CAN

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

**NATIONAL
INSTRUMENTS™**

Important Information

Warranty

The CAN hardware is warranted against defects in materials and workmanship for a period of one year from the date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace equipment that proves to be defective during the warranty period. This warranty includes parts and labor.

The media on which you receive National Instruments software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace software media that do not execute programming instructions if National Instruments receives notice of such defects during the warranty period. National Instruments does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

National Instruments believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, National Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult National Instruments if errors are suspected. In no event shall National Instruments be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, NATIONAL INSTRUMENTS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF NATIONAL INSTRUMENTS SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. NATIONAL INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. This limitation of the liability of National Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. Any action against National Instruments must be brought within one year after the cause of action accrues. National Instruments shall not be liable for any delay in performance due to causes beyond its reasonable control. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow the National Instruments installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failure or surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

Copyright

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of National Instruments Corporation.

Trademarks

CVI™, LabVIEW™, natinst.com™, National Instruments™, and NI-CAN™ are trademarks of National Instruments Corporation.

Product and company names mentioned herein are trademarks or trade names of their respective companies.

WARNING REGARDING USE OF NATIONAL INSTRUMENTS PRODUCTS

(1) NATIONAL INSTRUMENTS PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN.

(2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO DEVELOP AN APPLICATION, INSTALLATION ERRORS, SOFTWARE AND HARDWARE COMPATIBILITY PROBLEMS, MALFUNCTIONS OR FAILURES OF ELECTRONIC MONITORING OR CONTROL DEVICES, TRANSIENT FAILURES OF ELECTRONIC SYSTEMS (HARDWARE AND/OR SOFTWARE), UNANTICIPATED USES OR MISUSES, OR ERRORS ON THE PART OF THE USER OR APPLICATIONS DESIGNER (ADVERSE FACTORS SUCH AS THESE ARE HEREAFTER COLLECTIVELY TERMED "SYSTEM FAILURES"). ANY APPLICATION WHERE A SYSTEM FAILURE WOULD CREATE A RISK OF HARM TO PROPERTY OR PERSONS (INCLUDING THE RISK OF BODILY INJURY AND DEATH) SHOULD NOT BE RELIANT SOLELY UPON ONE FORM OF ELECTRONIC SYSTEM DUE TO THE RISK OF SYSTEM FAILURE. TO AVOID DAMAGE, INJURY, OR DEATH, THE USER OR APPLICATION DESIGNER MUST TAKE REASONABLY PRUDENT STEPS TO PROTECT AGAINST SYSTEM FAILURES, INCLUDING BUT NOT LIMITED TO BACK-UP OR SHUT DOWN MECHANISMS. BECAUSE EACH END-USER SYSTEM IS CUSTOMIZED AND DIFFERS FROM NATIONAL INSTRUMENTS' TESTING PLATFORMS AND BECAUSE A USER OR APPLICATION DESIGNER MAY USE NATIONAL INSTRUMENTS PRODUCTS IN COMBINATION WITH OTHER PRODUCTS IN A MANNER NOT EVALUATED OR CONTEMPLATED BY NATIONAL INSTRUMENTS, THE USER OR APPLICATION DESIGNER IS ULTIMATELY RESPONSIBLE FOR VERIFYING AND VALIDATING THE SUITABILITY OF NATIONAL INSTRUMENTS PRODUCTS WHENEVER NATIONAL INSTRUMENTS PRODUCTS ARE INCORPORATED IN A SYSTEM OR APPLICATION, INCLUDING, WITHOUT LIMITATION, THE APPROPRIATE DESIGN, PROCESS AND SAFETY LEVEL OF SUCH SYSTEM OR APPLICATION.

Compliance

FCC/DOC Radio Frequency Interference Class A Compliance

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, 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). This equipment has been tested and found to comply with the following two regulatory agencies:

Federal Communications Commission

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

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

This device complies with the FCC rules only if used with shielded interface cables of suitable quality and construction. National Instruments used such cables to test this device and provides them for sale to the user. The use of inferior or nonshielded interface cables could void the user's authority to operate the equipment under the FCC rules.

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

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

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

Contents

Appendix B
Forcing Windows to Detect the CAN Hardware

Appendix C
Cabling Requirements for High-Speed CAN

Appendix D
Cabling Requirements for Low-Speed CAN

Appendix E
Troubleshooting and Common Questions

Appendix F
Specifications

Appendix G
Technical Support Resources

Glossary

Figures

Tables

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, PCI-CAN/2, PCI-CAN/LS2, PCMCIA-CAN, and PCMCIA-CAN/2.

This manual assumes that you are already familiar with Windows.

How To Use the Manual Set
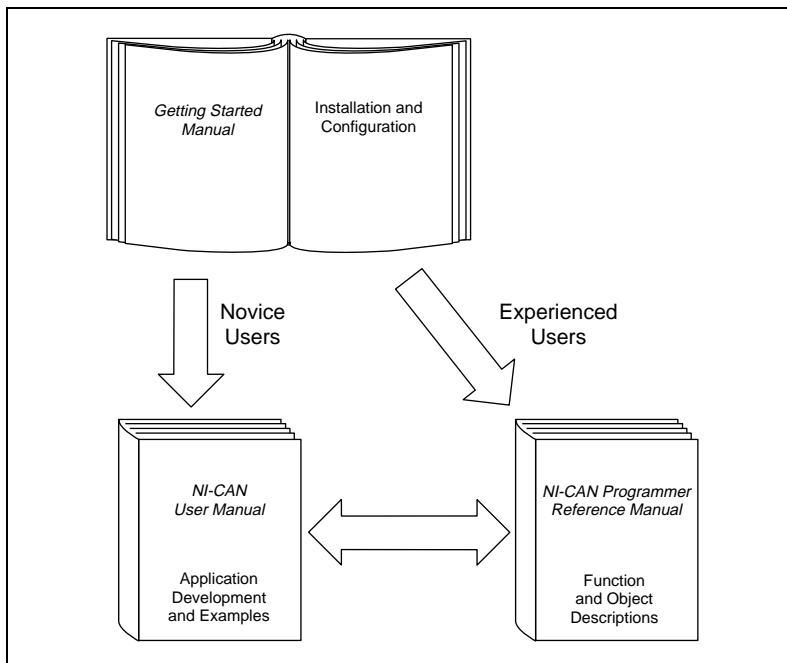
Use this getting started manual to install and configure your CAN hardware and the NI-CAN software for Windows 98/95.

