

Astraea Users Guide

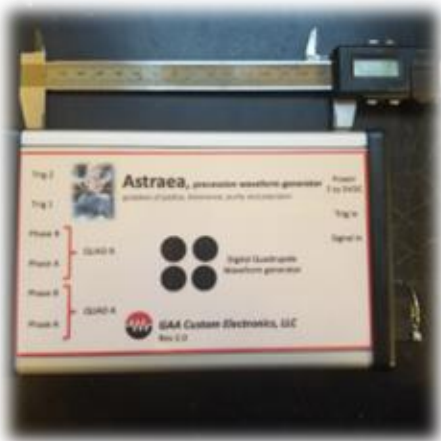
GAA Custom Electronics, LLC

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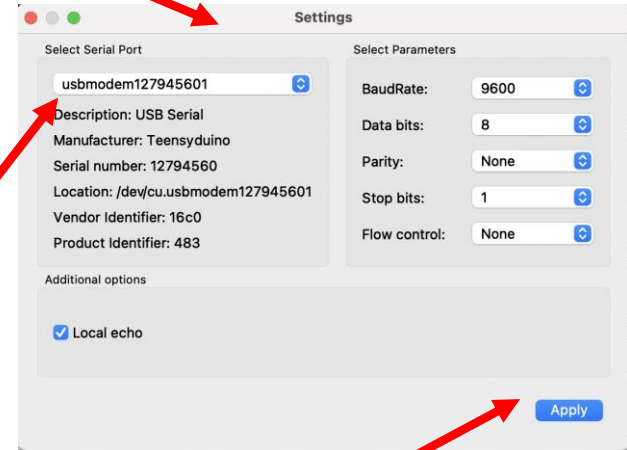
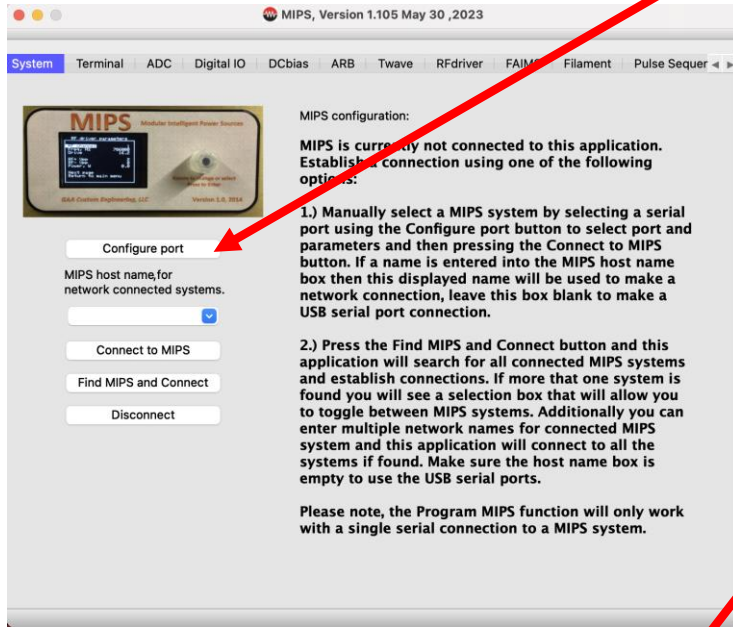
This user guide outlines how to connect the MIPS host application to Astraea and load the control panel user interface.

- Make sure you connect the USB cable between Astraea and your PC.
- Apply power to Astraea using the supply power adapter.
- Astraea will generate signals for two quads and has a trigger input and output signals that are described in this document.
- Astraea also has data collection, scanning, and plotting capability. The signal input is a single-ended 0 to 10V high-impedance input.

Connecting to Astraea and Loading
the Control Panel User Interface.

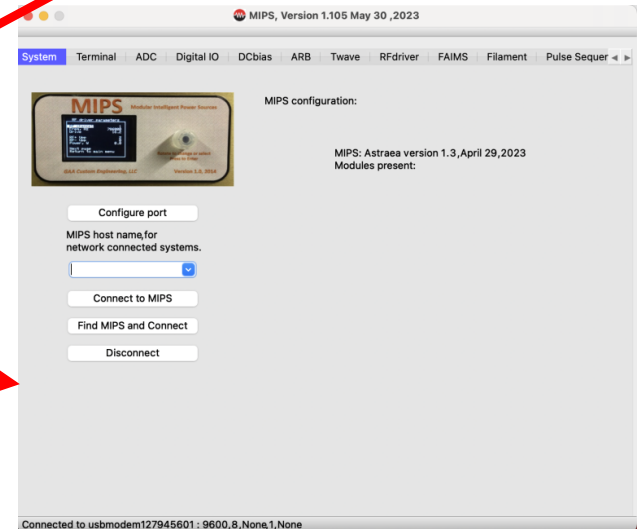
Startup dialog for the MIPS application used to communicate with Astraea.

To connect to Astraea make sure the USB cable is connected to your PC. Press the Configure port button and this setting dialog will appear.



Select the comm port and then you can press apply, none of the other parameters should be changed. The system will connect and you will see the startup dialog update as shown.

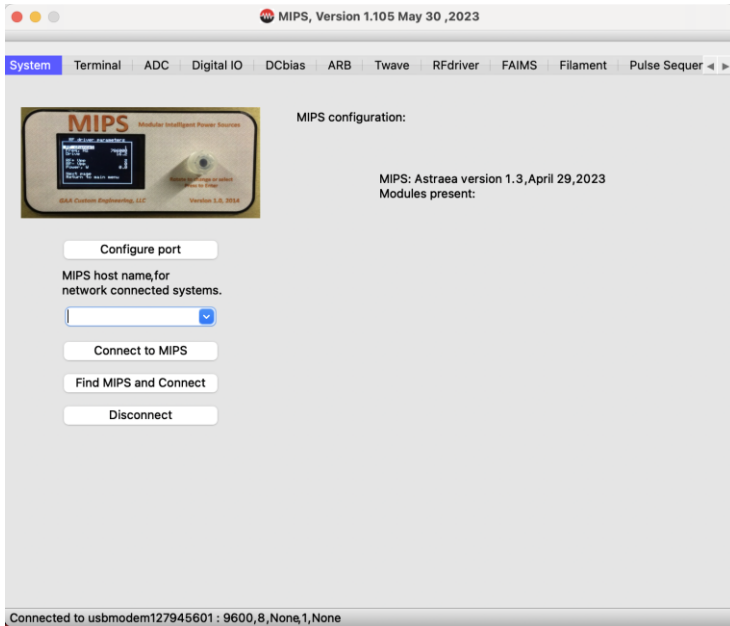
You can also just press the Find MIPS and Connect button to automatically perform the connect.



After you have connected to Astraea you can load the control panel interface as shown. Please note, you can load the control panel even if you are not connected. The controls will all be blank if not connected to Astraea.

MIPS Help File Terminal Tools

Press the Tools option of the MIPS app menu bar.

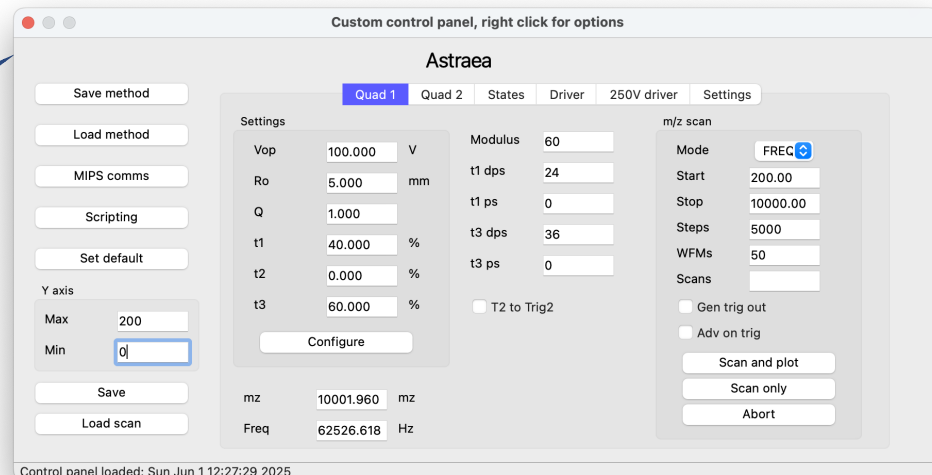


Program MIPS

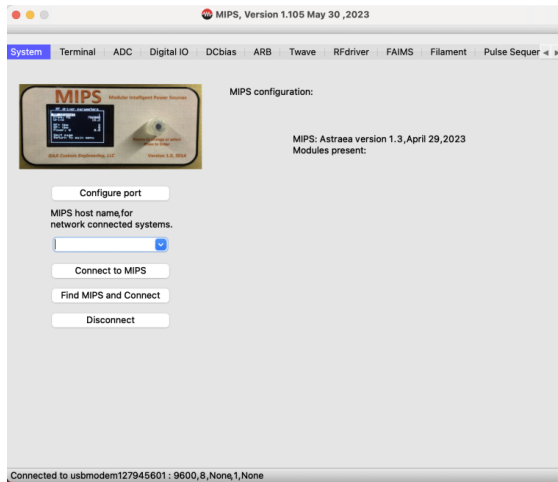
Save current MIPS firmware
Set bootloader boot flag
Program RFmega
Load configuration...
Scripting...

