

CAN

Getting Started with Your CAN Hardware and the NI-CAN™ Software for Windows NT

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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.

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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.

Canadian Department of Communications

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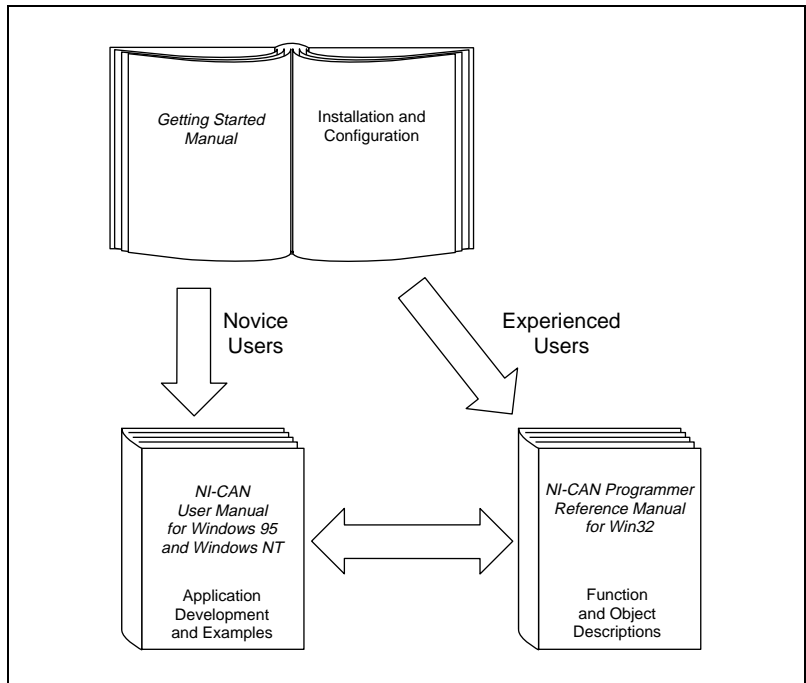
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***About
This
Manual***

This manual contains instructions to help you install and configure the National Instruments CAN hardware and the NI-CAN software for Windows NT. The National Instruments CAN hardware supported under Windows NT includes the PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2.

This manual assumes that you are already familiar with Windows NT.

How to Use the Manual Set



Use this getting started manual to install and configure your CAN hardware and the NI-CAN software for Windows NT.

Use the *NI-CAN User Manual for Windows 95 and Windows NT* to learn the basics of CAN and how to develop an application program. The user manual also contains debugging information and detailed examples.

Use the *NI-CAN Programmer Reference Manual for Win32* for specific information about each NI-CAN function and object, such as format, parameters, and possible errors.

Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, explains how to use this manual, lists what you need to get started and optional equipment you can order, and briefly describes the CAN hardware and the NI-CAN software for Windows NT.
- Chapter 2, *Installation and Configuration*, describes how to install and configure the CAN hardware and the NI-CAN software for Windows NT.
- Chapter 3, *Verify the Installation*, describes how to verify the hardware and software installation.
- Chapter 4, *Begin to Use the NI-CAN Software*, helps you get started with the NI-CAN software for Windows NT.
- Appendix A, *Uninstall the Hardware and Software*, describes how to uninstall the CAN hardware and the NI-CAN software from Windows NT.
- Appendix B, *Cabling Requirements*, describes the cabling requirements for CAN interfaces.
- Appendix C, *Troubleshooting and Common Questions*, describes how to troubleshoot problems and answers some common questions.
- Appendix D, *Specifications*, describes the physical characteristics of the CAN hardware, along with the recommended operating conditions.
- 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 a description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.

Conventions Used in This Manual

The following conventions are used in this manual:

»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence File»Page Setup»Options»Substitute Fonts directs you to pull down the File menu, select the Page Setup item, select Options , and finally select the Substitute Fonts options from the last dialog box.
bold	Bold text denotes the names of menus, menu items, parameters, dialog boxes, dialog box buttons or options, icons, windows, Windows NT tabs, or LEDs.
<i>bold italic</i>	Bold italic text denotes a note or warning.
CAN hardware	<i>CAN hardware</i> refers to the PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2 in cases where the material applies to all the interfaces.
<i>italic</i>	Italic text denotes emphasis, a cross reference, or an introduction to a key concept. This font also denotes text for which you supply the appropriate word or value, such as in Windows 3.x.
<i>italic monospace</i>	Italic text in this font denotes that you must supply the appropriate words or values in the place of these items.
monospace	Text in this font denotes text or characters that you should literally 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 for statements and comments taken from program code.
paths	Paths in this manual are denoted using backslashes (\) to separate drive names, directories, folders, and files.

Related Documentation

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

- ANSI/ISO Standard 11898-1993, *Road Vehicles—Interchange of Digital Information—Controller Area Network (CAN) for High-Speed Communication*
- *CAN Specification Version 2.0*, 1991, Robert Bosch GmbH, Postfach 500, D-7000 Stuttgart 1
- CiA Draft Standard 102, Version 2.0, *CAN Physical Layer for Industrial Applications*
- *DeviceNet Specification, Volume 1, Version 2.0*, Open DeviceNet Vendor Association
- *Microsoft Windows NT User's Guide*, Microsoft Corporation

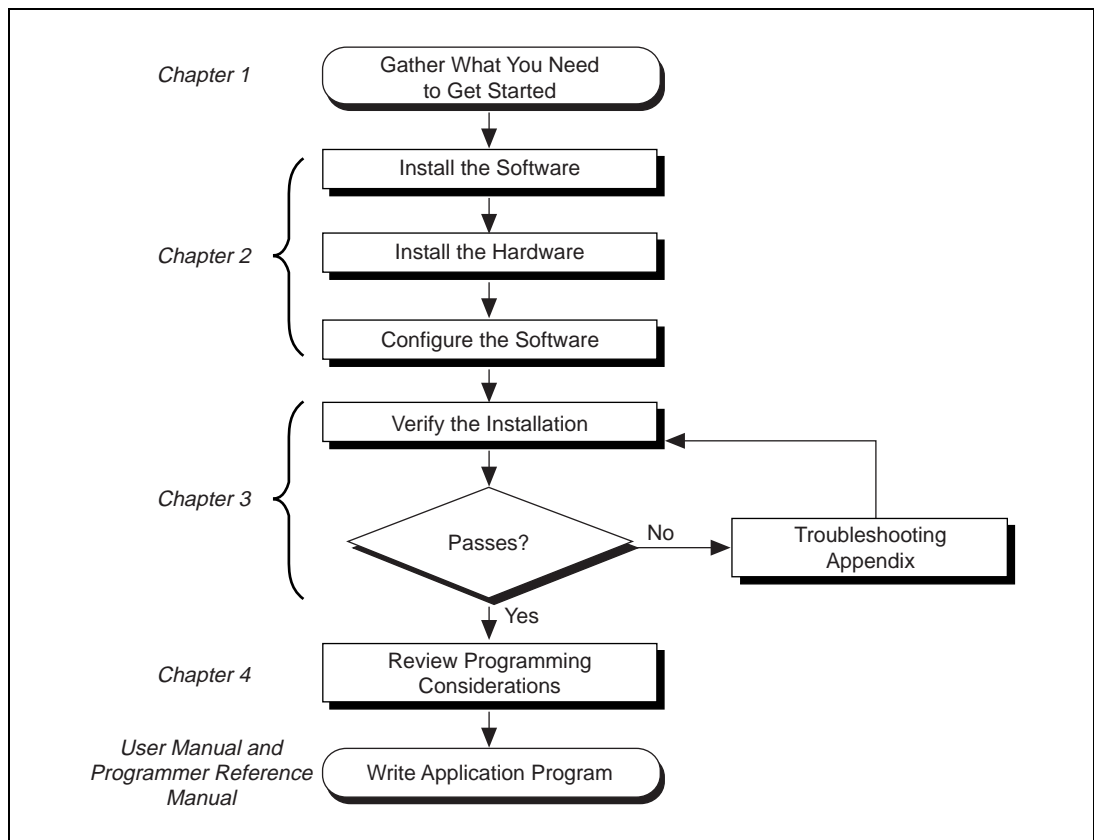
Customer Communication

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.

