Lock-in Amplifier

Specifications Sheet

Lock-in amplifiers are versatile instruments that can be used to recover the magnitude and phase of weak oscillating signals buried under overwhelming noise. They are used in a vast range of applications including atomic physics, radio-frequency engineering, materials science, precision laser metrology and many more.

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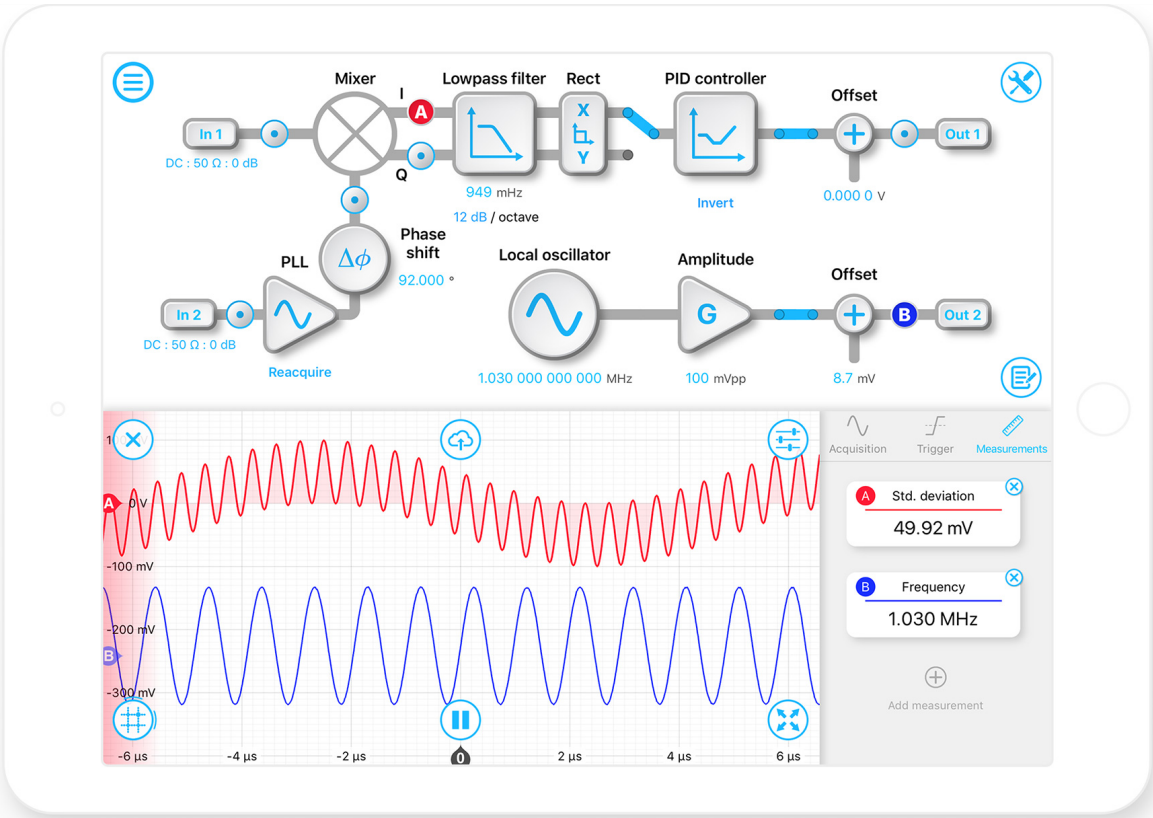
Description

Moku:Lab's digital Lock-In Amplifier supports dual-phase demodulation (XY/RΘ) from 1 mHz to 200 MHz with up to 120 dB of dynamic reserve. It also features an integrated 2-channel oscilloscope and data logger, enabling you to observe signals at up to 500 MSa/s and log data at up to 1 MSa/s.



