Model 7280

Wide Bandwidth DSP Lock-in Amplifier

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 µs 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

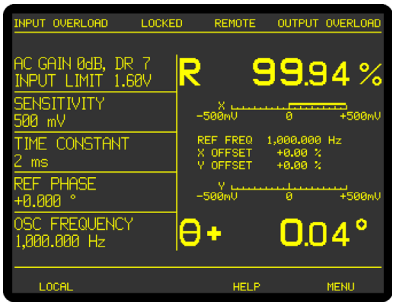
- **Scanned probe microscopy**
- **Optical measurements**
- **Audio studies**
- **AC impedance studies**
- **Atomic force microscopy**

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 µs 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.

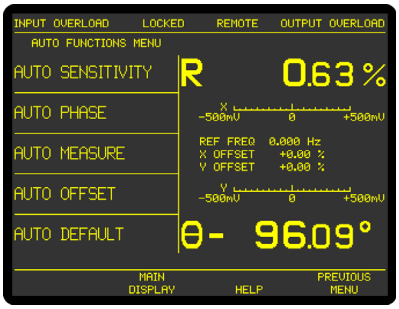
In addition to its excellent technical specifications, it is also very easy to use. The front panel is dominated by a large electroluminescent display panel, used both to show the instrument's outputs and for adjusting its controls via a series of menus. Controls are set by a combination of the use of 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**



Auto Functions Menu

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.

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 — *n*F, $n \leq 32$

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 Hz ≤ F ≤ 2.0 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 (¼ 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)
Full-scale Sensitivity	
0.5 Hz ≤ F ≤ 250 kHz	10 nV to 1 V in a 1-2-5 sequence
250 kHz < F ≤ 2.0 MHz	100 nV to 1 V in a 1-2-5 sequence
Max. Dynamic Reserve	> 100 dB
Impedance	100 MΩ // 25 pF
Maximum Safe Input	20 V pk-pk
Voltage Noise	5 nV/√Hz @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz
Frequency Response	0.5 Hz to 2.0 MHz
Gain Accuracy	±0.3% typ, ±0.6% max. (full bandwidth)
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 kΩ to ground

Current Input

Mode	Low Noise, Normal or Wide Bandwidth
Full-scale Sensitivity	
Low Noise	10 fA to 10 nA in a 1-2-5 sequence
Normal	10 fA to 1 µA in a 1-2-5 sequence
Wide Bandwidth	
F ≤ 250 kHz	1 pA to 100 µA in a 1-2-5 sequence
F > 250 kHz	10 pA to 100 µA 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 kΩ @ 100 Hz
Normal	< 250 Ω @ 1 kHz
Wide Bandwidth	< 25 Ω @ 10 kHz
Noise	
Low Noise	13 fA/√Hz @ 500 Hz
Normal	130 fA/√Hz @ 1 kHz
Wide Bandwidth	1.3 pA/√Hz @ 1 kHz
Gain Accuracy	± 0.6% typ, midband
Line Filter	attenuates 50, 60, 100, 120 Hz
Grounding	BNC shield can be grounded or floated via 1 kΩ to ground

Reference Channel

TTL Input (rear panel)

Frequency Range	0.5 Hz to 2.0 MHz

Analog Input (front panel)

Impedance	1 MΩ // 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° increments
Phase Noise at 100 ms TC, 12 dB/octave slope	
Internal Reference	< 0.0001° rms
External Reference	< 0.01° rms @ 1 kHz
Orthogonality	90° ±0.0001°
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

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/°C
Harmonic Rejection	-90 dB
Output Filters	
X, Y and R outputs only	
Time Constant	1 µs to 1 ms in a 1-2-5 sequence, and 4 ms
Slope (roll-off)	6 and 12 dB/octave
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: ±300% full-scale
Absolute Phase Measurement Accuracy	≤ 0.01°

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	±0.2%
Stability	50 ppm/°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 MΩ // 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

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 ±300% full-scale
Impedance	1 kΩ
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 kΩ

Auxiliary D/A Output 1 and 2

Maximum Output	±10 V
Resolution	1 mV
Accuracy	±10 mV
Output Impedance	1 kΩ

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 × 16-bit data points, may be organized as 1×32k, 2×16k, 3×10.6k, 4×8k, etc.
Max Storage Rate	
From LIA	up to 1000 16-bit values per second
From ADC1	up to 40,000 16-bit values per second

