BNC-2090 User Manual

Rack-Mount BNC Accessory

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Table of Contents

About This Manual

Chapter 1
Introduction

Chapter 2
Configuration, Installation, and Signal Connection

Chapter 3
Signal Conditioning Application Examples

Appendix A
Specifications

Appendix B
Using the PC-LPM-16

Appendix C
Customer Communication

Glossary

Index

Figures

Tables

About This Manual

The *BNC-2090 User Manual* describes the features, functions, and operation of the BNC-2090 accessory. The BNC-2090 is a rack-mount analog breakout accessory with BNC-style connectors and spring-type terminal blocks. This accessory connects to the National Instruments MIO and PC-LPM-16 data acquisition (DAQ) boards for the IBM PC/XT/AT and compatible computers, Macintosh NuBus and compatible computers, PCI compatible computers, Sun SPARCstation SBus computers, and NEC PC-9800 Series computers.

Organization of This Manual

The *BNC-2090 User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the BNC-2090 accessory, lists what you need to get started, and describes the optional equipment.
- Chapter 2, *Configuration, Installation, and Signal Connection*, explains how to configure the switches and jumper on the BNC-2090, install the BNC-2090, and connect signals to the accessory.
- Chapter 3, *Signal Conditioning Application Examples*, contains instructions for adding signal conditioning components to your BNC-2090 and contains signal conditioning examples for the BNC-2090 in use with the MIO boards.
- Appendix A, *Specifications*, lists the specifications for the BNC-2090.
- Appendix B, *Using the PC-LPM-16*, contains information on using the PC-LPM-16 with the BNC-2090.
- Appendix C, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.
- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.
- The *Index* contains an alphabetical list of key terms and topics in this manual, including the page where you can find each one.

Conventions Used in This Manual

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, ACH<0..7> stands for ACH0 through ACH7).
bold	Bold text denotes menus, menu items, or dialog box buttons or options.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
bold italic	Bold italic text denotes a note, caution, or warning.
DAQ	Refers to the National Instruments data acquisition products.
MIO	Refers to the National Instruments 100-pin, 68-pin, and 50-pin MIO Series boards.
SC-205*X*	Refers to the National Instruments SC-2050, SC-2051, SC-2052, SC-2053, SC-2054, SC-2055, and SC-2056 boards.
SC-206*X*	Refers to the National Instruments SC-2060, SC-2061, and SC-2062 boards.
SC-207*X*	Refers to the National Instruments SC-2070, SC-2071, and SC-2072 boards.

Abbreviations, acronyms, metric prefixes, mnemonics, symbols, and terms are listed in the *Glossary*.

Related Documentation

The following documents contain information that you may find helpful as you read this manual:

- Your MIO or PC-LPM-16 board user manual
- *SC-205X Series User Manual*
- *SC-206X Series User Manual*
- *SC-207X Series User Manual*

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix C, *Customer Communication*, at the end of this manual.

Chapter 1

Introduction

This chapter describes the BNC-2090 accessory, lists what you need to get started, and describes the optional equipment.

About the BNC-2090

The BNC-2090 accessory is a rack-mount analog breakout accessory with signal-labeled BNC connectors, spring terminal blocks, and analog signal conditioning areas. The BNC-2090 accessory simplifies the connection of analog signals and digital signals to the DAQ board for use in laboratory, test, and production environments. You can configure the BNC-2090 to use eight differential or 16 single-ended analog input channels available on the accessory. The BNC-2090 has silkscreened component locations for resistors and capacitors for building single-pole highpass and lowpass filters and voltage dividers.

You can use the BNC-2090 with a 50, 68, or 100-pin MIO DAQ board or a 50-pin PC-LPM-16 DAQ board. Refer to Appendix B, *Using the PC-LPM-16*, for information on using the PC-LPM-16 with the BNC-2090.

What You Need to Get Started

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

❑ BNC-2090 accessory

❑ *BNC-2090 User Manual*

❑ One of the following DAQ boards and the appropriate cable

50-pin MIO board (requires SH6850 or R6850 cable)

68-pin MIO board (requires SH6868 or R6868 cable)

100-pin MIO board (requires SH1006868 cable)

PC-LPM-16 DAQ board (requires SH6850 or R6850 cable)

- ❑ Screwdrivers (Phillips and flathead)
- ❑ Four adhesive rubber feet (optional)

Detailed specifications for the BNC-2090 are in Appendix A, *Specifications*.

Optional Equipment

You can also use the following National Instruments products with your BNC-2090, including cables, connector blocks, and other accessories:

- SSR Series 8-channel backplane (with 0.4 m cable for the SC-205X Series boards)
- SC-2050, SC-2051, or SC-2055 board (with 0.5 or 1.0 m 50-pin cable)
- SC-2056 board (without cable)
- SC-2060, SC-2061, or SC-2062 (with 0.2 or 0.4 m 50-pin cable)
- SC-2070, SC-2072, or SC-2072D (with 0.5 or 1.0 m 50-pin cable)

Configuration, Installation, and Signal Connection

Chapter 2

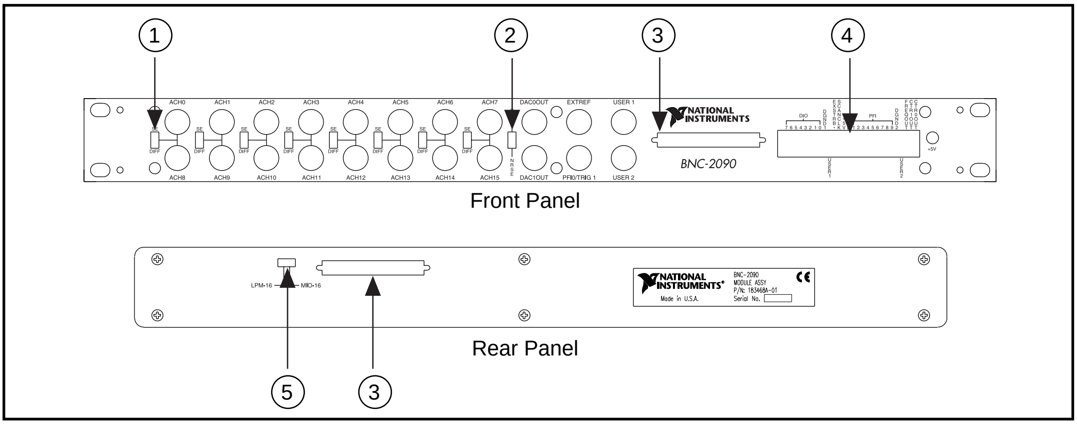
This chapter explains how to configure the switches and jumper on the BNC-2090, install the BNC-2090, and connect signals to the accessory.

Configuring Your BNC-2090

Your BNC-2090 is factory-configured. However, you must reconfigure your accessory if you want to do any of the following:

- Use your BNC-2090 with a MIO board configured for RSE or NRSE mode
- Connect the BNC-2090 shield directly to digital ground (DGND)
- Use a PC-LPM-16 as the BNC-2090 power source
- Condition your signals (Refer to Chapter 3, *Signal Conditioning Application Examples*)

Figure 2-1 shows the front and back panels of the BNC-2090.



1	SW1	2	SW9	3	68-Position Connector
4	Spring Terminal Blocks	5	Power Switch		

Figure 2-1. BNC-2090 Rack-Mount Breakout Accessory

Mode Configuration

The BNC-2090 is factory-configured for use with the MIO board in the DIFF mode. Therefore, you must configure the BNC-2090 if you want to use the accessory with the MIO board in either RSE or NRSE mode. The BNC-2090 has nine front panel switches, shown in Figure 2-1, that configure the accessory for differential (DIFF), referenced single-ended (RSE), or nonreferenced single-ended (NRSE) mode.

If you want to measure floating signal sources, configure the MIO board for DIFF or NRSE mode, both of which require bias resistors, or for RSE mode. Refer to Chapter 3, *Signal Conditioning Application Examples*, for information on installing bias resistors.

If you want to measure ground-referenced signal sources, configure the MIO board for the NRSE mode or DIFF mode. Both types of signal sources are discussed in the following sections.

If you configure the MIO board in the RSE mode, all 16 analog input channels are referenced to AIGND. For more information on the input configurations, see your MIO board user manual.

