UHFLI
600 MHz Lock-in Amplifier

2 Input Channels, 2 Signal Outputs
Ultra-low time constant

Product Leaflet
Release Date: June 2017

Key Features

- ▬ DC to 600 MHz, 1.8 GSa/s, 12 bit
- ▬ 4 nV/√Hz input noise, 100 dB dynamic reserve, 30 ns minimum time constant
- ▬ 8 demodulators, up to 8 oscillators
- ▬ LabOne® Toolset: Scope, Imaging Module, FFT Spectrum Analyzer, Parametric Sweeper
- ▬ APIs for LabVIEW®, .NET, MATLAB®, C and Python

Summary

The Zurich Instruments UHFLI is a ultra-high-frequency dual channel lock-in amplifier that sets the industry standard in terms of frequency range, demodulation bandwidth, integrated tool set and control software. To meet the requirements of the most demanding applications the basic instrument functionality can be extended with the following options:

- ▬ UHF-BOX Boxcar Averager
- ▬ UHF-AWG Arbitrary Waveform Generator
- ▬ UHF-DIG Digitizer
- ▬ UHF-MF Multi-frequency
- ▬ UHF-PID Quad PID/PLL Controller
- ▬ UHF-MOD AM/FM Modulation
- ▬ UHF-CNT Pulse Counter

These options are upgradeable in the field. For applications that require a high-accuracy frequency reference the UHF-RUB Rubidium atomic clock is available as a hardware option.

Description

Signal Inputs and Outputs

The two 12 bit signal inputs exhibit a minimum noise of 4 nV/√Hz. The 1.8 GSa/s sampling rate ensures sufficient aliasing suppression and high SNR. Linear combinations of multiple sinusoids can be generated at 14 bit resolution in multiple ranges up to ±1.5 V. The UHF-MF Multi-frequency option increases the number of oscillators from 2 to 8. Arbitrary waveforms can be generated with the UHF-AWG option installed.

Demodulators and Filters

The filters of all 8 dual-phase demodulators can be individually configured. The digital filters offer a much higher dynamic reserve, zero drift, precise phase shifts, and perfect orthogonality in contrast to their analog counterparts. All demodulated signals can be output with a bandwidth of up to 5 MHz on 4 auxiliary outputs with 16 bit resolution.
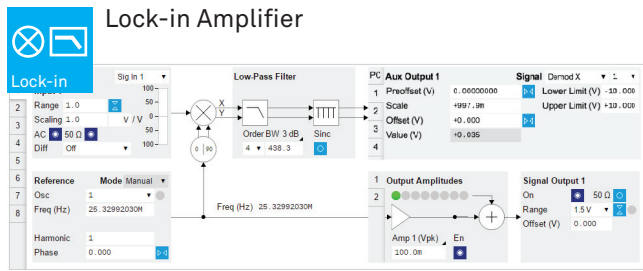
LabOne is Instrument Control

The UHFLI includes the LabOne control software. Thanks to the latest web server technology, the user interface can be easily accessed from any browser. With LabOne the computer is the cockpit for instrument control, data capture, analysis and storage where every setting is no more than 2 clicks away. The functionality includes an Oscilloscope, a Spectrum Analyzer, an Imaging Module, a Plotter and a Parametric Sweeper for quick and easy measurement automation and much more.

Choice of APIs

For convenient integration into existing control environments, programming interfaces for LabVIEW, .NET, MATLAB, C and Python are provided.

LabOne User Interface

Lock-in Amplifier

Every demodulator has a graphical representation in the form of a block-diagram for intuitive instrument control. In addition, the overview tab allows the control of all demodulators, signal inputs and signal outputs from a single panel.

