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DAQ

BNC-2090A User Manual

Rack-Mount Connector Accessory for E/M Series DAQ Devices

January 2007
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Consult the FCC Web site at `www.fcc.gov` for more information.

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

Conventions

The following conventions are used in this manual:

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

» The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

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. When this symbol is marked on a product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document, available on `ni.com/manuals`, for information about precautions to take.

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 variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text 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.

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1

BNC-2090A Overview

This user manual contains in-depth information about using the National Instruments BNC-2090A.

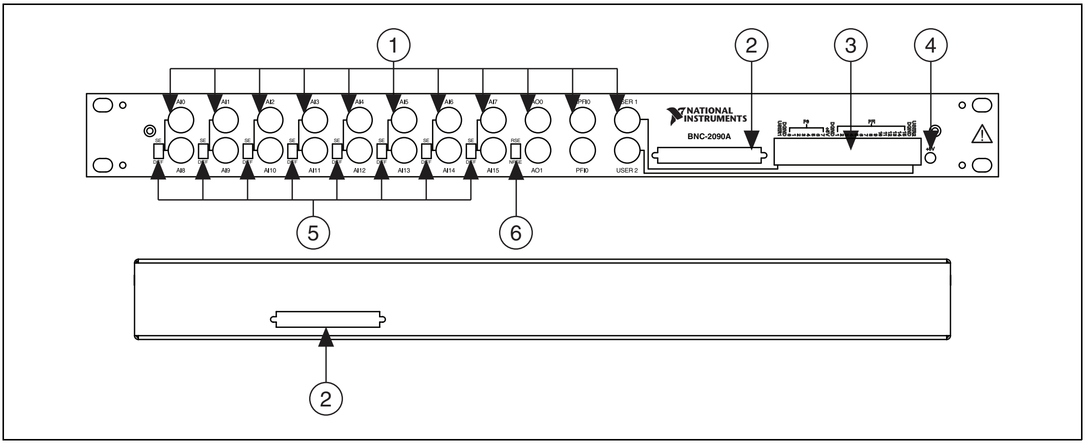
The BNC-2090A is a desktop or rack-mount analog breakout accessory you can connect to E/M Series multifunction DAQ devices[1]. The BNC-2090A has the following features:

- 16 analog input (AI) BNC connectors for eight differential or 16 single-ended channels
- Two analog output (AO) BNC connectors
- Two user-defined BNC connectors
- One APFI BNC connector
- One PFI BNC connector
- Spring terminal block for digital input/output (DIO) and Programmable Function Interface (PFI) connections
- Silkscreened component locations for resistors and capacitors for building single-pole highpass and lowpass filters and voltage dividers
- Two 68-pin input/output (I/O) connectors for DAQ device connection

Refer to the *BNC-2090A Quick Start Guide* for basic installation and signal connection instructions.

Figure 1-1 shows the front panel and enclosure back of the BNC-2090A.

[1] You can also use the BNC-2090A with PCI-6013 and PCI-6014 B Series devices.



1	BNC Connectors	4	+5V LED
2	68-Position Connectors	5	SE/DIFF Switches
3	Spring Terminal Block	6	RSE/NRSE Switch

Figure 1-1. BNC-2090A Front Panel and Back of Enclosure

What You Need to Get Started

To set up and use your BNC-2090A accessory, you need the following:

- ❑ BNC-2090A accessory
- ❑ *BNC-2090A Quick Start Guide* and *BNC-2090A User Manual*
- ❑ One of the following DAQ devices:
  - – 68-pin M Series device (with one or two I/O connectors)
  - – 68-pin E Series device
  - – 100-pin E Series device
- ❑ 68-position[1] or 100-position cable(s)
- ❑ The *E Series User Manual* or the *M Series User Manual*
- ❑ BNC cables
- ❑ 20 AWG wire or smaller
- ❑ Wire strippers

[1] Two-connector M Series devices can be cabled to two BNC-2090A accessories with two cables.

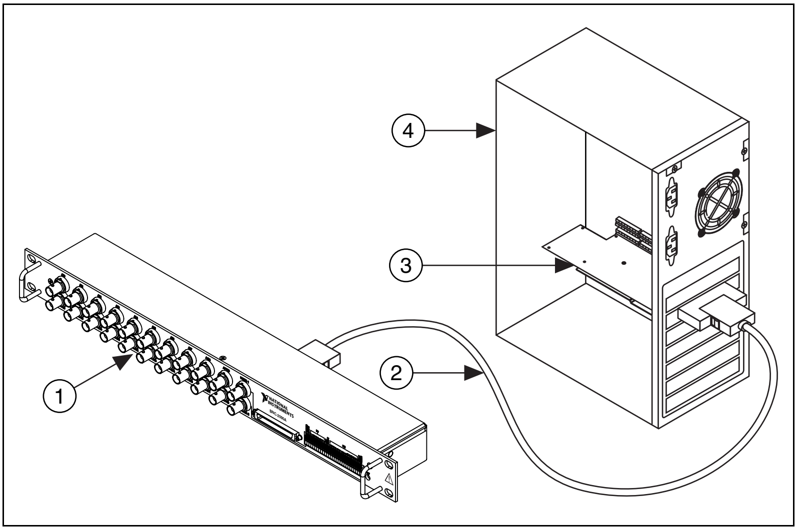
- ❑ Small flathead screwdriver
- ❑ Four adhesive rubber feet (supplied)

You can find detailed specifications for the BNC-2090A in Appendix A, *Specifications*.

Installing the BNC-2090A

The *BNC-2090A Quick Start Guide* contains general installation information for the BNC-2090A. To connect the BNC-2090A to your DAQ device, refer to Figure 1-2 as you complete the following steps. Consult your computer user manual or technical reference manual for specific instructions and warnings.

Note If you have not already installed your DAQ device, refer to the *DAQ Getting Started Guide* for instructions.



1	BNC-2090A	3	E/M Series DAQ Device
2	Shielded Cable	4	Personal Computer

Figure 1-2. Connecting the BNC-2090A to Your DAQ Device

1. Verify that the SE/DIFF switches and RSE/NRSE switch are set correctly for your current application, as described in Chapter 2, *Connecting Signals*.

2. (Optional) If you need to connect the BNC-2090A shield directly to digital ground (D GND), verify that the shield ground jumper is set correctly for your current application. Refer to the *Setting the BNC-2090A Shield Ground Jumper* section for more information.
3. (Optional) If you are performing signal conditioning, determine what signal conditioning you need for analog inputs and install the necessary components into the open component positions. Refer to the *Adding Signal Conditioning Components* section of Chapter 3, *Signal Conditioning* for more information.
4. Place the BNC-2090A near the host computer or mount the BNC-2090A into a 19 inch rack. If you do not rack-mount the accessory, attach the four adhesive rubber feet included in the BNC-2090A kit to the bottom of the accessory.

Caution Do *not* connect the BNC-2090A to any device other than a National Instruments E Series or M Series DAQ device. Doing so can damage the BNC-2090A, the DAQ device, or host computer. National Instruments is *not* liable for damages resulting from these connections.

5. Connect the BNC-2090A to the DAQ device using the front or rear 68-position connector, as shown in Figure 1-1.

Figure 1-3 shows the BNC-2090A connected directly to different M Series DAQ systems.