DIFF Input Mode

The BNC-2090 is factory-configured for DIFF mode so that all eight switches (SW1–SW8) are in the DIFF position. In DIFF mode, the first eight analog BNC connectors (ACH<0..7>) are used and the remaining eight analog BNC connectors (ACH<8..15>) are not used. (BNC-2090 switch SW9 position is irrelevant in this mode.) Make sure that your MIO board is configured for DIFF input mode.

Note: ***All of the switches are required to be in the same position; that is, S1 through S8 must all be in either the DIFF position or in the SE position.***

RSE and NRSE Input Mode

First, configure the MIO board for RSE or NRSE input mode. Next, configure the BNC-2090 for SE mode by flipping all eight switches (SW1–SW8) next to each pair of BNC connectors to SE to have 16 single-ended channels. In this mode, all 16 BNC connectors are in use and all 16 BNC shields are tied to a common signal. You can switch the common signal between AIGND and AISENSE through switch SW9. AISENSE is tied to a common signal for NRSE mode configuration and AIGND is tied to a common signal for RSE mode configuration.

Figure 2-2 shows the BNC-2090 front panel switches configured for DIFF, RSE, and NRSE modes.

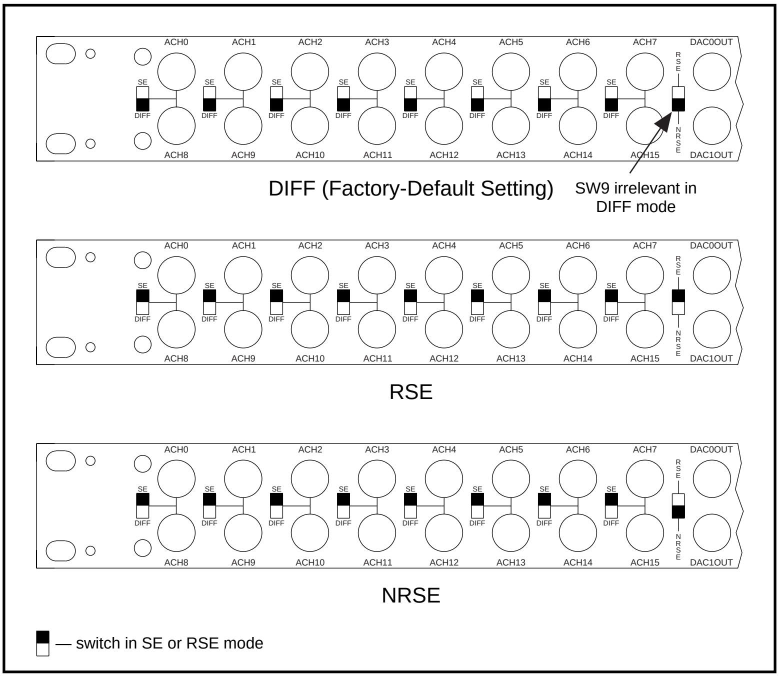


Figure 2-2. BNC-2090 Front-Panel Switch Configurations

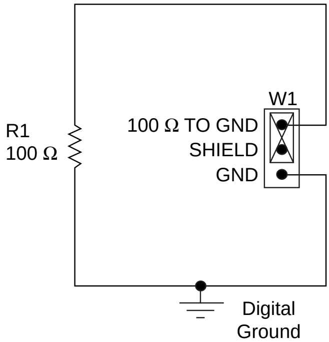
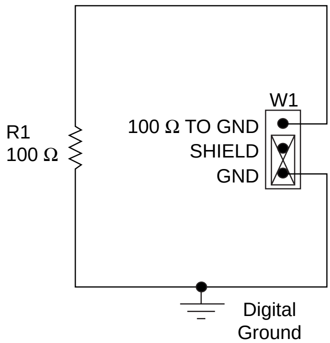
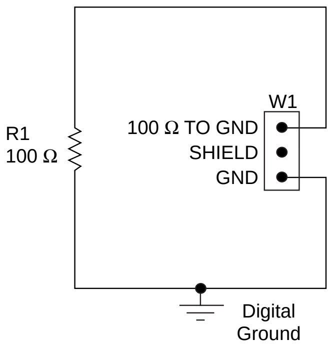
Power Selection Switch

The BNC-2090 has a power switch on the rear panel, shown in Figure 2-1. If you use an MIO DAQ board, slide this switch to the MIO position. If you use a PC-LPM-16 DAQ board, slide this switch to the LPM-16 position.

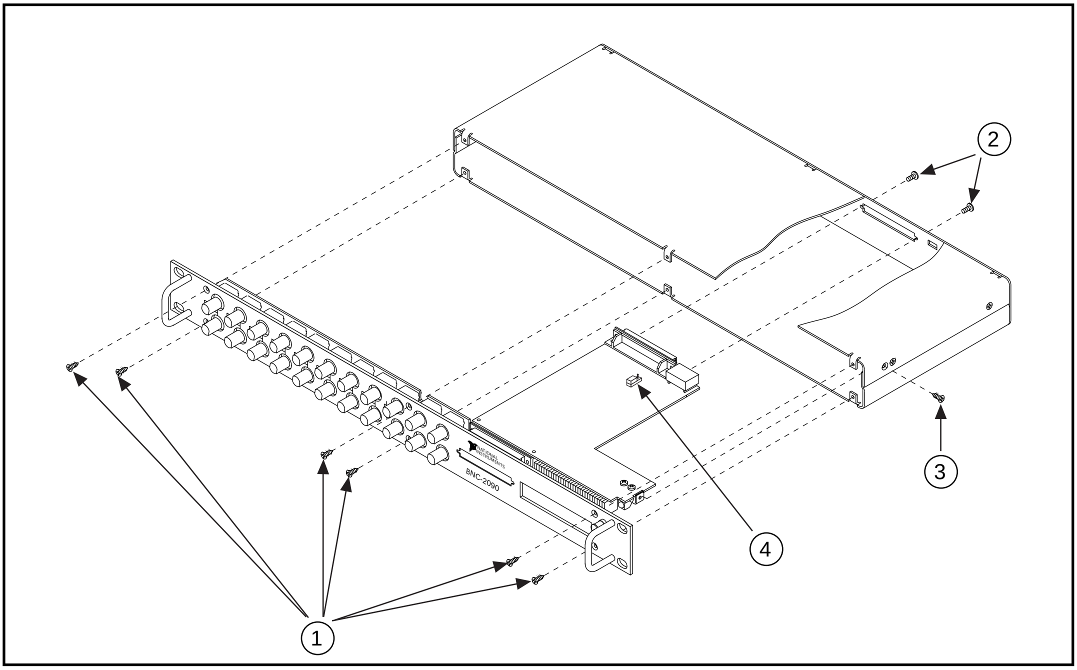
Shield Ground Jumper

Jumper W1, located inside the BNC-2090 near the power switch, connects the shield of the 68-position connectors and BNC-2090 metal case *through* a 100 Ω resistor to DGND or *directly* to DGND. Table 2-1 shows your configuration options.

Table 2-1. Jumper W1 Settings

Configuration	Description
	100 Ω to Ground—Use this setting to reduce any potential ground loop current, thereby improving the system noise performance. (When the BNC-2090 is rack-mounted, it will be connected to a different ground.) This is the factory-default setting.
	GND—Use this setting when the BNC-2090 metal case is neither connected to any other ground via a rack mount nor connected to the MIO ground via a shielded cable such as the SH6868. (Use this setting when you use the R6868, R6850, or SH6850 cable.)
	You can also disconnect the shield from the MIO ground by removing the jumper from W1, which prevents the ground loop current from being carried in the DGND return of the shielded cable. This option is best for rack-mount configurations where the BNC-2090 metal case is already grounded.

To access and reconfigure jumper W1, perform the steps below. Figure 2-3 shows the parts of the BNC-2090 you must remove.



1 Front Panel Screws	2 Rear Panel Screws	3 Side Panel Screw	4 Jumper W1

Figure 2-3. Accessing Jumper W1

1. Remove the six front panel screws.
2. Remove one side panel screw.
3. Remove two rear panel screws.
4. Hold the front panel and slide the unit out of the metal case.
5. Set jumper W1 as needed.
6. Reassemble the BNC-2090 in reverse order.

