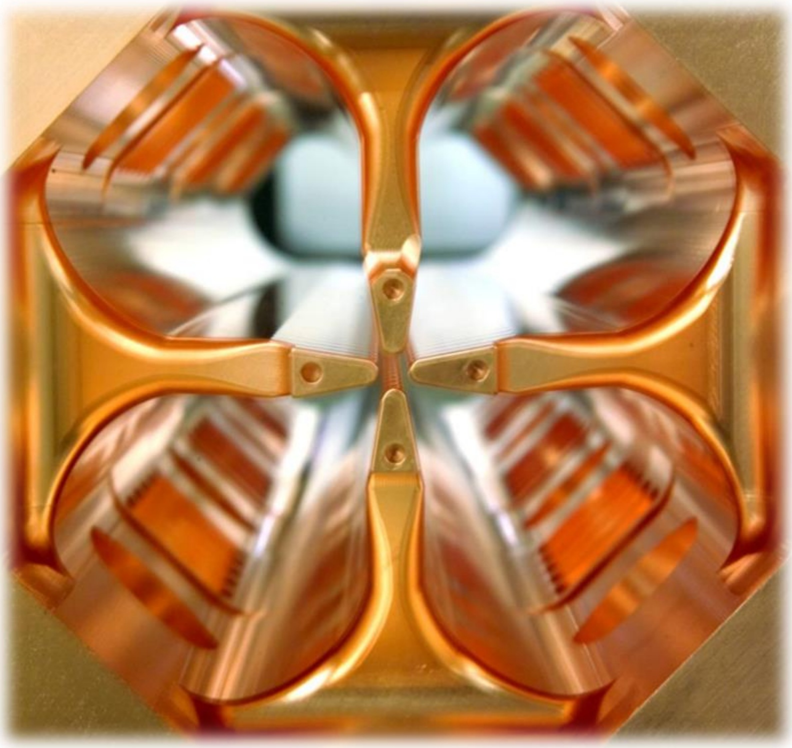
MIPS

Modular Intelligent Power Sources

RF QUAD Operations Manual
Rev 3.0, October 23, 2025



GAA Custom Electronics, LLC
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WARNING

TO REDUCE THE RISK OF FIRE OR ELECTRICAL SHOCK DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOSITURE.

WARNING

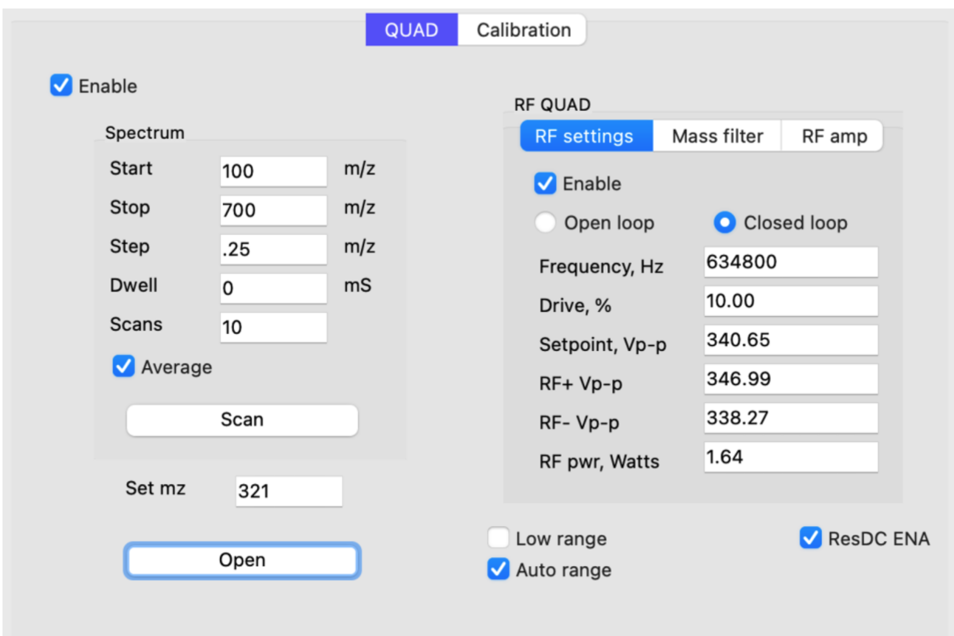
Only qualified electrical workers should operate and install this system.
Avoid spilling liquids onto/into the unit.
Do not expose to excessive heat or moisture.
Do not open – there are no user serviceable parts inside.
Do not block the chassis vent slots or the fan inlet.
Do not operate in an explosive environment.

This document outlines the QUAD module option available in MIPS systems. A MIPS system can have multiple modules. The QUAD module, coupled with an RF amplifier and a High Q RF head, enables control of a quadrupole for both mass filtering operations and m/z scanning. This scanning function necessitates the connection of a detector to the ADC input of the MIPS system to monitor and plot the detected signal.

The calibration section of this document provides a detailed procedure for setting up and calibrating your system, which is crucial for performing mass spectrometry scans and filtering functions.

Your MIPS system, which includes the QUAD module, came with an "About You System" document that includes a connection diagram. This diagram outlines all the module connections and connections to your system. You must complete these connections before you can use these features.

