Liquid Instruments Moku:Pro Laser Lock Box User Manual

Moku:Pro Laser Lock Box
User Manual

Contents

Moku:Pro Laser Lock Box

The Moku:Pro Laser Lock Box enables you to stabilize a laser's frequency to a reference cavity or atomic transition using high-performance modulation locking techniques. The Laser Lock Box is designed with the concept of staged locking and a "Lock Assist", enabling a user-defined locking process to quickly lock to any zero-crossing on the demodulated error signal. It also features an integrated four-channel Oscilloscope, allowing you to observe signals at any point in the signal processing chain at up to 1.25 GSa/s. Additionally, the built-in Data Logger enables long-term recording of signals.

Ensure Moku:Pro is fully updated. For the latest information, visit: liquidinstruments.com

Introduction

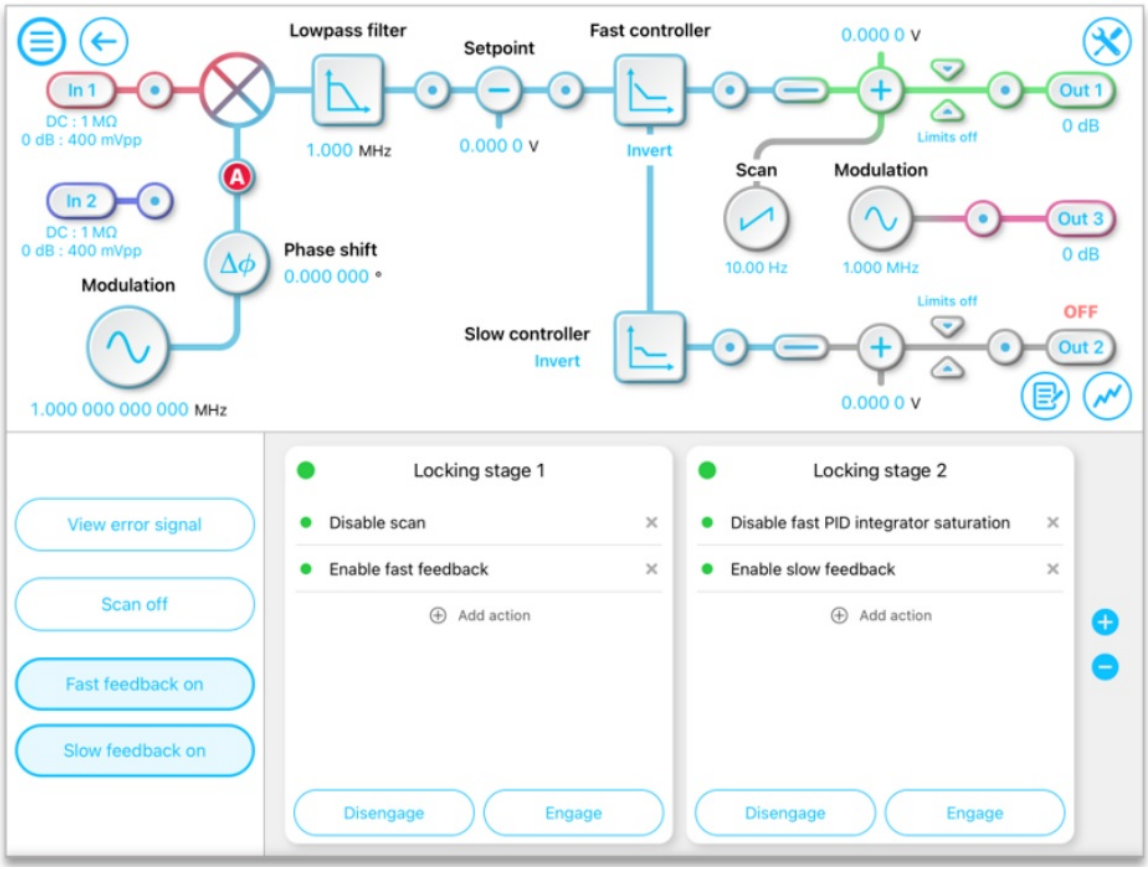
Laser locking systems are widely used to control and match a laser's frequency to an optical frequency reference, such as an optical reference cavity or atomic transition. Such systems are vital for high-resolution interference measurement, spectroscopy, and time and frequency standards.
Locking a laser by forcing the laser and reference frequency to be equal allows for two scenarios:

- The locking system steers the laser frequency to be equal to the reference frequency, which is referred to as frequency stabilization; and
- The locking system forces the reference frequency to follow the laser frequency, which is referred to as frequency tracking.