Introduction

This chapter explains how to use this manual, lists what you need to get started and optional equipment you can order, and briefly describes the CAN hardware and the NI-CAN software for Windows NT.

How to Use This Manual



What You Need to Get Started

Make sure you have all of the following items before you attempt to install the hardware and software:

- Windows NT 3.51 or higher installed on your computer
- One of the following CAN interfaces, which is included in your kit:
 - PCI-CAN
 - PCI-CAN/2
 - PCMCIA-CAN
 - PCMCIA-CAN/2
- The following 3.5 in., high density (1.44 MB) disks, which are included in your kit:
 - NI-CAN Software for Windows 95 and Windows NT (Disk 1)*
 - NI-CAN Software for Windows 95 and Windows NT (Disk 2)*
- PCMCIA-CAN cable, which is included in your kit, if you have a PCMCIA-CAN or PCMCIA-CAN/2
- CAN interface cables that meet the requirements in Appendix B, *Cabling Requirements*

CAN Hardware Overview

The National Instruments CAN hardware supported under Windows NT includes the PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2

The PCI-CAN and PCI-CAN/2 are completely software configurable and compliant with the PCI Local Bus Specification. With a PCI-CAN or PCI-CAN/2 board, you can make your PC-compatible computer with PCI Local Bus slots communicate with and control CAN devices.

The PCMCIA-CAN and PCMCIA-CAN/2 are Type II PC Cards that are completely software configurable and compliant with the PCMCIA standards for 16-bit PC Cards. With a PCMCIA-CAN card or PCMCIA-CAN/2 card, you can make your PC-compatible notebook with PCMCIA sockets communicate with and control CAN devices.

The PCI-CAN and PCMCIA-CAN interfaces each have one CAN port. The PCI-CAN/2 and PCMCIA-CAN/2 interfaces each have two CAN ports.

CAN interfacing is accomplished using the Intel 82527 CAN controller chip. The PCI-CAN physical layer fully conforms to the ISO 11898 physical layer specification for CAN and is optically isolated to 500 V. The PCI-CAN also meets the electrical requirements of DeviceNet by powering the CAN physical layer from the CAN bus. PCI-CAN boards are available with two physical connector types: DB-9 D-Sub (for non-DeviceNet applications) and Combicon-style pluggable screw terminals (as required by the DeviceNet specification). PCMCIA-CAN cards are available with either a cable that is DeviceNet-compliant and therefore powers the CAN physical layer from the bus cable power, or a cable that powers the CAN physical layer from the card. The CAN hardware supports a wide variety of transfer rates up to 1 Mbytes/s.

All of the CAN hardware uses the Intel 386EX embedded processor to implement time-critical features provided by the NI-CAN software. The CAN hardware communicates with the NI-CAN driver through on-board shared memory and an interrupt.

NI-CAN Software Overview

The NI-CAN software includes a native, 32-bit multitasking Windows NT kernel driver.

The NI-CAN software for Windows NT supports the concurrent use of multiple types of CAN hardware. For example, you can communicate with CAN devices through both a PCI-CAN and PCI-CAN/2 in the same system at the same time. The NI-CAN software is fully integrated into the Windows NT operating system. It is configurable through the Windows NT Control Panel and uninstallable through the Add/Remove Programs applet of the Control Panel.

The NI-CAN software, along with the CAN hardware, transforms your computer into a CAN interface with complete communications and bus management capability. The NI-CAN software includes the following components:

- Firmware (runs on embedded Intel 386EX)
- Device driver
- Diagnostic test utility

- Configuration utility
- Language interface libraries for Microsoft Visual C/C++ 2.0 or higher, LabWindows®/CVI 4.0 or higher, and LabVIEW 4.0 or higher
- Example programs that use NI-CAN functions

Optional Programming Tools

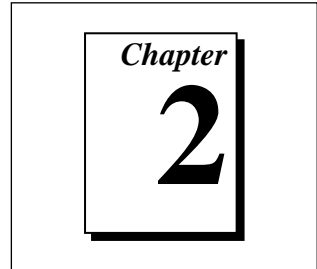
Your kit includes the NI-CAN software for Windows NT. In addition, you can order the LabWindows/CVI or LabVIEW software from National Instruments.

LabWindows/CVI is an interactive ANSI 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. It also includes built-in libraries for IEEE 488.2, VXI, RS-232 control, and plug-in data acquisition. When you order LabWindows/CVI, you also get hundreds of complete instrument drivers, which are modular, source-code programs that handle the communication with your instrument so that you do not have to learn the programming details.

LabVIEW is a complete programming environment that departs from the sequential nature of traditional programming languages and features a graphical programming environment. It includes all the tools needed for instrument control, data acquisition, analysis, and presentation. LabVIEW also includes an extensive instrument driver library.

For more information about LabWindows/CVI and LabVIEW, contact National Instruments.

Installation and Configuration



This chapter describes how to install and configure the CAN hardware and the NI-CAN software for Windows NT.

Install the NI-CAN Software

Before installing the CAN hardware, complete the following steps to install the NI-CAN software for Windows NT.

Installing for Windows NT 3.51

1. Log in as `Administrator` or as a user that has Administrator privileges.
2. Insert the *NI-CAN Software for Windows 95 and Windows NT (Disk 1)* into an unused drive.
3. In the **Run...** dialog box, type the following:
`x:\setup`
where `x` is the letter of the drive containing the disk (usually `a` or `b`).
4. Shut down your computer when the setup is complete.

Installing for Windows NT 4.0

1. Log in as `Administrator` or as a user that has Administrator privileges.
2. Select **Start»Settings»Control Panel**.
3. Double-click on the **Add/Remove Programs** icon in the Control Panel to launch the Add/Remove Programs applet. A dialog box similar to the one in Figure 2-1 appears.



Figure 2-1. Add/Remove Programs Properties Dialog Box

You can use this same applet to uninstall the NI-CAN software at a later time. Refer to Appendix A, *Uninstall the Hardware and Software*, for more information.

4. Click on the **Install...** button.
5. Insert the *NI-CAN Software for Windows 95 and Windows NT (Disk 1)*, and click on the **Next** button to proceed. The software installation wizard begins with the screen shown in Figure 2-2.