Once you've completed all your system connections, you can perform initial testing. The minimum requirement for initial system testing is to perform the auto-tune operation defined in the calibration section and then press the "Open" button to place the system in pass-through mode.



Control panel user interface allowing full control of the quadrupole system.

This interface enables you to set the quadrupole in a passthrough mode (press "Open"), filter for a specific m/z value (enter the value in the "Set m/z" box), or perform a m/z scan and plot the results using the options in the "Spectrum" group box.

Features described in this document require:

MIPS firmware rev 1.260 or later
MIPS host application 2.16 or later

RF Amplifier Main Menu, page 1

The MIPS hardware control box features a front panel interface that enables users to interact with the module without relying on the host software and control panel user interface. While the control panel interface offers greater capabilities, it is the preferred mode of operation. For completeness, the MIPS box controls are defined here.

The RF QUAD system main menu presents two pages of parameters that control the system. Each parameter is described below:

Module
: Selects the module number you wish to work with. Up to two modules can be installed in one MIPS system.

Enable
: This option will enable the RF drive and send power to RF head.

Mode
: The system can operate in two modes, open loop and closed loop. In open loop mode the drive power is fixed, in closed loop mode the drive power is adjusted to keep a constant RF level. System tuning is done in open loop mode.

Frequency
: This sets the RF frequency applied to the RF head and QUADS.

Drive
: This option only appears in open loop mode and allows you to set the RF drive level in percent.

SetPoint, Vp-p
: This option only appears in closed loop mode and allows you to define the RF QUAD peak-to-peak voltage.

RF+ Vp-p
RF- Vp-p
: These two parameters are display only values and will show you the RF voltage levels on each phase of the RF high Q head.

SWR
: RF load standing wave ratio, for a perfect load this value is 1.0. This value is very helpful in tuning the system. The SWR will change as the power level increases so you should check this setting at a few power levels.

Next page
: Advances to the next page of options.

Return to main menu
: Returns to the MIPS controller main menu.

Page two parameters

QUAD parameters

Selecting this option will display a new menu with all the QUAD specific parameters define in the QUAD parameter section.

RF amp parameters

Selecting this option will display a new menu with all the RF amplifier specific parameters, defined in the RF amp parameters section.

DC bias outputs

Selecting this option will display a new menu with the DC bias voltage options.

Invert

This parameter inverts the closed loop control logic; you should never change this value.

Calibration

This option is for factory calibration procedures.

Auto tune

Selecting this option will start an auto-tune process.

Save settings

Select this option to save your setting to non-volatile memory in MIPS.

Restore settings

Select this option to restore setting from the non-volatile memory in MIPS.

First page

Returns to page 1 or the menu.

QUAD parameters

Ro, mm

This parameter allows you to define your QUAD's Ro value in mm.

RDC=RFpp/k, k=

This is a calibration parameter that calculates the resolving DC voltages from the RF peak-to-peak voltage on each phase. The nominal value is 6 and this parameter can be adjusted to calibrate the system.

Resolving DC, V

This parameter allows you to define the resolving QUAD DC voltages.

Pole Bias, V

This parameter allows you to apply a DC bias voltage to the QUAD if needed.

Resolution AMU

This parameter allows you to define the theoretical resolution in AMU. This parameter is used when calculating the RF and DC voltages.

m/z

This is the m/z value you wish to pass through the QUAD.

Update

Selecting this option will cause the system to calculate the Resolving DC voltage and RF voltage level based on the current settings. This should be after the RF system is calibrated and in closed loop mode and all of the parameters above should first be defined.

Previous page

Selecting this option will return you to the main menu.

RF amp parameters

DC voltage, V

Input DC voltage applied to the RF amplifier. This value should read close to 24 volts.

DC current, A

Input DC current that the RF amplifier is drawing.

DC pwr in, W

This parameter shows the input power in watts being consumed by the RF amplifier.

Heatsink temp, C

This parameter shows the temperature of the Heatsink in the RF amplifier used to cool the power MOSFET transistors.

RF voltage, Vrms

This is the RF output rms voltage in volts.

RF current, Irms

This is the RF output rms current in amps.

RF fwd pwr, W

RF output forward RF power in watts.

RF rev ppwr,W

RF output reflected RF power in watts.

SWR

RF load standing wave ratio, for a perfect load this value is 1.0.

Previous page

Selecting this option will return you to the main menu.

Host Commands

The QUAD RF module offers a range of host commands that enable a connected computer to monitor and control the system. The available commands and their corresponding parameters are presented below. A MIPS system can accommodate up to two QUAD modules. Notably, certain commands require a module parameter, which indicates whether you want to control module 1 or module 2. If only one module is present, you must specify 1 as the module number.

These are the commands the MIPS host application used to interact with the system. Under normal use, you shouldn’t need to use any of these commands because the MIPS host application automatically sends the required commands based on the user's actions.

SRFAENA,<Module>,<ON or OFF>
: Sets the RF system enable mode, ON or OFF. Enable must be ON to generate RF drive.

GRFAENA,<Module>
: Returns the RF system enable mode, ON or OFF

SRFAFREQ,<Module>,<Frequency>
: Sets the RF system frequency in Hz

GRFAFREQ,<Module>
: Returns the RF frequency in Hz

SRFAK,<Module>,<Ratio>
: Sets the resolving DC voltage ratio, this is the ratio of RF p-p to DC voltage

GRFAK,<Module>
: Returns the resolving DC voltage ratio

SRFAMOD,<Module>,<OPEN or CLOSED>
: Sets the RF system to open or closed loop. In closed loop mode the electronics monitors the RF level and adjusts the power to hold the RF at the selected value.