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, PCMCIA-CAN, and PCMCIA-CAN/2 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

1

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
   – 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 1.3
      (Disk x of 3)

❑ PCMCIA-CAN 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* or Appendix D, *Cabling Requirements for Low-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, 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 and PCI-CAN/LS series boards are completely software configurable and compliant with the PCI Local Bus Specification. With a PCI-CAN or PCI-CAN/LS 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 boards are available with DB-9 D-Sub connectors. PCMCIA-CAN cables include both a DB-9 D-Sub and a Combicon-style 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 two cables available for the PCMCIA-CAN cards. In one cable the CAN physical layer is powered internally (from the card). In the other cable the CAN physical layer is powered externally (from the bus cable power). The CAN hardware supports a wide variety of transfer rates up to 1 Mb/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 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 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.

2

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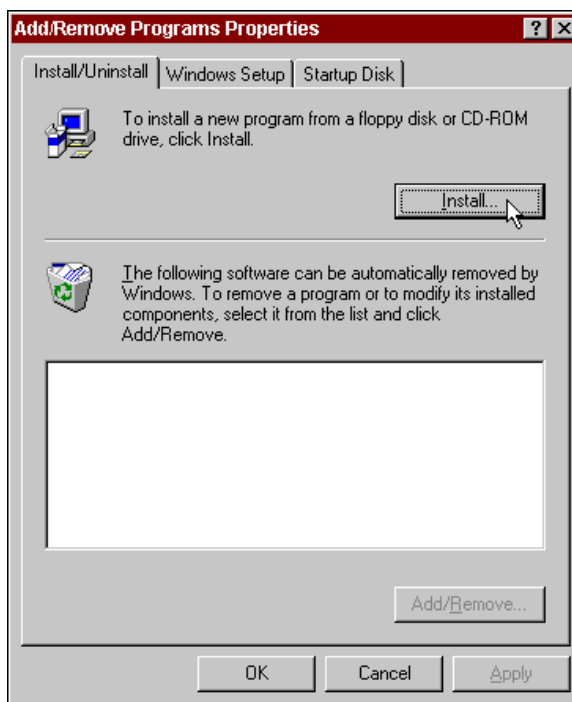
Figure 2-1. Add/Remove Programs Properties Dialog Box

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 *NI-CAN Software for Windows 95/98/NT Version 1.3 (Disk 1 of 3)*, 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 AT-CAN or PCI-CAN Series Board

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, you may need to change the power supply jumpers or termination resistors. See Appendix D, *Cabling Requirements for Low-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 AT-CAN into a 16-bit ISA expansion slot.
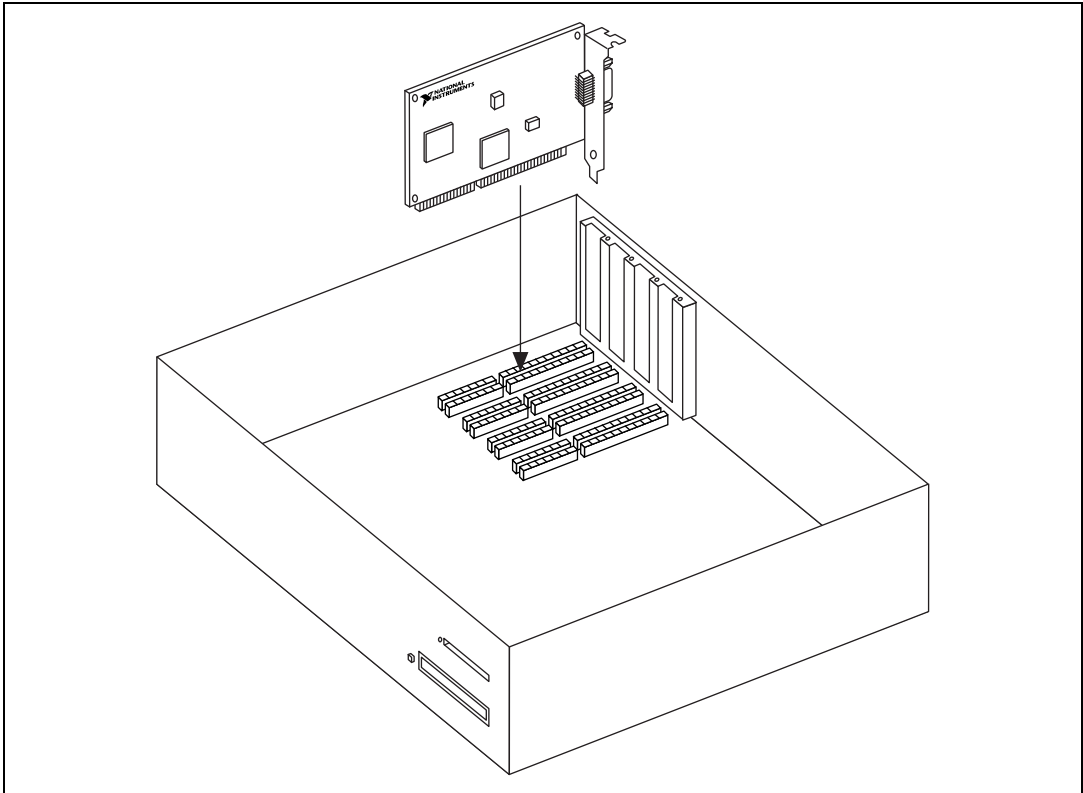
Figure 2-2. Installing the AT-CAN

