SHFLI
8.5 GHz Lock-in Amplifier

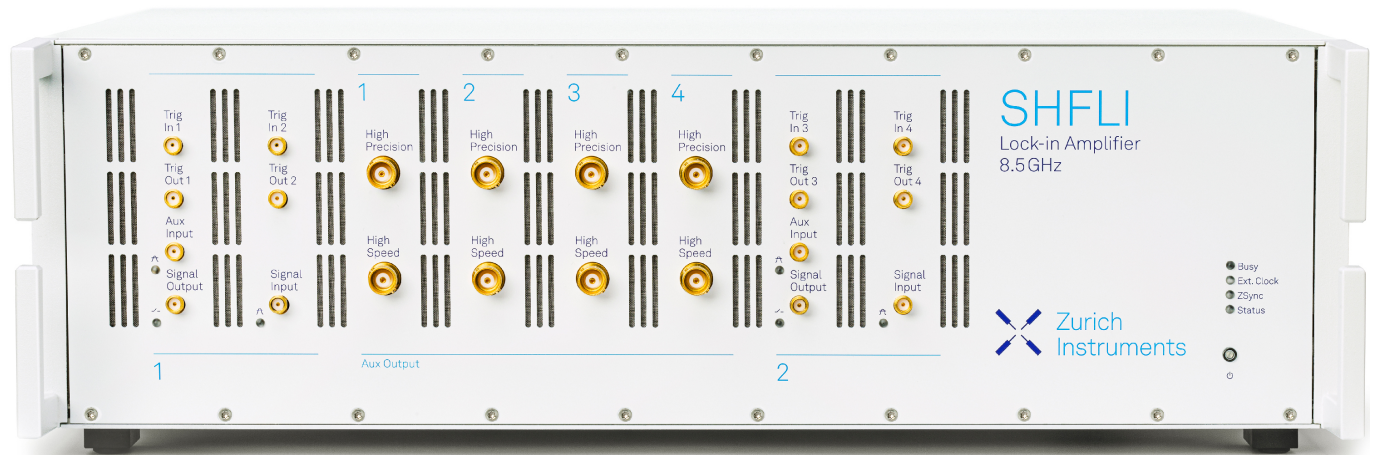Zurich Instruments

Dual channel microwave lock-in amplifier
Product Leaflet
Release date: September 2022

Introduction

The Zurich Instruments SHFLI Lock-in Amplifier brings the advantages of lock-in amplifiers – noise rejection, phase sensitivity, frequency tracking and more – to applications that operate at frequencies up to 8.5 GHz.

The SHFLI contains two physical channels that operate as independent lock-in amplifiers. Each one is equipped with 4 dual-phase demodulators that enable parallel multi-frequency analysis and with a 6 GSa/s signal generator for drive and reference signals. The demodulator filters can be tuned to give the best trade-off between noise rejection and measurement speed. The USB and gigabit ethernet digital interfaces offer continuous data transfer to the computer at up to 4 MSa/s while the 4 high-speed and 4 high-precision auxiliary outputs can convert the measurement results, with custom scaling and offset, into analog signals for integration with other instruments.

The SHFLI includes the LabOne® control software that makes setting it up easy and convenient thanks to its graphical user interface. It also provides firm control over the entire measurement toolset that comprises the lock-ins, a dual-channel oscilloscope with FFT, a parametric sweeper, a spectrum analyzer and much more. Additionally, all the functionality and data acquisition can be accessed through the major programming languages for ease of integration; LabVIEW™, MATLAB®, C, .NET and Python are supported.

The SHFLI's low input noise, its wide measurement window and its very fast time constant make it the ideal measurement tool even for the most demanding microwave applications.

Key Features

- Frequency Range: DC – 8.5 GHz
- Minimum demodulator time constant: 14 ns
- 2 independent lock-in units with signal generators
- 4 independent demodulators per lock-in unit
- 4 high-speed and 4 high-precision auxiliary outputs
- LabOne® toolset

Applications

The SHFLI can serve even the most demanding applications that require measurement and tracking of periodic signals, and device characterization and control up to 8.5 GHz.

- **Sensors:** MEMS, NEMS, quantum sensing, Surface Acoustic Waves
- **Optics:** mode-locked lasers, pump-probe spectroscopy, nano-optomechanics, optical-PLLs
- **Spin qubits:** RF-reflectometry, qubit readout

LabOne® Graphical User Interface

The LabOne® graphical user interface offers an intuitive approach to the SHFLI control and data visualization. Thanks to its tab design, all tools can run in parallel and be a maximum of 1 click away.