Oscilloscope with FFT
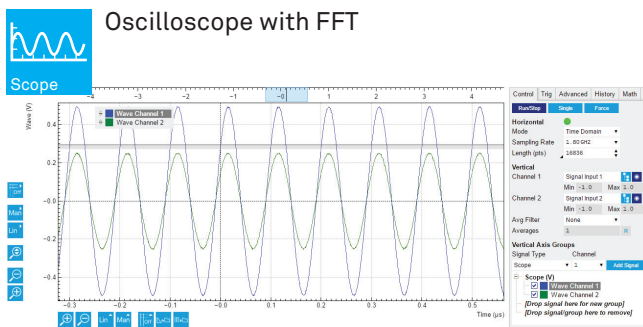
Time and frequency domain analysis of signal inputs and trigger signals with the following key features:

- Full input A/D resolution: 12 bit, 1.8 GSa/s
- Cursor math: Location, Area, Tracking, Wave, Peak, Histogram
- 2 independent channels, 128 MSa segmented waveform memory with UHF-DIG option

Parametric Sweeper
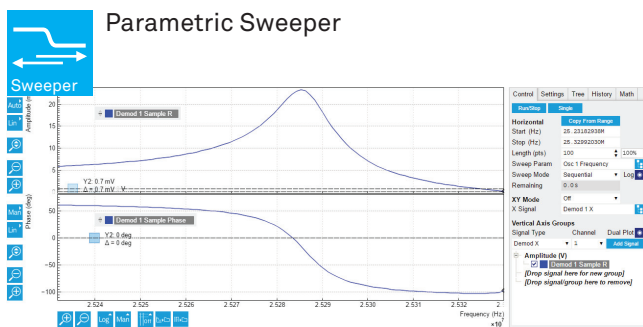
The Parametric Sweeper enables the user to automate measurements by scanning instrument parameters over a defined range with a freely adjustable number of scan steps, either linearly or logarithmically. The recording of frequency dependence as well as the variation of bias voltages or test signal amplitudes can be easily automated. A variety of application modes help the user to measure with optimum settings and get the most accurate results in a minimum of measurement time without manual tweaking.

- Sweep parameters: frequency, phase shift, output amplitude, signal offset, etc.
- Frequency response analyzer (Bode plots)
- Application modes: FRA, Noise, 3-Omega, etc.
- Normalization, auto bandwidth, averaging and standard deviation

FFT Spectrum Analyzer
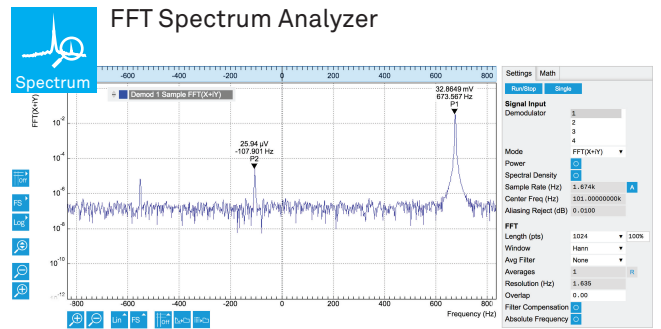
The Spectrum Analyzer takes any of the demodulators' signals or frequency as an input and applies a fast Fourier transform. The main features are:

- Modes: FFT(X+iY), FFT(R), FFT(Θ), FFT(f) and FFT(($d\Theta/dt)/2\pi$)
- Auto bandwidth, auto span, filter compensation
- 4 different FFT window functions
- Amplitude, spectral density and power spectrum

Plotter & Software Trigger
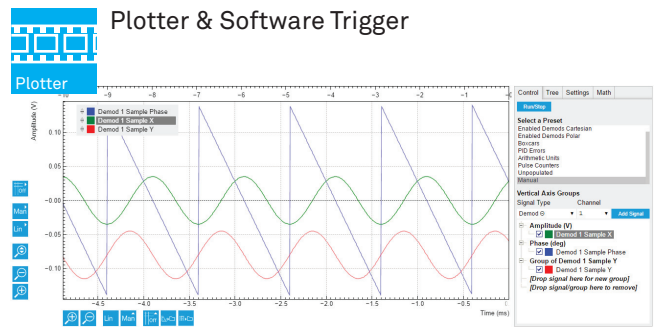
The Plotter and Software Trigger display multiple measurement data in the time domain. The Plotter displays the data continuously and the Software Trigger captures and displays individual shots based on numerous internal and external trigger conditions.