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

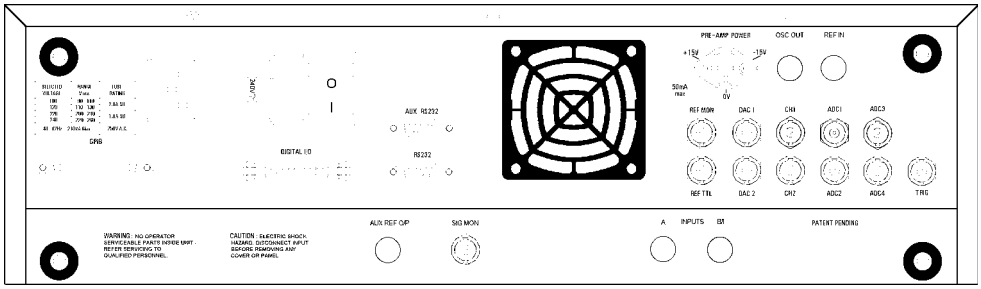
General

Power Requirements

Voltage	110/120/220/240 VAC
Frequency	50/60 Hz
Power	200 VA max

Dimensions

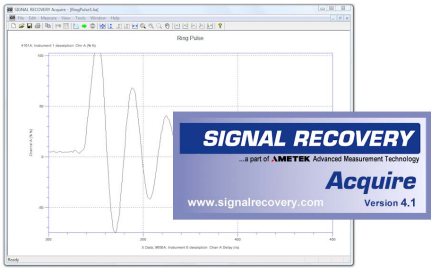
Width	17¼" (435 mm)
Depth	19" (485 mm)
Height	
With feet	6" (150 mm)
Without feet	5¼" (130mm)
Weight	25.4 lb (11.5 kg)



Model 7280 Rear Panel

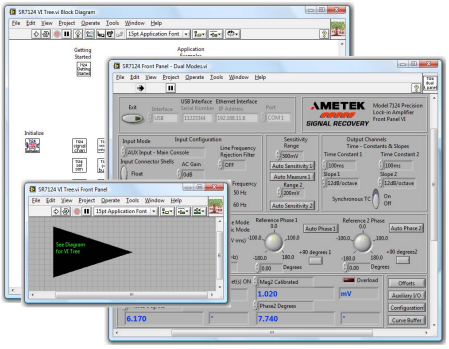
SIGNAL RECOVERY Acquire Software (see page 56)

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 XP/ Vista, extends the capabilities of the instrument by, for example, adding the ability to record 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 XP/Vista operating systems
Model K02004	Rack mount to mount one model 7280 in a 19" rack

Why should you choose *SIGNAL RECOVERY* products?

Models 7280 and 7280BFP Wide Bandwidth DSP Lock-in Amplifiers

SIGNAL RECOVERY **Product Features**	**Benefit to you**
◆ They are the only commercially available 2 MHz genuine DSP lock-in amplifiers	Allows use in systems requiring short output time constants without problems caused by an insufficient number of samples per signal cycle
◆ Analog outputs updated at 7.5 MHz for use with time constants down to 1 µs	Ideal for scanned probe microscopy feedback control loops
◆ Spectral Display (Model 7280 only)	See in the frequency domain where interfering signals are and choose a quiet region for your reference frequency
◆ Dual Reference	Measure two signals at two different frequencies simultaneously, without the expense involved in buying two instruments
◆ Dual Harmonic	Measure two signals at two different harmonics simultaneously, without the expense involved in buying two instruments
◆ Curve Buffer Graphical Display	Strip chart mode display is invaluable for monitoring during manual adjustment of experiments
◆ Virtual Reference	Recover signals even without a reference
◆ Large high resolution electroluminescent display (Model 7280 only)	Excellent viewing angle for good visibility even across a crowded laboratory
◆ Easy to set controls with keypad and cursor movement keys (Model 7280 only)	Enter the exact setting you need without having to fiddle with a sensitive rotary knob. Move the cursors on the graphical display with ease
◆ User upgradeable firmware	Benefit from future firmware upgrades without having to send the instrument to a service facility
◆ 2-input multiplexing using A and -B inputs - even under computer control	Measure two signals sequentially under computer control using the same lock-in without having to switch connections
◆ 8 User Settings Memory (Model 7280 only)	Several users can share an instrument but keep their own personalized settings
◆ Internal Oscillator can be used independently of rest of instrument	Set OSC OUT to a different frequency to the reference e.g. Use it to control a ***SIGNAL RECOVERY*** chopper at *f* and then connect the lock-in's reference input to the chopper's *f*/10 SYNC output
◆ Auxiliary Digital Input and Output port	Eliminate the need for separate digital I/O cards when building complex computer controlled experiments
◆ Excellent LabVIEW driver	Saves programming time
◆ Compatible with Acquire software	Eliminates the need to develop programs
◆ Compatible with SRInstComms	Control the instrument from any ActiveX enabled programming language, such as Visual Basic, VBA (Excel, Word, Access) and VBScript (Internet Explorer)