MEGA LAB

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Model 7270
DSP Lock-in Amplifier

- 1 mHz – 250 kHz frequency range
- 2 nV/2 fA – 1 V/1 µA FS sensitivity
- Main ADC and analog outputs update rate of 1 MSa/s
- Large, easy-to-use color display with comprehensive range of operating modes
- USB, Ethernet and RS-232 computer interfaces

...all in a compact benchtop enclosure

Signal Recovery
AMETEK

Model 7270 DSP Lock-in Amplifier

The new standard for general purpose DSP lock-in amplifiers

Overview

The model 7270 sets a new standard for general-purpose DSP lock-in amplifiers. We've taken advantage of the developments in technology since the first DSP lock-in amplifiers were introduced in the early 1990s to update the core design but made sure that we've included all the best features of our model 7265 and 7280 instruments. What's more, the new architecture has allowed us to offer even better specifications in an instrument that is physically much more compact than older designs. The result is a lock-in amplifier of outstanding performance that is easy to use and suitable for all measurements over a frequency range extending from 1 mHz to 250 kHz.

Versatility

In common with other models in our range, the 7270 offers much more than just dual phase lock-in detection at the reference frequency of an applied signal. We've included features unique to SIGNAL RECOVERY instruments such as dual reference and dual harmonic detection, which allow signals at two different frequencies to be measured simultaneously. The spectral display mode shows the power spectral density of the input signal, making it easy to avoid interfering signals when selecting a reference frequency. It is now even possible to perform tandem demodulation. In this mode, an amplitude-modulated signal at a (high) "carrier" frequency is first demodulated at that frequency. The resulting in-phase output, at short time constant settings, is a signal at the modulating frequency that is then passed forward for detection by a second set of demodulators running at the same modulating frequency. Such detection techniques, which can be used in pump-probe measurements, have until now required two separate instruments with an analog connection between them.

Fast Data Processing

The main ADC sampling rate and the rate at which the analog signal outputs are updated is 1 MSa/s, giving excellent performance when used at short output filter time constant settings, such as in scanned probe measurements. But we've also increased the maximum rate at which data can be stored to the internal curve buffer to 1 µs per point, allowing for the first time direct capture of instrument outputs when using these short time constants. The buffer length has also been increased to 100,000 sets of points, giving recording times of 100 ms at the fastest sampling rates. What's more, in the fast capture mode the length does not need to be divided by the number of outputs being stored, making it possible, for example, to store the full 100,000 points of X, Y and auxiliary ADC1 values at the same time.

Remote Control

The built-in RS-232, USB and Ethernet connections allow full operation from a controlling computer. We offer a comprehensive software package, Acquire, that can operate the instrument via any of these interfaces and makes it easy to set up and run complex experiments, such as frequency response measurements, as well as allowing remote control of every instrument function. Users who wish to do their own programming can use our ActiveX control and toolkit (SRInstComms), or free LabVIEW driver, to simplify the task.

See what you've been missing...

In summary, if you're looking for a general-purpose lock-in amplifier to work in the range 1 mHz to 250 kHz, then you need to look no further—you've found it in the SIGNAL RECOVERY model 7270.

- 1 mHz to 250 kHz operating frequency range
- Voltage and current mode inputs
- 1 MHz main ADC sampling rate
- 10 µs to 100 ks output filter time constants
- Precision DDS sinewave oscillator with adjustable amplitude and frequency
- Oscillator output can be amplitude or frequency modulated
- Harmonic measurements up to 127 × F
- Dual Reference, Dual Harmonic and Virtual Reference operating modes
- Easy manual operation using large full-color display, soft keys and numeric keypad
- Built-in on-screen context sensitive help
- Auxiliary analog and digital inputs and outputs
- Internal data buffer for recording instrument outputs at rates down to 1 µs per point
- USB, RS-232 and Ethernet computer interfaces

Instrument Format

The 7270 is packaged as a compact, benchtop unit with a color display, keys for accessing menus and adjusting controls, and a keypad for entry of numeric values. It uses powerful DSP algorithms running in a dedicated field-programmable gate array (FPGA), supported by a ColdFire processor, to deliver the best possible performance.

Signal and Reference Connections

The front-panel signal input connectors can be switched to operate in single-ended or differential voltage mode, or in current mode with a choice of two transimpedance settings. They can also be used to switch between two single-ended voltage signals, for simple sequential measurement under computer control of two inputs. In cases where further preamplification is needed, then one of the SIGNAL RECOVERY remote preamplifiers can be used with its output connected to the 7270's "A" input connector. This flexible choice of input modes allows the best possible connection to be made to the experiment.

If using an external reference signal, then either the front-panel general-purpose analog or rear-panel TTL logic reference inputs can be used. For internal reference work, a precision DDS oscillator generates a sinewave signal of adjustable frequency and amplitude that is available at the front-panel OSC OUT connector.

Signal Path

Following input amplification, the signal can optionally be passed through an analog line-frequency rejection filter, with configurable center frequency and mode, before reaching the main anti-aliasing filter. It is then applied to the signal channel precision ADC. This operates at 1 MHz, delivering an accurate digital representation of the signal to be measured and the noise accompanying it to the signal inputs of the in-phase and quadrature demodulators, which are implemented in an FPGA.

Reference Channel

The reference channel signal drives a phase locked loop, which in turn drives the reference channel. When the instrument is set to Internal Reference mode, the internal precision quartz stabilized oscillator is used to generate the sinewave output at the OSC OUT connector.

When set to the Harmonic Detection mode, an internal frequency multiplier permits measurement of signals at frequencies up to 127 times the reference frequency, allowing distortion measurements to be easily made.

The reference channel also includes a precision phase shifter to permit the phase of the reference inputs to the demodulator to be adjusted.

The output of the reference channel is a series of digital phase values, updated at the same 1 MHz rate as the signal channel ADC sampling rate. These are used to derive digital representations of cosinusoidal and sinusoidal waveforms, which are applied to the reference channel inputs of the inphase and quadrature demodulators respectively.

Digital Demodulators

At the heart of the instrument are the demodulators, implemented using DSP techniques. Unlike the analog multipliers or switches used in older lock-in amplifiers, this type of demodulator does not use DC coupled electronics. Hence it is immune from the potential errors caused by DC drift and offset introduced by such designs.

Output Channels

Following the demodulators, the first stage of output filtering, providing time constants in the range 10 µs to 500 ms, is carried out using digital finite impulse response (FIR) filters implemented within the FPGA and updated at the 1 MHz signal sampling rate. Further filtering, if required, is provided using similar filters implemented in the instrument's main microprocessor.

After filtering, the output signals are potentially further modified by offset and expansion controls, before being displayed either as basic X-output and Y-output values or being processed to give derived outputs, including signal vector magnitude and phase. The instrument can also be used to measure the noise accompanying the signal and the ratio or logarithm of the ratio of the X-channel output to other signals, such as the voltage at the auxiliary ADC inputs.

There are four rear-panel DAC outputs that can be set to convert the internal digital output values back to analog signals, at the same 1 MHz update rate, thereby making them usable down to the shortest possible output filter time constant settings.

- **Dual Reference**—Simultaneously measure two signals at different frequencies
- **Spectral Display**—See the power spectral density of the input signal plus noise
- **Dual Harmonic**—Simultaneously measure two harmonics of the reference frequency
- **Virtual Reference**—Make reference-free measurements even on noisy signals
- **VCO**—Use external analog signal to control the frequency or amplitude of the precision internal oscillator
- **Synchronous Oscillator Output**—Access the sinewave being used for demodulation, including any frequency multiplication and/or phase shift

Extended Operating Modes

The instrument includes the extended operating modes made popular by other SIGNAL RECOVERY lock-in amplifiers, such as the 7265 and 7280.

In normal Single Reference mode, harmonic analysis can be performed on harmonics up to 127 × F, while in Dual Harmonic mode, the signals at two harmonics of the reference signal can be simultaneously measured. The instrument can therefore be used to measure a fundamental frequency and one harmonic of it at the same time.

Dual Reference mode permits measurement of two signals at two unrelated frequencies to be performed simultaneously. For example, in an optical experiment the signals passing through two different paths can be independently measured if they are modulated at two different modulation frequencies.

The instrument also includes a “tandem” demodulation mode that allows an amplitude-modulated signal to be first demodulated at a carrier frequency, with the output from this demodulation being processed by a second demodulator running at a lower frequency.

The Synchronous Oscillator output is an analog sinusoidal signal equivalent to that being used to drive the in-phase demodulator, and available in both internal and external reference modes. Hence, for example, if the instrument is set to 2F reference mode and a 1 kHz reference is applied, then this output will be a 2 kHz sinewave.

Manual Operation

Just like other SIGNAL RECOVERY instruments, the 7270 is exceptionally easy to use, both manually and when operated from a remote computer.

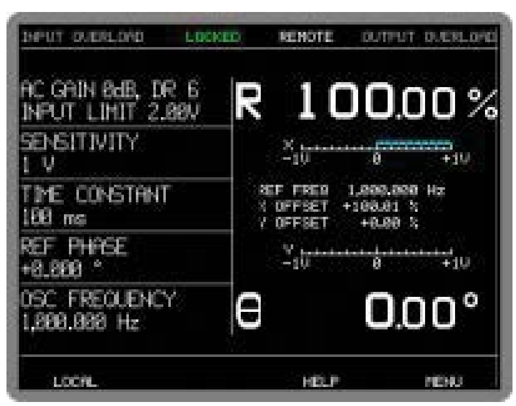
In manual use, the color TFT display panel is used in conjunction with the keys grouped around it and the numeric keypad to adjust the instrument’s controls, with the selected outputs being shown both on the display and being available as analog signals from four rear-panel connectors.

