Digital Lock-In Amplifier

OE1022 -DSP Lock-in Amplifier V250418

Key Features

- 1 mHz to 102 kHz frequency range
- 1 nV to 1 V full-scale sensitivity
- Time constants from 10 μs to 3 ks
- >120 dB dynamic reserve
- Multiple-harmonic measurement
- FFT spectral analysis

Overview

OE1022 DSP Lock-in Amplifier provides a superb performance within its bandwidth from 1 mHz to 102 kHz. With the advantage of the latest digital signal processing technology and high-precision 24-bit ADC, OE1022 can easily detect the phase and the magnitude of weak signals overwhelmed by various large noise. The performance of OE1022 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.

Otherwise, OE1022 integrates some special functions like multiple harmonic measurement and FFT, which meets the needs of scientific research and industrial application well.

Reference Signal 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 1μdeg. OE1022 can work at any fixed frequency from 1 mHz to 102 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 OE1022 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 102 kHz.

Input Signal Channel

OE1022 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 5nV/$\sqrt{\text{Hz}}$@997 Hz. The input impedance is 10 MΩ and the full-scale input voltage sensitivity ranges from 1nV to 1V. Besides, OE1022 can be used for current measurement with gains of 10^6 V/A or 10^8 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 OE1022 can keep a high dynamic reserve of 120 dB. The high-precision 24-bit ADC has a sampling rate of 312.5kSPS, and the excellent anti-aliasing filter in front of the ADC can effectively prevent signal aliasing.

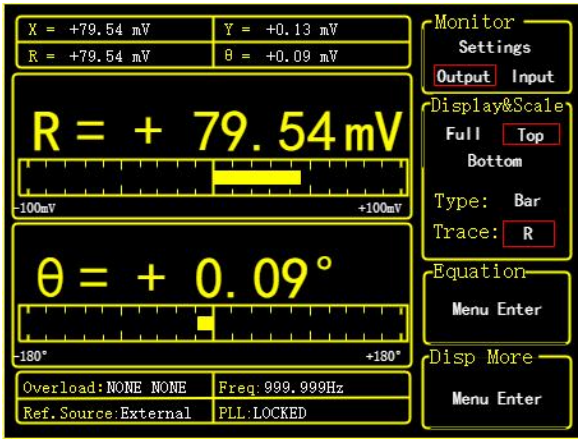
Digital Demodulator and Output Filter

The key component of the OE1022 is the digital demodulator. Compared to traditional analog lock-in amplifiers, the OE1022'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.

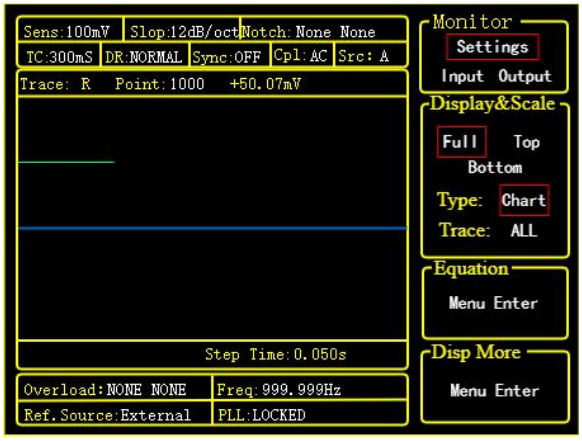
This low-pass digital filter is implemented using a high performance digital filter with a sample rate of 312.5 kHz. The digital demodulation and the low-pass filter used in OE1022 guarantees a high dynamic reserve (>120dB), accurate phase (absolute phase error<1deg). Moreover, when the frequency of the input signal is lower than 200 Hz, A

Display

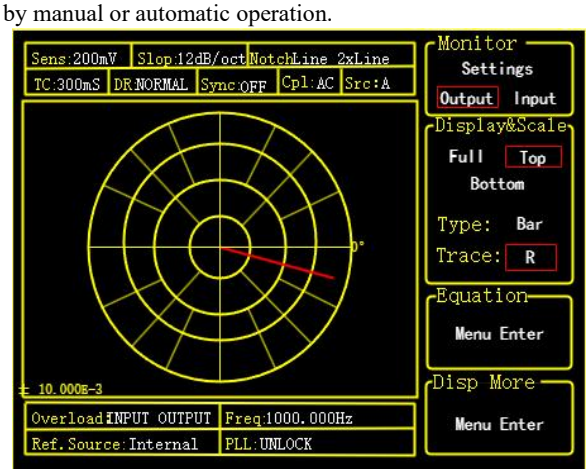
OE1022 has a 5.6-inch 640 x 480 color TFT-LCD.The measurement results of OE1022, such as X, Y, R, and θ, are shown in numerical form, bar graph, X-Y chart and polar coordinates on the display.



