Frequency Response Analyzer

Moku:Pro User Manual

Moku:Pro's Frequency Response Analyzer can be used to measure a system's frequency response from 10 mHz up to 300 MHz.

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

V22-0627

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

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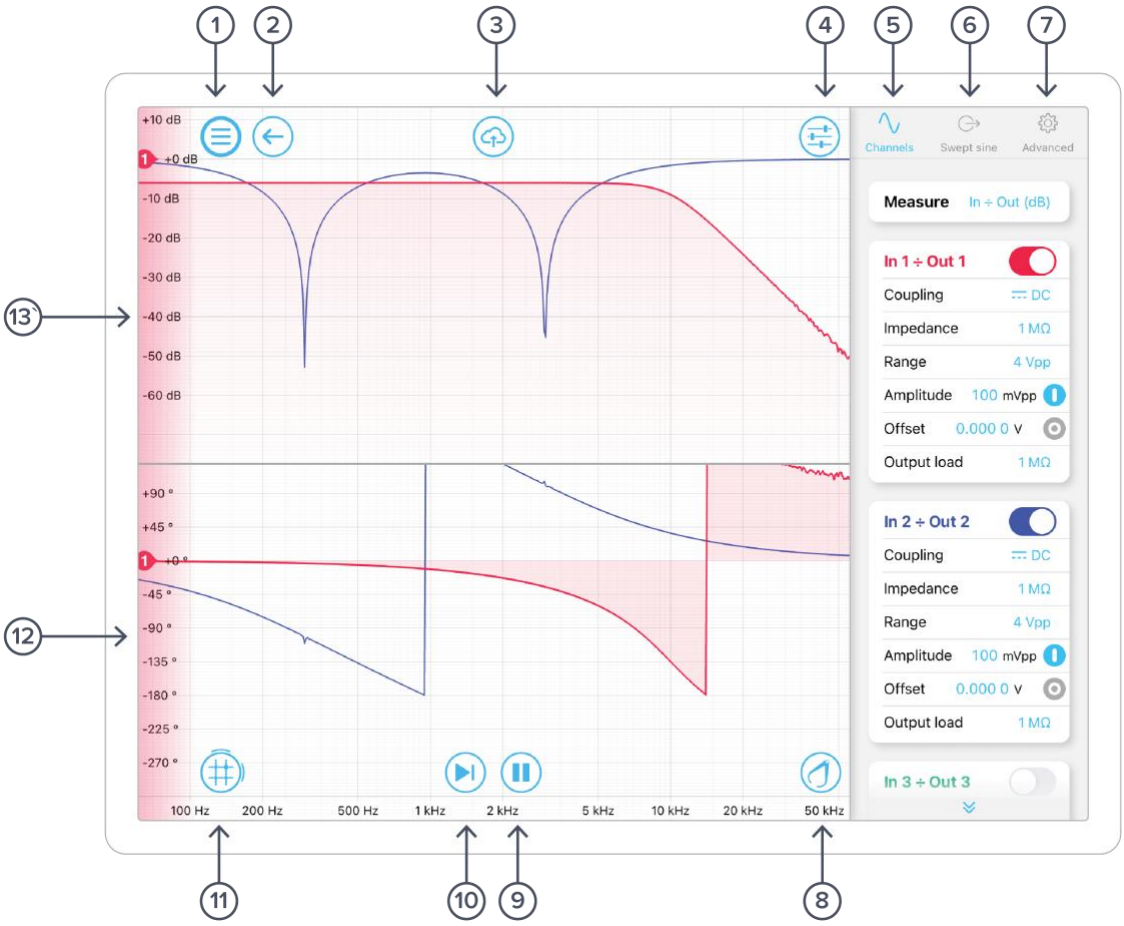
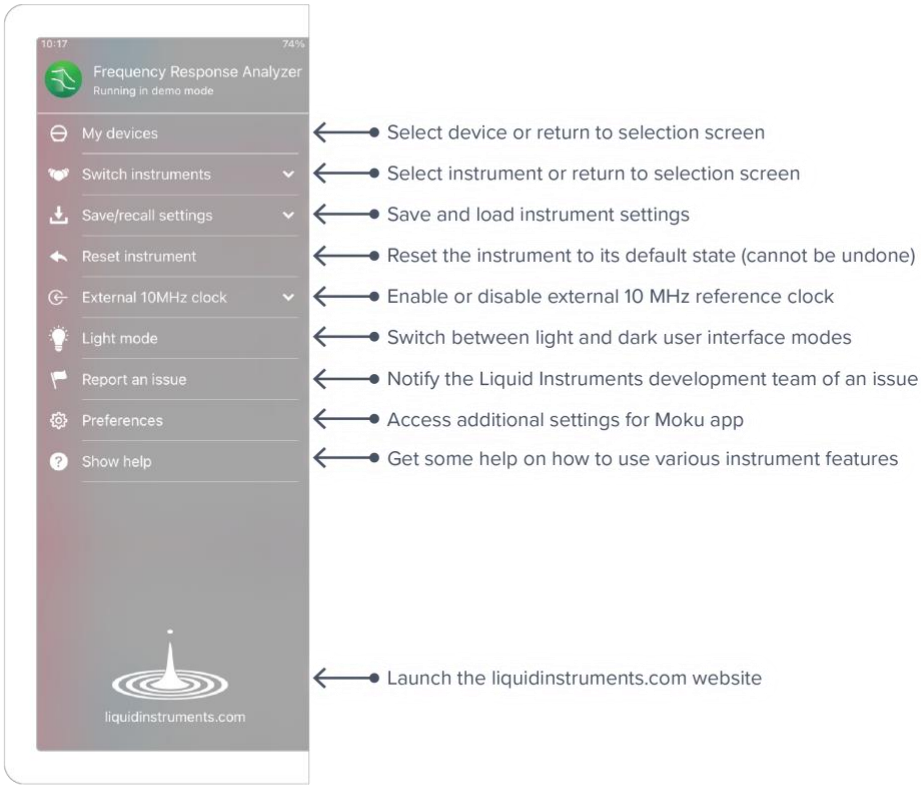
User Interface



