DAQ

NI 6703/6704 User Manual

DC Analog Output Devices
for PCI/PXI/CompactPCI Bus Computers

NATIONAL INSTRUMENTS

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About This Manual

This manual contains information about using the NI PCI-6703/6704 and NI PXI-6704 devices. The NI 6703/6704 devices are designed for precise DC setpoint applications and provide general-purpose digital I/O.

If you are using NI-DAQ 8.6 or later, refer to the *DAQ Getting Started Guide*, which you can download at `ni.com/manuals`. The *DAQ Getting Started Guide* offers NI-DAQ users step-by-step instructions for installing software and hardware, configuring channels and tasks, and getting started developing an application.

Conventions

The following conventions appear in this manual:

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

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

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

This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on a product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document for information about precautions to take.

When symbol is marked on a product, it denotes a warning advising you to take precautions to avoid electrical shock.

When symbol is marked on a product, it denotes a component that may be hot. Touching this component may result in bodily injury.

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

italic	Italic text denotes variables, emphasis, a cross-reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.
NI 6703/6704	This phrase refers to any device in the NI 6703/6704 family.

Related Documentation

Each application software package and driver includes information about writing applications for taking measurements and controlling measurement devices. The following references to documents assume you have NI-DAQ 8.6 or later, and where applicable, version 7.0 or later of the NI application software.

NI-DAQmx for Windows

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

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

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

NI-DAQmx for Linux

The *DAQ Getting Started Guide* describes how to install your NI-DAQmx-supported DAQ device and confirm that your device is operating properly.

The *NI-DAQ Readme for Linux* lists supported devices and includes software installation instructions, frequently asked questions, and known issues.

The *C Function Reference Help* describes functions and attributes.

The *NI-DAQmx for Linux Configuration Guide* provides configuration instructions, templates, and instructions for using test panels.

Note All NI-DAQmx documentation for Linux is installed at `/usr/local/natinst/` `nidaqmx/docs`.

LabVIEW

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

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

- **Getting Started»Getting Started with DAQ**—Includes overview information and a tutorial to learn how to take an NI-DAQmx measurement in LabVIEW using the DAQ Assistant.

- **VI and Function Reference»Measurement I/O VIs and Functions**—Describes the LabVIEW NI-DAQmx VIs and properties.

- **Taking Measurements**—Contains the conceptual and how-to information you need to acquire and analyze measurement data in LabVIEW, including common measurements, measurement fundamentals, NI-DAQmx key concepts, and device considerations.

LabWindows/CVI

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

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

Measurement Studio

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

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

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

1. In Visual Studio .NET, select **File»New»Project** to launch the New Project dialog box.

2. Find the Measurement Studio folder for the language you want to create a program in.

3. Choose a project type. You add DAQ tasks as a part of this step.

ANSI C without NI Application Software

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

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

.NET Languages without NI Application Software

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

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

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

Device Documentation

The *NI 6703/6704 Specifications*, available at `ni.com/manuals` contains detailed hardware specifications for NI 6703/6704 devices.

NI 6703/6704 Calibration Procedure for NI-DAQmx, available at `ni.com/manuals`, contains instructions for calibrating the NI 6703/6704 for PCI/PXI/CompactPCI using NI-DAQmx.

NI 6703/6704 Calibration Procedure for Traditional NI-DAQ, available at `ni.com/manuals`, contains instructions for calibrating the NI 6703 for PCI or NI 6704 for PCI/PXI/CompactPCI using Traditional NI-DAQ (Legacy).

The following documents also contain information you may find helpful:

- NI Developer Zone tutorial, *Field Wiring and Noise Considerations for Analog Signals*, located at `ni.com/zone`
- *PCI Local Bus Specification Revision 2.2*
- *PICMG CompactPCI 2.0 R3.0 Core Specification*
- *PXI Specification Revision 2.0*, available from `www.pxisa.org`

Documentation for supported devices and accessories, including PDF and help files describing device terminals, specifications, features, and operation are on the NI-DAQmx media that includes Device Documentation. Insert the media, open the Device Documentation directory, and double-click the Device Documents shortcut for your language to find, view, and print device documents.

Training Courses

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

Technical Support on the Web

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

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

DAQ specifications and some DAQ manuals are available as PDFs. You must have Adobe Acrobat Reader with Search and Accessibility 5.0.5 or later installed to view the PDFs. Refer to the Adobe Systems Incorporated Web site at `www.adobe.com` to download Acrobat Reader. Refer to the National Instruments Product Manuals Library at `ni.com/manuals` for updated documentation resources.

