CAN

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

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

Canadian Department of Communications

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

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

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About This Manual

This manual contains instructions to help you install and configure the National Instruments CAN hardware and the NI-CAN software for Windows 95. The National Instruments CAN hardware includes the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2.

This manual assumes that you are already familiar with Windows 95.

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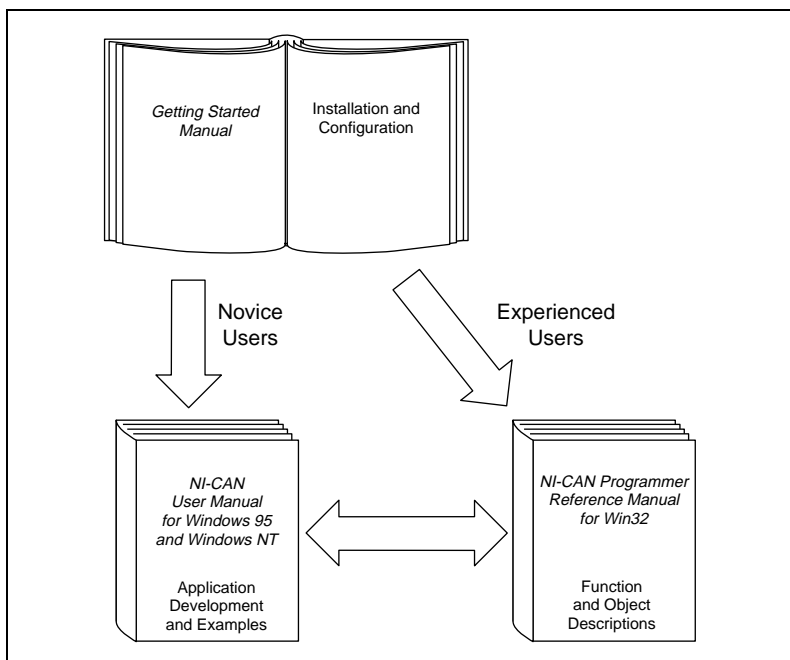
Use this getting started manual to install and configure your CAN hardware and the NI-CAN software for Windows 95.

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

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

Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, explains how to use this manual, lists what you need to get started and optional equipment you can order, and briefly describes the CAN hardware and the NI-CAN software for Windows 95.

- Chapter 2, *Installation and Configuration*, describes how to install and configure the CAN hardware and the NI-CAN software for Windows 95.

- Chapter 3, *Verify the Installation*, describes how to verify the hardware and software installation.

- Chapter 4, *Begin to Use the NI-CAN Software*, helps you get started with the NI-CAN software for Windows 95.

- Appendix A, *Uninstalling the Hardware and Software*, describes how to uninstall the CAN hardware and the NI-CAN software from Windows 95.

- Appendix B, *Forcing Windows 95 to Detect the CAN Hardware*, contains instructions to help you install your CAN interface if Windows 95 has not detected it properly.

- Appendix C, *Cabling Requirements*, describes the cabling requirements for the CAN hardware.

- Appendix D, *Troubleshooting and Common Questions*, describes how to troubleshoot problems and answers some common questions.

- Appendix E, *Specifications*, describes the physical characteristics of the CAN hardware, along with the recommended operating conditions.

- Appendix F, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.

- The *Glossary* contains an alphabetical list and a description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.

Conventions Used in This Manual

The following conventions are used in this manual.

»	The **»** symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options»Substitute Fonts** directs you to pull down the **File** menu, select the **Page Setup** item, select **Options**, and finally select the **Substitute Fonts** option from the last dialog box.
⚠	This icon to the left of bold italicized text denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash.
bold	Bold text denotes the names of menus, menu items, parameters, dialog boxes, dialog box buttons or options, icons, windows, Windows 95 tabs, or LEDs.
bold italic	Bold italic text denotes a caution.
CAN hardware	*CAN hardware* refers to the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2 in cases where the material applies to all the interfaces.
italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
`monospace`	Text in this font denotes text or characters that you should literally enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions, and for statements and comments taken from program code.
paths	Paths in this manual are denoted using backslashes (\) to separate drive names, directories, folders, and files.

Related Documentation

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

• ANSI/ISO Standard 11898-1993, *Road Vehicles—Interchange of Digital Information—Controller Area Network (CAN) for High-Speed Communication*

- *CAN Specification Version 2.0*, 1991, Robert Bosch Gmbh., Postfach 500, D-7000 Stuttgart 1

- CiA Draft Standard 102, Version 2.0, *CAN Physical Layer for Industrial Applications*

- *DeviceNet Specification, Volume 1, Version 2.0*, Open DeviceNet Vendor Association

- *Microsoft Windows 95 User's Guide*, Microsoft Corporation

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix F, *Customer Communication*, at the end of this manual.

1

Introduction

This chapter explains how to use this manual, lists what you need to get started and optional equipment you can order, and briefly describes the CAN hardware and the NI-CAN software for Windows 95.