ID	Description	ID	Description
1	Main menu	**8**	Normalization tool
2	Back to instrument selection screen	**9**	Sweep mode
3	Export data	**10**	Start / pause sweep
4	Instrument configuration menu	**11**	Cursors
5	Channel settings	**12**	Phase plot
6	Swept sine output settings	**13**	Magnitude plot
7	Advanced demodulation settings		

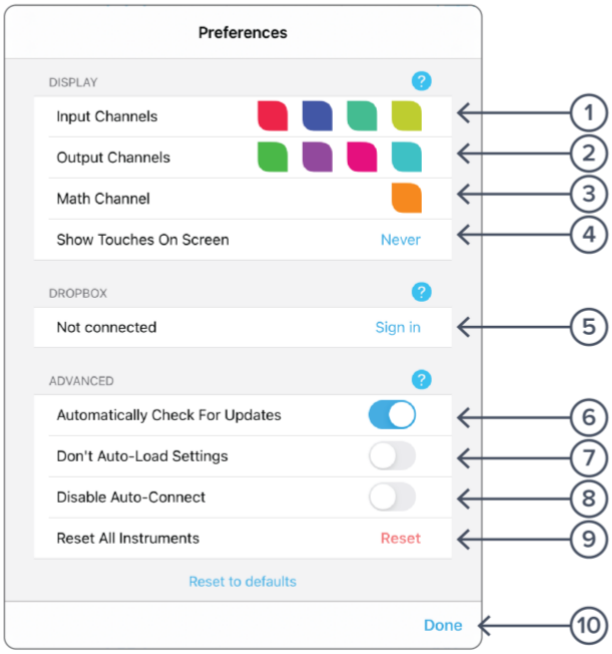
Main Menu

The **main menu** can be accessed by pressing th icon, allowing you to:



Preferences

The preferences pane can be accessed via the main menu. In here, you can reassign the color representations for each channel, connect to Dropbox, etc. Throughout the manual, the default colors (shown in the figure below) are used to present instrument features.