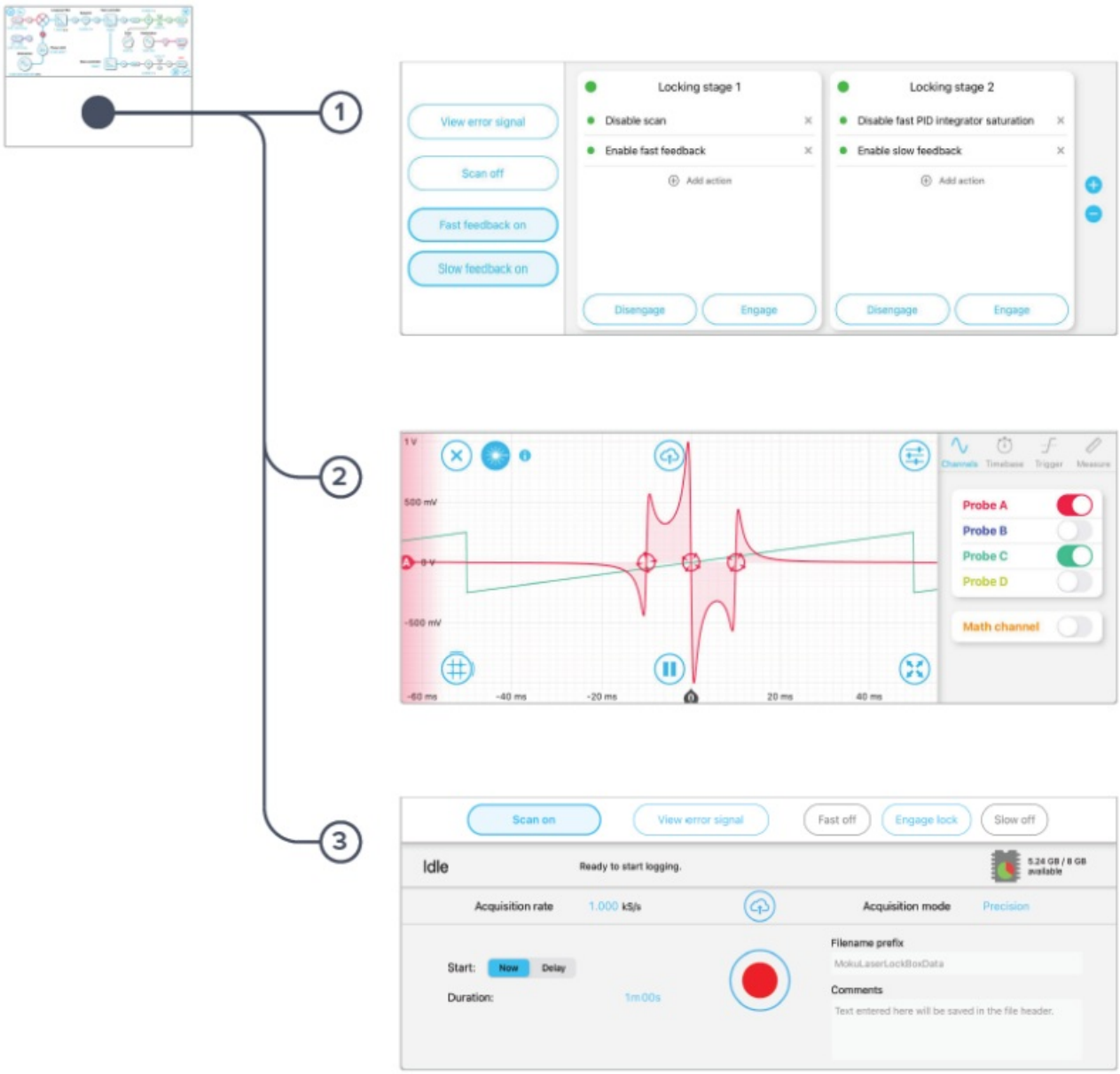
Whether used for frequency stabilization or frequency tracking, the Moku:Pro Laser Lock Box is designed to assist in high-performance, high-gain laser locking systems. It offers advanced setup, acquisition, and diagnostic features that makes it easier and quicker to set up and characterize laser locking systems.

User Interface

The main user interface is divided into upper and lower screen sections. The upper user interface displays the processing chain and principal controls of the Laser Lock Box.



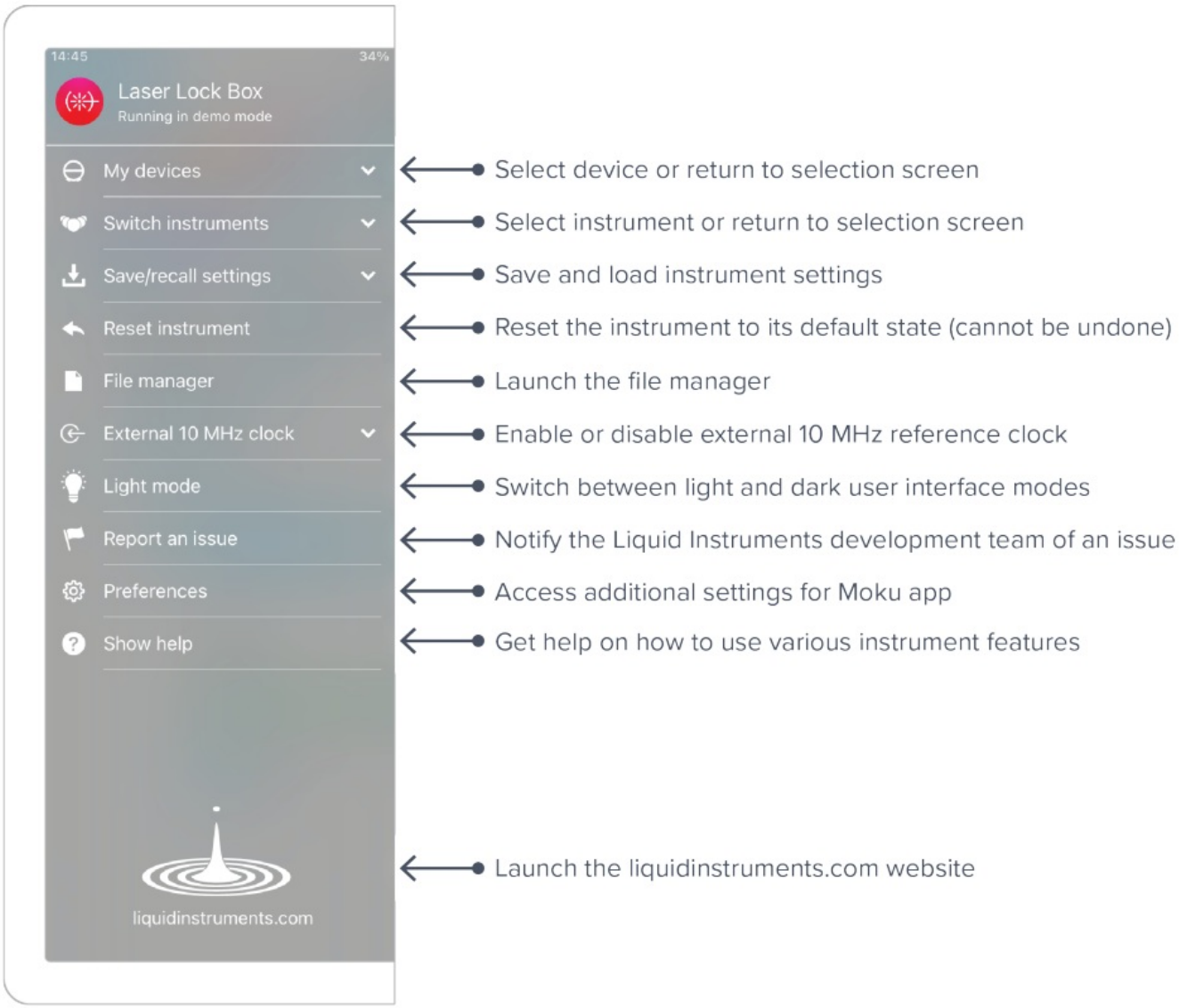
The lower half is readily set to display one of three parameter control panels: locking stages, Oscilloscope, and Data Logger.



