PXI™

PXI-PCI 8330 Series User Manual

MXI-3 Multi-System Extension Interface for PCI, CompactPCI, and PXI Bus Computers

NATIONAL INSTRUMENTS™

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Federal Communications Commission

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

Notices to User: ***Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.***

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Contents

About This Manual

Chapter 1
Introduction

Chapter 2
Installation

Chapter 3
Hardware Overview

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Figure

Tables

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About This Manual

This manual describes the features, functions, and operation of the PXI-PCI 8330 Series. The four products in this series are the PCI-8330, the PXI-8330, the PCI-8335, and the PXI-8335. The PXI-PCI 8330 Series incorporates MXI-3 technology, which couples two physically separate PCI, CompactPCI, or PXI buses with either a copper or fiber-optic data link capable of 1.5 Gbytes/s serial data rates.

Conventions

The following conventions appear in this manual:

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.

This icon denotes a warning, which advises you of precautions to take to avoid being electrically shocked.

bold — Bold text denotes items that you must select or click on 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. This font also denotes text that is a placeholder for a word or value that you must supply.

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

`monospace italic` — Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

MXI-3 card — MXI-3 card refers to both the PCI MXI-3 and PXI MXI-3 cards, unless otherwise noted.

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Related Documentation

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

- *Set Up Your MXI-3 System*
- Your computer or chassis documentation
- *PXI Specification*, revision 1.0
- *PCI Specification*, revision 2.2
- *PCI-PCI Bridge Architecture Specification*, revision 1.0
- *PICMG CompactPCI 2.0 R2.1* specification
- PXI chassis and documentation (PXI bus systems only)

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1

Introduction

This chapter describes the PXI-PCI 8330 Series, lists what you need to get started, and explains how to unpack and set up your hardware. The four products in this series are the PCI-8330, the PXI-8330, the PCI-8335, and the PXI-8335. The PXI-PCI 8330 Series incorporates MXI-3 technology. The terms *MXI-3*, *MXI-3 card* and *MXI-3 system* in this manual refer to both the PCI MXI-3 and PXI MXI-3 cards and systems, unless otherwise noted.

About the MXI-3 System

Description and Features

MXI-3 is a PCI master/slave system implementing the PCI-PCI bridge register set. It couples two physically separate PCI, CompactPCI, or PXI buses with either a copper or fiber-optic data link capable of 1.5 Gbytes/s serial data rates. With the MXI-3 system, you can do the following:

- Increase the available number CompactPCI or PXI slots for your application
- Physically separate the measurement or automation system from the host PC
- Combine PCI, CompactPCI, and PXI devices in the same system

Note Your MXI-3 card will work in any standard CompactPCI chassis adhering to the *PICMG CompactPCI 2.0 R2.1* specification.

Large System Size

You can use MXI-3 to control remote devices on up to 255 buses from any PCI-based system, provided the BIOS supports such a configuration. You can use either a daisy-chain or a star configuration, with maximum bus-to-bus distances of 20 meters (copper cable) or 200 meters (fiber-optic cable).

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Software Transparency

Because the MXI-3 system is a *PCI-PCI bridge*, all devices on the system appear as local devices to the primary computer. You do not need to rewrite your device drivers for operation on a MXI-3 system.

High Performance

MXI-3 supports write posting and read prefetching to enhance performance, and provides clock distribution and bus arbitration for up to seven slots on each secondary bus. MXI-3 buffers and retimes the signals between the buses, maintaining the tight timing and high performance PCI requires.

What You Need to Get Started

To set up and use your MXI-3 system, you need the following:

- ❑ Two PXI MXI-3 cards *or* a PXI MXI-3 card and a PCI MXI-3 card
- ❑ Copper or fiber-optic MXI-3 cable
- ❑ Documentation—*Set Up Your MXI-3 System* and *Getting Started with Your MXI-3 System*
- ❑ Primary bus—A computer with a PCI backplane, or a PXI embedded controller on a PXI/CompactPCI chassis
- ❑ Secondary bus—A PXI/CompactPCI chassis
- ❑ Software—*MXI-3 Software Installation Diskette for Windows NT/98/95*

Unpacking

Your MXI-3 cards are shipped in antistatic packages to prevent electrostatic damage to the devices. Electrostatic discharge can damage several components on the device. To avoid such damage in handling the device, take the following precautions:

1. Ground yourself via a grounding strap or by holding a grounded object.
2. Before removing the device from the package, touch the antistatic package to a metal part of your computer chassis.