How to Use This Manual

```
Chapter 1          ( Gather What You Need )
                   (    to Get Started     )
                           |
                           v
                   [ Install the Software ]
                           |
                           v
Chapter 2          [ Install the Hardware ]
                           |
                           v
                   [ Configure the Software ]
                           |
                           v
                   [ Verify the Installation ] <------------+
                           |                                |
                           v                                |
Chapter 3              < Passes? >  --No-->  [ Troubleshooting ]
                           |                  [    Appendix    ]
                          Yes
                           |
                           v
Chapter 4          [ Review Programming ]
                   [  Considerations    ]
                           |
User Manual and            v
Programmer Reference ( Write Application Program )
Manual
```
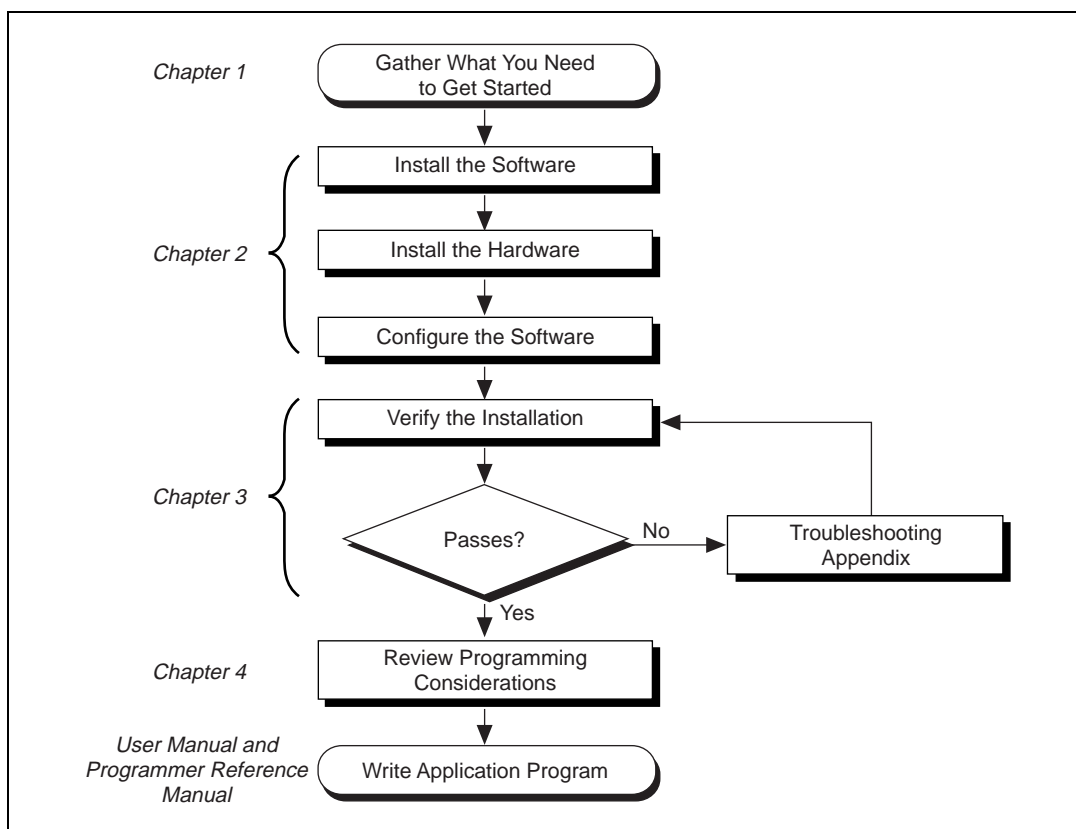
What You Need to Get Started

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

❑ Windows 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/2
PCMCIA-CAN
PCMCIA-CAN/2

❑ The following 3.5 in., high-density (1.44 MB) disks, which are included in your kit:

NI-CAN Software for Windows 95 and Windows NT (Disk 1)

NI-CAN Software for Windows 95 and Windows NT (Disk 2)

❑ PCMCIA-CAN cable, which is included in your kit, if you have a PCMCIA-CAN or PCMCIA-CAN/2

❑ CAN interface cables that meet the requirements in Appendix C, *Cabling Requirements*

CAN Hardware Overview

The National Instruments CAN hardware includes the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2.

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

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

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

CAN interfacing is accomplished using the Intel 82527 CAN controller chip. The CAN physical layer fully conforms to the ISO 11898 physical layer specification for CAN and is optically isolated to 500 V. AT-CAN and PCI-CAN boards are available with two physical connector types: DB-9 D-Sub and Combicon-style pluggable screw terminals. 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 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 includes a native, 32-bit multitasking Windows 95 driver that is fully Plug and Play aware. The driver components are dynamically loaded when Windows 95 detects new CAN hardware, and dynamically unloaded when Windows 95 detects the removal of CAN hardware.

The NI-CAN software is fully integrated into the Windows 95 operating system. You can configure it through the Windows 95 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 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 95.

Install the NI-CAN Software

Before installing the CAN hardware, complete the following steps to install the NI-CAN software for Windows 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 and Windows NT (Disk 1)*, and click on the **Next** button to proceed. The software installation wizard begins with the screen shown in Figure 2-2.
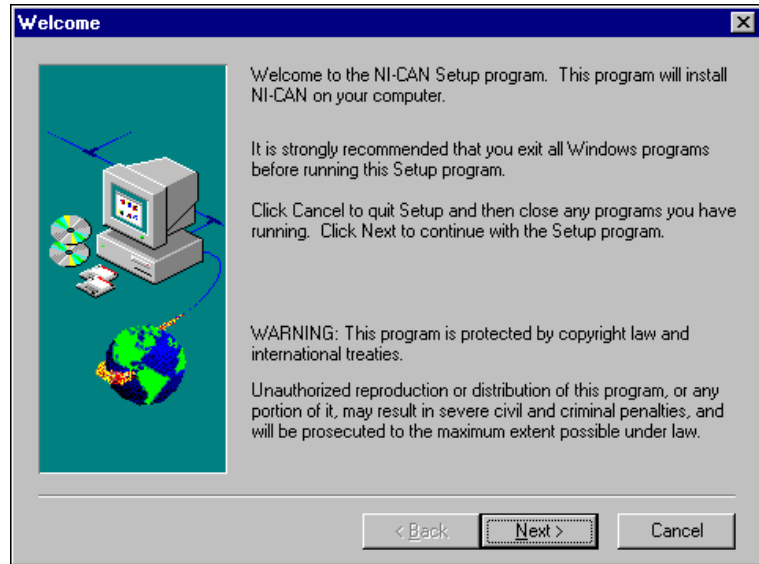
Figure 2-2. NI-CAN Software Setup Screen

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

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

Install the CAN Hardware

This section describes how to install your CAN hardware.