- Multi-trace support with axis grouping for flexible axis scaling
- Polar and Cartesian data format
- Cursor math: Location, Area, Tracking, Wave, Peak, Histogram
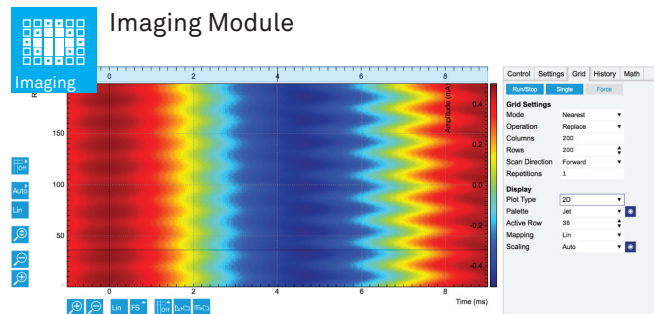
Imaging Module

The imaging module converts any of the measurement signals into images and supports:

- A clear definition of a "line" based on a line trigger and a user-defined duration
- Resampling to a defined number of pixels with a suitable interpolation and/or averaging
- Store images in different file formats

Upgrade Options

UHF-MF Multi-frequency

- 8 oscillators instead of 2
- Arbitrary choice of frequency
- Output adder for 8 sinusoidal signals

The UHF-MF option adds another 6 internal oscillators to the instrument and allows a free choice of frequency for each of the 8 demodulators. This extends the capability of the Instrument by offering a wide range of additional configurations for measurement and signal generation.

UHF-DIG Digitizer
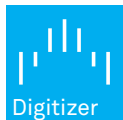
- Dual-trace oscilloscope with FFT
- 128 MSa memory per channel
- Segmented memory
- Fast continuous data streaming

The combination of Lock-in amplifier, AWG and Digitizer in one instrument enables a wide range of new measurement opportunities utilizing continuous streaming, sophisticated cross-domain triggering and a segmented 128 MSa memory for each of the 2 Scope channels.

UHF-PID Quad PID/PLL Controller

- 4 independent PID controllers
- 300 kHz maximum loop filter bandwidth
- LabOne PID Advisor and Auto-tune
- ±64 π phase-unwrap

The 4 PID controllers are seamlessly integrated into the lock-in and can take all input and measurement signals as inputs and provide feedback via signal amplitudes, phase shifts, signal offsets, auxiliary outputs and more. The LabOne PID Advisor and Auto-tune features support you to achieve locking quickly and with high performance.
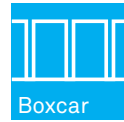
UHF-MOD AM/FM Modulation

- AM and FM modulation/demodulation
- Single sideband operation
- Higher harmonics of carriers and higher order sidebands

Measure at up to 2 phase coherent linear combinations of 2 oscillator frequencies. The filter for each frequency component can be individually configured.

UHF-BOX Boxcar Averager

- 2 Boxcar units
- Baseline suppression
- 2 Periodic Waveform Analyzers (PWA)
- Zero acquisition dead time

The UHF-BOX is the first fully digital boxcar averager enabling a performance step-up analyzing non-sinusoidal signals with small duty cycles. It operates as a high speed digitizer synchronized to an oscillator and therefore captures every sample without any dead time while rejecting all non-periodic signal components. With the Periodic Waveform Analyzer (PWA) you can visualize the averaged signal over a single or multiple periods and set the boxcar and the baseline suppression windows.

UHF-CNT Pulse Counter

- 4 counter modules
- 225 MHz maximum count rate
- Adjustable discriminator level
- Background subtraction

The UHF-CNT Pulse Counter features analysis of up to 4 pulse trains in parallel, enabling event based measurements, e.g. photon detection using photo-multiplier tubes. There are five distinct modes of operation and each channel offers an adjustable discriminator. Through the cross-domain trigger, branching conditions for the UHF-AWG can be defined based on counter values, enabling ultra-fast feed-forward loops for quantum error correction.

