DISCHARGE CONTROLLER
MODEL DC25020
MANUAL

CONTENTS

CONTENTS

FIGURES

TABLES

1. General Information

1.1 Introduction

The Kaufman & Robinson, Inc. Discharge Power Supply is designed for use with a Kaufman & Robinson Ion Source. The intended use of this Power Supply is to provide DC voltage and current to the Ion Source Anode for ion production. The purpose of this publication is to provide the user with information regarding safe operation and use of this device. This power Supply has numerous features built in. Features designed into this unit follow:

- Both Current and Voltage control adjustment.
- 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 Pow er Supply, therefore, the Pow er Supply chassis shoul d not be opened. Removal of the Power Supply cover will void all warranties.

The Discharge Power Supply 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 Power Supply.
- Do not use the Power Supply in a method not described in this publication without consult and approval by KRI engineering.

- Disconnect the power cord from the back of the Discharge Power Supply prior to making any modifications to the power supply inputs or outputs.
- The Discharge Power Supply should only be serviced by Kaufman & Robinson, Inc.

1.3 Specifications

The following specifications pertain to the Kaufman & Robinson, Inc., Discharge Power Supply, Models DC25020.

1.3.1 Dimensions

The Power Supply is designed to be mounted in a standard 19-inch (48.3 cm) rack mount cabinet. The height of this Power Supply is 3.5 inches (8.9 cm) and its depth is approximately 21 inches (53.3 cm).

1.3.2 Weight

The weight of this unit is 12.4 kg (27.5 pounds).

1.3.3 AC Input

The input voltage for the Discharge Power Supply is 85-275 volts ac single phase at 50-60 Hz. The maximum input current to the unit is electronically limited to 28 amps RMS. Operation at lower line voltages may be limited by outlet capacity and/or circuit breakers.

1.3.4 DC Output

The maximum output for the DC25020 model of this Power Supply is 250 VDC at 20 amps. Operation at this level is limited by thermal protection. Continuous duty operation is specified at 4000 watts up to 40˚C ambient air temperature.

2. INSPECTION AND INSTALLATION

This section describes how to install the Kaufman & Robinson, Inc., KRI® Hi-P Discharge Power Supply which has been designed for operation of a KRI Ion Source. 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 Power Supply was inspected and tested and has been shipped free of defects. As soon as the Power Supply 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 Power Supply. Inventory the contents shipped to determine completeness of the order.

2.2 Inventory

The following items are shipped with each Power Supply:

Table 2-1. Inventory List.

Quantity	Desciption	Part Number
1	Discharge Power Supply	DC25020
1	Power Discharge Supply Cable	CBL-A07-PWR-HF-EH-HO
1	Atmosphere Discharge Cable	CBL-A04-ATM-HF-EH
1	Discharge Power Supply Manual	

2.3 Physical Description

2.3.1 Front Panel

Figure 2-1 shows the front panel of this Power Supply. The Power Supply 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. The front panel displays are still active in the STANDBY mode. The middle button switch selects if the front panel (Local) or rear panel (Remote) control of the VOLTAGE, and CURRENT. The rear panel (Remote) includes both analog and RS-232 interface. The right button selects between the output VOLTAGE, or CURRENT adjustment for the far right encoder knob. The left display shows the Discharge voltage setpoint or readback in volts. The right display shows the Discharge current setpoint or readback in amps. The Discharge voltage or current is adjustable using the adjust 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 power limit is being exceeded. 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 Discharge Power Supply. An RS-232 connection is provided on the back panel of this Power Supply for remote operation. RS-232 connection at the back panel utilizes a DB-9 connector.

The RS-485 is for the KRI autocontroller.

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

Analog connections, utilizing DB-25 female connectors, are provided on the back panel of this controller for remote operation.

2.4 Installation

2.4.1 Mounting

The Power Supply is designed to be mounted in a standard 19-inch (48.3 cm) rack mount cabinet. The height of this Power Supply is 3.5 inches (8.9 cm) and the depth of the unit is approximately 21 inches (53.3 cm). When installing the Discharge Power Supply into the cabinet, refer to the Ion Source Controller Manual for installation orientation relative to the other ion source Power Supplies. Install the Power Supply in the rack mount cabinet prior to making any electrical connections.

