

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 μ 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

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 |
| θ | 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 Ω // 30 pF

Bipolar Input 10 k Ω // 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 ≤ F ≤ 900 Hz | 1 mHz |
| F > 900 Hz | 4 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

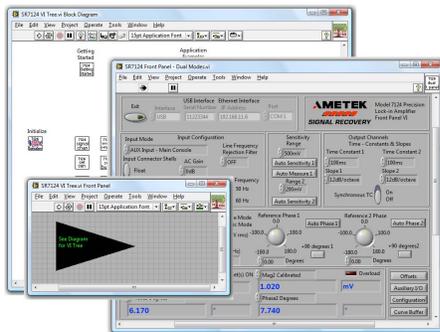
| | |
|-----------------|-----------------------------|
| ADC 1 & 2 | |
| Maximum Input | ±10 V |
| Resolution | 1 mV |
| Accuracy | ±20 mV |
| Input Impedance | 1 MΩ // 30 pF |
| Sample Rate | |
| ADC 1 only | 40 kHz max. |
| ADC 1 and 2 | 17.8 kHz max. |
| Trigger Mode | Internal, External or burst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



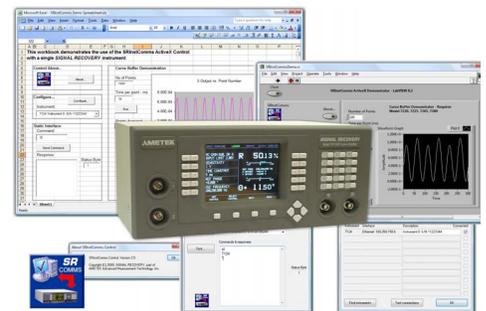
SIGNAL RECOVERY Acquire Software (see page 56)

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 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.



SRInstComms Software (see page 59)

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.

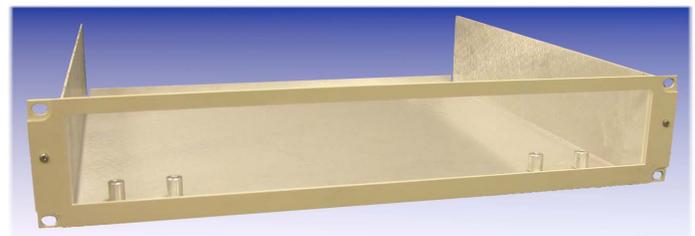


Ordering Information

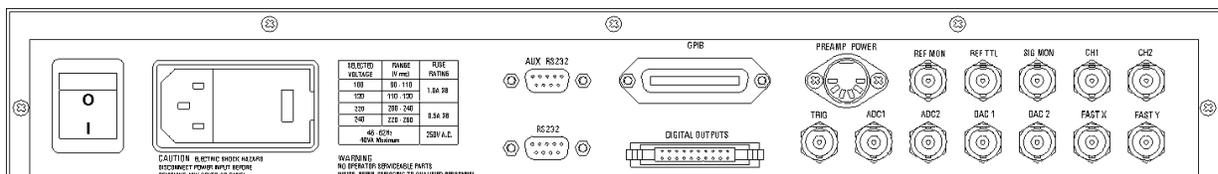
Each model 7225 is supplied complete with a comprehensive instruction manual. Users may download the instrument's LabVIEW driver software and a free demonstration copy, DemoAcquire, of the **SIGNAL RECOVERY** lock-in amplifier applications software package, from the www.signalrecovery.com website.

Optional Accessories

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



Model K02002 Rack Mount Kit



Model 7225 Rear Panel Layout