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AT-CAN-2

CAN

Getting Started with Your CAN Hardware and the NI-CAN™ Software for Windows 98/95

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FCC/Canada Radio Frequency Interference Compliance*

Determining FCC Class

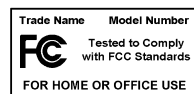
The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). 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 labelled 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.

The curious reader can 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

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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.

European Union - Compliance to EEC Directives

Readers in the EU/EEC/EEA 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.

* 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.

Contents

About This Manual

How To Use the Manual Set	xi
Conventions	xii
Related Documentation.....	xii

Chapter 1

Introduction

What You Need to Get Started	1-1
CAN Hardware Overview	1-2
NI-CAN Software Overview	1-3
Optional Programming Tools	1-4

Chapter 2

Installation and Configuration

Install the NI-CAN Software	2-1
Install the CAN Hardware	2-2
Check the Configuration of Your Can Hardware.....	2-2
Install Your AT-CAN or PCI-CAN Series Board.....	2-2
Install Your PCMCIA-CAN Series Card	2-4
Connect the Cables	2-5
Configure the NI-CAN Software.....	2-6

Chapter 3

Verify the Installation

Chapter 4

Begin to Use the NI-CAN Software

Using the NI-CAN Software.....	4-1
General Programming Considerations.....	4-2

Appendix A

Uninstalling the Hardware and Software

Uninstalling the CAN Hardware from Windows	A-1
Uninstalling the NI-CAN Software from Windows	A-2

Appendix B

Forcing Windows to Detect the CAN Hardware

Appendix C

Cabling Requirements for High-Speed CAN

Connector Pinouts	C-1
Power Supply Information for the High-Speed CAN Ports	C-3
Bus Power Supply Requirements	C-5
Cable Specifications	C-5
Cable Lengths	C-6
Number of Devices	C-6
Cable Termination	C-7
Cabling Example	C-8

Appendix D

Cabling Requirements for Low-Speed CAN

Connector Pinouts	D-1
Power Supply Information for the Low-Speed CAN Ports	D-2
Bus Power Supply Requirements	D-4
Cable Specifications	D-4
Number of Devices	D-5
Low-Speed Termination	D-5
Determining the Necessary Termination Resistance for Your Board	D-6
Replacing the Termination Resistors on Your PCI-CAN/LS Board	D-8
Replacing the Termination Resistors on Your PCMCIA-CAN/LS Cable	D-9
Cabling Example	D-10

Appendix E

Cabling Requirements for Dual-Speed CAN

Port Identification	E-1
---------------------------	-----

Appendix F

RTSI Bus

Connector Pinouts	F-1
RTSI Cables	F-3
RTSI Programming	F-3

Appendix G

Troubleshooting and Common Questions

Device Manager Problems.....	G-1
No National Instruments CAN Interfaces	G-1
Missing CAN Interface.....	G-2
Problem Shown in Device Manager.....	G-2
Diagnostic Utility Failures.....	G-3
Memory Resource Conflict	G-3
Interrupt Resource Conflict	G-4
NI-CAN Software Problem Encountered	G-4
Missing CAN Interface.....	G-4
CAN Hardware Problem Encountered	G-4
Common Questions.....	G-5

Appendix H

Specifications

Appendix I

Technical Support Resources

Glossary

Index

Figures

Figure 2-1.	Add/Remove Programs Properties Dialog Box.....	2-1
Figure 2-2.	Installing the PCI-CAN	2-3
Figure 2-3.	Inserting the PCMCIA-CAN.....	2-5
Figure 2-4.	Device Manager Shows CAN Interface That Is Working Properly	2-6
Figure 2-5.	Device Manager Shows CAN Interface That Is Not Working Properly	2-6
Figure 2-6.	NI-CAN Hardware Settings Dialog Box.....	2-7
Figure 3-1.	NI-CAN Diagnostic Utility after Testing.....	3-1
Figure A-1.	Selecting an Interface to Remove from Windows.....	A-2
Figure C-1.	Pinout for 9-Pin D-Sub Connector	C-1
Figure C-2.	Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal	C-2
Figure C-3.	PCMCIA-CAN Cable.....	C-2

Figure C-4.	AT-CAN/2 Parts Locator Diagram	C-3
Figure C-5.	PCI-CAN/2 Parts Locator Diagram	C-4
Figure C-6.	Power Source Jumpers	C-4
Figure C-7.	Termination Resistor Placement	C-7
Figure C-8.	Cabling Example.....	C-8
Figure D-1.	Pinout for 9-Pin D-Sub Connector.....	D-1
Figure D-2.	PCMCIA-CAN/LS Cable	D-2
Figure D-3.	PCI-CAN/LS2 Parts Locator Diagram	D-3
Figure D-4.	Power Source Jumpers	D-4
Figure D-5.	Termination Resistor Placement for Low-Speed CAN	D-5
Figure D-6.	Location of Termination Resistors on PCI-CAN/LS2 Board	D-8
Figure D-7.	Preparing Lead Wires of Replacement Resistors.....	D-9
Figure D-8.	Preparing Lead Wires of PCMCIA-CAN/LS Cable Replacement Resistors	D-9
Figure D-9.	Cabling Example.....	D-10
Figure F-1.	AT-CAN Series RTSI Connector Pinout	F-1
Figure F-2.	PCI-CAN Series RTSI Connector Pinout	F-2
Figure G-1.	Device Manager Shows CAN Interface That Is Not Working Properly	G-2

Tables

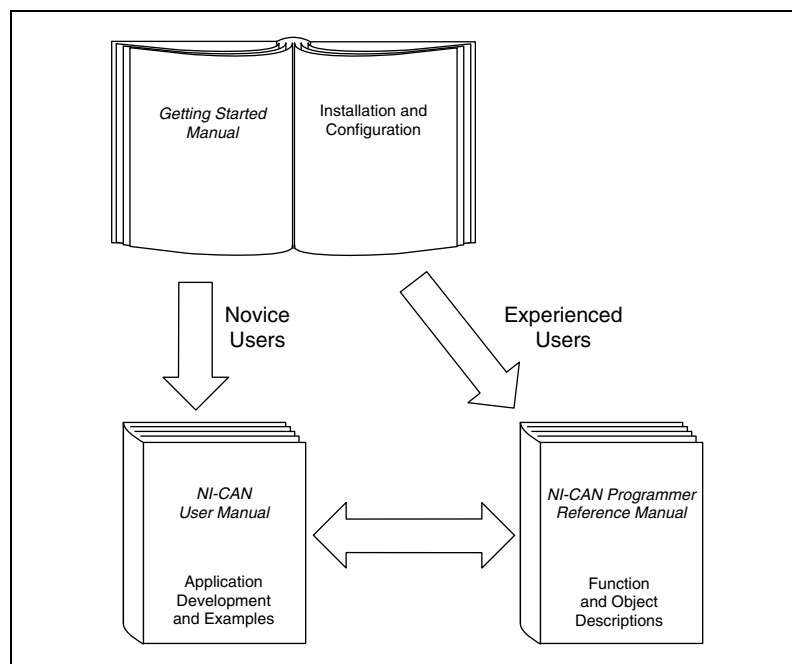
Table C-1.	Power Requirements for the CAN Physical Layer for Bus-Powered Versions	C-5
Table C-2.	ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires	C-6
Table C-3.	DeviceNet Cable Length Specifications	C-6
Table D-1.	Power Requirements for the Low-Speed CAN Physical Layer for Bus-Powered Versions	D-4
Table D-2.	ISO 11519-2 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires	D-5

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 98/95. The National Instruments CAN hardware covered in this manual includes the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/LS (low-speed CAN), PCI-CAN/2, PCI-CAN/LS2 (low-speed CAN), PCI-CAN/DS (dual-speed CAN), PCMCIA-CAN, and PCMCIA-CAN/2.

This manual assumes that you are already familiar with Windows.

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 98/95.

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

Conventions

The following conventions appear 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** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



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

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

CAN hardware *CAN hardware* refers to the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/LS, PCI-CAN/2, PCI-CAN/LS2, PCI-CAN/DS, PCMCIA-CAN, and PCMCIA-CAN/2 and in cases where the material applies to all the interfaces.

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept.

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.

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*

- ANSI/ISO Standard 11519-2-1994, *Road Vehicles—Low-Speed Serial Data Communication—Part 2: Low-Speed Controller Area Network (CAN)*
- *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 user's guide, Microsoft Corporation

Introduction

This chapter 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 98/95.

What You Need to Get Started

Make sure you have all of the items listed before you attempt to install the hardware and software.

- Windows 98/95 installed on your computer
- One of the following CAN interfaces, which is included in your kit:
 - AT-CAN
 - AT-CAN/2
 - PCI-CAN
 - PCI-CAN/LS
 - PCI-CAN/2
 - PCI-CAN/LS2
 - PCI-CAN/DS
 - PCMCIA-CAN
 - PCMCIA-CAN/2
- 3.5 in., high-density (1.44 MB) disks, which are included in your kit:
 - *NI-CAN Software for Windows 95/98/NT
Version 1.4
(Disk x of 3)*
- PCMCIA-CAN, PCMCIA-CAN/LS, or PCMCIA-CAN/DS cable, which is included in your kit if you have a PCMCIA-CAN series card.
- CAN interface cables that meet the requirements in Appendix C, *Cabling Requirements for High-Speed CAN*, Appendix D, *Cabling Requirements for Low-Speed CAN* or Appendix E, *Cabling Requirements for Dual-Speed CAN*.

CAN Hardware Overview

The National Instruments CAN hardware covered in this manual includes the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/LS, PCI-CAN/2, PCI-CAN/LS2, PCI-CAN/DS, PCMCIA-CAN, and PCMCIA-CAN/2.

The AT-CAN series boards are fully software configurable and compliant with the Plug and Play ISA standard. With an AT-CAN or AT-CAN/2 board, you can make your PC AT-compatible computer communicate with and control CAN devices.

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

The PCMCIA-CAN series cards 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 series card, you can make your PC-compatible notebook with PCMCIA sockets communicate with and control CAN devices.

CAN interfacing is accomplished using the Intel 82527 CAN controller chip. The high-speed CAN physical layer fully conforms to the ISO 11898 physical layer specification for CAN and is optically isolated to 500 V. The low-speed CAN physical layer conforms to the ISO 11519-2 physical layer specification for CAN and is also optically isolated to 500 V.

AT-CAN and PCI-CAN series boards are available with two physical connector types: DB-9 D-Sub and Combicon-style pluggable screw terminals. Low-speed PCI-CAN/LS and PCI-CAN/DS boards are available with DB-9 D-Sub connectors. PCMCIA-CAN, PCMCIA-CAN/LS and PCMCIA-CAN/DS cables include both a DB-9 D-Sub and a pluggable screw terminal.

The CAN physical layer on AT-CAN and PCI-CAN series cards can be powered either internally (from the card) or externally (from the bus cable power). The power source for the CAN physical layer for each port is configured with a jumper. There are four cables available for the PCMCIA-CAN cards. In one cable the CAN physical layer is powered internally (from the card). In the second cable the CAN physical layer is powered externally (from the bus cable power). The CAN physical layer on the PCMCIA-CAN/LS cable requires that only V-, CAN_L, and CAN_H

be connected to the bus. Power for the low-speed physical layer and the V-BAT pin of the low-speed transceiver is supplied internally through the card. This also applies to the low-speed CAN port (port 2) on the PCMCIA-CAN/DS cable. The high-speed CAN port (port 1) on the PCMCIA-CAN/DS cable provides internal physical-layer power from the card. The CAN hardware supports a wide variety of transfer rates up to 1 Mb/s.

The PCI-CAN and AT-CAN series boards use the Real-Time System Integration (RTSI) bus to solve the problem of synchronizing several functions across multiple boards to a common trigger or timing event. The RTSI bus consists of the National Instruments RTSI bus interface and ribbon cable to route timing and trigger signals between the CAN hardware and National Instruments DAQ, IMAQ, or additional CAN hardware.

