
Model 160 Filament Power Supply Manual

Model 160 Filament Power Supply Manual



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Model 160 Filament Power Supply Manual

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1.0 Packing List

1.1 Packing List for Filament Power Supply

The Filament Power Supply is shipped with the following items:

Table 1. Filament Power Supply

| Quantity | Part Description | Description |
|----------|------------------------------------|---|
| 1 | Model 160 FIL_PS_SERIES_2 | Filament Power Supply |
| 1 | CABL_POW_110AC_10FT | Universal AC power cable for US use, 10 feet long |
| 1 | M-160 Filament Power Supply Manual | Filament Power Supply Operators Manual |

1.2 Filament Power Supply Optional Accessories

The following is the recommended cable for the filament power supply:

Table 1. Filament Power Supply

| Quantity | Part Description | Description |
|----------|-----------------------|----------------|
| 1 | CABL_OPTX_7B3_10FT_01 | Filament Cable |

2.0 Product Identification

In all communication with Ardara Technologies, please specify the Ardara Technologies Model number for the power supply from your original purchase order (Model 160).

3.0 Scope of Manual

This manual applies to the Ardara Technologies Filament Power Supplies identified with “Ardara” in the upper left hand corner and “Filament Power Supply” in the lower right hand corner of the box’s front panel, and the Model Number 160 on the upper left hand corner of the back panel.

This document is valid as of the date of publication. We reserve the right to make technical changes to the design. As this design of the Filament Power Supply is customizable, please refer to configuration document.

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4.0 Intended Use

The Ardara Technologies Filament Power Supply was designed to provide stable emission-regulated electron current from a heated filament for use with electron impact ionizers such as Ardara Technologies' Axial Molecular Beam Ionizer and Cross Beam Ionizer.

5.0 Safety

This Filament Power Supply is capable of generating lethal voltages. Care must be taken to ensure safety in use.

5.1 Input Power

This Filament power supply is equipped with a universal input AC power connection, which requires that the power cord ground connection be connected to earth ground through a properly wired AC outlet to ensure safe operation. The use of a 'ground isolator' or similar device is prohibited for safe operation.

The AC power input is compatible with worldwide AC power, from 100 to 240 VAC, 50-60 Hz and 170 Watts.

5.2 Custom Output Connections

Use only approved high voltage cables and connectors, which are rated to the voltages in use.

It is often the case that this Filament power supply is used to replace another in an existing application. Be sure to review the voltage ratings of the cables and vacuum feedthrus in use to verify compatibility with high voltages possible from this Filament supply.

5.3 Vacuum Pressure Considerations

The Ardara Filament Power Supply is often used to power pressurized ionizers. One challenge to operating pressurized high voltage devices is the impact of gas pressure on the voltage discharge limit.

At high vacuum (10^{-5} torr and below) and at atmospheric pressure and above, devices can tolerate quite high voltage gradients with very small electrode gaps.

However, for intermediate pressures (10^{-2} torr to 1 torr), the tolerance to high voltage gradients is dramatically reduced, resulting in discharges (i.e. glow discharge) which can damage the device as well as damage the power supplies

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driving it. This phenomenon is described in the literature using the Paschen Curve.

In addition, for the safety of the Ion Source, it is important to allow the filament to cool before returning it to atmospheric pressure. At pressures of 10^{-4} torr and higher the rapid exposure of a hot filament to air will oxidize the filament wire, reducing the life of the filament and increasing the likelihood of breaking the fine filament wire.

6.0 Liability and Warranty

Ardara Technologies assumes no liability and the warranty becomes null and void if the end user or third parties:

- Disregard the information in this manual
- Use the product in a non-conforming manner
- Make any kind of changes (modifications, alterations, etc.) to the Filament Power Supply.
- Use the product with accessories not listed in the corresponding product documentation

7.0 Product Overview

7.1 Summary

The Ardara Technologies Filament Power Supply was designed to provide stable emission-regulated electron current from a heated filament for use with electron impact ionizers such as Ardara Technologies' Axial Molecular Beam Ionizer and Cross Beam Ionizer.