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. 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 the PCMCIA-CAN cable and connector to the card.
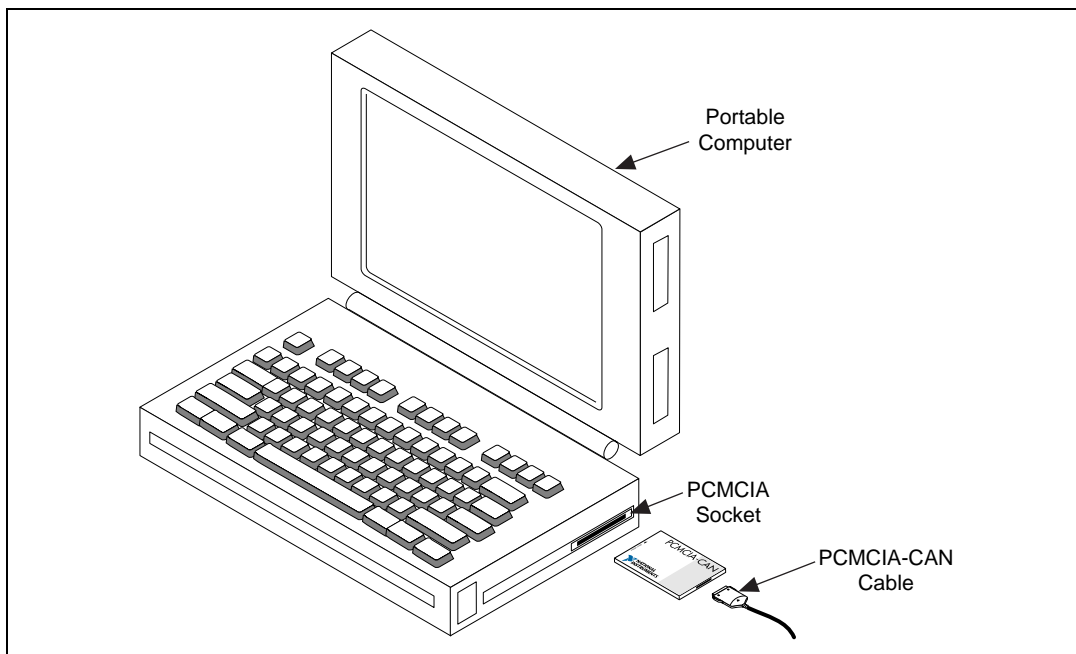
Figure 2-3. Inserting the PCMCIA-CAN

3. Connect the PCMCIA-CAN cable 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 cable. Refer to Appendix C, *Cabling Requirements for High-Speed CAN*, or Appendix D, *Cabling Requirements for Low-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 E, *Troubleshooting and Common Questions,* to resolve the problem.
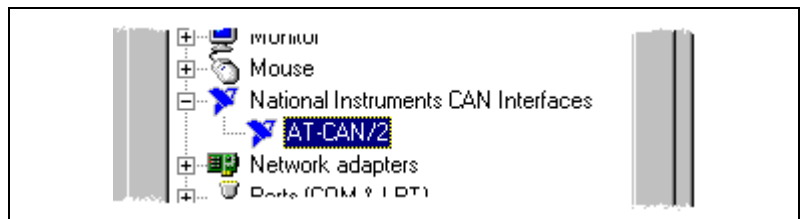
Figure 2-4. Device Manager Shows CAN Interface That Is Working Properly
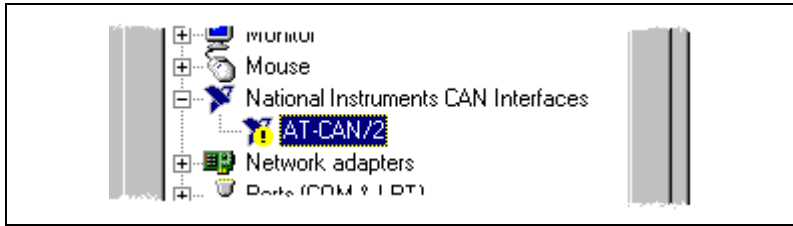
Figure 2-5. Device Manager Shows CAN Interface That Is Not Working Properly

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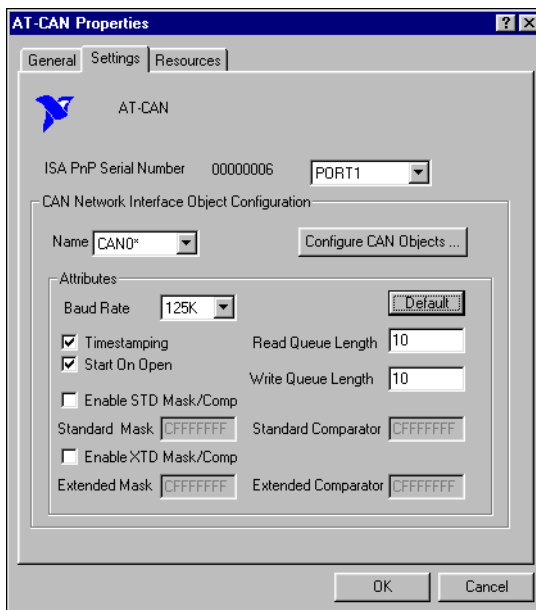
Figure 2-6. NI-CAN Hardware Settings Dialog Box

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*.

3

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**.

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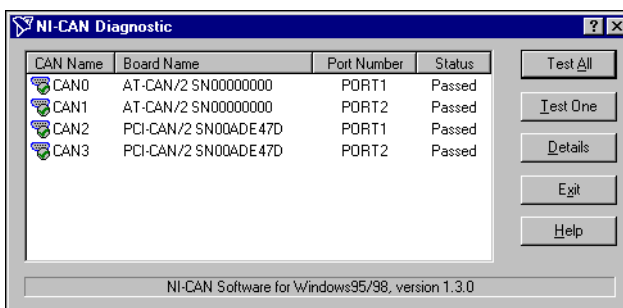
Figure 3-1. NI-CAN Diagnostic Utility after Testing

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 E, *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.

4

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*.