Install Your AT-CAN, AT-CAN/2, PCI-CAN, or PCI-CAN/2

⚠️ **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 2-3 shows how to install the AT-CAN into a 16-bit ISA expansion slot.
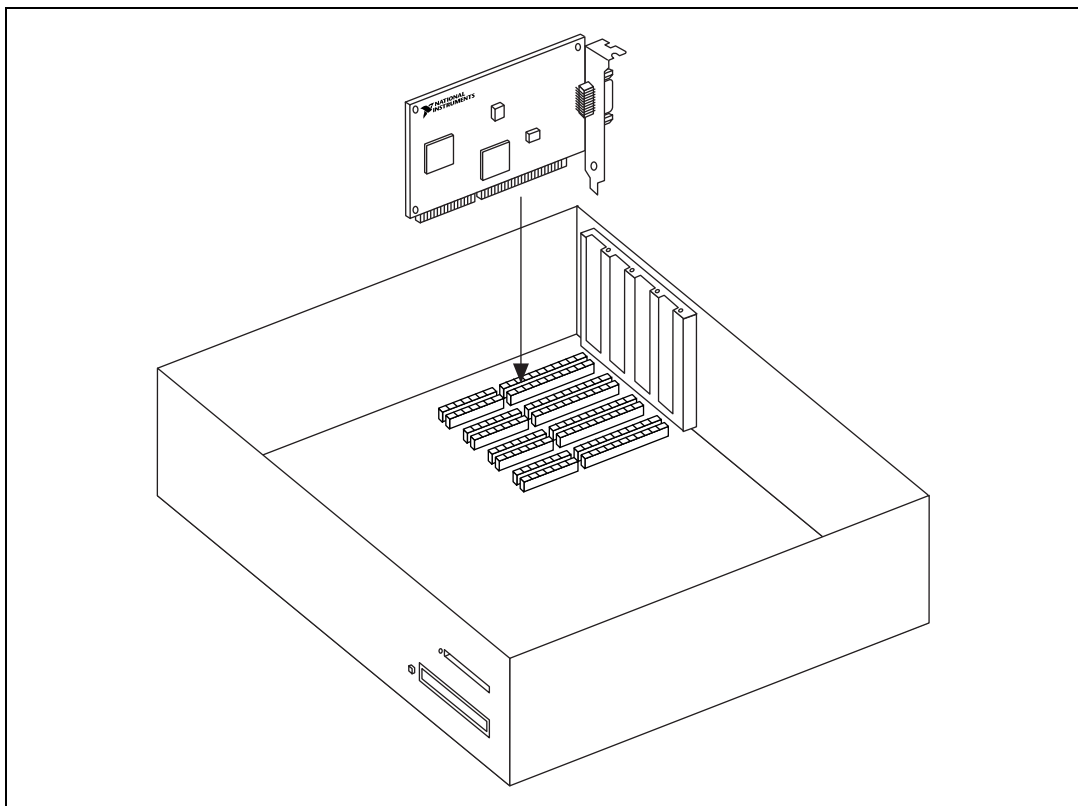
Figure 2-3. Installing the AT-CAN

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 95. Windows 95 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 95, refer to Appendix B, *Forcing Windows 95 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 or PCMCIA-CAN/2

⚠ **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 2-4 shows how to insert the card and how to connect the PCMCIA-CAN cable and connector to the card.
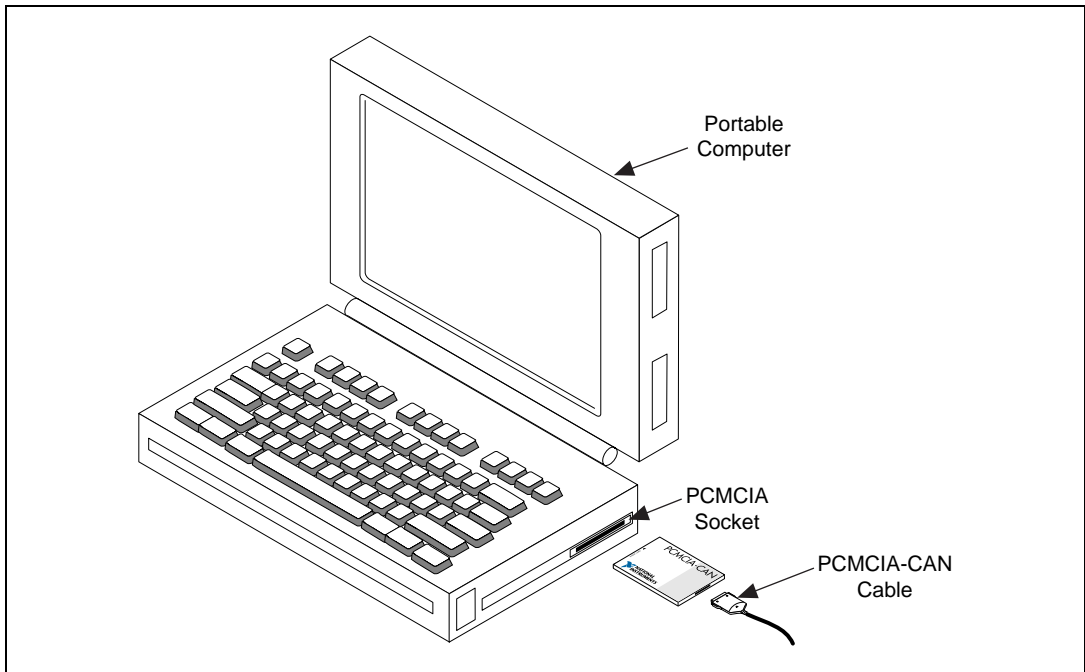
Figure 2-4. Inserting the PCMCIA-CAN

