VXI

Getting Started with Your VXI-1394 Interface for Windows NT/98

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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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If necessary, consult National Instruments or an experienced radio/television technician for additional suggestions. The following booklet prepared by the FCC may also be helpful: *Interference to Home Electronic Entertainment Equipment Handbook.* This booklet is available from the U.S. Government Printing Office, Washington, DC 20402.

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This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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About This Manual

This manual contains instructions for installing and configuring the National Instruments VXI-1394 interface kit for Windows 98 and Windows NT. The VXI-1394 kit is a low-cost, VXI*plug&play*-compliant IEEE 1394 interface that gives external PCI-based computers the capabilities of embedded VXI controllers.

Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, describes your VXI-1394 interface kit, lists what you need to get started, and includes a brief description of the hardware and software.
- Chapter 2, *Setup*, explains how to set up your VXI system using the VXI-1394 hardware and NI-VXI/VISA software.
- Chapter 3, *Developing Your Application*, discusses the software utilities you can use to start developing applications that use the NI-VXI/VISA driver.
- Appendix A, *Specifications*, lists the specifications for the VXI-1394 module.
- Appendix B, *Default Settings*, summarizes the default settings for the hardware and software in the VXI-1394 kit.
- Appendix C, *Advanced Hardware Configuration Settings*, describes the factory-default and alternate hardware configuration settings of the VXI-1394. The board is set at the factory for the most commonly used configuration. Use this appendix if you want to try a different hardware configuration, or if you would like more information on a particular setting. This information is intended for more advanced users.
- Appendix D, *Common Questions*, addresses common questions you may have about using the NI-VXI/VISA software on the VXI-1394 platform.
- Appendix E, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.

- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.
- The *Index* alphabetically lists topics covered in this manual, including the page where you can find the topic.

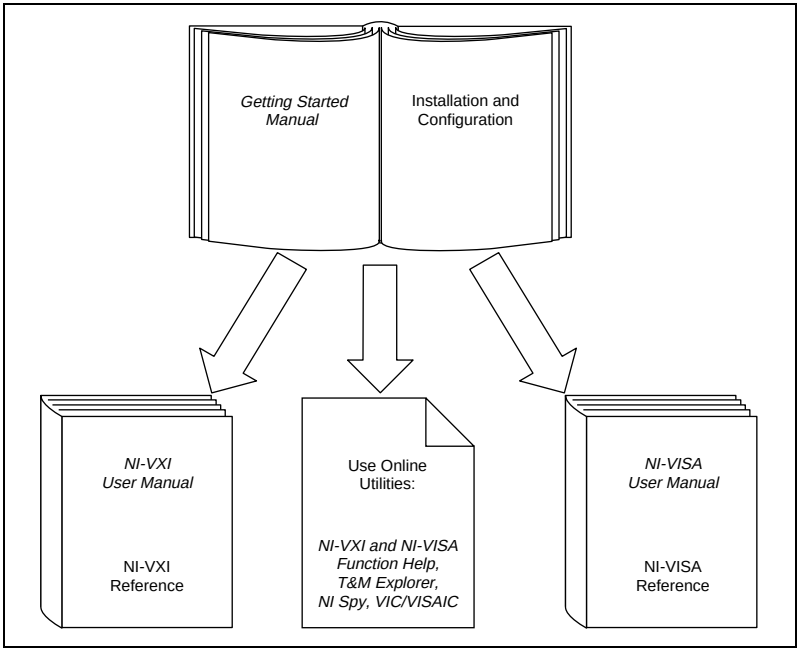
Conventions Used in This Manual

The following conventions are used in this manual:

<>	Angle brackets enclose the name of a key on the keyboard—for example, <Enter>.
♦	The ♦ symbol indicates that the text following it applies only to a specific product, a specific operating system, or a specific software version.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **T&M Explorer»Help»Help Topics** directs you to launch **T&M Explorer**, pull down the **Help** menu, and finally select the **Help Topics** options from the last dialog box.
☞	This icon to the left of bold italicized text denotes a note, which alerts you to important information.
⚠	This icon to the left of bold italicized text denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.
bold	Bold text denotes the names of menus, menu items, parameters, dialog boxes, dialog box buttons or options.
bold italic	Bold italic text denotes a note or caution statement.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text from which you supply the appropriate word or value, as in *x*86.
`monospace`	Text in this font denotes text or characters that you should literally enter from the keyboard, sections of code, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, functions, variables, filenames and extensions, and for statements and comments taken from programs.
`monospace bold`	Bold text in this font denotes the messages and responses that the computer automatically prints to the screen.

monospace italic	Italic text in this font denotes that you must enter the appropriate words or values in the place of these items. For example, *NIVXI* in a directory path refers to the actual location where you installed the NI-VXI software.
paths	Paths in this manual are denoted using backslashes (\) to separate drive names, directories, folders, and files.

How to Use This Documentation Set



This getting started manual contains an overview of the VXI-1394 hardware and the NI-VXI/VISA software, guides you through setting up your kit, and helps you get started with application development. You can also use this manual as a reference for the hardware and software default settings and to find the answers for commonly asked questions.

When you have successfully set up your system, you can begin to develop applications in NI-VXI and/or NI-VISA. The *NI-VXI User Manual* presents the concepts of VXI and prepares you for detailed explanations of the NI-VXI functions. Study the descriptions of each function given in the online help utility to fully understand the purpose and syntax of each function. This manual is available in the *NIVXI*\manuals directory (where *NIVXI* refers to the actual location where you have installed the NI-VXI

software) under the name NIVXIUM.pdf. Use the Acrobat Reader program, Version 3 or later, to open this file. You can also access the NI-VXI online help for Windows NT/98 in the NIVXI folder.

Refer to the *NI-VISA User Manual* to learn about VISA and how to use it in your system. The NI-VISA online help describes the attributes, events, and operations you can use in NI-VISA. The user manual is available in the *VXIpnp**os*\NIvisa\manuals directory (where *VXIpnp* refers to the actual location where you have installed the NI-VISA software, and *os* is either WinNT or Win95) under the name NIVISAUM.pdf. Use the Acrobat Reader program, Version 3 or later, to open this file.

Related Documentation

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

- ANSI/IEEE Standard 1014-1987, *IEEE Standard for a Versatile Backplane Bus: VMEbus*
- ANSI/IEEE Standard 1155-1998, *IEEE VMEbus Extensions for Instrumentation: VXIbus*
- ANSI/VITA 1-1994, *VME64*
- IEEE Standard 1394-1995, *IEEE Standard for a High Performance Serial Bus*
- *PCI Local Bus Specification*, Revision 2.1, PCI Special Interest Group
- VXI-6, *VXIbus Mainframe Extender Specification*, Rev. 2.0, VXIbus Consortium

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 E, *Customer Communication*, at the end of this manual.

1 Introduction

This chapter describes your VXI-1394 interface kit, lists what you need to get started, and includes a brief description of the hardware and software.

The VXI-1394 interface kit links a PCI-based computer to the VXIbus using the IEEE 1394, or FireWire, high-speed serial bus. This kit makes your computer perform as though it were plugged directly into the VXI backplane, giving your external computer the capability of an embedded computer. You can connect streaming devices such as digital cameras to either the VXI-1394 interface in your VXI mainframe or the PCI-1394 interface in your computer. IEEE 1394 features *hot plug-in capability*, which means you can add and configure 1394 devices without having to power down your system.

Your kit contains a National Instruments VXI-1394 interface module, which plugs into your VXI mainframe and links your computer to the VXIbus. The VXI-1394/G option adds a front panel connection to IEEE 488.2 devices so that you can control a test system including both GPIB and VXI devices.

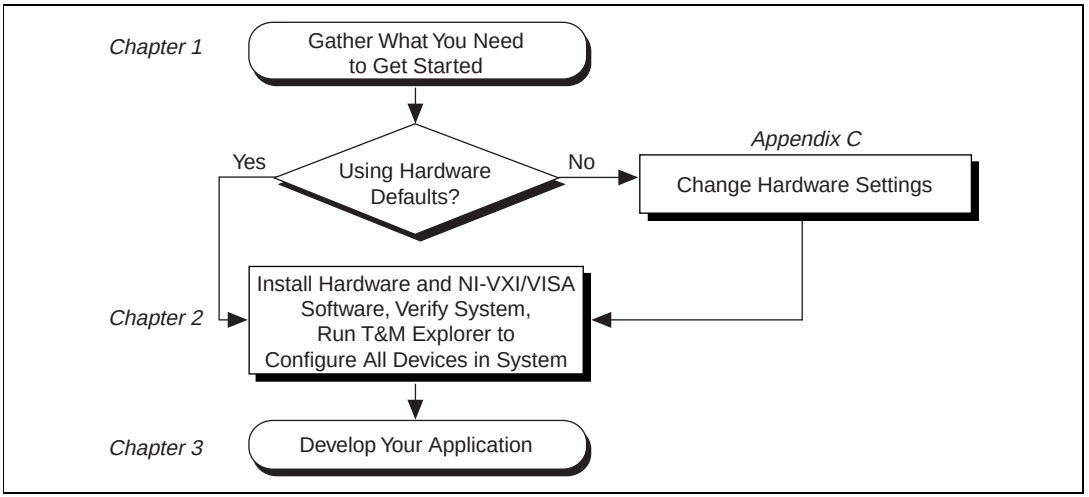
Unless your computer is already equipped with an IEEE 1394 bus, your kit also contains a PCI-1394 interface module. This is a 1394 host adapter, which links your PCI-based computer to the IEEE 1394 bus.

Your software consists of the NI-VXI/VISA bus interface software, which is fully VXI*plug&play* compliant. It is the National Instruments implementation of the VISA I/O software standard on which all VXI*plug&play* software components are based.

This manual uses the term *NI-VXI/VISA* when software information applies to both NI-VXI and NI-VISA, and the term *Windows NT/98* when information applies to both operating systems.

How to Use This Manual

The following flowchart shows where to turn for more details on configuring and using the hardware and software.



The default hardware configuration of the VXI-1394 should be acceptable for most systems. Appendix C, *Advanced Hardware Configuration Settings*, is necessary only if your system will make use of the front-panel CLK10 and trigger SMB connectors.

What You Need to Get Started

- ❑ A computer running either Windows NT or Windows 98 and equipped with an IEEE 1394 serial bus (this bus can be either built-in or installed through a plug-in PCI-1394 host adapter board)
- ❑ VXIbus mainframe
- ❑ VXI-1394 interface module that plugs directly into a VXI mainframe
- ❑ 1394 cable
- ❑ National Instruments software media
- ❑ Adaptec AHA-8940 PCI-1394 host adapter (optional) that you install in an available PCI slot in your PCI-based computer

☞ **Note** ***You need the PCI-1394 adapter only if your computer is not already equipped with an IEEE 1394 bus. The computer in which you install the host adapter must be PCI Rev. 2.x compliant.***

VXI-1394 Interface Kit Overview

The interface kits described in this manual link a 1394-equipped computer directly to the VXIbus using the IEEE 1394 bus. The VXI-1394 kit uses this high-speed (up to 400 Mbits/s) serial bus to link your computer running Windows NT/98 to a VXI chassis.

☞ **Note** ***You can connect multiple 1394 devices together in a tree topology. However, increasing the complexity of the 1394 bus topology can lower its performance.***

All VXI-1394 kits include the NI-VXI/VISA software for Windows NT/98, a C-size VXI-1394 module, and a 1394 cable. If your computer is not equipped with a IEEE 1394 bus, your kit should also contain the Adaptec AHA-8940 PCI-1394 host adapter. This adapter is not necessary if your computer is already 1394 equipped.

A 1394-equipped computer connected to a VXI-1394 interface can function as a VXI Commander and Resource Manager. The VXI-1394 interface kit gives your computer the capability to perform as if it is plugged directly into the VXI backplane as an embedded CPU module. The VXI-1394 transparently translates between the IEEE 1394 and VXI protocols.

The software included with the kits is for *x*86/Pentium-based computers.

Hardware Description

The VXI-1394 module is a VXIbus device with optional VXIbus Slot 0 capability so that it can reside in any slot in a C-size or D-size chassis. The VXI-1394 can automatically determine whether it is located in VXI Slot 0.