Ardara Technologies' Filament power supply is conveniently designed to install into a standard 19-inch (48.25 cm) instrument rack, allowing for adequate ventilation on the sides.

The power supply has a Universal AC input of 100-240 VAC, 50-60 Hz.

The system is rated up to 100-Watt output with up to ten (10) amperes filament current with up to eight (8) volts across the filament. Filament current limit is adjustable through the front panel potentiometer.

The Ion Region power supply can be adjusted from -250 V to $+250$ V via the front panel potentiometer. The Ion Region power supply is typically configured as the main reference for all other supplies in the device. By floating the filament emission current circuit on the Ion Region supply, the electron energy will be maintained at its setpoint, even when the ion region potential is changed.

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The voltage reference for the emission circuit can be switched via the back panel switch labeled Electron Energy Reference. The electron energy can have a reference point of either ground or the ion region voltage. The front panel display will show the voltage setpoints and readbacks, as well as the status of the back panel switch.

The Filament power supply Electron Energy can be adjusted from -250V to +250V electron energy relative to the ion region potential via front panel controls.

Emission current controls are accessible on the front panel potentiometer to 10 mA. Emission current is regulated as electron current leaving the filament circuit traveling to the ion region circuit.

The Front Panel Display has three display modes, showing the Setpoints, Status, and Diagnostics respectively. The mode selection push button adjusts the display readout between these three modes.

Front panel filament On/Off switch enables the emission current; when emission is off the electron energy supply is still enabled.

The bottom row of the Status Display state indicates if the filament is in standby state, enabled okay state, or enabled failure state.

7.2 Theory of Operation

In a traditional “Electron Impact” or Electron Ionization (EI) ion source, a thin filament (typically one or more half inch to three quarter inch lengths of 0.005 inch diameter tungsten wire), is heated by passing a current through it until it ‘glows orange hot’, resulting in the emission of infra red photons and thermionic emission of electrons.

A potential difference (Electron Energy or ‘eV’) is maintained between the center of the filament power supply and the ‘ionization region’, to cause these thermionic emitted electrons to be accelerated through a slit or grid into the ionization region. For most organic compounds, the ionization probability maximizes between 70 and 100 eV electron energy.

If the electron energy is set to low (below 15 eV) the emitted electrons have less acceleration to the ion region, resulting in a higher amount of heat (power) to get the ions to leave the filament to achieve the desired emission current to the ionization region, which can dramatically reduce filament lifetime. For this reason there is an internal software parameter that will prevent the filament heating circuit from being enabled if the electron energy setpoint is set to below 15 eV. This is a factory setting, but can be changed in the field if necessary. Contact the factory if electron energies less than 15 eV are required.

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Note that the front panel display presents the voltages as actual voltages, not energy, so you will need to set the 'electron energy' to -15 volts to achieve 15 eV of electron energy.

The Ardara Technologies Model 160 Filament Power Supply allows direct control of the ionization region potential in the range of -250 to +250 volts, relative to ground. The electron energy can be set in the range of -250 to +250 volts relative to either ground or the ionization region, although, if the electron energy is less than 15 eV, then the emission circuit will be disabled. Even with the filament emission disabled, the 'electron energy' bias voltage is presented to the filament plate, so that it can still be used as a focusing lens for analysis of externally generated ions.

The emission current control circuit that provides the power to heat the filament allows for direct control of the emission current via the emission current setpoint, with the 'emission current' being defined as the current of electrons that leave the filament circuit to take any path back to ground.

The emission current control circuit regulates the amount of current provided to heat the filament hot enough for thermionic emission of electrons, and controls that filament current to make the measured emission current matches the requested emission current.

One of the curious features of a tungsten filament is the fact that at room temperature, the filament has virtually zero resistance, whereas for the filament configuration typically used for EI ionizers, the resistance rises to about an ohm when the filament is heated up hot enough for thermionic emission.

