



Overview

The OE1311/OE1351/OE1301 module lock-in amplifier is the latest core technology product, featuring high performance and cost-effectiveness. Utilizing digital modulation, output filter, and high-precision 24-bit analog-to-digital converter (ADC) with the new Zynq architecture, it can accurately and quickly measure effective signal components submerged in high noise.

Moreover, the OE1311/OE1351/OE1301 lock-in amplifier can simultaneously measure the amplitude and phase information of the input signal. It's comparable to the top technology of the international industry in terms in core parameters such as measurement accuracy, operating frequency range, signal-to-noise ratio, and dynamic reserve. Newly developed functions such as multi-harmonic measurement, oscilloscope, and spectrum analysis enable the OE1311/OE1351/OE1301 to meet various scientific and industrial applications.

Input Signal Channel

With the low-noise analog front-end amplifier, the OE1311/OE1351/OE1301 lock-in amplifier can effectively handle differential or single-ended signals with an equivalent input noise of $5 \text{ nV}/\sqrt{\text{Hz}}$. The input impedance is $10 \text{ M}\Omega$, and the full-scale sensitivity is 1 nV to 5 V . Additionally, the OE1311/OE1351/OE1301 can measure input current signals with a front-end current gain of 10^6 V/A . The dynamic range exceeds 120 dB , allowing adjustment of the internal programmable gain amplifier based on the amplitude of the input signal to change the system's dynamic reserve. The high-precision 24-bit ADC's sampling rate is 4 MSPS , and the anti-aliasing filter in front of the ADC can effectively

Key Features

- Frequency Range: DC-100kHz\500kHz\1MHz
- Full-scale Sensitivity: $1 \text{ nV} - 5 \text{ V}$
- Time Constant: $1 \mu\text{s} - 3 \text{ ks}$
- Dynamic Reserve: $>120 \text{ dB}$
- Auto Phase/Range
- Simultaneous multi-harmonic measurement
- Spectrum Analysis and Oscilloscope

Reference Signal Channel

The OE1311/OE1351/OE1301 digital lock-in amplifier's reference signal can be a sine wave or square wave chosen based on the user's needs or an internally synthesized reference signal. When it is set to the internal reference signal mode, the instrument's high-precision oscillator and digital synthesis algorithm generate sine wave signals for multiplication with the input signal, with almost no phase noise impact. The digital phase shifting technology achieves a phase resolution of $1 \mu\text{deg}$. The internal reference signal mode operates in the frequency range of DC to $100 \text{ kHz}/500 \text{ kHz}/1 \text{ MHz}$. The OE1311/OE1351/OE1301 can also use an external reference signal mode, with sine wave signals and TTL logic levels as external references. The rising edge or falling edge of the external reference signal triggers the internal digital phase-locked loop (DPLL). Based on the reference signal's frequency, the OE1311/OE1351/OE1301 can detect harmonic signals up to 65535 times the fundamental frequency, but the maximum harmonic frequency can not exceed the operating frequency of $100 \text{ kHz}/500 \text{ kHz}/1 \text{ MHz}$.

Filter

The time constant of the OE1311/OE1351/OE1301 can be set between $1 \mu\text{s}$ and 3 ks . The output low-pass filter's roll-off rate can be set to 6, 12, 18, 24, 30, 36, 42 and 48 dB/oct. This low-pass digital filter is implemented using an infinite impulse response (IIR) filter structure with a signal processing sampling rate of 4 MHz . The digital modulation method and filter structure of the OE1311/OE1351/OE1301 ensure higher dynamic reserve ($>120 \text{ dB}$), precise phase (absolute phase error $<1 \text{ deg}$), zero DC drift and good

prevents signal aliasing.

Signal Generator

Based on a 16-bit digital-to-analog converter (DAC), the OE1311/OE1351/OE1301 can generate sine wave signals with a frequency range of DC to 100 kHz/500 kHz/1 MHz. The phase of the signal is related to the instrument's internal oscillator and it's amplitude can be set. The maximum amplitude of the sine wave signal generated by the OE1311/OE1351/OE1301 signal generator is 5 Vrms.

