

Zurich  
Instruments

# HF2LI 50 MHz Lock-in Amplifier

2 Input Channels, 2 Signal Outputs  
High dynamic reserve, low noise

Product Leaflet  
Release date: June 2017

## Key Features

- DC – 50 MHz, 210 MSa/s, 14 bit
- 5 nV/√Hz input noise, 120 dB dynamic reserve, 1 μs minimum time constant
- 6 demodulators, up to 6 oscillators
- LabOne® Toolset: Scope, Parametric Sweeper, Imaging Module, FFT Spectrum Analyzer
- APIs for LabVIEW®, .NET, MATLAB®, C and Python

## Summary

The Zurich Instruments HF2LI is a high-frequency dual channel lock-in amplifier that uses the latest hardware and software technologies to provide industry leading specification and functionality. The dynamic reserve of 120 dB sets the benchmark in the 50 MHz frequency range. In many setups a single HF2LI replaces multiple conventional instruments.

The basic instrument functionality can be extended with the following upgrade options:

- HF2LI-MF Multi-frequency
- HF2LI-PID Quad PID Controller
- HF2LI-PLL Dual Phase-locked Loop
- HF2LI-MOD AM/FM Modulation

These options are upgradable in the field. For current measurements we offer the HF2TA Current Amplifier as an active probe that can be placed close to the setup, e.g. for 4-probe measurements.

## Description

### Signal Inputs and Outputs

The two 14 bit signal inputs exhibit a minimum noise of 5 nV/√Hz. The 210 MSa/s sampling rate ensures sufficient aliasing suppression and high SNR. Linear combinations of up to 6 sinusoids can be output at a resolution of 16 bit in multiple ranges up to ±10 V. The amplitude, frequency,



and the phase shift of each component can be controlled with the HF2LI-MF Multi-frequency option installed.

### Demodulators and Filters

All filter properties of the 6 dual-phase demodulators can be individually configured, including the time constants (1 μs to 500 s) or bandwidths (80 μHz to 200 kHz) and filter orders (1<sup>st</sup> to 8<sup>th</sup>). The digital filters offer a much higher dynamic reserve, zero drift, precise phase shifts, and perfect orthogonality in contrast to their analog counterparts.

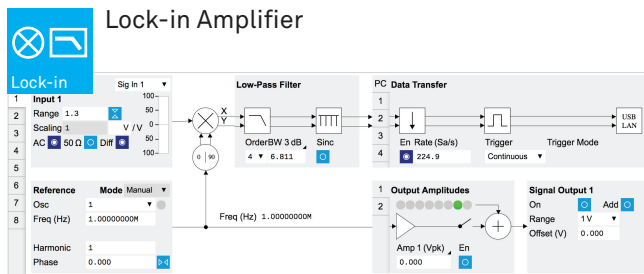
### LabOne is Instrument Control

The HF2LI 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.

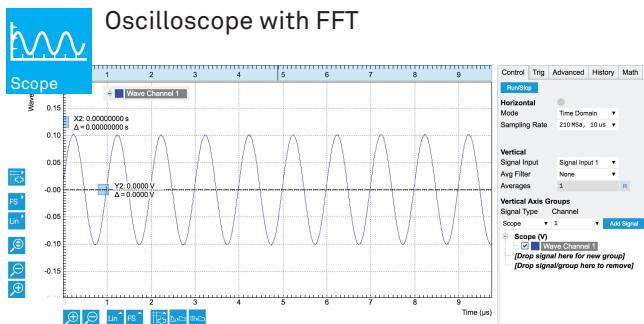
### Choice of APIs

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

# LabOne User Interface

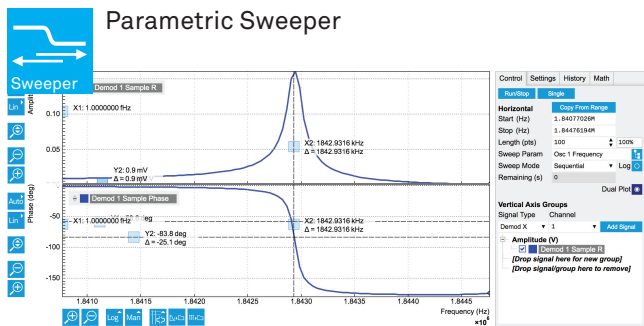


Every demodulator has a graphical representation in the form of a block-diagram for intuitive instrument. In addition, the overview tab allows the control of all demodulators, signal inputs and signal outputs from a single panel.



