Bode Analyzer

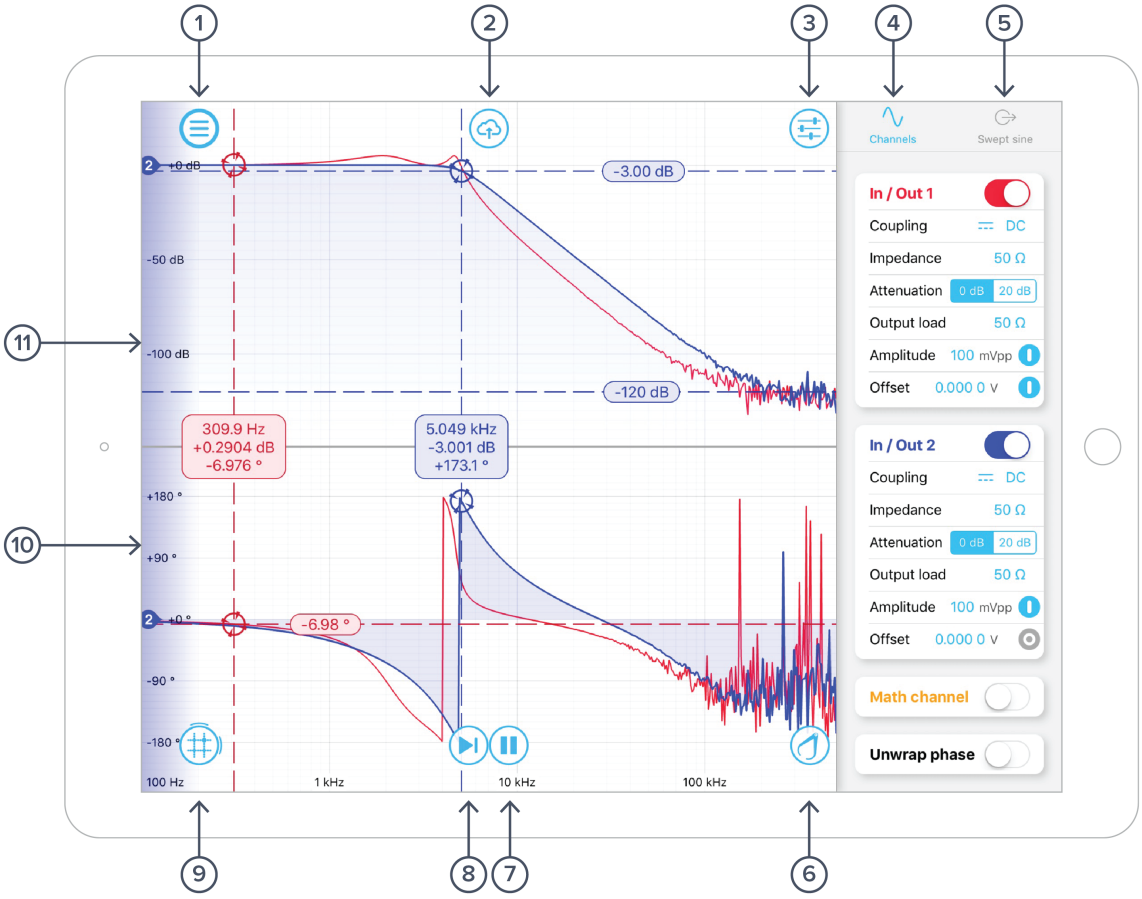
User Manual

The Moku:Lab's Bode Analyzer can be used to measure a system's frequency response from 10 mHz up to 120 MHz.

Bode Analyzers are commonly used to measure the transfer functions of electrical and 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 behaviour in non-linear systems, design filters, or measure the bandwidth of different electronic or optical components. Bode Analyzer's are quite simply an indispensable tool in any electronics and optics lab.