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

Caution *Never* touch the exposed pins of connectors. Doing so may damage the device.

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2

Installation

This chapter explains how to install the MXI-3 software and hardware.

Software Installation

Your MXI-3 kit includes a setup program for Microsoft Windows operating system. The setup program works in the same manner for Windows NT, 98, and 95. Users of other operating systems can ignore this section.

Note The software included for Microsoft Windows is provided so that the performance of National Instruments PXI modules is optimized across a PCI-PCI bridge. The MXI-3 interface is completely functional without this additional software. The software does not affect PXI or CompactPCI modules from other vendors.

The setup program is an interactive application that installs the MXI-3 software and configures your system for use with the MXI-3 card. Follow these steps to perform the installation.

Note You can quit the setup program at any time by choosing the **Cancel** option.

1. Insert the disk labeled *MXI-3 Software for Windows NT/98/95*.
2. Select **Run** from the **Start** menu and type the following text (where *X* is the drive letter of your floppy drive):

   X:\setup.exe
3. Press <Enter>.
4. Click on the **Next** button at the **Welcome** screen to start the installation. You must accept the license agreement to enable installation.
5. The setup program now copies the necessary files to your hard drive. When the installation process is complete, you must reboot your computer for the changes to take effect.
6. Review the information in the README.TXT file for the most up-to-date information on your MXI-3 card.

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Hardware Installation

You can install a MXI-3 card in any available PCI expansion slot in your PC.

The following are general instructions for installing the PCI MXI-3 and PXI MXI-3 cards. Consult your computer user manual or technical reference manual for specific instructions and warnings.

Installing a PCI MXI-3 Card

1. Plug in but do not turn on your computer before installing the PCI MXI-3 device. The power cord grounds the computer and protects it from electrical damage while you are installing the module.

Warning To protect both yourself and the computer from electrical hazards, your computer should remain off until you finish installing the PCI MXI-3 device.

2. Remove the top cover or access port to the PCI bus.
3. Select any available PCI expansion slot.
4. Locate the metal bracket that covers the cut-out in the back panel of the computer for the slot you have selected. Remove and save the bracket-retaining screw and the bracket cover.
5. Touch the metal part of the power supply case inside the computer to discharge any static electricity that might be on your clothes or body.
6. Line up the PCI MXI-3 with the 68-pin connector near the cut-out on the back panel. Slowly push down on the top of the PCI MXI-3 until its card-edge connector is resting on the expansion slot receptacle. Using slow, evenly distributed pressure, press the PCI MXI-3 straight down until it seats in the expansion slot.
7. Reinstall the bracket-retaining screw to secure the PCI MXI-3 to the back panel rail.
8. Replace the computer cover.

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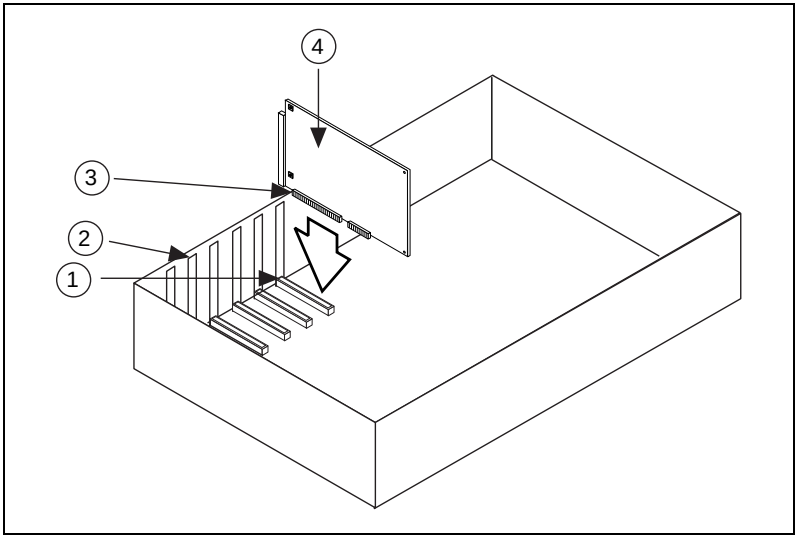

1	PCI Bus Slot	3	PCI Bus Card-Edge Connector
2	Cut-Outs	4	PCI MXI-3 Board

Figure 2-1. Installing the PCI MXI-3

Installing a PXI MXI-3 Card

You can install the PXI MXI-3 in any available 5 V slot in your PXI or CompactPCI chassis.

