Digital Lock-In Amplifiers

SE1201-DSP Lock-In Amplifier

50 mHz to 120 kHz

Features

- *50 mHz to 120 kHz frequency range*
- *Low-noise current and voltage inputs*
- *1 nV to 1 V full-scale sensitivity*
- *Time constants from 10 µs to 3 ks*
- *Up to 100 dB dynamic reserve*
- *Up to 100 dB CMRR*
- *Small size (259*320*102 mm)*

Overview

SE1201 Small-sized DSP Lock-in Amplifier provides an excellent performance within its bandwidth from 50 mHz to 120 kHz. With the high-speed 4-core architecture, high-precision ADC and excellent analog performance, SE1201 can easily detect the phase and the magnitude of weak signals overwhelmed by various large noise. The performance of SE1201 is as good as other lock-in amplifiers all over the world, even better than them in some certain parameters, such as measurement accuracy, operating bandwidth, which meets the needs of scientific research and industrial application well.

Input Channel

SE1201 detects an input signal in a single-ended mode or a differential voltage mode. With an ultra low-noise pre-amplifier, the input noise is as low as 10 nV/ √ Hz@997 Hz. The input impedance is 10 M Ω and the full-scale input voltage sensitivity ranges from 1 nV to 1 V. Besides, SE1201 can be used for current measurement with gains of 106 or 108 V/A. Two line filters (50/60 Hz and 100/120 Hz) are designed to eliminate power frequency interference. A programmable gain amplifier is used to adjust the dynamic reserve of the system, so that SE1201 can keep a high dynamic reserve of 100 dB.

Reference Channel

The reference signal can work in external mode or internal mode. In internal mode, a precision and stable internal oscillator generates sin wave

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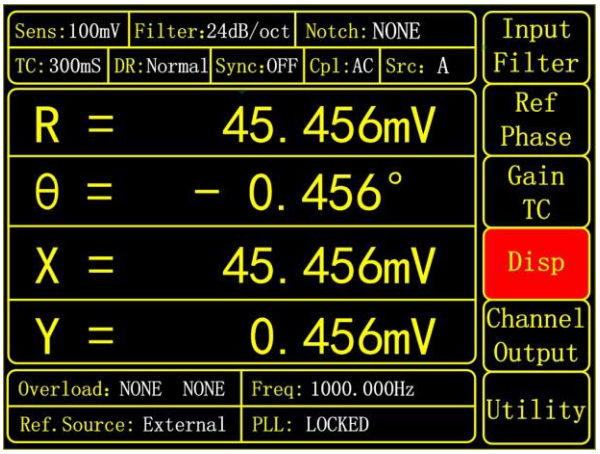
as an internal reference that is multiplied by the input signal. This internal signal is without any phase noise. With the digital phase-shifting technique, the phase resolution of the reference signal is 0.01°. SE1201 can work at any fixed frequency from 50 mHz to 120 kHz in this mode. In external mode, the reference signal can be a sine wave or a TTL pulse or a square wave. The rising or falling edge of the external reference signal triggers the Phase Lock Loop (PLL) to lock the external signal. Based on the frequency of the reference signal, the SE1201 can detect the harmonics of the input signal. The maximum harmonic signal frequency can reach 32,767 times the fundamental frequency, and the maximum harmonic frequency cannot exceed the maximum operating frequency of the instrument by 120 kHz.

Digital Demodulator and Output Filter

The key component of the SE1201 is the digital demodulator. Compared to traditional analog lock-in amplifiers, the SE1201's internal digital demodulator effectively rejects the measurement errors caused by DC drift and offset. In addition, by optimizing the multiplication of the internal coherent signal of the digital demodulator, the calculation error is minimized so that the instrument can accurately detect the input weak signal. Time constants of the output low-pass filter from 10 μs to 3 ks can be selected with a choice of 6, 12, 18 or 24dB/oct rolloff. This low-pass digital filter is implemented using a high performance digital filter with a sample rate of 485 kHz. The digital demodulation and the low-pass filter used in SE1201 guarantees a high dynamic reserve (>100dB), accurate phase (absolute phase error <1°). Moreover, when the frequency of the input signal is lower than 20 Hz, A synchronous filter can be used to eliminate the harmonic influence of the reference signal, ensuring that SE1201 can detect a low-frequency signal quickly and effectively.

Display

SE1201 has a 3.5-inch 320 x 240 color TFT-LCD. The measurement results of SE1201, such as X, Y, R, and θ, are shown in numerical form.



Internal Oscillator

The internal oscillator of SE1201 generates a low distortion (-80 dBc) sine reference signal varying from 50 mHz to 120 kHz, which has a high frequency resolution of 1 mHz.

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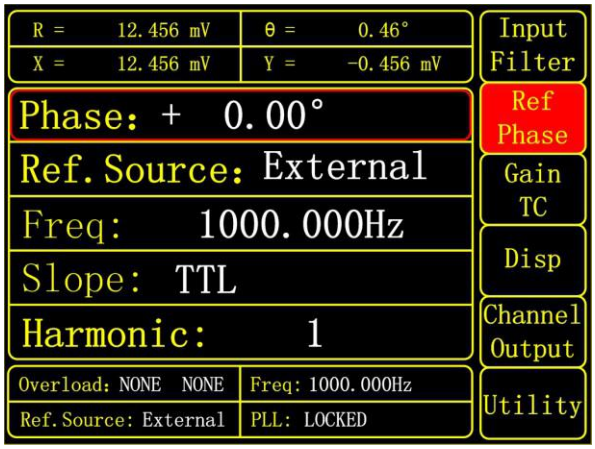
The frequency and amplitude of the reference signal can be set by using the front panel of SE1201 or communication interface. When SE1201 is set in the external reference mode, the internal reference signal is phase-locked with the external reference signal.



