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DAQPad™-1200
User Manual

Data Acquisition and Control for the Parallel Port

November 1995 Edition

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About This Manual

This manual describes the electrical and mechanical aspects of the DAQPad-1200 and contains information concerning its operation and programming. The DAQPad-1200 is an independent data acquisition unit that communicates with the PC through the parallel port.

Organization of This Manual

The *DAQPad-1200 User Manual* is organized as follows:

- Chapter 1, *Introduction*, describes the DAQPad-1200; lists what you need to get started with your DAQPad-1200; and describes the software programming choices and optional equipment.
- Chapter 2, *Installation and Configuration*, describes how to install and software configure the DAQPad-1200.
- Chapter 3, *Signal Connections*, describes the connection of a standard parallel port device to the rear panel transparent parallel port connector, the signal connections to the DAQPad-1200 unit via the DAQPad-1200 front I/O connector, and includes specifications and connection instructions for the DAQPad-1200 connector signals.
- Chapter 4, *Calibration*, discusses the calibration procedures for the DAQPad-1200 analog I/O circuitry.
- Appendix A, *Specifications*, lists the DAQPad-1200 specifications.
- Appendix B, *Parallel Port Configuration Troubleshooting*, contains installation troubleshooting information.
- Appendix C, *Customer Communication,* contains forms you can use to request help from National Instruments or to comment on our products.
- 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:

bold italic	Bold italic text denotes a note, caution, or warning.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
MC	MC refers to the Micro Channel series computers.
`monospace`	Lowercase text in this font denotes text or characters that are to be literally input 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, variables, filenames, and extensions, and for statements and comments taken from program code.
NB	NB refers to the NuBus series computers.
NI-DAQ	NI-DAQ is used throughout this manual to refer to the NI-DAQ software for PC compatibles, unless otherwise noted.
PC	PC refers to the IBM PC/XT, the IBM PC AT, and compatible computers.

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

National Instruments Documentation

The *DAQPad-1200 User Manual* is one piece of the documentation set for your system. You could have any of several types of manuals, depending on the hardware and software in your system. Use the different types of manuals you have as follows:

- Your DAQ hardware user manuals—These manuals have detailed information about the DAQ hardware that plugs into or is connected to your computer. Use these manuals for hardware installation and configuration instructions, specification information about your DAQ hardware, and application hints.
- Software manuals—Examples of software manuals you may have are the LabVIEW and LabWindows® /CVI manual sets and the NI-DAQ manuals. After you set up your hardware system, use either the application software (LabVIEW or LabWindows/CVI) manuals or the NI-DAQ manuals to help you write your application. If you have a large and complicated system, it is worthwhile to look through the software manuals before you configure your hardware.
- Accessory installation guides or manuals—If you are using accessory products, read the terminal block and cable assembly installation guides or accessory board user manuals. They explain how to physically connect the relevant pieces of the system. Consult these guides when you are making your connections.

Related Documentation

In addition, the following National Instruments manual contains detailed information for the register-level programmer.

- *DAQPad-1200 Register-Level Programmer Manual*

This manual is available from National Instruments by request. If you are using NI-DAQ, LabVIEW, or LabWindows/CVI, you should not need the register-level programmer manual. Using NI-DAQ, LabVIEW, or LabWindows/CVI is easier than and as flexible as using the low-level programming described in the register-level programmer manual. Refer to *Software Programming Choices* in Chapter 1, *Introduction*, of this manual to learn about your programming options.

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 DAQPad-1200; lists what you need to get started with your DAQPad-1200; and describes the software programming choices and optional equipment.

About the DAQPad-1200

The DAQPad-1200 is a low-cost high-performance DAQ unit that communicates with the PC through the parallel port on IBM PC/XT/AT and compatible computers. The DAQPad-1200 has eight analog input channels that you can configure as eight single-ended or four differential inputs; a 12-bit successive-approximation ADC; two 12-bit DACs with voltage outputs; 24 lines of TTL-compatible digital I/O; and three 16-bit counter/timers for timing I/O. The DAQPad-1200 is completely software-configurable and self-calibrated. You never need to open the unit to set jumpers or adjust trimpots.

The DAQPad-1200 is register- and pin-compatible with the Lab-PC+ multifunction I/O plug-in board. The DAQPad-1200 is EPP compatible with IEEE 1284, a standard for high-performance PC parallel ports. The DAQPad-1200 works with two different parallel port types–the original Centronics or unidirectional port for printers, and the Enhanced Parallel Port (EPP). The DAQPad-1200 has a second parallel port connector for transparent pass-through connection to a standard parallel port device.

You can power the DAQPad-1200 from the included AC adapter, the optional BP-1 rechargeable DAQPad battery pack, or any 9 to 42 VDC source such as a standard 12 V car battery.

By combining multifunction analog, digital, and timing I/O capabilities in a compact, lightweight unit, the DAQPad-1200 is ideal for portable applications using notebook computers or any PC with a parallel printer port. Because the DAQPad-1200 can take advantage of the high throughput capabilities of the PC parallel port, the unit delivers high-performance data acquisition and control for any application where PC expansion slots are unavailable.

What You Need to Get Started

To set up and use your DAQPad-1200, you will need the following:

- ❑ DAQPad-1200 unit
- ❑ *DAQPad-1200 User Manual*
- ❑ NI-DAQ software for PC compatibles, with manuals
- ❑ Parallel port cable
- ❑ 120 or 230 VAC wall-mount power supply adapter, the BP-1 battery power supply, or any 9–42 VDC power supply
- ❑ IBM PC/XT/AT or compatible computer

Detailed specifications of the DAQPad-1200 are listed in Appendix A, *Specifications*.

Software Programming Choices

There are four options to choose from when programming your National Instruments DAQ and SCXI hardware. You can use LabVIEW, LabWindows/CVI, or NI-DAQ.

The DAQPad-1200 works with LabVIEW for Windows, LabWindows/CVI for Windows, and the NI-DAQ software for PC compatibles.

LabVIEW and LabWindows/CVI Application Software

LabVIEW and LabWindows/CVI are innovative program development software packages for data acquisition and control applications. LabVIEW uses graphical programming, whereas LabWindows/CVI enhances traditional programming languages. Both packages include extensive libraries for data acquisition, instrument control, data analysis, and graphical data presentation.

LabVIEW features interactive graphics, a state-of-the-art user interface, and a powerful graphical programming language. The LabVIEW Data Acquisition VI Library, a series of VIs for using LabVIEW with National Instruments DAQ hardware, is included with LabVIEW. The LabVIEW Data Acquisition VI Libraries are functionally equivalent to the NI-DAQ software.

LabWindows/CVI features interactive graphics, a state-of-the-art user interface, and uses the ANSI standard C programming language. The LabWindows/CVI Data Acquisition Library, a series of functions for using LabWindows/CVI with National Instruments DAQ hardware, is included with the NI-DAQ software kit. The LabWindows/CVI Data Acquisition libraries are functionally equivalent to the NI-DAQ software.

Using LabVIEW or LabWindows/CVI software will greatly diminish the development time for your data acquisition and control application.

NI-DAQ Driver Software

The NI-DAQ driver software is included at no charge with all National Instruments DAQ hardware. NI-DAQ is not packaged with SCXI or accessory products, except for the SCXI-1200. NI-DAQ has an extensive library of functions that you can call from your application programming environment. These functions include routines for analog input (A/D conversion), buffered data acquisition (high-speed A/D conversion), analog output (D/A conversion), waveform generation (timed D/A conversion), digital I/O, counter/timer operations, SCXI, RTSI, self calibration, messaging, and acquiring data to extended memory.

NI-DAQ has both high-level DAQ I/O functions for maximum ease of use and low-level DAQ I/O functions for maximum flexibility and performance. Examples of high-level functions are streaming data to disk or acquiring a certain number of data points. An example of a low-level function is writing directly to registers on the DAQ device. NI-DAQ does not sacrifice the performance of National Instruments DAQ devices because it lets multiple devices operate at their peak performance—up to 500 kS/s on ISA computers and up to 1 MS/s on EISA computers.

NI-DAQ also internally addresses many of the complex issues between the computer and the DAQ hardware such as programming the PC interrupt and DMA controllers. NI-DAQ maintains a consistent software interface among its different versions so that you can change platforms with minimal modifications to your code. Figure 1-1 illustrates the relationship between NI-DAQ and LabVIEW and LabWindows/CVI. You can see that the DAQ parts of LabVIEW and LabWindows/CVI are functionally equivalent to the NI-DAQ software.

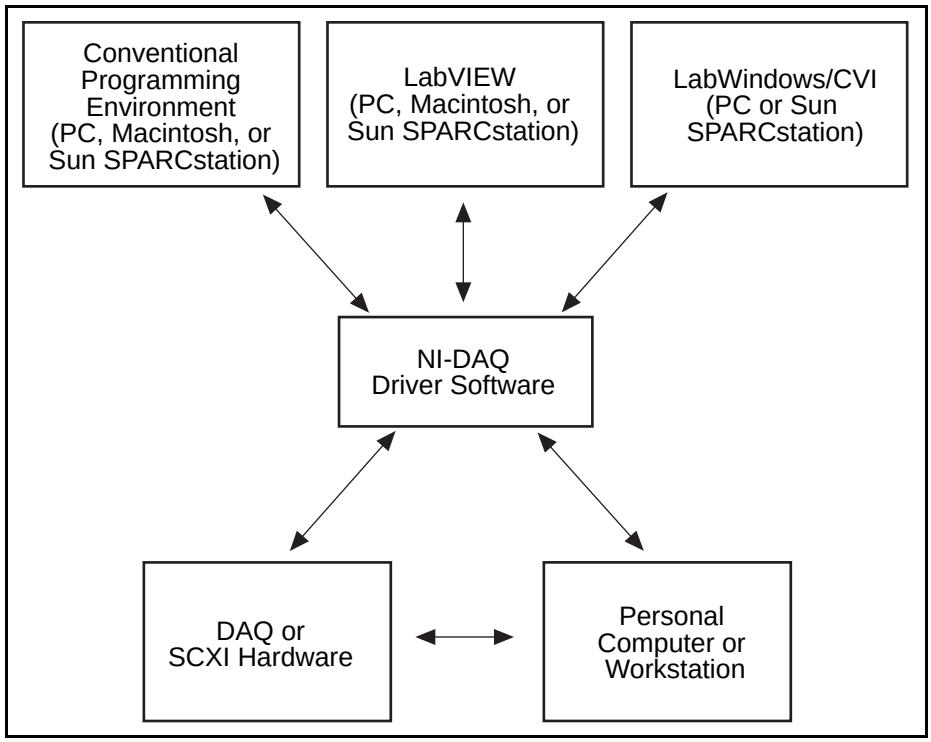


Figure 1-1. The Relationship between the Programming Environment, NI-DAQ, and Your Hardware

Register-Level Programming

The final option for programming any National Instruments DAQ hardware is to write register-level software. Writing register-level programming software can be very time-consuming and inefficient and is not recommended for most users.

Even if you are an experienced register-level programmer, always consider using NI-DAQ, LabVIEW, or LabWindows/CVI to program your National Instruments DAQ hardware. Using the NI-DAQ, LabVIEW, or LabWindows/CVI software is as easy and as flexible as register-level programming and can save you weeks of development time.

Optional Equipment

Contact National Instruments to order any of the following optional equipment:

- ❑ BP-1 battery pack with a 110 or 230 VAC charger
- ❑ 0.5 or 1.0 m type NB1 ribbon cable
- ❑ CB-50 I/O connector block with a 1.0 m type NB1 cable
- ❑ CB-50 I/O connector block only
- ❑ SC-2071 general-purpose termination breadboard with a 0.5 or 1.0 m type NB1 ribbon cable
- ❑ 2 m parallel port cable

BP-1 Battery Pack

For total portability, you can power the DAQPad-1200 with the optional BP-1 battery pack. The BP-1 includes a 12 V, 3.2 Ahr battery packaged in an enclosure with the same dimensions as the DAQPad-1200. A fully charged BP-1 typically powers the DAQPad-1200 for 11 hours. A charger unit is included with the BP-1.

Adding an Enhanced Parallel Port (EPP)

If you have a slot available in your PC, you can add an EPP card to achieve higher DAQ rates. You can order one such card, the F/Port Enhanced Parallel Port Card, from Far Point Communications. You can use the card in a PC/AT 386, 486, or compatible computer.

If you have a PCMCIA type II slot available in your PC, you can add a PCMCIA to an EPP card to achieve higher DAQ rates. Two options are the SPP-100 from Quatech and the ExpressPort from FarPoint. Both cards comply with the PCMCIA PC Standard Specification 2.1.

Custom Cables

The DAQPad-1200 front signal connector is a 50-pin male ribbon-cable header. The manufacturer part number of the header National Instruments uses is as follows:

- AMP Inc. (part number 1-103310-0)

The mating connector for the DAQPad-1200 front signal connector is a 50-position polarized ribbon-socket connector with strain relief. National Instruments uses a polarized or keyed connector to prevent inadvertent upside-down connection to the DAQPad-1200. Recommended manufacturer part numbers for this mating connector are as follows:

- Electronic Products Division/3M (part number 3425-7650)
- T&B/Ansley Corporation (part number 609-5041CE)

Standard 50-conductor 28 AWG stranded ribbon cables that work with these connectors are as follows:

- Electronic Products Division/3M (part number 3365/50)
- T&B/Ansley Corporation (part number 171-50)

The DAQPad-1200 two rear connectors (the parallel and transparent parallel port connectors) are the standard 25-pin D-Subminiature. The manufacturer part number of the connector National Instruments uses is as follows:

- AMP Inc. (part number 747846-5)

You can use standard DB-25-style male connectors as mating connectors for the DAQPad-1200 rear connector.

Chapter 2
Installation and Configuration

This chapter describes how to install and software configure the DAQPad-1200.

Hardware Installation

There are five basic steps to installing the DAQPad-1200:

> **Note:** ***If you are using the BP-1 battery pack, follow the installation instructions in your BP-1 installation guide instead of steps 1 and 2. The maximum recommended discharge time for a fully-charged battery pack is 11 hours for an unloaded DAQPad-1200 and five hours for a DAQPad-1200 loaded at 350 mA from the +5 V I/O connector (pin 49).***

1. Verify that the voltage on the wall-mount supply matches the voltage supplied in your area.
2. Connect one end of the wall-mount supply to an electrical outlet. Connect the other end to the rear panel jack.
3. Connect the parallel port cable to the PC parallel port. Connect the other end of the cable to port A on the DAQPad-1200, and screw in the mounting screws on the connectors to establish a firm connection.
4. If you are using the transparent parallel port, connect another parallel port cable to port B on the DAQPad-1200. Connect the other end of the second parallel port cable to any standard parallel port device.
5. Push the front panel rocker switch to power on the DAQPad-1200. The power LED should light up immediately.

If the power LED does not light up immediately, check the polarity of your power connections. The power input of the DAQPad-1200 is protected by a positive temperature coefficient (PTC) resistor. It takes approximately 20 s for the PTC resistor to reset after being tripped. Contact National Instruments if the power LED does not light up after correcting any faulty power connections.

The DAQPad-1200 unit is installed. You are now ready to install and configure your software.

Configuration

The DAQPad-1200 is completely software configurable; refer to your software manuals to install and configure the software.

If you are using NI-DAQ, refer to the *NI-DAQ User Manual for PC Compatibles*. The software installation and configuration instructions are in Chapter 1, *Introduction to NI-DAQ*. Find the installation and system configuration section for your operating system and follow the instructions given there.