A

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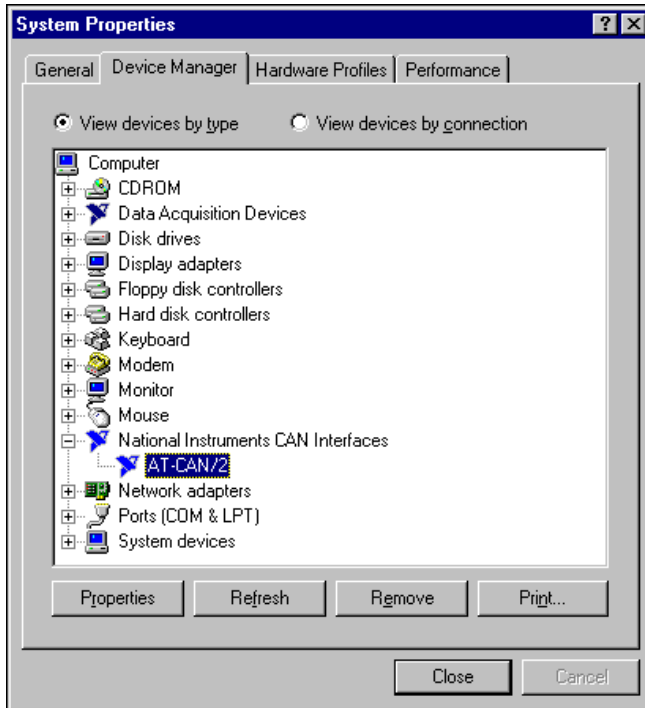
Figure A-1. Selecting an Interface to Remove from Windows

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*.

B

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*.

C

Cabling Requirements for High-Speed CAN

This appendix describes the cabling requirements for the 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.
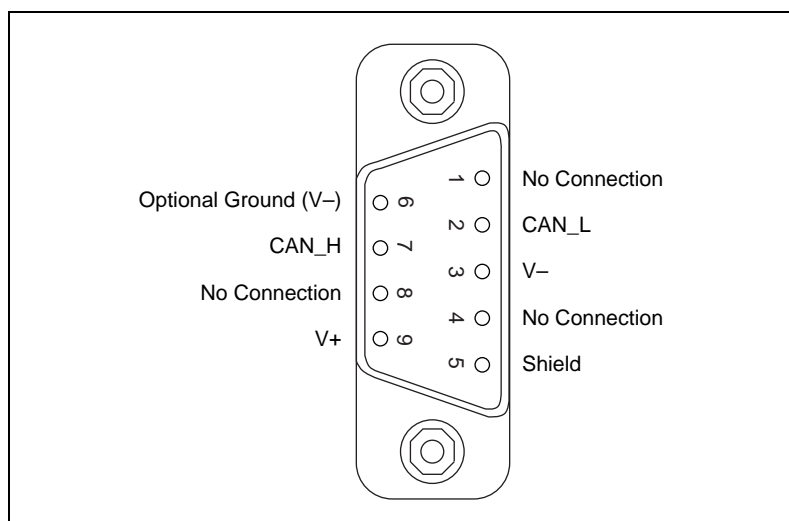
Figure C-1. Pinout for 9-Pin D-Sub Connector

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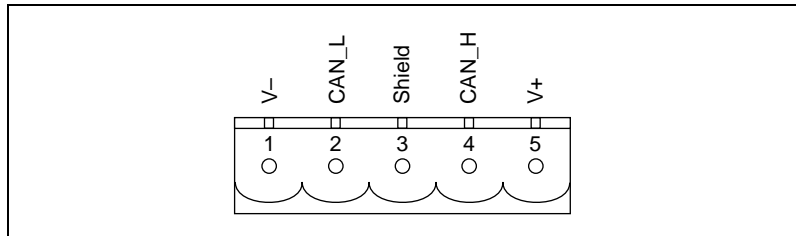
Figure C-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

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.
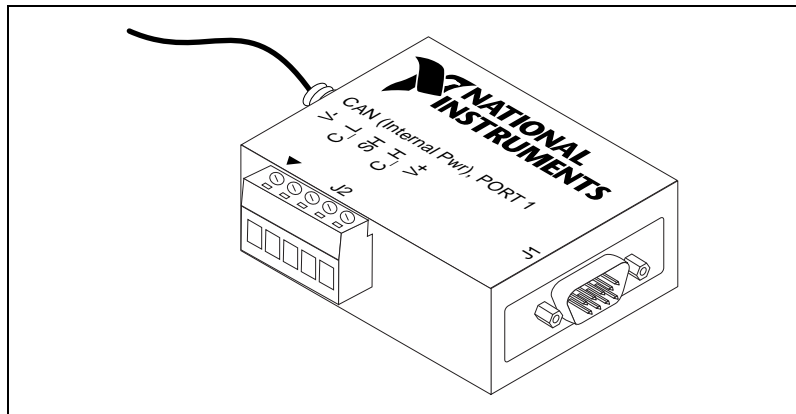
Figure C-3. PCMCIA-CAN Cable

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.