The keypad makes it simple to set controls, such as the oscillator frequency, that can be adjusted over a wide range and to a high precision. But once at the desired setting, the corresponding “increment/decrement” keys make it simple to change the set value by the required amount.

The Main Display is used in normal operation and shows four user-selected instrument controls on the left-hand side and four user-selected outputs, output offset status and the present reference frequency on the right.

The output display selections include digital and bar-graph displays in a variety of formats. Error information, such as input and output overload, and reference unlock indication, is clearly shown along the top edge of the display, while soft keys along the bottom edge are used for selecting controls and to initiate numerical keypad data entry.

Pressing the Menu key accesses the Main Menu, from which other menus may be reached. Some, such as those affecting the communications interface settings, occupy the full display. Others, such as the Signal Channel menu, occupy only the left-hand side of the display with the right-hand side continuing to show the selected outputs. This feature gives instant feedback on the effect of adjusting the controls.



Main Display

User Settings

Sophisticated instruments such as the model 7270 are often used by several users for different types of experiments. Setting all the controls to the required state each time the unit is moved can waste precious time; therefore, the instrument includes the ability to store up to eight complete records of all control settings, which can be recalled when required.

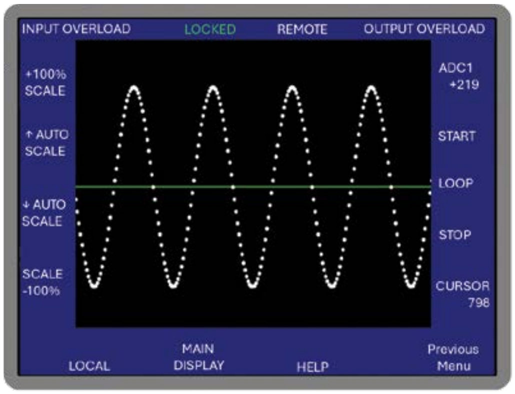
Auto Functions

Any one of the five auto functions can be reached with just two key presses from the Main Display, and on completion of the selected function the Main Display returns. When activated, these functions adjust the associated control to the optimum setting for the present input signal.

Data Storage

An internal, 100k-point buffer memory can be used to store selected outputs. Digitized information from the auxiliary ADCs can also be stored, which is especially useful when using the highest ADC sampling rates. If required, the data buffer can be subdivided to allow several outputs to be stored simultaneously giving, for example, the ability to store lock-in amplifier outputs and auxiliary ADC input signals on the same time axis.

The resulting data curves can be shown graphically on the display as they are acquired in a "strip chart" mode, which can prove very useful while making adjustments to the experiment. The instrument also includes a Spectral Display mode (unique to SIGNAL RECOVERY lock-in amplifiers) that shows the power spectral density of the input signal plus accompanying noise and proves to be an invaluable aid to selecting a reference frequency that is away from interfering signals.



Graphical Output Display

Remote Operation

The model 7270 includes USB, RS-232 and Ethernet bidirectional control interfaces, allowing controls to be set or interrogated and instrument outputs to be read.

The command set is based on the use of simple ASCII mnemonics, making user-written source code very easy to read and understand. In addition, a Communications Monitor display menu is available that shows all commands received and responses generated by the instrument. This is invaluable during program development and debugging.

Auxiliary Features

The model 7270 is much more than just a lock-in amplifier because it includes a number of auxiliary inputs and outputs to further increase its versatility.

Four sampled ADC inputs on the rear panel of the instrument can be used to digitize external voltage signals, such as those from transducers measuring variables like temperature, pressure, flow rate, optical intensity or liquid level. Various trigger modes are provided. For example, the instrument can function as a 15-bit ADC 200 kSa/s transient recorder with a 100k-point data memory.

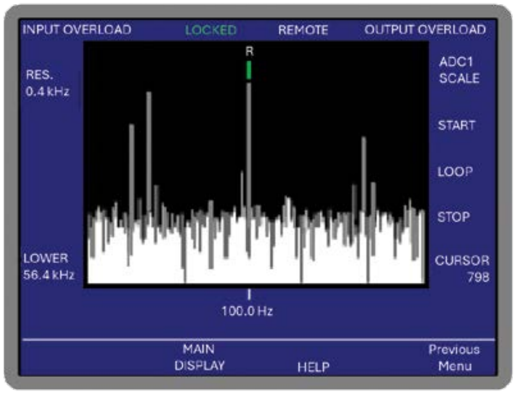
Calculations can be performed between any of the instrument's outputs and the digitized ADC inputs, allowing corrections for such variations as signal strength and standing offsets to be made.

The instrument also has four digital-to-analog converter (DAC) outputs that can be used to generate analog signals representing the instrument outputs (e.g., X, Y, Magnitude and Phase values) and voltages for the control of external equipment, such as motor speed, lamp intensity or fluid flow rate.

The instrument includes an 8-bit bidirectional TTL port that can be used to switch external equipment, such as relay input or output multiplexers.

User-Upgradeable Firmware

In common with most other SIGNAL RECOVERY instruments, the 7270's operating firmware can be updated via the USB or RS-232 port simply by downloading new code into it using a firmware update pack, which can be obtained free of charge from our website. You can therefore be sure you are always using the latest code. No other lock-in manufacturer offers this capability.



Spectral Display Mode

Specifications

Measurement Modes

X In-phase **Y Quadrature** **R Magnitude** **Ø Phase Angle** **Noise**	The instrument can simultaneously show any four of these outputs on the front panel display.
Harmonic	n × F, n ≤ 127
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 internal reference and F_2 is the external reference
Tandem Demodulation	Demodulates the signal using the internal reference frequency F_1, and then passes the resulting X channel output to a second demodulator running at an external reference frequency F_2
Virtual Reference	Locks to and detects a signal without a reference (100 Hz ≤ F ≤ 250 kHz)
Noise	Measures noise in a selected 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 250 kHz. The display is calibrated for frequency, but not amplitude, and is intended to assist in choosing the best reference frequency

Display

320 × 240 pixel color TFT display panel giving digital, analog bar-graph and graphical indication of measured signals.
Menu system with dynamic key function allocation.

Signal Channel

Voltage Input

Modes	A only, –B only or differential (A–B)
Frequency Response	1 mHz ≤ F ≤ 250 kHz (–3 dB)
Full-scale Sensitivity	2 nV to 1 V in a 1-2-5 sequence (e.g., 2 nV, 5 nV, 10 nV, 20 nV, etc.)
Input Impedance	
FET Input	10 MΩ // 25 pF, AC or DC coupled
Bipolar Input	10 kΩ // 25 pF, input must be DC coupled
Maximum Safe Input	±12 V
Voltage Noise	5 nV/√Hz @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz degrading by no more than 6 dB/octave with increasing frequency
Gain Accuracy	±0.5% typ, ±1.0% max.
Distortion	-90 dB THD (60 dB AC gain, 1 kHz)

Current Input

Mode	Low noise (10^8 V/A) or wide bandwidth (10^6 V/A)
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

Signal Channel, continued

Frequency Response (-3 dB)	
Low Noise	1 mHz ≤ F ≤ 500 Hz minimum
Wide Bandwidth	1 mHz ≤ F ≤ 50 kHz minimum
Impedance	
Low Noise	< 2.5 kΩ @ 100 Hz
Wide Bandwidth	< 250 Ω @ 1 kHz
Noise	
Low Noise	13 fA/√Hz @ 500 Hz
Wide Bandwidth	130 fA/√Hz @ 50 kHz
Gain Accuracy	± 2.0% typ, midband

Either Input Mode

Max. Dynamic Reserve	> 100 dB
Line Filter	Filter can be set to attenuate 50/60 Hz, 100/120 Hz, or both frequency bands
Grounding	BNC shields can be grounded or floated via 1 kΩ to ground

Signal Monitor

Amplitude	±1 V FS. This is the signal after preamplification and filtering immediately prior to conversion by the main ADC
Output Impedance	1 kΩ

Reference Input

TTL Input (rear panel)

Frequency Range	1 mHz to 250 kHz

Analog Input (front panel)

Impedance	1 MΩ // 30 pF
Sinusoidal Input	
Level	1 V rms
Frequency Range	0.5 Hz to 250 kHz
Squarewave Input	
Level	250 mV rms
Frequency Range	2 Hz to 250 kHz

Reference Channel

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 + 1 s
Reference Frequency Meter Resolution	4 ppm or 1 mHz, whichever is the greater

Demodulators and Output Processing

Output Zero Stability	
Digital Outputs	No zero drift on all settings
Displays	No zero drift on all settings
DAC Analog Outputs	< 100 ppm/°C
Harmonic Rejection	-90 dB

Demodulators and Output Processing. continued

Output Filters	
Time Constant	10 µs to 100 ks in a 1-2-5 sequence
Slope (roll-off)	
TC < 5 ms	6 or 12 dB/octave
TC ≥ 5 ms	6, 12, 18 or 24 dB/octave
Synchronous Filter	Available for F < 20 Hz
Offset	Auto/Manual on X and/or Y: ±300% F.S.
Phase Measurement Resolution	≤ 0.01°
Reference Monitor	TTL signal at current reference frequency, internal or external

