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USER GUIDE AND SPECIFICATIONS

NI USB-9229/9239

4-Channel, 24-Bit Analog Voltage Input Module

This user guide describes how to use the National Instruments USB-9229/9239 and lists the device specifications. In this document, the NI USB-9229 and NI USB-9239 are referred to inclusively as the NI USB-9229/9239.

Introduction

The NI USB-9229/9239 provides a USB interface for four channels of 24-bit simultaneous analog input with integrated signal conditioning. The NI USB-9229/9239 consists of two components: an NI 9229/9239 module and an NI USB-9162 carrier, as shown in Figure 1.

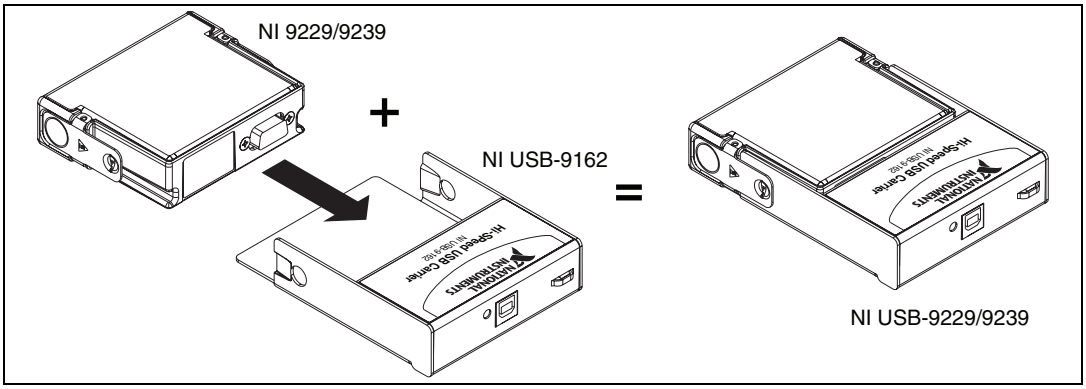


Figure 1. NI USB-9229/9239 Components

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Dimensions

Figure 2 shows the NI USB-9229/9239 device dimensions.

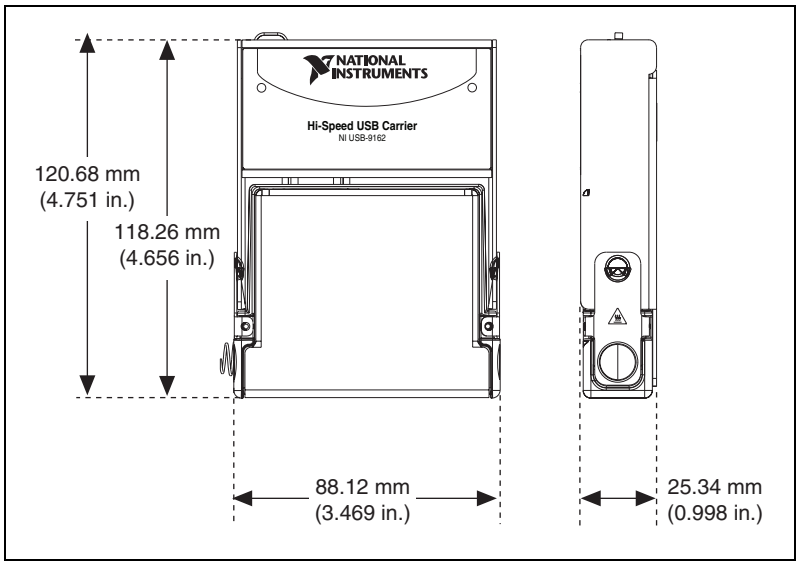


Figure 2. NI USB-9229/9239 Device in Millimeters (Inches)

Safety Guidelines

Operate the NI USB-9229/9239 only as described in these operating instructions.

Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Safety Guidelines for Hazardous Voltages

If hazardous voltages are connected to the module, take the following precautions. A hazardous voltage is a voltage greater than 42.4 V_{pk} or 60 VDC to earth ground.