Parallel Port Configuration

During configuration, you must know the parallel port I/O address and interrupt channel. Common parallel port addresses are 0x378, 0x278, 0x3BC, 0x280, and 0x290. The DAQPad-1200 can use the parallel port hardware interrupts for interrupt-driven data acquisition. Interrupt levels 7 and 5 are commonly used for parallel ports. Refer to your parallel port reference manual for details about interrupt selection and address assignment. If you have problems configuring your parallel port, refer to Appendix B, *Parallel Port Configuration Troubleshooting*.

Analog I/O Configuration

On power up or after a software reset, the DAQPad-1200 is set to the following configuration:

- Referenced single-ended input mode
- ±5 V analog input range (bipolar)
- ±5 V analog output range (bipolar)

Table 2-1 lists all the available analog I/O configurations for the DAQPad-1200 and shows the configuration in reset condition.

Table 2-1. Analog I/O Settings

Parameter	Configuration
Analog Output CH0 Polarity	Bipolar–±5 V (reset condition); Unipolar–0 to 10 V
Analog Output CH1 Polarity	Bipolar–±5 V (reset condition); Unipolar–0 to 10 V
Analog Input Polarity	Bipolar–±5 V (reset condition); Unipolar–0 to 10 V
Analog Input Mode	Referenced single-ended (RSE) (reset condition) Nonreferenced single-ended (NRSE) Differential (DIFF)

Both the analog input and analog output circuitries are software configurable.

Analog Output Polarity

The DAQPad-1200 has two channels of analog output voltage at the front panel I/O connector. You can configure each analog output channel for either unipolar or bipolar output. A unipolar configuration has a range of 0 to 10 V at the analog output. A bipolar configuration has a range of -5 V to +5 V at the analog output. In addition, you can select the coding scheme for each DAC as either two's complement or straight binary. If you select a bipolar range for a DAC, the two's complement coding is recommended. In this mode, data values written to the analog output channel range from F800 hex (-2,048 decimal) to 7FF hex (2,047 decimal). If you select a unipolar range for a DAC, the straight binary coding is recommended. In this mode, data values written to the analog output channel range from 0 to FFF hex (4,095 decimal).

Analog Input Polarity

You can select the analog input on the DAQPad-1200 for either a unipolar range (0 to 10 V) or a bipolar range (-5 to +5 V). In addition, you can select the coding scheme for analog input as either two's complement or straight binary. If you select a bipolar range, the two's complement coding is recommended. In this mode, -5 V input corresponds to F800 hex (-2,048 decimal) and +5 V corresponds to 7FF hex (2,047 decimal). If you select a unipolar mode, the straight binary coding is recommended. In this mode, 0 V input corresponds to 0 hex, and +10 V corresponds to FFF hex (4,095 decimal).

Analog Input Mode

The DAQPad-1200 has three different input modes–referenced single-ended (RSE) input, nonreferenced single-ended (NRSE) input, and differential (DIFF) input. The single-ended input configurations use eight channels. The DIFF input configuration uses four channels. Table 2-2 describes these configurations.

Table 2-2. Analog Input Modes for the DAQPad-1200

Analog Input Modes	Description
RSE	Referenced single-ended mode provides eight single-ended inputs with the negative input of the instrumentation amplifier referenced to analog ground (reset condition).
NRSE	Nonreferenced single-ended mode provides eight single-ended inputs with the negative input of the instrumentation amplifier tied to AISENSE/AIGND and not connected to ground.
DIFF	Differential mode provides four differential inputs with the positive (+) input of the instrumentation amplifier tied to channels 0, 2, 4, or 6 and the negative (-) input tied to channels 1, 3, 5, or 7, respectively, thus choosing channel pairs (0, 1), (2, 3), (4, 5), or (6, 7).

While reading the following paragraphs, you may find it helpful to refer to the *Analog Input Signal Connections* section of Chapter 3, which contains diagrams showing the signal paths for the three configurations.

RSE Input (Eight Channels, Reset Condition)

RSE input means that all input signals are referenced to a common ground point that is also tied to the DAQPad-1200 analog input ground. The differential amplifier negative input is tied to analog ground. The RSE configuration is useful for measuring floating signal sources. With this input configuration, the DAQPad-1200 can monitor eight different analog input channels.

Considerations for using the RSE configuration are discussed in Chapter 3, *Signal Connections*. Notice that in this mode, the return path of the signal is analog ground, at the connector through the AISENSE/AIGND pin.

NRSE Input (Eight Channels)

NRSE input means that all input signals are referenced to the same common-mode voltage, which floats with respect to the DAQPad-1200 analog ground. This common-mode voltage is subsequently subtracted by the input instrumentation amplifier. The NRSE configuration is useful for measuring ground-referenced signal sources.

Considerations for using the NRSE configuration are discussed in Chapter 3, *Signal Connections.* Notice that in this mode, the return path of the signal is through the negative terminal of the amplifier, at the connector through the AISENSE/AIGND pin.

DIFF Input (Four Channels)

DIFF input means that each input signal has its own reference, and the difference between each signal and its reference is measured. The signal and its reference are each assigned an input channel. With this input configuration, the DAQPad-1200 can monitor four differential analog input signals.

Considerations for using the DIFF configuration are discussed in Chapter 3, *Signal Connections*. Notice that the signal return path is through the negative terminal of the amplifier and through channel 1, 3, 5, or 7, depending on which channel pair you select.

Chapter 3
Signal Connections

This chapter describes the connection of a standard parallel port device to the rear panel transparent parallel port connector, the signal connections to the DAQPad-1200 unit via the DAQPad-1200 front I/O connector, and includes specifications and connection instructions for the DAQPad-1200 connector signals.

Transparent Parallel Port Connector

Note: ***You must power on the DAQPad-1200 to operate the standard parallel port device which is connected to the transparent parallel port connector.***

The DAQPad-1200 supports transparent parallel port connection to any standard parallel port device. The DAQPad-1200 does not support transparent parallel port connection to any device which supports the 1284 daisy-chain specification as defined by DISTEC, Inc.

When you power up the DAQPad-1200, the unit is in transparent mode. If you are using NI-DAQ, the DAQPad-1200 will be placed into transparent mode at the completion of every operation. In this mode, the DAQPad-1200 will transparently pass through all of the parallel port lines with minimal propagation delay. In normal applications, you operate either the DAQPad-1200 or the standard parallel port device connected to the transparent parallel port connector at any one time. For example, you cannot use a printer connected to the transparent parallel port connector and perform a DAQ operation at the same time. You can use the printer only after the DAQ operation has finished.

Front Connector

Figure 3-1 shows the pin assignments for the DAQPad-1200 front I/O connector. This connector is located on the front panel of the DAQPad-1200 unit.

Warning: ***Connections that exceed any of the maximum ratings of input or output signals on the DAQPad-1200 may result in damage to the DAQPad-1200 unit and to the PC. This includes connecting any power signals to ground and vice versa. National Instruments is NOT liable for any damages resulting from any such signal connections.***

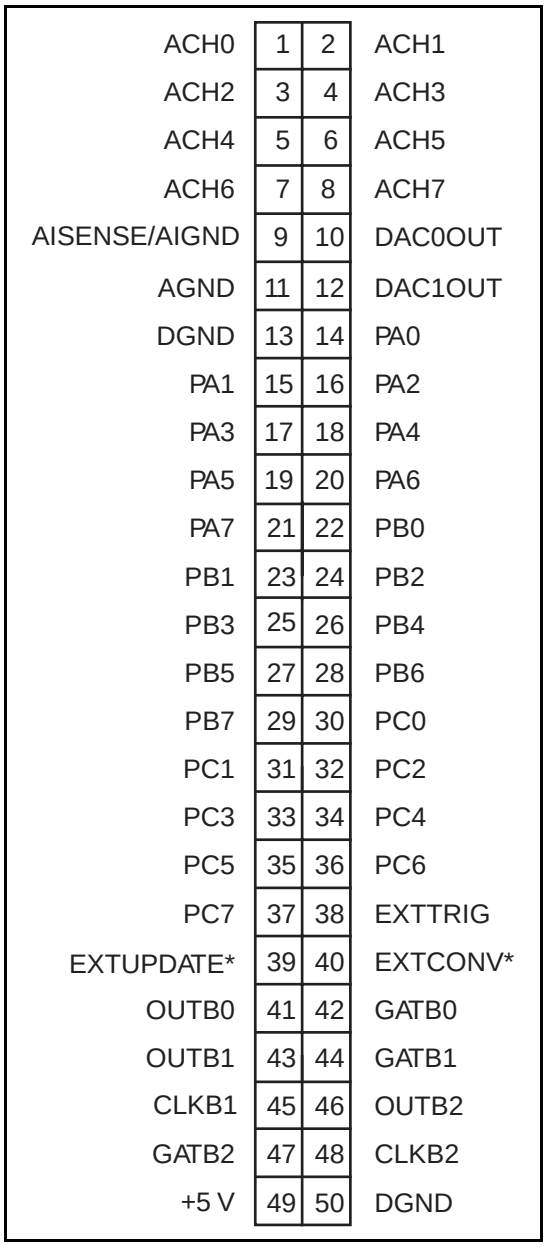


Figure 3-1. DAQPad-1200 Front I/O Connector Pin Assignments

Signal Connection Descriptions

The following table describes the connector pins on the DAQPad-1200 front I/O connector by pin number and gives the signal name and the significance of each signal connector pin.

Signal Name	Direction	Reference	Description
ACH<0..7>	AI	AGND	Analog Channel 0 through 7—Analog input channels 0 through 7.
AISENSE/AIGND	I/O	AGND	Analog Input Sense/Analog Input Ground—Connected to AGND in RSE mode, analog input sense in NRSE mode.
DAC0OUT	AO	AGND	Digital-to-Analog Converter 0 Output—Voltage output signal for analog output channel 0.
AGND	N/A	N/A	Analog Ground—Analog output ground reference for analog output voltages. Bias current return point for differential measurements.
DAC1OUT	AO	AGND	Digital-to-Analog Converter 1 Output—Voltage output signal for analog output channel 1.
DGND	N/A	N/A	Digital Ground—Voltage ground reference for the digital signals and the +5 V supply.
PA<0..7>	DI/O	DGND	Port A 0 through 7—Bidirectional data lines for port A. PA7 is the MSB, and PA0 is the LSB.
PB<0..7>	DI/O	DGND	Port B 0 through 7—Bidirectional data lines for port B. PB7 is the MSB, and PB0 is the LSB.
PC<0..7>	DI/O	DGND	Port C 0 through 7—Bidirectional data lines for port C. PC7 is the MSB, and PC0 is the LSB.
EXTTRIG	DI	DGND	External Trigger—External control signal to trigger a DAQ operation.
EXTUPDATE*	DI	DGND	External Update—External control signal to update DAC outputs.
EXTCONV*	DI	DGND	External Convert—External control signal to time A/D conversions.
OUTB0	DO	DGND	Output B0—Voltage output signal of counter B0.
GATB0	DI	DGND	Gate B0—External control signal for gating counter B0.
OUTB1	DI/O	DGND	OutputB1—Voltage output signal of counter B1 when selected as output. External control signal for timing an interval cycle when selected as input.
GATB1	DI	DGND	Gate B1—External control signal for gating counter B1.
CLKB1	DI	DGND	Clock B1—External control clock signal for counter B1.
OUTB2	DO	DGND	Counter B2—Voltage output signal of counter B2.
GATB2	DI	DGND	Gate B2—External control signal for gating counter B2.
CLKB2	DI	DGND	Clock B2—External control clock signal for counter B2.
+5 V	DO	DGND	+5 Volts—This pin is fused for up to 400 mA of +5 V supply.
DGND	N/A	N/A	Digital Ground—Voltage ground reference for the digital signals and the +5 V supply.

*Indicates that the signal is active low.

AI = Analog Input
AO = Analog Output
DI = Digital Input
DO = Digital Output
DI/O = Digital Input/Output
N/A = Not Applicable

The connector pins are grouped into analog input signal pins, analog output signal pins, digital I/O signal pins, timing I/O signal pins, and power connections. Signal connection guidelines for each of these groups are described in the following sections.

Analog Input Signal Connections

Pins 1 through 8 are analog input signal pins for the 12-bit ADC. Pin 9, AISENSE/AIGND, is an analog common signal. You can use this pin for a general analog power ground tie to the DAQPad-1200 in RSE mode, or as a return path in NRSE mode. Pin 11, AGND, is the bias current return point for differential measurements. Pins 1 through 8 are tied to the eight single-ended analog input channels of the input multiplexer through 4.7 kΩ series resistances. Pins 2, 4, 6, and 8 are also tied to an input multiplexer for DIFF mode.

The signal ranges for inputs ACH<0..7> at all possible gains are shown in Table 3-1 and Table 3-2. Exceeding the input signal range will not damage the input circuitry as long as the maximum input voltage rating of ±42 V is not exceeded. The DAQPad-1200 is guaranteed to withstand inputs up to the maximum input voltage rating.

Warning: ***Exceeding the input signal range results in distorted input signals. Exceeding the maximum input voltage rating may cause damage to the DAQPad-1200 unit and to the computer. National Instruments is NOT liable for any damages resulting from such signal connections.***

Table 3-1. Bipolar Analog Input Signal Range Versus Gain

Gain Setting	Input Signal Range
1	-5.0 to 4.99756 V
2	-2.5 to 2.49878 V
5	-1.0 to 0.99951 V
10	-500 to 499.756 mV
20	-250 to 249.877 mV
50	-100 to 99.951 mV
100	-50 to 49.975 mV

Table 3-2. Unipolar Analog Input Signal Range Versus Gain

Gain Setting	Input Signal Range
1	0 to 9.99756 V
2	0 to 4.99878 V
5	0 to 1.99951 V
10	0 to 999.756 mV
20	0 to 499.877 mV
50	0 to 199.951 mV
100	0 to 99.975 mV

How you connect analog input signals to the DAQPad-1200 depends on how you configure the DAQPad-1200 analog input circuitry and the type of input signal source. With different DAQPad-1200 configurations, you can use the DAQPad-1200 instrumentation amplifier in different ways. Figure 3-2 shows a diagram of the DAQPad-1200 instrumentation amplifier.

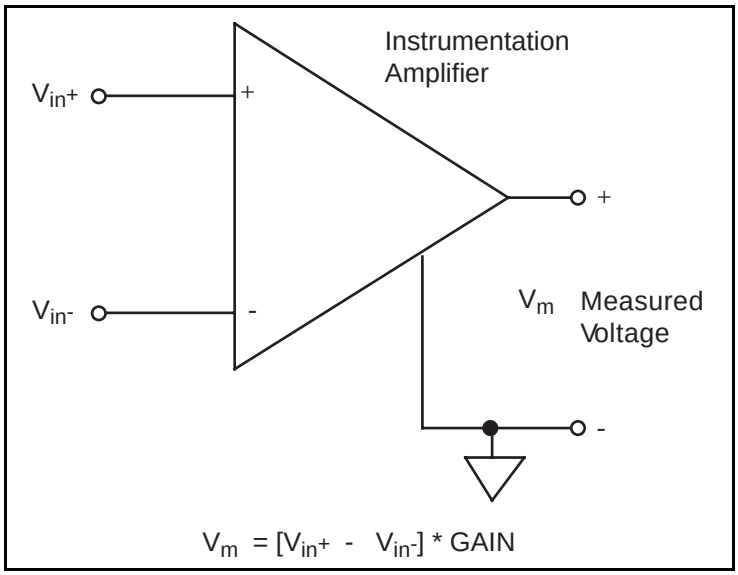


Figure 3-2. DAQPad-1200 Instrumentation Amplifier

The DAQPad-1200 instrumentation amplifier applies gain, common-mode voltage rejection, and high-input impedance to the analog input signals connected to the DAQPad-1200 unit. Signals are routed to the positive and negative inputs of the instrumentation amplifier through input multiplexers on the DAQPad-1200. The instrumentation amplifier converts two input signals to a signal that is the difference between the two input signals multiplied by the gain setting of the amplifier. The amplifier output voltage is referenced to the DAQPad-1200 ground. The DAQPad-1200 ADC measures this output voltage when it performs A/D conversions.