Signal Conditioning Jumpers

If you want to condition your input signals, you may have to remove the 0 Ω jumpers on the PWB behind the front panel (refer to Figure 3-1). If you do not need signal conditioning, leave these jumpers in their factory-default settings. Refer to Chapter 3, *Signal Conditioning Application Examples*, for more information.

Installing Your BNC-2090

Perform the following steps to connect your BNC-2090 to your DAQ system. Consult your computer user manual or technical reference manual for specific instructions and warnings.

1. Determine what signal conditioning you need for analog inputs and install the necessary components into the open component positions. Refer to *Analog Input*, in Chapter 3, *Signal Conditioning Application Examples*, for more information.
2. Make sure that jumper W1 and switches SW1–SW9 are set correctly for your current application.
3. Select the power source for the BNC-2090 by sliding the power switch, located on the rear panel of the BNC-2090, to select the DAQ board you are using (MIO or PC-LPM-16).
4. (Optional) You can mount the BNC-2090 into a 19 in. rack or place the accessory on a workbench near the host computer. If you do not rack-mount the accessory, you can use the four adhesive rubber feet included in the BNC-2090 kit to keep the accessory stationary on your workbench.
5. Connect the BNC-2090 to the DAQ board. Refer to Table 2-2 to make sure you have the appropriate cable for your pin connector.
6. Connect your field signals to the BNC-2090 at the BNC connectors or spring terminals. Refer to *Connecting Analog Inputs* or *Connecting Digital I/O Signals* for more detailed information.
7. Turn on the computer. If the green power LED, located on the front panel of the BNC-2090 to the right of the spring terminal blocks, does not light when you power on the DAQ board, turn off the power for the BNC-2090 and make sure the power switch is in the correct position for the board you are using.
8. When you have finished using your BNC-2090, be sure you turn off any powered external signals to the BNC-2090 *before* you turn off your computer.

Warning: ***The BNC-2090 is not designed for any input voltages greater than 42 V, even if a user-installed voltage divider reduces the voltage to within the input range of the DAQ board. Input voltages greater than 42 V can damage the BNC-2090, any and all boards 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.

Accessory-to-Board Cabling

The BNC-2090 has two 68-position connectors on the front and rear panels that you can use to connect to your DAQ board. Table 2-2 lists cables that you can use with the BNC-2090.

Table 2-2. BNC-2090 Cabling Options

DAQ Board	Required Cabling
100-pin MIO	SH1006868
68-pin MIO	SH6868 or R6868
50-pin MIO and PC-LPM-16*	SH6850 or R6850

*When you are using the PC-LPM-16 board with the BNC-2090, some signal labels on the BNC-2090 front panel are invalid. Refer to Table B-1 for the valid signals and their function.

Caution: ***Do not connect the BNC-2090 to any board other than a National Instruments MIO or PC-LPM-16 DAQ board, the SC-2070/72 board, or the SC-205X cable adapter board. Doing so can damage the BNC-2090, the DAQ board, or host computer. National Instruments is NOT liable for damages resulting from these connections.***

If you want to condition digital I/O port signals with the National Instruments SC-206*X* Series boards, you must use the SC-205*X* Series cable adapter board with your DAQ board.

If you are using an SC-205*X* Series cable adapter board or an SC-207*X* Series general-purpose termination breadboard with the BNC-2090, refer to your SC-205*X* Series and SC-207*X* user manuals for installation instructions. Then connect the SC-207*X* Series board and the SC-205*X* Series board to the BNC-2090 using the appropriate cable. Figure 2-4 shows the BNC-2090 connected directly to different DAQ systems. Figure 2-5 shows the BNC-2090 connected to DAQ boards and SC-20*XX* boards.

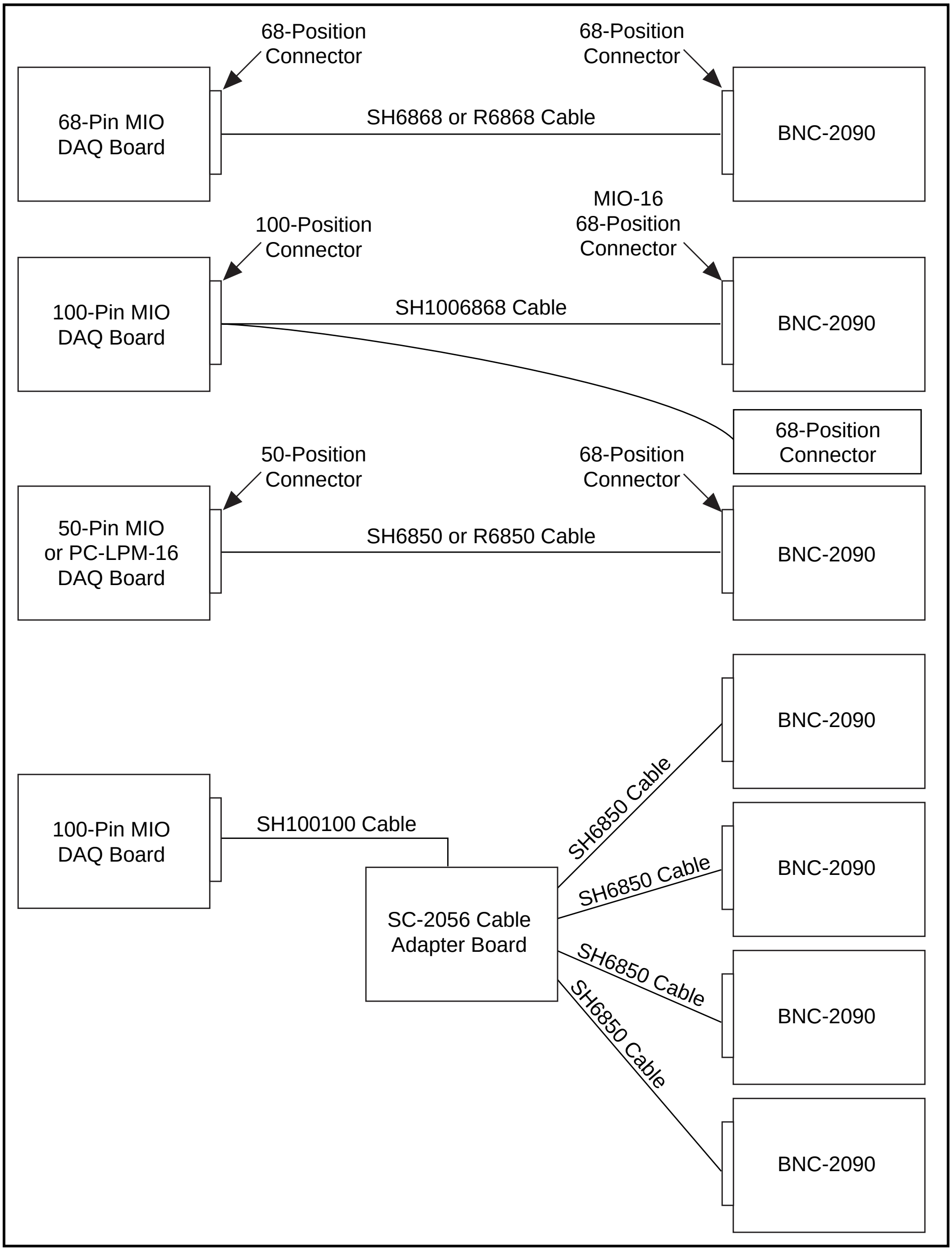


Figure 2-4. Direct Connection of an MIO Board to the BNC-2090

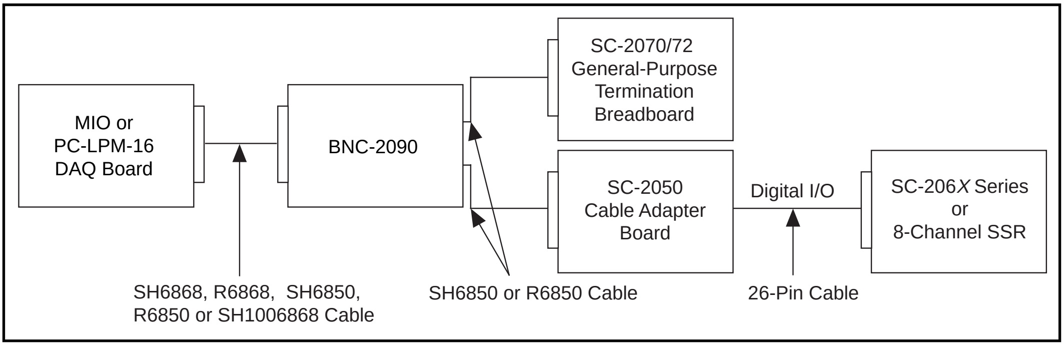


Figure 2-5. Connection between the DAQ Board, the BNC-2090 and SC-20*XX* Boards

Connecting Your Signals

The BNC-2090 board has BNC connectors for all analog signals, spring terminal blocks for digital signals, and two user-defined connectors.

