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Find the *National Instruments SHB4X-8BNC* at our website: *Click HERE*

# Sound and Vibration Data Acquisition

## NI PXI-449x, NI PXIe-449x *NEW!*

- 16 simultaneous analog inputs
- 24-bit resolution
- 204.8 kS/s maximum sampling rate
- 114 dB dynamic range
- +10, +20, and +30 dB gains
- ±0.316, 1, 3.16, and 10 V input ranges
- Antialiasing filters
- TEDS read/write
- IEPE – 4 mA (software-configurable)
- AC-coupled (0.5 Hz)

**Operating System**

- Windows Vista/XP/2000
- LabVIEW Real-Time

**Recommended Software**

- LabVIEW
- Sound and Vibration Measurement Suite
- LabVIEW Real-Time



| Analysis Capabilities |
|---|
| Power spectra |
| Zoom FFTs |
| Fractional-octave analysis |
| Vibration level measurements |
| Order spectra |
| Transient analysis |

## Overview

NI PXI-449x and PXIe-449x high-accuracy data acquisition modules are specifically designed for sound and vibration applications. With sixteen 24-bit analog inputs per module and IEPE constant current signal conditioning, NI 449x modules are ideal for making precision measurements with microphones, accelerometers, and other transducers that have very large dynamic ranges. The modules deliver up to 114 dB of dynamic range and simultaneous sampling on all 16 channels at rates up to 204.8 kS/s. In addition, the modules include built-in antialiasing filters that automatically adjust to your sampling rate and software-selectable input gains up to 30 dB. Common applications for NI 449x modules include in-vehicle acoustic test; noise, vibration, and harshness (NVH) analysis; large microphone arrays; and dynamic structural test. These modules are compatible with NI Sound and Vibration Measurement Suite analysis software to complete your application with a variety of time and frequency measurements including octave and order analysis.

## Analog Input Operation

Each input signal is simultaneously buffered, amplified, analog filtered, and sampled by a 24-bit delta-sigma analog-to-digital converter (ADC) that performs digital filtering with a cutoff frequency that automatically adjusts to a software-programmable sampling rate. The high resolution provides the necessary accuracy to make NI 449x modules well-suited for audio and vibration analysis applications. A programmable gain amplifier stage on the inputs offers gain selection from 0 to +30 dB in 10 dB steps. In addition, the modules include the capability to read and write to transducer electronic data sheet (TEDS) Class 1 smart sensors as well as operate with IEPE constant current on or off as selected in software.

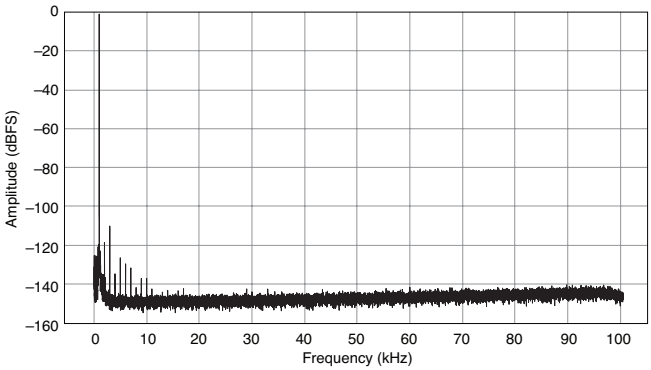



*Figure 1. FFT of -1 dBFS, 1 kHz Tone Acquired at 204.8 kS/s and 0 dB Gain Using the NI PXI-4498 (65,536 Samples with 10 RMS Averages Using the 7-Term Blackman-Harris Window)*

NI 449x modules use a method of A/D conversion known as delta-sigma modulation. With this technology, input signals are oversampled or sampled at many times the chosen data rate and then applied to a digital filter. NI 449x modules incorporate delta-sigma modulating ADCs, resulting in excellent phase linearity while maintaining low noise and distortion. In

| Model | Gains | Ranges | Coupling | IEPE | TEDS |
|---|---|---|---|---|---|
| NI 4498 | 0, 10, 20, 30 dB | ±0.316, 1, 3.16, and 10 V | AC | Software-selectable (0 or 4 mA) | ✓ |
| NI 4496 | 0, 20 dB | ±1 and 10 V | AC | Software-selectable (0 or 4 mA) | ✓ |
| PXI-4495 | 0, 20 dB | ±1 and 10 V | DC | Not available | – |

*Table 1. NI PXIe-449x and PXI-449x Dynamic Signal Acquisition Selection Guide*

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addition, this class of ADCs makes these modules immune to the differential nonlinearity (DNL) distortion associated with conventional data acquisition devices.