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 for Windows 98/95 includes a native, 32-bit multitasking Windows driver that is fully Plug and Play aware. The driver components are dynamically loaded when Windows detects new CAN hardware, and dynamically unloaded when Windows detects the removal of CAN hardware.

The NI-CAN software is fully integrated into the Windows operating system. You can configure it through the Windows Device Manager, and uninstall it through the Add/Remove Programs applet of the Control Panel.

With the NI-CAN software, you can use multiple types of CAN hardware concurrently. For example, you can communicate with CAN devices through both a PCI-CAN and AT-CAN in the same system at the same time.

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 later, LabWindows/CVI 4.0 or later, and LabVIEW 4.0 or later
- Example programs that use NI-CAN functions

Optional Programming Tools

Your kit includes the NI-CAN software for Windows 98/95. In addition, you can order the following software from National Instruments.

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.

Measurement Studio bundles LabWindows/CVI among other tools for C programmers designed for building measurement and automation applications. 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.

For more information about Measurement Studio 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 98/95.

Install the NI-CAN Software

Before installing the CAN hardware, complete the following steps to install the NI-CAN software for Windows 98/95.

1. Select **Start»Settings»Control Panel**.
2. 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.

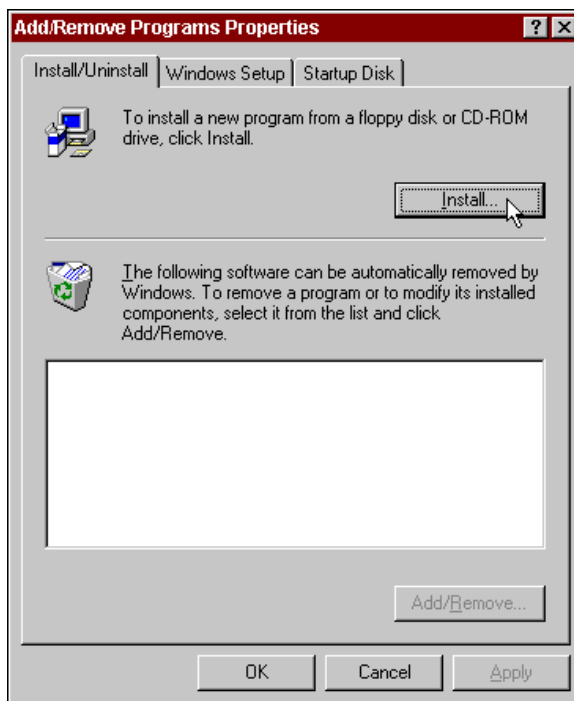


Figure 2-1. Add/Remove Programs Properties Dialog Box

You can use this same applet to uninstall the NI-CAN software at a later time. Refer to Appendix A, [Uninstalling the Hardware and Software](#), for more information.

3. Click on the **Install** button.
4. Insert the program CD, *NI-CAN Software for Windows 95/98/NT Version 1.4*, and click on the **Next** button to proceed.
5. 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 choosing **Back**. You can exit the setup where appropriate by choosing **Cancel**.
6. Shut down your computer when the setup is complete.

Install the CAN Hardware

This section describes how to install your CAN hardware.

Check the Configuration of Your Can Hardware

If you plan to use your CAN board in a system where bus power is available, you may want to configure the power supply jumpers on your board. See Appendix C, [Cabling Requirements for High-Speed CAN](#), for more information.

If you are installing a low-speed CAN board or a PCMCIA-CAN/LS cable, you may need to change the power supply jumpers or termination resistors. See Appendix D, [Cabling Requirements for Low-Speed CAN](#), for more information.

If you are installing a dual-speed CAN board or a PCMCIA-CAN/DS cable, you may have to change the power supply jumpers or termination resistors. See Appendix E, [Cabling Requirements for Dual-Speed CAN](#), for more information.

Install Your AT-CAN or PCI-CAN Series Board



Caution Before you remove the board from the package, touch the antistatic plastic package to a metal part of your system chassis to discharge electrostatic energy, which can damage several components on your CAN interface.

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 2-2 shows how to install the PCI-CAN into a 16-bit ISA expansion slot.

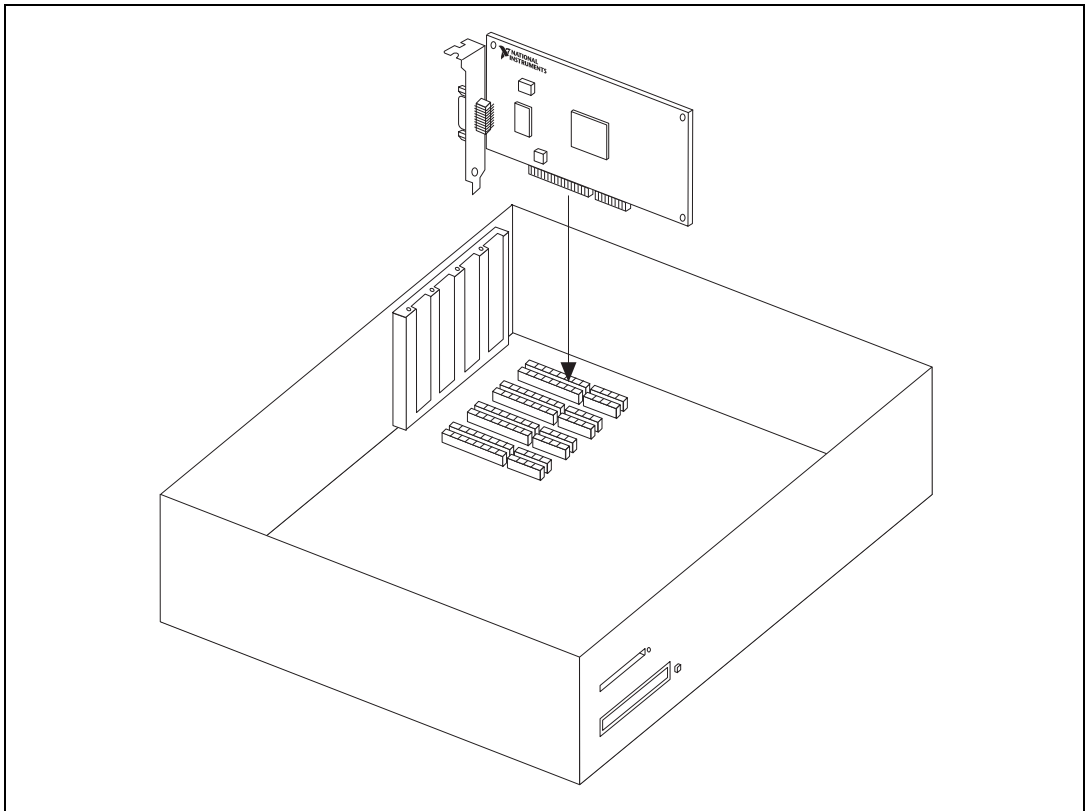


Figure 2-2. Installing the PCI-CAN

6. Screw the mounting bracket of the CAN interface to the back panel rail of the computer.
7. If desired, you can use a RTSI cable to connect your CAN board RTSI interface to other National Instruments RTSI-equipped hardware. Please refer to Appendix F, *RTSI Bus*, for information about the RTSI interface on your CAN board.
8. Replace the top cover (or the access panel to the expansion slot).
9. Turn on your computer and start Windows. Windows should automatically detect the CAN hardware and associate it with the NI-CAN software. A **New Hardware Found** dialog box appears, then goes away on its own. If the dialog box does not go away, select **Windows default driver** and click the **OK** button.

If the **New Hardware Found** dialog box does not appear when you restart Windows, refer to Appendix B, *Forcing Windows to Detect the CAN Hardware*.

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

Install Your PCMCIA-CAN Series Card



Caution Before you remove the card from the package, touch the antistatic plastic package to a metal part of your system chassis to discharge electrostatic energy, which can damage several components on your CAN interface.

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 2-3 shows how to insert the card and how to connect a PCMCIA-CAN cable to the card.

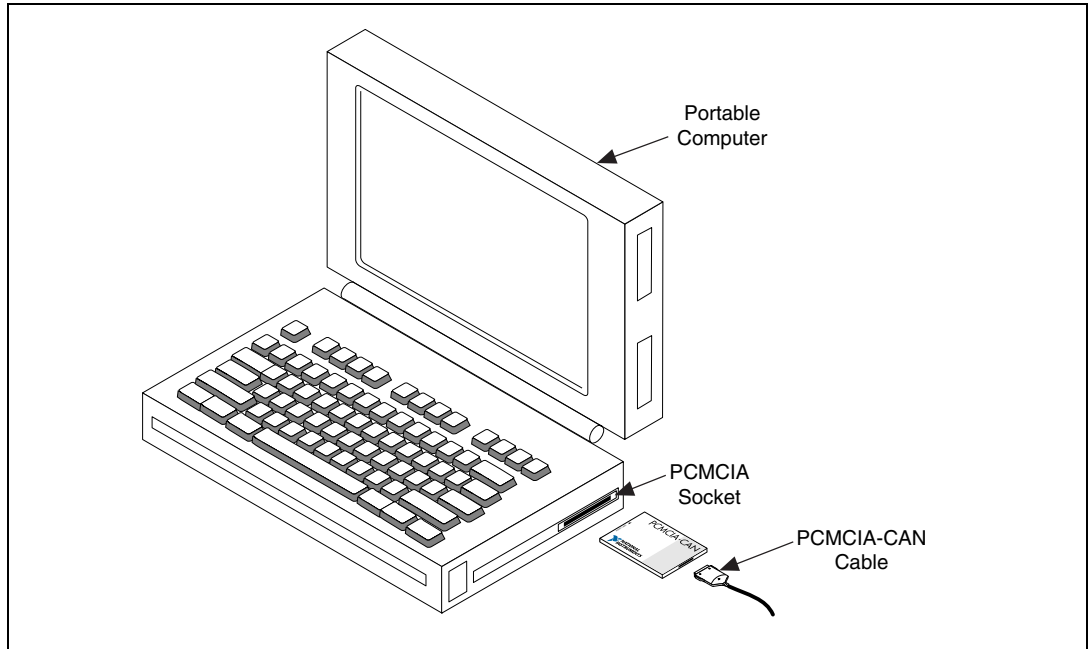


Figure 2-3. Inserting the PCMCIA-CAN

3. Connect the PCMCIA-CAN, PCMCIA-CAN/LS, or PCMCIA-CAN/DS cable to the card. Starting with NI-CAN Version 1.4, and the PCMCIA-CAN cards with low and high-speed CAN support, the NI-CAN software auto-detects which cable has been attached to the card.
4. Power on your computer.

Connect the Cables

After you have installed the CAN interface, connect your CAN cables to the interface. Because exact cabling requirements vary for each application, National Instruments does not provide cables, other than the PCMCIA-CAN, PCMCIA-CAN/LS, or PCMCIA-CAN/DS cable. Refer to either Appendix C, [Cabling Requirements for High-Speed CAN](#), Appendix D, [Cabling Requirements for Low-Speed CAN](#), or Appendix E, [Cabling Requirements for Dual-Speed CAN](#), for information about the cabling requirements of the CAN hardware.

Configure the NI-CAN Software

The NI-CAN Configuration utility is fully integrated with the Windows 98/95 Device Manager. 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 tabs, includes all of the information that you need to configure the NI-CAN software properly.

To configure the NI-CAN software, double-click on the **System** icon under **Start»Settings»Control Panel**. In the **System Properties** dialog box that appears, select the **Device Manager** tab, click the **View devices by type** radio button at the top of the tab, and double-click the **National Instruments CAN Interfaces** icon.

