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BNC-2140 User Manual

Dynamic Signal Acquisition Signal Conditioning Accessory

June 2003 Edition
Part Number 321933D-01

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Depending on where it is operated, this Class A product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.) Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products.

All Class A products display a simple warning statement of one paragraph in length regarding interference and undesired operation. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

Consult the FCC Web site at `www.fcc.gov` for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE marking Declaration of Conformity*, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by NI could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Readers in the European Union (EU) must refer to the manufacturer's Declaration of Conformity (DoC) for information* pertaining to the CE marking compliance scheme. The manufacturer includes a DoC for most hardware products except for those bought from OEMs. In addition, DoCs are usually not provided if compliance is not required, for example electrically benign apparatus or cables.

To obtain the DoC for this product, click **Declarations of Conformity Information** at `ni.com/hardref.nsf/`. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

* The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

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About This Manual

This manual describes the electrical and mechanical aspects of the BNC-2140 accessory and contains information concerning its operation.

Conventions

The following conventions are used in this manual:

<> Angle brackets containing numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, P0.<3..0>.

 This icon denotes a note, which alerts you to important information.

 This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

bold Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes a variable, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

Related Documentation

The following documents contain information you may find helpful:

- National Instruments Application Note 025, *Field Wiring and Noise Considerations for Analog Signals*
- *NI 4551/4552 User Manual*
- *PCI-4451/4452/4453/4454 User Manual*

1 Introduction

This manual describes the electrical and mechanical aspects of the BNC-2140 accessory and contains information concerning its operation.

This chapter describes the BNC-2140 accessory, lists what you need to get started, explains how to unpack your BNC-2140, and describes optional equipment.

The BNC-2140 is a signal conditioning accessory specifically designed for use with a dynamic signal acquisition (DSA) device. It interfaces four BNC signal inputs and two BNC signal outputs directly to National Instruments DSA products including the NI PCI-4451, NI PCI-4452, NI PCI-4551, and NI PCI-4552. The BNC-2140 connects to integrated circuit piezoelectric, also known as Integral Electronic Piezoelectric (IEPE), accelerometers, microphone preamplifiers, and other voltage sources with outputs of less than ±42.4 V.

Each input channel has an independent 4 mA current source suitable for use with IEPE-type accelerometers and microphone preamplifiers. You can manually enable or disable the IEPE signal conditioning on a per-channel basis. With IEPE disabled, a BNC-2140 input channel acts as a direct voltage input. You can manually switch each input channel and each output channel from differential (DIFF) to single-ended (SE) mode. In SE mode, the BNC shell is connected to analog ground through a 50 Ω resistor.

The BNC-2140 receives power for IEPE signal conditioning from the DSA plug-in device through the 68-pin high-density connector. A green LED indicates when the IEPE circuitry is powered on. When IEPE signal conditioning is not required, you can manually power off the circuits.

What You Need to Get Started

To set up and use the BNC-2140 device, you need the following:

- ❑ BNC-2140
- ❑ One of the following DSA devices and its documentation:
  - NI PCI 4451
  - NI PCI 4452
  - NI PCI 4551
  - NI PCI 4552
- ❑ *BNC-2140 User Manual*
- ❑ Your computer
- ❑ SHC68-C68-A1 analog cable

For more information, refer to `ni.com/appnotes.nsf` for the National Instruments Application Note 25, *Field Wiring and Noise Considerations for Analog Signals*.

Unpacking

The BNC-2140 is shipped in an antistatic plastic package to prevent electrostatic damage to the device. Several components on the device can be damaged by electrostatic discharge.

Caution *Never* touch the exposed pins of connectors.

To avoid damage in handling the device, take the following precautions:

- Ground yourself with a grounding strap or by holding a grounded object.
- Touch the plastic package to a metal part of your computer chassis before removing the device from the package.
- *Never* touch exposed connector pins.

Remove the device from the package and inspect the device for loose components or any other sign of damage. Notify National Instruments if the device appears damaged in any way. Do *not* install a damaged device onto your computer.

