Model 7265

DSP Lock-in Amplifier

SIGNAL RECOVERY

FEATURES

- **0.001 Hz to 250 kHz operation**
- **Voltage and current mode inputs**
- **Direct digital demodulation without down-conversion**
- **10 µs to 100 ks output time constants**
- **Quartz crystal stabilized internal oscillator**
- **Synchronous oscillator output for input offset reduction**
- **Harmonic measurements to 65,536F**
- **Dual reference, Dual Harmonic and Virtual Reference modes**
- **Spectral display mode**
- **Built-in experiments**

APPLICATIONS

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

DESCRIPTION

The ***SIGNAL RECOVERY*** model 7265 uses the latest digital signal processing (DSP) technology to extend the operating capabilities of the lock-in amplifier to provide the researcher with a very versatile unit suitable both for measurement and control of experiments. At the same time due consideration has been given to the needs of those users wishing only to make a simple measurement quickly and easily.

Operating over a frequency range of 1 mHz to 250 kHz, the model 7265 offers full-scale voltage sensitivities down to 2 nV and current sensitivities to 2 fA. The instrument has a choice of operating modes, signal recovery or vector voltmeter, for optimum measurement accuracy under different conditions, and the use of DSP techniques ensures exceptional performance.

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.

Several novel modes of operation are also include to give greater levels of versatility than ever before, for example:

- **Virtual Reference™**

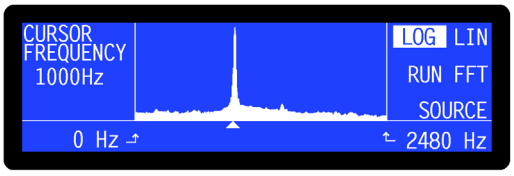
Under suitable conditions, this mode allows measurements to be made in the absence of a reference signal

- **Dual Reference**

In this mode the instrument can make simultaneous measurements on two signals at different reference frequencies, which is ideal, for example, for use in source compensated optical experiments

- **Spectral Display**

This allows the spectrum of the signals present at the input to be calculated and displayed, which can help when choosing the reference frequency



Spectral Display

- **Transient Recorder**

In this mode, the auxiliary ADC inputs can be used as a 40 kSa/s (25 µs/point) transient recorder, with the captured transient being displayed graphically

- **Frequency Response**

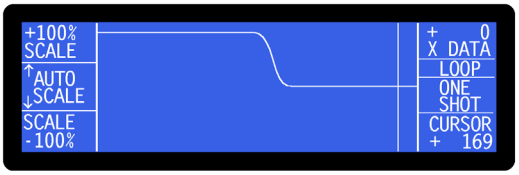
This built-in experiment allows the internal oscillator frequency to be swept between preset frequencies, while simultaneously measuring the input signal magnitude and phase. The mode is ideal for determining the frequency and phase response of external networks

PHOTONIC SOLUTIONS
Photonic Solutions Unit A, 40 Captains Road, Edinburgh, EH17 8QF, UK,
Tel: +44 (0)131 664 8122 Fax: +44 (0)131 664 8144
Email sales@photonicsolutions.co.uk Web www.photonicsolutions.co.uk

◆ Harmonic Analysis

Most lock-in amplifiers will measure signals at the applied reference frequency or its second harmonic. In the 7265, operation is possible at harmonics up the 65,536th, and in Dual Harmonic mode, simultaneous measurements can be made on two harmonics

Three auxiliary ADC inputs, one of which is a special integrating converter, 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, and even displayed graphically on screen.



Graphical Display

The model 7265 is extremely easy to use. All instrument controls are adjusted using soft-touch, front panel push-buttons, with the present settings and measured outputs being displayed on the centrally located, cold fluorescent backlit dot-matrix LCD. A particularly convenient feature is the pop-up keypad which is

Pop-up Keypad to set Controls

used when setting controls that need adjusting to a large number of significant figures.

Control selection and adjustment is aided by the logical structure of on-screen menus and sub-menus, supported by a series of context-sensitive help screens. A number of built-in automatic functions are also provided to simplify instrument operation.