Caution Ensure that hazardous voltage wiring is performed only by qualified personnel adhering to local electrical standards.

Caution Do *not* mix hazardous voltage circuits and human-accessible circuits on the same module.

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Caution Make sure that devices and circuits connected to the module are properly insulated from human contact.

Caution When module terminals are hazardous voltage LIVE (>42.4V_{pk}/60 VDC), you must ensure that devices and circuits connected to the module are properly insulated from human contact. You must use the NI 9971 connector backshell kit to ensure that the terminals are not accessible.

Figure 3 shows the NI 9971 connector backshell.

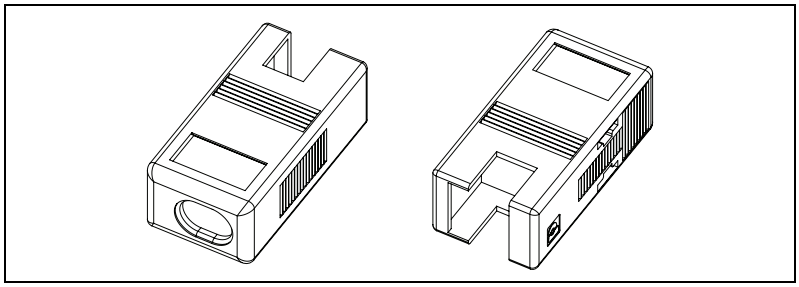


Figure 3. NI 9971 Connector Backshell

Refer to the *Installing the NI USB-9229/9239 Device* for more information about installing the backshell.

Related Documentation

Each application software package and driver includes information about writing applications for taking measurements and controlling measurement devices. The following references to documents assume you have NI-DAQmx 8.7 or later, and where applicable, version 7.1 or later of the NI application software.

NI-DAQmx for Windows

The *DAQ Getting Started Guide* describes how to install your NI-DAQmx for Windows software, your NI-DAQmx-supported DAQ device, and how to confirm that your device is operating properly. Select **Start»All Programs»National Instruments»NI-DAQ»DAQ Getting Started Guide**.

The *NI-DAQ Readme* lists which devices are supported by this version of NI-DAQ. Select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQ Readme**.

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The *NI-DAQmx Help* contains general information about measurement concepts, key NI-DAQmx concepts, and common applications that are applicable to all programming environments. Select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx Help**.

LabVIEW

If you are a new user, use the *Getting Started with LabVIEW* manual to familiarize yourself with the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications. Open the *Getting Started with LabVIEW* manual by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals** or by navigating to the `labview\manuals` directory and opening `LV_Getting_Started.pdf`.

Use the *LabVIEW Help*, available by selecting **Help»Search the LabVIEW Help** in LabVIEW, to access information about LabVIEW programming concepts, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools. Refer to the following locations on the Contents tab of the *LabVIEW Help* for information about NI-DAQmx:

- **Getting Started»Getting Started with DAQ**—Includes overview information and a tutorial to learn how to take an NI-DAQmx measurement in LabVIEW using the DAQ Assistant.
- **VI and Function Reference»Measurement I/O VIs and Functions**—Describes the LabVIEW NI-DAQmx VIs and properties.
- **Taking Measurements**—Contains the conceptual and how-to information you need to acquire and analyze measurement data in LabVIEW, including common measurements, measurement fundamentals, NI-DAQmx key concepts, and device considerations.

LabWindows/CVI

The **Data Acquisition** book of the *LabWindows/CVI Help* contains measurement concepts for NI-DAQmx. This book also contains *Taking an NI-DAQmx Measurement in LabWindows/CVI*, which includes step-by-step instructions about creating a measurement task using the DAQ Assistant. In LabWindows™/CVI™, select **Help»Contents**, then select **Using LabWindows/CVI»Data Acquisition**.

The **NI-DAQmx Library** book of the *LabWindows/CVI Help* contains API overviews and function reference for NI-DAQmx. **Select Library Reference»NI-DAQmx Library** in the *LabWindows/CVI Help*.