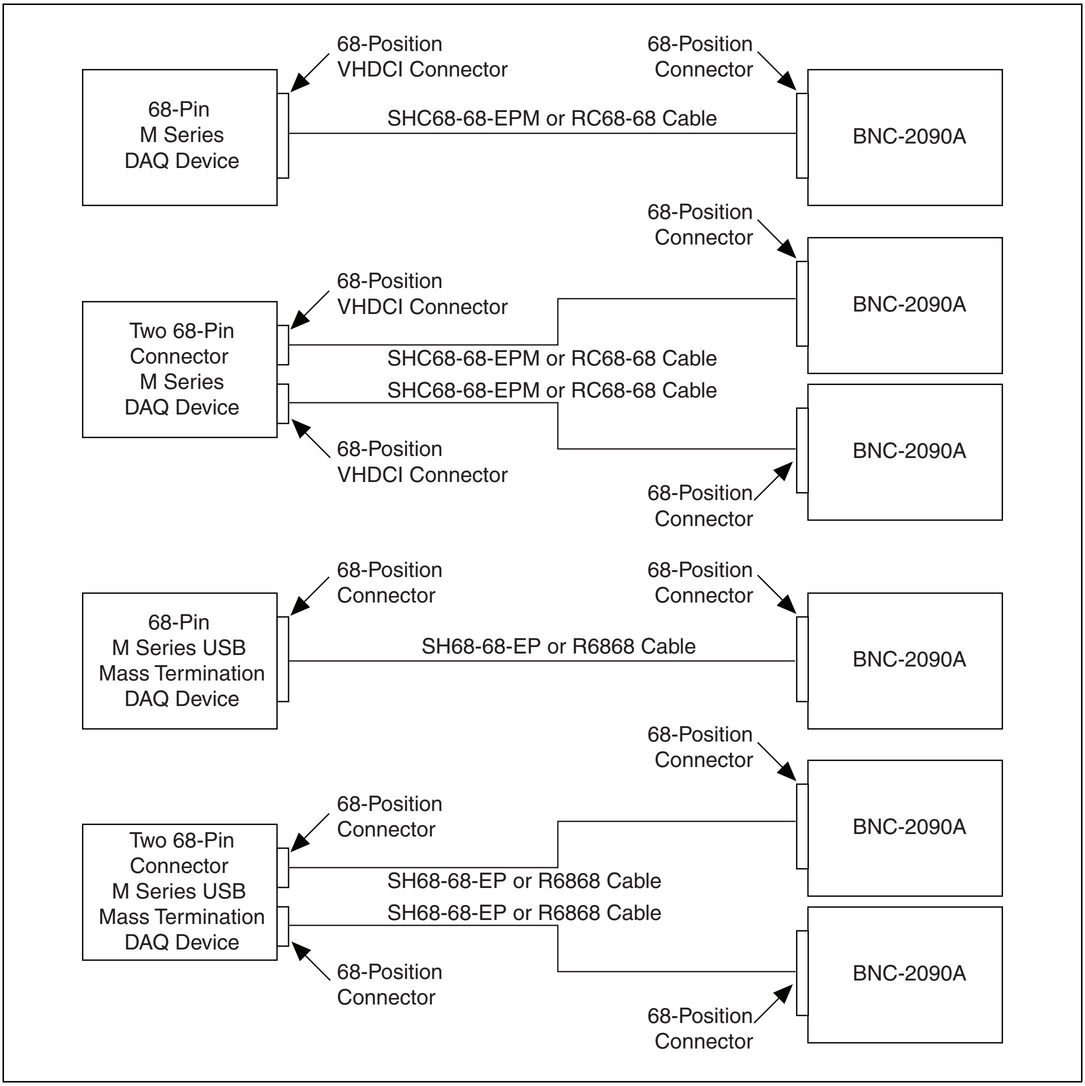


Figure 1-3. Direct Connection of M Series DAQ Devices to the BNC-2090A

Figure 1-4 shows the BNC-2090A connected directly to different E Series DAQ systems.

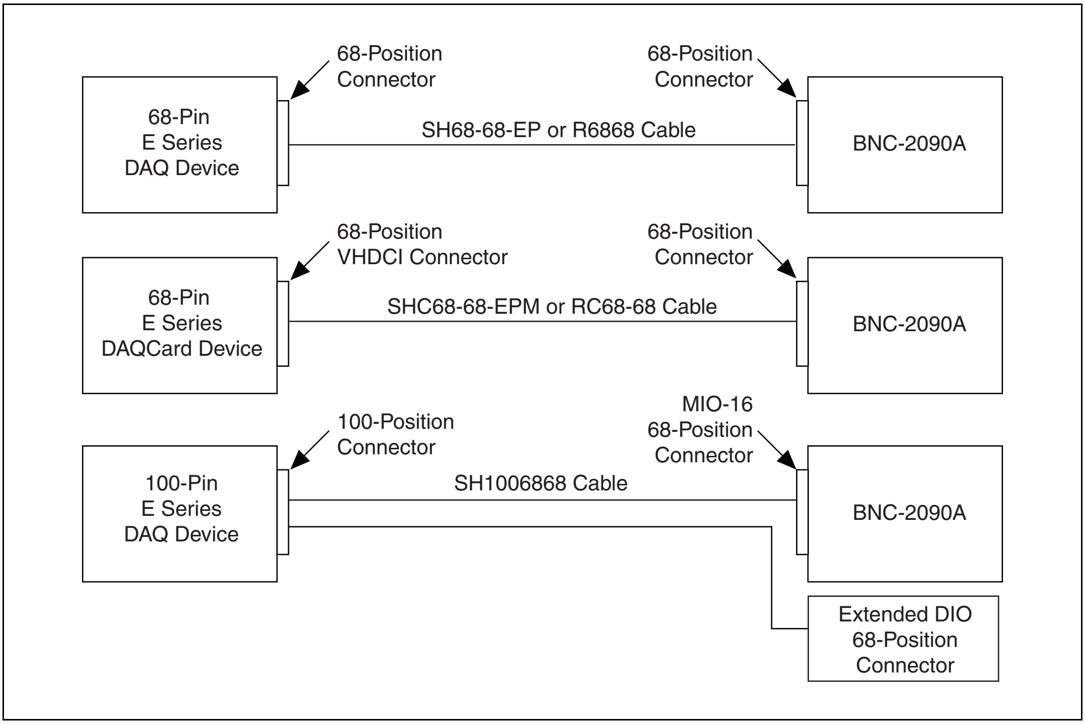


Figure 1-4. Direct Connection of E Series DAQ Devices to the BNC-2090A

If the +5V LED does not light, check the cable connections.

6. Connect signals to the BNC connectors and spring terminal block as described in Chapter 2, *Connecting Signals*.

When you have finished using the BNC-2090A, power off any external signals connected to the BNC-2090A before you power off your computer.

Note You can connect 68-pin cables to both the front connector and the rear connector of the BNC-2090A to create a pass-through.

Caution Do *not* connect input voltages greater than 42.4 V_{pk}/60 VDC to the BNC-2090A. The BNC-2090A is not designed for any input voltages greater than 42.4 V_{pk}/60 VDC, even if a user-installed voltage divider reduces the voltage to within the input range of the DAQ device. Input voltages greater than 42.4 V_{pk}/60 VDC can damage the BNC-2090A, all devices connected to it, and the host computer. Overvoltage can also cause an electric shock hazard for the operator. National Instruments is *not* liable for damage or injury resulting from such misuse.

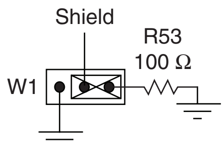
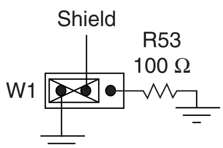
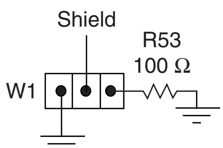
Setting the BNC-2090A Shield Ground Jumper

The BNC-2090A shield ground jumper, labeled W1 on the PCB, is factory-configured to connect the shield of the 68-position connectors and BNC-2090A metal case through a 100 Ω resistor to D GND.

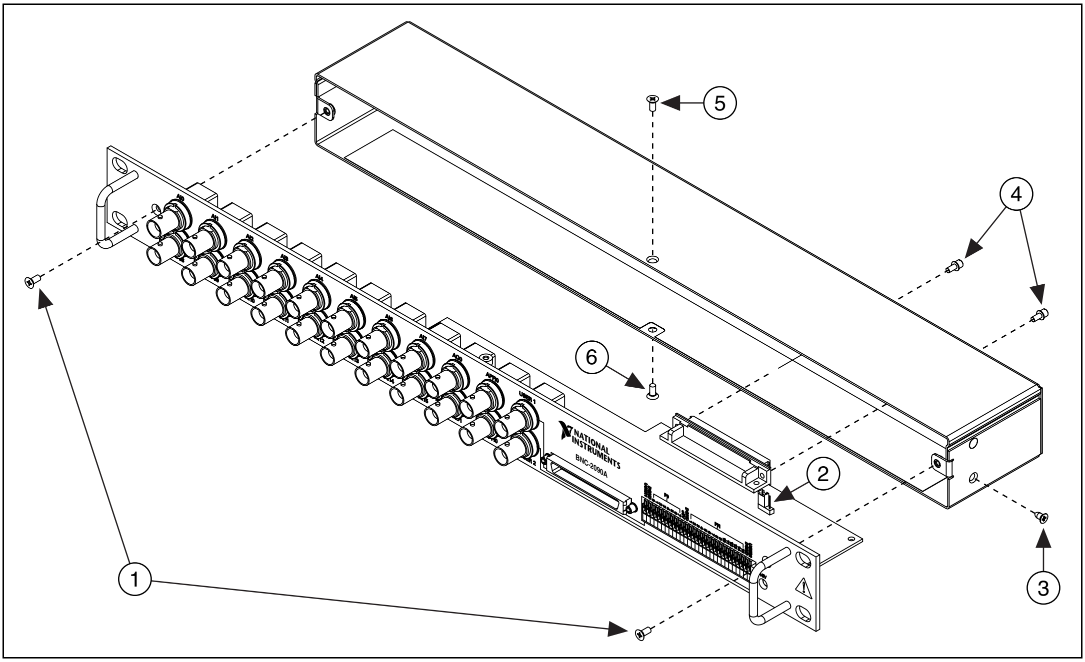
You must reconfigure the jumper if you want to connect the BNC-2090A shield directly to digital ground (D GND).

Table 1-1 shows the shield ground jumper setting options.

Table 1-1. Shield Ground Jumper Settings

Setting	Description
 Factory Default	**100 Ω to Digital Ground**—Use this setting to reduce any potential ground loop current, thereby improving the system noise performance. When the BNC-2090A is rack-mounted, it is connected to a different ground. This is the factory default setting.
	**Digital Ground**—Use this setting when the BNC-2090A metal case is *not* connected to any other ground through a rack mount or connected to the DAQ ground through a shielded cable. Use this setting when using unshielded cables.
	You can also disconnect the shield from the DAQ ground by removing shield ground jumper, which prevents the ground loop current from being carried in the D GND return of the shielded cable. This option is best for rack-mount configurations where the BNC-2090A metal case is already grounded.