Oscillator

Frequency	
Range	1 mHz to 250 kHz
Setting Resolution	1 mHz
Absolute Accuracy	± 50 ppm
Amplitude	
Range	1 µV to 5 V
Max. Setting Resolution	1 µV
Output Impedance	50 Ω
Sweep	
Frequency	
Output Range	1 mHz to 250 kHz
Law	Linear or logarithmic
Step Rate	1000 Hz maximum (1 ms/step)
Amplitude Sweep	
Output Range	0.000 to 1.000 V rms
Law	Linear
Step Rate	
Main Console	20 Hz maximum (50 ms/step)
RCU	1 Hz maximum (1 s/step)

Auxiliary Inputs

ADC 1, 2, 3 and 4	
Maximum Input	±11 V
Resolution	1 mV
Accuracy	±20 mV
Input Impedance	1 MΩ // 30 pF
Sample Rate	200 kHz maximum (one ADC only)
Trigger Mode	Internal, external or burst
Trigger Input	TTL compatible, rising or falling edge

Outputs

Analog Outputs	
DAC1	X, X1, Mag2, User DAC1, Output function
DAC2	Y, Y1, Pha2, User DAC2, Output function
DAC3	X2, Mag, Mag1, User DAC3, Output function
DAC4	Y2, Pha, Pha2, User DAC4, Output function
Output Functions	Noise, Ratio, Log Ratio and User Equations 1 & 2
Amplitude	
X(1), Y(1), Mag(1), Pha(1)	±2.5 V full-scale; linear to ±300% F.S.
User DACs and Output Functions	±10 V full-scale

Outputs, continued

Impedance	1 kΩ
Update Rate	
X(1/2), Y(1/2), Mag(1/2), Pha(1/2) @ TC < 1 s	1 MHz
User DACs, Output Functions and TCs ≥ 1 s	1 kHz
8-bit Digital Port	
Mode	0 to 8 lines can be configured as inputs, with the remainder being outputs
Status	Each output line can be set high or low and the status of each input line read
Power—Low Voltage	±15 V at 100 mA 5-pin rear-panel 180° DIN connector for powering compatible preamplifiers

Data Storage Buffer

Size	100,000 data points
Max. Storage Rate	
Fast Mode	1 MHz (X1, Y1, X2, Y2, ADC1, Demod I/P 1, Demod I/P 2)
Normal Mode	1 kHz

User Settings

Up to 8 complete instrument settings can be saved or recalled from memory as required.

Interfaces

USB 2.0, Ethernet and RS-232 allow complete control of instrument settings and data readout.

General

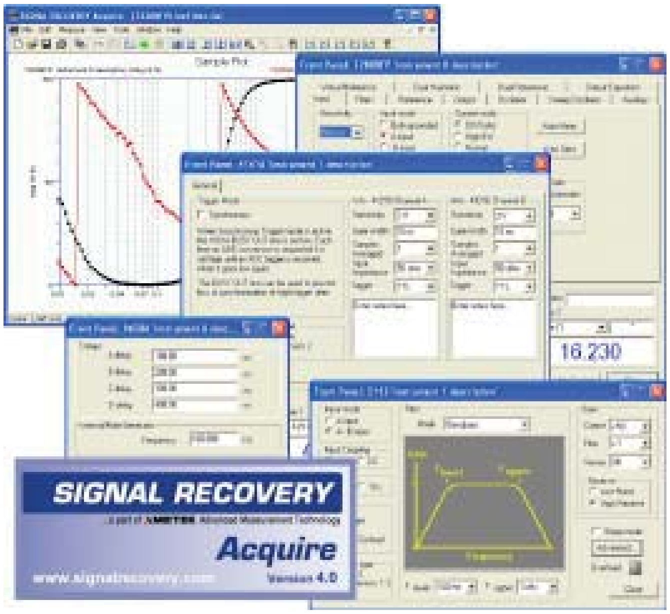
Power	
Voltage	110/120/220/240 VAC
Frequency	50/60 Hz
Power	40 VA max.
Dimensions	
Width	15½" (390 mm)
Depth	7¼" (185 mm)
Height	
With feet	7¼" (185 mm)
Without feet	6½" (170 mm)
Weight	12.8 lb (5.8 kg)

Preliminary specifications subject to change without notice.

Model 7270 Rear Panel

Acquire™ Applications Software

The Acquire Data Acquisition Software significantly extends the capabilities of the instrument by, for example, adding the ability to make swept frequency measurements. The software is suitable for Windows XP and later operating systems and allows up to ten compatible SIGNAL RECOVERY instruments to be controlled at the same time. A free demonstration version is available at **www.ameteksi.com**, which can be upgraded to the full version by purchase of an activation key.



Acquire Software

LabVIEW® Driver Software

A free LabVIEW driver is available for the instrument, 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

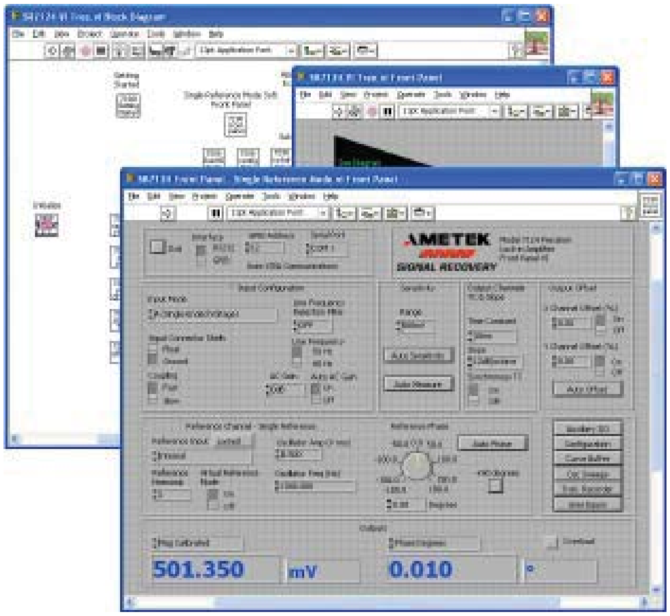
Each model 7270 is supplied complete with comprehensive instruction manual and line power cord.

Optional Accessories

SRInstComms	ActiveX Control and Software Toolkit for simple instrument control from a PC. Includes sample programs in C#, C++, Visual Basic, HTML, etc.
Acquire	Comprehensive control and acquisition software for use with Windows XP/Vista operating systems

External Preamplifiers

The model 7270 may also be used in conjunction with preamplifiers. Please contact us for details.



LabVIEW Driver

For more information, please visit our website at
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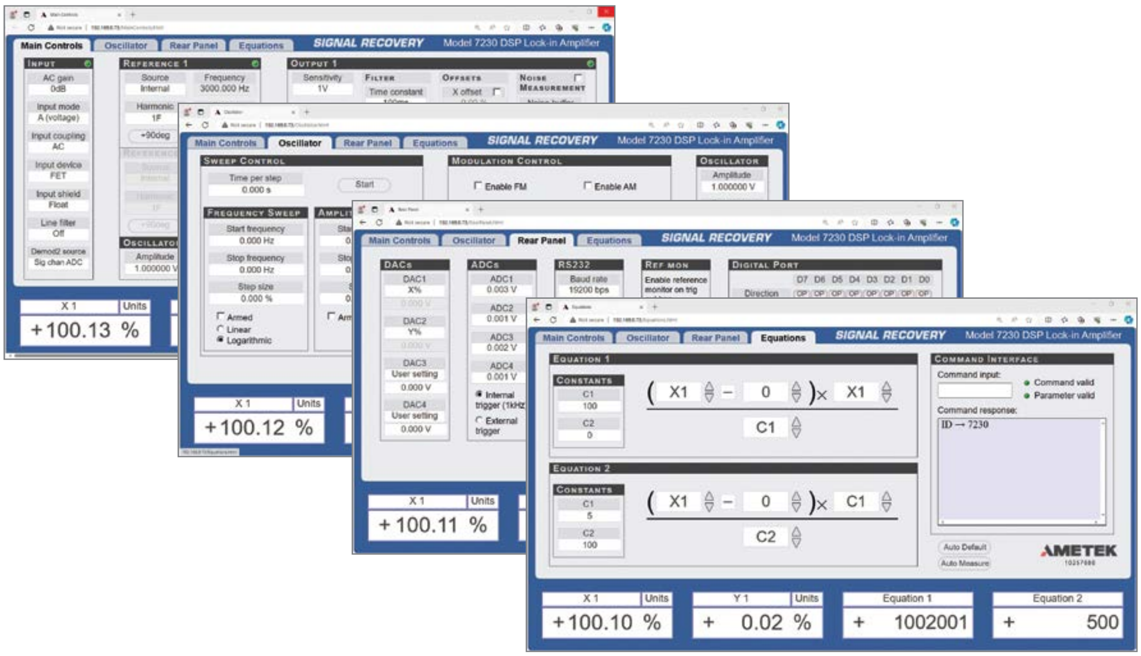
Model 7230A
DSP Lock-in Amplifier

...as easy to use as your favorite web browser



Just plug it in to your network!