If there is no **National Instruments CAN Interfaces** item or if a circled X or exclamation point (!) appears through the eagle icon, the CAN interface is not working properly. Figure 2-4 shows an example of an AT-CAN/2 that is working properly, and Figure 2-5 shows an example of an AT-CAN/2 that is not working properly. Refer to the *Device Manager Problems* section of Appendix G, *Troubleshooting and Common Questions*, to resolve the problem.

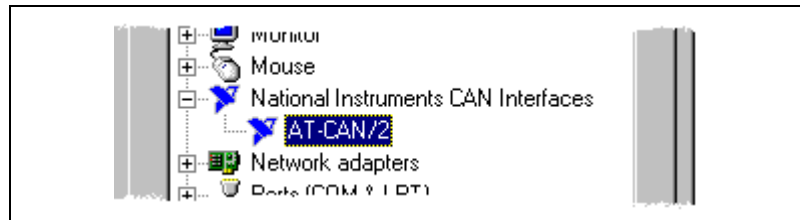


Figure 2-4. Device Manager Shows CAN Interface That Is Working Properly

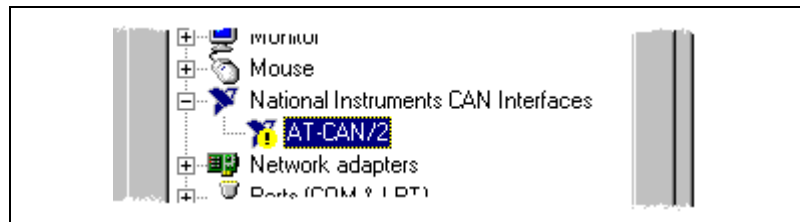


Figure 2-5. Device Manager Shows CAN Interface That Is Not Working Properly

To configure a particular interface, double-click on that interface in the list of installed interfaces below **National Instruments CAN Interfaces**.

The **Resources** tab provides information about the hardware resources assigned to the CAN interface. Use the **Resources** tab to examine the assigned resources to verify that there are no conflicts. The **Conflicting Device List** lists any conflicts. If conflicts exist, uncheck the **Use automatic settings** checkbox and use the **Change Setting** button to select conflict-free resources for the CAN hardware.

The **Settings** tab, shown in Figure 2-6, provides information about the NI-CAN software configuration for the CAN interface.

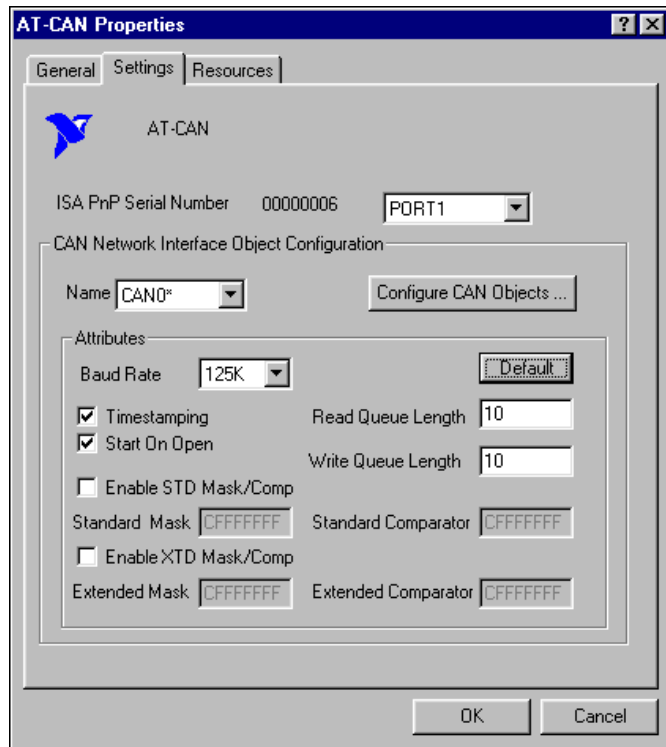


Figure 2-6. NI-CAN Hardware Settings Dialog Box

Each port of the CAN hardware interface is configured from the same 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, right-click the mouse anywhere on the **Settings** tab, and select **Full Help** from the pop-up menu that appears. Alternately, you can 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*.

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 under **Start»Programs»National Instruments CAN»NI-CAN**.

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.

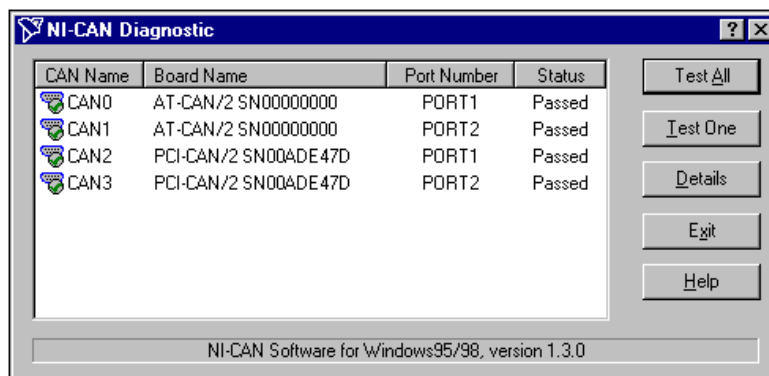


Figure 3-1. NI-CAN Diagnostic Utility after Testing

You can get details about any tested CAN interface by selecting the interface and clicking the **Details** button. For each failed CAN interface, select it and click the **Details** button to get a description of the failure. Use that information and the information in Appendix G, *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 98/95.

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 AT-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 on the NI-CAN software and functions, refer to the *NI-CAN User Manual* and the *NI-CAN Programmer Reference Manual*.

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 them as a guide for your own application development.

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

Uninstalling the Hardware and Software

This appendix describes how to uninstall the CAN hardware and the NI-CAN software from Windows 98/95.

Uninstalling the CAN Hardware from Windows

Before physically removing the CAN hardware from the computer, you must remove the hardware information from the Windows Device Manager.

To remove the hardware information from Windows, complete the following steps.

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. In the **System Properties** dialog box that appears, select the **Device Manager** tab.
4. Click the **View devices by type** button at the top of the **Device Manager** tab.
5. Double-click on the **National Instruments CAN Interfaces** icon.
6. To remove an interface, select it from the list of interfaces under **National Instruments CAN Interfaces** as shown in Figure A-1, and click on the **Remove** button.

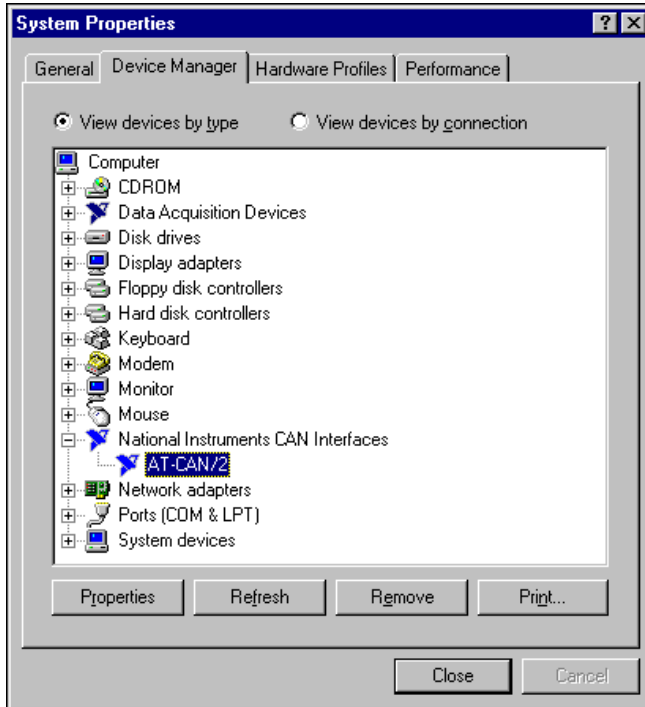


Figure A-1. Selecting an Interface to Remove from Windows

After you remove the appropriate CAN interface information from the Device Manager, you should shut down Windows, power off your computer, and physically remove the CAN interfaces from your computer.

Uninstalling the NI-CAN Software from Windows

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. Run the **Add/Remove Programs** applet from the Control Panel and this dialog box lists the software available for removal.
2. Select the NI-CAN software you want to remove, and click 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.

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.

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

Forcing Windows to Detect the CAN Hardware

This appendix contains instructions to help you install your CAN interface if Windows has not detected it properly.

If Windows does not detect your interface properly, it may not display the **New Hardware Found** dialog box when expected, and the NI-CAN Diagnostic utility reports no CAN interfaces present. This problem occurs if Windows has already configured the CAN interface as an “other device.” To fix the problem, complete the following steps:

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon to display the **System Properties** dialog box for the computer.
3. Click on the **Device Manager** tab at the top of the **System Properties** sheet to bring up the **Device Manager** property page. Make sure the **View devices by type** button at the top of the **Device Manager** page is selected.
4. Click on the + sign next to **Other Devices** to display a list of all the hardware devices that Windows has detected and configured as **Other Devices**.
5. For each National Instruments CAN interface listed, select the interface by clicking on it, and then click on the **Remove** button to remove each interface from the list of **Other Devices**.
6. After you have removed all of the National Instruments CAN interfaces from the list of **Other Devices**, click on the **Refresh** button to force Windows to detect each National Instruments CAN interface and to display a **New Hardware Found** dialog box for each one.
7. Proceed with the hardware installation, as described in Chapter 2, *Installation and Configuration*.



Cabling Requirements for High-Speed CAN

This section describes the cabling requirements for high-speed CAN hardware.

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 has DB-9 D-Sub connectors(s), or Combicon-style pluggable screw terminal connector(s), or both.

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

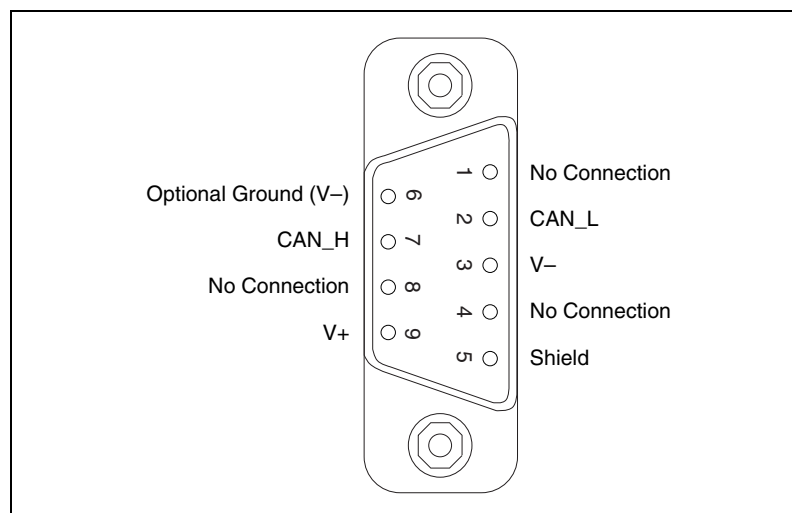


Figure C-1. Pinout for 9-Pin D-Sub Connector

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

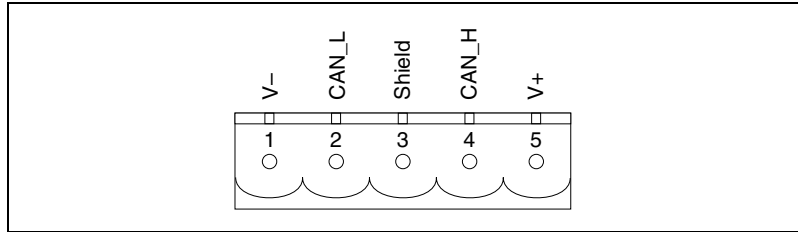


Figure C-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

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.

