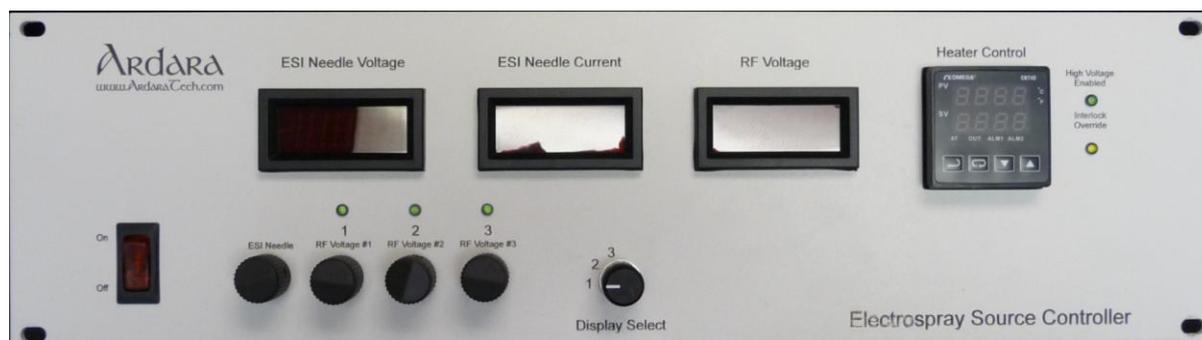


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# Model 152 : Electrospray Source Controller Manual

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## Model 152 Electrospray Source Controller Manual



**Version 3.0**  
**September 14, 2016**

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# Model 152 : Electrospray Source Controller Manual

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# Manual for Electrospray Source Controller

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## 1.0 Packing List

### 1.1 Packing List for Electrospray Source Controller

The Electrospray Source Controller is shipped with the following items:

**Table 1. Electrospray Source Controller**

Quantity	Part Number	Description
1	PS_ESI_CONT_152	Electrospray Source Controller
1	PS_ESI_CONT_152_MAN	Electrospray Source Controller Operator Manual
1	CABL_POW_110AC_10FT	Universal AC power cable for US use, 10 feet long
1	CABL_SPIN_SOURCE_DB37_10FT	Optics cable with 4 pin Mate-N-Lok, Mini-Fit Jr. and DB37, 10 feet long
3	CABL_DB25_M_F_10FT	DB 25 cable Male to Female
1	EA_SCID_to_SHV_BOX_2428	High voltage cable
1	CABL_RG59_72IN_SHV	SHV cable for high voltage connection

### 1.2 Optional Accessories for Electrospray Source Controller

The following list of optional cables and components are compatible with the Electrospray Source Controller. See Appendix A for more details.

**Table 2. Optional Accessories for Electrospray Source Controller**

Part Number	Name	Description
801109	CABL_OPTX_MXSOCK_8X_12IN	Optics breakout cable which mates to 8 pin Optics Power Supply optics output connector, with eight separate color coded wires terminated in two-socket Molex connectors.
801108	CABL_BNC_MXPIN_10FT_01	BNC to Molex plug cable, 12 inches long.
801122	CABL_OPTX_MS_MXPIN_10N0_10FT	Optics cable with 10 Pin MS connector and separate color coded wires terminated in two-pin Molex connectors, 10 feet long.
801118	CABL_SHV_MXPIN_10FT_01	SHV to Molex socket cable, 10 feet long.

## 2.0 Product Identification

In all communication with Ardara Technologies, please specify the Ardara Technologies part number for the power supply from your original purchase order, along with the serial number of the unit.

## 3.0 Scope of Manual

This manual applies to the Ardara Technologies Electrospray Source Controller Identified as PS\_ESI\_CONT\_152 in the upper right hand corner of the box's rear 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 Electrospray Source Controller is customizable, please refer to configuration document.

