



Frequency Response Analyzer

Moku:Go User Manual

The Moku:Go Frequency Response Analyzer can be used to measure a system's frequency response from 10 mHz up to 30 MHz.

Frequency response analyzers are commonly used to measure the transfer functions of electrical, mechanical, or optical systems by injecting a swept sine wave into the system and comparing the output voltage to the input voltage. The resulting measurements of the system's magnitude and phase response can help to optimize the closed-loop response of control systems, characterize resonant behavior in non-linear systems, design filters, or measure the bandwidth of different electronic components. The Frequency Response Analyzer is an indispensable tool in any electronics lab.





Table of contents

User interface	4
Main menu	5
Export data	6
Signal display navigation	7
Signal display position	7
Display scale and zoom	7
Auto scale	7
Settings	8
Channels	9
Math channel	9
Unwrap phase	9
Swept sine	10
Sweep points	10
Sweep scale	10
Averaging	11
Settling time	11
Advanced	12
Dynamic amplitude	12
Normalization	14
Sweep modes	15
Single	15
Continuous	15
Pause / restart	15
Cursors	16
User interface	16
Frequency cursor	17
Tracking cursor	18
Magnitude/phase cursor	19
Additional tools	20
File manager	20
File converter	21
Power Supply	22

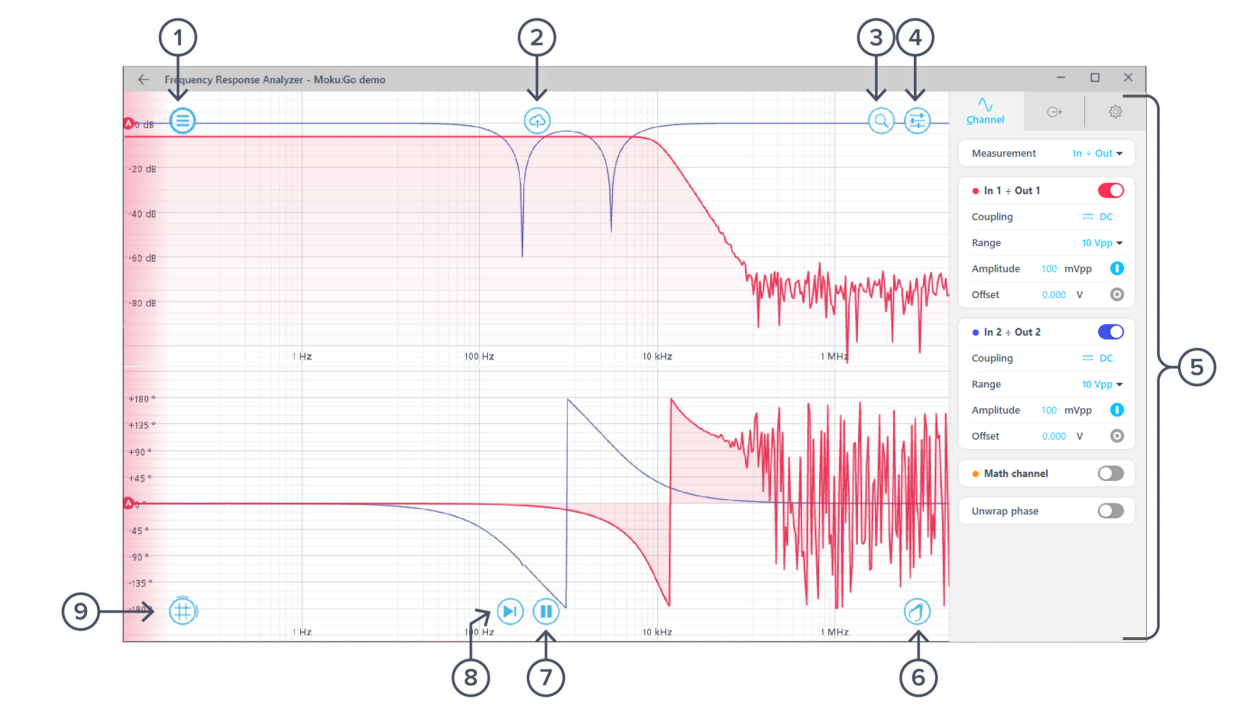


Ensure Moku:Go is fully updated. For the latest information:

