Model 171 Variable Frequency Quadrupole Power Supply Manual

Version 1.1

January 19, 2026

Table of Contents

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1.0 Packing List

1.1 Packing List for Model 171 Variable Frequency Quadrupole Power Supply

Table 1. QPS-171 Power Supply Packing List

Quantity	Part Number	Description
1	M129A QPS Controller	Quadrupole Power Supply Module.
1	31327_CABL_POW_110AC_10FT	Universal AC power cable for US use, 10 feet long.
1	801129_CABL_BNC_BNC_MXSOCK_10FT_01	(2) BNC cables to a 4 pin Molex Mini-Fit Jr. connector that connects the DC Offset voltage to the RF Driver.
	32763_E_CABL_DB25_M-F_10FT	DB25 Male to Female cable that connects between the M129A controller and the M171 RF Power Supply Driver.
1	M171 RF Power Supply Driver	Variable Frequency RF Driver.
1	32597_PS_24V_120W_DIN4PLUG_w/AC PLUG	24 Volt DC power supply to power M171 RF Power Supply Driver
	32762_CABL_IEC-C13_TO_IEC-C14_6FT_18AWG	AC power cord to connect between M129A QPS Controller and M171_RF Power Supply Driver.
1	M164 Variable Inductor Module	RF Power Supply Module with single pair of RF outputs
2	800103_CABL_RG62_36in_MHV-MHV	36 inch long RG62 coaxial cable with MHV connectors on either end, to connect sampled RF output back from M164 Variable Inductor Module to M171 RF Power Supply Driver. The resonant RF frequency can be increased If a shorter cable is substituted for this cable
2	801187_CABL_BNC_BNC_RG62_36IN	36 inch long RG62 coaxial cable with BNC connectors on either end, to connect high current low voltage RF drive signal from M171 RF Power Supply Driver to M164 Variable Inductor Module.
2	800156_CABL RG62 36in SHV-SHV	36 inch long RG62 coaxial cable with SHV connectors on either end, to connect high voltage RF outputs from M164 Variable Inductor Module to customer's quadrupole load.
1	M171_Variable Frequency Quadrupole Power Supply Manual	Operators Manual
1	Function Generator	(Optional, not a part of the system sold.)

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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 Variable Frequency Quadrupole Power Supply, which consists of three modules, a QPS-129A Quadrupole Power Supply Controller, a Model 171 Variable Frequency Driver, and a Model 164 variable Inductance Module.

This document is valid as of the date of publication. We reserve the right to make technical changes to the design.

In this manual, the terms QPS-171, Quadrupole Power Supply Controller and QPS Controller are used interchangeably.

4.0 Intended Use

The Ardara Technologies QPS-171 high frequency RF Quadrupole power supply was designed to provide fixed frequency resonant RF power supply with easy to change resonant frequency for powering quadrupoles for use in custom mass spectrometer systems.

The QPS-171 is compatible with a wide variety of capacitive loads (10 pF to hundreds of pF). This supported capacitance range allows its use for quadrupoles of varying lengths, from centimeters through meters.

The QPS-171 does not have a single fixed frequency, and requires an external frequency source to provide a sine wave at the resonant frequency, with 12.5 volts peak-to-peak amplitude, capable of driving a 50 ohm load.

The QPS-171 features an available 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.

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5.0 Safety

This quadrupole power supply is capable of generating lethal voltages. Care must be taken to ensure safety in use.

5.1 Input Power

This quadrupole 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, 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. These connectors are compatible with the full output power of the QPS-171 (up to 4,000 peak-to-peak). The QPS-171 is delivered with SHV to SHV cables and connectors to connect from the M163Variable Inductor Module to the vacuum flange.

However, often, end users intend to use an existing multi-pin connector, which are typically rated to 700-800 volts DC. Connection of the QPS-171 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 adjusting the Command Scale of the Model 171 RF Power Supply Driver.