1	Power Supply Jumper J3	3	Assembly Number	5	Product Name
2	Serial Number	4	Power Supply Jumper J4		
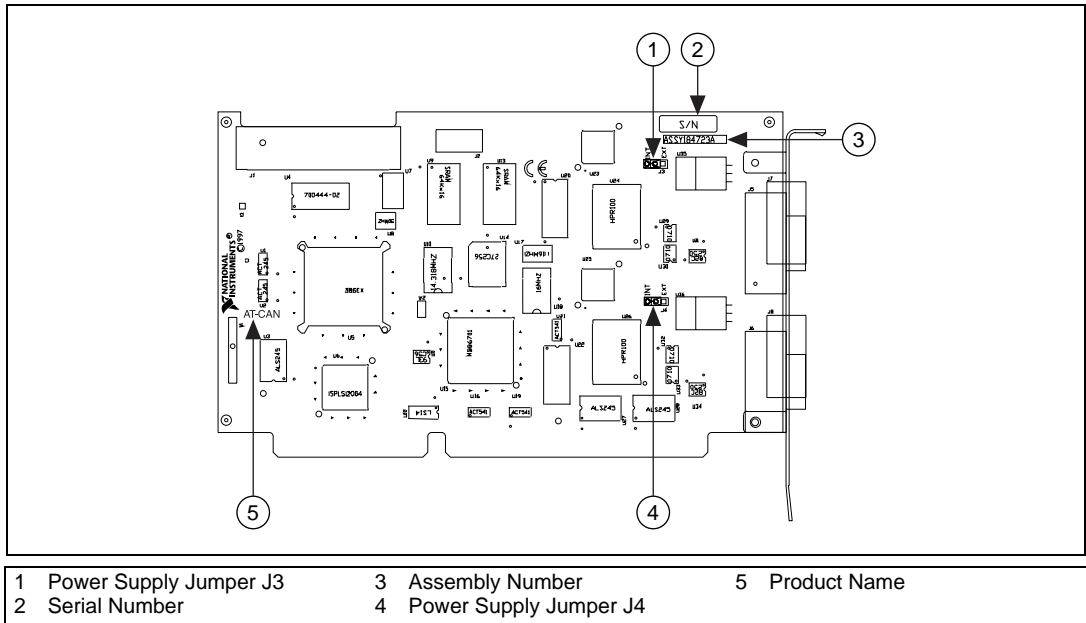
Figure C-4. AT-CAN/2 Parts Locator Diagram

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.

1	Power Supply Jumper J6	3	Serial Number	5	Power Supply Jumper J5
2	Product Name	4	Assembly Number		
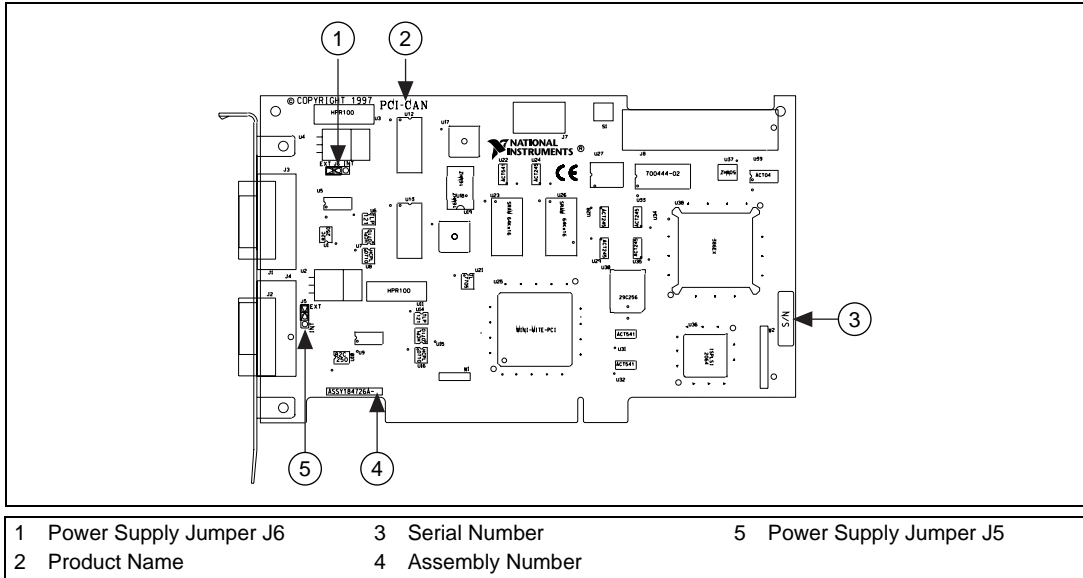
Figure C-5. PCI-CAN/2 Parts Locator Diagram

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.
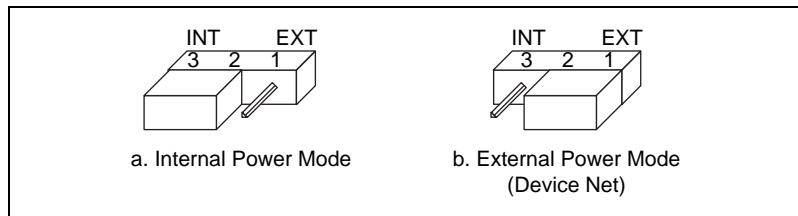
Figure C-6. Power Source Jumpers

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 mΩ/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.
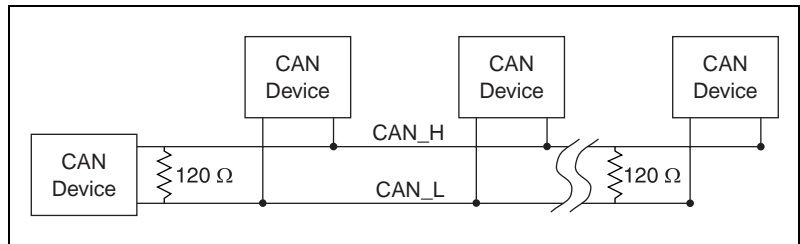
Figure C-7. Termination Resistor Placement