To access and reconfigure the shield ground jumper, complete the following steps while referring to Figure 1-5.



1	Front Panel Screws	3	Side Panel Screw	5	Top Screw
2	Shield Ground Jumper (W1)	4	Rear Panel Screws	6	Bottom Screw

Figure 1-5. Accessing the Shield Ground Jumper

1. Remove the two rear panel screws and one side panel screw.
2. Remove the top and bottom screws and two front panel screws.
3. Hold the front panel and slide the unit out of the metal case.
4. Set the shield ground jumper, labeled W1 on the PCB, as needed.
5. Reassemble the BNC-2090A in reverse order.

2

Connecting Signals

The BNC-2090A features 22 BNC connectors and a spring terminal block for analog and digital signal connection. Refer to the *E Series User Manual* or the *M Series User Manual* for information about the use of these signals.

Figure 2-1 shows an overview of the BNC-2090A circuitry.

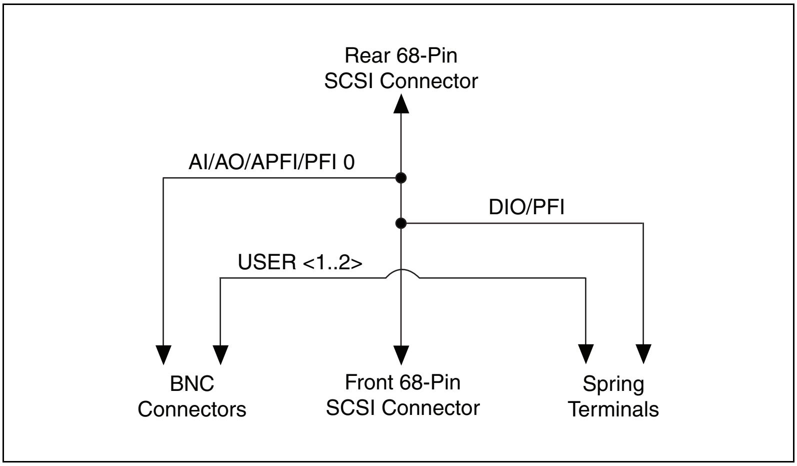


Figure 2-1. BNC-2090A Circuitry Overview

Connecting Analog Input Signals

The BNC-2090A can be configured in three analog input modes:

- Differential (factory-default setting)
- Referenced single-ended
- Nonreferenced single-ended

For more information about choosing an analog input mode, refer to *E Series User Manual* or the *M Series User Manual*.

Connecting Differential Analog Input Signals

Complete the following steps to measure a differential (DIFF) analog input signal.

1. Connect the BNC cable to one of the AI <0..7> BNC connectors on the front panel.

   Do not connect anything to the corresponding AI <8..15> BNC connector below the AI <0..7> BNC connector you use.
2. Move the corresponding SE/DIFF switch to the DIFF position. On the BNC-2090A front panel, a line indicates which SE/DIFF switch corresponds to each AI <0..7> BNC connector.
3. Configure your software to measure this channel differentially.

Figure 2-2 shows how differential AI signals are routed to the DAQ device.

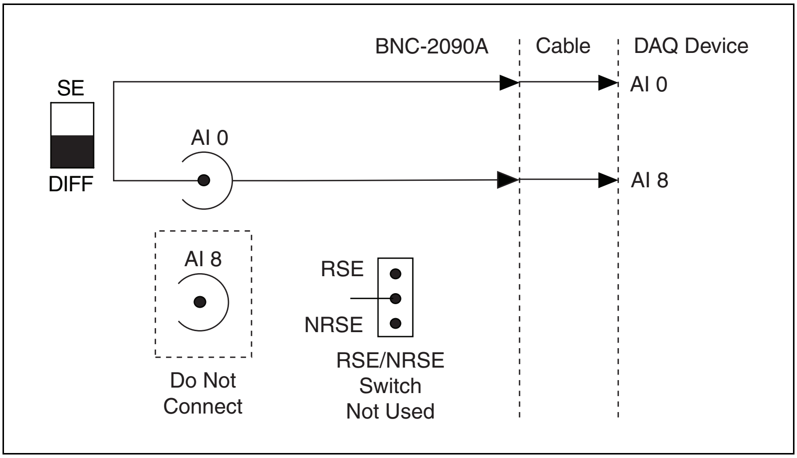


Figure 2-2. Analog Input Differential Mode

The BNC-2090A is configured for differential mode by default.

Measuring Floating Signals in Differential Input Mode

A *floating signal source* is a signal source that is not connected in any way to the building ground system, but has an isolated ground-reference point. If an instrument or device has an isolated output, that instrument or device falls into the floating signal source category. Some examples of floating signal sources are thermocouples, transformers, battery-powered devices, optical isolators, and isolation amplifiers. The ground reference of a floating source must be tied to the ground of the DAQ device to establish a local or on-device reference for the signal.

To provide a return path for the instrumentation amplifier bias currents, floating sources must have a 10–100 kΩ resistor to AI GND on one input if DC-coupled, or both inputs if AC-coupled. For more information about connections to floating signal sources and differential inputs, refer to *E Series User Manual* or the *M Series User Manual*. Refer to the *Installing Bias Resistors* section of Chapter 3, *Signal Conditioning*, for information about installing bias resistors.

Measuring Ground-Referenced Signals in Differential Input Mode

A *grounded signal source* is connected in some way to the building system ground; therefore, the signal source is already connected to a common ground point with respect to the DAQ device (assuming the host computer is plugged into the same power system). The non-isolated outputs of instruments and devices that plug into the building power system fall into this category.

If the DAQ device is configured for differential inputs, ground-referenced signal sources connected to the BNC-2090A need no special components added to the BNC-2090A. You can leave the inputs of the BNC-2090A in the factory-default configuration, with the 0 Ω jumpers in the two series positions, C and D, as listed in Table 3-1, *Channel Component Positions*. Refer to Chapter 3, *Signal Conditioning*, for information about building signal-conditioning circuitry, such as filters and attenuators, in the open-component positions.

Connecting Single-Ended Analog Input Signals

Complete the following steps to measure a single-ended (SE) analog input signal.

1. Connect the BNC cable to one of the AI <0..15> BNC connectors on the front panel.
2. Move the corresponding SE/DIFF switch to the SE position. On the BNC-2090A front panel, a line indicates which SE/DIFF switch corresponds to each AI <0..15> BNC connector.
3. Move the RSE/NRSE switch to select how the ground signal is routed. All single-ended signals share the one RSE/NRSE switch. For more information about non-referenced single-ended (NRSE) and

referenced single-ended (RSE) modes, refer to the *E Series User Manual* or the *M Series User Manual*.

4. Configure your software to measure this channel in RSE or NRSE mode.

Figure 2-3 shows how single-ended AI signals are routed to the DAQ device.

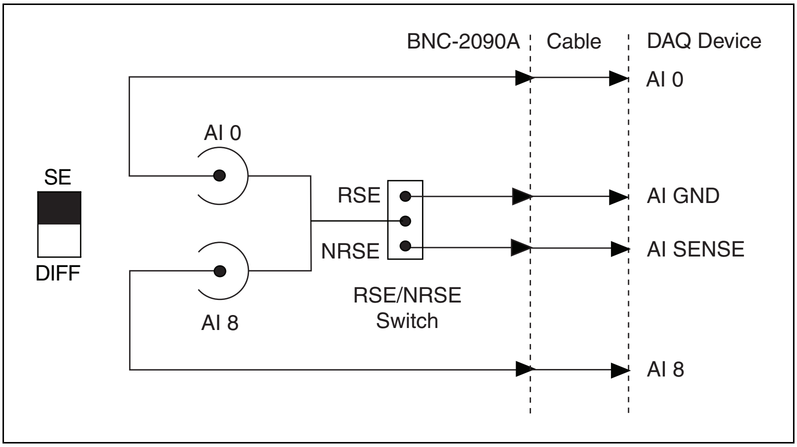


Figure 2-3. Analog Input Single-Ended Mode

Moving the RSE/NRSE switch to RSE, connects the BNC shields to AI GND. Moving the RSE/NRSE switch to NRSE connects the BNC shields to AI SENSE.

Measuring Floating Signals in Single-Ended Input Mode

A *floating signal source* is a signal source that is not connected in any way to the building ground system, but has an isolated ground-reference point. If an instrument or device has an isolated output, that instrument or device falls into the floating signal source category. Some examples of floating signal sources are thermocouples, transformers, battery-powered devices, optical isolators, and isolation amplifiers. The ground reference of a floating source must be tied to the ground of the DAQ device to establish a local or on-device reference for the signal.

When measuring floating signal sources, configure the DAQ device to supply a ground reference by placing the device in referenced single-ended (RSE) mode. This mode ties the negative input of the DAQ device instrumentation amplifier and the BNC shield to the analog ground.

Refer to Chapter 3, *Signal Conditioning*, for information about building additional signal-conditioning circuitry, such as filters and attenuators, in the open-component positions.