Table of Contents

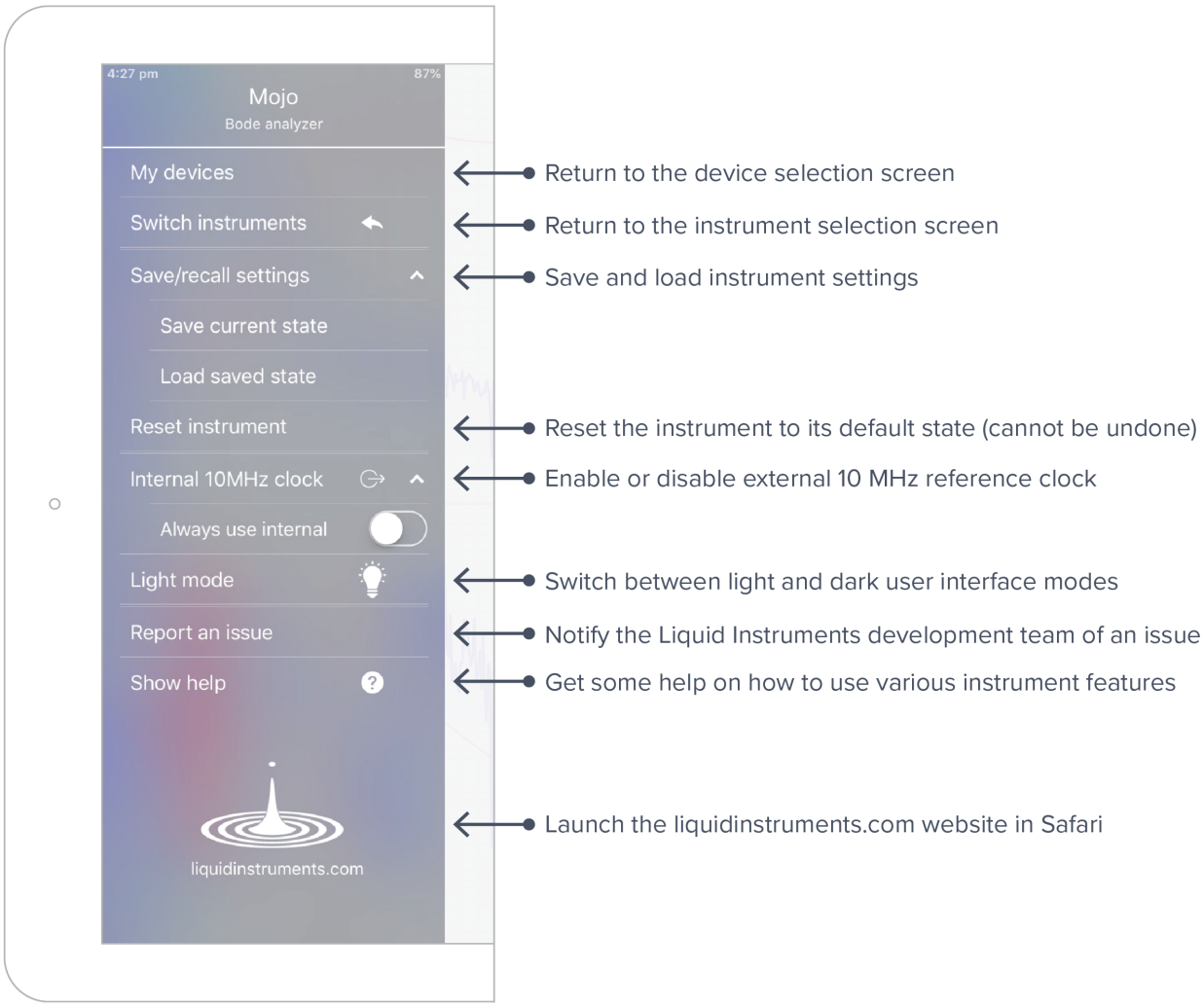
User Interface



ID	Description	ID	Description
1	Main menu	7	Sweep mode
2	Export data	8	Start / pause sweep
3	Instrument configuration menu	9	Cursors
4	Channel settings	10	Phase plot
5	Swept sine output settings	11	Magnitude plot
6	Calibration tool		

