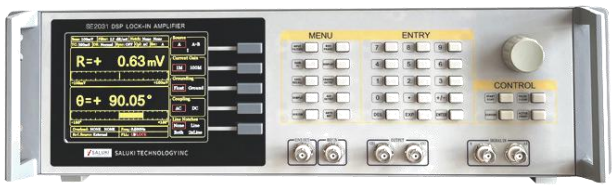
Digital Lock-In Amplifiers

SE2031-DSP Lock-In Amplifier

1 mHz to 10 MHz



Features

- *1 mHz to 10 MHz frequency range*
- *1 nV to 1 V full-scale sensitivity*
- *Time constants from 30 ns to 4 ks*
- *>120 dB dynamic reserve*
- *A high-performance signal generator*
- *Oscilloscope, spectrum analyzer*
- *PID controller, AM modulation*
- *Up to 4 demodulators*
- *5.6 inch color TFT-LCD screen*

Overview

SE2031 Digital Lock-in Amplifier provides an excellent performance within its bandwidth from 1 mHz to 10 MHz. With the advantage of the latest digital signal processing technology and high-speed 250MSPS 14-bit ADC, SE2031 can easily detect the phase and the magnitude of weak signals overwhelmed by various large noise. The performance of SE2031 is as good as other lock-in amplifiers all over the world, even better than them in some certain parameters, such as measurement accuracy, SNR, dynamic reserve, which meets the needs of scientific research and industrial application well.

Input Channel

SE2031 detects an input signal in a single-ended mode or a differential voltage mode. With an ultra low-noise preamplifier, the input noise is as low as 6 nV/√Hz@100 kHz. The input impedance is 50 Ω or 10 MΩ and the full-scale input voltage sensitivity ranges from 1 nV to 1 V. Besides, designed to eliminate power frequency interference. A programmable gain amplifier is used to adjust the dynamic reserve of the system, so that SE2031 can keep a high dynamic reserve of 120 dB. The high-precision 14-bit ADC has a sampling rate of 250 MSPS, and the excellent anti- aliasing filter in front of the ADC can effectively prevent signal aliasing.

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Reference Channel

The reference signal can work in external mode or internal mode. In internal mode, a precise and stable internal oscillator generates sine wave 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 0.001 deg. SE2031 can work at any fixed frequency from 1 mHz to 10 MHz in this mode.

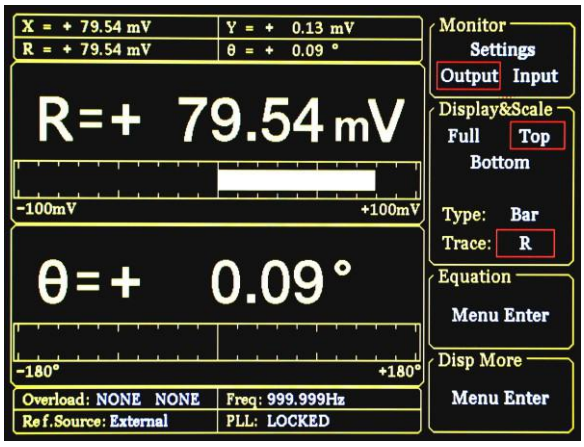
In external mode, the reference signal can be a sine wave or a TTL pulse or square wave. The rising or falling edge of the external reference signal triggers the Phase Lock Loop (PLL) to lock the external signal. Based on the frequency of the reference signal, can demodulate multiple harmonics and arbitrarily frequency 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 10 MHz.

Digital Demodulator and Output Filter

The key component of the SE2031 is the digital demodulator. Compared to traditional analog lock-in amplifiers, the SE2031'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 30 ns to 4.4 ks can be selected with a choice of 6, 12, 18, 24, 30, 36, 42 and 48 dB/oct rolloff. This low-pass digital filter is implemented using a high performance digital filter with a sample rate of 250 MHz. The digital demodulation and the low-pass filter used in SE2031 guarantees a high dynamic reserve (>120dB), accurate phase (absolute phase error <1 deg). Moreover, when the frequency of the input signal is lower than 200 Hz, A synchronous filter can be used to eliminate the harmonic influence of the reference signal, ensuring that SE2031 can detect a low frequency signal quickly and effectively.

Display

SE2031 has a 5.6-inch 640 × 480 color TFT-LCD. The measurement results of SE2031, such as X, Y, R, and θ, are shown in numerical form and bar graph on the display.



In X-Y chart, SE2031 shows the trend of measurement results over time, and check the value by using knob control cursor.

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Internal Oscillator

The internal oscillator of SE2031 generates a low distortion (–80 dBc) sine reference signal varying from 1 mHz to 10 MHz, which has a high frequency resolution of 1 mHz. The frequency and amplitude of the reference signal can be set by using the front panel of SE2031 or communication interface. When SE2031 is set in the external reference mode, the internal reference signal is phase-locked with the external reference signal.

