

Model 7280

Wide Bandwidth DSP Lock-in Amplifier

SIGNAL RECOVERY



FEATURES

- ◆ 0.5 Hz to 2 MHz operation
- ◆ Voltage and current mode inputs
- ◆ Direct digital demodulation without down-conversion
- ◆ 7.5 MHz main ADC sampling rate
- ◆ 1 μ s to 100 ks output time constants
- ◆ Quartz crystal stabilized internal oscillator
- ◆ Harmonic measurements to 32F
- ◆ Dual reference, Dual Harmonic and Virtual Reference modes
- ◆ Spectral display mode

APPLICATIONS

- ◆ Scanned probe microscopy
- ◆ Optical measurements
- ◆ Audio studies
- ◆ AC impedance studies
- ◆ Atomic force microscopy

DESCRIPTION

The model 7280 DSP Lock-in Amplifier is an exceptionally versatile instrument with outstanding performance. With direct digital demodulation over an operating frequency extending up to 2.0 MHz, output filter time constants down to 1 μ s and a main ADC sampling rate of 7.5 MHz it is ideal for recovering fast changing signals. But unlike some other high frequency lock-ins, it also works in the traditional audio frequency band.

In addition to its excellent technical specifications, it is also very easy to use. The front panel is dominated by a large electroluminescent display panel, used both to show the instrument's outputs and for adjusting its controls via a series of menus. Controls are set by a combination of the use of the keys surrounding the display and the numeric keypad, while four cursor-movement keys simplify use of the graphic display menus.

Users of the **SIGNAL RECOVERY** models 7260 and 7265 will find switching to the 7280 very easy, since we've designed it with a similar menu structure. The only significant changes are in some of the control menus, where the better resolution of the display allows both the controls and the instrument outputs to be shown simultaneously, for even faster feedback on the effects of control adjustments.

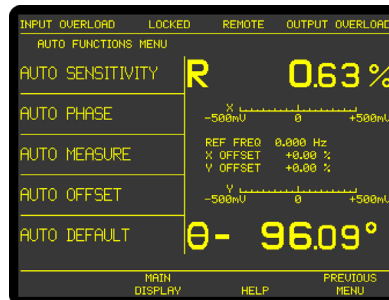


Main Display

Naturally, the instrument includes the extended operating modes like dual reference, dual harmonic and virtual reference made popular by the 7260 and 7265, as well as the spectral display mode used to aid reference frequency selection. It also includes GPIB and RS232 interfaces for remote computer control and a range of auxiliary analog and digital inputs and outputs. Compatible software is available in the form of a LabVIEW

driver supporting all instrument functions, and the Acquire lock-in amplifier applications software. The driver and a free demonstration version of the software, DemoAcquire, are available for download from our website at www.signalrecovery.com

In summary, if you need a lock-in capable of working beyond the traditional audio frequency band but still want the drift-free performance that only digital demodulation brings, then look no further - you have found it in the **SIGNAL RECOVERY** Model 7280.



Auto Functions Menu

Specifications

General

Dual-phase DSP lock-in amplifier operating over a reference frequency range of 0.5 Hz to 2.0 MHz. Direct digital demodulation using a main ADC sampling rate of 7.5 MHz.

Wide range of extended measuring modes and auxiliary inputs and outputs. User-upgradeable firmware.

Measurement Modes

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

X	In-phase
Y	Quadrature
R	Magnitude
θ	Phase Angle
Noise	
Harmonic	$nF, n \leq 32$

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 and F_2 where F_1 is the external and F_2 the internal reference

Frequency Ranges for Dual Harmonic and Dual Reference Modes:

Standard Unit	F_1 and $F_2 \leq 20$ kHz
With option -/99	F_1 and $F_2 \leq 800$ kHz
With option -/98	F_1 and $F_2 \leq 2.0$ MHz

Virtual Reference

Locks to and detects a signal without a reference ($100 \text{ Hz} \leq F \leq 2.0 \text{ MHz}$)

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 2.0 MHz. 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

Display

320×240 pixel ($\frac{1}{4}$ VGA) electroluminescent panel giving digital, analog bar-graph and graphical indication of measured signals. Menu system with dynamic key function allocation. On-screen context sensitive help

Signal Channel

Voltage Input

Modes	A only, -B only or Differential (A-B)
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Full-scale Sensitivity	
$0.5 \text{ Hz} \leq F \leq 250 \text{ kHz}$	10 nV to 1 V in a 1-2-5 sequence
$250 \text{ kHz} < F \leq 2.0 \text{ MHz}$	100 nV to 1 V in a 1-2-5 sequence

Max. Dynamic Reserve	> 100 dB
Impedance	100 M Ω // 25 pF
Maximum Safe Input	20 V pk-pk

Voltage Noise	5 nV/ $\sqrt{\text{Hz}}$ @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz
Frequency Response	0.5 Hz to 2.0 MHz
Gain Accuracy	$\pm 0.3\%$ typ, $\pm 0.6\%$ max. (full bandwidth)