In the X-Y plot, the OE1022 shows the trend of the measurement results over time and allows you to check the values using the knob control cursor.



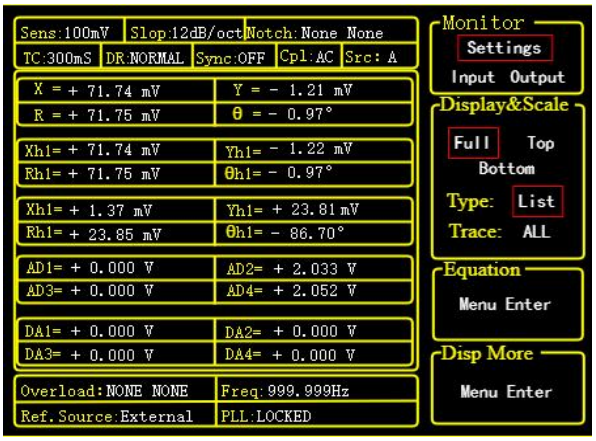
In addition, the OE1022 can display the in-phase and quadrature components of the input signal using polar coordinates. All these display modes can be easily adjusted by manual or automatic operation.



synchronous filter can be used to eliminate the influence of the harmonics of the reference signal, ensuring that OE1022 can detect a low-frequency signal quickly and effectively.

Multiple-harmonic Measurement

Traditional lock-in amplifiers can only measure the fundamental frequency or a harmonic component at the same time, so for some cases where multiple frequency components are needed, the amplitude and phase cannot be measured. Therefore, for some cases that require the amplitude and phase of multiple frequency components at the same time, traditional lock-in amplifiers are unable to meet the measurement requirements.The digital end of the OE1022 combines FPGA and ARM technology to realize higher processing bandwidth and more flexible digital architecture, with a digital processing accuracy of up to 48 bits, allowing simultaneous measurements of harmonics at three frequencies. This makes one OE1022 equivalent to three conventional lock-in amplifiers. The maximum detected harmonic frequency can reach 32,767 times the fundamental frequency, but the maximum harmonic frequency cannot exceed the instrument's operating frequency of 102 kHz.

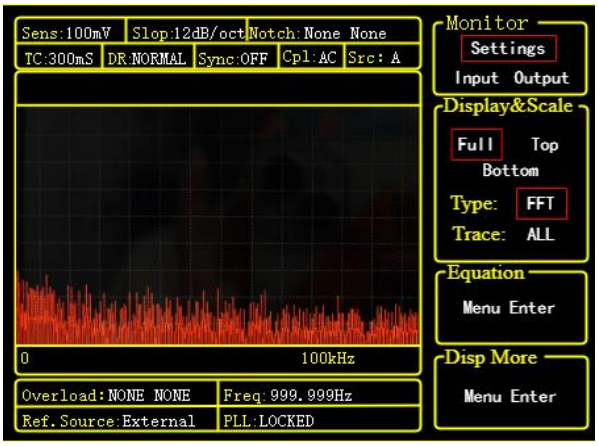


Internal Oscillator

The internal oscillator of OE1022 generates a low distortion (-80 dBc) sine reference signal varying from 1 mHz to 102 kHz, 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 OE1022 or communication interface. When OE1022 is set in the external reference mode, the internal reference signal is phase-locked with the external reference signal.

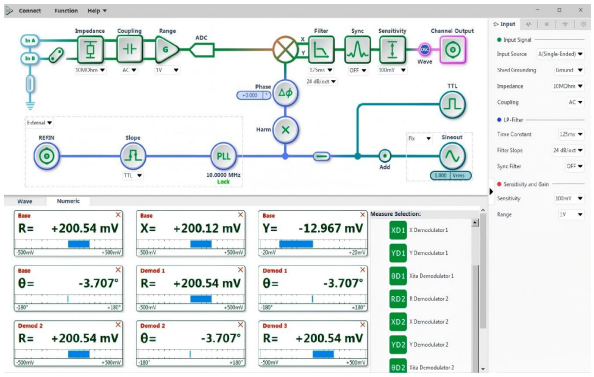
FFT Spectral analysis

OE1022 integrates a high precision FFT analysis function from 1 mHz to 102 kHz in order to analyze the noise component of the measured signal in real time.



