Pin D — Filament 2, positive electrode
- Pin E — Ground
- Pin F — No connection

3.4.5 Status Indicators

Nine indicators mounted on the rear panel are provided to show the status of the control unit.

- SEQ — LED on if the unit is not running properly. The control unit has to be switched off and on again.
- REG — LED is on if the high voltage regulation is off.
- PS — LED on if the internal power supply is not ready.
- IP — LED is on if the current limit of the internal power supply is exceeded.
- IH — LED is on if the limit of the high voltage current is exceeded.
- HVL — LED is on if the interlock for HV Lock is open.
- VAC — LED is on if the vacuum interlock is open.
- WTR — LED in on if the water interlock is open.
- RSV — Reserved, not used.

3.5 Grounding

The control unit is connected to the protective earth through the line voltage cord. However, a ground screw is provided on the rear panel for additional grounding. For a good system grounding, it is recommended to connect the source flange directly to the ground screw of the unit by using an appropriate cable. This arrangement eliminates ground loop problems and ensures a safe operation of the electronics in the neighborhood in case of arc occurrence in the source.

3.6 Remote Control

The optional remote control allows remote control via RS232 or CAN bus. This unit is also capable of ramping the high voltage automatically, e.g. after each bake out. For more information refer to the remote control manual and section 4.2 , 'Initial Setup" on page 24.

3.7 Technical Specifications

Line Input	90 V ac - 260 V ac, 50 Hz - 60 Hz, 1300 VA
Fuse	10 A slow blow @ 90 V ac - 120 V ac 6.3 A slow blow @ 200 V ac - 260 V ac
Anode Power	600W @ 90 V ac - 120 V ac line voltage 800W @ 200 V ac line voltage 1000W @ 220 V ac -.260 V ac line voltage
Filament Power	0 to 8 A, 10 V
Anode Voltage	15kV/66mA Panel meter with 31/2 digit displays the anode voltage. 10-turn potentiometer sets the voltage. HV On button with LED turns the voltage on and off. Push-button LED is blinking if the anode voltage is changing or can not be reached. Anode 1 and Anode 2, buttons to select anode 1 or anode 2. LED is on indicating the selected anode.
Emission Current	0-66mA Panel meter with 3 1/2 digit displays the current

	10-turn potentiometer sets the current.
	Standby push-button with LED selects standby mode.
	Operate push-button with LED selects operate mode.
Monitoring	A panel meter with 3 1/2 digits and 8 selection push-buttons with LED are provided to display one of the following values:
	I_A, anode current, LED is blinking if current limit is reached.
	P_A, anode power, LED is blinking if anode power limit is reached.
	I_F, filament current, LED is blinking if filament current limit is reached.
	U_F, filament voltage. LED is blinking if filament voltage limit is reached.
	I_E, emission current limit, LED is blinking if limit is reached.
	P_A, anode power limit, LED does not blink.
	I_M, maximum filament current, LED does not blink.
	I_S, standby filament current, LED does not blink.

Interlocks/Control

Indicators	Failure is on if the internal power supply fails.
	HV Lock is on if the interlock is open.
	Vacuum is on if the interlock is open.
	Water is on if the interlock is open.
Push-buttons	Remote button is on if unit is remotely controlled.
	Ramp button starts and stops the soft start (only with remote interface).
	Clear button reserved for future functions.
	Water button turns the cooling water on and off. LED is blinking if the water supply fails.
Interlocks Input	HV Lock, 3-pole socket connected to the source cover
	Vacuum, 4-pole socket connected to the vacuum meter
	Water, 6-pole socket connected to the water box
	HV socket, if HV connector is not plugged in the high voltage is inhibited.
Remote Control	An optional interface is used for remote control and soft start. For more details see the remote control manual.

