

Dual-phase DSP lock-in amplifier operating over a reference frequency range of 0.001 Hz to 250 kHz.

Wide range of extended measuring modes and auxiliary inputs and outputs.

User-upgradeable firmware.

### Measurements Modes

The instrument can simultaneously show any four of these outputs on the front panel display:

X In-phase

Y Quadrature

R Magnitude

ø Phase Angle

### Noise

Harmonic

nF,  $n \leq 65, 536$

Dual Harmonic

Simultaneously measures the signal at two different harmonics  $F_1$  and  $F_2$  of the reference frequency

Dual Reference

Simultaneously measures the signal at two different reference frequencies,  $F_1$   $F_2$  where  $F_1$  is the external and  $F_2$  the internal reference

Frequency Range for Dual Harmonic and Dual Reference Modes

$F_1$  and  $F_2 \leq 20$  kHz

Virtual Reference

Locks to and detects a signal without a reference ( $100 \text{ Hz} \leq F \leq 250 \text{ kHz}$ )

Noise

Measures noise in a given bandwidth centered at the reference frequency F

Spectral Display

Gives a visual indication of the spectral power distribution of the input signal in a user-selected frequency range lying between 1 Hz and 60 kHz. Note that although the display is calibrated in terms of frequency, it is not calibrated for amplitude. Hence it is only intended to assist in choosing the optimum

reference frequency	
<b>Display</b> 240 x 64 pixel cold fluorescent backlit LCD panel giving digital, analog bar-graph and graphical indication of measured signals. Menu system with dynamic key function allocation. On-screen context sensitive help	
<b>Signal Channel</b>	
Voltage Input Modes	A only, -B only or Differential (A-B)
Full-scale Sensitivity	2 nV to 1 V in a 1-2-5 sequence
Max. Dynamic Reserve	> 100 dB
Impedance FET Input Bipolar Input	10 M $\Omega$ // 30 pF 10 k $\Omega$ // 30 pF
Maximum Safe Input	20 V pk-pk
Voltage Noise FET Input Bipolar Input	5 nV/ $\sqrt{\text{Hz}}$ @ 1 kHz 2 nV/ $\sqrt{\text{Hz}}$ @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz
Frequency Response	0.001 Hz to 250 kHz
Gain Accuracy	$\pm 0.2\%$ typ
Distortion	-90 dB THD (60 dB AC gain, 1 kHz)
Line Filter	attenuates 50, 60, 100, 120 Hz
Grounding	BNC shields can be grounded or floated via 1 k $\Omega$ to ground
<b>Current Input</b>	
Mode	Low Noise or Wide Bandwidth
Full-scale Sensitivity	

Low Noise Wide Bandwidth	2fA to 10 nA in a 1-2-5 sequence 2 fA to 1 $\mu$ A in a 1-2-5 sequence
Max. Dynamic Reserve	> 100 dB
Frequency Response	(-3 dB)
Low Noise Wide Bandwidth	> 500 Hz $\geq$ 50 kHz
Impedance Low Noise Wide Bandwidth	< 2.5 k $\Omega$ ! 100 Hz <250 $\Omega$ @ 1 kHz
Noise Low Noise Wide Bandwidth	13 fA/ $\sqrt{\text{Hz}}$ @ 500 Hz 1.3 pA/ $\sqrt{\text{Hz}}$ @ 1 kHz
Gain Accuracy	$\pm$ 0.6% typ, midband
Line Filter	attenuates 50, 60, 100, 120 Hz
Grounding	BNC shield can be grounded or floated via 1 k $\Omega$ to ground-
<b>Reference Channel</b>	
TTL input (rear panel) Frequency Range	0.001 Hz to 250 kHz
Analog Input (front panel) Impedance Sinusoidal input Level Frequency Range Squarewave input Level Frequency Range	1 M $\Omega$ // 30 pF  1.0 V rms* 0.3 Hz to 250 kHz  250 mV rms* 2 Hz to 250 kHz
*Note: Lower levels can be used with the analog input at the expense of increased phase errors	
Phase Set Resolution	0.001 $^\circ$ increments
Phase Noise at 100 ms TC, 12 dB/octave slope Internal Reference	