ID	Description
1	Tap to change the color associated with input channels.
2	Tap to change the color associated with output channels.
3	Tap to change the color associated with math channel.
4	Indicate touch points on the screen with circles. This can be useful for demonstrations.
5	Change the currently linked Dropbox account to which data can be uploaded.
6	Notify when a new version of the app is available.
7	Moku:Pro automatically saves instrument settings when exiting the app, and restores them again at launch. When disabled, all settings will be reset to defaults on launch.
8	Moku:Pro can remember the last used instrument and automatically reconnect to it at launch. When disabled, you will need to manually connect every time.
9	Reset all instruments to their default state.
10	Save and apply settings.

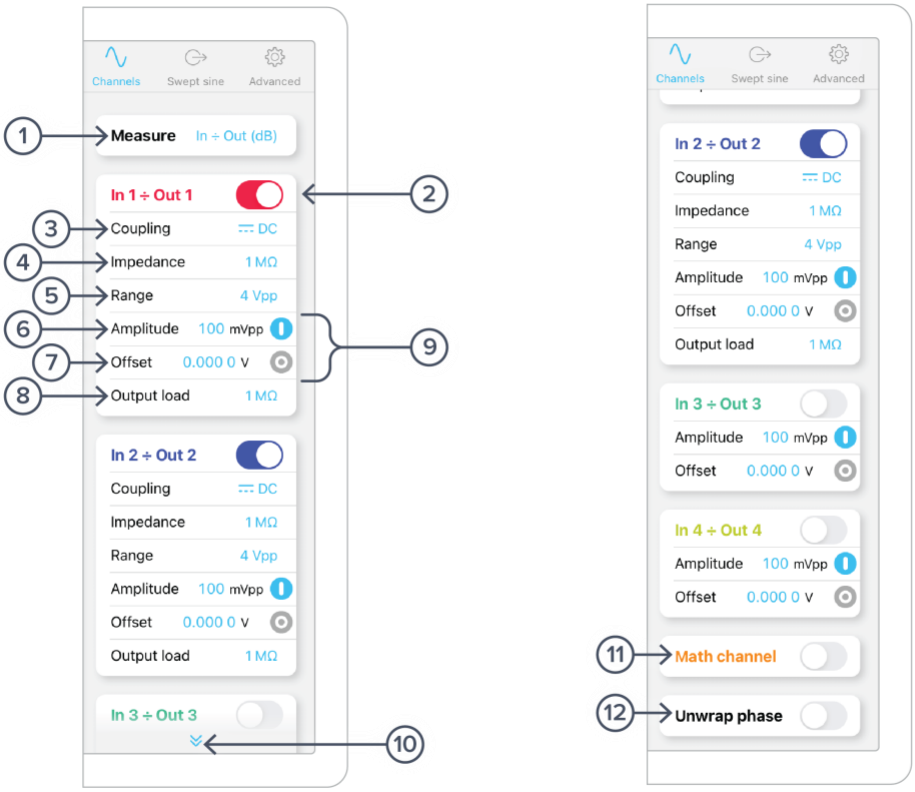
Instrument Configuration

The instrument configuration 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 configuration menu by pressing the icon.

Channels

Additional settings can be accessed by scrolling up and down.