Features

- Measure XY or RΘ simultaneously relative to an internal or external reference
- Observe signals at different stages in the signal processing chain using probe points
- Demodulate signals at frequencies up to 200 MHz
- Reveal signals obscured by noise with more than 120 dB dynamic reserve
- Log data from any probe point at up to 1 MSa/s

Specifications

Signal channel

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 attenuation	0 dB / 20 dB
Input range	10 V_{pp} with 20 dB input attenuation 1 V_{pp} with 0 dB input attenuation
Input noise	< 200 nV/√Hz above 1 kHz at 1 V_{pp} input range < 30 nV/√Hz above 100 kHz at 1 V_{pp} input range < 10 nV/√Hz above 1 MHz at 1 V_{pp} input range

External reference

Reference input

Input coupling	AC / DC
Input impedance	50 Ω / 1 MΩ
Frequency range	DC to 200 MHz
Input attenuation	0 dB / 20 dB
External reference modes	Direct, phase-locked
Direct demodulation	X = Rcosθ
Harmonic distortion	< -60 dBc

Phase-locked loop

PLL frequency range	10 kHz to 200 MHz
PLL tracking bandwidth	10 kHz, 2.5 kHz, 600 Hz, 150 Hz, 40 Hz, 10 Hz
Phase range	0 to 360°
Phase resolution	0.001°
Demodulation	XY / Rθ
Orthogonality	90° ± 0.000,002°

Internal reference

Internal reference waveforms

Waveform	Sine
Frequency range	1 mHz to 200 MHz
Frequency resolution	3.55 µHz
Phase range	0 to 360°
Phase resolution	0.001°

Internal reference waveforms

Demodulation	XY / Rθ
Harmonic demodulation	2F, 3F, ..., nF up to 200 MHz
Orthogonality	90° ± 0.000,002°
Output distortion	< -70 dBc for frequencies lower than 10 kHz < -60 dBc for frequencies greater than 10 kHz

Internal reference auxiliary output

Amplitude range	1 mV_{pp} to 1 V_{pp} into 50 Ω
Amplitude resolution	1 mV
Offset range	± 1 V
Output limit (AC + DC)	± 1 V
Amplitude accuracy	1%
Output impedance	50 Ω
Can be phase-locked to external 10 MHz timebase?	Yes

Demodulator

Demodulator characteristics

Sources	Internal reference oscillator, external direct, external with phase-locked loop
Types	Internal: XY / Rθ External direct: X = Rcosθ External with PLL: XY / Rθ
Filter mode	Low-pass filter
Filter cut-off frequency (-3dB)	300 mHz to 4.97 MHz
Filter time-constant	32 nanoseconds to 0.537 seconds
Filter slope	6, 12, 18, 24 dB per octave
Phase shift precision	0.001°
Dynamic reserve	> 120 dB

Signal output

Output characteristics

Modes	XY (cartesian mode); Rθ (polar mode); Auxiliary Oscillator
Number of output channels	2
Channel 1 output	X/R
Channel 2 output	Y/θ, auxiliary oscillator, or local oscillator
Output gain mode	Direct, PID[1]

[1] Only one output may have a PID controller enabled at a time

Output characteristics

Gain range (direct)	-80 dB to +160 dB (XY mode), ±80 (Rθ mode)
Phase scale (Rθ mode)	1 V/cycle
Output voltage offset	± 1 V into 50 Ω
Output voltage range (AC + DC)	± 1 V into 50 Ω
Output impedance	50 Ω
D/A conversion	16-bits, 1 GSa/s, 300 MHz analog bandwidth

PID controller

Controller frequency range	100 mHz to 10 MHz
Proportional gain	± 120 dB (XY mode), ± 60 dB (Rθ mode)
Integrator crossover frequency	1 Hz to 100 kHz
Int. saturation crossover frequency	1 Hz to 100 kHz
Integrator gain range	Proportional gain to +120 dB (XY mode), +60 dB (Rθ mode)
Differentiator crossover frequency	10 Hz to 1 MHz
Diff. saturation crossover frequency	10 Hz to 1 MHz
Differentiator gain range	Proportional gain to +120 dB (XY mode), +60 dB (Rθ mode)