## 4.0 Intended Use

The Ardara Technologies Electrospray Source Controller was designed to provide stable high voltages suitable for up to five optics elements, including lenses, quadrupole deflectors, ion guide offset potentials, pre-filter offset potentials and other ion optics devices. Three more controls are for High-Q Heads mating to two ion funnels and an ion guide.

The controller also features an available high voltage interlock input on its back panel, which is designed to disable the voltage output under conditions where the electrospray source is not attached.

The high frequency RF power supplies designed into the Electrospray Source Controller were designed to provide an easy-to-install self-oscillating RF power supply for powering RF-only ion guides for use in custom mass spectrometer systems.

Because the design is self-oscillating (i.e. there is no crystal to fix the frequency), the RF power supply can self-resonate on a variety of loads, with no user intervention required, no matching networks, no tuning procedures.

## 5.0 Safety

This Electrospray Source Controller is capable of generating lethal voltages. Care must be taken to ensure safety during use.

### 5.1 Input Power

This Electrospray Source Controller is equipped with a universal input AC power connection, which requires that the power cord ground connection be connected

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# Manual for Electrospray Source Controller

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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 600 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 controller is used to replace another in an existing application. Be sure to review the voltage ratings of the cables and vacuum feedthroughs in use to verify compatibility with high voltages possible from this controller.

## 5.3 Vacuum Pressure Considerations

The Ardara Electrospray Source Controller is designed to be used to power ion optics spanning atmospheric to high vacuum pressure. One challenge to operating 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 driving it. This phenomenon is described in the literature using the Paschen Curve. Care must be taken that ions produced are not from any glow discharge sources instead of the electrospray source.

## 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 Electrospray Source Controller.
- Use the product with accessories not listed in the corresponding product documentation

## 7.0 Product Overview

### 7.1 Summary

The Ardara Technologies Electrospray Source Controller was developed to provide users with stable high voltage sources for an electrospray source and its ion optics to high vacuum. Ardara's Electrospray Source Controller is conveniently designed to install into a standard 19-inch (48.25 cm) instrument rack, allowing for adequate ventilation.

The design incorporates one +/- 5000 volt, up to four +/- 400-volt, three pairs of RF outputs, and temperature controller standard.

The two front panel meters on the left show the output voltage for the +/- 5000 volt power supply and output current. The front panel display switch allows direct measurement of the other individual output voltages using the third front panel digital voltmeter. The front panel also features ten-turn potentiometers for fine control of each individual output. Combined, these offer an easy, fast, and efficient voltage adjustment. The temperature controller is a self-contained unit for setting and readbacks of temperature from a heater and thermocouple.

External command inputs can be implemented through the use of the DB25 connector, featured on the back panel. For the 5000 volt power supply, a +/- 5.00V command yields +/-5000V output. For the 400 volt power supplies, a +/- 4.00V command yields +/-400V output; with a 1 Mohm input impedance. The RF power supplies are commanded via 0 to 5 volts to output 0 to maximum voltage peak-to-peak. The unit can be switched between front panel control and external command by switching the Internal/External switch.

The accompanying RF power supply was developed to address the need in the marketplace for a stable, easy-to-use bipolar RF power supply for use with RF-only ion guides (quadrupoles, hexapoles, octopoles...).

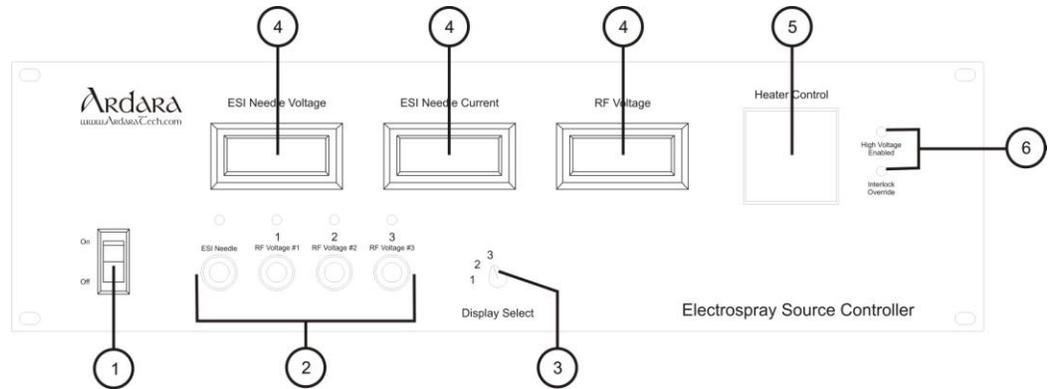
The design is based on a self-oscillating circuit, which automatically adjusts the output frequency to the capacitive load presented to the RF output connectors on the High-Q Head.