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 7265 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, 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**

Specifications

General

Dual-phase DSP lock-in amplifier operating over a reference frequency range of 0.001 Hz to 250 kHz.

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, $n \leq 65{,}536$

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 Range for Dual Harmonic and Dual Reference Modes: F_1 and $F_2 \leq 20$ kHz

Virtual Reference

Locks to and detects a signal without a reference (100 Hz ≤ F ≤ 250 kHz)

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 60 kHz. 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

240 × 64 pixel cold fluorescent backlit LCD 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	2 nV to 1 V in a 1-2-5 sequence
Max. Dynamic Reserve	> 100 dB
Impedance	
FET Input	10 MΩ // 30 pF
Bipolar Input	10 kΩ // 30 pF
Maximum Safe Input	20 V pk-pk
Voltage Noise	
FET Input	5 nV/√Hz @ 1 kHz
Bipolar Input	2 nV/√Hz @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz
Frequency Response	0.001 Hz to 250 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 (-3 dB)	
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

Model 7265 Specifications (continued)

Reference Channel

TTL Input (rear panel)	
Frequency Range	0.001 Hz to 250 kHz
Analog Input (front panel)	
Impedance	1 MΩ // 30 pF
Sinusoidal Input	
Level	1.0 V rms*
Frequency Range	0.3 Hz to 250 kHz
Squarewave Input	
Level	250 mV rms*
Frequency Range	2 Hz to 250 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, Y and R 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 250 kHz
Setting Resolution	1 mHz
Absolute Accuracy	± 50 ppm
Distortion (THD)	-80 dB @ 1 kHz and 100 mV rms
Amplitude (rms)	
Range	1 µV to 5 V rms
Setting Resolution	
1 µV to 4 mV	1 µV
4 mV to 500 mV	125 µV
500 mV to 2 V	500 µV
2 V to 5 V	1.25 mV
Accuracy	
> 1 mV	±0.3%, $F \leq 60$ kHz, ±0.5%, $F > 60$ kHz
100 µV - 1 mV	±1%, $F \leq 60$ kHz ±3%, $F > 60$ kHz
Stability	50 ppm/°C
Output Impedance	50 Ω
Sweep	
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 250 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
ADC 3	
Maximum Input	±10 V
Resolution	12 to 20 bit, depending on sampling time
Input Impedance	1 MΩ // 30 pF
Sampling Time	10 ms to 2 s, variable

Outputs

Fast Outputs	
Function	X and Y or X and Mag
Amplitude	±2.5 V full-scale; linear to ±300% full-scale
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

User Settings

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

Interfaces

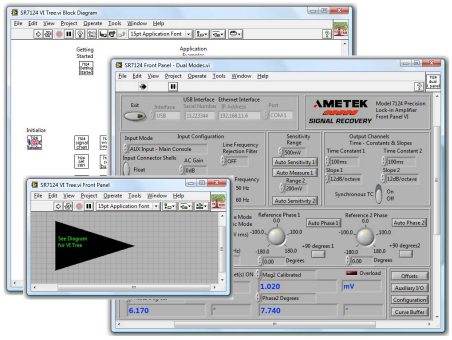
RS232 and GPIB (IEEE-488). A second RS232 port is provided to allow “daisy-chain” connection and control of up to 16 compatible instruments from a single RS232 computer port

General

Power Requirements	
Voltage	110/120/220/240 VAC
Frequency	50/60 Hz
Power	40 VA max
Dimensions	
Width	13¼" (350 mm)
Depth	16½" (415 mm)
Height	
With feet	4¼" (105 mm)
Without feet	3½" (90mm)
Weight	18 lb (8.1 kg)

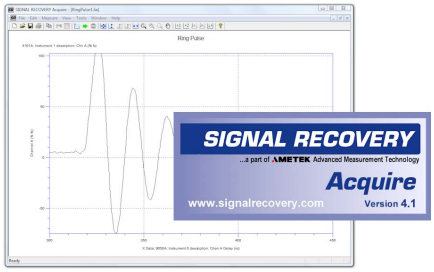
LabVIEW Driver Software

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.



