Serial

Getting Started with Your PCMCIA Serial Hardware and Software for Windows NT

Worldwide Technical Support and Product Information

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

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

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

Consult the FCC web site http://www.fcc.gov for more information.
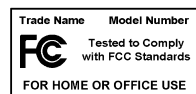
FCC/DOC Warnings

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

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

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Federal Communications Commission

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

Canadian Department of Communications

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canadian Department of Communications

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

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

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

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

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About This Manual

This manual contains instructions to help you install and configure the National Instruments serial hardware and the NI-Serial software for Windows NT. The serial hardware covered by this manual includes the PCMCIA-232, PCMCIA-232/2, PCMCIA-232/4, PCMCIA-485, and PCMCIA-485/2. This manual assumes that you are already familiar with Windows NT.

Conventions

This manual uses the following conventions:

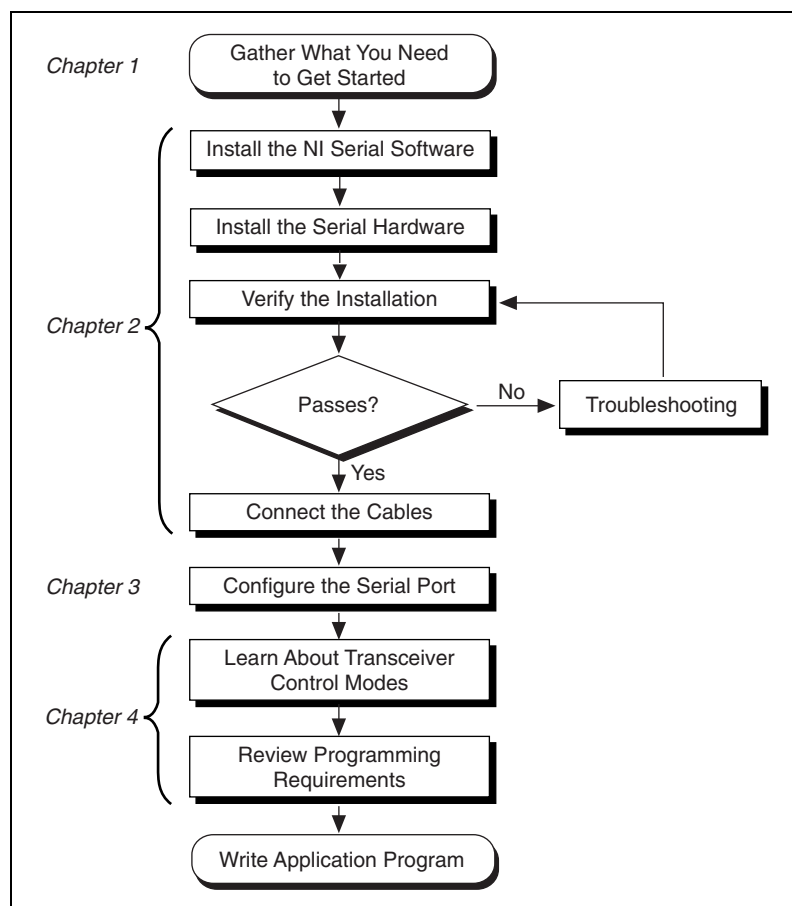|	
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
	This icon denotes a note, which alerts you to important information.
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.
italic	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.
monospace	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.
monospace bold	Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.

Related Documentation

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

- ANSI/EIA-232-D Standard, *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*

- EIA/RS-422-A Standard, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*

- EIA-485 Standard, *Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*

- *Microsoft Win32 Software Developer Kit*, Online Documentation for *Win32 Overviews*, *Win32 Reference*, and *Microsoft Windows NT System Guide*, Microsoft Corporation

- *NS16550AF Universal Asynchronous Receiver/Transmitter with FIFOs*, National Semiconductor

- *ST16C654 Asynchronous Receiver/Transmitter with FIFOs*, EXAR Corp.

1

Introduction

This chapter explains how to use this manual, lists what you need to get started, provides an overview of the serial hardware and the NI-Serial software, and describes optional equipment you can order.

How to Use This Manual

```
Chapter 1      ( Gather What You Need )
                 (  to Get Started      )

                 | Install the NI Serial Software |

                 | Install the Serial Hardware |

Chapter 2        | Verify the Installation |  <----+
                                                   |
                      < Passes? >  --No-->  | Troubleshooting |
                          |
                         Yes
                 | Connect the Cables |

Chapter 3        | Configure the Serial Port |

                 | Learn About Transceiver |
                 |     Control Modes        |
Chapter 4
                 | Review Programming |
                 |    Requirements    |

                 ( Write Application Program )
```

What You Need to Get Started

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

❑   Windows NT version 4.0 or later installed on your computer

❑   One of the following serial interfaces, which is included in your kit:

PCMCIA-232 (one, two, or four port)
PCMCIA-485 (one or two port)

❑   CD, *NI-Serial Software for Windows 2000/NT/Me/9x*, which is included in your kit

❑   Adapter cable from PCMCIA card to DB-9 connector, which is included in your kit

Optional Equipment

Call National Instruments for more information about the following optional equipment:

•   DB-9 RS-485 termination connector

•   RS-232 9-pin to 9-pin null modem cable

•   RS-232 9-pin to 25-pin null modem cable

Serial Hardware Overview

The serial hardware gives you a variety of solutions for serial communications. The PCMCIA-232 interfaces work with the RS-232 protocols, and the PCMCIA-485 interfaces work with the RS-422 and RS-485 protocols. You can use the PCMCIA-232 hardware for serial communication up to distances of 50 ft. You can connect the PCMCIA-485 hardware with up to 31 devices using serial cable lengths up to 4,000 ft.