On the High-Q Head a square 4-pin Molex plug connector is used to provide the pole bias offset. This connector does not have an internal resistor to ground. When using the High-Q Head, a voltage even if it is ground should be applied to the appropriate pin.

The unit has a high-voltage interlock connector on the back panel, which allows an external contact closure to enable or disable the high voltage optics. This feature can also be used to turn voltages on and off remotely, by applying a 5-volt signal to pin 2 of this connector.

# Manual for Electrospray Source Controller

## 7.2 Front Panel Display



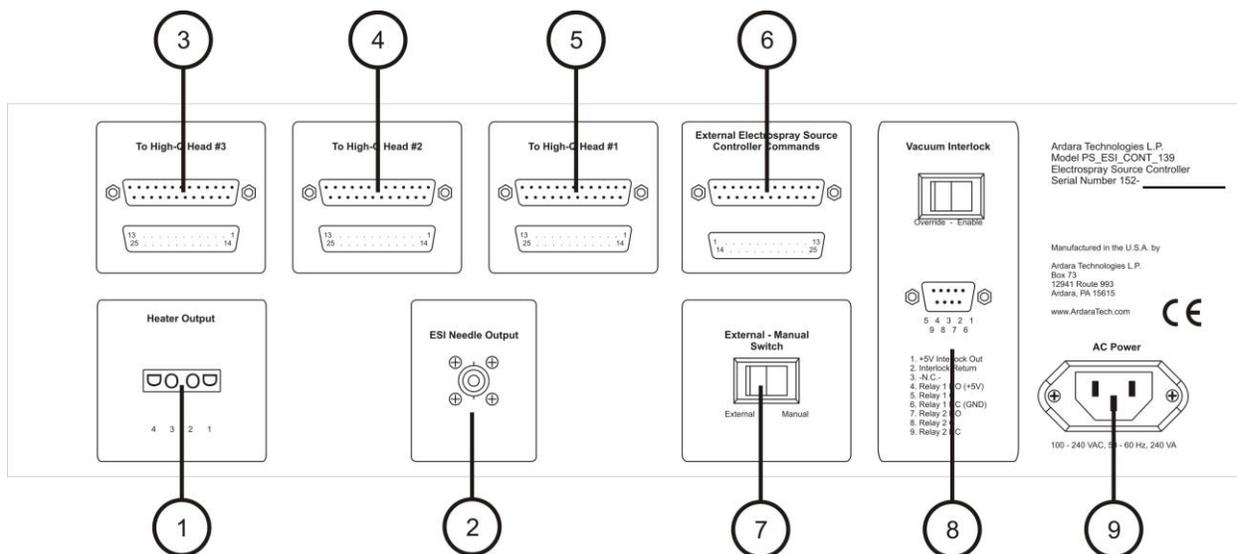
**Figure 1. Front Panel Controls for Electrospray Source Controller**