1

Introduction

This chapter describes the NI 6703/6704 devices, lists what you need to get started, describes optional software, equipment, and custom cables, and explains how to unpack your device.

For information about installing and configuring your device, refer to the *DAQ Getting Started Guide* at ni.com/manuals.

About the NI 6703/6704

The NI 6703/6704 devices are precise DC setpoint devices for PCI and PXI. The NI 6703 devices have 16 voltage output channels. The NI 6704 devices have 16 voltage output channels and 16 current output channels for a total of 32 analog output channels. The NI 6703/6704 devices have eight digital I/O lines.

You can use the NI 6703/6704 devices in a wide variety of DC setpoint and digital I/O applications. With the NI 6703/6704 devices, your PC system can serve as a digital I/O system controller for laboratory testing, production testing, and industrial process monitoring and control. These devices can do the following:

*   Generate experimental stimuli

*   Generate analog functions

*   Connect to a variety of signal types, including:

    –   Electromechanical relays

    –   LEDs

    –   Optically isolated, solid-state relays and I/O module mounting racks

    –   Voltage and current excitation for precision transducers

    –   Current excitation for precision transducers (NI 6704 only)

For detailed specifications for the NI 6703/6704 devices, refer to the *NI 6703/6704 Specifications*, available at ni.com/manuals.

Using PXI with CompactPCI

The ability to use PXI-compatible products with standard CompactPCI products is an important feature of *PXI Specification Revision 2.0*. If you use a PXI-compatible plug-in device in a standard CompactPCI chassis, you are unable to use PXI-specific functions, but you can still use the basic plug-in device functions.

The CompactPCI specification permits vendors to develop sub-buses that coexist with the basic PCI interface on the CompactPCI bus. Compatible operation is not guaranteed between CompactPCI devices with different sub-buses nor between CompactPCI devices with sub-buses and PXI devices. The standard implementation for CompactPCI does not include these sub-buses. The NI PXI-6704 works in any standard CompactPCI chassis adhering to the *PICMG CompactPCI 2.0 R3.0* core specification.

What You Need to Get Started

To set up and use your NI 6703/6704 device, you will need the following:

❑   One of the following devices:
  –   NI PCI-6703
  –   NI PCI-6704
  –   NI PXI-6704

❑   One of the following software packages and documentation:
  –   NI-DAQ 7.4 or later
  –   LabVIEW for Windows
  –   LabWindows/CVI for Windows
  –   Measurement Studio
  –   ANSI C without NI Application Software
  –   .NET Languages without NI Application Software

❑   PC with a free PCI slot or PXI chassis with a free slot

❑   68-pin cable (SH68-68-D1)

❑   68-pin terminal block (SCB-68)

Optional Equipment

National Instruments offers a variety of products to use with your NI 6703/6704, including cables, connector blocks, and other accessories, as follows:

- Cables and cable assemblies, shielded and ribbon

- Connector blocks, shielded and unshielded screw terminals

For more specific information about these products, visit `ni.com/products`.

Custom Cabling

Follow these guidelines if you want to develop your own cable:

- Route the analog lines separately from the digital lines.

- When using a cable shield, use separate shields for the analog and digital halves of the cable. Failure to do so results in noise coupling into the analog signals from transient digital signals.

National Instruments offers cables and accessories for you to prototype your application or to use if you frequently change module interconnections. For more specific information about these products, visit `ni.com/products`.

For more information on the connectors used for DAQ devices, refer to the KnowledgeBase document, *Specifications and Manufacturers for Board Mating Connectors* at `ni.com/support`.

2

Signal Connections

This chapter provides connection instructions for the signals on your NI 6703/6704 device I/O connector.

⚠ **Caution**   Connections that exceed any of the maximum ratings of input or output signals on the NI 6703/6704 device can damage the device and the computer. Maximum input ratings for each signal are given in this chapter under the discussion of that signal. National Instruments is *not* liable for any damages resulting from any incorrect signal connections.

I/O Connector Pin Assignments

Figures 2-1 and 2-2 show the I/O connector pin assignments for the NI 6703/6704 devices.

