

# **GPIB**

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## **Getting Started with Your PCI-GPIB, PXI™-GPIB, or PMC-GPIB and NI-488.2™ for Solaris**

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ni.com

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## FCC/Canada Radio Frequency Interference Compliance\*

### Determining FCC Class

The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.)

Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/DOC Warnings apply in the following sections. (Some products may not be labeled at all for FCC; if so, the reader should then assume these are Class A devices.)

FCC Class A products only display a simple warning statement of one paragraph in length regarding interference and undesired operation. Most of our products are FCC Class A. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

FCC Class B products display either a FCC ID code, starting with the letters EXN, or the FCC Class B compliance mark that appears as shown here on the right.

Consult the FCC web site <http://www.fcc.gov> for more information.



### FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Mark Declaration of Conformity\*\*, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

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

### Class A

#### 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.

#### Canadian Department of Communications

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.

### Class B

#### Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## Canadian Department of Communications

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

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

## Compliance to EU Directives

Readers in the European Union (EU) must refer to the Manufacturer's Declaration of Conformity (DoC) for information\*\* pertaining to the CE Mark compliance scheme. The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

To obtain the DoC for this product, click **Declaration of Conformity** at [ni.com/hardref.nsf/](http://ni.com/hardref.nsf/). This website lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

\* Certain exemptions may apply in the USA, see FCC Rules §15.103 **Exempted devices**, and §15.105(c). Also available in sections of CFR 47.

\*\* The CE Mark Declaration of Conformity will contain important supplementary information and instructions for the user or installer.

# Conventions

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The following conventions are used in this manual:



This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.

*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 bold`**

Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.

*`monospace italic`*

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

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# Introduction

This chapter lists what you need to get started, and briefly describes the PCI-GPIB, PXI-GPIB, and PMC-GPIB interface boards and NI-488.2 for Solaris.

## What You Need to Get Started

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- Solaris version 2.5.1 or higher installed on your Sun SPARC system
- One of the following GPIB interfaces:
  - PCI-GPIB
  - PXI-GPIB
  - PMC-GPIB
- NI-488.2 for Solaris and PCI-GPIB, PXI-GPIB, or PMC-GPIB, Version 2.x* CD-ROM
- Super-user privilege
- One of the following GPIB cables:
  - For the PCI-GPIB or PXI-GPIB—single-shielded or double-shielded cables, Type X1, X2, X4, X5, or X11, which you can order from National Instruments
  - For the PMC-GPIB—MicroGPIB cable, which is included in your kit

## GPIB Hardware Overview

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The PCI-GPIB is an IEEE 488 interface for computers with PCI expansion slots. The PXI-GPIB and PMC-GPIB are IEEE 488 interfaces for Compact PCI/PXI and PMC (PCI Mezzanine Card) buses, respectively. Each GPIB controller performs the basic IEEE 488 Talker, Listener, and Controller functions, including those required by the IEEE 488.2 standard.

The controllers can sustain data transfer rates of up to 1.3 Mbytes/s, or 7.2 Mbytes/s using the high-speed GPIB protocol (HS488), depending on the speed of your system.

You can connect the PCI-GPIB, PXI-GPIB, or PMC-GPIB with up to 14 instruments. If you need to use more than the maximum number of instruments, you can use the National Instruments GPIB extenders or the GPIB expander/isolator to add more instruments to the system. Double-shielded GPIB cables are also available.

For more information about hardware specifications and recommended operating conditions, refer to Appendix B, [Specifications](#).

## NI-488.2 Overview

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NI-488.2 for Solaris consists of a loadable driver and utilities that transform a Sun SPARC system running Solaris into an IEEE 488.2 (GPIB) controller with complete communication and bus management capabilities.

NI-488.2 includes the following components:

- C language interface
- Two software diagnostic utilities
- Interactive control utility
- Interactive configuration utility

NI-488.2 supports up to four PCI-GPIB, PXI-GPIB, or PMC-GPIB boards and is completely compatible with both IEEE 488 and IEEE 488.2 instruments.