liquidinstruments.com



User interface



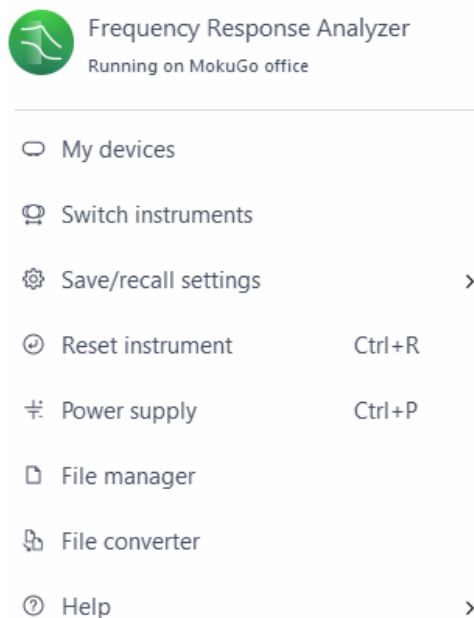
ID	Description	ID	Description
1	Main menu	6	Normalization*
2	Export data	7	Start / pause sweep*
3	Signal display navigation	8	Single / continuous mode switch*
4	Settings	9	Cursors
5	Control pane		

*Find detailed information in the Sweep mode section.



Main menu

The **main menu** can be accessed by clicking the  icon on the top-left corner.



This menu provides the following options:

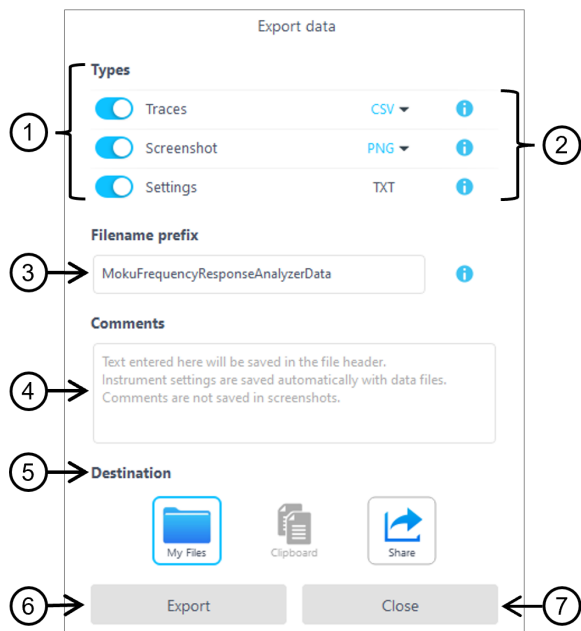
Options	Shortcuts	Description
Save/recall settings:		
• Save instrument state	Ctrl+S	Save the current instrument settings.
• Load instrument state	Ctrl+O	Load last saved instrument settings.
• Show current state		Show the current instrument settings.
Reset instrument	Ctrl+R	Reset the instrument to its default state.
Power supply		Access power supply control window.*
File manager		Open file manager tool.
File converter		Open file converter tool.
Help		
• Liquid Instruments website		Access Liquid Instruments website.
• Shortcuts list	Ctrl+H	Show Moku:Go app shortcuts list.
• Manual	F1	Access instrument manual.
• Report an issue		Report bug to Liquid Instruments.
• About		Show app version, check update, or license information.

* Power supply is available on Moku:Go M1 and M2 models. Find detailed information about power supply in the Moku:Go power supply manual.



Export data

The **export data** options can be accessed by clicking the  icon, allowing you to:




ID Description

- | | |
|---|-------------------------------------------------------|
| 1 | Select the type of data to export. |
| 2 | Select the file format. |
| 3 | Enter a filename prefix for the saved file. |
| 4 | Enter additional comments for the saved file. |
| 5 | Select the exporting location on your local computer. |
| 6 | Click to execute data export. |
| 7 | Click to close the export data window. |




Signal display navigation

Signal display position

Move the displayed signal around the screen by clicking anywhere on the signal display window and dragging to the new position. The cursor will turn into a  icon once clicked. Drag horizontally to shift along the frequency axis and drag vertically to shift along the amplitude/power axis.

You can also move the signal display horizontally and vertically with the arrow keys.