Measuring Ground-Referenced Signals in Single-Ended Input Mode

A *grounded signal source* is connected in some way to the building system ground; therefore, the signal source is already connected to a common ground point with respect to the DAQ device (assuming the host computer is plugged into the same power system). The non-isolated outputs of instruments and devices that plug into the building power system fall into this category.

When measuring ground-referenced signals, the external signal supplies its own reference ground point and the DAQ device should not supply one. Therefore, configure the DAQ device for the nonreferenced single-ended (NRSE) mode, in which all of the signal grounds are tied to AI SENSE, which connects to the negative input of the instrumentation amplifier on the DAQ device.

Refer to Chapter 3, *Signal Conditioning*, for information about building additional signal-conditioning circuitry, such as filters and attenuators, in the open-component positions.

Connecting AO, APFI 0, and PFI 0 Signals

Use the BNC-2090A BNC connectors on the front panel to connect AO <0..1>, APFI 0, and PFI 0 signals to your DAQ device. Refer to the *E Series User Manual* or the *M Series User Manual* for information about the use of these signals.

Figure 2-4 shows how AO 0, AO 1, APFI 0, and PFI 0 signals are routed to the DAQ device.

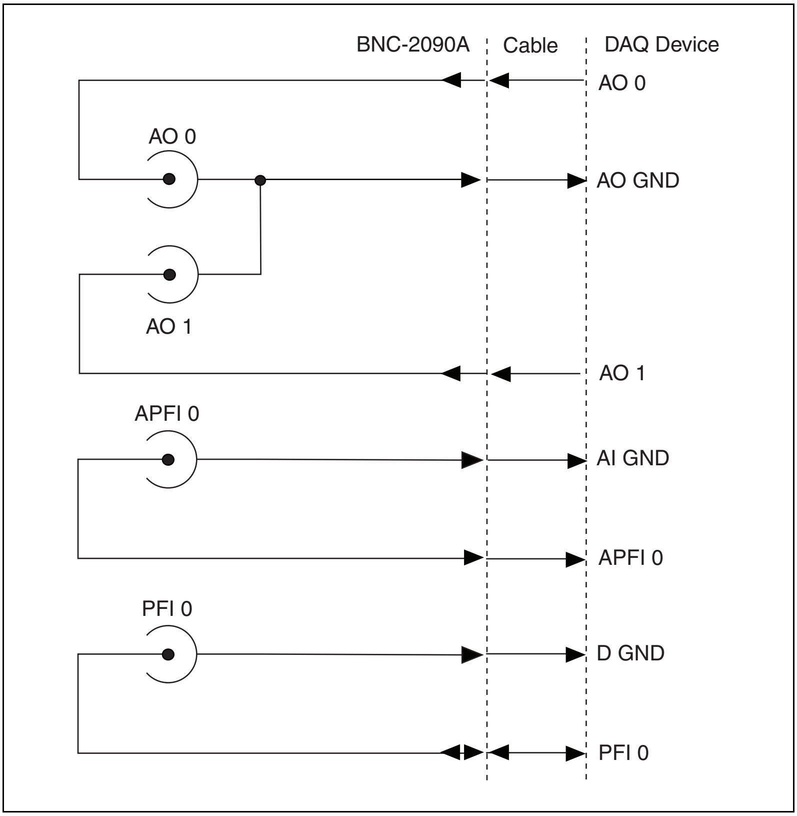


Figure 2-4. Analog Output, APFI 0, and PFI 0

Refer to Chapter 3, *Signal Conditioning*, for information about building additional signal-conditioning circuitry.

Connecting Digital Signals

Use the BNC-2090A spring terminal block on the front panel to connect digital signals to your DAQ device. Refer to the *E Series User Manual* or the *M Series User Manual* for information about the use of these signals.

When connecting signals to the spring terminal blocks, you can use up to 20 AWG wire with the insulation stripped to 0.5 in.

Using the USER 1 and USER 2 BNC Connectors

The USER 1 and USER 2 BNC connectors allow you to use a BNC connector for a digital or timing I/O signal of your choice. The USER 1 and USER 2 BNC connectors are routed (internal to the BNC-2090A) to the USER1 and USER2 spring terminals, as shown in Figure 2-5.

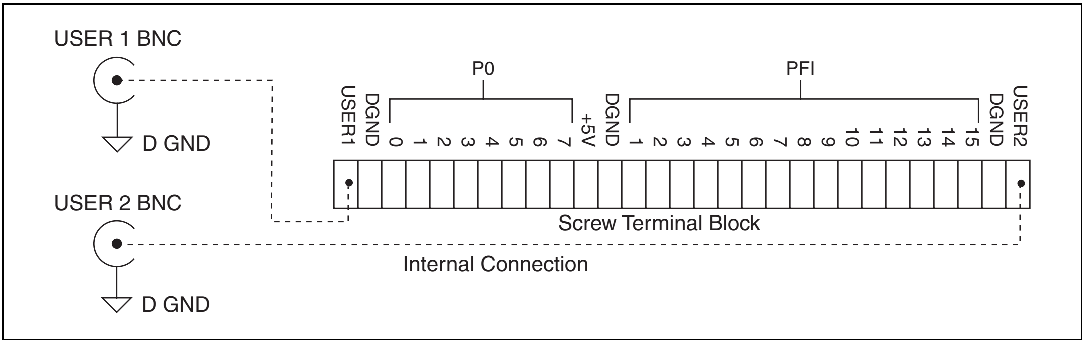


Figure 2-5. USER <1..2> BNC Connections

Figure 2-6 shows an example of how to use the USER <1..2> BNCs. To access the PFI 5 signal from a BNC, connect USER1 on the spring terminal block to PFI 5 with a wire.

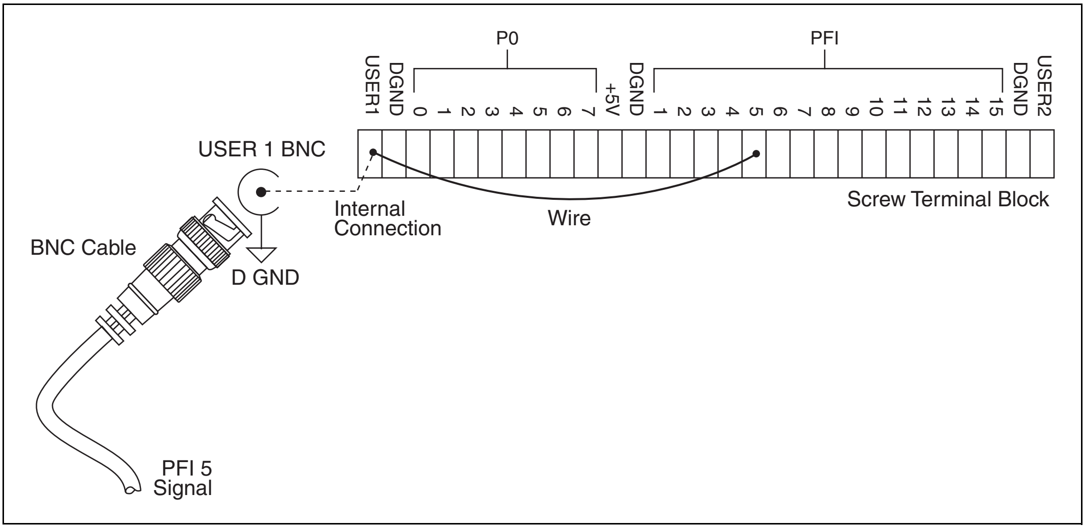


Figure 2-6. Connecting PFI 5 to USER 1 BNC

3

Signal Conditioning

This chapter contains information about adding signal conditioning components to the BNC-2090A and signal conditioning examples for using the BNC-2090A with your DAQ device.

Analog Input Signal Conditioning

Each analog input signal has several open positions for passive signal conditioning components. The factory-default positions for the 0 Ω jumpers are the C and D positions of the input network, as shown in Figure 3-1. You can remove these 0 Ω jumpers to build analog input signal conditioning circuits. You can also add passive analog input signal conditioning, such as filters and dividers.

Figure 3-1 shows the onboard components for differential mode.