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Measurement Studio

If you program your NI-DAQmx-supported device in Measurement Studio using Visual C++, Visual C#, or Visual Basic .NET, you can interactively create channels and tasks by launching the DAQ Assistant from MAX or from within Visual Studio .NET. You can generate the configuration code based on your task or channel in Measurement Studio. Refer to the *DAQ Assistant Help* for additional information about generating code. You also can create channels and tasks, and write your own applications in your ADE using the NI-DAQmx API.

For help with NI-DAQmx methods and properties, refer to the NI-DAQmx .NET Class Library or the NI-DAQmx Visual C++ Class Library included in the *NI Measurement Studio Help*. For general help with programming in Measurement Studio, refer to the *NI Measurement Studio Help*, which is fully integrated with the Microsoft Visual Studio .NET help. To view this help file in Visual Studio. NET, select **Measurement Studio» NI Measurement Studio Help**.

To create an application in Visual C++, Visual C#, or Visual Basic .NET, follow these general steps:

1. In Visual Studio .NET, select **File»New»Project** to launch the New Project dialog box.
2. Find the Measurement Studio folder for the language you want to create a program in.
3. Choose a project type. You add DAQ tasks as a part of this step.

ANSI C without NI Application Software

The *NI-DAQmx Help* contains API overviews and general information about measurement concepts. Select **Start»All Programs»National Instruments»NI-DAQ»NI-DAQmx Help**.

The *NI-DAQmx C Reference Help* describes the NI-DAQmx Library functions, which you can use with National Instruments data acquisition devices to develop instrumentation, acquisition, and control applications. Select **Start»All Programs»National Instruments»NI-DAQ» NI-DAQmx C Reference Help**.

.NET Languages without NI Application Software

With the Microsoft .NET Framework version 1.1 or later, you can use NI-DAQmx to create applications using Visual C# and Visual Basic .NET without Measurement Studio. You need Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005 for the API documentation to be installed.

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The installed documentation contains the NI-DAQmx API overview, measurement tasks and concepts, and function reference. This help is fully integrated into the Visual Studio .NET documentation. To view the NI-DAQmx .NET documentation, go to **Start»Programs»National Instruments»NI-DAQ»NI-DAQmx .NET Reference Help**. Expand **NI Measurement Studio Help»NI Measurement Studio .NET Class Library»Reference** to view the function reference. Expand **NI Measurement Studio Help»NI Measurement Studio .NET Class Library»Using the Measurement Studio .NET Class Libraries** to view conceptual topics for using NI-DAQmx with Visual C# and Visual Basic .NET.

To get to the same help topics from within Visual Studio, go to **Help» Contents**. Select **Measurement Studio** from the **Filtered By** drop-down list and follow the previous instructions.

Device Documentation and Specifications

NI-DAQmx includes the Device Document Browser, which contains online documentation for supported DAQ, SCXI, and switch devices, such as help files describing device pinouts, features, and operation, and PDF files of the printed device documents. You can find, view, and/or print the documents for each device using the Device Document Browser at any time by inserting the CD. After installing the Device Document Browser, device documents are accessible from **Start»All Programs»National Instruments»NI-DAQ»Browse Device Documentation**.

Note You can also download these documents at `ni.com/manuals`.

Training Courses

If you need more help getting started developing an application with NI products, NI offers training courses. To enroll in a course or obtain a detailed course outline, refer to `ni.com/training`.

Technical Support on the Web

For additional support, refer to `ni.com/support` or `zone.ni.com`.

Installing the Software

Software support for the NI USB-9229/9239 for Windows Vista/XP/2000 is provided by NI-DAQmx. The *DAQ Getting Started Guide*, which you can download at `ni.com/manuals`, offers NI-DAQmx users step-by-step instructions for installing software and hardware, configuring channels and tasks, and getting started developing an application.

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Installing Other Software

If you are using other software, refer to the installation instructions that accompany your software.

Example Programs

The NI-DAQmx CD contains example programs that you can use to get started programming with the NI USB-9229/9239. Refer to the *NI-DAQmx for USB Devices Getting Started Guide* that shipped with your device, and is also accessible from **Start»All Programs»National Instruments» NI-DAQ**, for more information.