## Antialiasing

All of the input channels use both analog and digital filters implemented in hardware to prevent aliasing. Signals are first passed through fixed analog filters to remove any signals with frequency components beyond the range of the ADCs. Then digital antialiasing filters automatically adjust their cutoff frequencies to remove any frequency components above half the programmed sampling rate. This specialized architecture means that you do not need to add more external filters to prevent aliasing.

## PXI versus PXI Express

PXI Express technology is the latest addition to the PXI platform. The PXI Express Specification integrates PCI Express signaling into the PXI standard, which increases backplane bandwidth from 132 MB/s to 6 GB/s, a 45 times improvement. It also enhances PXI timing and synchronization features by incorporating a 100 MHz differential reference clock and differential triggers. With PXI Express, you can easily synchronize 17 NI PXIe-449x modules in an 18-slot PXI Express chassis and simultaneously sample 272 channels at full bandwidth.

## Triggering

NI 449x modules feature analog and digital signal triggering for acquisition with two modes of operation. Trigger sources can come from any analog input channel, the external digital trigger input, or the PXI trigger bus. The external digital trigger, which is 5 V TTL/CMOS-compatible, is activated by a choice of rising or falling edge. When used in the start trigger mode, an NI 449x acquires signals only after the trigger condition has occurred. In the reference trigger mode, the device can acquire signals before and after the trigger condition occurs. Triggering is often used in applications with transient signals. For example, when measuring vibrations resulting from striking a mechanical structure with a hammer, acquisition of accelerometer signals is triggered by the hammer impact.

## Calibration

National Instruments calibrates the offset voltage and gain accuracy of the analog input before every device leaves the factory. An onboard precision voltage reference is included on each device for internal calibration to ensure that the gain and offset remain stable and accurate. NIST-traceable and ISO-9002-certified calibration certificates are available online.

## Signal Connectivity

### InfiniBand Overview

NI 449x modules use two 4X InfiniBand connectors, with each connector carrying eight analog input channels, AI0-7 and AI8-15. The 4X InfiniBand is widely used in high-performance computing applications because it provides excellent signal integrity with a shield plate between signal connection pairs, reducing crosstalk between inputs.



*Figure 2. SHB4X-8BNC Shielded InfiniBand to BNC Cable*

### Direct to BNC Connectivity

A shielded InfiniBand to BNC cable, the NI SHB4X-8BNC is available in a two pack for direct connectivity to NI 449x modules. Each cable has a 4X InfiniBand connector on one end and eight BNC jack inputs on the other end.



*Figure 3. NI BNC-2144 Rack-Mount Accessory*

### Rack-Mount BNC

The NI BNC-2144 is a signal connector accessory for NI PXIe-449x and PXI-449x modules. It has 32 BNC jack inputs on the front and four 4X InfiniBand connectors on the rear for use with up to two NI 449x modules. You can mount it on a standard 19 in. rack for simple, direct connections to accelerometers and microphones.



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# Software

## Analysis Software

NI 449x modules are well-suited for noise and vibration analysis applications, which you can specifically address with the NI Sound and Vibration Measurement Suite. The suite has two components – the NI Sound and Vibration Assistant and LabVIEW analysis VIs (functions) for power spectra, frequency response (FRF), fractional octave analysis, sound level measurements, order spectra, order maps, order extraction, sensor calibration, human vibration filters, and torsional vibration.

## Sound and Vibration Assistant

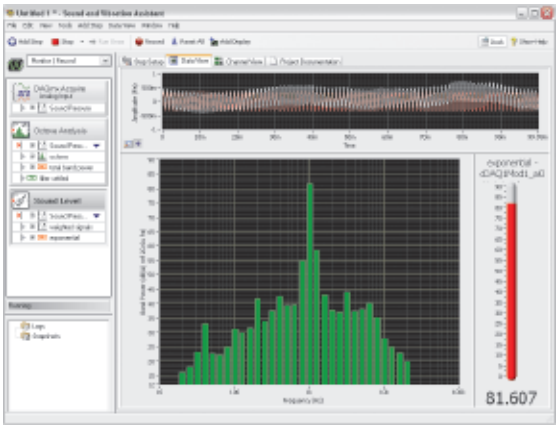



*Figure 4. The Sound and Vibration Assistant combines live data capture, the ability to modify analysis settings dynamically, and data logging with an easy drag-and-drop user interface.*

The Sound and Vibration Assistant is interactive software designed to simplify the process of acquiring and analyzing noise and vibration signals by offering the following:

- A drag-and-drop, interactive analysis and acquisition environment
- Rapid measurement configuration
- Extended functionality through LabVIEW

## Interactive Analysis Environment

The Sound and Vibration Assistant introduces an innovative approach to configuring your measurements using intuitive drag-and-drop steps. Combining the functionality of traditional noise and vibration analysis software with the flexibility to customize and automate routines, the Sound and Vibration Assistant can help you streamline your application.

