

# AC DISCHARGE CONTROLLER MANUAL

## MODEL AC1006



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## **CONTENTS**

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### **Contents**

1 GENERAL INFORMATION .....	1-1
1.1 Introduction .....	1-1
1.2 Safety .....	1-1
1.3 Specifications .....	1-2
1.4 Dimensions .....	1-2
1.4.1 Weight .....	1-2
1.4.2 AC Input .....	1-2
1.4.3 AC Output .....	1-2
2 INSPECTION AND INSTALLATION .....	2-1
2.1 Unpacking and Inspection .....	2-1
2.2 Inventory .....	2-1
2.3 Physical Description .....	2-1
2.3.1 Front Panel .....	2-1
2.3.2 Rear Panel .....	2-2
2.4 Installation .....	2-2
2.4.1 Mounting .....	2-2
2.4.2 Cooling .....	2-3
2.4.3 Electrical-connections to electron source and emission controller .....	2-3
2.4.4 Electrical-AC input .....	2-3
3 OPERATION .....	3-1
3.1 Local Mode .....	3-1
3.2 Remote Mode RS-232 .....	3-2
3.2.1 Direct RS-232 connection from computer to AC discharge controller .....	3-3
3.2.1.1 Software .....	3-3
3.2.2 Communications settings .....	3-3
3.2.3 Commands .....	3-3
3.2.4 Operational sequence .....	3-4
3.2.5 Electrical-Analog .....	3-6
3.2.5.1 ANALOG Input/Output .....	3-6
4 DIAGNOSTICS .....	4-1
4.1 General .....	4-1
4.2 Diagnostic Table .....	4-1
5 LIMITED WARRANTY .....	5-1
6 SERVICE AND TECHNICAL INFORMATION .....	6-1

**Figures**

Figure 2-1 AC Discharge Controller front panel. .... 2-4  
Figure 2-2 AC Discharge Controller rear panel. .... 2-5  
Figure 2-3 Operating cable electrical connector. .... 2-6

**Tables**

Table 2-1 Inventory List ..... 2-1  
  
Table 3-1. Analog connections. .... 3-6  
Table 3-2. Interlock connections. .... 3-7  
  
Table 4-1 Diagnostic Table ..... 4-1

## **1 GENERAL INFORMATION**

### **1.1 Introduction**

The Kaufman & Robinson, Inc. AC Discharge Controller is designed for use with a Kaufman & Robinson Electron Source. The intended use of this controller is to provide AC voltage and current to the Electron Source neutralizer for ion production and neutralization of the ion beam. The purpose of this publication is to provide the user with information regarding safe operation and use of this device. This controller has numerous features built in. Features designed into this unit follow:

- Automatic adjustment of AC Discharge current and voltage to maintain constant emission.
- Local mode operation.
- Remote mode operation using analog I/O through DB25 connector.
- Remote programming and monitoring via RS232 interface.
- RS485 High Speed Serial link for proprietary communications with KRI Controllers.
- "Fan on Demand" cooling with thermal shutdown protection.
- Front panel selectivity for local/remote mode.

### **1.2 Safety**

**Caution: Only technically qualified personnel should install, maintain, and troubleshoot the equipment described herein.**

**Lethal voltages and currents can be developed within the controller, therefore, the controller chassis should not be opened. Removal of the controller cover will void all warranties.**

**The AC Discharge Controller for the electron source must be installed in a grounded 19-inch (483 mm) rack mount cabinet before operation.**

**The following safety procedures must be followed for safety purposes:**

- Do not remove covers.
- Proper grounding of the chassis is required.
- Use caution when making input power connections.
- Do not remove warning labels from controller.
- Do not use the controller in a method not described in this publication.
- Disconnect the power cord from the back of the AC Discharge Controller prior to making any modifications to the power supply inputs or outputs.

- The AC Discharge Controller should only be serviced by Kaufman & Robinson, Inc.

### **1.3 Specifications**

The following specifications pertain to the Kaufman & Robinson, Inc., AC Discharge Controller, Model: AC1006.