The practical consequence of this effect is that a cold filament will surge to the maximum current allowed by its power source when initially powered up. (Did you ever notice that good old fashioned incandescent light bulbs typically have their failure mode right when you turn them on?)

For this reason, the Ardara Filament Power Supply has a setting to limit the current available to the filament, typically set to about 10% higher current than the typical operating current. See Section 9.1 of this manual for the procedure to set this up for the first time.

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7.2 Front Panel



Figure 1. Front Panel Controls for Filament Power Supply

Table 1. Filament Power Supply Front Panel Controls

| Left to Right | Function | Description |
|---------------|--------------------------------|---|
| 1 | On / Off Power Switch | Lighted power switch that enables AC power for the Optics power supply and also serves as a circuit breaker. |
| 2 | Ion Region Command Knob | Commands Ion Region potential in range of -250 V to +250 V. |
| 3 | Electron Energy Command Knob | Commands Electron Energy potential from -250V to +250V. |
| 4 | Front Panel Display | Displays Setpoints, Status, and Diagnostics (See Section 7.3) |
| 5 | Display Mode | Momentary contact which shuffles the display through the three display modes. |
| 6 | Emission Current Command Knob | Commands Emission Current in the range of 0 to 10 mA emission. |
| 7 | Filament Enable Switch | Enables emission current from the filament. |
| 8 | Current Limit Command | Sets the maximum filament current in the range of 0 to 10 amps. |
| 9 | Manual Computer Control Switch | For future use. Set to Manual, or the front panel knobs won't do anything. If you want to be really clever, set the front panel knobs to whatever values you want to operate from, then switch this switch to computer mode. By disabling the front panel knobs, you are turning them into 'Boss Knobs', that you can freely allow your professor to adjust to their heart's content, since they won't do anything until you switch back to Manual mode. |
| 10 | Vacuum Interlock LEDs | Lit LEDs indicate if Vacuum OK has a contact closure through the Vacuum Interlock DB9 and if the Vacuum Interlock switch is set to Interlock Override. |

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7.3 Front Panel LCD Display

The Ardara Technologies Filament Power Supply utilizes a front panel LCD display to present the setpoints, feedbacks, and diagnostics.

Upon power up, the LCD display indicates the power supply model number, and software revision.



Figure 2. Initial Power Up LCD Display

After a few seconds, the front panel LED display will switch to the 'Setpoint Display Mode', which shows the requested setpoints for Ion Region potential, Electron Energy, and Emission Current, as selected by the front panel potentiometers. This display mode also presents the real-time status of the filament emission circuit.

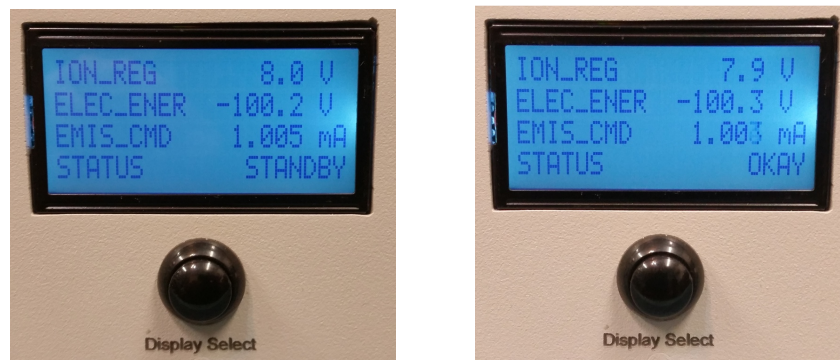


Figure 3. Setpoint LCD display mode.

Displayed voltages are the requested voltages from the front panel potentiometers.

Possible STATUS states include:

STANDBY

OKAY (Emission enabled, and at setpoint)

EMIS_FAIL (temporary condition that emission is enabled but not matching setpoint)

EE_TooLow (Electron Energy setpoint is less than 15 eV - Fail).

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By pressing the Display Select momentary contact switch, you can change the display mode to toggle through the other two display sets.

