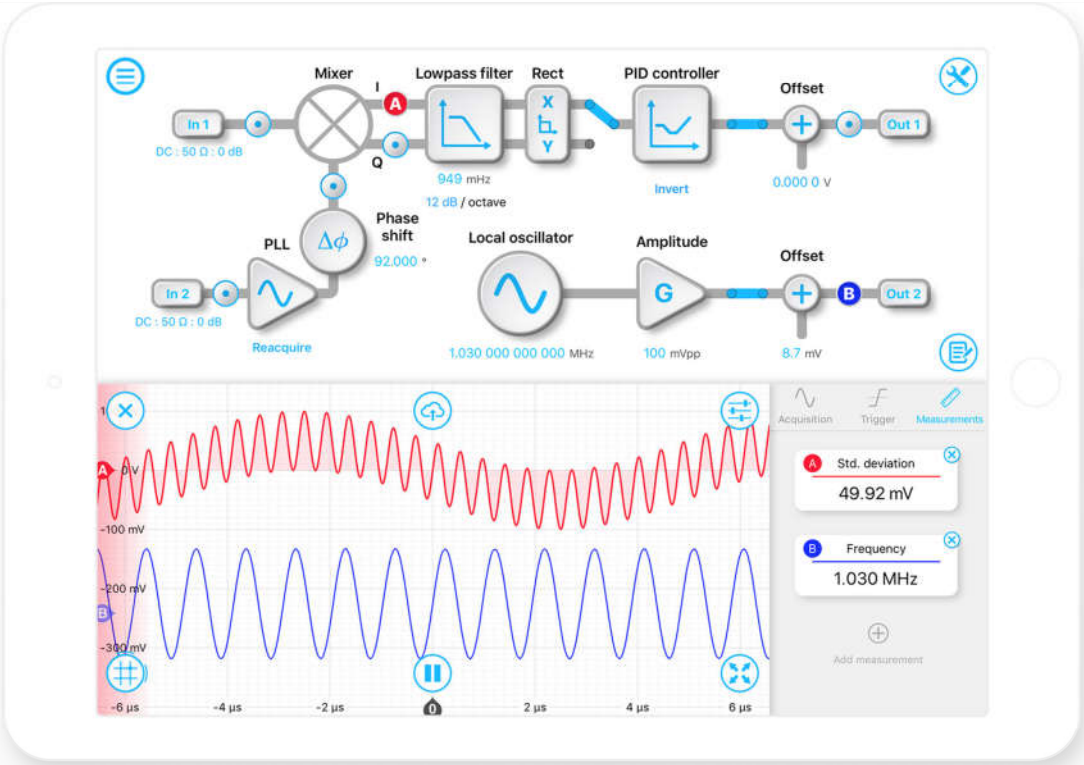
Lock-In Amplifier

Description

The Moku:LockInAmplifier is a versatile instrument with a number of operating modes, enabling you to reveal signals obscured by noise, accurately measure the phase of an incoming signal relative to an internal or external reference, or behave as a phase-sensitive detector and controller in a feedback loop. The Moku:Lab's fluid and intuitive user interface enables you to rapidly configure your lock-in amplifier for different types of measurements, monitor signals at different locations within the signal processing chain using probe points, and log data from any probe point in the block diagram at up to 1 MS/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 80 dB dynamic reserve
- Log data from any probe point at up to 1 MS/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 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	< 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 gain	-20 dB / 0 dB
External reference modes	Direct, phase-locked
Direct demodulation	X = Rcosθ
Harmonic distortion	< -60 dBc

Phase-locked loop

PLL frequency range	2 MHz to 200 MHz
PLL tracking bandwidth	10 kHz
Phase range	0 to 360°
Phase resolution	0.001°
Demodulation	XY / Rθ
Orthogonality	90° ± 0.000,002°

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

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°
Demodulation	XY / Rθ
Harmonic demodulation	2F, 3F, ..., nF up to 200 MHz
Concurrent demodulation	No
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, internal auxiliary 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)	237 mHz to 3.98 MHz
Filter time-constant	251 nanoseconds to 4.219 seconds
Filter slope	6 dB or 12 dB per octave
Phase shift precision	0.001°
Dynamic reserve	> 80 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 or auxiliary local oscillator
Output gain mode	Direct, PID[3]
Gain range (direct)	± 80 dB
Phase scale (Rθ mode)	0.8 V/cycle 0.127 V/radian 2.22 mV/degree
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 GS/s, 300 MHz analog bandwidth

PID controller

Controller frequency range	100 mHz to 10 MHz
Proportional gain	± 60 dB
Integrator crossover frequency	1 Hz to 100 kHz
Int. saturation crossover frequency	1 Hz to 100 kHz
Integrator gain range	Proportional gain to +60 dB
Differentiator crossover frequency	10 Hz to 1 MHz
Diff. saturation crossover frequency	10 Hz to 1 MHz
Differentiator gain range	Proportional gain to +60 dB

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

Saving Data

Saving data

File formats	Plain text: records data using a standard CSV format
	Binary: records data using a proprietary LI format for high-speed data logging. **Note:** data saved using the LI format must be converted to plain text using the LI file converter available here: https://github.com/liquidinstruments/lireader
Maximum sampling rate	1 MS/s into RAM (format: *.li binary) (single channel) 500 kS/s into RAM (format: *.li binary) (two channels) 100 kS/s into SD card (format: *.li binary) 20 kS/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)
Delayed log start time	Up to 240 hours
Log duration	1 second up to 240 hours