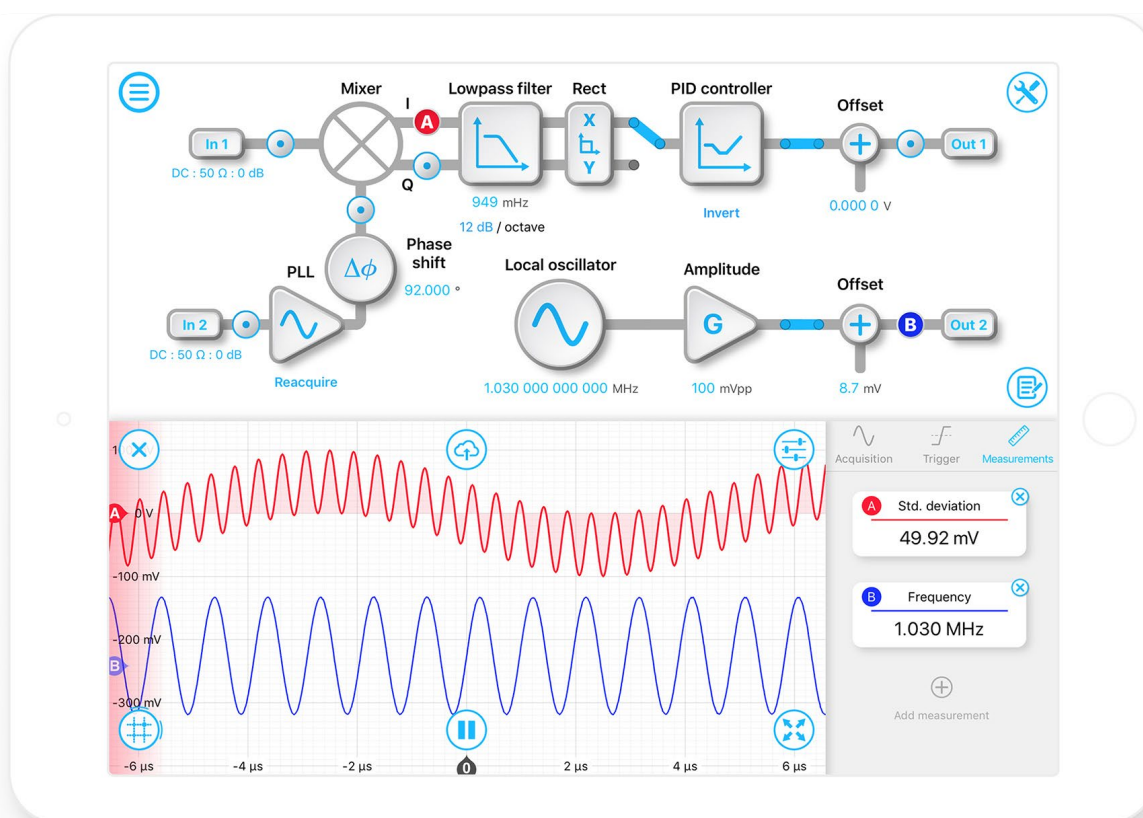




Lock-In Amplifier

Description

Moku:Lab's digital Lock-In Amplifier supports dual-phase demodulation (XY/R θ) from DC to 200 MHz with up to 100 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 R θ 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 MSa/s



Specifications

Signal channel

Signal input

Input coupling	AC / DC
Input impedance	50 Ω / 1 M Ω
AC coupling corner (-3 dB)	100 Hz into 50 Ω 30 Hz into 1 M Ω
Frequency range	DC to 200 MHz
Input gain ⁶	-20 dB / 0 dB / +24 dB / +48 dB
Gain accuracy	\pm 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/ \sqrt Hz above 1 kHz at 1 V _{pp} input range < 30 nV/ \sqrt Hz above 100 kHz at 1 V _{pp} input range < 10 nV/ \sqrt Hz above 1 MHz at 1 V _{pp} input range

External reference

Reference input

Input coupling	AC / DC
Input impedance	50 Ω / 1 M Ω
Frequency range	DC to 200 MHz
Input gain	-20 dB / 0 dB
External reference modes	Direct, phase-locked
Direct demodulation	$X = R\cos\theta$
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 / R θ
Orthogonality	90° \pm 0.000,002°

⁶ +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 μ Hz
Phase range	0 to 360°
Phase resolution	0.001°
Demodulation	XY / R θ
Harmonic demodulation	2F, 3F, ..., nF up to 200 MHz
Concurrent demodulation	No
Orthogonality	90° \pm 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	\pm 1 V
Output limit (AC + DC)	\pm 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 / R θ External direct: X = Rcos θ External with PLL: XY / R θ
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); R θ (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 ⁷
Gain range (direct)	± 80 dB
Phase scale (R θ 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 GSa/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

⁷ 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. 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 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