All signals must be referenced to ground, either at the source device or at the DAQPad-1200. If you have a floating source, you must use a ground-referenced input connection at the DAQPad-1200. If you have a grounded source, you must use a nonreferenced input connection at the DAQPad-1200.

Types of Signal Sources

When configuring the input mode of the DAQPad-1200 and making signal connections, you must first determine whether the signal source is floating or ground referenced. These two types of signals are described as follows.

Floating Signal Sources

A floating signal source is not connected in any way to the building ground system but has an isolated ground-reference point. Some examples of floating signal sources are outputs of transformers, thermocouples, battery-powered devices, optical isolator outputs, and isolation amplifiers. You must tie the ground reference of a floating signal to the DAQPad-1200 analog input ground to establish a local or onboard reference for the signal. Otherwise, the measured input signal varies or appears to float. An instrument or device that supplies an isolated output falls into the floating signal source category.

Ground-Referenced Signal Sources

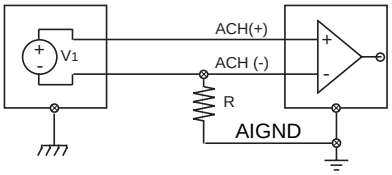
A ground-referenced signal source is connected in some way to the building system ground and is therefore already connected to a common ground point with respect to the DAQPad-1200, assuming that the PC is plugged into the same power system. Nonisolated outputs of instruments and devices that plug into the building power system fall into this category.

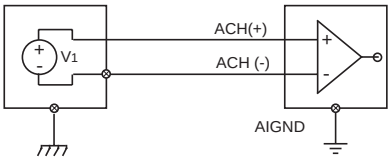
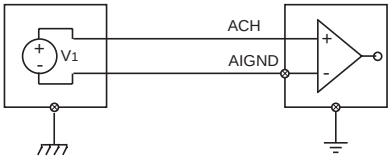
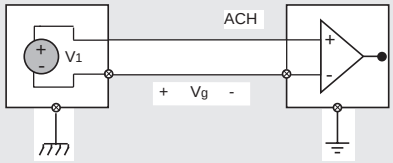
The difference in ground potential between two instruments connected to the same building power system is typically between 1 mV and 100 mV but can be much higher if power distribution circuits are not properly connected. The connection instructions that follow for grounded signal sources eliminate this ground potential difference from the measured signal.

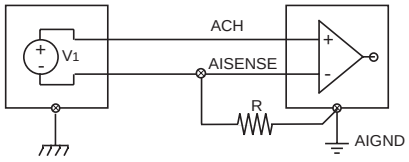
Note: ***If you power both the DAQPad-1200 and your PC with a floating power source (such as a battery), then your system may be floating with respect to earth ground. In this case, treat all of your signal sources as floating sources.***

Input Configurations

You can configure the DAQPad-1200 for one of three input modes—RSE, NRSE, or DIFF. The following sections discuss the use of single-ended and differential measurements, and considerations for measuring both floating and ground-referenced signal sources. Figure 3-3 summarizes the recommended input configurations for both types of signal sources.

<table>
<tr><th rowspan="2">Input</th><th colspan="2">Signal Source Type</th></tr>
<tr><th>Floating Signal Source
(Not Connected to Building Ground)</th><th>Grounded Signal Source</th></tr>
<tr><td></td><td>Examples
• Ungrounded Thermocouples
• Signal conditioning with isolated outputs
• Battery devices</td><td>Examples
• Plug-in instruments with nonisolated outputs</td></tr>
<tr><td>Differential
(DIFF)</td><td>

See text for information on bias resistors.</td><td>
</td></tr>
<tr><td>Single-Ended —
Ground
Referenced
(RSE)</td><td>
</td><td>NOT RECOMMENDED


Ground-loop losses, V_g, are added to measured signal</td></tr>
<tr><td>Single-Ended —
Nonreferenced
(NRSE)</td><td>

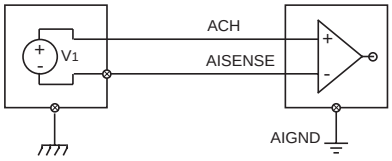
See text for information on bias resistors.</td><td>
</td></tr>
</table>

Figure 3-3. Summary of Analog Input Connections

Differential Connection Considerations (DIFF Configuration)

Differential connections are those in which each DAQPad-1200 analog input signal has its own reference signal or signal return path. These connections are available when you configure the DAQPad-1200 in the DIFF mode. Each input signal is tied to the positive input of the instrumentation amplifier, and its reference signal, or return, is tied to the negative input of the instrumentation amplifier.

When you configure the DAQPad-1200 for DIFF input, each signal uses two of the multiplexer inputs—one for the signal and one for its reference signal. Therefore, only four analog input channels are available when using the DIFF configuration. You should use the DIFF input configuration when any of the following conditions are present:

- Input signals are low level (less than 1 V).
- Leads connecting the signals to the DAQPad-1200 are greater than 15 ft.
- Any of the input signals requires a separate ground-reference point or return signal.
- The signal leads travel through noisy environments.

Differential signal connections reduce picked-up noise and increase common-mode signal and noise rejection. With these connections, input signals can float within the common-mode limits of the input instrumentation amplifier.

Differential Connections for Grounded Signal Sources

Figure 3-4 shows how to connect a ground-referenced signal source to a DAQPad-1200 unit configured for DIFF input. Configuration instructions are included in the *Analog I/O Configuration* section in Chapter 2, *Installation and Configuration*.

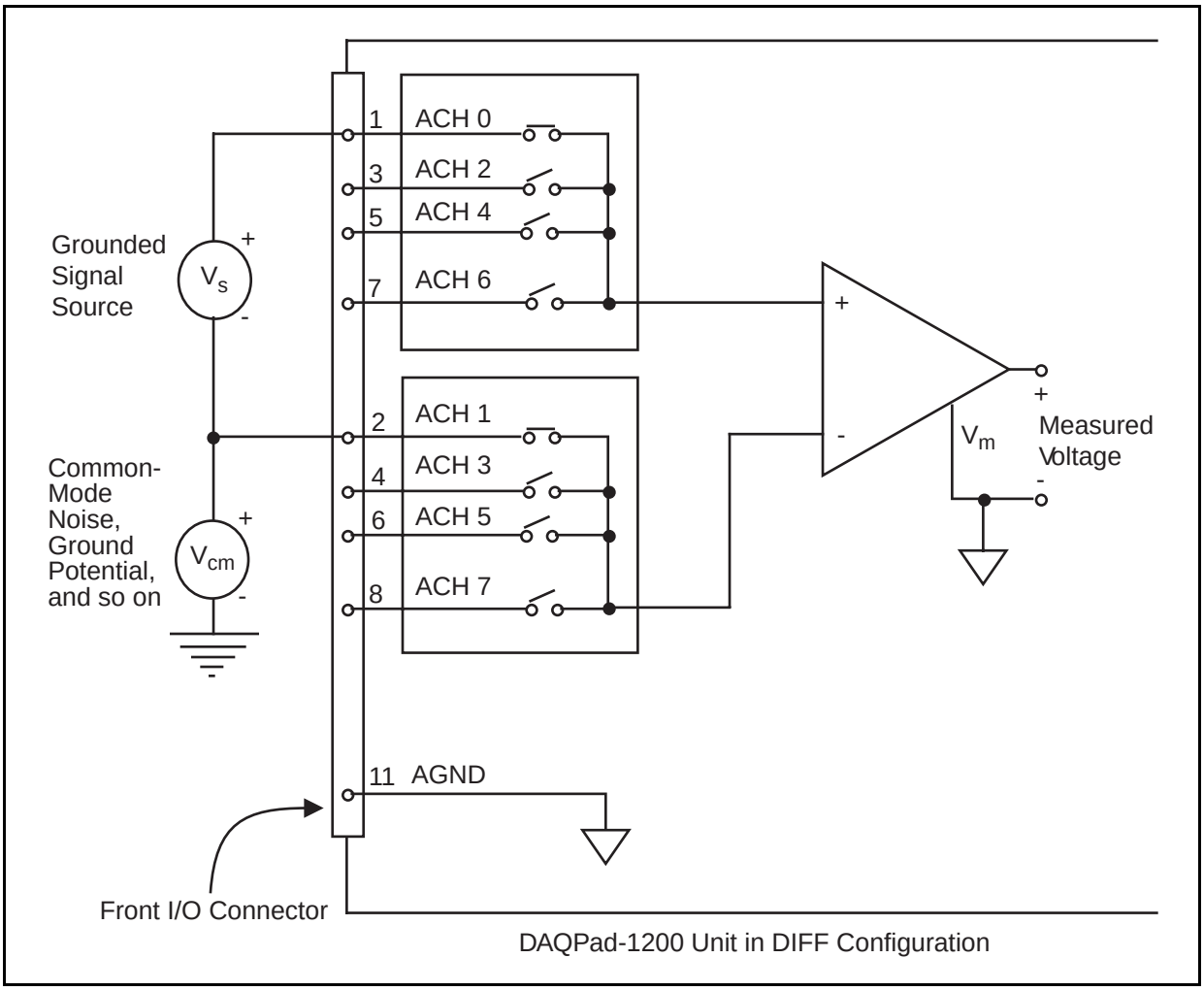


Figure 3-4. Differential Input Connections for Grounded Signal Sources

With this type of connection, the instrumentation amplifier rejects both the common-mode noise in the signal and the ground-potential difference between the signal source and the DAQPad-1200 ground (shown as V_{CM} in Figure 3-4).

Differential Connections for Floating Signal Sources

Figure 3-5 shows how to connect a floating signal source to a DAQPad-1200 unit that is configured for DIFF input. Configuration instructions are included in the *Analog I/O Configuration* section of Chapter 2, *Installation and Configuration*.

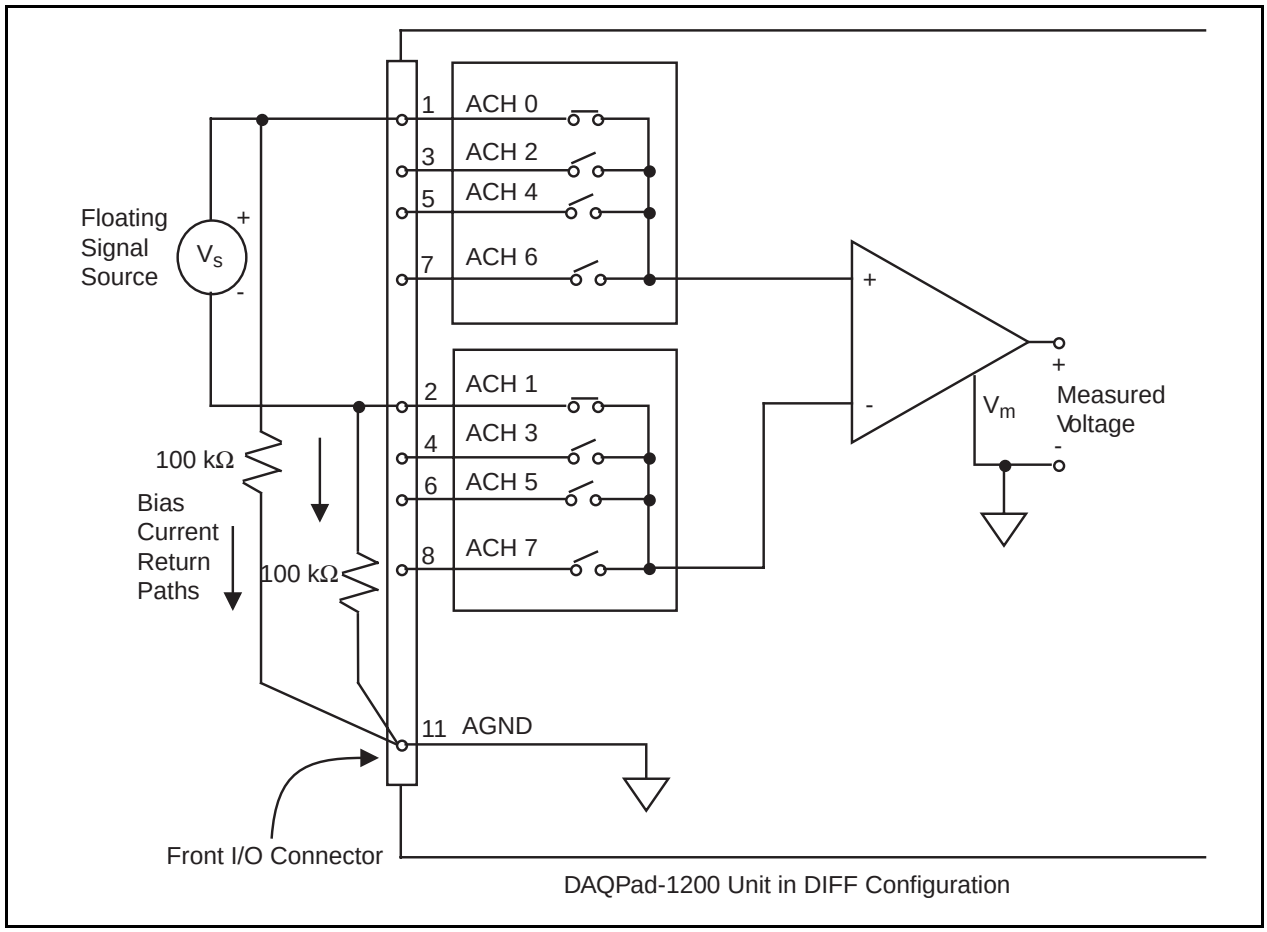


Figure 3-5. Differential Input Connections for Floating Sources

The 100 kΩ resistors shown in Figure 3-5 create a return path to ground for the bias currents of the instrumentation amplifier. If there is no return path, the instrumentation amplifier bias currents charge stray capacitances, resulting in uncontrollable drift and possible saturation in the amplifier. Typically, values from 10 to 100 kΩ are used.

A resistor from each input to ground, as shown in Figure 3-5, provides bias current return paths for an AC-coupled input signal.

If the input signal is DC-coupled, you need only the resistor that connects the negative signal input to ground. This connection does not lower the input impedance of the analog input channel.

Single-Ended Connection Considerations

Single-ended connections are those in which all DAQPad-1200 analog input signals are referenced to one common ground. The input signals are tied to the positive input of the instrumentation amplifier, and their common ground point is tied to the negative input of the instrumentation amplifier.

When the DAQPad-1200 is configured for single-ended input (NRSE or RSE), eight analog input channels are available. You can use single-ended input connections when the following criteria are met by all input signals:

1. Input signals are high level (greater than 1 V).

2. Leads connecting the signals to the DAQPad-1200 are less than 15 ft.

3. All input signals share a common reference signal (at the source).

If any of the preceding criteria are not met, using DIFF input configuration is recommended.

You can software configure the DAQPad-1200 for two different types of single-ended connections, RSE configuration and NRSE configuration. Use the RSE configuration for floating signal sources; in this case, the DAQPad-1200 provides the reference ground point for the external signal. Use the NRSE configuration for ground-referenced signal sources; in this case, the external signal supplies its own reference ground point and the DAQPad-1200 should not supply one.

Single-Ended Connections for Floating Signal Sources (RSE Configuration)

Figure 3-6 shows how to connect a floating signal source to a DAQPad-1200 unit configured for single-ended input. You must configure the DAQPad-1200 analog input circuitry for RSE input to make these types of connections. Configuration instructions are included in the *Analog I/O Configuration* section of Chapter 2, *Installation and Configuration*.