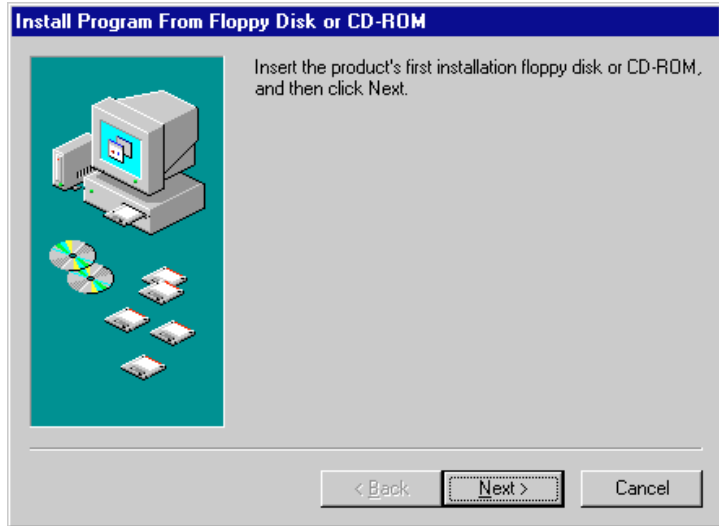


Figure 2-2. NI-CAN Software Setup Screen

The setup wizard guides you through the necessary steps to install the NI-CAN software. You may go back and change values where appropriate by clicking on the **Back** button. You can exit the setup where appropriate by clicking on the **Cancel** button.

6. Shut down your computer when the setup is complete.

Install the CAN Hardware

This section describes how to install your CAN hardware.

Install Your PCI-CAN or PCI-CAN/2



Caution: *Electrostatic discharge can damage several components on these CAN interfaces. To avoid such damage in handling your interface, touch the antistatic plastic package to a metal part of your computer chassis before removing the interface from the package.*

1. Make sure that your computer is turned off. Keep the computer plugged in so that it remains grounded while you install the CAN interface.
2. Remove the top cover (or other access panels) to give yourself access to the computer expansion slots.

3. Find an unused expansion slot of the appropriate type in your computer.
4. Remove the corresponding slot cover on the back panel of the computer.
5. Insert the CAN interface into the slot with the CAN connector(s) sticking out of the opening on the back panel. It might be a tight fit, but do not force the interface into place. Figure 2-3 shows how to install the PCI-CAN into a PCI expansion slot.

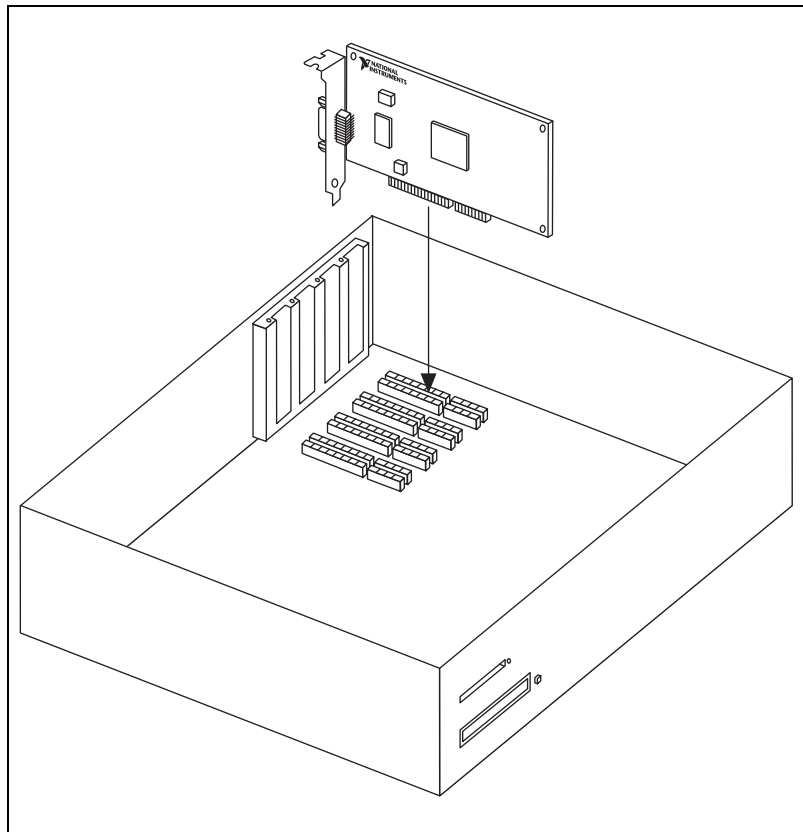


Figure 2-3. Installing the PCI-CAN

6. Screw the mounting bracket of the CAN interface to the back panel rail of the computer.
7. Replace the top cover (or the access panel to the expansion slot).
8. Turn on your computer and start Windows NT.

When you have finished installing the hardware, proceed to the *Connect the Cables* section, later in this chapter.

Install Your PCMCIA-CAN or PCMCIA-CAN/2



Caution: *Electrostatic discharge can damage several components on these CAN interfaces. To avoid such damage in handling your interface, touch the antistatic plastic package to a metal part of your computer chassis before removing the interface from the package.*



Note: *Because of restrictions imposed by Windows NT, only one PCMCIA-CAN or PCMCIA-CAN/2 can be used in a given Windows NT system. For example, if you have a PCMCIA-CAN card in your system, you cannot use a PCMCIA-CAN/2 card at the same time.*

1. Shut down your operating system and power off your system.
2. Insert the card into a free PC Card (PCMCIA) socket. The card has no jumpers or switches to set. Figure 2-4 shows how to insert the card and how to connect the PCMCIA-CAN cable and connector to the card.

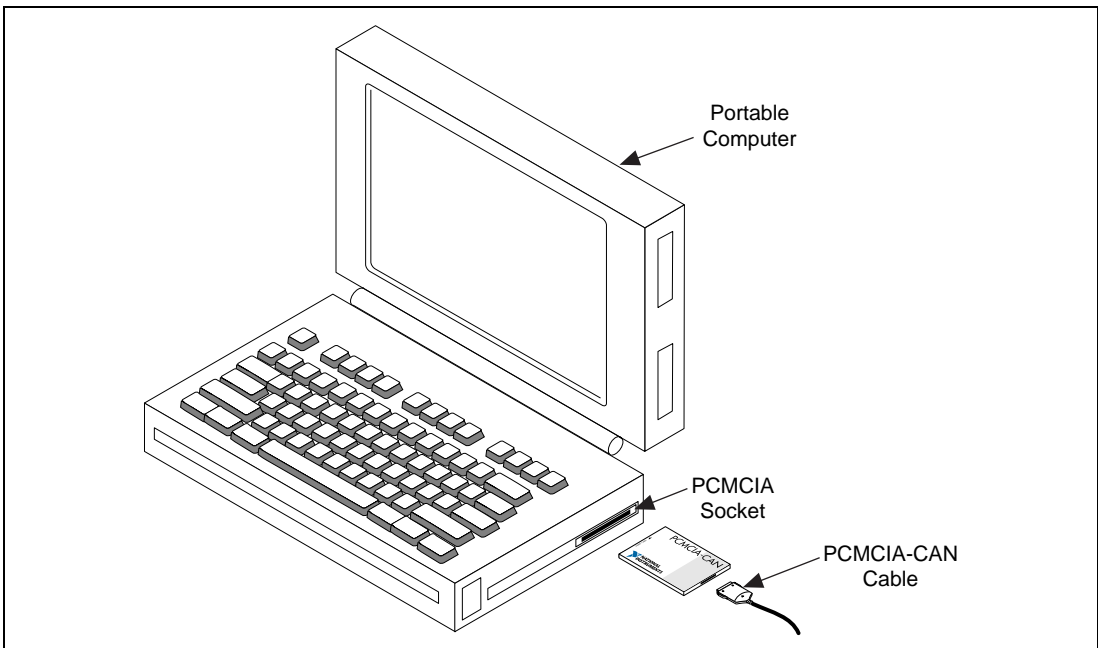


Figure 2-4. Inserting the PCMCIA-CAN

3. Connect the PCMCIA-CAN cable to the card.
4. Power on your computer.

When you have finished installing the hardware, proceed to the next section, *Connect the Cables*.