Signal Recovery
AMETEK

Model 7230A DSP Lock-in Amplifier

Outstanding performance at a surprisingly low price

Overview

The model 7230A is a new concept in general-purpose DSP lock-in amplifiers. It offers the excellent signal recovery performance that users expect from our instruments but at a lower price than many competitive models. We've achieved this improvement in price/performance ratio by replacing traditional control buttons and display with easy-to-use control panels that can be operated from any computer via your favorite browser. No longer do you need to be in front of the instrument to operate it—now you can set up your experiment in the lab but return to the office while it runs, monitoring what is happening via your computer. And if you need to make a change to a setting, then it's as easy as clicking a button on a web page.

You can use any web compatible device to operate the model 7230A, ranging from a simple netbook to the most powerful development machine, from an Android smartphone to the latest iPad. No special software is needed, since the panels work directly through the device's browser. All that is necessary is that the computer and instrument be connected to the same Ethernet network.

The instrument is also much more compact than traditional designs, making it easier to accommodate in crowded laboratories. And, it does not include any cooling fans so it is completely silent, which is especially useful for acoustic research.

Model 7230A offers an operating frequency range of 1 mHz to 250 kHz.

Versatility

In common with other models in our range, the 7230A offers much more than just dual phase lock-in detection at the reference frequency of an applied signal. It includes features unique to SIGNAL RECOVERY instruments such as dual reference and dual harmonic detection, which allow signals at two different frequencies to be measured simultaneously, and tandem demodulation. It also includes virtual reference mode, allowing reference-free measurement of suitable signals.

Fast Data Processing

The main ADC sampling rate and the rate at which the analog signal outputs are updated is 1 MSa/s, giving excellent performance when used at short output filter time constant settings, such as in scanned probe measurements. The maximum rate at which data can be stored to the internal curve buffer is 1 µs per point, allowing direct capture of instrument outputs when using these short time constants. The buffer length of 100,000 sets of points gives a recording time of 100 ms at the fastest sampling rate.

Remote Control

The built-in web control pages allow full operation via the Ethernet interface, which with the USB and RS-232 connections, can also be used to operate the instrument from our comprehensive software package, Acquire, from our ActiveX control and toolkit (SRInstComms), or using the free LabVIEW driver.

See what you've been missing...

In summary, the Model 7230A offers a very cost-effective solution to users who need a lock-in amplifier suitable for straightforward applications but with the versatility to also be used in complex experiments.

- Built-in web pages for control from any computer on the same network
- 1 mHz to 250 kHz operating frequency range
- Voltage and current mode inputs
- 1 MHz main ADC sampling rate
- 10 µs to 100 ks output filter time constants
- Precision DDS sinewave oscillator with adjustable amplitude and frequency
- Oscillator output can be amplitude or frequency modulated
- Harmonic measurements up to 127 × F
- Dual Reference, Dual Harmonic and Virtual Reference operating modes
- Auxiliary analog and digital inputs and outputs
- Internal data buffer for recording instrument outputs at rates down to 1 µs per point
- Ethernet, USB and RS-232 computer interfaces
- Free LabVIEW driver

Instrument Format

The 7230A is packaged as a very compact benchtop unit with separate power supply module. It uses powerful DSP algorithms running in a dedicated field-programmable gate array (FPGA), supported by a ColdFire processor, to deliver the best possible performance.

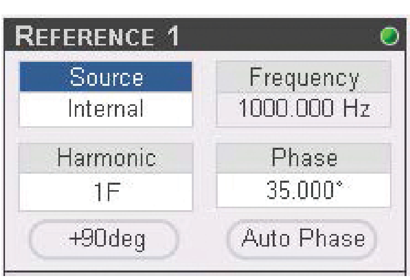
Signal and Reference Connections

The front-panel signal input connectors can be switched to operate in single-ended or differential voltage mode, or in current mode with a choice of two transimpedance settings. They can also be used to switch between two single-ended voltage signals, for simple sequential measurement under computer control of two inputs. In cases where further preamplification is needed, then one of the SIGNAL RECOVERY remote preamplifiers can be used with its output connected to the 7230A's "A" input connector. This flexible choice of input modes allows the best possible connection to be made to the experiment.

If using an external reference signal, then either analog or TTL logic signals can be used. For internal reference work, a precision DDS oscillator generates a sinewave signal of adjustable frequency and amplitude that is available at the front panel OSC OUT connector.

Signal Path

Following input amplification, the signal can optionally be passed through an analog line-frequency rejection filter, with configurable center frequency and mode, before reaching the main anti-aliasing filter. It is then applied to the signal channel precision ADC. This operates at 1 MHz, delivering an accurate digital representation of the signal to be measured and the noise accompanying it to the signal inputs of the inphase and quadrature demodulators, which are implemented in an FPGA.



Reference Channel

The reference channel signal drives a phase locked loop, which in turn drives the reference channel. When the instrument is set to Internal Reference mode, the internal precision quartz stabilized oscillator is used to generate the sinewave output at the OSC OUT connector.

When set to the Harmonic Detection mode, an internal frequency multiplier permits measurement of signals at frequencies up to 127 times the reference frequency, allowing distortion measurements to be easily made.

The reference channel also includes a precision phase shifter to permit the phase of the reference inputs to the demodulator to be adjusted.

The output of the reference channel is a series of digital phase values, updated at the same 1 MHz rate as the signal channel ADC sampling rate. These are used to derive digital representations of cosinusoidal and sinusoidal waveforms, which are applied to the reference channel inputs of the inphase and quadrature demodulators respectively.

Digital Demodulators

At the heart of the instrument are the demodulators, implemented using DSP techniques. Unlike the analog multipliers or switches used in older lock-in amplifiers, this type of demodulator does not use DC coupled electronics. Hence it is immune from the potential errors caused by DC drift and offset introduced by such designs.

Output Channels

Following the demodulators, the first stage of output filtering, providing time constants in the range 10 µs to 500 ms, is carried out using digital finite impulse response (FIR) filters implemented within the FPGA and updated at the 1 MHz signal sampling rate. Further filtering, if required, is provided using similar filters implemented in the instrument's main microprocessor.

After filtering, the output signals are potentially further modified by offset and expansion controls, before being displayed via the web panels either as basic X-output and Y-output values or being processed to give derived outputs, including signal vector magnitude and phase. The instrument can also be used to measure the noise accompanying the signal and the ratio or logarithm of the ratio of the X-channel output to other signals, such as the voltage at the auxiliary ADC inputs.

There are four rear-panel DAC outputs that can be set to convert the internal digital output values back to analog signals, at the same 1 MHz update rate, thereby making them usable down to the shortest possible output filter time constant settings.

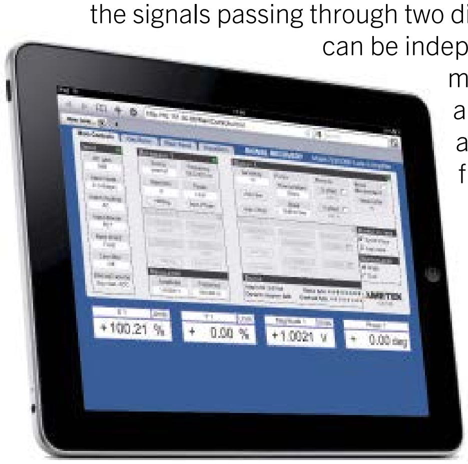
- **Dual Reference**—Simultaneously measure two signals at different frequencies
- **Dual Harmonic**—Simultaneously measure two harmonics of the reference frequency
- **Virtual Reference**—Make reference-free measurements even on noisy signals
- **VCO**—Use external analog signal to control the frequency or amplitude of the precision internal oscillator
- **Synchronous Oscillator Output**—Access the sinewave being used for demodulation, including any frequency multiplication and/or phase shift

Extended Operating Modes

The instrument includes the extended operating modes made popular by other SIGNAL RECOVERY lock-in amplifiers, such as the 7265, 7124, 7270 and 7280.

In normal Single Reference mode, measurements can be made at harmonics of up to 127 × F, while in Dual Harmonic mode, the signals at two harmonics of the reference signal can be simultaneously measured. The instrument can therefore be used to measure a fundamental frequency and one harmonic of it at the same time.

Dual Reference mode permits measurement of two signals at two unrelated frequencies to be performed simultaneously. For example, in an optical experiment the signals passing through two different paths can be independently measured if they are modulated at two different frequencies.



Control from your iPad…

A variant of the Dual Reference mode is tandem demodulation, which allows an amplitude-modulated signal at a (high) “carrier” frequency to be demodulated at that frequency. The resulting in-phase output, at short time constant settings, is a signal at the modulating frequency that is then passed forward to a second set of demodulators to give an output proportional to the amplitude of the modulation.

In Virtual Reference mode, the instrument extracts a reference from the applied signal, allowing reference-free measurements where signals are derived from stable frequency sources.

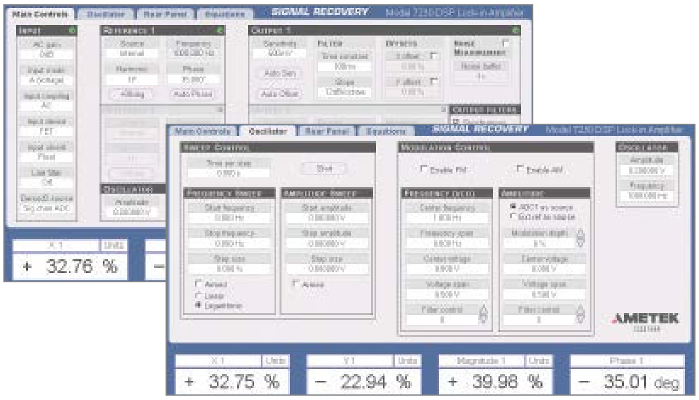
The Synchronous Oscillator output is an analog sinusoidal signal equivalent to that being used to drive the in-phase demodulator, and available in both internal and external reference modes. Hence, for example, if the instrument is set to 2F reference mode and a 1 kHz reference is applied, then this output will be a 2 kHz sinewave.