3. Connect the PCMCIA-CAN cable to the card.

4. Power on your computer.

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

Connect the Cables

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

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

Configure the NI-CAN Software

The NI-CAN Configuration utility is fully integrated with the Windows 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 2-5 shows an example of an AT-CAN/2 that is working properly, and Figure 2-6 shows an example of an AT-CAN/2 that is not working properly. Refer to the *Troubleshooting Device Manager Problems* section of Appendix D, *Troubleshooting and Common Questions,* to resolve the problem.
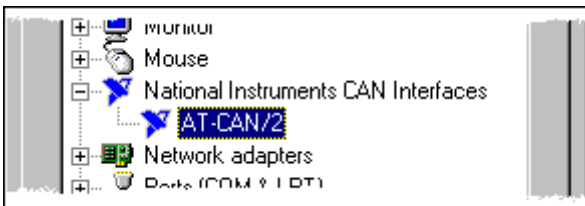
Figure 2-5. Device Manager Shows CAN Interface That Is Working Properly
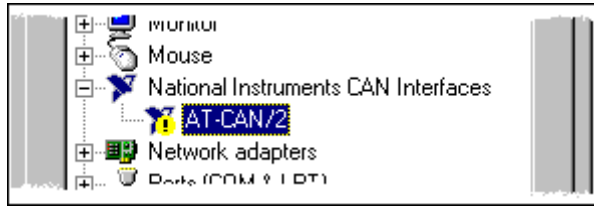
Figure 2-6. Device Manager Shows CAN Interface That Is Not Working Properly

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 2-7, provides information about the NI-CAN software configuration for the CAN interface.
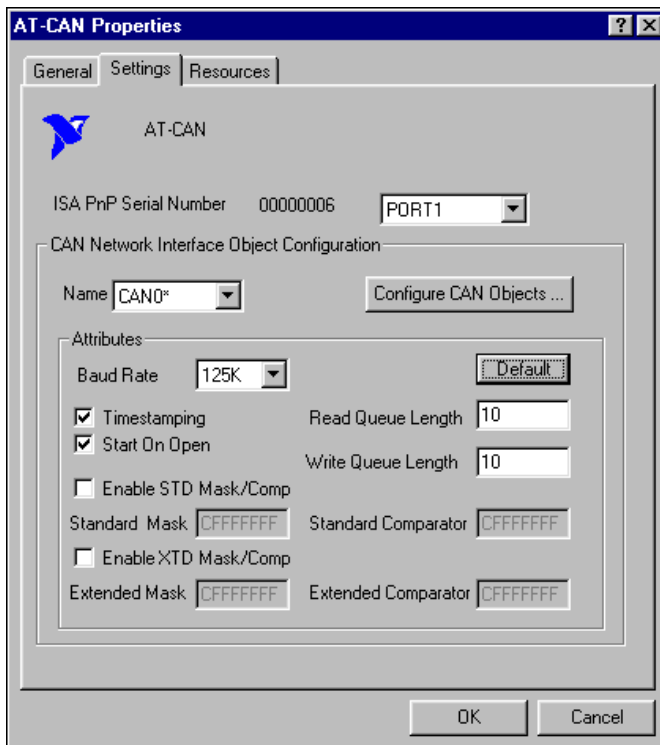
Figure 2-7. Settings Tab for the AT-CAN

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»NI-CAN Software for Windows 95**.

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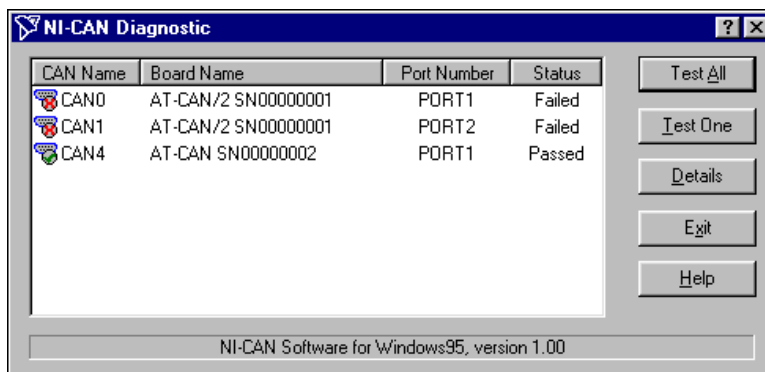
Figure 3-1. NI-CAN Diagnostic Utility after Testing

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 D, *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 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 for Windows 95 and Windows NT* and the *NI-CAN Programmer Reference Manual for Win32*.

General Programming Considerations

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

- For your LabVIEW application, you must use the NI-CAN LabVIEW functions in `nican.llb`.

- For your C/C++ application, you must include the NI-CAN header file, `nican.h`, in your source code.

- The NI-CAN software is accessed through the 32-bit DLL, `nican.dll`, either by linking with one of the language interfaces provided with the NI-CAN software, or by using direct DLL entry from other programming environments.

- Several sample CAN applications are included with the NI-CAN software. Use them as a guide for your own application development.

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

A

Uninstalling the Hardware and Software

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

Uninstalling the CAN Hardware from Windows 95

Before physically removing the CAN hardware from the computer, you must remove the hardware information from the Windows 95 Device Manager.