Remote Operation

OE1022 is equipped with graphical upper computer software. With quick graphic buttons and rich graphic operation functions, in addition, this software has a clear numerical value display and waveform display function, real-time display of measurement data, measurement results can be saved in excel format output for subsequent analysis of professional software, so that the test is easy to use. In addition, we also fully support Python, MATLAB and LabVIEW application program interface (API).



Manual Operation

The OE1022 can use the softkeys on the front panel, together with the knobs, to realize convenient and quick parameter adjustments, such as adjusting the frequency and phase of the internal reference signal.

Auto Function

OE1022 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.

Signal Generator

OE1022 uses a 16-bit 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 from the OE1022's display, and the maximum amplitude of the sine wave is 5 Vrms.

Communication Interface

OE1022 comes standard with RS-232 to USB2.0 interface and optional GPIB interface. Through the communication interface, you can control all functions of the instrument and read all data in real time. Meanwhile, all interfaces of OE1022 are distributed on the front and rear panels.

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Input Signal Channel

Voltage input Mode	Single-ended or Differential
Full-scale Sensitivity	1 nV - 1 V (voltage input) 1 fA - 1 μA (current input）
Current input	10^6 or 10^8 V/A
Impedance	
Voltage	10 MΩ // 25pF, AC or DC coupled
Current	1kΩ to virtual ground
C.M.R.R	>100 dB to 10 kHz, Decreasing by 6 dB/oct
Dynamic reserve	>120 dB
Gain accuracy	0.2% typ., 1% max
Voltage Noise	5 nV/$\sqrt{Hz}$@997 Hz
Current Noise	15 fA/$\sqrt{Hz}$@97 Hz,13 fA/$\sqrt{Hz}$@997 Hz
Line filters	50/60 Hz and 100/120 Hz
Grounding	BNC shield can be grounded or floated via 10 kΩ to ground

Reference Signal Channel

Input	
Frequency range	1 mHz to 102 kHz
Reference input	TTL or Sine
Input impedance	1 MΩ//25 pF
Phase	
Resolution	1μdeg
Absolute phase error	<1deg
Relative phase error	<0.01deg
Drift	<0.01deg /℃ below 10 kHz <0.1deg /℃ above 10 kHz
Harmonic detection	2F, 3F, …nF to 102 kHz (n<32,767)
Acquisition time	
Internal Ref.	Instantaneous acquisition
External Ref.	(2 cycles + 5 ms) or 40 ms

Demodulator

Number	3
Stability	
Digital outputs	no zero drift on all setting
Display	no zero drift on all setting
Analog outputs	<5 ppm/℃ for all dynamic reserve settings
Harmonic rejection	-90 dB
Time constants	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 200 Hz (18, 24 dB/oct rolloff)

Internal Oscillator

Frequency	
Range	1 mHz to 102 kHz
Accuracy	2 ppm + 10 μHz
Resolution	1 mHz
Distortion	-80 dBc (f<10 kHz), -70 dBc (f>10 kHz)
Amplitude	100 μVrms - 5 Vrms
Accuracy	0.5% typ.(f<10 kHz), 1%max
Stability	100 ppm/℃
Sine output	Output impedance 50Ω
TTL sync output	5V TTL/CMOS level Output Impedance 200Ω

Display

Screen	5.6 inch, 640×480 TFT
Screen format	Single or dual display
Display quantities	X,Y,R,θ values can be displayed for each channel
Display types	Numerical form, bar graph, polar plot and strip chart

Outputs

CH1 and CH2 Outputs	
Function	Output X,Y,R,θ, harmonics
Output Voltage	±10 V
Output Current	±30 mA max
Update Rate	312.5 kSa/s

Communication Interface

RS-232 to USB interface

IEEE-488 interface(optional)

General

Power requirements	
Voltage	100/120/220/240 VAC
Frequency	50/60 Hz
Power	30 W typ., 40W max
Dimensions	
Width	448 mm
Depth	
With handle	515 mm
Height	
With feet	148 mm
Weight	11 kg