Installing the NI USB-9229/9239 Device

Before installing the device, you must install the software you plan to use with the device. Refer to the *Installing the Software* section of this guide and the documentation included with the software for more information.

Installing the NI 9229/9239 Device into the NI USB-9162 Carrier

The NI 9229/9239 module and NI USB-9162 carrier are packaged separately. Refer to Figure 4, while completing the following assembly steps:

1. Make sure that no signals are connected to the NI 9229/9239 module and the USB cable is not connected to the device.
2. Remove the protective cover from the 15-pin D-SUB connector.
3. Align the I/O module with the carrier, as shown in Figure 4.

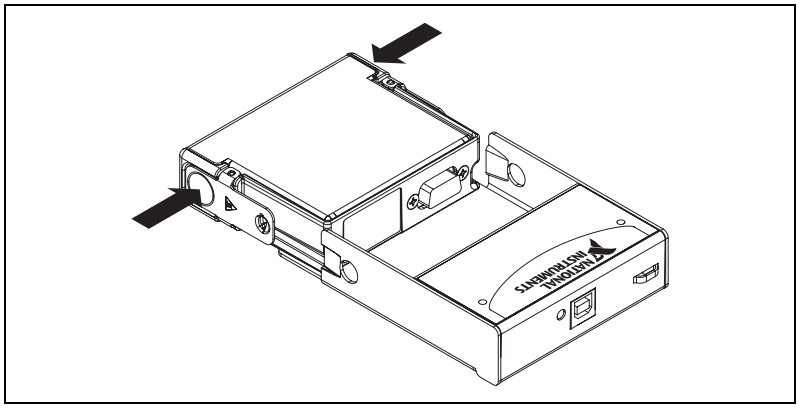


Figure 4. Module Installation

4. Squeeze the latches and insert the NI 9229/9239 module into the NI USB-9162 carrier.

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5. Press firmly on the connector side of the NI 9229/9239 module until the latches lock the module into place, as shown in Figure 5.

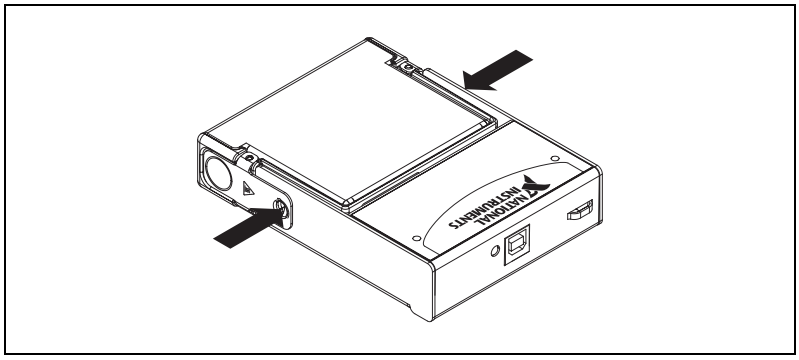


Figure 5. Locking Module into Place

Mounting the NI USB-9229/9239 to a Panel

Threaded inserts are located in the NI USB-9229/9239 for mounting it to a panel. Refer to Figure 6 for dimensions.