The V+ and V- pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V- pin serves as the reference ground for CAN_H and CAN_L. See the next section, [Power Supply Information for the High-Speed CAN Ports](#), for more information.

Figure C-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.

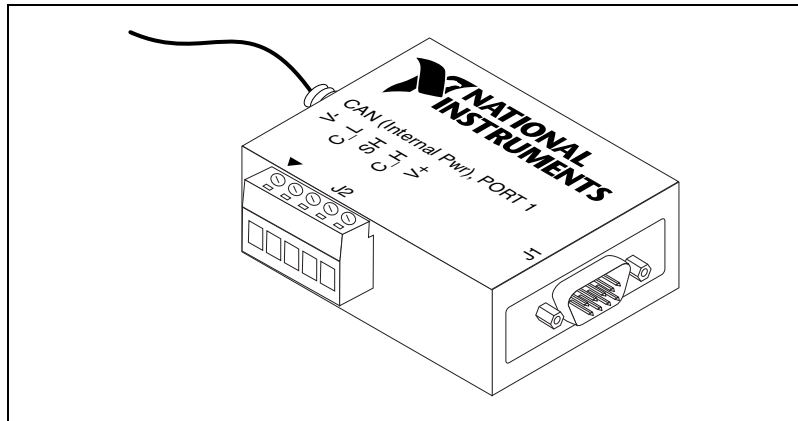


Figure C-3. PCMCIA-CAN Cable

Power Supply Information for the High-Speed CAN Ports

For the AT-CAN and PCI-CAN series boards, the power source for the CAN physical layer is configured with a jumper. For the AT-CAN and port one of the AT-CAN/2, power is configured with jumper J3. For port two of the AT-CAN/2, power is configured with jumper J4. The location of these jumpers is shown in Figure C-4.

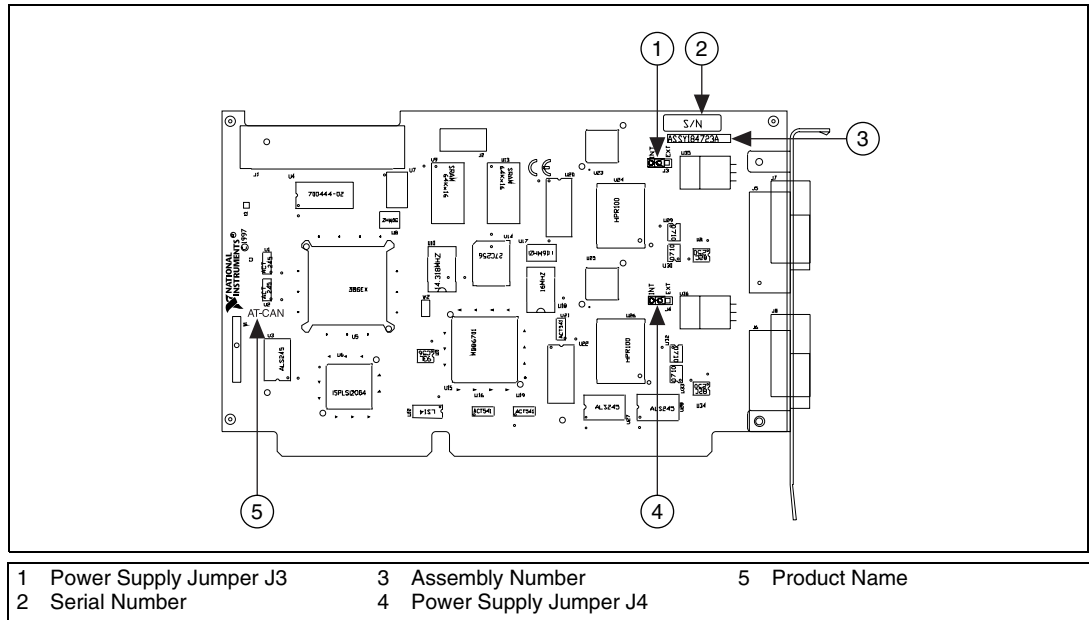


Figure C-4. AT-CAN/2 Parts Locator Diagram

For the PCI-CAN and port one of the PCI-CAN/2 power is configured with jumper J6. For port two of the PCI-CAN/2, power is configured with jumper J5. These jumpers are shown in Figure C-5.

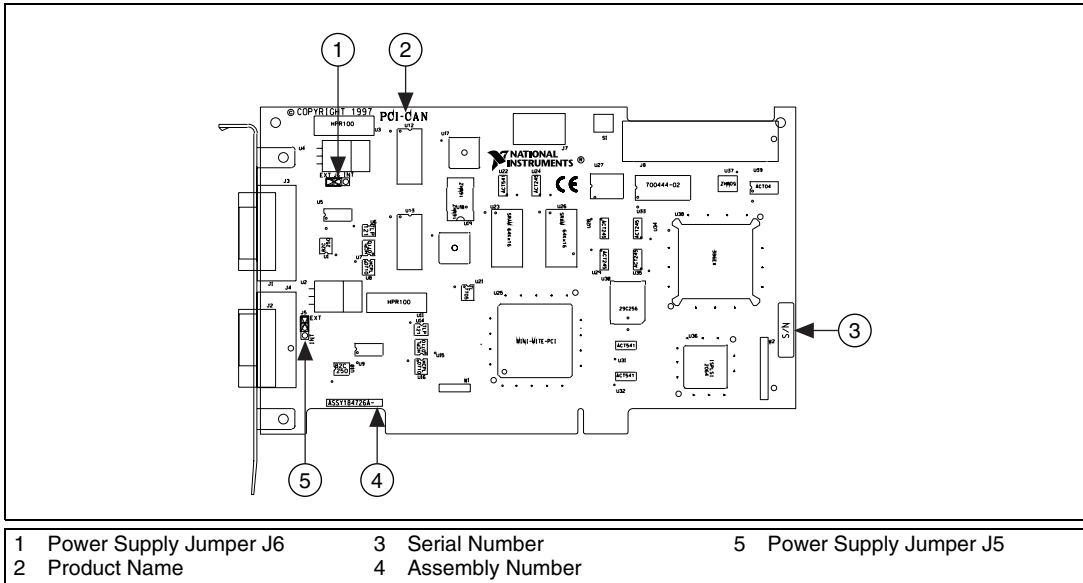


Figure C-5. PCI-CAN/2 Parts Locator Diagram

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the card). In this configuration, the V– signal serves as the reference ground for the isolated signals.

Figure C-6 shows how to configure your jumpers for internal or external power supplies.

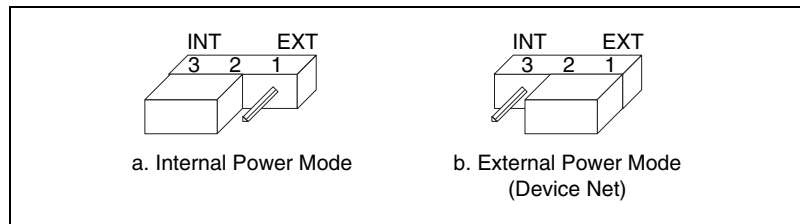


Figure C-6. Power Source Jumpers

The CAN physical layer is still isolated regardless of the power source chosen.

The PCMCIA-CAN series cards are available with two types of cable. The DeviceNet (bus powered) cable requires that the CAN physical layer be powered from the bus cable power.

The internal-powered cable supplies power to the CAN physical layer 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– pins serves as the reference ground for the isolated signals.

The CAN physical layer is isolated from the computer in both types of cable.

Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 10 V to 30 V. The power requirements for the CAN ports for Bus-Powered configurations are shown in Table C-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table C-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

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table C-2.

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

Table C-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 recommendations 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 C-3 lists the DeviceNet cable length specifications.

Table C-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

Number of Devices

The maximum number of devices 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 C-7 for an example of where termination resistors should be placed in a system with more than two devices.

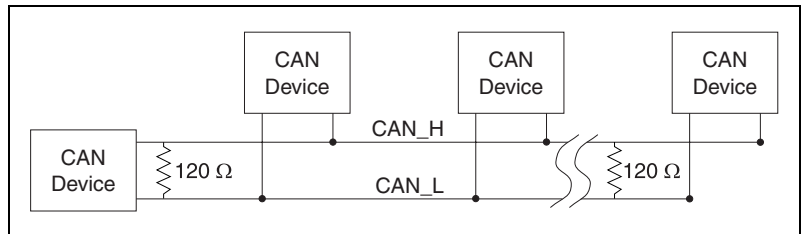


Figure C-7. Termination Resistor Placement

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 C-8 shows an example of a cable to connect two CAN devices. For the internal power configuration, no V+ connection is required.

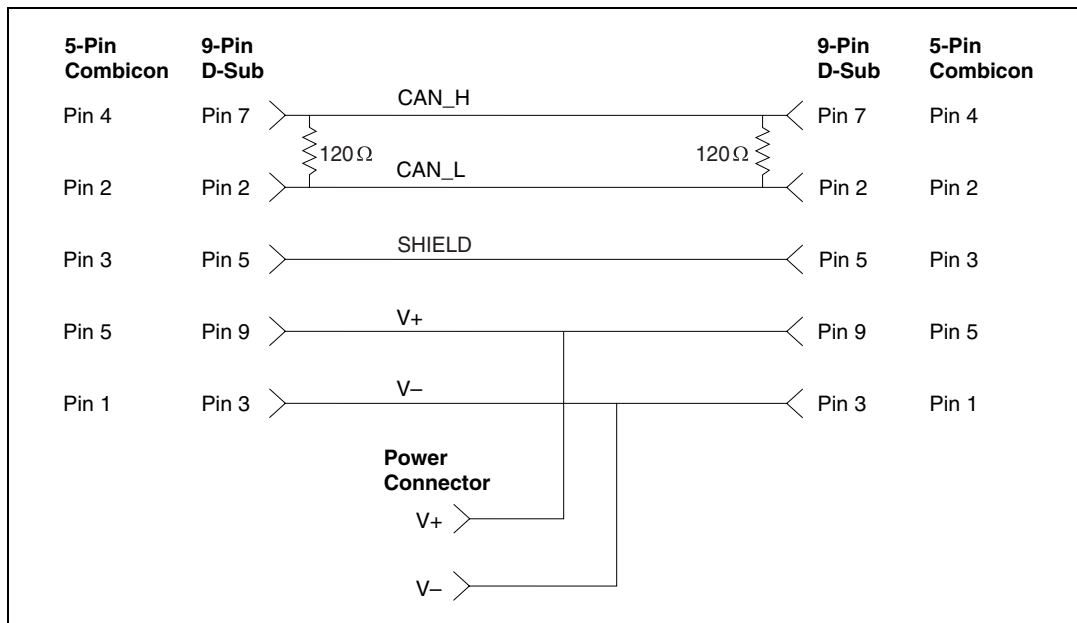


Figure C-8. Cabling Example

Cabling Requirements for Low-Speed CAN

This appendix describes the cabling requirements for the low-speed CAN hardware.

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

Connector Pinouts

The low-speed CAN hardware has DB-9 D-Sub connector(s). The 9-pin D-Sub follows the pinout recommended by CiA DS 102. Figure D-1 shows the pinout for this connector.