1. Turn off your PXI or CompactPCI chassis, but leave it plugged in while installing the PXI MXI-3 card. The power cord grounds the chassis and protects it from electrical damage while you install the module.
2. Install the PXI MXI-3 card:
   - Secondary PXI MXI-3 card—Install the PXI MXI-3 in the controller slot (Slot 1) of your chassis. This slot must support bus arbitration and bus mastering. The secondary PXI MXI-3 contains onboard logic that can operate only in such a slot.
   - Primary PXI MXI-3 card—Choose any unused PXI or CompactPCI 5 V peripheral slot *except* Slot 1. (Slot 1 is reserved for the system controller.)

Warning To protect both yourself and the mainframe from electrical hazards, leave the mainframe off until you finish installing the PXI MXI-3 card.

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3. Remove or open any doors or covers blocking access to the system controller slot (Slot 1) in the mainframe.
4. Touch the metal part of the case to discharge any static electricity that might be on your clothes or body.
5. Make sure the injector/ejector handle is in its downward position. Align the PXI MXI-3 card with the card guides on the top and bottom of the system controller slot.

Caution Do not raise the injector/ejector handle as you insert the PXI MXI-3 card. It will not insert properly unless the handle is in its downward position so that it does not interfere with the injector rail on the mainframe, as shown in Figure 2-2, *PXI MXI-3 Before Installation*.

6. Hold the handle as you slowly slide the module into the chassis until the handle catches on the injector/ejector rail.
7. Raise the injector/ejector handle until the module firmly seats into the backplane receptacle connectors. The front panel of the PXI MXI-3 card should be even with the front panel of the chassis.
8. Tighten the bracket-retaining screws on the top and bottom of the front panel to secure the PXI MXI-3 card to the chassis.
9. Check the installation.
10. Replace or close any doors or covers to the chassis.

Figure 2-2 shows a PXI MXI-3 card just before installation in the system controller slot of a National Instruments PXI-1000 mainframe. You can place PXI devices in any other slot.

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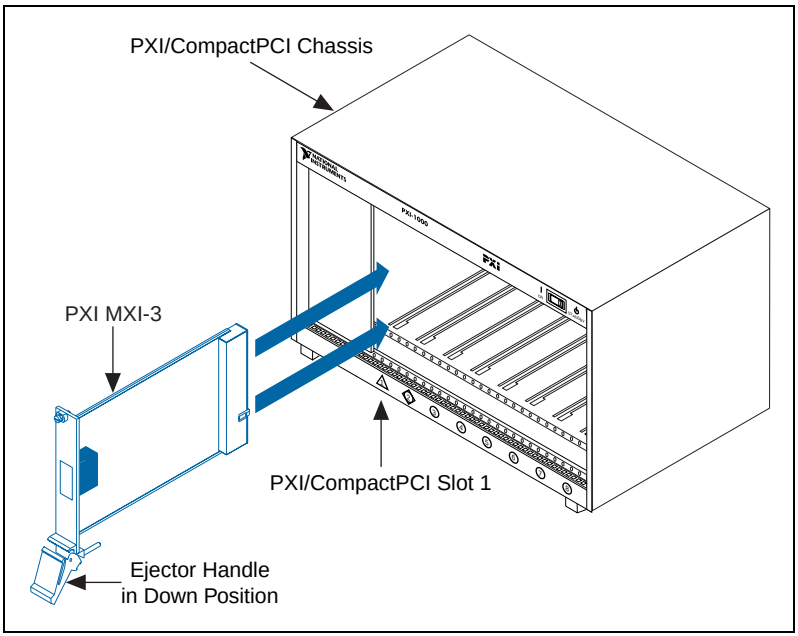

Figure 2-2. PXI MXI-3 Before Installation

Cabling

1. Connect the appropriate serial cable to both primary and secondary MXI-3 cards. If you are using a fiber-optic cable, be sure to remove the protective caps from the connectors.