**Table 3. Electrospray Source Controller Front Panel Controls**

Balloon Number	Function	Description
1	On / Off Power Switch	Lighted power switch that enables AC power for the Electrospray Source Controller and also serves as a circuit breaker.
2	Manual Voltage Adjustments	Ten turn potentiometers that control the voltages, with LED's above indicating what is currently being displayed.
3	Voltage Display Selector	Selects the supply voltage that will be shown on the Optics & RF Voltage Display.
4	Voltage Display	Displays actual output voltage of the selected output. Note that because of the presence of a 2 Mohm series output resistor, the voltage read using a high input impedance voltmeter will likely read 80-90% of the actual value. The voltage displayed on the front panel voltmeter is accurate if there is no load.
5	Heater Control	Setting and readback for controlling a heater cartridge coupled with a thermocouple.
6	High Voltage OK and Interlock Override LED's	High Voltage OK LED lights when vacuum pressure of the system is OK. Interlock Override LED lights when the Override switch on the back panel has been activated.

# Manual for Electrospray Source Controller

## 7.3 Rear Panel Display



**Figure 2. Rear Panel Controls for Electrospray Source Controller**

**Table 4. Electrospray Source Controller Front Panel Controls**

Balloon Number	Function	Description
1	Heater/Thermocouple Connections	4 pin Mate-N-Lok connector Pin 1 is the + of the heater. Pin 2 is the - of the heater. Pin 3 is the + of the thermocouple. Pin 4 is the - of the thermocouple.
2	High Voltage Output	SHV connector to be used in the standard configuration to provide the +/- 5000 volt output to the ESI source.
3, 4, and 5	High-Q Head Connections	Female DB25 output that allows the operation of the High-Q Head which provides the RF output to the ion guide.
7	High-Q Head Connection	Female DB25 output that allows the operation of the High-Q Head which provides the RF output to the ion guide.

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# Manual for Electrospray Source Controller

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6	External Control Input	<p>Female DB25 input that allows the control of the voltages by applying a scaled command as listed below.</p> <p>Pin 1 commands the Electrospray Needle Voltage with +/-5 volt command corresponding +/- 5000 volt DC output.</p> <p>Pin 3 commands RF Power Supply #1 with 0 to +5 volt command corresponding to 0 to 2,000 Vpp output..</p> <p>Pin 5 commands RF Power Supply #2 with 0 to +5 volt command corresponding to 0 to 2,000 Vpp output..</p> <p>Pin 7 commands RF Power Supply #3 with 0 to +5 volt command corresponding to 0 to 2,000 Vpp output..</p> <p>Pin 17 read back for the Electrospray Needle Voltage (+5V = +5,000V).</p> <p>Pin 18 read back for RF Power Supply #1, (2V = 2,000V).</p> <p>Pin 19 read back for RF Power Supply #2, (2V = 2,000V).</p> <p>Pin 20 read back for RF Power Supply #3, (2V = 2,000V).</p> <p>Pins 2, 16, and 17 are Ground / Signal Common.</p>
8	High Voltage Interlock Switch and Connector	<p>The switch controls whether the high voltage interlock feature is enabled.</p> <p>When set to 'Override', the high voltage output is always enabled when AC power is turned on.</p> <p>When set to 'Enable', the high voltage output is enabled only when +5 interlock voltage is presented to pin 2 of the High Voltage Interlock Connector.</p> <p>The connector is a female DB9 input that allows external enabling and disabling of the high voltage output.</p> <p>Enables or disables the high voltage output depending on whether there is +5 volts presented to pin 2 from an outside source.</p> <p>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.</p> <p>A +5V signal present at pin 2 energizes two relays (#1, and #2)</p> <p>The Optics supply utilizes relay #1 internally, with pins 4, 5, and 6 available for diagnostics purposes.</p> <p>Relay #2 is available to echo the contact closure status, allowing the unit to daisy chain the vacuum interlock contact closure to other devices.</p> <p>The vacuum interlock relays used in this device support DC operation to 24 volts.</p>
9	Universal AC Power Input	<p>100 to 240 VAC, 60 Hz universal power input.</p>

## 7.4 High-Q Head Controls

The High-Q Head has five potentiometers (RF Gain, RF Bias, RF Clamp, RF Offset, and RF RDBK Gain) on its top panel and one potentiometer on its output panel (RF CMD LIMIT). These are set at the factory and should not be changed unless as a last resort to troubleshoot the RF power supply.