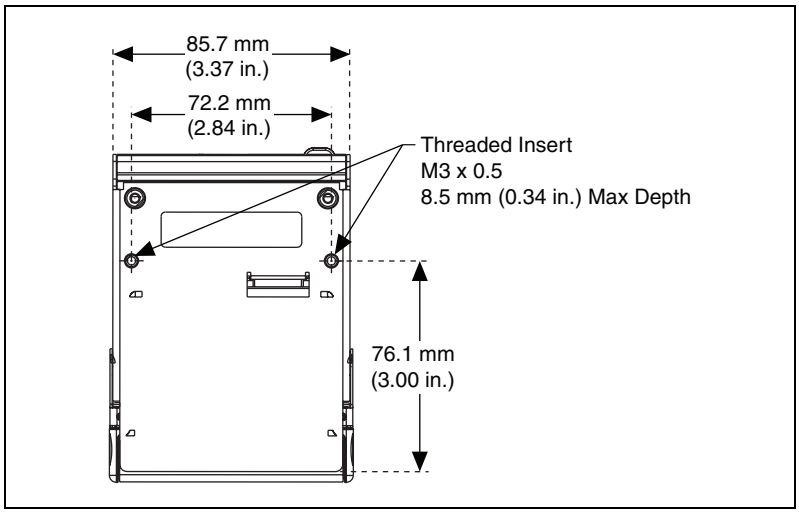


Figure 6. Module Dimensions In Millimeters (Inches)

Connecting the NI USB-9229/9239 to a Computer

Plug one end of the USB cable into the NI USB-9229/9239 and the other end into an available USB port on the computer. Refer to the *NI-DAQmx for USB Devices Getting Started Guide* that shipped with your device, and is also accessible from **Start»All Programs»National Instruments» NI-DAQ**, for more information.

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LED Indicator

The NI USB-9229/9239 device has a green LED next to the USB connector. The LED indicator indicates device status, as listed in Table 1. When the device is connected to a USB port, the LED blinks steadily to indicate that the device is initialized and is receiving power from the connection.

If the LED is not blinking, it may mean that the device is not initialized or the computer is in standby mode. In order for the device to be recognized, the device must be connected to a computer that has NI-DAQmx installed on it. If your device is not blinking, make sure your computer has the latest version of NI-DAQmx installed on it, and the computer is not in standby mode.

Table 1. LED State/Device Status

LED State	Device Status
Not lit	Device not connected or in suspend.
On, not blinking	Device connected, but no module installed.
Single-blink	Operating normally.
Double-blink	Connected to USB Full-Speed port. Device performance might be affected. Refer to the *Specifications* section for more information.
Quadruple-blink	Device error. Refer to `ni.com/support`.

Wiring the NI USB-9229/9239

Note Table 2 illustrates the accessories available from `ni.com` for use with the NI USB-9229/9239.

Table 2. Accessories

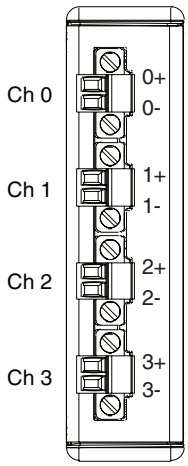
Accessory	Accessory Description
NI 9971	Strain relief and high-voltage backshell
NI 9976	2-position screw-terminal plug

The NI USB-9229/9239 has four 2-terminal detachable screw-terminal connectors that provide connections for four simultaneously sampled, isolated analog input channels. Connect the positive signal of the signal source to the AI+ terminal, and connect the negative signal of the signal

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source to the AI– terminal. Refer to Table 3 for the terminal assignments for each channel.

Table 3. Terminal Assignments

Module	Channel	Terminal	Signal
	0	0+	AI0+
		0–	AI0–
	1	1+	AI1+
		1–	AI1–
	2	2+	AI2+
		2–	AI2–
	3	3+	AI3+
		3–	AI3–

Wiring for High-Vibration Applications

If an application is subject to high vibration, National Instruments recommends that you either use ferrules to terminate wires to the detachable screw-terminal connector or use the NI 9971 backshell kit to protect the connections. Refer to Figure 7 for an illustration.

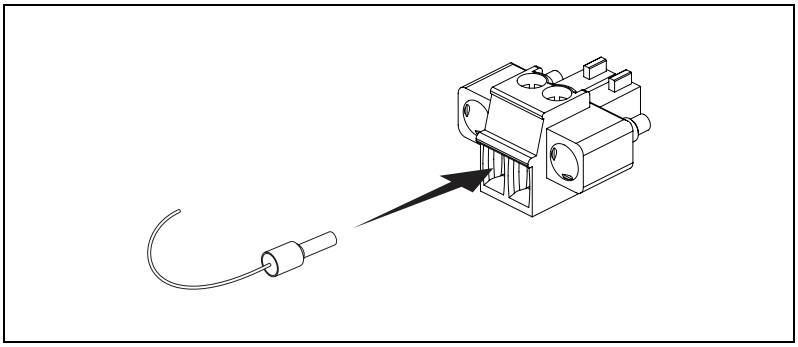


Figure 7. 2-Terminal Detachable Screw-Terminal Connector with Ferrule

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Connecting Signal Sources to the NI USB-9229/9239

