STANFORD RESEARCH SYSTEMS

SR810 and SR830 DSP Lock-In Amplifiers

DSP LOCK-IN AMPLIFIERS

SR810
Single Phase...$3650 *(U.S. list)*
SR830
Dual Phase...$3950 *(U.S. list)*

- *1 mHz to 102 kHz frequency range*
- *100 dB dynamic reserve without pre-filtering (< 5 ppm stability)*
- *Auto-gain, phase and reserve*
- *Time constants from 10 s to 30 ks (6, 12, 18, 24 dB/oct rolloff)*
- *Harmonic detection (2F, 3F, ... nF)*
- *Synthesized reference source*
- *Four 16-bit ADCs and DACs*
- *GPIB and RS-232 interfaces*

The new SR810 and SR830 are the latest additions to the SRS family of DSP Lock-In Amplifiers. The SR830 simultaneously measures the magnitude and phase of a signal, while the SR810 measures the magnitude of a signal at a specific phase. Both instruments use digital signal processing (DSP) to replace the demodulators, output filters and amplifiers found in conventional lock-ins. The SR810 and SR830 provide uncompromised performance with an operating range of 1 mHz to 102 kHz and 100 dB of drift-free dynamic reserve, outperforming all analog lock-ins.

Extended Dynamic Reserve

Conventional lock-in amplifiers use an analog demodulator to mix an input signal with a reference signal. Dynamic reserve is limited to about 60 dB, and these instruments suffer from poor stability, output drift and excessive gain and phase error. Demodulation in the SR810 and SR830 is accomplished by sampling the input signal with a high precision A/D converter, and multiplying the digitized input by a synthesized reference signal. This digital demodulation technique results in more than 100 dB of true dynamic reserve (no pre-filtering) and is free of the errors associated with analog instruments. Using DSP, a small signal embedded in noise that's a million times larger can easily be measured.

Digital Filtering

The digital signal processor also handles the task of output filtering, allowing time constants from 10 µsec to 30,000 sec, with a choice of 6, 12, 18 and even 24 dB/oct rolloff. For low frequency measurements (below 200 Hz), synchronous filters can be engaged to notch out multiples of the reference frequency. Since the harmonics of the reference have been eliminated (notably 2F), effective output filtering can be achieved with much shorter time constants.

Digital Phase Shifting

Analog phase shifting circuits have also been replaced with a DSP calculation. Phase is measured with 0.01° resolution and the X and Y outputs are orthogonal to 0.001°. This represents a significant improvement over analog instruments.

Frequency Synthesizer

The built-in direct digital synthesis (DDS) source generates a very low distortion (-80 dBc) reference signal. Single frequency sinewaves can be generated from 1 mHz to 102 kHz with 4 1/2 digits of resolution. Both frequency and amplitude can be set from the front panel or from a computer. When using an external reference, the synthesized source is phase locked to the reference signal.

Easy Operation

Unlike some lock-in amplifiers, the SR810 and SR830 are simple to use. All instrument functions are set from the front panel keypad, and a spin knob is provided to quickly adjust parameters. Up to nine different instrument configurations can be stored in non-volatile RAM for fast and easy instrument setup. Standard RS-232 and GPIB (IEEE-488) interfaces provide communication with computers. All functions can be controlled and read through the interfaces.

Useful Features

Auto-functions allow parameters that are frequently adjusted to automatically be set by the instrument. Gain, phase, offset and dynamic reserve are each quickly optimized with a single key press. The offset and expand features are useful when examining small fluctuations in a measurement. The input signal is quickly nulled with the auto-offset function, and resolution is increased by expanding around the relative value by up to 100 times. Harmonic detection is no longer limited to only the 2F component.

Any harmonic (2F, 3F, ... nF) up to 102 kHz can now be measured without changing the reference frequency.

Analog Inputs and Outputs

The SR810 and SR830 have a voltage input sensitivity range that extends from 2 nV to 1 V. A current input is also provided with a choice of 10^6 or 10^8 volts/amp gain ratio. Both instruments have a user-defined output for measuring X, R, X-noise, Aux1, Aux 2 or the ratio of the input signal to an external voltage. The SR830 has a second user-defined output that measures Y, Θ, Y-noise, Aux 3, Aux 4 or ratio. The SR810 and SR830 both have X and Y analog outputs (rear panel) that are updated at 256 kHz. Four auxiliary inputs (16-bit ADCs) are provided for general purpose use, like normalizing the input to source intensity fluctuations. Four programmable outputs (16-bit DACs) provide voltages from -10.5 V to +10.5 V and are settable via the front panel or computer interfaces.