Distortion	-90 dB THD (60 dB AC gain, 1 kHz) attenuates 50, 60, 100, 120 Hz
Line Filter	
Grounding	BNC shields can be grounded or floated via 1 k Ω to ground

Current Input Mode	Low Noise, Normal or Wide Bandwidth
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Full-scale Sensitivity	
Low Noise	10 fA to 10 nA in a 1-2-5 sequence
Normal	10 fA to 1 μ A in a 1-2-5 sequence
Wide Bandwidth	
$F \leq 250 \text{ kHz}$	1 pA to 100 μ A in a 1-2-5 sequence
$F > 250 \text{ kHz}$	10 pA to 100 μ A in a 1-2-5 sequence

Max. Dynamic Reserve > 100 dB

Frequency Response (-3 dB)

Low Noise	≥ 500 Hz
Normal	≥ 50 kHz
Wide Bandwidth	≥ 1 MHz

Impedance

Low Noise	< 2.5 k Ω @ 100 Hz
Normal	< 250 Ω @ 1 kHz
Wide Bandwidth	< 25 Ω @ 10 kHz

Noise

Low Noise	13 fA/ $\sqrt{\text{Hz}}$ @ 500 Hz
Normal	130 fA/ $\sqrt{\text{Hz}}$ @ 1 kHz
Wide Bandwidth	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 Ω to ground
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Reference Channel

TTL Input (rear panel)	
Frequency Range	0.5 Hz to 2.0 MHz
Analog Input (front panel)	
Impedance	1 M Ω // 30 pF
Sinusoidal Input	
Level	1.0 V rms*
Frequency Range	0.5 Hz to 2.0 MHz
Squarewave Input	
Level	250 mV rms*
Frequency Range	2 Hz to 2 MHz

*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	< 0.0001 $^\circ$ rms
External Reference	< 0.01 $^\circ$ rms @ 1 kHz
Orthogonality	90 $^\circ \pm 0.0001^\circ$
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
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Demodulator and Output Processing

Output Zero Stability	
Digital Outputs	No zero drift on all settings
Displays	No zero drift on all settings
Analog Outputs	< 5 ppm/ $^\circ$ C
Harmonic Rejection	-90 dB
Output Filters	
X, Y and R outputs only	
Time Constant	1 μ s to 1 ms in a 1-2-5 sequence, and 4 ms 6 and 12 dB/octave
Slope (roll-off)	
All outputs	
Time Constant	5 ms to 100 ks in a 1-2-5 sequence
Slope	6, 12, 18 and 24 dB/octave
Synchronous Filter	Available for $F < 20$ Hz
Offset	Auto and Manual on X and/or Y: $\pm 300\%$ full-scale
Absolute Phase Measurement Accuracy	$\leq 0.01^\circ$

Oscillator

Frequency	
Range	0.5 Hz to 2.0 MHz
Setting Resolution	1 mHz
Absolute Accuracy	± 50 ppm
Distortion (THD)	-80 dB @ 1 kHz and 100 mV rms
Amplitude (rms)	
Range	1 mV to 1 V
Setting Resolution	1 mV
Accuracy	$\pm 0.2\%$
Stability	50 ppm/ $^\circ$ C
Output Impedance	50 Ω
Sweep	
Amplitude Sweep	
Output Range	0.000 to 1.000 V rms
Law	Linear
Step Rate	20 Hz maximum (50 ms/step)
Frequency Sweep	
Output Range	0.5 Hz to 2.0 MHz
Law	Linear or Logarithmic
Step Rate	20 Hz maximum (50 ms/step)

Auxiliary Inputs

ADC 1, 2, 3 and 4	
Maximum Input	± 10 V
Resolution	1 mV
Accuracy	± 20 mV
Input Impedance	1 M Ω // 30 pF
Sample Rate	
ADC 1 only	40 kHz max.
ADC 1 and 2	17.8 kHz max.
Trigger Mode	Internal, External or burst
Trigger Input	TTL compatible

Lock-in Amplifiers

Model 7280 Specifications

Outputs

Main Analog (CH1 and CH2) Outputs

Function X, Y, R, θ , Noise, Ratio, Log Ratio and User Equations 1 & 2.

Amplitude ± 2.5 V full-scale; linear to $\pm 300\%$ full-scale

Impedance 1 k Ω

Update Rate:

X, Y or R @ TC ≤ 4 ms 7.5 MHz

All outputs @ TC ≥ 5 ms 1 kHz

Signal Monitor

Amplitude ± 1 V FS

Impedance 1 k Ω

Auxiliary D/A Output 1 and 2

Maximum Output ± 10 V

Resolution 1 mV

Accuracy ± 10 mV

Output Impedance 1 k Ω

8-bit Digital Port

0 to 8 lines can be configured as inputs, with the remainder being outputs. Each output line can be set high or low and each input line read to allow interaction with external equipment. Extra line acts as trigger input

Reference Output

Waveform 0 to 3 V rectangular wave

Impedance TTL-compatible

Power - Low Voltage

± 15 V at 100 mA rear panel 5-pin 180° DIN connector for powering **SIGNAL RECOVERY** preamplifiers

Data Storage Buffer Size

32k \times 16-bit data points, may be organized as 1 \times 32k, 2 \times 16k, 3 \times 10.6k, 4 \times 8k, etc.