All of the analog signals from the MIO board are available at the front panel of the BNC-2090. Because these signals are not conditioned or changed in any way by the BNC-2090, refer to your MIO board user manual for information on the use of these signals.

Table 2-3 shows the front panel labels for the BNC and terminal block signal connectors. Refer to your MIO board user manual for more information on these signals.

Table 2-3. BNC-2090 Front Panel Labels

BNC-2090 Front Panel Labels		Signal Description
BNC Connectors	ACH<0..15>	Analog Channels 0 through 15
	DAC0OUT	D/A Converter 0 Out
	DAC1OUT	D/A Converter 1 Out
	EXTREF	External Reference
	PFI0/TRIG1	Programmable Function I0/Trigger 1

Table 2-3. BNC-2090 Front Panel Labels (Continued)

BNC-2090 Front Panel Labels		Signal Description
	USER1	User-Defined 1 (Connected to USER1 Terminal Block)
	USER2	User-Defined 2 (Connected to USER2 Terminal Block)
Terminal Blocks	DIO<7..0>	Digital Input/Output Channels 7 through 0
	DGND1	Digital Ground 1
	USER1	User-Defined 1 (Connected to USER1 BNC)
	EXSTRB*	External Strobe
	SCANCLK	Scan Clock
	+5 V	+5 V Power
	GND	Ground
	PFI<1..9>	Programmable Function Input Channels 1 through 9
	DGND2	Digital Ground 2
	USER2	User-Defined 2 (Connected to USER2 BNC)
	FREQOUT	Frequency Out
	CTR1OUT	Counter 1 Out
	CTR0OUT	Counter 0 Out

Connecting Analog Inputs

Connecting Nonreferenced (or Floating) Signal Sources

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 board to establish a local or onboard reference for the signal.

DIFF Inputs

To provide a return path for the instrumentation amplifier bias currents, floating sources must have a 10–100 kΩ resistor to AIGND on one input if DC-coupled, or both inputs if AC-coupled. For more detailed information on connections to floating signal sources and differential inputs, refer to the configuration chapter in your MIO-16 board user manual.

You can install these bias resistors in positions A and B (see Table 3-1 and Figure 3-2) of the BNC-2090. Figure 2-6 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 (B position in Table 3-1). Refer to Chapter 3, *Signal Conditioning Application Examples*, for information on building additional signal conditioning circuitry, such as filters and attenuators, in the open component positions.

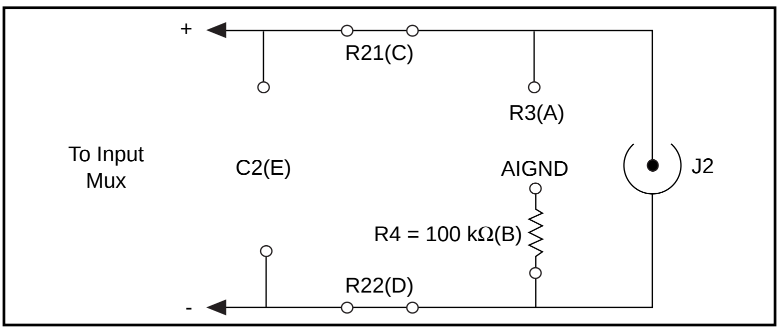


Figure 2-6. Bias Return Resistor for DC-Coupled Floating Source on Channel 1 in DIFF Mode

SE Inputs

When measuring floating signal sources, configure the MIO board to supply a ground reference by placing the board in RSE mode. This mode ties the negative input of the MIO board instrumentation amplifier to the analog ground.

When the MIO board is configured for RSE mode, keep your BNC-2090 in the factory-default configuration, in which the 0 Ω jumpers are in the two series positions, C and D (see Table 3-1) and all of the signal grounds are tied to AIGND. Refer to Chapter 3, *Signal Conditioning Application Examples*, for information on building additional signal-conditioning circuitry, such as filters and attenuators, in the open-component positions.

Connecting Ground-Referenced Signal Sources

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 board (assuming the host computer is plugged into the same power system). The nonisolated outputs of instruments and devices that plug into the building power system fall into this category.

DIFF Inputs

If the MIO board is configured for differential inputs, ground-referenced signal sources connected to the BNC-2090 need no special components added to the BNC-2090. You can leave the inputs of the BNC-2090 in the factory-default configuration, with the 0 Ω jumpers in the two series positions, C and D (see Table 3-1). Refer to Chapter 3, *Signal Conditioning Application Examples*, for information on building signal-conditioning circuitry, such as filters and attenuators, in the open-component positions.

SE Inputs

When measuring ground-referenced signals, the external signal supplies its own reference ground point and the MIO board should not supply one. Therefore, configure the MIO board for the NRSE mode, in which all of the signal grounds are tied to AISENSE, which connects to the negative input of the instrumentation amplifier on the MIO board. You can leave the inputs of the BNC-2090 in the factory-default configuration, with the 0 Ω jumpers in the series position (C or D, depending on the channel). You should not use the open positions, A and B (see Table 3-1 and Figure 3-2), that connect the input to AIGND. This incorrect ground reference can cause inaccurate measurements.

Connecting Analog Outputs

Each analog output BNC connector has two open-component positions for optional signal conditioning components. One of these is designated as a resistor and the other as a capacitor. DAC1OUT circuitry is identical to that of DAC0OUT, but the component positions for DAC0OUT are labeled R17 and C9 and the component positions for DAC1OUT are labeled R18 and C10. Figure 2-7 shows the equivalent circuit for DAC0OUT.

The board is shipped with 0 Ω jumpers inserted into the R17 and R18 positions, shown in Figure 3-8. You can easily remove these to build passive analog output signal conditioning circuits, such as voltage dividers and lowpass filters. Refer to Chapter 3, *Signal Conditioning Application Examples*, for more information.

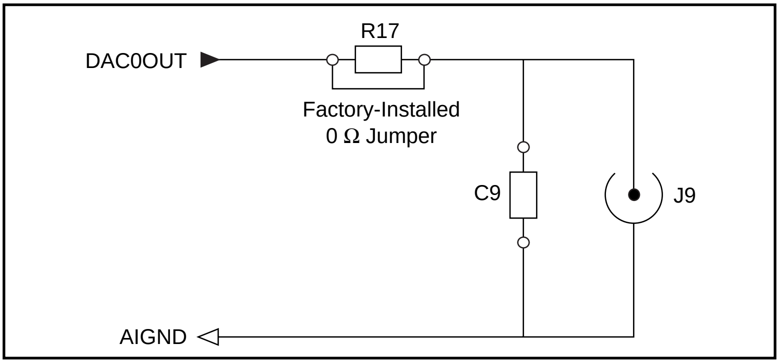


Figure 2-7. Analog Output Schematic for DACs

Connecting Digital I/O Signals

Use the BNC-2090 BNC connectors and spring terminal blocks to connect your digital signals to your DAQ board. When connecting signals to the spring terminal blocks, you can use up to 20 AWG wire with the insulation stripped to 0.5 in. Table 2-3 lists labels for each signal connector and terminal block.

Notice that there are two user-defined BNC connectors (USER1, USER2) that are connected to the spring terminal blocks labeled USER1 and USER2. These terminals and their associated BNC connectors provide some flexibility in choosing up to two additional digital/timing signals that you can access via BNC connectors. For example, if an application requires access to CTR0OUT and CTR1OUT signals, you can wire the spring terminals labeled CTR0OUT and CTR1OUT to terminals labeled USER1 and USER2, respectively. This configures BNC connector USER1 as CTR0OUT and USER2 as CTR1OUT.

All of the digital signals from the MIO board are available at the front panel of the BNC-2090. Refer to your MIO board user manual for information on the use of these signals.