Browser Operation

Just like other SIGNAL RECOVERY instruments, the 7230A is exceptionally easy to use. Plug it in to your network and if a DHCP server is present (most networks include one), then it will be allocated an IP address; simply type this address into any browser on a device on the same network, and the main display panel will be shown. It is also possible to set the instrument to a manual IP address.

The web pages use tabbed panels containing both drop-down selectors and text boxes to set the instrument controls, and four digital indicators to show selected outputs.

The Main Controls panel is used to configure the signal channel input settings, the reference source and mode, the output filter settings, and the internal oscillator frequency and amplitude. Status indicators give an immediate indication of conditions such as input or output overload, or loss of reference lock.



More complex control of the internal oscillator, such as frequency or amplitude sweeps, is possible via the Oscillator panel. The Rear Panel tab includes controls for setting the voltages at the DAC outputs, and for reading the voltages present at the auxiliary ADC inputs.

Calculations can be performed between any of the instrument's outputs and the digitized ADC inputs, allowing corrections for such variations as signal strength and standing offsets to be made. These are specified on the Equations tab.

Auto Functions

Any one of the four auto functions can be reached with just a single click on a button on the Main Controls tab. When activated, these functions adjust the associated control to the optimum setting for the present input signal, and the effect is immediately visible on the digital indicators.

Remote Operation

There are some situations where the built-in web control panels do not offer sufficient flexibility. This is typically when data from the instrument needs to be stored to a disk file, or where the model 7230A needs to be used in conjunction with other instruments. It therefore also includes USB and RS-232, as well as the Ethernet, interfaces, allowing controls to be set or interrogated, and instrument outputs to be read.

The command set is based on the use of simple ASCII mnemonics, making user-written source code very easy to read and understand.

An internal, 100,000 point buffer memory can be used to store selected outputs. Digitized information from the auxiliary ADCs can also be stored, which is especially useful when using the highest ADC sampling rates. If required, the data buffer can be sub-divided to allow several outputs to be stored simultaneously giving, for example, the ability to store lock-in amplifier outputs and auxiliary ADC input signals on the same time axis.

The resulting data curves can be transferred via the interfaces to the controlling computer for storage or further manipulation.

Auxiliary Features

The model 7230A is much more than just a lock-in amplifier because it includes a number of auxiliary inputs and outputs to further increase its versatility.

Four sampled analog-to-digital (ADC) inputs on the rear panel of the instrument can be used to digitize external voltage signals, such as those from transducers measuring variables like temperature, pressure, flow rate, optical intensity or liquid level. Various trigger modes are provided. For example, the instrument can function as a 15-bit ADC 200 kSa/s transient recorder with a 100,000 point data memory.

The instrument also has four digital-to-analog converter (DAC) outputs that can be used to generate analog signals representing the instrument outputs (e.g., X, Y, Magnitude and Phase values) and voltages for the control of external equipment, such as motor speed, lamp intensity or fluid flow rate.

The instrument includes an 8-bit bidirectional TTL port that can be used to switch external equipment, such as relay input or output multiplexers.

...or your desktop

User-Upgradeable Firmware

In common with most other SIGNAL RECOVERY instruments, the 7230A's operating firmware can be updated via the USB or RS-232 port simply by downloading new code into it using a firmware update pack, which can be obtained free of charge from our website. You can therefore be sure you are always using the latest code.

Specifications

Measurement Modes

X In-phase **Y Quadrature** **R Magnitude** **Ø Phase Angle** **Noise**	The instrument can simultaneously show any four of these outputs via the web control pages.
Harmonic	n × F, n ≤ 127
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 one is the internal and the other the external reference
Tandem Demodulation	Demodulates the signal using the internal reference frequency, and then passes the resulting X channel output to a second demodulator running at an external reference frequency
Virtual Reference	Locks to and detects a signal without a reference (100 Hz ≤ F ≤ 250 kHz)
Noise	Measures noise in a selected bandwidth centered at the reference frequency F

Display

Four web control pages showing four selected outputs and controls for all instrument functions.

Signal Channel

Voltage Input	
Modes	A only, –B only or differential (A–B)
Frequency Response	1 mHz ≤ F ≤ 250 kHz
Full-scale Sensitivity	10 nV to 1 V in a 1-2-5 sequence (e.g., 10 nV, 20 nV, 50 nV, 100 nV, etc.)
Input Impedance	
FET Input	10 MΩ // 25 pF, AC or DC coupled
Bipolar Input	10 kΩ // 25 pF, input must be DC coupled
Maximum Safe Input	±12 V
Voltage Noise	
FET Input	5 nV/√Hz @ 1 kHz
Bipolar Input	2 nV/√Hz @ 1 kHz
C.M.R.R.	> 100 dB @ 1 kHz degrading by no more than 6 dB/octave with increasing frequency
Gain Accuracy	±0.5% typ, ±1.0% max.
Distortion	-90 dB THD (60 dB AC gain, 1 kHz)
Current Input	
Mode	Low noise (10^8 V/A) or wide bandwidth (10^6 V/A)
Full-scale Sensitivity	
Low Noise	10 fA to 10 nA in a 1-2-5 sequence
Wide Bandwidth	10 fA to 1 µA in a 1-2-5 sequence

Signal Channel, continued

Frequency Response (-3 dB)	
Low Noise	1 mHz ≤ F ≤ 500 Hz minimum
Wide Bandwidth	1 mHz ≤ F ≤ 50 kHz minimum
Impedance	
Low Noise	< 2.5 kΩ @ 100 Hz
Wide Bandwidth	< 250 Ω @ 1 kHz
Noise	
Low Noise	13 fA/√Hz @ 500 Hz
Wide Bandwidth	130 fA/√Hz @ 50 kHz
Gain Accuracy	± 2.0% typ, midband
Either Input Mode	
Max. Dynamic Reserve	> 100 dB
Line Filter	Filter can be set to attenuate 50/60 Hz, 100/250 Hz, or both frequency bands
Grounding	BNC shields can be grounded or floated via 1 kΩ to ground
Signal Monitor	
Amplitude	±1 V FS. This is the signal after preamplification and filtering immediately prior to conversion by the main ADC
Output Impedance	1 kΩ

Reference Input

TTL setting	
Frequency Range	1 mHz to 250 kHz
Analog setting	
Impedance	1 MΩ // 30 pF
Sinusoidal Input	
Level	1 V rms
Frequency Range	0.5 Hz to 250 kHz
Squarewave Input	
Level	250 mV rms
Frequency Range	2 Hz to 250 kHz

Reference Channel

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 + 1 s
Reference Frequency Meter Resolution	4 ppm or 1 mHz, whichever is the greater

Demodulators and Output Processing

Output Zero Stability	
Digital Outputs	No zero drift on all settings
Displays	No zero drift on all settings
DAC Analog Outputs	< 100 ppm/°C
Harmonic Rejection	-90 dB
Output Filters	
Time Constant	10 µs to 100 ks in a 1-2-5 sequence
Slope (roll-off)	
TC < 5 ms	6 or 12 dB/octave
TC ≥ 5 ms	6, 12, 18 or 24 dB/octave
Synchronous Filter	Available for F < 20 Hz
Offset	Auto/Manual on X and/or Y: ±300% F.S.
Phase Measurement Resolution	≤ 0.01°
Reference Monitor	TTL signal at current reference frequency, internal or external

Oscillator

Frequency	
Range	1 mHz to 250 kHz
Setting Resolution	1 mHz
Absolute Accuracy	± 50 ppm
Amplitude	
Range	1 µV to 5 V
Max. Setting Resolution	1 µV
Output Impedance	50 Ω
Sweep	
Frequency	
Output Range	1 mHz to 250 kHz
Law	Linear or logarithmic
Step Rate	1000 Hz maximum (1 ms/step)
Amplitude Sweep	
Output Range	0.000 to 5.000 V rms
Law	Linear
Step Rate	20 Hz maximum (50 ms/step)

Auxiliary Inputs

ADC 1, 2, 3 and 4	
Maximum Input	±11 V
Resolution	1 mV
Accuracy	±20 mV
Input Impedance	1 MΩ // 30 pF
Sample Rate	200 kHz maximum (one ADC only)
Trigger Mode	Internal, external or burst
Trigger Input	TTL compatible, rising or falling edge

Outputs

Analog Outputs	
DAC1	X, X1, Mag2, User DAC1, Output function
DAC2	Y, Y1, Pha2, User DAC2, Output function
DAC3	X2, Mag, Mag1, User DAC3, Output function
DAC4	Y2, Pha, Pha2, User DAC4, Output function
Output Functions	Noise, Ratio, Log Ratio and User Equations 1 & 2
Amplitude	
X(1), Y(1), Mag(1), Pha(1)	±2.5 V full-scale; linear to ±300% F.S.
User DACs and Output Functions	±10 V full-scale
Impedance	1 kΩ
Update Rate	
X(1/2), Y(1/2), Mag(1/2), Pha(1/2) @ TC < 1 s	1 MHz
User DACs, Output Functions and TCs ≥ 1 s	1 kHz
8-bit Digital Port	
Mode	0 to 8 lines can be configured as inputs, with the remainder being outputs
Status	Each output line can be set high or low and the status of each input line read

Data Storage Buffer

Size	100,000 data points
Max. Storage Rate	
Fast Mode	1 MHz (X1, Y1, X2, Y2, ADC1, Demod I/P 1, Demod I/P 2)
Normal Mode	1 kHz

Interfaces

USB 2.0, Ethernet and RS-232 allow complete control of instrument settings and data readout.

