



Overview

OE1022D 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, OE1022D can easily detect the phase and the magnitude of weak signals overwhelmed by various large noise.

OE1022D has two independent input channels and two independent high-precision signal generators, each input channel and signal generator can be used independently, and can measure the amplitude and phase information of two input signals at the same time, which has reached the international leading level in terms of key performance indexes, such as measurement accuracy, operating frequency range, signal-to-noise ratio and dynamic reserve. In addition, the addition of multi-harmonic measurement, and PID control functions make the OE1022D widely applicable to a variety of needs in scientific research and industrial fields.

Input Signal Channel

Two independent input channels have high synchronicity and can be individually configured as a single-ended mode or a differential voltage mode. With an ultra low-noise pre-amplifier, the input noise is as low as $5 \text{ nV}/\sqrt{\text{Hz}}@997 \text{ Hz}$. The input impedance is 10 M Ω and the full-scale input voltage sensitivity ranges from 1 nV to 1 V. Besides, OE1022D can be used for current measurement with gains of 10^6 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

Key Features

- 2 independent input channels
- 2 signal generators
- 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

Reference Signal Channel

Two independent reference channels 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 1 μdeg . OE1022D 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 OE1022D 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.

Digital Demodulator and Output Filter

The key component of the OE1022D is the digital demodulator. Compared to traditional analog lock-in amplifiers, the OE1022D'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

the dynamic reserve, so that OE1022D can keep a high dynamic reserve of 120 dB. The high-precision 24-bit ADC has a sampling rate of 312.5 kSPS, and the excellent anti-aliasing filter in front of the ADC can effectively prevent signal aliasing.

Multiple-harmonic Measurement

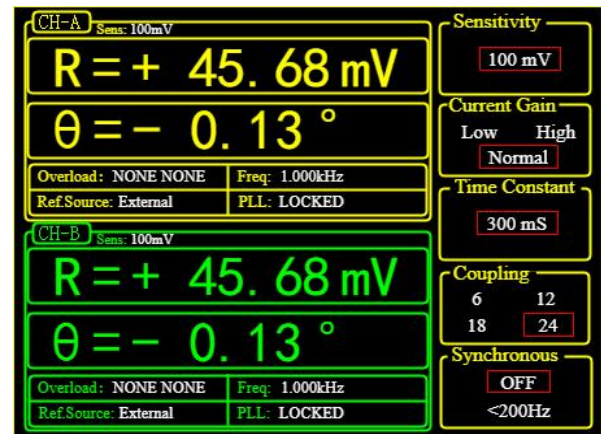
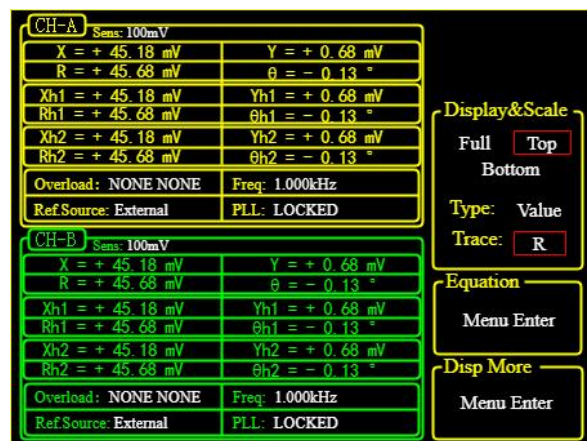
Conventional lock-in amplifiers can only measure the fundamental frequency or a harmonic component at the same time, so for some cases where multiple frequency components are required, the amplitude and phase cannot be measured. Therefore, for some cases where the amplitude and phase of multiple frequency components need to be measured at the same time, traditional lock-in amplifiers are unable to meet the measurement requirements.

The digital end of the OE1022D combines FPGA and ARM technology to realize higher processing bandwidth and more flexible digital architecture, and the digital processing accuracy can reach 48 bits, which allows simultaneous harmonic measurements at three frequencies, making one OE1022D equivalent to three traditional lock-in amplifiers. This makes one OE1022D equivalent to three conventional lock-in amplifiers. Since the OE1022D has two independent input channels, it can simultaneously detect 6 harmonics (2nd fundamental and 4th harmonic). The maximum harmonic signal frequency can be up to 32,767 times the fundamental frequency, but the maximum harmonic frequency cannot exceed the instrument's maximum operating frequency of 102 kHz.