☞ **Note** ***D-size VXI mainframes have connections for a P3 connector. The VXI-1394, however, does not have this connector and, if configured as a Slot 0 controller, cannot provide the necessary control for VXI devices that need P3 support.***

The VXI-1394 links the computer to the VXIbus and converts 1394 data transfers into VXIbus data transfers and vice versa. The VXI-1394 includes additional 1394 ports you can use to connect other 1394 devices.

The VXI-1394/G version includes a front-panel GPIB port you can use to integrate GPIB devices into your VXI-based instrumentation system without the need of a GPIB adapter in the host computer. The standard VXI-1394 and VXI-1394/G are otherwise functionally equivalent. The GPIB port on the VXI-1394/G cannot be used to control the VXIbus; it is intended for controlling only GPIB instruments through either NI-488.2 or NI-VISA. With the VXI-1394/G, you can control both GPIB and VXI instruments using a single 1394 cable from your host computer.

The Adaptec AHA-8940 PCI-1394 is included in some of the kits and is intended for users whose computers are not already 1394 equipped. The PCI-1394 is an industry-standard 1394 host adapter on a PCI board, which gives your computer the capability to control 1394 devices. The PCI-1394 also supplies power to the IEEE 1394 bus, which is required by some devices.

VXI-1394 Front Panel Features

The VXI-1394 has the following front panel features.

- Three front panel LEDs
  - **SYSFAIL** LED indicates that the VMEbus SYSFAIL line is asserted.
  - **1394** LED indicates when the VXI-1394 is accessed from the IEEE 1394 bus.
  - **VXI** LED indicates when the VXI-1394 is accessed from the VXIbus.
- Three 1394 6-pin connectors
- GPIB connector (VXI-1394/G version only)
- Three SMB connectors
  - External clock
  - Trigger output
  - Trigger input
- System reset push-button

Software Description

NI-VXI is the name of the National Instruments VXI bus control library. You can create applications using NI-VXI to control both VXI and VME devices. NI-VXI gives you complete VXI/VME functionality, including an API for performing basic VXI/VME data transfers and handling VXI/VME interrupts as well as VXI-specific functionality, such as doing message-based communication and handling VXIbus triggers.

NI-VISA is the National Instruments implementation of the VISA specification. VISA is a uniform API for communicating with and controlling Serial, GPIB, VXI, and VME instruments. This API aids in the creation of more portable applications and instrument drivers.

The NI-VXI/VISA software includes an interactive configuration and troubleshooting program, libraries of software routines for test and measurement (T&M) programming, interactive control programs for both NI-VXI and NI-VISA, a logging utility you can use for debugging your applications, and a VXI Resource Manager. You can use this software to seamlessly program multiple-mainframe configurations and have software compatibility across a variety of controller platforms.

If your VXI-1394 model is the VXI-1394/G, which includes the optional GPIB port on its front panel, you can use the National Instruments NI-488.2 software kit, which gives you access to the industry-standard NI-488.2 software for controlling external GPIB instruments. The GPIB interface is fully compatible with the NI-488.2 driver for Windows NT. Any GPIB application using either NI-488.2 or NI-VISA will run on the VXI-1394/G.

Use T&M Explorer to view your entire T&M system and configure various components, whether they are Serial, GPIB, VXI, or VME devices. It is easy to add VME devices using T&M Explorer and view them on a screen display along with the rest of your system. This utility also adopts the functionality of the NI-DAQ Configuration utility so you can configure National Instruments VXI-DAQ cards.

T&M Explorer also features various options of how to run the VXI Resource Manager (Resman). You can still execute Resman independently to configure your instruments after a power cycle, but you can also perform resource manager operations directly from T&M Explorer or configure it to run Resman automatically at Windows startup.

The NI Spy utility tracks the calls your application makes to National Instruments T&M drivers, including NI-VXI, NI-VISA, and NI-488.2. NI Spy helps you debug your application by clearly highlighting the functions that return errors. You can let NI Spy keep a log of your program's calls to these drivers so that you can check them for errors at your convenience.

National Instruments Application Software

In addition to the NI-VXI/VISA software, you can use the National Instruments LabVIEW and LabWindows/CVI application programs and instrument drivers to ease your programming task. These standardized programs match the modular virtual instrument capability of VXI and can reduce your VXI/VME software development time. These programs are fully VXI*plug&play* compliant and feature extensive libraries of VXI instrument drivers written to take full advantage of direct VXI control. LabVIEW and LabWindows/CVI include all the tools needed for instrument control, data acquisition, analysis, and presentation.

LabVIEW is a complete programming environment that departs from the sequential nature of traditional programming languages and features a graphical programming environment.

LabWindows/CVI is an interactive C development environment for building test and measurement and instrument control systems. It includes interactive code-generation tools and a graphical editor for building custom user interfaces.

If you want to use either of these application programs, install them prior to installing the NI-VXI/VISA software. You also get hundreds of complete instrument drivers, which are modular, source-code programs that handle the communication with your instrument to speed your application development.

2

Setup

This chapter explains how to set up your VXI system using the VXI-1394 hardware and NI-VXI/VISA software.

Configuring the Hardware

This section contains basic information about configuring your VXI-1394 hardware.

- **Windows 98 users**—We recommend that you install the NI-VXI software for Windows 98 first, and then install the hardware. The software installation instructions are later in this chapter.

The default settings for your VXI-1394 hardware are acceptable for most typical applications. Refer to Appendix B, *Default Settings*, for a complete listing of the hardware and software default settings. Refer to Appendix C, *Advanced Hardware Configuration Settings*, if you want information about other possible settings.

Use the T&M Explorer utility in NI-VXI/VISA to change any of the configuration settings for the VXI-1394. For information on the software, including optional settings, use T&M Explorer and its online help. Use the Windows **Start** menu to open either the NI-VXI or NI-VISA program group, launch T&M Explorer, and select **Help»Help Topics**.

Installing the Hardware

This section summarizes how to install your VXI-1394 hardware. Your kit contains a VXI-1394 interface module and may also contain a PCI-1394 adapter board.

Caution ***To guard against electrostatic discharge, touch the antistatic plastic packages to a metal part of your computer or chassis before removing the boards from their packages. Your computer or chassis should be plugged in but powered off.***

Figure 2-1 illustrates a system that includes an IEEE 1394-equipped computer, a VXI-1394/G, IEEE 1394 devices, and a GPIB device. Each 1394 device should have only one connection to the 1394 system.

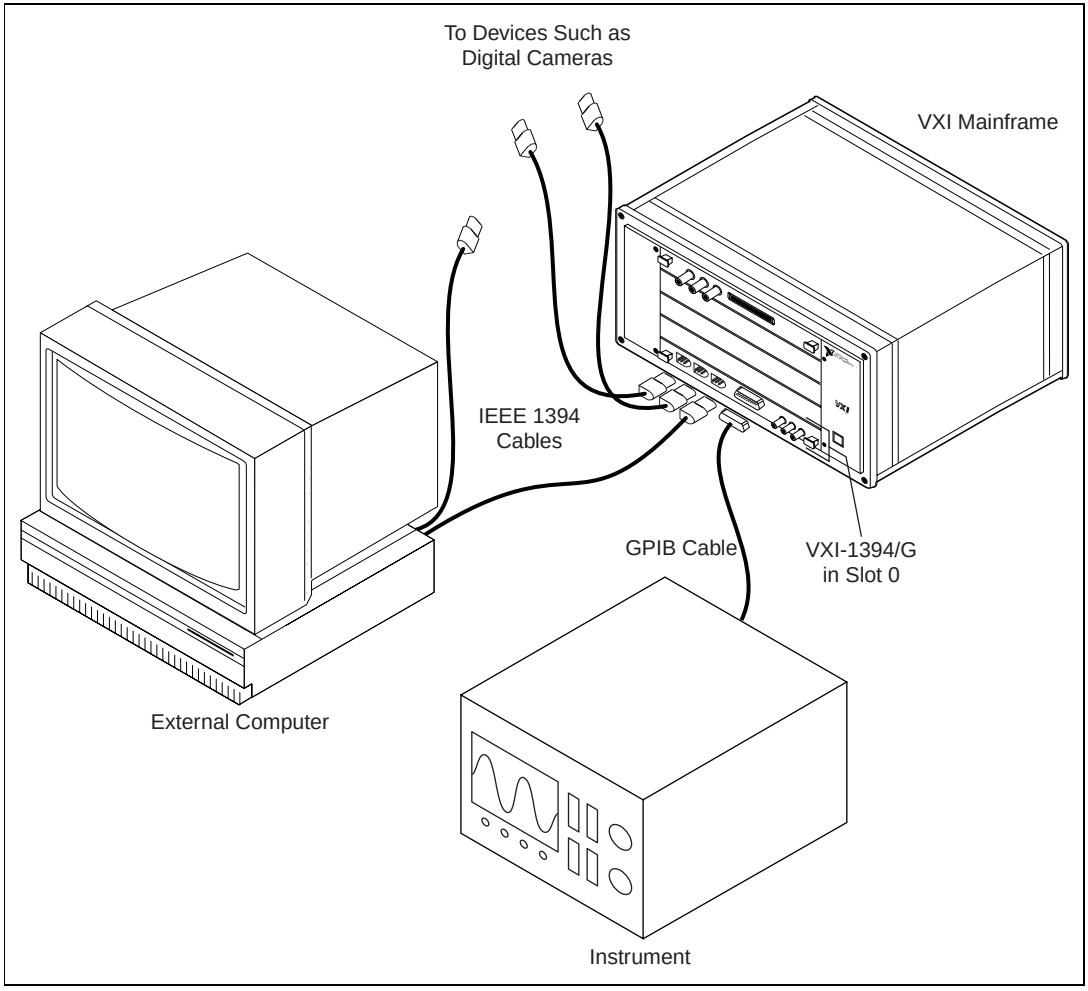


Figure 2-1. Typical VXI-1394 System

Install Your PCI-1394 Interface Board

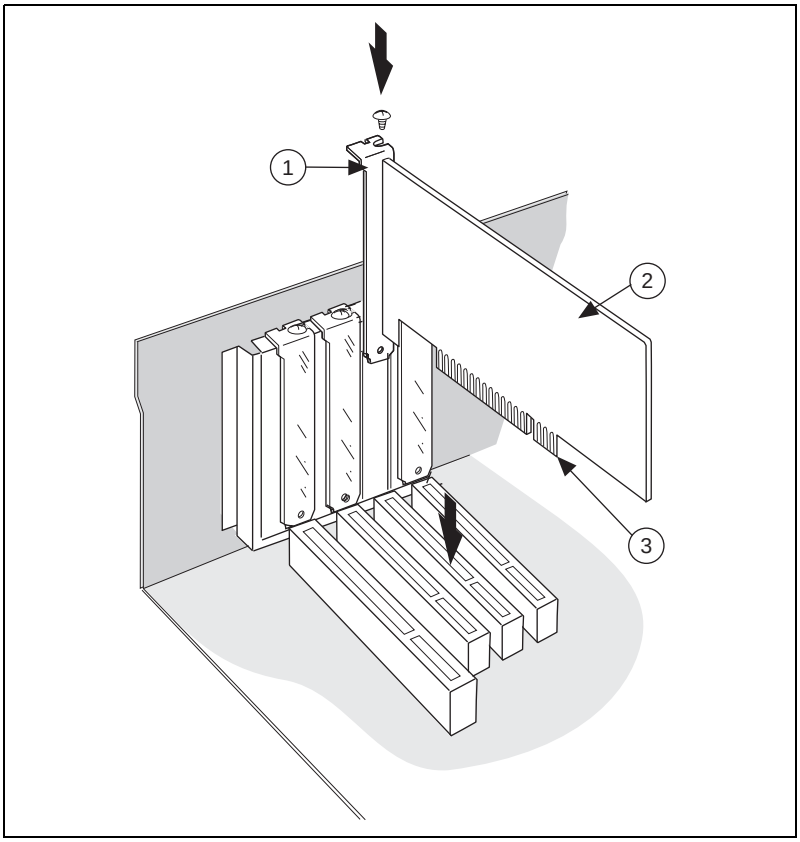
☞ **Note** ***You can skip this section if your computer is already IEEE 1394 equipped.***

If your computer is not already equipped with an IEEE 1394 bus, your kit contains an Adaptec AHA-8940 PCI-1394 host adapter. There is nothing to configure on this module; it is configured automatically when installed in

a computer that has a Plug and Play BIOS and/or a Plug and Play operating system.