## Rapid Measurement Configuration

There are many built-in steps available for immediate use in the Sound and Vibration Assistant. You can instantly configure a measurement and analysis application with the following:

- Hardware I/O – generation and acquisition of signals from a variety of devices
- Signal processing – filtering, windowing, and averaging
- Time-domain analysis – sound and vibration level trending
- Frequency-domain analysis – ANSI and IEC fractional octave analysis, frequency response, power in band, and distortion
- Order analysis – tachometer processing, order power spectrum, order tracking, order extraction, waterfall plot, Bode plots, spectral maps
- Report generation – ability to drag and drop graphs to Microsoft Word or export data to Microsoft Excel or UFF58

## Extended Functionality through LabVIEW

Reuse your measurement applications developed with the Sound and Vibration Assistant in LabVIEW by converting projects into LabVIEW block diagrams. With LabVIEW, a full-featured graphical programming environment, you can further automate your application or customize your analysis.

## Sound and Vibration Analysis VIs for LabVIEW

With the Sound and Vibration Analysis VIs in LabVIEW, you can develop a variety of custom audio, acoustic, and vibration applications. Functionality includes:

- Fractional octave analysis with A-, B-, and C-weighting
- Vibration level with single and double integration
- Sound level with A-, B-, and C-weighting
- Power spectrum
- Zoom power spectrum
- Peak search
- Power in band
- Frequency response
- Filtering
- Order tracking
- Order extraction
- Tachometer signal processing
- Joint time-frequency analysis (JTFA)
- UFF58 file I/O
- Human vibration weighting filters
- Torsional vibration

In addition, more than 50 ready-to-run examples are provided to make it easier to get started with noise and vibration analysis in LabVIEW.

**BUY ONLINE** at **ni.com** or **CALL 800 813 3693 (U.S.)**



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## Sound and Vibration Data Acquisition

| Product | Bus | Input Resolution (bits) | Dynamic Range (dB) | Sampling Rate per Channel | Analog Inputs | Input Range | Gain Settings | Coupling | TEDS Support | Analog Outputs |
|---|---|---|---|---|---|---|---|---|---|---|
| **High Performance** | | | | | | | | | | |
| NI 4461 | PXI, PCI | 24 | 118 | 204.8 kS/s | 2 | ±42 V to 316 mV | -20 to 30 dB in 10 dB increments | AC/DC | ✓ | 2 |
| NI 4462 | PXI, PCI | 24 | 118 | 204.8 kS/s | 4 | ±42 V to 316 mV | -20 to 30 dB in 10 dB increments | AC/DC | ✓ | 0 |
| **High Density** | | | | | | | | | | |
| NI 4495 | PXI | 24 | 114 | 204.8 kS/s | 16 | ±10 V | 0 and 20 dB | DC | – | 0 |
| NI 4496 | PXI, PXI Express | 24 | 114 | 204.8 kS/s | 16 | ±10 V | 0 and 20 dB | AC | ✓ | 0 |
| NI 4498 | PXI, PXI Express | 24 | 114 | 204.8 kS/s | 16 | ±10 V to 316 mV | 0 to 30 dB in 10 dB increments | AC | ✓ | 0 |
| **Low Cost** | | | | | | | | | | |
| NI 4472 | PXI, PCI | 24 | 110 | 102.4 kS/s | 8 | ±10 V | – | AC/DC | – | 0 |
| NI 4474 | PCI | 24 | 110 | 102.4 kS/s | 4 | ±10 V | – | AC/DC | – | 0 |
| **Portable/Compact** | | | | | | | | | | |
| NI 9233 | USB | 24 | 102 | 50 kS/s | 4 | ±5 V | – | AC | ✓ | 0 |
| NI 9234 | USB, Wi-Fi | 24 | 102 | 51.2 kS/s | 4 | ±5 V | – | AC/DC | ✓ | 0 |

*Table 2. Additional NI Dynamic Signal Acquisition Devices*

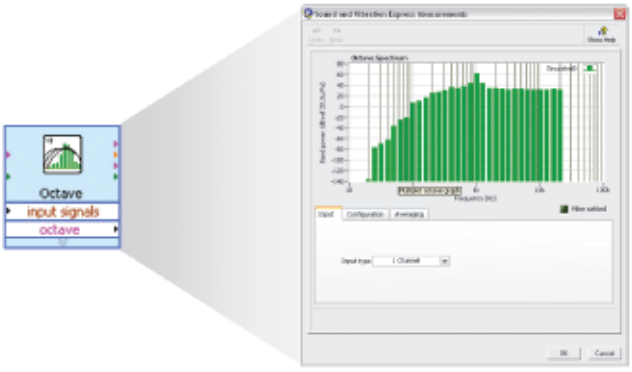



*Figure 5. The NI Sound and Vibration Measurement Suite features more than 30 Express VIs for signal processing including octave analysis.*

### Additional Dynamic Signal Acquisition Platforms

There are numerous system requirements to consider when selecting data acquisition hardware for measuring or generating sound and vibration signals. From IEPE signal conditioning for accelerometers and microphones to high dynamic range (up to 118 dB) and multichannel synchronization (up to 13,000 channels), National Instruments offers a range of hardware products for your application.