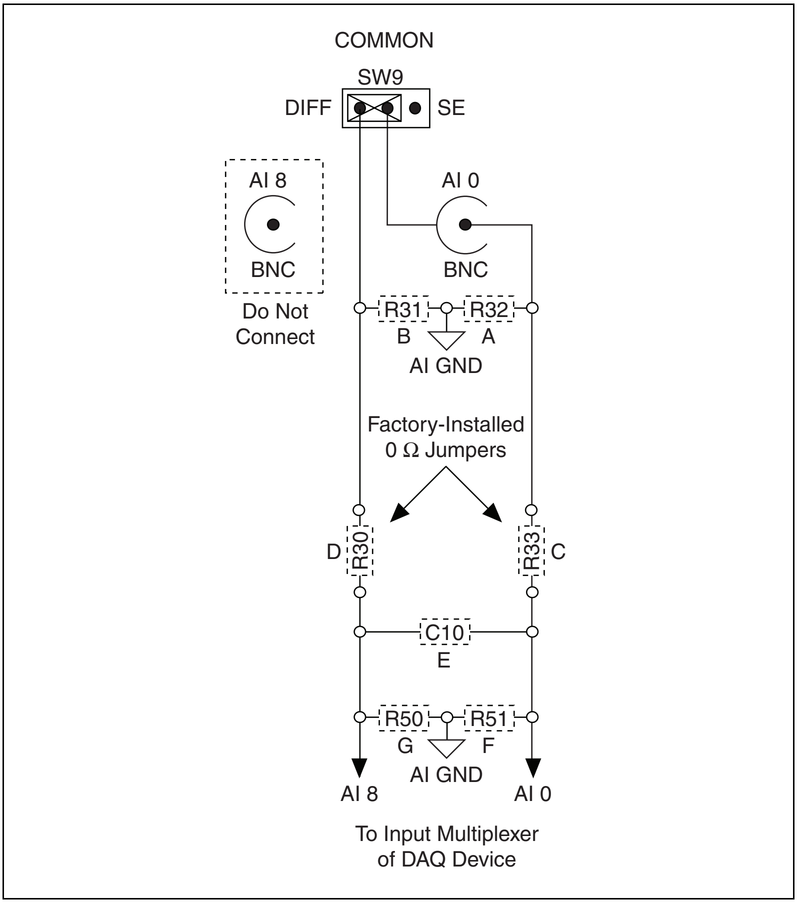


Figure 3-1. Channel 0 Differential Mode Onboard Components

Figure 3-2 shows the onboard components for single-ended mode.

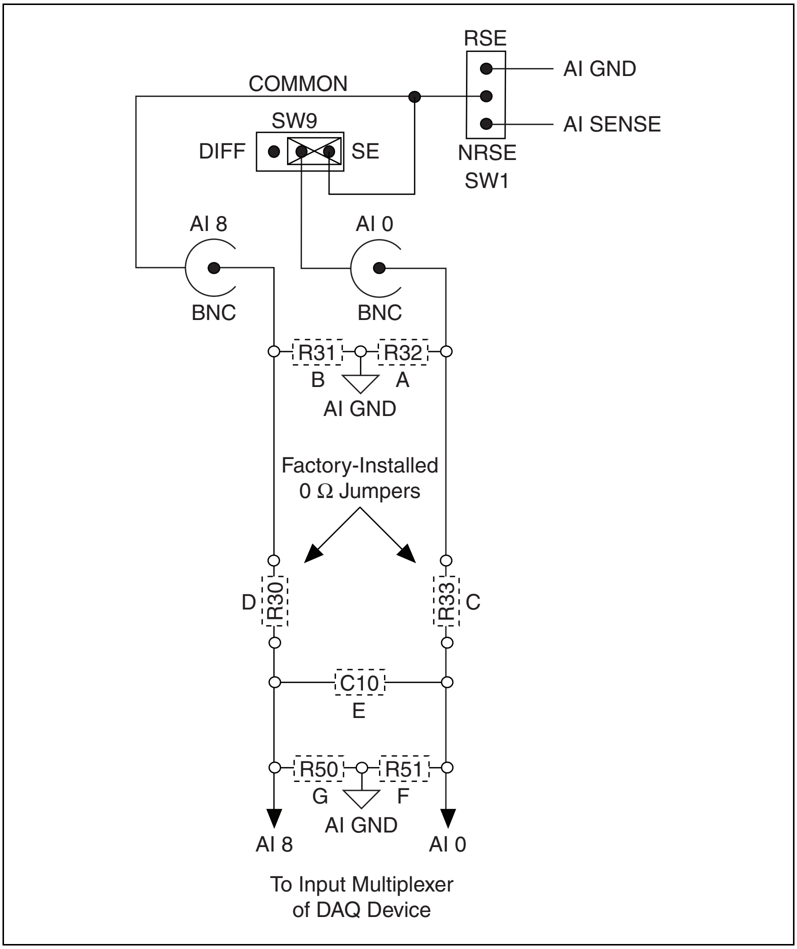


Figure 3-2. Channel 0 and Channel 8 Single-Ended Mode Onboard Components

Table 3-1 lists the different component positions for each channel.

Table 3-1. Channel Component Positions

Channel		Position in Figures 3-1 and 3-2						
Differential	**Single-Ended**	**A**	**B**	**C***	**D***	**E**	**F**	**G**
0	0, 8	R32	R31	R33	R30	C10	R51	R50
1	1, 9	R28	R27	R29	R26	C9	R49	R48
2	2, 10	R24	R23	R25	R22	C8	R47	R46
3	3, 11	R20	R19	R21	R18	C7	R45	R44
4	4, 12	R16	R15	R17	R14	C6	R43	R42
5	5, 13	R12	R11	R13	R10	C5	R41	R40
6	6, 14	R8	R7	R9	R6	C4	R39	R38
7	7, 15	R4	R3	R5	R2	C3	R37	R36

* Factory-installed 0 Ω jumpers.

Table 3-2 lists population options for passive signal conditioning components.

Table 3-2. Signal Conditioning Component Population Options

Configuration		Normal	Attenuator	Lowpass Filter	Highpass Filter	AC Couple	Termination
Single-Ended	A	Open	Open	Open	Open	Open	Resistor
	B	Open	Open	Open	Open	Open	Resistor
	C*	0 Ω Jumper	Resistor	Resistor	Capacitor	Capacitor	0 Ω Jumper
	D*	0 Ω Jumper	Resistor	Resistor	Capacitor	Capacitor	0 Ω Jumper
	E	Open	Open	Open	Open	Open	Open
	F	Open	Resistor	Capacitor	Resistor	Open	Open
	G	Open	Resistor	Capacitor	Resistor	Open	Open
Differential	A	Open	Open	Open	Open	Open	Resistor
	B	Open	Open	Open	Open	Open	Resistor
	C*	0 Ω Jumper	Resistor	Resistor	Capacitor	Capacitor	0 Ω Jumper
	D*	0 Ω Jumper	Resistor	Resistor	Capacitor	Capacitor	0 Ω Jumper
	E	Open	Resistor	Capacitor	Resistor	Open	Open
	F	Open	Open	Open	Open	Open	Open
	G	Open	Open	Open	Open	Open	Open

* Factory-installed 0 Ω resistor.

Building Lowpass Filters

You can install simple, RC lowpass filters on any input channel of the BNC-2090A. The filters are useful for accurate measurement and noise rejection. By substituting resistance and capacitance values into Equation 3-1, you can calculate a simple, one-pole RC filter to have a –3 dB cutoff frequency (f_c):

$$f_c = \frac{1}{(2\pi RC)} \tag{3-1}$$

The frequency response rolls off at a rate of –20 dB per decade of increase thereafter. Figure 3-3 shows a Bode plot of the amplitude versus normalized frequency.

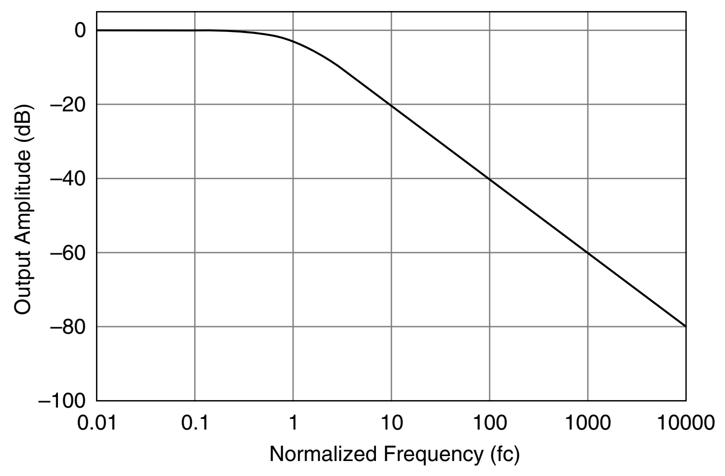


Figure 3-3. Normalized Frequency Response of Lowpass Filter

Example

When measuring low-frequency signals (about 4 Hz), if you have 400 Hz noise on your input signals, you can add a lowpass filter with a cutoff frequency of 4 Hz. The 400 Hz noise then attenuates by 40 dB. Notice that your 4 Hz signal also attenuates, by 3 dB. Do not neglect any potential attenuation of signals of interest by this low-order filter.

You must also choose the filter component values. You can select the resistance or the capacitance arbitrarily; one value determines the other. Picking the capacitor first and letting its value determine the resistance required is preferable because more standard resistor values are available. If a capacitance of 1µF is available, the resistance is (by substitution into Equation 3-1) about 39.8 kΩ. This resistance must be split evenly between each input of a differential channel. Therefore, in this example, each input channel has a 19.89 kΩ resistor (or the closest standard value) in its series positions, C and D. NI recommends using 1% or better tolerance resistors in this application because differences between the resistor values degrade the common-mode rejection ratio (CMRR).

Figure 3-4 shows both the schematic and the component placement for a 4 Hz lowpass filter placed on differential input channel 1. If the input signal source is floating, you must place a bias return resistor in positions A and/or B (R28 and R27, respectively).