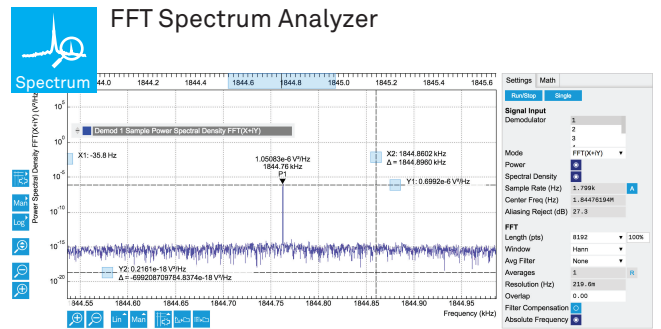
Time and frequency domain analysis of signal inputs and trigger signals with the following key features:

- Signal sources: signal inputs, signal outputs, etc.
- Multiple trigger sources and trigger methods
- 2048 samples of memory



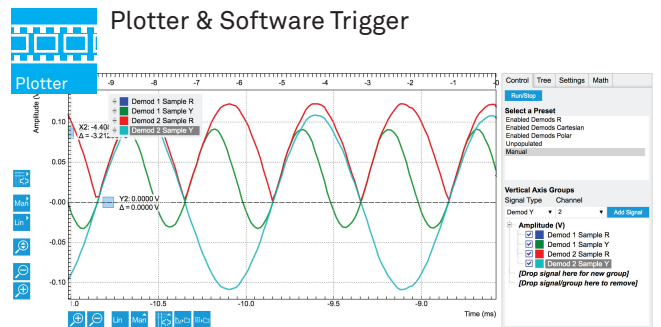
The Parametric Sweeper enables the user to automate measurements by scanning instrument parameters over a defined range with a freely adjustable number of scan steps, either linearly or logarithmically. The recording of frequency dependence as well as the variation of bias voltages or test signal amplitudes 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



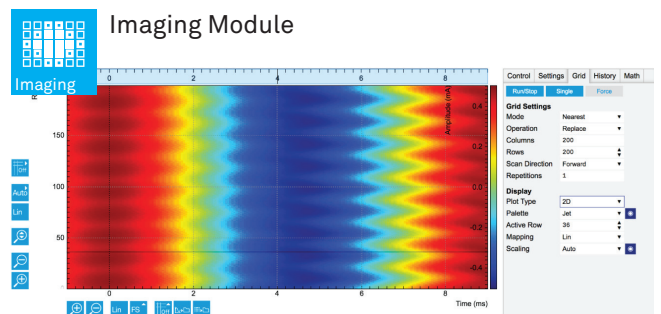
The Spectrum Analyzer takes any of the demodulators' signals or frequency as an input and applies a fast Fourier transform. The main features are:

- Modes: FFT(X+iY), FFT(R), FFT(θ), FFT(f) and FFT((dθ/dt)/2π)
- Auto bandwidth, auto span, filter compensation
- 4 different FFT window functions
- Amplitude, spectral density and power spectrum



The Plotter and Software Trigger display multiple measurement data in the time domain. The Plotter displays the data continuously and the Software Trigger captures 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



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

## HF2LI-MF Multi-frequency



- 6 oscillators instead of 2
- Signal input switch matrix for all 6 demodulators
- Up to 6 frequencies on each output

Increase the numbers of oscillators to analyze each of the signal inputs at up to 6 arbitrary frequencies simultaneously. Use linear combinations of the 6 demodulator frequencies freely configured in terms of amplitude and phase.

## HF2LI-PLL Dual Phase-locked Loop



- 50 kHz maximum loop filter bandwidth
- LabOne PLL Advisor
- Best-in-class harmonic input and harmonic output distortion

The 2 PLL controllers can utilize each of the 6 demodulators as a fully configurable phase detector. The bandwidth is tunable over a wide range and the frequency shift can be output with an offset and scaling factor to any of the 4 auxiliary outputs. The LabOne PLL Advisor supports you to achieve locking quickly and with high performance.

## HF2LI-PID Quad PID Controller



- 5 kHz maximum loop filter bandwidth
- LabOne PID Advisor
- Basic arithmetic unit
- Set point: toggle, external, cascaded

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 helps finding a suitable set of parameters quickly.