Connect the Cables

Because exact cabling requirements will vary for each application, National Instruments does not provide cables, other than the PCMCIA-CAN cable. Refer to Appendix B, *Cabling Requirements*, for information about the cabling requirements of the CAN hardware.

After you have installed the CAN interface, connect your CAN cables to the interface. The CAN hardware installation is now complete. Proceed to the next section, *Configure the NI-CAN Software*.

Configure the NI-CAN Software

The NI-CAN Configuration utility is located in the Windows NT Control Panel. You can use it to examine or modify the configuration of the NI-CAN software. The context-sensitive online help, available by right-clicking on any of the controls on the configuration utility buttons, includes all of the information that you need to configure the NI-CAN software properly.

To use the NI-CAN Configuration utility, you must first log in as Administrator or as a user that has Administrator privileges. To configure the NI-CAN software, double-click on the **NI-CAN Configuration** icon in the **Control Panel**:

- Windows NT 3.51: Open the **Control Panel** in the **Main** group of the **Program Manager**.
- Windows NT 4.0 or higher: Select **Start»Settings»Control Panel**.

Figure 2-5 shows a CAN interface that is working properly. If no interfaces are listed under **NI-CAN Configuration**, refer to the *Missing CAN Interface in the NI-CAN Configuration Utility* section in Appendix C, *Troubleshooting and Common Questions*, to resolve the problem.

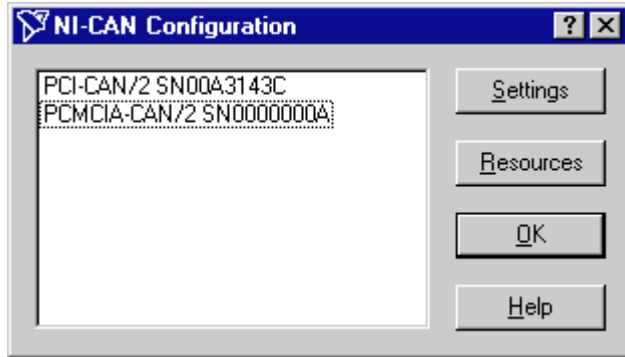


Figure 2-5. CAN Interface That Is Working Properly

To select a particular interface, click on that interface in the list.

When you install a PCI-CAN interface, your computer automatically assigns valid resources to it. Because this resource assignment is automatic, you do not need to use the **Resources** dialog box for the PCI-CAN, and you do not need to restart Windows NT.

When you install a PCMCIA-CAN interface, your computer assigns default resources to it. Because the default resources may conflict with other devices in your system, you must use the **Resources** dialog box to select valid resources for the PCMCIA-CAN. Figure 2-6 shows the **Resources** dialog box for the PCMCIA-CAN.

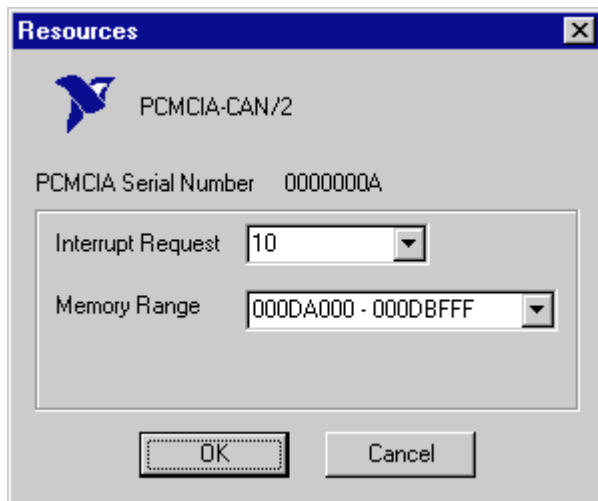


Figure 2-6. Resources Dialog Box for the PCMCIA-CAN

Click on the **Settings** button to view information about the NI-CAN software configuration for the CAN interface. Figure 2-7 shows the **Settings** dialog box.

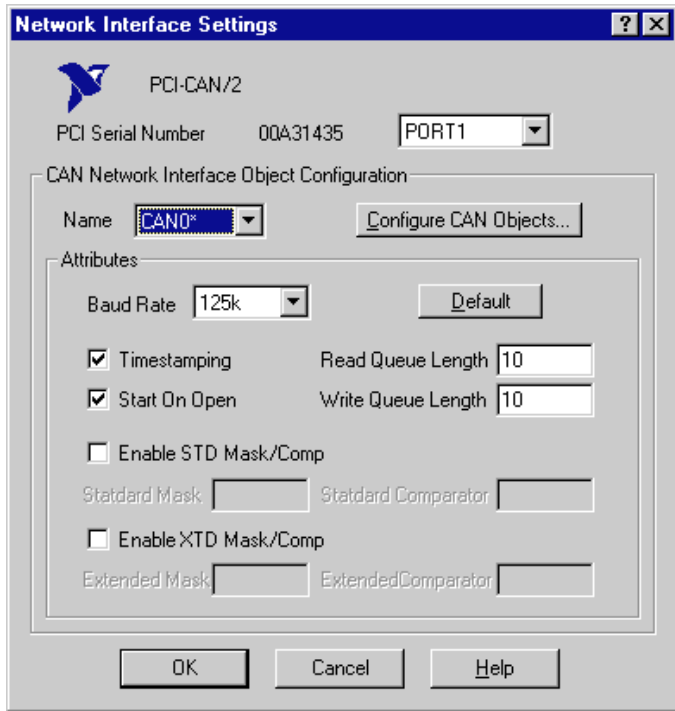


Figure 2-7. NI-CAN Settings for the PCI-CAN/2

Each port of the CAN hardware interface is configured from this tab. Use the drop-down box nearest the top of the tab to select the physical port number to configure. For each port, use the **Name** drop-down box to select the name for the CAN Network Interface Object (CAN0, CAN1, and so on). You use this name to refer to the physical port from within your NI-CAN application.

To access online help for the NI-CAN Configuration utility, click on the **Help** button. Alternately, you can right-click on a specific control and select **What's This?** from the pop-up menu to see context-sensitive help for the item you have clicked on.

When you have finished configuring the NI-CAN software, proceed to Chapter 3, *Verify the Installation*.



Note:

If you changed the resources for any PCMCIA-CAN or PCMCIA-CAN/2 interface, you must restart Windows NT for the changes to take effect.

Verify the Installation

This chapter describes how to verify the hardware and software installation.

You can use the NI-CAN Diagnostic utility, installed with your NI-CAN software, to test the hardware and software installation. The utility verifies that your hardware and software are functioning properly and that the configuration of your CAN interfaces does not conflict with anything else in your system.

To run the utility, select the **NI-CAN Diagnostic** item:

- Windows NT 3.51: Double-click on the **NI-CAN Diagnostic** icon in the **NI-CAN Software for Windows NT** group of the **Program Manager**.
- Windows NT 4.0 or higher: Select **Start»Programs»NI-CAN Software for Windows NT»NI-CAN Diagnostic**.