The following are general installation instructions:

1. Remove the computer chassis cover to expose the expansion slots and external access covers.
2. Select an available PCI slot in your computer. The slot you select should support bus mastering. Refer to your computer documentation to determine if the slot you select supports bus mastering.
3. Remove the corresponding expansion slot cover from the chassis.
4. Align the bus connector on the bottom of the host adapter with the PCI bus slot.



1 Host Adapter Mounting Bracket
2 Host Adapter
3 Bus Contacts

Figure 2-2. Installing the PCI-1394 Host Adapter

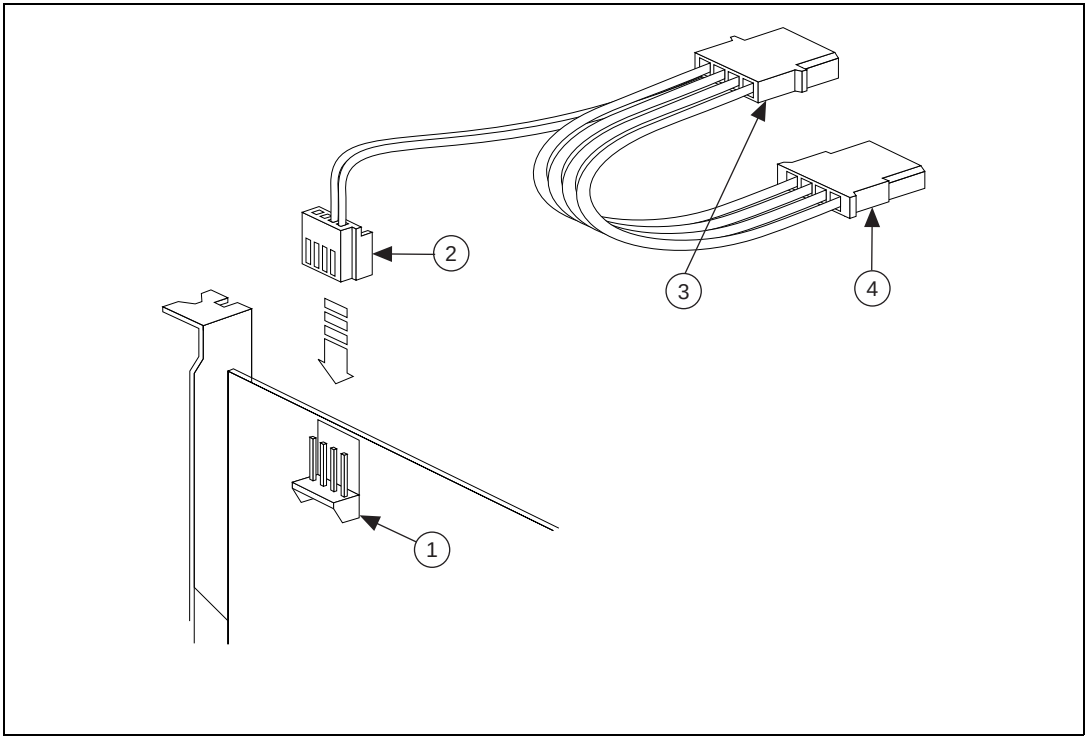
5. Carefully press the host adapter into the slot.
6. Secure the host adapter bracket to the computer chassis with the screw from the removed expansion slot cover.
7. If you are going to install a cable to power any 1394 devices, follow the instructions as described in the next section. Afterward, restore the chassis cover.

Connect the Host Adapter Power Supply

The VXI-1394 draws its power from the host, as do most 1394 devices. The PCI-1394 can supply 12 V up to a maximum draw of 1.5 A. You can use either a miniature power cable or the DC power cable that comes with your kit.

- If you have a miniature power cable available in your system, and the cable is long enough, plug it into the power connector on the host adapter.
- If the miniature power cable in your system is not long enough, or if it is not available, use the DC power cable. Plug it into the power connector on one end and the regular disk drive power connector on the other end, as shown in Figure 2-3.

☞ **Note** ***The power supplied by the host adapter is limited by a self-resetting 1.5 A fuse.***



1	12 VDC Power Connector	2	Miniature Power Connector	3	Power-In (from system power supply)	4	Power-Out (to disk drives)

Figure 2-3. Connecting the Power Cable

- **Windows 98 users**—When you power-on your computer after installing your hardware, Windows 98 will prompt you for the original Windows 98 CD for the IEEE 1394 host adapter drivers.

Install Your VXI-1394 Interface Board

All kits contain a VXI-1394 interface module. Install the VXI-1394 in Slot 0 of your VXI chassis.

The VXI-1394 default configuration automatically detects whether it should be the VXI system controller. The VXI system controllers operate certain VXI lines as required for VXI systems. Verify that any other VXI devices with system controller capability that are located in the same chassis are *not* configured as system controller.

Caution ***Having more than one device configured as system controller can damage the VXI system.***

For VXI systems that include VME devices, ensure that the VME devices are not configured in the upper 16 KB (starting from 0xC000) of the A16 address space. This region is reserved for VXI device configuration registers, which are used for initializing, configuring, and interacting with VXI devices. The VXI-1394 also uses this region for this purpose.

Note ***Also ensure that no VXI devices in your system are configured for logical address 0. This is the default configuration for the VXI-1394.***

Cable Your System

Connect the IEEE 1394 cable to the computer's 1394 interface and to the VXI-1394. You can use any available 1394 port for each device. The VXI-1394 has three external ports. If your computer's 1394 interface is the Adaptec PCI-1394 host adapter, it has two external and one internal port; you should use only the external ports.

You can connect any other 1394 devices to any available port on an existing device, but for best results minimize the number of levels in the tree topology. Adding to the number of levels in the tree degrades system performance.

Caution ***Do not cable devices to your 1394 system in such a way as to form a loop. Any device should have only one connection to the 1394 bus. An example of a loop would be a system containing a PCI-1394, a VXI-1394, and a device connected to both. Such a closed loop would break the 1394 system.***

Some 1394 devices require different cables than others. Your kit includes one 6-to-6-pin cable to link the VXI-1394 to your computer. Some other devices such as a video conferencing camera, for example, also require a 6-to-6-pin cable for proper connection to the 1394 system. Many other devices such as camcorders, VCRs, and so on, take a 6-to-4-pin cable. If you have the VXI-1394/G option, use a GPIB cable to attach your GPIB instruments to the GPIB port on the VXI-1394/G.

Restarting Power to the System

1. Be sure all cables are connected securely.
2. Check that all power switches are off, and then reconnect the computer power cables.
3. Turn on the external computer.
4. *For PC systems:* If your system CMOS setup requires you to enable PCI bus parameters, do so at this time.

Note ***The PCI bus usually assigns IRQs and port addresses automatically. However, in some PC systems, you may need to manually edit the PCI bus parameters in your CMOS setup. Refer to your computer documentation for further instructions.***

5. You can now turn on any external devices.
6. Ensure that the VXI-1394 is turned on prior to using the NI-VXI/VISA software.

Installing the Software for Windows NT/98

Use the Setup program that came with your NI-VXI/VISA software to install the entire software package or a software update, or to reinstall software in the event that your files were accidentally erased. The Setup program works in the same manner for either Windows 98 or Windows NT. You can install NI-VXI with or without NI-VISA.

Some of the utilities rely on the LabWindows/CVI Run-Time Engine. This software is installed, if necessary, during the NI-VXI/VISA installation.

Depending on the type of installation you choose, you may need up to 20 MB of free space available on your hard drive to accommodate the NI-VXI/VISA software. If you choose the **Custom** installation method, Setup displays the amount of free space you will need for the options you select.

To be compliant with VXI*plug&play* specifications, a VXI controller must provide the VISA I/O driver library standardized by VXI*plug&play.* VISA ensures that your controller can run all VXI*plug&play*-compatible software now and in the future.

The NI-VISA software in this kit is compatible with the WINNT/GWINNT and WIN95/GWIN95 frameworks. With NI-VISA installed on your computer, you can run any VXI*plug&play* software that is compatible with these frameworks. This includes instrument drivers and executable soft front panel software that are included with VXI*plug&play*-compatible instruments from a variety of vendors.

Installing the Software

This section describes how to install the 32-bit NI-VXI/VISA software. The Setup program works the same whether you are using Windows 98 or Windows NT. Please carefully read these directions along with any messages on the screen before making your selections.

You can quit the Setup program at any time by pressing the **Cancel** button.

Setup is an interactive, self-guiding program that installs the NI-VXI/VISA software and configures your system to use the software with the VXI-1394. Follow these steps to perform the installation:

1. Insert disk 1 of your set of disks labeled *NI-VXI/VISA for VXI-1394 and Windows xx* (where *xx* is either 98 or NT).
2. Select **Start»Run...** and enter the following text, where *X* is your floppy drive (usually A):

   X:\setup.exe

   and press <Enter>.
3. Click on the **Next** button at the **Welcome** screen to start the installation and accept the license agreement.

Note ***If Setup detects a 16-bit (DOS or Windows 3.x) version of the NI-VXI software, it prompts you to remove it. Setup will quit so you can uninstall the old software. If you have a previous 32-bit (Windows NT/98/95) version of the NI-VXI software installed, Setup installs the new version over the previous version.***

Caution ***If you want to keep the manufacturer/model name tables or the VME device configuration from a previous installation, be sure to back them up before starting Setup.***

4. Select the type of installation from the **Choose Setup Type** screen.
   - **Express** setup is the fastest and simplest installation option. This option installs all the NI-VXI/VISA software in default directories without prompting you to make any further choices.
   - **Typical** setup prompts you to make high-level choices of which driver(s) to install and the destination directories.
   - **Custom** setup gives you complete control over which files and utilities you want installed on your system. This option is recommended for advanced users.
5. The **Express** setup completes without further questions. Follow the prompts if you select either the **Typical** or the **Custom** setup options. The final prompt displays the choices you made concerning applications, support, and destination directories. Click on the **Next** button to begin the installation.
6. Setup now copies the necessary files to your hard drive and creates program icons.

Completing the Software Installation

1. Please review the information in any `readme` files that Setup prompts you to read.
2. When the installation process completes, you must reboot your computer for the changes to take effect. The NI-VXI driver is loaded at this time.
3. If you backed up the manufacturer and model name files, restore them to the `TBL` subdirectory of your NI-VXI directory before running T&M Explorer.
4. After you install the NI-VXI/VISA software, run the T&M Explorer program. It prompts you to run Resman, the National Instruments Resource Manager. You must run Resman every time the chassis power is cycled so that your application can access devices in the VXI chassis. You can also configure T&M Explorer to run Resman automatically at every computer startup.
5. After you run Resman, you are ready to use T&M Explorer to interactively configure the National Instruments hardware in your system. Use the right-click help for information about the various configuration options.

Verifying Your System Configuration

After you finish configuring the system through T&M Explorer, verify the system configuration through one of the interactive control utilities. Use VIC under NI-VXI or VISAIC under NI-VISA.

For more details about the utilities in NI-VXI/VISA, refer to Chapter 3, *Developing Your Application*.

3

Developing Your Application

This chapter discusses the software utilities you can use to start developing applications that use the NI-VXI/VISA driver.

After verifying your system configuration, you can begin to develop your VXI or VISA application software. Be sure to check the `readme.txt` file for the latest application development notes and changes.

Your software includes several utilities to help you develop your system. These include T&M Explorer, Resman, NI Spy, VISAIC, and VIC. You can also access several examples to learn how to use NI-VISA or NI-VXI for certain tasks. Each of these components assists you with one of four steps of development: configuration, device interaction, programming, and debugging.

After installation, you can access these utilities through the Windows **Start** menu. Open either the NI-VXI or NI-VISA program group and select the utility you want to use.

Configuration

The configuration utilities in your kit are T&M Explorer and Resman. Resman is the application that performs VXI Resource Manager functions as described in the VXIbus specification. Its most important functions include configuring all devices on the VXI backplane for operation and allocating memory for devices that request it.

☞ **Note** ***Because power cycling resets all devices, run Resman to reconfigure them every time chassis power is cycled.***

T&M Explorer presents a graphical display of your entire test and measurement system to help you configure various components. When you launch T&M Explorer, you see all your VXI, GPIB, GPIB-VXI, and serial devices on the screen. You can add devices that cannot be detected dynamically by T&M Explorer through the **Add Device Wizard** in the **Edit** menu. Such devices include VME devices, certain GPIB devices, and serial ports. You can view the properties (such as logical address, address space used, primary address, and so on) of each device by right-clicking on

the device in the tree. When you view the properties of most National Instruments devices, you can configure the hardware settings directly in the property pages.