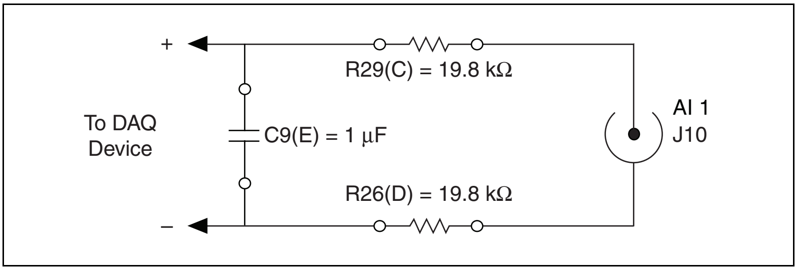


Figure 3-4. Lowpass Filter on Differential Channel 1

Figure 3-5 shows both the schematic and the component placement for a 4 Hz lowpass filter placed on single-ended input channel 1. Refer to the *Installing Bias Resistors* section for information about installing bias resistors.

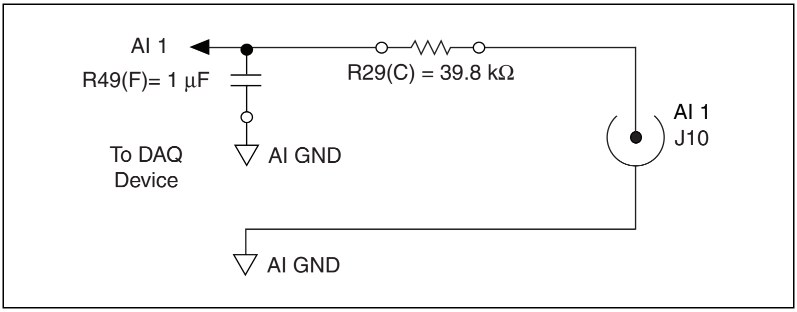


Figure 3-5. Lowpass Filter on Single-Ended Channel 1

Building Highpass Filters

You can install simple, RC highpass filters on any input channel of the BNC-2090A. The filters are useful for accurate high-frequency measurement and low-frequency noise rejection. By substituting resistance and capacitance values into Equation 3-1, you can calculate a simple, one-pole RC filter to have a –3 dB cutoff frequency, f_c. The frequency response rolls off at a rate of –20 dB per decade decrease thereafter. Figure 3-6 shows a Bode plot of the amplitude versus normalized frequency.

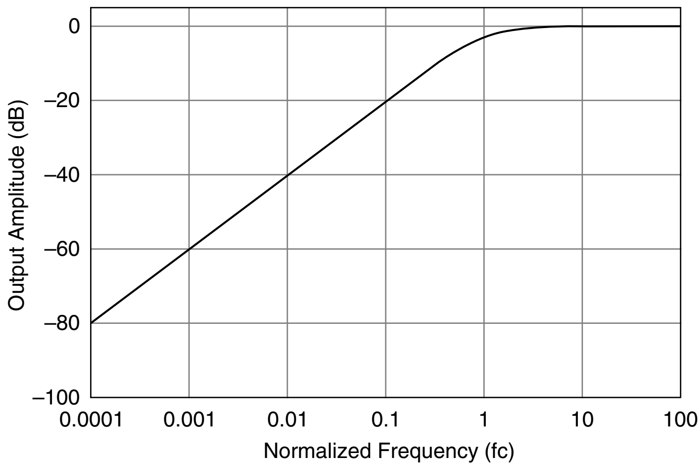


Figure 3-6. Normalized Frequency Response of Highpass Filter

Example

When measuring high-frequency signals (about 50 kHz), if you have 50 Hz noise on your input signals, you can add a highpass filter with a cutoff frequency of 50 kHz. The 50 Hz noise then attenuates by 60 dB. Notice that your 50 kHz signal also attenuates, by 3 dB. Do not neglect any potential attenuation of signals of interest if you add a low-order filter.

You must also choose the filter component values. You can select the resistance or the capacitance arbitrarily; one value determines the other. Picking the capacitor first and letting its value determine the resistance required is preferable because more standard resistor values are available. The filter circuit has one series capacitor on each input signal of the differential channel. Because the two capacitors are in series, the capacitance value that must be substituted into Equation 3-1 is the series capacitance of the two capacitors. For two capacitors in series, the net capacitance is the reciprocal of the sum of the reciprocals of the two capacitances. For example, two 0.001 μF capacitors in series have a net capacitance of 0.0005 μF. The two capacitors should be the same value, or the CMRR is degraded. If capacitors of 0.001 μF are available, the resistance is (by substitution into Equation 3-1) about 6.4 kΩ. Therefore, in this example, the input channel has a 6.34 kΩ resistor (or the closest standard value) in position E.

Note Highpass filters generally exhibit poorer common-mode rejection characteristics than lowpass filters because capacitors are in the series input paths. Capacitors have poorer tolerances than resistors, and matching the input impedances is crucial for good common-mode rejection.

Figure 3-7 shows both the schematic and the component placement for a 50 kHz highpass filter placed on differential input channel 1. If the input signal source is floating, you must place a bias return resistor in positions A and/or B position (R28 and R27, respectively). Refer to the *Installing Bias Resistors* section for information about installing bias resistors.

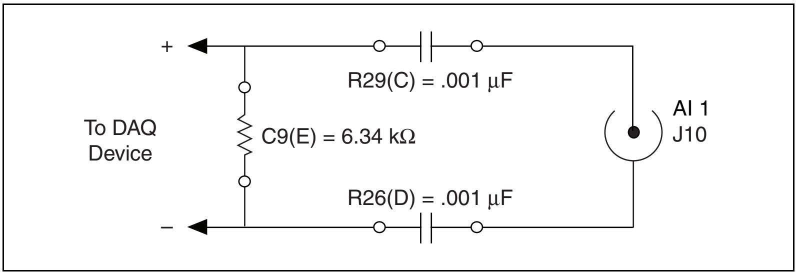


Figure 3-7. Highpass Filter on Differential Channel 1

Figure 3-8 shows both the schematic and the component placement for a 50 kHz highpass filter placed on single-ended input channel 1. Refer to the *Installing Bias Resistors* section for information about installing bias resistors.

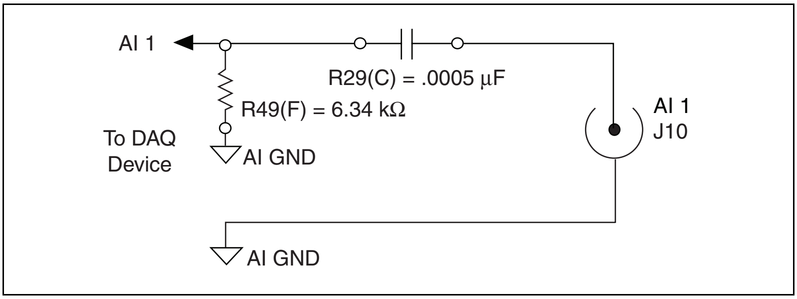


Figure 3-8. Highpass Filter on Single-Ended Channel 1

Building Attenuators (Voltage Dividers)

Attenuators or voltage dividers allow voltage measurements larger than the maximum input range of DAQ devices. For example, voltage signals in the ±20 V range can be measured by building a 2:1 voltage divider circuit.

You can connect attenuators to the analog inputs of the BNC-2090A when the inputs from its DAQ device are in differential or single-ended mode.

Caution Do *not* connect input voltages greater than 42.4 V_{pk}/60 VDC to the BNC-2090A. The BNC-2090A is not designed for any input voltages greater than 42.4 V_{pk}/60 VDC, even if a user-installed voltage divider reduces the voltage to within the input range of the DAQ device. Input voltages greater than 42.4 V_{pk}/60 VDC can damage the BNC-2090A, all devices connected to it, and the host computer. Overvoltage can also cause an electric shock hazard for the operator. National Instruments is *not* liable for damage or injury resulting from such misuse.

The gain in differential mode, G_{DIFF}, of this attenuator is given by the Equation 3-2.

$$G_{DIFF} = \frac{R_E}{(R_C + R_D + R_E)} \tag{3-2}$$

The gain in single-ended mode, G_{SE}, of this attenuator is given by the Equation 3-3.

$$G_{SE} = \frac{R_F}{R_C + R_F} \tag{3-3}$$

Therefore, the input to the DAQ device (V_{MIO}) for Equation 3-2 or 3-3 is as follows:

$$V_{MIO} = V_{in} \cdot G \tag{3-4}$$

where V_{in} is the voltage applied to the BNC connectors of the BNC-2090A. The accuracy of this gain equation depends on the tolerances of the resistors used.

Figure 3-9 shows a resistor circuit for attenuating voltages at the differential inputs of the BNC-2090A. It also shows the placement of the resistors on the open-component positions for channel 1.