Optional Equipment

If your application requires that you use transducers with microdot connectors, use the BNC plug screw-on receptacle adapter, part number 033-0101-0001, from Microdot Connectors. This accessory allows you to connect BNC and microdot connectors.

If your application requires that you use a prepolarized microphone with a microphone preamplifier, contact Brüel and Kjær or go to `bksv.com`.

2

Installation and Configuration

This chapter explains how to install and configure the BNC-2140.

Installation

Note You must power off the computer and install your National Instruments DSA device before installing the BNC-2140. Refer to your DSA device documentation for instructions.

Perform the following steps to install the BNC-2140:

1. Insert either end of the SHC68-C68-A1 analog cable into the 68-pin connector on the BNC-2140.
2. Insert the other end into the 68-pin connector on the DSA plug-in device.
3. Tighten the jackscrews on both ends of the cable.
4. Power on the computer.

The BNC-2140 accessory is now installed.

Device Configuration

You must manually configure the BNC-2140 accessory by setting the channel switches. You can configure each input channel to enable or disable IEPE signal conditioning and to take differential or single-ended measurements. You also can configure each output channel for differential or single-ended measurements. When IEPE signal conditioning is enabled, large DC offset voltages can occur on signal inputs due to the output bias voltage requirements of the IEPE transducer you are using. To remove this offset, you must enable AC coupling on the affected input channels of the DSA device. If you do not require IEPE signal conditioning, you can turn the power off for the IEPE signal conditioning circuitry. Turning off the IEPE power will disable IEPE excitation on all input channels. Refer to Figure 2-1 for the location of the switches.

Note You can connect or disconnect BNC cables carrying signals without powering off the computer.

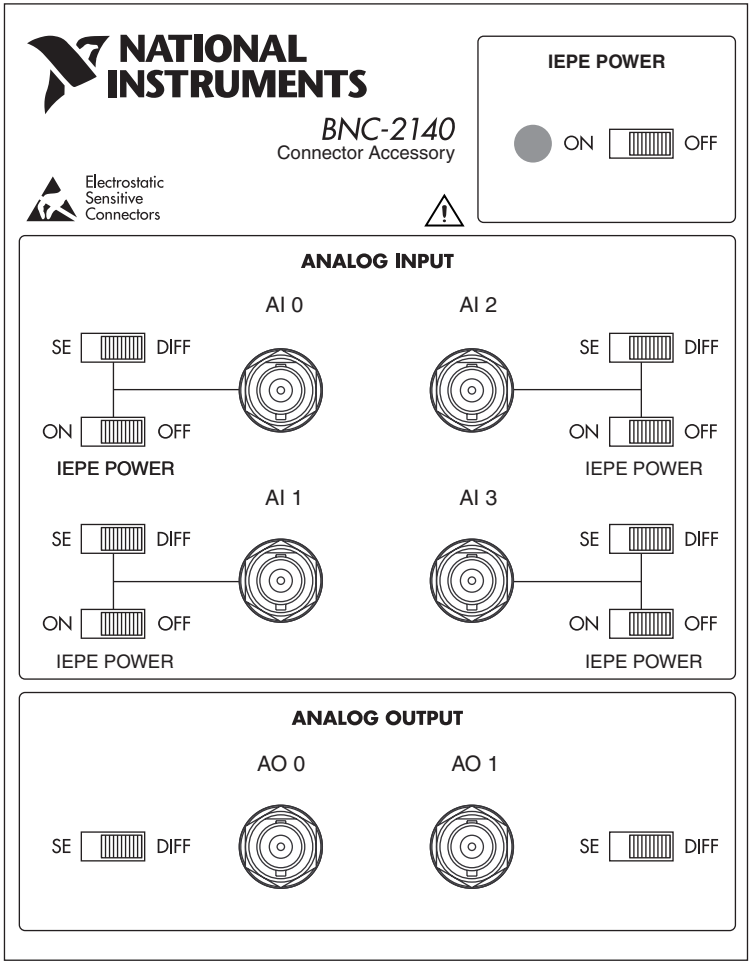

Figure 2-1. Switch Settings and Signal Connections

3

Signal Connections

This chapter describes how to connect input and output signals to the BNC-2140.