Caution Do *not* remove the cable after the system is powered on. Doing so may crash the system.

2. Turn on your secondary chassis.
3. Turn on your primary chassis.

For more information on cables, see the *MXI-3 Cable Options* section in Chapter 3, *Hardware Overview*.

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3

Hardware Overview

This chapter presents an overview of the hardware functions of your MXI-3 system, and explains the operation of each functional unit.

Functional Overview

The MXI-3 system is a PCI-PCI bridge that needs no software for normal operation. When the desktop PC or the CompactPCI/PXI controller powers on, the system BIOS scans its local PCI bus for devices. When it finds the primary interface of the MXI-3 card, it opens memory windows in the card and searches for PCI devices through those windows using PCI transactions. The PC recognizes all devices on the secondary bus to be on a single PCI bus.

Figure 3-1, *MXI-3 Block Diagram*, shows the basic architecture of the MXI-3 system. The MXI-3 card interfaces to the PCI bus with the National Instruments MXI-3 ASIC. The ASIC converts PCI transactions into a 20-bit wide parallel bus. A parallel to serial converter transmits the 20-bit data as serial data at 1.5 GBytes/s. If you are using copper cable, the system sends the unmodified serial data through the cable. If you are using fiber-optic cable, the system converts the serial data to light using a VCSEL module.

On the other side of the system, the MXI-3 card receives the data, using high-speed photodetectors to convert light signals back to digital data if necessary. A serial to parallel converter then converts the digital serial data to the original 20-bit wide packets of data for the MXI-3 ASIC. MXI-3 then recreates the PCI transaction with appropriate modifications.

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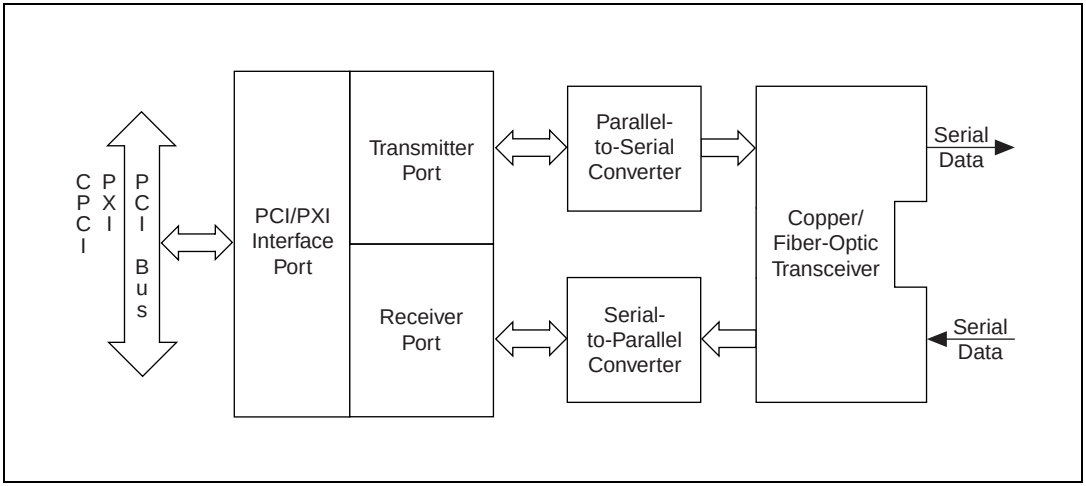

Figure 3-1. MXI-3 Block Diagram

MXI-3 Chassis Expansion

By plugging a PXI MXI-3 module into any of slots 2 through 8 of a PXI/CompactPCI chassis and a PXI MXI-3 module into Slot 1 of an additional PXI/CompactPCI chassis and connecting them with a cable, one PXI/CompactPCI chassis can be expanded to two. The PXI MXI-3 modules detect the slot in which they reside and automatically configure themselves as primary or secondary. In accordance with the PCI-to-PCI Bridge specification, up to 254 chassis can be linked to a single desktop PC.

Figure 3-2 shows the most basic MXI-3 configurations.