General

Power	Via external universal power supply (NRTL certified)
Voltage	100 – 250 VAC
Frequency	50/60 Hz
Power	40 VA max.
Dimensions	
Width	15" (390 mm)
Depth	10" (250 mm)
Height	
With feet	3" (75 mm)
Without feet	2½" (64 mm)
Weight	6.6 lb (3.0 kg)

Power Supply

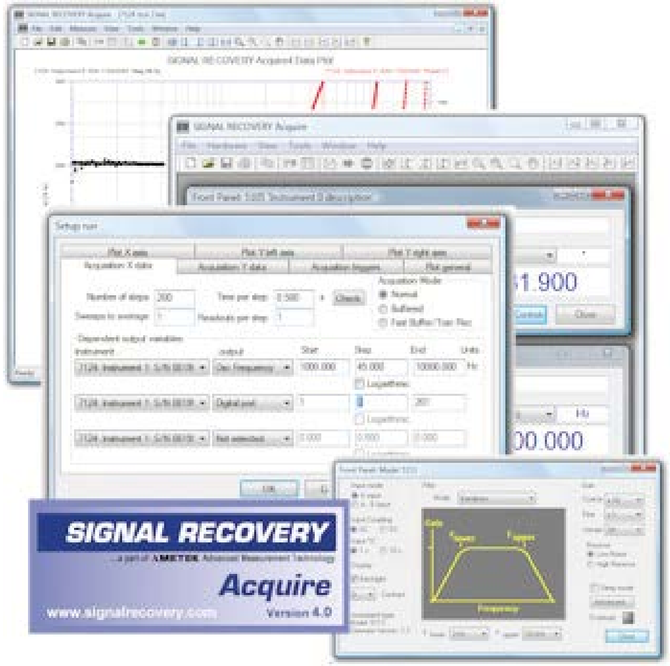
Model 7230A Rear Panel

Acquire™ Applications Software

The Acquire Data Acquisition Software significantly extends the capabilities of the instrument by, for example, adding the ability to make swept frequency measurements. The software is suitable for Windows 11 and later operating systems and allows up to ten compatible SIGNAL RECOVERY instruments to be controlled at the same time. A free demonstration version is available at **www.ameteksi.com**, which can be upgraded to the full version by purchase of an activation key.

LabVIEW® Driver Software

A free LabVIEW driver is available for the instrument, 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.



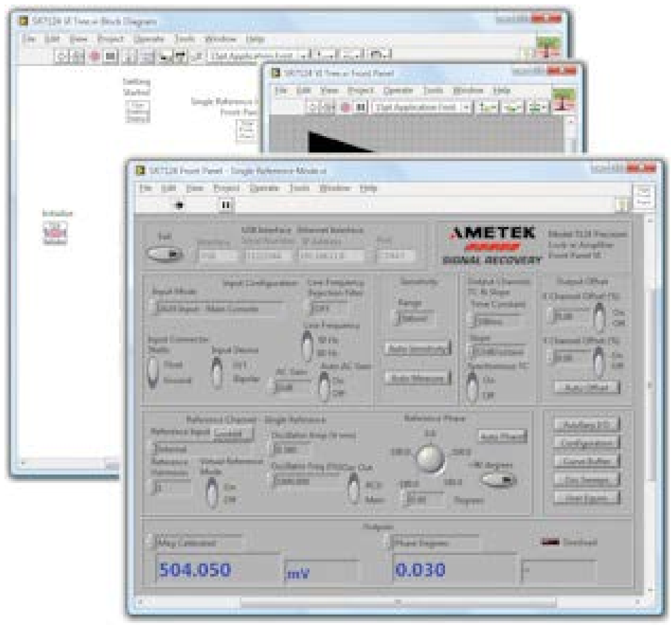
Acquire Software

Ordering Information

Each model 7230A is supplied complete with line power cord and comprehensive instruction manual.

Optional Accessories

SRInstComms	ActiveX Control and Software Toolkit for simple instrument control from a PC. Includes sample programs in C#, C++, Visual Basic, HTML, etc.
Acquire	Comprehensive control and acquisition software for use with Windows 10/ Windows 11 operating systems



Free LabVIEW Driver

External Preamplifiers

The model 7230A may also be used in conjunction with preamplifiers. Please contact us for details.

For more information, please visit our website at
www.ameteksi.com

Signal Recovery
AMETEK

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5113A
Low-Noise Voltage Preamplifier

- Low noise
- Single-ended or differential input modes
- DC to 1 MHz frequency response
- Optional low-pass, bandpass or high-pass signal channel filtering
- “Sleep” mode to eliminate digital noise
- Optically isolated RS-232 control interface
- Battery or line power

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5113A Low-Noise Voltage Preamplifier

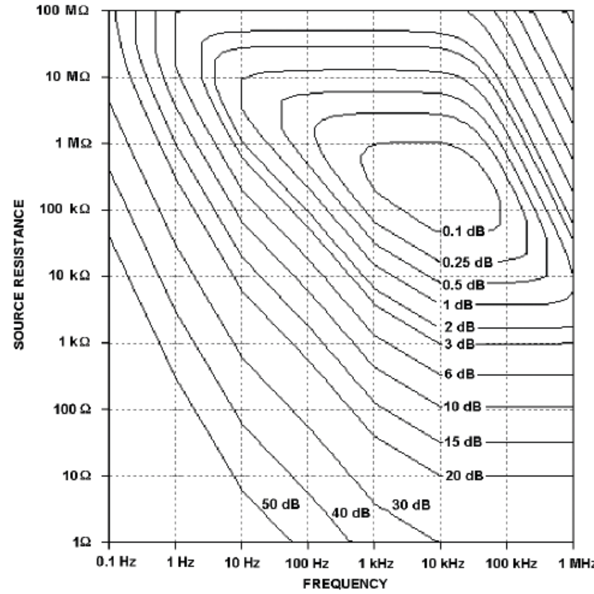
Description

The 5113A is a high-performance, low-noise voltage preamplifier with continuously adjustable gain and selectable high, low or bandpass filtering. Its input can be configured for either single-ended or true differential operation with either DC or AC coupling, and its output will deliver up to 1 V pk-pk into a 50 Ω load.

All the principal instrument controls are operated via the three front-panel rotary knobs with a back-lit LCD display to show their present settings. The instrument also includes an optically isolated bi-directional RS-232 interface allowing remote operation and interrogation of all controls. Because in some experiments even the very low levels of noise introduced by the internal microprocessor that supports these capabilities may cause problems, the unit includes a “sleep” function whereby every source of digital noise is turned off after a predetermined interval. When in the sleep mode, the preamplifier “wakes up” as soon as any control is adjusted and goes back to sleep when adjustment is complete.

The instrument can either be continuously line-powered from its supplied power supply or be run from the internal rechargeable batteries that are charged whenever the power supply is connected. Battery operation often allows troublesome line frequency pick-up to be eliminated, as well as permitting operation away from a source of line power.

If the signal of interest is limited to a single frequency or narrow range of frequencies, then the filters allow selective signal amplification, making subsequent signal measurement, for example on an oscilloscope or a lock-in amplifier, easier. The filters can of course be switched out of use to give a flat frequency response.



Noise Figure Contours (Typical)
Gain = x1000, AC Coupling, 10 s coupling time-constant, Flat filter mode

Applications

The 5113A will be of use in applications as diverse as radio astronomy, audiometry, test and measurement, process control and general-purpose signal amplification as well as being ideally suited to work with our range of lock-in amplifiers.

- Acoustic research
- Radio astronomy
- AC bridge measurements
- Oscilloscope preamplification
- Hall-effect signal amplification

5113A Voltage Preamplifier Product Features	Benefit to You
• No digital noise when in sleep mode	• Digital noise cannot exist when processor is turned off
• Unit wakes up as soon as a control setting is changed	• Easy to change settings
• Gain is defined by switches and relays rather than by a cheaper multiplying DAC, as used in competing instruments	• Bandwidth remains stable even as gain is changed, so gain changes do not change the shape of the signal being measured as happens in units using a multiplying DAC
• RS-232 control is bidirectional	• Programs can check that settings are correct and can even allow for manual interaction
• Excellent LabVIEW driver available	• Saves programming time
• RS-232 Interface is opto-isolated	• Removes one potential ground-loop, reducing line frequency pick-up
• Rotary knobs allow a wider range of filter settings	• Better selection of the wanted signal

Specifications

General

DC or AC coupled voltage amplifier with adjustable gain and a maximum frequency response extending from DC to 1 MHz. Single-ended or differential high-impedance input, and single-ended output, via BNC connectors.

Signal channel high- and low-pass filters with variable cut-off frequencies and slope may be switched into circuit to give an overall low-pass, high-pass, bandpass or flat response.

Computer control via optically isolated RS-232 interface.

Battery powered from internal rechargeable batteries, which recharge when separate line power supply is connected.

