Digital Lock-In Amplifiers

OE2052 dual channel lock-in amplifier

Key Features

— 2 independently synchronized input channels
— Input noise as low as 3nV/$\sqrt{Hz}$
— Input range 1nV to 1Vrms
— DC -1uHz to 400MHz
— Dynamic reserve＞120dB
— 3-channel demodulator synchronization measurements
— 4-channel oscilloscope with FFT analysis function
— 2-channel PID controller

Overview

The OE2052 dual-channel lock-in amplifier is the latest core technology product currently available with excellent high performance and broadband measurement capability. The instrument is based on digital modulation technology, equipped with 1GSPS 16-bit digital-to-analog converter (DAC) and 14-bit analog-to-digital converter (ADC), and adopts the DSP platform architecture, which is capable of accurately and quickly detecting the effective signal components hidden in the strong noise.

With two independent and synchronized input channels, the OE2052 is not only able to measure the amplitude and phase information of two input signals at the same time, but also reaches the international leading level in terms of key performance indicators such as measurement accuracy, operating frequency range, signal-to-noise ratio and dynamic reserve. In addition, the addition of multi-harmonic measurement, oscilloscope and spectrum analyzer functions, and PID control functions make the OE2052 widely applicable to a wide range of needs in the scientific research and industrial fields.

Digital Demodulator

The time constant of the OE2052 can be flexibly set from 25ns to 4ks, and users can customize the time constant according to their needs. The filter steepening rate can be selected from 6 to 48 dB/oct in 8 steps. With digital modulation technology and advanced filter structure, the OE2052 offers higher dynamic reserve (>120dB), more accurate phase (absolute phase error <), zero DC drift, and excellent quadrature performance than traditional analog lock-in amplifiers. In addition, the OE2052 provides an optional synchronization filter that effectively eliminates the effects of reference signal harmonics, ensuring that the instrument accurately detects low-frequency signals while providing a fast response.

Reference Signal Channel

The reference signal of the lock-in amplifier can be selected as a sine wave or square wave signal according to the user's actual needs, or the reference signal can be digitally synthesized inside the instrument. When the OE2052 is set to internal reference signal mode, the instrument's internal high-precision oscillator and digital synthesis algorithm will generate a sine wave signal for multiplying with the input signal, and this internal reference signal is almost unaffected by phase noise.

The phase resolution of the internal reference signal can be as high as 1μdeg by digital phase shifting technique. When the OE2052 operates in the external reference signal mode, it can accept a sine wave signal or TTL logic level as the external reference signal, and this signal will be locked by the internal digital phase-locked loop. Based on the frequency of the reference signal, the OE2052 can detect the same frequency of the signal and its harmonics, up to the 65535th harmonic of the fundamental frequency, but the maximum harmonic frequency cannot exceed the upper limit of the measurement bandwidth of the instrument.

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Input Signal Channel

The OE2052 is equipped with a low-noise analog front-end amplifier, capable of efficiently processing differential or single-ended signals with an equivalent input noise as low as 3nV/$\sqrt{Hz}$. The channel's input impedance can be selected from 50 Ω or 10M Ω , and the full-scale sensitivity range is from 1nV to 1V, with a dynamic range of more than 120dB.

In addition, the signal input channel adopts a dual ADC design, taking into account the needs of high-speed and high-precision measurements. Users can choose between a high-speed 14-bit ADC (supporting DC to 400MHz band) or a high-precision 24-bit ADC (supporting DC to 100kHz band) according to the actual application scenario.

Output Signal Channel

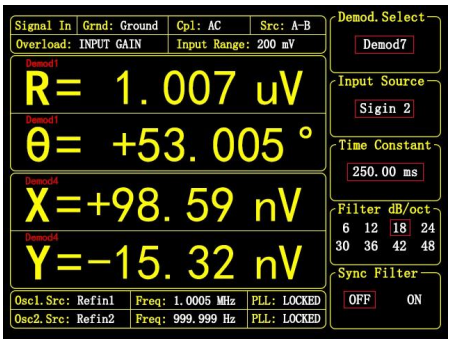
Based on a 1GSPS 16-bit digital-to-analog converter (DAC), the OE2052 is capable of generating sine wave signals over a frequency range of 1Hz to 400MHz with adjustable DC bias. Under a 50 Ω load, the signal amplitude ranges from 1 Vpp to 1.5 Vpp, and the DC bias range is ±1.5 Vdc. For external devices that require a bias voltage, such as electro-optical modulators, the OE2052, with its excellent drive capability, can directly drive the device without the need for an additional level shifting amplifier. The phase of the output signal is synchronized with the instrument's internal oscillator, and the phase offset can be set independently.