ID	Description	ID	Description
1	Select the measurement mode	**7**	Swept sine amplitude
2	Toggle channel on/off	**8**	Swept sine offset
3	Select AC or DC coupling	**9**	Turn on/off amplitude and/or offset
4	Select 1 MΩ or 50 Ω input impedance	**10**	Access additional settings
5	Select input range 400 mV, 4 V or 40 V peak-to-peak	**11**	Enable/disable Math channel
6	Select 1 MΩ or 50 Ω output load	**12**	Unwrap/wrap phase

Measurement mode

The frequency response can be displayed in Input (dBm), In ÷ Out (dB), and In ÷ In1 (dB) mode. In the Input mode, the amplitude response is displayed as the measured power in dBm, irrespective of the output amplitude. The In ÷ Out (dB) displays the response as the input power ÷ output power in dB. The In ÷ In1 (dB) allows the user to dynamic measure the amplitude of swept sine wave via Input 1 and calculate the relative amplitude response with respect to the measured amplitude from Input 1.

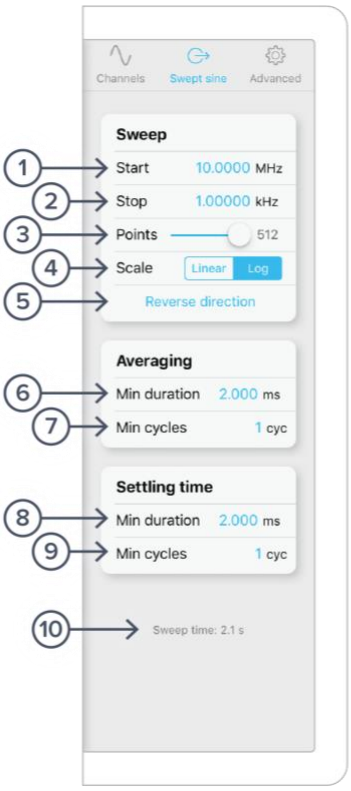
Math channel

- Select between addition, subtraction, multiplication, and division of two channels.
- Compare transfer functions of channel 1, 2, 3, and 4 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	Configure sweep start frequency	**6**	Configure minimum averaging time
2	Configure sweep stop frequency	**7**	Configure minimum averaging cycles
3	Select number of sweep points	**8**	Configure minimum settling time
4	Select Linear or Log scale	**9**	Configure minimum setting cycles
5	Reverse direction of sweep	**10**	Total sweep time based upon selected parameters

Sweep points

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

Sweep scale

- Select whether or not the discrete points in the swept sine output are spaced linearly or logarithmically. Logarithmic sweeps provide greater measurement resolution at lower frequencies.

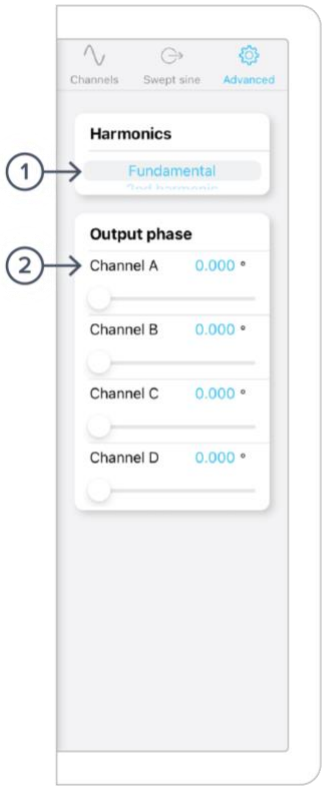
Averaging

- 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 in order to control signal-to-noise ratio. Longer averaging times result in higher SNRs, allowing small features to be detected with greater precision. Shorter averaging times result in lower SNR measurements but the reduce 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. Moku:Pro's 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 also be used to account for transmission delays in cables. When interrogating a non-resonant system, the settling time should be set 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