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5.3 Vacuum Pressure Considerations

While the QPS-171 can be used to power pressurized ion guides, care must be taken to not output voltages high enough for discharge at higher operating pressures. One challenge if the quadrupole power supply is used in resolving mode in pressurized situations would be that the gas load would cause ion scattering and a significant loss of ion signal would occur. Another 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 driving it. This phenomenon is described in the literature using the Paschen Curve.

If the intended use for this quadrupole power supply is to drive devices at or near this glow discharge limit, please contact the factory for de-rating of the power supply to limit its output voltage to a safe level.

The vacuum interlock feature of this quadrupole power supply was designed to be utilized in conjunction with a vacuum gauge that features a contact closure output when the measured pressure is below a given set point. It is recommended that this feature of the quadrupole power supply be implemented to ensure safe operation.

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 Quadrupole Power Supply
- Use the product with accessories not listed in the corresponding product documentation

7.0 Product Overview

7.1 Summary

The QPS-171 quadrupole power supply product line was developed to address the need in the marketplace for a stable, easy-to-use quadrupole power supply with a wide range of operating RF frequencies.

The design is based on a fixed frequency circuit, whose frequency will need to be tuned to the load by varying the drive frequency.

As such, this Quadrupole Power Supply design is compatible with a wide range of capacitive loads (10 pF to hundreds of pF), with 255 discrete RF frequencies selectable by jumpering a combination of 8 inductor pairs whose inductances are a sequential binary multiples of two, relative to each other (1 uH to 128 uH each, in a sequence of 1, 2, 4, 8. 16, 32, 64, and 128) resulting in a corresponding frequency range from less than 1 Mz to over 7 MHz, depending on capacitive load.

The five front panel potentiometers, control the voltages for resolving RF (Mass), Pole Bias Offset, Low Mass Resolution and Fine High Mass Resolution, and Coarse High Mass Resolution. The Pole Bias ranges from -100 to +100 VDC, with 0 VDC being set at 5 on the potentiometer dial.

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 4,000 volts.

There is a male DB-15 connector on the back panel to provide external commands for Mass Command, Low Mass Resolution Command, Pole Bias Offset Command, and RF Mode TTL. Mass Commands are given through pin 1, with 10 volts corresponding to the maxium of the mass range. Mass Read back is taken from pin 15 (typically 2.0 V = 2,000 Vpp). Mass Resolution Command can be altered by the voltage (-10 V to +10 V) applied to pin 4. The Pole Bias Offset Command is given through pin 2, 10V = 100 VDC. The Pole Bias Offset Read Back is taken from pin 6 (1 V = 100 VDC). This pole bias offset can be pulsed, although the response of the circuit will be adversely affected by the additional time constant from a pull down resistor that is in the circuit. The RF Mode TTL (Pin 3) determines the state that the quadrupole power supply is in. At a low (0V) command the power supply will be in RF-only mode, while at a high (5V) command it will run in Resolving mode.

The unit has a vacuum interlock connector on the back panel, which allows an external contact closure to enable or disable the RF high voltage. This feature is compatible with ionization gauge pressure transducers with vacuum interlock outputs, and allows the quadrupole power supply to be put into a safe state if there is not adequate vacuum. 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.

7.2 Front Panel Controls

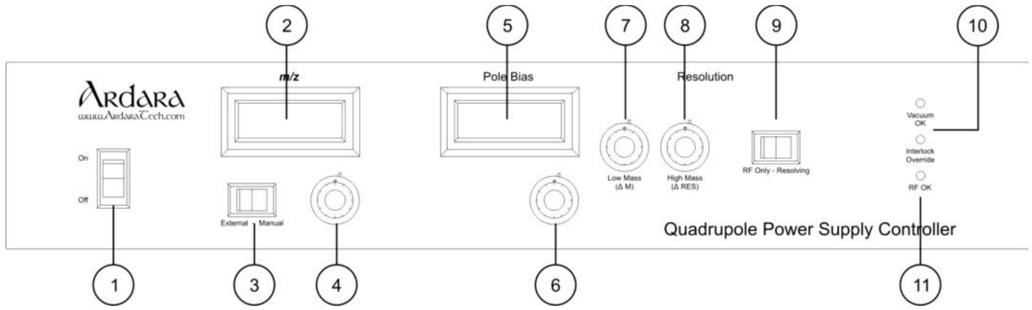

Figure 1. Front Panel controls for Quadrupole Power Supply.