Internal Memory

The SR810 has an 8,000 point memory buffer for recording the time history of a measurement at rates up to 512 samples/sec. The SR830 has two 16,000 point buffers to simultaneously record two measurements, like R and Θ. Data is transferred from the buffers using the computer interfaces. A trigger input is also provided to externally synchronize data recording.

Absolute Value

The SR810 and SR830 DSP Lock-In Amplifiers from Stanford Research Systems offer outstanding performance, features, and value. Specification by specification, feature by feature, no other lock-ins can compare.

SIGNAL CHANNEL

Voltage inputs	Single-ended or differential
Sensitivity	2 nV to 1 V
Current input	10^6 or 10^8 Volts/Amp
Impedance	Voltage: 10 MΩ + 25 pf, AC or DC coupled Current: 1 kΩ to virtual ground
Gain accuracy	± 1% absolute., ± 0.2% typical
Noise	6 nV/-Hz at 1 kHz (typical) 0.13 pA/√Hz at 1 kHz (10^6 V/A) 0.013 pA/√Hz at 100 Hz (10^8 V/A)
Line filters	60 [50] Hz and 120 [100] Hz notch (Q=4)
CMRR	100 dB to 10 kHz, - 6 dB/oct above 10 kHz
Dynamic reserve	> 100 dB without prefilters (< 5 ppm/°C)

REFERENCE CHANNEL

Frequency range	0.001 Hz to 102 kHz
Reference input	TTL or sine (400 mVp-p minimum)
Input impedance	1 MΩ, 25 pf
Phase resolution	0.01° front panel, 0.008° through computer interfaces.
Absolute phase error	< 1°
Relative phase error	< 0.001°
Orthogonality	90° ± 0.001°
Phase noise	Internal oscillator reference: Synthesized, < 0.0001°rms at 1 kHz. External reference applied: 0.005° rms at 1 kHz, 100 ms, 12 dB/oct.
Phase drift	< 0.01°/°C below 10 kHz, < 0.1°/°C below 100 kHz.
Harmonic detection	2F, 3F, ... nF to 102 kHz (n<19,999).
Acquisition time	2 cycles + 5 ms or 40 ms (whichever is larger)

DEMODULATOR

Stability	Digital outputs and display: no drift. Analog outputs: < 5 ppm/°C for all dynamic reserve settings.
Harmonic rejection	-90 dB
Time constants	10 µs to 30 ks (6, 12, 18, 24 dB/oct rolloff). Synchronous filters available below 200 Hz.

INTERNAL OSCILLATOR

Range	1 mHz to 102 kHz
Frequency accuracy	25 ppm + 30 µHz
Frequency resolution	4 1/2 digits or 0.1 mHz, whichever is greater.
Distortion	- 80 dBc (f<10kHz), -70 dBc (f>10kHz) @ 1 Vrms amplitude.
Amplitude	0.004 to 5 Vrms into 10 kΩ (2 mV resolution). 50 Ω output impedance. 50 mA maximum current into 50 Ω.
Amplitude accuracy	1%
Amplitude stability	50 ppm/°C
Outputs	Sine, TTL. (When using an external reference, both outputs are phase locked to the external reference)

DISPLAYS

Channel 1	4 1/2 digit LED display with 40 segment LED bar graph. X, R, X-noise, Aux 1 or Aux 2. The display can also be any of these quantities divided by Aux 1 or Aux 2.
Channel 2 (SR830)	4 1/2 digit LED display with 40 segment LED bar graph. Y, Θ, Y-noise, Aux 3 or Aux 4. The display can also be any of these quantities divided by Aux 3 or Aux 4.
Offset	X, Y, R can be offset up to ±105% of full scale.
Expand	X, Y, R can be expanded by 10 or 100.
Reference	4 1/2 digit LED display.