ID	Description
1	Locking stages
2	Oscilloscope
3	Data Logger

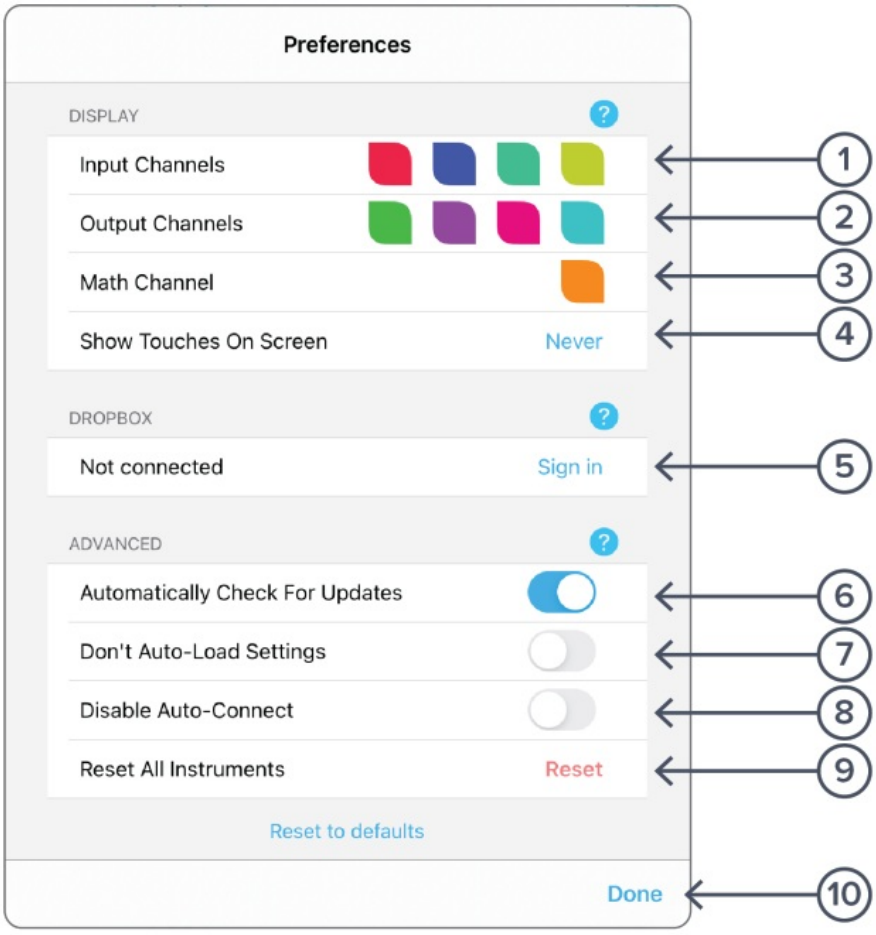
Main Menu

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



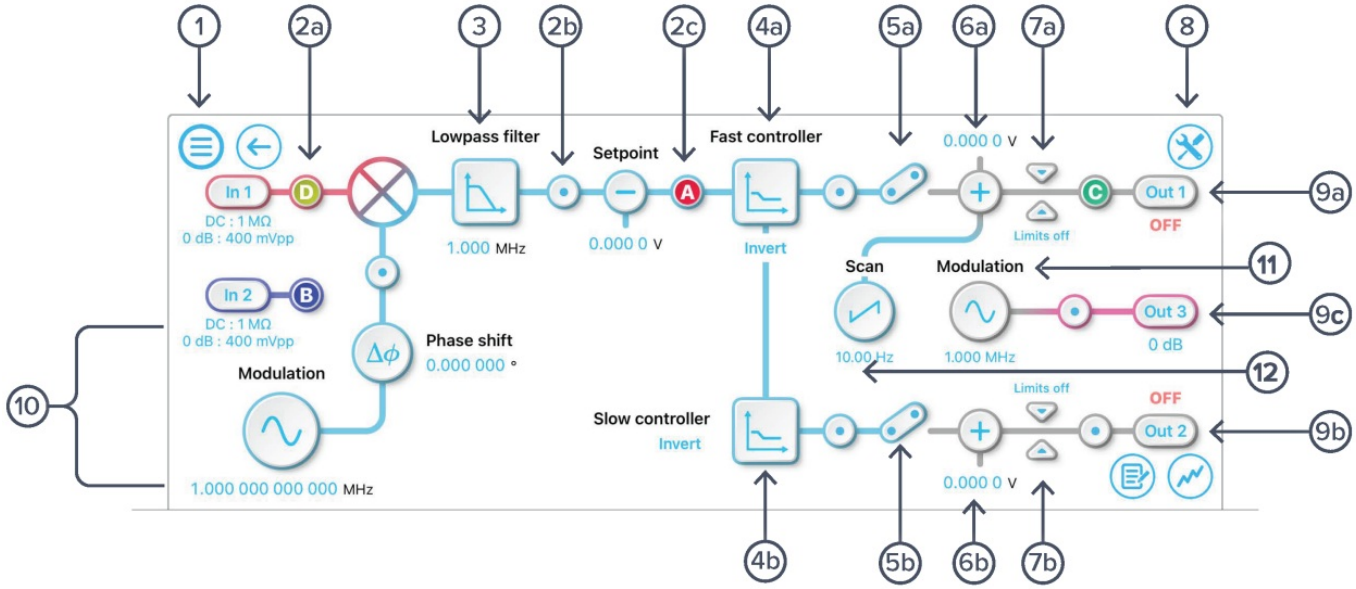
Preferences

The preferences pane can be accessed via the main menu. In here, you can reassign the color representations for each channel, connect to Dropbox, and more. Throughout this 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 maths 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 l aunch. 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.