Main Menu

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

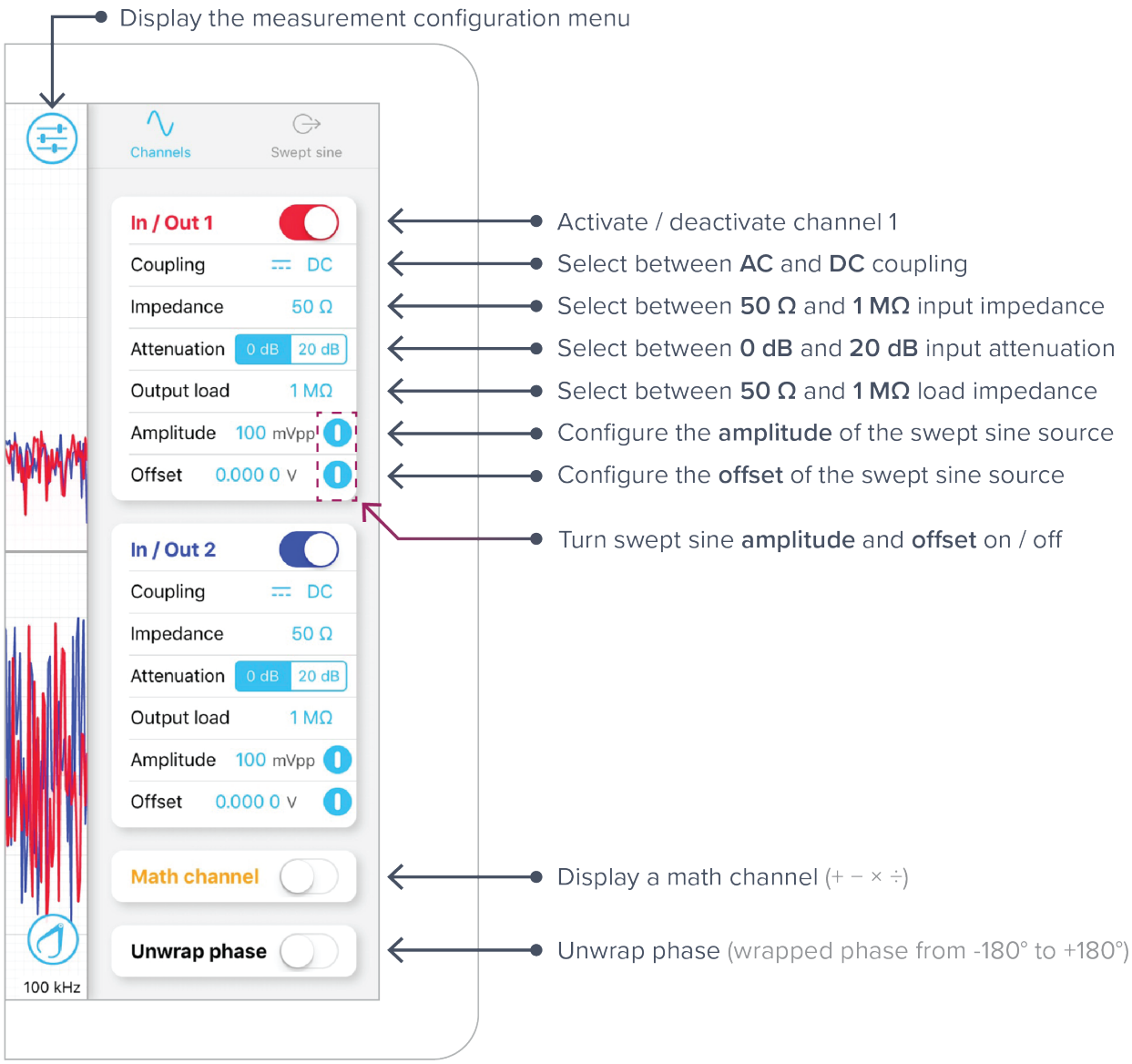


Measurement Configuration

The **measurement configuration menu** allows you to configure the Bode Analyzer for your measurement, which will vary depending on the specific characteristics of the system under test.

Access the measurement configuration menu by pressing the icon.