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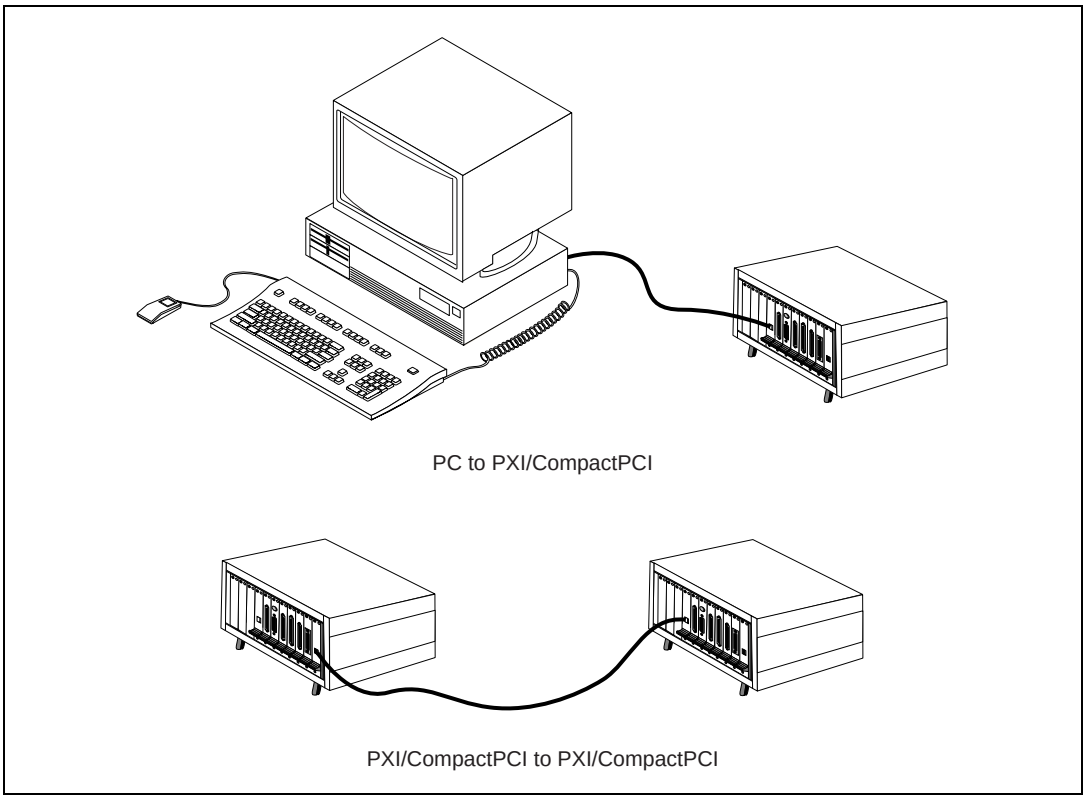

Figure 3-2. Basic MXI-3 Configurations

Because MXI-3 complies with the standard PCI-to-PCI bridging specification, it can take advantage of a variety of other extension configurations. Figure 3-3, *Additional MXI-3 Configurations*, shows how MXI-3 can be used to daisy-chain multiple systems in row, all under the control of the primary system, in this case a PC.

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Star configurations are also possible using MXI-3 interfaces in the primary system to fine tune performance.