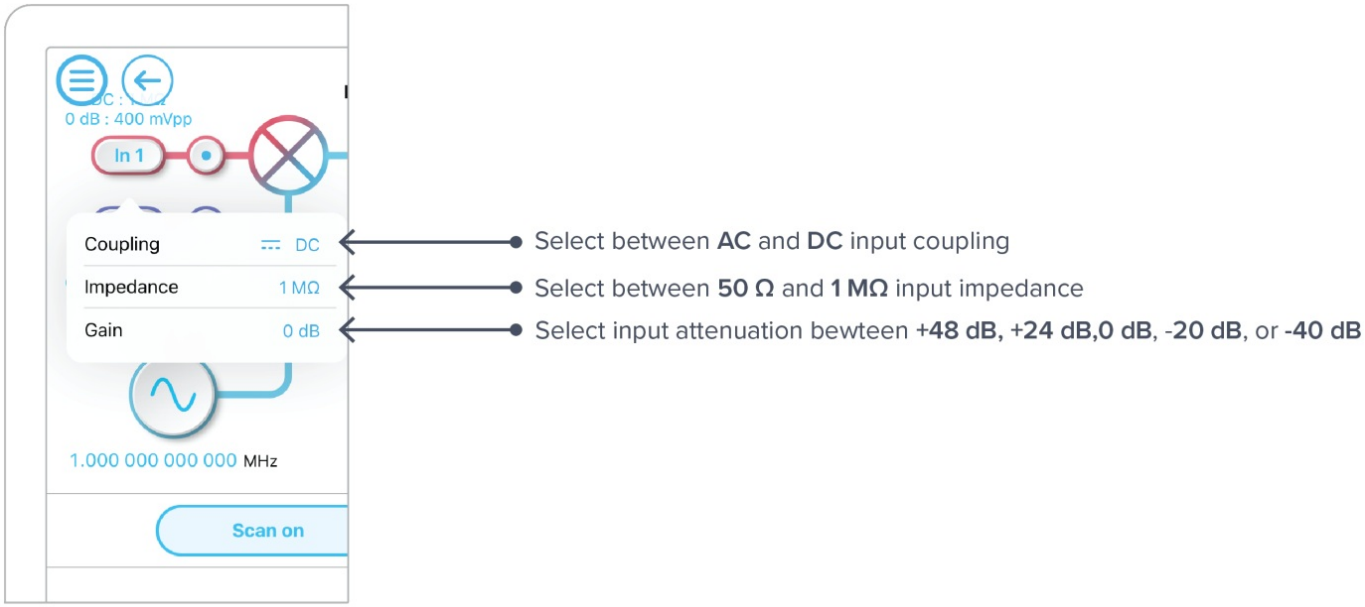
Upper User Interface



ID	Description
1	Main menu
2a-c	Tap to drop oscilloscope probe points to examine signals along the processing chain
3	Tap to configure the digital filter
4a	Tap to configure fast PID controller
4b	Tap to configure slow PID controller
5a	Connect fast PID chain to output
5b	Connect slow PID chain to output
6a	Apply output offset to fast PID chain
6b	Apply output offset to slow PID chain
7a	Output limiter on fast PID chain
7b	Output limiter on slow PID chain
8	Configure demodulation modes
9a	Turn output 1 on/off
9b	Turn output 2 on/off
9c	Configure output 3 gain
10	Configure local oscillator demodulation
11	Configure modulation frequency, amplitude and output channel
12	Configure scan frequency, shape, amplitude and output channel

Signal input

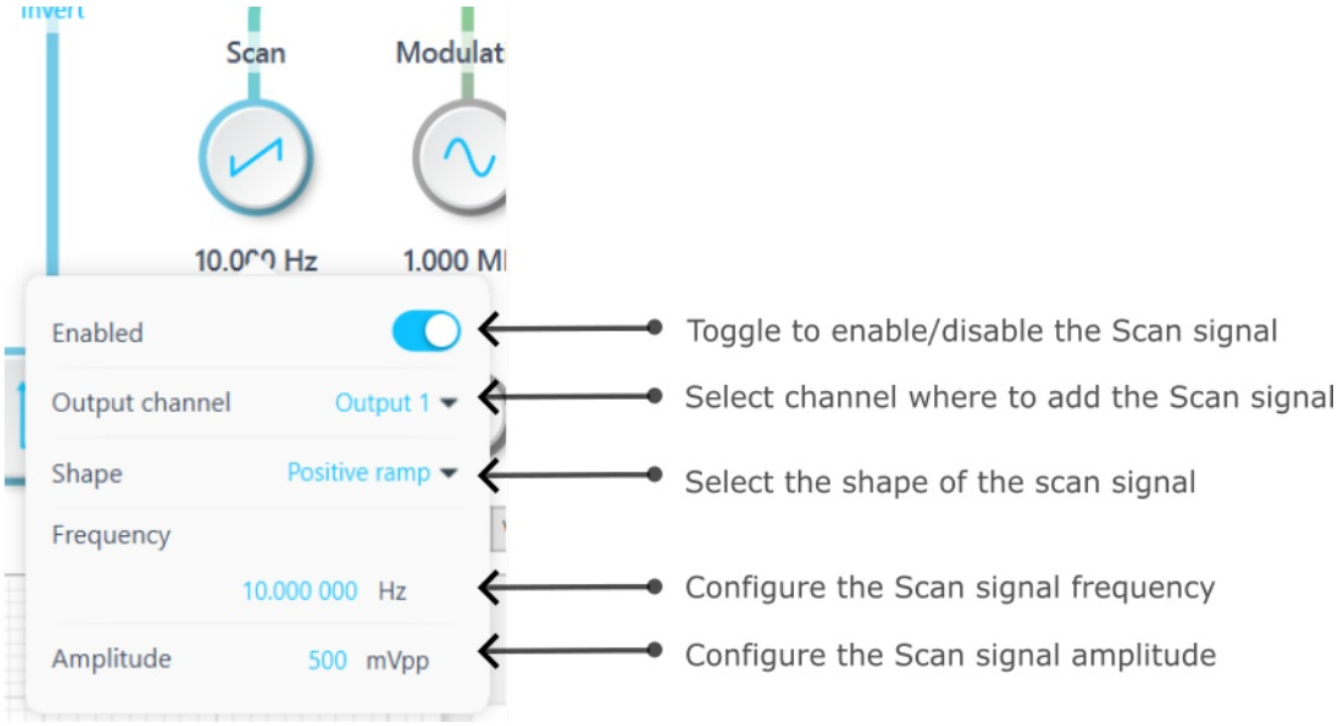
Tap the In 1 icon to configure the input settings for the signal input. Similar configurations can be made on input 2.