Press the Load selection... option and you will then see a file select box, navigate to and load the Astraea.cfg file.

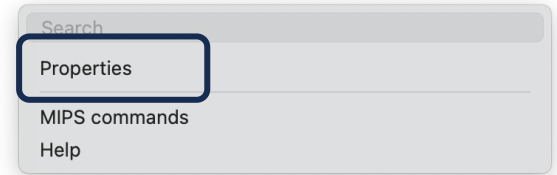
After you select the Astraea.cfg file you will see this dialog appear and the MIPS main dialog will be minimized.



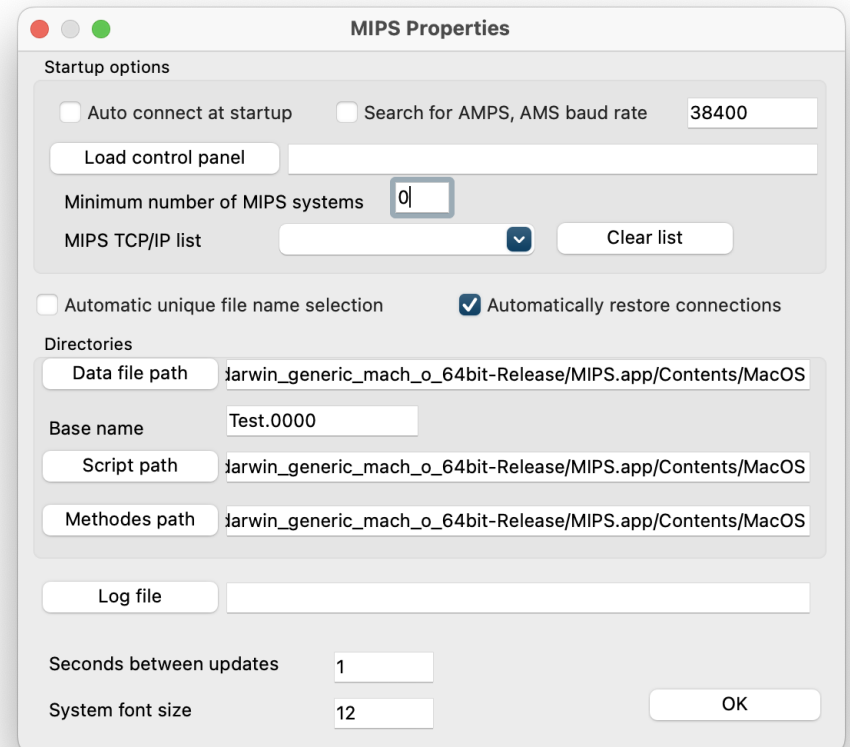
You can automate the entire startup process and the MIPS will connect and load the control panel when the MIPS app starts.



Start the MIPS app and then select the Properties option under the main menu Help option.



Using this properties dialog check the Auto connect at startup and then press the Load control panel button, use the displayed file section dialog to select the Astraea.cfg file. Next check the Automatically restore connections button and press OK. The next time you start the MIPS app it will automatically connect and load the control panel.



General Interface Controls,
common to all modes

Pressing this button will popup a file selection dialog allowing you to load the setting from a file.

Pressing this button will popup a file selection dialog allowing you to save the setting to a file.

These tabs select different options for setting the system parameters.

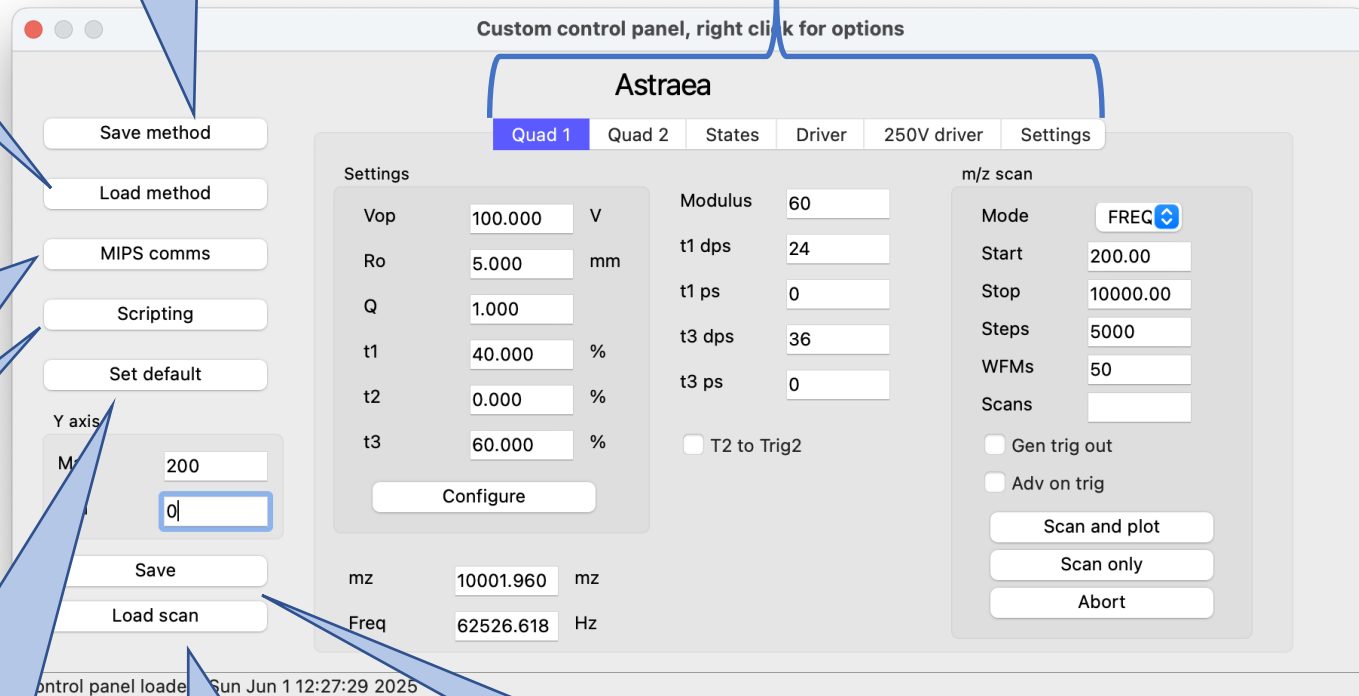
Pressing this button will popup a file communication dialog box allowing you to send commands to Astraera. While this box is displayed the interface will not update so make sure and close the dialog when finished.