AO 0 (V)	34	68	AO GND 0
AO GND 1	33	67	NC
NC	32	66	AO 1 (V)
AO 2 (V)	31	65	AO GND 2
AO GND 3	30	64	NC
NC	29	63	AO 3 (V)
AO 4 (V)	28	62	AO GND 4
AO GND 5	27	61	NC
NC	26	60	AO 5 (V)
A0 6 (V)	25	59	AO GND 6
AO GND 7	24	58	NC
NC	23	57	AO 7 (V)
AO 8 (V)	22	56	AO GND[1]
NC	21	55	AO GND 8
AO GND 9	20	54	AO 9 (V)
AO GND[1]	19	53	NC
AO GND 10	18	52	AO 10 (V)
AO 11 (V)	17	51	NC
NC	16	50	AO GND 11
AO 12 (V)	15	49	AO GND 12
AO GND 13	14	48	NC
NC	13	47	AO 13 (V)
AO 14 (V)	12	46	AO GND 14
AO GND 15	11	45	NC
NC	10	44	AO 15 (V)
P0.7	9	43	AO GND[1]
P0.6	8	42	D GND
P0.5	7	41	D GND
P0.4	6	40	RESERVED
P0.3	5	39	D GND
P0.2	4	38	RESERVED
P0.1	3	37	D GND
P0.0	2	36	D GND
+5 V	1	35	D GND[1]

V = Voltage
NC = No Connect

1   No Connect when using the SH68-68-D1 cable.

Figure 2-1. NI 6703 Connector Pin Assignments

AO 0 (V)	34	68	AO GND 0/16
AO GND 1/17	33	67	AO 16 (I)
AO 17 (I)	32	66	AO 1 (V)
AO 2 (V)	31	65	AO GND 2/18
AO GND 3/19	30	64	AO 18 (I)
AO 19 (I)	29	63	AO 3 (V)
AO 4 (V)	28	62	AO GND 4/20
AO GND 5/21	27	61	AO 20 (I)
AO 21 (I)	26	60	AO 5 (V)
A0 6 (V)	25	59	AO GND 6/22
AO GND 7/23	24	58	AO 22 (I)
AO 23 (I)	23	57	AO 7 (V)
AO 8 (V)	22	56	AO GND[1]
AO 24 (I)	21	55	AO GND 8/24
AO GND 9/25	20	54	AO 9 (V)
AO GND[1]	19	53	AO 25 (I)
AO GND 10/26	18	52	AO 10 (V)
AO 11 (V)	17	51	AO 26 (I)
AO 27 (I)	16	50	AO GND 11/27
AO 12 (V)	15	49	AO GND 12/28
AO GND 13/29	14	48	AO 28 (I)
AO 29 (I)	13	47	AO 13 (V)
AO 14 (V)	12	46	AO GND 14/30
AO GND 15/31	11	45	AO 30 (I)
AO 31 (I)	10	44	AO 15 (V)
P0.7	9	43	AO GND[1]
P0.6	8	42	D GND
P0.5	7	41	D GND
P0.4	6	40	RESERVED
P0.3	5	39	D GND
P0.2	4	38	RESERVED
P0.1	3	37	D GND
P0.0	2	36	D GND
+5 V	1	35	D GND[1]

V = Voltage
I = Current
NC = No Connect

1   No Connect when using the SH68-68-D1 cable.

Figure 2-2. NI 6704 Connector Pin Assignments

Signal Connection Descriptions

Signal Name	Reference	Direction	Description
P0.<0..7>	D GND	Input or Output	Digital I/O lines—Line 7 is the MSB and Line 0 is the LSB.
AO <0..15> (V)	AO GND	Output	Voltage output channels.
AO <16..31> (I)	AO GND	Output	Current output channels on the NI 6704. No connects on the NI 6703.
AO GND <0/16..15/31>	—	—	Analog Output Grounds—Each ground pin is shared between one voltage and one current channel. These pins are connected to the NI 6703/6704 device analog ground plane. All NI 6703/6704 device ground planes connect to the computer system's ground signal.
AO GND	—	—	Additional pins connected to analog output ground. If you are using a SH68-68-D1 cable, these signals are not connected.
D GND	—	—	Digital Ground—These pins are connected to the NI 6703/6704 device digital ground plane. All NI 6703/6704 device ground planes connect to the computer system's ground signal.
+5 V	D GND	Output	+5 V—This pin is connected to the computer system's +5 VDC supply through a self-resetting circuit breaker.
NC	—	—	Do not connect external circuitry to these pins.
RESERVED	—	—	Reserved for future use.