You can connect external analog signals through six BNC connectors. Four of the BNC connectors are for input signals and two are for output signals.

The SHC68-C68-A1 shielded cable connects the BNC-2140 internal analog signal connector to the DSA plug-in device. A single 68-pin 0.8 mm VHDCI connector connects the analog I/O signals to the shielded cable.

I/O Connectors

Table 3-1 describes the pin assignments for the six external I/O BNC connectors.

Table 3-1. BNC Analog I/O Connector Signal Descriptions

Signal Name	Reference	Direction	Description
+AI <0..3>	AI GND	Input	+Analog Input Channel 0 through 3—Each channel can have IEPE enabled or disabled. This signal passes through the BNC internal conductor.
–AI <0..3>	AI GND	Input	–Analog Input Channel 0 through 3—In SE mode, the inverting (negative) terminal is connected to ground through a 50 Ω resistor. This signal passes through the external BNC shell.
+AO 0	–AO 0	Output	+Analog Output Channel 0—This pin supplies the analog non-inverting output channel 0. This signal passes through the internal BNC conductor.
–AO 0	+AO 0	Output	–Analog Output Channel 0—This pin supplies the analog inverting output channel 0. This signal passes through the external BNC shell. In SE mode, the inverting (negative) terminal is connected to ground through a 50 Ω resistor.

Table 3-1. BNC Analog I/O Connector Signal Descriptions (Continued)

Signal Name	Reference	Direction	Description
+AO 1	–AO 1	Output	+Analog Output Channel 1—This pin supplies the analog non-inverting output channel 1. This signal passes through the internal BNC conductor.
–AO 1	+AO 1	Output	–Analog Output Channel 1—This pin supplies the analog inverting output channel 1. This signal passes through the external BNC shell. In SE mode, the inverting (–) terminal is connected to ground through a 50 Ω resistor.

Figure 3-1 illustrates the pin assignments on the BNC-2140 68-pin connector.

