
Manual M159: Triple Jumper RF Power Supply

Triple Jumper High-Q Head RF Power Supply



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1.0 Packing List

1.1 Packing List for PSRF-159 Power Supply

The PSRF-159 Power Supply is typically shipped with the following items:

Table 1. PSRF-159 Power Supply Packing List

Quantity	Part Number	Description
1	PSRF-159	High-Q Head-G Power Supply Module
1	AC Power Converter	120 Watt 24VDC Power Supply
1	M151	Triple Jumper RF Power Supply Manual
1	CABL_POW_110AC_10FT	Universal AC power cable for US use, 10 feet long.
2	CABL_RG62_36IN_MHV	RG-62 Coaxial Cable with MHV to MHV 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-159.

Table 2. PSRF-159 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_BN C_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-159 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-159 and High-Q Head-G Power Supply are used interchangeably.

4.0 Intended Use

The Ardara Technologies PSRF-159 series of high frequency RF Quadrupole power supplies were designed to provide an easy-to-resonate RF power supply, that can be resonated at three distinct frequencies, depending on the jumper selection, accessible from the top panel.

The PSRF-159 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.

In contrast to its sibling, the PSRF 151, which as an internal crystal to provide the RF frequency, the PSRF-159 requires an external customer supplied sine wave function generator as its frequency source.

The PSRF-159 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-159 is delivered with MHV to MHV 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-159 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.

Alternatively, the RF Command Limit Potentiometer, accessible through the top panel can be adjusted to limit the commanded range.

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

7.0 Product Overview

7.1 Summary

The PSRF-159 product line was developed to address the need in the marketplace for a stable, easy-to-use RF power supply, that can be easily reconfigured to operate at multiple frequencies.

The design is based on a fixed frequency circuit, which will need to be tuned to the load via adjusting either the output inductor coils or adding 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), with three inductor selections with nominally 2.6 MHz, 3.9 MHz, and 5.5 MHz, with 40 pF loads.

For the RF outputs, a single 0 to +5 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 2,000 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 supply transistors, 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 yield no signal at the RF output cables with a zero volt input command.

The RF Readback and RF Readback Zero potentiometers scale the RF readback output signal. They are typically set at the factory to yield a two volt output corresponding to 2000 Vpp and zero volt output at 0 Vpp. The output will vary according to the configured output range for the power supply.

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 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 command 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 potentiometers to correct for any error in the mass range.

Other features that are on the front panel are the RF Output connectors (typically MHVs), the Test Load connectors (typically SMHVs), 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).

The External Frequency BNC Input is also on the back panel, and should be connected to a function generator with 50 ohm output impedance using an RG58 cable, and the function generator providing a 125 volt peak-to-peak sine wave at the resonant frequency of the jumpered configuration.

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.

7.4 RF Frequency Select Jumpers

The PSRF-159 offers the unique ability to quickly reconfigure the resonant output frequency by removing the small panel located at the top of the enclosure and

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selecting which inductor pairs are to be included in the RF circuit, and which inductor pairs are to be shunted from inclusion with the RF output.

There are three pairs of these jumpers, labeled A, B and C, with pair A being the furthest from the RF output connection, and pair C being the closest to the RF output connection.

There are seven logical combinations of these jumper settings, which yield different RF output frequencies. The eighth logical combination, (jumpering out all three pairs) being non-sensical and ineffective.

The effective jumper selections include three cases of jumpering two of the three inductor pairs out of the circuit (jumper A and B, C open, jumper A and C, B open, and jumper B and C, A open) and three cases of jumpering only one of the inductor pairs out of the circuit (jumper A, with B and C open, jumper B with A and C open, and jumper C, with A and B open), and the final lowest frequency case of no jumpers installed.

Table 3. Typical Jumper / RF Frequency Settings (40 pF load, plus cables)

Jumper Setting	Resonant Frequency	Max RF Output Meter – (Oscilloscope) in Vpp
A Open, B C Jumpered	5.35 MHz	1248 – (1,220)
B Open, A C Jumpered	3.79 MHz	1933 – (1,890)
C Open, A B Jumpered	2.52 MHz	1999 – (2,000)

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 pole bias offset input connection is rated to +/- 500 volts. This input controls the centerline DC offset potential 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 RF command is connected via the DB25 on the back panel. The 0 - +5V command is applied on pin 1 with its common (ground) on pin 2. Also on the DB25 is the V_{pp} readback which is measured on pin 17 (2.0 V = 2,000 V_{pp}) with its common 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 connecting the output of a function generator to bring a 12.5 V_{pp} sine wave to the BNC connector on the back panel. The frequency of this sine wave should be adjusted such that the maximum RF amplitude is observed.

For example, with the jumper settings selected with Coil Pair C opened, with a 30 pF capacitive load, and the RF command set to 10 on the dial, one might find that the maximum achievable RF amplitude is 2000 V_{pp}, which might be achievable at a narrow range of frequencies centered around 2.52 MHz. One should choose an operating frequency in the middle of the range of the RF frequencies where this maximum output is achieved.

9.0 Commissioning

The RFPS-159 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).
- **Set function generator to 12.5 Vpp output sine wave (centered around ground) at the resonant RF frequency. If the resonant RF frequency is not known yet, set the RF frequency to some nominal value, such as 4 MHz.**
- **The resonant frequency can then be determined by adjusting this drive frequency up or down until the RF output is seen to increase. Continue adjusting until a local maximum is reached. There will be narrow a range of voltages which achieve the same maximum output voltage. Select a value in the center of this frequency range.**
- 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 on the front panel meter 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-159 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.