The RF Gain potentiometer allows control of the output gain of the RF Drive circuit, optimizing the RF supply for stable operation. The RF Gain potentiometer is a factory adjustment only, as improper adjustment can lead to instabilities in RF amplitude.

In the event that the power supply is not functioning throughout the whole desired range or at all, the RF Bias can be adjusted. Turning the potentiometer counter-clockwise will increase the Bias voltage. The RF Bias voltage can be read from the Bias Test Point. Typically the RF Bias voltage is between 3.8 and 4.5 volts. If the RF Bias is too small the RF supply will not turn on, however if the RF Bias is too large the RF output amplitude might become unstable.

The RF Clamp potentiometer is factory set to limit the RF output capability of the RF supply transistors, and should not be modified in the field.

The RF Offset potentiometer scales the zero point of the RF power supply. It is set at the factory to yield a zero volt output when no signal is measured at the RF output cables.

The RF RDBK Gain potentiometer scales the RF readback output signal. It is typically set at the factory to yield a two volt output with a 2,000 volt peak-to-peak signal at the RF output cables, as measured using a pair of 100X oscilloscope probes and an oscilloscope.

The RF CMD LIMIT will limit the maximum voltage that the output can achieve if there are concerns of glow discharge or low rated connections.

## 7.4 Test Load Procedure

The Test Load is provided to allow the RF power supply to be tested without anything else attached. With the RF power supply turned off, connect the RF Output to the Test Load with the RF cables. Switch the front panel External / Manual switch to Manual mode and make sure that the RF command is set to 10.0 and the RF Amplitude Limit is set to full counter-clockwise. Turn on the RF power supply and the RF Output front panel meter should read about the +5 VDC Command voltage that is stated on the High-Q Head.

## 8.0 Installation

### 8.1 Installing the Electrospray Source Controller

Installation of the Electrospray Source Controller onto a system requires the following:

- Do not obstruct the airflow around the Electrospray Source Controller and High-Q Head.
- Do not operate the Electrospray Source Controller in an environment that is subject to dust, high humidity, or mechanical vibrations.
- The Electrospray Source Controller is designed to be mounting onto a 19-inch instrument rack, with adequate ventilation to the rear. 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 Electrospray Source Controller box is connected to ground via the ground connection in the three-pronged AC power cable.

- It is not safe to operate the Electrospray Source Controller using a ‘ground isolator’ or three-prong to two-prong converter.
- Use only approved high voltage cables and connectors, which are rated to the maximum output voltage of the Electrospray Source Controller.
- Make all connections with the Electrospray Source Controller supply turned off

#### 8.2.2 Optional External Optics Output

Standard optics output is +/-400 volts with 2 Mohm out impedance. Ripple is less than 0.1% of maximum output voltage.

#### 8.2.3 External Control Input

The optics outputs can be controlled via external inputs through the DB25 connector. To be controlled externally the External/Manual switch must be set to External.

#### 8.2.4 High Voltage Interlock Input

The vacuum interlock feature of this power supply should be implemented by constructing a cable that brings the +5 V command from pin 1 of the back panel female DB9 vacuum interlock connector out to the vacuum interlock contact closure from an ionization gauge controller, bringing the contact closure output back to pin 2 of the back panel vacuum interlock connector.

