

KEEPER CONTROLLER MODEL KC8002 MANUAL



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July 2007
Version 2

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1. General Information

1.1 Introduction

The Kaufman & Robinson, Inc. Keeper Power Supply is designed for use with a Kaufman & Robinson Hollow Cathode Electron Source. The intended use of this Power Supply is to provide DC voltage and current to start the hollow cathode. 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:

- Current 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 Power Supply, therefore, the Power Supply chassis should not be opened. Removal of the Power Supply cover will void all warranties.

The Keeper 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 Keeper Power Supply prior to making any modifications to the power supply inputs or outputs.
- The Keeper Power Supply should only be serviced by Kaufman & Robinson, Inc.

1.3 Specifications

The following specifications pertain to the Kaufman & Robinson, Inc., Keeper Power Supply, Model KC8002.

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 1.75 inches (4.45 cm) and its depth is approximately 21 inches (53.3 cm).

1.3.2 Weight

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

1.3.3 AC Input

The input voltage for the Keeper Power Supply is 85-275 volts ac single phase at 50-60 Hz. The maximum input current to the unit is electronically limited to 14 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 KC8002 model of this Power Supply is 800 VDC at 2 amps. Operation at this level is limited by thermal protection. Continuous duty operation is specified at 1500 watts up to 40°C ambient air temperature.

2. INSPECTION AND INSTALLATION

This section describes how to install the Kaufman & Robinson, Inc., KRI® Keeper 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	Description	Part Number
1	Keeper Power Supply	KC8002
1	Power Keeper Supply Cable	CBL-A07-PWR-HC-EH
1	Keeper 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 two 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 right button switch selects if the front panel (Local) or rear panel (Remote) control of the CURRENT. The rear panel (Remote) includes both analog and RS-232 interface. The left display shows the Keeper voltage readback in volts. The right display shows the Keeper current setpoint or readback in amps. The Keeper 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 Keeper 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 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 (483 mm) rack mount cabinet. The height of this Power Supply is 1.75 inches (45 mm) and the depth of the unit is approximately 21 inches (533 mm). When installing the Keeper 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 Keeper Power Supply

Located on the back panel of the Power Supply are two sections of three connectors each for connecting the Keeper Power Supply directly to the hollow cathode through a KRI operating cable. Each terminal is capable of the full output of the Keeper Power Supply. Multiple outputs are provided to allow multiple supplies to share connections.

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

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

2.4.4 Electrical-AC Input

The Power Supply has been designed for 85-285 volts AC input voltage, 50-60 Hz, single-phase with a maximum current of 14 amps at the lowest line voltage.

A power supply cable has been included with the Power Supply. This cable has a female plug at one end that corresponds to the male socket at the rear panel of 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 Keeper Supply Cable to the AC voltage within the facility should only be made by qualified personnel.**



Fig. 2-1 Keeper Power Supply front panel.

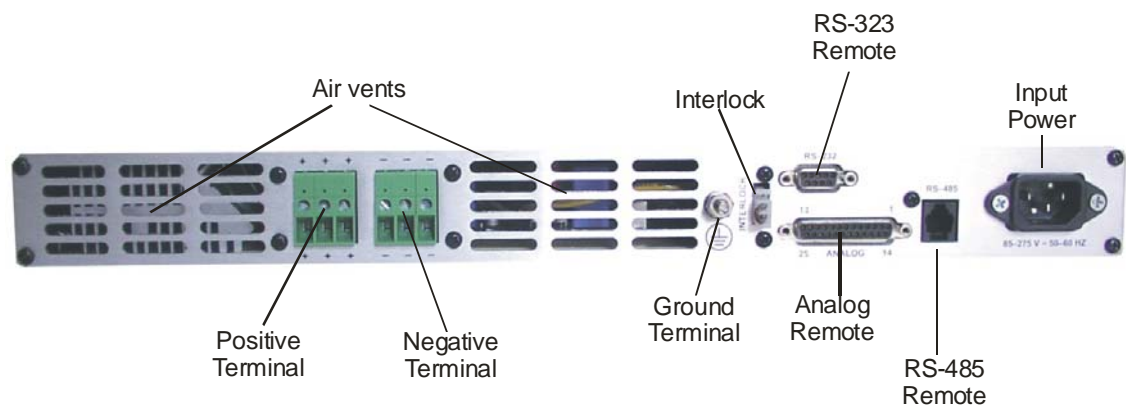


Fig 2-2 Keeper Power Supply rear panel.

3. Operation

The Keeper 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 Keeper Power Supply.

3.1. Local Mode

Operation of the Keeper 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 Keeper 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 Keeper Amps Setpoint displayed. The 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 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 Amps Display indicates the current Setpoint.

When Enabled is selected, the Power Supply regulates the Keeper Amps to maintain the Setpoint Limit.

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

Keeper Volts display – Displays the measured Keeper voltage in volts.

Keeper Amps display – Displays the Keeper 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 Amps setpoint is 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 Current setpoint when in local mode.

3.2. Remote Mode RS-232

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

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

The Keeper 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 Keeper 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 Keeper Power Supply only.