Analog Output Signal Connections

This section describes how to make connections for voltage and current outputs. The NI 6704 has both voltage and current outputs. The NI 6703 has voltage outputs only. A 68-pin cable such as the SH68-68-D1 cable is required. Figure 2-3 shows how to connect the voltage channel as a voltage output.
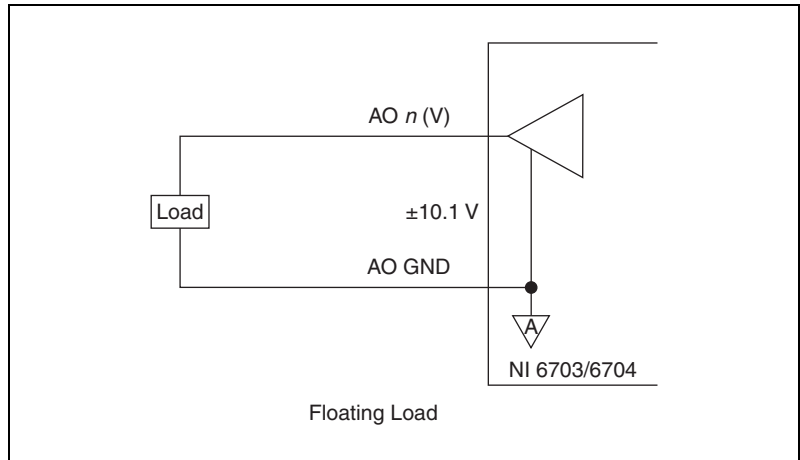
Figure 2-3. Voltage Output Connections

Voltage Output

You can connect a floating load to your NI 6703/6704 device at the voltage output channel.

⚠ **Caution**   Because NI 6703/6704 devices are not electrically isolated from high voltages, a load with high common-mode voltages can damage the devices. National Instruments is *not* liable for any damages resulting from any such signal connections.

The NI 6703/6704 device has a bipolar voltage range of –10.1 to +10.1 V. Maximum load current is ±10.1 mA for 16-bit linearity.

Power-On State

All voltage outputs are at their user-defined values to full accuracy within 1 s of power-on board reset. Before this time, the voltage outputs can float to unspecified values. Take this behavior into account when connecting external devices to the NI 6703/6704.

NI 6704 Current Output

You can connect a floating or grounded load to your NI 6704 device at the current output channel. You do not need an external floating power supply to complete the controlled current loop. You can control the current loop from 0.1 to 20.2 mA. The compliance for the current loop is 0 V to 10 VDC.

📝 **Note** The voltage is not clamped at 10 V. If the current supplied to the load generates a voltage greater than 10 V, the device will generate a voltage greater than 10 V.

⚠️ **Caution** Because the NI 6704 is not electrically isolated from high voltages, a load with high common-mode voltages can damage the NI 6704. National Instruments is *not* liable for any damages resulting from any such signal connections.

Figure 2-4 shows how to connect a current channel as a current output.
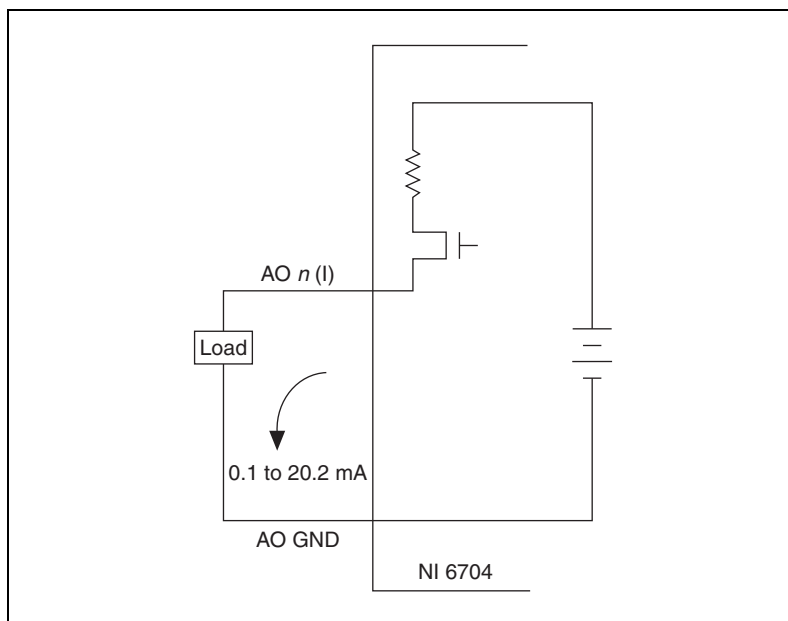
Figure 2-4. Current Output Connections