You can connect ground-referenced or floating signal sources to the NI USB-9229/9239. If you make a ground-referenced connection between the signal source and the NI USB-9229/9239, make sure the voltage on the AI+ and AI– connections are in the channel-to-earth safety voltage range to ensure proper operation of the NI USB-9229/9239. Refer to the *Specifications* section for more information about operating voltages and overvoltage protection.

Figures 8 and 9 illustrate connecting grounded and floating signal sources to the NI USB-9229/9239.

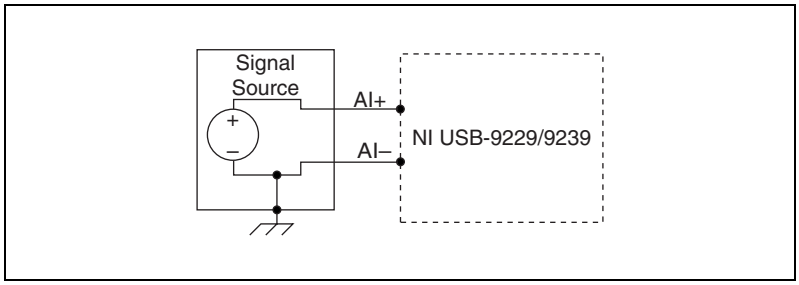


Figure 8. Connecting a Grounded Signal Source to the NI USB-9229/9239

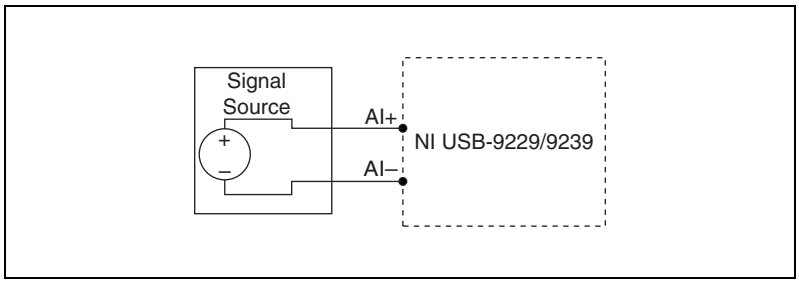


Figure 9. Connecting a Floating Signal Source to the NI USB-9229/9239

NI USB-9229/9239 Circuitry

The NI USB-9229/9239 analog input channels are floating with respect to earth ground and each other. The incoming analog signal on each channel is conditioned, buffered, and then sampled by a 24-bit Delta-Sigma ADC.

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Each channel provides an independent signal path and ADC, enabling you to sample all four channels simultaneously. Refer to Figure 10 for an illustration of the circuitry for one channel.

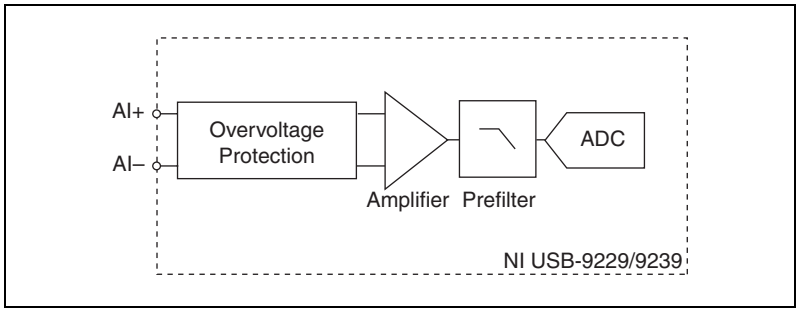


Figure 10. Input Circuitry for One Channel

Understanding NI USB-9229/9239 Filtering

The NI USB-9229/9239 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the alias-free bandwidth.