### **1.4 Dimensions**

The controller is designed to be mounted in a standard 19-inch (48.3 cm) rack mount cabinet. The height of this controller is 1.75 inches (4.45 cm) and its depth is approximately 21 inches (53.3 cm).

#### **1.4.1 Weight**

The weight of this unit is 7.27 kg (16 pounds).

#### **1.4.2 AC Input**

The input voltage for the AC Discharge Controller is 85-275 volts ac single phase at 50-60 Hz. The maximum input current to the unit is 15 amps.

#### **1.4.3 AC Output**

The maximum output out of this controller is 40 V ac at 25 amps.

## ***INSPECTION AND INSTALLATION***

**2-1**

### **2 INSPECTION AND INSTALLATION**

This section describes how to install the Kaufman & Robinson, Inc., KRI® AC Discharge Controller, which has been designed for operation of a KRI Electron Source, LFN2000. Unpacking and inspection, physical description, hardware inventories and installation information is provided to assist in facilitating a successful installation.

#### **2.1 Unpacking and Inspection**

Prior to shipment, the controller was inspected and tested and has been shipped free of defects. As soon as the controller has been completely removed from all packing materials a visual inspection should be made to determine if there has been any damage to the products during shipment. If any damage has occurred contact Kaufman & Robinson, Inc., in addition to the shipping company to report any damage, see Warranty section 5. Retain packaging materials for shipment of the controller. Inventory the contents shipped to determine completeness of the order.

#### **2.2 Inventory**

The following items are shipped with each controller:

Table 2-1 Inventory List

Quantity	Description	Part Number
1	AC Discharge Controller	AC1006
1	Power Hot AC Discharge Supply Cable	CBL-A07-PWR-ACD-LFN
1	Atmosphere Hot AC Discharge Cable	CBL-A04-ATM-ACD-LFN
1	AC Discharge Controller, Model A1006 Manual	

#### **2.3 Physical Description**

##### **2.3.1 Front Panel**

Figure 2-1 shows the front panel of this controller. The controller has one power switch located on the front panel. The three white buttons on the front panel are used for manual control of the power supply. The button switch on the left allows the unit to be placed in an active (enabled) or inactive (standby) mode. In the STANDBY mode, the discharge current setpoint is

displayed. The middle button switch selects if the front panel discharge set point control is (local) or if programming inputs from the rear panel (remote) will determine the output settings for the supply. The right button selects the cathode VOLTAGE to be viewed on the left display. Two seconds after the right button is released the left display returns to displaying the cathode current. The right display shows the discharge in amps. The discharge is adjustable using the adjust/discharge knob on the front panel. This knob will also adjust the setpoint when the unit is in Standby mode.

Three indicator lights are located between the power switch and the Enable/Standby button. The top light indicates if the cathode filament is broke, thus an open circuit. The middle light indicates remote operated interlock is open. And the bottom light indicates the unit is shutdown in remote mode.

### **2.3.2 Rear Panel**

Figure 2-2 shows the back panel of the AC Discharge Controller. Analog connections, utilizing DB-25 female connectors, are provided on the back panel of this controller for remote operation.

RS-232 remote operation utilizes a DB-9 female connector and is located on the back panel above the analog remote.

Two sockets are installed at the back panel for connecting the AC Discharge Controller to the Emission Controller and for connection from the AC Discharge Controller to the vacuum feedthrough, these sockets are labeled "Source".

A ground stud is provided on the rear panel of this unit for grounding the chassis of the controller.

Air vents at the rear panel of the controller keep all of the electrical components within the controller cool.

## **2.4 Installation**

### **2.4.1 Mounting**

The controller is designed to be mounted in a standard 19-inch (48.3 cm) rack mount cabinet. The height of this controller is 1.75 inches (4.4 cm) and the depth of the unit is approximately 21 inches (53.3 cm). When installing the AC Discharge controller into the cabinet refer to the KRI® RF Ion Source Controller Manual for installation orientation relative to the other ion source



## ***INSPECTION AND INSTALLATION***

**2-3**

controllers. Install the controller in the rack mount cabinet prior to making any electrical connections.