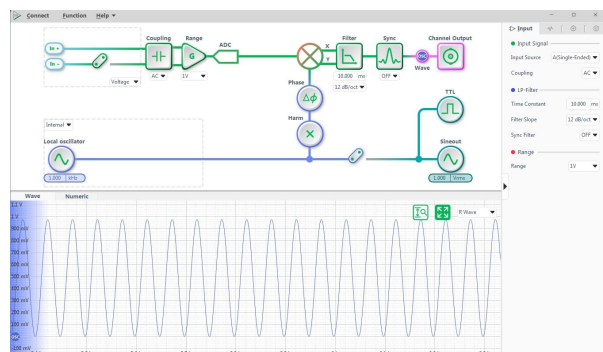
Communication Interface

The OE1311/OE1351/OE1301 features a standard 1000 Mbps RJ45 Ethernet port and a RS232 serial port (optional XH2.54-4PIN Port with TTL logic level).

Users can effectively use all testing functions of the OE1311/OE1351/OE1301, including setting reasonable control parameters of the instrument and reading the data measured by the instrument.

PC Software

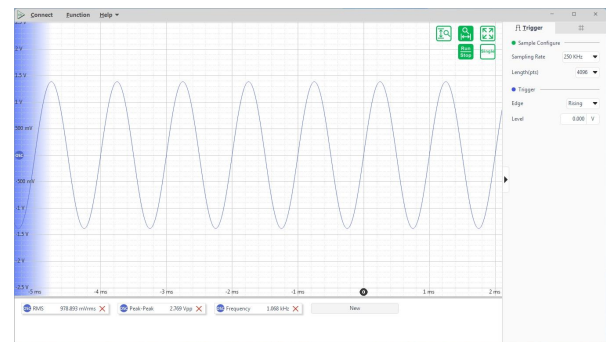
The OE1311/OE1351/OE1301 is equipped with graphical upper computer software. With quick graphic buttons and rich graphic operation functions, in addition, this software has a clear numerical value display and waveform display function, real-time display of measurement data, measurement results can be saved in excel format output for subsequent analysis of professional software, so that the test is easy to use. In addition, we also fully support Python, MATLAB and LabVIEW application program interface (API).



orthogonality compared to analog lock-in amplifiers. When the frequency of the input signal is lower than 1kHz, the OE1311/OE1351/OE1301 can use a synchronous filter to eliminate the harmonic impact of the reference signal, ensuring fast detection of effective low-frequency signals.

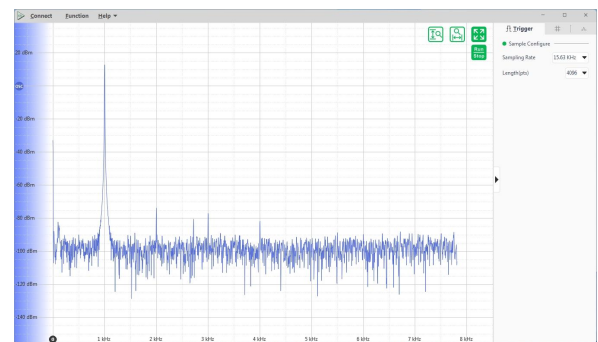
Oscillator

The oscilloscope features a 4 MSa/s analog input channel, a 5 Vrms input voltage range and user-configurable AC/DC coupling and 10 MΩ impedance.



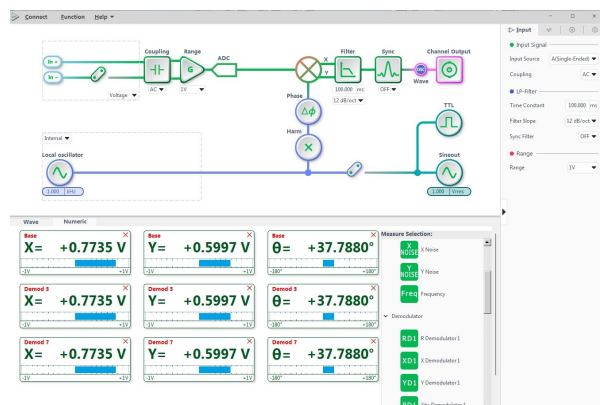
Spectrum Analysis

The spectrum analysis can observe DC to 2 MHz input signals in the frequency domain with a resolution bandwidth down to 1 Hz and a minimum span of 100 Hz.