3.2.1.1 Software

Software control of the Keeper Power Supply can be accomplished using a variety of methods. Some types of terminal or communications programs, 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 programming user guide for installation and operation of the software.

3.2.2 Communications Settings

Operation of the Keeper 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 Keeper Power Supply. These commands allow the user to adjust the setpoints on the Keeper Power Supply and monitor the output voltages and currents.

- VAXxxx Sends a Current setpoint to the Keeper 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.
- *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 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 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.

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

NOTE: If the VA 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 Keeper Power Supply set the output to zero current output for safety. Input "VA0" then press the enter key.
- Determine the Keeper output current required. Using the following formula, determine the decimal value required for input into the terminal program corresponding to the required Keeper current :

Input value = required Keeper current = (0 to maximum amps) x 4095/15.

Example: A value of 1.5 amps of Keeper current is desired. Using the above formula, $1.5 \times 4095/2 = 3071$.

- Input "VAxxxx" then press the enter key. Note: xxxx corresponds to a decimal number from 0-4095. For the example above, input "VA3071" into the terminal program and then press the enter key to set the output to half the maximum current in amps.
- Powering down the Keeper 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 Keeper Power Supply and the value 3071 was returned from the terminal program. To convert this value to the output current take 3071 and divide by 4095, times 2 equals 5, this would give a output current of 1.5 amps.

- **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 Keeper Power Supply and the value of 77 was returned from the terminal program. To convert this value to the output voltage, divide 77 by 4095 and multiply by 800 volts.

3.3 Remote Mode Analog

The Keeper Power Supply can be operated using analog.

3.3.1 ANALOG Input/Output

The Keeper 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	Remote Local Indicator Output – 0 volts = Remote, 5 volts = Local (5 kΩ source impedance). Also available on pin 20.

5	No Contact.
6	Common.
7	Keeper Current Monitor – Outputs 0 to 5 volts for 0 to maximum amps of Keeper current.
8	No contact
9	No Contact
10	Keeper Current Setpoint – Input 0 to 5 volts for 0 to maximum amps of Keeper 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	Remote Shutdown, Active Low – Output is disabled when connected to common. The shutdown is deactivated when 15 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 k Ω source impedance).
19	Keeper Voltage Monitor – Outputs 0 to 5 volts for 0 to maximum volts Keeper voltage.
20	Remote Local Indicator Output – 0 volts = Remote, 5 volts = Local (5 k Ω source impedance). Also available on pin 4.
21	Common
22	Keeper Current Setpoint – Input 0 to 5 volts for 0 to maximum amps of Keeper current. Also available at pin 10.
23	Regulation Mode – A 5 volt output indicates current regulation. A 0 volt output indicates voltage regulation. 5 k Ω source impedance.
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 Keeper Power Supply.
2	Interlock Return – Common.

4. Diagnostics

4.1 General

The Keeper front panel displays have the additional function of displaying help codes and error messages. If it becomes necessary to display a help code or an error message, these power supplies may switch to standby mode, depending on the type of code or message. The front panel will display "HLP" and a number for the help code. The error messages will be displayed as one or two abbreviated words. A description of the help codes and the error messages is given below in table 7-3 along with possible corrective action that may need to be taken.

Power must be removed from the Power Supplies prior to performing maintenance.

4.2 Diagnostic Table

The following table may be used to assist in determining faults and corrective action for the Keeper Power Supply.

Table 4-1. Help codes and error messages for the Keeper 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.

Help Code or Error Message	Description	Possible Causes and Corrective Action
HLP 7	RS-485 Serial Communication Lost. — HLP 7 is displayed when the unit is in REMOTE and unit is in STANDBY.	<p>Communication for remote RS-485 communication was detected and then lost.</p> <p>Check connection of the RS-485 cables.</p> <p>Make sure Auto Controller has input power and is turned on.</p>
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.	<p>Informational display only. No action taken on unit operation. Unit recovers from error condition if the problem goes away.</p> <p>Make sure all of the equipment has adequate grounding.</p>
HLP 10	Start failed. — The hollow cathode did not start.	<p>Press and release the STANDBY/ENABLE button or remove the remote enable signal to clear the code. The unit remains in STANDBY until STANDBY/ENABLE is pressed again or the remote enable signal is reapplied.</p> <p>Open or shorted cathode or keeper cables. Inspect the in vacuum cable and replace if necessary.</p> <p>No gas flow to the hollow cathode. Due to empty gas bottle, valve off somewhere in the gas supply, faulty MFC, or MFC cable damaged or unplugged.</p>
Hot	Thermal Overload – Internal	Leave the power supply turned on

Help Code or Error Message	Description	Possible Causes and Corrective Action
	temperature in the power supply is too hot. Power supply is in STANDBY.	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. – Keeper Power Supply is in STANDBY.	Insufficient line voltage. Message will clear itself when there is sufficient line voltage.

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, Reflectors, Gas Line Isolator, Vacuum Cables, fuses, and Hollow Cathode tips.

For Service or Repair, contact KRI:

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
- Return to vender number (RTV#)
- 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.