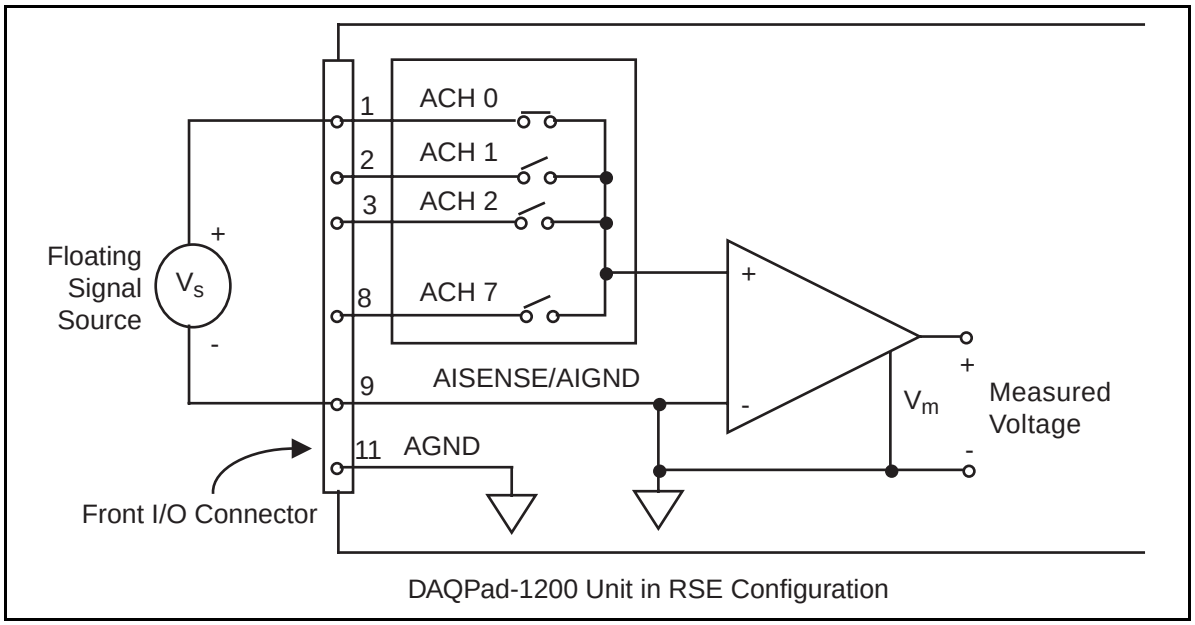


Figure 3-6. Single-Ended Input Connections for Floating Signal Sources

Single-Ended Connections for Grounded Signal Sources (NRSE Configuration)

If you measure a grounded signal source with a single-ended configuration, you must configure the DAQPad-1200 in the NRSE input configuration. The signal is connected to the positive input of the DAQPad-1200 instrumentation amplifier and the signal local ground reference is connected to the negative input of the DAQPad-1200 instrumentation amplifier. Therefore, you must connect the ground point of the signal to the AISENSE pin. Any potential difference between the DAQPad-1200 ground and the signal ground appears as a common-mode signal at both the positive and negative inputs of the instrumentation amplifier and is therefore rejected by the amplifier. On the other hand, if the input circuitry of the DAQPad-1200 is referenced to ground, such as in the RSE configuration, this difference in ground potentials appears as an error in the measured voltage.

Figure 3-7 shows how to connect a grounded signal source to a DAQPad-1200 unit configured in the NRSE configuration. Configuration instructions are included in the *Analog I/O Configuration* section in Chapter 2, *Installation and Configuration*.

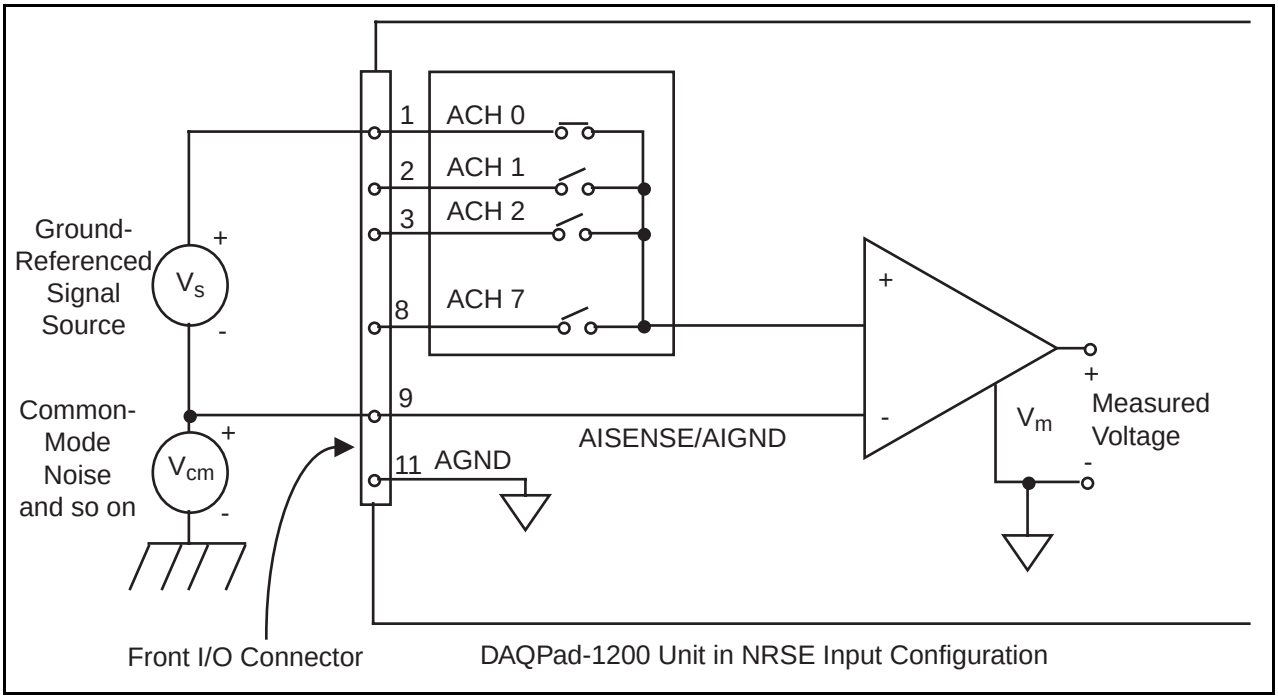


Figure 3-7. Single-Ended Input Connections for Grounded Signal Sources

Common-Mode Signal Rejection Considerations

Figures 3-4 and 3-7 show connections for signal sources that are already referenced to some ground point with respect to the DAQPad-1200. In these cases, the instrumentation amplifier can reject any voltage caused by ground-potential differences between the signal source and the DAQPad-1200. In addition, with differential input connections, the instrumentation amplifier can reject common-mode noise pickup in the leads connecting the signal sources to the DAQPad-1200.

The common-mode input range of the DAQPad-1200 instrumentation amplifier is the magnitude of the greatest common-mode signal that can be rejected.

The common-mode input range for the DAQPad-1200 depends on the size of the differential input signal ($V_{diff} = V^{+}_{in} - V^{-}_{in}$)and the gain setting of the instrumentation amplifier. In unipolar mode, the differential input range is 0 to 10 V. In bipolar mode, the differential input range is -5 to +5 V. Inputs should remain within a range of -5 to 10 V in both bipolar and unipolar modes.

Analog Output Signal Connections

Pins 10 through 12 of the front connector are analog output signal pins.

Pins 10 and 12 are the DAC0OUT and DAC1OUT signal pins. DAC0OUT is the voltage output signal for analog output channel 0. DAC1OUT is the voltage output signal for analog output channel 1.

Pin 11, AGND, is the ground-reference point for both analog output channels as well as analog input.

The following output ranges are available:

- Output signal range
  - Bipolar output ±5 V*
  - Unipolar output 0 to 10 V*

*Maximum load current ±2 mA for 12-bit linearity.

Figure 3-8 shows how to make analog output signal connections.

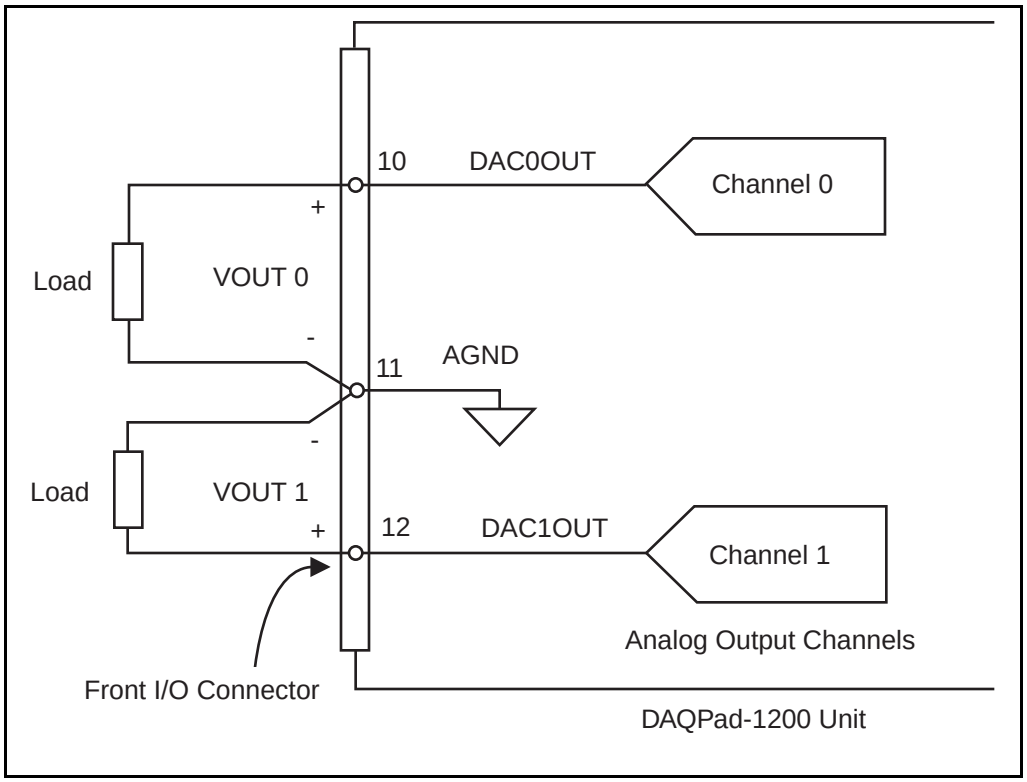


Figure 3-8. Analog Output Signal Connections

Digital I/O Signal Connections

Pins 13 through 37 of the front connector are digital I/O signal pins. Digital I/O on the DAQPad-1200 uses the 82C55A integrated circuit. The 82C55A is a general-purpose peripheral interface containing 24 programmable I/O pins. These pins represent the three 8-bit ports (PA, PB, and PC) of the 82C55A.

Pins 14 through 21 are connected to the digital lines PA<0..7> for digital I/O port A. Pins 22 through 29 are connected to the digital lines PB<0..7> for digital I/O port B. Pins 30 through 37 are connected to the digital lines PC<0..7> for digital I/O port C. Pin 13, DGND, is the digital ground pin for all three digital I/O ports. Refer to Appendix A, *Specifications*, for signal voltage and current specifications.

Figure 3-9 illustrates signal connections for three typical digital I/O applications.

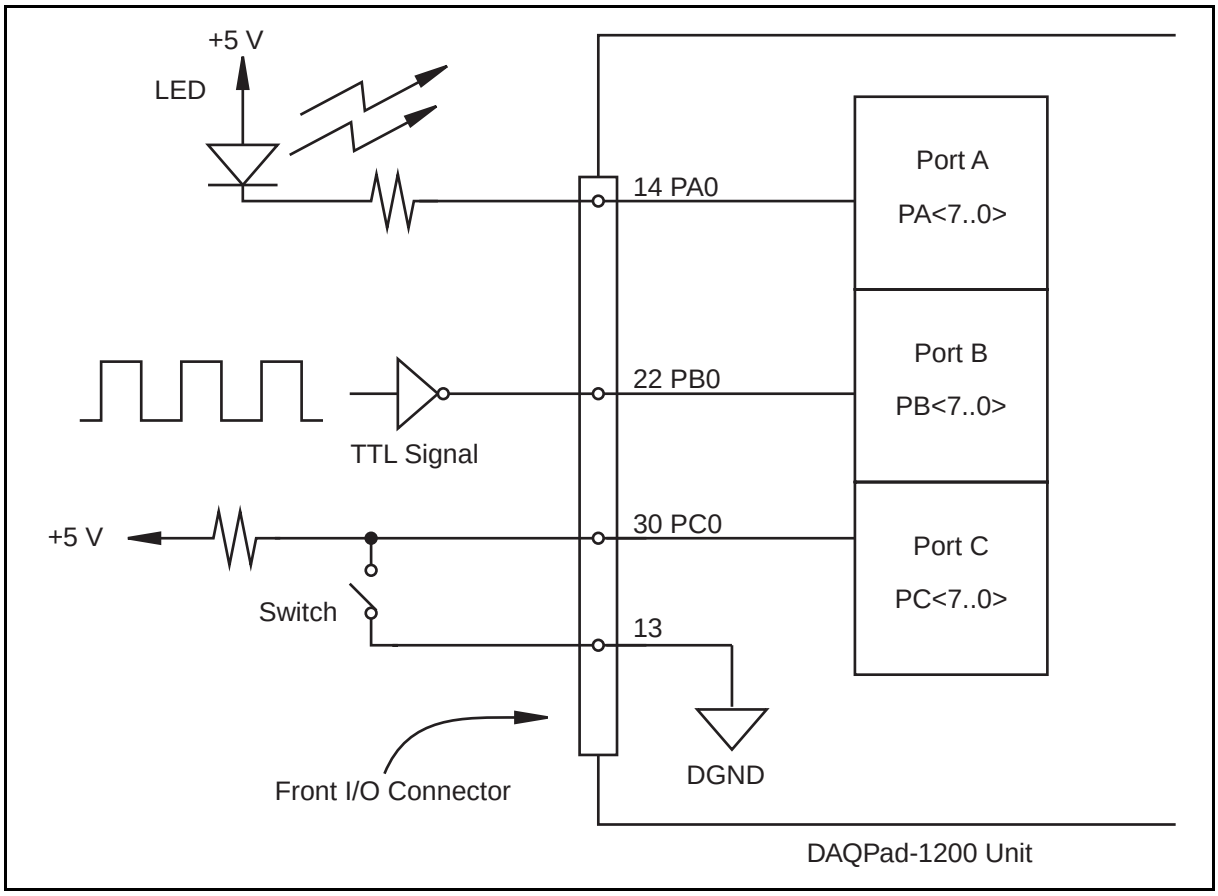


Figure 3-9. Digital I/O Connections

In Figure 3-9, port A is configured for digital output, and ports B and C are configured for digital input. Digital input applications include receiving TTL signals and sensing external device states such as the switch in Figure 3-9. Digital output applications include sending TTL signals and driving external devices such as the LED shown in Figure 3-9.

Port C Pin Connections

The signals assigned to port C depend on the mode in which the 82C55A is programmed. In mode 0, port C is considered to be two 4-bit I/O ports. In modes 1 and 2, port C is used for status and handshaking signals with two or three I/O bits mixed in. Table 3-3 summarizes the signal assignments of port C for each programmable mode. See your *DAQPad-1200 Register-Level Programmer Manual* for programming information.