Channels



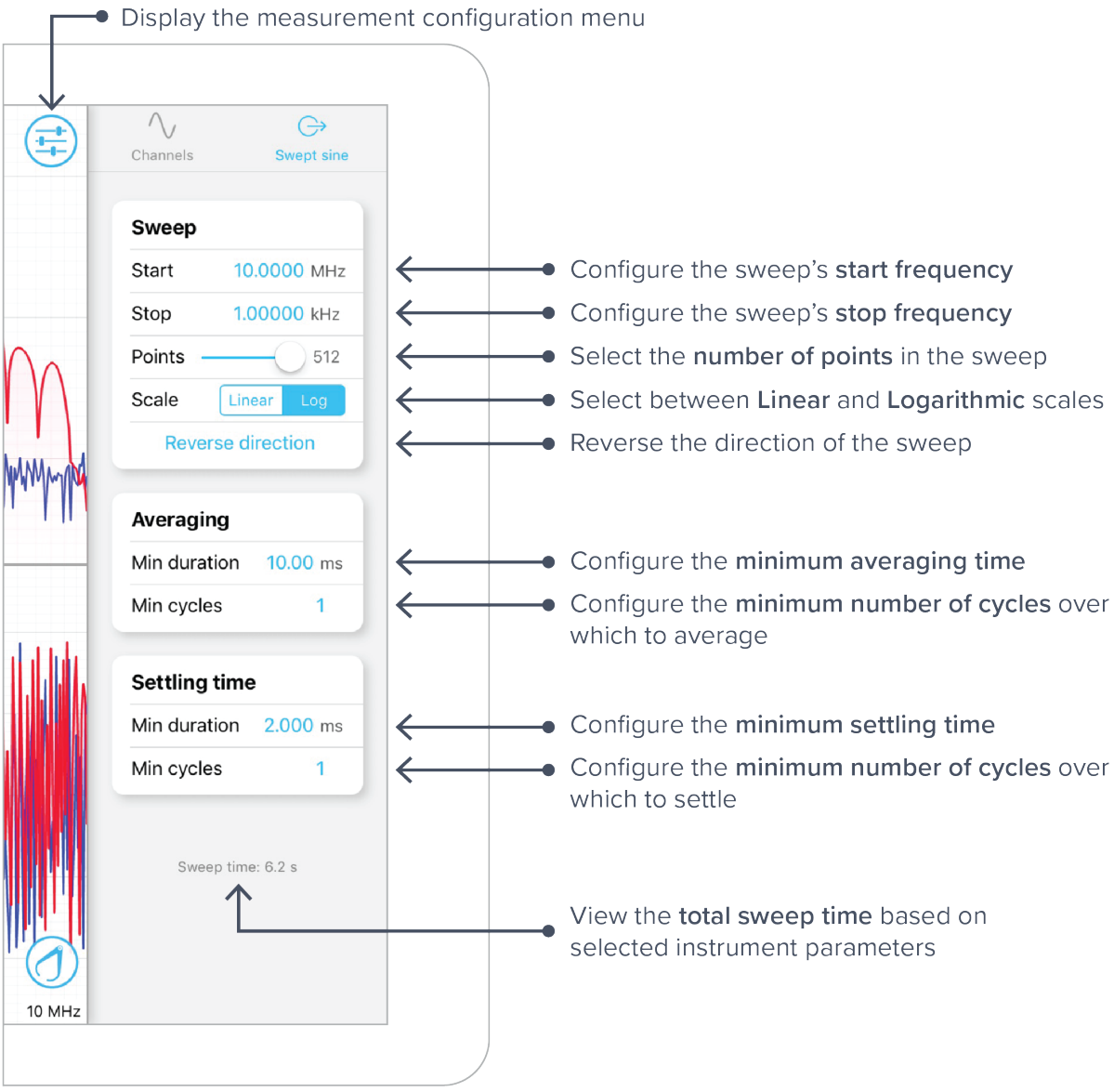
Math channel

- Select between addition, subtraction, multiplication and division of the two measurements.
- 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



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:BodeAnalyzer averages for the greater of the two values rounded up to the nearest number of integer cycles in order to avoid spectral leakage.