### **2.4.2 Cooling**

This controller is forced air cooled with the airflow entering through a vent in the back panel of the chassis. The air flow exits through a vent in the back panel of the chassis. Ensure that there are no obstructions in the rack mount cabinet that will restrict the airflow from entering or exiting through the vents.

### **2.4.3 Electrical-connections to electron source and emission controller**

Located on the back panel of the controller is a connector for connecting the AC Discharge Controller to the electron source and connection of the AC Discharge Controller to the Emission Controller.

If the AC Discharge Controller was purchased with an Emission Controller; interconnecting cables are provided. Information regarding installation of these connecting cables can be found in the "KRI® RF Ion Source Controller Manual".

If the AC Discharge Controller was purchased as a stand alone unit contact Kaufman & Robinson, Inc. for cabling requirements.

### **2.4.4 Electrical-AC input**

The controller has been designed for 85-275 volts AC input voltage, 50-60 Hz, single-phase with a maximum current of 15 amps. A power supply cable has been included with the controller. This cable has a female plug at one end that corresponds to the male socket at the rear panel of the controller. The opposite end of this cable has been intentionally left bare so that the cable may be installed to facility requirements. Electrical connection made from the AC Discharge Supply Cable to the AC voltage within the facility should only be made by qualified personnel.



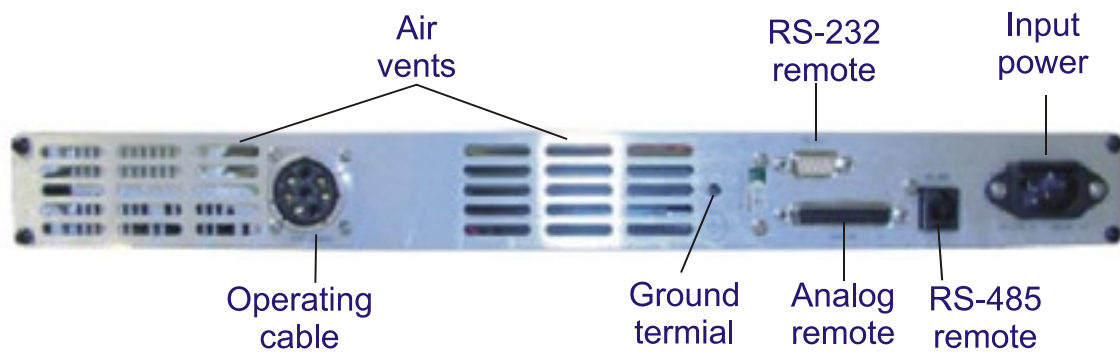
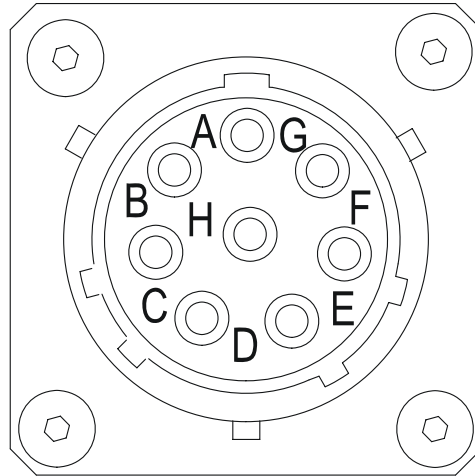


Figure 2-2 AC Discharge Controller rear panel.



- Location A, Not Used
- Location B, Filament Line 1
- Location C, Ground
- Location D, Filament Line 1
- Location E, Not Used
- Location F, Filament Line 2
- Location G, Filament Line 2
- Location H, Not Used

Figure 2-3 Operating cable electrical connector.

### **3 OPERATION**

The AC Discharge Controller can be operated in Local and Remote modes. Mode selection between Local and Remote modes is controlled using a switch located on the front panel of the controller. A lighted indicator is located above and below this switch to indicate local or remote mode.