Communications Interface

The OE2052 has USB2.0 (host and slave interfaces), 1000Mbps RJ45 network port and RS232 serial port. Through each communication interface, users can effectively use all the test functions of OE2052 on the control computer, set up reasonable control parameters of the instrument and read the data measured by the instrument.

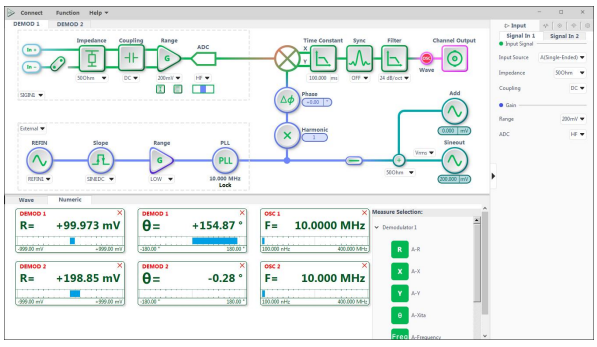
Color Display Screen

The OE2052 is equipped with a 5.6-inch, 640 x 480 resolution TFT color display, which serves as the main display interface of the instrument and allows full independent control of the instrument through the keyboard. On the display, users can flexibly view the demodulator's X, Y, R, θ and other parameters, and also configure a variety of basic settings such as filter constants, making operation intuitive and convenient.



PC Software

OE2052 also provides users with professional software, each demodulator, input channel and output channel of the lock-in amplifier can be configured through the schematic block diagram or control panel, which is both professional and practical as well as simple and intuitive. The software has a clear numerical display and real-time display of waveforms, and the measurement results can be saved in a csv file output for subsequent analysis by professional software, making the test easy to handle. In addition, we also fully support Python, MATLAB and LabVIEW multi-language application program interface (API).



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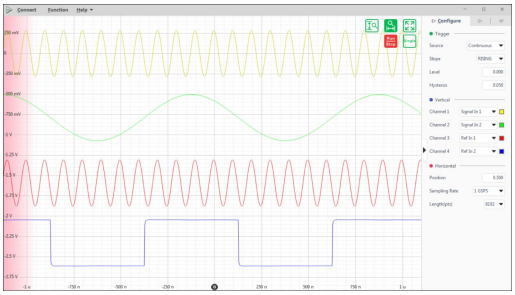
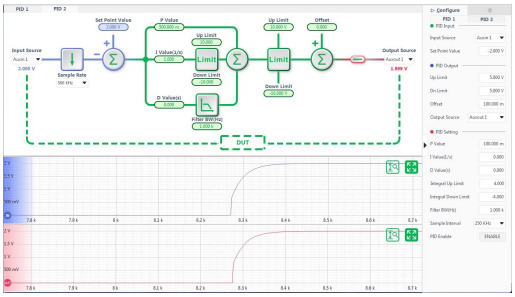
Oscilloscope

Oscilloscope function with 4 signal channels, selectable signal input, reference input, signal output, auxiliary input and output signals, with a variety of triggering methods, for the user real-time display of time domain signals. Maximum 65536 sampling depth, adjustable sampling time 65us - 1s.



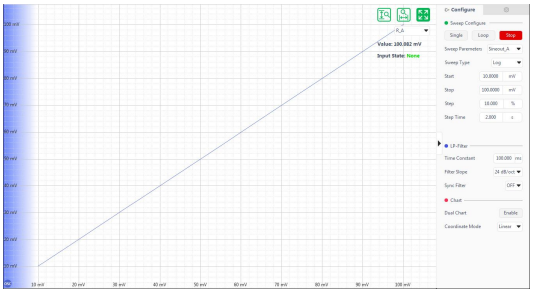
PID Controllers

The OE2052 has a built-in independent 2-channel digital PID controller with a sampling rate of up to 4 MSPS, which is tightly coupled with a lock-in amplifier to control the amplitude, phase, frequency and other signals of the output signal according to the measured value of the demodulator, thus realizing the precise regulation of a variety of controlled quantities.