GRFAMOD,<Module>
: Returns the RF mode state, open or closed

SRFADRV,<Module>,<Drive>
: Sets the RF drive level to 0 to 100 %; this parameter only applies in open loop mode. In open loop mode the user defines the RF drive power level in percentage.

GRFADRV,<Module>
: Returns the RF drive level

SRFALEV,<Module>,<Voltage p-p>
: Sets the RF output voltage setpoint, in closed loop mode this value defined the output voltage p-p value.

GRFALEV,<Module>
: Returns the RF output voltage setpoint

GRFAVPPA,<Module>
: Returns the RF output A actual level in volts p-p

GFRAVPPB,<Module>
: Returns the RF output B actual level, in volts p-p

GRFAPWR,<Module>
: Returns the RF amp RF forward pwr in watts

SRFARNG,<Module>,<Voltage p-p>
: Sets the QUAD RF maximum RF level, this is a configuration command used in the factory for system setup

GRFARNG,<Module>
: Returns the QUAD RF maximum RF level

SRFAPB,<Module>,<Voltage>

Sets the pole bias DC in volts
GRFAPB,<Module>
Returns the pole bias DC
SRFARDC,<Module>,<Voltage>
Sets the resolving DC + and - voltages using DC bias channels 1 and 2
GRFARDC,<Module>
Returns the resolving DC + and - voltages using DC bias channels 1 and 2
SRFAR0,<Module>,<Ro>
Sets the Ro value in mm
GRFAR0,<Module>
Returns the Ro value in mm
SRFAMZ,<Module>,<m/z>
Sets the m/z in amu
GRFAMZ,<Module>
Returns the m/z in amu
SRFARES,<Module>,<Resolution in AMU>
Sets the resolution in AMU
GRFARES,<Module>
Returns the resolution in AMU
RFAQUPDATE,<Module>
Updates the QUAD parameters, this command will calculate the required RF and DC voltages based on the system settings and apply these voltages.
SRFAGAIN,<Module>,<HIGH or LOW>
Sets RF head level control gain, HIGH or LOW
GRFAGAIN,<Module>
Returns RF head level control gain, HIGH or LOW
RRFAAMP,<Module>
Reports RF amplifier parameters
SRFADCCH,<Module>,<ch>
Defines the resolving DC channel to use on the MIPS DCbias module. If ch is 1 then channel 1 is used for pole 1 and channel 2 is used for pole 2.
GRFADCCH,<Module>
Returns the DCbias channel number used for resolving DC.
SRFDRVZ,<Module>,<zp>
This command allows setting the RF drive level for 0 output RF drive, this is used to adjust for offset in the hardware.
SRDCENA,TRUE or FALSE
If true this command will enable the resolving DC.
GRDCENA
Returns TRUE is the resolving DC is enable, else returns FALSE.
SRFAAR,<Module>,TRUE or FALSE
This command controls the automatic level range mode, if TRUE the level control range is automatically set by the system.

GRFAAR,<Module>

Returns TRUE is the system is automatically controlling the RF level range, else returns FALSE.

The QUAD system is equipped with firmware that enables the adjustment of the gain of the level detection systems as a function of frequency. This allows for the control of the compensation system.

SRFACP,<Module>, TRUE or FALSE

If TRUE this command will enable the frequency compensation algorithm.

GRFACP,<Module>

Returns TRUE if the frequency compensation system is enabled or FALSE if disabled.

SRFACPF,<Module>,<freq>

This command sets the base frequency in Hertz. This is the frequency at which the calibration was performed and serves as the reference point for calculating the correction factor as a function of frequency.

GRFACPF,<Module>

Returns the base frequency in Hz.

SRFACPG,<Module>,<gain>

This command sets the correction factor gain. The correct factor is calculated by subtracting the actual frequency from the base frequency and multiplying the result by the gain value. This product is then used to adjust the RF level system gain to compensate for changes in frequency.

GRFACPG,<Module>

This command returns the correction factor gain value.

The auto-tune system has several parameters that control the tuning procedure. These parameters, defined by the commands, apply to all QUAD modules in the system and are not saved.

SRFATUNE,<Module>

This command will start the Auto tune procedure for the selected channel.

SRFATUNER,<Module>

This command will start the Auto tune procedure for the selected channel and report the results to the console.

SRFATMINF,<freq>

This command set the minimum frequency in Hz for an auto tune process.

GRFATMINF

This command returns the minimum frequency in Hz for an auto tune process.

SRFATMAXF,<freq>

This command set the maximum frequency in Hz for an auto tune process.

GRFATMAXF

This command returns the maximum frequency in Hz for an auto tune process.

SRFATHP,<drive>

The auto-tune process has two phases. In the second phase, the frequency is adjusted at a higher drive level. This command enables you to specify the higher drive level in percentage.

GRFATHP

This command returns the auto-tune second phase drive level in percent.

SRFATSWR,TRUE or FALSE

If this command is TRUE, the second phase of the auto-tune process will monitor the SWR and minimize its value. Conversely, if the command is FALSE, the RF level will be monitored and maximized.