## Time-Saving Development Software

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Your kit includes NI-488.2 for Solaris. After you install your GPIB controller and NI-488.2, you can use standard GPIB I/O functions in LabVIEW and LabWindows/CVI with your GPIB interface. If you already have one or both of these applications and want to use them with your PCI-GPIB, PXI-GPIB, or PMC-GPIB refer to your product documentation for information about GPIB I/O functions. For ordering information, contact National Instruments.

LabVIEW is a graphical programming environment you can use to acquire data from thousands of different instruments, including IEEE 488.2 devices, VXI devices, serial devices, PLCs, and plug-in data acquisition boards. After you acquire raw data, you can convert it into meaningful results using the data analysis routines in LabVIEW. The LabVIEW instrument drivers reduce software development time because you do not have to program the low-level control of each instrument.

LabWindows/CVI is an interactive ANSI C programming environment designed for building virtual instrument applications. LabWindows/CVI delivers a drag-and-drop editor for building user interfaces, a complete ANSI C environment for building your test program logic, and a collection of automated code generation tools, as well as utilities for building automated test systems, monitoring applications, or laboratory experiments.

---

# Installation

This chapter describes how to install NI-488.2 for Solaris and the PCI-GPIB, PXI-GPIB or PMC-GPIB. The NI-488.2 software included in this kit is intended for use with Sun SPARC systems running Solaris 2.5.1 or higher.

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## Installing the GPIB Hardware

---

This section describes how to install your GPIB hardware. Refer to the section that describes the installation for your particular board.

Before you install your GPIB controller, consult the manual that came with your workstation for specific instructions and warnings. You must have super-user privileges to install the hardware and software.

### Installing the PCI-GPIB



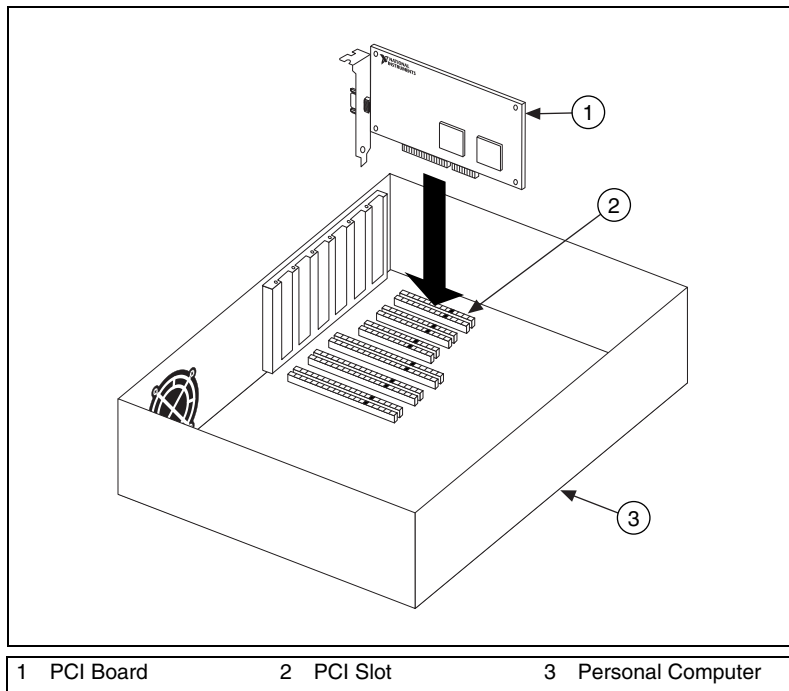
**Caution** Electrostatic discharge can damage several components on your GPIB board. To avoid electrostatic damage when you handle the module, touch the antistatic plastic package to a metal part of your computer chassis before you remove the board from the package.

Complete the following steps to install the PCI-GPIB.

1. Log on as super-user. To become a superuser, type `su root` and enter the root password.
2. Shut down your system by typing the following commands at the command line prompt:  

```
sync ; sync ; shut down
```
3. Turn off your computer after it has shut down. Keep the computer plugged in so that it remains grounded while you install the PCI-GPIB.
4. Remove the top cover (or other access panels) to give yourself access to the computer expansion slots.
5. Find an unused PCI slot in your computer.
6. Remove the corresponding slot cover.