Inputs	
Modes	A or A-B
Coupling	AC or DC
Impedance	
AC Coupled	Either 10 MΩ or 100 MΩ in parallel with 25 pF and in series with 0.1 µF
DC Coupled	Either 10 MΩ or 100 MΩ in parallel with 25 pF
Max. Input without Damage	
DC Coupled	+10 V, -9 V
AC Coupled	Coupling capacitors can withstand 100 V. Transients that pass through coupling capacitors must not exceed DC coupled operation limits.
Max. Input for Linear Operation	
Common Mode	1 V peak
Differential Mode	See Table 1.

Table 1. Maximum Input as a Function of Filter Reserve and Coarse Gain Setting

Coarse Gain	Max. Peak Input	
	Low Filter Reserve	High Filter Reserve
5 to 25	1 V	1 V
50 to 500	100 mV	1 V
1000 to 5000	10 mV	100 mV
10,000 to 50,000	10 mV	10 mV

Common Mode Rejection Ratio, C.M.R.R.	
DC to 1 kHz	>120 dB
1 kHz to 1 MHz	-6 dB/octave
Gain	Coarse gain of ×5 to ×50,000 in 1-2-5 sequence with an accuracy of 1%. Fine gain extends range from ×1 to ×100,000 with an accuracy of 2%. An uncalibrated vernier provides gain adjustment of +20% of coarse gain.

Inputs, continued	
Overload Recovery	Front-panel pushbutton or computer command
Voltage Noise	Typically 4 nV/√Hz at 1 kHz referred to input

Filters	
Type	One high-pass and one low-pass stage
Mode	Low-pass, high-pass, bandpass, flat (No filter)
Slope	
Low Pass	6 or 12 dB/octave
High Pass	6 or 12 dB/octave
Bandpass	6 dB/octave
Frequency Response	
Flat Mode	DC to 1 MHz
Low Pass	-3 dB frequency selectable from 0.03 Hz to 300 kHz in a 1-3-10 sequence (Figure 1)
High Pass	-3 dB frequency selectable from 0.03 Hz to 300 kHz in a 1-3-10 sequence (Figure 2)

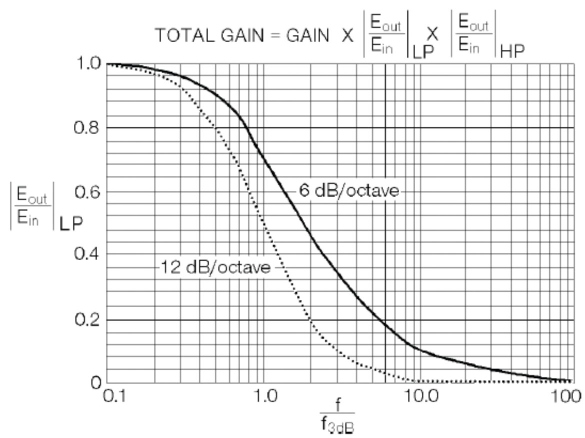


Figure 1. Low-Pass Filter Amplitude vs. Normalized Freq. Response

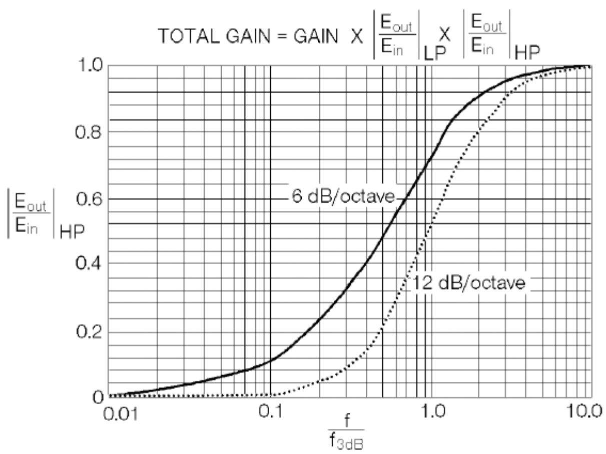


Figure 2. High-Pass Filter Amplitude vs. Normalized Freq. Response

Filters, continued

DC Drift	
Referred to Input (DC Coupling)	Maximum 10 µV/°C or less than 10 µV per 24 hours at constant ambient temperature
Referred to Output (AC Coupling)	
Coarse Gain Only	75 µV/°C
With Fine Gain	250 µV/°C maximum
DC Input Offset Control	Front-panel screwdriver control provides for DC zeroing

Output

Max. Output Voltage	2 V pk-pk ahead of 50 Ω
Output Impedance	50 Ω ± 2%

Computer Interface

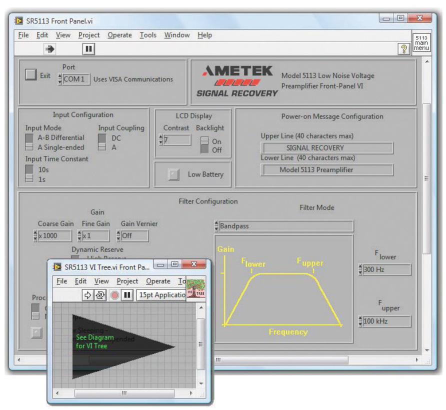
Type	Opto-isolated RS-232
Connector	DB25 25-pin female connector
Baud Rate	300 to 9600 baud
Parameters	No parity, eight data bits and one stop bit

General

Power Requirements	Internal sealed maintenance-free rechargeable lead-acid batteries provide approximately 30 hours operation between charges. An LCD display page provides information on their state of charge.
External Power Supply	
Input Voltage	110/120/220/240 Vac
Frequency	50–60 Hz
Input Connector	IEC line input; matching power cord supplied
Output Voltage	± 18 Vdc nominal, unregulated
Output Connector	DIN 5-pin 180° plug
Dimensions	
5113A	
Width	8.25" (210 mm)
Depth	11" (279 mm)
Height	3.5" (89 mm)
External Power Supply	
Width	3" (77 mm)
Depth	5.3" (135 mm)
Height	2.4" (61 mm)
Weight	
5113A	8 lb (3.7 kg)
External Power Supply	2.2 lb (1.0 kg)

LabVIEW® Driver Software

A LabVIEW driver for the 5113A is available from the www.ameteksi.com website, offering example VIs for all the controls, as well as the usual Getting Started and Utility VIs. It also includes an example soft-front panel built using these VIs, demonstrating how you can incorporate them in more complex LabVIEW programs.



LabVIEW Driver for 5113A

For more information, please visit our website at **www.ameteksi.com**

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5402A

Low-Noise Current Amplifier

Overview

The 5402A is a low-noise current input preamplifier designed for use whenever the signal source is a current source—for example, an electron multiplier, ion collector, photo multiplier or photodiode, or when measuring sample impedances. The gain (transimpedance) is switch selectable with six settings enabling the amplifier, on its most sensitive range, to detect fractions of a picoamp without noise degradation.

The unit has a bandwidth of 100 kHz on its highest gain (1 GV/A) and greater than 4 MHz on its lowest gain (10 kV/A), while still maintaining low-input current noise ranging from 25 fA /√Hz on the 1 GV/A range to 5 pA/√Hz on the 10 kV/A range. The gain setting is changed by simply pressing a pushbutton, with the present setting being indicated by an LED. The setting is retained when the power switch is turned off and restored when it is turned on again.

Switch-selectable output filters allow AC or DC output coupling, and three choices of low-pass filtering that can reduce overall noise, especially when working at high gains if the full bandwidth is not required. The 5402A is powered by two internal lithium-ion rechargeable batteries that allow operation for up to 48 hours on a single charge. This method of powering delivers the lowest possible noise as well as allowing isolated operation, preventing problems that might be caused by ground loops. A plug-in power adapter is provided, which typically recharges the 5402A within three hours.

Features

- Low-input impedance
- Low noise
- Single-ended virtual ground input
- Six gain settings
- DC to > 4 MHz frequency response
- Internal rechargeable batteries

Applications

- Photodiode amplification
- Photomultiplier amplification
- Ion collector amplification
- Electron multiplier amplification
- Impedance measurements

Signal Recovery

AMETEK

5402A Low-Noise Current Amplifier

Specifications

Input	
Mode	Single-ended
Coupling	DC
Connector	BNC socket
Max. Safe Input Voltage	±20 Vdc
Input Bias Current	1 pA typical
Input Referred Voltage Noise	2.5 nV/√Hz typical
Input Referred Current Noise	See Table 1

Gain and Frequency Response	
Gain	Switch selectable (6 settings) to 1 G, 100 M, 10 M, 1 M, 100 K, 10 K V/A
Accuracy	± 0.5 dB
Flatness in Pass-Band	± 0.5 dB
Frequency Response	See Table 1

Output Filters	
Output Coupling (High-Pass)	When set to DC, amplifier is DC coupled When set to AC, low-frequency cut off is 0.1 Hz
Output Filter (Low-Pass)	Low-pass Butterworth filter with 18 dB/octave roll-off filter reduces overall noise, especially when working at high gains, if full bandwidth is not required
Cut-Off Frequency Settings	
10 MHz	Full bandwidth
1 MHz	1 MHz ± 150 kHz
100 kHz	100 kHz ± 15 kHz

Table 1. Typical Frequency Response

Gain	Bandwidth (–3 dB) with C_{in} = 10 pF	Bandwidth (–3 dB) with C_{in} = 1 nF	Input Referred Current Noise (typical)
10 K	> 5 MHz	> 500 kHz	5 pA/√Hz
100 K	> 2 MHz	> 200 kHz	1 pA/√Hz
1 M	> 800 kHz	> 100 kHz	500 fA/√Hz
10 M	> 450 kHz	> 80 kHz	100 fA/√Hz
100 M	> 250 kHz	> 25 kHz	50 fA/√Hz
1 G	> 100 kHz	> 20 kHz	25 fA/√Hz

Output	
Impedance	50 Ω
Connector	BNC jack
Max. Voltage Swing	> 5 V pk-pk
Polarity	Current flowing into the input produces a positive output voltage
Protection	Output is short-circuit protected

Power	
Internal	Rechargeable lithium-ion batteries provide up to 48 hours of use. Batteries recharge automatically when DC power is connected. Recharge time is maximum of 3 hours.
External	9 Vdc @ 350 mA maximum
Connector	1.3 mm DC power socket, inner pin positive, outer barrel negative

General	
Dimensions	
Excluding Connectors	3½" W x 1¼" D x 2¾" H (85 mm x 31 mm x 71 mm)
Including Connectors	4½" W x 1¼" D x 2¾" H (114 mm x 31 mm x 71 mm)
Weight	7.5 oz (210 g) excluding optional power supply
Operating Temperature	5 °C to 40 °C
Storage Temperature	–25 °C to 70 °C

Ordering Information

5402A

Low-noise current amplifier complete with line power supply.