2.4.2 Cooling

This Power Supply is forced air cooled with the airflow entering and exiting through the back panel of the chassis. Ensure that there are no obstructions in the rack mount cabinet that will restrict the airflow.

2.4.3 Electrical-Connections to Ion Source and Discharge Power Supply

Located on the back panel of the Power Supply are two sections of three connectors each for connecting the Discharge Power Supply directly to the ion source or through a KRI Filament Power Supply.   Each terminal is capable of the full output of the Discharge Power Supply. Multiple outputs are provided to allow multiple supplies to share connections.

If the Discharge Power Supply was purchased with an Ion Source and Filament Power Supply, interconnecting cables are provided. Information regarding installation of these connecting cables can be found in the "Ion Source Filament Cathode Version Controller Manual".

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

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2.4.4 Electrical-AC Input

The Power Supply has been designed for 185-285 volts AC input voltage, 50-60 Hz, three-phase with a maximum current of 10 amps per phase at the lowest line voltage. A power supply cable has been included attached to the Power Supply. 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 Discharge Supply Cable to the AC voltage within the facility should only be made by qualified personnel.**

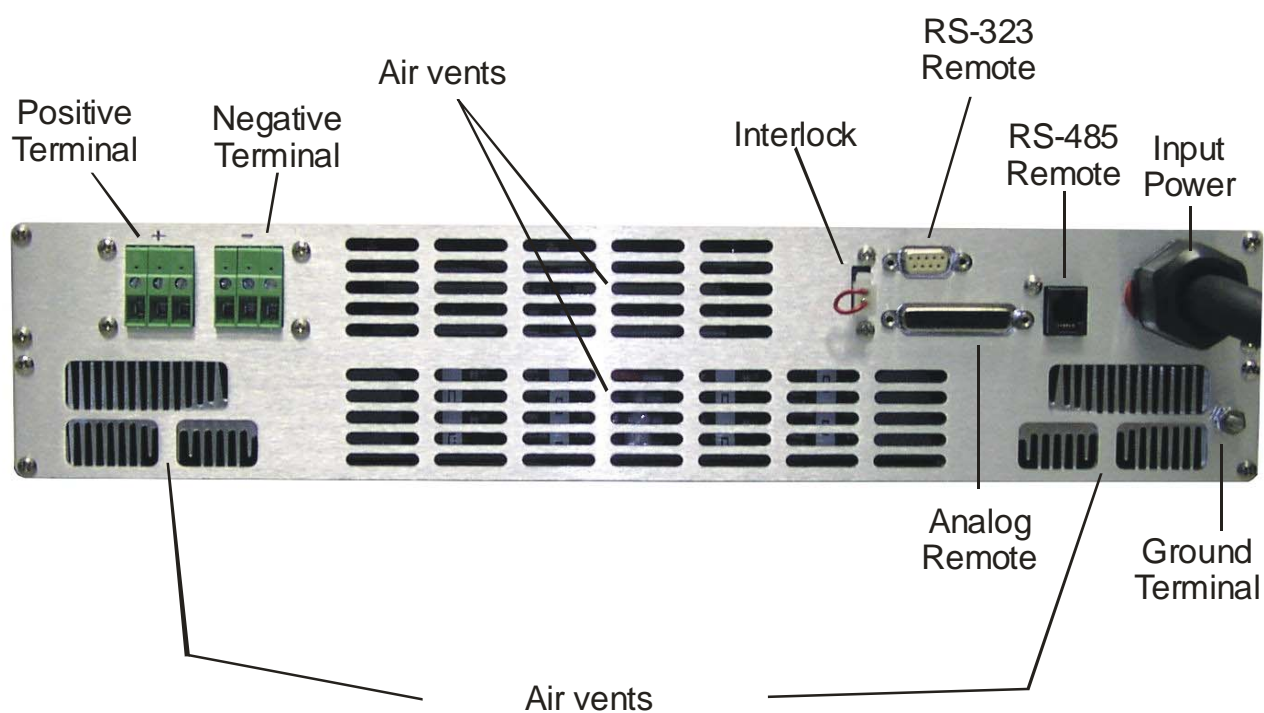Fig. 2-1   Discharge Hi-P Power Supply front panel.