Display scale and zoom

Scrolling the mouse wheel zooms in and out along the primary axis. Access the scroll setting by hovering the cursor over the  icon.

Icons	Description
-------	-------------



Assign the horizontal axis as the primary axis.



Assign the vertical axis as the primary axis.



Rubber band zoom: hold the primary mouse button to draw a region to zoom in, release the button to execute.

Additional keyboard combinations are also available.

Actions	Description
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Ctrl + Scroll Wheel

Zoom secondary axis.

+/-

Zoom primary axis with keyboard.

Ctrl +/-

Zoom secondary axis with keyboard.

Shift + Scroll Wheel

Zoom primary axis towards the center.

Ctrl + Shift + Scroll Wheel

Zoom secondary axis towards the center.

R

Rubber band zoom.

Auto scale

Double click anywhere on the signal display window to auto scale the traces.



Settings

The instrument control menu allows you to configure the Frequency Response Analyzer for your measurement, which will vary depending on the specific characteristics of the system under test.

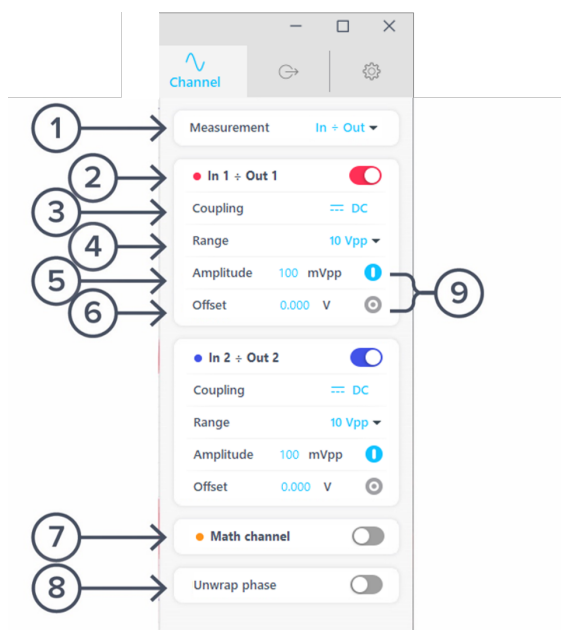
Access the instrument Control menu by clicking the  icon.



ID	Description
1	Channel
2	Swept sine
3	Advanced



Channels



ID	Description	ID	Description
1	Select to display In (dBm) or In/Out (dB)	6	Swept sine (output) offset
2	Toggle channel on/off	7	Enable/disable Math channel
3	Select AC or DC coupling	8	Unwrap/wrap phase
4	Select input range 10 Vpp or 50 Vpp	9	Turn on/off amplitude and/or offset
5	Swept sine (output) amplitude		

Math channel

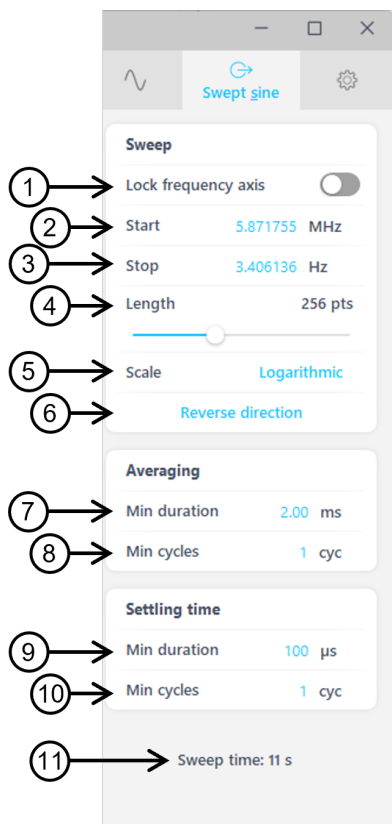
- Select between addition, subtraction, multiplication, and division of the two channels.
- Additionally, you can create arbitrary complex-valued equations of the two channels.
- Compare transfer functions of channel 1 and 2 by configuring them identically.

Unwrap phase

- Phase is measured as a modulo of 2π . Enabling unwrapping will display an estimate of the total accumulated phase of the system.