To remove the hardware information from Windows 95, 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.
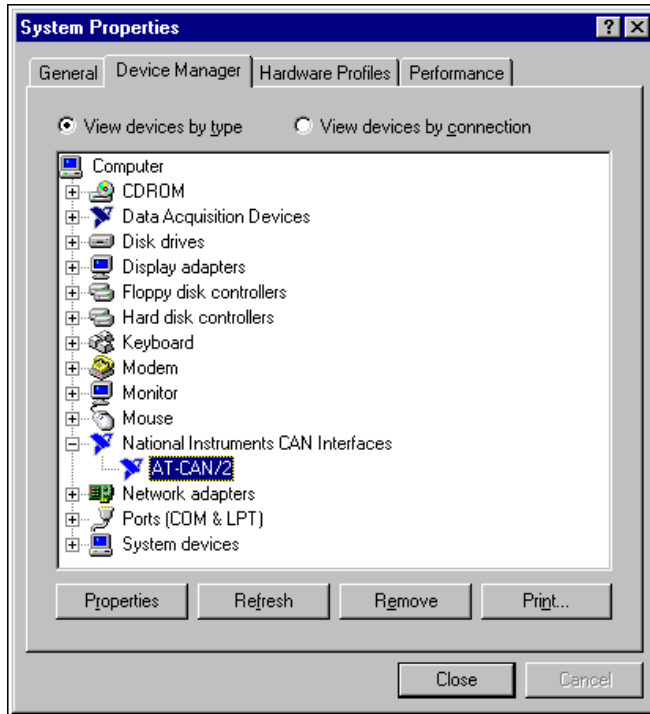
Figure A-1. Selecting an Interface to Remove from Windows 95

After you remove the appropriate CAN interface information from the Device Manager, you should shut down Windows 95, power off your computer, and physically remove the CAN interfaces from your computer.

Uninstalling the NI-CAN Software from Windows 95

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. A dialog box similar to the one in Figure A-2 appears. This dialog box lists the software available for removal.
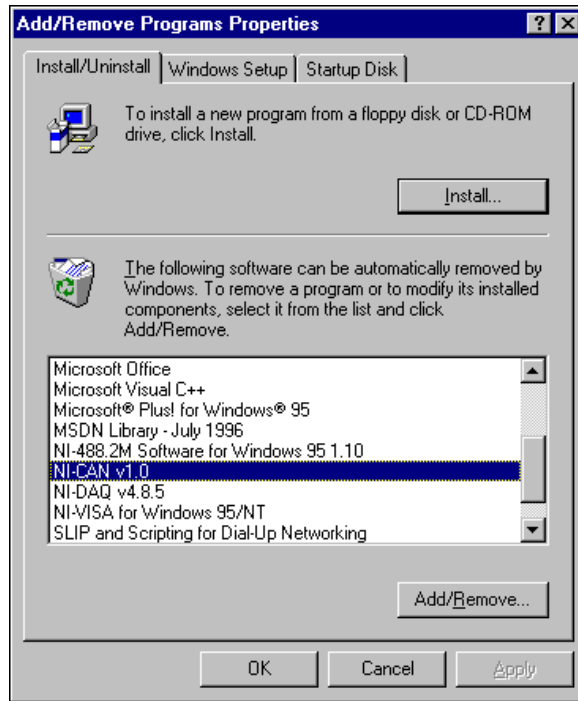
Figure A-2. Add/Remove Programs Properties Dialog Box

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. Figure A-3 shows the results of a
     successful uninstallation.
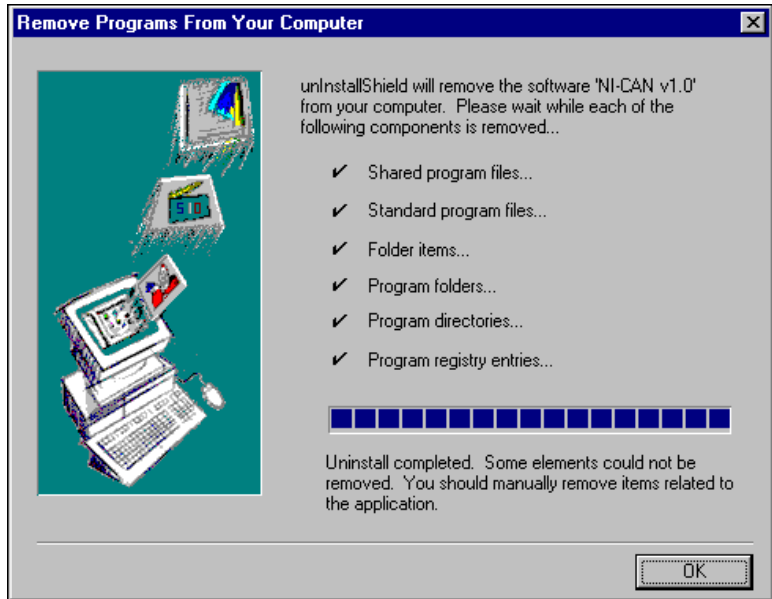
Figure A-3. NI-CAN Uninstallation Results

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory, because the directory is not empty after the uninstallation. You 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 95 to Detect the CAN Hardware

This appendix contains instructions to help you install your CAN interface if Windows 95 has not detected it properly.