Table 3. Quadrupole Power Supply Front Panel Controls

Balloon Number	Function	Description
1	On / Off Power Switch	Lighted power switch that enables AC power for the Quadrupole Power Supply
2	Mass Front Panel Meter	Displays mass value that the Quadrupole Power Supply is set to allow to pass through the device. This meter has two points for calibration that are located on the inner box.
3	External / Manual Switch	When 'External' command is selected, the Mass Command and RF Mode is controlled via the voltages applied to the External Command DB9 connector on the back panel. When Manual command is selected, the front panel potentiometers and switches can be used to control voltages and modes.
4	Mass Command Potentiometer	Ten turn potentiometer that controls the RF amplitude when the External / Manual switch is set to 'Manual'.
5	Pole Bias Offset Front Panel Meter	Displays the pole bias offset voltage to drive the DC offset of the Quadrupole power supply.
6	Pole Bias Offset Command Potentiometer	Ten turn potentiometer that controls Pole Bias Offset. This value is added to the value that is supplied externally through the External Command DB9 connector.
7	Delta-M - Resolution (Low Mass) Command Potentiometer	Ten turn potentiometer that controls the Low Mass Resolution Command when the Resolving Mode switch is set to 'Resolving'.
8	Fine Delta-Res - Resolution (High Mass) Command Potentiometer	Ten turn potentiometer that controls the High Mass Command Resolution when the Resolving Mode switch is set to 'Resolving' This potentiometer has ¼ the range as the Coarse .
9	RF-Only and Resolving Mode Switch	Switches between Ion Guiding RF and Resolving DC voltages or only Ion Guiding RF Voltages.
10	Vacuum OK and Interlock Override LEDs	The Vacuum OK LED indicates that the Vacuum Interlock is receiving +5V from an outside source and is presented to pin 2 of the Vacuum Interlock Connector (female DB-9). The Interlock Override LED indicates that the Vacuum Interlock Control is set to 'Override' and the voltages are always enabled when AC power is turned on.
11	RF OK	Indicates that the high voltage outputs are enabled..

Not Shown	Coarse Delta-Res - Resolution (High Mass) Command Potentiometer	Ten turn potentiometer that controls the High Mass Command Resolution when the Resolving Mode switch is set to ‘Resolving’ This potentiometer has 4 times the range as the Fine Delta Res potentiometer.

7.3 Back Panel Controls

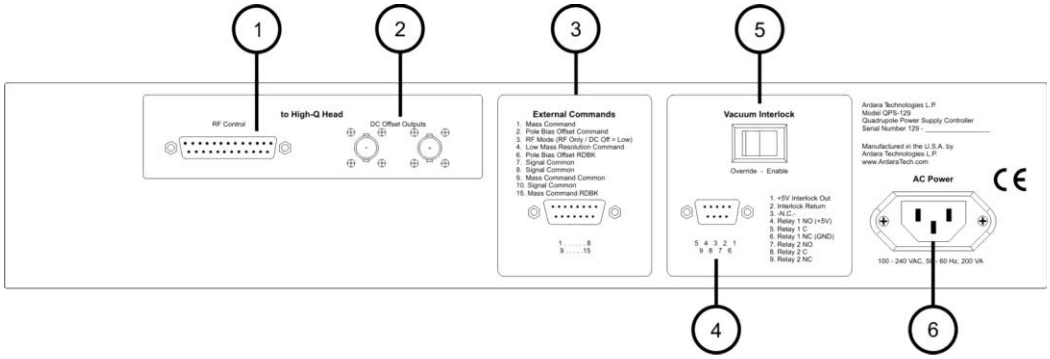

Figure 2. Back Panel controls for Quadrupole Power Supply.