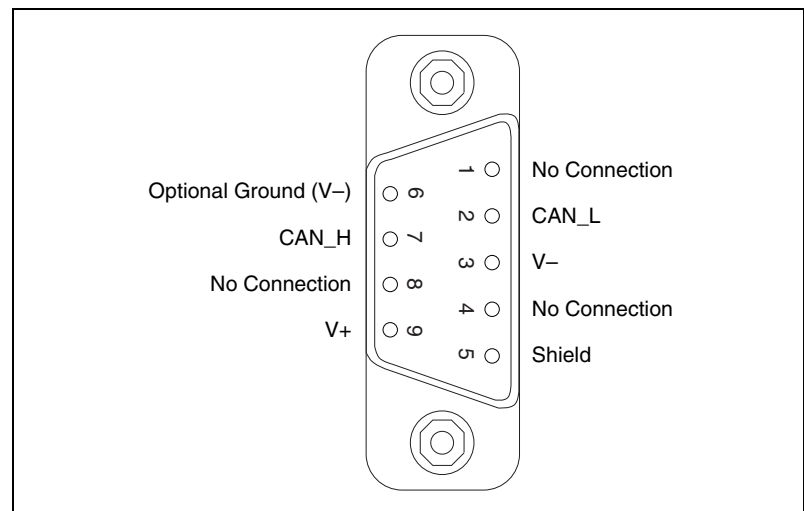


Figure D-1. Pinout for 9-Pin D-Sub Connector

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.

The V+ and V– pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V– pin serves as the reference ground for CAN_H and CAN_L. See the next section, *Power Supply Information for the Low-Speed CAN Ports*, for more information.

Figure D-2 shows the end of a PCMCIA-CAN/LS cable. The arrow points to pin 1 of the 7-pin screw terminal block. All of the signals on the 7-pin pluggable screw terminal, except RTL and RTH, are connected directly to the corresponding pins on the 9-pin D-Sub.

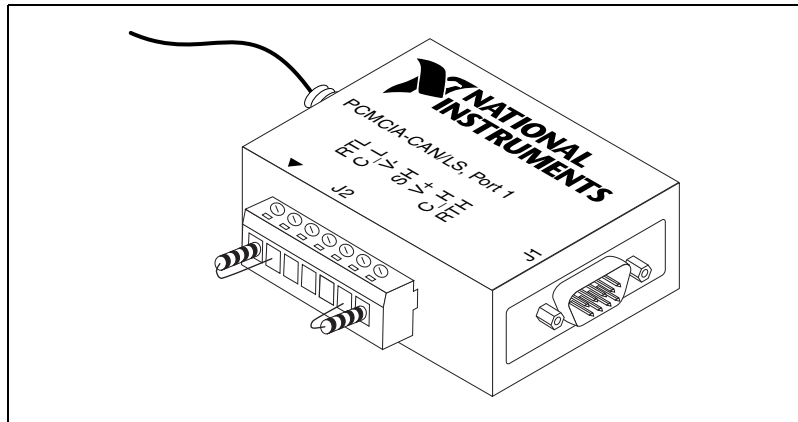


Figure D-2. PCMCIA-CAN/LS Cable

Power Supply Information for the Low-Speed CAN Ports

For the PCI-CAN/LS and port one of the PCI-CAN/LS2, power is configured with jumper J6. For port two of the PCI-CAN/LS2, power is configured with jumper J5. These jumpers are shown in Figure D-3.

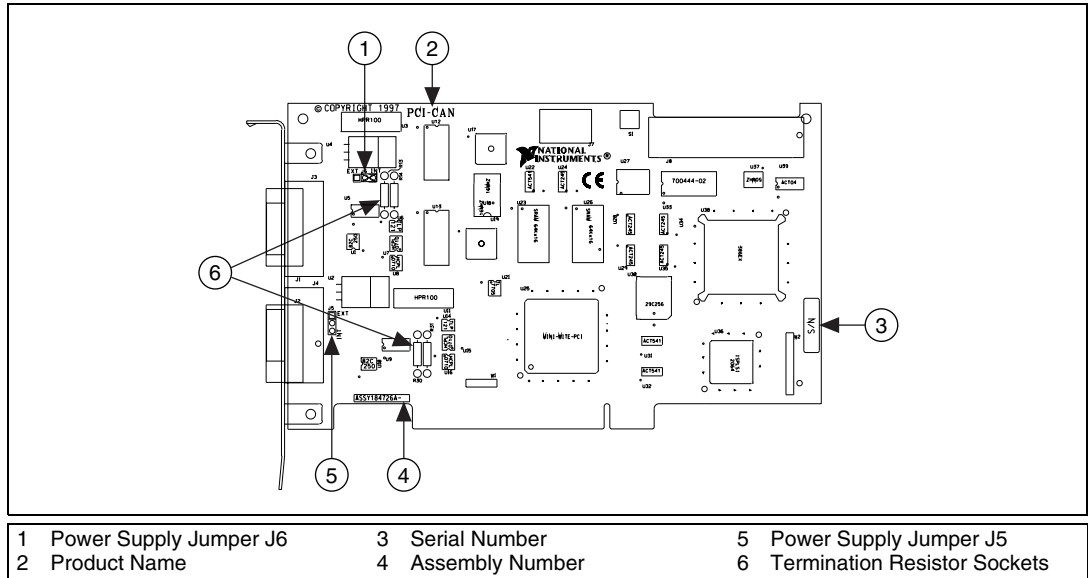


Figure D-3. PCI-CAN/LS2 Parts Locator Diagram

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the card). In this configuration, the V– signal serves as the reference ground for the isolated signals. Even if the CAN physical layer is powered internally, the fault-tolerant CAN transceiver still requires bus power to be supplied in order for it to monitor the power supply (battery) voltage.

Figure D-4 shows how to configure your jumpers for internal or external power supplies.

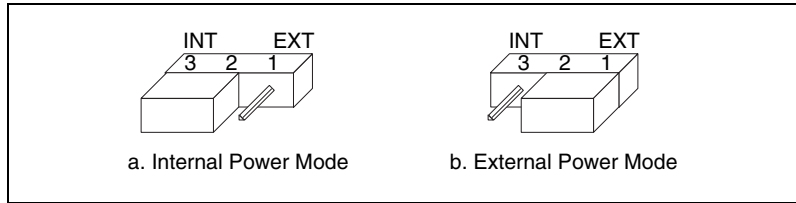


Figure D-4. Power Source Jumpers

The CAN physical layer is still isolated regardless of the power source chosen.

Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 8 V to 27V. The power requirements for the CAN ports for Bus-Powered configurations are shown in Table D-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table D-1. Power Requirements for the Low-Speed CAN Physical Layer for Bus-Powered Versions

Characteristic	Specification
Voltage requirement	V+ 8-27 VDC
Current requirement	40 mA typical 100 mA maximum

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11519-2, shown in Table D-2.

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

Table D-2. ISO 11519-2 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

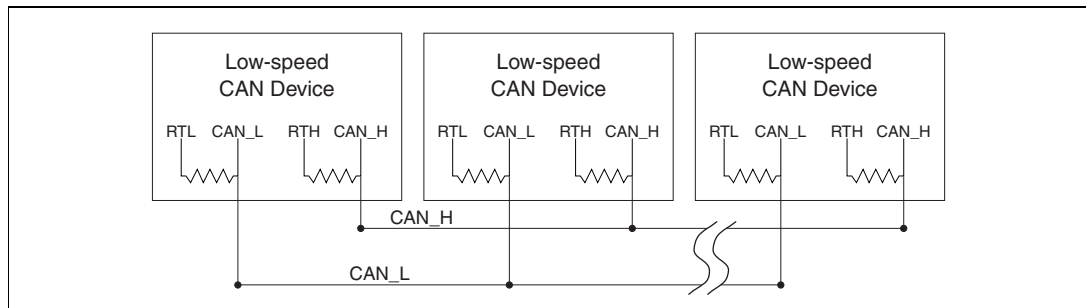
Characteristic	Value
Length-related resistance	90 mΩ/m nominal
Length-related capacitance: CAN_L and ground, CAN_H and ground, CAN_L and CAN_H	30 pF/m nominal

Number of Devices

The maximum number of devices depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of ISO 11519-2, at least 20 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 11519-2 signal level specifications.

Low-Speed Termination

Every device on the low-speed CAN network requires a termination resistor for each CAN data line: R_{RTH} for CAN_H and R_{RTL} for CAN_L. Figure D-5 shows termination resistor placement in a low-speed CAN network.

**Figure D-5.** Termination Resistor Placement for Low-Speed CAN

The following sections explain how to determine the correct resistor values for your low-speed CAN board, and how to replace those resistors, if necessary.

Determining the Necessary Termination Resistance for Your Board

Unlike high-speed CAN, low-speed CAN requires termination at the low-speed CAN transceiver instead of on the cable. The termination requires one resistor: RTH for CAN_H and RTL for CAN_L. This configuration allows the Philips fault-tolerant CAN transceiver to detect any of seven network faults. You can use your PCI-CAN/LS to connect to a low-speed CAN network having from two to 32 nodes as specified by Philips (including the port on the PCI-CAN/LS as a node). You can also use the PCI-CAN/LS to communicate with individual low-speed CAN devices. It is important to determine the overall termination of your existing network, or the termination of your individual device, before connecting it to a PCI-CAN/LS port. Philips recommends an overall RTH and RTL termination of 100 to 500 Ω (each) for a properly terminated low-speed network. The overall network termination may be determined as follows:

$$\frac{1}{R_{\text{RTH overall}}^\dagger} = \frac{1}{R_{\text{RTH node 1}}} + \frac{1}{R_{\text{RTH node 2}}} + \frac{1}{R_{\text{RTH node 3}}} + \frac{1}{R_{\text{RTH node n}}}$$

Philips also recommends an individual device RTH and RTL termination of 500 Ω to 16 k Ω . The PCI-CAN/LS board ships with mounted RTH and RTL values of 510 $\Omega \pm 5\%$ per port. The PCI-CAN/LS kit also includes a pair of 15 k $\Omega \pm 5\%$ resistors for each port. After determining the termination of your existing network or device, you can use the following formula to indicate which value should be placed on your PCI-CAN/LS board in order to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the board:

$$R_{\text{RTH overall}}^{*\dagger} = \frac{1}{\left(\frac{1}{R_{\text{RTH of low-speed CAN interface}}^{**}} + \frac{1}{R_{\text{RTH of existing network or device}}} \right)}$$

* $R_{\text{RTH overall}}$ should be between 100 and 500 Ω

** $R_{\text{RTH of low-speed CAN interface}}$ = 510 $\Omega \pm 5\%$ (mounted) or 15 k $\Omega \pm 5\%$ (in kit)

$$\dagger R_{\text{RTH}} = R_{\text{RTL}}$$

As the formula indicates, the 510 $\Omega \pm 5\%$ shipped on your board will work with properly terminated networks having a total RTH and RTL termination of 125 to 500 Ω , or individual devices having an RTH and RTL termination of 500 Ω to 16 k Ω . For communication with a network having an overall RTH and RTL termination of 100 to 125 Ω , you will need to replace the

510 Ω resistors with the 15 k Ω resistors in the kit. Please refer to the next section, [Replacing the Termination Resistors on Your PCI-CAN/LS Board](#).