If Windows 95 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 95 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 95 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 95 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

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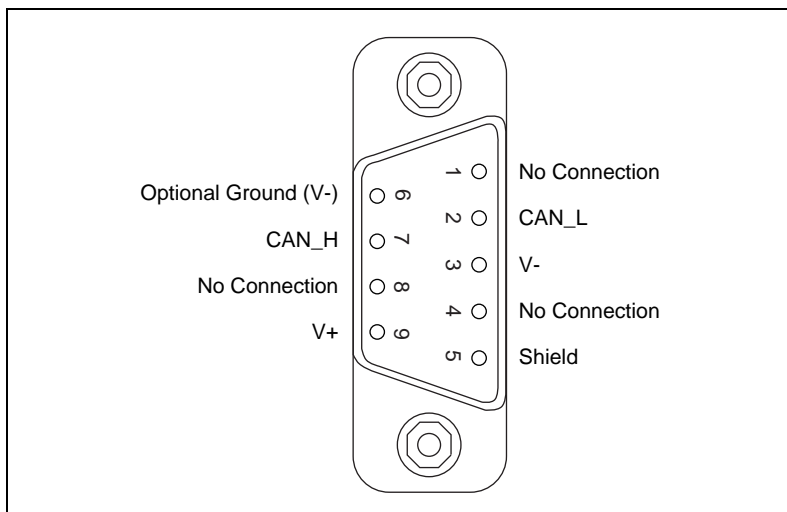
Figure C-1. Pinout for 9-Pin D-Sub Connector

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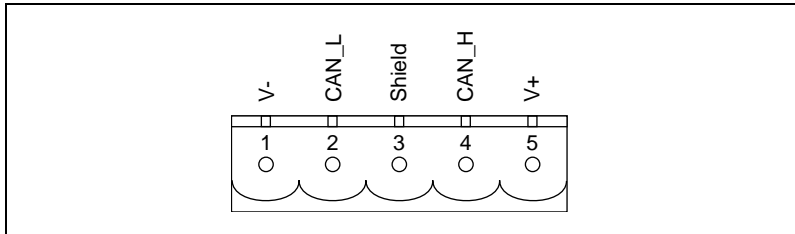
Figure C-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

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 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.
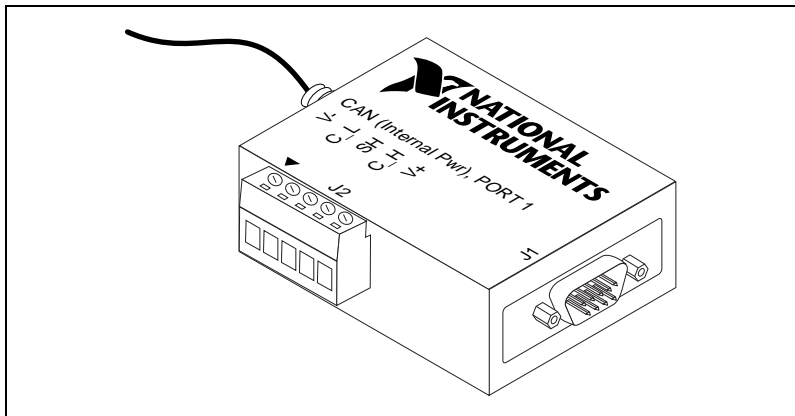
Figure C-3. PCMCIA-CAN Cable

Power Supply Information for the CAN Ports

For the AT-CAN, AT-CAN/2, PCI-CAN, and PCI-CAN/2, 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		
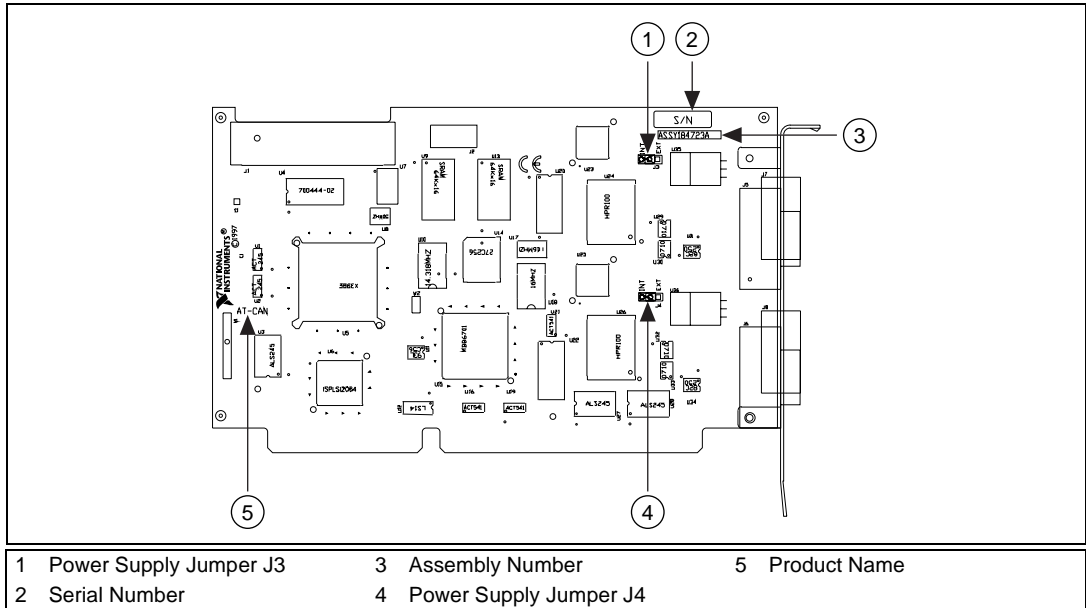
Figure C-4. AT-CAN/2 Power Source Jumpers