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.
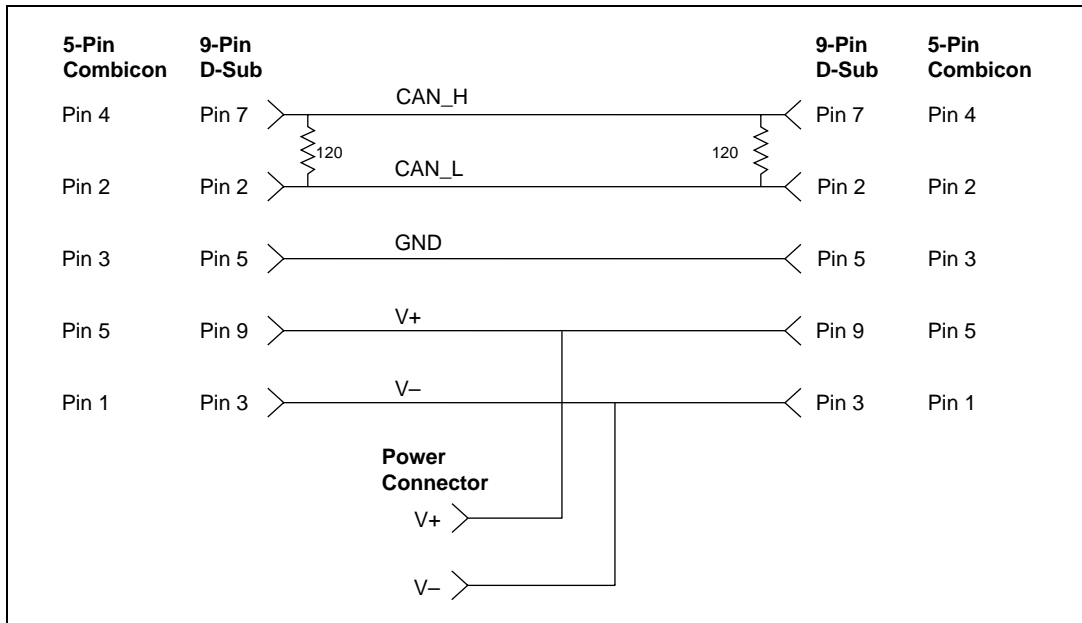
Figure C-8. Cabling Example

D

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.

1	No Connection
Optional Ground (V−) 6	2 CAN_L
CAN_H 7	3 V−
No Connection 8	4 No Connection
V+ 9	5 Shield
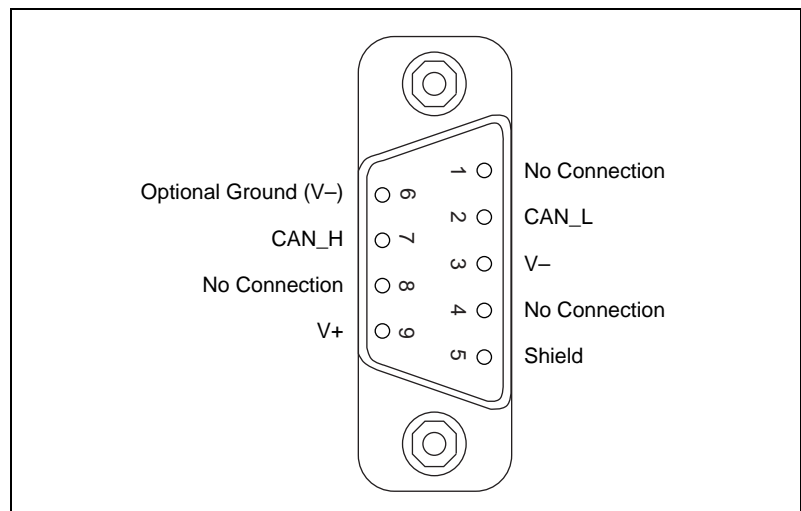
Figure D-1. Pinout for 9-Pin D-Sub Connector

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.

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-2.
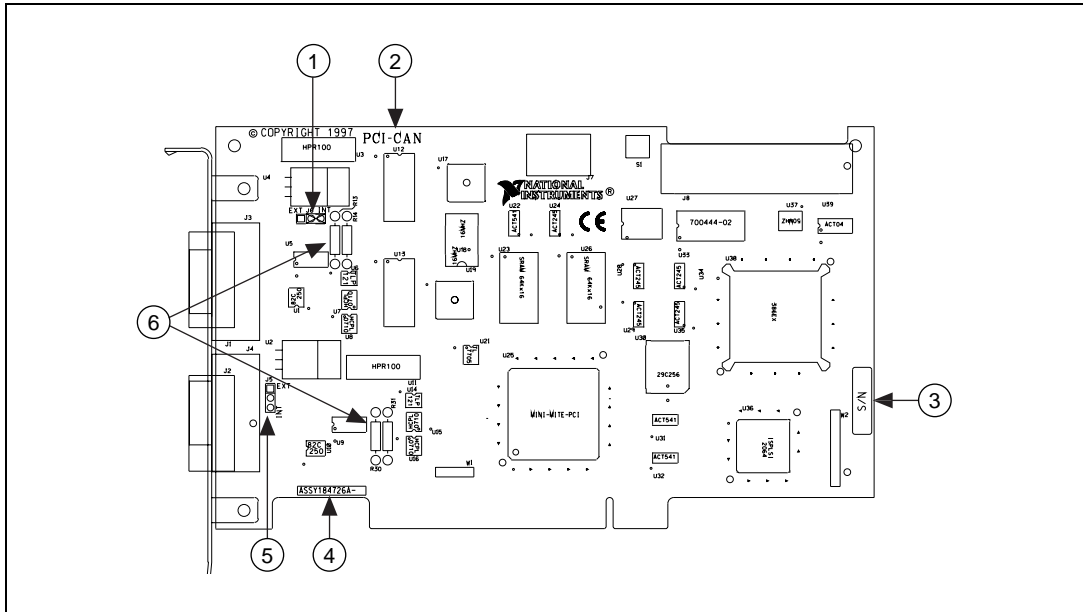
1	Power Supply Jumper J6	3	Serial Number	5	Power Supply Jumper J5
2	Product Name	4	Assembly Number	6	Termination Resistor Sockets

Figure D-2. 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-3 shows how to configure your jumpers for internal or external power supplies.
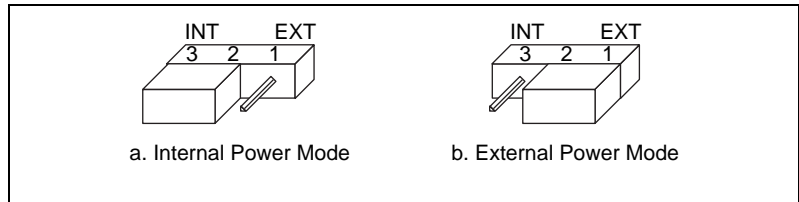
Figure D-3. Power Source Jumpers