When you have started the NI-CAN Diagnostic utility, test your CAN interfaces by clicking on the **Test All** button. You can also test one CAN interface by highlighting it and clicking on the **Test One** button. If the NI-CAN Diagnostic is successful, it puts a checkmark next to the interface and changes its status from **Untested** to **Passed**. If the NI-CAN Diagnostic fails, it puts an X next to the interface, and changes its status from **Untested** to **Failed**. Figure 3-1 shows the NI-CAN Diagnostic utility after it has tested some CAN interfaces.

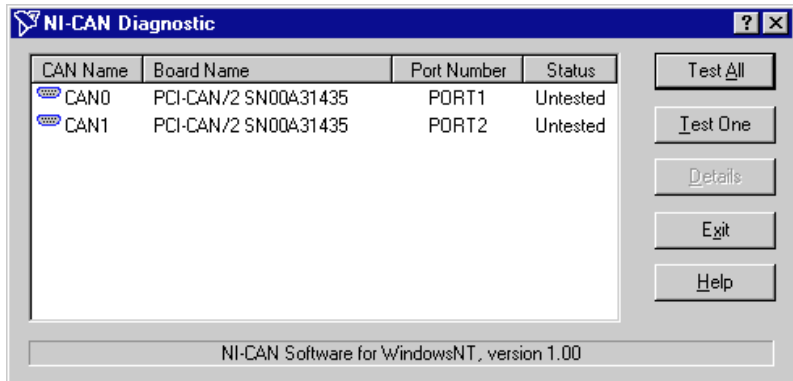
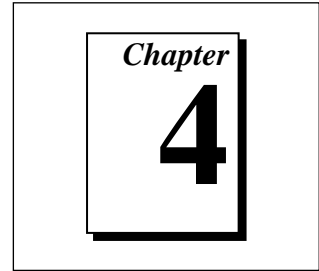


Figure 3-1. NI-CAN Diagnostic Utility after Testing

You can get details about any tested CAN interface by selecting the interface and clicking on the **Details** button. For each failed CAN interface, select it and click on the **Details** button to get a description of the failure. Use that information and the information in Appendix C, *Troubleshooting and Common Questions*, to troubleshoot the problem. Troubleshooting information is also available in the online help for the NI-CAN Diagnostic utility, which you can access by clicking on the **Help** button.

Begin to Use the NI-CAN Software



This chapter helps you get started with the NI-CAN software for Windows NT.

Using the NI-CAN Software

The functions provided by the NI-CAN software are similar to those provided by many other device drivers. For example, NI-CAN has open, close, read, and write functions. NI-CAN provides two different levels of access to a CAN network: the CAN Network Interface Object and CAN Objects. Both forms of access support timestamping of incoming data, as well as various forms of queuing.

The CAN Network Interface Object provides low-level access to a CAN network. Each CAN Network Interface Object maps to a specific CAN port, with no limitation on the maximum number of ports or cards you can use (for example, two PCI-CAN/2 interfaces would provide CAN0 through CAN3). You can use this object to transmit and receive entire CAN frames. For example, to transmit a CAN frame, you would specify the outgoing arbitration ID, frame type (data or remote), data length, and data.

The CAN Objects provide higher level access to a CAN network. Each CAN Object maps to a specific data item (arbitration ID), and you can use multiple CAN Objects for a given port. When configuring a CAN Object for use, you specify the arbitration ID, direction of data transfer, data length, and how you want the data to be accessed (such as periodically). For example, you could configure a CAN Object to transmit an outgoing data frame for a specific arbitration ID every 100 ms. After opening this CAN Object, you use the write function to provide data to transmit, and the NI-CAN embedded firmware handles all periodic timing.

For detailed information about the NI-CAN software and functions, refer to the *NI-CAN User Manual for Windows 95 and Windows NT* and the *NI-CAN Programmer Reference Manual for Win32*.

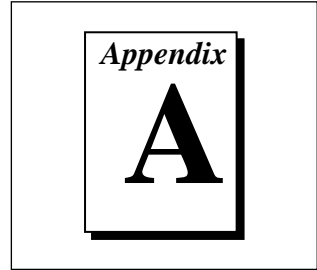
General Programming Considerations

As you begin developing your Win32 NI-CAN application, remember the following points:

- For your LabVIEW application, you must use the NI-CAN LabVIEW functions in `nican.llb`.
- For your C/C++ application, you must include the NI-CAN header file, `nican.h`, in your source code.
- The NI-CAN software is accessed through the 32-bit DLL, `nican.dll`, either by linking with one of the language interfaces provided with the NI-CAN software, or by using direct DLL entry from other programming environments.
- Several sample CAN applications are included with the NI-CAN software. Use these as a guide for your own application development.

For information about developing your application, refer to the *NI-CAN User Manual for Windows 95 and Windows NT*. For detailed information about NI-CAN functions and objects, refer to the *NI-CAN Programmer Reference Manual for Win32*.

Uninstall the Hardware and Software



This appendix describes how to uninstall the CAN hardware and the NI-CAN software from Windows NT.

Uninstalling the CAN Hardware from Windows NT

Because the current version of Windows NT does not maintain hardware information for the CAN interfaces, you just need to physically remove the CAN interfaces from your computer. To do so, shut down Windows NT, power off your computer, and physically remove the CAN interfaces.

Uninstalling the NI-CAN Software from Windows NT



Note:

The following instructions apply to Windows NT 4.0 only. If you are using Windows NT 3.51, refer to the `readme.txt` file in your NI-CAN directory for information on how to uninstall the NI-CAN software.

Before uninstalling the NI-CAN software, you should remove all CAN interface hardware from your computer, as explained in the previous section.

Complete the following steps to remove the NI-CAN software:

1. Select the **Add/Remove Programs** icon under **Start»Settings»Control Panel**. A dialog box similar to the one in Figure A-1 appears. This dialog box lists the software available for removal.

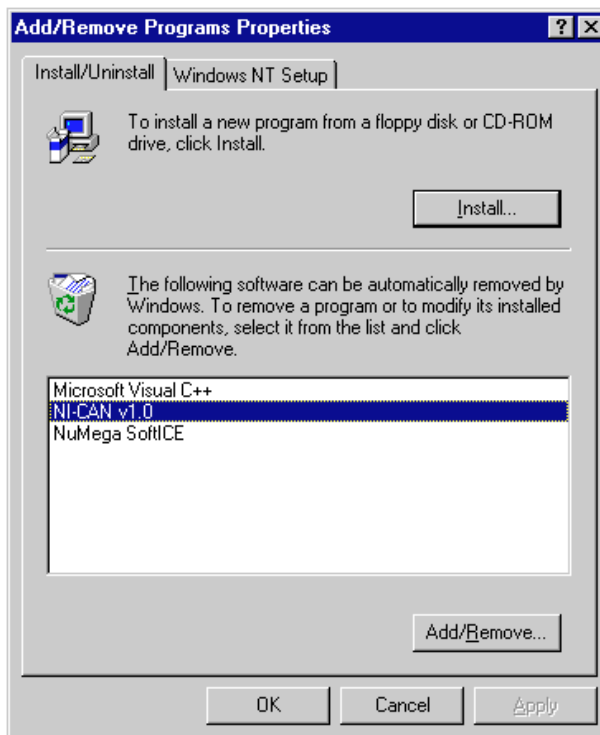


Figure A-1. Add/Remove Programs Properties Dialog Box

2. Select the NI-CAN software you want to remove, and click on the **Add/Remove...** button. The uninstall program runs and removes all folders, utilities, device drivers, DLLs, and registry entries associated with the NI-CAN software. Figure A-2 shows the results of a successful uninstallation.