INPUTS AND OUTPUTS

CH1 output	± 10V output of X, R, X noise, Aux 1 or Aux 2. Updated at 512 Hz.
CH2 output (SR830)	± 10V output of Y, Θ, Y noise, Aux 3 or Aux 4. Updated at 512 Hz.
X, Y outputs	In phase and quadrature components (± 10V). Updated at 256 kHz. (Rear panel)
Aux. A/D inputs	4 BNC inputs, 16 bit, ± 10 V, 1 mV resolution, sampled at 512 Hz.
Aux. D/A outputs	4 BNC outputs, 16 bit, ± 10 V, 1 mV resolution.
Sine Out	Internal oscillator analog output.
TTL Out	Internal oscillator TTL output.
Data Buffer	The SR810 has an 8,000 point memory buffer. The SR830 has two 16,000 point buffers. Data is recorded at rates up to 512 Hz and is read using the computer interfaces.
Trigger In	TTL signal synchronizes stored data recording.
Remote pre-amp	Provides power to the optional SR550 and SR552 preamplifiers.

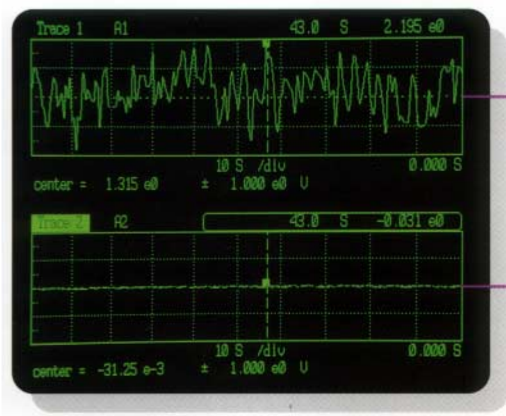
GENERAL

Interfaces	IEEE-488 and RS-232 interfaces standard. All instrument functions can be controlled and read through IEEE-488 or RS-232 interfaces.
Power	40 Watts, 100/120/220/240 VAC, 50/60 Hz.
Dimensions	17"W x 5.25"H x 19.5"L
Weight	23 lbs.
Warranty	One year parts and labor on materials and workmanship.

SR810 & SR830 Rear Panel

More About Dynamic Reserve

Dynamic reserve is defined as the ratio of the largest interfering signal or noise to full scale signal that can accurately (<5%) be measured by a lock-in amplifier. For example, if full scale is 1 µV, then a dynamic reserve of 60 dB means that noise as large as 1 mV (60 dB greater than full scale) won't affect the measurement more than a few percent. Analog lock-ins are limited to about 60 dB dynamic reserve and experience poor stability (> 500 ppm/°C) when measuring a small signal in an extremely noisy environment. To achieve more than 60 dB dynamic reserve, they resort to pre-filtering the input signal which degrades accuracy. Using DSP to replace the demodulator, amplifiers and output filters found in analog lock-ins, the SR810 and SR830 are able to provide greater than 100 dB dynamic reserve (< 5 ppm/°C) without pre-filtering, and measurements are free of the artifacts and limitations found in conventional lock-ins.



Analog Lock-In Amplifier

DSP Lock-In Amplifier

The SR830 and an analog lock-in are both presented with a 10 mV interference signal at 600 Hz, while locked at 350 Hz. Under identical test conditions (10 µV sensitivity, 60 dB dynamic reserve, 300 msec output time constant with 12 dB/oct rolloff), the analog instrument (top graph) exhibits an average error of 13% and varies up to 22% of full scale. In contrast, the SR830 DSP Lock-In Amplifier (bottom graph) has an average error of about 0.3% and the variation is negligible.

Many lock-in manufacturers call their instruments "digital lock-in amplifiers" because of their front panel digital controls, computer interfaces and microprocessor designs. But the heart of these instruments, the demodulator, is still analog in nature. Using DSP to replace analog circuits with mathematical calculations, the DSP lock-ins from SRS provide performance never before possible, and are true "digital lock-in amplifiers". They have at least 40 dB more dynamic reserve than their analog counterparts, and are the most effective lock-in amplifiers available for extracting a small signal from a noisy background.

Ordering Information (all prices U.S. list)

SR810
Single Phase Lock-In Amplifier $3650

SR830
Dual Phase Lock-In Amplifier $3950

Accessories

SR540 Chopper	$1095	*4 Hz to 3.7 kHz, 4 digit display, input control voltage.*
SR550 Preamplifier	$595	*3.6 nV/√Hz input noise, 100 MΩ input impedance.*
SR552 Preamplifier	$595	*1.4 nV/√Hz input noise, 100 kΩ input impedance.*

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