Swept sine



ID	Description	ID	Description
1	Lock frequency axis	7	Configure the minimum averaging time
2	Configure the sweep start frequency	8	Configure the minimum averaging cycles
3	Configure the sweep stop frequency	9	Configure the minimum settling time
4	Select the number of sweep point	10	Configure the minimum settling cycles
5	Select Linear or Log scale	11	Total sweep time based on selected parameters
6	Reverse sweep direction		

Sweep points

- Increasing the number of points in the sweep increases frequency resolution of the measurement, allowing the detection of narrower features over a wider frequency range but will increase the total measurement duration.

Sweep scale

- The discrete points in the swept sine output can be spaced linearly or logarithmically. Logarithmic sweeps provide greater measurement resolution at lower frequencies.



Averaging

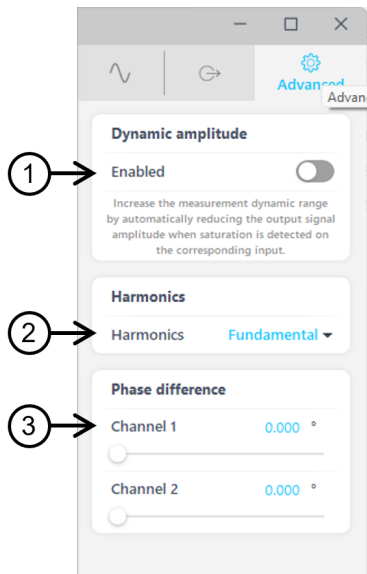
- Measurements at each point in the frequency sweep are averaged to improve accuracy and precision. You can configure the period over which each measurement is averaged to control the signal-to-noise ratio (SNR). Longer averaging times result in higher SNRs, allowing the detection of small features with greater precision. Shorter averaging times result in lower SNR measurements with reduced total sweep time.
- The total averaging time is determined based on the **minimum duration** and **minimum number of cycles** over which each point in the sweep is averaged. The Moku:Go Frequency Response Analyzer averages for the greater of the two values rounded up to the nearest number of integer cycles in order to avoid spectral leakage.

Settling time

- The settling time determines how long the Frequency Response Analyzer waits before performing measurements at each frequency in the sweep. Settling time is important when characterizing resonant systems with high Q-factors in order to allow excitations to ‘settle’ between measurements. It can help to account for transmission delays in cables. When measuring a non-resonant system, set the settling time to equal the total propagation delay through the system.
- The total settling time is determined based on the **minimum duration** and **minimum number of cycles** over which the instrument will wait before beginning a measurement at each frequency in the sweep. The Frequency Response Analyzer will wait for the greater effective duration of the two settings before beginning a measurement at each point in the sweep.



Advanced

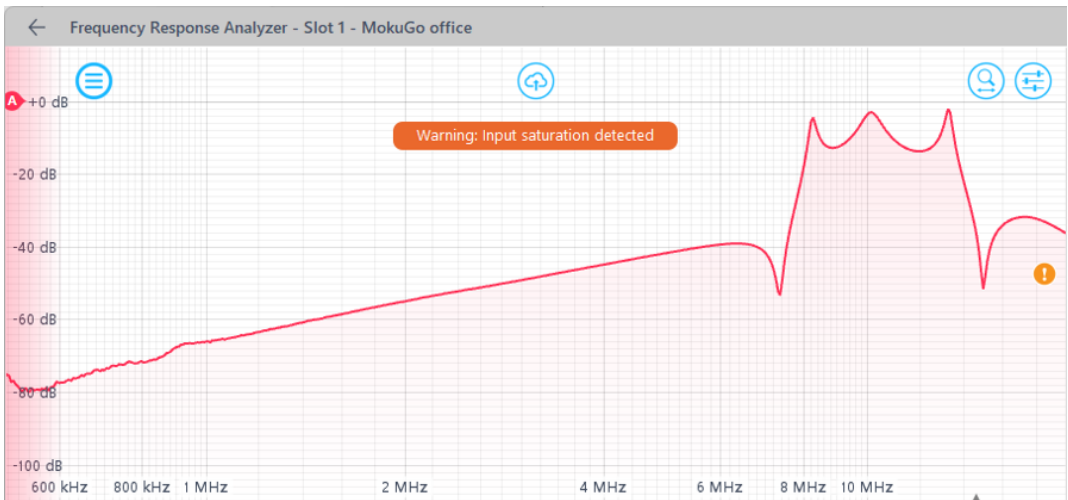


ID	Description
1	Enable/disable dynamic amplitude scaling
2	Select a harmonic to measure the frequency response of the swept sine
3	Set the phase difference between the output and local oscillator