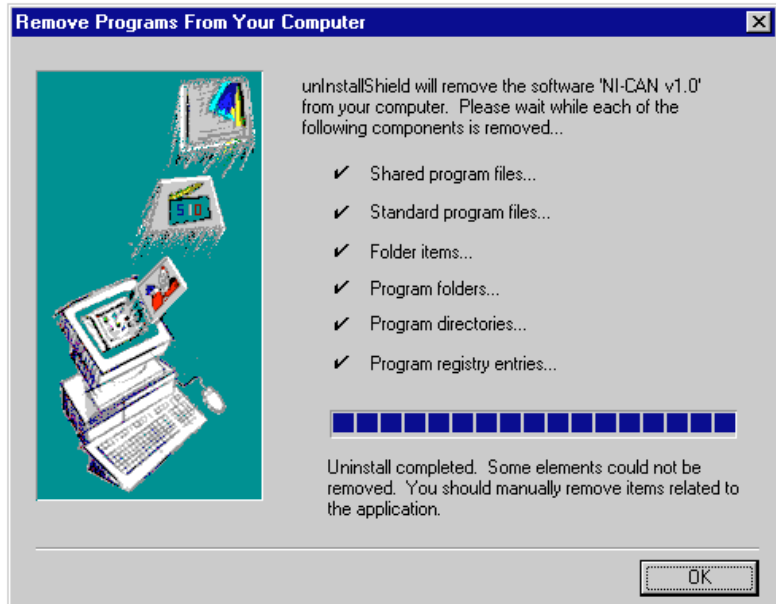


Figure A-2. NI-CAN Uninstallation Results

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory, because the directory is not empty after the uninstallation. You need to remove any remaining components yourself.

If you want to reinstall the hardware and software, refer to Chapter 2, *Installation and Configuration*.

Cabling Requirements

This appendix describes the cabling requirements for CAN interfaces.

Cables should be constructed to meet these requirements, as well as the requirements of the other CAN or DeviceNet devices in the network.

Connector Pinouts

Depending on the type of CAN interface you are installing, the CAN hardware either has DB-9 D-Sub connectors(s), or Combicon-style pluggable screw terminal connector(s).

The 9-pin D-Sub follows the pinout recommended by CiA DS 102. Figure B-1 shows the pinout for this connector.

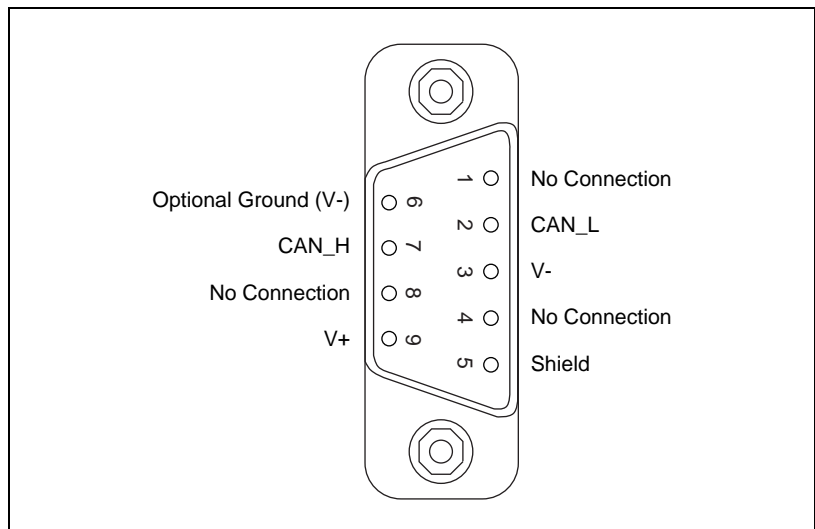


Figure B-1. Pinout for 9-Pin D-Sub Connector

The 5-pin Combicon-style pluggable screw terminal follows the pinout required by the DeviceNet specification. Figure B-2 shows the pinout for this connector.

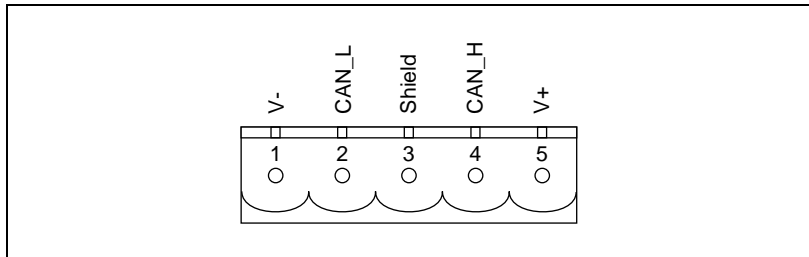


Figure B-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

CAN_H and CAN_L are signal lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

For the PCI-CAN, PCI-CAN/2, and the DeviceNet (bus-powered) version of the PCMCIA-CAN or PCMCIA-CAN/2 cable, V+ and V- supply power to the CAN physical layer. See the next section, *Power Supply Information for the CAN Ports*, for more information.

Figure B-3 shows the end of a PCMCIA-CAN cable. The arrow points to pin 1 of the 5-pin screw terminal block. All of the signals on the 5-pin Combicon-style pluggable screw terminal are connected directly to the corresponding pins on the 9-pin D-Sub.

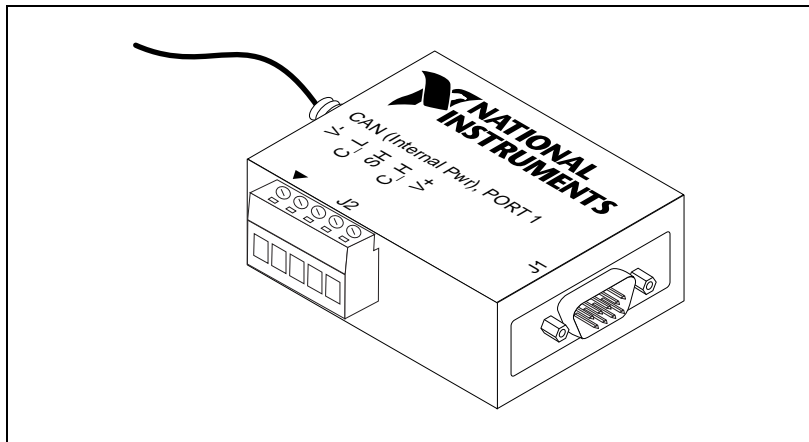


Figure B-3. PCMCIA-CAN Cable

Power Supply Information for the CAN Ports

For the PCI-CAN, PCI-CAN/2, and the DeviceNet (bus-powered) version of the PCMCIA-CAN and PCMCIA-CAN/2 cable, the bus must supply power to each CAN port. The bus power supply should be a DC power supply with an output of 10 V to 30 V. The CAN physical layer is powered from the bus using the V+ and V- lines.

The power requirements for the CAN ports are shown in Table B-1. You should take these requirements into account when determining the requirements of the bus power supply for the system.

Table B-1. Power Requirements for the CAN Physical Layer for Bus-Powered Versions

Characteristic	Specification
Voltage Requirement	V+ 10-30 VDC
Current Requirement	40 mA typical 100 mA maximum

For the internal power version of the PCMCIA-CAN or PCMCIA-CAN/2 cable, the power for the CAN physical layer comes from the host computer. The V+ pin is not connected to any internal signals, but the corresponding pins on the 9-pin D-Sub and the 5-pin Combicon-style connectors are still connected. The V- pin serves as the reference ground for the isolated signals.