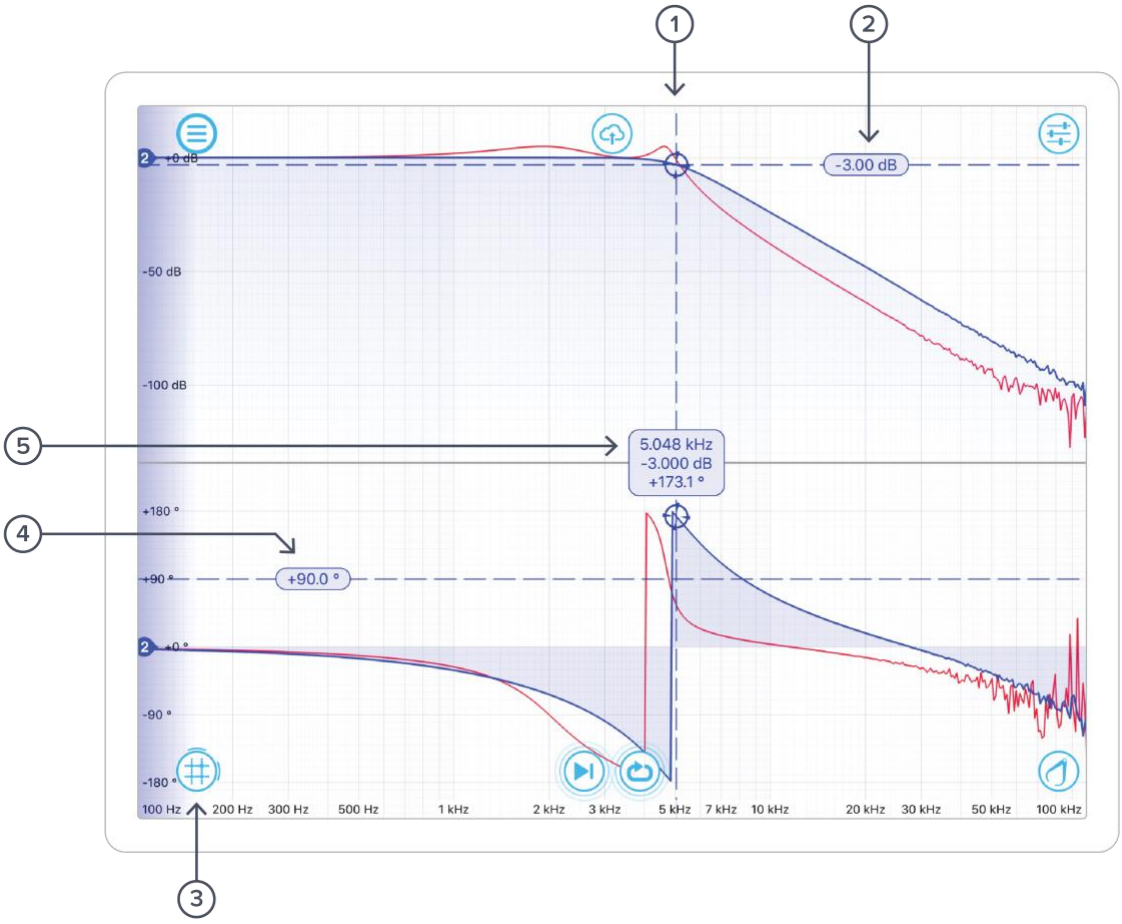


ID	Description	ID	Description
1	Select a harmonic to measure the frequency response of the swept sine	**2**	Adjust output phase for each channel

