

# Model 7225

## DSP Lock-in Amplifier



### FEATURES

- ◆ 0.001 Hz to 120 kHz operation
- ◆ Voltage and current mode inputs
- ◆ Direct digital demodulation without down-conversion
- ◆ 10  $\mu$ s to 100 ks output time constants
- ◆ Quartz crystal stabilized internal oscillator
- ◆ Synchronous oscillator output for input offset reduction
- ◆ Harmonic measurements to 32f

### APPLICATIONS

- ◆ Chopped light measurements
- ◆ AC bridge measurements
- ◆ Audio studies
- ◆ AC impedance studies
- ◆ Vibration studies
- ◆ Thermal wave detection

### DESCRIPTION

The **SIGNAL RECOVERY** model 7225 offers a cost-effective solution to the researcher needing the performance provided by DSP demodulation but not requiring the additional features or higher operating frequencies of the models 7280 and 7265.

The instrument performs all of the normal measurements of a dual phase lock-in amplifier, measuring the in-phase and quadrature components, vector magnitude, phase angle and noise of the input signal.

Two auxiliary ADC inputs, four DAC outputs and eight output logic lines are provided. These can be used to record the magnitude of external signals associated with the experiment, such as temperature or pressure, or to generate voltages to control or switch other equipment. Information from the ADCs together with the lock-in amplifier's output data can be stored in the 32k point buffer memory prior to transfer back to a controlling computer.

The model 7225 is extremely easy to use. All instrument controls are adjusted via the left-hand display panel and its associated keys, while the right hand panel shows the two selected instrument outputs. Auto functions need only two keypresses to activate and in many cases eliminate the need for manual control adjustment.

External control of the unit is via either the RS232 or GPIB interfaces, using simple mnemonic-type ASCII commands. A second RS232 port allows up to sixteen 7225 or compatible instruments to be operated from a single RS232 computer port by connecting them in a "daisy-chain" configuration.

Compatible software is available in the form of a LabVIEW driver supporting all instrument functions, the Acquire lock-in amplifier applications software and the SRInstComms ActiveX control and software toolkit. The driver and a demonstration version of the applications software, DemoAcquire, are available for download from our website at [www.signalrecovery.com](http://www.signalrecovery.com)

### Specifications

#### General

Dual-phase DSP lock-in amplifier operating over a reference frequency range of 0.001 Hz to 120 kHz. Wide range of auxiliary inputs and outputs and user-upgradeable firmware.

#### Measurement Modes

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

X	In-phase
Y	Quadrature
R	Magnitude
$\theta$	Phase Angle

#### Noise

Harmonic  $nF, n \leq 32F$

#### Noise

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

#### Displays

Two 2-line 16 character backlit LCD panels giving digital indication of measured signals

#### Signal Channel

##### 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 10 M $\Omega$  // 30 pF

Bipolar Input 10 k $\Omega$  // 30 pF

Maximum Safe Input 20 V pk-pk

##### Voltage Noise

FET Input 5 nV/ $\sqrt{\text{Hz}}$  @ 1 kHz

Bipolar Input 2 nV/ $\sqrt{\text{Hz}}$  @ 1 kHz

# Lock-in Amplifiers

## Model 7225 Specifications

### Voltage Input (continued)

C.M.R.R.	> 100 dB @ 1 kHz
Frequency Response	0.001 Hz to 120 kHz
Gain Accuracy	±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 kΩ to ground

### Current Input

Mode	Low Noise or Wide Bandwidth
Full-scale Sensitivity	
Low Noise	2 fA to 10 nA in a 1-2-5 sequence
Wide Bandwidth	2 fA to 1 μA in a 1-2-5 sequence
Max. Dynamic Reserve	> 100 dB
Frequency Response (-3dB)	
Low Noise	≥ 500 Hz
Wide Bandwidth	≥ 50 kHz
Impedance	
Low Noise	< 2.5 kΩ @ 100 Hz
Wide Bandwidth	< 250 Ω @ 1 kHz
Noise	
Low Noise	13 fA/√Hz @ 500 Hz
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	0.001 Hz to 120 kHz
Analog Input (front panel)	
Impedance	1 MΩ // 30 pF
Sinusoidal Input	
Level	1.0 V rms*
Frequency Range	0.3 Hz to 120 kHz
Squarewave Input	
Level	250 mV rms*
Frequency Range	2 Hz to 120 kHz

\*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 and Y outputs only:	
Time Constant	10 μs to 640 μs in a binary sequence
Slope (roll-off)	6 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	0.001 Hz to 120 kHz
Setting Resolution	1 mHz
Absolute Accuracy	± 50 ppm
Distortion (THD)	-80 dB @ 1 kHz and 100 mV rms
Amplitude (rms)	
Range	1 mV to 5 V rms
Setting Resolution	
1 mV to 500 mV	1 mV
500 mV to 2 V	4 mV
2 V to 5 V	10 mV
Accuracy	±0.3%, F ≤ 60 kHz, ±0.5%, F > 60 kHz
Stability	50 ppm/°C
Output Impedance	50 Ω
Sweep (computer control only)	
Amplitude Sweep	
Output Range	0.000 to 5.000 V rms
Law	Linear
Step Rate	20 Hz maximum (50 ms/step)
Frequency Sweep	
Output Range	0.001 Hz to 120 kHz
Law	Linear or Logarithmic
Step Rate	20 Hz maximum (50 ms/step)