GRFATSWR

This command returns TRUE when the second tuning phase is minimizing SWR and FALSE when it is maximizing RF level.

System mass calibration

The QUAD RF system's output voltages are calibrated in the factory, but this won't guarantee perfect mass calibration in your system. It will serve as a starting point. To achieve accurate mass calibration, you'll need to adjust parameters in your actual system. In this section, we've provided details on calibrating your system.

Measurement accuracy and resolution in a quadrupole can be influenced by several factors.

- The mechanical precision of the quadrupole and its design.
- The length of the quadrupole; longer quads result in longer residence times and higher potential resolution.
- Ion energies; lower velocity ions have increased residence time in the quad.
- Vacuum pressures; lower pressures result in fewer collisions.
- Quad operating frequency; lower frequencies mean fewer RF cycles are seen by the ions and lower the resolution.
- Electronics stability and noise.

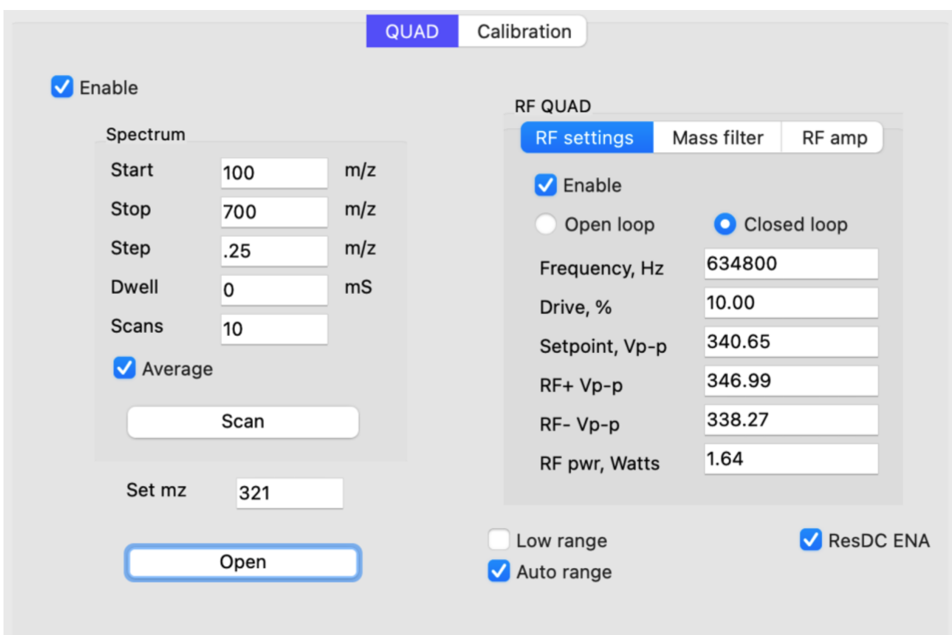
It's important to remember that higher resolution leads to lower transmission and subsequently lower sensitivity.

The quad interface offers the user a resolution adjustment feature. The resolution can be set in AMU, where this value determines the peak width in AMU. This value assumes perfect calibration and operation at the theoretical limit of the system, assuming all variables that limit resolution have been eliminated. Of course, this is not feasible, but the resolution control is useful when selecting the optimal trade-off between resolution and sensitivity.

Calibration of the system involves several steps. First, the quadrupole operating parameters are determined. Subsequently, the m/z calibration and resolution optimization are performed. To complete this procedure, a calibration standard is required. A suitable candidate is Agilent Tune Mix (P/N G2431A). It's advisable to have at least three peaks across the m/z range where you intend to operate.

Before initiating the calibration procedure, ensure that your system is operational and capable of measuring ion current using the ADC in your MIPS system. The ADC can accept positive signals from your detector within the range of 0 to 10 volts. This procedure assumes that you have a properly calibrated detector connected to the MIPS ADC input. Your system will feature a control panel that is loaded by the MIPS host software. This control panel enables you to control all features of your MIPS system and supports the system calibration procedure outlined in this document.

The quadrupole electronics generates the required RF and DC voltages to operate the system. These voltages have been calibrated in the factory and serve as a starting point for the calibration procedure. Before initiating the calibration, you will need to have your quadrupole's inscribed radius (Ro) ready. Additionally, your system must be in its final configuration, and a detector should be placed after the quadrupole to measure the transmitted ion current and its output connected to the MIPS ADC input.



The user interface (UI) for the quadrupole operation and calibration is described in detail later in this document.

Preliminary steps:

1.) Enter the Ro value (mm) in the interface, in the Mass filter tab.
2.) Enable the system by checking the Enable box.