Dynamic amplitude

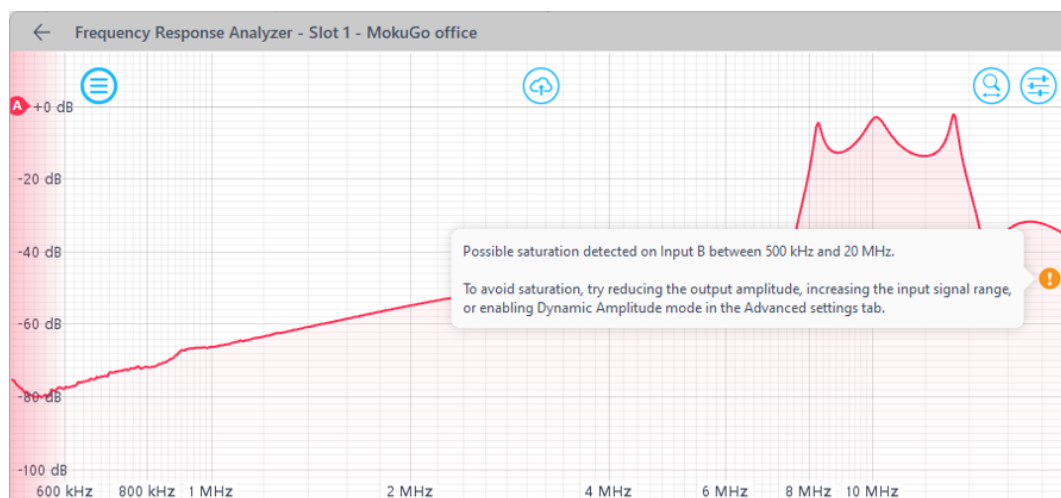
Enabling dynamic amplitude maximizes the dynamic range of the measurement by automatically reducing the output signal amplitude when Moku:Go detects saturation on the corresponding input channel. This can be very useful when measuring devices whose amplitude response varies strongly with frequency, making it difficult to measure the frequency response with high dynamic range using a constant driving source.

Additionally, the user interface provides a momentary pop-up warning when input saturation is detected.







Clicking the orange exclamation icon on the right-hand side of the graph will provide additional information regarding which frequencies are saturated and possible solutions, including enabling dynamic amplitude mode.





Normalization


The Moku:Go Frequency Response Analyzer features a Normalization  tool that can be used to normalize subsequent measurements. Normalization is useful when compensating for cable delays and comparing different devices under test.

Clicking the  icon will open the Normalization menu. **Re-normalize** will replace the current Normalization trace with a new one. **Remove Normalization** will erase all stored Normalization settings and cannot be undone.




Sweep modes



Single

Clicking the  icon will enable single sweep mode, which will pause the swept sine source at the end of the next full sweep. The swept sine signal will be turned off after the sweep completes and displayed data will not be updated.

Continuous

Clicking the  icon will enable continuous sweep mode, which will perform a new measurement as soon as the previous one has finished. This mode is commonly used to monitor systems with transfer functions that may change over time (e.g., control loops).


Pause / restart

Clicking the  icon will immediately pause the current sweep. While paused, you can zoom in on features for more details, but no new data will be captured. Pressing the  icon will also pause capture.