7. Insert the PCI-GPIB into the slot with the GPIB connector sticking out of the opening on the back panel, as shown in Figure 2-1. It might be a tight fit, but do not force the board into place.
8. Replace the top cover (or the access panel to the PCI slot).
9. Turn on your computer. The PCI-GPIB interface board is now installed.



**Figure 2-1.** Installing the PCI-GPIB

## Installing the PXI-GPIB

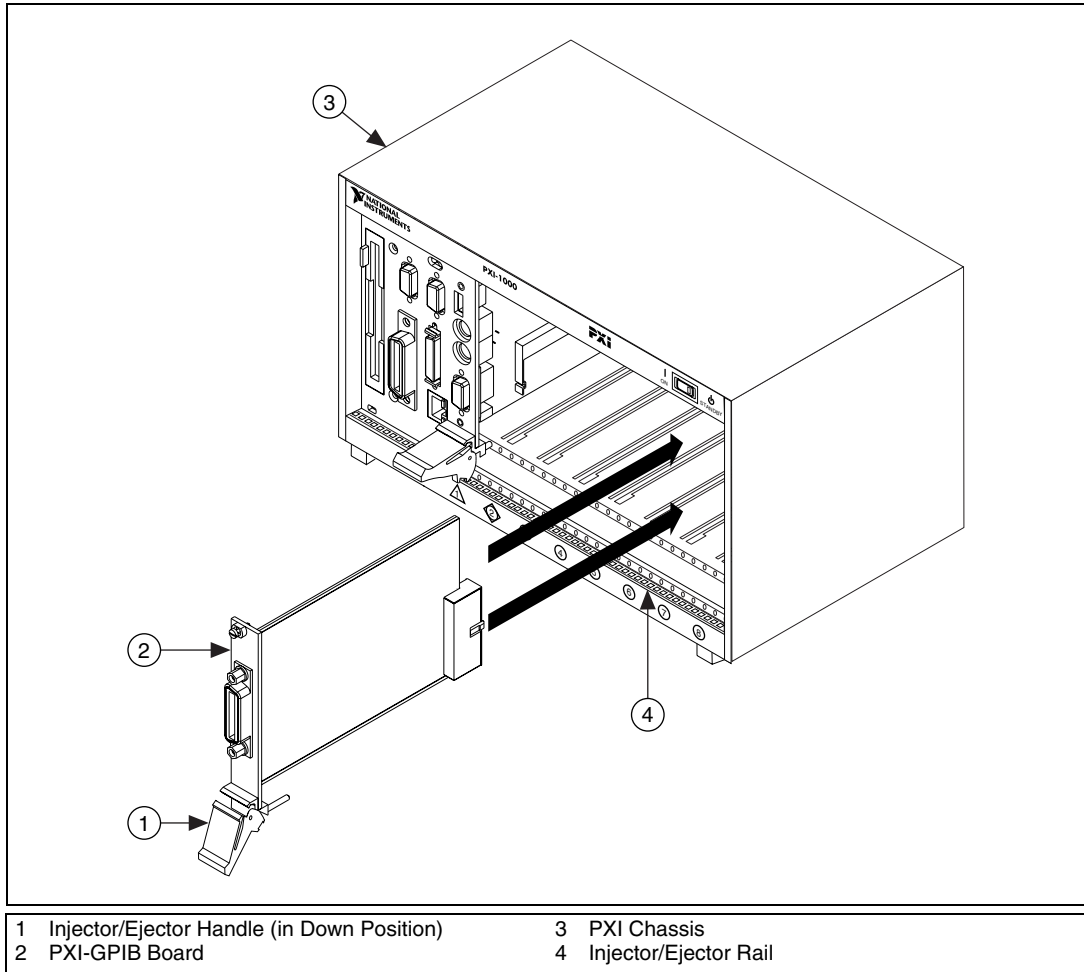


**Caution** Electrostatic discharge can damage several components on your GPIB board. To avoid electrostatic damage when you handle the module, touch the antistatic plastic package to a metal part of your system chassis before you remove the board from the package.

Complete the following steps to install the PXI-GPIB.