For more information, please visit our website at
www.ameteksi.com

Signal Recovery
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7210DIF

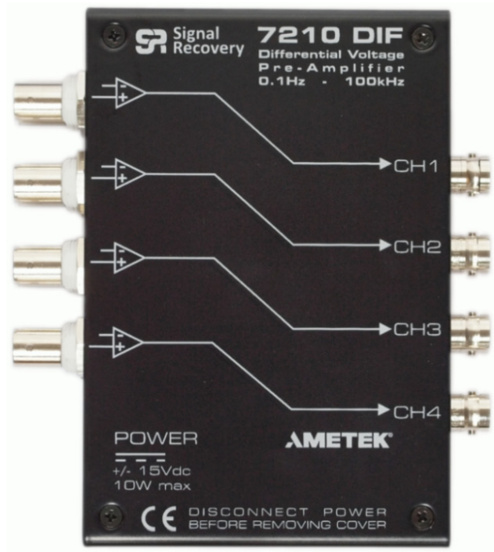
4 Channel Differential Voltage Preamplifier

Features

- True differential inputs
- High Input Impedance
- 0.1 Hz to 100 kHz range
- Gain of x100 with x1, x10 and x1000 available
- Low Noise: <10 nV / √Hz at 1 kHz
- External Power, Battery or Line

Applications

- Acoustic research
- Radio Astronomy
- AC bridge measurements
- Oscilloscope preamplification
- Hall-effect signal amplification

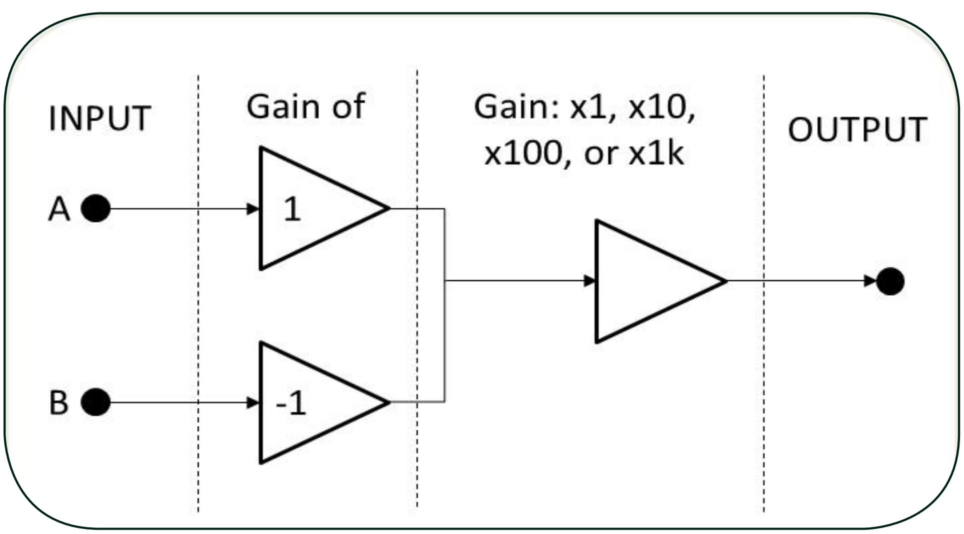


Overview

The Model 7210DIF is a four channel, high input impedance, low-noise, AC-coupled voltage preamplifier which offers a true differential input. It has a frequency response from 0.1 Hz to 100 kHz and gain setting of x100 with x1, x10, and ×1000 available. It is a general purpose preamplifier which has the facility to be connected to grounded sources in a manner which breaks ground loops and since it has a true differential input it can be used to measure floating sources, such as the output from an AC bridge, without imposing an asymmetrical load onto the source. It can be powered from an external low voltage supply (±15 V) or from the model PS0110-MD remote line power supply. This preamplifier can also be powered from most of our range of lock-in amplifiers.

Flow Diagram

The simplified signal path for each channel can be seen in the diagram below:



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Specifications

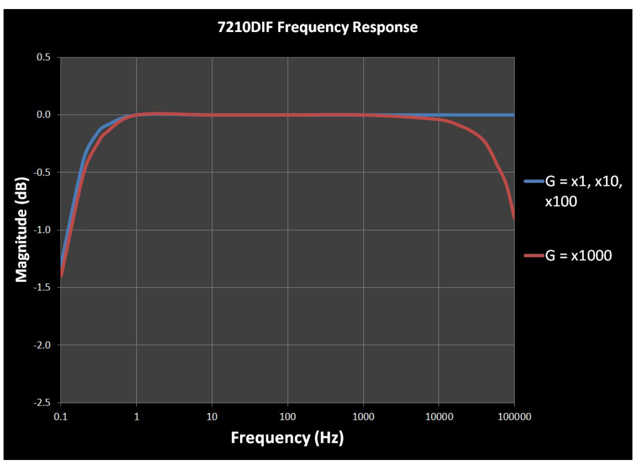
Electrical	
Gain Settings	x1, x10, x100, and x1000
Passband Gain Accuracy	0.1% plus 100 ppm/°C
Frequency Range:	
G = x1	0.1 Hz – 1 MHz
G = x10	0.1 Hz – 1 MHz
G = x100	0.1 Hz – 1 MHz
G = x1000	0.1 Hz – 0.1 MHz
CMRR (@1 kHz)	100 dB at G = x1000
Total Input Voltage Noise F = 1 kHz RS = 1 kΩ G = ▯100	6.9 nV/√Hz typical (see table below)
Input Impedance	1 MΩ
Minimum load	1 kΩ
Abs. Max Input Voltage	± 28 V pk
Max Output Voltage	± 9 V pk

General	
Dimensions L x W x H	133.0 mm x 122.0 mm x 39.5 mm
Weight (7210DIF only):	400 g
DC Input (7210DIF):	
Voltage	±15 ± 0.5 V DC
Input Power	10 W max
AC Input (PS0110-MD):	
Line Voltage	100 – 240 V AC, 50/60 Hz
Power	42 W max
Safety complies with	BS EN 61010-1:2010
EMC complies with	BS EN 61326-1:2013
RoHS compliant	Yes

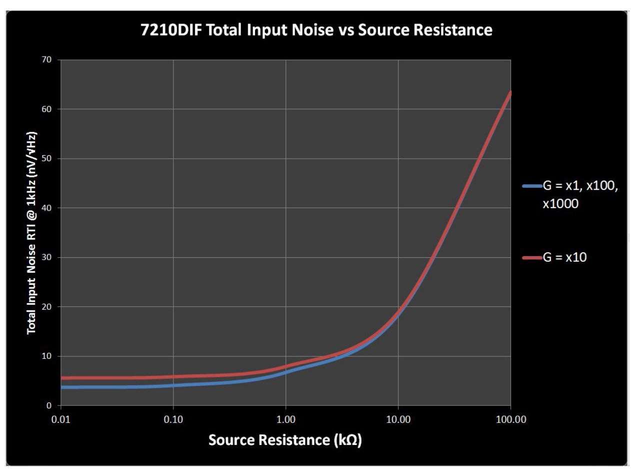
Environmental	
Location	Indoor use only
Operating Temperature	5° to 40°C

Typical Noise
Specifications (@1 kHz)

Series Resistance	Gain			
	x1	x10	x100	x1000
10 Ω	3.72 nV/√Hz	5.61 nV/√Hz	3.92 nV/√Hz	3.74 nV/√Hz
100 Ω	4.09 nV/√Hz	5.86 nV/√Hz	4.28 nV/√Hz	4.10 nV/√Hz
1 kΩ	6.75 nV/√Hz	7.95 nV/√Hz	6.87 nV/√Hz	6.76 nV/√Hz
10 kΩ	18.48 nV/√Hz	18.95 nV/√Hz	18.52 nV/√Hz	18.48 nV/√Hz
100 kΩ	63.35 nV/√Hz	63.49 nV/√Hz	63.36 nV/√Hz	63.35 nV/√Hz



Frequency Response per Gain Level



Total Input Noise vs Source Impedance

Order Details

7210DIF-P	One 4 channel preamplifier module with 120V external power supply, and User Manual

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