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		
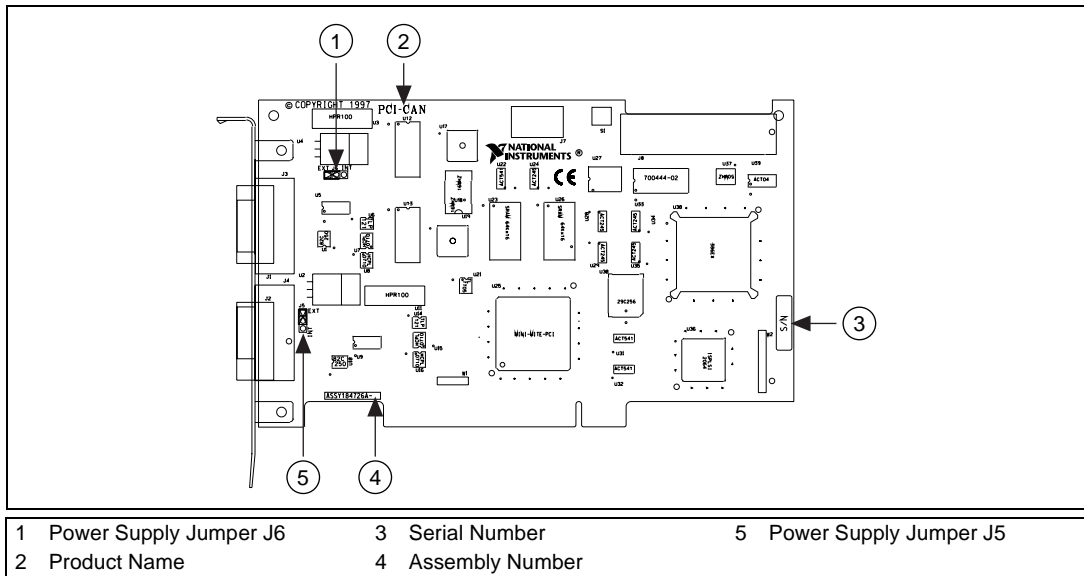
Figure C-5. PCI-CAN/2 Power Source Jumpers

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.
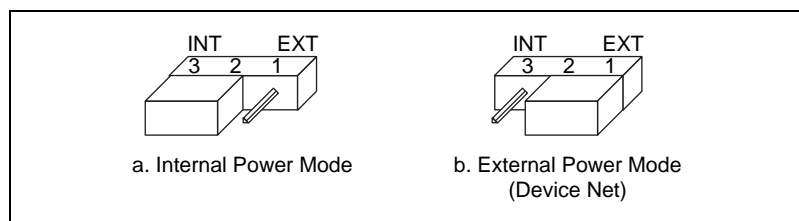
Figure C-6. Power Source Jumpers

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

The PCMCIA-CAN and PCMCIA-CAN/2 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.
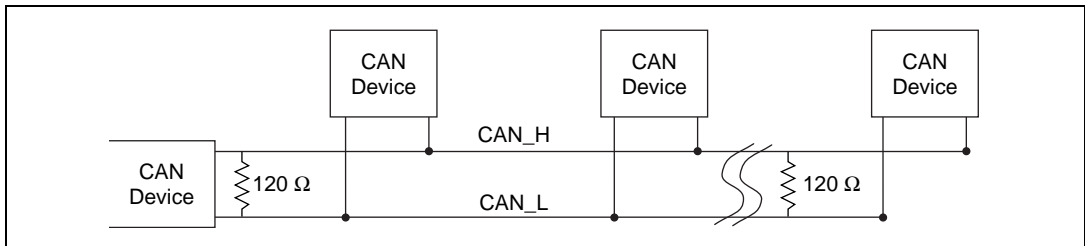
Figure C-7. Termination Resistor Placement

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 each 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.
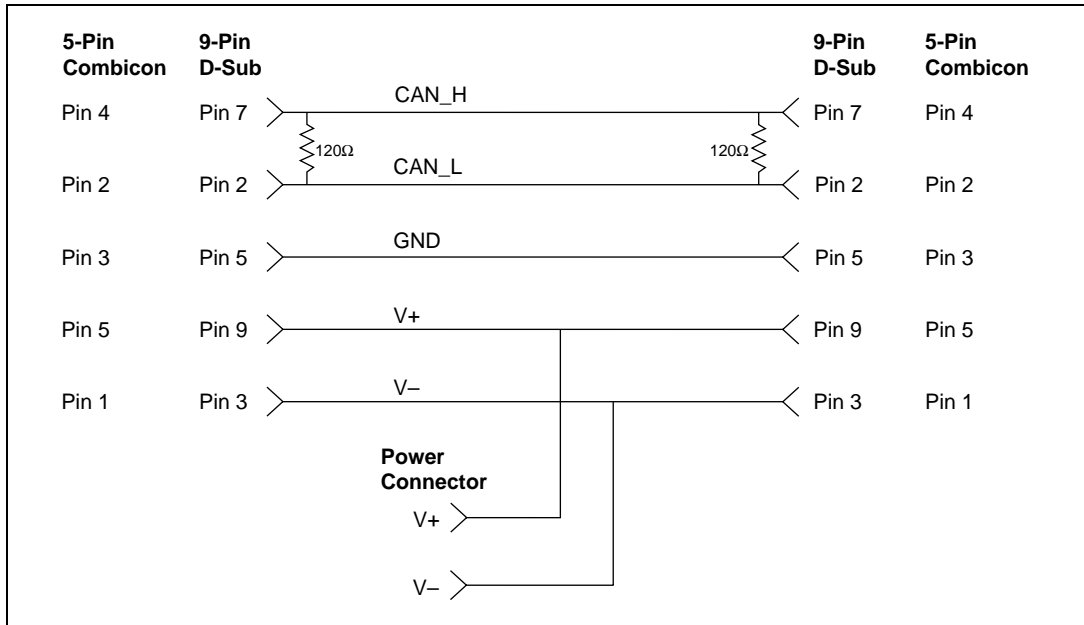
Figure C-8. Cabling Example