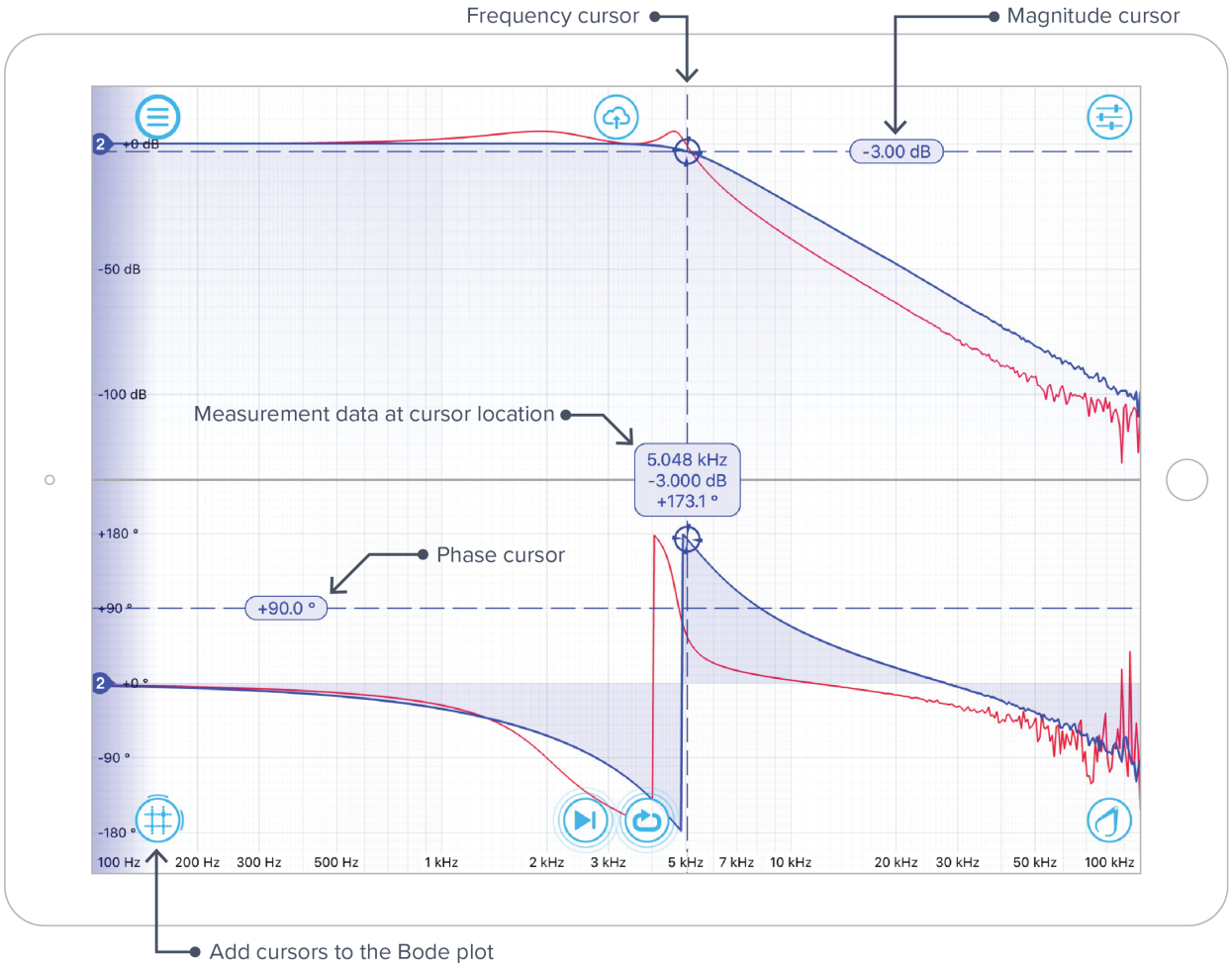
Settling time

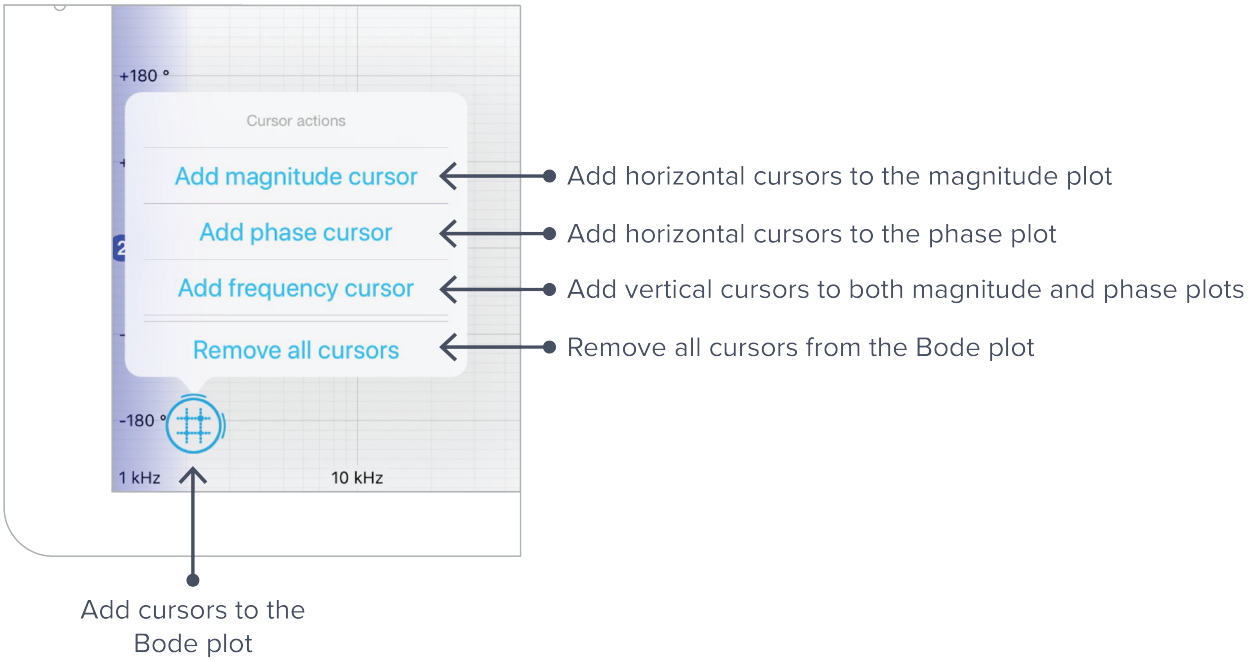
- The settling time determines how long the Bode analyzer waits before performing measurements at each frequency in the sweep. Settling time is important when characterizing resonant systems with high Q-factors in order to allow excitations to ‘settle’ between measurements. It can also be used to account 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 Bode analyzer will wait for the greater effective duration of the two settings before beginning a measurement at each point in the sweep.

Cursors

Magnitude and phase cursors can be added to the Bode plot pressing the icon.

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