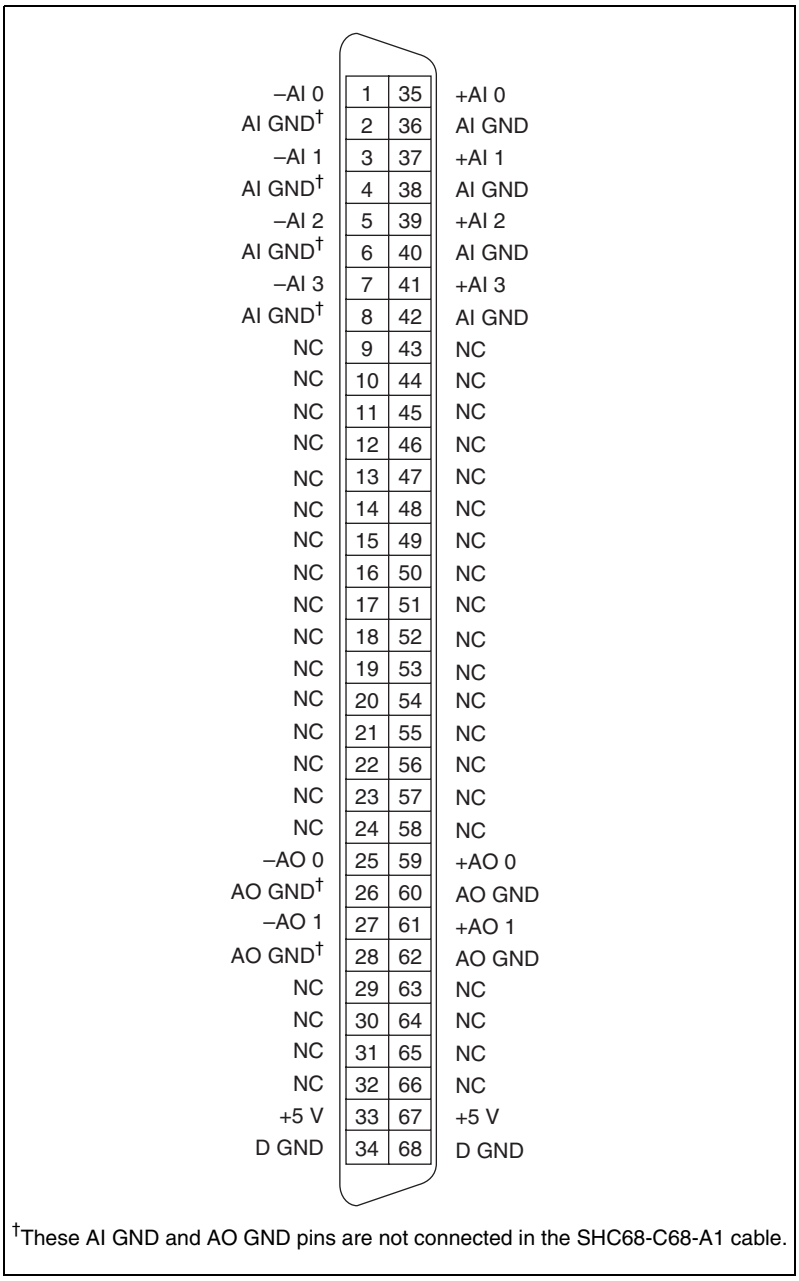

Figure 3-1. BNC-2140 External 68-Pin Analog Connector

Note This BNC-2140 pin assignment maps to the pin assignment of the DSA device you are connecting to the BNC-2140. Refer to the DSA device documentation for the pin assignments specific to your device connection.

Table 3-2 describes the signals for the internal 68-pin I/O connector.

Table 3-2. 68-Pin Analog I/O Connector Signal Descriptions

Signal Name	Reference	Direction	Description
AI GND	—	—	Analog Input Ground—These pins are the reference point for single-ended measurements in SE mode and the bias current return point for differential measurements.
+AI <0..3>	AI GND	Input	+Analog Input Channel 0 through 3
–AI <0..3>	AI GND	Input	–Analog Input Channel 0 through 3
+AO 0	–AO 0	Output	+Analog Output Channel 0
–AO 0	+AO 0	Output	–Analog Output Channel 0
+AO 1	–AO 1	Output	+Analog Output Channel 1
–AO 1	+AO 1	Output	–Analog Output Channel 1
AO GND	—	—	Analog Output Ground—The analog output voltages are ultimately referenced to this node.
D GND	—	—	Digital Ground—This pin supplies the reference for the +5 VDC supply.
+5 V	D GND	Output	+5 VDC Source—These pins are fused for up to 0.5 A of +5 V supply on the DSA plug-in device. The fuse is self-resetting. This source powers the IEPE circuits of the BNC-2140.
Note: For +AI <0..3>, –AI <0..3>, +AO 0, –AO 0, +AO 1, and –AO 1 descriptions, refer to Table 3-1.			

Caution Connections that exceed the maximum ratings for input or output signals on the BNC-2140 accessory can damage the BNC-2140, any device connected to it, and the host computer. Maximum input ratings for each signal are listed in Appendix A, *Specifications*. National Instruments is *not* liable for any damage resulting from signal connections exceeding maximum ratings.

In DIFF mode, the outer shell is the inverting differential signal. In SE mode, the outer shell is connected to ground (0 V) through a 50 Ω, 1 W resistor. The outer shell of the BNC is not directly connected to ground (0 V) or the metal case of the BNC-2140.

Analog Input Signal Connections

The analog input signals for the BNC-2140 device are +AI <0..3> and –AI <0..3>. How you connect analog input signals to the BNC-2140 depends on the configuration of the input signal sources.