T&M Explorer and Resman are designed to work together. You can run the Resource Manager through T&M Explorer by either clicking on the **Run Resource Manager** button on the toolbar, or selecting **Tools»VXI Resource Manager**. From **Tools»Options**, you can also configure T&M Explorer to run Resman automatically when the computer boots up. Resman reports all errors that it finds in your system to T&M Explorer. When you view your system through T&M Explorer, you can easily spot any errors in your system that Resman found.

You can find more information about T&M Explorer by using its online help. From T&M Explorer, select **Help»Help Topics**.

Device Interaction

After Resman has detected and configured all VXI/VME devices, you can view specific information on each device in your system by using the T&M Explorer utility. This utility includes a **System View**, which contains a description for each device, including each VXI device's logical address.

You can interact with your VXI/VME devices by using either the VIC or VISAIC utility (VIC for NI-VXI or VISAIC for NI-VISA). You can use these utilities to interactively control your VXI/VME devices without having to use a conventional programming language, LabVIEW, or LabWindows/CVI.

☞ **Note** ***You can launch VIC or VISAIC from the* Tools *menu in T&M Explorer.***

Try the following in VIC. In the **Command** entry field, type:

```
help vxiinreg
```

This help file shows you the syntax for this command, which reads VXI device configuration registers. The first argument is a logical address, and the second is the offset of the VXI device configuration register to be read.

Type:

```
vxiinreg 0,0
```

The **History** window shows the result of the command execution, such as:

```
Return Status (0): Success.
Value = 0xBFF6
```

If the value ends with `FF6`, you have successfully read the National Instruments manufacturer ID from the VXI-1394 ID register.

You may now want to read the configuration registers from other VXI devices in your system using the command `vxiinreg`. This command accesses only the upper 16 KB of A16 space. Try reading a register from each of the devices listed in the **Connection View** of T&M Explorer. In this way, you can verify that your VXI-1394 can access each of the devices in your VXI system successfully.

You can also access VXI and VME devices that are configured in A16, A24, and A32 address space by using the `vxiin` or `vxiout` commands. For more information regarding VIC operation and commands, refer to the VIC online help.

Alternatively, you can use VISAIC to interact with your devices. VISAIC lists the available devices, similar to what T&M Explorer displays. By double-clicking on a given device, you can open a VISA session and access the device through it. For more information regarding VISAIC, use the right-click help available from all panels.

Programming with VXI

National Instruments provides two different programming interfaces for accessing your instruments: NI-VISA and NI-VXI. NI-VISA is the National Instruments implementation of the VISA API as defined by the VXI*plug&play* standard. It is very useful in situations where you have different types of instruments in your system—such as VXI, VME, GPIB, and serial devices—because the NI-VISA functions have the same interface.

NI-VXI is the National Instruments proprietary interface for programming VXI/VME instruments. Both NI-VXI and NI-VISA grant you register-level access of VXI instruments as well as messaging capability to message-based devices. With either interface you can service asynchronous events, such as triggers and signals, and also assert them.

The best way to learn how to program with NI-VXI or NI-VISA is by reviewing the example programs included in your software. In the `Examples` directory you will find examples for many different types of applications. If you are just getting started, you should first learn how to access registers with high-level calls and send messages with word serial functions. The NI-VXI examples are called `VXIhigh.c` and `VXIws.c`. The NI-VISA examples of these tasks are called `VISAhigh.c` and `VISAws.c`. Use the other examples as you try more advanced techniques. Consult the *NI-VXI User Manual* or the *NI-VISA User Manual* for additional information on these topics.

☞ **Note** ***The*** *NI-VXI User Manual* ***resides in the*** *`NIVXI`*`\manuals` ***directory, and the*** *NI-VISA User Manual* ***is in the*** *`VXIpnp\OS`*`\NIvisa\manuals` ***directory, where*** *`OS`* ***would be either*** `WinNT` ***or*** `Win95`***. Use the Acrobat Reader program to open and navigate through the manuals.***

Table 3-1 summarizes the topics addressed by the example programs.

Table 3-1. NI-VXI/VISA Examples

Coverage	NI-VXI Example	NI-VISA Example
Message-Based Access	`VXIws.c`	`VISAws.c`
High-Level Register Access	`VXIhigh.c`	`VISAhigh.c`
Low-Level Register Access	`VXIlow.c`	`VISAlow.c`
Sharing Memory	`VXImem.c`	`VISAmem.c`
Interrupt Handling	`VXIint.c`	`VISAint.c`
Trigger Handling	`VXItrig.c`	`VISAtrig.c`

☞ **Note** ***T&M Explorer includes special settings that you must use for memory sharing. Consult the T&M Explorer online help for information on setting these up.***

Notes about VME Support

To use VME devices in your system, configure NI-VXI to see these devices by using the **Add Device Wizard** in T&M Explorer. VME devices with two blocks of memory in the same address space require two entries. You can also specify which interrupt levels the device uses. VXI and VME devices cannot share interrupt levels. You can then access the VME device

from NI-VXI or NI-VISA just as you would a register-based VXI device, by specifying the address space and the offset from the base at which you have configured it. NI-VISA support for VME devices includes the register access operations (both high-level and low-level) and the block move operations, as well as the ability to receive interrupts.

Additional Compiler Information

When building an application with NI-VISA, you must include `"visa.h"` in your source code. In addition, you should link in the appropriate import library for your compiler.

☞ **Note** ***LabWindows/CVI automatically includes the VISA library if it is needed. You do not need to explicitly link to the VISA import library when using LabWindows/CVI.***

For the Microsoft C/C++ environment, use the `visa32.lib` in the *`VXIpnp`*`\`*`os`*`\lib\msc` directory. For the Borland C/C++ environment, use the `visa32.lib` in the *`VXIpnp`*`\`*`os`*`\lib\bc` directory. For example, if you are using Microsoft C/C++ with Windows NT and have installed NI-VISA into the default directory, you would normally specify `C:\VXIpnp\WinNT\lib\msc\visa32.lib`.

When building an application with NI-VXI, you must include `"nivxi.h"` in your source code. In addition, you should link in the appropriate import library for your compiler.

☞ **Note** ***LabWindows/CVI automatically includes the VXI library if it is needed. You do not need to explicitly link to the NI-VXI import library when using LabWindows/CVI.***

For the Microsoft C/C++ environment, use the `nivxint.lib` in the *`NIVXI`*`\win32\msc` directory. For Borland C/C++, use the `nivxint.lib` in the *`NIVXI`*`\win32\borlandc` directory. For example, if you are using Microsoft and have installed NI-VXI into the default directory, you would normally specify `C:\NIVXI\msc\nivxint.lib`.

Refer to the documentation that came with your compiler package for detailed instructions about using the compiler and the various tools (linker, debugger, and so on). Your compiler documentation is an important and useful source of information for writing, compiling, and debugging C programs.

Debugging

NI Spy, VISAIC, and VIC are useful utilities that can aid in identifying the causes of problems in your application.

NI Spy tracks the calls your application makes to National Instruments T&M drivers including NI-VXI, NI-VISA, and NI-488.2. This utility highlights functions that return errors, so you can quickly spot which functions failed during your development. NI Spy can log the calls your program makes to these drivers so you can check them for errors at your convenience.

You can also control your instruments interactively using VISAIC and VIC. You can use VISAIC to control and communicate with your instruments with NI-VISA without having to write a program. VIC gives you a similar environment that uses NI-VXI. These utilities are an excellent platform for quickly testing instruments and learning how to communicate with them.

Refer to the online help for instructions on how to use VIC or VISAIC and to learn about their features. In VIC, click on the **?** button (located next to the **Go** button) to get help for that page, or type `help`. You can also right-click on a component on the screen to access **What's This** help. In VISAIC, you can right-click to reach **What's This** help and function help.

A

Specifications

This appendix lists the specifications for the VXI-1394 module.

Requirements

VXIbus Configuration Space ..... 64 B

A24 or A32 Space ..... Programmable
Default ..... None

Environmental

Temperature
Operating .....0° to 55° C
Storage .....–20° to 70° C

Relative Humidity
Operating ..... 10% to 90% noncondensing
Storage ..... 5% to 95% noncondensing

EMI ..... FCC Class A verified, EC verified

Functional Shock

MIL-T-28800E Class 3 (30 g half-sine shock pulse)
Also meets IEC 60068-2-27

Random Vibration

MIL-T-28800E, MIL-STD-810E Category 1

Operational ..... 5 to 500 Hz, 0.3 g_{rms}

Non-operational ..... 5 to 500 Hz, 2.4 g_{rms}

Power Requirement

+5 V

Typical.....2.23 A
Maximum (fused).....7 A

–5.2 V

Typical.....176 mA
Maximum (fused).....1 A

–2 V

Typical.....89.5 mA
Maximum (fused).....1 A

+12 V

Typical.....750 µA
Maximum (fused).....1 A

Physical

Dimensions

Fully enclosed, shielded VXI C-size board
233.35 by 340 mm (9.187 by 13.386 in.)

Weight

VXI-1394.....1.11 kg (2.45 lb.)
(No DRAM installed)
VXI-1394/G.....1.15 kg (2.53 lb.)
(No DRAM installed)

I/O Connectors

6-pin 1394.....3
SMB.....3
GPIB (optional).....1

Slot Requirements.....Single VXI C-size slot

Compatibility.....Fully compatible with VXI specification

VXI Keying Class.....Class 1 TTL

MTBF.....Contact factory

Performance

VXI Transfer Rate
- Peak ..... 8 Mbytes/s
- Sustained ..... 6 Mbytes/s

IEEE 1394 Capability Descriptions

Speed Support ..... 100, 200, 400 Mbits/s

Protocol Support ..... Asynchronous Quadlet and Block

Data Payload Packet Sizes ..... Up to 2048 bytes

Asynchronous Target and Initiator

VMEbus Capability Codes

A32, A24, A16 (master)
VMEbus master A32, A24, and A16 addressing

A32, A24, A16 (slave)
VMEbus slave A32, A24, and A16 addressing

D64, D32, D16, D08(EO) (master)
VMEbus master D64, D32, D16, and D08 data sizes

D64, D32, D16, D08(EO) (slave)
VMEbus slave D64, D32, D16, and D08 data sizes

BLT, MBLT (master)
VMEbus master block and D64 transfers

BLT, MBLT (slave)
VMEbus slave block and D64 transfers

RMW (master)
VMEbus master read/modify/write transfers

RMW (slave)
VMEbus slave read/modify/write transfers

RETRY (master)
VMEbus master retry support

RETRY (slave)
VMEbus slave retry support

FSD
First slot detector

SCON
VMEbus System Controller (Automatic Detection)

PRI, RRS
Prioritized or Round Robin Select arbiter

ROR, FAIR
Release on Request and FAIR bus requester

IH(7-1)
Interrupt handler for levels 7-1

I(7-1)
Interrupt requester for levels 7-1

D32, D16, D08(O) (Interrupt Handler)
VMEbus D32, D16, D08(O) interrupt handler

D32, D16, D08(O) (Interrupter)
VMEbus D32, D16, D08(O) interrupter

ROAK, RORA
Release on Acknowledge or Register Access interrupter

BTO(x)
VMEbus bus timer (programmable limit)

LOCK
Can lock the VMEbus for indivisible transfers

B

Default Settings

This appendix summarizes the default settings for the hardware and software in the VXI-1394 kit. If you need more information about a particular setting, or if you want to try a different configuration, please refer to Appendix C, *Advanced Hardware Configuration Settings*, for your hardware reference and to the T&M Explorer online help for your software reference.