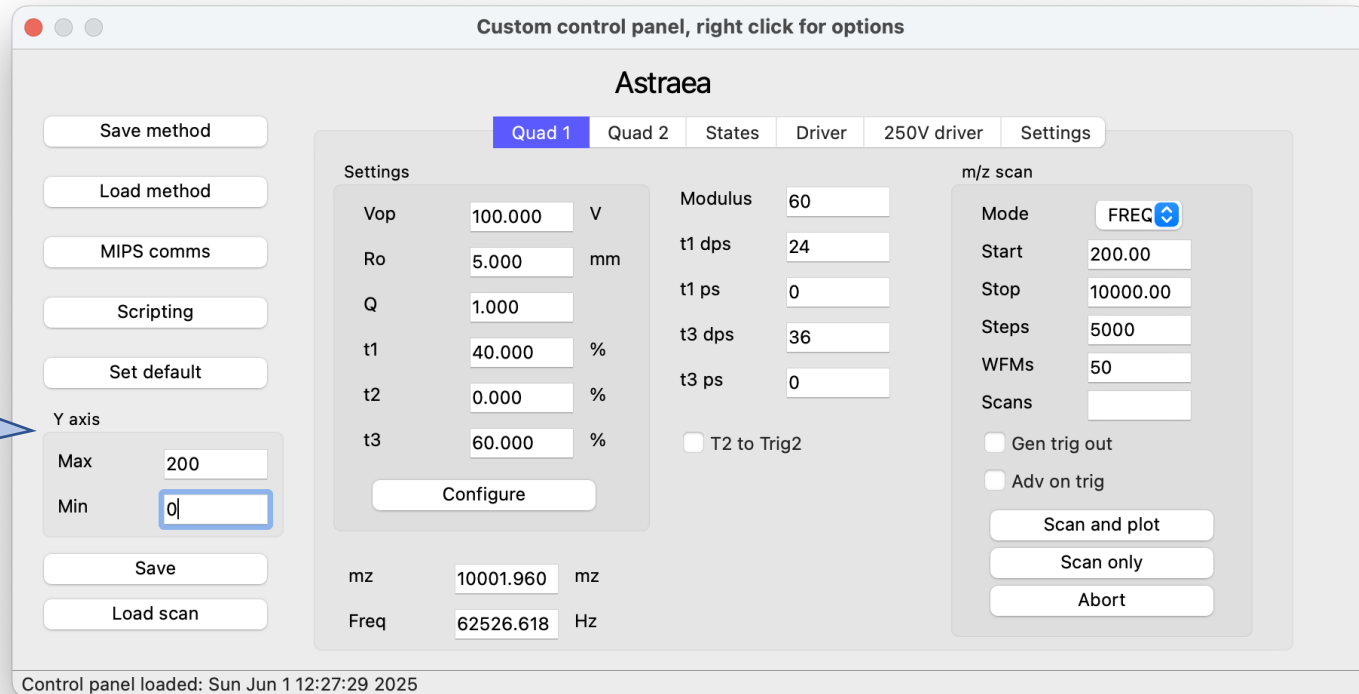
Pressing this button will popup the scripting dialog allowing you to create custom scripts.

Pressing this button runs the default.script file that will setup the system and load a default settings file. This button is automatically pressed on control panel load.

This button allow you to load a previously saved plot file.

Pressing this button will save all setting to flash memory in Astraera, the parameter will persist even with the power is cycled.

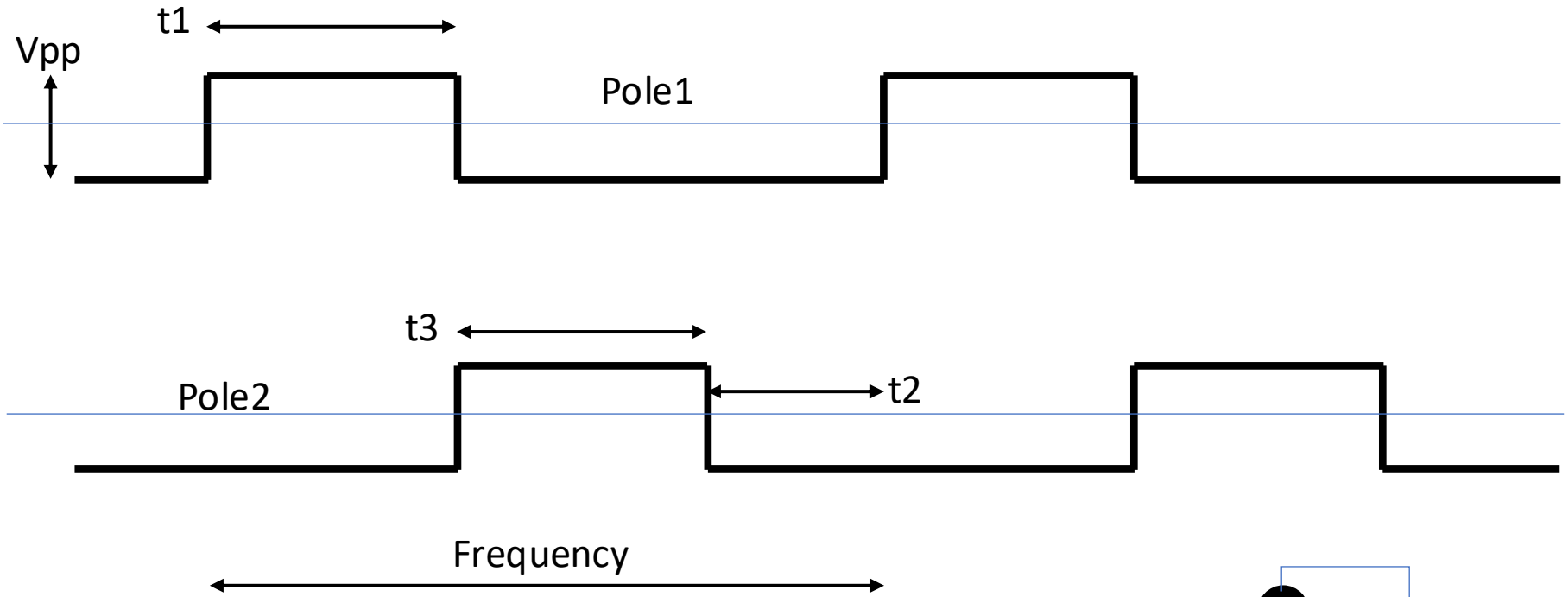




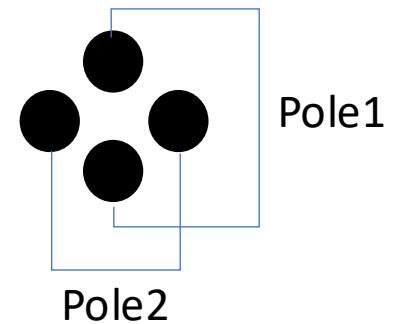
This box allows you to set the Y axis maximum and minimum values. This range is used for all plotting functions.

Astraea QUAD 1 User Interface Parameters

Waveform Details



t_1 , t_2 , and t_3 are in percentage



t1 duty cycle in percent. This value should be entered before t3. After t1 is entered t3 is set to 100-t1.

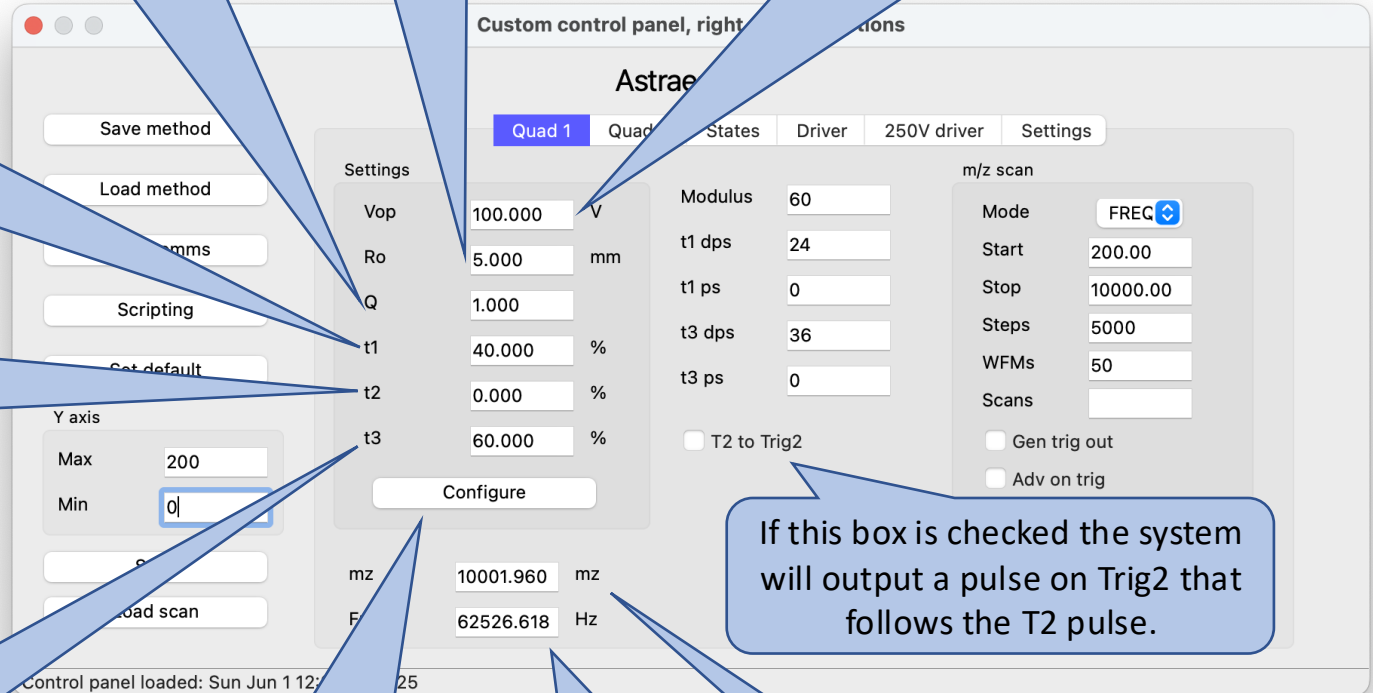
t2 is a display only value and is the difference between t1 and t3.

t3 duty cycle in percent. Enter this value after t1, t2 will be automatically calculated.

