High-Q Head-G Power Supply

Version 1.1

July 1, 2024

Phone: (412) 468-0377 • Fax: (412) 592-0911 • Web: http://www.ArdaraTech.com • E-mail: info@ArdaraTech.com

Table of Contents

Phone: (412) 468-0377 • Fax: (412) 592-0911 • Web: http://www.ArdaraTech.com • E-mail: info@ArdaraTech.com

1.0 Packing List

1.1 Packing List for PSRF-151 Power Supply

The PSRF-151 Power Supply is typically shipped with the following items:

Table 1. PSRF-151 Power Supply Packing List

Quantity	Part Number	Description
1	PSRF-151	High-Q Head-G Power Supply Module
1	PSRF-151-POWER CONVERTER	Universal AC Power Converter.
1	PSRF-151_DC PLUG	Mini-Fit Jr. Ground Plug.
1	PSRF-151-MAN	High-Q Head-G Operators Manual
1	CABL_POW_110AC_10FT	Universal AC power cable for US use, 10 feet long.
2	CABL_RG59_36IN_SHV	RG-59 Coaxial Cable with SHV to SHV connectors. Three foot length. Nominal capacitance 44 pF per cable, 22 pF for parallel pair.

1.2 Optional Cables and Components

The following list of optional cables and components are compatible with the PSRF-151.

Table 2. PSRF-151 Optional Components

Quantity	Part Number	Description
1	CABL_RG62_12IN_SHV	RG-62 Coaxial Cable with MHV to SHV connectors. One foot length. Nominal capacitance 15 pF per cable, 7.5 pF for parallel pair.
1	CABL_RG62_24IN_SHV	RG-62 Coaxial Cable with MHV to SHV connectors. Two foot length. Nominal capacitance 30 pF per cable, 15 pF for parallel pair.
1	CABL_RG62_12IN_MHV	RG-62 Coaxial Cable with two MHV connectors. One foot length. Nominal capacitance 15 pF per cable, 7.5 pF for parallel pair.
1	CABL_RG62_24IN_MHV	RG-62 Coaxial Cable with two MHV connectors. Two foot length. Nominal capacitance 30 pF per cable, 15 pF for parallel pair.
1	CABL_RG62_36IN_MHV	RG-62 Coaxial Cable with one MHV connector and one BNC connector, 3 foot length. Nominal capacitance 44 pF per cable, 22 pF for parallel pair.
1	CABL_DB25_22AWG	DB25 cable to connect the controller to the High-Q Head
1	CABL_BNC_MXSOCK_BNC_10FT_01	(2) BNC cables to a 4 pin Molex Mini-Fit Jr. connector that connects the DC Offset voltage to the High-Q Head.

2.0 Product Identification

In all communication with Ardara Technologies, please specify the information that is on the nameplate at the right side of the back panel of the electronics module, including the serial number.

3.0 Scope of Manual

This manual applies to the Ardara Technologies Quadrupole power supplies identified as PSRF-151 on the top of the box.

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 High-Q Head power supply is customizable, please refer to the markings on the RF output panel for specific frequencies, voltage outputs, and capacitance loads for a given RF output of the High-Q Head unit.

In this manual, the terms PSRF-151 and High-Q Head-G Power Supply are used interchangeably.

4.0 Intended Use

The Ardara Technologies PSRF-151 series of high frequency RF Quadrupole power supplies were designed to provide an easy-to-install crystal-fixed frequency RF power supply for powering quadrupoles for use in custom mass spectrometer systems.

The PSRF-151 is compatible with a wide variety of capacitive loads (20 pF to 360 pF using the standard configuration). This supported capacitance range allows its use for quadrupoles of varying lengths, from centimeters through meters.

Because the design has a crystal to fix the frequency, the PSRF-151 has a tuning capacitor that allows for a range of 2 to 10 pF to resonate with the desired load.

The PSRF-151 features an optional vacuum interlock input on its back panel, which is designed to disable the RF voltage output under conditions where the vacuum pressure is too high for safe operation. This input can be designed to be a fast on/off input switch.

5.0 Safety

This High-Q Head power supply is capable of generating lethal voltages. Care must be taken to ensure safety in use.

5.1 Input Power

This High-Q Head power supply is equipped with a universal input AC power converter, 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, and 50-60 Hz.

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 quadrupole 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 RF supply.

For example, MHV and SHV connectors are rated to 5kV DC, and can generally be used beyond 7 kV peak-to-peak for RF applications. The PSRF-151 is delivered with SHV to SHV cables and connectors.