Note ***There are no hardware settings on the PCI-1394 board.***

Hardware Settings

Table B-1. VXI-1394 Hardware Default Settings

Hardware Component	Default Setting
W1—VXIbus Slot 0/Non-Slot 0	Automatic detection
S6—VXIbus CLK10 source	From onboard oscillator
S5—External trigger termination	OFF: unterminated
S3—SMB CLK10 direction	IN: receive CLK10 signal
S2—SMB CLK10 termination	OFF: ignored
S4—Polarity of external SMB CLK10	Inverted
S7—Configuration EEPROM	Do not load from factory setting
DRAM SIMMs installed	Per customer order

Software Settings

Table B-2. T&M Explorer Device Tab Default Settings

Editor Field	Default Setting
Logical address	0
Device class	Message based
Size of Servant area	0
System interrupt level	Disabled
Number of handlers	1
Number of interrupters	0

Table B-3. T&M Explorer Shared Memory Tab Default Settings

Editor Field	Default Setting
Memory sharing	Don’t share memory
Shared RAM size	A16—none A24—256 B A32—64 KB
Reserved physical memory	0
Lower half window byte swapping	Disabled
Upper half window byte swapping	Disabled
Map upper and lower halves at same PCI address	Disabled

Table B-4. T&M Explorer VXI Bus Tab Default Settings

Editor Field	Default Setting
Bus timeout value	125 µs
VXI retry generation	Enabled
Automatic retries	Disabled
A24/A32 write posting	Disabled
Transfer limit	256
Requester mode	Release on Request
Request level	3
Fair requester	Enabled
Bus arbitration mode	Prioritized
Arbiter timeout	Enabled

C

Advanced Hardware Configuration Settings

This appendix describes the factory-default and alternate hardware configuration settings of the VXI-1394. The board is set at the factory for the most commonly used configuration. Use this appendix if you want to try a different hardware configuration, or if you would like more information on a particular setting. This information is intended for more advanced users.

Hardware Default Settings

The following hardware configuration settings are user configurable:

- VXIbus Slot 0/Non-Slot 0
- Configuration EEPROM
- VXIbus CLK10 routing
- Trigger input termination

Figure C-1 shows the factory-default settings of the user-configurable jumper and switches on the VXI-1394. The slot selection jumper and six switches are located in the corner of the board behind the front panel SMB connectors.

Note ***Please do not attempt an alternate setting unless you are familiar with its purpose. In addition, do not reconfigure any switches or jumpers not described in this appendix unless directed by National Instruments support.***

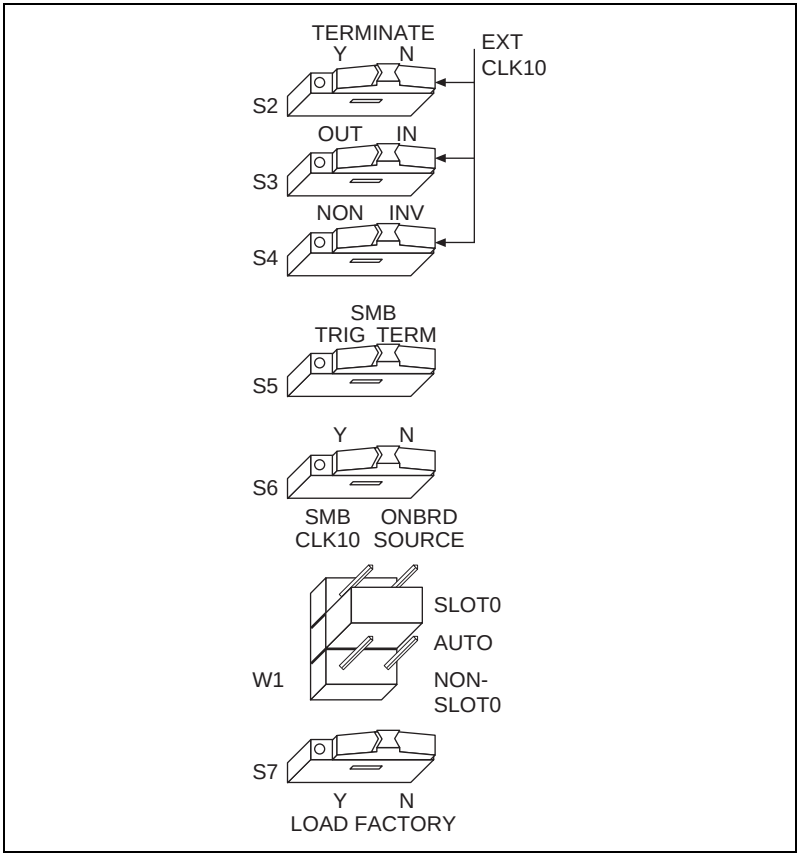


Figure C-1. VXI-1394 Default Configuration Settings

VXIbus Slot 0/Non-Slot 0

The VXI-1394 is configured at the factory to automatically detect if it is installed in Slot 0 of a VXIbus mainframe. With automatic Slot 0 detection, you can install the VXI-1394 into any VXIbus slot.

You can manually configure the VXI-1394 for either Slot 0 or Non-Slot 0 operation by defeating the automatic-detection circuitry. Use the three-position jumper W1 to select automatic Slot 0 detection, Slot 0, or Non-Slot 0 operation. Figure C-2 shows these three settings.

Caution ***Do not install a device configured for Slot 0 into another slot without first reconfiguring it to either Non-Slot 0 or automatic configuration. Neglecting to do this could damage the device, the VXIbus backplane, or both.***

Note ***The setting of any switch shown with this pattern (▨) has no bearing on the configuration described in any of the following figures. For example, Figure C-2 shows switch S7 merely because its close proximity to W1.***

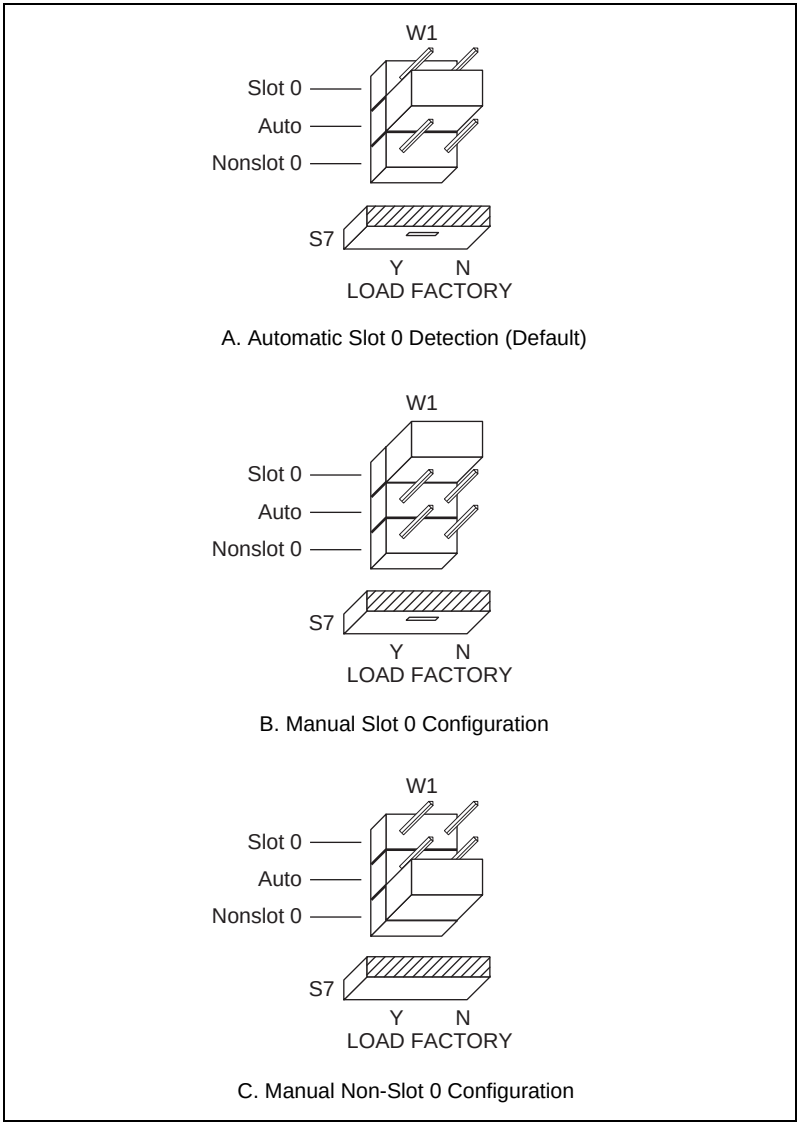


Figure C-2. VXIbus Slot Configuration

When the VXI-1394 is installed in Slot 0, it becomes the VXIbus System Controller. In this role, it has VXIbus Data Transfer Bus Arbiter circuitry that accepts bus requests on all four VXIbus request levels, prioritizes the requests, and grants the bus to the highest priority requester. As VXIbus System Controller, the VXI-1394 also uses an onboard 16 MHz oscillator to drive the 16 MHz VXIbus system clock.

As required by the VXIbus specification, the VXI-1394 drives the 10 MHz signal CLK10 on a differential ECL output when installed in Slot 0. When not installed in Slot 0, the VXI-1394 only receives the CLK10 signal.

Configuration EEPROM

The VXI-1394 has an onboard EEPROM, which stores default register values that are loaded at power-on. The EEPROM is divided into two halves—a factory-configuration half, and a user-configuration half. Both halves were factory configured with the same configuration values so you can modify the user-configurable half, while the factory-configured half stores a back-up of the default settings.

The Load Factory switch (switch S7) causes the VXI-1394 to boot off the factory-configured half instead of the user-modified settings. This is useful in the event that the user-configured half of the EEPROM becomes corrupted in such a way that the VXI-1394 boots to an unusable state.

Figure C-3 shows the configuration settings for EEPROM operation.

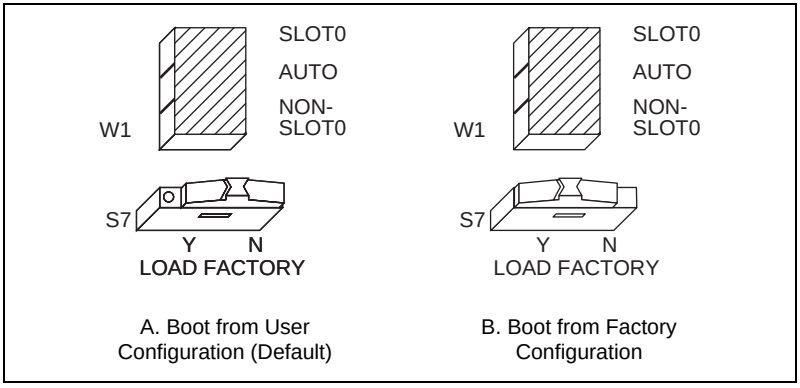


Figure C-3. EEPROM Operation

VXIbus CLK10 Routing

When the VXI-1394 is installed in Slot 0 of your mainframe, it supplies the VXIbus CLK10 signal. The VXI-1394 has four hardware switches that work together to control various aspects of CLK10 routing. Please read this section carefully and notice that if you change one switch, you may need to change another. This section includes several diagrams that show how to configure the four switches to accomplish various CLK10 configurations.

Conversely, the configuration of one switch may make the setting of another switch irrelevant. For example, only switches S3 and S4 are relevant if you install the VXI-1394 in a slot other than Slot 0. The drawings use the ▨ pattern to depict switches that are either irrelevant or disabled for a particular CLK10 configuration.

Switch S5 uses this pattern in all of the CLK10 drawings. It deals with the external trigger input SMB and is discussed later in this chapter.

The VXI-1394 can use two different sources to generate the VXIbus CLK10 signal—an onboard oscillator or the external CLK SMB connector. Use switch S6 to select between these options. The VXI-1394 uses the onboard oscillator by default.

The VXI-1394 can also be configured to drive the external CLK SMB from the VXIbus CLK10 signal. Switch S3 controls whether the VXI-1394 drives or receives the external CLK SMB. If you change the S3 setting to drive CLK10 out the external CLK10 SMB connector, do not set switch S6 to receive the SMB CLK10 signal; instead use its default setting so that the onboard oscillator generates the signal.

You can use an additional switch, S4, to control the polarity of the external CLK SMB signal when S3 is configured to drive it. S4 is unused—its setting is irrelevant—when S3 is configured to receive the external CLK SMB signal.

When switch S3 is set so that the VXI-1394 receives the SMB CLK10 signal, you have the option to add a 50 Ω termination to the signal by setting switch S2. S2 is unused—its setting is irrelevant—when S3 is configured to drive the external CLK SMB signal.

Figure C-4 shows the default settings for the CLK10 switches. This configuration is as follows:

- CLK10 is generated from the onboard oscillator (S6).
- The CLK10 signal is not terminated (S2).
- The VXI-1394 receives the external CLK10 signal (S3).
- The polarity of the CLK10 signal (S4) is irrelevant when the VXI-1394 receives the external CLK10 signal. However, it is configured to be inverted when the CLK10 SMB is used as output.