QUAD Ro value in mm.

QUAD Q value.

Enter the base to peak voltage that is applied to the QUAD, note this parameter is not automatically set when using the integrated QUAD driver.



If this box is checked the system will output a pulse on Trig2 that follows the T2 pulse.

This button should be pressed after the settings values are updated. When this button is pressed all QUAD value are calculated and the hardware updated.

Enter the desired frequency in Hz. The m/z value will be calculated and displayed as well as updating the hardware.

Enter the desired m/z. The frequency will be calculated and displayed as well as updating the hardware

These are internal parameters used to generate the waveform. These are display only parameters.
Modulus, output frequency division
t1 dps, t1 active count
t1 ps, t1 DDS phase offset
t3 dps, t3 active count
T3 ps, t3 DDS phase offset

Options in this section support scanning of QUAD 1.

Scanning is supported of m/z, freq, t1, or t3. This option allows you to select the setting you wish to scan.

Defines the scan start value.

Defines the scan end value.

Defines the number of points in the scan.

Defines the waveforms to generate at each scan point

Defines the number of scans to perform. The plot will have one extra plot that is the average of all scans.

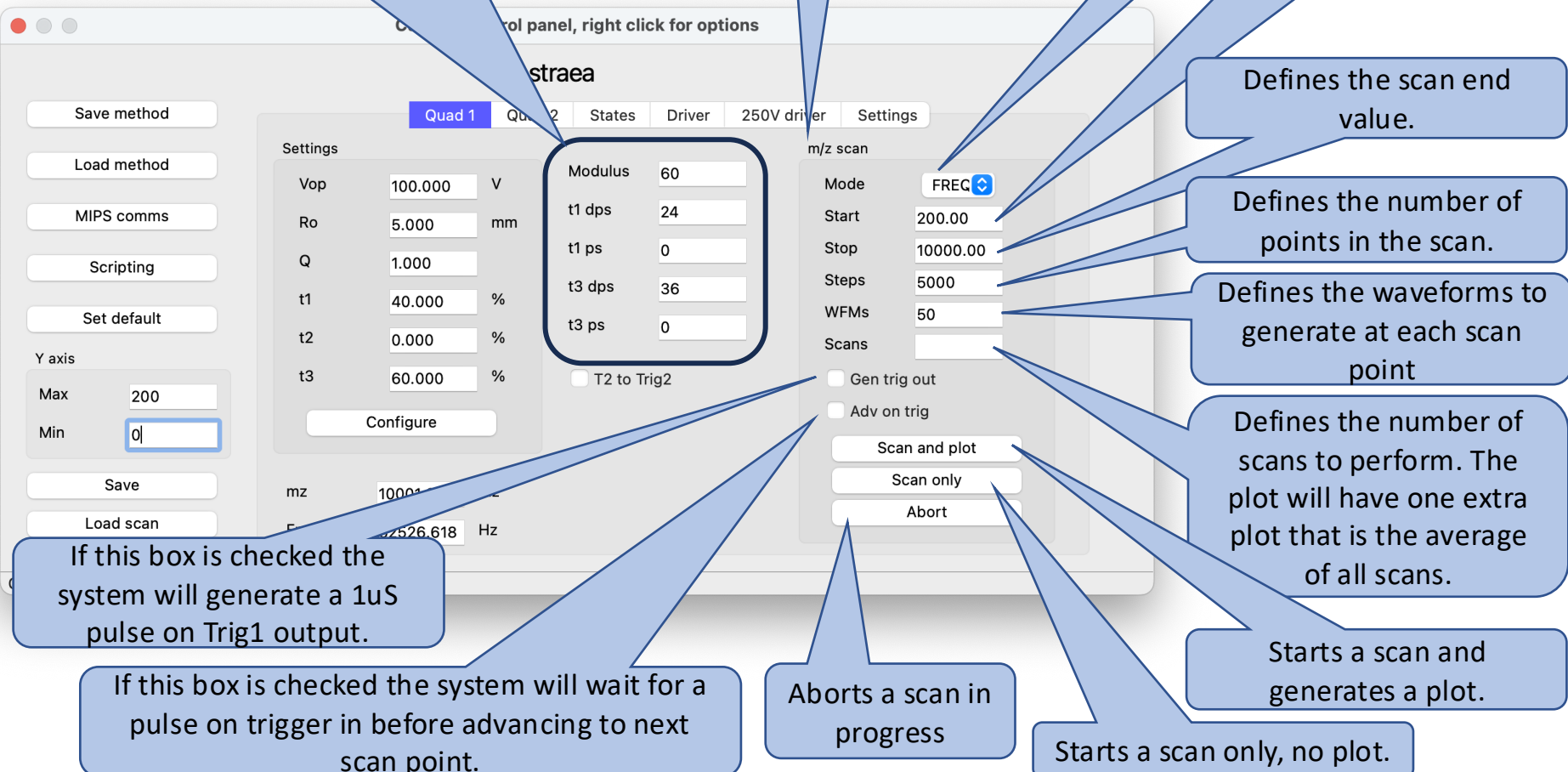
Starts a scan and generates a plot.

Starts a scan only, no plot.

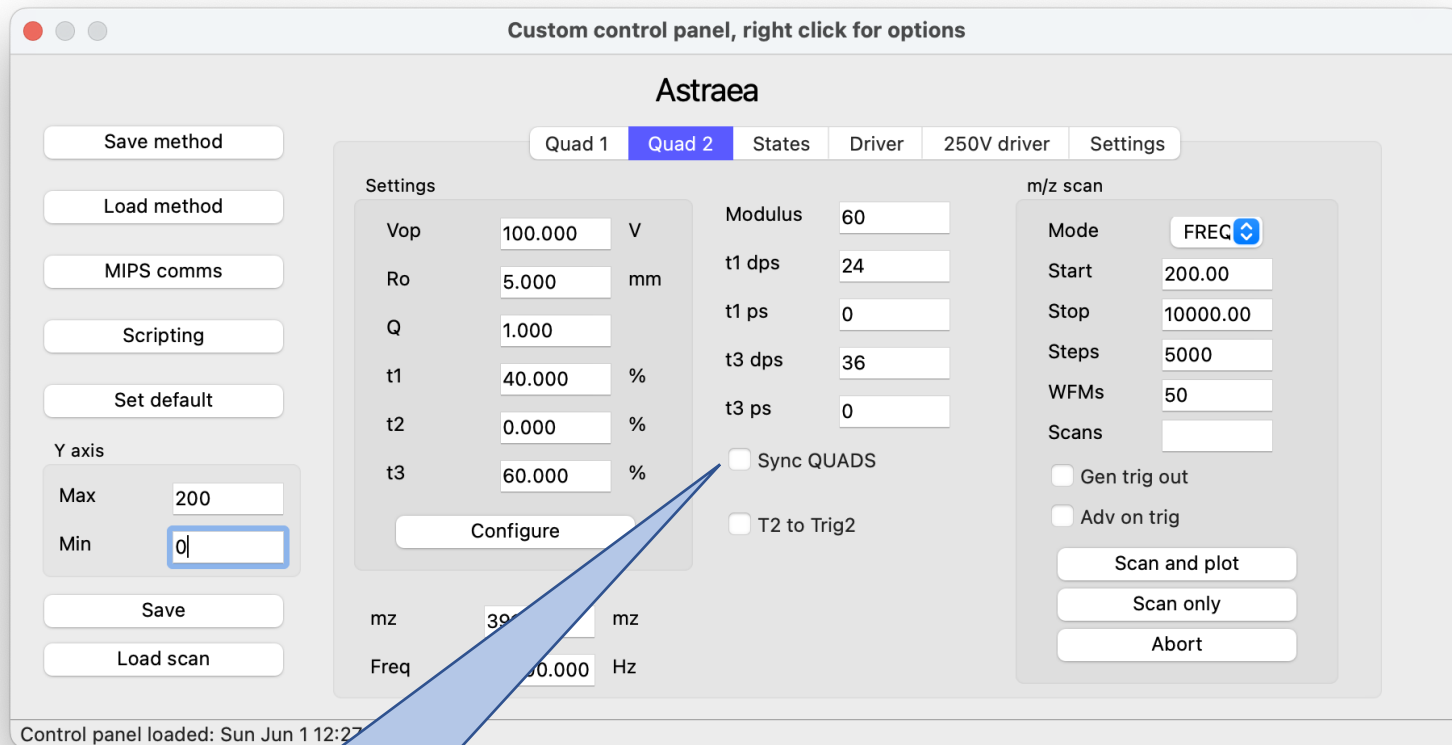
Aborts a scan in progress

If this box is checked the system will generate a 1uS pulse on Trig1 output.