1. Log on as super-user. To become a superuser, type `su root` and enter the root password.
2. Shut down your system by typing the following commands at the command line prompt:  

```
sync ; sync ; shutdown
```
3. Turn off your PXI or CompactPCI chassis after it has shut down. Keep the chassis plugged in so that it remains grounded while you install the PXI-GPIB.
4. Choose an unused PXI or CompactPCI 5 V peripheral slot. For maximum performance, the PXI-GPIB has an onboard DMA controller that can only be used if the board is installed in a slot that supports bus arbitration, or bus master cards. National Instruments recommends installing the PXI-GPIB in such a slot. If you install the board in a non-master slot, you must disable the PXI-GPIB onboard DMA controller using the board-level call `ibdma`. Refer to the *NI-488.2M Software Reference Manual* for a complete description of `ibdma`.
5. Remove the filler panel for the peripheral slot you have chosen.
6. Touch a metal part on your chassis to discharge any static electricity that might be on your clothes or body.
7. Insert the PXI-GPIB into the selected 5 V slot. Use the injector/ejector handle to fully inject the device into place. Figure 2-2 shows how to install the PXI-GPIB into a PXI or CompactPCI chassis.
8. Screw the front panel of the PXI-GPIB to the front-panel mounting rail of the PXI or CompactPCI chassis.
9. Turn on your PXI or CompactPCI chassis. The PXI-GPIB interface board is now installed.



**Figure 2-2.** Installing the PXI-GPIB

## Installing the PMC-GPIB



**Caution** Electrostatic discharge can damage several components on your GPIB board. To avoid electrostatic damage when you handle the module, touch the antistatic plastic package to a metal part of your computer chassis before you remove the board from the package.

Complete the following steps to install the PMC-GPIB.

1. Log on as super-user. To become a superuser, type `su root` and enter the root password.
2. Shut down your system by typing the following commands at the command line prompt:  

```
sync ; sync ; shutdown
```
3. Turn off your system.
4. Find an unused PMC slot in your system. You may need to remove the host from the system to access the slot.
5. Remove the corresponding slot filler panel from the host.
6. Touch a metal part on your chassis to discharge any static electricity that might be on your clothes or body.
7. Insert the PMC-GPIB into the slot as shown in Figure 2-3. It might be a tight fit, but do not force the board into place.
8. Use the mounting hardware provided to fasten the PMC-GPIB to the host.
9. Reinstall the host, if you removed it to install the PMC-GPIB.
10. Turn on your system. The PMC-GPIB interface board is now installed.