Table 4. Quadrupole Power Supply Back Panel Controls

Balloon Number	Function	Description
1	High-Q Head Control Connector	Female DB-25 connector which will be needed to connect to the High-Q Head via a DB-25 Male-Female cable.
2	DC Offset Outputs	2 BNC connectors designated for the (+) / (-) phases of the RF output. These two BNCs must be connected to the High-Q Head for the resolving DC to be added onto the device.
3	External Control Input	Male DB15 connector which allows external Mass Command, Low Mass Resolution Command, Pole Bias Offset Command, and RF Mode Command. Mass Command is controlled via pin 1. Typical: 10 V = max mass Pole Bias Offset Command is controlled via pin 2. 10V command = -100V pole bias. RF Mode is controlled via pin 3. (Low = RF Only; High = Resolving) Low Mass Resolution Command is changed by a voltage applied to pin 4. 10V command yields 50V of resolving DC. Pole Bias Readback is measured via pin 6. Typical: 1V = 100V Mass Readback is given from pin 15. Typical: 2 V = 2,000 Vop. Pins 7, 8, and 10 are Signal Common. Pin 9 is Mass Command Common.
4	Vacuum Interlock Connector	Female DB-9 connector to allow control of the vacuum interlock. See Vacuum Interlock Control below for pinout.

5	Vacuum Interlock Control	Controls the vacuum interlock feature. When set to ‘Override’, the RF voltage is always enabled when AC power is turned on. When set to ‘Enable’, RF voltage is enabled only when +5 volts from an outside source is presented to pin 2 of the Vacuum Interlock Connector (female DB-9). For convenience, a plus-five-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 RF 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. The vacuum interlock relays used in this device support DC operation to 24 volts.
6	Universal AC Power Input	100 to 240 VAC, 50-60 Hz universal power input.

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7.4 High-Q Head Controls

The High Q Head has six labeled potentiometers (RF Gain, RF Clamp, Zero Correction, RF Readback Scale, and RF Readback Zero and Command Scale) on the top panel. 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 circuit, to protect internal components, 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 a zero volt RF output when the mass command is set to zero.

The RF Readback potentiometer scales the RF readback output signal that goes to the front panel m/z meter and to the back panel DB15 on pin 15. It is typically set at the factory to yield a 0 to 2 volt output corresponding to the RF output voltage, scaled to 1 volt = 1,000 Vop. The output will vary according to the configured mass range for the power supply.

Another feature on the top panel of the M171 Module is the ability to scale the incoming mass command to improve the granularity of the mass command for higher RF frequency operation, which doesn’t reach to as high an output voltage. This is effected through the RF Command Scale potentiometer, accessible through the top panel.

The outputs of the M171 Module include BNC connections to provide the high current RF drive to, and high voltage RF for readback from the Model 164 Variable Inductor Module, as well as the Pole DC input connector (4-pin Molex Mini-Fit Jr. Connector.

The Pole DC input is connected to the BNC DC Offset connectors that are on the back panel of the QPS Controller. A dual coaxial cable to Molex Minifit Jr. connector is provided for this function.

Lastly, on the back panel of the Model 171 High-Q Head is the DB-25 connector. Use the provided DB-25 cable to connect the Model 171 High-Q Head to the Model 129A QPS controller box.

The connections on the front panel of the Model 164 Variable Inductor Module include the RF Output connectors (SHV), the Test Load connectors (SHV), High Voltage RF Readback connectors (MHV), and the high current RF Drive Inputs (BNC). The Test Load connectors just have a discrete capacitor across the two connectors. This capacitive load can be used to test if the power supply is working properly by itself. See section 7.5 Test Load Procedure for directions to perform the self-test.

7.5 Test Load Procedure

The Test Load is provided to allow the RF power supply to be tested without connecting to the quadrupole / vacuum feedthroughs. 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.