Fig 2-2   Discharge Hi-P Power Supply rear panel.

3. Operation

The Discharge Power Supply can be operated in Local and Remote modes. Mode selection between Local and Remote modes is controlled using a Momentary Push Button located on the front panel of the Power Supply.

The following information is provided for operation of the Discharge Power Supply.

3.1. Local Mode

Operation of the Discharge Power Supply in Local mode requires the mode indicator LED, located on the front panel of the Power Supply, to be set to Local. This allows the user to adjust the output for the Discharge Supply using the knob on the front panel. Information regarding operation of this Power Supply with the End Hall Ion Source can be found in the End Hall Ion Source Manual, included in the End Hall Documentation package.

ON/OFF Switch – Supplies power to the Power Supply.

When switched to the ON position, the Power Supply may be in either Remote or Local control depending on the last operation.
If the last operation was with Local control, then the Power Supply will be in Local when switched ON. In this case the supply will be in Standby with the Discharge Amps and Volts Setpoints displayed. The Setpoints that are displayed will be the last setpoints used before the supply was switched OFF.
If the last operation was with Remote control, then the Power Supply will be in Remote when switched ON. In this case the supply will respond to the remote commands in effect when switched ON.

Power Limit indicator – Indicates that the output power exceeds the setup limits.

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 Push Button – Enables or disables the output.

When Standby is selected, the Displays indicate Setpoints. When Enabled

is selected, the Power Supply regulates the Discharge Amps/Volts to maintain the Setpoint Limits.

Note: The setpoints are output "limits" and only one can be "regulated" at any given time. The load will determine the other. Example: If the Discharge setpoints are 5 amps and 200 volts and the load is 25 Ohms then the output will be limited to 5 amps and the output voltage will be 5x25 = 125 volts according to Ohms law (V = IxR). If the Load resistance is 50 Ohms then the output will be limited to 200 volts and the current will be 200/50 = 4 amps. The Discharge control offers automatic and extremely fast crossover between Voltage and Current regulation.

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

Amps/Volts Select – Selects which parameter is being adjusted by the setpoint adjust encoder knob as indicated by the amps or volts light.

Discharge Volts display – Displays the measured discharge voltage in volts.

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

Setpoint indicator – Indicates when the setpoints are being displayed on the Digital Displays. When the yellow setpoint indicator below the display is illuminated, the setpoint value is displayed. When the green run indicator is illuminated, the run value is displayed.

Run indicator – Indicates when the running values are being displayed on the Digital Displays.

Setpoint Adjust knob – Adjusts the Voltage and Current setpoints when in local mode.

3.2. Remote Mode RS-232

Operation of the Discharge Power Supply in Remote mode requires the mode selector switch, located on the front panel of the Power Supply, to be switched to Remote.

The Discharge Power Supply 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 Discharge Power Supply, labeled, "RS-232", "Discharge". This approach uses an RS-232 straight through cable that connects to a DB-9 male connector. This approach allows the user to control the Discharge Power Supply only.

3.2.1 Direct RS-232 Connection From Computer to Discharge Power Supply

The Discharge Power Supply 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 Discharge Power Supply, labeled, "RS-232". This approach uses an RS-232 straight through cable that connects to a DB-9 male connector. This approach allows the user to control the Discharge Power Supply only.

3.2.1.1   Software

Software control of the Discharge Power Supply 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^{TM} by National Instruments^{TM}. 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 Discharge Power Supply using a Serial connection requires the following settings within the terminal or communications program:

- Set communications port to available Comm number.
- Baud Rate Selectable = 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115,200 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 ascii commands are specific for the Discharge Power Supply. These commands allow the user to adjust the setpoints on the Discharge Power Supply and monitor the output voltages and currents.