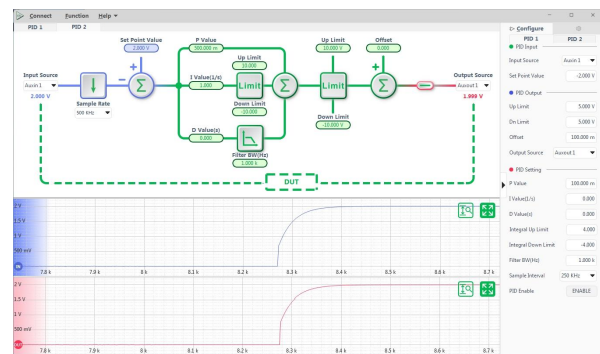
Multi-Demodulator

Traditional lock-in amplifiers can only measure the fundamental frequency signal or a specific harmonic signal component at the same time. Therefore, they cannot meet the measurement requirements for applications requiring the amplitude and phase of multiple frequency components simultaneously. The digital section of the OE1311/OE1351/OE1301 integrates FPGA and ARM technology for higher processing bandwidth and more flexible digital architecture, with digital processing precision up to 48 bits, allowing up to 8 arbitrary frequency signal inputs to be analyzed simultaneously. The 8 demodulators can freely configure amplitude and phase for linear combination.



PID Controllers

The OE1311/OE1351/OE1301 features a built-in independent 2-channel digital PID controllers, the PID sampling rate can reach up to 4 MSA/s. The 2 PID controllers are tightly connected to the lock-in amplifier and can take all input interfaces and measurement signals as inputs and provide feedback via signal amplitudes, phase shifts, output interfaces and more. The PID provide stable and accurate control, can handle changes in system dynamics effectively, making them suitable for a wide range of applications.



Input Signal Channel

Voltage input Mode	Single-ended or Differential
Full-scale Sensitivity	1 nV - 5 V (voltage input) 1 fA - 5 μ A (current input)
Current Input Gain	10^6 V/A
Impedance	
Voltage	10 M Ω // 10pF, AC or DC coupled
Current	1k Ω to virtual ground
C.M.R.R	>70 dB (within 10 kHz), Decreasing by 6 dB/oct
Dynamic reserve	>120 dB
Gain accuracy	0.2% typ., 1% max
Voltage Noise	5 nV/ $\sqrt{\text{Hz}}$ @997 Hz
Current Noise	260 fA/ $\sqrt{\text{Hz}}$ @997 Hz

Reference Signal Channel

Input	
Frequency range	DC - 1 MHz
Reference input	TTL or Sine
Input impedance	10 M Ω
Square Wave Reference Level:	$V_{IH} > 3V, V_{IL} < 0.5V$
Sine Wave Reference Signal:	>1 Hz, >400 mVpp
Phase	
Resolution	1 μ deg
Absolute phase error	<1deg
Relative phase error	<1mdeg
Orthogonality	
Internal Ref.	<0.0001deg rms@1 kHz
External Ref.	0.005deg rms@1 kHz (time constant 100 ms, 12 dB/oct)
Drift	
Below 10 kHz	<0.01deg / $^{\circ}$ C
Above 10 kHz	<0.1deg / $^{\circ}$ C
Harmonic detection	2F, 3F, ...nF to 1 MHz (n< 65,535)
Acquisition time	
Internal Ref.	Instantaneous acquisition
External Ref.	(3 cycles + 5 ms) or 40 ms
Demodulator	
Number	8
Stability	
Digital outputs	No zero drift for all settings
Analog Output	<5 ppm/ $^{\circ}$ C
Harmonic Suppression	-75 dB

Time Constant	1 μ s to 3 ks. 6, 12, 18, 24, 30, 36, 42, 48 dB/oct roll-off
Synchronous Filter	Available below 1 kHz (>18 dB/oct roll-off)

Signal Generator

Frequency Range	DC - 1 MHz
Accuracy	2 ppm + 10 μ Hz
Resolution	1 μ Hz
Distortion	-80 dBc (f<10 kHz), -70 dBc (f>10 kHz)
Amplitude	100 μ Vrms to 5 Vrms (resolution: 10 μ Vrms)
Error	1%
Stability	100 ppm/ $^{\circ}$ C
Sine output	Output impedance 50 Ω
TTL sync output	5V TTL/CMOS level Output Impedance 200 Ω

AUX Outputs

CH1 and CH2	
Function	Output X,Y,R, θ , harmonics
Amplitude	± 10 V
Impedance	100 Ω

AUX Inputs

Function	2-channel input
Amplitude	± 10 V
Impedance	1 M Ω

Communication Interface

UART	RS232 (Optional XH2.54-4PIN)
Ethernet	Isolated 1000Mbps RJ45 interface

General

Power requirements	
Voltage	12 V DC $\pm 5\%$
Power	15W typ., 24W max
Dimensions	
Width	180 mm
Depth	106 mm
Height	44 mm