Magnitude cursors

Magnitude cursors can be added to the Bode plot by tapping the 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 Bode plot by tapping the 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 Bode 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 Bode plot 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.

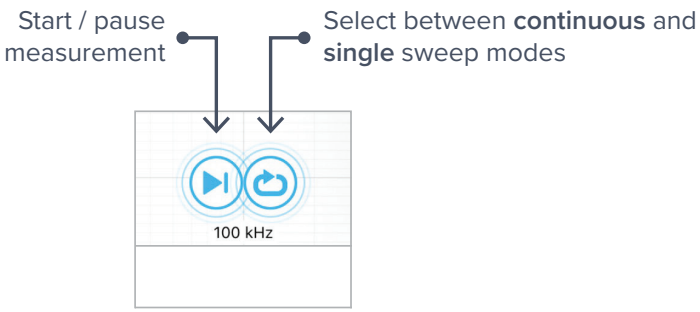
Continuous

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

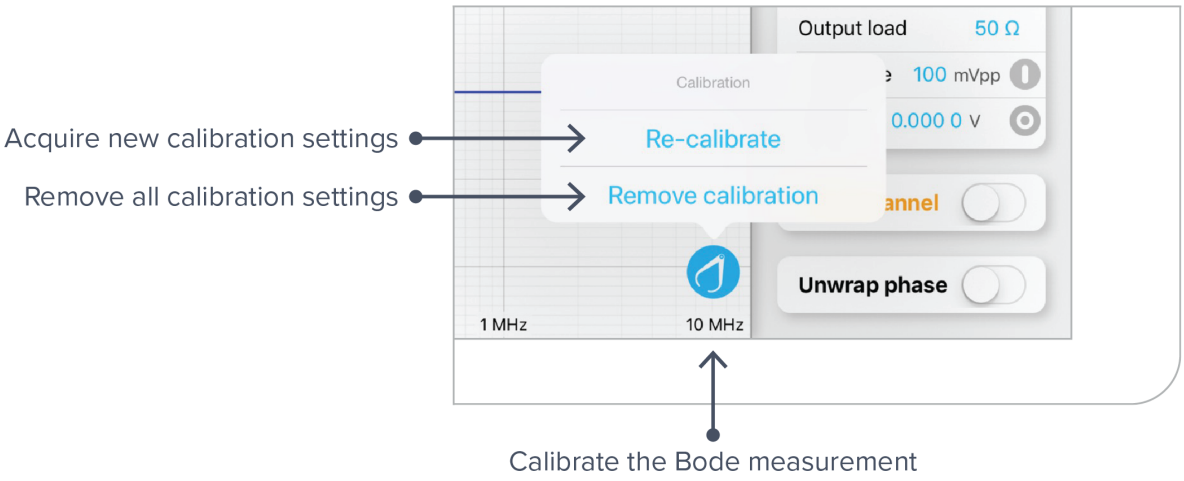
Tapping the icon will immediately pause the current sweep. While paused, you can zoom in on features for more details, but no new data will be captured. Pressing the icon will also pause capture.