## 9.0 Commissioning

### 9.1 Initial Operation

- Set control to default to the front panel potentiometers by switching the External/Manual switch to Manual.
- Connect all back panel output connectors so that the controller is connected to the electrospray source and ion guide.
- Set the back panel Vacuum Interlock switch to override.
- Turn display selector knob to 1 and adjust potentiometer 1 between low and high voltage limits. Unit should display -5000V to 5000V.
- Repeat for all other connectors. The Unit should display -400V to +400V for the optics supplies and 0 to >1000Vpp for the RF supply.
- As the front panel command voltage is increased, verify that the resulting output voltage indicated on the front panel meter increases linearly.
- If using an external voltage source to control the unit, plug in DB25 input in rear panel DB25 connection and switch the External/Manual switch to External. The front panel controls should now be disabled. Also adjusting the front panel potentiometer should have no affect on displayed voltage.
- Apply a range of voltages to individual optics and ensure that the voltage low and high limits reached.
- Contact the Ardara Technologies Technical Support if the power supply fails to reach the appropriate maximum voltage.
- Note that there are current limiting resistors in series with each +/-400V output. Attempts to measure the output voltage directly with a digital multimeter will result in erroneous readings which are proportionally lower than the values shown on the front panel display, due to a voltage divider configuration.
- If the displayed power supply output voltage appears erratic at higher voltage commands, then there may be some discharging happening external to the power supply, likely due to operation at too high a pressure, at too high a voltage for electrodes that are too close to each other or to ground.
- Check to see if the Heater Control is actively controlling the temperature. The front panel meter should read two temperatures (upper = actual; lower = setpoint)

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# Manual for Electrospray Source Controller

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## 10.0 Maintenance and Care

Under normal operating conditions, the Electrospray Source Controller does not require maintenance.

### 10.1 External Cleaning

Use a slightly moist cloth to clean the outside of the Electrospray Source Controller. 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 Electrospray Source Controller.

## 11.0 Dimensions

Table 5. PS\_ESI\_CONT\_152 Dimensions

Description	Dimension
Box dimensions (WxHxD)	Rack mount front panel 19 x 5.25 x 15 inches
Power Cable length	10 feet (removable)
Optics Cables	10 feet (removable)
RF output Cable Length	3 feet (removable)
High-Q Head Cable Length	10 feet (removable)
Weight (with cables)	16 pounds
Shipping Weight	18 pounds

## 12.0 Typical RF Performance Data

The following table illustrates typical measured performance for a RF power supply operated under a variety of capacitive loads. This data is provided as an example of typical performance.

Note that the front panel voltage display follows the command voltage linearly, but the actual peak-to-peak voltage (as measured using an analog oscilloscope with a 100X probe) has a reproducible non-linear response to the command voltage, but is calibrated to match the display voltage at the peak voltage output.

**Table 6. Typical PSRF performance at different capacitive loads at the end of three foot cables set at maximum command where +5V command = 1570 Vpp, with Standard Coil. All values are in peak-to-peak voltage.**

Capacitive Load	Output Voltage MAX	Frequency
10 pf	1.57 kV	2.02 MHz
20 pf	1.57 kV	1.86 MHz
30 pf	1.57 kV	1.72 MHz
40 pf	1.57 kV	1.62 MHz
50 pf	1.57 kV	1.53 MHz
60 pf	1.57 kV	1.45 MHz
70 pf	1.57 kV	1.39 MHz
80 pf	1.57 kV	1.33 MHz
90 pf	1.57 kV	1.28 MHz
100 pf	1.57 kV	1.24 MHz

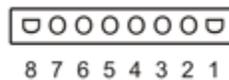
## Appendix A: Cable and Connector Options

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

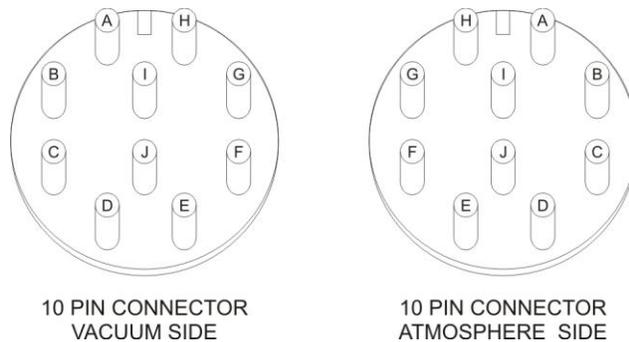
This Appendix provides an overview of various cable assemblies, which are compatible with the Optics Power Supply.