The PCMCIA-232 is available with one, two, or four ports. The PCMCIA-485 is available in a one-port version or two-port version. All PCMCIA cards come with cables for each port that terminates in a standard DB-9 D-Sub connector. Throughout this manual, references to PCMCIA serial interfaces generally refer to all versions of the interfaces.

The PCMCIA-485 interfaces support four hardware transceiver control modes for reliable communication with two-wire and four-wire devices.

Refer to Chapter 4, *Using Your Serial Hardware*, for more information about transceiver control modes.

All of the serial hardware uses standard 16550-compatible UARTs (Universal Asynchronous Receiver/Transmitters) for 100 percent compatibility with standard PC COM ports. The serial hardware contains FIFOs (First-In-First-Out buffers) for reduced susceptibility to interrupt latency and faster transmission rates. Full Plug and Play compatibility gives you the convenience of switchless configuration and installation. Refer to Appendix D, *Specifications*, for more information about the serial hardware specifications and operating conditions.

NI-Serial Software Overview

The NI-Serial software for Windows NT includes a native Windows NT kernel driver that can provide full interrupt-driven, buffered I/O for multiple COM ports. You can obtain a maximum baud rate of 115.2 KBaud. The NI-Serial software also provides a configuration utility, which is integrated with the Windows NT Control Panel. Refer to Appendix D, *Specifications*, for more information about software specifications and recommended operating conditions.

The NI-Serial software includes the following components:

- Device driver
- Diagnostic test
- Configuration utility
- Product manuals

The NI-Serial software supports all National Instruments serial hardware, including all AT, PCI, PXI, CompactPCI, and PCMCIA versions.

Time-Saving Development Tools

Your kit includes the NI-Serial software for Windows NT. In addition, you can order the LabWindows/CVI or LabVIEW software from National Instruments to speed your application development time and make it easier to communicate with your instruments.

LabVIEW is an easy-to-use, graphical programming environment you can use to acquire data from thousands of different instruments, including IEEE 488.2 devices, VXI devices, serial devices, PLCs, and plug-in data acquisition boards. After you have acquired raw data, you can

convert it into meaningful results using the powerful data analysis routines in LabVIEW. LabVIEW also comes with hundreds of instrument drivers, which dramatically reduce software development time, because you do not have to spend time programming the low-level control of each instrument.

LabWindows/CVI is similar to LabVIEW, except that it combines an interactive, easy-to-use development approach with the programming power and flexibility of compiled ANSI C code.

For ordering information, or to request free demonstration software, contact National Instruments.

Using Your Serial Hardware with LabVIEW and LabWindows/CVI

After you install your serial hardware and the NI-Serial software, you can use standard serial I/O functions in LabVIEW and LabWindows/CVI with your serial interface. If you already have LabVIEW or LabWindows/CVI and want to use it with your serial hardware, refer to your LabVIEW or LabWindows/CVI documentation for information about serial I/O functions.

2

Installation and Verification

This chapter contains instructions to help you install the NI-Serial software, serial hardware, and cables, and to verify the installation.

Install the NI-Serial Software

Install the NI-Serial software for Windows NT before you install the hardware.

1. Log on as `Administrator` or as a user who has `Administrator` privileges.

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

3. Double-click on the **Add/Remove Programs** icon in the Control Panel to launch the Add/Remove Programs applet. A dialog box similar to the one in Figure 2-1 appears.
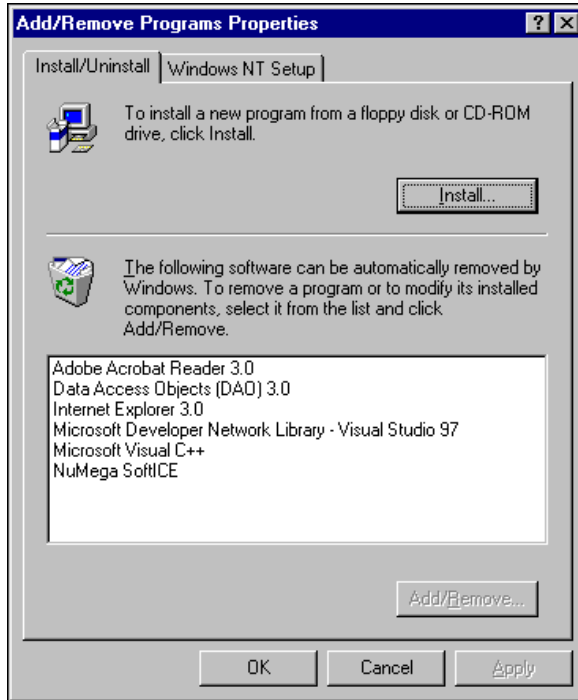
Figure 2-1. Add/Remove Programs Properties Dialog Box

4. Click on the **Install** button.

5. When prompted, insert the *NI-Serial Software for Windows 2000/NT/Me/9x* CD 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-Serial Setup Screen

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

✏️ **Note** This installation backs up the Microsoft Windows NT serial driver `serial.sys` to `serial.bak` and then overwrites `serial.sys`. You can find `serial.sys` in the Windows NT `...\system32\drivers` directory.

The software installation is complete. Proceed to the next section, *Install the PCMCIA Serial Hardware*.

Install the PCMCIA Serial Hardware

Complete the following steps to install the PCMCIA-232 or PCMCIA-485 in your computer:

1. Shut down the computer.

2. Insert the card into a free PC Card (PCMCIA) socket the same way you insert a disk into a floppy drive. The card has no jumpers or switches to set.