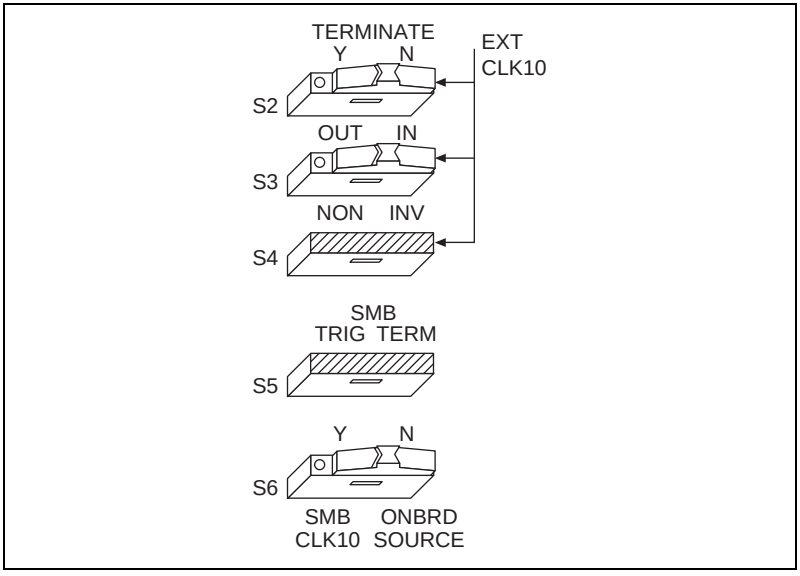


Figure C-4. Receive External CLK SMB (Default)

The configuration in Figure C-5 adds a 50 Ω termination to the signal by changing switch S2.

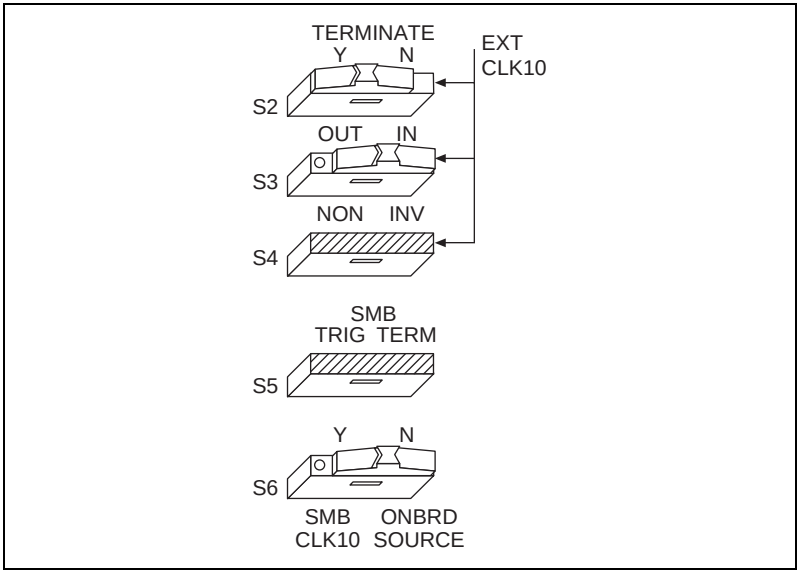


Figure C-5. Receive External CLK SMB with 50 Ω Termination

In Figures C-6 and C-7, switch S6 uses the alternate configuration to generate the VXIbus CLK10 signal. Instead of the onboard oscillator, the VXI-1394 generates from the external CLK SMB connector and drives to the backplane. You can choose whether to terminate the signal using S2. Polarity remains irrelevant to these configurations.

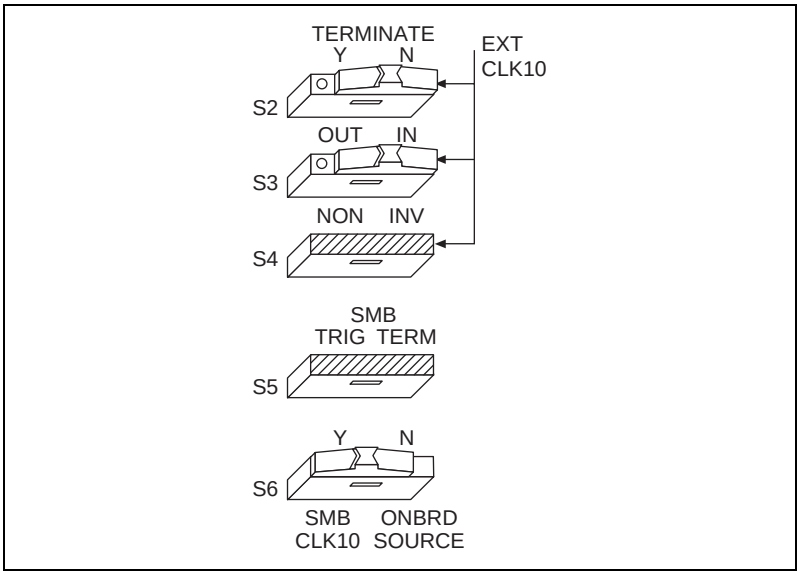


Figure C-6. Receive External CLK SMB and Drive to the Backplane Unterminated

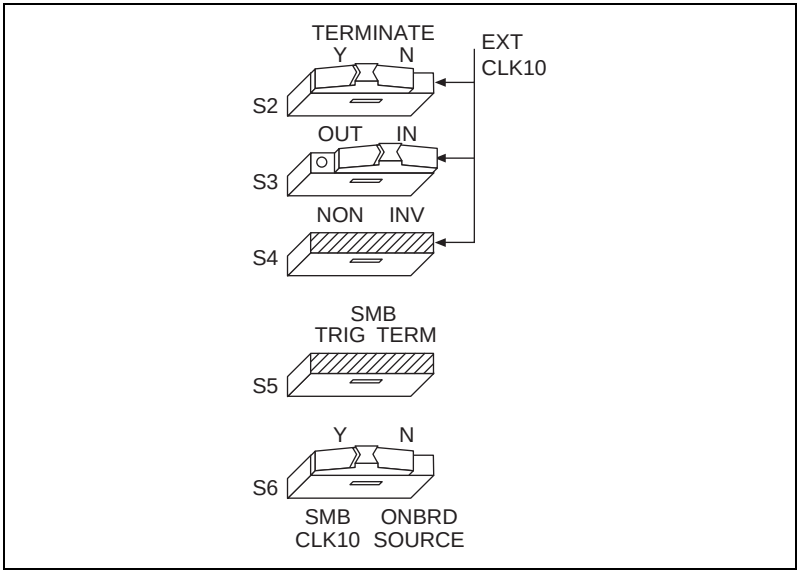


Figure C-7. Receive External CLK SMB with 50 Ω Termination and Drive to the Backplane

Figures C-8 and C-9 show two configurations for driving the external CLK SMB from the VXIbus CLK10 signal by changing switch S3 to its alternate setting. Switch S6 must be in its default position for these configurations. Signal termination is not an issue when driving the signal, so the position of S2 does not matter. The difference between these two configurations is whether to use inverted or non-inverted polarity when driving the signal.

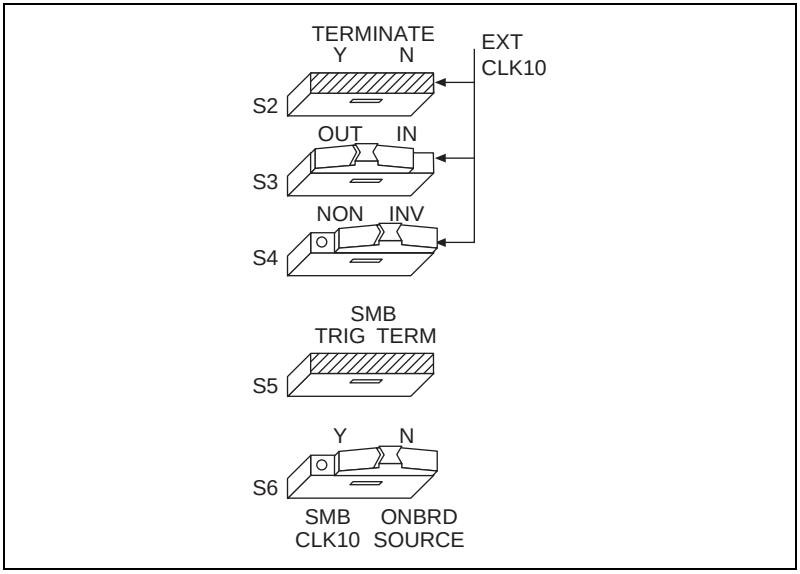


Figure C-8. Drive Inverted External CLK SMB

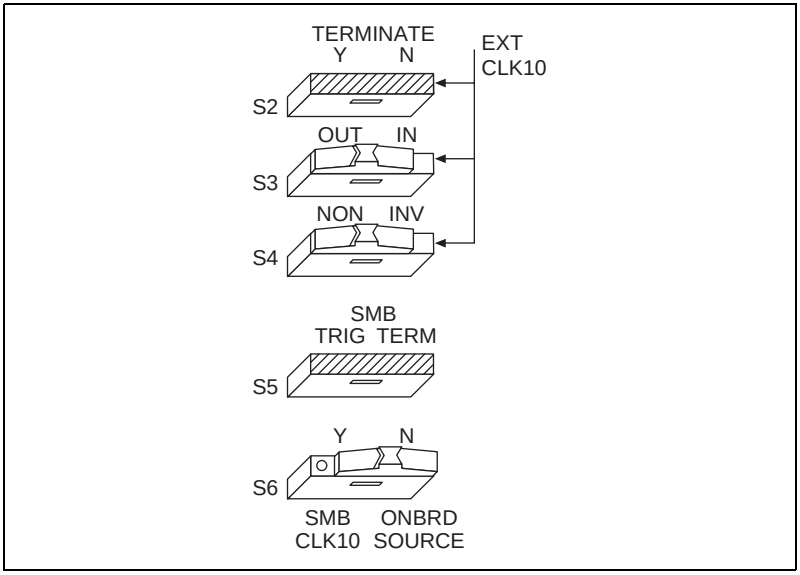


Figure C-9. Drive Non-inverted External CLK SMB

Trigger Input Termination

Located within the group of CLK10 switches is switch S5, which controls whether to put a 50 Ω termination on the external trigger input SMB. Figure C-10A shows the default setting for a non-terminated trigger input SMB. Use the setting of Figure C-10B to terminate the trigger input SMB.

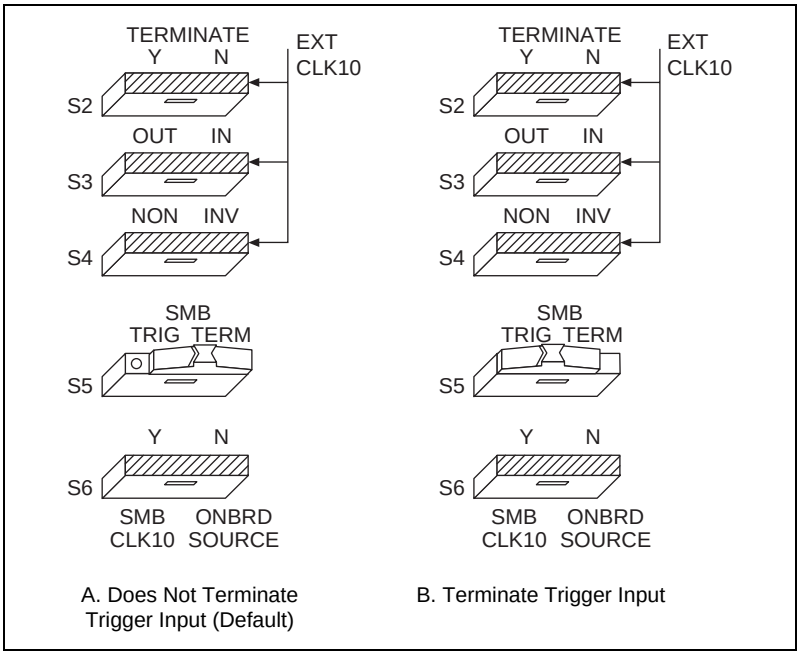


Figure C-10. SMB Trigger Input Termination

D

Common Questions

This appendix addresses common questions you may have about using the NI-VXI/VISA software on the VXI-1394 platform.