8.0 Installation

8.1 Installing the Quadrupole Power Supply

Installation of the QPS-171 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 DC power supplies.
- Do not operate the quadrupole power supply in an environment that is subject to dust, high humidity, or mechanical vibrations.
- The quadrupole 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 quadrupole 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 quadrupole 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 quadrupole power supply turned off.

8.2.2 External Control Input

The Mass Command can be controlled via external commands connected to pin 1 on the back panel male DB9 External Control Input, with Mass Read Back measured from pin 15. The Pole Bias Offset input connection is rated to +/- 10 volts, where 10 V command yields -100 VDC pole bias. This input controls the centerline DC offset potential of the RF-only ion guide. Pole Bias is controlled by commands connected to pin 2 and has a Read Back on pin 6 of 1 V = 100 VDC. The RF Mode is controlled via pin 3 with TTL logic. Low is for RF Only mode and high is for Resolving mode. Low Mass Resolution can be controlled via commands connected to pin 4.

8.2.3 Vacuum 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

The QPS-171 quadrupole power supply needs to be resonated to work at maximum efficiency. To achieve the peak resonance a function generator needs to provide a 12.5 volt sine wave at the resonant frequency to be input into the M171 RF Power Supply Driver to match the resonant frequency of the chosen inductance and capacitive load. 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.
- Configure the jumpers in the Model 164 Variable Inductor Module to the selected Inductance/RF frequency. This module is configured with eight inductors on each side, with a binary sequence of inductor values from 1 to 256 uHenry inductances. High voltage jumpers are provided to jumper out (shunt) any or all but one of these inductor pairs to select a total binary inductance value from 2 to 1022 uH, in 255 steps, with the 256th possible jumper combination non-sensical, since it would mean 0 uH inductance. See Appendix A for typical performance examples.

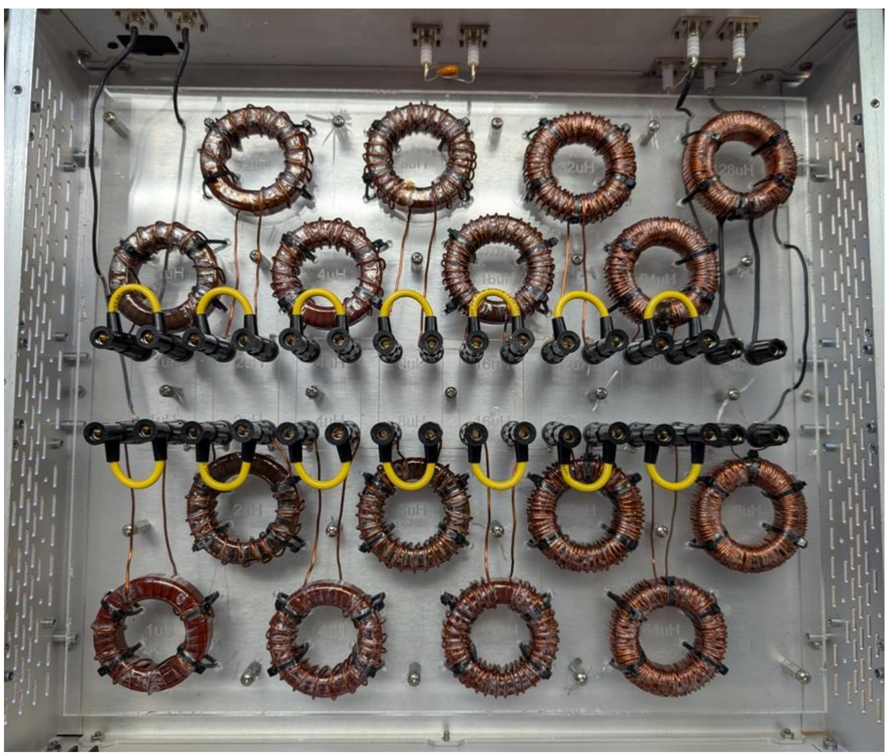

Figure 3. Top view of Internal connections of Model 164 Variable Inductor Module, showing eight possible pairs of jumper locations, seven occupied by the yellow jumpers.