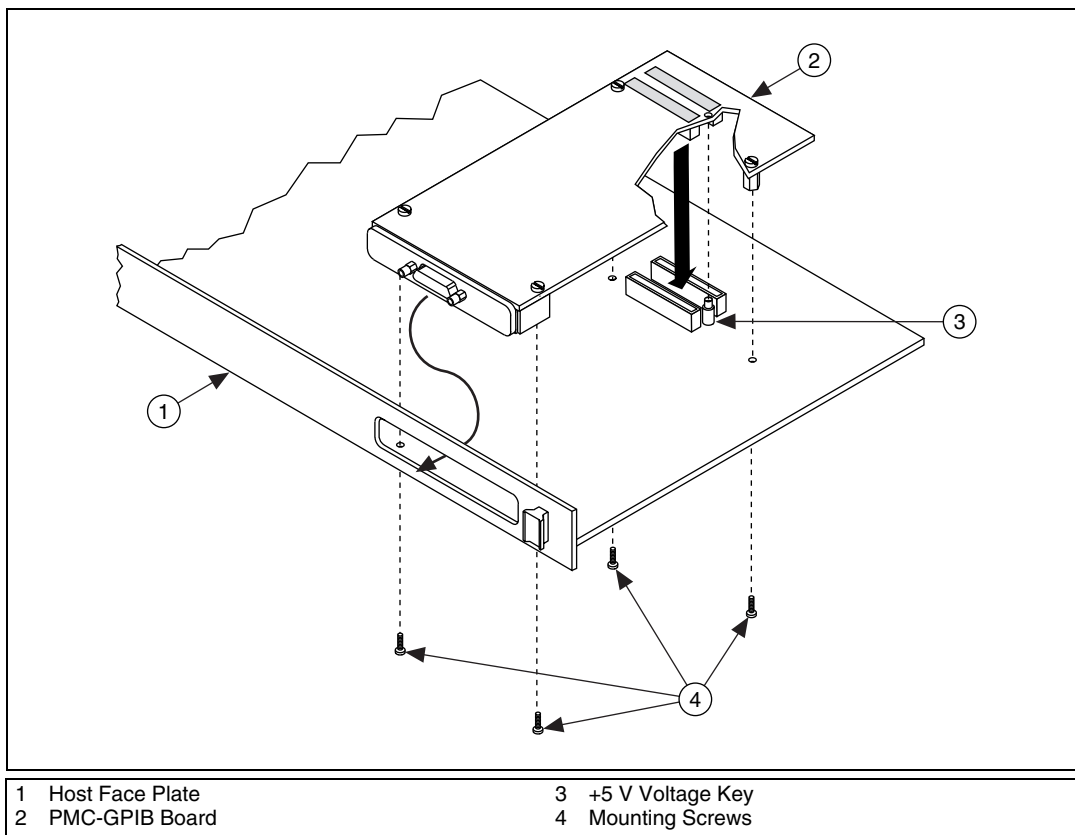


Figure 2-3. Installing the PMC-GPIB

## Installing NI-488.2

Complete the following steps to install NI-488.2 for Solaris.

1. Insert the NI-488.2 for Solaris installation CD-ROM.
2. You must have superuser privilege before you can install NI-488.2 for Solaris. If you are not already a superuser, type `su root` and enter the root password.

3. Add NI-488.2 to the operating system by entering the following command.
  - a. On Solaris 2.5.1 or later versions, the CD automatically mounts as soon as you insert the CD. If this feature is disabled on your workstation, you must mount the CD by typing the following command:
 

```
/usr/sbin/mount -o ro -F hsfs /dev/dsk/c0t6d0s2 /cdrom/cdrom0
```
  - b. Enter the following command to add NI-488.2 to your system:
 

```
/usr/sbin/pkgadd -d /cdrom/cdrom0 NIpigpib
```
4. Follow the instructions on your screen to complete the installation.

## Configuring the Software with `ibconf` (Optional)

---

`ibconf` is an interactive utility you can use to examine or modify the configuration of the driver. You might want to run `ibconf` to change the settings of the software parameters. You must have super-user privilege to run `ibconf`.

`ibconf` is largely self explanatory and contains help screens that explain all commands and options. For more information on using `ibconf`, refer to the *NI-488.2M Software Reference Manual*.

Complete the following steps to change the default parameters of your NI-488.2 software. The driver should not be in use while you run `ibconf`.

1. Log on as super-user (`root`)
2. Type the following command to start `ibconf`.

```
ibconf
```

After you have installed and configured the software, you should verify the installation. Refer to Chapter 3, [Verify the Installation](#).

## Removing NI-488.2 (Optional)

---

If you ever decide to stop using your PCI-GPIB, PXI-GPIB, or PMC-GPIB, you can remove the board and the NI-488.2 software. To remove NI-488.2 from the kernel configuration, you must have super-user privilege and the driver must not be in use. Enter the following command to unload the software:

```
pkgrm NIpigpib
```

---

# Verify the Installation

This chapter describes how to verify the software installation. If you encounter problems, please refer to Appendix A, *Common Questions*.

## Verifying the System Boot Messages

---

If a message in the following format displays on the console or in the command tool window during software installation, the driver has established communication with the hardware device and recognized it.

```
NI-488.2 GPIB Device Driver, Version 2.x  
Copyright (c) 2001 National Instruments Corp.  
All Rights Reserved.
```

```
National Instruments PCI-GPIB (gpibx, slot y, S/N nnn) XXXXXXXX
```

where *nnn* is the serial number of the board; and *XXXXXXXX* could either be blank, indicating the driver is capable of DMA I/O transfers, or `*** NON-DMA ***`, indicating the driver is not capable of DMA I/O transfers.

## Running the Software Installation Test

---

The software installation test has two parts: `ibtsta` and `ibtstb`.