If you want optical isolation of or relay control by the digital I/O lines, you must use the SC-2050 cable adapter board and the appropriate SC-206*X* Series digital signal conditioning board. If you want access to all MIO signals via screw terminals, you must use the SC-2070 or SC-2072 board. For more information on the SC-205*X* Series boards, the SC-206*X* Series boards, or the SC-207*X* Series boards, refer to either your National Instruments catalog, the *SC-205X Series User Manual*, the *SC-206X Series User Manual*, or the *SC-207X Series User Manual*.

Signal Conditioning Application Examples

Chapter 3

This chapter contains instructions for adding signal conditioning components to your BNC-2090 and contains signal conditioning examples for the BNC-2090 in use with MIO boards.

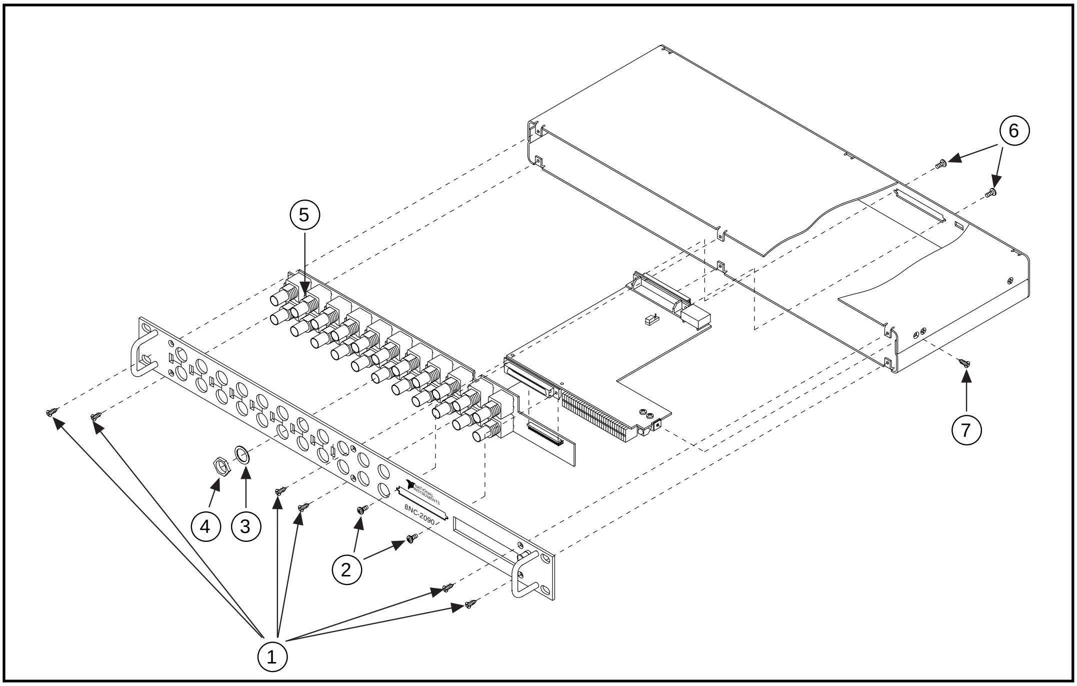
Adding Signal Conditioning Components

The BNC-2090 has open-component positions in the input paths into which you can insert resistors and capacitors for conditioning the 16 single-ended or 8 differential analog input signals. You can also use the BNC-2090 in conjunction with other signal conditioning accessories. This chapter covers several types of signal conditioning applications including filtering and attenuation.

To add signal conditioning components to the BNC-2090, you must disassemble the BNC-2090 to gain access to the open-component positions.

The figures in this section 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.

Figure 3-1 shows the disassembly of the BNC-2090.



1 Front Panel Screws	2 Front Connector Screws	3 Front Panel Washer
4 Front Panel Nut	5 0 Ω Jumpers	6 Rear Panel Screws
7 Side Panel Screw		

Figure 3-1. Disassembly of the BNC-2090

1. Remove the six front panel screws.
2. Remove one side panel screw.
3. Remove two rear panel screws.
4. Hold the front panel and slide the unit out of the metal case.
5. Remove the 22 front panel nuts and washers on the BNC connectors.
6. Remove two front connector screws.
7. Carefully slide the front panel off the unit and separate the two printed wire boards (PWBs).
8. Install and/or remove components as necessary. Refer to *Soldering and Desoldering on the BNC-2090* for more information.
9. Reassemble the BNC-2090 in reverse order. When reassembling the two PWBs together, make sure that all the pins are aligned in the correct holes on the board-to-board connector.

Soldering and Desoldering on the BNC-2090

Some applications require you to modify the PWB, usually by removing 0 Ω jumpers and adding components. The BNC-2090 is shipped with 0 Ω jumpers in the C and D positions (see Table 3-1 and Figure 3-2). Use vacuum-type tools when desoldering on the BNC-2090 and avoid damaging component pads.

Use a low-wattage soldering iron (20 to 30 W) when soldering to the board. You should use only rosin-core, electronic-grade solder. Acid-core solder damages the printed circuit board and components.

Analog Input

Each analog input signal has several open positions for passive signal conditioning components. Four of these positions are designated as resistors and one is designated as a capacitor. The factory-default positions for the 0 Ω jumpers are the C and D positions of the input network, as shown in Figure 3-2. 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.

The component positions are different for each channel. Figure 3-2 shows the onboard equivalent circuit.

Table 3-1. Channel Component Positions

Channel		Position in Figure 3-2				
Differential	**Single-Ended**	**A**	**B**	**C**	**D**	**E**
0	0, 8	R1	R2	R19	R20	C1
1	1, 9	R3	R4	R21	R22	C2
2	2, 10	R5	R6	R23	R24	C3
3	3, 11	R7	R8	R25	R26	C4
4	4, 12	R9	R10	R27	R28	C5
5	5, 13	R11	R12	R29	R30	C6

Table 3-1. Channel Component Positions (Continued)

Channel		Position in Figure 3-2				
Differential	**Single-Ended**	**A**	**B**	**C**	**D**	**E**
6	6, 14	R13	R14	R31	R32	C7
7	7, 15	R15	R16	R33	R34	C8

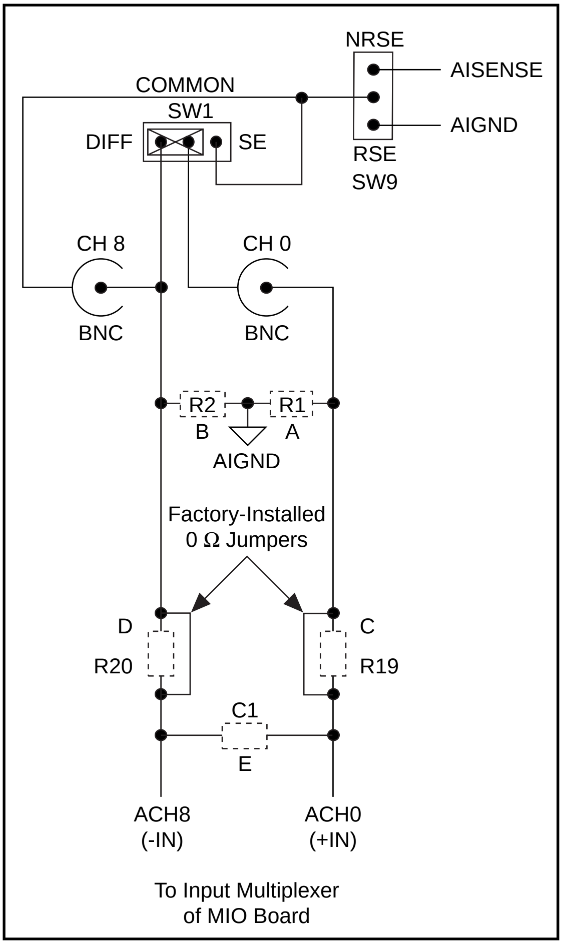


Figure 3-2. Onboard Equivalent Circuit for DIFF Mode

Building Lowpass Filters

You can install simple, RC lowpass filters in the BNC-2090 on any differential input channel. The filters are useful for accurate measurement and noise rejection. By substituting resistance and capacitance values into the following formula (hereafter referred to as Formula 3-1), you can calculate a simple, one-pole RC filter to have a -3 dB point cutoff frequency (f_c):

$$f_c = \frac{1}{(2\pi RC)} \qquad \textbf{(Formula 3-1)}$$

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.