Scan configurations

Tap the 

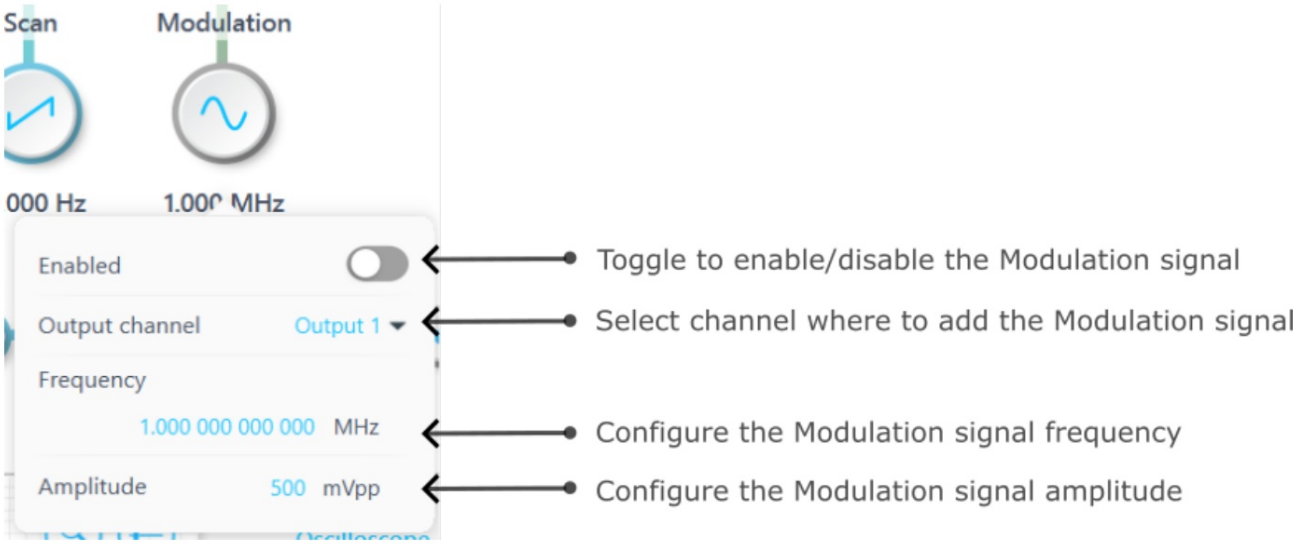
icon to configure the settings for the scan signal.



Modulation configuration

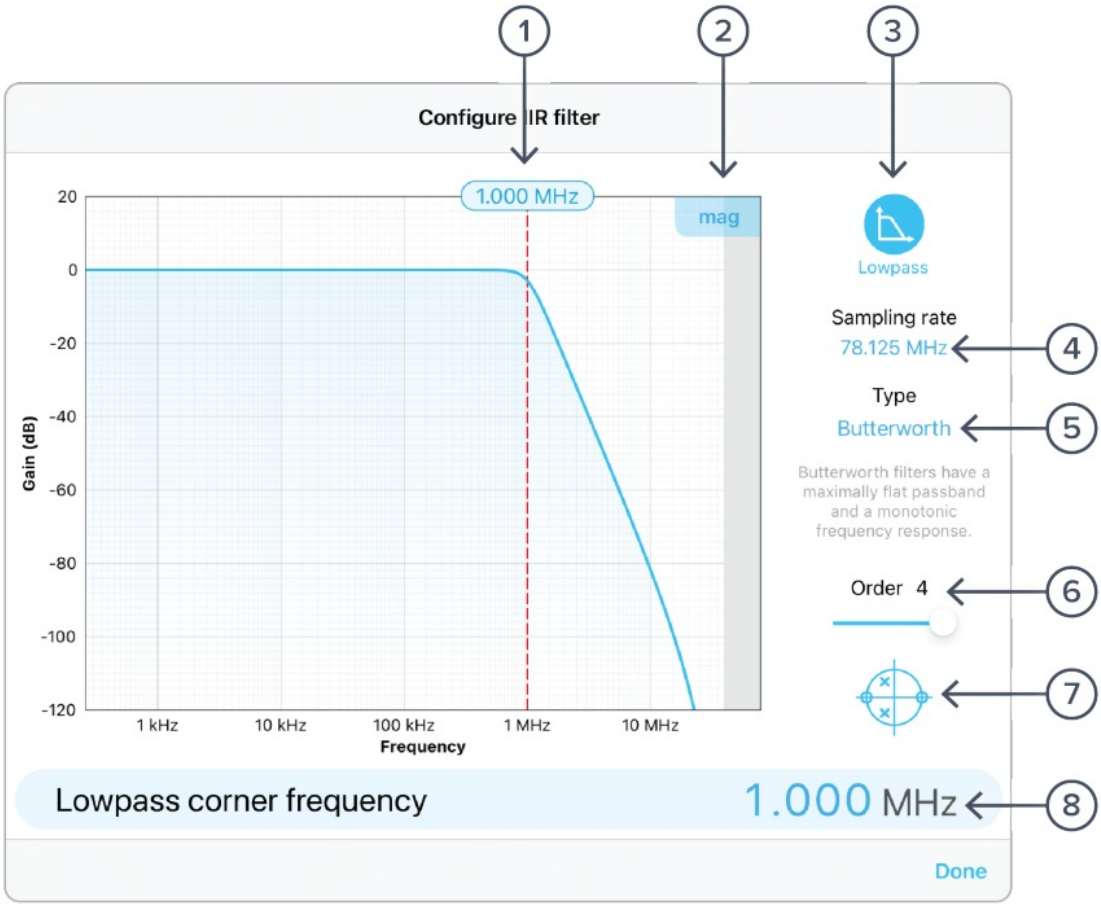
Tap the 

icon to configure the settings for the modulation signal.