However, often, end users intend to use an existing multi-pin connector, which are typically rated to 700-800 volts DC. Connection of the PSRF-151 to such a connector at full power output will lead to unsafe operation, with potential for discharge.

If it is determined that the rating of the connector to be used is less than the potential RF output voltage, then it is recommended that the unit be returned to Ardara Technologies for de-rating or the RF amplitude limit dial to be set accordingly, to limit the output voltage to a safe level.

The de-rating of the power supply involves reducing the gain of the High-Q Head Power Supply and re-calibrating the front-panel voltmeter.

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 High-Q Head Power Supply
- Use the product with accessories not listed in the corresponding product documentation

Phone: (412) 468-0377 • Fax: (412) 592-0911 • Web: http://www.ArdaraTech.com • E-mail: info@ArdaraTech.com

7.0 Product Overview

7.1 Summary

The PSRF-151 product line was developed to address the need in the marketplace for a stable, easy-to-use RF power supply.

The design is based on a crystal-fixed frequency circuit, which will need to be tuned to the load via adjustable and fixed capacitors.

As such, this High-Q Head Power Supply design is compatible with a wide range of capacitive loads (20 pF to 360 pF with standard configuration, >1000 pF with a custom modified version), resulting in a corresponding frequency range from 6.5 MHz to 500 kHz.

For the RF outputs, a single 0 to +10 volt command signal results in generation of a pair of high voltage RF outputs which are 180 degrees out of phase with each other, with peak-to-peak voltages as high as 6,000 volts.

The High-Q Head has a DC input connector to apply a separate offset to the two outputs.

7.2 High-Q Head Controls

The High-Q Head has three sets of potentiometers on the top panel. The set on the left has five potentiometers (RF Gain, RF Clamp, Zero Correction, RF Readback, and RF Readback Zero). 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.

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

The Zero Correction potentiometer scales the zero point of the RF power supply. It is set at the factory to calibrate the lower m/z ions, since the use of a resolution DC offset (Delta-M) distorts mass calibration for the lightest ions.

The RF Readback and RF Readback Zero potentiometers scale the buffered RF readback output signal. They are typically set at the factory to yield a two volt output corresponding to 4,000 Vop and zero volt output at 0 Vpp. The output will vary according to the configured output range for the power supply. Similarly, they can be adjusted to display m/z on the front panel of the quadrupole power supply controller. (For a 4,000 amu system, 0.4 volts corresponds to 4,000 amu.)

The potentiometers on the right side of the top panel are to allow the user to linearize the command of the RF power supply via hardware settings. They all

can be jumpered in/out of the circuit if needed. There are a single limit and two sets in the row of potentiometers.

The RF Limit potentiometer can be jumpered into the circuit and used to limit the RF output by scaling the mass command from 10V down to 1V. It is not recommended to utilize the limit if a stable output is desired.

The next five potentiometers are the set points that correspond to certain mass command set points. The last six provide the degree of change above or below each set point; where the first one is above the first set point and the rest are below the corresponding set points. The potentiometers are arranged from top to bottom to affect the high to low commands respectively. While these potentiometers will be set at the factory, the user may find that the final setup may cause the command to be non-linear. Adjustments can be made to the

A variable capacitor is provided on the front panel of the High-Q Head to adjust the load allowing for the RF power supply to be in resonance. The RF power supply will work best when it is at peak resonance. See the Commissioning section for the proper resonating procedure.

Other features that are on the front panel are the RF Output connectors (typically SHVs), the Test Load connectors (typically SHVs), and the Pole DC input connector (4-pin Molex Mini-Fit Jr. Connector). The RF Output connectors will need to be attached via cables to the device that the power supply is to drive. The Test Load connectors just have a discrete capacitor across the two connectors. This capacitive load can be used to mimic/test if the power supply is working properly by itself. See section 7.3 Test Load Procedure for directions to perform the self-test.

Lastly, on the back panel are 24V power input and the DB25 connector. The 24V must be applied for the unit to be powered. The DB25 connector contains the command and readback pin connections. There is also optional connections and switches for vacuum interlock and external frequency control (see section 8 for pinouts for the options).

7.3 Test Load Procedure

The Test Load is provided to allow the RF power supply to be tested with a known capacitive load. 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 Command Limit is full counter-clockwise. Turn on the RF power supply and the RF Output front panel meter should read about the +10 VDC Command voltage that is stated on the High-Q Head.