D

Troubleshooting and Common Questions

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

Troubleshooting Device Manager Problems

The Windows 95 Device Manager contains configuration information for all of the CAN hardware it is aware of that is installed in your system. To start the Windows 95 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 Plug and Play 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 D-1.
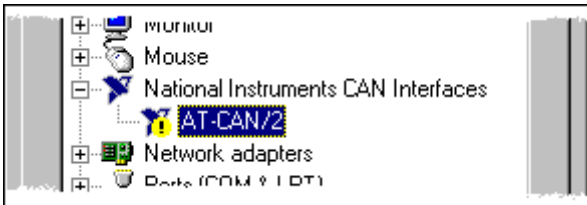
Figure D-1. Device Manager Shows CAN Interface That Is Not Working Properly

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 95.

- Code 9: Windows 95 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 95 might configure your CAN interface without a physical memory assignment. The NI-CAN software for Windows 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 95 might configure your CAN interface without an Interrupt Request level. The NI-CAN software for Windows 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 95 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).

Troubleshooting 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 95 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 95 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 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 95 Device Manager to see if Windows 95 has detected the hardware. For more information, refer to the *Troubleshooting 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 95 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, fill out the forms in Appendix F, *Customer Communication*, and 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»NI-CAN Software for Windows 95**. 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 95 support?

The NI-CAN software for Windows 95 supports the AT-CAN, AT-CAN/2, PCI-CAN, PCI-CAN/2, PCMCIA-CAN, and PCMCIA-CAN/2.

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

Refer to the *Troubleshooting Diagnostic Utility Failures* section 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, fill out the forms in Appendix F, *Customer Communication*, and contact National Instruments.

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

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

Are interrupts required for the NI-CAN software for Windows 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 for Windows 95 and Windows NT.*

How do I use NI-CAN from within LabVIEW?

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

Why does the uninstall program leave some components installed?

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

What information should I have before I call National Instruments?

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

E

Specifications

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

Table E-1. AT-CAN and AT-CAN/2 Hardware Characteristics

Characteristic	Specification
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
    Relative Humidity
	
	0° to 55° C
	10% to 90%, noncondensing

Storage Environment
    Temperature
    Relative Humidity
	
	–20° to 70° C
	5% to 90%, noncondensing

Table E-2. PCI-CAN and PCI-CAN/2 Hardware Characteristics

Characteristic	Specification
Dimensions	10.67 by 17.46 cm (4.2 by 6.88 in.)
Power Requirement	+5 VDC 775 mA typical
I/O Connector	9-pin D-Sub for each port (standard) or 5-pin Combicon-style pluggable DeviceNet screw terminal

Operating Environment
    Ambient Temperature
    Relative Humidity
	0° to 55° C
	10% to 90%, noncondensing

Storage Environment
    Temperature
    Relative Humidity
	–20° to 70° C
	5% to 90%, noncondensing

Table E-3. PCMCIA-CAN and PCMCIA-CAN/2 Hardware Characteristics

Characteristic	Specification
Dimensions	8.56 by 5.40 by 0.5 cm (3.4 by 2.1 by 0.4 in.)
Power Requirement	500 mA typical
I/O Connector	Cable with 9-pin D-Sub and 5-pin Combicon-style pluggable screw terminal for each port

Operating Environment
    Component Temperature
    Relative Humidity
	0° to 55° C
	10% to 90%, noncondensing

Storage Environment
    Temperature
    Relative Humidity
	–20° to 70° C
	5% to 90%, noncondensing

Table E-4. CAN Port Characteristics for Bus-Powered Ports

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

F

Customer Communication

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

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

Electronic Services

Bulletin Board Support

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

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

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

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

FTP Support

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

Fax-on-Demand Support

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

E-Mail Support (Currently USA Only)

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

`support@natinst.com`

Telephone and Fax Support

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

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

Technical Support Form

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

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

Name _____

Company _____

Address _____

_____

Fax (___) _____Phone (___) _____

Computer brand_____ Model _____Processor_____

Operating system (include version number) _____

Clock speed _____MHz RAM _____MB   Display adapter _____

Mouse ___yes   ___no   Other adapters installed _____

Hard disk capacity _____MB Brand_____

Instruments used _____

_____

National Instruments hardware product model _____ Revision _____

Configuration _____

National Instruments software product _____ Version _____

Configuration _____

The problem is: _____

_____

_____

_____

_____

List any error messages: _____

_____

_____

The following steps reproduce the problem: _____

_____

_____

_____

_____

Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

National Instruments Products

General Information

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

NI-CAN Diagnostic Utility Results _____

Version Information

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

```
candiag -v
```

Version Information from the NI-CAN Diagnostic _____

_____

Other Products

Resource Summary Report from the Device Manager

To create this report, first display the **System Properties** dialog box for the computer by double-clicking on the **System** icon under **Start»Settings»Control Panel**. Then click on the **Device Manager** tab and highlight the **Computer** icon. Click on the **Print** button, and check the **Print to File** checkbox in the **Print** dialog box before clicking on **OK**.

Programming Environment Information

Programming Language _____

Compiler Vendor_____

Compiler Version _____

Application Information

LabVIEW Application _____

Win32 Application _____

If Win 32, method of accessing DLL (link with language interface or direct entry?) _____

_____

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            for Windows 95

Edition Date: January 1998

Part Number: 321371C-01

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Glossary

Prefix	Meanings	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
C	Celsius
CAN	Controller Area Network
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
KB	kilobytes of memory
m	meters
MB	megabytes of memory
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