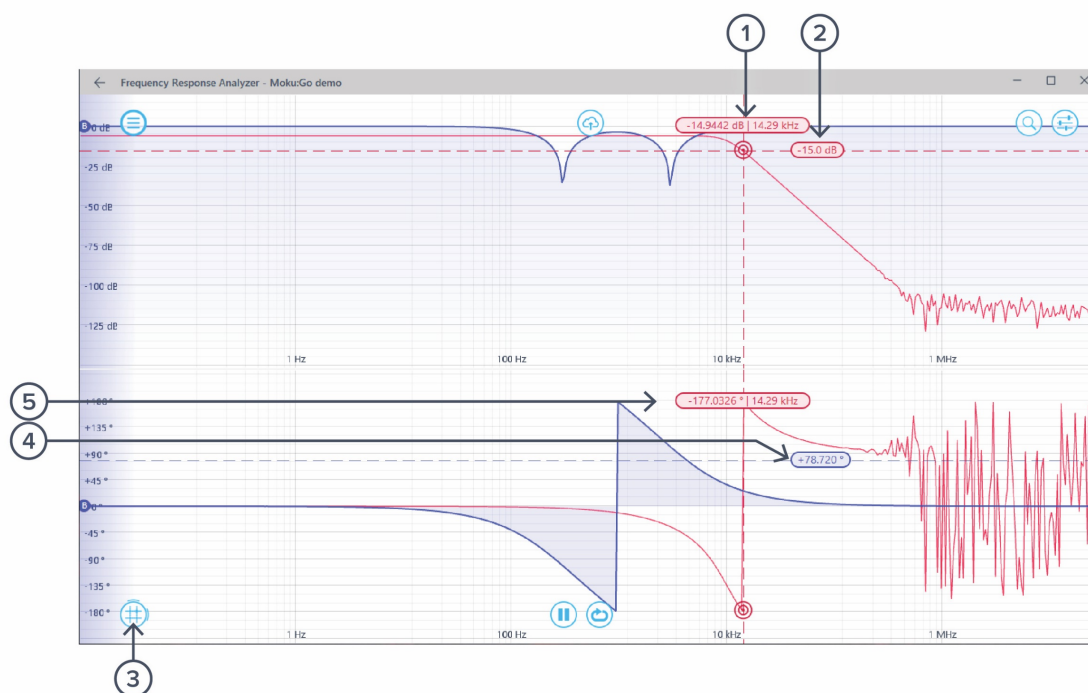
Tapping the  or  icons will restart the sweep.



Cursors

Access **cursors** by clicking the  icon, allowing you to add power or frequency cursors, or remove all cursors. In addition, you can click and hold the cursors icon and drag horizontally to add a frequency cursor, or drag vertically to add a magnitude or phase cursor.

User interface

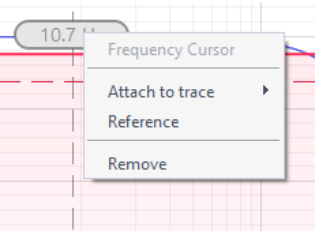


ID	Cursor item	Description
1	Frequency/tracking cursor	Drag to reposition the cursor (Gray – Unattached, Red – channel 1, Blue – channel 2, Yellow – math).
2	Amplitude cursor	Drag to reposition, right click to set magnitude manually and other options.
3	Create cursor	Cursor options.
4	Phase cursor	Drag to adjust, right click to set phase manually and other options
5	Cursor label	Label depicting frequency, magnitude, and phase of cursor. Drag to reposition.



Frequency cursor

Right-click (secondary click) to reveal frequency cursor options:

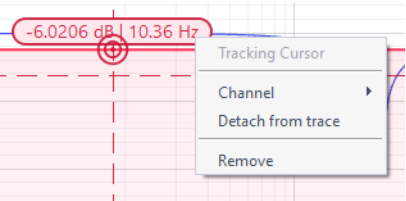


Options	Description
Frequency cursor	Cursor type.
Attach to trace	Choose to attach the frequency cursor to channel A, channel B, or the math channel. Once the cursor is attached to a channel, it becomes to a tracking cursor.
Reference	Set the cursor as the reference cursor. All other cursors in the same domain and channel measure the offset to the reference cursor.
Remove	Remove the frequency cursor



Tracking cursor

Once a frequency cursor is attached to a channel, it becomes a tracking cursor. It displays the frequency and power level of the signal at the set frequency.

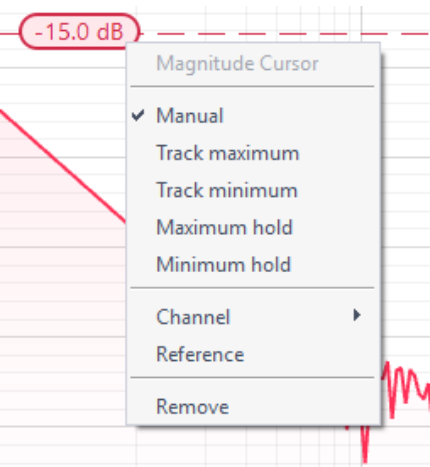


Options	Description
Tracking cursor	Cursor type.
Channel	Assign tracking cursor to a specific channel.
Detach from trace	Detach the tracking cursor from the channel to a frequency cursor.
Remove	Remove the tracking cursor.