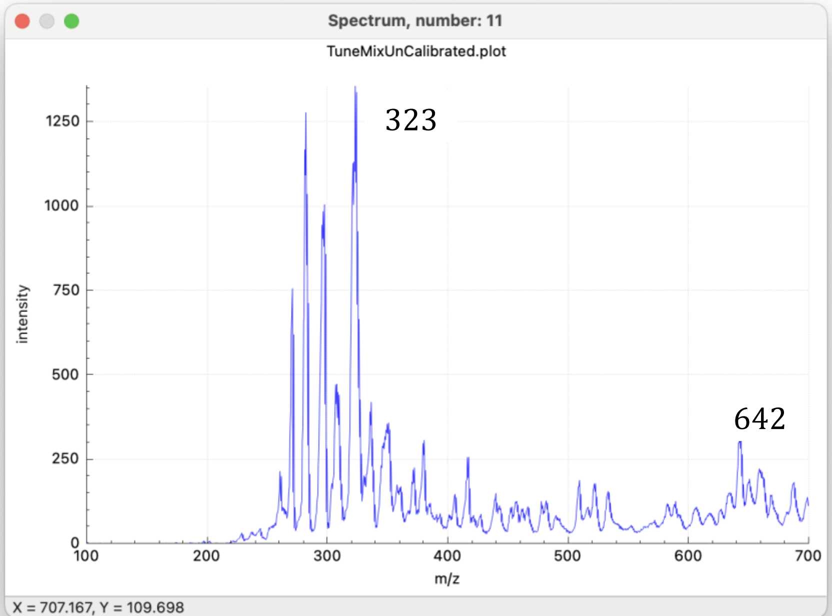
3.) To tune the quadrupole, press the Auto Tune button in the Calibration tab of the user interface. The MIPS front panel will display a message indicating that the system is tuning. Wait for the Tuning message to disappear, which signifies that the process has been completed.
4.) Press the Closed loop button to return the system to normal operation.
5.) Press the Open button to place the quadrupole is a mode to pass all ions.

Quadrupole operating parameter calibration steps:

The objective of this step is to adjust the Ro value and K value to enable the detection of the calibration peaks you intend to use in the final calibration phase. The Ro value influences the m/z calibration, and it's not crucial at this stage to generate an accurate calibration. The K value determines the ratio between the RF voltage level and the resolving DC voltage. A theoretical value of 5.958 corresponds to optimal resolution when the resolution parameter is set to 0.

1.) Set the resolution to 5.
2.) Set the K factor to 6.4, larger values will pass more ions at lower resolution.
3.) Set the Spectrum scan parameters to scan the m/z range of interest.
4.) Step is the m/z scan step size in m/z units, set this to 1 or 0.5.
5.) Dwell is the time in mS that the scanning will pause at each point, set this to 0 or 5 depending on how you intend to operate.
6.) Set scans to 1 and uncheck the Average box.
7.) Press the Scan button to record a spectrum. Inspect the spectrum to see if you've detected the calibration peaks of interest. To narrow the peaks, lower the K factor. To change the detected m/z value, adjust the Ro value.

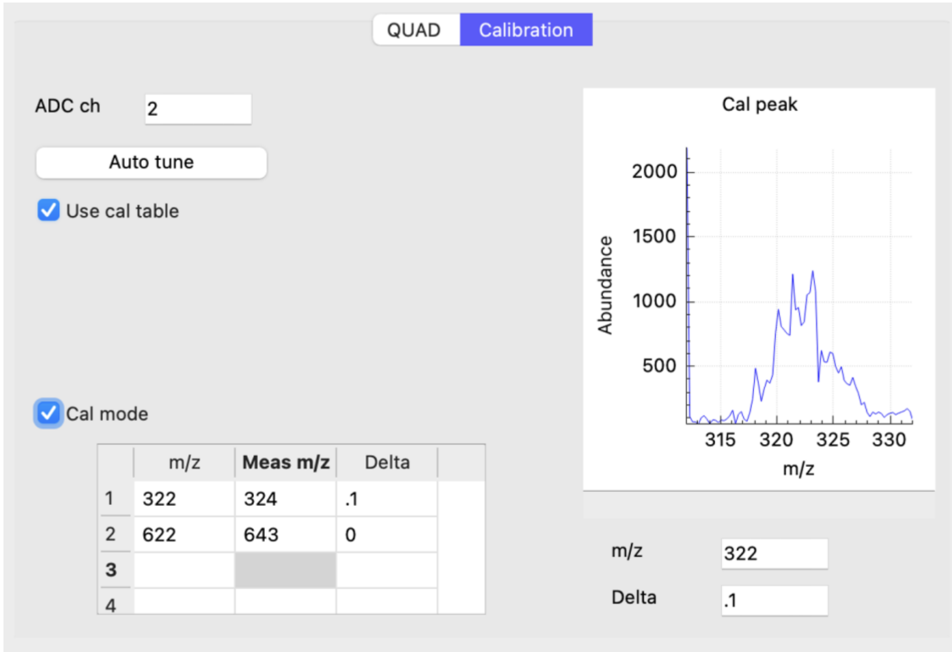
Iterate on these steps to find a good compromise for Ro and K. These parameters should remain unchanged after the initial calibration.



This example spectrum, recorded using tune mix, demonstrates the detection of the 322 ion at 323 and the 622 ion at 642. It's important to note that this system has several contaminate peaks that complicate the spectrum, but this still serves as a good example.

Quadrupole mass accuracy and resolution optimization:

The final stage of the calibration procedure involves correcting the m/z errors from the previous step and optimizing the peak shape. To perform these final adjustments, select the Calibration tab on the user interface, which will provide the necessary visualization and controls.