Cable Specifications

Cables should meet either the physical medium requirements specified in ISO 11898 shown in Table B-2 or the requirements of the DeviceNet cable specification.

Belden cable (3084A) meets all of those requirements, and should be suitable for most applications.

Table B-2. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Impedance	108 Ω minimum, 120 Ω nominal, 132 Ω maximum
Length-related resistance	70 m Ω /m nominal
Specific line delay	5 ns/m nominal

Cable Lengths

The allowable cable length is affected by the characteristics of the cabling and the desired bit transmission rates. Detailed cable length requirements can be found in the ISO 11898, CiA DS 102, and DeviceNet specifications.

ISO 11898 specifies 40 m total cable length with a maximum stub length of 0.3 m for a bit rate of 1 Mb/s. The ISO 11898 specification says that significantly longer cable lengths may be allowed at lower bit rates, but each node should be analyzed for signal integrity problems.

Table B-3 lists the DeviceNet cable length specifications.

Table B-3. DeviceNet Cable Length Specifications

Bit Rate	Thick Cable	Thin Cable
500 kb/s	100 m	100 m
250 kb/s	200 m	100 m
100 kb/s	500 m	100 m

Maximum Number of Devices

The maximum number of devices that you can connect to a CAN port depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of ISO 11898, at least 30 devices may be connected to the bus. Higher numbers of devices may be connected if the electrical characteristics of the devices do not degrade signal quality below ISO 11898 signal level specifications. If all of the

devices on the network meet the DeviceNet specifications, 64 devices may be connected to the network.

Cable Termination

The pair of signal wires (CAN_H and CAN_L) constitutes a transmission line. If the transmission line is not terminated, each signal change on the line causes reflections that may cause communication failures.

Because communication flows both ways on the CAN bus, CAN requires that both ends of the cable be terminated. However, this requirement does not mean that every device should have a termination resistor. If multiple devices are placed along the cable, only the devices on the ends of the cable should have termination resistors. See Figure B-4 for an example of where termination resistors should be placed in a system with more than two devices.

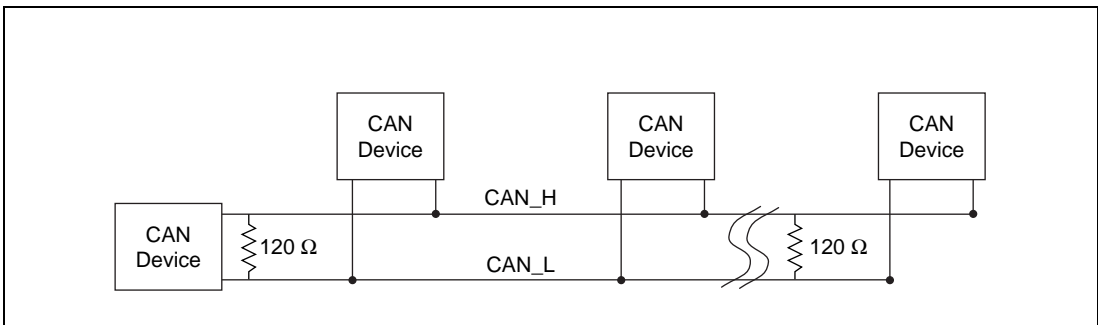


Figure B-4. Termination Resistor Placement

The termination resistors on a cable should match the nominal impedance of the cable. ISO 11898 requires a cable with a nominal impedance of 120 Ω; therefore, a 120 Ω resistor should be used at each end of the cable. Each termination resistor should be capable of dissipating 0.25 W of power.

Cabling Example

Figure B-5 shows an example of a cable to connect two CAN devices. For the internal power version of the PCMCIA-CAN or PCMCIA-CAN/2 cable, no V+ connection is required.

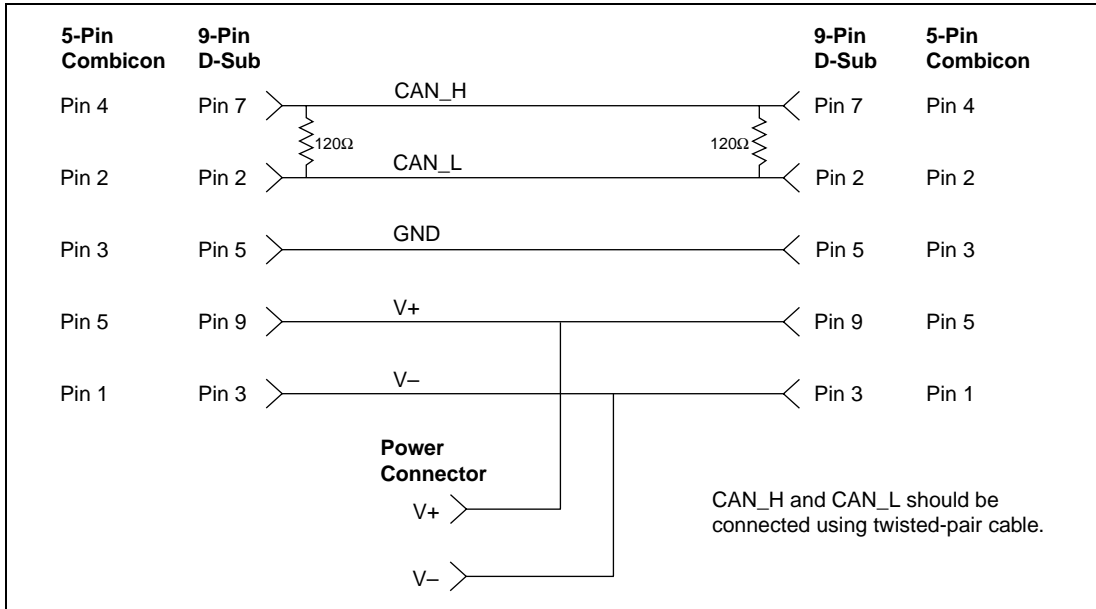
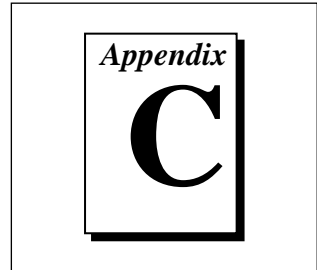


Figure B-5. Cabling Example

Troubleshooting and Common Questions



This appendix describes how to troubleshoot problems and answers some common questions.

Missing CAN Interface in the NI-CAN Configuration Utility

The NI-CAN Configuration utility contains configuration information for all of the CAN hardware it is aware of that is installed in your system. To start the NI-CAN Configuration utility, double-click on the **NI-CAN Configuration** icon in the **Control Panel**:

- Windows NT 3.51: Open the **Control Panel** in the **Main** group of the **Program Manager**.
- Windows NT 4.0 or higher: Select **Start»Settings»Control Panel**.

If the CAN interface you are looking for is not listed under **NI-CAN Configuration**, the CAN interface is not properly installed. For National Instruments CAN hardware, this means that the interface is not physically present in the system. If the interface is firmly plugged into its slot and the problem persists, contact National Instruments.

Troubleshooting Diagnostic Utility Failures

The following sections explain common error messages generated by the NI-CAN Diagnostic utility.

Resource Errors

This error occurs if the memory resource or interrupt resource assigned to a CAN interface conflicts with the resources being used by other devices in the system. If a resource error occurs, click on the **Resources** button in the NI-CAN Configuration utility to view the board resources. For the PCMCIA-CAN, change the conflicting resource shown in **Resources** until the interface passes the diagnostic test. For the PCI-CAN, if legacy boards in your system are using the resources, change the resource configuration of the legacy board. If the problem persists, contact National Instruments.