Table 3-3. Port C Signal Assignments

Programmable Mode	Group A					Group B		
	PC7	**PC6**	**PC5**	**PC4**	**PC3**	**PC2**	**PC1**	**PC0**
Mode 0	I/O	I/O	I/O	I/O	I/O	I/O	I/O	I/O
Mode 1 Input	I/O	I/O	IBF_A	STB_A*	$INTR_A$	STB_B*	$IBFB_B$	$INTR_B$
Mode 1 Output	OBF_A*	ACK_A*	I/O	I/O	$INTR_A$	ACK_B*	OBF_B*	$INTR_B$
Mode 2	OBF_A*	ACK_A*	IBF_A	STB_A*	$INTR_A$	I/O	I/O	I/O
*Indicates that the signal is active low.								

Timing Specifications

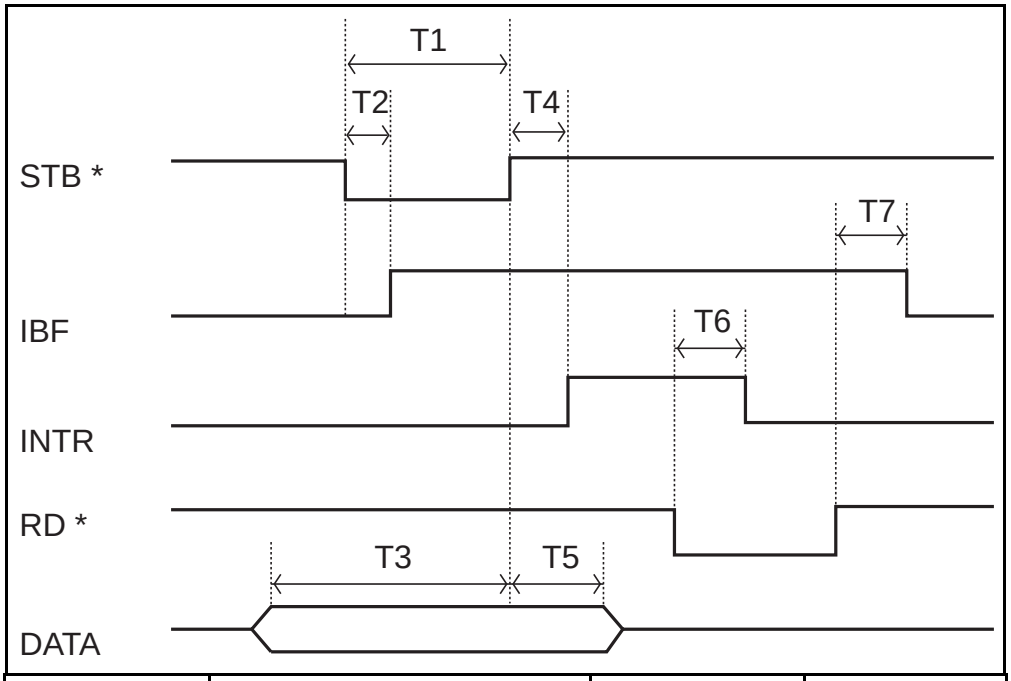
Use the handshaking lines STB* and IBF to synchronize input transfers. Use the handshaking lines OBF* and ACK* to synchronize output transfers.

The following signals are used in the timing diagrams shown later in this chapter:

Name	Type	Description
STB*	Input	Strobe Input—A low signal on this handshaking line loads data into the input latch.
IBF	Output	Input Buffer Full—A high signal on this handshaking line indicates that data has been loaded into the input latch. This is primarily an input acknowledge signal.
ACK*	Input	Acknowledge Input—A low signal on this handshaking line indicates that the data written from the specified port has been accepted. This signal is primarily a response from the external device that it has received the data from the DAQPad-1200.
OBF*	Output	Output Buffer Full—A low signal on this handshaking line indicates that data has been written from the specified port.
INTR	Output	Interrupt Request—This signal becomes high when the 82C55A is requesting service during a data transfer. Set the appropriate interrupt enable signals to generate this signal.
RD*	Internal	Read Signal—This signal is the read signal generated from the parallel port interface circuitry.
WRT*	Internal	Write Signal—This signal is the write signal generated from the parallel port interface circuitry.
DATA	Bidirectional	Data Lines at the Specified Port—This signal indicates when the data on the data lines at a specified port is or should be available.

Mode 1 Input Timing

The timing specifications for an input transfer in mode 1 are as follows:



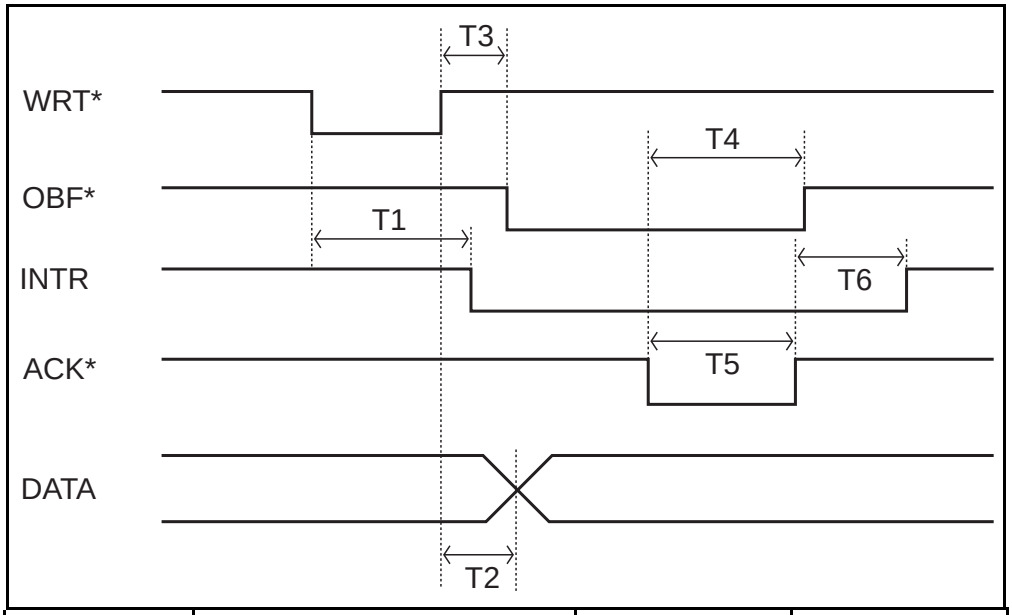
Name	Description	Minimum	Maximum
T1	STB* pulse width	500	–
T2	STB* = 0 to IBF = 1	–	300
T3	Data before STB*= 1	0	–
T4	STB* = 1 to INTR = 1	–	300
T5	Data after STB* = 1	180	–
T6	RD* = 0 to INTR = 0	–	400
T7	RD* = 1 to IBF = 0	–	300

All timing values are in nanoseconds.

Figure 3-10. Mode 1 Timing Specifications for Input Transfers

Mode 1 Output Timing

The timing specifications for an output transfer in mode 1 are as follows:



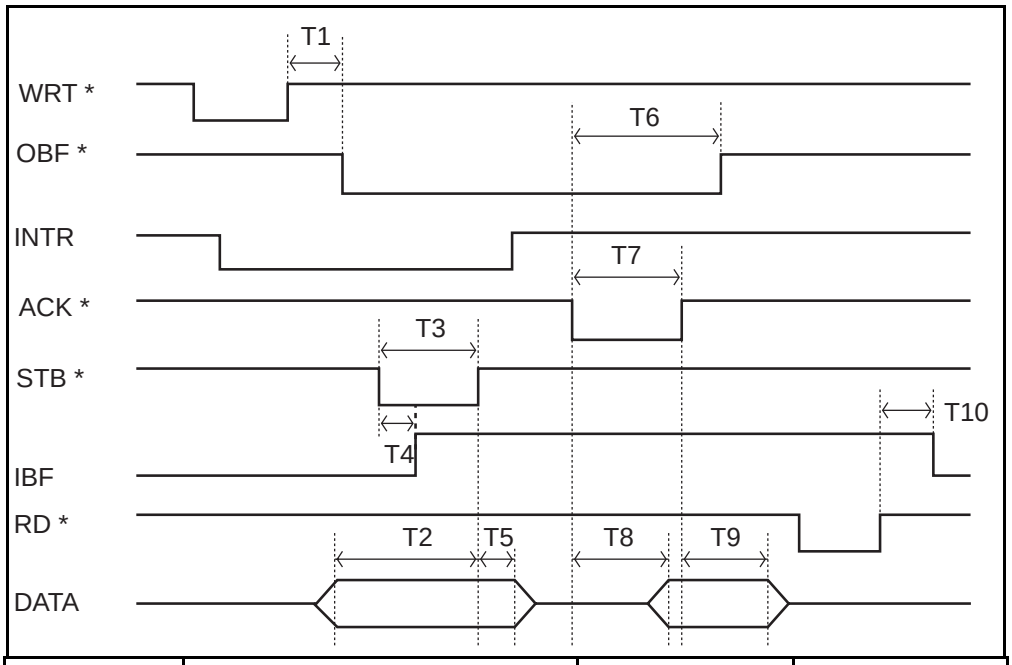
Name	Description	Minimum	Maximum
T1	WRT* = 0 to INTR = 0	–	450
T2	WRT* = 1 to output	–	350
T3	WRT* = 1 to OBF* = 0	–	650
T4	ACK* = 0 to OBF* = 1	–	350
T5	ACK* pulse width	300	–
T6	ACK* = 1 to INTR = 1	–	350

All timing values are in nanoseconds.

Figure 3-11. Mode 1 Timing Specifications for Output Transfers

Mode 2 Bidirectional Timing

The timing specifications for bidirectional transfers in mode 2 are as follows:



Name	Description	Minimum	Maximum
T1	WRT* = 1 to OBF* = 0	–	650
T2	Data before STB*= 1	0	–
T3	STB* pulse width	500	–
T4	STB* = 0 to IBF = 1	–	300
T5	Data after STB* = 1	180	–
T6	ACK* = 0 to OBF = 1	–	350
T7	ACK* pulse width	300	–
T8	ACK* = 0 to output	–	300
T9	ACK* = 1 to output float	20	250
T10	RD* = 1 to IBF = 0	–	300

All timing values are in nanoseconds.

Figure 3-12. Mode 2 Timing Specification for Bidirectional Transfers

DAQ and General-Purpose Timing Signal Connections

Pins 38 through 48 of the front connector are connections for timing I/O signals. The DAQPad-1200 timing I/O uses two 82C53 counter/timer integrated circuits. One circuit, designated 82C53(A), is used exclusively for DAQ timing, and the other, 82C53(B), is available for general use. You can use pins 38 through 40 and pin 43 to carry external signals for DAQ timing in place of the dedicated 82C53(A). These signals are explained in the next section, *DAQ Timing Connections*. Pins 41 through 48 carry general-purpose timing signals from 82C53(B). These signals are explained in the *General-Purpose Timing Signal Connections* section later in this chapter.

DAQ Timing Connections

Each 82C53 counter/timer circuit contains three counters. Counter 0 on the 82C53(A) counter/timer (referred to as A0) is a sample-interval counter in timed A/D conversions. Counter 1 on the 82C53(A) counter/timer (referred to as A1) is a sample counter in controlled A/D conversions. Therefore, counter A1 stops data acquisition after a predefined number of samples. These counters are not available for general use.

Instead of counter A0, you can use EXTCONV* to externally time conversions. Figure 3-13 shows the timing requirements for the EXTCONV* input. An A/D conversion is initiated by a falling edge on the EXTCONV*.

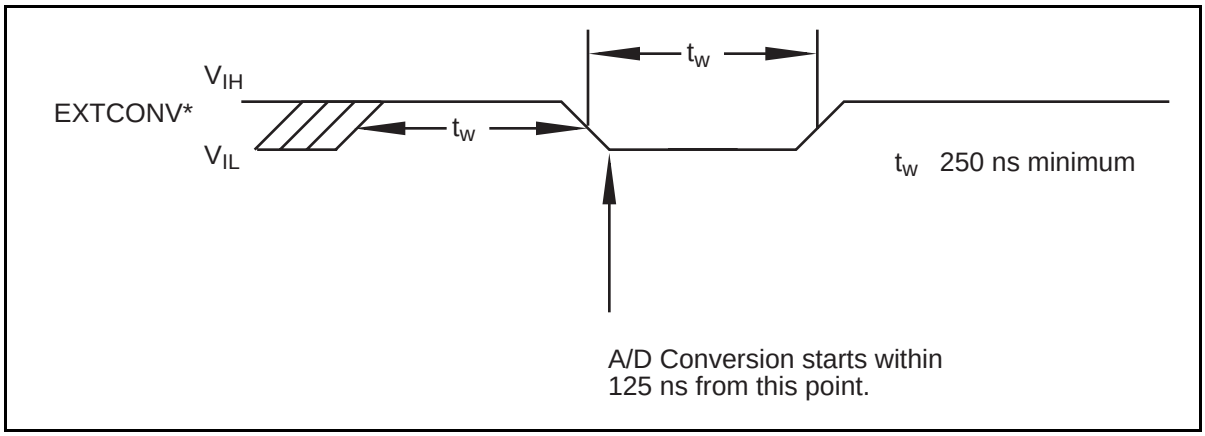


Figure 3-13. EXTCONV* Signal Timing

The external control signal EXTTRIG can either start a DAQ sequence or terminate an ongoing DAQ sequence depending on the mode—Posttrigger (POSTTRIG) or Pretrigger (PRETRIG). These modes are software selectable.

In the POSTTRIG mode, EXTTRIG serves as an external trigger that initiates a DAQ sequence. When you use counter A0 to time sample intervals, a rising edge on EXTTRIG starts counter A0 and the DAQ sequence. When you use EXTCONV* to time sample intervals, data acquisition is enabled on a rising edge of EXTTRIG followed by a rising edge on EXTCONV*. The first conversion occurs on the next falling edge of EXTCONV*. Further transitions on the EXTTRIG line have no effect until a new DAQ sequence is established.

Figure 3-14 shows a possible controlled DAQ sequence using EXTCONV* and EXTTRIG. The rising edge of EXTCONV* that enables external conversions must occur a minimum of 50 ns after the rising edge of EXTTRIG. The first conversion occurs on the next falling edge of EXTCONV*.

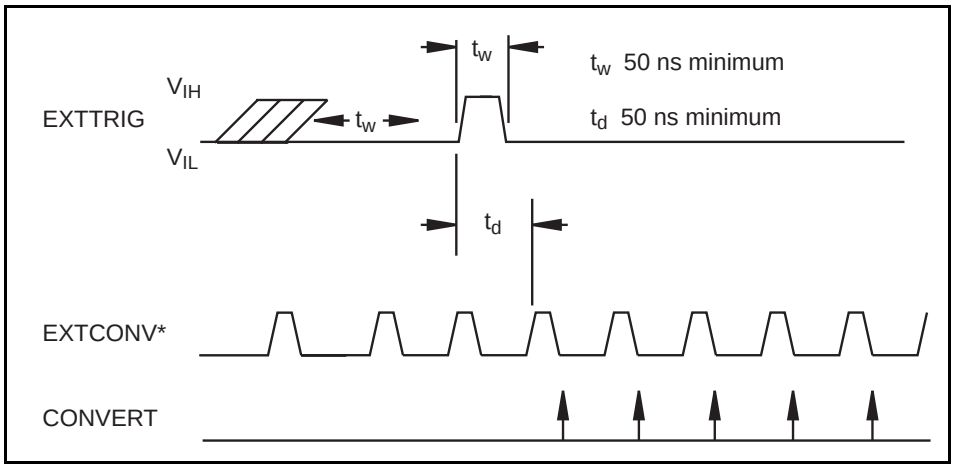


Figure 3-14. Posttrigger DAQ Timing

In the PRETRIG mode, EXTTRIG serves as a stop-trigger signal. Data is acquired both before and after the stop trigger occurs. A/D conversions are software enabled, which initiates the DAQ operation. However, the sample counter is not started until a rising edge is sensed on the EXTTRIG input. Conversions remain enabled until the sample counter counts to zero. The maximum number of samples acquired after the stop trigger is limited to 65,535. The number of samples acquired before the trigger is limited only by the size of the memory buffer available for data acquisition.