1.) With the Cal mode box unchecked enter the m/z value for your first peak, use the measured m/z value and not the actual value.
2.) Adjust the Delta value to optimize the peak shape.
3.) After completing the adjustments, enter the actual m/z, the measured m/z, and the delta value in the calibration table. Ensure that the entries are in ascending order.
4.) When complete, uncheck the Cal mode and then check the Use cal table box if you wish to use your calibration parameters.

The MIPS control panel, which includes the UI described in this document, also features a Save method button. Once you've completed the calibration process, ensure you press the Save method button to save the settings to a file for future reference. This action will save all the calibration parameters, as well as all MIPS interface parameters.

Warrantee

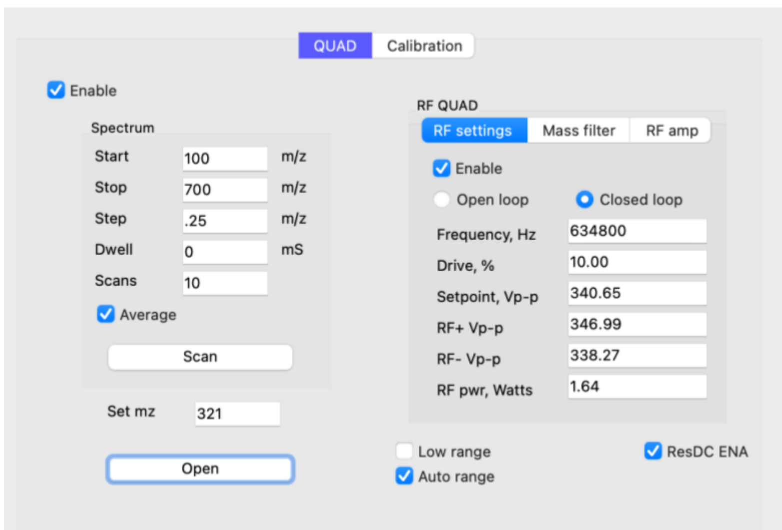
GAA Custom Electronics, LLC warrantees the MIPS system to be free from defects in materials and workmanship and will repair or replace the unit for a period of one year. This warrantee assumes the system is operated in compliance with the procedures and recommendation outlines in this document. GAA Custom Electronics, LLC will also provide free phone support and firmware bug fixes for up to one year. The addition of new features is not covered in this warrantee.

Liability

The liability of GAA Custom Electronics, LLC hereunder or otherwise is solely and exclusively limited to replacement, repair or credit at the purchase price, as GAA Custom Electronics, LLC may elect, for any product which is returned by Buyer during the applicable warranty period, or services for which timely notice of defect has been given by Buyer, and which are found by GAA Custom Electronics, LLC to be subject to adjustment under this warranty. IN NO EVENT SHALL GAA Custom Electronics, LLC BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSS OF ANTICIPATED PROFIT OR OTHER ECONOMIC LOSS OR FOR ANY DAMAGES ARISING IN TORT WHETHER BY REASON OF STRICT LIABILITY, NEGLIGENCE OR OTHERWISE.

Appendix A, MIPS Quad User interface:

The quadrupole user interface (UI) is an integral part of the MIPS control panel. It will automatically load when you open the control panel file that came with your system. This section delves into the UI controls and provides guidance on how to effectively use this interface to operate and calibrate your system.



The quadrupole UI features two main tabs at the top: QUAD mode and Calibration mode. In normal operation, you'll use the QUAD mode to perform m/z spectrum scans and set the m/z filter function. The controls on the UI are discussed in detail below.

Enable:

The Enable check box is used to enable and disable the quadrupole system. By default, it automatically enables all subsystems, making it the preferred option for enabling or disabling the system.

Spectrum:

The controls in this group box enable you to specify the parameters used for performing an m/z scan and displaying a spectrum. You can define the start and stop m/z range for a scan, as well as the scan size in m/z. This step size represents the interval between each point in the m/z spectrum that will be recorded and displayed.

The dwell time in mS determines how long the system will delay at each point before recording the detector voltage and updating the spectrum. You can define the number of scans to be recorded when you press the Scan button. All the recorded scans will be saved in the same plot, allowing you to scroll through them using the arrow keys.

If you select the Average check box and the total number of scans is greater than 1, an average of all the scans will be added to the display as a file scan.

The recorded spectrum's plots offer various options. Users can right-click on the graph to access a popup menu with options like saving the data, zooming, and filtering.

Set m/z:

The Set m/z box enables users to select a specific mass-to-charge (m/z) value. Upon selecting this value, the system adjusts its parameters to filter or pass only that particular m/z value. The current quadrupole calibration setting is used for calculating and adjusting the quadrupole. Please note that this control senses changes in the value and performs an update accordingly. If you modify the setting using another option on the interface, ensure you also change the value of this control to trigger an update.

Open:

Pressing this button will put the quadrupole in open mode. In this mode, the resolving DC is reduced to zero, and the RF level is set to a value defined in the MIPS control panel. These settings will cause the quadrupole to pass a range of m/z values.