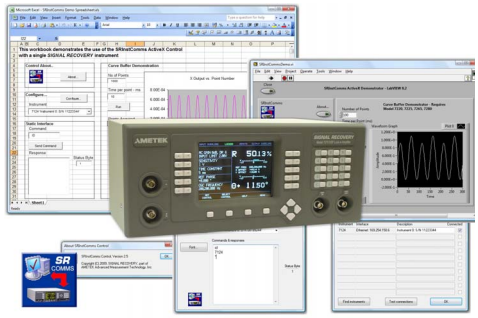
SIGNAL RECOVERY Acquire Software (see page 56)

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*** Instruments 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.

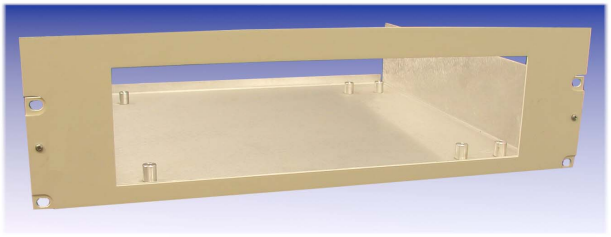


Ordering Information

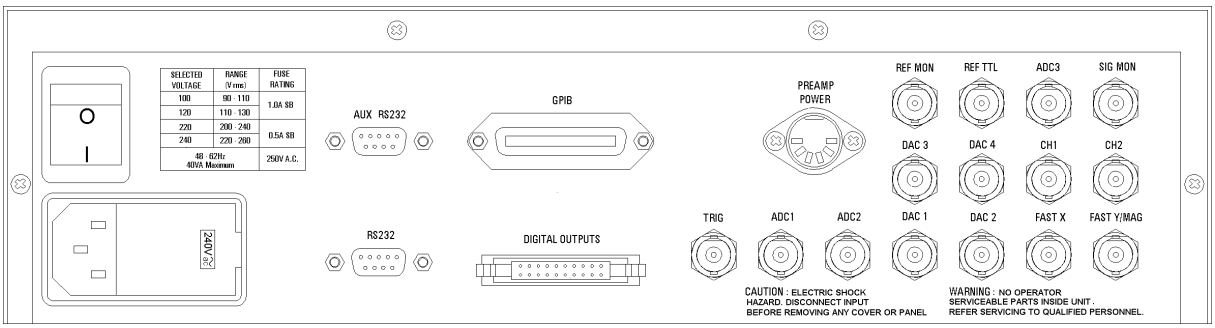
Each model 7265 is supplied complete with a comprehensive instruction manual. Users may download the instrument's LabVIEW driver software and a free demonstration copy, DemoAcquire, of the ***SIGNAL RECOVERY*** lock-in amplifier applications software package, from the **www.signalrecovery.com** website.

Optional Accessories

Model K02003 Rack mount to mount one model 7265 in a 19" rack



Model K02003 Rack Mount Kit



Model 7265 Rear Panel Layout

Why should you choose *SIGNAL RECOVERY* products?

Model 7265 DSP Lock-in Amplifier

SIGNAL RECOVERY Product Features	Benefit to you
◆ Physically compact	Saves valuable space in crowded laboratories
◆ Spectral Display	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 good for monitoring during manual adjustment of experiments
◆ Virtual Reference	Recover signals even without a reference
◆ Easy to set controls - pop-up keypad	Enter the exact setting you need without having to fiddle with a sensitive rotary knob
◆ Experiments - frequency response	Perform complete swept-frequency response measurement and display the results graphically without having to write any program
◆ Transient Recorder	Capture the waveform of any signal at up to 40 kSa/s
◆ User upgradeable firmware	Benefit from future firmware upgrades without having to send the instrument to a service facility
◆ Synchronous Oscillator output	Allows input offset removal (see Applications Note AN1001 on page 123)
◆ 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	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
◆ 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)

PHOTONIC SOLUTIONS
Photonic Solutions Unit A, 40 Captains Road, Edinburgh, EH17 8QF, UK,
Tel: +44 (0)131 664 8122 Fax: +44 (0)131 664 8144
Email sales@photonicsolutions.co.uk Web www.photonicsolutions.co.uk