Signal Generator

SE1201 uses a high precision digital-to-analog converter (DAC) to output a sine wave signal at the same frequency as the internal reference signal. The amplitude and phase of the output sine wave can be set through the SE1201's display, where the maximum amplitude of the sine wave is 1 Vrms.

Manual Operation

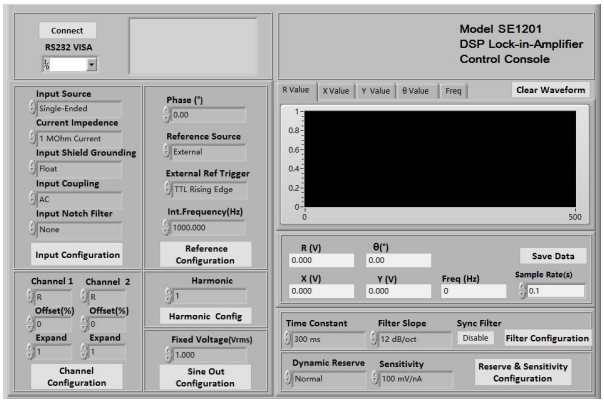
The parameters are convenient to be adjusted by the soft keys besides the display and the numeric keypad on the front panel, such as the internal oscillator frequency and the SINE OUT amplitude.

Interface

SE1201 uses 9-pin RS-232 and RS-232 to USB interfaces as standard. Through communication interfaces, all instrument functions can be controlled and all data can be read in real- time. Meanwhile, all interfaces of SE1201 are distributed on the front panel and the rear panel.

Remote Operation

Users can use PC to control SE1201 through communication interfaces, including setting the parameters and reading the measurement data. SE1201 is equipped with a free LabVIEW program, which makes it easy to use in complex scientific experiments.



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Technical Specifications

➢ Signal Channel

Voltage Input Mode	Single-ended or Differential
Full-scale Sensitivity	1 nV to 1 V in a 1-2-5 sequence 1 fA to 1 μA
Current Input	10^6 or 10^8 V/A
Impedance	
Voltage	10 MΩ // 25 pF, AC or DC coupled
Current	1 kΩ to virtual ground
C.M.R.R	>100 dB to 10 kHz, decreasing by 6 dB/oct
Dynamic Reserve	>100 dB
Gain Accuracy	0.2% typ, 1% max
Voltage Noise	9 nV/√Hz at 997 Hz
Current Noise	0.13 pA/√Hz at 97 Hz 0.14 pA/√Hz at 997 Hz
Line Filters	50/60 Hz and 100/120 Hz
Gounding	BNC shield can be grounded or floated via 1 kΩ to ground

➢ Reference Channel

Input	
Frequency range	50 mHz to 120 kHz
Reference input	TTL or Sine
Input impedance	1 MΩ//25 pF
Phase	
Resolution	0.01°
Absolute phase error	<1°
Relative phase error	<0.01°
Phase noise	
Internal ref.	Synthesized, <0.0001°rms at 1 kHz
External ref.	0.005°rms at 1 kHz (100 ms time constant, 12 dB/oct)
Drift	<0.1°/℃ below 10 kHz <0.5°/℃ above 10 kHz
Harmonic Detection	2F, 3F, …nF to 120 kHz (n<32767)
Acquisition Time	
Internal ref.	Instantaneous acquisition
External ref.	(2 cycles + 5 ms) or 40 ms, whichever is larger

➢ Demodulator

Stability	
Digital output	no zero drift on all setting
Display	no zero drift on all setting
Analog output	<5 ppm/℃ for all dynamic reserve settings
Harmonic Rejection	-90 dB
Time Constant	10 μs to 3 ks (<200 Hz) 10 μs to 30 s (>200 Hz) (6, 12, 18, 24 dB/oct rolloff)
Synchronous Filters	Available below 20 Hz

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➢ Internal Oscillator

Frequency	
Range	50 mHz to 120 kHz
Accuracy	2 ppm + 10 μHz
Resolution	1 mHz
Distortion	-80 dBc (f<10 kHz), -70 dBc (f>10 kHz)
Amplitude	0.10 Vrms to 1 Vrms
Accuracy	1%
Stability	50 ppm/℃
Output	Sine output on rear panel TTL sync output on rear panel

➢ Interfaces

RS-232 and RS-232 to USB interfaces

➢ Display

Screen	3.5 inch, 320×240 TFT
Display Quantities	4 channels of data to display X,Y,R,θ
Display Types	Numerical form

➢ Outputs

CH1 and CH2 Outputs

Function	Output X, Y, R, θ
Output voltage	±5 V full scale, 30 mA max output current

➢ General

Power Requirement

Voltage	220 - 240 VAC, 100 - 120 VAC (optional)
Frequency	50/60 Hz
Power	20 W
Dimension	259 (W)×115 (H)×320 (D) mm (with feet) 259 (W)×102 (H)×320 (D) mm (without feet)
Weight	3.2kg

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