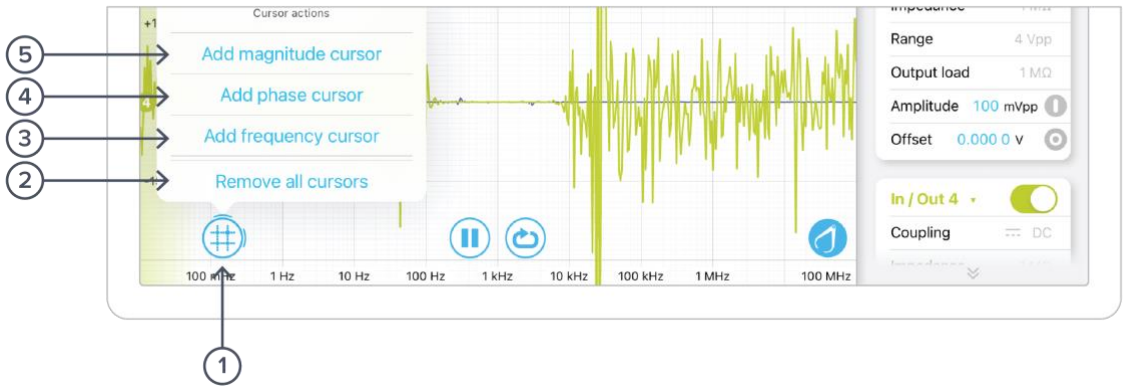
Cursors

Magnitude and phase cursors can be added to the Frequency Response plot by pressing the button.

Tip: Magnitude and phase cursors can be moved between the two plots by dragging them vertically across the horizontal divider.



ID	Cursor item	Description
1	Frequency cursor	Drag to adjust frequency, tap and hold to hide channel
2	Amplitude cursor	Drag to adjust tap to set magnitude manually & other options
3	Create cursor	Tap to create, or drag up or drag right for magnitude/frequency cursor
4	Phase cursor	Drag to adjust, tap to set phase manually & other options
5	Cursor label	Label depicting frequency, amplitude, and phase of cursor. Drag to adjust. Tap to manually adjust or remove



ID	Description	ID	Description
1	Cursor action buttons	**4**	Add phase cursor
2	Remove all cursors	**5**	Add magnitude cursor
3	Add frequency cursor		

Magnitude cursors

Magnitude cursors can be added to the magnitude plot by tapping th icon and selecting *"Add magnitude cursor"*. A magnitude cursor can also be created by dragging your finger up from the cursor icon and then repositioning it on the magnitude plot.

Phase cursors

Phase cursors can be added to the phase plot by tapping th icon and selecting *"Add phase cursor"*. A phase cursor can also be created by dragging your finger up from the cursor icon and then repositioning it on the phase plot.

Frequency cursors

Up to five frequency cursors can be added to the frequency plot by tapping the icon and selecting *"Add frequency cursor"*. Frequency cursors can also be created by dragging your finger to the right from the cursor icon.

Removing cursors

All active cursors can be removed from the frequency and phase plots by tapping the icon and selecting "*Remove all cursors"*. Individual cursors can be removed by tapping their label and pressing *"Remove"*.

Sweep modes

Single

Tapping 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.

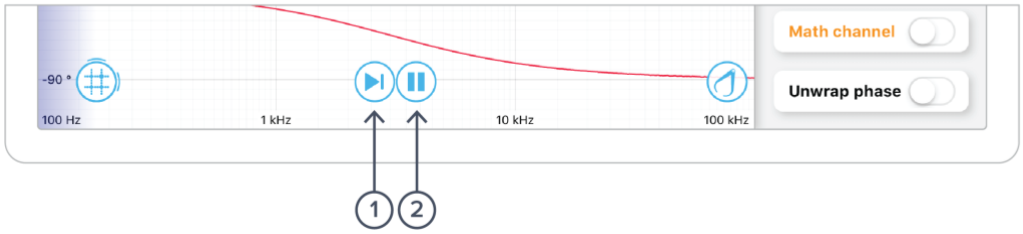
Continuous

Tapping 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

Tapping 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. Pres the icon will also pause capture.

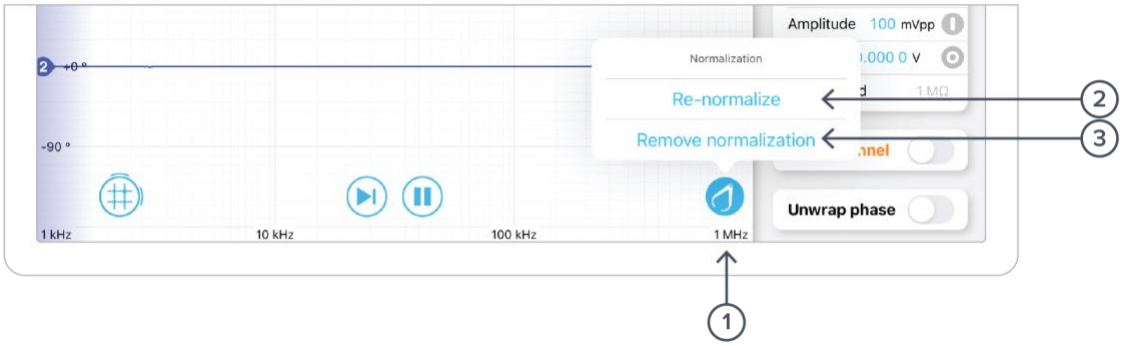
Tapping the o icons will restart the sweep.