### Auxiliary Inputs

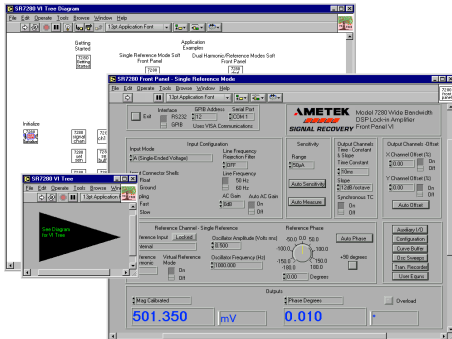
ADC 1 & 2	
Maximum Input	±10 V
Resolution	1 mV
Accuracy	±20 mV
Input Impedance	1 MΩ // 30 pF
Sample Rate	
ADC 1 only	40 kHz max.
ADC 1 and 2	17.8 kHz max.
Trigger Mode	Internal, External or burst
Trigger Input	TTL compatible

### Outputs

Fast Outputs	
Function	X and Y
Amplitude	±2.5 V full-scale; linear to ±300% f.s.
Impedance	1 kΩ
Update Rate	166 kHz
Main Analog (CH1 and CH2) Outputs	
Function	X, Y, R, θ, Noise, Ratio, Log Ratio and User Equations 1 & 2.
Amplitude	±10.0 V full-scale; linear to ±120% full-scale
Impedance	1 kΩ
Update Rate	200 Hz
Signal Monitor	
Amplitude	±10 V FS
Impedance	1 kΩ
Auxiliary D/A Outputs 1, 2, 3 and 4	
Maximum Output	±10 V
Resolution	1 mV
Accuracy	±10 mV
Output Impedance	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	0 to 5 V rectangular wave
Impedance	TTL-compatible
Power - Low Voltage	±15 V at 100 mA rear panel 5-pin 180° DIN connector for powering <b>SIGNAL RECOVERY</b> 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
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	40 VA max
Dimensions	
Width	17" (432 mm)
Depth	16½" (415 mm)
Height	
With feet	3" (74 mm)
Without feet	2¼" (60 mm)
Weight	16 lb (7.4 kg)

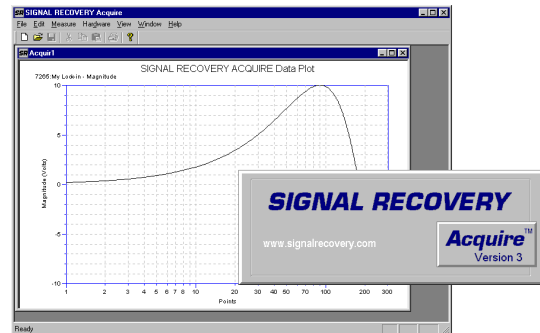
### LabVIEW® Driver Software

A LabVIEW driver for the instrument is available from the [www.signalrecovery.com](http://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.



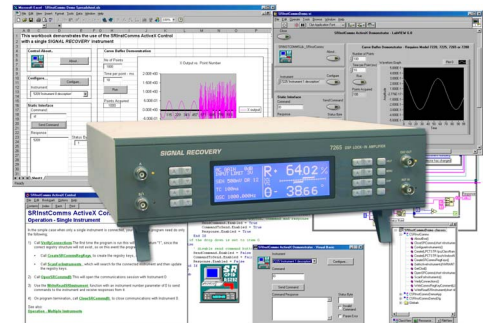
### SIGNAL RECOVERY Acquire Software (see page 56)

Those 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 oscillator amplitude 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.



### SRInstComms Software (see page 58)

Control up to ten **SIGNAL RECOVERY** instruments directly from Visual Basic, Visual C++, LabVIEW, Visual Basic for Applications (included in Word, Excel, Outlook, Access and other Microsoft products) and VBScript (supported by Internet Explorer 3 and later) without having to worry about low-level communications routines. The SRInstComms control handles all the communications between your software and the instrument(s) via the RS232 and/or GPIB interfaces, leaving you free to develop the code to run your experiment.

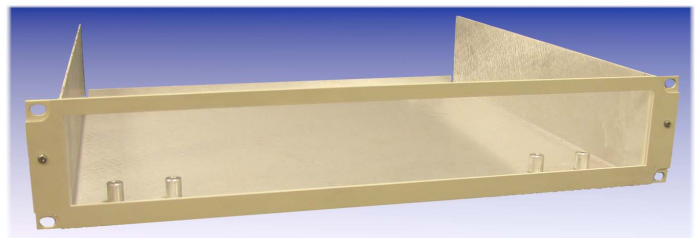


### Ordering Information

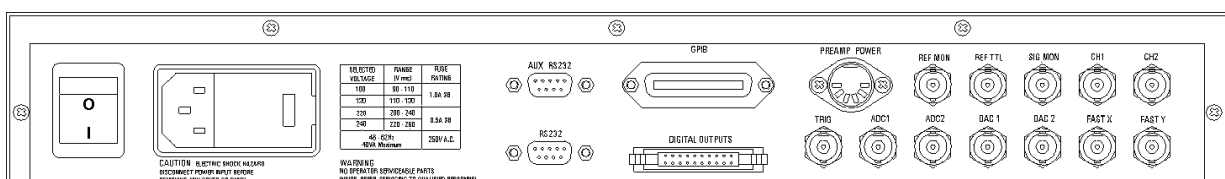
Each model 7225 is supplied complete with a comprehensive instruction manual. Users may download the instrument's LabVIEW driver software and a free demonstration copy, DemoAcquire, of the **SIGNAL RECOVERY** lock-in amplifier applications software package, from the [www.signalrecovery.com](http://www.signalrecovery.com) website.

### Optional Accessories

**Model K02002** Rack mount to mount one model 7225 in a 19" rack



Model K02002



Model 7225 Rear Panel Layout