The following information is provided for operation of the AC Discharge Controller.

#### **3.1 Local Mode**

Operation of the AC Discharge Controller in Local mode requires the mode selector switch, located on the front panel of the controller, to be switched to Local. This allows the user to adjust the cathode emission for the AC Discharge cathode using the knob on the front panel. Information regarding operation of this controller with the Electron Source can be found in the RF Ion Source Controller Manual.

**ON/OFF** Switch – Supplies power to the controller.

When switched to the ON position, the controller may be in either Remote or Local control depending on the last operation.

If the last operation was with Local control, then the controller will be in Local when switched ON. In this case the supply will be in Standby with the Discharge Amps Setpoint displayed. The Discharge Amps Setpoint that is displayed will be the last setpoint used before the supply was switched OFF.

If the last operation was with Remote control, then the controller will be in Remote when switched ON. In this case the supply will respond to the remote commands in effect when switched ON.

**Open Cathode** indicator – Indicates that the filament is open.

When a cathode filament breaks or there is no contact to the filament, the red Open Cathode indicator LED (light emitting diode) will be illuminated. Additionally there will be an audible alarm and the front panel LED display will show HLP 3. Cycling power using the ON/OFF switch or opening the interlok resets the Open Cathode indicator, alarm and LED display.

**Open Interlock** indicator – Indicates that the interlock connection located on the back panel is open.

**Remote Shutdown** indicator – Indicates that remote shutdown has been commanded through the analog or RS-232 remote interface.

**Enable/Standby** switch – Enables or disables the output.

When Standby is selected, the Discharge Amps Setpoint is displayed. When Enabled is selected, the controller regulates the Cathode Amps/Volts to maintain the Discharge Amps Setpoint. The Discharge Amps Run value is displayed when enabled, along with the Cathode Amps. The Cathode Volts can be displayed by pressing the View Cathode Voltage switch when Enable is selected.

**Local/Remote** switch – Selects Local (front panel) or Remote (analog or RS-232) control.

**View Cathode Voltage** switch – Displays the cathode voltage in the Cathode Amps/Volts display when pressed and continues for two seconds after it is released, then the display reverts to the Cathode Amps.

**Cathode Amps/Volts** display – Displays the measured cathode current in amps as the default or the cathode voltage when the View Cathode Voltage button is pressed as described above.

**Discharge Amps** display – Displays the discharge setpoint and run values in amps. When the yellow setpoint indicator below the display is illuminated, the discharge setpoint value is displayed. When the green run indicator is illuminated, the discharge run value is displayed.

**Setpoint** indicator – Indicates when the discharge setpoint is being displayed on the Discharge Amps display.

**Run** indicator – Indicates the run value for the discharge when illuminated.

**Discharge Adjust** knob – Adjusts the discharge setpoint when in local mode.

### **3.2 Remote Mode RS-232**

Operation of the AC Discharge Controller in Remote mode requires the mode selector switch, located on the front panel of the controller, to be switched to Remote.

The AC Discharge Controller can be operated from a host computer using an RS-232 port on the computer. Connection from the computer is made from a serial port on the computer to the serial port on the AC Discharge Controller,

labeled, "RS-232", "AC Discharge". This approach uses an RS-232 straight through cable that connects to a DB-9 male connector.

### **3.2.1 Direct RS-232 connection from computer to AC discharge controller**

The AC Discharge Controller can be operated from a host computer using an RS-232 port on the computer. Connection from the computer is made from a serial port on the computer to the serial port on the AC Discharge Controller, labeled, "RS-232". This approach uses an RS-232 straight through cable that connects to a DB-9 male connector.

#### **3.2.1.1 Software**

Software control of the AC Discharge Controller can be accomplished using a variety of methods. Some type of terminal or communications program, or programming can be used for controlling this unit. Some examples of programs that can be used are Hyper Terminal provided with Microsoft® Windows® systems and Labview™ by National Instruments™. Consult the user guide for installation and operation of the software that you plan on using for use of that program.

