Digital Lock-In Amplifiers

SE1311/SE1351 Module Lock-in Amplifier

Main Parameters:

- Measurement signal frequency range from 1uHz to 100/500kHz
- Input level at full-scale scale output is 1nV to 5V
- Time constant from 1μs to 3ks
- Dynamic reserve greater than 120dB
- Phase/amplitude automatic adjustment
- Multi-harmonic measurement
- Spectrum Analysis, Oscilloscope

Overview

SE1311/SE1351 module lock-in amplifier is the latest core technology product, and it is a measuring instrument with high performance and high cost performance. Based on digital modulation, output filter and high-precision 24-bit digital-to-analog converter (ADC), the new Zynq architecture can accurately and quickly measure the effective signal components submerged in large noise. Moreover, SE1311/SE1351 lock-in amplifiers can simultaneously measure the amplitude and phase information of the input signal, and are comparable to the top technologies in the same industry in the world in terms of core parameters such as measurement accuracy, operating frequency range, signal-to-noise ratio, and dynamic reserve. At the same time, functions such as multi-harmonic measurement, oscilloscope, and spectrum analyzer have been newly developed, so that the functions of SE1311/SE1351 can meet various scientific research and industrial purposes.

Input signal channel

The low-noise analog front-end amplifier employed in the lock-in amplifier SE1311/SE1351 can efficiently handle differential or single-ended signals with an equivalent input noise of 10nV/√Hz. The input impedance of this channel is 10MΩ, and the input signal level that can be detected at full-scale output is 1nV to 5V. In addition, SE1311/SE1351 can be applied to the measurement of input current signal, and its front-end variable current gain is 106 V/A. The dynamic range of SE1311/SE1351 can reach more than 120dB, which can adjust the internal programmable gain amplifier according to the amplitude of the input signal to change the dynamic reserve of the whole system. The high-precision 24-bit ADC has a sampling rate of 4SPS, and the anti-aliasing filter in front of the ADC can effectively prevent signal aliasing.

Reference signal channel

The reference signal of SE1311/SE1351 digital lock-in amplifier can choose sine wave signal or square wave signal according to the actual situation of the user, and the reference signal of digital synthesis inside the instrument can also be used. When SE1311/SE1351 is set to the internal reference signal mode, the high-precision oscillator and digital synthesis algorithm inside the instrument can generate a sine wave signal for multiplying the input signal, and the internal reference signal at this time is almost free from phase noise Impact.

Using digital phase shifting technology, the phase of the internal reference signal can achieve 1udeg resolution accuracy. The internal reference signal mode of this instrument can work normally in the frequency range from 1uHz to 100\500kHz. In addition, SE1311/SE1351 can also use external reference signal mode, sine wave signal and TTL logic level can be used as external reference signal. The rising or falling edge of the external reference signal triggers the internal phase-locked loop (PLL). Based on the frequency of the reference signal, SE1311/SE1351 can detect signal harmonics. The maximum harmonic signal frequency it can detect is 65535 times the fundamental frequency, but the maximum harmonic frequency cannot exceed the operating frequency of the instrument 100\500 kHz .

Filter

The time constant of SE1311/SE1351 can be programmed between 1μs and 3ks. The roll-off rate of the output low pass filter 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 signal processing at a sampling rate of 4 MHz. The digital modulation method and filter structure adopted by SE1311/SE1351 ensure that it has higher dynamic reserve (>120dB), accurate phase (absolute phase error <1°), zero DC drift and Good orthogonality. In addition, when the frequency of the input signal is lower than 1 kHz, the SE1311/SE1351 will also use a synchronous filter to eliminate the harmonic influence of the reference signal to ensure that the instrument can quickly detect effective low-frequency signals.

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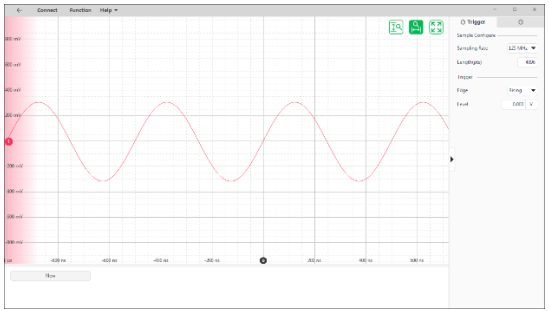
Oscilloscope

The oscilloscope has one 4 MSa/s analog input channel with 2MHz analog bandwidth, 5 Vrms input voltage range, and user-configurable AC/DC coupling and 10 MΩ impedance.

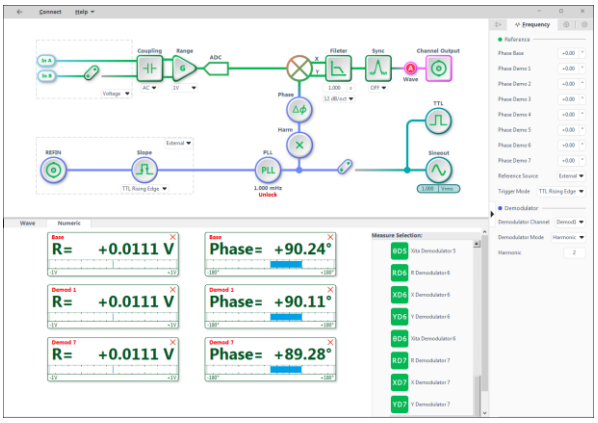


Spectrum analysis

A spectrum analyzer can observe DC to 2MHz input signals in the frequency domain. Simultaneous resolution bandwidths as low as 1 Hz with a minimum span of 100 Hz.