### Ordering Information

NI PXIe-4498 ..... 780218-01
NI PXIe-4498
with Sound and Vibration Measurement Suite ..... 780218-02
NI PXIe-4496 ..... 780217-01
NI PXIe-4496
with Sound and Vibration Measurement Suite ..... 780217-02

NI PXI-4498 ..... 779747-01
NI PXI-4498
with Sound and Vibration Measurement Suite ..... 779747-02
NI PXI-4496 ..... 779748-01
NI PXI-4496
with Sound and Vibration Measurement Suite ..... 779748-02
NI PXI-4495 ..... 780059-01
NI PXI-4495
with Sound and Vibration Measurement Suite ..... 780060-01

**Connectivity Options**

BNC-2144 ..... 779763-01
SHB4X-8BNC InfiniBand to BNC cable ..... 780040-01
SHB4X-B4X InfiniBand to InfiniBand cable, 1 m ..... 197516-01
SHB4X-B4X InfiniBand to InfiniBand cable, 2 m ..... 197516-02

***BUY NOW!***

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to **ni.com/soundandvibration.**



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# Specifications

*>>For complete specifications, see the* **NI 449x Specifications** *manual at* **ni.com/manuals**.

## Dynamic Characteristics

### Bandwidth and Alias Rejection

| Specifications | Low-Frequency Alias Rejection Enabled | Low-Frequency Alias Rejection Disabled (Default) |
|---|---|---|
| Alias-free bandwidth (passband) | DC to 0.4 $f_s$ | DC to 0.4535 $f_s$ |
| Alias rejection, minimum | 104 dBc | 120 dBc |
| -3 dB bandwidth | 0.484 $f_s$ | 0.491 $f_s$ |

### AC Coupling

-3 dB cutoff frequency ..... 0.5 Hz
-0.1 dB cutoff frequency ..... 3.3 Hz

### Flatness

| Frequency Band | 20 Hz to 20 kHz | 20 Hz to 45 kHz | 20 Hz to 92.2 kHz |
|---|---|---|---|
| Flatness[1] (dB) | ±0.003 | ±0.01 | ±0.05 |
| [1]Relative to 1 kHz | | | |

### Spectral Noise Density

NI 4496 and PXI-4495 input voltage noise density..... 14 nV/$\sqrt{\text{Hz}}$ at 20 dB gain, 1 kHz
NI 4498 input voltage noise density..... 7 nV/$\sqrt{\text{Hz}}$ at 30 dB gain, 1 kHz

### Spurious-Free Dynamic Range (SFDR)

NI 4496 and PXI-4495 SFDR (dBc)[1, 2, 3]..... 102
NI 4498 SFDR (dBc)[1, 2, 3] ..... 104

*[1]$f_s$ = 204.8 kS/s*

*[2]1 kHz input tone, input amplitude is -1 dBFS*

*[3]Measurement includes all harmonics*

### Dynamic Range (NI 4496 and PXI-4495)

| Gain (dB)[1] | Dynamic Range (dBFS)[1] | | |
|---|---|---|---|
| | 51.2 kS/s | 102.4 kS/s | 204.8 kS/s |
| 20 | 110 | 107 | 103 |
| 0 | 114 | 111 | 106 |

[1]1 kHz input tone, unweighted. Input amplitude is -60 dBFS.

### Dynamic Range (NI 4498)

| Gain (dB)[1] | Dynamic Range (dBFS)[1] | | |
|---|---|---|---|
| | 51.2 kS/s | 102.4 kS/s | 204.8 kS/s |
| 30 | 116 | 103 | 100 |
| 20 | 112 | 109 | 105 |
| 0, 10 | 114 | 111 | 106 |

[1]1 kHz input tone, unweighted. Input amplitude is -60 dBFS.

### Interchannel Gain Mismatch

Gain mismatch ..... 0.02 dB at 1 kHz

### Interchannel Phase Mismatch

Phase mismatch ..... 0.01 deg at 1 kHz

**Note**: All gain and phase mismatch specifications are for the same device and are not applicable between different NI 449x modules.

### Phase Linearity

20 Hz to 20 kHz ..... ±0.01 deg
20 Hz to 92.2 kHz ..... ±0.3 deg



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## Hardware Services

### System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at **ni.com/advisor** to find a system assurance program to meet your needs.

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