Because each current channel shares a ground line with a voltage channel, try to minimize the effect of the return current from your current channel on the voltage that you are outputting on your voltage channel. For example, if you output 20 mA on a current channel and return that current to the NI 6704 device along the shared ground line in a cable with an

impedance of 0.1 Ω, the voltage output will drop 2 mV on the voltage channel sharing the ground line. You can avoid this problem in the following ways:

• Use a shorter cable to minimize the impedance of the shared ground line.

• Use separate wiring for voltage channel and current channel ground lines return to minimize common ground impedance.

• Use different pairs of voltage and current channels to keep your sensitive voltage outputs separate from your higher output current channels.

Power-on State

All current outputs are within ± 1.1 mA maximum of their user-defined values within 0.5 s of power-on board reset. The current outputs will settle to their user-defined values to full accuracy within 7 s of power-on board reset. Take this behavior into account when connecting external devices to the NI 6704.

Digital I/O Signal Connections

Figure 2-5 illustrates example signal connections for three typical digital I/O applications.
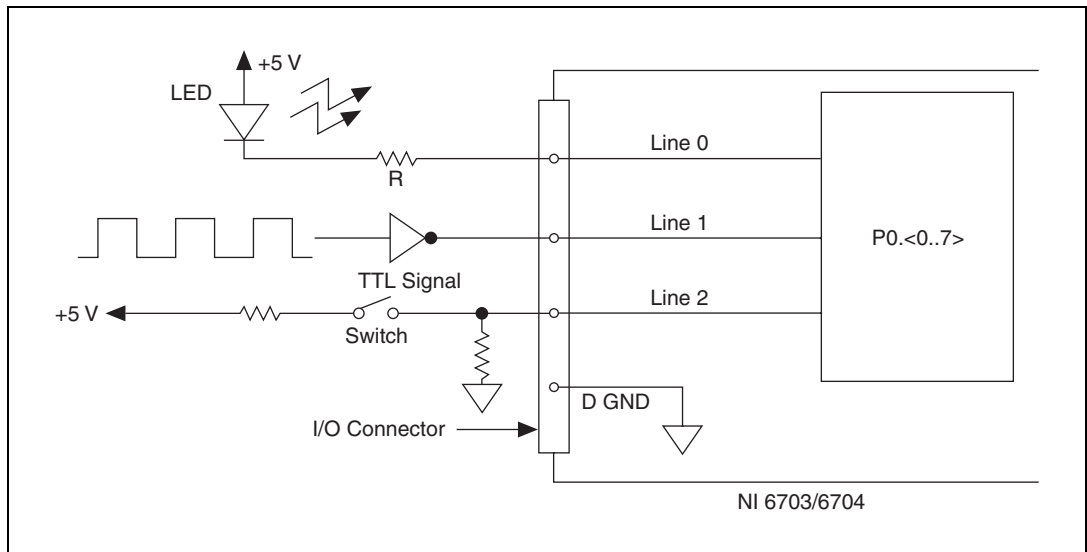
Figure 2-5. Example Digital I/O Connections

In Figure 2-5, Line 0 is configured for digital output; Lines 1 and 2 are configured for digital input.

Digital input applications include receiving TTL signals and sensing external device states such as the switch in Figure 2-5. Digital output applications include sending TTL signals and driving external devices such as the LED shown in Figure 2-5.

✎ **Note**   The NI 6703/6704 devices allow line-by-line direction control of digital I/O connections.

Refer to the *NI 6703/6704 Specifications*, available at `ni.com/manuals`, for a list of the digital I/O signal ratings.

Power-on State

At power on, all of the DIO lines on the NI 6703/6704 devices are configured as input lines.

Power Connections

Pin 1 on the I/O connector is connected to the +5 V supply from the PCI or PXI bus power supply. This pin is referenced to D GND and can supply power to external circuitry. The +5 V supply has a total of 0.75 A available.

Power rating...0.75 A at +5 V ±10%,
+4.55 to +5.25 VDC at 0.75 A

The +5 V power supply has a self-resetting protection circuit breaker in series. If the circuit breaker protection is activated, remove the circuit causing the heavy current load and the circuit breaker will reset itself. For more information on these output pins, refer to the *NI 6703/6704 Specifications*, available at `ni.com/manuals`.