3. Power on the computer and start Windows NT.

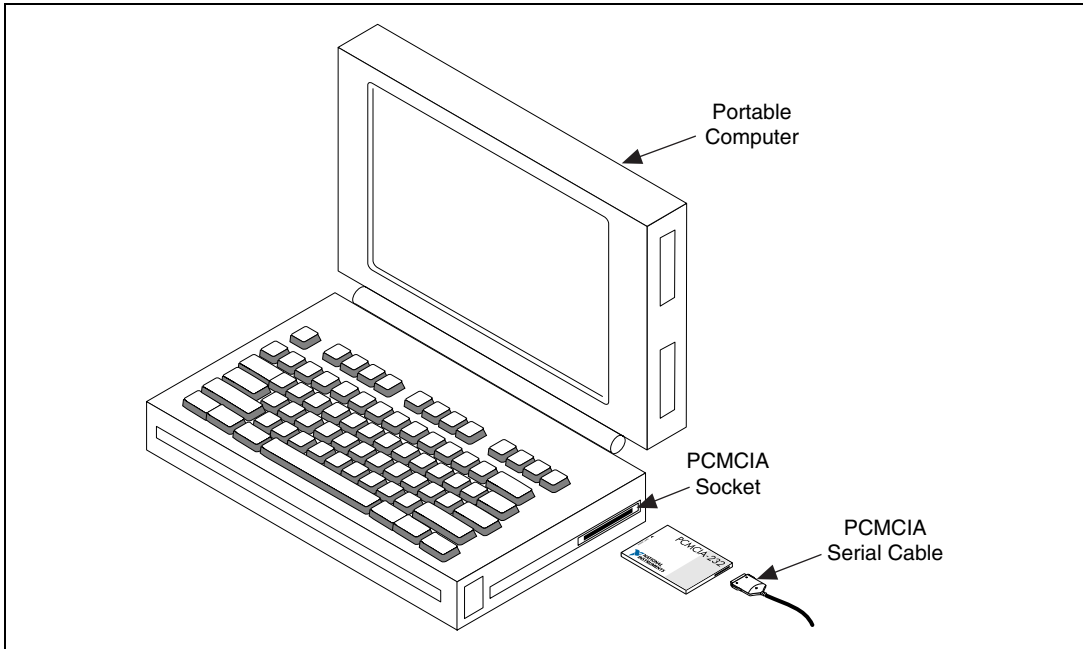Figure 2-3 shows how to insert a PCMCIA serial card and how to connect the cable.

Figure 2-3. Inserting a PCMCIA Serial Card

Proceed to the next section, *Select Resources for the PCMCIA Card*.

Select Resources for the PCMCIA Card

Complete the following steps to select resources for your PCMCIA card.

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

2. Double-click on the **niports** icon.

3. Select the PCMCIA card you just installed from the **Add a New PCMCIA Card** list, and click on the **Add** button.

4. In the **Resource Configuration** dialog box, select nonconflicting base I/O address and IRQ settings for your port/card, and click on **OK**.

    For more information on selecting resources for your port/card, refer to the *Resource Settings* section in Chapter 3, *Configuration*.

5. Exit **niports** and restart the computer.

After you have selected resources for your PCMCIA card, proceed to the next section, *Verify the Installation*.

Verify the Installation

Determine Which Physical Port Is Associated with COMx

Select **Start»Settings»Control Panel**, and double-click on **niports**. A list showing installed National Instruments ports with their logical COM*x* names appears. If your interface is not on the list, refer to Appendix C, *Troubleshooting and Common Questions*.

Select the COM port you want and click on the **Settings** button to display the **General Port Settings** dialog box for that port. This dialog box displays the physical port number starting at 1.

When you have finished verifying the driver installation and physical port, proceed to the next section, *Run the Diagnostic Test*.

Run the Diagnostic Test

To verify and test the installation, run the diagnostic program that came with your NI-Serial software. The diagnostic program verifies that your serial driver is installed properly, that the configuration of your hardware does not conflict with anything else in your system, and that the serial driver can communicate with your hardware correctly.

To run the test, select the **diagnostics** item under **Start»Programs» National Instruments Serial**.

If the diagnostic test completes with no failures, your serial hardware and software are installed properly. If it fails, refer to Appendix C, *Troubleshooting and Common Questions*, for troubleshooting instructions.

Connect the Cables

For the PCMCIA serial cards, you can use the standard DB-9 connector found on most serial cables.

Figure 2-4 and Table 2-1 give the pin locations and descriptions of the DB-9 connector, which is found on the PCMCIA serial cable.
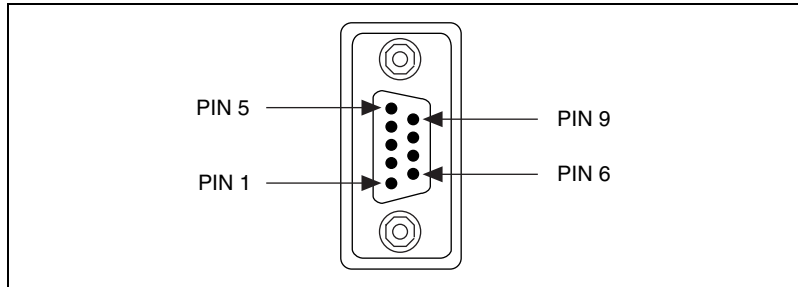

Figure 2-4. DB-9 Connector Pin Locations

Table 2-1. DB-9 Pin Descriptions

DB-9 Pin	232 Signal	485 Signal
Pin 1	DCD	GND
Pin 2	RXD	CTS+ (HSI+)
Pin 3	TXD	RTS+ (HSO+)
Pin 4	DTR	RXD+
Pin 5	GND	RXD-
Pin 6	DSR	CTS- (HSI-)
Pin 7	RTS	RTS- (HSO-)
Pin 8	CTS	TXD+
Pin 9	RI*	TXD-
* This signal is not supported on ports 3 and 4 of the four-port version.		