Digital filter configuration

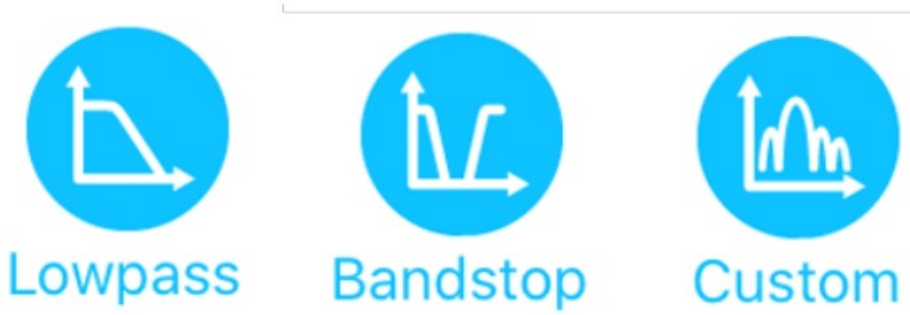
Immediately after the demodulation function, there is a digital filter designed to remove unwanted signal components. This is highly configurable; just tap the lowpass filter icon.



ID	Description
1	Configure lowpass filter corner frequency: tap to enter frequency or touch and drag
2	Toggle between magnitude or phase plots
3	Tap to select filter shape
4	Fixed sample rate of 78.125 MHz
5	Tap to select filter type
6	Tap to select filter order
7	Toggle view of poles/zeroes of filter
8	Tap to enter corner frequency

Filter shapes

The shape of the filter can be selected by tapping the filter icon. There are two pre-defined filter shapes and a fully customizable filter option.

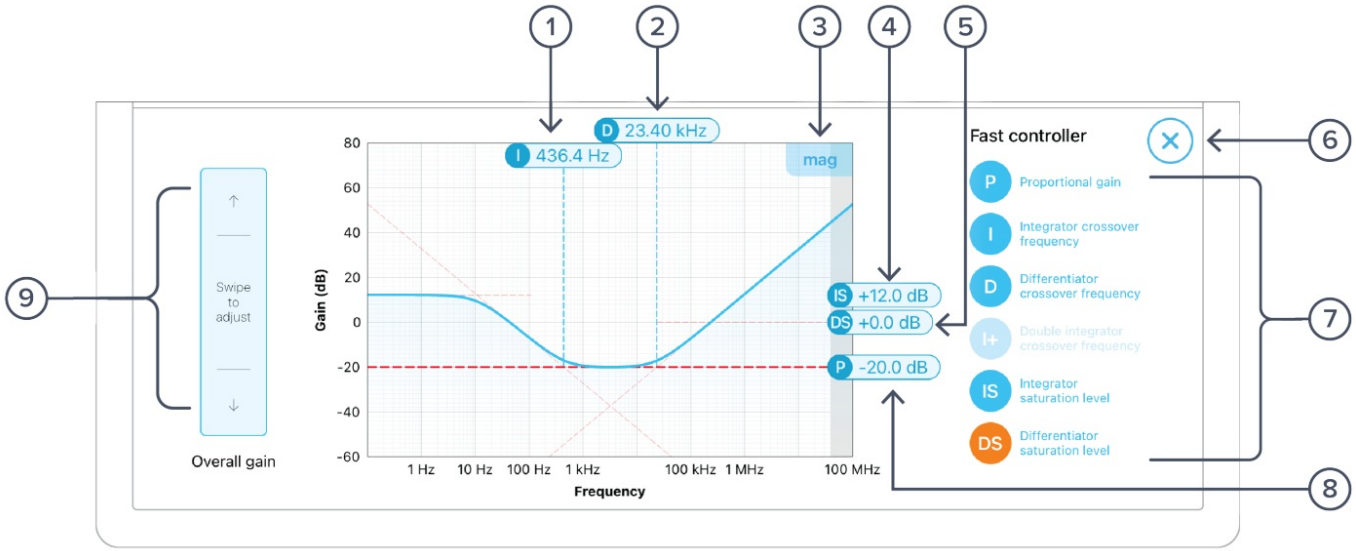


PID controllers

The Moku:Pro Laser Lock Box implements two cascaded PID controllers: a fast controller and a slow controller. The input of the slow PID controller is the output of the fast PID controller.

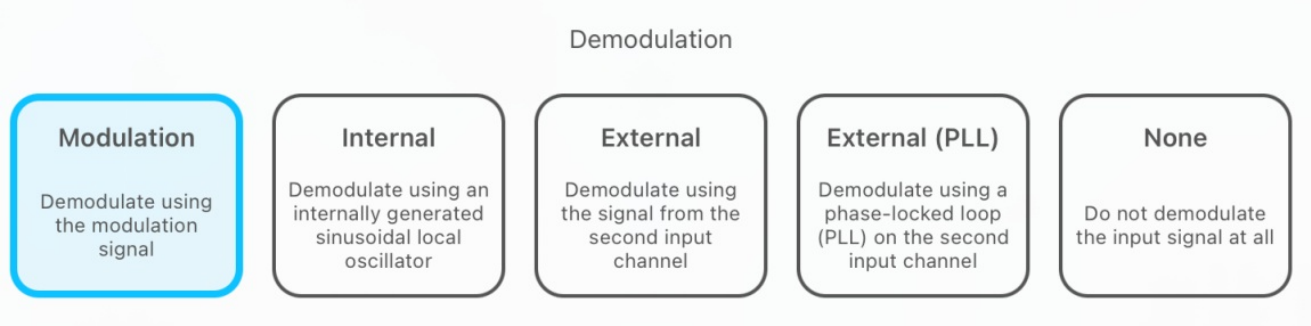
Both the fast and slow PID controllers can be configured graphically by dragging interactively on the magnitude chart or by tapping on cross-over tabs and entering frequency or gain on the soft keypad.

The PID controller provides full control over proportional, integral, and derivative gain profiles with saturation levels available for the integral and derivative components. The PID's transfer function is updated in real time.



ID	Description
1	Drag or tap to enter integrator crossover frequency
2	Drag or tap to enter differentiation crossover frequency
3	Toggle between magnitude or phase plots
4	Drag or tap to enter integrator saturation
5	Tap to set differentiation saturation
6	Close the PID controller interface
7	Proportional, integrator, differentiation, double integrator (only on the fast controller), integrator saturation, and differentiation saturation settings
8	Drag or tap to enter proportional gain
9	Swipe to adjust selected PID parameter

Local oscillator
The demodulation signal source can be configured in the settings dialog.