The PCMCIA-CAN/LS cable ships with screw-terminal mounted RTH and RTL values of 510 $\Omega \pm 5\%$ per port. The PCMCIA-CAN/LS cable also internally mounts a pair of 15.8 K $\Omega \pm 1\%$ resistors in parallel with the external 510 Ω resistors for each port. This produces an effective RTH and RTL of 494 Ω per port for the PCMCIA-CAN/LS cable. After determining the termination of your existing network or device, you can use the formula below to indicate which configuration should be used on your PCMCIA-CAN/LS cable to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the cable:

$$R_{\text{RTH overall}^\dagger} = \frac{1}{\left(\frac{1}{R_{\text{RTH of PCMCIA-CAN/LS}^{**}}} + \frac{1}{R_{\text{RTH of existing network or device}}} \right)}$$

* $R_{\text{RTH overall}}$ should be between 100 and 500 Ω

** $R_{\text{RTH of PCMCIA-CAN/LS}} = 494 \Omega$ (510 $\Omega \pm 5\%$ (external) in parallel with 15.8K $\Omega \pm 1\%$ (internal)), or 15.8K $\Omega \pm 1\%$ (internal) only

† $R_{\text{RTH}} = R_{\text{RTL}}$

As the formula indicates, the 510 $\Omega \pm 5\%$ in parallel with 15.8 K $\Omega \pm 1\%$ shipped on your cable will work with properly terminated networks having a total RTH and RTL termination of 125 to 500 Ω , or individual devices having an RTH and RTL termination of 500 to 16 K Ω . For communication with a network having an overall RTH and RTL termination of 100 to 125 Ω , you will need to disconnect the 510 Ω resistors from the 7-pin pluggable screw terminal. This will make the RTH and RTL values of the PCMCIA-CAN/LS cable equal to the internal resistance of 15.8 K $\Omega \pm 1\%$. To produce RTH and RTL values between 494 Ω and 15.8 K Ω on the PCMCIA-CAN/LS cable, use the following formula:

$$R_{\text{External RTH of PCMCIA-CAN/LS}^\dagger} = \frac{1}{\left(\frac{1}{R_{\text{Desired RTH of PCMCIA-CAN/LS}}} - \frac{1}{R_{\text{Internal RTH of PCMCIA-CAN/LS}^{***}}} \right)}$$

*** $R_{\text{Internal RTH of PCMCIA-CAN/LS}} = 15.8 \text{ K}\Omega \pm 1\%$

† $R_{\text{RTH}} = R_{\text{RTL}}$

For information on replacing the external RTH and RTL resistors on your PCMCIA-CAN/LS cable, refer to [Replacing the Termination Resistors on Your PCMCIA-CAN/LS Cable](#).

Replacing the Termination Resistors on Your PCI-CAN/LS Board

Follow these steps to replace the termination resistors on your PCI-CAN/LS board, after you have determined the correct value in the previous section, [Determining the Necessary Termination Resistance for Your Board](#).

1. Remove the termination resistors on your low-speed CAN board. Figure D-6 shows the location of the termination resistor sockets on a PCI-CAN/LS2 board.

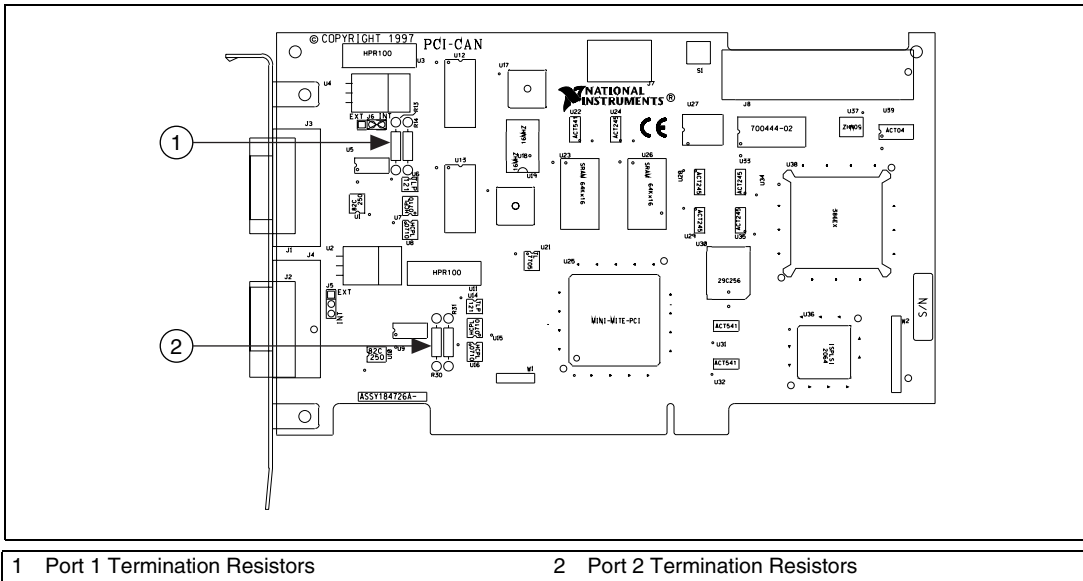


Figure D-6. Location of Termination Resistors on PCI-CAN/LS2 Board

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure D-7.

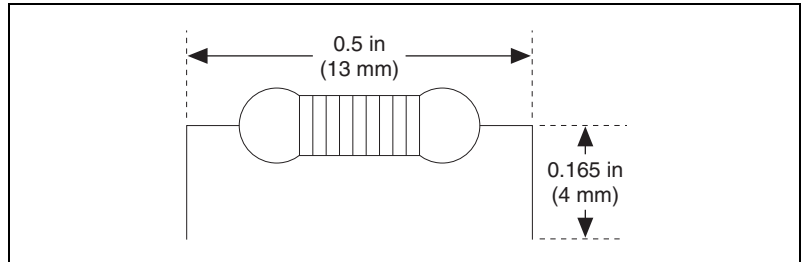


Figure D-7. Preparing Lead Wires of Replacement Resistors

3. Insert the replacement resistors into the empty sockets.
4. Refer to *Install the CAN Hardware*, in Chapter 2, *Installation and Configuration*, to complete the hardware installation.

Replacing the Termination Resistors on Your PCMCIA-CAN/LS Cable

Follow these steps to replace the termination resistors on your PCMCIA-CAN/LS cable after you have determined the correct value in the section *Determining the Necessary Termination Resistance for Your Board*.

1. Remove the two termination resistors on your PCMCIA-CAN/LS cable by loosening the pluggable terminal block mounting screws for pins 1 and 2 (RTL) and pins 6 and 7 (RTH).
2. Bend and cut the lead wires of the two resistors you want to install, as shown in the following figure.

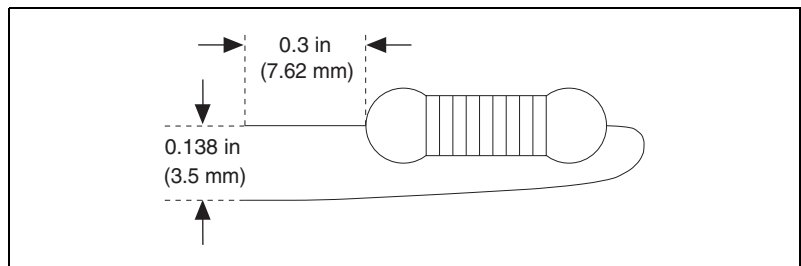


Figure D-8. Preparing Lead Wires of PCMCIA-CAN/LS Cable Replacement Resistors

3. Mount RTL by inserting the leads of one resistor into pins 1 and 2 of the pluggable terminal block and tightening the mounting screws. Mount RTH by inserting the leads of the second resistor into pins 6 and 7 of the pluggable terminal block and tightening the mounting screws.
4. Refer to *Install the CAN Hardware*, in Chapter 2, *Installation and Configuration*, to complete the hardware installation.

Cabling Example

Figure D-9 shows an example of a cable to connect two low-speed CAN devices. For the PCMCIA-CAN/LS cables, only V-, CAN_L, and CAN_H are required to be connected to the bus.

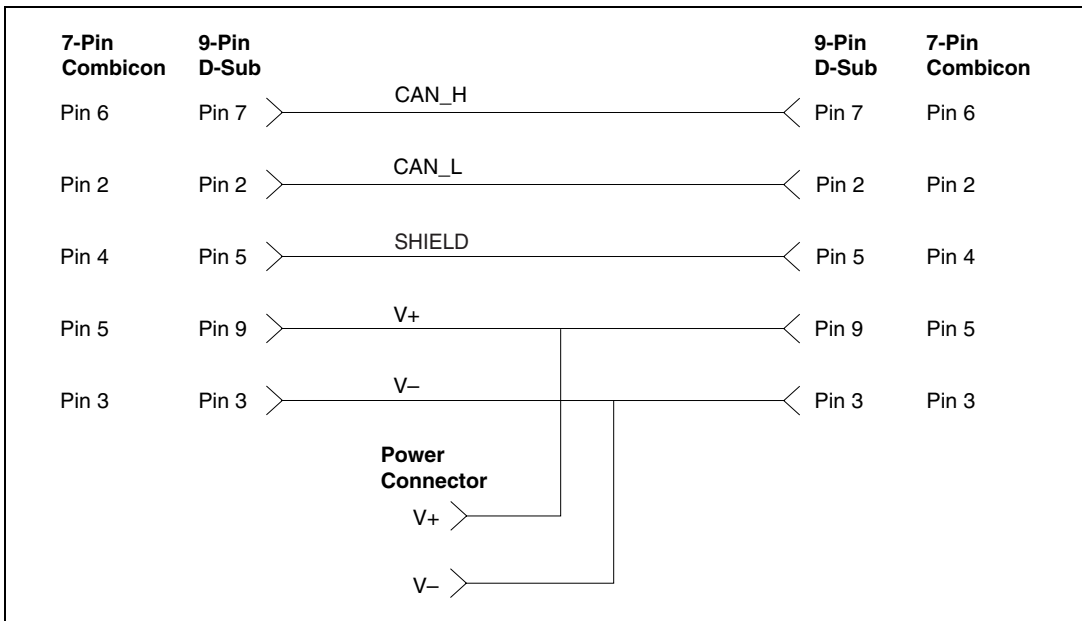


Figure D-9. Cabling Example

Cabling Requirements for Dual-Speed CAN

This section describes the cabling requirements for the dual-speed CAN hardware.

Port Identification

The PCI-CAN/DS board and PCMCIA-CAN/DS cable each provide a high-speed CAN port (port one), and a low-speed CAN port (port two). Port one of the PCI-CAN/DS is identical to port one of the PCI-CAN and PCI-CAN/2, and port two is identical to port two of the PCI-CAN/LS2. Port one of the PCMCIA-CAN/DS cable is identical to port one of the PCMCIA-CAN and PCMCIA-CAN/2 cables, and port two is identical to port two of the PCMCIA-CAN/LS2 cable. The PCI-CAN/DS board and PCMCIA-CAN/DS cable allow simultaneous communication with both a high-speed and low-speed bus, each with its own specific cabling and termination requirements. For cabling requirements and port information for the high-speed CAN port, please refer to Appendix C, [Cabling Requirements for High-Speed CAN](#). For cabling requirements and port information for the low-speed CAN port, please refer to Appendix D, [Cabling Requirements for Low-Speed CAN](#).

RTSI Bus

This appendix describes the RTSI interface on your CAN board.

Connector Pinouts

Figure F-1 shows the RTSI connector pinout for the AT-CAN series boards. Figure F-2 shows the RTSI connector pinout for the PCI-CAN series boards.