Limits Setting	8 easily accessible potentiometers are provided on the rear side of the front panel allowing the adjustment of the following limits:
	I_E anode1 / I_E anode2, emission current limit.
	P_A anode1 / P_A anode2, anode power limit.
	I_M anode1 / I_M anode2. filament current limit in operate mode.
	I_S anode1 / I_S anode2, filament current limit in standby mode.
Mechanical	19 inch rack mount case, height 3 unit, depth 495 mm, weight 18.5 kg

Chapter 4

Operation of the XRC 1000

Attention

Mind the safety hints given on page 1!!!

For the initial commissioning and after each venting of the vacuum system or in a situation after bad vacuum conditions a careful setup of the X-ray source is recommended.

Note: Some steps described here result in pressure increases due to gas desorption. The pressure will decrease afterwards continuously. Each step should stay as long as the pressure is not longer decreasing, especially at higher voltages. A rapid increase of the high voltage can lead to violent plasma discharges and sparking, thus x-ray source and electronics can be damaged.

If stable operation of the X-ray source was observed over some hours before, the procedure described here can be to abridged in case of a repetition. The high voltages and the emission currents can be set with the velocities implemented by the power supply.

4.1 Test Prior To Installation

1. Check that the mains fit to the recommended voltage range and power consumption.
2. Check all cables for possible damage.
3. If not a complete x-ray package was delivered by SPECS, the set standby current and the maximum current limits could not fit to your equipment. Please check section 3.3 , 'Limits Setting" on page 16.

4.2 Initial Setup

For the initial commissioning and after each venting of the vacuum system or in a situation after bad vacuum conditions a careful setup of the X-ray source is recommended.

Please check the hints given in your source manual (XR50: see "Manual Initial Setup" on page 24).

If your supply dispose of a soft start ramp simply push the **Ramp** button. The **Ramp** push-button can only be used in conjunction with the optional remote interface. Upon pushing this button the high voltage and the emission current are ramped slowly for both anodes. This function is usually used to start up the source automatically after each bake out. The LED's of **Remote** and **Ramp** are on if the ramp is in progress.

4.3 Operation

1. Check vacuum, the vacuum should be better than 1×10^{-7} mbar.
2. **Power** on (switch left side at the front panel). The display comes up and the interlock lamps indicate the actual status. The lamp for the interlock **Water** is on.
3. If any of the other interlocks are enlightened check the appropriate connection, refer to the fault finding guide in section 5.1 , 'Power Supply Fault Finding Guide" on page 27.
4. Push **Water** button. Now the cooling water circuit is switched on i.e. the valve for the water flow is opened. After a few seconds the interlock indicator lamp switches off.
5. Select the anode by pushing the button **Anode 1** or **Anode 2**.
6. Push **Standby** (right side). This will set filament current to the standby current within few seconds. You may check this pressing I_F button below the monitoring display.
7. Choose the desired voltage with **Set** potentiometer below the 'Anode Voltage (kV)' section and switch **HV on** (red button). Wait for the end of the voltage ramp.
8. **Set** the emission current to the desired value and start the emission regulation circuit by pushing the **Operate** button.
9. You can watch total current, power, filament current and filament voltage supplied to the anode in the power supply display by pressing the inscribed buttons section 3.2.2 , 'Monitoring" on page 14).
10. Wait until the system has become stable (monitoring the pressure)

In case the high voltage is automatically switched off due to an interrupt of water flow (e.g. air bubbles) or due to activation of vacuum safety control the above described procedure should be repeated to turn on the high voltage again.

Beware

If in the „operate" mode the I_F is blinking, the „current limit" is active, then the filament assembly is shorted or the preset high voltage is not sufficient to enable the chosen emission current. Check filament resistance! In the second case it is necessary to increase immediately the high voltage or decrease the emission current. Otherwise the life time of the filament would be reduced or cathode material could be evaporated onto the anode faces or Al-window.