NI-CAN Software Problem Encountered

This error occurs if the NI-CAN Diagnostic utility detects that it is unable to communicate correctly with the CAN hardware using the installed NI-CAN software. If you get this error, shut down your computer, restart it, and run the NI-CAN Diagnostic utility again. If the problem persists, try reinstalling the NI-CAN software for Windows NT.

Missing CAN Interface

If a National Instruments CAN interface is physically installed in your system, but is not listed in the NI-CAN Diagnostic utility, check to see if the NI-CAN Configuration utility has detected the hardware. For more information, refer to the *Missing CAN Interface in the NI-CAN Configuration Utility* section earlier in this appendix.

CAN Hardware Problem Encountered

This error occurs if the NI-CAN Diagnostic utility detects a defect in the CAN hardware. If you get this error, write down the numeric code shown with the error, and contact National Instruments. Depending on the cause of the hardware failure, you may need to repair or replace your CAN interface.

Common Questions

How can I determine which type of CAN hardware I have installed?

Run the NI-CAN Configuration utility. To run the utility, select **Start»Settings»Control Panel»NI-CAN Configuration**. If any CAN

hardware is correctly installed, it is listed under **National Instruments CAN Interfaces**.

How do I connect a CAN cable to my CAN interface?

For information about cabling requirements for National Instruments CAN hardware, refer to Appendix B, *Cabling Requirements*.

How can I determine which version of the NI-CAN software I have installed?

Run the NI-CAN Diagnostic utility. To run the utility, select the **NI-CAN Diagnostic** item under **Start»Programs»NI-CAN Software for Windows NT**. The NI-CAN Diagnostic utility displays information about the version of the NI-CAN software currently installed.

Which CAN interfaces does the NI-CAN software for Windows NT support?

The NI-CAN software for Windows NT supports the PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2.

What do I do if the NI-CAN Diagnostic utility fails with an error?

Refer to the *Troubleshooting Diagnostic Utility Failures* section in this appendix for specific information about what might cause the NI-CAN Diagnostic utility to fail. If you have already completed the troubleshooting steps, fill out the forms in Appendix E, *Customer Communication*, and contact National Instruments.

How many CAN boards can I configure for use with my NI-CAN software for Windows NT?

The NI-CAN software for Windows NT can be configured to communicate with up to 10 CAN boards.

Are interrupts required for the NI-CAN software for Windows NT?

Yes, one interrupt per board is required.

How do I use an NI-CAN language interface?

For information about using NI-CAN language interfaces, refer to Chapter 3, *Developing Your Application*, in the *NI-CAN User Manual for Windows 95 and Windows NT*.

How do I use NI-CAN from within LabVIEW?

For information about using NI-CAN from within LabVIEW, refer to Chapter 3, *Developing Your Application*, in the *NI-CAN User Manual for Windows 95 and Windows NT*.

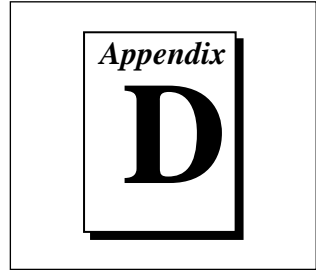
Why does the uninstall program leave some components installed?

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory, because the directory is not empty after the uninstallation. You must remove any remaining components yourself.

What information should I have before I call National Instruments?

When you call National Instruments, you should have all of the information filled out on the *Hardware and Software Configuration Form* in Appendix E, *Customer Communication*.

Specifications



This appendix describes the physical characteristics of the CAN hardware, along with the recommended operating conditions.

Table D-1. PCI-CAN and PCI-CAN/2 Hardware Characteristics

Characteristic	Specification
Dimensions	10.67 by 17.46 cm (4.2 by 6.88 in.)
Power Requirement	+5 VDC 775 mA typical
I/O Connector	9-pin D-Sub for each port (standard) or 5-pin Combicon-style pluggable DeviceNet screw terminal
Operating Environment Ambient Temperature Relative Humidity	0° to 55° C 10% to 90%, noncondensing
Storage Environment Temperature Relative Humidity	-20° to 70° C 5% to 90%, noncondensing
EMI	FCC Class A Verified

Table D-2. PCMCIA-CAN and PCMCIA-CAN/2 Hardware Characteristics

Characteristic	Specification
Dimensions	8.56 by 5.40 by 0.5 cm (3.4 by 2.1 by 0.4 in.)
Power Requirement	500 mA typical
I/O Connector	Cable with 9-pin D-Sub and 5-pin Combicon-style pluggable screw terminal for each port
Operating Environment Component Temperature Relative Humidity	0° to 55° C 10% to 90%, noncondensing
Storage Environment Temperature Relative Humidity	-20° to 70° C 5% to 90%, noncondensing
EMI	FCC Class A Verified

Table D-3. CAN Port Characteristics for Bus-Powered Ports

Characteristic	Specification
Power Requirement	10-30 V 40 mA typical 100 mA maximum
Isolation	500 VDC optical

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve 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 application 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 U.S. 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.



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
Canada (Ontario)	905 785 0085	905 785 0086
Canada (Quebec)	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 5734815	03 5734816
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
U.K.	01635 523545	01635 523154

Technical Support Form

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

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

Name _____

Title _____

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 will reproduce the problem _____

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

General Information

CAN Interface Type (such as PCI-CAN/2) _____

NI-CAN Diagnostic Utility Results _____

Version Information

To access complete version information, including the hardware version and the NI-CAN driver version, open the **MS-DOS Prompt** and change to the NI-CAN installation directory (usually `c:\nican`). At the prompt, enter the following command:

```
canddiag -v
```

Version Information from the NI-CAN Diagnostic _____

Other Products

Programming Environment Information

Programming Language _____

Compiler Vendor _____ Compiler Version _____

Application Information

LabVIEW Application _____ Win32 Application _____

If Win32, method of accessing DLL (link with language interface or direct entry?)

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 CAN Hardware and the NI-CAN™ Software for Windows NT*

Edition Date: June 1997

Part Number: 321372B-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.

Thank you for your help.

Name _____

Title _____

Company _____

Address _____

Phone (____) _____ Fax (____) _____

Mail to: Technical Publications
National Instruments Corporation
6504 Bridge Point Parkway
Austin, TX 78730-5039

Fax to: Technical Publications
National Instruments Corporation
(512) 794-5678

A rectangular box containing a smaller, slightly offset rectangular box with the word "Glossary" written in a serif font inside it.

Glossary

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

°	degrees
Ω	ohms
%	percent
A	amperes
AC	alternating current
AT-compatible	compatible with the 16-bit Industry Standard Architecture
b	bits
B	bytes
C	Celsius
CAN	Controller Area Network
CiA	CAN in Automation
DLL	dynamic link library

Glossary

DMA	direct memory access
EMI	electromagnetic interference
FCC	Federal Communications Commission
Hz	hertz
in.	inches
IRQ	interrupt request
ISA	Industry Standard Architecture
ISO	International Standards Organization
m	meters
PC	personal computer
PCI	peripheral component interconnect
PnP	Plug and Play
RAM	random-access memory
resource	hardware settings used by National Instruments CAN hardware, including an interrupt request level (IRQ) and an 8 KB physical memory range (such as D0000 to D1FFF hex)
s	seconds
V	volts
VDC	volts direct current
W	watts