Tapping the or icons will restart the sweep.



Calibration

Moku:Lab's Bode Analyzer features a calibration tool that can be used to normalize subsequent measurements. Calibration is useful when compensating for delays and comparing different devices under test.

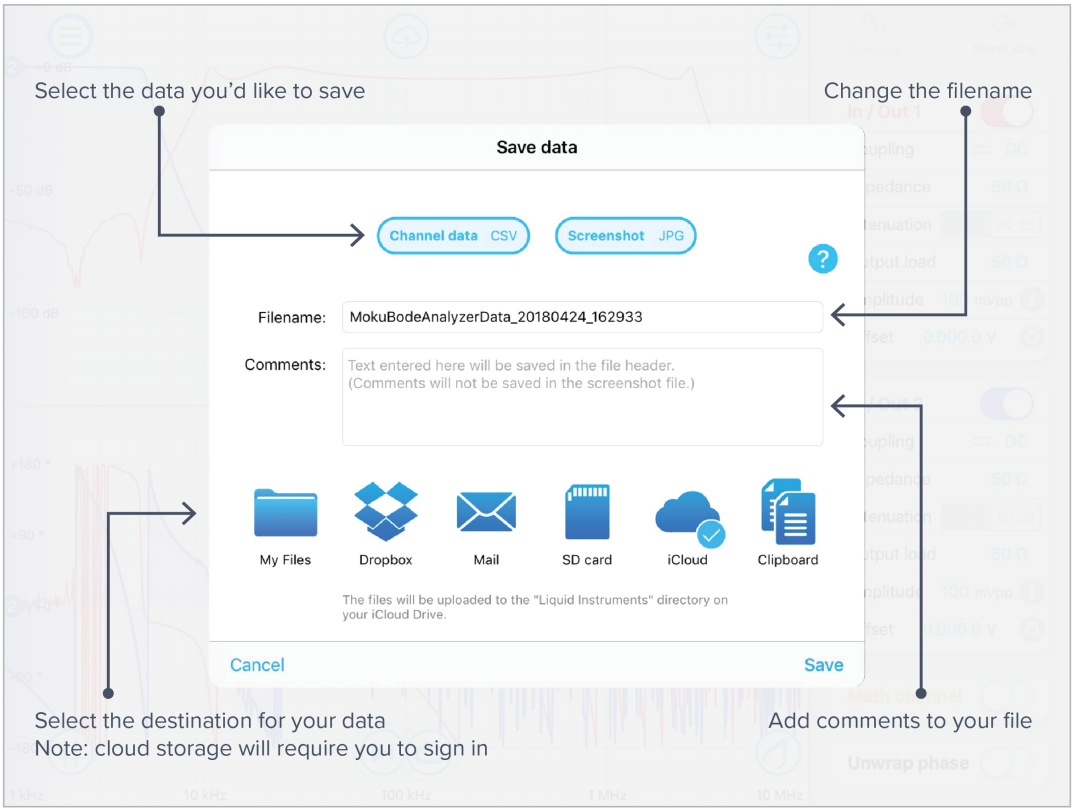


Tapping the icon will bring up the calibration menu. **Re-calibrate** will replaces the current calibration trace with a new one. **Remove calibration** will erase all stored calibration settings and cannot be undone.

Exporting Data

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

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



SD card

- Upload files to SD card by inserting a compatible FAT32 formatted drive into the Moku:Lab's SD card slot, located on the rear of the device next to the power connector.

Dropbox

- Upload files to Dropbox by logging in to your account with the Moku:Lab app on the iPad.