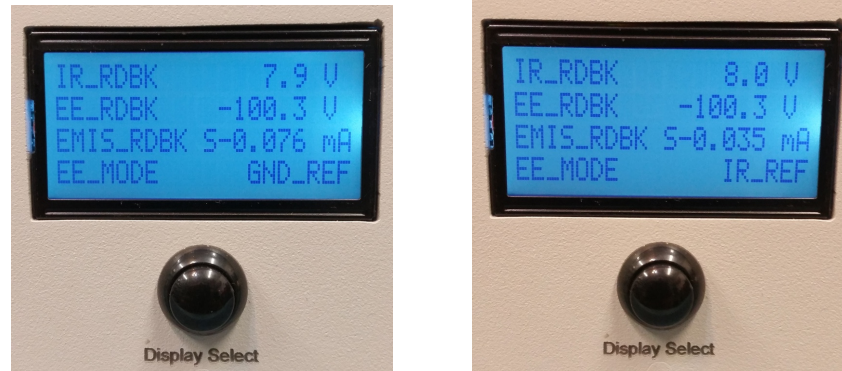


Figure 4. Readback LCD display mode.

Readback values are the actual real-time measured readbacks for the various parameters.

The EMIS_RDBK (emission readback) also includes a single character status in the middle of its row, where S indicates Standby mode, F indicates Emission Failure, and G indicates Okay (Good, since O here might be confused with the number zero).

The EE_Mode indicates the selection on the back panel switch to have the electron energy referenced from the ion region (IR_REF, which is the default mode) or ground referenced (GND_REF, the exceptional case where you may want to consider the filament entrance plate as a lens element to transmit externally generated ions).

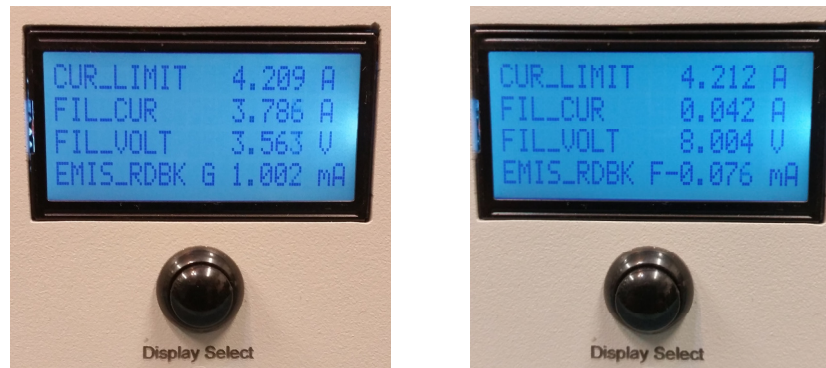


Figure 5. Filament Diagnostic LCD display mode.

The CUR_LIMIT is the filament current limit, as selected by the front panel potentiometer.

FIL_CUR is the real-time readback of the actual current that is passing through the filament to heat it.

FIL_VOLT is the real-time readback of the actual voltage drop across the filament(s) connections. (If the FIL_VOLT is 8.00 volts, but the FIL_CUR is ~zero, then the filament circuit is open, either burnt out or not connected.)

For a typical filament assembly of ~1 ohm resistance at temperature, since $P=IV$, the

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filament voltage and current will be about the same magnitude when the filament is 'happy'. This can be a useful diagnostic to tell when one of a pair of parallel filaments is open, the current and voltage won't match...

The EMIS_RDBK (emission readback) also includes a single character status in the middle of its row, where S indicates Standby mode, F indicates Emission Failure, and G indicates Okay (Good, since O here might be confused with the number zero).