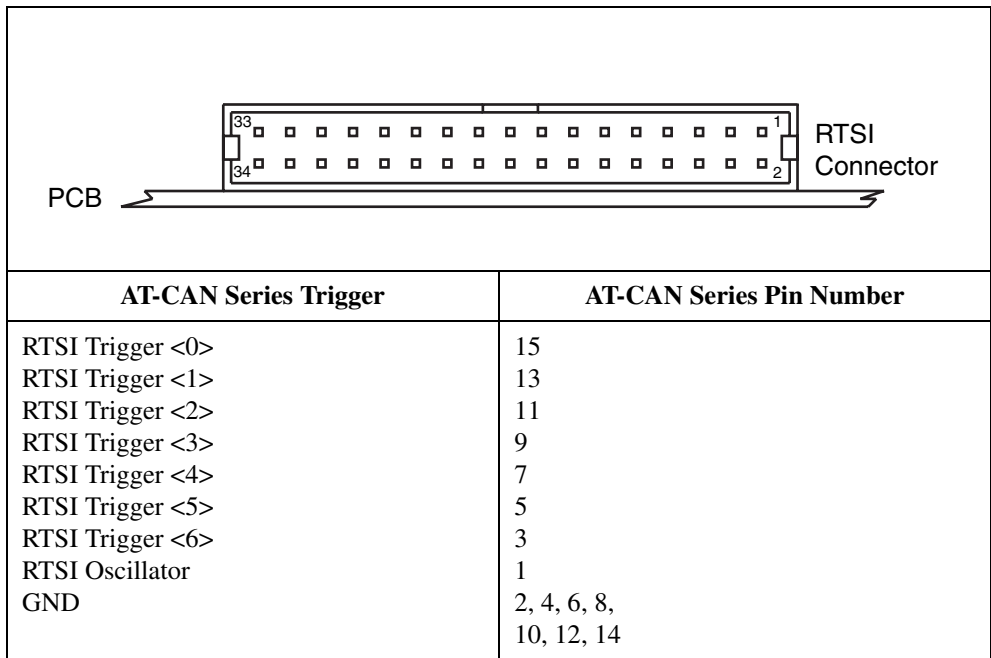


Figure F-1. AT-CAN Series RTSI Connector Pinout

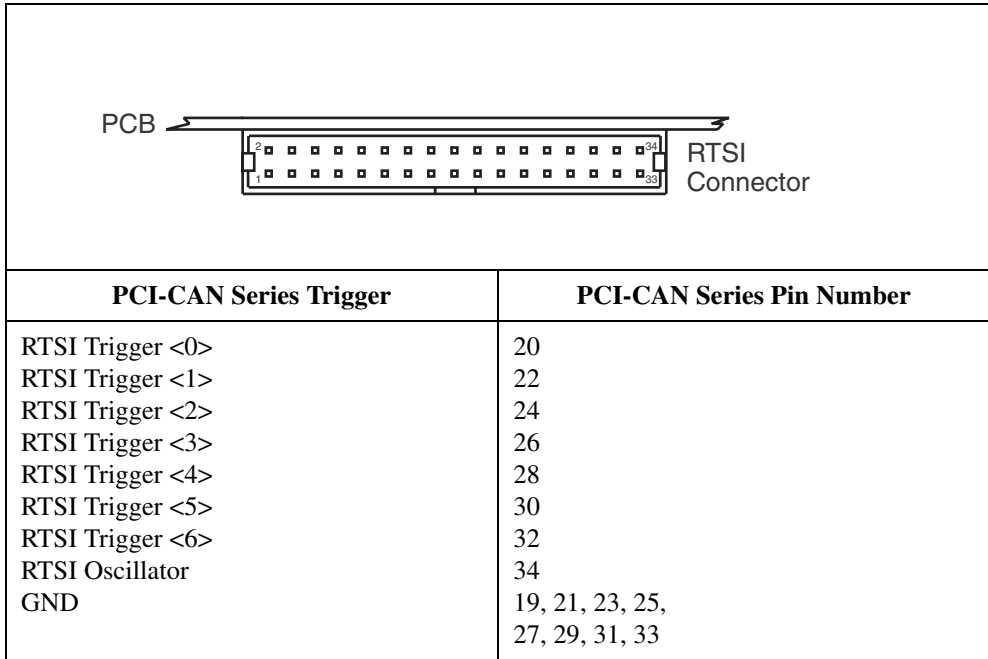


Figure F-2. PCI-CAN Series RTSI Connector Pinout

Using the National Instruments RTSI bus with your CAN board consists of connecting it to other RTSI-equipped boards with RTSI ribbon cable, to route timing and trigger signals between the boards. Using the RTSI bus, your CAN board can be synchronized with multiple National Instruments DAQ boards in your computer. The RTSI bus can also be used to synchronize multiple CAN boards.

The AT-CAN, AT-CAN/2, PCI-CAN and PCI-CAN/2 boards allow for the connection of four RTSI input signals and four RTSI output signals. In order to fully support the fault reporting capabilities of the low-speed transceivers used on the PCI-CAN/LS, PCI-CAN/LS2, and PCI-CAN/DS, three RTSI lines on those boards are reserved for low-speed CAN fault reporting. This allows for the connection of three RTSI input signals and two RTSI output signals to the boards, providing them the real time synchronization benefits of RTSI without sacrificing low-speed CAN fault reporting.

RTSI Cables

National Instruments offers a variety of RTSI bus cables for connecting your CAN board to other CAN or DAQ hardware. For more specific information about these cables, you can refer to the National Instruments catalog, or our Web site ni.com, or call the office nearest you listed in the *Worldwide Support* section of Appendix I, *Technical Support Resources*.

RTSI Programming

For more information on RTSI and RTSI programming, refer to the *NI-CAN User Manual* and the *NI-CAN Programmer Reference Manual*.



Troubleshooting and Common Questions

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

Device Manager Problems

The Windows Device Manager contains configuration information for all of the hardware it is aware of that is installed in your system. To start the Windows Device Manager, double-click on the **System** icon under **Start»Settings»Control Panel**. In the **System Properties** box that appears, select the **Device Manager** tab and click the **View devices by type** radio button at the top of the tab.

If there is no **National Instruments CAN Interfaces** item and you are certain you have a CAN interface installed, refer to the *No National Instruments CAN Interfaces* section of this appendix.

If the **National Instruments CAN Interfaces** item exists, but the CAN interface you are looking for is not listed there, refer to the *Missing CAN Interface* section of this appendix.

If the CAN interface you are looking for is listed, but has a circled X or exclamation mark (!) over its icon, refer to the *Problem Shown in Device Manager* section of this appendix.

No National Instruments CAN Interfaces

If you are certain you have a CAN interface installed, but no **National Instruments CAN Interfaces** item appears in the **Device Manager**, the interface is probably incorrectly listed under **Other Devices**. Double-click on the **Other Devices** item in the Device Manager and, one by one, remove each National Instruments CAN interface listed there by selecting its name and then clicking the **Remove** button. After all of the National Instruments CAN interfaces have been removed from **Other Devices**, click the **Refresh** button. At this point, the system rescans the installed hardware, and the

CAN interface should appear under **National Instruments CAN Interfaces** without any problems. If the problem persists, contact National Instruments.

Missing CAN Interface

If the **National Instruments CAN Interfaces** item exists, but the CAN interface you are looking for is not listed there, the CAN interface is not properly installed. For National Instruments CAN hardware, this problem indicates that the interface is not physically present in the system.

Problem Shown in Device Manager

If a CAN interface is not working properly, its icon has a circled X or exclamation mark (!) overlaid on it, as shown in Figure G-1.

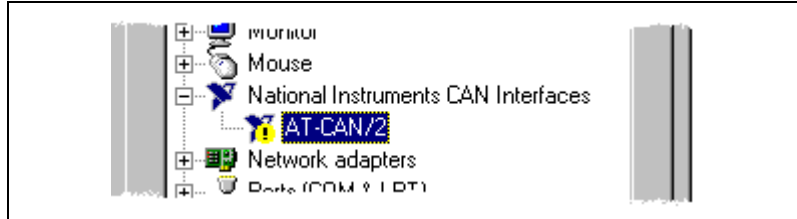


Figure G-1. Device Manager Shows CAN Interface That Is Not Working Properly

This problem can occur for several reasons. If you encounter this problem, the Device Manager should list an error code that indicates why the problem occurred. To see the error code for a particular interface, select the name of the interface and click on the **Properties** button to go to the **General** tab for that CAN interface. The **Device Status** section of the **General** tab shows the error code. Locate the error code in the following list to find out why your CAN interface is not working properly.

- Code 8—The NI-CAN software was incompletely installed. To solve this problem, reinstall the NI-CAN software for Windows 98/95.
- Code 9—Windows had a problem reading information from the CAN interface. Contact National Instruments for assistance.
- Code 12—The CAN interface was not assigned a physical memory range. If your computer does not have 8 KB of available memory, Windows 98/95 might configure your CAN interface without a physical memory assignment. The NI-CAN software for Windows 98/95 cannot function without 8 KB of physical memory. Another way to verify this problem is to look at the **Resource settings** list on the **Resources** tab to verify that the CAN interface was not

assigned a Memory Range. To solve this problem, free up an 8 KB Memory Range (such as D0000 to D1FFF hex) that is being used by another device in the system.

- Code 15—The CAN interface was not assigned an Interrupt Request level. If your computer does not have any available Interrupt Request levels, Windows might configure your CAN interface without an Interrupt Request level. The NI-CAN software for Windows 98/95 cannot function without an Interrupt Request level. Another way to verify this problem is to look at the **Resource settings** list on the **Resources** tab to verify that the CAN interface was not assigned an Interrupt Request level. To solve this problem, free up an Interrupt Request level that is being used by another device in the system.
- Code 22—The CAN interface is disabled. To enable the CAN interface, check the appropriate configuration checkbox in the **Device Usage** section of the **General** tab.
- Code 24—The CAN interface is not present, or the Device Manager is unaware that the CAN interface is present. To solve this problem, select the interface in the Device Manager, and click on the **Remove** button. Next, click the **Refresh** button. At this point, the system rescans the installed hardware, and the CAN interface should show up without any problems. If the problem persists, contact National Instruments.
- Code 27—Windows was unable to assign the CAN interface any resources. To solve this problem, free up system resources by disabling other unnecessary hardware so that enough resources are available for the CAN interface. The resources required for a single CAN interface are an Interrupt Request level and an 8 KB physical memory range (such as D0000 to D1FFF hex).

Diagnostic Utility Failures

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

Memory Resource Conflict

This error occurs if the memory resource assigned to a CAN interface conflicts with the memory resources being used by other devices in the system. Resource conflicts typically occur when your system contains legacy boards that use resources that have not been reserved properly with the Device Manager. If a resource conflict exists, write down the memory resource that caused the conflict and refer to the Microsoft Windows user's

guide for instructions on how to use the Device Manager to reserve memory resources for legacy boards. After the conflict has been resolved, run the NI-CAN Diagnostic utility again.

Interrupt Resource Conflict

This error occurs if the interrupt resource assigned to a CAN interface conflicts with the interrupt resources being used by other devices in the system. Resource conflicts typically occur when your system contains legacy boards that use resources that have not been reserved properly with the Device Manager. If a resource conflict exists, write down the interrupt resource that caused the conflict and refer to the Microsoft Windows user's guide for instructions on how to use the Device Manager to reserve interrupt resources for legacy boards. After the conflict has been resolved, run the NI-CAN Diagnostic utility again.

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 98/95.

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 the Windows Device Manager to see if Windows has detected the hardware. For more information, refer to the [Device Manager Problems](#) 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, National Instruments may need to upgrade your CAN interface.

Common Questions

What do I do if my CAN hardware is listed in the Windows Device Manager with a circled X or exclamation point (!) overlaid on it?

Refer to the *Problem Shown in Device Manager* section of this appendix for specific information about what might cause this problem. If you have already completed the troubleshooting steps, contact National Instruments.

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»System**. Select the **Device Manager** tab in the **System Properties** dialog box. Click on the **View devices by type** radio button at the top of the sheet. If any CAN hardware is correctly installed, a **National Instruments CAN Interfaces** icon appears in the list of device types. Double-click this icon to see a list of installed CAN hardware.

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 **Diagnostic** item under **Start»Programs»National Instruments CAN**. 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 support?

Contact National Instruments to determine which CAN products are available for your operating system. You can find a list of Industrial products in the online catalog at ni.com/catalog/

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

Refer to the *Diagnostic Utility Failures* section of this appendix for specific information about what might cause the NI-CAN Diagnostic utility to fail. If you have already completed the troubleshooting steps, contact National Instruments.

How many CAN interfaces can I configure for use with my NI-CAN software for Windows 98/95?

The NI-CAN software for Windows 98/95 can be configured to communicate with up to 10 CAN interfaces.

Are interrupts required for the NI-CAN software for Windows 98/95?

Yes, one interrupt per interface is required.

How do I use an NI-CAN language interface?

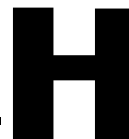
For information about using NI-CAN language interfaces, refer to Chapter 3, *Developing Your Application*, in the *NI-CAN User Manual*.