Sweeper: easy parametric scans
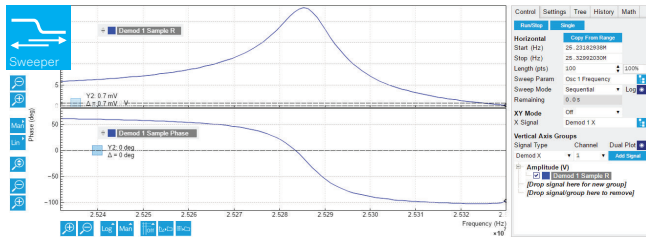
- Quickly characterize your devices in amplitude and phase and directly obtain important information such as their resonance parameters.
- Save time by acquiring multiple signals in parallel.
- Choose from a range of parameters, including: frequency, phase, amplitudes, DC offset and more.

## Lock-in control tab: all lock-in parameters and settings in one place
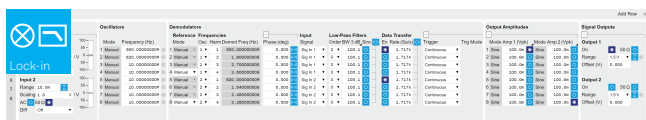
- Set up your measurement quickly and efficiently.
- Find and monitor all important lock-in amplifier parameters and settings in one tab.

## Data acquisition: choose the best tool for your needs
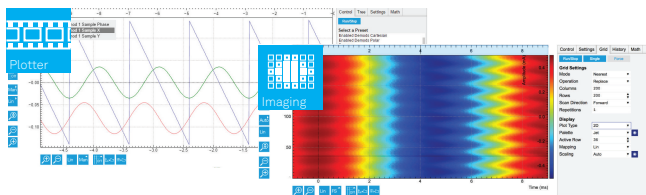
- Easy set-up of streaming and triggered data acquisitions at high data rate.
- Capture multiple data sources in parallel.
- Convert your traces into 2d images directly in the LabOne® GUI.
- Export data in CSV, MAT and HDF5®, and plots in PNG or SVG.

Scope: time- and frequency-domain input signal monitoring
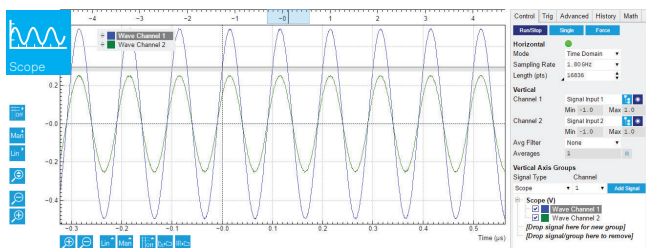
- Dual channel oscilloscope
- Cross-domain triggering
- Time- and frequency-domain views
- Multiple signal sources including signal inputs and trigger inputs

Spectrum: high-resolution spectral analysis
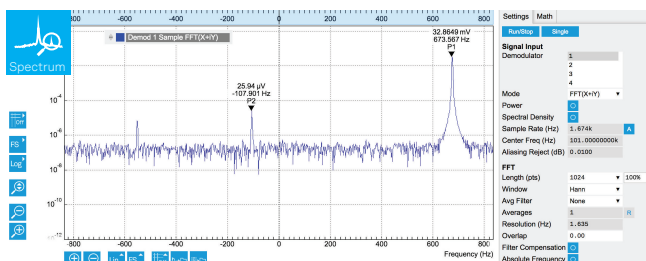
- Fast, high-resolution FFT spectrum analyzer of demodulated data
- Available spectrum modes: FFT(X+iY), FFT(R), FFT(Θ), FFT(f) and FFT((dΘ/dt)/2π)
- Access to amplitude, spectral density, and power spectrum

Learn more about LabOne® and watch the toolset videos.

Upgrade Options (coming in 2023)

SHFLI-MF Multi-Frequency Option

- Measure up to 8 arbitrary frequencies in parallel within the measurement window.
- Generate multi-tone signals with free choice of frequency, phase and amplitude.

This option opens the door to multi-frequency analysis: each demodulator can be set to a different arbitrary frequency inside the measurement window and can be assigned to any of the inputs, offering a wide range of additional configurations for measurement and signal generation.

SHFLI-PID Quad PID/PLL Controller Option

- Create advanced feedback loops with up to 4 PID controllers.
- Find the PID parameters quickly and easily with the Advisor and Auto Tune.

The 4 PID controllers are integrated into the lock-in and can take as inputs all measurement signals over the entire DC to 8.5 GHz range. The choice of output signals is equally large and it includes RF signal amplitude, frequency, phase, offset, auxiliary outputs and more. The LabOne PID Advisor and Auto-tune feature support you so you can achieve your desired feedback response in a very short amount of time.