7.4 Rear Panel

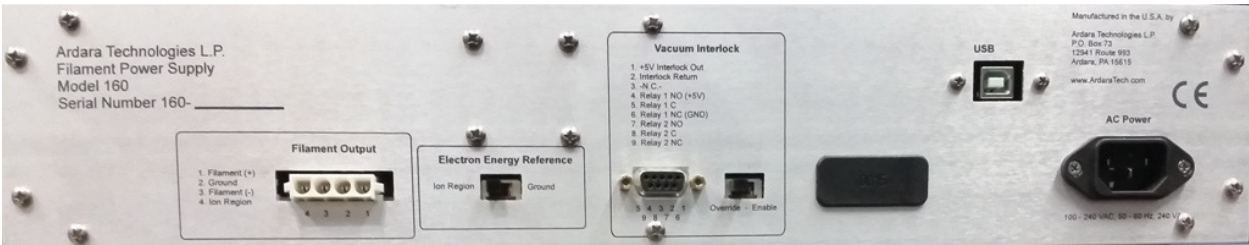


Figure 6. Rear Panel Controls for Filament Power Supply

Table 4. Filament Power Supply Rear Panel Controls

| Left to Right | Function | Description |
|---------------|----------------------------|---|
| 1 | Serial Number | Ardara Technologies Model Number and serial number of Filament Power Supply |
| 2 | Optics Output | 4 pin AMP connector Pin 1 is the output for Filament (+). Pin 3 is the output for Filament (-). Pin 4 is the output for Ion Region. |
| 3 | Electron Energy Reference | Switch that allows the electron energy to be either referenced to ground or the ion region voltage. Only the output will reflect the selection, the display will still indicate the delta. This should almost always be set to Ion Region reference. |
| 4 | Vacuum Interlock Connector | Female DB9 input that allows external enabling and disabling of the high voltage output. Enables or disables the high voltage output depending on whether there is +5 volts presented to pin 2 from an outside source. For convenience, a +5 volt source is provided on pin 1, suitable for use with an ion gauge controller which has a contact closure output when a suitable pressure is established. A +5V signal present at pin 2 energizes two relays (#1, and #2) The Optics supply utilizes relay #1 internally, with pins 4, 5, and 6 available for diagnostics purposes. Relay #2 is available to echo the contact closure status, allowing the unit to daisy chain the vacuum interlock contact closure to other devices. |

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| | | |
|---|--------------------------|--|
| 5 | Vacuum Interlock Enable | Controls whether the vacuum interlock feature is enabled. When set to 'Override', the high voltage output is always enabled when AC power is turned on. When set to 'Enable', the high voltage output is enabled only when +5 interlock voltage is presented to pin 2 of the Vacuum Interlock Connector via contact closure on an ion gauge. |
| 6 | USB Input | For future use. |
| 7 | Universal AC Power Input | 100 to 240 VAC, 60 Hz universal power input. |

8.0 Installation

8.1 Installing the Filament Power Supply

Installation of the Filament Power Supply onto vacuum system to power and electron impact ionizer requires the following:

- Do not obstruct the airflow around the Filament Power Supply.
- Do not operate the Filament Power Supply in an environment that is subject to dust, high humidity, or mechanical vibrations.
- The Filament power supply is designed to be mounting onto a 19-inch instrument rack, with adequate ventilation to the sides. The chassis of the controller must be properly connected to the mains ground, through mechanical fasteners.

8.2 Electrical Connections

8.2.1 AC Power Input

The Filament power supply box is connected to ground via the ground connection in the three-pronged AC power cable.

- It is not safe to operate the Filament power supply using a 'ground isolator' or three-prong to two-prong converter.
- Use only approved high voltage cables and connectors, which are rated to maximum output voltage of the Filament power supply.
- Make all filament connections with the Filament Power Supply turned off

8.2.2 External Filament Output

The Filament Power Supply output is rated up to 100 Watts, with a max of 12 Amps of filament current and up to 8 V across the filament.

Ion Region power supply is full adjustable from -250V to +250V.

Electron Energy is factory configured to allow and operating range from 15 to 250 eV, with Emission current control from 0 mA to 10 mA. Consult the factory if operation at an electron energy below 15 eV is required.

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8.2.3 Vacuum Interlock

The vacuum interlock feature needs a contact closure between pin 1 and 2 of the back panel female DB9 vacuum interlock connector. The contact closure from an ionization gauge controller would provide an ideal mechanism for the feature.