ID	Description	ID	Description
1	Start single sweep	**2**	Stop sweep

Normalization

Moku:Pro's 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.



ID	Description	ID	Description
1	Normalize menu	**3**	Remove normalization
2	Re-normalize		

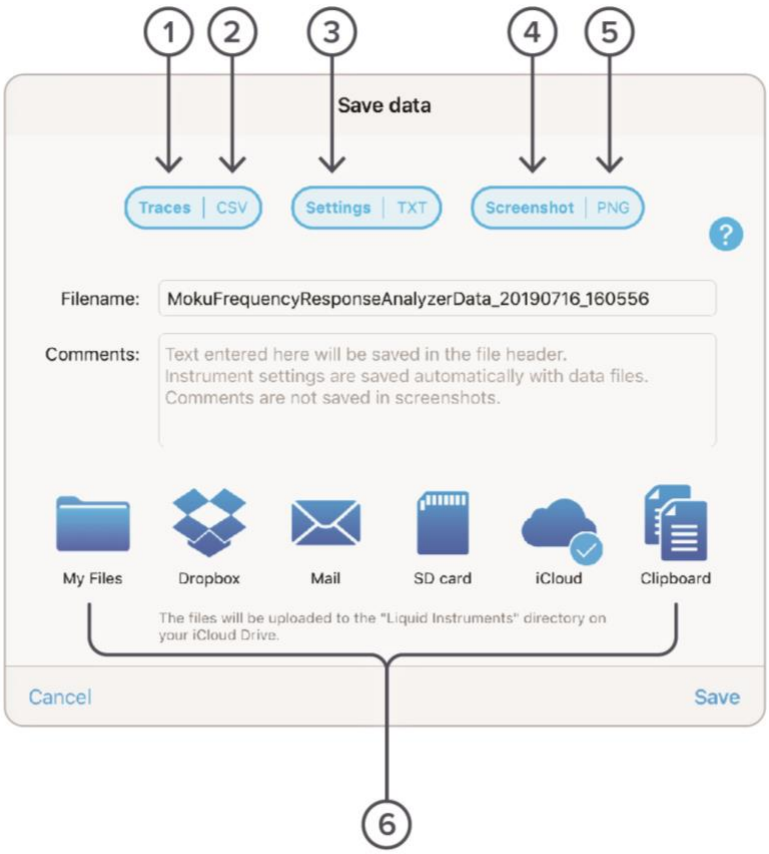
Tapping the icon will bring up the normalization menu. Re-normalize will replace the current normalization trace with a new one. Remove normalization will erase all stored normalization settings and cannot be undone.

Exporting Data

Measurement traces and screenshots can be uploaded to My Files (iOS 11 or later), Dropbox, Email, SD card, iCloud, Clipboard (screenshot is not copied to the clipboard).

The Frequency Response Analyzer instrument settings can also be exported for future reference.

To export a measurement trace, press the icon at the top of the frequency response plot.



ID	Button	Description
1	Traces data	Select to enable saving of trace data
2	Traces format	Tap to select CSV or MATLAB format
3	Settings data	Select to save instrument settings
4	Screenshot capture	Select to capture screenshot
5	Screenshot format	Tap to select JPG or PNG screenshot format
6	Saved data destination	Select data destination

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