Figure 3-15 shows a pretrigger DAQ timing sequence using EXTTRIG and EXTCONV*. The DAQ operation has been initiated through software. Notice that the sample counter has been programmed to allow five conversions after the rising edge on the EXTTRIG signal. Additional transitions on the EXTTRIG line have no effect until you initiate a new DAQ sequence.

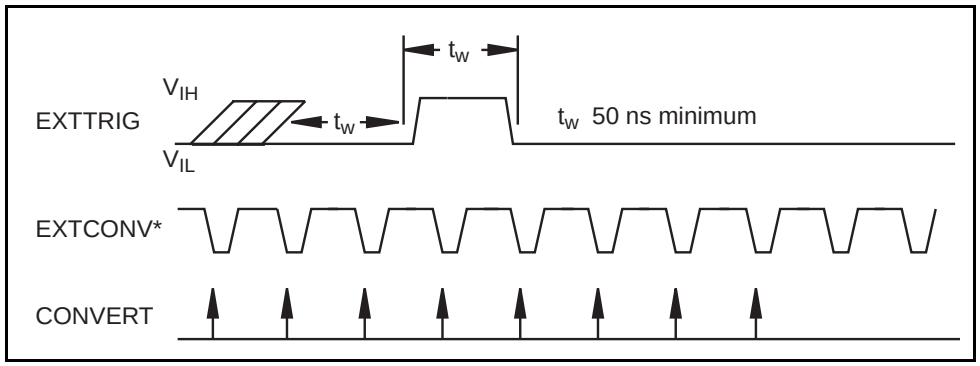


Figure 3-15. Pretrigger DAQ Timing

Because both pretrigger and posttrigger modes use EXTTRIG input, you can only use one mode at a time.

For interval scanning data acquisition, counter B1 determines the scan interval. Instead of using counter B1, you can externally time the scan interval through OUTB1. If you externally time the sample interval, we recommend that you also externally time the scan interval.

Figure 3-16 shows an example of a multiple-channel interval-scanning DAQ operation. The scan interval and the sample interval are being timed externally through OUTB1 and EXTCONV*. Channels 1 and 0 of the input multiplexers are being scanned once during each scan interval. The first rising edge of EXTCONV* must occur a minimum of 50 ns after the rising edge on OUTB1. The first rising edge of EXTCONV* after the rising edge of OUTB1 enables an internal GATE signal that allows conversions to occur. The first conversion then occurs on the following falling edge of EXTCONV*.

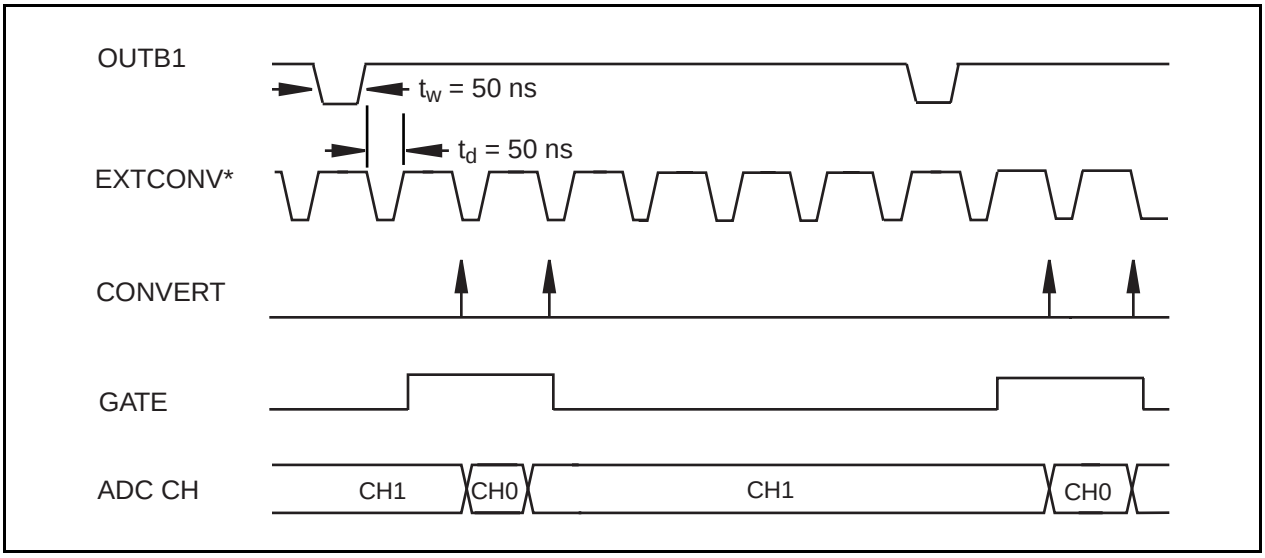


Figure 3-16. Interval-Scanning Signal Timing

You use the final external control signal, EXTUPDATE*, to externally control updating the output voltage of the 12-bit DACs and/or to generate an externally timed interrupt. There are two update modes, immediate update and delayed update. In immediate update mode the analog output is updated as soon as a value is written to the DAC. If you select the delayed update mode, a value is written to the DAC; however, the corresponding DAC voltage is not updated until a low level on the EXTUPDATE* signal is sensed. Furthermore, if you enable interrupt generation, an interrupt is generated whenever a rising edge is detected on the EXTUPDATE* bit. Therefore, you can perform externally timed interrupt-driven waveform generation on the DAQPad-1200.

Figure 3-17 illustrates a waveform generation timing sequence using the EXTUPDATE* signal and the delayed update mode. The DACs are updated by a high level on the DAC OUTPUT UPDATE signal, which in this case is triggered by a low level on the EXTUPDATE* line. CNTINT is the signal that interrupts the PC. This interrupt is generated on the rising edge of EXTUPDATE*. DACWRT is the signal that writes a new value to the DAC.

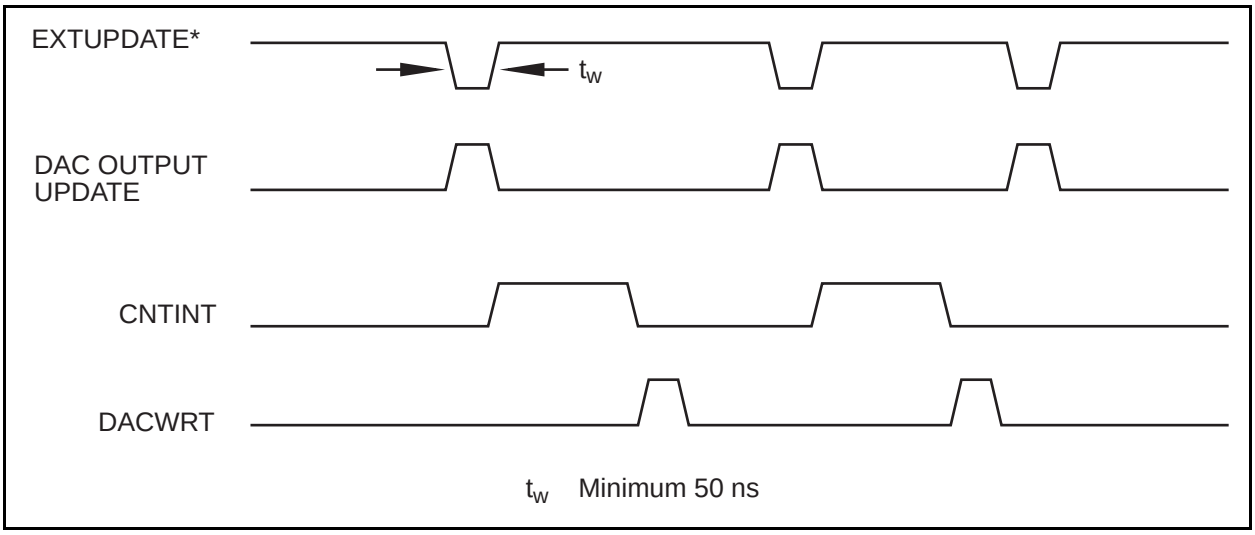


Figure 3-17. EXTUPDATE* Signal Timing for Updating DAC Output

The following rating applies to the EXTCONV*, EXTTRIG, OUTB1, and EXTUPDATE* signals.

- Absolute maximum voltage input rating -0.5 to 7.0 V with respect to DGND

For more information concerning the various modes of data acquisition and analog output, refer to your NI-DAQ manual or to Chapter 2, *Theory of Operation*, in the *DAQPad-1200 Register-Level Programmer Manual*.

General-Purpose Timing Signal Connections

The general-purpose timing signals include the GATE, CLK, and OUT signals for the three 82C53(B) counters. The 82C53 counter/timers can be used for general-purpose applications such as pulse and square wave generation; event counting; and pulse-width, time-lapse, and frequency measurement. For these applications, the CLK and GATE signals at the front I/O connector control the counters. The single exception is counter B0, which has an internal 2 MHz clock. Refer to the *DAQPad-1200 Register-Level Programmer Manual* for programming information.

You perform pulse and square wave generation by programming a counter to generate a timing signal at its OUT output pin. You perform event counting by programming a counter to count rising or falling edges applied to any of the 82C53 CLK inputs. You can then read the counter value to determine the number of edges that have occurred. You can gate counter operations on and off during event counting. Figure 3-18 shows connections for a typical event-counting operation in which a switch is used to gate the counter on and off.

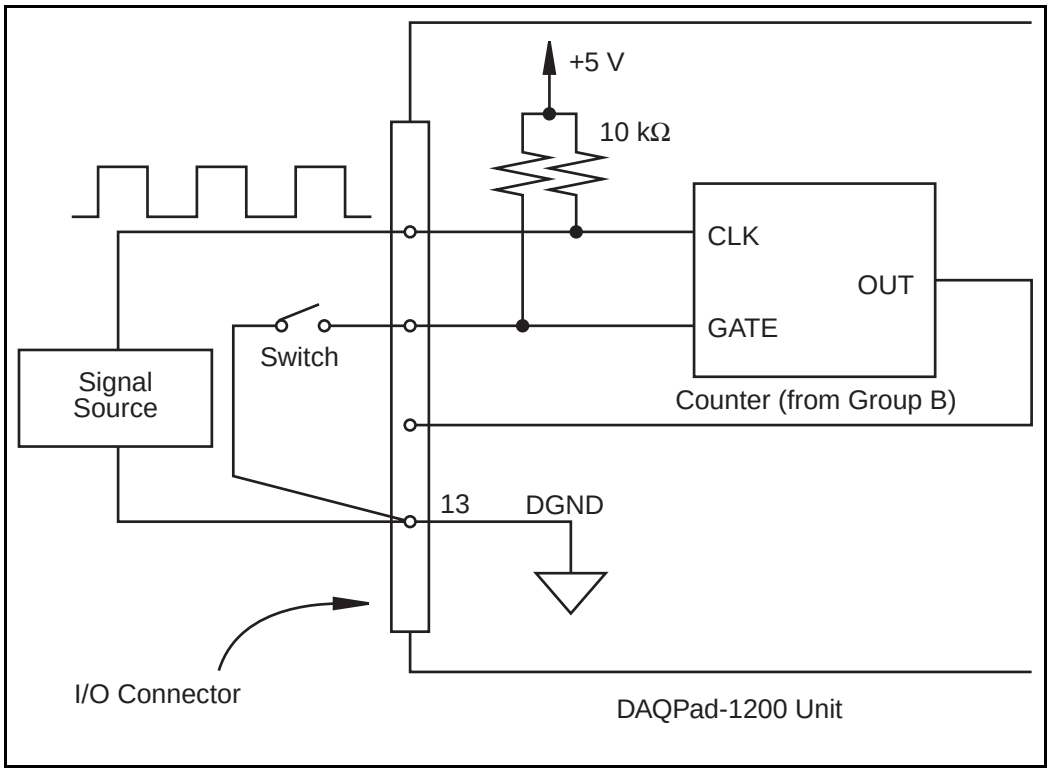


Figure 3-18. Event-Counting Application with External Switch Gating

Pulse-width measurement is performed by level gating. The pulse you want to measure is applied to the counter GATE input. The counter is loaded with the known count and is programmed to count down while the signal at the GATE input is high. The pulse width equals the counter difference (loaded value minus read value) multiplied by the CLK period.

Perform time-lapse measurement by programming a counter to be edge gated. An edge is applied to the counter GATE input to start the counter. You can program the counter to start counting after receiving a low-to-high edge. The time lapse since receiving the edge equals the counter value difference (loaded value minus read value) multiplied by the CLK period.

To perform frequency measurement, program a counter to be level gated and count the number of falling edges in a signal applied to a CLK input. The gate signal applied to the counter GATE input is of known duration. In this case, you program the counter to count falling edges at the CLK input while the gate is applied. The frequency of the input signal then equals the count value divided by the gate period. Figure 3-19 shows the connections for a frequency measurement application. You can also use a second counter to generate the gate signal in this application. In this case, program the second counter for a one-shot mode, which requires an external inverter to make the output pulse of the second counter active high.