- VAxxxx Sends a Current setpoint to the Discharge Power Supply.
  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.

- VBxxxx Sends a Voltage setpoint to the Discharge Power Supply.
  Note: xxxx is a decimal value from 0-4095. VB0 is the minimum or zero output, it also puts the unit in standby mode, while VB4095 is maximum output.

- *IDN? Identification query. Returns the product identifier code.

- RD0 Returns a decimal number 0-4095 for conversion to the corresponding output current.

- RD1 Returns a decimal number 0-4095 for conversion to the corresponding output voltage.

- RD? Returns both RD parameters with one request.

- *RST Reset. Puts the unit into standby and resets the output to zero.

- *TST? Test. Returns a 0 (zero) if the unit is functioning normally, or a number that corresponds to the front panel help codes as described in diagnostics section 4.

- MEASure:CURRent? or MEAS:CURR? Measure current query. Returns the DC output current in amps with three decimal places.

- MEASure:VOLTage? or MEAS:VOLT? Measure voltage query. Returns the DC output voltage in volts with three decimal places

- SOURce:CURRent or SOUR:CURR Input the operating current. The desired operating current in amps following either the long or short form of the command. A space can be inserted after the command, or the space can be omitted. The level of current must be within the range for

the power supply. Up to three decimal places may be used to input the current, but these decimal places do not have to be specified. The decimal point is also not required if there are no significant decimal places. In the case of the bias and keeper supply, if this command is anything other than zero, it also enables the supply. Conversely, a command of zero will put the power supply into standby for the bias and keeper. The discharge supply requires that both the SOURce:CURRent and SOURce:VOLTage be non zero to enable the power supply.

- SOURce:VOLTage or SOUR:VOLT Input the operating voltage. The desired operating voltage in volts follow either the long or short form of the command. A space can be inserted after the command, or the space can be omitted. The level of voltage must be within the range for the power supply. Up to three decimal places may be used to input the voltage, but these decimal places do not have to be specified. The decimal point is also not required if there are no significant decimal places. The discharge supply requires that both the SOURce:CURRent and SOURce:VOLTage be non zero to enable the power supply. A current or voltage command of zero will put the discharge power supply into standby.

All the commands and queries must be followed by a carriage return.

NOTE: If either VX command is zero the unit will go to standby.

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 Discharge Power Supply set the output to zero current output for safety. Input "VA0" then press the enter key.

- Determine the Discharge output 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 discharge current = (0 to maximum amps) x 4095/10.

Example: A value of 5 amps of discharge current is desired. Using the above formula, 5 X 4095/20 = 1024 for modelDC25020.

- Determine the Discharge output Voltage required. Using the following formula, determine the decimal value required for input into the terminal program corresponding to the required Discharge voltage :

  Input value = required discharge voltage = (0 to maximum volts) x 4095/250.

  Example: A value of 200 volts of discharge voltage is desired. . Using the above formula, 200 X 4095/250 = 3270 for model with a maximum voltage of 300 volts.

- Input "VAxxxx" then press the enter key. Note: xxxx corresponds to a decimal number from 0-4095. For the example above, input "VA2047" into the terminal program and then press the enter key to set the output to half the maximum current in amps.

- Input "VBxxxx" then press the enter key. Note: xxxx corresponds to a decimal number from 0-4095. For the example above, input "VB2730" into the terminal program and then press the enter key to set the output to two third (2/3) the maximum voltage in volts.

- Powering down the Discharge Power Supply 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 output will drop to zero and the Standby LED will be illuminated.

- **Output Current:** Monitoring of the output current 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 output current. To convert the decimal number to the output current, divide the returned value by 4095 and multiply by the maximum current.

Returned value/4095 X maximum current.

Example: The command RD0 was sent to the Discharge Power Supply and the value 2048 was returned from the terminal program. To convert this value to the output current take 2048 and divide by 4095, times 20 equals 10, this would give a output current of 10 amps for model DC25020.

- **Output Voltage:** Monitoring of the output voltage 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 output voltage divide the returned value by 4095 and multiply by the maximum voltage of that model power supply.