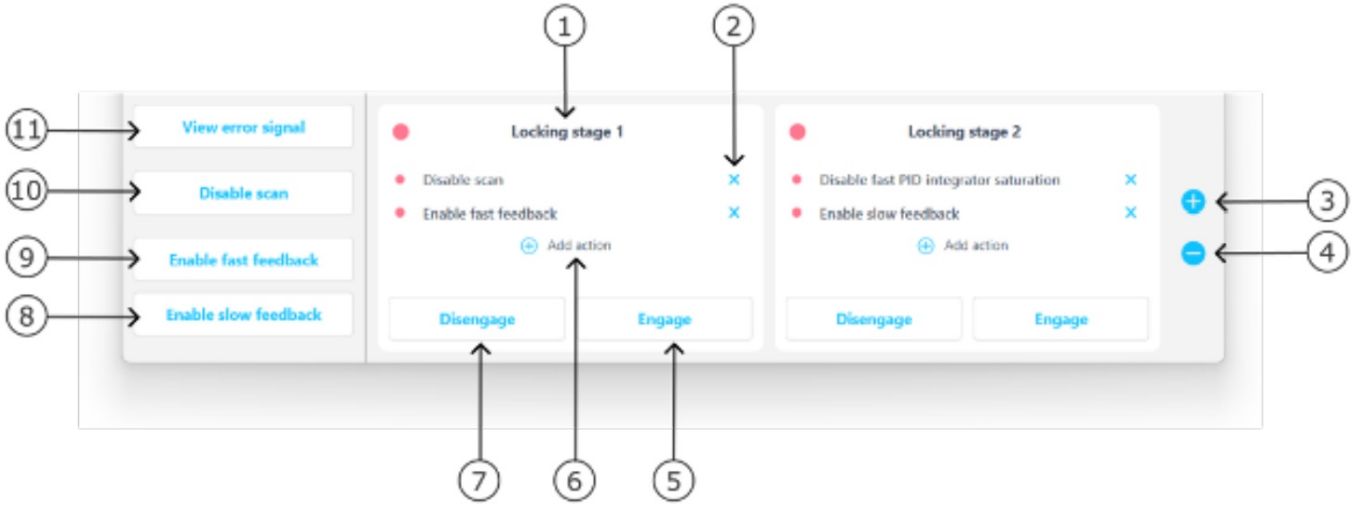


Demodulation
The demodulation mode determines which reference oscillator is used to demodulate the input signal.
Modulation
The input signal can be demodulated with the modulation signal, which is user-configured here. This local oscillator is locked to the modulation signal with a frequency range from 1 mHz to 300 MHz.
Internal
The input signal can be demodulated with an internally generated reference signal. This local oscillator is derived from the Moku:Pro internal clock and thus shares the same time base. The frequency range of the internal reference is 1 mHz to 600 MHz.
External
The input signal can be demodulated by a direct external reference, permitting the use of non sinusoidal demodulation using the input signal applied on input 2.
External (PLL)
External (PLL) mode enables the Laser Lock Box to lock to an externally sourced demodulation reference applied to input 2. This mode uses a digitally implemented phase-locked loop (PLL) to track the phase of the external reference with a user configurable bandwidth. To configure the bandwidth of the PLL, tap the PLL icon to select the bandwidth between 1 Hz to 1 MHz. The PLL will automatically lock to the strongest harmonic of the external reference in the range of 10 Hz to 600 MHz with a manually configurable local phase shift. The PLL can be manually set as low at 10 Hz. The PLL can be frequency multiplied up to 250x or divided down to 1/8x with the Multiplier for use as local oscillator, minimum Multiplier step size is 1/8 th. The reacquire button can be used to re lock to the external reference.
None
The demodulation step can be bypassed by selecting “None.” This enables modulation-free locking techniques such as DC locking, fringe-side locking, and tilt locking.

Lower User Interface

Use the lower user interface to either configure the locking stages or display the half screen Oscilloscope or Data Logger.

Locking stages



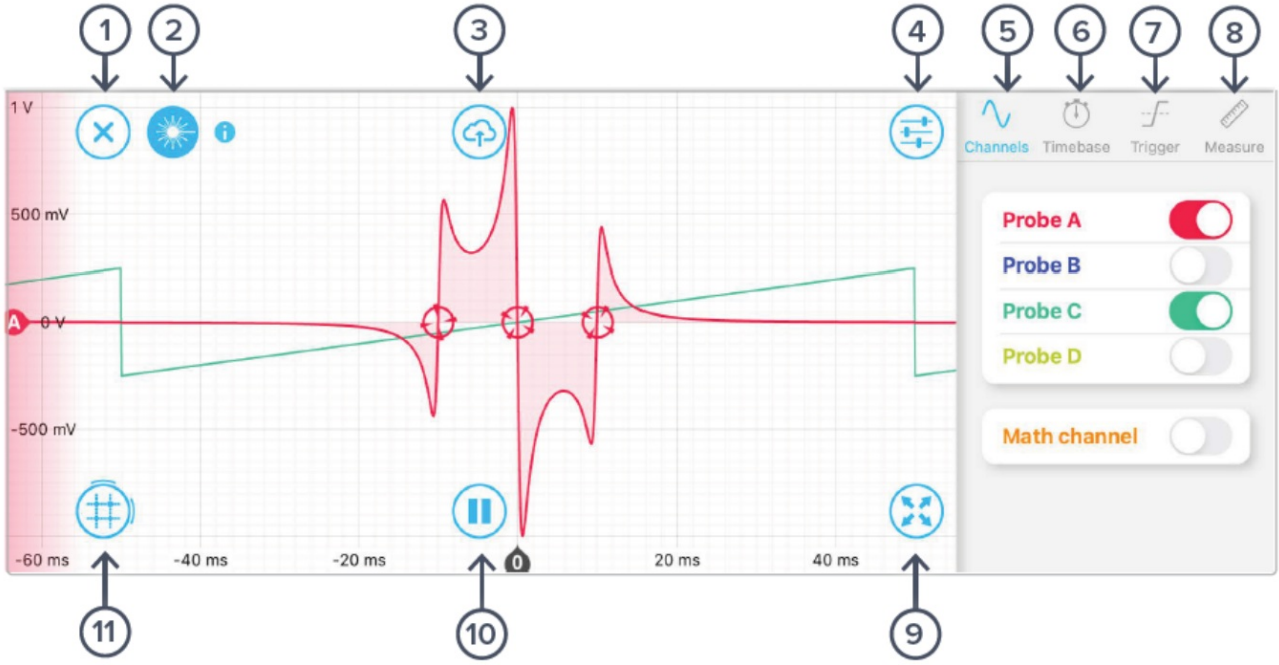
ID	Description
1	Lock stage 1 of (up to) 3
2	Remove a certain action in the locking stage
3	Add a new locking stage (allows up to 3 stages at maximum)
4	Remove a certain locking stage
5	Engage the actions defined in the locking stage
6	Add a new action in the locking stage
7	Disengage the actions defined in the locking stage
8	Tap to connect the slow PID to Output 1to enable the slow feedback
9	Tap to connect the fast PID to Output 2 to enable the fast feedback
10	Tap to enable/disable the scan signal
11	Tap to switch to the Oscilloscope to view the error signal, where the user can select the locking point