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Figure 4. Example of one of the Jumpers that are used to shunt out one of the inductor coils.

- Set the front panel switch to manual mode
- Set the front panel Mass Command potentiometer control to full counter-clockwise (zero reading on the dial).
- Set the back panel Vacuum Interlock switch to Override.
- Attach a variable frequency function generator configured to output a sine wave at 12.5 Vpp to the frequency input of the Model 171 Variable Frequency RF Driver.
- Making sure that there is suitably low pressure vacuum, slowly turn the front panel Mass Command potentiometer clockwise, to 10.0 on the dial and observe the Mass readout on the front panel voltmeter.
- Adjust the input RF frequency until the M/Z readout is maximized. There will be a narrow range of frequencies which will work, choose the average of the frequencies (center of the range).
- The power supply is operating at peak efficiency when the front panel meter is at its maximum. This indicates that the correct RF frequency has been input for the chosen inductance and capacitance.
- For best operation of the power supply the above resonance procedure should be checked at a few m/z commands, starting at a low command and ending at the maximum command. Once the power supply is resonated at the maximum m/z command, the power supply will operate at peak performance.
- Contact the Ardara Technologies Technical Support if the power supply fails to resonate and/or reach the appropriate maximum voltage.
- If the displayed m/z appears erratic at higher voltage commands, then there may be some discharging occurring 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.

- The Pole Bias meter should read ~0 with a front panel command of 5 on the dial. With the Pole Bias dial set to 10 the meter should provide a +100.0 V reading and at 0 the meter should read -100.0 V.

Note: This configuration was optimized for maximum efficiency (Vpp) at the highest frequency range. The maximum output was scaled to calibrate approximately 2,000 Vop output for a 10 on the dial command, even though the system doesn't get to that high a voltage even at the lowest RF frequencies.

A simple change to the locations where the current transformer inputs are soldered on an internal board can change the configuration to favor higher efficiencies at lower RF frequencies. Contact the factory for more information if this is desired.

The front panel voltmeter on the Model 128A Quadrupole Power Supply Controller has been calibrated to read back zero-to-peak voltages, calibrated at around 1 MHz operating frequency. The RF readback circuit does not scale linearly across all RF frequencies, resulting in the readbacks for higher operating frequencies reading up to 10% low, relative to the actual RF outputs.

Setting the resolution commands for unit mass resolution requires an intimate understanding of quadrupole theory. In short, the resolving DC voltage required for unit mass resolution needs to be ~1/6 the zero-to-peak RF Voltage.

For this system design, setting the Delta-M (Low mass) and Fine Delta-Res (High Mass) resolution controls, as well as the Coarse Delta-Res resolution control to mid-scale will yield a resolving DC output of +/-200 VDC.

The Coarse Delta-Res control has a range of -160 volts to +160 volts, and the Fine Delta-Res control has a range of -40 volts to +40 volts at a mass command setting of 10 on the dial.

As shipped from the factory, the front panel controls should be set to 5.0 on the dial for Delta-M, 5.0 on the dial for Fine Delta-Res, and 8.0 on the dial for Coarse Delta-Res, to yield a nominal resolving DC output of 320 V with 10 on the mass command dial, which should yield broad, poorly resolved mass peaks upon initial operation, with the Fine Delta-Res potentiometer having enough range to adjust to unit mass resolution.

At higher RF frequencies, this combination of factory default settings might lead to a narrow range of front panel mass command potentiometer settings, limited to a fraction of the front panel knob settings where an increase in mass command yields a linear increase in RF output voltage. For example 1.6 on the dial is where the peak RF voltage maxes out at around 7 MHz; commands above that setting yields the same RF amplitude.

If the user chooses to expand the granularity of the front panel mass command, so that 10 on the mass command dial corresponds to the maximum possible peak RF voltage, then the ‘Command Scale’ potentiometer accessed through the top panel of the Model 171 Variable Frequency Driver Head can be adjusted to scale down the mass command, internal to the RF Driver Head. However, since the mass command inside the QPS Controller isn’t scaled down, the Delta-Res Slope command would need to be adjusted down to yield a nominal resolving DC equal to 1/6 of the new maximum peak RF voltage corresponding to 10 on the dial.