⚠ **Caution**   Never connect these +5 V power pins directly to ground or to any other voltage source on your NI 6703/6704 device or any other device. Doing so can damage your device and your computer system. National Instruments is *not* liable for damage resulting from such a connection.

3

Hardware Overview

This chapter contains an overview of the hardware functions on the NI 6703/6704. The block diagram in Figure 3-1 illustrates the key functional components of the NI 6703/6704.
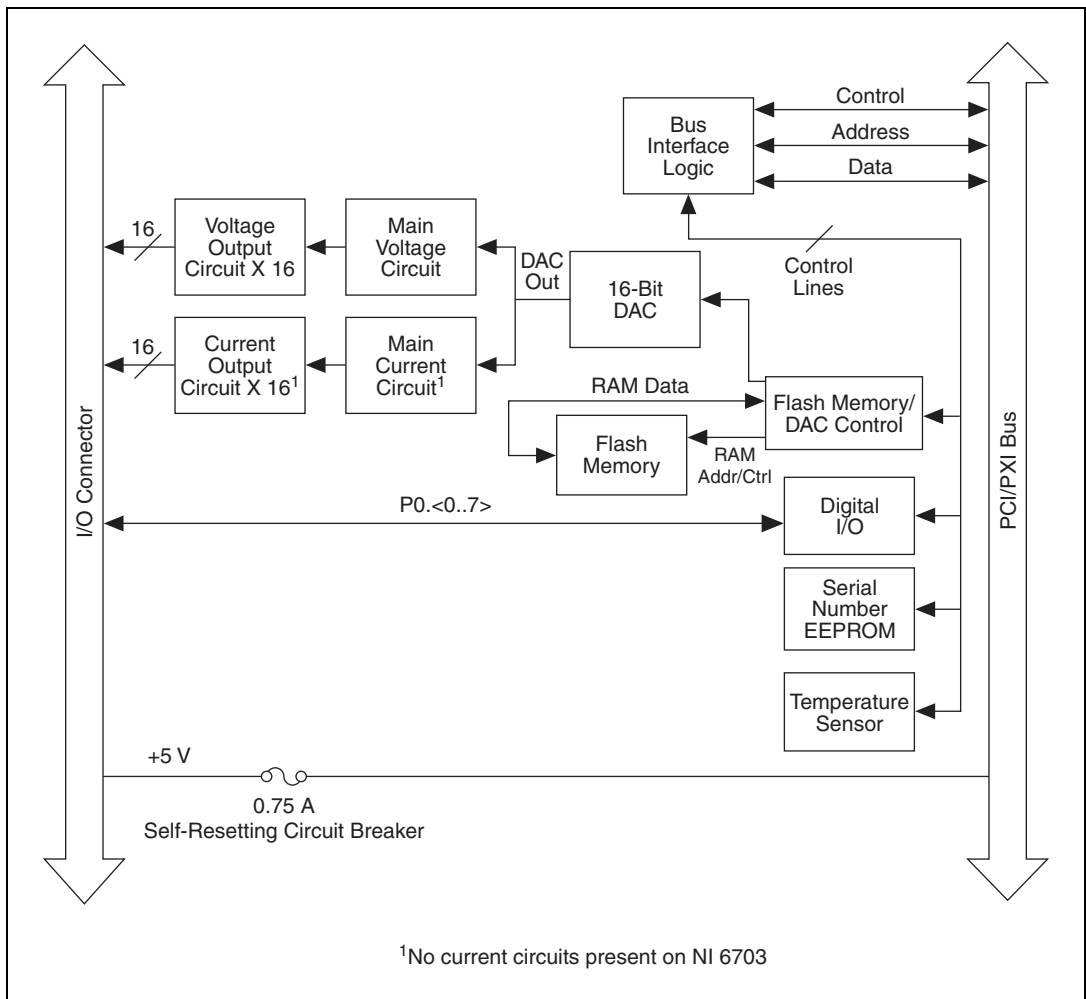
Figure 3-1. NI 6703/6704 Block Diagram

Bus Interface Circuitry

The bus interface circuitry monitors the PCI or PXI bus. If the bus address matches the NI 6703/6704 device address, the board is enabled and the corresponding register on the NI 6703/6704 is accessed.