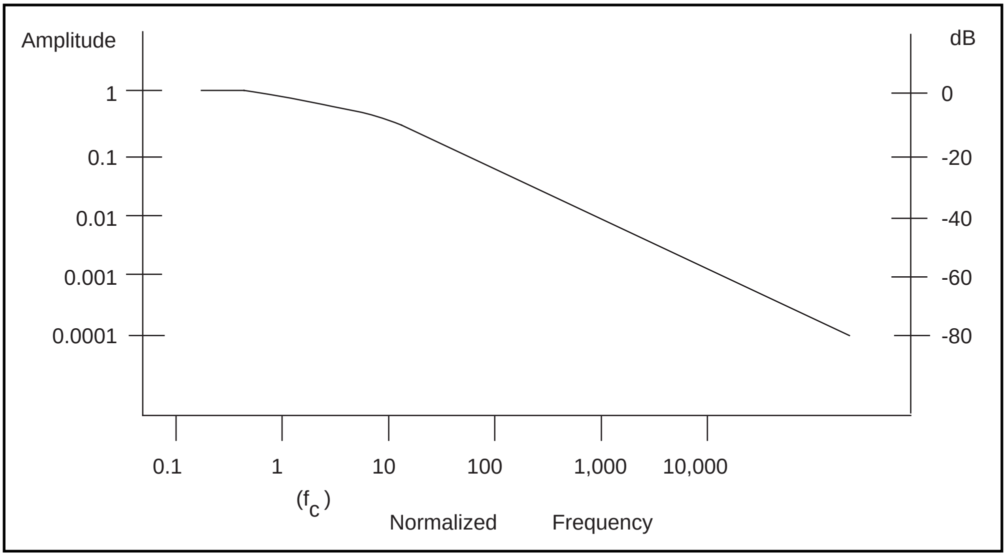


Figure 3-3. Normalized Frequency Response of Lowpass Filter

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, but by only 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 1 µF is available, the resistance is (by substitution into Formula 3-1) about 39.8 kΩ. This resistance must be divided by two to get the resistor value on 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. The closest standard 5% tolerance resistors are 20 kΩ. The closest standard 0.5% resistors are 19.8 kΩ. National Instruments 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 the B position (R4 in this case).

☞ **Note:** ***The BNC-2090 open-component locations do not facilitate RC lowpass filters with the MIO board configured for single-ended inputs. Therefore, if you configure the MIO board for single-ended inputs, you must build lowpass filters external to the BNC-2090.***

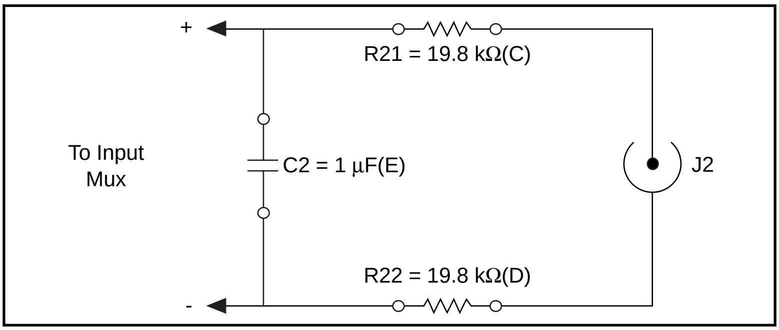


Figure 3-4. Lowpass Filter on Differential Channel 1

Building Highpass Filters

You can install simple, RC highpass filters in the BNC-2090 on any differential input channel. The filters are useful for accurate high-frequency measurement and low-frequency noise rejection. By substituting resistance and capacitance values into Formula 3-1, you can calculate a simple, one-pole RC filter to have a -3 dB point f_c. The frequency response rolls off at a rate of -20 dB per decade decrease thereafter. Figure 3-5 shows a Bode plot of the amplitude versus normalized frequency.

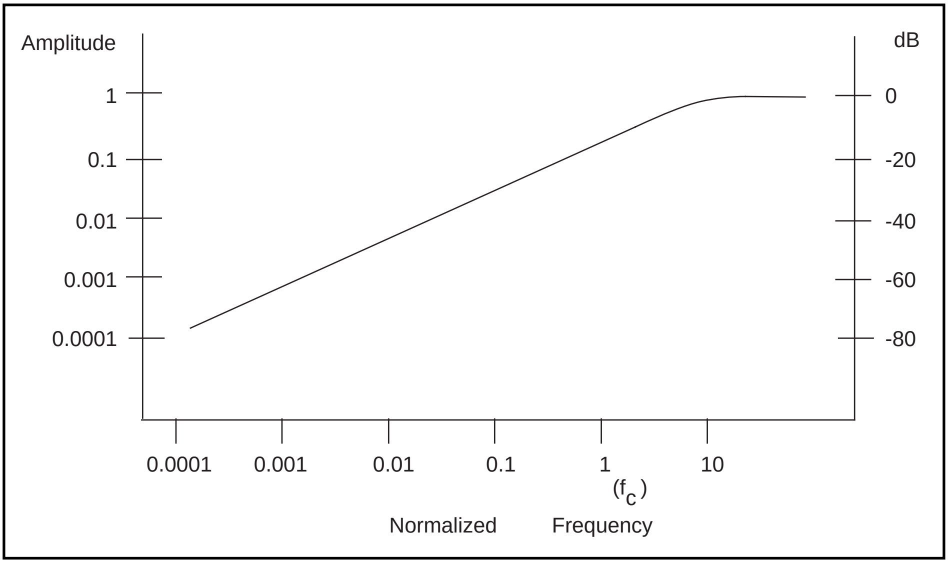


Figure 3-5. Normalized Frequency Response of Highpass Filter

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, but by only 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 Formula 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 Formula 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 its capacitor position, E. The closest standard 5% tolerance resistors are 6.2 kΩ. The closest standard 1% resistors are 6.34 kΩ. Figure 3-6 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 the B position (R4 in this case).

☞ **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.***

The BNC-2090 open component locations do not facilitate RC highpass filters with the MIO board configured for single-ended inputs. Therefore, if the MIO board is configured for single-ended inputs, you must build highpass filters external to the BNC-2090.

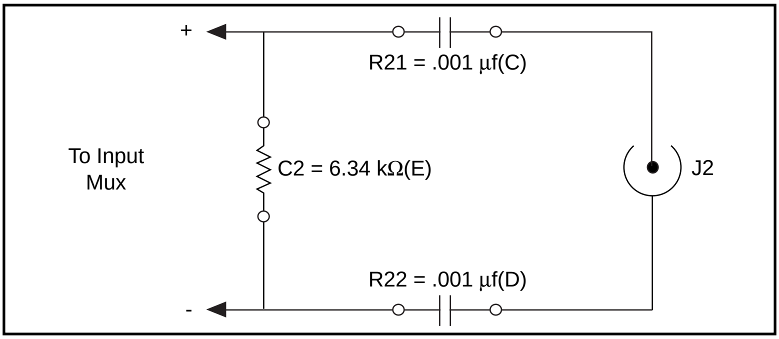


Figure 3-6. Highpass Filter on Differential Channel 1

Building Attenuators (Voltage Dividers)

Attenuators or voltage dividers allow voltage measurements larger than the maximum input range of MIO boards. 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-2090 when the inputs from its DAQ board are in DIFF mode. The BNC-2090 open component positions do not facilitate voltage dividers with the MIO board configured for single-ended input signals. Therefore, if you configure the MIO board for single-ended inputs, you must build attenuators external to the BNC-2090. You can use attenuators to reduce a signal that is outside the normal input range of the DAQ board (±10 V maximum).