UHF-AWG Arbitrary Waveform Generator

- Dual 600 MHz AWG
- 600 MHz bandwidth, 1.8 GSa/s
- 14-bit vertical resolution
- Amplitude modulation

The UHF-AWG option brings state-of-the-art arbitrary waveform generator (AWG) capabilities to the UHFLI, the world's fastest and most advanced lock-in amplifier. The result is a very powerful combination of complex signal generation and analysis tools conveniently combined in LabOne®, the intuitive and platform-independent instrument control software. The figure below shows a dual-channel AWG signal captured with the UHF-DIG Digitizer using the internal cross-domain trigger.
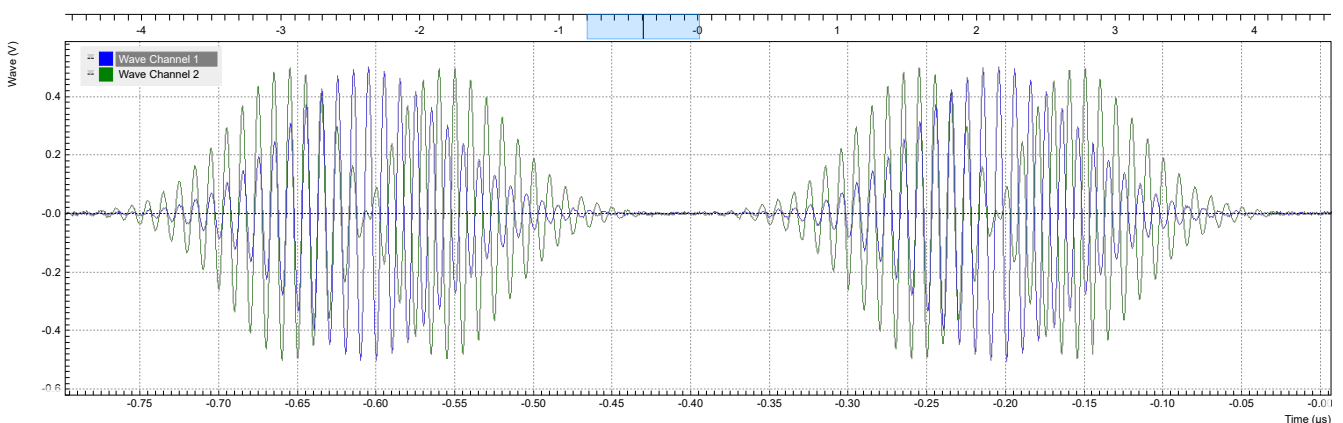
Specification

General

Dimensions	45 × 35 × 10 cm (19" rack) 17.7 × 13.6 × 3.9 inch
Weight	6.4 kg
Power supply	AC: 100 – 240 V, 50/60 Hz
Connectors	BNC on front panel SMA on back panel

Signal Inputs

Frequency range	DC – 600 MHz
Input impedance	50 Ω or 1 MΩ ‖ 18 pF
Input voltage noise	4 nV/√Hz (> 100 kHz)
Dynamic reserve	100 dB
Input full range sensitivity	1 nV to 1.5 V
A/D conversion	12 bit, 1.8 GSa/s

Signal Outputs

Frequency range	DC – 600 MHz
Output ranges	±150 mV, ±1.5 V (high-Z) −12.5 dBm, 7.5 dBm (50 Ω)
D/A conversion	14 bit, 1.8 GSa/s

Demodulators & Reference

No. of demodulators	8 dual-phase
No. of oscillators	2 (8 with UHF-MF)
Output sample rate	1 GbE: 1.6 MSa/s (max) USB: 400 kSa/s (max) Aux Outputs: 28 MSa/s
Time constant	30 ns to 76 s
Measurement bandwidth	80 µHz to 5 MHz
Filter slope (dB/Oct)	6, 12, 18, 24, 30, 36, 42, 48
Phase resolution	1.0 µdeg
Frequency resolution	6 µHz
Reference and trigger	2 bidirectional, 2 input, 2 output connectors

Auxiliary & Others

Auxiliary Outputs	4 channels, ±10 V, 16 bit, 28 MSa/s, X, Y, R, θ, f
Auxiliary Inputs	2 channels, ±10 V, 16 bit, 400 kSa/s
Connectivity	USB 2.0, LAN 1GbE
Clock	10 MHz input and output
Digital I/O	4× 8 bit, bidirectional