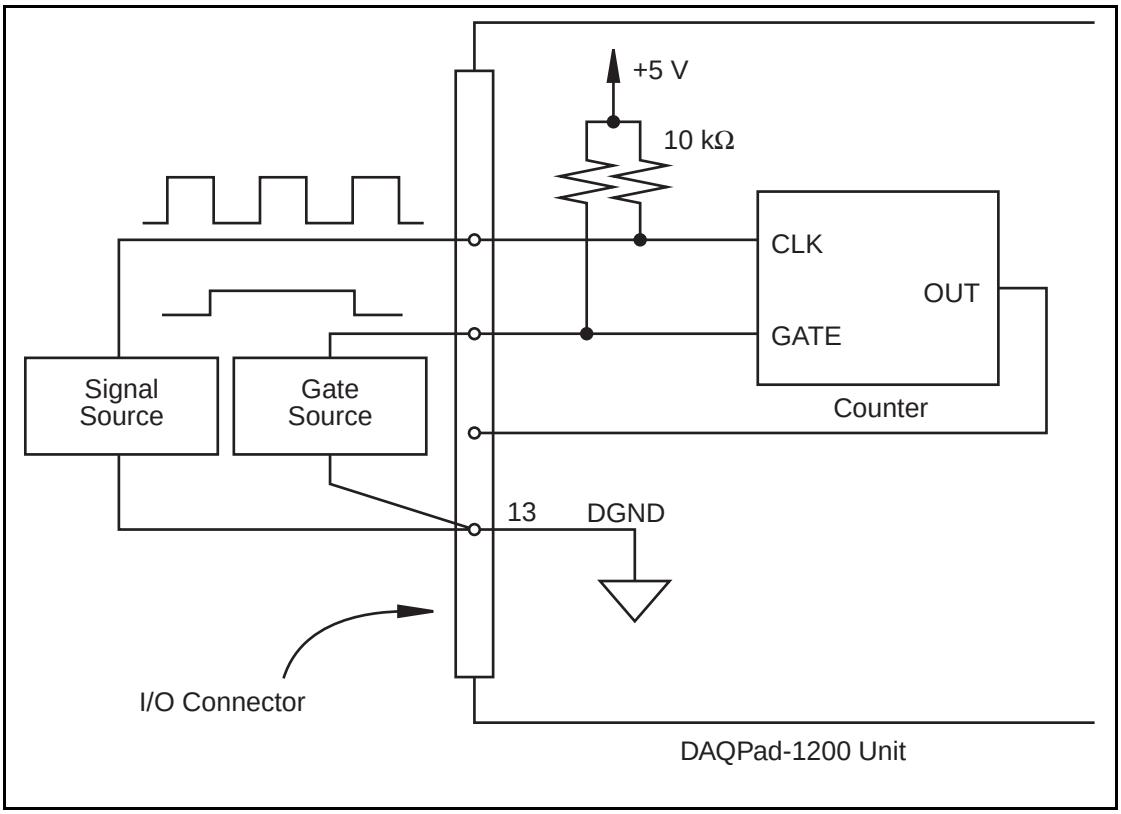
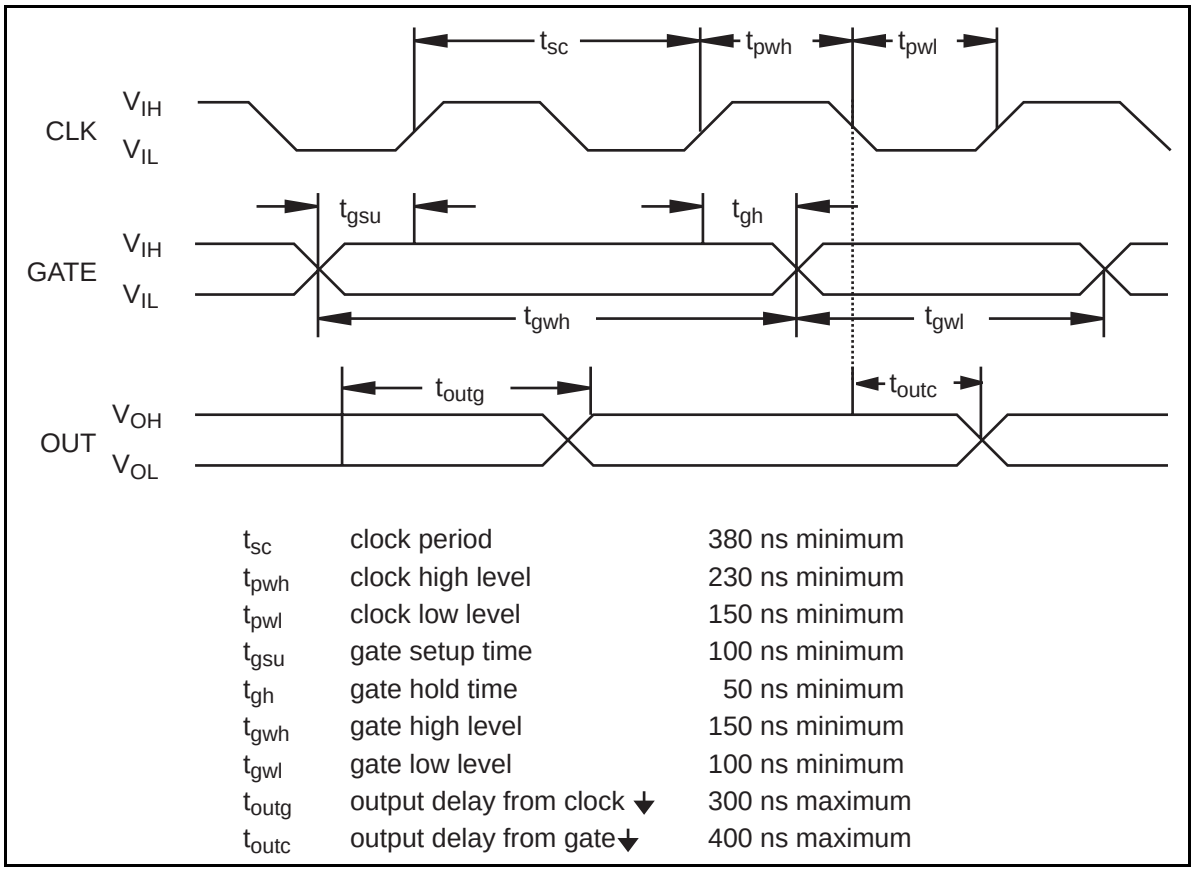


Figure 3-19. Frequency Measurement Application

The GATE, CLK, and OUT signals for counters B1 and B2 are available at the I/O front connector. The GATE and CLK pins are internally pulled up to +5 V through a 10 kΩ resistor. Refer to Appendix A, *Specifications*, for signal voltage and current specifications.

Figure 3-20 shows the timing requirements for the GATE and CLK input signals and the timing specifications for the OUT output signals of the 82C53.



t_{sc}	clock period	380 ns minimum
t_{pwh}	clock high level	230 ns minimum
t_{pwl}	clock low level	150 ns minimum
t_{gsu}	gate setup time	100 ns minimum
t_{gh}	gate hold time	50 ns minimum
t_{gwh}	gate high level	150 ns minimum
t_{gwl}	gate low level	100 ns minimum
t_{outg}	output delay from clock ↓	300 ns maximum
t_{outc}	output delay from gate ↓	400 ns maximum

Figure 3-20. General-Purpose Timing Signals

The GATE and OUT signals in Figure 3-20 are referenced to the rising edge of the CLK signal.

Power Connections

Pin 49 of the I/O connector supplies +5 V from the DAQPad-1200 power supply. This pin is referenced to DGND and you can use the +5 V to power external digital circuitry.

- Power rating 400 mA at +5 V max

Warning: ***Do not directly connect this +5 V power pin to any other voltage source on the DAQPad-1200 or any other device. Doing so can damage the DAQPad-1200 or your PC. National Instruments is NOT liable for any damage due to incorrect power connections.***

Pin 49 is fused for up to 400 mA. Shorting pin 49 to a ground will not damage the DAQPad-1200. If you do not receive +5 V from pin 49 of the I/O connector, make sure that the front panel rocker switch is turned on and check for any shorts between the +5 V power pin and ground.

Note: ***You can replace a blown fuse with the spare fuse located on the printed wire board by removing the two rear panel screws. However, we recommend that you contact National Instruments. The DAQPad-1200 uses a 400 mA, 63 V quick-acting surface mount fuse from Schurter.***

Field Wiring Considerations

Environmental noise can seriously affect the accuracy of measurements made with your DAQPad-1200 if you do not take proper care when running signal wires between signal sources and the board. The following recommendations apply mainly to analog input signal routing to the board, although they also apply to signal routing in general.

You can minimize noise pickup and maximize measurement accuracy by taking the following precautions:

- Use differential analog input connections to reject common-mode noise.
- Use individually shielded, twisted-pair wires to connect analog input signals to the DAQPad-1200. With this type of wire, the signals attached to the ACH+ and ACH- inputs are twisted together and then covered with a shield. You then connect this shield only at one point to the signal source ground. This kind of connection is required for signals traveling through areas with large magnetic fields or high electromagnetic interference.
- Route signals to the board carefully. Keep cabling away from noise sources. The most common noise source in a PC data acquisition system is the video monitor. Separate the monitor from the analog signals as much as possible.

The following recommendations apply for all signal connections to your DAQPad-1200:

- Separate DAQPad-1200 signal lines from high-current or high-voltage lines. These lines are capable of inducing currents in or voltages on the DAQPad-1200 signal lines if they run in parallel paths at a close distance. To reduce the magnetic coupling between lines, separate them by a reasonable distance if they run in parallel, or run the lines at right angles to each other.
- Do not run signal lines through conduits that also contain power lines.
- Protect signal lines from magnetic fields caused by electric motors, welding equipment, breakers, or transformers by running them through special metal conduits.

Chapter 4
Calibration

This chapter discusses the calibration procedures for the DAQPad-1200 analog I/O circuitry. However, the DAQPad-1200 is factory calibrated, and National Instruments can recalibrate your unit if needed. To maintain the 12-bit accuracy of the DAQPad-1200 analog input and analog output circuitry, recalibrate at 6 month intervals.

There are three ways to perform calibrations.

- Use the NI-DAQ `SCXI_1200_Calibrate` function. (This function is also used for the SCXI-1200 module, which is functionally equivalent to the DAQPad-1200.) This is the simplest method.
- Use the NI-DAQ functions to write to the calibration DACs and the EEPROM.
- Use your own register-level writes to the calibration DACs and the EEPROM.

To accomplish calibration using the last two methods, you need to know the details of the calibration process. This information is in the *Theory of Operation* chapter of the *DAQPad-1200 Register-Level Programmer Manual*.

The DAQPad-1200 is software calibrated, therefore there are no calibration trimpots. The unit is shipped with a utility software for calibration. The calibration process involves reading offset and gain errors from the analog input and analog output sections and writing values to the appropriate calibration DACs to null the errors. There are four calibration DACs associated with the analog input section and four calibration DACs associated with the analog output section, two for each output channel. After the calibration process is complete, each calibration DAC is at a known value. Because these values are lost when the board is powered down, they are also stored in the onboard EEPROM for future reference.

The factory information occupies one half of the EEPROM and is write protected. The lower half of the EEPROM contains user areas for calibration data. There are six different user areas. When the DAQPad-1200 is powered on, or the conditions under which it is operating change, you must load the calibration DACs with the appropriate calibration constants.

If you use the DAQPad-1200 with NI-DAQ and LabVIEW or LabWindows/CVI, the factory calibration constants are automatically loaded into the calibration DAC the first time a function pertaining to the DAQPad-1200 is called, and then each time you change your configuration (which includes gain). You can instead choose to load the calibration DACs with calibration constants from the user areas in the EEPROM or you can recalibrate the DAQPad-1200 and load these constants directly into the calibration DACs. Calibration software is included with the DAQPad-1200 as part of the NI-DAQ software.

Calibration at Higher Gains

The DAQPad-1200 has a maximum gain error of 0.5%. This means that if the board is calibrated at a gain of 1, and if the gain is switched to 100, a maximum of 50 mV error may result in the reading. Therefore, when you are recalibrating the DAQPad-1200, you should perform gain calibration at all other gains (2, 5, 10, 20, 50, and 100), and store the corresponding values in the user gain calibration data area of the EEPROM, thus ensuring a maximum error of 0.02 % at all gains.

Calibration Equipment Requirements

The equipment you use to calibrate the DAQPad-1200 should have a ±0.001% rated accuracy, which is 10 times as accurate as the DAQPad-1200. However, calibration with only four times the accuracy as the DAQPad-1200 and a ±0.003% rated accuracy are acceptable. The inaccuracy of the calibration equipment results only in gain error; offset error is unaffected.

Calibrate the DAQPad-1200 to a measurement accuracy of ±0.5 LSBs, which is within ±0.012% of its input range.

For analog input calibration, use a precision DC voltage source, such as a calibrator, with the following specifications.

Voltage	0 to 10 V
Accuracy	±0.001% standard
	±0.003% acceptable

Using the Calibration Function

NI-DAQ contains the `SCXI_1200_Calibrate` function, with which you can either load the calibration DACs with the factory constants or the user defined constants stored in the EEPROM, or perform your own calibration and directly load these constants into the calibration DACs. To use the `SCXI_1200_Calibrate` function for analog input calibration, you must ground an analog input channel at the front connector (for offset calibration) and apply an accurate voltage reference to another input channel (for gain calibration). For analog output calibration, the DAC0 and DAC1 outputs must be wrapped back and applied to two other analog input channels.

When you perform analog input calibration, you must first configure the ADC for referenced single-ended (RSE) mode and for the correct polarity at which you want to perform data acquisition. When you perform analog output calibration, you must first configure the analog input circuitry for RSE and for bipolar polarity, and you must configure the analog output circuitry for the correct polarity at which you want to perform output waveform generation. Refer to the *NI-DAQ User Manual for PC Compatibles* for more details on the `SCXI_1200_Calibrate` function.

Appendix A
Specifications

This appendix lists the specifications of the DAQPad-1200. These specifications are typical at 25° C unless otherwise stated. The operating temperature range is 0° to 50° C.

Analog Input

Input Characteristics

Number of channels	Eight single-ended, four differential, software selectable
Type of ADC	Successive approximation
Resolution	12 bits, 1 in 4,096
Conversion time (including acquisition time)	8.5 µs

Input signal ranges

Analog Input Signal Gain (Software Selectable)	Analog Input Signal Ranges (Software Selectable)	
	Bipolar	Unipolar
1	±5 V	0 to 10 V
2	±2.5 V	0 to 5 V
5	±1 V	0 to 2 V
10	±500 mV	0 to 1 V
20	±250 mV	0 to 500 mV
50	±100 mV	0 to 200 mV
100	±50 mV	0 to 100 mV

Input coupling	DC
Max working voltage	Input average should remain within 7 V of ground
Overvoltage protection	±42 V powered on, ±15 V powered off
Inputs protected	ACH0..ACH7
FIFO buffer size	2,048 samples
Data transfers	Interrupts, programmed I/O
Minimum DAQ Rate	1 sample every 35 minutes

Maximum Sustained DAQ Rates[1]

Acquisition Mode	Gain Setting	Rate	
		EPP Mode	Centronics Mode
Single channel	1, 2, 5, 10, 20, 50, 100	100 kS/s	25 kS/s
Multiple channel	1, 2, 5, 10	83.3 kS/s	25 kS/s
	20	62.5 kS/s	25 kS/s
	50	55.5 kS/s	25 kS/s
	100	25 kS/s	25 kS/s

Transfer Characteristics

Relative accuracy (nonlinearity)	±0.5 LSB typ, ±1.5 LSB max
INL	±0.5 LSB typ, ±1 LSB max
DNL	±0.5 LSB typ, ±1 LSB max
No missing codes	12 bits, guaranteed
Offset error	
After calibration, at all gains	±(5 μV + 0.36 mV/gain) max
Before calibration, at all gains	±(15 mV + 150 mV/gain) max
Offset adjustment range	±37 mV max
Gain error	
After calibration, at all gains	0.020% of reading max
Before calibration	
Gain = 1	2% of reading max
Gain ≠1 with gain error adjusted to 0 at gain = 1	0.5% of reading max
Gain adjustment range	±25 mV max

Amplifier Characteristics

Input bias current	200 pA max
Input offset current	100 pA max
Input impedance	100 GΩ in parallel with 45 pF

CMRR

Gain	CMRR DC to 60 Hz
1	60 dB
2	66 dB
5	74 dB
10 to 100	80 dB

Dynamic Characteristics

Analog input bandwidth

Gain	Single channel bandwidth
1 to 10	400 kHz
20	200 kHz
50	80 kHz
100	40 kHz

[1] Typical timing data observed in LabVIEW on a 486 DX2/66 MHz PC using a Trunknet plug-in Centronics parallel port card and a FarPoint F/Port plug-in enhanced parallel port card.

Settling time to full-scale step

Gain	Settling time to 0.012% (±0.5 LSB) accuracy
1	12 µs
2–50	16 µs typ, 18 µs max
100	40 µs

System noise (including quantization error)

Gain	Dither off	Dither on
1 to 50	0.3 LSB rms	0.6 LSB rms
100	0.6 LSB rms	0.8 LSB rms

Stability

Recommended warm-up time	15 min
Offset temperature coefficient	±(20 + 100/gain) µV/°C
Gain temperature coefficient	±50 ppm/°C

Explanation of Analog Input Specifications

Relative accuracy is a measure of the linearity of an ADC. However, relative accuracy is a tighter specification than a *nonlinearity* specification. Relative accuracy indicates the maximum deviation from a straight line for the analog-input-to-digital-output transfer curve. If an ADC has been calibrated perfectly, then this straight line is the ideal transfer function, and the relative accuracy specification indicates the worst deviation from the ideal that the ADC permits.

A relative accuracy specification of ±1 LSB is roughly equivalent to (but not the same as) a ±0.5 LSB nonlinearity or integral nonlinearity specification because relative accuracy encompasses both nonlinearity and variable quantization uncertainty, a quantity often mistakenly assumed to be exactly ±0.5 LSB. Although quantization uncertainty is ideally ±0.5 LSB, it can be different for each possible digital code and is actually the analog width of each code. Thus, it is more specific to use relative accuracy as a measure of linearity than it is to use what is normally called nonlinearity, because relative accuracy ensures that the *sum* of quantization uncertainty and A/D conversion error does not exceed a given amount.