Max Storage Rate From LIA

up to 1000 16-bit values per second up to 40,000 16-bit values per second

From ADC1

User Settings

Up to 8 complete instrument settings can be saved or recalled at will from non-volatile memory

Interfaces

RS232 and GPIB (IEEE-488). A second RS232 port is provided to allow "daisy-chain" connection and control of up to 16 units from a single RS232 computer port

General

Power Requirements

Voltage 110/120/220/240 VAC

Frequency 50/60 Hz

Power 200 VA max

Dimensions

Width 17 $\frac{1}{4}$ " (435 mm)

Depth 19" (485 mm)

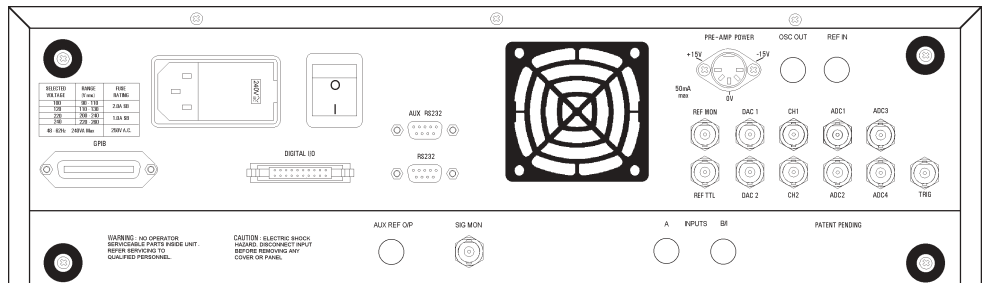
Height

With feet 6" (150 mm)

Without feet 5 $\frac{1}{4}$ " (130mm)

Weight

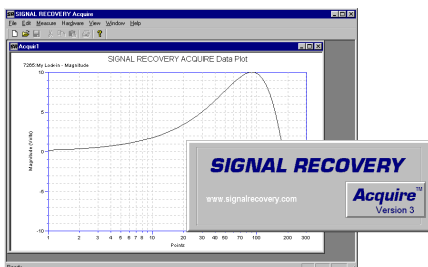
25.4 lb (11.5 kg)



Model 7280 Rear Panel

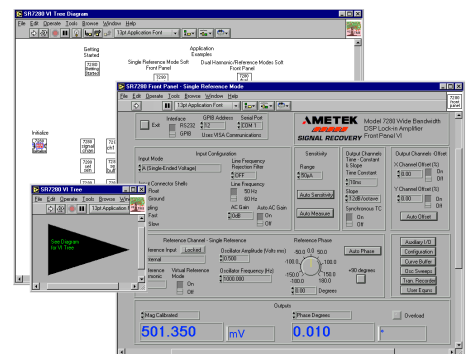
SIGNAL RECOVERY Acquire Software (see page 56)

Users who do not wish to write their own control code but who still want to record the instrument's outputs to a computer file will find the **SIGNAL RECOVERY** Acquire Lock-in Amplifier Applications Software, available at a small extra cost, useful. This 32-bit package, suitable for Windows 95/98/ME/NT/2000/XP, extends the capabilities of the instrument by, for example, adding the ability to make swept frequency measurements. It also supports the internal curve buffer, allowing acquisition rates of up to 1000 points per second independent of the computer's processor speed.



LabVIEW Driver Software

A LabVIEW driver for the instrument is available from the www.signalrecovery.com website, offering example VIs for all its controls and outputs, as well as the usual Getting Started and Utility VIs. It also includes example soft-front panels built using these VIs, demonstrating how you can incorporate them in more complex LabVIEW programs.



Ordering Information

Each model 7280 is supplied complete with a comprehensive instruction manual. Users may download the instrument's LabVIEW driver software and a free demonstration copy, DemoAcquire, of the **SIGNAL RECOVERY** lock-in amplifier applications software package, from the www.signalrecovery.com website.

Optional Accessories

Model 7280/99 Extended frequency range (800 kHz) for Dual Reference and Dual Harmonic Modes

Model 7280/98 Extended frequency range (2.0 MHz) for Dual Reference and Dual Harmonic Modes

Acquire™ 32-bit lock-in amplifier applications software for use with Windows 95/98/ME/NT/2000/XP operating systems

Model K02004 Rack mount to mount one model 7280 in a 19" rack