Magnitude/phase cursor

Right-click (secondary click) to reveal power cursor options:



Options	Description
Manual	Manually set the vertical position of the cursor.
Track maximum	Track the maximum magnitude/phase.
Track minimum	Track the minimum magnitude/phase.
Maximum hold	Set the cursor to hold at the maximum magnitude/phase level.
Minimum hold	Set the cursor to hold at the minimum magnitude/phase level.
Channel	Assign the power cursor to a specific channel.
Reference	Set the cursor as the reference cursor.
Remove	Remove the magnitude/phase cursor.

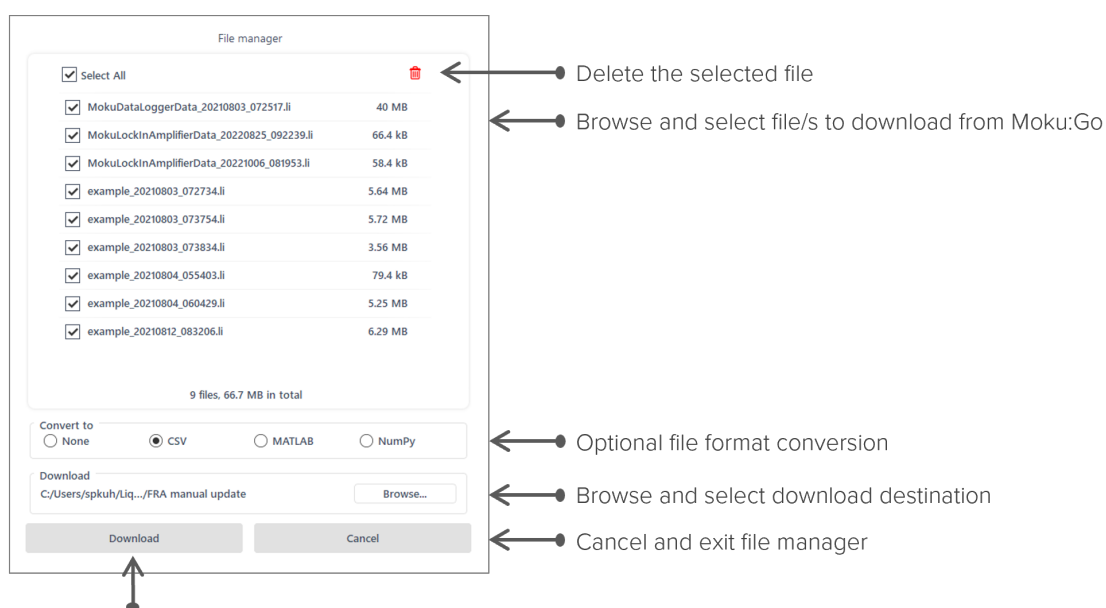


Additional tools

Moku:Go app has two built-in file management tools: file manager and file converter.

File manager

The file manager allows the user to download the saved data from Moku:Go to local computer, with optional file format conversion.