Connecting Two-Wire Devices

The PCMCIA-485 cards are designed to work with either two- or four-wire devices. If you are using a two-wire device, refer to the device documentation for specific wiring instructions.

In general, half-duplex networks use a single twisted pair of wires for communication in both directions, so you must connect both the transmitter and the receiver at each end of the same pair of wires. For example, to connect an RS-485 data acquisition device to a port on your PCMCIA-485 using half-duplex communication, you need a single twisted pair of wires. At the PCMCIA-485, connect the TXD+ and RXD+ signals (pins 8 and 4 on a DB-9 connector) together and to one wire. Connect the other end of this wire to both the TXD+ and RXD+ signals on the data acquisition device. You use the same method to connect the TXD– and RXD– signals (pins 9 and 5 on a DB-9 connector) to the second wire.

Refer to Chapter 4, *Using Your Serial Hardware*, for information on setting the transceiver mode for two-wire communication. Refer to Appendix A, *Serial Port Information*, for more information on duplex architectures.

3

Configuration

This chapter contains instructions to help you view or change the communication port settings.

Change/View Communication Port Settings

The serial configuration utility is fully integrated with the Windows NT Control Panel. You can use it to examine or modify the configuration of the serial port.

Follow these steps to configure the serial port.

1. Select **Start»Settings»Control Panel** and double-click on the **niports** icon. A list of National Instruments ports appears, as shown in Figure 3-1.
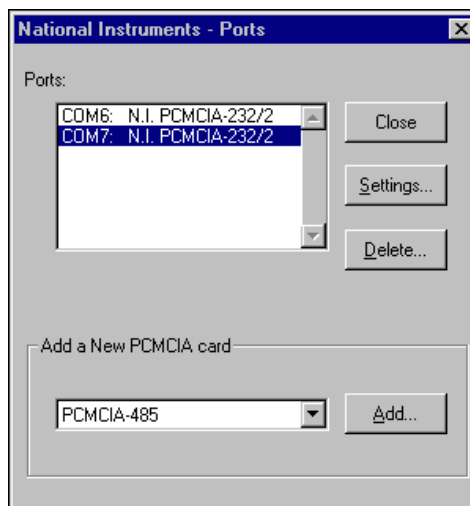
Figure 3-1. niports Configuration Utility

2. Select the port you are interested in.

3. Click on the **Settings** button to view or configure the port settings. Refer to the next section, *General Port Settings*, for more information.

4. Click on the **Resources** button in the **General Port Settings** dialog box to view or configure the resources for the port. Refer to the *Resource Settings* section, later in this chapter, for more information.

5. Click on **Delete** to remove hardware information about the port from Windows NT. You should do this before you physically remove your PCMCIA card.

6. Click on **Add** to configure resources for a new PCMCIA card.

General Port Settings

This section describes the options you can set in the **General Port Settings** dialog box, shown in Figure 3-2.
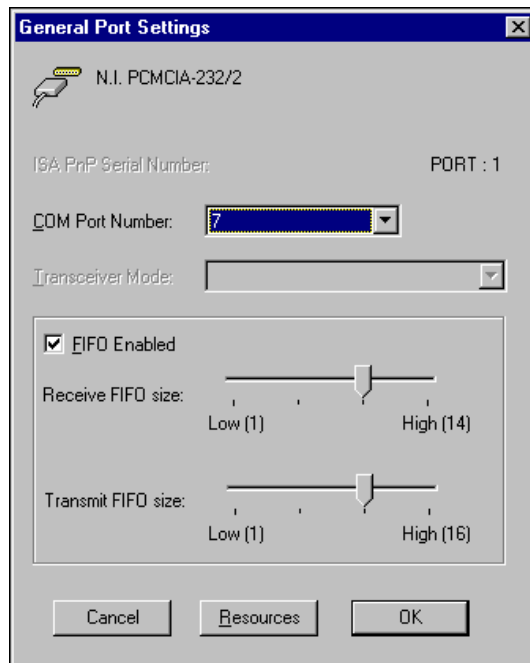
Figure 3-2. General Port Settings Dialog Box

COM Port Number

You can use the **COM Port Number** control to change the COM*x* name of the port selected.

Transceiver Mode

The transceiver mode selection shows the transceiver mode in use, and applies only to PCMCIA-485 cards. Refer to Chapter 4, *Using Your Serial Hardware*, for more information about transceiver modes. If you use two-wire $\overline{\text{TXRDY}}$ mode, FIFOs must be enabled.

FIFO Enabled

You can use the **FIFO Enabled** control to enable or disable the FIFO buffers on the serial port. FIFO buffers are present on the 16550-compatible UARTs—one for the transmitter and one for the receiver.

FIFO Buffers

The FIFO buffer control is available by clicking on the **Advanced** button on the **Port Settings** tab. FIFO buffers are present on the 16550-compatible UARTs—one for the transmitter and one for the receiver. The receive FIFO trigger denotes the number of characters received in the FIFO before the PC is interrupted to read the data. The transmit FIFO trigger denotes the maximum number of bytes written to the FIFO in a block when the PC is interrupted to write the data. Consider the following points when selecting FIFO settings:

- You can select larger FIFO settings to reduce the number of interrupts and therefore minimize system overhead.

- If transfer rates are high, you can lower receive FIFO settings to reduce the number of interrupts and therefore prevent overrun errors due to interrupt latency.

- If data transfer sizes are small, selecting receive FIFO settings just above data sizes can reduce efficiency, so select lower settings.

Resources

Click on the **Resources** button to display the resource configuration dialog box for the port. For more information on resource configuration, refer to the next section, *Resource Settings*.

Resource Settings

The following sections explain the resource configuration options for each serial interface.