SHFLI-MOD AM & FM Modulation Option

- Measure individually the carrier and sidebands of amplitude- and frequency-modulated signals.
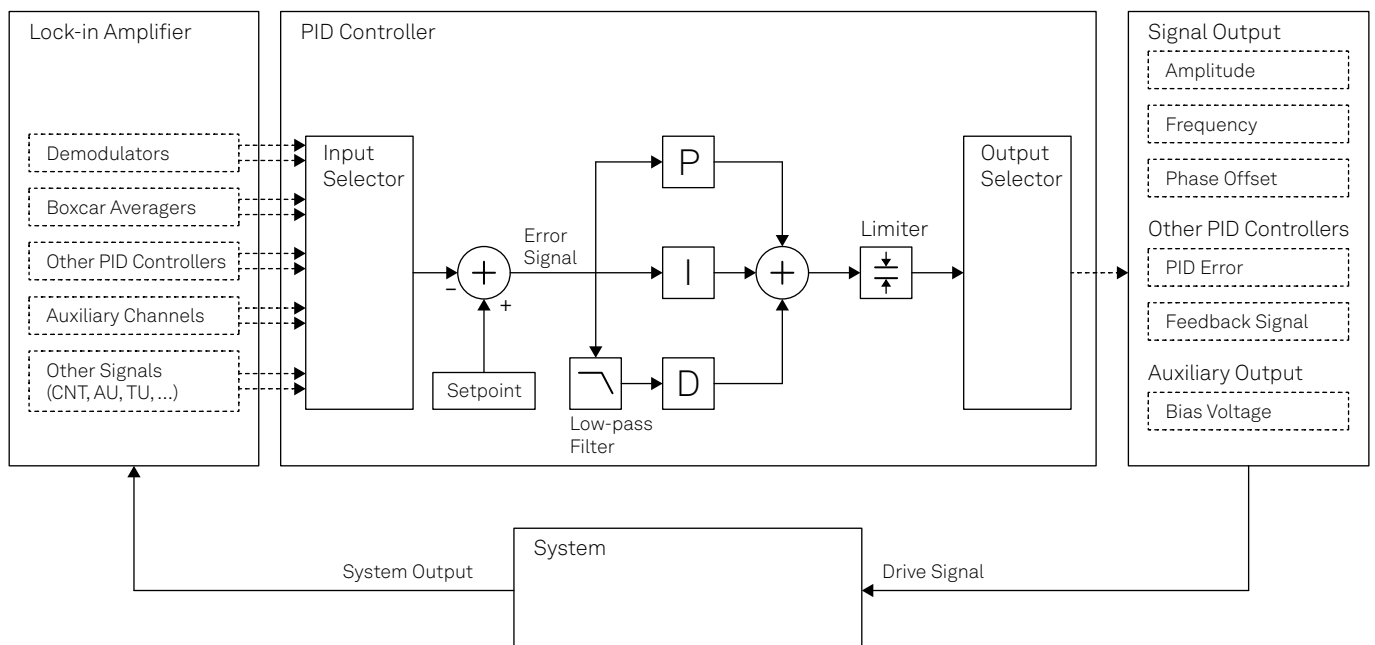- Avoid the bandwidth limitations of tandem demodulation.

Measure and generate up to 2 phase-coherent linear combinations of 2 oscillator frequencies. The parameters for each frequency component can be individually set.

Specifications

General

Dimensions	$449 \times 460 \times 145$ mm^3
	$17.6 \times 18.1 \times 5.7$ inch^3
Power supply	AC: 100 – 240 V, 50/60 Hz

Signal Inputs and Outputs

Frequency range	DC – 8.5 GHz
Analysis bandwidth	1 GHz (>0.8 GHz)
Impedance	50 Ω (Input/output)
Input noise floor	≤ 3.5nV/$\sqrt{\text{Hz}}$ (<0.8 GHz)
	≤ 2.5nV/$\sqrt{\text{Hz}}$ (>0.8 GHz)
Dynamic reserve	100 dB (typical)
Input ranges	10 mV$_{pk}$ – 1 V$_{pk}$ (<0.8 GHz)
	1 mV$_{pk}$ – 1 V$_{pk}$ (>0.8 GHz)
Output ranges	10 mV$_{pk}$ – 0.5 V$_{pk}$ (<0.8 GHz)
	10 mV$_{pk}$ – 1 V$_{pk}$ (>0.8 GHz)
D/A conversion	14 bit, 6 GSa/s

Demodulators

No. of demodulators	8 dual-phase
Continuous data rate	4 MSa/s (max)
Triggered data rate	50 MSa/s (max)
Time constant	14 ns – 21 s
Demodulator BW	3.2 mHz – 11 MHz
Filter slopes (dB/Oct)	6, 12, 18 and 24

Auxiliary & Others

Auxiliary Outputs (High precision)	4 Channels, ±4 V (in 50 Ω), 18 bit, 1 MSa/s, 200 kHz
Auxiliary Outputs (High speed)	4 Channels, ±4 V (in 50 Ω), 14 bit, 50 MSa/s, 25 MHz
Auxiliary Inputs	2 Channels, ±1.5 V, 14 bit
Triggers	4 inputs, 4 outputs
Clock (in/out)	10 MHz or 100 MHz
Connectivity	USB 3.0, LAN 1GbE

Your Notes

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Visit the SHFLI webpage to learn more about the product and watch the overview video.

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