8.0 Installation

8.1 Installing the High-Q Head Power Supply

Installation of the RFPS-151 power supply is fairly straightforward, as long as the following conditions are followed:

- Do not obstruct the airflow to the back panel cooling fan which blows air across the internal components.
- Do not operate the High-Q Head power supply in an environment that is subject to dust, high humidity, or mechanical vibrations.
- The High-Q Head power supply can be mounted onto almost any surface, although it is recommended that the distance to the RF vacuum flange be minimized to minimize the cable length and hence its capacitive load.

8.2 Electrical Connections

8.2.1 AC Power Input

The High-Q Head 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 High-Q Head 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 the maximum output voltage of the quadrupole power supply.
- Make all RF connections with the High-Q Head power supply turned off.

8.2.2 DC Input

The DC input connection is rated to +/- 600 volts. This input controls the resolving DC potentials of the RF outputs. This input is compatible with most DC optics supplies, and can also be pulsed.

8.2.3 External Control Input

The output command can be controlled via the DB25 on the back panel. The 0 - 10V command is applied on pin 1 with a ground connection on pin 2. Also on the DB25 is the Vpp readback which is measured on pin 17 with the ground on pin 5.

8.2.4 Vacuum Interlock Input (Optional)

The vacuum interlock feature of this power supply should be implemented by constructing a cable that brings a +5 V enable to Pin 3 of the back panel female DB9 connector.

8.2.5 External Frequency Input (Optional)

The external frequency feature of this power supply should be implemented by constructing a cable that brings a square wave to Pin 6 of the back panel female DB9 connector. The square wave must be double the desired frequency and between 3 - 5 V peak-to-peak with the low sitting at 0 volts (i.e. for a 5 Vpp square wave the low would be 0V and the high would be 5V).

9.0 Commissioning

The RFPS-151 power supply needs to be resonated to work at maximum efficiency. To achieve the peak resonance the correct capacitive load must be attached to the RF outputs. While the High-Q Head power supply was resonated at the factory the final setup may have be different than the one used at the factory. To ensure that the power supply is at the ideal resonance, it is recommended that the following procedure be followed for initial operation:

- Install the power supply at its final location and attach all of the cables.
- Set the input command to zero volts.
- Set the back panel Vacuum Interlock switch to Override (if available).
- Making sure that there is suitably low vacuum, slowly increase the input command, and observe the RF voltage readback. The customized settings for a given RF supply are identified in the upper left hand corner of the front panel of the High-Q Head and in the configuration document.
- As the command voltage is increased, verify that the resulting output voltage indicated by the readback increases linearly (i.e. 1.0 V command should yield 0.100 volts readback, 5.0 V command should yield 0.500 volts readback).
- Once any voltage is applied, m/z voltmeter on the front panel of the quadrupole power supply controller should provide feedback on the degree of resonance. The power supply is at peak operation when the displayed output voltage is at its maximum. This indicates that the correct capacitance has been added to the device outputs. To adjust the resonance/capacitance, turn the Tuning Capacitor potentiometer on the front panel of the High-Q Head. The Tuning Capacitor has a range of 2 to 10 pF and turning the potentiometer clockwise increases the capacitance. The position of the potentiometer should be left at the point when the RF output maximizes.
- For best operation of the power supply the above resonance procedure should be checked at a few commands, starting at a low command and ending at the maximum command. Once the power supply is resonated at the maximum command, the power supply will operate at peak performance.
- If the readback appears erratic at higher voltage commands, then there may be some discharging occuring external to the power supply, likely due to operation at too high a pressure, with too high a voltage, for electrodes which are too close to each other or to ground. Verify that the RF power supply can reach its full voltage stably with a connection to the test load.

10.0 Maintenance and Care

Under normal operating conditions, the High-Q Head power supply does not require maintenance.

10.1 External Cleaning

Use a slightly moist cloth to clean the outside of the High-Q Head 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 High-Q Head power supply.

11.0 Technical Data

11.1 Dimensions

Table 8. PSRF-151 Dimensions

Description	Dimension
Box dimensions (WxHxD)	14.0 x 6.5 x 5.0 inches 355.6 x 165.1 x 127.0 mm
Power Cable length	10 feet (removable)
Power Converter Cable Length	4 feet (removable)
RF output Cable Length	3 feet (removable)
Weight (with cables)	8.0 lbs.
Shipping Weight	10.0 lbs.