## HF2TA Current Amplifier



- Up to 50 MHz signal bandwidth
- 2 independent amplification channels
- Gain range 100 V/A to 100 MV/A
- Low noise and low input leakage

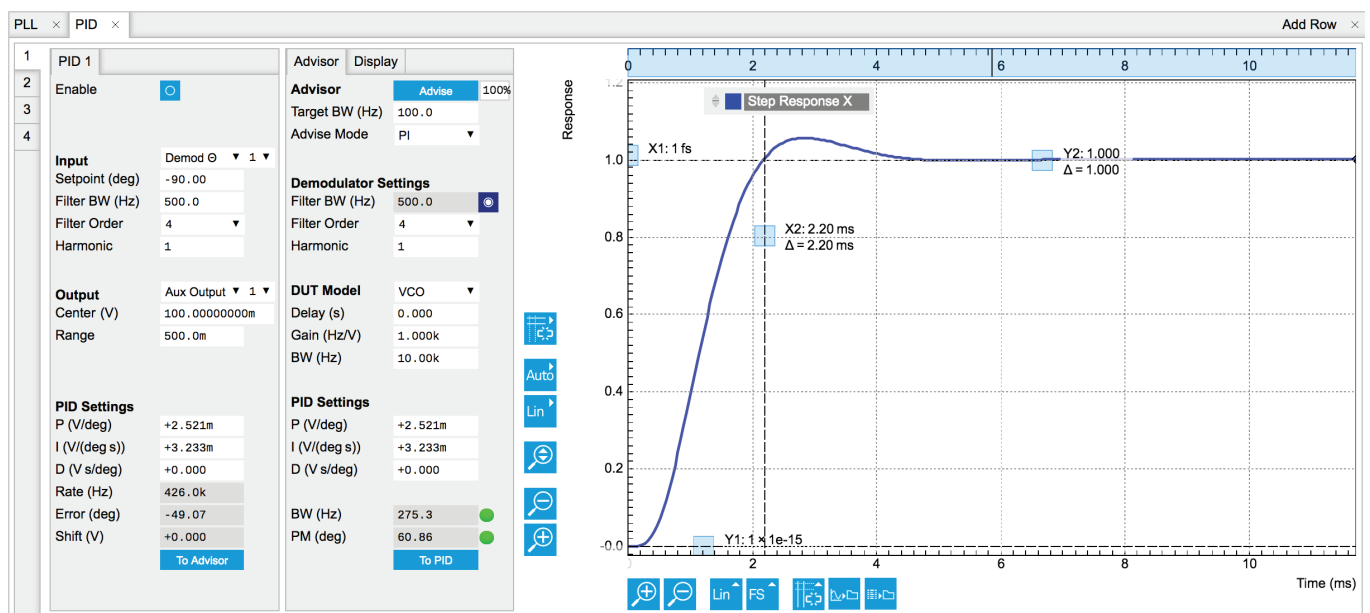
The HF2TA dual channel current amplifier converts up to 2 input currents into corresponding output voltages in the frequency range up to 50 MHz. This device is an active probe which can be conveniently placed close to the measurement setup. It is powered through the HF2LI and controlled with the LabOne software.

## HF2LI-MOD AM/FM Modulation



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

The two modulation units generate a carrier and two sidebands each. The filter settings for each frequency component can be individually set.



Each of the 4 PID controllers has a dedicated tab with the main controller settings in the left section, the DUT model settings and auto-tune further to the right and a large diagram to see the modelled transfer function or step-response.

# Specification

## General

Dimensions	45 × 35 × 10 cm (19" rack) 11.1 × 9.2 × 4 inch
Weight	6.2 kg; 8.4 lbs
Power supply	AC: 100 – 120 V; 220 – 240 V 50/60 Hz

## Signal Inputs

Frequency range	DC to 50 MHz
Input impedance	50 Ω or 1 MΩ    20 pF
Input voltage noise	5 nV/√Hz (> 10 kHz)
Dynamic reserve	120 dB
Input range	±3.3 V
Input AC range	±1.5 V (DC coupling)
A/D conversion	14 bit, 210 MSa/s