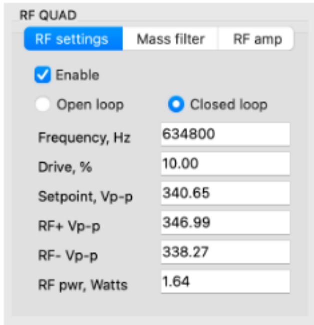
RF QUAD:

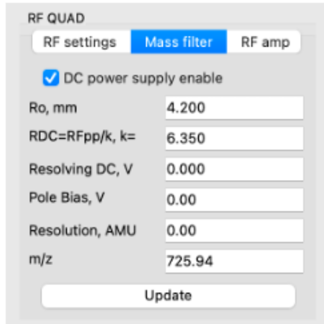
The RF QAUD section has three tabs to enable users to monitor and adjust settings as needed. In normal operation, users should only monitor these settings. However, during the calibration procedure, some settings may require adjustment. Once the system is calibrated, normal operation should not necessitate changing these settings.

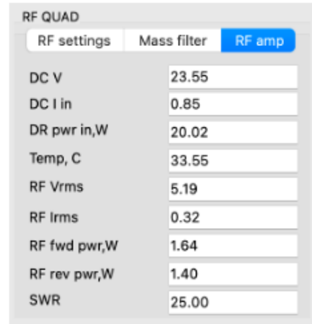
The RF settings tab controls allow setting the frequency, drive level, setpoint, and monitoring the output voltages generated. Additionally, it enables or disables the RF drive and switches between open and closed loop operating modes.

The Mass filter settings enable monitoring and defining calibration parameters such as Ro, k, and Resolution. They also allow setting any necessary pole bias offset and entering a m/z value, which triggers the system to calculate and set the parameters.

The RF amp tab monitors the operating parameters of the RF amplifier used to drive the quadrupole high-Q head.







Low range:

The Low range check box enables users to monitor the range of the RF level detection system. When this box is checked, the system operates in the low range mode, which enhances accuracy for low RF levels. Users should only monitor this value.

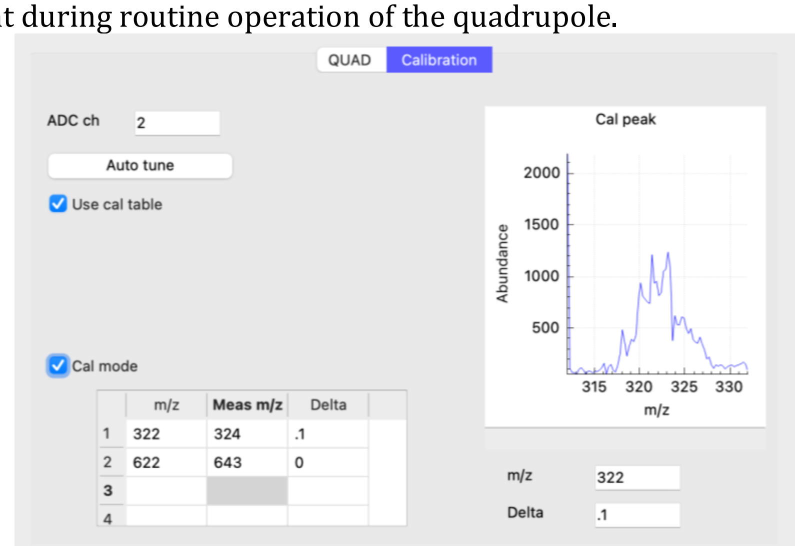
Auto range:

When this checkbox is selected, the system automatically sets the low range option based on the required RF level. It's essential to always check this option.

ResDC ENA:

This checkbox enables the resolution of DC power supplies. The system automatically controls this setting and should not be adjusted by the user.

The calibration tab of the Quadrupole interface is primarily used during calibration and initial setup of the system. These settings should not require adjustment during routine operation of the quadrupole.



ADC Ch:

This control defines the MIPS ADC channel number used to record the detector signal and plot the results. It's important to note that this value is set in the factory and should not require any manual adjustments.

Auto tune:

This button initiates an automatic frequency turn operation, adjusting the quadrupole RF frequency and monitoring the output level to determine the optimal operating point. This process is crucial during the initial setup and calibration phase.

Use cal table:

After the system calibration procedure is complete, check this box to allow the calibration table to be applied to the data as it is acquired. When checked, the scans will use the data in the calibration table to adjust the m/z values and resolving DC voltages as the data is recorded and plotted.

Cal mode:

This checkbox enables users to monitor a specific m/z value specified in the m/z input box. Before checking this box, the user must enter the desired m/z value. Upon checking, the system will monitor and plot the selected m/z value in the cal peak spectrum plot.

Calibration table:

This table stores the calibration data used to correct raw data during a mass spectrometry scan or when the mass spectrometer's filter value is set. This table is only used if the "Use cal table" checkbox is selected and the table is populated. The calibration procedure provides instructions on how to set these table values.

Cal peak spectrum:

This plot displays the selected m/z peak when the system is in calibration mode. The plot will continuously update whenever the calibration mode box is checked.

m/z:

This box specifies the calibration peak to be monitored and displayed. Please note that this value should only be modified when the calibration mode box is unchecked.

Delta:

This box defines the user-defined voltage delta during the calibration procedure. The value is adjusted while observing the calibration peak spectrum to achieve the best peak shape.

Appendix B, Electronics initial calibration:

This section delves into the electrical calibration of the system. In this context, the term "Calibration" refers to the electrical voltages generated by the quadrupole electronics, not the calibration of the m/z system. These steps are performed in the factory, and users should never attempt to perform them themselves.