External Reference	< 0.001° rms <0.01° rms @ 1 kHz
Orthogonality	90° ±0.001°
Acquisition Time Internal Reference	instantaneous acquisition
External Reference	2 cycles + 50 ms
Reference Frequency Meter Resolution	1 ppm or 1 mHz, whichever is the greater
<b>Demodulator and Output Processing</b>	
Output Zero Stability Digital Outputs Displays Analog Outputs	No zero drift on all settings No zero drift on all settings < 5 ppm/°C
Harmonic Rejection	-90 dB
Output Filters X, Y and R outputs only Time Constant  Slope (roll-off) All outputs Time Constant Slope	10 µs to 640 µs in a binary sequence  6 dB/octave  5 ms to 100 ks in a 1-2-5 sequence 6, 12, 18 and 24 dB/octave
Synchronous Filter	Available for F < 20 Hz
Offset	Auto and Manual on X and/or Y: ±300% full-scale
Absolute Phase Measurement Accuracy	≤0.01°
<b>Oscillator</b>	
Frequency Range Setting Resolution 1 mHz ≤ F ≤ 900 Hz F . 900 Hz Absolute Accuracy	0.001 Hz to 250 kHz  1 mHz 4 mHz ± 50 ppm
Distortion (THD)	-80 dB @ 1 kHz and 100 mV rms

Amplitude (rms) Range 1 $\mu$ V to 4 mV 4 mV to 500 mV 500 mV to 2 V 2 V to 5 V Accuracy > 1 mV 100 $\mu$ V - 1 mV Stability	1 $\mu$ V to 5 V rms 1 $\mu$ V 125 $\mu$ V 500 $\mu$ V 1.25 mV  $\pm 0.3\%$ , $F \leq 60$ kHz, $\pm 0.5\%$ , $F > 60$ kHz $\pm 1\%$ , $F \leq 60$ kHz, $\pm 3\%$ , $F > 60$ kHz 50 ppm/ $^{\circ}$ C
Output Impedance	
Sweep Amplitude Sweep Output Range Law Step Rate	0.001 to 5.000 V rms Linear 20 Hz maximum (50 ms/step)
Frequency Sweep Output Range Law Step Rate	0.001 Hz to 250 kHz Linear or Logarithmic 20 Hz maximum (50 ms/step)
<b>Auxiliary Inputs</b>	
ADC 1 & 2 Maximum input Resolution Accuracy Input Impedance Smple Rate ADC 1 only ADC 1 and 2 Trigger Mode Trigger Input	$\pm 10$ V 1 mV $\pm 20$ mV 1 M $\Omega$ // 30 pF  40 kHz max. 17.8 kHz max. Internal, External or burst TTL compatible
ADC 3 Maximum input Resolution Input Impedance Sampling Time	$\pm 10$ V 12 to 20 bit, depending on sampling time 1 M $\Omega$ // 30 pF 10 ms to 2 s, variable
<b>Outputs</b>	
Fast Outputs	

Function Amplitude	X and Y or X and Mag ±2.5 V full-scale; linear to ±300% full-scale
Impedance Update Rate	1 kΩ 166 kHz
Main Analog (CH1 and CH2) Outputs Function  Amplitude	X, Y, R, $\phi$ , Noise, Ratio, Log Ratio and User Equations 1 & 2. ±10.0 V full-scale; linear to ±120% full-scale
Impedance Update Rate	1 kΩ 200 Hz
Signal Monitor Amplitude Impedance	±10 V FS 1 kΩ
Auxiliary D/A Outputs 1, 2, 3 and 4 Maximum Output Resolution Accuracy Output Impedance	±10 V 1 mV ±10 mV 1 kΩ
8-bit Digital Output Port 8 TTL-compatible lines that can be independently set high or low to activate external equipment	
Reference Output Waveform Impedance	0 to 5 V rectangular wave TTL-compatible
Power - Low Voltage	±15 V at 100 mA rear panel 5-pin 180° DIN connector for powering SIGNAL RECOVERY preamplifiers
<b>Data Storage Buffer</b> Size  Max Storage Rate  From LIA	32k x 16-bit data points, may be organized as 1x32k, 2x16k, 3x10.6k, 4x8k, etc.

From ADC1	up to 1000 16-bit values per second up to 40,000 16-bit values per second
<b>User Settings</b> Up to 8 complete instrument settings can be saved or recalled from non-volatile memory	
<b>Interfaces</b> RS232 and GPIB (IEEE-488). A second RS232 port is provided to allow "daisy-chain" connection and control of up to 16 compatible instruments from a single RS232 computer port	
<b>General</b> Power Requirements Voltage Frequency Power	110/120/220/240 VAC 50/60 Hz 40 VA max
Dimensions Width Depth Height With feet Without feet	13¼" (350 mm) 16½" (415 mm)  4¼" (105 mm) 3½" (90 mm)
Weight	18 lb (8.1 kg)