## Signal Outputs

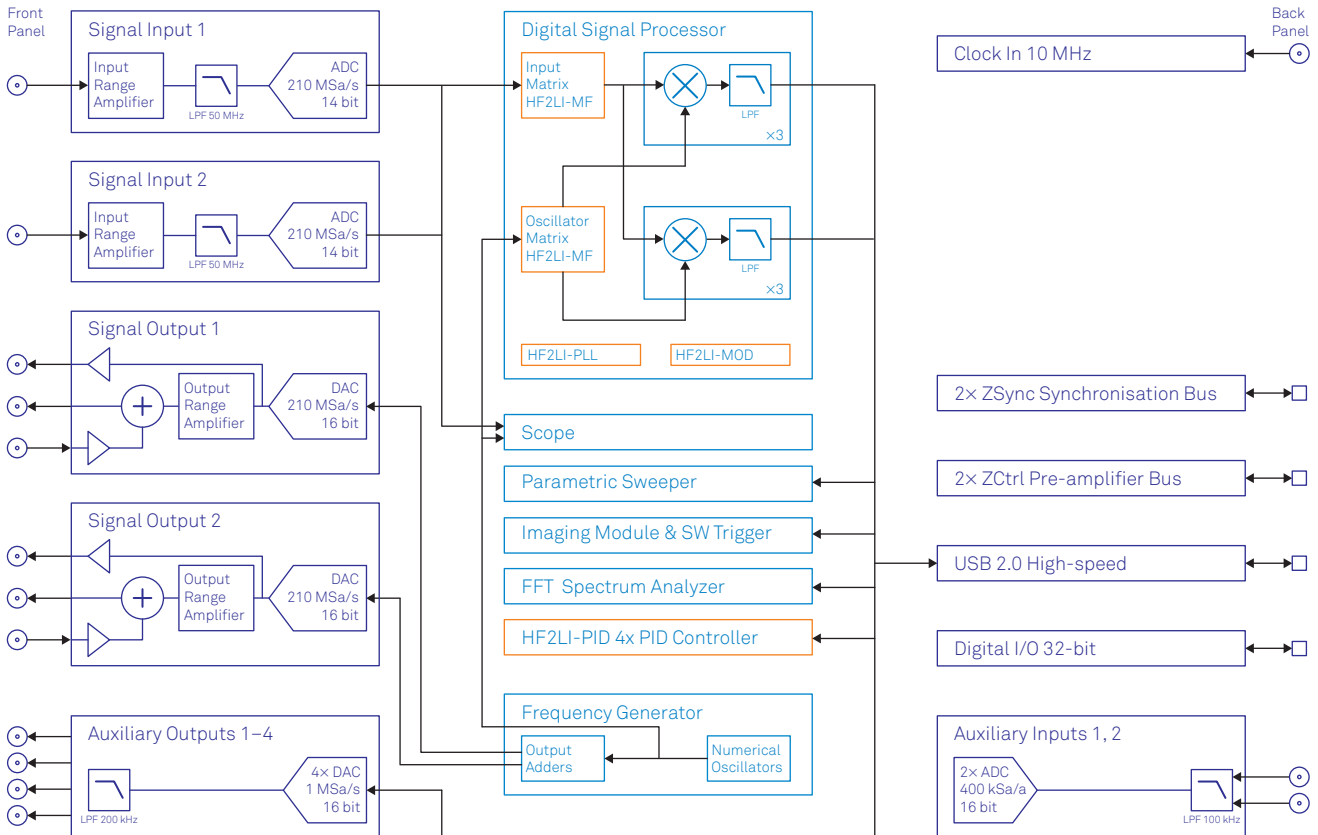
Frequency range	DC to 50 MHz
Output ranges	±10 mV, 100 mV, 1 V, 10 V
Signal adder	±10 V, DC to 50 MHz
D/A conversion	16 bit, 210 MSa/s

## Demodulators & Reference

Number of demodulators	6 dual-phase
Number of oscillators	2 (6 with HF2LI-MF)
Output sample rate	USB: up to 460 kSa/s Auxiliary outputs: 1 MSa/s
Time constant, Meas. bandwidth	1 μs to 500 s, 80 μHz to 200 kHz
Filter slope (dB/Oct)	6, 12, 18, 24, 30, 36, 42, 48
X, Y, R, θ	64 bit full range
Phase resolution	1 μdeg
Frequency resolution	0.7 μHz

## Auxiliary & Others

Auxiliary Outputs	4 BNC, ±10 V, 16 bit, 1 MSa/s, offset, scaling
Auxiliary Inputs	2 BNC, ±10 V, 16 bit, 400 kSa/s; 100 kHz bw
Digital I/O	16 bit input, 16 bit bidirectional, 50 MHz
Other interfaces	clock input, USB 2.0, 2× ZCtrl, 2× ZSync



**Option** Functionality displayed in orange boxes requires one or multiple upgrade options.