### **3.2.2 Communications settings**

Operation of the AC Discharge controller using a Serial connection requires the following settings within the terminal or communications program:

- Set communications port to available Com number.
- Baud Rate Selectable = 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 Baud. Note: The default value is 9600. Contact KRI® for other baud rates.
- Data Bits = 8.
- Parity = None.
- Stop Bits = 1.

### **3.2.3 Commands**

The following commands are specific to the AC Discharge Controller. These commands allow the user to set the emission on the AC Discharge cathode and monitor the voltages and currents output from the controller.

- VAXxxx Outputs decimal data as analog voltage with power supply for setting the AC Discharge cathode discharge current. Note: xxxx is a decimal

value from 0-4095. VA0 is the minimum or zero output, it also puts the unit in standby mode, while VA4095 is maximum output.

- \*IDN? Returns the 4 digit product identifier code.
- RD0 Returns a decimal number for conversion to the corresponding cathode voltage.
- RD1 Returns a decimal number for conversion to the corresponding cathode current.
- RD2 Returns a decimal number for conversion to the corresponding cathode emission.

### **3.2.4 Operational sequence**

Using a terminal program configured for the communications settings previously mentioned, input the following commands in the defined sequence. User Inputs are shown with quotations to designate the exact command the user must input, the quotation marks should not be input into the terminal program.

- During power up of the AC Discharge Controller set the output to zero current output for safety. Input "VA0" then press the enter key.
- Determine the AC Discharge cathode discharge current required. Using the following formula, determine the decimal value required for input into the terminal program corresponding to the required discharge current :

Input value = required cathode discharge /12.5 X 4095.

Example: A value of 5 amps of cathode discharge is required for a particular process, keeping the cathode discharge equal to the discharge current. Using the above formula,  $5/12.5 \times 4095 = 1638$ .

- Input "VAxxxx" then press the enter key. Note: xxxx corresponds to a decimal number from 0-4095. For the example above, input "VA1638" into the terminal program and then press the enter key to set the cathode discharge to 5.0 amps.



- Powering down the AC Discharge Controller should be done by resetting the output current to zero, this is done by inputting the following command into the terminal program: Input "VA0" then press the enter key. The discharge will drop to zero and the Standby LED will be illuminated.
- Cathode Voltage: Monitoring of the cathode voltage can be done using the following command: Input "RD0" then press the enter key. This reads a decimal number from 0-4095 that can then be converted to the corresponding cathode voltage. To convert the decimal number to the cathode voltage, divide the returned value by 81.9.

Returned value/81.9=Cathode voltage

Example: The command RD0 was sent to the AC Discharge Controller and the value 2048 was returned from the terminal program. To convert this value to the cathode voltage take 2048 and divide by 81.9, this would give a cathode voltage of 25 volts.

- Cathode Current: Monitoring of the cathode current can be done using the following command: Input "RD1" then press the enter key. This reads a decimal number from 0-4095 that can then be converted to the corresponding cathode current. To convert the decimal number to the cathode current divide the returned value by 102.38.

Returned value/102.38=Cathode current

Example: The command RD1 was sent to the AC Discharge Controller and the value of 2048 was returned from the terminal program. To convert this value to the cathode current, divide 2048 by 102.38 which gives a cathode current of 20 amps.

- Discharge Current: Monitoring of the discharge current can be done using the following command: Input "RD2" then press the enter key. This reads a decimal number from 0-4095 that can then be converted to the corresponding discharge current. To convert the decimal number to the discharge current, divide the returned value by 81.9.

Example: The command RD2 was sent to the AC Discharge Controller and the value of 410 was returned from the terminal program. To convert this value to the discharge current, divide 410 by 81.9 which gives a discharge current of 5 amps.

### **3.2.5 Electrical-Analog**

The AC Discharge Controller can be operated using analog.