What does *hot plugging* mean in terms of IEEE 1394?

The concept of hot plugging in 1394 means that you can remove and insert 1394 cables without powering down your computer and devices. The 1394 Plug and Play architecture is designed so that the host computer can recognize when to load and remove the appropriate drivers. However, notice that inserting or removing any 1394 cable results in an interrupt condition on all devices, which may adversely affect any applications using the VXI-1394 at that time. For that reason, we recommend closing all 1394-related applications before changing your 1394 bus configuration, and running Resource Manager after adding any new 1394 devices to your system.

Does it matter whether I plug in a 1394 device to the PCI-1394 in my computer or to the VXI-1394 in my mainframe?

The only difference is the topology of the system. If your system consists of a PC connected to a VXI-1394 which is in turn connected to a digital camera, you can get the best performance by connecting a third peripheral to the VXI-1394 rather than to the PC or the digital camera. This restricts the maximum distance between any two nodes to two cable segments. Connecting the third peripheral to either the PC or the digital camera would create a maximum distance of three cable segments between any two nodes.

Use only a tree topology to build your system. A closed loop is illegal, and will not work. For example, if you have a PCI-1394 and a VXI-1394 cabled together and you add direct connections from both of them to the same digital camera, you create a closed loop. A 1394 device should have only one connection to the 1394 system.

Can I have both a PCI-MXI-2 and a PCI-1394 interface in the same computer?

You can have both installed in your computer, but the NI-VXI software will recognize only one of the boards as your VXI interface, depending on your version of the software.

I need more devices than can fit in one chassis. How can I expand my VXI-1394 system?

Although it is physically possible to plug in another VXI-1394, software does not currently support this option. The recommended strategy is to use a VXI-MXI-2, which follows the VXI-6 specification for mainframe extension. This extends full VXI functionality across multiple mainframes, including a common device address space and interframe triggering, interrupts, and bus mastering. Place a VXI-MXI-2 in the same frame as the Slot 0 VXI-1394, and another VXI-MXI-2 in Slot 0 of the next mainframe. You can then fill up this mainframe with additional devices.

If you have additional GPIB devices to add to the system—such as a GPIB-VXI/C controller in Slot 0 of another VXI chassis—the VXI-1394/G comes with a built-in GPIB controller so that you can connect GPIB devices directly off the VXI-1394/G without the need for a GPIB controller in your host computer.

How can I determine the serial number and hardware revision of the VXI-1394 board?

Run T&M Explorer and right-click on the name of the VXI-1394 board. Select **Hardware Configuration**, and the dialog box for the VXI-1394 board is displayed. The title bar includes the serial number and hardware revision of the board.

How can I determine the version of the NI-VXI/VISA software I have installed?

There are several ways to find this information.

- Select **T&M Explorer»Help»About...»Software Info** button. This displays version information on NI-VXI and NI-VISA files.
- Under Windows NT 4.0 and Windows 98, you can find version information by right-clicking on any component and selecting the **Properties** option. This displays a property sheet with a version tab. This tab has version information about the product (NI-VXI) and the component (`NIVXINT.DLL`, for example).

- You can find version information about the NI-VXI driver by running the VIC utility program. Type `ver` at the prompt, and the utility displays the versions of VIC and NI-VXI, and the latest VXI-1394 board revision that this NI-VXI driver supports.
- You can find version information about the VISA driver through **VISAIC»Help»About...**.

What is Resman?

Resman is the name of the utility that performs the duties of a VXI Resource Manager as discussed in the VXIbus specification. When you set a National Instruments controller to Logical Address 0, you will at some point need to run Resman to configure your VXI instruments. If your controller uses a different (non-zero) logical address and is a message-based device, you need to start Resman before running it on the Logical Address 0 computer.

When do I need to run Resman?

Run Resman whenever you need to configure your VXI instruments. For example, if you power-cycle your VXI chassis, your instruments will be reset, and you will need to run Resman to configure them. You can get into trouble if you run Resman when your devices are not in a reset state. Therefore, if you have to run Resman after running it once, you should reset all of your VXI instruments.

You can perform resource manager operations from within T&M Explorer after you install the VXI-1394 and cable it to your computer. With the VXI-1394, you may need to run the Resman utility if you boot your computer before turning on your VXI chassis or if you power-cycle your VXI chassis while the external PC remains on. In these cases, the instruments would have been reset without the computer rebooting. You will need to run the Resman utility or configure your system in T&M Explorer to initialize your VXI system.

Which NI-VXI utility program must I use to configure the VXI-1394?

Use the T&M Explorer program to configure the VXI-1394. T&M Explorer is located in the `NIVXI` and `VXIpnp` program group folders.

Which NI-VXI utility program must I use to initialize the VXI-1394?

The VXI-1394 initializes itself at chassis power-up.

How do I handle VME devices?

Although there is no way to automatically detect VME devices in a system, you can add them easily through the **Add Device Wizard** in T&M Explorer. Through this procedure, you can reserve resources for each of your VME devices and configure T&M Explorer to show VME devices on the screen with all your other devices.

Which NI-VXI utility program must I use to perform startup Resource Manager operations?

Use the Resman program to perform startup Resource Manager operations. It is located in the `NIVXI` directory. Resman uses the settings configured in T&M Explorer. It initializes your VXI/VMEbus system and stores the information that it collects in the `RESMAN.TBL` file in the `TBL` subdirectory of the `NIVXI` directory.

You can also run Resource Manager operations from T&M Explorer. Through T&M Explorer, you can also configure Resman to run automatically at computer startup.

What can I do to make sure that my system is up and running?

The fastest method for testing the system is to run Resman. This program attempts to access memory in the upper A16 address space of each device in the system. If Resman does not report any problems, the VXI-1394 communication system is operational.

To test individual devices, you can use the VIC or VISAIC program to interactively issue NI-VXI functions or NI-VISA operations, respectively. You can use the `VXIin()` and `VXIout()` functions or the `VXIinReg()` and `VXIoutReg()` functions to test register-based devices by programming their registers. If you have any message-based devices, you can send and receive messages with the `WSwrt()` and `WSrd()` functions. Notice that `VXIinReg()` and `VXIoutReg()` are for VXI devices only, but you can use `VXIin()` and `VXIout()` for both VXI and VME.

Finally, if you are using LabVIEW or LabWindows/CVI and you have instrument drivers for the devices in your chassis, you can use the interactive features of these programs to quickly test the functionality of the devices.

What should I do if I get a `Configuration EEPROM is Invalid` message?

There are several reasons why you might get the **`Configuration EEPROM is Invalid`** message. If you turned off the VXI chassis while

the configuration update process was still in progress, the board functions normally except when running T&M Explorer. To correct these problems, reboot the VXI chassis with the Load Factory switch set (as described in Appendix C, *Advanced Hardware Configuration Settings*) and update the configuration, or load the configuration from file.

What do the LEDs on the front of the VXI-1394 mean?

- The **SYSFAIL** LED shows the state of the VXI/VMEbus SYSFAIL line. This line is asserted whenever any device in the chassis has not yet passed its self test, if it has failed its self test, or if it has detected a failure after originally passing its self test.
- The **1394** LED indicates that the VXI-1394 is being accessed by another device on the IEEE 1394 bus, such as when the computer communicates with either the VXI-1394 or another device in the chassis.
- The **VXI** LED, when lit, indicates that the VXI-1394 is being accessed by another device in the VXI chassis, such as when a bus master inside the chassis wants to talk to either the VXI-1394 or memory in the computer.

What kind of signal is CLK10 and what kind of signal do I need for an external CLK10?

CLK10 is a differential ECL signal on the VXIbus backplane. However, the oscillator for the VXI-1394 and the EXTCLK input from the front panel use TTL. Therefore, supply a TTL-level signal for EXTCLK, and our voltage converters will convert the signal to differential ECL.

What is the accuracy of the CLK10 signal?

The CLK10 generated by the VXI-1394 is 100 ppm (0.01%) as per the VXIbus specification. If you need a more accurate CLK10 signal, you can use the EXTCLK input at the front of the VXI-1394.

What is shared memory and dual-ported memory?

These terms refer to a block of memory that is accessible to both a client and a server. The memory block operates as a message buffer for communications. Shared memory is applicable only if you are using either A24 or A32 address space.

E

Customer Communication

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

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

Electronic Services

Bulletin Board Support

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

United States: 512 794 5422
Up to 14,400 baud, 8 data bits, 1 stop bit, no parity

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

France: 01 48 65 15 59
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

FTP Support

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

Fax-on-Demand Support

Fax-on-Demand is a 24-hour information retrieval system containing a library of documents on a wide range of technical information. You can access Fax-on-Demand from a touch-tone telephone at 512 418 1111.

E-Mail Support (Currently USA Only)

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

`support@natinst.com`

Telephone and Fax Support

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

Country	Telephone	Fax
Australia	03 9879 5166	03 9879 6277
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Brazil	011 288 3336	011 288 8528
Canada (Ontario)	905 785 0085	905 785 0086
Canada (Québec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 26 02
Finland	09 725 725 11	09 725 725 55
France	01 48 14 24 24	01 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Israel	03 6120092	03 6120095
Italy	02 413091	02 41309215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	5 520 2635	5 520 3282
Netherlands	0348 433466	0348 430673
Norway	32 84 84 00	32 84 86 00
Singapore	2265886	2265887
Spain	91 640 0085	91 640 0533
Sweden	08 730 49 70	08 730 43 70
Switzerland	056 200 51 51	056 200 51 55
Taiwan	02 377 1200	02 737 4644
United Kingdom	01635 523545	01635 523154
United States	512 795 8248	512 794 5678

Technical Support Form

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

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

Name _____

Company _____

Address _____

_____

Fax (___) _____Phone (___) _____

Computer brand_____ Model _____Processor_____

Operating system (include version number) _____

Clock speed _____MHz RAM _____MB Display adapter _____

Mouse ___yes ___no Other adapters installed_____

Hard disk capacity _____MB Brand_____

Instruments used _____

_____

National Instruments hardware product model _____ Revision _____

Configuration _____

National Instruments software product _____ Version _____

Configuration _____

The problem is: _____

_____

_____

_____

_____

List any error messages: _____

_____

_____

The following steps reproduce the problem: _____

_____

_____

_____

_____

VXI-1394 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

NI-VXI/VISA Software Version Number _____

Using Both NI-VXI and NI-VISA? _____

NI-488.2 Software Version Number (if applicable) _____

LabVIEW Software Version Number (if applicable) _____

LabWindows/CVI Software Version Number (if applicable) _____

List Any Other National Instruments Software and Version Number _____

VXI-1394 Hardware Configuration

Hardware Revision Number _____

Slot Location _____

W1—VXIbus Slot 0/Non-Slot 0 _____

S6—VXIbus CLK10 Routing _____

S3—SMB CLK10 Direction _____

S2—SMB CLK10 Termination _____

S4—SMB CLK10 Polarity _____

S5—Trigger Input Termination _____

S7—EEPROM Operation _____

DRAM SIMMs Installed _____

VXI-1394 Configuration Settings in T&M Explorer

Logical Address _____

Device Class _____

Size of Servant Area _____

System Interrupt Level _____

Number of Handlers _____

Number of Interrupters _____

Memory Sharing _____

Shared RAM Size _____

Reserved Physical Memory _____

Lower Half Window Byte Swapping _____

Upper Half Window Byte Swapping _____

Mapping Both Halves to Same PCI Address _____

Bus Timeout Value _____

VXI Retry Generation _____

Automatic Retries _____

A24/A32 Write Posting _____

Transfer Limit _____

Requester Mode _____

Request Level _____

Fair Requester _____

Bus Arbitration Mode _____

Arbiter Timeout _____

Other Products

Using PCI-1394 Adapter? _____

Computer Make and Model _____

Mainframe Make and Model _____

Microprocessor _____

Clock Frequency _____

Type of Video Board Installed _____

Operating System and Version _____

Operating System Mode _____

Programming Language and Version _____

VXIbus Resource Manager
(Make, Model, Version, Software Version) _____

List Other Boards in VXI Mainframe

Slot	LA	DMA	IRQ	Manufacturer, Description, Function

List Other IEEE-1394 Devices in System

Manufacturer, Description, Function	Topology Level

List GPIB Devices in System (applicable to VXI-1394/G only)

Address	DMA	Manufacturer, Description, Function

Documentation Comment Form

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

Title: *Getting Started with Your VXI-1394 Interface for Windows NT/98*

Edition Date: November 1998

Part Number: 322109A-01

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

_____

_____

_____

_____

_____

_____

_____

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

_____

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Thank you for your help.