Integral nonlinearity (INL) in an ADC is an often ill-defined specification that is supposed to indicate a converter's overall A/D transfer linearity. The manufacturer of the ADC chip used by National Instruments on the DAQPad-1200 specifies its integral nonlinearity by stating that the analog center of any code will not deviate from a straight line by more than ±1 LSB. This specification is misleading because although a particularly wide code's center may be found within ±1 LSB of the ideal, one of its edges may be well beyond ±1.5 LSB; thus, the ADC would have a relative accuracy of that amount. National Instruments tests its boards to ensure that they meet all three linearity specifications defined in this appendix.

Differential nonlinearity (DNL) is a measure of deviation of code widths from their theoretical value of 1 LSB. The width of a given code is the size of the range of analog values that can be input to produce that code, ideally 1 LSB. A specification of ±1 LSB differential nonlinearity ensures that no code has a width of 0 LSBs (that is, no missing codes) and that no code width exceeds 2 LSBs.

System noise is the amount of noise seen by the ADC when there is no signal present at the input of the board. The amount of noise that is reported directly (without any analysis) by the ADC is not necessarily the amount of real noise present in the system, unless the noise is considerably greater than 0.5 LSB rms. Noise that is less than this magnitude produces varying amounts of flicker, and the amount of flicker seen is a function of how near the real mean of the noise is to a code transition. If the mean is near or at a transition between codes, the ADC flickers evenly between the two codes, and the noise is very near 0.5 LSB. If the mean is near the center of a code and the noise is relatively small, very little or no flicker is seen, and the noise reported by the ADC as nearly 0 LSB. From the relationship between the mean of the noise and the measured rms magnitude of the noise, the character of the noise can be determined. National Instruments has determined that the character of the noise in the DAQPad-1200 is fairly Gaussian, so the noise specifications given are the amounts of pure Gaussian noise required to produce our readings.

Explanation of Dither

The *dither circuitry*, when enabled, adds approximately 0.5 LSB rms of white Gaussian noise to the signal to be converted to the ADC. This addition is useful for applications involving averaging to increase the resolution of the DAQPad-1200 to more than 12 bits, as in calibration. In such applications, which are often lower frequency in nature, noise modulation is decreased and differential linearity is improved by the addition of the dither. For high-speed 12-bit applications not involving averaging, dither should be disabled because it only adds noise.

When taking DC measurements, such as when calibrating the board, enable dither and average about 1,000 points to take a single reading. This process removes the effects of 12-bit quantization and reduces measurement noise, resulting in improved resolution. Dither, or additive white noise, has the effect of forcing quantization noise to become a zero-mean random variable rather than a deterministic function of input. For more information on the effects of dither, see "Dither in Digital Audio" by John Vanderkooy and Stanley P. Lipshitz, *Journal of the Audio Engineering Society*, Vol. 35, No. 12, Dec. 1987.

Explanation of DAQ Rates

Maximum DAQ rates (number of samples per second) are determined by the conversion period of the ADC plus the sample-and-hold acquisition time, which is specified at 8.5 µs. For single channel, sustained data acquisition, the maximum DAQ rate is limited by the speed of the parallel port, 100 kS/s for EPP and 25 kS/s for Centronics. During multiple-channel scanning, the DAQ rates are further limited by the settling time of the input multiplexers and programmable gain amplifier. After the input multiplexers are switched, the amplifier must be allowed to settle to the new input signal value to within 12-bit accuracy. The settling time is a function of the gain selected.

Analog Output

Output Characteristics

Number of output channels	Two single ended
Resolution	12 bits, 1 part in 4,096
Update rate[2]	8 kS/s in EPP mode, 4 kS/s with standard Centronics port
Type of DAC	Double-buffered
Data transfers	Interrupts, programmed I/O

Transfer Characteristics

Relative accuracy (INL)	±0.25 LSB typ, ±0.50 LSB max
DNL	±0.25 LSB typ, ±0.75 LSB max
Monotonicity	12 bits, guaranteed
Offset error	
After calibration	±0.2 mV max
Before calibration	±50 mV max
Offset adjustment range, min	±37 mV
Gain error	
After calibration	0.004% of reading max
Before calibration	±1% of reading max
Gain adjustment range, min	±100 mV

Voltage output

Ranges	0 to +10 V, ±5 V, software selectable
Output coupling	DC
Output impedance	0.2 Ω
Current drive	±2 mA
Protection	Short circuit to ground
Power-on state	0 V in bipolar mode, 5 V in unipolar mode

Dynamic Characteristics

Settling time to 0.012%	6 µs for 10 V step
Slew rate	10 V/µs
Offset temperature coefficient	±60 µV/°C
Gain temperature coefficient	±10 ppm/°C

Explanation of Analog Output Specifications

Relative accuracy in a D/A system is the same as nonlinearity because no uncertainty is added due to code width. Unlike an ADC, every digital code in a D/A system represents a specific analog value rather than a range of values. The relative accuracy of the system is therefore limited to the worst-case deviation from the ideal correspondence (a straight line), excepting noise. If a D/A system has been calibrated perfectly, then the relative accuracy specification reflects its worst-case absolute error.

Differential nonlinearity (DNL) in a D/A system is a measure of deviation of code width from 1 LSB. In this case, code width is the difference between the analog values produced by consecutive digital codes. A specification of ±1 LSB differential nonlinearity ensures that

[2] Typical timing data observed in LabVIEW on a 486 DX2/66 MHz PC using a Trunknet plug-in Centronics parallel port card and a FarPoint F/Port plug-in enhanced parallel port card.

the code width is always greater than 0 LSBs (guaranteeing monotonicity) and is always less than 2 LSBs.

Digital I/O

Number of channels 24
Compatibility TTL
Digital logic levels

Level	Min	Max
Input low voltage	-0.3 V	0.8 V
Input high voltage	2.2 V	5.3 V
Output low voltage (2.5 mA)	–	0.4 V
Output high voltage (-2.5 mA)	3.7 V	–
Absolute max voltage	-0.5 V	5.5 V

Handshaking 3 wire, 2 ports
Power-on state Inputs
Data Transfers Programmed I/O, interrupts

Timing I/O

Number of channels Three 16-bit counter/timers (uses two 82C53 STCs)
Resolution counter/timers 16 bits
Compatibility TTL, counter gate and clock inputs are pulled up with 10 kΩ resistors onboard.
Base clock available 2 MHz
Base clock accuracy ±0.01%
Max clock frequency 8 MHz
Min clock pulse duration 60 ns
Min gate pulse duration 50 ns
Digital logic levels

Level	Min	Max
Input low voltage	-0.3 V	0.8 V
Input high voltage	2.2 V	5.3 V
Output low voltage (4 mA)	–	0.4 V
Output high voltage (-1 mA)	3.7 V	–
Absolute max voltage	-0.5 V	5.5 V

Parallel Port

Types Compatible with Centronics and Enhanced Parallel Port (EPP)
Throughput[3] 50 kBytes/s Centronics
200 kBytes/s EPP

[3] Typical timing data observed in LabVIEW on a 486 DX2/66 MHz PC using a Trunknet plug-in Centronics parallel port card and a FarPoint F/Port plug-in enhanced parallel port card.

Physical

Dimensions	1.5 by 5.8 by 8.4 in. (3.8 x 14.6 x 21.3 cm)
Connectors	50-pin male DIN C front I/O connector 25-pin female D-sub rear connectors
Weight	1.7 lb (0.77 kg)

Power Requirements

Voltage	9 to 42 V
Reverse Voltage Protection	-42 VDC max
Power consumption	250 mA at 12 VDC
+5 V I/O connector (pin 49)	Protected by 400 mA, 63 V quick-acting surface mount Schurter fuse
Max discharge time with BP-1 battery pack	11 hours unloaded 5 hours loaded at 350 mA from +5 V I/O connector

Environment

Operating temperature	0° to 50° C
Storage temperature	-55° to 70° C
Relative humidity	5% to 90% noncondensing

Appendix B
Parallel Port Configuration Troubleshooting

This appendix contains installation troubleshooting information.

1. The configuration utility (WDAQCONF for Windows and DAQCONF for DOS) reports an error when I try to save the settings.

Check the following items if you receive a base address error.

a. Make sure your chassis is switched on and the screws of the cable are tightly fastened.

b. Make sure you have connected the parallel port cable to port A of the DAQPad-1200.

c. Check that your base address is correct. This can be done either by checking your computer technical manual or, in some cases, by checking the base address jumper. In Windows applications, you may have a Hardware Control panel that will allow you to enable and disable the parallel port. Common parallel port addresses are 0x378, 0x278, 0x3BC, 0x280, and 0x290.

Note: ***If your parallel port address does not appear under the Base Addr window in WDAQCONF, you must turn off the Auto Test option under the Options menu in the main window to access the other parallel port addresses.***

d. Check that you are using the included 1 m parallel port cable. If you suspect that you have a bad parallel port cable, replace with a new cable or one that you know works with another peripheral. If you are using another parallel port cable, check to make sure it meets the required specifications (see the last note below).

e. If you are still having problems, please report the computer make and model number to National Instruments. If you have a noncompatible parallel port and you have an available slot for a plug-in board, try using the Far Point EPP card described in the *Optional Equipment* section of Chapter 1, *Introduction*.

Check the following items if you receive an interrupt conflict error.

a. IRQ levels 7 and 5 are the most common interrupt levels reserved for the parallel port. Try saving your configuration for both IRQ7 and IRQ5.

Note: ***If either IRQ level 7 or 5 are unselectable under the IRQ menu in WDAQCONF, then another National Instruments board is using this interrupt. You will have to free the appropriate IRQ level to allocate it for your parallel port.***

b. You may have an interrupt conflict with a non-National Instruments device. If you have installed a PCMCIA card or a plug-in board, you will have to ensure that IRQ5 or IRQ7 have not been allocated for these devices.

Note: ***For some PCMCIA cards installed with Cardware, it may be possible to exclude your parallel port interrupt level by including the line*** `XIRQ=7, E for IRQ 7` ***or*** `XIRQ=5, E for IRQ 5` ***in the*** `cardware.ini` ***file.***

c. You may have an interrupt conflict with a Windows-based application. You will have to ensure that IRQ5 or IRQ7 have not been allocated for this application. One place to search is your `system.ini` file under Windows.

d. If you are still having problems, please report the computer make and model number to National Instruments.

2. The configuration utility works fine when I use a 1 m parallel port cable but reports an error when I try to use a longer parallel port cable.

a. Ensure that your parallel port cable meets the required specifications. (See the last note below.)

b. You may have to use a unidirectional parallel port extender in order to achieve long distance solutions (one such extender is made by BRAVO Communications). Your parallel port will be recognized as a Centronics port with this extender.

Note: ***National Instruments does not guarantee functionality with parallel port cables longer than 2 m.***

3. I have an EPP port, but the configuration utility reports that I have a Centronics port when I try to save the configuration settings.

a. You may have to enable your parallel port as an EPP port. Check for such utilities and ensure that your port is configured for EPP.

b. It is possible that your DAQPad-1200 and NI-DAQ software are not compatible with your EPP port. In this case, your parallel port will be treated as a Centronics port.

Parallel Port Cable Specifications

- Unbalanced impedance of each signal and ground pair of 62 Ω ±6 Ω, 4–16 MHz
- Unbalanced capacitance of each cable pair less than 107 pF/m at 1 MHz
- DC resistance of each cable wire less than 0.22 Ω/m
- Total propagation delay less than 150 ns

Appendix C
Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

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Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	95 800 010 0793	05 404 0890
Netherlands	03480 33466	03480 30673
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 20 51 51	056 20 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 _____

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 will reproduce the problem _____

_____

_____

DAQPad-1200 Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or 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

- Interrupt Level of parallel port _____
- Analog Output Channel 0 Configuration (Reset condition—Bipolar) _____
- Analog Output Channel 1 Configuration (Reset condition—Bipolar) _____
- Analog Input Configuration (Reset condition—Bipolar) _____
- NI-DAQ or LabWindows Version _____

Other Products

- Microprocessor _____
- Clock Frequency _____
- Computer Make and Model _____
- Type of Video Board Installed _____
- Operating System _____
- Operating System Version _____
- Programming Language _____
- Programming Language Version _____
- Other Boards in System _____
- Interrupt Level of Other Boards _____

Documentation Comment Form

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Title: **DAQPad-1200 User Manual**

Edition Date: **November 1995**

Part Number: **371351A-01**

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Glossary

Prefix	Meaning	Value
p-	pico-	10^{-12}
n-	nano-	10^{-9}
µ-	micro-	10^{-6}
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}

°	degrees
>	greater than
≥	greater than or equal to
<	less than
-	negative of, or minus
Ω	ohms
%	percent
±	plus or minus
+	positive of, or plus
+5 V	+5 Volts signal
A	amperes
ACH <0..7>	Analog Channel 0 through 7 signals
ACK*	Acknowledge Input signal
A/D	analog-to-digital
ADC	analog-to-digital converter
AGND	Analog Ground signal
AISENSE/AIGND	Analog Input Sense/Analog Input Ground signal
ANSI	American National Standards Institute
AWG	American Wire Gauge
C	Celsius
CLKB1, CLKB2	Counter B1, B2 Clock signals
cm	centimeters
CNTINT	Counter Interrupt signal
D/A	digital-to-analog
D*/A	Data/Address signal
DAC	digital-to-analog converter
DAC OUTPUT UPDATE	DAC output update signal
DACWRT	DAC Write signal
DAQ	data acquisition
DAQD*/A	Data Acquisition Board Data/Address Line signal
DAC0OUT, DAC1OUT	Digital-to-Analog Converter 0, 1 Output signals
DATA	Data Lines at the Specified Port signal
dB	decibels
DGND	Digital Ground signal

DIFF	differential
DIN	Deutsche Industrie Norme
DMA	direct memory access
EEPROM	electrically erased programmable read-only memory
EPP	Enhanced Parallel Port
EXTCONV*	External Convert signal
EXTTRIG	External Trigger signal
EXTUPDATE*	External Update signal
ft	feet
GATB <0..2>	Counter B0, B1, B2 Gate signals
hex	hexadecimal
IBF	Input Buffer Full signal
in.	inches
INTR	Interrupt Request signal
I/O	input/output
LSB	least significant bit
m	meters
max	maximum
MB	megabytes of memory
min	minutes
MIO	multifunction I/O
MSB	most significant bit
NRSE	nonreferenced single-ended
OBF*	Output Buffer Full signal
OUTB0, OUTB1	Counter B0, B1 Output signals
PA, PB, PC <0..7>	Port A, B, or C 0 through 7 signals
POSTTRIG	Posttrigger mode
PRETRIG	Pretrigger mode
RD*	Read signal
R_{EXT}	external resistance
RSE	referenced single-ended
RTSI	Real-Time System Integration
s	seconds
SCXI	Signal Conditioning eXtensions for Instrumentation (bus)
SDK	Software Developer's Kit
SERCLK	Serial Clock signal
SERDATIN	Serial Data In signal
SERDATOUT	Serial Data Out signal
SLOT0SEL*	Slot 0 Select signal
SPICLK	Serial Peripheral Interface Clock signal
SS*	Slot-select signal
STB	Strobe Input signal
TTL	transistor-transistor logic
typ	typical
UP/BP*	Unipolar/bipolar bit
V	volts
$V^{\pm}_{in}$	positive/negative input voltage
V_{cm}	common-mode noise
V_{diff}	differential input voltage

V_{EXT}	external voltage
VI	virtual instrument
V_m	measured voltage
Vrms	volts, root-mean-square
V_s	signal source
W	watts
WRT*	Write signal

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