Flash Memory/DAC Control

The NI 6703/6704 devices have one 16-bit DAC that is time-division multiplexed to create all the output channels. Each channel has a track-and-hold circuit to maintain the channel value between DAC updates. On the NI 6703, the DAC is multiplexed to create 16 voltage outputs and two calibration channels. On the NI 6704, the DAC is multiplexed to create 16 voltage outputs, 16 current outputs, and four calibration channels.

Data is stored in Flash memory. The Flash memory/DAC control reads the DAC channel data stored in the Flash memory and updates the DAC periodically. The Flash memory/DAC control also controls the analog demultiplexing circuits to route the DAC output to the correct analog output channel. You can choose to save Flash memory data so that the current output values will become the power-on states. For information about how to set the power-on states, refer to the *Setting the Power-On States for Software-Timed Digital I/O Devices* topic in the *NI-DAQmx Help*.

Digital I/O Control

The NI 6703/6704 devices have eight digital I/O lines configured as one 8-bit port. You can configure each line independently as an input or output. The DIO lines have 16 mA of sink capability and 16 mA of source capability. All digital lines are TTL-compatible. At power on, all digital lines are configured as inputs.

Temperature Sensor

The onboard temperature sensor measures the air temperature flowing over the board. This sensor is positioned near the onboard precision voltage reference, which can be affected by extreme temperatures. This sensor has a serial digital interface.

4

Calibration

This chapter discusses the calibration options for the NI 6703/6704. Calibration is the process of minimizing output errors by making small circuit adjustments. There are two calibration channels used to make adjustments to the voltage channels on the NI 6703/6704. The NI 6704 has two additional channels used to make adjustments to the current channels.

Internal or Self-Calibration

The NI 6703/6704 devices perform continuous self-calibration. In addition to the accessible analog output channels, there are internal calibration channels that are scanned and refreshed with all the output channels. There are two of these calibration channels for the voltage outputs: the voltage offset channel and the voltage gain channel.

There are also two calibration channels for the current outputs on the NI 6704: the current offset channel and the current gain channel. The outputs of these calibration channels are continuously compared to onboard references, and the 16-bit DAC offset and gain are adjusted to minimize the errors in the calibration channels. Since NI 6703/6704 devices have excellent channel-to-channel matching of offset and gain errors, minimizing the errors in the calibration channels also minimizes the errors for all the voltage and current outputs.

External Calibration

The only calibration adjustment you must make is to adjust the values of the calibration channels to account for time- or temperature-related drift of the onboard reference. These calibration values are loaded into Flash memory at factory calibration. You do not need to adjust them for at least one year after the date of factory calibration unless you are operating your device at an extreme temperature.

To perform an external calibration, refer to the *NI 6703/6704 Calibration Procedure for NI-DAQmx*.

A

Common Questions

This appendix contains commonly asked questions and their answers relating to usage and special features of the NI 6703/6704.

Analog Output

How fast does the NI 6703 sample channels?

The NI 6703 devices have one 16-bit DAC that is time-division multiplexed to create 16 voltage output and two calibration channels. The channels are sampled at a rate of 50 µs per channel, meaning a channel can change value a maximum of 0.9 ms after it has been updated by software.

How fast does the NI 6704 sample channels?

The NI 6704 devices have one 16-bit DAC that is time-division multiplexed to create 16 voltage output, 16 current output, and four calibration channels. The channels are sampled at a rate of 50 µs per channel, meaning a channel can change value a maximum of 1.8 ms after it has been updated by software.

B

Technical Support and Professional Services

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

- **Support**—Technical support at `ni.com/support` includes the following resources:

    - **Self-Help Technical Resources**—For answers and solutions, visit `ni.com/support` for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at `ni.com/forums`. NI Applications Engineers make sure every question submitted online receives an answer.

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

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

Glossary

Symbol	Prefix	Value
n	nano	10^{-9}
μ	micro	10^{-6}
m	milli	10^{-3}
k	kilo	10^{3}
M	mega	10^{6}
G	giga	10^{9}

Symbols

°	Degrees.
–	Negative of, or minus.
Ω	Ohms.
/	Per.
%	Percent.
±	Plus or minus.
+	Positive of, or plus.

A

A	Amperes.
A/D	Analog-to-digital.
ANSI	American National Standards Institute.
AO GND	Analog output ground signal.

B

bit   One binary digit, either 0 or 1.

bus   The group of conductors that interconnect individual circuitry in a computer. Typically, a bus is the expansion vehicle to which I/O or other devices are connected.