Add action

Choose any of the available actions to add to each locking stage. When engaged, all of the actions associated with that stage will be enabled simultaneously.

Oscilloscope

The Moku:Pro Laser Lock Box includes a built-in Oscilloscope, enabling you to observe and record data of up to four signals at a time in the Laser Lock Box's processing chain.



ID	Description
1	Close Oscilloscope panel
2	Select Lock Assist
3	Share Oscilloscope data
4	Reveal/hide settings sidebar
5	Tap to select channel tab
6	Tap to select time base tab
7	Tap to select trigger tab
8	Tap to select measurements tab
9	Tap to set Oscilloscope to full screen
10	Pause/run Oscilloscope
11	Tap to add time/voltage cursors, or drag right or drag up to create a cursor

The Oscilloscope will appear automatically when a probe point is activated.

You can hide the Oscilloscope by pressing the icon and reveal it by pressing the icon.

Lock Assist feature

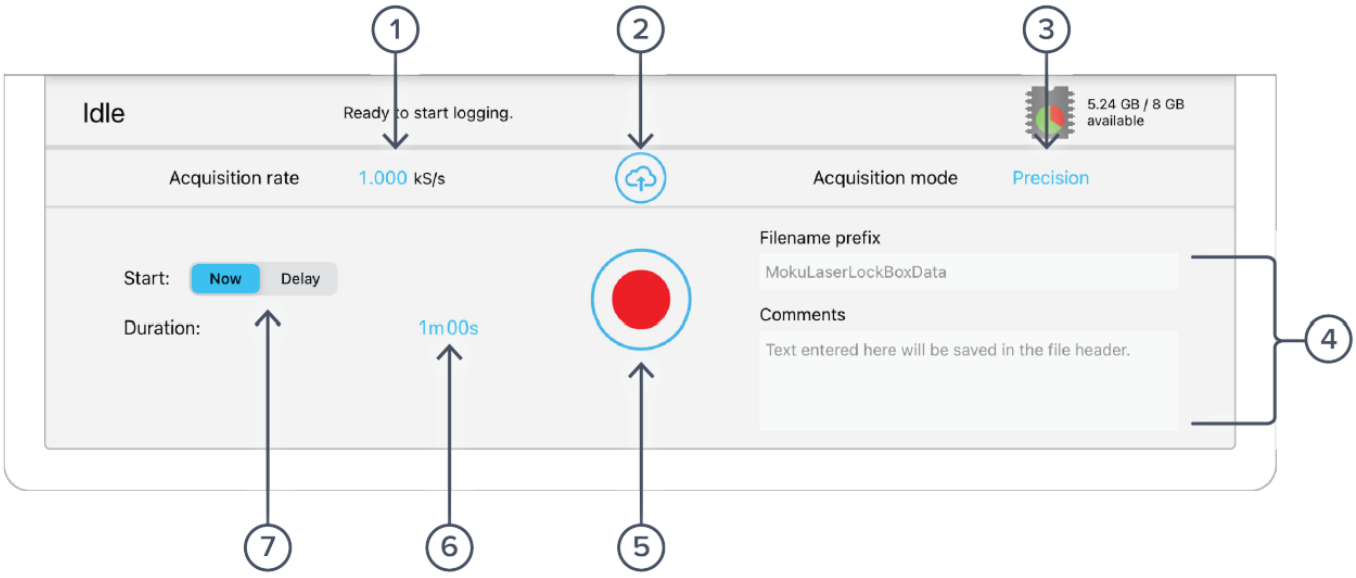
The Lock Assist can only be enabled after the locking stage is configured. When the Lock Assist is enabled, the trigger settings will be configured to synchronize the oscilloscope traces with the scan waveform. Selecting one of the error signal's zero crossings will then adjust the output offset to the corresponding voltage and engage the first locking stage which is not already fully engaged.

Additional details about the Oscilloscope can be found in the Moku:Pro Oscilloscope manual.

Data Logger

The built-in Data Logger allows you to acquire data from up to four probe points at a time at a maximum sampling rate of 2.5 MSa/s with three or four channels, 5 MSa/s with two channels and 10 MSa/s with one channel. To

access the data acquisition menu, press the icon. More details about Data Logger are available in the Moku:Go Data Logger manual.



ID	Description
1	Select the sampling rate at which your measurement is recorded
2	Upload saved data
3	Select between Normal, Precision, or Peak Detection acquisition modes
4	Change filename and comments for the logged file
5	Record a new measurement
6	Configure measurement duration
7	Configure when to begin recording data

The embedded Data Logger can stream over a network or save data on Moku:Pro. For details, refer to the Data Logger user manual. More streaming information is in our API documents at apis.liquidinstruments.com. Ensure Moku:Pro is fully updated. For the latest information, visit: liquidinstruments.com

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Documents / Resources

	**Liquid Instruments Moku:Pro Laser Lock Box** [pdf] User Manual Moku Pro Laser Lock Box, Moku Pro, Laser Lock Box, Lock Box, Box

References

- Moku API Home | Moku API
- Liquid Instruments
- Liquid Instruments

Manuals+,