### 3.2.5.1 ANALOG Input/Output

The AC Discharge Controller can be remotely controlled using a 0-5 volt DC analog interface. The analog remote uses 0-5 volt signals for controlling and monitoring the controller. There is one 25 pin female D connector labeled ANALOG on the back of the controller for connection to the analog interface. The pin descriptions for the interface are given below in table 3-1. There is a button on the front panel that can be used to switch from remote to local control. There is also a two pin Molex connector on the back panel labeled INTERLOCK. The pin descriptions for the interlock are also given below in table 3-2.

Table 3-1. Analog connections.

Pin Number	Description
1	Output Enable – Output is enabled when 5 volts is applied. Output goes to standby mode when 0 volts is applied or when no contact is made. Enable and Standby are indicated on the front panel.
2	Remote Shutdown, Active High – Output is disabled when 5 volts is applied. The shutdown is deactivated when 0 volts is applied or no contact is made. Remote Shutdown is indicated on the front panel when activated.
3	Common.
4	Remote Local Indicator Output – 0 volts = Remote, 5 volts = Local (5 k $\Omega$ source impedance). Also available on pin 20.
5	No Contact.
6	Common.
7	Cathode Current Monitor – Outputs 0 to 5 volts for 0 to 40 amps of cathode current.
8	Discharge Current Monitor – Outputs 0 to 5 volts for 0 to 20 amps of discharge current.
9	Discharge Current Setpoint – Input 0 to 5 volts for 0 to 12.5 amps of discharge current.
10	No Contact.

<b>Pin Number</b>	<b>Description</b>
11	Common
12	Common.
13	Auxiliary +5 volts DC, 200 mA max. Also available at pin 15 and 25.
14	Remote Shutdown, Active Low – Output is disabled when connected to common. The shutdown is deactivated when 5 volts is applied or no contact is made. Remote shutdown is indicated on the front panel when activated.
15	Auxiliary +5 volts DC, 200 mA max. Also available at pin 13 and 25.
16	Common
17	Common
18	Over Temperature Output – A 5 volt output indicates over temperature (5 kΩ source impedance).
19	Cathode Monitor – Outputs 0 to 5 volts for 0 to 50 volts cathode voltage.
20	Remote Local Indicator Output – 0 volts = Remote, 5 volts = Local (5 kΩ source impedance). Also available on pin 4.
21	Common
22	No contact.
23	Open Cathode Indicator – A 5 volt output indicates an open cathode (5 kΩ source impedance). Open cathode is also indicated on the front panel.
24	Common
25	Auxiliary +5 volts DC, 200 mA max. Also available at pin 13 and 15.

Table 3-2. Interlock connections.

<b>Pin Number</b>	<b>Description</b>
1	Active Low Interlock – Connect to common (Interlock pin 2) to enable the AC Discharge controller.
2	Interlock Return – Common.



**4 DIAGNOSTICS**

**4.1 General**

The AC Discharge Controller has been designed for operating a filament cathode in a vacuum environment for use in a electron source. The filament cathode provides electrons for starting the ion source in addition to neutralizing the ion beam.

In local mode operation of the AC Discharge Controller the adjustment knob on the front panel is adjusted from minimum up to a desired emission current that is equal to or greater than the ion source discharge current. In normal operation as the knob is rotated clockwise from minimum to the desired emission current, the cathode Voltage, Current, and Emission displayed on the front panel should increase.

The following information is intended to facilitate troubleshooting of the AC Discharge Controller. This information assumes that the controller is connected to power and that all interconnects between power supplies and the ion source cable are made correctly. It is also assumed that all gas connections are in good condition and that the gas circuit is complete from the gas bottle to the ion source.

**Power must be removed from the controllers prior to performing maintenance on the Ion Source.**

**4.2 Diagnostic Table**

The following table may be used to assist in determining faults and corrective action for the AC Discharge Controller.