For most signals, use a DIFF configuration and connect the signal to +AI *x* (where *x* is the BNC-2140 channel) and the signal ground (or signal minus), as appropriate, to –AI *x*. If a signal has a high output impedance (greater than 1 kΩ) and is floating, you may use an SE configuration. Single-ended mode connects the negative side of the input signal to AI GND using a 50 Ω resistor. This configuration reduces common-mode interference.

Analog Output Signal Connections

The BNC-2140 analog output signals are +AO 0, –AO 0, +AO 1, and –AO 1.

±AO 0 is the voltage output signal for analog output channel 0. ±AO 1 is the voltage output signal for analog output channel 1.

The connection of analog output signals from the BNC-2140 depends on the configuration of the devices receiving the signals. For most signals, use a DIFF configuration and connect +AO *x* (where *x* is the BNC-2140 channel) to the signal and –AO *x* to the signal ground (or signal minus), as appropriate. When driving some devices with floating grounds, you may use the SE configuration and connect the floating ground system of the device to AO GND. This reduces common-mode noise coupled from an interfering source to the device.

Caution When configuring an analog output channel in the SE mode, the voltage between AO GND and –AO *x* must *not* exceed ±7.07 V_P (5 V_{rms}). Voltage that exceeds this rating can damage the BNC-2140, the DSA plug-in device, and the computer. National Instruments is *not* responsible for any damage resulting from connections that exceed this rating.

4

Theory of Operation

This chapter contains a functional overview of the BNC-2140.

Functional Overview

Figure 4-1 is a block diagram of the BNC-2140.

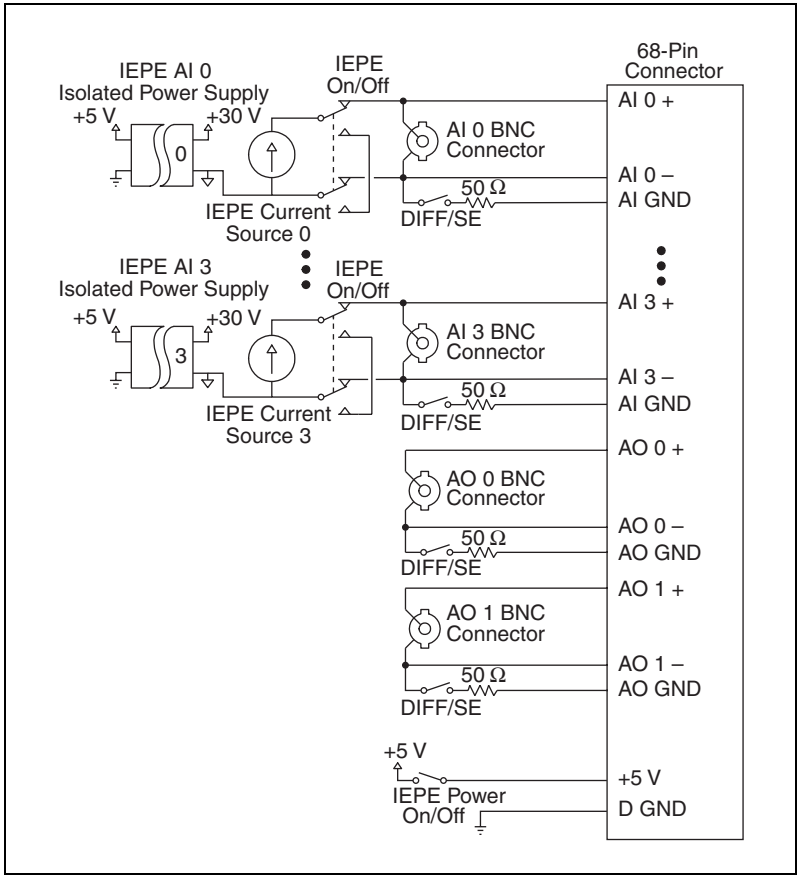

Figure 4-1. BNC-2140 Block Diagram

Analog Input Circuitry

The BNC-2140 has four identical analog input channels.