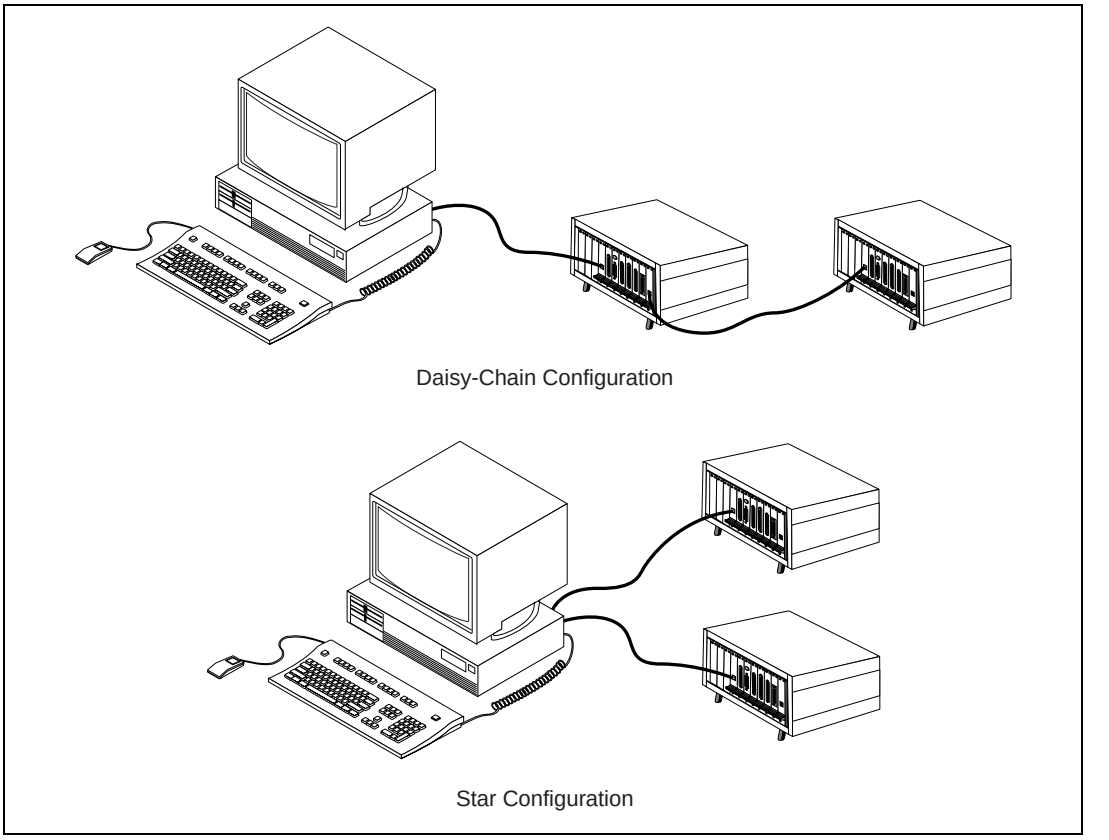

Figure 3-3. Additional MXI-3 Configurations

Functional Unit Descriptions

National Instruments MXI-3 ASIC

The MXI-3 ASIC, which contains most of the design of the two-board system, is a PCI master/slave device using the PCI-PCI bridge register set. MXI-3 uses data queues to store data for transmission, and also uses data queues to store received data waiting for access to the target PCI bus. MXI-3 transmits data to the parallel-to-serial converters, and receives data from the serial-to-parallel converters.

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Serial Transmitter

The serial transmitter is a parallel-to-serial data converter. The parallel-to-serial converter serializes the 20-bit wide parallel data from the MXI-3 ASIC and sends it to the transceiver.

Serial Receiver

The serial receiver is a serial-to-parallel data converter. The serial-to-parallel converter deserializes the data from the receiver and supplies the 20-bit wide parallel data to the MXI-3 ASIC.

High Speed Serial Data Connector (HSSDC) Receptacle

The HSSDC 8-position right-angle receptacle assembly interfaces the electrical data to the copper serial cable.

High Speed Serial Data Connector (HSSDC) Cable

The HSSDC 8-position cable assembly is the copper medium through which the serial data is transferred.

Gigabit Ethernet Link (Duplex SC Connector)

The Gigabit Ethernet Link Duplex SC Connector uses VCSEL technology to convert electrical data into laser light, and transmits the data across a fiber-optic cable. It also converts the laser light back to electrical data after receiving it from the cable.

Gigabit Ethernet Link (Multi-Mode Fiber-Optic Cable)

The Gigabit Ethernet Link Multi-Mode Fiber-Optic Cable is the medium through which the laser light is transferred.

MXI-3 Cable Options

Both copper and fiber-optic cables are available for your MXI-3 system. Copper links are the least expensive interconnect and can span up to 10 meters between systems. Fiber optic links offer connections between systems separated by up to 200 meters without repeaters. National Instruments offers 2 meter, 5 meter, and 10 meter copper cables and a 30 meter fiber optic cable as described in Table 3-1.

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Table 3-1. National Instruments MXI-3 Cables

Cable length (meters)	Description
2 m	MXI-3 copper cable
5 m	MXI-3 copper cable
10 m	MXI-3 copper cable
30 m	MXI-3 fiber optic cable

If you require lengths greater than 30 meters in fiber optic cable, contact Molex, cable vendor for National Instruments. Table 3-2 describes Molex cables. The fiber-optic cable offered by Molex is a multimode, 62.5/125 µm cable with a duplex, zipcord, 3.0 × 6.5 mm, OFNR cable construction. The connector style is SC Duplex with a multimode, ceramic ferrule. A standard PC finish is used on both ends.