Table 4-1 Diagnostic Table

<b>Symptom</b>	<b>Possible Cause</b>	<b>Correction</b>
No power to the controller when power switch is in the on position	AC power cable disconnected  Blown fuse or fuses inside chassis	Plug in controller  Inspect and replace blown fuse or fuses

Symptom	Possible Cause	Correction
No voltage or current displayed as discharge adjustment knob is rotated clockwise, local mode operation	Mode switch on front panel set to Remote Controller in Standby Mode	Switch mode switch to Local Switch to Enable
No voltage or current displayed on front panel when Remote mode operation	Mode switch on front panel set to Local Cables not connected correctly Incorrect terminal settings	Switch mode switch to Remote Consult RF Ion Source Controller Manual to verify cable interconnects Review terminal settings and compare to the required setting outlined in section 3-2
No voltage or current displayed on front panel when Remote mode operation	Incorrect command used or command input incorrectly	Review section 3.2 for commands and usage information
Cathode voltage and current increase with clockwise rotation of Discharge adjust knob, no Discharge current displayed	Low gas flow into the electron source Poor electrical connections Fault in electron source used	Increase gas flow Calibrate flow controller Check all electrical connections including grounds to insure electrical circuit is complete and the electrical connections are reliable Troubleshoot electron source and correct any deficiencies

## **5 LIMITED WARRANTY**

Kaufman & Robinson, Inc. (KRI) warrants to the purchaser or end user of the equipment it sells that such equipment will be free from defects in material and workmanship under normal use and service. This warranty is for a period of fifteen (15) months from the date of original shipment F.O.B KRI's facility, Fort Collins, Colorado, or one year from the date the equipment is placed in use by the purchaser or end user thereof, whichever occurs first. This warranty is void if the equipment is not used, operated, and maintained in accordance with the manual accompanying the equipment. KRI shall not be responsible for any direct or indirect loss or damage resulting from accident, negligence of a user, alteration, abuse, or misuse of the equipment. Upon acceptance of this Limited Warranty, purchaser waives all warranties, guarantee, or remedies not specifically stated in this Limited Warranty. This warranty does not cover ordinary wear and tear or expendable components.

KRI's obligation under this Limited Warranty is, at KRI's option, to repair or replace any defective equipment or parts of the equipment, without charge to the purchaser, which are returned, shipping prepaid, to the KRI facility, 1306 Blue Spruce, Unit A, Fort Collins, Colorado, 80524 USA. For return or repair of equipment, purchaser must contact KRI for a Return Materials Authorization prior to shipment of the equipment to KRI. If KRI has designated an Authorized Warranty Service Representative in the purchaser's country, contact may be made with the Authorized Warranty Service Representative and defective equipment may be delivered to such Authorized Warranty Service Representative to service warranty claims.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranties of merchantability and fitness for any particular purpose. The purchaser acknowledges the purchaser is not relying in KRI's skill or judgment to select or furnish equipment suitable for any particular purpose.

This Limited Warranty will be construed in accordance with the Uniform Commercial Code as adopted by the State of Colorado.

This warranty does not cover expendable parts; expendable parts are as follows:

Alumina Insulators  
Vacuum Cables  
Filaments  
Fuses

For Service or Repair, contact KRI:

Kaufman & Robinson, Inc.  
1330 Blue Spruce Dr.  
Fort Collins, CO 80526  
(970) 495-0187  
(970) 484-9350 (FAX)

Please indicate the following items relating to the defect with the item to be returned:

Product  
Serial Number  
Detailed description of problem  
Date of purchase  
Name of Company with address, and contact person



## **SERVICE AND TECHNICAL INFORMATION**

**6-1**

### **6 SERVICE AND TECHNICAL INFORMATION**

For technical information, repairs or replacement during Warranty, or repairs thereafter, please contact:

Kaufman & Robinson, Inc.  
1330 Blue Spruce Dr.  
Fort Collins, CO 80524  
Tel.: 970-495-0187  
Fax.: 970-484-9350  
www.ionsources.com

Please include the following details relating to the problem encountered or the item to be returned:

- Product
- Serial number
- Detailed description of problem
- Date of purchase
- Name and address of company
- Contact person

If return to KRI is required, you will be given an authorization number and instructed where to send it.