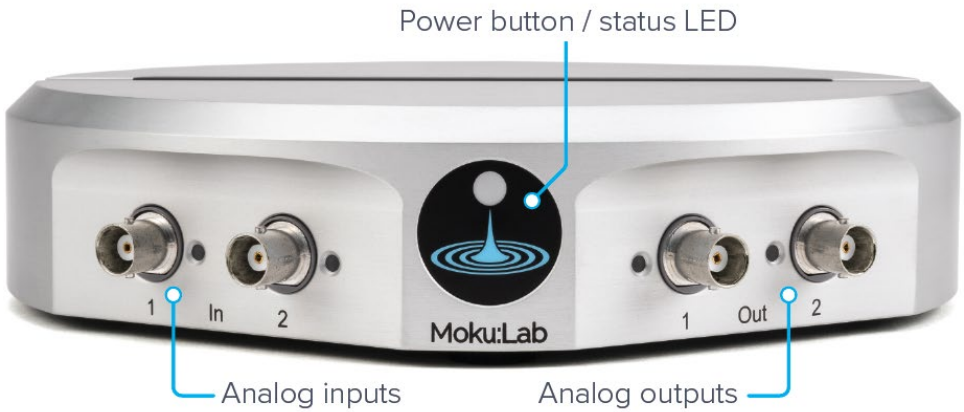
Saving data

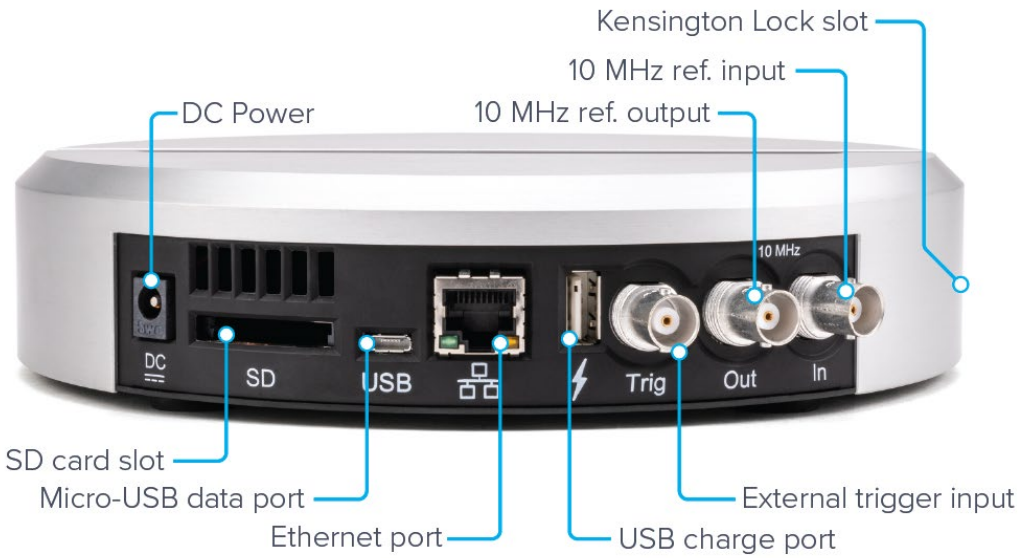
Saving data

File formats	Plain text: records data using a standard CSV format Binary: records data using a proprietary LI format.
Maximum sampling rate	1 MSa/s into RAM (format: *.li binary) (single channel) 500 kSa/s into RAM (format: *.li binary) (two channels) 100 kSa/s into SD card (format: *.li binary) 20 kSa/s into RAM / SD card (format: *.csv) **Note:** data saved to the Moku:Lab's on-board RAM will be lost when the device is rebooted.
Export modes	SD Card, Dropbox, E-mail and iCloud, My Files (iOS 11 or later)
Delayed log start time	Up to 240 hours
Log duration	1 second up to 240 hours

General connectivity

Connectivity	
Analog inputs	2 x BNC
Analog outputs	2 x BNC
Network	Ethernet (10/100 Base-T) Wi-Fi 802.11 b/g/n
USB data port	Micro-USB // For connecting the iPad to the Moku:Lab via USB Requires an Apple USB connection kit and Micro-USB to USB cable
USB charge port	Type-A // For iPad charging only (no data connectivity) Maximum power draw 10 W
SD card	16 GB class 10 supplied
External trigger input	BNC
10 MHz clock reference input	BNC
10 MHz clock reference output	BNC
DC Power	12 V (power module supplied)





For more specifications on Moku:Lab's suite of instruments

www.liquidinstruments.com/docs