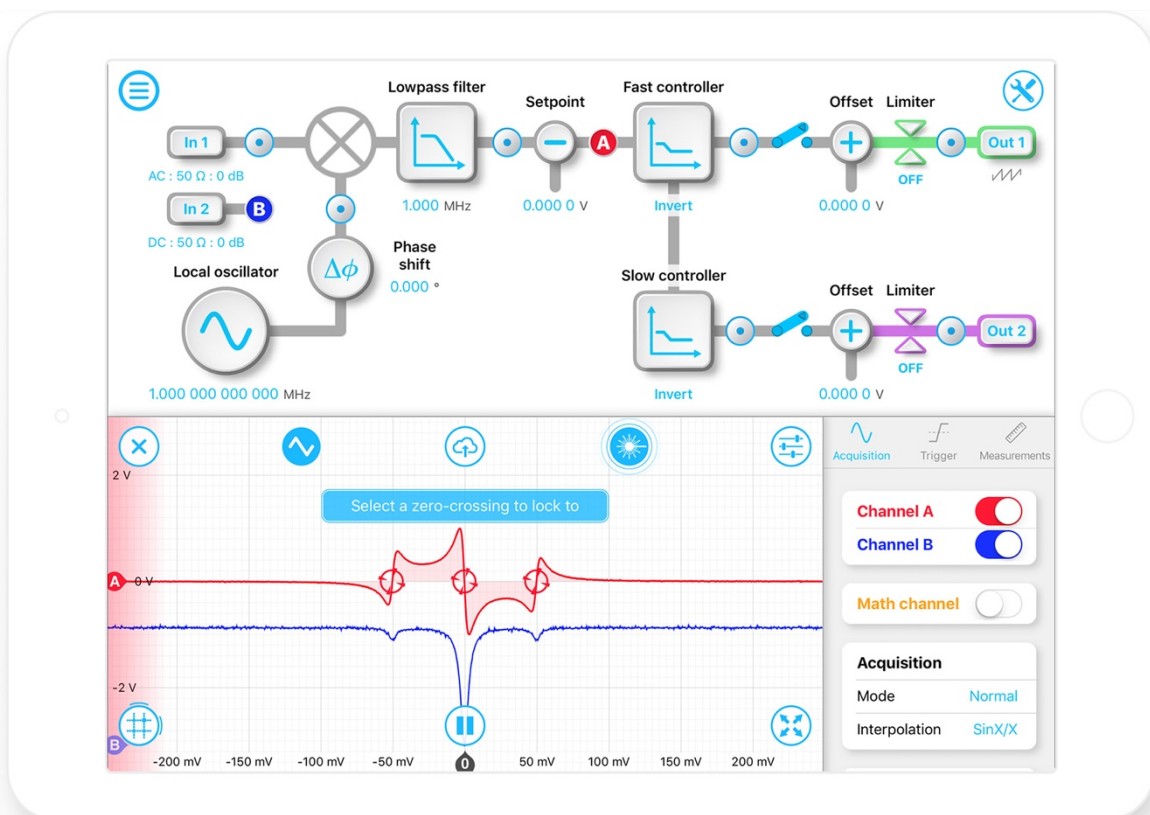# Laser Lock Box

Description

Moku:Lab's 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 includes a 'Tap-to-Lock' feature, enabling you to quickly lock to any zero-crossing on the demodulated error signal.

Features

- Generate modulation signals at up to 200 MHz
- Demodulate signals with internal or external local oscillators
- Scan resonances with sawtooth or triangle waveforms at up to 1 MHz
- Observe signals at different locations in the signal processing chain using an integrated oscilloscope
- Quickly lock to any zero-crossing in the error signal using the 'Tap-to-Lock' feature
- Filter demodulated signals with up to fourth order infinite-impulse response filters
- Individually configure high- and low-bandwidth PID controllers for fast and slow feedback

Specifications

Signal input

Signal input

Input coupling	AC / DC
Input impedance	50 Ω / 1 MΩ
AC coupling corner (-3 dB)	100 Hz into 50 Ω 30 Hz into 1 MΩ
Frequency range	DC to 200 MHz
Input gain[2]	-20 dB / 0 dB / +24 dB / +48 dB
Gain accuracy	± 1%
Input range	10 V_{pp} with -20 dB input gain 1 V_{pp} with 0 dB input gain 60 mV_{pp} with +24 dB input gain 3 mV_{pp} with + 48 dB input gain
Input noise	< 10 nV/√Hz above 1 MHz at 1 V_{pp} input range