The NI USB-9229/9239 represents signals within the passband, as quantified primarily by passband ripple and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

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Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The digital filters of the NI USB-9229/9239 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate. Figure 11 shows typical passband flatness for the 50 kS/s data rate.

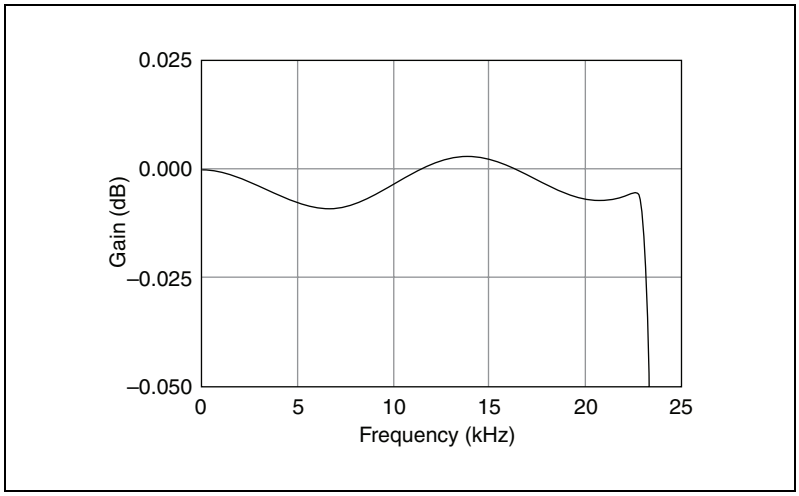


Figure 11. Typical Passband Response

Stopband

The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Alias-Free Bandwidth

Any signal that appears in the alias-free bandwidth of the NI USB-9229/9239 is not an aliased artifact of signals at a higher frequency. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency and equals the data rate minus the stopband frequency.

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Specifications

The following specifications are typical for the range 0 to 60 °C unless otherwise noted. All voltages are relative to the AI– signal on each channel unless otherwise noted.

Input Characteristics

Number of channels.....4 analog input channels

ADC resolution.....24 bits

Type of ADC .....Delta-Sigma (with analog prefiltering)

Sampling mode .....Simultaneous

Data rate range (f_s)

Minimum .....1.613 kS/s

Maximum .....50 kS/s[1]

Data rates (f_s).....$\frac{50\text{kS/s}}{n}$, n = 1, 2, ... 31.

Master timebase (internal)

Frequency .....12.8 MHz

Accuracy.....±100 ppm max

Operating voltage ranges[2]

	Measurement Voltage, AI+ to AI–		
	Nominal (V)	**Typical (V)**	**Minimum (V)**
NI USB-9229	±60	±62.64	±61.5
NI USB-9239	±10	±10.52	±10.3

Overvoltage protection .....±100 V

Input coupling.....DC

Input impedance (AI+ to AI–) .....1 MΩ

[1] Full performance requires the use of a USB 2.0 Hi-Speed host controller and USB 2.0 hubs.

[2] Refer to the *Safety Guidelines* section for more information about safe operating voltages.

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Accuracy, NI USB-9229

Error	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Calibrated max (–0 to 60 °C)	±0.13%	±0.05%
Calibrated typ (25 °C, ±5 °C)	±0.03%	±0.008%
Uncalibrated max (0 to 60 °C)	±1.2%	±0.55%
Uncalibrated typ (25 °C, ±5 °C)	±0.3%	±0.11%
* Range equals 62.64 V		

Accuracy, NI USB-9239

Error	Percent of Reading (Gain Error)	Percent of Range* (Offset Error)
Calibrated max (0 to 60 °C)	±0.13%	±0.05%
Calibrated typ (25 °C, ±5 °C)	±0.03%	±0.008%
Uncalibrated max (0 to 60 °C)	±1.4%	±0.67%
Uncalibrated typ (25 °C, ±5 °C)	±0.3%	±0.11%
* Range equals 10.52 V		