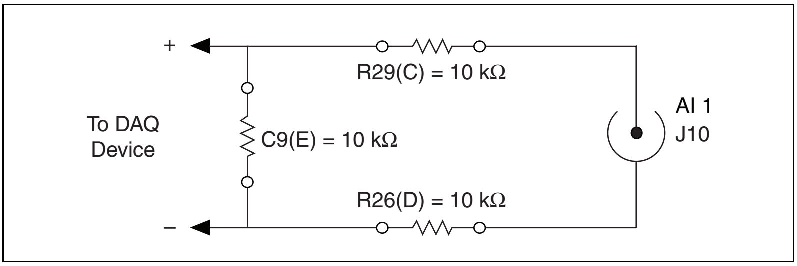


Figure 3-9. Attenuator for Use with Differential Inputs

Figure 3-10 shows a resistor circuit for attenuating voltages at the single-ended inputs of the BNC-2090A. It also shows the placement of the resistors on the open-component positions for channel 1.

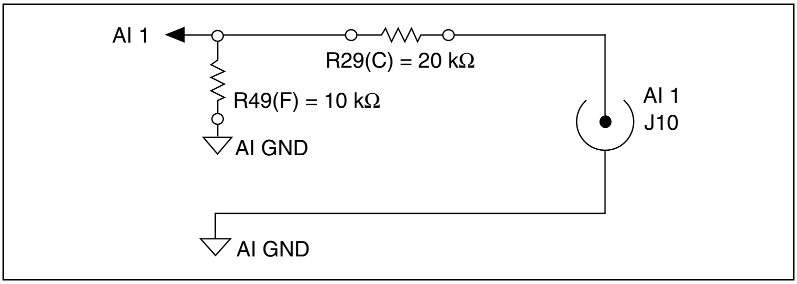


Figure 3-10. Attenuator for Use with Single-Ended Inputs

Using the values in Figure 3-9,

$$G_{DIFF} = \frac{10\ \text{k}\Omega}{10\ \text{k}\Omega + 10\ \text{k}\Omega + 10\ \text{k}\Omega} = \frac{1}{3} \quad (3\text{-}5)$$

or Figure 3-10,

$$G_{SE} = \frac{10\ \text{k}\Omega}{20\ \text{k}\Omega + 10\ \text{k}\Omega} = \frac{1}{3} \quad (3\text{-}6)$$

Therefore in either case,

$$V_{MIO} = V_{in} \cdot \frac{1}{3} \quad (3\text{-}7)$$

When the DAQ device is configured for ±10 V input signals, the device can acquire ±30 V signals with this attenuator circuit.

Notice that the input impedance for the channels employing voltage dividers circuit is reduced. In the differential example in Figure 3-9, the input impedance has been reduced to:

$$10\ k\Omega + 10\ k\Omega + 10\ k\Omega = 30\ k\Omega$$

The reduced input impedance can cause loading errors for signal sources with large source impedance. In general, the input impedance presented by the voltage divider circuit must be much larger than the source impedance of the signal source to avoid signal loading errors.

Analog Output Signal Conditioning

Each analog output has two open-component positions for passive signal conditioning components. One is designated as a resistor and one is designated as a capacitor. Factory-default positions for the 0 Ω jumpers are R34 and R1 as shown in Figure 3-11.

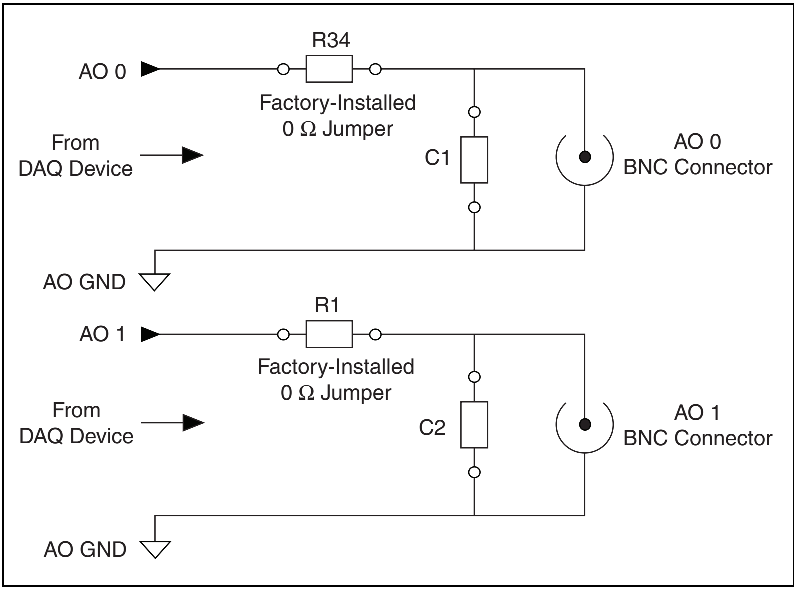


Figure 3-11. AO 0 and AO 1

You can remove and/or install components in these locations to build highpass and lowpass filters. Refer to the *Adding Signal Conditioning Components* section for instructions.

Note Channels that use these filters have greater output impedance. This can result in loading errors if the connected load impedance is not much higher than the filter's output impedance.

Building Lowpass Filters

Building lowpass filters for the analog output signals is the same as for the analog inputs. Refer to the *Analog Input Signal Conditioning* section for more detailed information about lowpass filters and how to calculate values for lowpass filters. Refer to Figure 3-14 for component locations. Figure 3-12 shows a 4 Hz lowpass filter for AO 0.

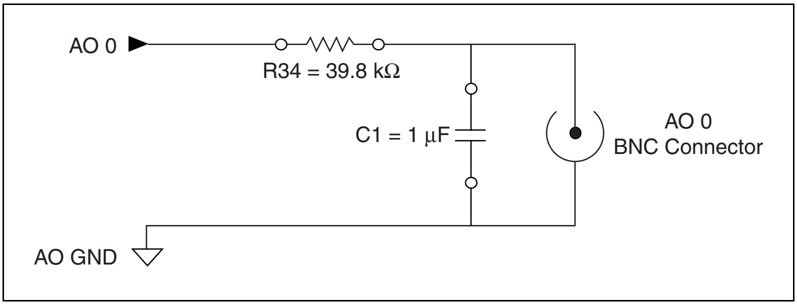


Figure 3-12. Lowpass Filter on AO 0

Building Highpass Filters

Building highpass filters for analog output is the same as for analog input. Refer to the *Analog Input Signal Conditioning* section for more detailed information about highpass filters and how to calculate values for them. Refer to Figure 3-14 for component locations. Figure 3-13 shows a 50 kHz highpass filter for AO 0.

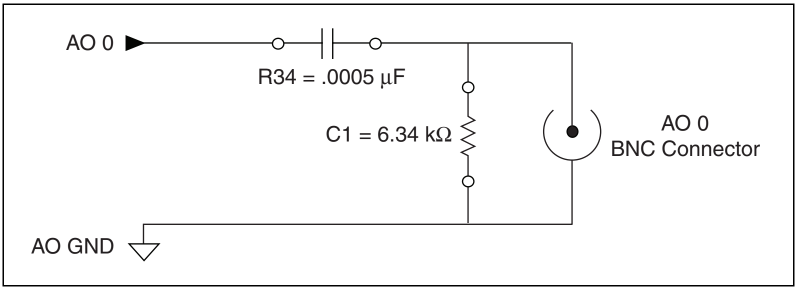


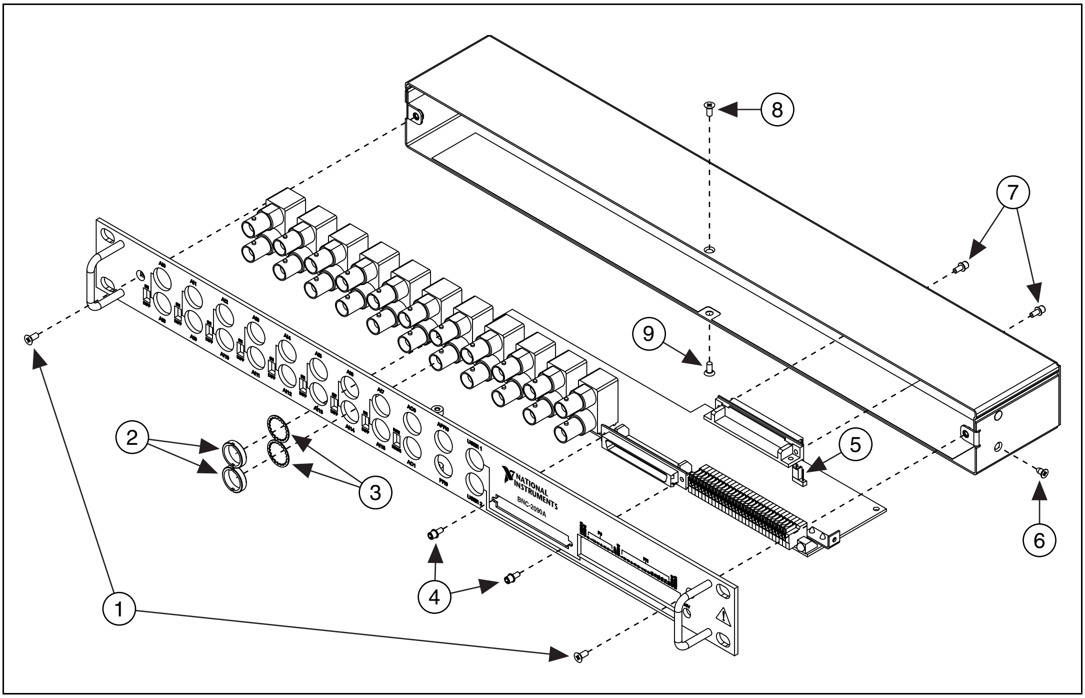
Figure 3-13. Highpass Filter on AO 0

Adding Signal Conditioning Components

The BNC-2090A has open-component positions in the input paths into which you can insert resistors and capacitors for conditioning the 16 single-ended or eight differential analog input signals and the two analog output signals. You can also use the BNC-2090A in conjunction with other signal conditioning accessories.