Internal demodulation local oscillator

Internal reference waveform

Waveform	Sine
Frequency range	1 mHz to 200 MHz
Frequency resolution	3.55 µHz
Phase offset range	0 to 360°
Phase offset resolution	0.001°
Output impedance	50 Ω
Can be phase-locked to external 10 MHz timebase?	Yes

External demodulation reference

Demodulation reference input

Input coupling	AC / DC
Input impedance	50 Ω / 1 MΩ
Frequency range	DC to 200 MHz
Input gain	-20 dB / 0 dB
External reference modes	Direct, phase-locked

Phase-locked loop

PLL frequency range	2 MHz to 200 MHz

---

[2] +24 dB and +48 dB input gains are applied digitally and can be used to maximise the Laser Lock Box's dynamic range for weak input signals

Phase-locked loop

PLL tracking bandwidth	10 kHz
Phase offset range	0 to 360°
Phase offset resolution	0.001°
Orthogonality	90° ± 0.000,002°

Low-pass filter

Low-pass filter

Filter architecture	Infinite Impulse Response (IIR)
Filter shape	Low-pass filter
Sampling rate	31.25 MHz
Filter types	Butterworth, Chebyshev I, Chebyshev II, Elliptic, Bessel, Gaussian, Legendre
Filter order	2, 4
Min. corner frequency	1.040 kHz
Max. corner frequency	14.06 MHz
Passband ripple[3]	0.1 dB to 10 dB
Stopband attenuation[4]	10 dB to 100 dB

Auxiliary oscillator

Auxiliary oscillator waveform

Waveform	Sine
Frequency range	DC to 200 MHz
Frequency resolution	3.55 µHz
Amplitude range (AC)	1 mV$_{pp}$ to 1 V$_{pp}$ into 50 Ω
Amplitude resolution	1 mV
Offset range (DC)	± 1 V
Output limit (AC + DC)	± 1 V into 50 Ω
Amplitude accuracy	1%
Output distortion	< -70 dBc for frequencies lower than 10 kHz < -60 dBc for frequencies greater than 10 kHz
Output impedance	50 Ω
Can be phase-locked to demodulation local oscillator?	Yes

---

[3] Applies to Chebyshev I and Elliptical filter types.
[4] Applies to Chebyshev II and Elliptical filter types.

Scan waveform

Scanning waveform

Waveform	Sawtooth, Triangle
Frequency range	DC to 1 MHz
Frequency resolution	<1 µHz
Amplitude range (AC)	1 mV$_{pp}$ to 1 V$_{pp}$ into 50 Ω
Amplitude resolution	1 mV
Offset range (DC)	± 1 V
Output limit (AC + DC)	± 1 V into 50 Ω
Amplitude accuracy	1%
Output impedance	50 Ω

PID Controllers

Set point

Set point range	-1 V to +1 V
Set point resolution	100 µV

Fast controller

Sampling rate	31.25 MHz
Proportional gain	± 60 dB
Integrator crossover frequency	1.25 Hz to 125 kHz
Int. saturation crossover frequency	1.25 Hz to 125 kHz
Integrator gain range	Proportional gain to +60 dB
Differentiator crossover frequency	12.5 Hz to 1.25 MHz
Diff. saturation crossover frequency	12.5 Hz to 1.25 MHz
Differentiator gain range	Proportional gain to +60 dB

Slow controller

Sampling rate	488.28 kHz
Proportional gain	± 60 dB
Integrator crossover frequency	19.53 mHz to 1.953 kHz
Int. saturation crossover frequency	19.53 mHz to 1.953 kHz
Integrator gain range	Proportional gain to +60 dB
Differentiator crossover frequency	195.3 mHz to 19.53 kHz
Diff. saturation crossover frequency	195.3 mHz to 19.53 kHz
Differentiator gain range	Proportional gain to +60 dB

Saving data

Integrated oscilloscope

Acquisition mode	Normal, Precision[5]
Maximum sampling rate	500 MSa/s
Memory depth	16,384 Samples per channel 32.7 µs at 2 ns/div
Averaging (linear)	Off, 2 to 100 waveforms
Persistence	Off, 100 ms to 10 s, infinite
Interpolation	Linear, SinX/X, Gaussian

---

[5] Precision mode samples the waveform at the full rate and applies a finite impulse response (FIR) low-pass filter to attenuate noise above the usable bandwidth of the measurement sampling rate and prevent aliasing.