Input noise

NI USB-9229 ..... 320 μV_{rms}

NI USB-9239 ..... 70 μV_{rms}

Stability

Gain drift ..... ±5 ppm/°C

Offset drift

NI USB-9229 ..... ±150 µV/°C

NI USB-9239 ..... ±24 µV/°C

Post calibration gain match
(ch-to-ch, 20 kHz) ..... 0.22 dB max

Crosstalk (1 kHz) ..... –130 dB

Phase mismatch (ch-to-ch)

NI USB-9229 ..... 0.045°/kHz max

NI USB-9239 ..... 0.075°/kHz max

Phase mismatch (module-to-module, max)

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NI USB-9229.....0.045°/kHz + 360°· f_{in}/M_{clk}[1]

NI USB-9239.....0.075°/kHz + 360°· f_{in}/M_{clk}[1]

Phase nonlinearity (f_s = 50 kS/s).....0.11° max

Input delay

NI USB-9229.....38.4/f_s + 2.6 µs

NI USB-9239.....38.4/f_s + 3 µs

Passband

Frequency .....0.453 · f_s

Flatness (f_s = 50 kS/s).....±100 mdB max

Stopband

Frequency .....0.547 · f_s

Rejection.....100 dB

Alias-free bandwidth .....0.453 · f_s

–3 dB prefilter bandwidth
(f_s = 50 kS/s) .....24.56 kHz

CMRR (f_{in} = 60 Hz)

NI USB-9229.....116 dB

NI USB-9239.....126 dB

SFDR (1 kHz, –60 dBFS).....–128 dBFS

Total Harmonic Distortion (THD)

1 kHz, –1 dBFS .....–99 dB

1 kHz, –20 dBFS .....–105 dB

Power Requirements

Current consumption from USB.....500 mA, max

Suspend mode.....2.5 mA, max

Bus Interface

USB specification .....USB 2.0 Hi-Speed

[1] M_{clk} is the master timebase.

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Physical Characteristics

Screw-terminal wiring ..... 16 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end

Torque for screw terminals ..... 0.22 to 0.25 N · m (1.95 to 2.21 lb · in.)

Ferrules ..... 0.25 mm^2 to 0.5 mm^2

Weight ..... 249 g (8.8 oz)

Safety

If you need to clean the module, wipe it with a dry towel.

Safety Voltages

Isolation

Channel-to-earth ground

Continuous ..... 250 V_{rms}, Measurement Category II

Withstand ..... 2300 V_{rms}, verified by a 5 s dielectric withstand test

Channel-to-channel

Continuous ..... 250 V_{rms}, Measurement Category II

Withstand ..... 1390 V_{rms}, verified by a 5 s dielectric withstand test

Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe. Do *not* connect the NI USB-9229/9239 to signals or use for measurements within Measurement Categories III or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

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Note For UL and other safety certifications, refer to the product label or visit `ni.com/certification`, search for the module number or product line, and click the appropriate link in the Certification column.

Hazardous Locations

The NI USB-9229/9239 is not certified for use in hazardous locations.

Environmental

The NI USB-9229/9239 devices are intended for indoor use only but may be used outdoors if installed in a suitable enclosure.

Operating temperature
(IEC 60068-2-1, IEC 60068-2-2) .....0 to 60 °C

Storage temperature
(IEC 60068-2-1, IEC 60068-2-2) .....–40 to 85 °C

Operating humidity
(IEC 60068-2-56) .....10 to 90% RH, noncondensing

Storage humidity
(IEC 60068-2-56) .....5 to 95% RH, noncondensing

Maximum altitude.....2,000 m

Pollution Degree (IEC 60664).....2

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note For EMC compliance, operate this device with shielded cabling.

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CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EEC; Electromagnetic Compatibility Directive (EMC)

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee.htm`.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。
关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。
(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI USB-9229/9239 at `ni.com/calibration`.

Calibration interval ..... 1 year

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Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

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Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,
Italy 39 02 41309277, Japan 0120-527196, Korea 82 02 3451 3400,
Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710,
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Singapore 1800 226 5886, Slovenia 386 3 425 42 00,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
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