Name _____

Title _____

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Glossary

Prefix	Meanings	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}
G-	giga-	10^{9}
t-	tera-	10^{12}

Symbols

°	degrees
Ω	ohms

A

A	amperes
A16 space	VXIbus address space equivalent to the VME 64 KB *short* address space. In VXI, the upper 16 KB of A16 space is allocated for use by VXI devices' configuration registers. This 16 KB region is referred to as VXI configuration space.
A24 space	VXIbus address space equivalent to the VME 16 MB *standard* address space.
A32 space	VXIbus address space equivalent to the VME 4 GB *extended* address space.
address	Character code that identifies a specific location (or series of locations) in memory. In VISA, it identifies a resource.

address modifier	One of six signals in the VMEbus specification used by VMEbus masters to indicate the address space in which a data transfer is to take place.
address space	A set of 2^n memory locations differentiated from other such sets in VXI/VMEbus systems by six addressing lines known as address modifiers. *n* is the number of address lines required to uniquely specify a byte location in a given space. Valid numbers for *n* are 16, 24, and 32. In VME/VXI, because there are six address modifiers, there are 64 possible address spaces.
ANSI	American National Standards Institute
API	Application Programming Interface—the direct interface that an end user sees when creating an application.
arbitration	A process in which a potential bus master gains control over a particular bus.
asynchronous	Not synchronized; not controlled by time signals. In IEEE 1394, specifically, this is the standard protocol for sending packets that require an acknowledgment. This guarantees data delivery. The NI-VXI/VISA drivers for 1394 use this protocol exclusively.

B

b	Bit—one binary digit, either 0 or 1.
B	Byte—eight related bits of data, an 8-bit binary number. Also used to denote the amount of memory required to store one byte of data.
backplane	An assembly, typically a printed circuit board, with 96-pin connectors and signal paths that bus the connector pins. A C-size VXIbus system will have two sets of bused connectors called J1 and J2. A D-size VXIbus system will have three sets of bused connectors called J1, J2, and J3.
BERR*	bus error signal
BIOS	Basic Input/Output System. BIOS functions are the fundamental level of any PC or compatible computer. BIOS functions embody the basic operations needed for successful use of the computer's hardware resources.

block-mode transfer — An uninterrupted transfer of data elements in which the master sources only the first address at the beginning of the cycle. The slave is then responsible for incrementing the address on subsequent transfers so that the next element is transferred to or from the proper storage location. A VME data transfer may have no more than 256 elements.

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 buses include the ISA bus, PCI bus, VXI bus, and VME bus.

bus error — An error that signals failed access to an address. Bus errors occur with low-level accesses to memory and usually involve hardware with bus mapping capabilities. For example, nonexistent memory, a nonexistent register, or an incorrect device access can cause a bus error.

bus master — A device that is capable of requesting the Data Transfer Bus (DTB) for the purpose of accessing a slave device.

byte order — How bytes are arranged within a word or how words are arranged within a longword. Motorola ordering stores the most significant byte (MSB) or word first, followed by the least significant byte (LSB) or word. Intel ordering stores the LSB or word first, followed by the MSB or word.

C

C — Celsius

CLK10 — A 10 MHz, ±100 ppm, individually buffered (to each module slot), differential ECL system clock that is sourced from Slot 0 of a VXIbus mainframe and distributed to Slots 1 through 12 on P2. It is distributed to each slot as a single-source, single-destination signal with a matched delay of under 8 ns.

CMOS — Complementary Metal Oxide Semiconductor—a process used in making chips.

Commander	A message-based device that is also a bus master and can control one or more Servants.
configuration registers	A set of registers through which the system can identify a module device type, model, manufacturer, address space, and memory requirements. To support automatic system and memory configuration, the VXI specification requires that all VXIbus devices have a set of such registers.

D

Data Transfer Bus	DTB; one of four buses on the VMEbus backplane. The DTB is used by a bus master to transfer binary data between itself and a slave device.
DMA	Direct Memory Access—a method by which data is transferred between devices and internal memory without intervention of the central processing unit. DMA is the fastest method of transferring data to/from computer memory.
DRAM	Dynamic RAM (Random Access Memory)—storage that the computer must refresh at frequent intervals.
dynamic configuration	A method of automatically assigning logical addresses to VXIbus devices at system startup or other configuration times.
dynamically configured device	A device that has its logical address assigned by the Resource Manager. a VXI device initially responds at Logical Address 255 when its MODID line is asserted. The Resource Manager subsequently assigns it a new logical address, to which the device responds until powered down.

E

ECL	Emitter-Coupled Logic
EEPROM	Electronically Erasable Programmable Read Only Memory—ROM that can be erased with an electrical signal and reprogrammed.
embedded controller	An intelligent CPU (controller) interface plugged directly into the VXI backplane, giving it direct access to the VXIbus. It must have all of its required VXI interface capabilities built in.
EMC	electromagnetic compliance

EMI	electromagnetic interference
external trigger	A voltage pulse from an external source that triggers an event.

F

fair requester	A VXIbus device that will not arbitrate for the VXIbus after releasing it until it detects the bus request signal inactive. This ensures that all requesting devices will be granted use of the bus.
FireWire	An Apple trademark for the technology that came to be defined as IEEE 1394. *See* IEEE 1394.

G

g	1. grams 2. a measure of acceleration equal to 9.8 m/s^2
GPIB	General Purpose Interface Bus (IEEE 488)
g_{RMS}	A measure of random vibration. The root mean square of acceleration levels in a random vibration test profile.

H

hex	Hexadecimal—the numbering system with base 16, using the digits 0 to 9 and letters A to F.
hot plug-in capability	The ability, a feature in IEEE 1394, to add and remove devices to a computer while the computer is running and have the operating system automatically recognize the change.
Hz	hertz; cycles per second

I

IDE	Integrated Drive Electronics. Denotes the most common interface to the hard drive on PCs.

IEC	International Electrotechnical Commission. The IEC publishes internationally recognized standards. IEC 60068 contains information on environmental testing procedures and severities.
IEEE	Institute of Electrical and Electronics Engineers
IEEE 1394	A cross-platform implementation of the high-speed serial data bus, defined by IEEE Standard 1394-1995, that can move large amounts of data between computers and peripheral devices. It features simplified cabling, hot swapping, and transfer speeds of up to 400 Mbits/s. IEEE 1394 also enables the connection of digital consumer products, including digital camcorders, digital video tapes, digital video disks, set-top boxes, and music systems, directly to a personal computer.
i.LINK	A brand name initiated by Sony for digital consumer products using IEEE 1394. *See* IEEE 1394.
in.	inches
I/O	Input/output—the techniques, media, and devices used to achieve communication between machines and users.
instrument driver	A set of routines designed to control a specific instrument or family of instruments, and any necessary related files for LabWindows/CVI or LabVIEW.
interrupt	A means for a device to request service from another device; a computer signal indicating that the CPU should suspend its current task to service a designated activity.
interrupt handler	A VMEbus functional module that detects interrupt requests generated by interrupters and responds to those requests by requesting status and identify information.
interrupt level	The relative priority at which a device can interrupt.
IRQ*	interrupt signal
isochronous	Pertains to processes that require timing coordination to be successful, such as voice and digital video transmission. A sound or picture going from a peripheral computer device or across a network into a computer or television set needs to arrive at close to the same rate of data flow as the source. In IEEE 1394, this protocol is used for purposes such as feeding digital image data from a peripheral device (such as a video camera) to a display mechanism within a computer.

K

K	kilo—(1) the standard metric prefix for 1,000, or 10^3, used with units of measure such as volts, hertz, and meters; (2) the prefix for 1,024, or 2^{10}, used with B (byte) in quantifying data or computer memory.

L

logical address	An 8-bit number that uniquely identifies each VXIbus device in a system. It defines the A16 register address of a device, and indicates Commander and Servant relationships.

M

m	meters
M	mega—(1) the standard metric prefix for 1 million or 10^6, when used with units of measure such as volts and hertz; (2) the prefix for 1,048,576, or 2^{20}, when used with B (byte) to quantify data or computer memory.
master	A functional part of a VME/VXIbus device that initiates data transfers on the backplane. A transfer can be either a read or a write.
message-based device	An intelligent device that implements the defined VXIbus registers and communication protocols. These devices are able to use Word Serial Protocol to communicate with one another through communication registers.
MODID	Module ID lines—used in VXI to geographically locate boards and to dynamically configure boards.
MTBF	Mean Time Between Failure

N

NI-488.2 or NI-488.2M	The National Instruments industry-standard software for controlling GPIB instruments.
NI-DAQ	The National Instruments industry-standard software for data acquisition instruments.

NI-VISA	The National Instruments implementation of the VISA standard; an interface-independent software that provides a unified programming interface for VXI, GPIB, and serial instruments.
NI-VXI	The National Instruments bus interface software for VME/VXIbus systems.
Non-Slot 0 device	A device configured for installation in any slot in a VXIbus mainframe other than Slot 0. Installing such a device into Slot 0 can damage the device, the VXIbus backplane, or both.

P

PCI	Peripheral Component Interconnect. The PCI bus is a high-performance 32-bit or 64-bit bus with multiplexed address and data lines.

R

register-based device	A Servant-only device that supports VXIbus configuration registers. Register-based devices are typically controlled by message-based devices via device-dependent register reads and writes.
Resman	The name of the National Instruments Resource Manager in NI-VXI bus interface software. *See* Resource Manager.
Resource Manager	A message-based Commander located at Logical Address 0, which provides configuration management services such as address map configuration, Commander and Servant mappings, and self-test and diagnostic management.
retry	An acknowledge by a destination that signifies that the cycle did not complete and should be repeated.
RMS	Root mean squared. See *g_{RMS}*.

S

s	seconds
SIMM	Single In-line Memory Module

slave	A functional part of a VME/VXIbus device that detects data transfer cycles initiated by a VMEbus master and responds to the transfers when the address specifies one of the device's registers.
Slot 0 device	A device configured for installation in Slot 0 of a VXIbus mainframe. This device is unique in the VXIbus system in that it performs the VXI/VMEbus System Controller functions, including clock sourcing and arbitration for data transfers across the backplane. Installing such a device into any other slot can damage the device, the VXIbus backplane, or both.
SMB	Sub Miniature Type B connector that features a snap coupling for fast connection.
statically configured device	A device whose logical address cannot be set through software; that is, it is not dynamically configurable.
streaming data	Data that is structured and processed in a continuous flow, such as digital audio and video. In IEEE 1394, this is often sent with the isochronous protocol rather than the standard asynchronous protocol.
SYSFAIL	A VMEbus signal that is used by a device to indicate an internal failure. A failed device asserts this line. In VXI, a device that fails also clears its PASSed bit in its Status register.

T

trigger	Either TTL or ECL lines used for intermodule communication.
TTL	Transistor-Transistor Logic

V

V	volts
VGA	Video Graphics Array; the minimum video display standard for all PCs.
VIC	VXI Interactive Control program, a part of the NI-VXI bus interface software. Used to program VXI devices and develop and debug VXI application programs.
VISA	Virtual Instrument Software Architecture. This is the general name given to VISA and its associated architecture.

VISAIC	VISA Interactive Control program, a part of the NI-VISA software. Used to program devices and develop and debug application programs.
VITA	VMEbus International Trade Association
VME	Versa Module Eurocard or IEEE 1014
VMEbus System Controller	A device configured for installation in Slot 0 or a VXIbus mainframe or the first slot in a VMEbus chassis. This device is unique in the VMEbus system in that it performs the VMEbus System Controller functions, including clock sourcing and arbitration for data transfers across the backplane. Installing such a device into any other slot can damage the device, the VMEbus/VXIbus backplane, or both.
VXIbus	VMEbus Extensions for Instrumentation

W

W	watts
Word Serial Protocol	The simplest required communication protocol supported by message-based devices in a VXIbus system. It utilizes the A16 communication registers to transfer data using a simple polling handshake method.
write posting	A mechanism that signifies that a device will immediately give a successful acknowledge to a write transfer and place the transfer in a local buffer. The device can then independently complete the write cycle to the destination.

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