Table 3-2. Molex MXI-3 Fiber-Optic Cables

Cable length (meters)	Molex Part Number
60 m	MXBBA-FGA-FGA-M060-A000-A000
XXX m	MXBBA-FGA-FGA-M*xxx*-A000-A000

For more information, you can contact Molex through its Web site at `http://www.molex.com`, or at Molex Incorporated, 2222 Wellington Court, Lisle IL 60532-1682, USA, 1-800-786-6539.

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A

Specifications

This appendix lists the system specifications for PCI MXI-3 and PXI MXI-3 cards. These specifications are typical at 25 °C, unless otherwise stated.

Physical

Dimensions

PCI ..... 10.7 by 17.5 cm (4.2 by 6.9 in.)

PXI ..... 10.0 by 16.0 cm (3.9 by 6.3 in.)

Available cable lengths

Copper..... 2 m, 5 m, 10 m, 20 m

Fiber-optic..... 30 m through 200 m

Environment

Operating temperature..... 0 to 50 °C

Storage temperature ..... –20 to 70 °C

Operating relative humidity ..... 10 to 90%, noncondensing

Storage relative humidity ..... 5 to 95%, noncondensing

Emissions ..... EN 55011:1991 Group 1
Class A at 10 m
FCC Class A at 10 m

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B

Technical Support Resources

This appendix describes the comprehensive resources available to you in the Technical Support section of the National Instruments Web site and provides technical support telephone numbers for you to use if you have trouble connecting to our Web site or if you do not have internet access.

NI Web Support

To provide you with immediate answers and solutions 24 hours a day, 365 days a year, National Instruments maintains extensive online technical support resources. They are available to you at no cost, are updated daily, and can be found in the Technical Support section of our Web site at `www.natinst.com/support`.

Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.
- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.
- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.
- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.
- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

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Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.
- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.
- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

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Glossary

Prefix	Meaning	Value
n-	nano-	10^{-9}
µ-	micro-	10^{-6}
m-	milli-	10^{-3}
c-	centi-	10^{-2}
k-	kilo-	10^{3}
M-	mega-	10^{6}

Symbols

°	Degrees
≥	Equal or greater than
≤	Equal or less than
%	Percent

A

ASIC	Application-Specific Integrated Circuit—a proprietary semiconductor component designed and manufactured to perform a set of specific functions for a specific customer

B

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. Examples of PC buses are the AT bus, NuBus, Micro Channel, and EISA bus.
bus master	a type of a plug-in board or controller with the ability to read and write devices on the computer bus

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C

C	Celsius
clock	hardware component that controls timing for reading from or writing to groups
counter/timer	a circuit that counts external pulses or clock pulses (timing)

D

device	a plug-in instrument card or pad that can contain multiple channels and conversion devices. Plug-in boards and PCMCIA cards, which connects to your computer parallel port, are examples of devices.
digital trigger	a TTL level signal having two discrete levels—a high and a low level
DMA	direct memory access—a method by which data can be transferred to/from computer memory from/to a device or memory on the bus while the processor does something else. DMA is the fastest method of transferring data to/from computer memory.

I

IEEE	Institute of Electrical and Electronics Engineers

M

MITE	MXI Interfaces To Everything—a custom ASIC designed by National Instruments that implements the PCI bus interface. The MITE supports bus mastering for high speed data transfers over the PCI bus.

P

PCI	Peripheral Component Interconnect—a high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA. It is achieving widespread acceptance as a standard for PCs and workstations; it offers a theoretical maximum transfer rate of 132 Mbytes/s.

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PCI-MITE	A custom ASIC designed by National Instruments that implements the PCI bus interface. The PCI-MITE supports bus mastering for high speed data transfers over the PCI bus. It is also used in PXI cards.
PCI-PCI bridge	A device that transparently expands the PCI bus on a computer motherboard to another bus segment in the same machine. The bridge expands the number of PCI expansion slots, but remains transparent to the end user.
PXI	Stands for PCI eXtensions for Instrumentation. PXI is an open specification that builds off the CompactPCI specification by adding instrumentation-specific features.

V

VCSEL	Vertical Cavity Surface Emitting Laser

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Index

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O

P

R

S

T

W

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