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-4 shows termination resistor placement in a low-speed CAN network.
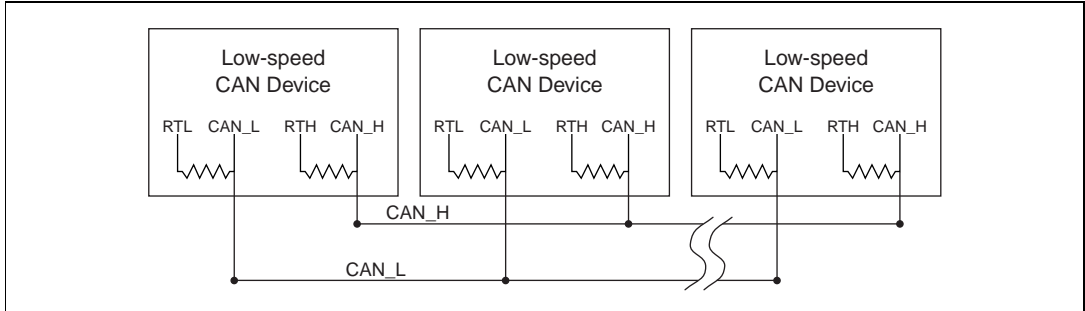
Figure D-4. Termination Resistor Placement for Low-Speed CAN

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:

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

Philips also recommends an individual device RTH and RTL termination of 500 Ω to 16 kΩ. The PCI-CAN/LS board ships with mounted RTH and RTL values of 510 Ω ±5% per port. The PCI-CAN/LS kit also includes a pair of 15 kΩ ±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:

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

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

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

†$R_{\text{RTH}} = R_{\text{RTL}}$

As the formula indicates, the 510 Ω ±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 kΩ. 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 kΩ resistors in the kit. Please refer to the next section, *Replacing the Termination Resistors*.

Replacing the Termination Resistors

Follow these steps to replace the termination resistors, 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-5 shows the location of the termination resistor sockets on a PCI-CAN/LS2 board.

1 Port 1 Termination Resistors	2 Port 2 Termination Resistors
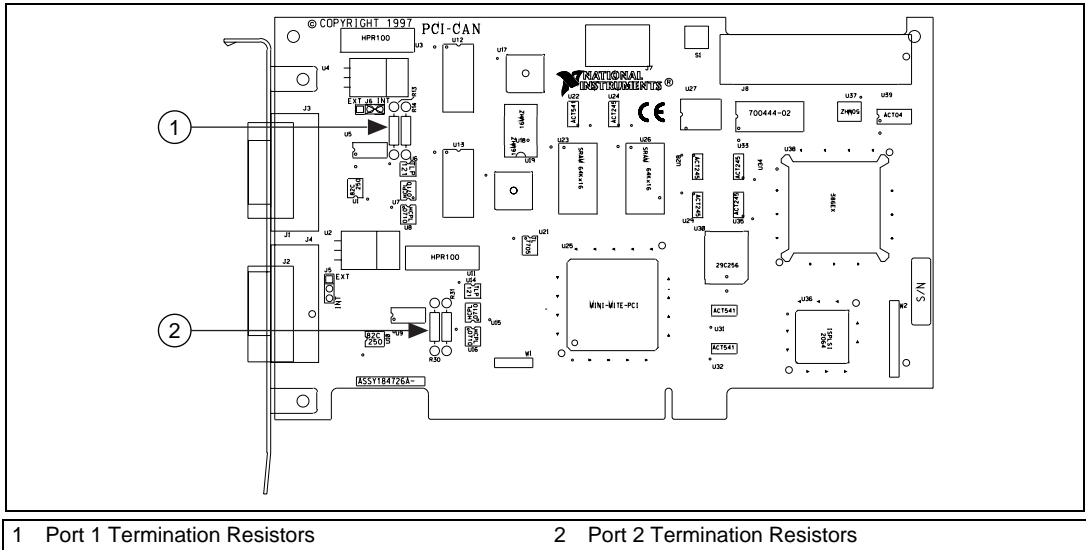
Figure D-5. Location of Termination Resistors on PCI-CAN/LS2 Board

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure D-6.
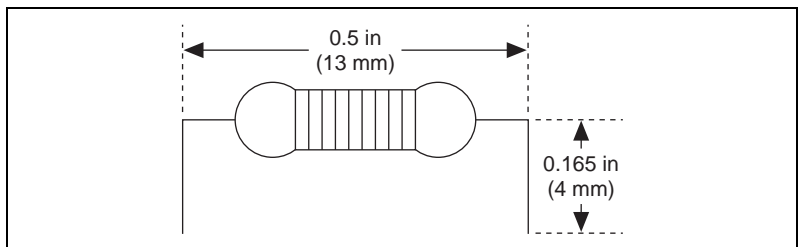
Figure D-6. Preparing Lead Wires of Replacement Resistors

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.

Cabling Example

Figure D-7 shows an example of a cable to connect two low-speed CAN devices. For the internal power configuration, the V+ connection is required for the low-speed transceiver to operate as specified in the Philips data sheet.

5-Pin Combicon	9-Pin D-Sub		9-Pin D-Sub	5-Pin Combicon
Pin 4	Pin 7	CAN_H	Pin 7	Pin 4
Pin 2	Pin 2	CAN_L	Pin 2	Pin 2
Pin 3	Pin 5	GND	Pin 5	Pin 3
Pin 5	Pin 9	V+	Pin 9	Pin 5
Pin 1	Pin 3	V–	Pin 3	Pin 1