9.0 Commissioning

9.1 Initial Operation

The Filament Current Limit setpoint should be optimized before normal operation. This is a one time adjustment to determine the optimal filament current limit.

1. Attach the AC power cable to the connector on the back panel, with front panel switched off.
2. Set the filament enable switch to standby, before turning on the filament power supply.
3. Set the Ion Region Command to +8 volts, set the Electron Energy Command to -100 V, set the Emission Current Command to 1 mA, and set the Current Limit to an initial value of 0 V (zero on the potentiometer knob).
4. Verify that the Vacuum Interlock is either set to Override mode, with the Vacuum Interlock Override LED lit, or that the vacuum interlock is enabled, and that there is a contact closure between pins 1 and 2 on the vacuum interlock back panel DB9 connector. If the vacuum interlock is either okay, or overridden, then the readbacks for the ion region and electron energy will match their setpoints. If not, then switch the vacuum interlock to override, or fix the vacuum interlock input.
5. Set the Display Mode Switch to select the Filament Diagnostic display mode. See Figure 7. Since an initial value of 0 volts for the current limit setpoint will by definition prevent the filament from heating up to generate electrons, this is a safe starting condition.

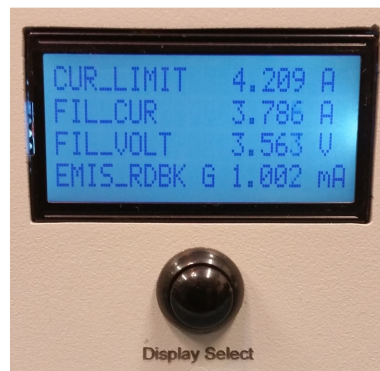


Figure 7. Filament Diagnostic Display Mode

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6. Switch the filament enable switch to 'Enable'. Since the current limit is set too low from the start, the emission readback will be zero, with a status letter of 'F' for fail.
7. Slowly adjust the current limit potentiometer (about ten seconds per turn of the dial), and observe the displayed Current Limit increasing, until the emission readback starts to be a non-zero value. Then even more slowly, adjust the Current Limit potentiometer until the emission current gets to 1.00 mA, and indicates 'G' for good.
8. Record the actual filament current that is required to get that 1.0 mA emission, and then adjust the Current Limit potentiometer until it is 110% of that actual filament current.
9. The Filament power supply is ready to use. If the experiment requires a different emission current, then use a similar procedure to determine what filament current limit to use.
10. To verify proper operation, turn off the filament enable, wait ten seconds, then enable the filament again. The filament should be 'happy' again in about ten seconds.

9.2 Connecting to the Ion Source

1. First insure that all Ion Source Connections are free from inter element and system common shorts.
2. Attach the connections for the outputs in the rear panel to the connectors on the Ion Source.
3. Once all connections are made, power on the Filament Power Supply. Adjust the Election Energy to -100 VDC and the Ion Region to +8 VDC. (This is a general tuning parameter that will allow the immediate formation and extraction of ions. Once it is determined that ions are being emitted, the tuning parameters can be adjusted to suit the users individual needs.)
4. Set the filament Enable to the Enable state to turn on the filament.
5. The filament emission power will slowly warm up the filament (~10 seconds) until the filament reaches thermal equilibrium and the actual emission current will match its setpoint.
6. If the filament Emission Status does not change to Okay after approximately ten seconds, then it is likely that you either have an open filament, or that your filament current limit is set too low. Look at the LCD display in Diagnostics mode and note whether the filament current is non-zero. If the filament current is zero, and the Filament Voltage is +8 volts, then you likely have an

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open filament. If the filament current is close to the current limit, then you will likely need to increase the current limit until the filament is ‘Okay’. The proper Current Limit is around 10% Amps larger than the Filament Current required for the desired emission. As the filament ages, or for higher emission currents, you will likely need to increase this current limit slightly.