If this box is checked the system will wait for a pulse on trigger in before advancing to next scan point.



Astraea QUAD 2 User Interface Parameters



The Quad 2 interface is identical to Quad 1 with the addition of this Sync QUADS checkbox. If checked the two Quads will run at the same frequency and will be kept in sync with each other.

Astraea Agility Capability

- Agility refers to Astraea's ability to rapidly change waveform settings. This is done by defining states for each waveform configuration and then defining a state transition order.
- Scanning can also be performed using the agility capability.
- The following pages describe how to define states, transition tables and perform scanning.

The States tab allows you to define a set of Quad states and to then define a sequence that you would like to execute these states. The states can be defined for Quad 1 or Quad 2, the quad states are named lower case a thru z. The Sequence string defines the order of state execution.

Each quad state will stop the execution of the sequence until the state has completed the number of defined waveforms.

There are a number of additional Sequence commands that support synchronizing with external systems and scanning. A full list of options are defined on the following pages.

Define the state name, a thru z, lower case.

Enter a state Name and press Read to display the state's parameters.

Enter a state Name and all parameters then press Write to save the state.

Define the Quad you wish to use for this state.

Selected Quad Q.

Selected Quad t1, in percent.

Selected Quad t3, in percent.

Selected Quad number of waveforms to execute.

Custom control panel, right click for options

Astraea

Quad 1 Quad 2 **States** Driver 100V driver Settings

Define/Edit States

Name	Quad #	t1	t3	NumWFM	Fmult
a	1	1.000	50.000	10	0.000
q	1	1.000	50.000	10	0.000
t1	1	1.000	50.000	10	0.000
t3	1	1.000	50.000	10	0.000

Buttons: Read, Write, List, Clear all states, Use fixed m/z, Fixed m/z: 0.000

Sequence: [Wab]100

Buttons: Save, Load scan, Execute, Abort

Executing:

m/z: 1000.000

m/z scan

Start: 200.00

Stop: 10000.00

Steps: 5000

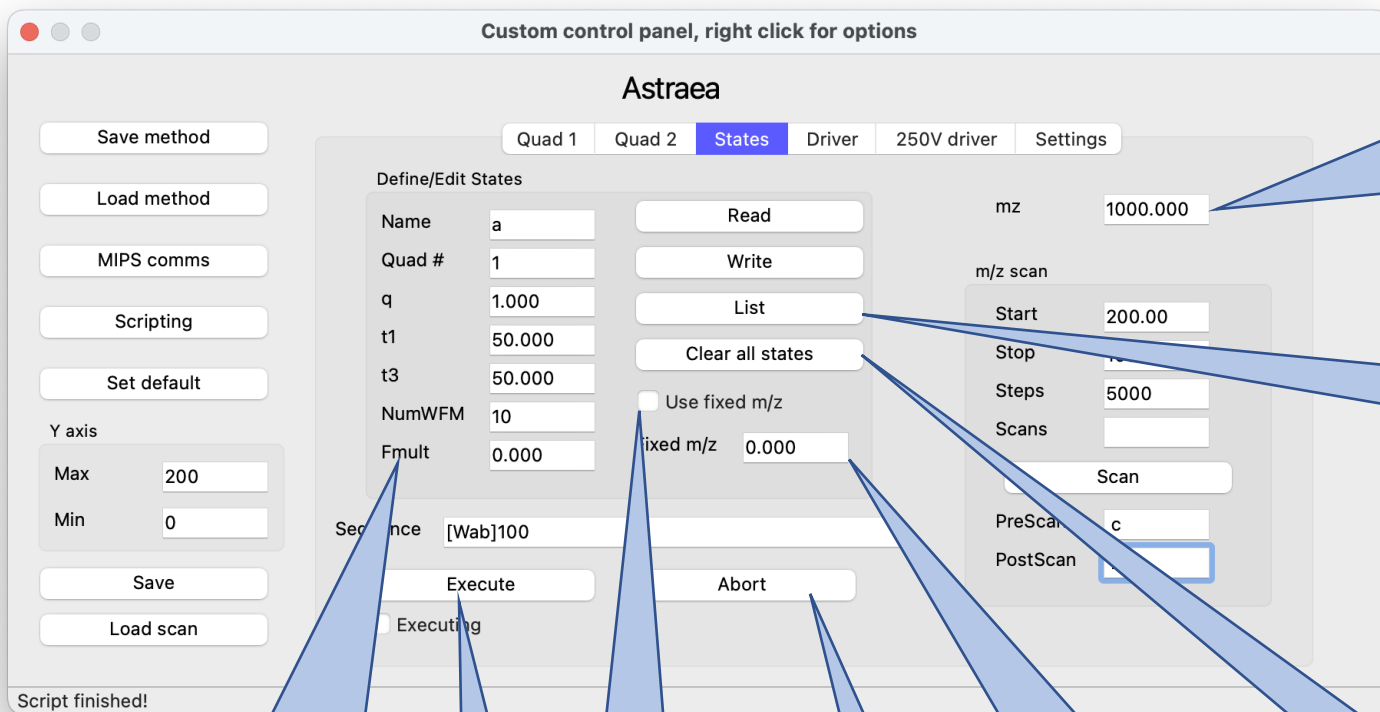
Scans: []

Scan: []

PreScan: c

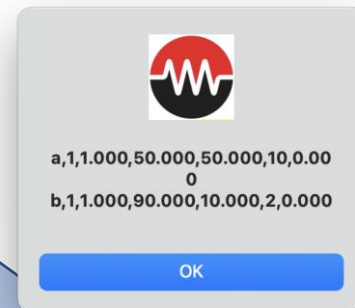
PostScan: z

Script finished!



This m/z value will define the m/z used in all the states. When you change this value the system will update all the states.

List will pop up a dialog showing all the currently defined states



Clear will delete all the states.

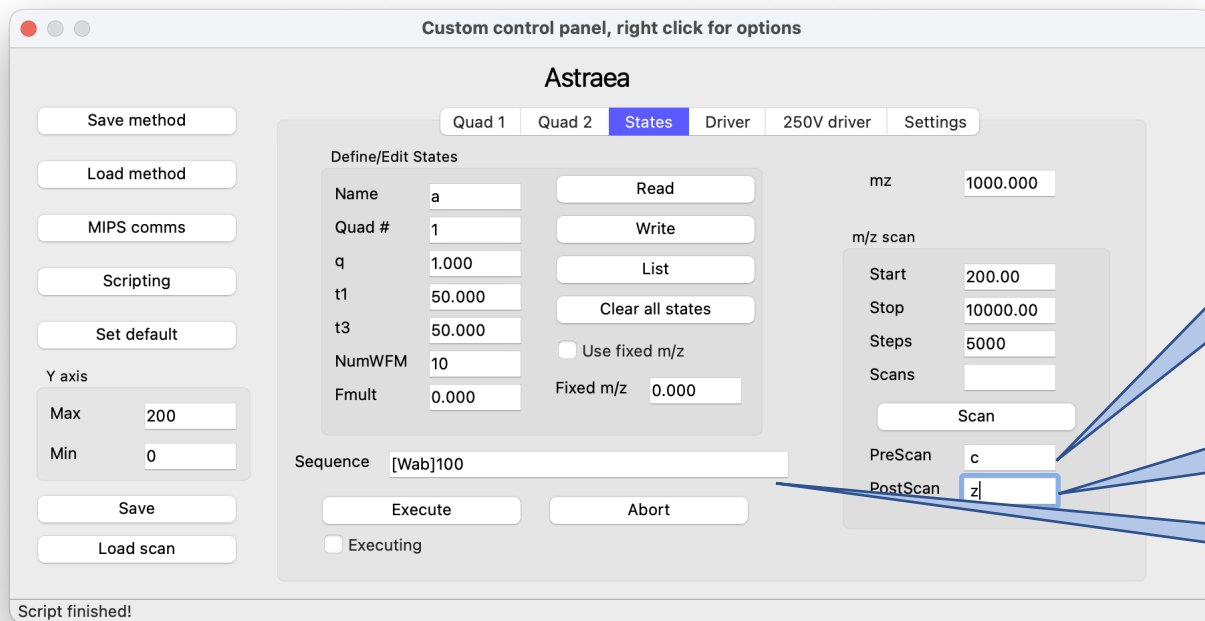
When this value is non 0 then the multiplier is applied to the calculated frequency.

