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.

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.
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.

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

- X: In-phase
- Y: Quadrature
- R: Magnitude
- i: Phase Angle

Noise
Harmonic
- Harmonic: nF, n ≤ 32

Dual Harmonic
Simultaneously measures the signal at two different harmonics F1 and F2 of the reference frequency

Dual Reference
Simultaneously measures the signal at two different reference frequencies, F1 and F2, where F1 is the external and F2 the internal reference

Frequency Ranges for Dual Harmonic and Dual Reference Modes:
- Standard Unit: F1 and F2, ≤ 20 kHz
- With option -99: F1 and F2, ≤ 800 kHz
- With option -98: F1 and F2, ≤ 2 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
- 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
  - Impedance: > 100 dB
  - 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

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

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
- External Reference: 2 cycles + 50 ms

*Note: Lower levels can be used with the analog input at the expense of increased phase errors

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
  - Absolute 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: (50 ms/step)
  - ADC 1 only: 40 kHz max.
  - ADC 1 and 2: 17.8 kHz max.
  - Trigger Mode: Internal, External or Burst
  - Trigger Input: TTL compatible

www.signalrecovery.com
## Model 7280 Specifications

### Outputs

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Amplitude</td>
<td>±2.5 V full-scale; linear to ±300% full-scale</td>
</tr>
<tr>
<td>Impedance</td>
<td>1 kΩ</td>
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<tr>
<td>Update Rate:</td>
<td>X, Y or R @ TC ≤ 4 ms</td>
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<td>7.5 MHz</td>
</tr>
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<td>All outputs @ TC</td>
<td>≥ 5 ms 1 kHz</td>
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</table>

### Main Analog (CH1 and CH2) Outputs

- **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 for X, Y, R
- **All outputs @ TC**: ≥ 5 ms 1 kHz

### Signal Monitor

- **Amplitude**: ±1 V FS
- **Impedance**: 1 kΩ
- **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

### 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.

### Power - Low Voltage

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

### 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 V AC
  - **Frequency**: 50/60 Hz
  - **Power**: 200 VA max

### Dimensions

- **Width**: 17¼” (435 mm)
- **Depth**: 19” (485 mm)
- **Height**: 6” (150 mm) with feet, 5¼” (130 mm) without feet

### Weight

- 25.4 lb (11.5 kg)

### Interface Requirements

- **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.

### 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, from the SIGNAL RECOVERY 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

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**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.

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**Catiss7Web:0710UK**

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# Why should you choose SIGNAL RECOVERY products?

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

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