10.0 Maintenance and Care

Under normal operating conditions, the Filament power supply does not require maintenance.

10.1 External Cleaning

Use a slightly moist cloth to clean the outside of the Filament power supply. Aggressive scouring or cleaning agents might damage the painted surfaces.

10.2 Internal Cleaning

Under normal operating conditions, there should be no need to clean the inside of the Filament power supply.

11.0 Dimensions

Table 5. PB_6511A Dimensions

| Description | Dimension |
|------------------------|--|
| Box dimensions (WxHxD) | Rack mount front panel 19 x 3.5 x 14 inches |
| Power Cable length | 10 feet (removable) |
| Filament Cable | 10 feet (removable) |
| Weight (with cables) | 13 lbs. |
| Shipping Weight | 15lbs. |

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Appendix A: Cable and Connector Options

There are numerous options for providing cabling between the Optics Power Supply and the user's hardware.

This Appendix provides an overview of various cable assemblies which are compatible with the Optics Power Supply.

A.1 Connector Drawings

The following two figures illustrate the pinout for the eight pin AMP connector on the Optics Supply back panel, and the MS-10 connector commonly used for bringing high voltages from the filament power supply into a vacuum chamber.

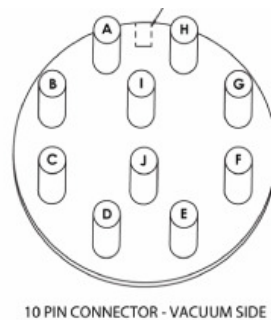


Figure A1. Pinout of Vacuum side of MS-10 Connector.

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Molex connectors are commonly used in break out cables to map out multiple devices or connectors. The following figures represent the pinouts for Molex connectors commonly used in Ardara Technologies cables.

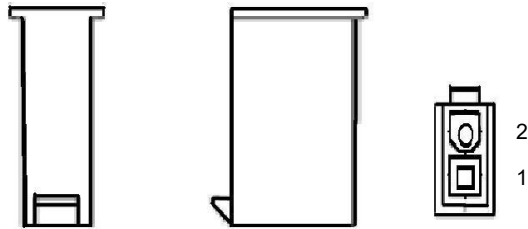


Figure A2. Pinout of 2 Pin Molex Plug.

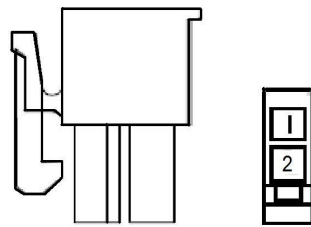


Figure A3. Pinout of 2 Socket Molex Socket.

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A.2 Cable PN 801123 (CABL_OPTX_7B3_10FT_01)

The following table identifies the pinout for one of the standard cables that can be used with the Filament Power Supply.

This cable consists of a three-conductor sixteen gauge filament cable, and a ten conductor optics cable that is ten feet long, using multi-colored, insulated twenty gauge wires.

Table A1. Cable Pinout for PN 801123, (CABL_OPTX_7B3_10FT_01), Optics cable with Seven Optics connections and Filament connection with one optics).

| Element | Connector PinOut | Wire Color (16 Gauge) | Wire Color (20 Gauge) | MS-10 Connector Socket |
|--------------|--------------------|--------------------------|--------------------------|------------------------------|
| | 2-Pin Molex, Pin 1 | | Brown | A |
| | 2-Pin Molex, Pin 1 | | Orange | B |
| Filament (+) | AMP 4Sock, #1 | Red | | C |
| | AMP 4Sock, #2 | | | (Not connected) |
| Filament (-) | AMP 4Sock, #3 | Black | | D |
| Ion Region | AMP 4Sock, #4 | White | | E |
| | 2-Pin Molex, Pin 1 | | Green | F |
| | 2-Pin Molex, Pin 1 | | Yellow | G |
| | 2-Pin Molex, Pin 1 | | Blue | H |
| | 2-Pin Molex, Pin 1 | | Black | I |
| | 2-Pin Molex, Pin 1 | | White | J |