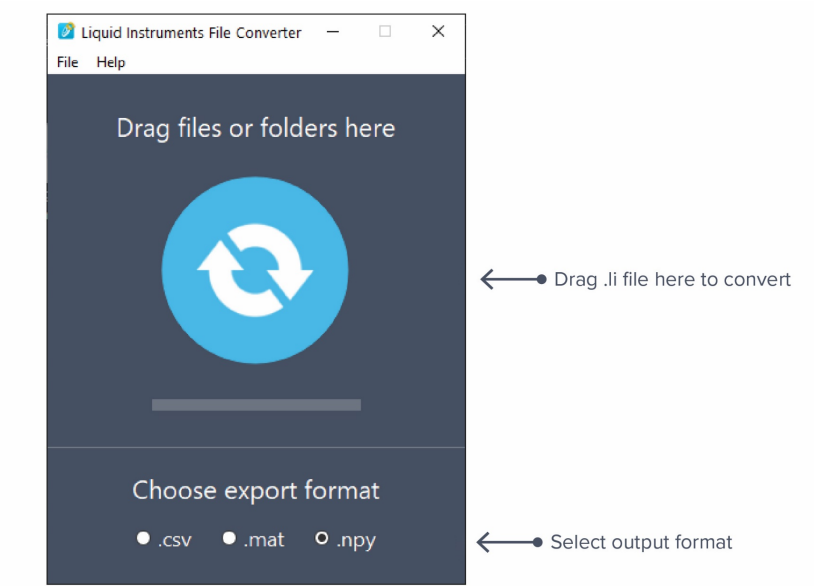


Once a file is transferred to the local computer, a  icon shows up next to the file.



File converter

The file converter converts the Moku:Go binary (.li) format on the local computer to either .csv, .mat, or .npz format.



The converted file is saved in the same folder as the original file.

Liquid Instruments File Converter has the following menu options:

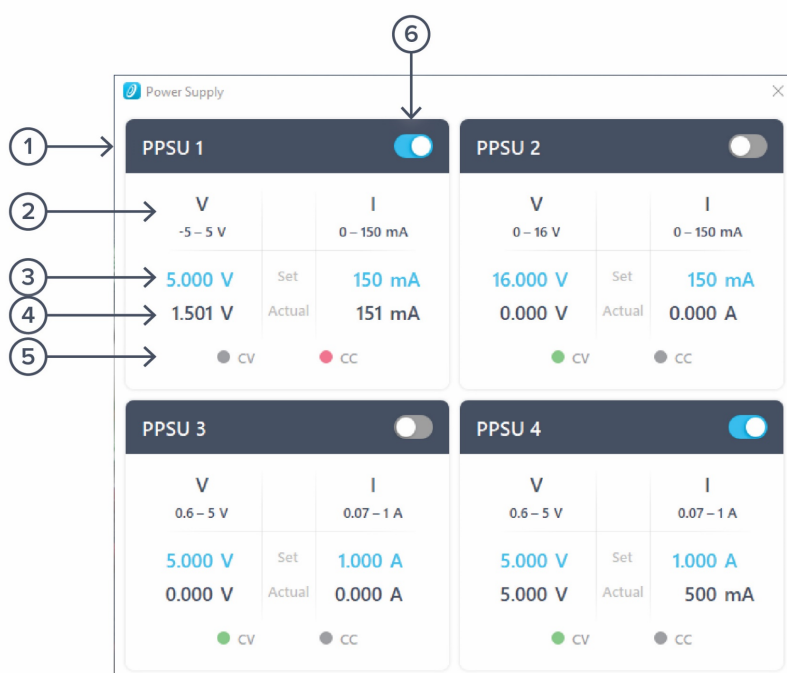
Options	Shortcut	Description
File		
• Open file	Ctrl+O	Select a .li file to convert
• Open folder	Ctrl+Shift+O	Select a folder to convert
• Exit		Close the file converter window
Help		
• Liquid Instruments website		Access Liquid Instruments website
• Report an issue		Report bug to Liquid Instruments
• About		Show app version, check update, or license information



Power Supply

Moku:Go Power Supply is available on M1 and M2 models. M1 features a 2-channel Power Supply, while M2 features a 4-channel Power Supply. Access the Power Supply control window in all instruments under the main menu.

The Power Supply operates in two modes: **constant voltage (CV)** or **constant current (CC)** mode. For each channel, the user can set a current and voltage limit for the output. Once a load is connected, the Power Supply operates either at the set current or set voltage, whichever comes first. If the Power Supply is voltage limited, it operates in the CV mode. If the Power Supply is current limited, it operates in the CC mode.



ID	Function	Description
1	Channel name	Identifies the power supply being controlled.
2	Channel range	Indicates the voltage/current range of the channel.
3	Set value	Click the blue numbers to set the voltage and current limit.
4	Readback numbers	Voltage and current readback from the power supply, the actual voltage and current being supplied to the external load.
5	Mode indicator	Indicates if the power supply is in CV (green) or CC (red) mode.
6	On/Off toggle	Click to turn the power supply on and off.



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