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*.

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.



Specifications

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

AT-CAN Series

Dimensions.....	10.67 by 16.51 cm (4.2 by 6.5 in.)
Power requirement	+5 VDC, 500 mA typical
I/O Connector.....	9-pin D-Sub for each port (standard) or 5-pin Combicon-style pluggable DeviceNet screw terminal
Operating environment	
Component temperature.....	0 to 55 °C
Relative humidity.....	10% to 90%, noncondensing
Storage environment	
Temperature	-20 to 70 °C
Relative humidity.....	5% to 90%, noncondensing

PCI-CAN Series

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 (high- speed CAN only)

Operating environment

Ambient temperature0 to 55 °C
Relative humidity10% to 90%, noncondensing

Storage environment

Temperature.....-20 to 70 °C
Relative humidity5% to 90%, noncondensing

PCMCIA-CAN Series

Dimensions8.56 by 5.40 by 0.5 cm
(3.4 by 2.1 by 0.4 in.)

Power requirement.....500 mA typical

I/O connectorCable with 9-pin D-Sub and
pluggable screw terminal for each
port

Operating environment

Component temperature0 to 55 °C
Relative humidity10% to 90%, noncondensing

Storage Environment

Temperature.....-20 to 70 °C
Relative humidity5% to 90%, noncondensing

High-Speed CAN Port Characteristics

Bus Power.....0-30 V, 40 mA typical
100mA maximum

CAN-H, CAN-L-8 to +18V, DC or peak, CATI

Low-Speed CAN Port Characteristics

Bus Power.....8-27 V, 40 mA typical
100 mA maximum

CAN-H, CAN-L-10 to +27V, DC or peak, CATI

Technical Support Resources

Web Support

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

NI Developer Zone

The NI Developer Zone at 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

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 for online course schedules, syllabi, training centers, and class registration.

System Integration

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

Worldwide Support

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. 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

Prefix	Meaning	Value
n-	nano-	10^{-9}
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
ANSI	American National Standards Institute
AT-compatible	compatible with the 16-bit Industry Standard Architecture
b	bits
B	bytes
C	Celsius
CAN	Controller Area Network
CAN/LS	Low-speed CAN
CAN/DS	Dual-speed CAN
CiA	CAN in Automation
DLL	dynamic link library
DMA	direct memory access
EMI	electromagnetic interference
FCC	Federal Communications Commission

Hz	hertz
IEEE	Institute of Electrical and Electronic Engineers
in.	inches
IRQ	interrupt request
ISA	Industry Standard Architecture
ISO	International Standards Organization
m	meters
PC	personal computer
PCI	peripheral component interconnect
PCMCIA	Personal Computer Memory Card International Association
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)
RTSI bus	Real-Time System Integration Bus. The National Instruments timing bus that connects CAN and DAQ boards directly, by means of connectors on top of the PCI-CAN and AT-CAN series boards, for precise synchronization of functions.
trigger	Any event that causes or starts some form of data capture.
s	seconds
V	volts
VDC	volts direct current
W	watts

Index

Numerics

- 5-pin combicon-style pluggable screw terminal (figure), C-2
- 9-pin D-sub connector pinout, high-speed (figure), C-1
- 9-pin D-sub connector pinout, low-speed (figure), D-1

A

- AT-CAN series board, 1-2
 - AT-CAN/2 parts locator diagram (figure), C-3
 - installing, 2-2
 - power supply information for high-speed CAN ports, C-3
 - specifications, H-1

B

- bus power supply requirements, high-speed, C-5
- bus power supply requirements, low-speed, D-4

C

- cable lengths, C-6
 - DeviceNet cable-length specifications (table), C-6
- cable specifications, C-5, D-4
 - ISO 11519-2 specifications for characteristics of a CAN_H and CAN_L pair of wires (table), D-5
 - ISO 11898 specifications for characteristics of a CAN_H and CAN_L pair of wires (table), C-6
- cable termination, high-speed CAN, C-7
- cable termination, low-speed CAN, D-5

- cabling example, high-speed CAN (figure), C-8
- cabling example, low-speed CAN (figure), D-10
- cabling requirements
 - dual-speed CAN, E-1
 - high-speed CAN, C-1
 - low-speed CAN, D-1
- CAN hardware
 - applicable interfaces, *xii*
 - forcing Windows to detect, B-1
 - getting started, 1-1
 - installing, 2-2
 - overview, 1-2
 - settings dialog box, 2-7
 - troubleshooting, G-1
 - uninstalling, A-1 (figure), A-2
- CAN Hardware Problem Encountered (error message), G-4
- CAN interface cables
 - 5-pin combicon-style pluggable screw terminal (figure), C-2
 - cable lengths, C-6
 - cable termination, high-speed CAN, C-7
 - cable termination, low-speed CAN, D-5
 - cabling example, high-speed CAN (figure), C-8
 - cabling example, low-speed CAN (figure), D-10
 - connecting, 2-5
 - connector pinouts, high-speed, C-1
 - connector pinouts, low-speed, D-1
 - connector pinouts, RTSI, F-1, F-2
 - DeviceNet cable-length specifications (table), C-6
 - dual-speed, E-1
 - getting started, 1-1
 - high-speed, C-1

- low-speed, D-1
- PCMCIA-CAN cable (figure), C-2
- PCMCIA-CAN/LS cable (figure), D-2
 - termination resistors, D-9
- pinout for 9-pin D-sub connector, high-speed (figure), C-1
- specifications, C-5
 - ISO 11898 specifications for characteristics of a CAN_H and CAN_L pair of wires (table), C-6
- termination resistor placement (figure), C-7
- termination resistor placement, low-speed CAN, D-5
- common questions, G-1, G-5
- configuration, 2-1
 - add/remove programs properties dialog box (figure), 2-1
 - check hardware configuration, 2-2
 - NI-CAN software, 2-6
- connector pinouts, high-speed, C-1
- connector pinouts, low-speed, D-1
- connector pinouts, RTSI, F-1, F-2
- conventions used in this manual, *xii*
- customer education, 3

D

- detect CAN hardware,
 - forcing Windows to, B-1
- device manager problems, G-1
- DeviceNet cable-length specifications (table), C-6
- documentation
 - related documents, *xii*
- dual-speed CAN
 - cabling requirements, E-1

E

- error messages
 - See* troubleshooting

G

- getting started
 - what you need, 1-1

H

- hardware
 - interfaces covered in this manual, *xi*
- high-speed CAN
 - cabling requirements, C-1
 - port characteristics, H-2
- how to use the manual set, *xi*

I

- installation, 2-1
 - verifying, 3-1
- interrupt resource conflict, G-4

L

- LabVIEW, 1-4
- LabWindows/CVI, 1-4
- low-speed CAN
 - cabling requirements, D-1
 - port characteristics for bus-powered ports, H-2
 - termination resistors, D-5

M

- manual
 - how to use the manual set, *xi*
- Measurement Studio, 1-4
- memory resource conflict, G-3
- missing CAN interface, G-2, G-4

N

National Instruments Web support, 3
 NI Developer Zone, 3
 NI-CAN Diagnostic utility, 3-1
 troubleshooting, G-3
 NI-CAN software
 configuring, 2-6
 installing, 2-1
 add/remove programs properties
 dialog box (figure), 2-1
 overview, 1-3
 programming considerations, 4-2
 troubleshooting, G-1, G-4
 uninstalling, A-2
 using, 4-1
 See also optional programming tools.
 No National Instruments CAN Interfaces
 (Device Manager item), G-1
 number of devices, C-6
 number of devices (ISO 11519-2), D-5

O

optional programming tools
 LabVIEW, 1-4
 LabWindows/CVI, 1-4
 Measurement Studio, 1-4

P

PCI-CAN series board, 1-2
 installing, 2-2
 (figure), 2-3
 PCI-CAN/2 parts locator diagram
 (figure), C-4
 power supply information for high-speed
 CAN ports, C-3
 power source jumpers (figure), C-4
 specifications, H-1
 PCI-CAN/DS series board, 1-2

 PCI-CAN/LS series board, 1-2
 power supply information for low-speed
 CAN ports, D-2
 PCI-CAN/LS2 series board, 1-2
 parts locator diagram (figure), D-3
 power source jumpers, D-4
 power supply information for low-speed
 CAN ports, D-2
 PCMCIA-CAN series card, 1-2
 installing, 2-4
 (figure), 2-5
 PCMCIA-CAN cable (figure), C-2
 specifications, H-2
 PCMCIA-CAN/LS series card
 PCMCIA-CAN/LS cable
 (figure), D-2
 replacing termination resistors, D-9
 pinout for 9-pin D-sub connector, high-speed
 (figure), C-1
 pinout for 9-pin D-sub connector, low-speed
 (figure), D-1
 power requirements for the high-speed CAN
 physical layer for bus-powered versions
 (table), C-5
 power requirements for the low-speed CAN
 physical layer for bus-powered versions
 (table), D-4
 power source jumpers (figure), C-4, D-4
 power supply
 bus power supply requirements,
 high-speed, C-5
 bus power supply requirements,
 low-speed, D-4
 power requirements for the high-speed
 CAN physical layer for bus-powered
 versions (table), C-5
 power requirements for the low-speed
 CAN physical layer for bus-powered
 versions (table), D-4
 power source jumpers (figure), C-4, D-4

- power supply information for high-speed CAN ports, C-3
- power supply information for low-speed CAN ports, D-2
- programming
 - general considerations, 4-2
 - See also* optional programming tools.
- PXI-8460
 - port characteristics for bus-powered ports, H-2
- PXI-8461
 - port characteristics, H-2

R

- Real-Time System Integration (RTSI)
 - See* RTSI.
- related documentation, *xii*
- resistance, determining termination, D-6
- resistor, replacing termination on
 - PCI-CAN/LS board, D-8
- resistor, replacing termination on
 - PCMCIA-CAN/LS cable, D-9
- resistor, termination, C-7
 - high-speed CAN (figure), C-7
 - location on PCI-CAN/LS2 board (figure), D-8
 - low-speed CAN (figure), D-5
 - preparing lead wires of
 - PCMCIA-CAN/LS cable replacement (figure), D-9
 - preparing lead wires of replacement (figure), D-9
- RTSI
 - AT-CAN series RTSI connector pinout, F-1
 - bus definition (glossary), G-2
 - cable, 2-4, F-3
 - definition of, 1-3
 - interface description, F-1
 - low-speed CAN, F-2

- PCI-CAN series RTSI connector pinout, F-2
- programming, F-3

S

- software-related resources
 - LabVIEW, 1-4
 - LabWindows/CVI, 1-4
 - Measurement Studio, 1-4
- specifications
 - AT-CAN series board, H-1
 - DeviceNet cable-length specifications (table), C-6
 - PCI-CAN series board, H-1
 - PCMCIA-CAN series card, H-2
- system integration, by National Instruments, 3

T

- technical support resources, 3
- termination resistance, determining, D-6
- termination resistor, C-7
 - location on PCI-CAN/LS2 board (figure), D-8
 - placement (figure), C-7
 - placement for low-speed CAN (figure), D-5
 - preparing lead wires of
 - PCMCIA-CAN/LS cable replacement (figure), D-9
 - preparing lead wires of replacement (figure), D-9
 - replacing on PCI-CAN/LS board, D-8
 - replacing on PCMCIA-CAN/LS cable, D-9
- troubleshooting, G-1
 - CAN Hardware Problem Encountered (error message), G-4
 - common questions, G-5
 - device manager problems, G-1

interrupt resource conflict, G-4
memory resource conflict, G-3
missing CAN interface, G-2, G-4
NI-CAN Diagnostic utility, G-3
No National Instruments CAN Interfaces
 (Device Manager item), G-1
problem shown in device manager, G-2

W

Web support from National Instruments, 3
worldwide technical support, 4