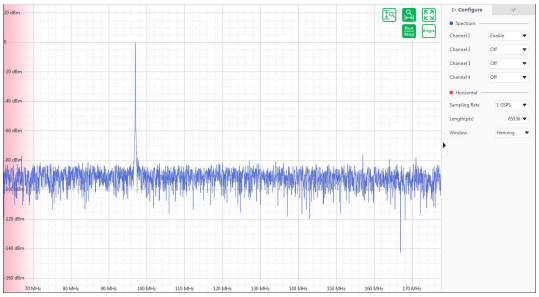
Parametric Scanner

The parameter scanner provides users with convenient and fast scanning for instantaneous plotting of frequency response, amplitude response and other curves, and offers single or cyclic scanning modes.



FFT Spectrum Analyzer

FFT spectrum analyzers analyze the frequency domain information of a signal based on the waveform captured by an oscilloscope. Depending on the sampling rate, the frequency resolution of the spectrum analyzer is approximately 1Hz - 15kHz.



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Signal Input Channel

Voltage Input Mode	Single-ended or Differential
Full-scale Sensitivity	1nV 至 1 Vrms
Measuring Range	100 μ V, 500 μ V, 2mV, 10mV, 50mV, 200mV, 1.3V
Maximum Amplitude	< 1.3 Vrms
Input Coupling	DC or AC
Input Impedance	50Ω or 10 MΩ‖15 pF
Dynamic Reserve	120 dB
Amplitude Accuracy	±0.5% typical ， ±1% max
Temperature Drift	0.1% / ℃ typical
Input Voltage Noise	4 nV/$\sqrt{Hz}$（f > 100 kHz）
	3 nV/$\sqrt{Hz}$（f > 1 MHz）
Data Conversion	14bit, 1 GSPS
	24bit, 244 kSPS

Reference Input Channel

Signal	
Frequency Range	1 μHz - 400 MHz
Input Impedance	50 Ω or 1 MΩ
Signal Type	Sine or Square Wave
Sine Reference Level	
Low Range	250 mVpp < Vpp < 2.5 Vpp
High Range	2.5 Vpp < Vpp < 10 Vpp
Square Reference Level	
Low Range	-0.1 V < V_{IL} < 0.1 V, 0.25 V < V_{IH} < 2.5 V
High Range	-0.5 V < V_{IL} < 0.5 V, 2.5 V < V_{IH} < 5.0 V
Phase	
Resolution	1.0 μdeg
Relative phase error	±0.5deg typical ， ±3deg max
Harmonic detection	1-65535F (nF < 400MHz)
Acquisition Time	
Internal Ref. Mode	Instantaneous
External Ref. Mode	100 cycles or 1.5 ms
Data Conversion	14 bit, 1 GSPS

Oscillators

Number of Oscillators	2
PLL Source Select	Ref in ports or Signal in ports
System Crystal Oscillator	
Accuracy	±0.1 ppm
Temp. Stability	±0.01 ppm / ℃
Aging	±0.05 ppm / year
Phase Noise	−150 dBc/Hz @10 kHz

Signal Output Channel

Frequency Range	DC - 400MHz
Sine Output	
Amplitude(HiZ Load)	2μVpp - 3.0 Vpp (< 250 MHz)
	2μVpp - 2.2 Vpp (< 320 MHz)
	2μVpp - 1.2 Vpp (< 400 MHz)
Amplitude (50Ω Load)	1μVpp - 1.5 Vpp (< 250 MHz)
	1μVpp - 1.1 Vpp (< 320 MHz)
	1μVpp - 0.6 Vpp (< 400 MHz)
Resolution	1μVpp
Amplitude Accuracy	±0.5% typical ， ±1% max
Output Bias (50Ω Load)	-1.5V to 1.5V
Output Impedance	50Ω
Max Output Current	±100 mA
Data Conversion	16 bit, 1 GSPS

Demodulators

Number of Demodulators	3
Input Source Select	2 input channels selectable
Time Constant	25ns - 4ks
Measurement Bandwidth	40 μHz - 6 MHz
Filter Slope	6, 12, 18, 24, 30, 36, 42, 48 dB/oct

Auxiliary Inputs and Outputs

AUX Inputs	
Function	4 channel inputs
Range	±10V，1 mV resolution
Input Impedance	1MΩ
Data Conversion	16 bit, 244.14 kSPS
AUX Outputs	
Function	4 channel outputs
Range	±10V，1 mV resolution
Drive Current	±30 mA max
Data Conversion	16 bit, 976.56 kSPS

Remote Interfaces

RS-232	DB-9 female connector
USB2.0	High-Speed 480 Mbps Type-B
	3 Type-A ports
Ethernet	1000 Mbps

General

Power requirements	
Voltage	220/240 V AC
	100/120 V AC(Optional)
Power	100 W typical，120 W max
Dimension	438mm×550mm×147mm
Weight	12 kg