Warning: ***The BNC-2090 is not designed for any input voltages greater than 42 V, even if a user-installed voltage divider reduces the voltage to within the input range of the DAQ board. Input voltages greater than 42 V can damage the BNC-2090, any and all boards 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.***

Figure 3-7 shows a three-resistor circuit for attenuating voltages at the differential inputs of the BNC-2090. The figure also shows the placement of the resistors on the open-component positions for differential channel 1. The gain (G) of this attenuator is given by the following formula:

$$G = \frac{R_E}{(R_C + R_D + R_E)}$$ **(Formula 3-2)**

Therefore, the input to the MIO board (V_{MIO}) is as follows:

$$V_{MIO} = V_{SC}(G)$$ **(Formula 3-3)**

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

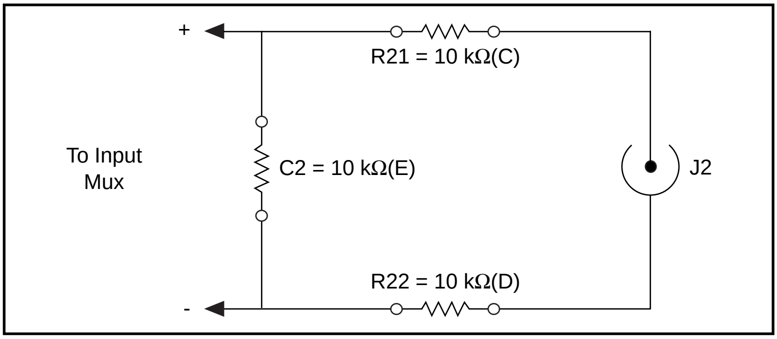


Figure 3-7. Attenuator for Use with Differential Inputs

Using the values in Figure 3-7,

$$G = \frac{10\ \text{k}\Omega}{(10\ \text{k}\Omega + 10\ \text{k}\Omega + 10\ \text{k}\Omega)} = \frac{1}{3}$$ **(Formula 3-4)**

Therefore,

$$V_{MIO} = \frac{1}{3}(V_{SC})$$ **(Formula 3-5)**

When the MIO board is configured for ±10 V input signals, the board 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 example above, the input impedance has been reduced to:

10 kΩ + 10 kΩ + 10 kΩ = 30 kΩ

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.

If your application requires the use of thermocouples, using a National Instruments SC-2070 board is better suited for the task. The SC-2070 board is equipped with an onboard temperature sensor for use with thermocouple cold-junction compensation.

Analog Output

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 R17 and R18 as shown in Figure 3-8.

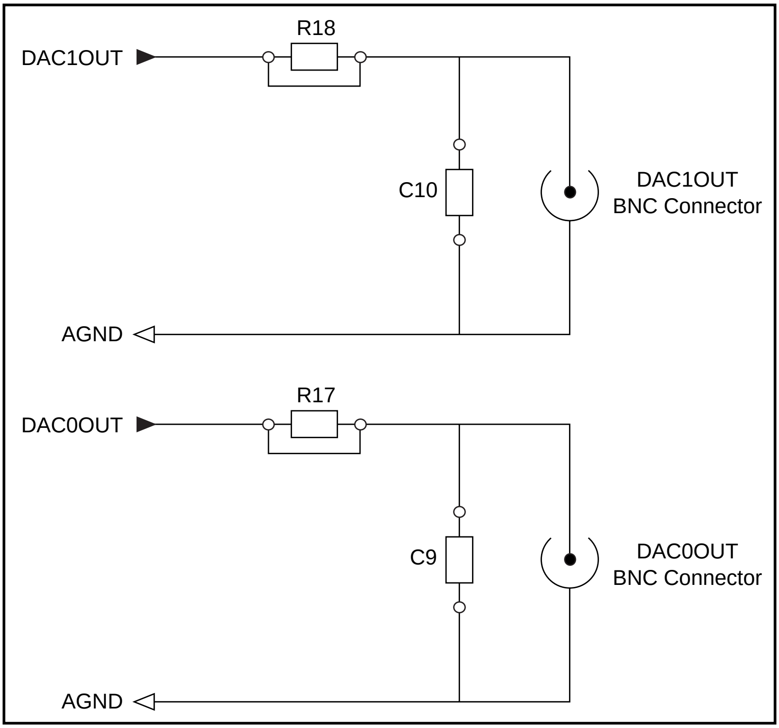


Figure 3-8. DAC0OUT and DAC1OUT

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

Building Lowpass Filters

Building lowpass filters for the analog output signals is the same as for the analog inputs. Refer to *Analog Input* for more detailed information about lowpass filters and how to calculate values for lowpass filters. Refer to Figure 3-1 for component locations. Figure 3-9 shows a 4 Hz lowpass filter for DAC0OUT.

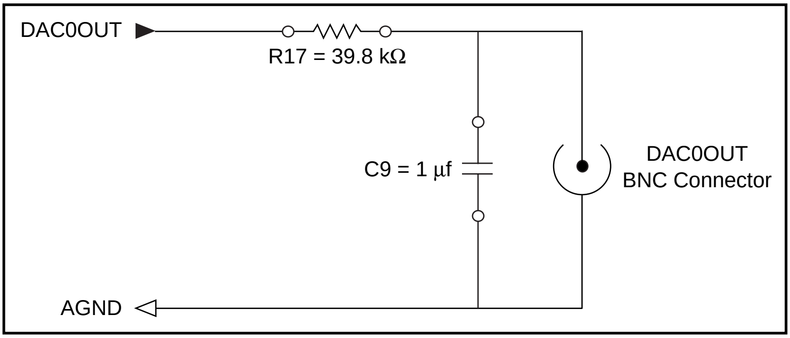


Figure 3-9. Lowpass Filter on DAC0OUT

Building Highpass Filters

Building highpass filters for analog output is the same as for analog input. Refer to *Analog Input* for more detailed information about highpass filters and how to calculate values for them. Refer to Figure 3-1 for component locations. Figure 3-10 shows a 50 kHz highpass filter for DAC0OUT.

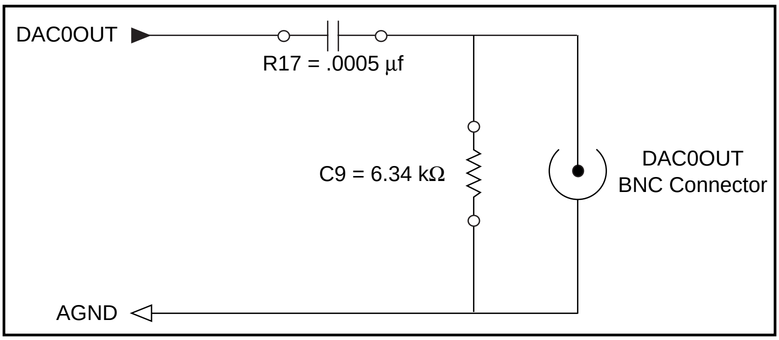


Figure 3-10. Highpass Filter on DAC0OUT

Appendix A

Specifications

This appendix lists the specifications of the BNC-2090.

Analog Input

Input Characteristics

Number of channels .... 16 single-ended or 8 differential

Field connection................................ 22 BNC connectors (18 analog,[1] 2 digital, and 2 user-defined), 28 spring terminal blocks

Signal conditioning capability........... 5 open component positions per channel that allow simple passive; lowpass or highpass filter; voltage attenuator circuits in signal path

Power Requirement (from host computer)

+5 VDC (±5%)

Typical....................................... 10 mA (no signal conditioning installed)

Maximum.................................... 1 A (fuse-limited by host DAQ board)

Physical

Dimensions .... 43.2 x 18.8 x 4.4 cm (19 by 7.4 by 1.7 in.)

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

BNC connectors 22

Spring terminal blocks 28

---

1. The DAC0OUT and DAC1OUT BNC connectors are for use only with MIO boards. These connectors are connected to ±12 VDC when the PC-LPM-16 is in use.

Environment

Operating temperature........................0° to 70° C

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

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

Using the PC-LPM-16

Appendix B

This appendix contains information on using the PC-LPM-16 with the BNC-2090.

When using the PC-LPM-16 with the BNC-2090, the functions of the front panel switches and connectors are different because of the difference between the MIO I/O connector signals and the PC-LPM-16 I/O connector signals.

Analog I/O

The analog input section of a PC-LPM-16 DAQ board consists of 16 ground-referenced single-ended channels. Therefore, the only valid configuration for the BNC-2090 is also RSE mode, which uses all 16 analog input BNC connectors. Switches S1 through S8 must be in the SE position and S9 should be in the RSE position, as shown in Figure B-1.