PCMCIA-232, PCMCIA-485, PCMCIA-232/4

Figure 3-3 shows the resource configuration dialog box for a PCMCIA-485. The PCMCIA-232 and PCMCIA-232/4 dialog boxes are similar.
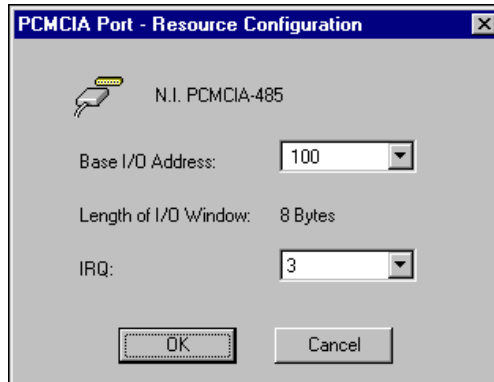

Figure 3-3. Resource Configuration Dialog Box for the PCMCIA-485

Base I/O Address:	The base I/O address assigned to the port.
IRQ:	The IRQ assigned to the port.
Length:	The size (in bytes) of the I/O window.
	For the PCMCIA-232 and PCMCIA-485, the length is 8 (the size of the I/O window for one port).
	For the PCMCIA-232/4, the length is 32 bytes (the size of the I/O window for four ports).

PCMCIA-232/2, PCMCIA-485/2

These cards require two base I/O settings, one for each port, and they share an IRQ.

Figure 3-4 shows the resource configuration dialog box for a PCMCIA-485/2. The PCMCIA-232/2 dialog box is similar.
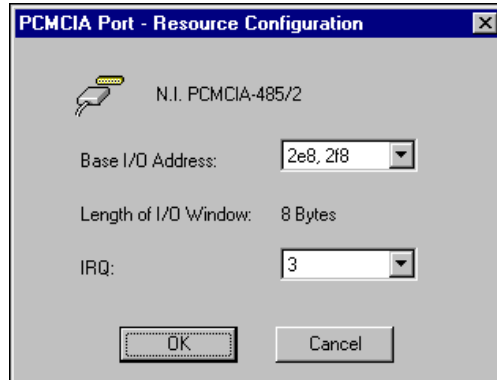
Figure 3-4. Resource Configuration Dialog Box for the PCMCIA-485/2

Base I/O Address:	The base I/O addresses assigned to the two ports.
IRQ:	The IRQ shared by the two ports.
Length:	The size of each I/O window (in bytes).

Note   When you select resources for the PCMCIA cards, use the Microsoft Windows NT diagnostics utility to make sure that the resources have not been assigned to any other device. This utility displays a list of I/O port addresses and IRQ levels that are currently being used in your system.

4

Using Your Serial Hardware

This chapter describes how to set the hardware transceiver control mode for your RS-485 interfaces and lists some general programming requirements.

Advanced Transceiver Control for the PCMCIA-485

The PCMCIA-485 cards support four modes of hardware transceiver control. (Transceiver modes apply only to these interfaces.) You can use hardware flow control to enable and disable your transmitters and receivers to work on different bus topologies. Table 4-1 lists the status of the transmitters and receivers under each of the transceiver control modes.

Table 4-1. Transceiver Control Modes

Mode	Transmitter	Receiver
Four-wire mode	Always enabled	Always enabled
Two-wire mode: $\overline{\text{DTR}}$ with echo	Enabled with $\overline{\text{DTR}}$ unasserted	Always enabled
Two-wire mode: $\overline{\text{DTR}}$ controlled	Enabled with $\overline{\text{DTR}}$ unasserted	Enabled with $\overline{\text{DTR}}$ asserted
Two-wire mode: $\overline{\text{TXRDY}}$ auto control	Enabled with $\overline{\text{TXRDY}}$ asserted	Enabled with $\overline{\text{TXRDY}}$ unasserted

Note Signal names with an overscore, such as $\overline{\text{DTR}}$, indicate that the signal is active low.

Four-Wire Mode

Use the four-wire mode for most full-duplex systems. In this mode, the transmitter and receiver are always enabled. This mode is the default.

Two-Wire Mode: $\overline{\text{DTR}}$ with Echo

Use this mode in half-duplex systems where the $\overline{\text{DTR}}$ (Data Terminal Ready) line must control the transmitter. In the $\overline{\text{DTR}}$-with-echo mode, the transmitter is tri-stated when the $\overline{\text{DTR}}$ signal of the UART (Universal Asynchronous Receiver/Transmitter) is asserted. To transmit, your application must first clear the $\overline{\text{DTR}}$ bit to enable the transmitter. After the data is fully transmitted, your application once again sets the $\overline{\text{DTR}}$ bit to disable the transmitter. Because the receiver is always enabled in this mode, you not only receive packets from other devices, you also receive the packets sent from your transmitter.

Two-Wire Mode: $\overline{\text{DTR}}$ Controlled

This mode is similar to the two-wire, $\overline{\text{DTR}}$-with-echo mode. Use this mode in half-duplex systems where the $\overline{\text{DTR}}$ line must control the transmitter. Although this mode uses the same method as the $\overline{\text{DTR}}$-with-echo mode to control the transmitter, the hardware automatically disables the receiver whenever the transmitter is enabled. Thus, you do not receive packets that you have transmitted.

Two-Wire Mode: $\overline{\text{TXRDY}}$ Auto Control

In this mode, the hardware transparently enables the transmitter and receiver in a two-wire system. This mode removes the burden of flow control from the user software. By connecting the transmitter to the $\overline{\text{TXRDY}}$ (Transmit Ready) line, the hardware enables the transmitter for each byte to be transmitted. Also, the hardware disables the receiver whenever the transmitter is enabled, so you do not receive packets that you have transmitted.