The BNC-2140 supplies a constant current for IEPE accelerometers and microphone preamplifiers. Many accelerometers use piezoelectric materials to generate a charge proportional to the acceleration applied. These types of accelerometers are susceptible to external noise. A charge amplifier is embedded within the sensor to reduce the effects of cable length, noise, and other spurious effects. The BNC-2140 supplies the constant current required to power the embedded charge amplifier in the IEPE sensor, so you can use inexpensive cables, such as BNC cables.

Some manufacturers use IEPE signal conditioning to power their prepolarized microphones. If your application requires a microphone preamplifier for use with a prepolarized microphone, refer to the *Optional Equipment* section of Chapter 1, *Introduction*, for supplier information.

If you attach an IEPE-type of accelerometer or microphone preamplifier to an analog input channel, you must turn on the IEPE power switch and enable the IEPE circuit for that channel to generate the required current. The IEPE circuitry of any input channel can be enabled or disabled independently of any other input channel. When IEPE is disabled, the connection from the IEPE circuit to that channel breaks and has no effect on the incoming signal. If IEPE is not required on any of the four input channels, power off IEPE to de-energize the circuitry. Powering off IEPE removes noise induced by the circuitry on the incoming signal.

The BNC-2140 allows you to select between DIFF and SE input modes. You can use IEPE signal conditioning when the inputs are in either mode.

Analog Output

The BNC-2140 has two analog output channels. The BNC-2140 can select between DIFF and SE outputs.

In DIFF mode, the positive and negative sides of the output channel are floating. Use DIFF mode when the unit under test has grounded input terminals. In SE mode, the negative side of the output channel is connected to AO GND with a 50 Ω resistor.

A

Specifications

This appendix lists the specifications of the BNC-2140. These specifications are typical at 25 °C unless otherwise noted. All specifications are relative to measurement standards and require a 15-minute warm-up time. Specifications do not include transducer error.

Analog Input

Voltage Input

Number of channels 4

Maximum input voltage
(Signal + common mode voltage)..... ±42.4 V_P (30 V_{rms}) of AI GND

Input coupling ..... DC

Input capacitance[1]

Input Mode	Current Excitation	
	On	Off
DIFF	85 pF	75 pF
SE	150 pF	145 pF

Current Excitation

Level..... 4 mA

Accuracy ..... ±1.31%

Temperature coefficient ..... ±141 ppm/°C

Voltage compliance..... 24 V

Excitation overvoltage protection ..... ±42.4 V_P (30 V_{rms}) powered on or off

[1] Includes the effects of the BNC-2140 with a 1 m SHC68-C68-A1 analog cable.

Analog Output

Number of channels.....2

Maximum voltage (SE mode).....±7.07 V_P (5 V_{rms})
between AO GND and –AO *x*

Output coupling .....DC

Power Requirement (from DSA device)

Power consumption .....400 mA at +5 VDC

Physical

Dimensions .....14.4 by 11.2 by 5.5 cm
(5.7 by 4.4 by 2.2 in.)

I/O connectors

I/O signals.....6 BNC connectors (outer shell isolated from the metal case)

DSA device connection .....68-pin 0.8 mm VHDCI female connector

Environment

Operating temperature .....0 to 55 °C

Storage temperature.....–55 to 150 °C

Relative humidity .....5 to 90% noncondensing

Safety

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 3111-1, UL 61010B-1
- CAN/CSA C22.2 No. 1010.1

Note For UL and other safety certifications, refer the the product label or to `ni.com`.

Electromagnetic Compatibility

Emissions	EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
Immunity	EN 61326:1997 + A2:2001, Table 1
EMC/EMI	CE, C-Tick, and FCC Part 15 (Class A) Compliant

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

CE Compliance

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

Low-Voltage Directive (safety)	73/23/EEC
Electromagnetic Compatibility Directive (EMC)	89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click **Declarations of Conformity Information** at `ni.com/hardref.nsf/`. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

B

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- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/hardref.nsf.

- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Glossary

Symbol	Prefix	Value
p	pico	10^{-12}
m	milli	10^{-3}
k	kilo	10^{3}
M	mega	10^{6}

Numbers/Symbols

%	percent
+	positive of, or plus
–	negative of, or minus
/	per
°	degree
Ω	ohm
+5 V	+5 VDC source signal

A

A	amperes
AC	alternating current
AC coupled	allowing the transmission of AC signals while blocking DC signals
accelerometer	a transducer for measuring the dynamic acceleration of a physical device
AI	analog input channel signal
AO 0	analog output channel 0 signal

AO 1	analog output channel 1 signal
AO GND	analog output ground

B

bias	a DC signal added to the original signal
BNC	a type of coaxial signal connector

C

C	Celsius
channel	pin or wire lead to which you apply or from which you read the analog or digital signal; analog signals can be single-ended or differential
charge amplifier	an electronic amplifier sensitive to changes in the charge of a device, typically used with piezoelectric accelerometers and capacitive transducers to condition the extremely high output impedance of the transducer to a low impedance voltage suitable for transmission over longer cables
common-mode signal	the mathematical average voltage, relative to the computer's ground, of the signals from a differential input
common-mode voltage	any voltage present at the instrumentation amplifier inputs with respect to amplifier ground
coupling	the manner in which a signal is connected from one location to another
current excitation	a source that supplies the current needed by a sensor for its proper operation

D

D GND	digital ground signal
DC	direct current
DC offset	the DC voltage or current present on a signal
DIFF	differential mode

differential input	an analog input consisting of two terminals, both of which are isolated from computer ground, whose difference is measured
differential measurement system	a way you can configure your device to read signals, in which you do not need to connect either input to a fixed reference, such as the earth or a building ground
DSA	Dynamic Signal Analysis—the analysis of dynamically changing waveforms or systems using digital signal processing (DSP) techniques

E

electrostatic discharge	a high-voltage, low-current discharge of static electricity that can damage sensitive electronic components

F

F	farads—a unit of capacitance
floating signal sources	signal sources with voltage signals that are not connected to an absolute reference or system ground—also called nonreferenced signal sources; common examples are batteries, transformers, or thermocouples

G

grounded measurement system	*See* SE

H

hardware	the physical components of a computer system such as the circuit boards, plug-in boards, chassis, enclosures, peripherals, and cables

I

I/O	input/output—the transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces
IEPE	Integral Electronic Piezoelectric, also known as integrated circuit piezoelectric—identifies products that operate using a constant current source and return the output signal in the form of voltage modulation on the same line as the constant current source
in.	inches

L

LED	Light Emitting Diode, a semiconductor light source

M

m	meters
microphone	a transducer that converts acoustical waves into electrical signals

N

noise	an undesirable electrical signal—comes from external sources such as the AC power line, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and internal sources such as semiconductors, resistors, and capacitors; corrupts signals you are trying to send or receive

P

PCI	Peripheral Component Interconnect—a high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA; offers a theoretical maximum transfer rate of 132 Mbytes/s and is achieving widespread acceptance as a standard for PCs and work-stations
pF	picofarad—one-trillionth of a farad
ppm	parts per million

R

rms	root mean square—the square root of the average value of the square of the instantaneous signal amplitude; a measure of signal amplitude

S

SE	single-ended—a term used to describe an analog input that is measured with respect to a common ground
signal conditioning	the manipulation of signals to prepare them for digitizing; electronic equipment that makes transducer or other signals suitable in level and range to be transmitted over a distance, or to interface with voltage input instruments

T

transducer	a device that responds to a physical stimulus (heat, light, sound, pressure, motion, flow, and so on), and produces a corresponding electrical signal

V

V	volts
VDC	volts direct current
V_{rms}	volts $_{rms}$

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