  Returned value/4095 X maximum output voltage.

  Example: The command RD1 was sent to the Discharge Power Supply and the value of 2048 was returned from the terminal program. To convert this value to the output voltage, divide 2048 by 4095 and multiply by 250 volts for model DC25020 power supply.

3.3   Remote Mode Analog

The Discharge Power Supply can be operated using analog.

3.3.1 ANALOG Input/Output

The Discharge Power Supply 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 Power Supply. There is one 25 pin female D connector labeled ANALOG on the back of the Power Supply for connection to the analog interface. The pin descriptions for the interface are given below in table 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 3-4.1.

Table 3-4.1. 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	No Contact.
5	No Contact.
6	Common.
7	Discharge Current Monitor – Outputs 0 to 5 volts for 0 to maximum amps of discharge current.
8	No contact
9	Discharge Voltage Setpoint – Input 0 to 5 volts for 0 to maximum discharge volts.
10	Discharge Current Setpoint – Input 0 to 5 volts for 0 to maximum amps of discharge current. Also available at pin 22.
11	Common.
12	Common.
13	Auxiliary +5 volts DC, 200 mA max. Also available at pin 15 and 25.
14	No Contact
15	Auxiliary +5 volts DC, 200 mA max. Also available at pin 13 and 25.
16	Common
17	Common
18	General Fault. Indicated on the front panel.
19	Discharge Voltage Monitor – Outputs 0 to 5 volts for 0 to maximum volts discharge voltage.
20	No Contact.
21	Common
22	Discharge Current Setpoint – Input 0 to 5 volts for 0 to maximum amps of discharge current. Also available at pin 10.
23	No Contact.
24	Common
25	+Auxiliary + 5 volts DC, 200 mA max. Also available at pin 13.

Table 3-4.2. Interlock connections.

Pin Number	Description
1	Active Low Interlock – Connect to common (Interlock pin 2) to enable the Discharge Power Supply.
2	Interlock Return – Common.

4. Diagnostics

4.1 General

The following information is intended to facilitate troubleshooting of the Discharge Power Supply. This information assumes that the Power Supply 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 Power Supplies 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 Discharge Power Supply.

Table 4-1. Help codes and error messages for the Discharge Power Supply.

Help Code or Error Message	Description	Possible Causes and Corrective Action
HLP 1	Current Latch – A high current was encountered. Power supply latched off to prevent a failure.	Switch off the power until the display is dark and then switch the power back on to reset
HLP 2	Thermal Failure.	Open or shorted thermistor detected. Contact KRI.
HLP 7	RS-485 Serial Communication Lost. – HLP 7 is displayed.	Communication for remote RS-485 communication was detected and then lost. Check connection of the RS-485 cables.

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Help Code or Error Message	Description	Possible Causes and Corrective Action
		Make sure Auto Controller has input power and is turned on.
HLP 8	RS-232 Interface Serial Common Error. — High current flowing in the ground connection of the serial interface between the unit and the PC. Shows up only in remote RS-232 operation. Display says HLP 8 for 5 seconds.	Informational display only. No action taken on unit operation. Unit recovers from error condition if the problem goes away.

Make sure all of the equipment has adequate grounding. |
| Hot | Thermal Overload – Internal temperature in the power supply is too hot. Power supply is in STANDBY. | Leave the power supply turned on until the Hot message is cleared.

Make sure there is no blockage of the vents on the rear panel.

Ambient temperature is too high. Reduce ambient temperature below 40°C. |
| Not Rdy | Not Ready. – Discharge Power supply is in STANDBY. | Insufficient line voltage. Fault will clear itself when the power supplies receive sufficient line voltage. |

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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 two years from the date of original shipment F.O.B KRI's facility, Fort Collins, Colorado. 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; examples of expendable parts are as follows:

Alumina Insulators, Filaments, Reflectors, Gas Line Isolator, Vacuum Cables and fuses.For Service or Repair, contact KRI:

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6. SERVICE AND TECHNICAL INFORMATION

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

Kaufman & Robinson, Inc.
1306 Blue Spruce Dr. Unit A
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.