Calibration of the QUAD module necessitates a fully functional RF QUAD system and a high-voltage oscilloscope (scope) probe. The probe will be employed to monitor one of the two RF QUAD outputs, providing a known voltage reading during the calibration process. The calibration accuracy hinges on the accuracy of the scope probe. Prior to commencing this procedure, ensure that the RF head is tuned and that stable RF voltages of 4KV can be achieved with the probe attached.

During this procedure, you'll need to move the probe between the RF+ and RF- outputs on the RF head. Ensure that the RF and DC levels are reduced to zero when making these changes. Additionally, unplugging the RF drive signal going into the RF head can help eliminate any RF generation. The most convenient way to calibrate the RF head is by connecting the RF cables to the head and disconnecting them from your vacuum system. When switching channels, you can move the probe from one cable to the next. Always keep both cables plugged into the RF head.

The procedure calibrates the RF head readbacks in both high and low ranges and the voltage level setpoint control.

This calibration procedure will be performed using the MIPS controller front panel controls. Please connect the MIPS host application to the MIPS controller, as we will be entering a few commands during the calibration process.

Before we begin the calibration, it's essential to save all the current settings in the MIPS system. This can be done by issuing the SAVEALL command.

The following steps are performed with the system in open loop mode.

RF+ low range

1.) Connect the probe to the RF+ output
2.) Enable the RF amp module
3.) Select the calibration option from the MIPS controller front panel
4.) Set the "Range thres" to 200 (this is a typical value but can change depending on application)
5.) Select the first voltage option you see under the "CAL LR V+" heading
6.) While monitoring the oscilloscope adjust the control knob until you reach the proper voltage on the scope, note this is a p-p value.
7.) Select the second voltage option you see under the "CAL LR V+" heading
8.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
9.) Select "Next" and then select "Calibrate" to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting "Abort", this will exit without performing the calibration. If anything goes wrong in the process you should exit with the "Abort" option.

RF- low range

1.) Connect the probe to the RF- output
2.) Enable the RF amp module
3.) Select the calibration option from the MIPS controller front panel
4.) Set the "Range thres" to 200 (this is a typical value but can change depending on application)
5.) Select the first voltage option you see under the "CAL LR V-" heading
6.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
7.) Select the second voltage option you see under the "CAL LR V-" heading
8.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
9.) Select "Next" and then select "Calibrate" to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting "Abort", this will exit without performing the calibration. If anything goes wrong in the process you should exit with the "Abort" option.

RF+

1.) Connect the probe to the RF+ output
2.) Enable the RF amp module
3.) Select the calibration option from the MIPS controller front panel
4.) Select "Next" to view the second page of options
5.) Select the first voltage option you see under the "Calibrate V+" heading
6.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
7.) Select the second voltage option you see under the "Calibrate V+" heading
8.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
9.) Select "Calibrate" to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting "Abort", this will exit without performing the calibration. If anything goes wrong in the process you should exit with the "Abort" option.

RF-

1.) Connect the probe to the RF- output
2.) Enable the RF amp module
3.) Select the calibration option from the MIPS controller front panel
4.) Select "Next" to view the second page of options
5.) Select the first voltage option you see under the "Calibrate V-" heading
6.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
7.) Select the second voltage option you see under the "Calibrate V-" heading
8.) While monitoring the oscilloscope adjust the control knob until you read the proper voltage on the scope, note this is a p-p value.
9.) Select "Calibrate" to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting "Abort", this will exit

without performing the calibration. If anything goes wrong in the process you should exit with the “Abort” option.

The following two calibration steps require the system in closed loop mode. The scope can monitor either the RF+ or RF- output.

Setpoint low range

1.) Enable the RF amp module
2.) Make sure you are in closed loop mode
3.) Select the calibration option from the MIPS controller front panel
4.) Select “Point 1” option under the “Cal LR SP” heading
5.) Adjust the control knob until to read 50 Vp-p on the scope
6.) Select “Point 2” option under the “Cal LR SP” heading
7.) Adjust the control knob until to read 50 Vp-p on the scope
8.) Select “Calibrate” to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting “Abort”, this will exit without performing the calibration. If anything goes wrong in the process you should exit with the “Abort” option.

Setpoint

1.) Enable the RF amp module
2.) Make sure you are in closed loop mode
3.) Select the “Next” option to see the second page of options
4.) Select the calibration option from the MIPS controller front panel
5.) Select “Point 1” option under the “Calibrate SP” heading
6.) Adjust the control knob until to read 1000 Vp-p on the scope
7.) Select “Point 2” option under the “Calibrate SP” heading
8.) Adjust the control knob until to read 3000 Vp-p on the scope
9.) Select “Calibrate” to accept the parameters and perform the calibration. You can also exit the calibration mode by selecting “Abort”, this will exit without performing the calibration. If anything goes wrong in the process you should exit with the “Abort” option.

Saving the new calibration

1.) After the calibration is complete the new parameters need to be saved
2.) Disable the RF amp module
3.) Set the RF mode to open loop
4.) Select the “Save settings” option to save the new calibration
5.) The settings can also be backed up to the SD card in the MIPS controller. This is done using the SAVEALL command. This command will backup the settings from all the modules in the system to the SD card. Make sure you fully test the new calibration before you save to SD.