- **Never short the interlock system for HV Guard and Cooling!**
- **Never operate the X-ray source without cooling! The anode coatings will be evaporated immediately and the anode can be cracked.**

4.4 Switch-Off

1. For turning off the power supply push the **HV on** button. HV will be switch off and the filament goes immediately in the **Standby** mode (The LED at this button is active).
2. Push **Standby** to switch off the filament (LED in this button is off).
3. Wait one minute then turn off the water circuit by pushing the **Water** button.
   The water cooling should not be continued, otherwise the anode will be cooled down and become the coldest surface of the analysis system. Intensive condensation of contaminants at the anode surface would be the unintended result.
4. **Power** will switch off the power supply.
5. Turn off the water support from (and to) the cooling unit. For a longer non-operational period it is recommended to remove the water supply and to effuse the water from the pipes.

Attention

Mind the safety hints given on page 1!!!
Warning: It will take 3 minutes before all high voltages are absent. So wait at least 3 minutes before disconnecting any cables from the power supply or the X-ray SOURCE.

Chapter

5

Fault Finding

5.1 Power Supply Fault Finding Guide

Problem:	**Check:**
Panel meters not on	Check line fuses on rear panel or line cable
Water indicator on	Water interlock not connected, cooling circuit is not working, water flow is insufficient
Vacuum indicator on	Check interlock connection and chamber pressure
HV Lock indicator on	HV connector is not plugged in, Interlock cable is not connected, the source cover switch is open
Failure indicator on	Upon turning on the control unit, the failure illuminates a few seconds indicating that the internal power supply is starting up. If the indicator illuminates more than 5 sec., the internal power supply is defective.
HVOn	XRC 1000 can not supply the high voltage. Check the line voltage.

LED blinking:

I_A — The anode current limit is reached. Check if there is a short between anodeand ground.

I_E — Emission current limit is reached. Check the high voltage and the filament current.

I_F — Filament current limit is reached. Choose a lower emission current or a higher voltage. Check the resistance of the filament.

U_F — Filament voltage limit is reached. Measure the resistance of the filament.

P_A — The power at the anode reaches the preset limit. Check emission currentand high voltage settings.

5.2 HV Spark-over

If HV sparks occur normally the power supply will switch off the HV and go to standby mode. At the beginning of the source operation and after venting or replacement of source parts some sparks may occur. Normally the abundance will go down.

Possible sources for HV sparks are:

- bad ground connections
- bad vacuum conditions
- water leakage inside the protection cover
- the protection cover itself (PTFE isolation)
- the HV cable or the HV supply
- the anode
  (especially the critical distance between anode and Al window rod which suppress the crosstalk). Overload, contaminations, dust particles or cooling problems perform the building of small spots with a crater shape and sharp edges. HV sparks force the building of such pits. This is accompanied in an evaporation of the anode material or in the worst case in a cracked anode with water injection into the vacuum chamber.

Attention

Mind the safety hints given on page 1!!!
Warning: It will take 3 minutes before all high voltages are absent. So wait at least

3 minutes before disconnecting any cables from the power supply or the X-ray source.

If the frequency of sparks increases it is absolutely necessary to find out the reason. Please try to find out either the sparks are outside or inside the source (vacuum). Please contact SPECS prior to dangerous test procedures!

1. The sparks effect the pressure inside the vacuum chamber or not? Please consider that even in case of HV sparks outside the source module the vacuum reading at the controller can be influenced by electromagnetic pulse EMP, pretending a pressure increase.
2. Do the sparks depend on operate / standby and / or the absolute value of high voltage?
3. Do the PTFE shield inside the protection cover is not complete and / or shows HV traces and / or is dirty / wet?
4. Switch off the HV and check the HV cable isolation between line and screen. Disconnect the HV cable at the source (banana plug) and isolate this contact very proof.

WARNING!
HAZARDOUS VOLTAGE! DANGER FOR LIFE!

5. Sparks occur still in standby mode?
   (Do not perform operate, because the filament current will goes to I_M. This will decrease the filament life time.)

   If sparks still occur:
   HV sparks are in the supply the protection cover or the HV cable!
   Separate the source by disconnecting step by step the supply line.

   Reassemble the original configuration to avoid any dangerous situation.

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