When check this state will use a fixed m/z value

This is the fixed m/z value that is used when the checkbox is selected.

Execute will start the sequence table. The Executing check box will tell you if the system is executing a sequence.

Abort will stop a sequence that is in progress.



User defined state sequence table that is executed one time when the Scan button is pressed before the m/z scanning starts.

User defined state sequence table that is executed after a m/z scan completes.

User defined state sequence table.

Valid Sequence commands:

- a thru z, these commands reference states. The system will execute the state if found and wait for the state to complete before advancing to the next command.
- Dx, delay in milliseconds where x is the number of milliseconds to delay.
- W, Stop the execution of the table and wait for a hardware trigger input to proceed.
- C, Collet data on the next state, this is used for scanning.
- R, Report the collected data and clear, this is used for scanning and sends the data to the host computer.
- Tx, generate a pulse on Trig2 for x uS.
- /, this command will set the Trig2 output high.
- \, this command will set the Trig2 output low.
- H, This command is used after R and tells the system to wait for a response from the host before proceeding with the scan point. The H command is not used in the buffered scan mode, this interface uses the buffered scan mode.
- O, disables the quad outputs, followed by 1 or 2
- E, enables the quad outputs, followed by 1 or 2
- [], parameters placed inside square brackets are repeated the number of times defined after the closing bracket, for example [acb]10 will execute the states abc and repeat for a total of 10 cycles.
- All commands (except []) can be followed by a value, this value is 1 if not defined. In the case of the States this value is a repeat count. So a is the same as a1, and a2 is the same as entering aa.

The screenshot shows the 'Astraea' software interface with the 'States' tab selected. The interface includes a 'Define/Edit States' section with fields for Name (a), Quad # (1), q (1.000), t1 (50.000), t3 (50.000), NumWFM (10), and Fmult (0.000). There are also buttons for Read, Write, List, and Clear all states. A 'Sequence' field contains '[Wab]100'. The 'm/z scan' section has fields for Start (200.00), Stop (10000.00), Steps (5000), Scans, PreScan (c), and PostScan (z). Callout boxes provide explanations for these fields.

Options in this section support scanning using the state system.

Defines the starting m/z.

Defines the ending m/z.

Defines the number of points in the scan.

Defines the number of scans to perform. The plot will have one extra plot that is the average of all scans.

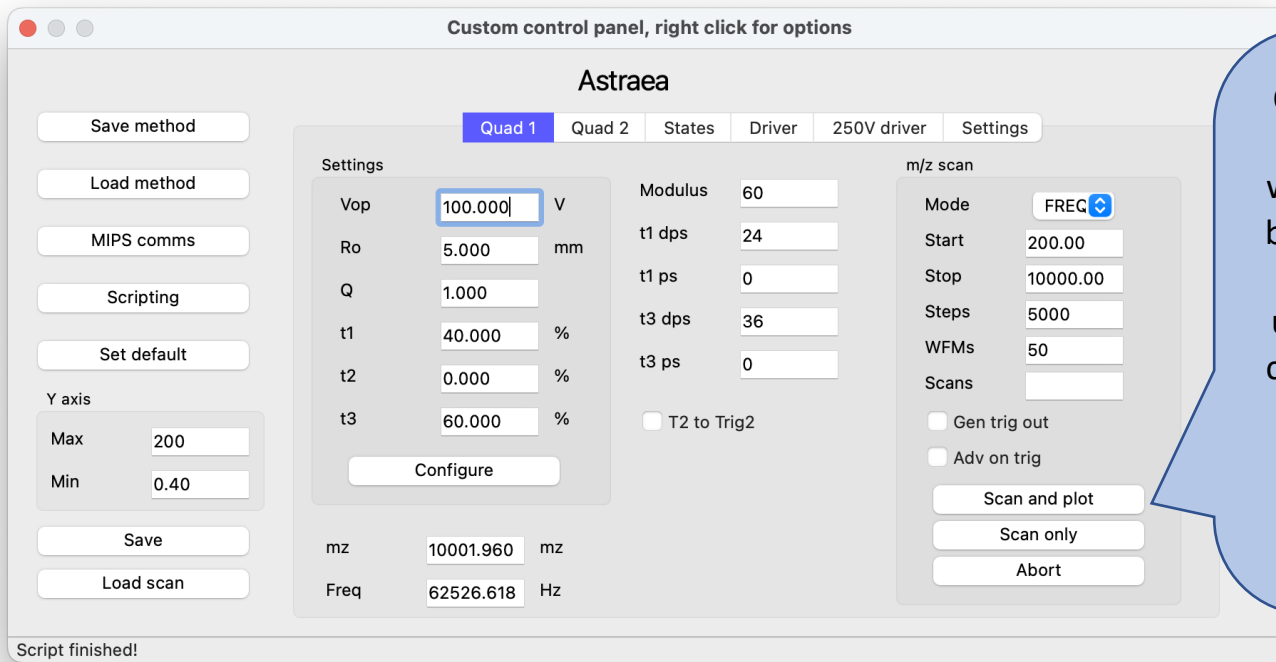
Starts a scan.

A few notes about state based scanning:

- When the Scan button is pressed the system will execute the state table at each scan m/z point from Start to Stop.
- The sequency should have a C command at the state or states where you wish to collect data and a RH at the end of the sequence to report the results to the host computer.
- In the example shown state b is executed and then data is collected during state a and reported at the end of the sequency.
- Sequences can be a lot more complex and can include repeat loops, for example lets assume you have states t for trap, f for filter and r for release. The following sequency, [tCr]10RH will execute the trap state then the filter state and collect data during the release state and repeat this process for a total of 10 cycles then report the results.

Scanning and Plotting

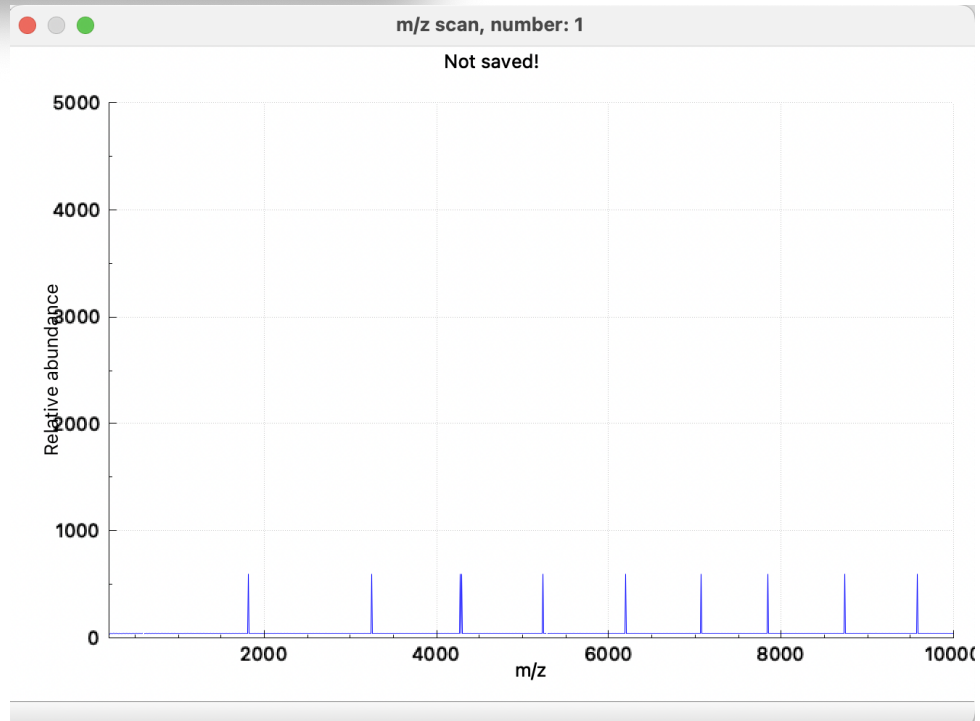
- The following pages describe scanning and plotting details that are common to the Quad and States based scanning capability.