Note   It is recommended that you use the two-wire $\overline{\text{TXRDY}}$ auto control mode when you are communicating with a two-wire device. Because this mode handles the transmitter/receiver enabling for a two-wire connection in your hardware, it reduces the software overhead required to perform this operation in your application program. For more information about serial communication in two- or four-wire modes, refer to the section *Serial Communication Issues* in Appendix A, *Serial Port Information*.

Setting the Transceiver Control Mode

The recommended method for setting the transceiver control mode is with the serial configuration utility located in the Windows NT Control Panel. For more information, refer to the *General Port Settings* section in Chapter 3, *Configuration*. The mode you select in the Control Panel is automatically configured when you open a port on a serial interface.

Setting the Transceiver Mode with DeviceIoControl

The NI-Serial software extends the Windows function `DeviceIoControl` for programming the transceiver control mode. To program the transceiver control mode using `DeviceIoControl`, complete the following steps.

1. Add the following lines to your source code.

    ```
    #include <winioctl.h>

    #define IOCTL_SERIAL_SET_TRANSCEIVER_MODE
    CTL_CODE(FILE_DEVICE_SERIAL_PORT,37,
    METHOD_BUFFERED, FILE_ANY_ACCESS)
    ```

2. Use the Win32 function `DeviceIoControl`. Use the defined control code value listed in Step 1 to set the transceiver mode, and the input buffer values (unsigned long) listed in Table 4-2 for programming different transceiver modes.

Table 4-2. DeviceIoControl Function Input Values

Transceiver Mode	DeviceIoControl Function Input Value
Four-wire mode	128
Two-wire mode: $\overline{DTR}$ with echo	129
Two-wire mode: $\overline{DTR}$ controlled	130
Two-wire mode: $\overline{TXRDY}$ auto control	131

For example, to set two-wire $\overline{TXRDY}$ auto control mode, use the following call:

```
ULONG TranceiverMode = 131;
DeviceIoControl(hDevice,
IOCTL_SERIAL_SET_TRANSCEIVER_MODE,(PVOID)
&TransceiverMode,sizeof(ULONG),lpOutBuffer,
nOutBufferSize,lpBytesReturned,lpOverlapped);
```

General Programming Requirements

Once installed, the NI-Serial software is integrated into the standard Windows NT communications software. NI serial ports are used like any other Windows NT communications (COM) port. Windows NT has standard communication functions for use within either 16-bit (Win16) applications or 32-bit (Win32) applications.

As you begin developing your application, remember that you must use the standard Microsoft Windows serial communication functions. For information about Microsoft Windows serial communication functions, refer to the *Win32 Software Development Kit,* online help for *Win32 Overviews,* and *Win32 Reference*.

If you have LabVIEW or LabWindows and want to use it with your serial hardware, refer to your LabVIEW or LabWindows documentation for information about serial I/O functions.

A

Serial Port Information

This appendix discusses the RS-232, RS-422, and RS-485 standards and explains some of the issues involved with these types of serial communication.

Table A-1 lists the features of the RS-232, RS-422, and RS-485 standards.

Table A-1. RS-232, RS-422, and RS-485 Features

Feature	RS-232	RS-422	RS-485
Type of transmission lines	Single ended	Differential	Differential
Maximum number of drivers	1	1	32
Maximum number of receivers	1	10	32
Maximum cable length	50 ft.	4,000 ft.	4,000 ft.
Maximum data rate	20 kbytes/s	10 Mbytes/s	10 Mbytes/s
Maximum CMV	±25 V	±7 V	+12 to –7 V
Driver output	5 to 25 V	2 to 6 V	1.5 to 6 V
Driver load	>3 kΩ	100 Ω	60 Ω

RS-232

RS-232, as specified in the ANSI/EIA-232-D Standard, *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, standardizes serial communication between computers and between computer terminals and modems. Most applications use the RS-232 standard for interfacing peripherals to personal computers. RS-232 uses transmission lines in which the state of each signal is represented by referencing the voltage level of a single line to ground. RS-232 was designed for serial communication up to

distances of 50 ft. and with data rates up to 20 kbytes/s. However, because of improvements in line drivers and cabling, you can often increase the actual performance of the bus past the limitations on speed and distance recommended in the specification.

RS-422

RS-422, as specified in the EIA RS-422-A Standard, *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*, defines a serial interface much like RS-232. However, RS-422 uses balanced (or differential) transmission lines. Balanced transmission lines use two transmission lines for each signal. The state of each signal is represented, not by a voltage level on one line referenced to ground as in RS-232, but rather by the relative voltage of the two lines to each other. For example, the TX signal is carried on two wires, wire A and wire B. A logical 1 is represented by the voltage on line A being greater than the voltage on line B. A logical 0 is represented by the voltage on line A being less than the voltage on line B. Differential voltage transmission creates a signal that is much more immune to noise as well as voltage loss due to transmission line effects. Thus, you can use RS-422 for much longer distances (up to 4,000 ft.) and much greater transmission speeds (up to 10 Mbytes/s) than RS-232.

RS-485

RS-485, as specified in the EIA-485 Standard, *Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems*, expands on the RS-422 standard by increasing the number of devices you can use from 10 to 32 and by working with half-duplex bus architectures. Unlike the RS-422 standard, RS-485 addresses the issue of using multiple transmitters on the same line. RS-485 defines the electrical characteristics necessary to ensure adequate signal voltages under maximum load, short-circuit protection, and the ability to withstand multiple drivers driving conflicting signals at the same time.

Serial Communication Issues

This section explains some serial communication issues, such as duplex architectures, termination methods, bias resistors, and types of connecting equipment.