Figures 3-1 through 3-13 give examples using a specific channel. If you want to install the circuit in a different channel, consult Table 3-1 to determine the equivalent component positions for the other channels.

Complete the following steps to add signal conditioning components to the BNC-2090A, as shown in Figure 3-14.



1	Front Panel Screws	4	Front Connector Screws	7	Rear Panel Screws
2	Front Panel Nuts	5	Shield Ground Jumper (W1)	8	Top Screw
3	Front Panel Washers	6	Side Panel Screw	9	Bottom Screw

Figure 3-14. Disassembly of the BNC-2090A

1. Remove the two rear panel screws, the side panel screw, the top screw, and the bottom screw.

2. Remove the two front panel screws.
3. Hold the front panel and slide the unit out of the metal case.
4. Install and/or remove components as necessary. Refer to the *Soldering and Desoldering on the BNC-2090A* section for more information.
5. Reassemble the BNC-2090A in reverse order.

Soldering and Desoldering on the BNC-2090A

Caution Use a low-wattage (20 to 30 W) soldering iron when soldering to the device. You should use only rosin-core, electronic-grade solder. Acid-core solder damages the printed circuit device and components. Use vacuum-type tools when desoldering on the BNC-2090A to avoid damaging component pads.

Some applications require you to modify the PWB, usually by removing 0 Ω jumpers and adding components. The BNC-2090A is shipped with 0 Ω jumpers in the C and D positions, as listed in Table 3-1 and shown in Figure 3-1.

Note This product is RoHS-compliant. If you require that the product remain RoHS-compliant, ensure that you use RoHS-compliant solder and components. Visit `ni.com/rohs` for more information.

Installing Bias Resistors

You can install bias resistors in positions A and B on the BNC-2090A, as listed in Table 3-1 and shown in Figure 3-1. Refer to the steps in the *Adding Signal Conditioning Components* section for instructions about accessing the resistors on the BNC-2090A.

Figure 3-15 shows both the schematic and the component placement for a single 100 kΩ bias return resistor on the negative input from a floating source connected to channel 1, the B position in Table 3-1. Refer to the *Analog Input Signal Conditioning* section for information about building additional signal conditioning circuitry, such as filters and attenuators, in the open component positions.

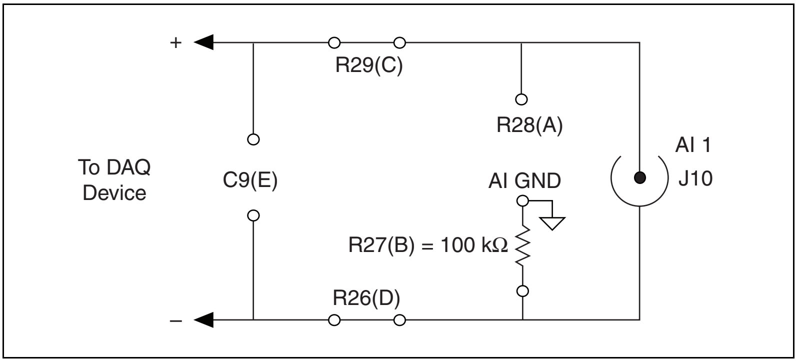


Figure 3-15. Bias Return Resistor for DC-Coupled Floating Source on Channel 1 in DIFF Mode

Figure 3-16 shows both the schematic and the component placement for an optional user-installed bias resistor, R35, between AI SENSE and AI GND.

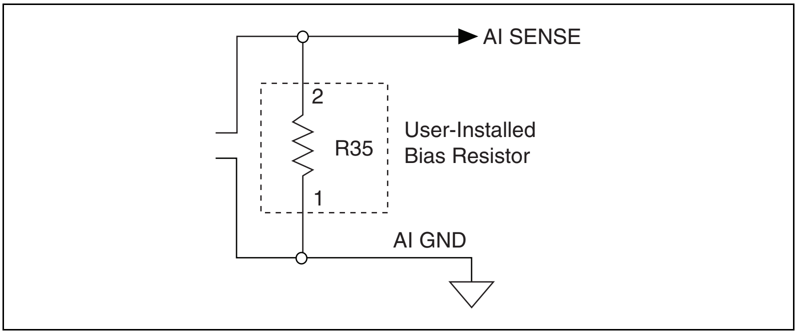


Figure 3-16. User-Installed Bias Resistor between AI SENSE and AI GND

A Specifications

This appendix lists the specifications of the BNC-2090A. These specifications are typical at 25 °C unless otherwise specified.

Analog Input

Channels .... 8 differential (default), 16 single-ended

Field connections .... 16 BNC connectors

Signal conditioning .... 7 component positions per differential channel

Analog Output

Channels .... 2 single-ended

Field connections .... 2 BNC connectors for AO, 1 BNC connector for APFI 0 input

Signal conditioning .... 2 component positions per output channel

Digital Input and Output

Channels .... 8 digital I/O, 16 PFI

Field connections .... 1 BNC connector for PFI 0.
2 BNC connectors for user-defined,
spring terminals for all other digital I/O and PFI

Signal conditioning .... 2 component positions per output channel

Power Requirement

+5 VDC (±5%) provided by DAQ device

Typical power consumed by BNC-2090A ....10 mA

Maximum power available at +5 V spring terminal....................1 A (fuse-limited by host DAQ device)

Physical

Dimensions ....$4.39 \times 48.26 \times 9.7$ cm ($1.73 \times 19 \times 3.82$ in.)

Weight ....700 g (24.69 oz)

I/O connector ....Two 68-position male connectors

BNC connectors......................................22

Spring terminal block ....29 positions

Environment

The BNC-2090A is intended for indoor use only.

Operating temperature ....0 to 70 °C

Storage temperature................................–55 to 125 °C

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

Pollution Degree (indoor use only) 2

Maximum Altitude ....2,000 m

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 61010-1, CSA 61010-1

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

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; Minimum 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 according to product documentation.

CE Compliance

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

- 73/23/EEC; Low-Voltage Directive (safety)
- 89/336/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.

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`.

B

Frequently Asked Questions

How does the BNC-2090A differ from the BNC-2090?

The BNC-2090A is based on the BNC-2090. The main differences between these two accessories are listed in Table B-1.

Table B-1. BNC-2090A and BNC-2090 Comparison

BNC-2090A	BNC-2090
Can be used with E/M Series devices	Can be used with E/M Series and PC-LPM-16 devices
NI-DAQmx naming conventions on front panel	Traditional NI-DAQ (Legacy) naming conventions on front panel
Extra spring terminal to access PFI 15	N/A
User-installed signal conditioning components are easy to access	N/A
More signal conditioning component options	N/A
Attenuators (voltage dividers) can be used with the DAQ device in both single-ended and differential modes	Attenuators (voltage dividers) can be used with the DAQ device in differential mode only
User-installed AI SENSE bias resistor	N/A
Clear labeling on the PCB for easier signal conditioning component installation	N/A
Easy assembly and disassembly	N/A
Smaller dimensions and weight	N/A
RoHS compliant	N/A

Can I use the SCXI resistor kit to build attenuators for my BNC-2090A?

Yes. You can use the SCXI resistor kit, which consists of four high precision 249 Ω resistors, to build attenuators (voltage dividers) for the BNC-2090A. Refer to the *Building Attenuators (Voltage Dividers)* section of Chapter 3, *Signal Conditioning*, for more information about building attenuators for the BNC-2090A.

Can I configure the BNC-2090A to measure current?

Yes. You can use a pair of channels to route current through the a sense resistor located in position E. Refer to the *Analog Input Signal Conditioning* section of Chapter 3, *Signal Conditioning*, for the exact location of this component.

Caution When adding custom signal conditioning, do *not* exceed the components' power dissipation ratings. Limit current into the BNC-2090A to ≤100 mA.

Set the SE/DIFF switch to SE mode and the RSE/NRSE switch to RSE. This connects the BNC shields to AI GND. Configure the DAQ device for a differential measurement across the sense resistor.

Can I attach 68-pin DAQ cables to the front and back of the BNC-2090A to make it a pass-through?

Yes.

C

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at `ni.com` for technical support and professional services:

- **Support**—Online technical support resources at `ni.com/support` include the following:
  - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
  - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Discussion Forums at `ni.com/forums`. National Instruments Application Engineers make sure every question receives an answer.

    For information about other technical support options in your area, visit `ni.com/services` or contact your local office at `ni.com/contact`.
- **Training and Certification**—Visit `ni.com/training` for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit `ni.com/alliance`.
- **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/certification`.

- **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.

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