### 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 into a vacuum chamber.



**Figure A1. Pinout of 8 pin AMP Connector on Back Panel of Optics Supply.**



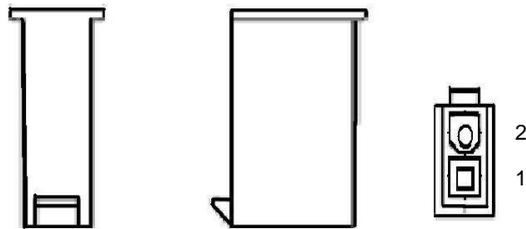
**Figure A2. Pinout of MS-10 Connector.**

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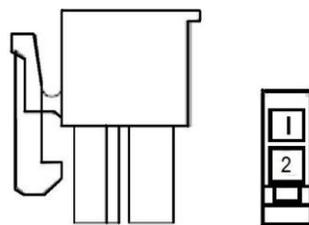
## Manual for Electrospray Source Controller

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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 A3. Pinout of 2 Pin Molex Plug.**



**Figure A4. Pinout of 2 Socket Molex Socket.**

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# Manual for Electrospray Source Controller

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## A.2 Cable PN 801122 (CABL\_OPTX\_MS\_MXPIN\_10N0\_10FT\_01)

The following table identifies the pinout for the standard cable that comes with the Optics Power Supply.

This cable is a ten-conductor cable that is ten feet long, using multi-colored, insulated twenty gauge wires. One end is terminated with a MS 10 connector to connect to a MS 10 feedthrough on a vacuum chamber. The other end is terminated with Molex Mini Fit Jr. connectors to allow the optics identities to be interchangeable.

Other optional cables such as the mxsock breakout cable (PN 801109) or the BNC to Molex cable (PN 801114) can be combined with the 10N0 cable to make a custom cable assembly.

Table A1. Cable Pinout for PN 801122, (CABL\_OPTX\_MS\_MXPIN\_10N0\_10FT\_01), Optics cable with ten Optics and no Filament connections.

Optics Power Supply Optics Amp Connector Socket Number	Wire Color (20 Gauge)	MS-10 Connector Socket
1	Red	E
2	Yellow	G
3	Orange	B
4	Brown	A
5	Blue	H
6	Green	F
7	Black	I
8	White	J
(Not Connected)	Gray	C
(Not Connected)	Purple	D

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## Manual for Electrospray Source Controller

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### A.3 Cable PN 801106 (CABL\_OPTX\_8N0\_10FT\_01)

The following table identifies the pinout for the standard cable that comes with the Optics Power Supply.

This cable is an eight-conductor cable that is ten feet long, using multi-colored, insulated twenty gauge wires.

**Table A2. Cable Pinout for PN 801106, (CABL\_OPTX\_8N0\_10FT\_01), Optics cable with eight Optics and no Filament connections.**

Optics Power Supply Optics Amp Connector Socket Number	Wire Color (20 Gauge)	MS-10 Connector Socket
1	Red	E
2	Yellow	G
3	Orange	B
4	Brown	A
5	Blue	H
6	Green	F
7	Black	I
8	White	J
(Not Connected)		C
(Not Connected)		D

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## Manual for Electrospray Source Controller

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### A.4 Cable PN 801109 (CABL\_OPTX\_MXSOCK\_8X\_12in\_01)

This breakout cable can be used for those cases where the Optics Power Supply outputs are to be mapped to multiple devices or connectors.

The eight-socket AMP connector side attaches to the Optics Power Supply output connector, with each output then available through an independent color-coded Molex two-socket connector.

Other optional cables such as the male breakout cable (PN 801110) or the BNC to Molex cable (PN 801108) can be combined with the female breakout cable to make a custom cable assembly.