Multiple demodulators

In a traditional lock-in amplifier, only the fundamental frequency signal or a certain harmonic signal component can be measured at the same time. Therefore, for some situations that require the amplitude and phase of multiple frequency components at the same time, the traditional lock-in amplifier cannot meet the measurement requirements. The digital side of SE1311/SE1351 combines FPGA and ARM technology to achieve higher processing bandwidth and more flexible digital architecture. The digital processing accuracy can reach 48 bits, and it can analyze signal input with up to 8 arbitrary frequencies at the same time. The 8 demodulators can freely configure the amplitude and phase to realize linear combination.



Signal generator

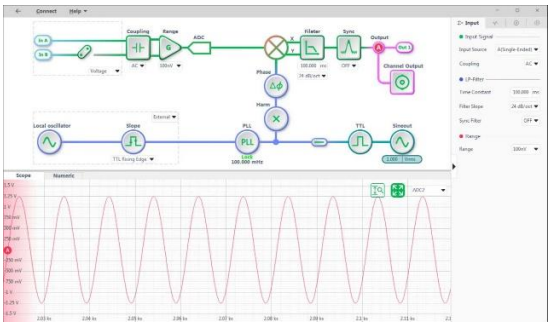
Based on a 16-bit digital-to-analog converter (DAC), SE1311/SE1351 can generate sine wave signals with a frequency range from 1uHz to 100\500kHz. The amplitude and phase of the signal are related to the internal oscillator of the instrument, which can be passed through the instrument The control category of the instrument can set the amplitude of the sinusoidal signal generated by the instrument. The signal generator of SE1311/SE1351 can generate a sine wave signal with a maximum amplitude of 5 Vrms.

Connector

The interface standard of SE1311/SE1351 is 1000Mbps RJ45 network port and XH2.54-4PIN serial port. Through the network port or serial port, users can effectively use all test functions of SE1311/SE1351 on the control computer, including setting reasonable control parameters of the instrument and reading the measured data of the instrument.

PC software operation

Supporting graphical host computer software. It has shortcut graphics buttons and rich graphics operation functions. In addition, this software has clear numerical display and waveform display functions, which can display measurement data in real time. The measurement results can be exported and saved in excel format for subsequent analysis by professional software. Handy. Additionally, we fully support Python, MATLAB, and LabVIEW application programming interfaces (API)



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Input signal channel

Voltage input mode	Single ended input or differential input
Full scale sensitivity	Increase 106 V/A in steps of 1-2 to 5
Current input gain	from 1nV to 5 V
Input impedance	
Inputr voltage	10M Ω//25pF, DC coupled or AC coupled
Input current	1k Ω to virtual ground terminal
CMRR	>120 dB (within 10 kHz), followed by a decrease of 6dB/oct
Dynamic reserve	>120dB
Gain accuracy	Typical value is 0.2%, maximum value is 1%
Noise performance	
997Hz :	5nV/√Hz（Voltage）
	260fA/√Hz （Current）

Reference signal channel

Input signal

Frequency range	1 uHz to 100\500 kHz
Input signal type	TTL logic level or sine wave
Input impedance	10 MΩ
Square wave reference level	V_IH>3V，V_IL<0.5V >2 Hz
Sinusoidal reference signal	> 400 mVpp

Phase

Resolution	1 udeg
Absolute phase error	<1 deg
Relative phase error	<0.01deg
Orthogonality	
Internal Reference	Overall,<0.0001 ° rms at 1kHz:
External Reference	0.005 ° rms (time constant of 100 ms, 12 dB/oct)
Temperature drift	
＜10kHz	<0.01°/℃
＞10kHz	<0.1°/℃
Harmonic	2F,3F,…nF to 100\500kHz（n<65,535）
Collection time	
Internal Reference	Instant access
External Reference	(3 cycles+5ms) or 40ms

Demodulator

Quantity	8
Stability	
Digital Output	All settings have no zero drift
Display	All settings have no zero drift
Analog Output	All dynamic reserve settings<5ppm/℃
Harmonic Suppression	-90 dB
Time constant	1 us to 3 ks 6, 12, 18, 24, 30, 36, 42, 48 dB/oct steep drop
Synchronous filter	Effective for steep drops below 1k Hz and above 18dB/oct

Signal generator

Frequency	
Range	1mHz to 100\500kHz 2ppm
Accuracy	+ 10μHz
Resolution	1uHz
Distortion	-80dBc（f<10kHz), -70dBc（f>10kHz）
Amplitude	0.001V to 5Vrms（Resolution:1mVrms）
Error	1%
Temperature Stability	100ppm/℃
Sinusoidal output	Sinusoidal signal with an output impedance of 50 Ω
TTL synchronous output	5V TTL/CMOS level, output impedance 200 Ω

Output

Channel 1 and Channel 2	
Functions	X、Y、R、θ、harmonic
Amplitude	±10V
Impedance	100Ω
AUX Inputs	
Functions	2-channel input
Amplitude	±10V
Impedance	1MΩ

Connector

UART	XH2.54-4PIN
Network interface	1000Mbps RJ45 interface with Ethernet port

Other

Power requirements	
Voltage	12VDC±5%
Power	Standard 18W, maximum not exceeding 24W
Size	
Length	180mm
Depth	106mm
Height	44mm