- `ibtsta` checks for correct nodes `/dev/gpib` and `/dev/gpib0` and correct access to the device driver.
- `ibtstb` checks for correct DMA and interrupt operation. `ibtstb` requires a GPIB analyzer, such as the National Instruments GPIB analyzer. You can omit this test if an analyzer is not available.

Follow these steps to run the software verification test.

1. Type the following command to verify the software installation.  
`ibtsta`
2. If `ibtsta` completes without errors and you have a bus analyzer, connect the bus analyzer to the GPIB board and run `ibtstb` by typing the following command.

`ibtstb`

If no error occurs, the NI-488.2 driver is installed correctly. If an error occurs, refer to the next section for troubleshooting information.

## Troubleshooting Error Messages

---

If `ibtsta` fails, the program generates common error messages that appear on your screen. These error messages explain what went wrong when you ran `ibtsta` and describe how you can correct the problem. For example, the following message might appear on your screen if you forgot to disconnect all your GPIB cables:

**The fact that the ENOL error was not received when expected indicates the possible presence of other devices on the bus. Please disconnect ALL GPIB cables from the GPIB board, then run this test again.**

If you are still unable to run `ibtsta` and/or `ibtstb` successfully after you follow the recommended actions from the error messages, refer to Appendix A, [Common Questions](#). If the problem persists, contact National Instruments.

---

# Using NI-488.2 with Solaris

This chapter helps you get started with NI-488.2 for Solaris.

## Using `ibic`

---

The NI-488.2 software includes the Interface Bus Interactive Control utility, `ibic`. You can use `ibic` to enter NI-488 functions and IEEE 488.2-style functions (also known as *NI-488.2 routines*) interactively and display the results of the function calls automatically. Without writing an application, you can use `ibic` to do the following:

- Verify GPIB communication with your device quickly and easily
- Become familiar with the commands of your device
- Receive data from your GPIB device
- Learn new NI-488.2 functions and routines before integrating them into your application
- Troubleshoot problems with your application

Enter the following command to run `ibic`:

```
ibic
```

For more information about `ibic`, refer to Chapter 6, *ibic*, in the *NI-488.2M Software Reference Manual*.

## Programming Considerations

---

Depending on the programming language you use to develop your application, you must include certain files, statements, or global variables at the beginning of your application. For example, you must include the header file `sys/ugplib.h` in your source code if you are using C/C++.

You must link the language interface library with your compiled source code. Link the GPIB C language interface library using one of the following commands, where `example.c` is your application name:

```
cc example.c -lgpib
or
cc example.c -dy -lgpib
or
cc example.c -dn -lgpib
```

`-dy` specifies dynamic linking, which is the default method. It links the application to `libgpib.so`. `-dn` specifies static linking in the link editor. It links the application to `libgpib.a`. For more information about compiling and linking, see the `man` pages for `cc` and `ld`.

For information about each NI-488 function and IEEE 488.2-style function, choosing a programming method, developing your application, or compiling and linking, refer to the *NI-488.2M Software Reference Manual*.

---

# Common Questions

This appendix describes how to troubleshoot problems and answers some common questions. Also refer to Appendix B, *Common Errors and Their Solutions*, in the *NI-488.2M Software Reference Manual*.

## **What do I do if the software verification test fails with an error?**

If `ibtsta` fails, make sure that no GPIB cables are connected to the PCI-GPIB, PXI-GPIB, or PMC-GPIB. If necessary, remove and reinstall NI-488.2 from the CD-ROM. If you already have completed the troubleshooting steps, contact National Instruments.

## **How should I check for errors in my GPIB application?**

Examine the value of `ibsta` after each NI-488 or NI-488.2 call. If a call fails, the ERR bit of `ibsta` is set and an error code is stored in `iberr`. For more information about global status variables, refer to the following sections in the *NI-488.2M Software Reference Manual*: the *General Programming Information* section in Chapter 3, *Understanding the NI-488.2 Software*, and Appendix B, *Common Errors and Their Solutions*.

## **When should I use `ibic`?**

You can use `ibic` to practice communication with your instrument, troubleshoot problems, and develop your application program. For more information about `ibic`, refer to Chapter 6, *ibic*, in the *NI-488.2M Software Reference Manual*.