**Table A3. CABL\_OPTX\_MXSOCK\_8X\_12IN\_01 – Optics cable with 8 pin optics input to Molex. Break out cable that connects to the Optics power supply.**

---

<b>AMP Connector Socket Number</b>	<b>Color (20 Gauge)</b>	<b>2 Pin Molex Socket Number</b>
1	Red	1
2	Yellow	1
3	Orange	1
4	Brown	1
5	Blue	1
6	Green	1
7	Black	1
8	White	1

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# Manual for Electrospray Source Controller

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## A.5 Cable PN 801108 (CABL\_BNC\_MXPIN\_10FT\_01)

This ten foot long coaxial output cable was designed to mate to a Molex two-socket connector on the female breakout cable (PN 801109), to bring Optics Power Supply voltages to BNC inputs such as the Ardara Technologies RF Power Supply pole bias offset inputs.

Table A4. CABL\_BNC\_MXPIN\_10FT\_01 – BNC to Molex cable. Extension for break out cable which allows connection to an external BNC input/output.

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2 Pin Molex Pin Number	BNC with RG-58 Cable Connection
1	Center Conductor
2	Shield

---

## A.6 Cable PN 801114 (CABL\_BNC\_MXSOCK\_10FT\_01)

This ten foot long coaxial output cable was designed to mate to a Molex two-socket connector on the male breakout cable (PN 801110), to bring external voltages from BNC outputs to the typical Ardara Technologies inputs.

Table A5. CABL\_BNC\_MXSOCK\_10FT\_01 – BNC to Molex cable. Extension for break out cable which allows connection to an external BNC input/output.

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2 Pin Molex Pin Number	BNC with RG-58 Cable Connection
1	Center Conductor
2	Shield

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# Manual for Electrospray Source Controller

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## A.7 Cable PN 801118 (CABL\_SHV\_MXPIN\_10FT\_01)

This ten foot long coaxial output cable was designed to mate to a Molex two-pin connector on the female breakout cable (PN 801109), to bring Optics Power Supply voltages to SHV inputs typically found on a flange face.

Table A6. CABL\_SHV\_MXPIN\_10FT\_01 – SHV to Molex cable. Extension for break out cable which allows connection to an external SHV input/output.

2 Pin Molex Pin Number	SHV with RG-58 Cable Connection
1	Center Conductor
2	Shield

## A.8 Optional Mating Parts

Ardara Technologies offers mated parts to match Optics Power Supply cables to vacuum systems. The Mini Conflat MS-10 Pin Connector serves as a feedthrough from atmosphere side to vacuum side and connects to CABL\_OPTX\_8N0\_10FT\_01.

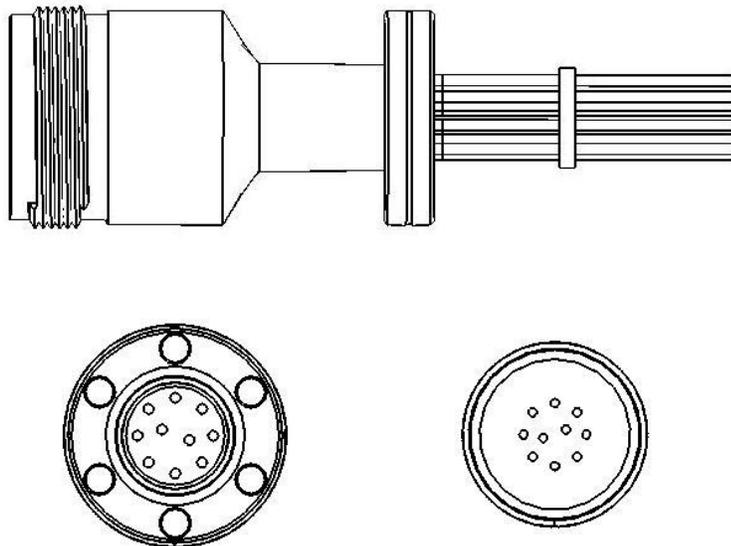


Figure A5: Mini Conflat MS-10 Pin Connector