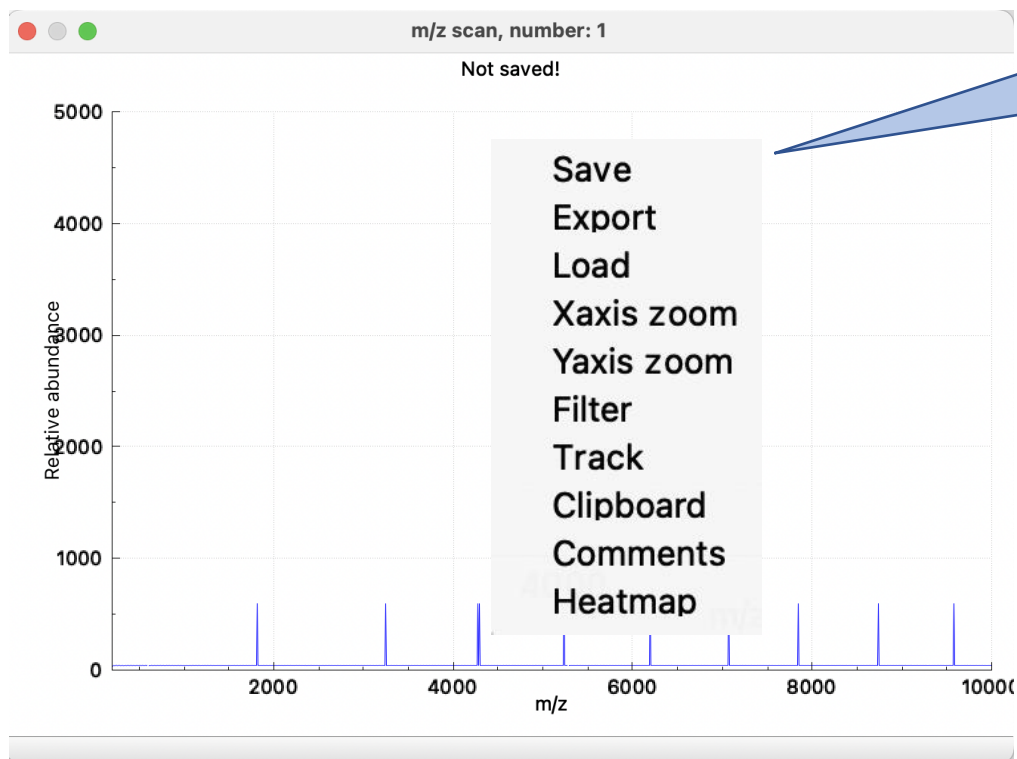


The Scan options for both Quads and for the State-based scanning behave in a similar way. After the parameters have been set and the Scan button is pressed, a plot dialog will pop up and display the scan after it completes. If you have selected multiple scans, then all the scans can be seen in the plot dialog, and the final scan will be the average of all the individual scans.

This area will display the scan progress as the data is collected.

Note; While the system is scanning do not interact with the user interface. The scanning will fail and message saying "Expected response" will be displayed if the scanning processes is interrupted.





When the scanning has completed if you right click on the plot area you will see a popup menu appear with a number of options.

A single plot dialog can contain several scans, the header of dialog will show the current scan displayed. Use the up down and right left area to move from scan to scan.

If you have multiple scans the last scan will be the average of all scans collected.

Save, allows you to save the plot to a file.

Export, generates a CSV files that can be loaded into excel.

Load, allows loading a previously saved plot file.

Xaxis zoom, enables zooming on the X axis using the mouse.

Yaxis zoom, , enables zooming on the Y axis using the mouse.

Filter, allows you to apply a Savizky-Golay filter to the recorded data.

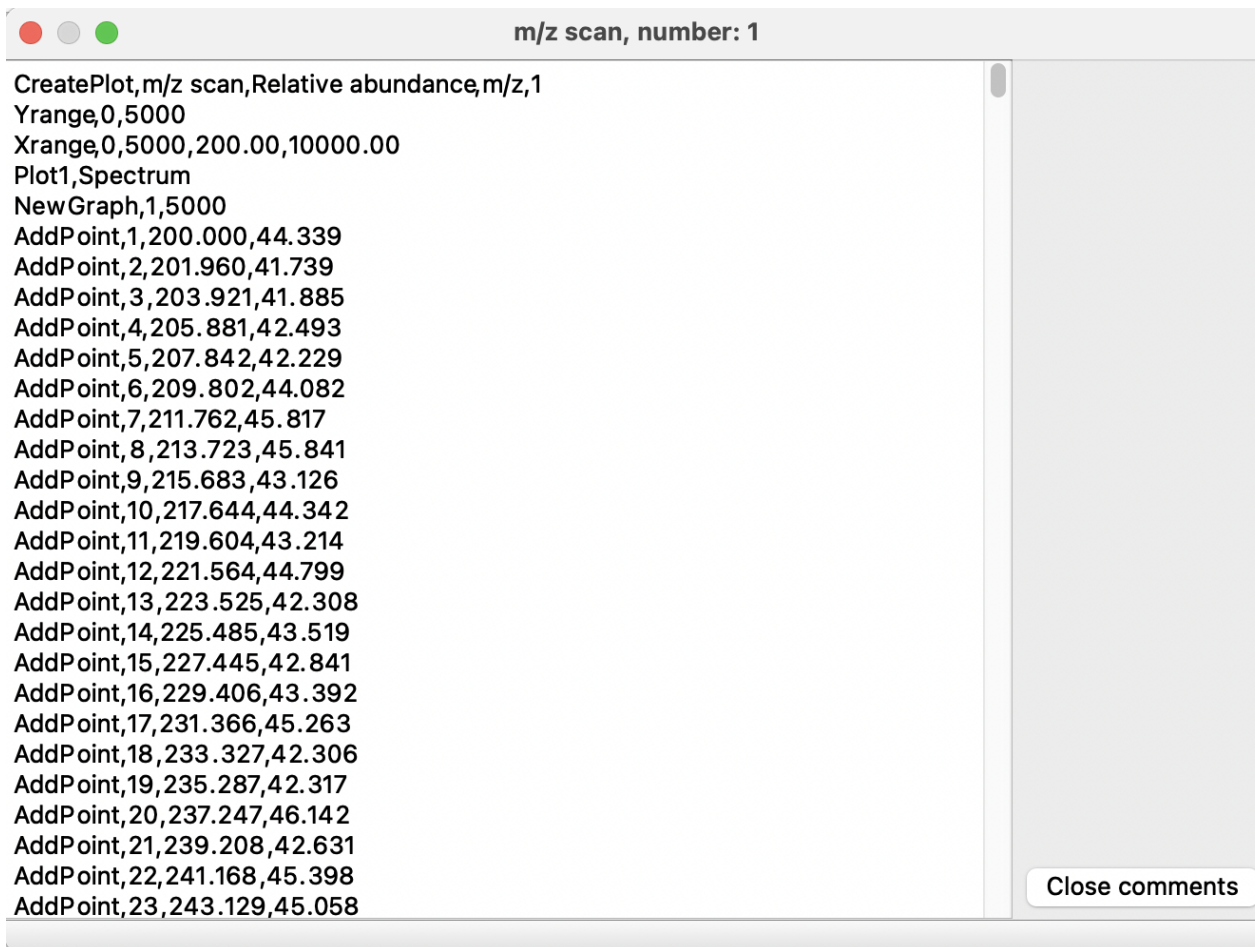
Track, This will turn on cursor tracking and display the X,Y position of the cursor.

Clipboard, copies the plot to the system clipboard.

Comments, displays the data in the plot comments are allows you to enter comments.

Heatmap, Displays the data in the plot as a heatmap, useful for visualizing multiple scans.