Signal Generator

SE2031 uses a high precision digital-to-analog converter (DAC) to output a sine wave signal at the same frequency as the internal reference signal from 1 mHz to 10 MHz. The amplitude and phase of the output sine wave can be set through the SE2031's display, where the maximum amplitude of the sine wave is 1 Vrms with 1 uVrms accuracy.

Auxiliary IO

SE2031 has many auxiliary input and output interface. AUX-IN ports can measure voltage below 10V, and their sample rate is 312.5 kSPS. AUX-OUT/CH-OUT can output X, Y, R, Xita value and arbitrary DC Volts. Otherwise, SE2031 has CLK-IN, CLK-OUT, SYNC IN, SYNC OUT and Monitor out ports.

Manual Operation

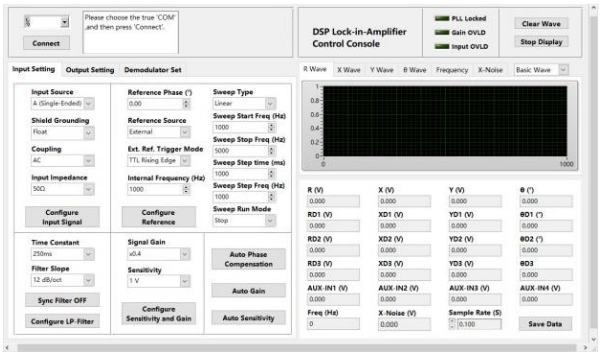
The parameters are convenient to be adjusted by the soft keys besides the display and the numeric keypad on the front panel, such as the internal oscillator frequency and the SINE OUT amplitude.

Auto Function

SE2031 can automatically adjust itself into different optimal operating modes for different input signals, such as Auto Gain mode, Auto Reserve mode and Auto Phase mode. This function makes it easier for users to measure signals more efficiently.

Remote Operation

Users can use PC to control SE2031 through communication interfaces, including setting the parameters and reading the measurement data. SE2031 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
Impedance	
Voltage	50 Ω// 5pF or 10 MΩ// 5pF, AC or DC coupled
C.M.R.R	>70 dB to 100 Hz, >50 dB to 100kHz
Dynamic Reserve	>120 dB
Gain Accuracy	0.5% typ (<1 MHz), 3% max
Noise	6 nV/√Hz at 99.99 kHz 14 nV/√Hz at 997 Hz
Gounding	BNC shield can be grounded or floated via 1 kΩ to ground

➢ Reference Channel

Input	
Frequency range	1 mHz to 10 MHz
Reference input	TTL or Sine
Input impedance	1 MΩ//5 pF
TTL level	V_{INH}>3 V , V_{INL}<0.5 V
Sine reference level	0.2 V < V_{PP} < 10 V, Freq > 1 Hz
Phase	
Resolution	0.001 deg
Absolute phase error	<1 deg typ. (<1 MHz), 5 deg max.
Relative phase error	< 1 mdeg
Orthogonality	90±0.001 deg
Phase noise	
Internal ref.	Synthesized, <0.0001 deg at 1 kHz
External ref.	0.005 deg at 1 kHz (100 ms time constant, 12 dB/oct)
Drift	<0.01 deg/℃ below 100 kHz <0.1 deg/℃ above 100 kHz
Harmonic Detection	2F, 3F, …nF to 10 MHz (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	<50 ppm/℃ for all dynamic reserve settings
Harmonic Rejection	-90 dB
Time Constant	30 ns to 4.4 ks (6,12,18,24,30,36,42,48 dB/oct rolloff)
Synchronous Filters	Available below 200 Hz (18,24,30,36,42,48 dB/oct rolloff)

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➢ Internal Oscillator

Frequency	
Range	1 mHz to 10 MHz
Accuracy	2 ppm + 10 μHz
Resolution	1 mHz
Distortion	-80 dBc (f<100 kHz), -60 dBc (f>1 MHz)
Amplitude	1μV to 1Vrms
Accuracy	0.5% typ. (<1 MHz), 2% max.
Stability	50 ppm/℃
Impedance	50 Ω
TTL Output	5V TTL/CMOS level 50Ω output impedance

➢ Display

Screen	5.6 inch, 640×480 TFT
Screen Format	Single or dual display
Display Quantities	Each display shows one trace, traces can be defined as X,Y,R,θ
Display Types	Numerical form, bar graph

➢ Auxiliary Inputs and Outputs

AUX Inputs	
Function	4 channel inputs
Voltage	±10 V full scale 0.1mV resolution
Impedance	1 MΩ
AUX/CH Outputs	
Function	4 channel outputs
Voltage	±10 V full scale 0.1mV resolution
Drive Current	30 mA max output current

➢ Remote Interfaces

USB2.0, RS-232(DB-9) and 1000Mbps Enthernet

➢ General

Power Requirement	
Voltage	220/240 V AC, 100/120 V AC (optional)
Frequency	50 (60 Hz optional)
Power	50 W typ, 70W max.
Dimension	448 (W)×148 (H)×513 (D) mm (with feet) 448 (W)×133 (H)×513 (D) mm (without feet)
Weight	12kg

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