## **What is wrong if `ibfind` returns a -1?**

The driver may not be installed correctly, or the nodes may not have been created when the driver was loaded. Try removing and reinstalling NI-488.2 from the CD-ROM, as described in Chapter 2, [Installation](#).

Also, the file may require read/write privileges you do not have, or you may have renamed a device. Make sure that the device names in your application program match the device names in `ibconf`.

**How do I use an NI-488.2 language interface?**

For information about using NI-488.2 language interfaces, refer Chapter 4, *Using NI-488.2 with Solaris*. Also refer to the *NI-488.2M Software Reference Manual*.

**How do I communicate with my instrument over the GPIB?**

Refer to the documentation that came from the instrument manufacturer. The command sequences you use are totally dependent on the specific instrument. The documentation for each instrument should include the GPIB commands you need to communicate with it. In most cases, NI-488 device-level calls are sufficient for communicating with instruments. Refer to Chapter 5, *NI-488M Software Characteristics and Functions*, in the *NI-488.2M Software Reference Manual*, for more information.

**What information should I have before I call National Instruments?**

Please have the results of the diagnostic test `ibtsta`. You also should have run `ibic` to try to find the source of your problem.

**Does this driver work with 64-bit Solaris?**

Yes. NI-488.2 for Solaris works with either 32-bit or 64-bit Solaris.



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## Specifications

This appendix describes the characteristics of the PCI-GPIB, PXI-GPIB, and PMC-GPIB interface boards and the transfer rates of the NI-488.2 software, along with the recommended operating conditions.

### Electrical Characteristics

Input power requirements ..... +5 VDC, 600 mA typical  
800 mA maximum

### Environmental Characteristics

#### Temperature

Operating ..... 0 to 55 °C  
Storage ..... -20 to 70 °C

#### Relative humidity

Operating ..... 10 to 90% noncondensing  
conditions  
Storage ..... 5 to 90% noncondensing  
conditions

EMI ..... FCC Class A Verified

### Physical Characteristics

#### Dimensions

PCI-GPIB ..... 13.3 by 10.7 cm (5.25 by 4.20 in.)  
PXI-GPIB ..... 10 by 16 cm (3.94 by 6.30 in.)  
PMC-GPIB ..... 7.4 by 14.9 cm (2.9 by 5.9 in.)

### I/O Connectors

PCI-GPIB ..... IEEE 488 standard 24 pin  
PXI-GPIB ..... IEEE 488 standard 24 pin  
PMC-GPIB ..... Micro D-sub 25 pin

## Maximum Software Transfer Rates<sup>1</sup>

### PCI-GPIB

3-wire (IEEE 488) .....	1.3 Mbytes/s
HS488 .....	7.2 Mbytes/s

### PXI-GPIB

3-wire (IEEE 488) .....	1.5 Mbytes/s
HS488 .....	7.8 Mbytes/s

### PMC-GPIB

3-wire (IEEE 488) .....	1.5 Mbytes/s
HS488 .....	7.8 Mbytes/s

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<sup>1</sup> Actual speed may vary considerably from speed shown due to system and instrumentation capabilities.



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# Technical Support Resources

## Web Support

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National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of [ni.com](http://ni.com).

## NI Developer Zone

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The NI Developer Zone at [ni.com/zone](http://ni.com/zone) is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

## Customer Education

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National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of [ni.com](http://ni.com) for online course schedules, syllabi, training centers, and class registration.

## System Integration

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If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of [ni.com](http://ni.com).

## Worldwide Support

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National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of [ni.com](http://ni.com). Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

# Glossary

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Prefix	Meaning	Value
m-	milli-	$10^{-3}$
c-	centi-	$10^{-2}$
k-	kilo-	$10^3$
M-	mega-	$10^6$

°	degrees
%	percent
A	amperes
ANSI	American National Standards Institute
C	Celsius
EMI	electromagnetic interference
FCC	Federal Communications Commission
GPIB	General Purpose Interface Bus
Hz	hertz
I/O	input/output
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
IRQ	interrupt request
m	meters
MB	megabytes of memory
RAM	random-access memory
s	seconds
V	volts
VDC	volts direct current

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