Duplex Architectures

Duplex refers to the means of bandwidth usage in a serial system. The two common means of bi-directional serial communication are full duplex and half duplex. Half-duplex communication involves a transmitter and a receiver connected to each end of the same wire or pair of wires. Because the same transmission line is used for both sending and receiving data, devices cannot send data in both directions at the same time. First, one device transmits over the wire(s) to the receiver of the second device. When the first device finishes transmitting, both devices switch the connections from their transmitter to their receiver or vice versa. The device that was receiving data can then transmit over the line.

In full-duplex communication, the devices use a separate wire (or pair of wires) for simultaneous transmission in each direction. Thus, there is no need to switch between transmitting and receiving.

In a differential serial bus (for example, RS-422 or RS-485), a half-duplex system can transmit and receive over the same twisted pair of wires. Thus, half-duplex communication is often referred to as *two-wire* communications. Likewise, full-duplex communication is often referred to as *four-wire* communications, because the full-duplex system uses a separate pair of wires for communication in each direction.

Full Duplex

A typical full-duplex multidrop bus architecture involves a master-slave protocol. Only one device, the master, can control access to the bus. All other devices are slaves. Slave devices must wait for the master to give them access to the bus. In a typical full-duplex system, one transmission line connects the bus master's transmitter to all of the slave receivers. A second transmission line connects all of the slave transmitters to the bus master's receiver. Because in a differential system each transmission line is composed of two separate wires, a full-duplex system is often referred to as a four-wire system. Figure A-1 shows a typical full-duplex system.
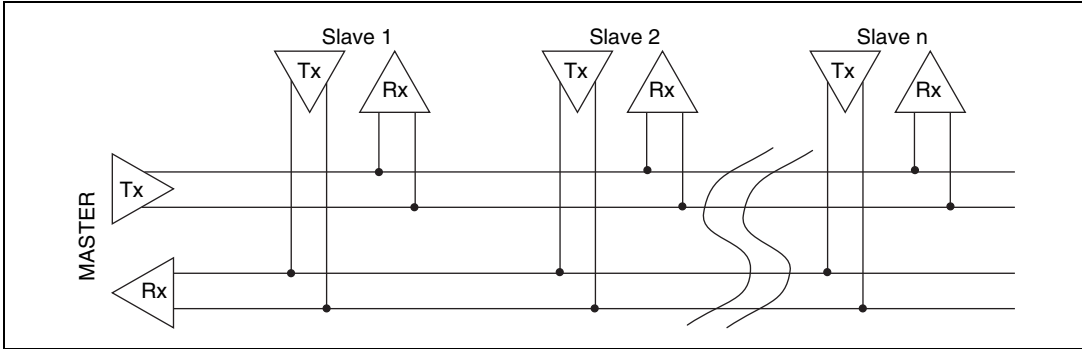
Figure A-1. Typical Full-Duplex System

Half Duplex

A typical half-duplex multidrop bus architecture also involves a master-slave protocol. In a half-duplex system, all transmitters and receivers are connected to the same transmission line. A half-duplex system is often referred to as a two-wire system. Figure A-2 shows a typical half-duplex system.
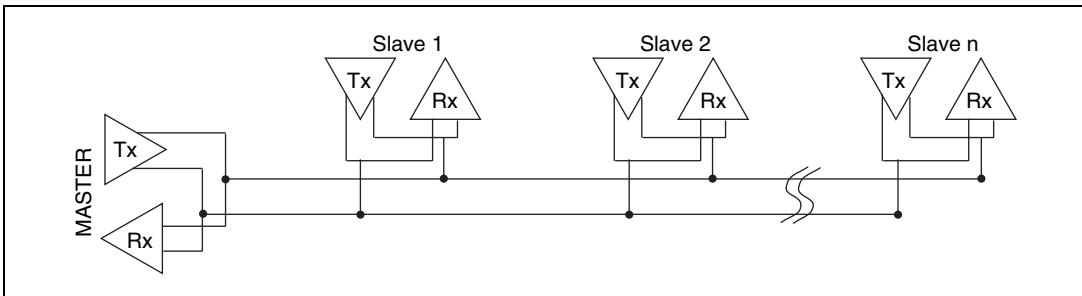

Figure A-2. Typical Half-Duplex System

Termination

Because each differential pair of wires is a transmission line, you must properly terminate the line to prevent reflections. A common method of terminating a two-wire multidrop RS-485 network is to install terminating resistors at each end of the multidrop network. If you daisy-chained multiple instruments together, you need a terminating resistor at only the first and last instruments. The terminating resistor should match the characteristic impedance of the transmission line (typically 100–120 Ω). National Instruments offers an optional DB-9 RS-485 termination connector that contains embedded terminating resistors for easy termination.

Figure A-3 shows a multidrop network using terminating resistors.
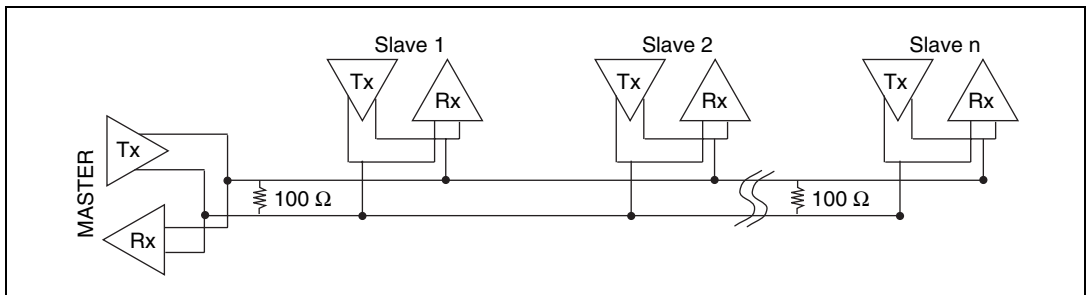
Figure A-3. Multidrop Network Using Terminating Resistors

DTE vs. DCE

Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) were the terms used in the RS-232 specification for the types of equipment on either end of a serial connection. (A DCE is called Data Circuit-Terminating Equipment in Revision D of the RS-232 specification.) In general, DTE and DCE refer to computer equipment and modems, respectively. Because the RS-232 specification mainly involves connecting a DTE directly to a DCE and vice versa, the pinouts are defined so that cabling is simple. That is, a cable connected a computer to a modem by wiring pin 1 to pin 1, pin 2 to pin 2, and so on. This method is commonly known as *straight-through* cabling.