Below you will see the plot dialog after the Show comments option has been selected. The data that is plotted is defined by comments as you can see below. This data can be copied and pasted into tools like Excel for additional processing.



```
CreatePlot,m/z scan,Relative abundance,m/z,1
Yrange,0,5000
Xrange,0,5000,200.00,10000.00
Plot1,Spectrum
NewGraph,1,5000
AddPoint,1,200.000,44.339
AddPoint,2,201.960,41.739
AddPoint,3,203.921,41.885
AddPoint,4,205.881,42.493
AddPoint,5,207.842,42.229
AddPoint,6,209.802,44.082
AddPoint,7,211.762,45.817
AddPoint,8,213.723,45.841
AddPoint,9,215.683,43.126
AddPoint,10,217.644,44.342
AddPoint,11,219.604,43.214
AddPoint,12,221.564,44.799
AddPoint,13,223.525,42.308
AddPoint,14,225.485,43.519
AddPoint,15,227.445,42.841
AddPoint,16,229.406,43.392
AddPoint,17,231.366,45.263
AddPoint,18,233.327,42.306
AddPoint,19,235.287,42.317
AddPoint,20,237.247,46.142
AddPoint,21,239.208,42.631
AddPoint,22,241.168,45.398
AddPoint,23,243.129,45.058
```

Close comments

QUAD Driver

- The QUAD drive is optional, not every system has this driver installed.
- The QUAD driver is connected to the QUAD 1 pole outputs.
- Adjusting the Driver voltage does not automatically update the QUAD 1 Vop value.
- Keep the BNC cables from the QUAD driver to your system as short as possible. Typical coax cable is 30pF a foot so just a couple feet is equal to the QUAD.
- The driver can be floated and you will find a BNC shorting cap installed on the float input. If you are not using the float keep the BNC shorting cap installed.
- Start with low voltage, 25 volts for example, to make sure everything is working.

QUAD Driver Interface

Enter the base to peak voltage you wish to use. Note; setting this value does not update the Vop value for Quad 1!

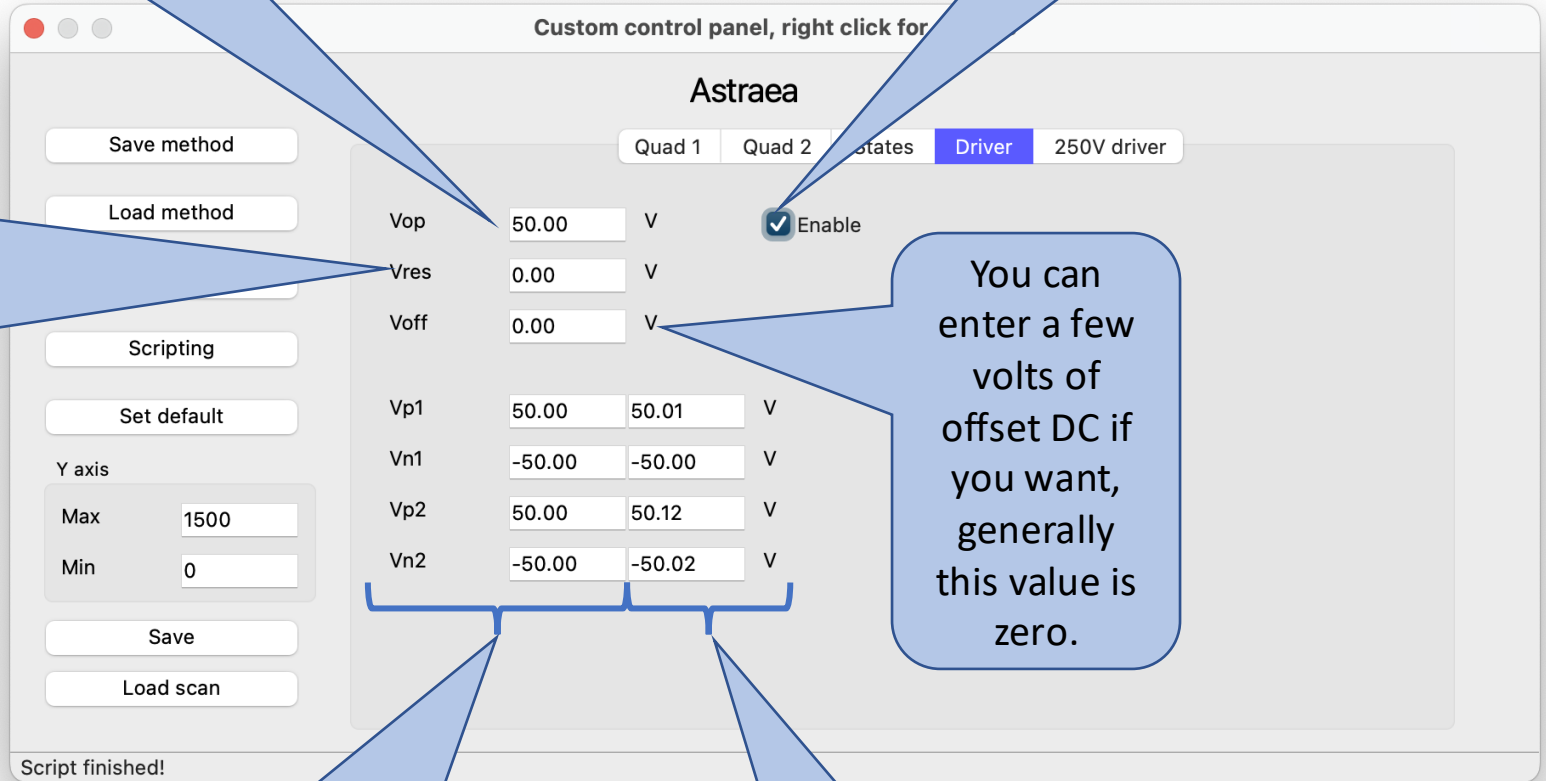
Enables the Quad outputs. This driver is connected to Quad 1

You can enter a few volts of resolving DC if you want, generally this value is zero.

You can enter a few volts of offset DC if you want, generally this value is zero.

You can also set the pole voltages, both the high and low value. Setting Vop will automatically set these values.

Output voltage readback values.



250V Quad Driver

The 250V Quad driver is a separate instrument that this interface supports. The 250V driver's interface and functions are very similar to the built-in 100V driver. The 250V driver has a maximum output voltage of 250V zero to peak or 500V peak to peak on each output. The user can set the output values using this interface. The 250V driver must be connected to the Astraea using SMA connectors. The 250V driver can be connected to the A or B Quad outputs from the Astraea.

250V Quad Driver Features

- User definable output voltage
- User definable resolving DC voltage
- User definable offset voltage
- Independent control of each poles positive and negative supply
- Fault monitoring and shutdown, power limit monitoring and supply readback testing
- Programmable power limits
- USB interface
- 24VDC wall power supply

250V Driver Interface

Enter the base to peak voltage you wish to use. Note; setting this value does not update the Vop value for Quad 1!

You can enter a few volts of resolving DC if you want, generally this value is zero.

You can enter a few volts of offset DC if you want, generally this value is zero.

You can also set the pole voltages, both the high and low value. Setting Vop will automatically set these values.

Output voltage readback values.

Enables the Quad outputs.

Enables the internal +/-250V power supply.

Displays the last fault condition.

Monitors internal supply voltages and power draw of the internal +/-250V supply.

The screenshot shows a software interface titled "Astraea" with a "250V driver" tab selected. The interface includes several sections:

- Control Panel (Left):** Contains buttons for "Save method", "Load method", "Scripting", "Set def", "Y", "Min", "Save", and "Load scan".
- Parameters (Center):** A list of voltage and power settings:
 - Vop: 20.00 V
 - Vres: 0.00 V
 - Voff: 0.00 V
 - Vp1: 20.00 V, 19.94 V
 - Vn1: -20.00 V, -19.98 V
 - Vp2: 20.00 V, 19.99 V
 - Vn2: -20.00 V, -20.03 V
- Enable/Disable (Center):** Checkboxes for "Enable" and "HV enable", both of which are checked.
- Supply Monitor (Right):** A table showing internal supply voltages and power draw:

Supply	23.99	V
12V	11.97	V
5V	5.00	V
3.3V	3.30	V
Power	0.70	W
- Other Elements:** A "Last fault" button and a status bar at the bottom that says "Script finished!".

Settings tab

Custom control panel, right click for options

Astraea

Quad 1 Quad 2 States Driver 250V driver Settings

Load method

MIPS comms

Scripting

Set default

Y axis

Max 200

Min 0.40

Save

Load scan

Script finished!

Quad 1 modulus

Max 60

Min 20

Quad 2 modulus

Max 60

Min 20

PHmagin 200

Ask for scope comment

Use correction factor

C factor

Sync with complete

Minimum and maximum modulus limit for Quad 1

Minimum and maximum modulus limit for Quad 2

DDS phase margin

If checked the user will be asked for a comment to add to the plot file header.

If checked a calibration correction factor will be applied to the plot.

This is the correction factor, this is a multiplier applied to the X axis values.

If checked the current state will finish before processing external events.