Power Connector

V+

V–
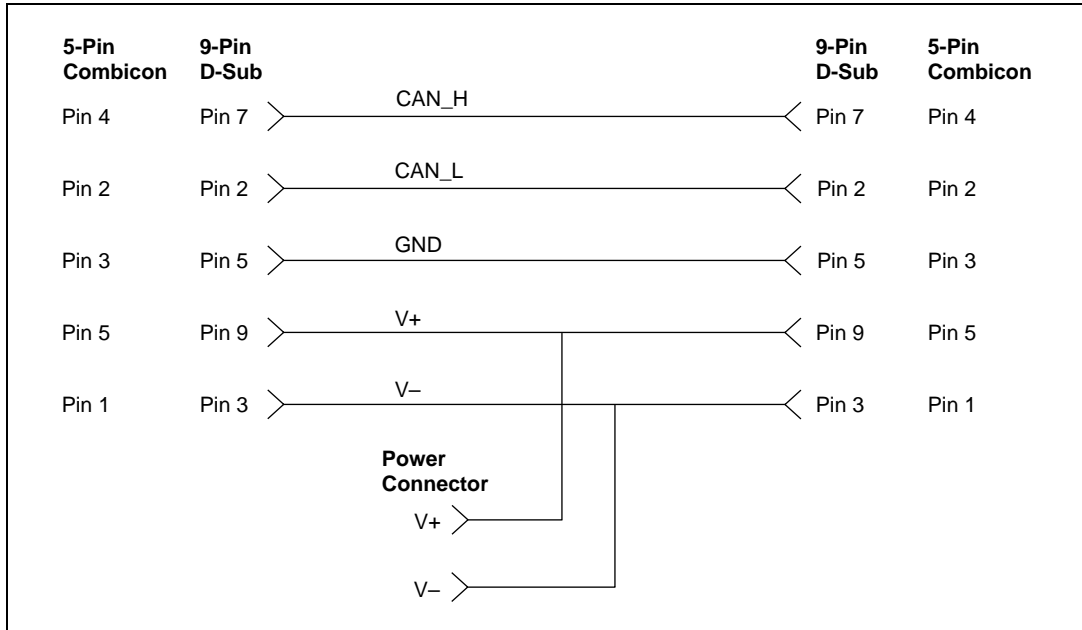
Figure D-7. Cabling Example

E

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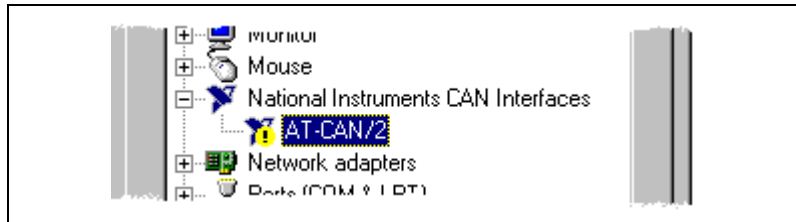
Figure E-1. Device Manager Shows CAN Interface That Is Not Working Properly

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 www.natinst.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.

F

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 temperature ....0 to 55 °C

    Relative humidity ....10% to 90%, noncondensing

Storage environment

    Temperature...................................–20 to 70 °C

    Relative humidity ....5% to 90%, noncondensing

PCMCIA-CAN Series

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 ....0 to 55 °C

    Relative humidity ....10% to 90%, noncondensing

Storage Environment

    Temperature...................................–20 to 70 °C

    Relative humidity ....5% to 90%, noncondensing

High-Speed CAN Port Characteristics for Bus-Powered Ports

Power requirement..................................10–30 V, 40 mA typical
100 mA maximum

Isolation ....500 VDC optical

Low-Speed CAN Port Characteristics for Bus-Powered Ports

Power requirement..................................8–27 V, 40 mA typical
100 mA maximum

Isolation ....500 VDC optical

G

Technical Support Resources

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

NI Web Support

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

Online Problem-Solving and Diagnostic Resources

- **KnowledgeBase**—A searchable database containing thousands of frequently asked questions (FAQs) and their corresponding answers or solutions, including special sections devoted to our newest products. The database is updated daily in response to new customer experiences and feedback.

- **Troubleshooting Wizards**—Step-by-step guides lead you through common problems and answer questions about our entire product line. Wizards include screen shots that illustrate the steps being described and provide detailed information ranging from simple getting started instructions to advanced topics.

- **Product Manuals**—A comprehensive, searchable library of the latest editions of National Instruments hardware and software product manuals.

- **Hardware Reference Database**—A searchable database containing brief hardware descriptions, mechanical drawings, and helpful images of jumper settings and connector pinouts.

- **Application Notes**—A library with more than 100 short papers addressing specific topics such as creating and calling DLLs, developing your own instrument driver software, and porting applications between platforms and operating systems.

Software-Related Resources

- **Instrument Driver Network**—A library with hundreds of instrument drivers for control of standalone instruments via GPIB, VXI, or serial interfaces. You also can submit a request for a particular instrument driver if it does not already appear in the library.

- **Example Programs Database**—A database with numerous, non-shipping example programs for National Instruments programming environments. You can use them to complement the example programs that are already included with National Instruments products.

- **Software Library**—A library with updates and patches to application software, links to the latest versions of driver software for National Instruments hardware products, and utility routines.

Worldwide Support

National Instruments has offices located around the globe. Many branch offices maintain a Web site to provide information on local services. You can access these Web sites from `www.natinst.com/worldwide`.

If you have trouble connecting to our Web site, please contact your local National Instruments office or the source from which you purchased your National Instruments product(s) to obtain support.

For telephone support in the United States, dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 03 9879 5166, Austria 0662 45 79 90 0, Belgium 02 757 00 20, Brazil 011 284 5011, Canada (Calgary) 403 274 9391, Canada (Ontario) 905 785 0085, Canada (Québec) 514 694 8521, China 0755 3904939, Denmark 45 76 26 00, Finland 09 725 725 11, France 01 48 14 24 24, Germany 089 741 31 30, Greece 30 1 42 96 427 Hong Kong 2645 3186, India 91805275406, Israel 03 6120092, Italy 02 413091, Japan 03 5472 2970, Korea 02 596 7456, Mexico (D.F.) 5 280 7625, Mexico (Monterrey) 8 357 7695, Netherlands 0348 433466, Norway 32 27 73 00, Singapore 2265886, Spain (Barcelona) 93 582 0251, Spain (Madrid) 91 640 0085, Sweden 08 587 895 00, Switzerland 056 200 51 51, Taiwan 02 2377 1200, United Kingdom 01635 523545

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
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)
s	seconds
V	volts
VDC	volts direct current
W	watts