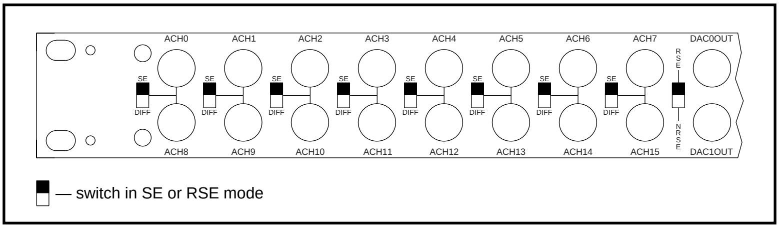


Figure B-1. Switch Configurations for RSE Mode (PC-LPM-16)

☞ **Note:** ***All the switches are required to be in the same position; that is, S1 through S8 must all be in the SE position and S9 must be in the RSE position to use the BNC-2090 with the PC-LPM-16.***

DAC0OUT and DAC1OUT BNC connectors are for use with the MIO boards only. These connectors are connected to ±12 V when the PC-LPM-16 is in use.

Digital I/O

Table B-1 shows the BNC-2090 front panel labels and the corresponding signal names when you use the accessory with a PC-LPM-16.

Table B-1. BNC-2090 Front Panel Labels and Corresponding Signal Names for PC-LPM-16

BNC-2090 Front Panel Labels		Signal Name for PC-LPM-16
Switches	RSE/NRSE	RSE
	SE/DIFF	SE
BNC Connectors	ACH<0..15>	No change
	DAC0OUT	Center is -12 V, outer is DIN1
	DAC1OUT	Center is +12 V, outer is DIN1
	EXTREF	DIN0
	PFI0/TRIG1	OUT1*
	USER1	Center is no change, outer DIN2 shorted to DOUT3
	USER2	Center is no change, outer DIN2 shorted to DOUT3
Terminal Blocks	DIO7	DOUT2
	DIO6	DOUT0
	DIO5	DIN6
	DIO4	DIN4
	DIO3	DOUT1
	DIO2	DIN7

Table B-1. BNC-2090 Front Panel Labels and Corresponding Signal Names for PC-LPM-16 (Continued)

BNC-2090 Front Panel Labels		Signal Name for PC-LPM-16
	DIO1	DIN5
	DIO0	DIN3
	DGND1	DOUT3 shorted to DIN2
	USER1	No change
	EXSTRB*	DOUT7
	SCANCLK	DOUT6
	+5 V	No change
	GND	No change
	PFI1	EXTINT*
	PFI2	EXTCONV*
	PFI3	OUT0
	PFI4	GATE0
	PFI5	GATE1
	PFI6	CLK1
	PFI7	OUT2
	PFI8	GATE2
	PFI9	CLK2
	DGND2	DOUT3 shorted to DIN2
	USER2	No change
	FREQOUT	DGND

Table B-1. BNC-2090 Front Panel Labels and Corresponding Signal Names for PC-LPM-16 (Continued)

BNC-2090 Front Panel Labels		Signal Name for PC-LPM-16
	CTR1OUT	OUT1
	CTR0OUT	+5 V

Appendix C

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve your technical problems and a form you can use to comment on the product documentation. When you contact us, we need the information on the Technical Support Form and the configuration form, if your manual contains one, about your system configuration to answer your questions as quickly as possible.

National Instruments has technical assistance through electronic, fax, and telephone systems to quickly provide the information you need. Our electronic services include a bulletin board service, an FTP site, a FaxBack system, and e-mail support. If you have a hardware or software problem, first try the electronic support systems. If the information available on these systems does not answer your questions, we offer fax and telephone support through our technical support centers, which are staffed by applications engineers.

Electronic Services

Bulletin Board Support

National Instruments has BBS and FTP sites dedicated for 24-hour support with a collection of files and documents to answer most common customer questions. From these sites, you can also download the latest instrument drivers, updates, and example programs. For recorded instructions on how to use the bulletin board and FTP services and for BBS automated information, call (512) 795-6990. You can access these services at:

United States: (512) 794-5422 or (800) 327-3077
Up to 14,400 baud, 8 data bits, 1 stop bit, no parity

United Kingdom: 01635 551422
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

France: 1 48 65 15 59
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

FTP Support

To access our FTP site, log on to our Internet host, `ftp.natinst.com`, as anonymous and use your Internet address, such as `joesmith@anywhere.com`, as your password. The support files and documents are located in the `/support` directories.

FaxBack Support

FaxBack is a 24-hour information retrieval system containing a library of documents on a wide range of technical information. You can access FaxBack from a touch-tone telephone at the following number:

(512) 418-1111

E-Mail Support (currently U.S. only)

You can submit technical support questions to the appropriate applications engineering team through e-mail at the Internet addresses listed below. Remember to include your name, address, and phone number so we can contact you with solutions and suggestions.

GPIB: `gpib.support@natinst.com`
DAQ: `daq.support@natinst.com`
VXI: `vxi.support@natinst.com`
LabWindows: `lw.support@natinst.com`
LabVIEW: `lv.support@natinst.com`
HiQ: `hiq.support@natinst.com`
VISA: `visa.support@natinst.com`

Fax and Telephone Support

National Instruments has branch offices all over the world. Use the list below to find the technical support number for your country. If there is no National Instruments office in your country, contact the source from which you purchased your software to obtain support.

	Telephone	Fax
Australia	03 9 879 9422	03 9 879 9179
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Canada (Ontario)	519 622 9310	
Canada (Quebec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 26 02
Finland	90 527 2321	90 502 2930
France	1 48 14 24 24	1 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Italy	02 413091	02 41309215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	95 800 010 0793	5 520 3282
Netherlands	0348 433466	0348 430673
Norway	32 84 84 00	32 84 86 00
Singapore	2265886	2265887
Spain	91 640 0085	91 640 0533
Sweden	08 730 49 70	08 730 43 70
Switzerland	056 200 51 51	056 200 51 55
Taiwan	02 377 1200	02 737 4644
U.K.	01635 523545	01635 523154

Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name ____

Company ____

Address ____

____

Fax (___)____________________ Phone (___) ____

Computer brand _________________ Model _________________ Processor ___________________

Operating system (include version number)____

Clock speed ______MHz RAM _____MB Display adapter __________________________

Mouse ___yes ___no Other adapters installed ____

Hard disk capacity _____MB Brand ____

Instruments used ____

____

National Instruments hardware product model____________ Revision__________________________

Configuration ____

National Instruments software product______________________________ Version_____________

Configuration ____

The problem is: ____

____

____

____

____

List any error messages: ____

____

____

The following steps reproduce the problem: ____

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____

BNC-2090 Hardware Configuration Form

Record the settings and revisions of your hardware on the line to the right of each item. Complete a new copy of this form each time you revise your hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

National Instruments Products

DAQ hardware ____________________

SW1 ____________________

SW2 ____________________

SW3 ____________________

SW4 ____________________

SW5 ____________________

SW6 ____________________

SW7 ____________________

SW8 ____________________

SW9 ____________________

Jumper W1 ____________________

Power selection switch ____________________

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: BNC-2090 User Manual

Edition Date: March 1996

Part Number: 321183A-01

Please comment on the completeness, clarity, and organization of the manual.

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If you find errors in the manual, please record the page numbers and describe the errors.

____
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Thank you for your help.

Name ____

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Glossary

Prefix	Meaning	Value
m-	milli-	10^{-3}
μ-	micro-	10^{-6}
n-	nano-	10^{-9}

°	degrees
Ω	ohms
%	percent
+5 V	+5 volt signal
A	amperes
AC	alternating current
ACH	analog channel
A/D	analog to digital
AIGND	analog input ground
AISENSE	analog input sense signal
ANSI	American National Standards Institute
C	Celsius
CMRR	common-mode rejection ratio
COMMON	common signal
CTROUT	counter output signal

D/A	digital to analog
DAC0OUT	DAC 0 output signal
dB	decibels
DC	direct current
DGND	digital ground
DIFF	differential input
DIO	digital I/O
EXTREF	external reference signal
EXTSTRB	external strobe signal
F	farads
FREQOUT	frequency out signal
G	gain
GND	ground signal
Hz	hertz
in.	inches
I/O	input/output
LED	light-emitting diode
m	meters
MIO	multifunction I/O
NRSE	nonreferenced single-ended input
PFI	programmable function input
RC	resistance-capacitance
RSE	referenced single-ended input
SC	signal conditioning

SCANCLK	scan clock signal
SE	single-ended input
SW	switch
TRIG	trigger signal
USER	user-defined signal
V	volts
VDC	volts, direct current
W	watts

Index

F

G

H

I

J

L

M

N

T

V

W