A typical procedure to expand the command scale at higher frequencies would be to set the Mass Command to 10 on the dial, then adjust the Command Scale potentiometer until the RF output is linear all the way through 10 on the dial, instead of yielding a flat response above a given lower setting.

Calculate the required resolving DC voltage by dividing the displayed maximum RF readback by 6.

Set the Mass Command potentiometer to 10 on the dial, the Pole Bias potentiometer, the Delta-Res potentiometer, and the Fine Delta-Res potentiometer to 5.0 on the dial.

Measure the actual resolving DC voltages at the output DC voltage BNC connectors on the back panel of the QPS controller.

Use the coarse Delta-Res potentiometer to adjust the nominal resolving DC voltage, to the calculated required DC voltage.

Note that to raise the resonant frequency of the system, substitute a shorter length of MHV high voltage coaxial cables between the M171 RF Power Supply Driver and the M164 Variable Inductor Module, and a shorter length of high voltage SHV coaxial cables between the M164 Variable Inductor Module and the quadrupole load.

For example, a three foot length of RG62 cable has an effective capacitance of ~21 pF, (14 pF per foot X 3 feet / 2, since the pair of cables represents capacitors in series).

We recommend the use of RG62 cables to minimize the effective capacitance.

RG62 cable has a capacitance of ~14 pF per foot, 7 pF per foot in a series pair.

RG59 cable has a capacitance of ~20 pF per foot, 10 pF per foot in a series pair.

RG58 cable has a capacitance of ~30 pF per foot, 15 pF per foot in a series pair.

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10.0 Maintenance and Care

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

10.1 External Cleaning

Use a slightly moist cloth to clean the outside of the Quadrupole 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 quadrupole power supply.

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11.0 Technical Data

11.1 Dimensions

Table 8. QPS-129A and M164 Variable Inductor Module Dimensions

Description	Dimension
Box dimensions (WxHxD)	17.5 x 3.5 x 15.0 inches
	444.5 x 88.9 x 381.0 mm
Front Panel (WxH)	19.0 x 3.5 inches
	482.6 x 88.9 mm
Power Cable length	10 feet (removable)
Control Cable Length	10 feet (removable)
DC Offset Cable Length	10 feet (removable)
RF output Cable Length	3 feet (removable)

Table 9. M171 RF Power Supply Driver 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	6 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.

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Appendix A: Typical Operating Performance

A-1 Frequency Selection:

Operating frequency can be estimated using the equation:

Frequency = 1/(square root (2 * P I * L *C))

Where Frequency is in Hertz, L is in uHenries, and C is in picofarads.

The inductance (L) is calculated as the sum of all of the inductors that haven't been jumpered out of the circuit.

The capacitance is calculated as the sum of the internal capacitance of the RF Driver circuit (~10 pF), plus the capacitance of the three foot long RG-62 MHV to MHV Feedback cables (~21 pF), plus the capacitance of the three foot long RG-62 SHV Output cables, plus the effective capacitance of the quadrupole load.

The following table shows experimental results for 9 of the 255 possible inductor jumper configurations, for this configuration of 36 inch long cable sets, with a 10 pF test load. (Estimated total capacitance of 10 + 21 + 21 + 10 = 62 pF)

Inductor Jumper Setting (All jumpered except:)	Resonant Frequency (MHz) (With 10 pF Test Load)	Max Voltage Output (Vop)
1 uH – (2 uH total)	7.688	253
2 uH – (4 uH total)	6.699	333
4 uH – (8 uH total)	5.509	484
8 uH – (16 uH total)	4.336	695
16 uH – (32 uH total)	3.292	937
32 uH – (64 uH total)	2.445	1,236
64 uH – (128 uH total)	1.798	1,420
128 uH – (256 uH total)	1.321	1,567
None Jumpered (511 uH)	0.940	1,788

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