C

C   Celsius.

channel   Pin or wire lead to which you apply or from which you read the analog or digital signal. Analog signals can be single-ended or differential. For digital signals, you group channels to form ports. Ports usually consist of either four or eight digital channels.

D

D/A   Digital-to-analog.

DAC   D/A converter.

DAQ   Data acquisition—(1) Collecting and measuring electrical signals from sensors, transducers, and test probes or fixtures and inputting them to a computer for processing. (2) Collecting and measuring the same kinds of electrical signals with A/D and/or DIO boards plugged into a computer, and possibly generating control signals with D/A and/or DIO boards in the same computer.

DC   Direct current.

device   A plug-in data acquisition board, card, or pad that can contain multiple channels and conversion devices. Plug-in boards, PCMCIA cards, and devices such as the DAQPad-1200, which connects to your computer parallel port, are all examples of DAQ devices.

DIO   Digital input/output.

DLL	Dynamic Link Library—A software module in Microsoft Windows containing executable code and data that can be called or used by Windows applications or by other DLLs. Functions and data in a DLL are loaded and linked at run time when they are referenced by a Windows application or other DLLs.
drivers/driver software	Software that controls a specific hardware device such as a DAQ board.

E

EEPROM	Electrically Erasable Programmable Read-Only Memory (ROM) that can be erased (usually by ultraviolet light exposure) and reprogrammed.

F

function	A set of software instructions executed by a single line of code that may have input and/or output parameters and returns a value when executed.

G

GND	Ground signal or bit.

H

hardware	The physical components of a computer system, such as the circuit boards, plug-in boards, chassis, enclosures, peripherals, cables, and so on.
hex	Hexadecimal.
Hz	Hertz—The number of scans read or updates written per second.

I

I/O	Input/output—The transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces.
IC	Integrated circuit.

in.	Inches.
INL	Integral Nonlinearity—A measure in LSB of the worst-case deviation from the ideal A/D or D/A transfer characteristic of the analog I/O circuitry.
interrupt	A computer signal indicating that the CPU should suspend its current task to service a designated activity.
interrupt level	The relative priority at which a device can interrupt.
I_{OH}	Current, output high.
I_{OL}	Current, output low.

K

KB	Kilobytes—1,024 bytes when referring to memory.

L

LED	Light-emitting diode.
LSB	Least significant bit.

M

m	Meters.
max	Maximum.
min	Minimum.
MSB	Most significant bit.

N

NC	Not connected.
NI-DAQ	National Instruments driver software for DAQ hardware.
noise	An undesirable electrical signal—Noise comes from external sources such as the AC power line, motors, generators, transformers, fluorescent lights, soldering irons, CRT displays, computers, electrical storms, welders, radio transmitters, and internal sources such as semiconductors, resistors, and capacitors. Noise corrupts signals you are trying to send or receive.

O

operating system	Base-level software that controls a computer, runs programs, interacts with users, and communicates with installed hardware or peripheral devices.

P

PCI	Peripheral Component Interconnect—A high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA. It has achieved widespread acceptance as a standard for PCs and workstations, and offers a theoretical maximum transfer rate of 132 Mbytes/s.
port	(1) A communications connection on a computer or a remote controller. (2) A digital port, consisting of four or eight lines of digital input and/or output.
ppm	Parts per million.
PXI	PCI eXtensions for Instrumentation—A rugged, open system for modular instrumentation based on CompactPCI, with special mechanical, electrical, and software features.

R

RAM	Random access memory.
resolution	The smallest signal increment that can be detected by a measurement system. Resolution can be expressed in bits, in proportions, or in percent of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244% of full scale.
RTSI	Real-Time System Integration.

S

s	Seconds.
settling time	The amount of time required for a voltage to reach its final value within specified limits.
slot	A position where a module can be inserted into the PCI bus.

T

transfer rate	The rate, measured in bytes/s, at which data is moved from source to destination after software initialization and set up operations; the maximum rate at which the hardware can operate.
TTL	Transistor-transistor logic.
typ	Typical.

U

update	The output equivalent of a scan. One or more analog or digital output samples. Typically, the number of output samples in an update is equal to the number of channels in the output group. For example, one pulse from the update clock produces one update which sends one new sample to every analog output channel in the group.

V

V	Volts.
VDC	Volts direct current.
VI	Virtual Instrument—(1) A combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument. (2) A LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program.

W

W	Watts.

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