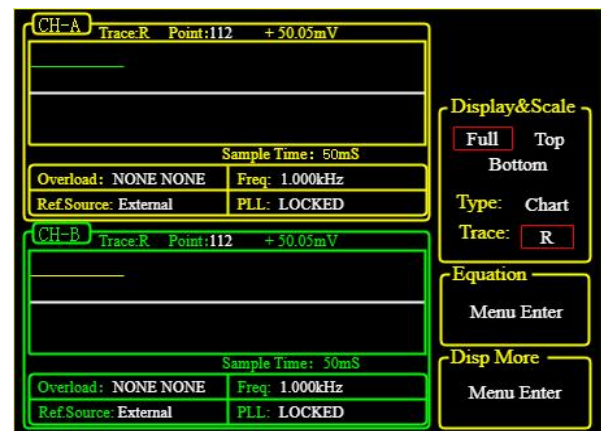
with a choice of 6, 12, 18 or 24dB/oct rolloff. This low-pass digital filter is implemented using an high performance digital filter with a sample rate of 312.5 kHz. The digital demodulation and the low-pass filter used in OE1022D guarantees a high dynamic reserve (>120dB), accurate phase (absolute phase error <1deg). Moreover, when the frequency of the input signal is lower than 200 Hz, A synchronous filter can be used to eliminate the harmonic influence of the reference signal, ensuring that OE1022D can detect a low-frequency signal quickly and effectively.

Display

OE1022D has a 5.6-inch 640 x 480 color TFT-LCD. The measurement results of OE1022D, such as X, Y, R, and θ , are shown in numerical form, bar graph, X-Y chart on the display.



In X-Y chart, OE1022D will shows the trend of measurement results over time, and check the value by using knob control cursor.

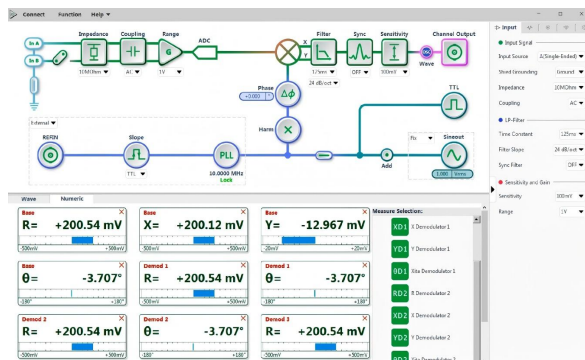


Signal Generator

The OE1022D can use two 16-bit high-precision digital-to-analog converters (DACs) to output two sine wave signals at the same frequency as their corresponding internal oscillators. The amplitude and phase of the output sine wave can be set through the OE1022D's display, where the maximum amplitude of the sine wave is 5 Vrms.

Remote Operation

OE1022D 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).



Auto Function

OE1022D 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.

Communication Interface

The OE1022D utilizes RS-232 and USB 2.0 as standard interfaces. Through the communication interface, all functions of the instrument can be controlled and all data can be read in real time. Meanwhile, all interfaces of the OE1022D are distributed on the front and rear panels.

Manual Operation

The OE1022D 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.

Internal Oscillator

The internal oscillator of OE1022D 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 OE1022D or communication interface. When OE1022D is set in the external reference mode, the internal reference signal is phase-locked with the external reference signal.

Two Input Signal Channel

Voltage input Mode	Single-ended or Differential
Full-scale Sensitivity	1 nV - 1 V (voltage input) 1 fA - 1 μ A (current input)
Current input	10^6 or 10^8 V/A
Impedance	
Voltage	10 M Ω // 25pF, AC or DC coupled
Current	1k Ω 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/ $\sqrt{\text{Hz}}$ @997 Hz
Current Noise	15 fA/ $\sqrt{\text{Hz}}$ @97 Hz, 13 fA/ $\sqrt{\text{Hz}}$ @997 Hz
Line filters	50/60 Hz and 100/120 Hz
Grounding	BNC shield can be grounded or floated via 10 k Ω to ground

Two Reference Signal Channel

Input	
Frequency range	1 mHz to 102 kHz
Reference input	TTL or Sine
Input impedance	1 M Ω //25 pF
Phase	
Resolution	1 μ deg
Absolute phase error	<1deg
Relative phase error	<0.01deg
Drift	<0.01deg / $^{\circ}$ C below 10 kHz <0.1deg / $^{\circ}$ C 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	6
Stability	
Digital outputs	no zero drift on all setting
Display	no zero drift on all setting
Analog outputs	<5 ppm/ $^{\circ}$ C for all dynamic reserve settings
Harmonic rejection	-90 dB
Time constants	10 μ s to 3 ks (<200 Hz) 10 μ s 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 μ Hz
Resolution	0.1 mHz
Distortion	-80 dBc (f<10 kHz), -70 dBc (f>10 kHz)
Amplitude	100 μ Vrms - 5 Vrms
Accuracy	0.5% typ.(f<10 kHz), 1%max
Stability	100 ppm/ $^{\circ}$ C
Sine output	Output impedance 50 Ω DC output mode, \pm 10V(optional)
TTL sync output	5V TTL/CMOS level Output Impedance 200 Ω

Display

Screen	5.6 inch, 640 \times 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, and strip chart

Outputs

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

Communication Interface

RS-232
USB2.0

General

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