Figure A-4 shows straight-through cabling in a DTE-to-DCE interface.
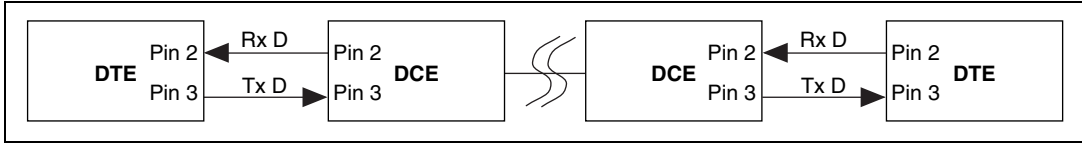
Figure A-4. Straight-Through Cabling in a DTE-to-DCE Interface

Straight-through cabling is still the standard method to connect a modem to your PC. However, because many applications use serial communication to connect two or more DTEs without modems, the cabling becomes more complicated. If two DTEs are wired together using a straight-through cable, one transmitter is connected to the other transmitter, and one receiver is connected to the other receiver. In this setup, no transmissions can occur. Thus, these applications must use a cabling scheme that connects the transmitter on one device to the receiver on the other device and vice versa. This method is known as *null-modem* cabling, because it replaces the two modems that traditional RS-232 applications would require between the two DTEs. You should use a null-modem cable to communicate from one serial port to another.

Figure A-5 shows null-modem cabling in a DTE-to-DTE interface.
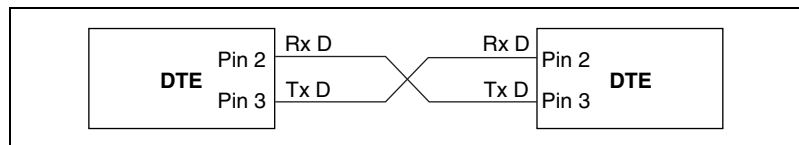
Figure A-5. Null-Modem Cabling in a DTE-to-DTE Interface

B

Uninstalling the Serial Hardware and Software

This appendix explains how to uninstall your serial hardware and NI-Serial software.

Removing the Hardware Information

Before physically removing the serial hardware, you must remove the hardware information from the Windows NT Control Panel.

Follow these steps to uninstall the hardware:

1. Double-click on the **niports** icon under **Start»Settings»Control Panel**.

2. Select the port to remove from the list of ports as shown in Figure B-1.
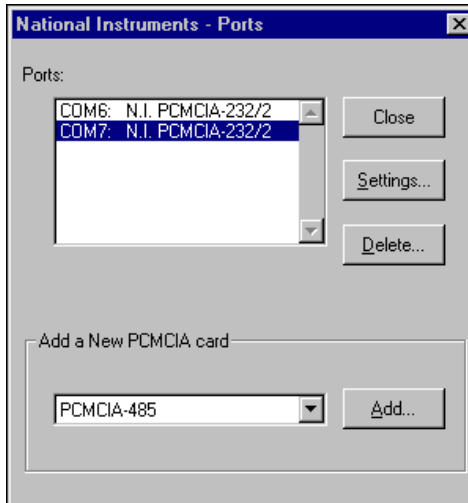
Figure B-1. Selecting an Interface to Uninstall

3. Click on the **Delete** button.

✎ **Note** For two-port and four-port PCMCIA cards, all ports on the interface are removed.

Uninstalling the NI-Serial Software

Before uninstalling the software, remove all serial port information from the Windows NT Control Panel, as described in the previous section. You do not need to shut down Windows NT before uninstalling the software.

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

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 B-2 appears. This dialog box lists the software available for removal.
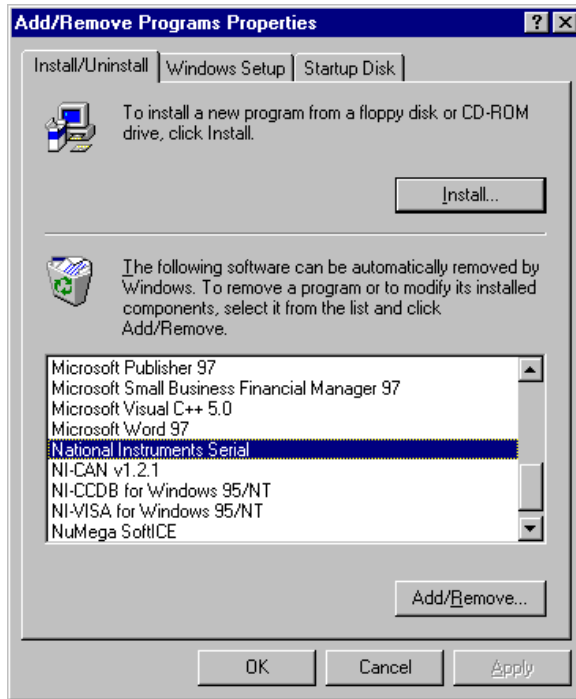
Figure B-2. Add/Remove Programs Properties Dialog Box

3. Select the serial software you want to remove, and click on the
    Add/Remove button. The uninstall program runs and removes all
    folders, utilities, and registry entries associated with the NI-Serial
    software. Figure B-3 shows the results of a successful uninstallation.
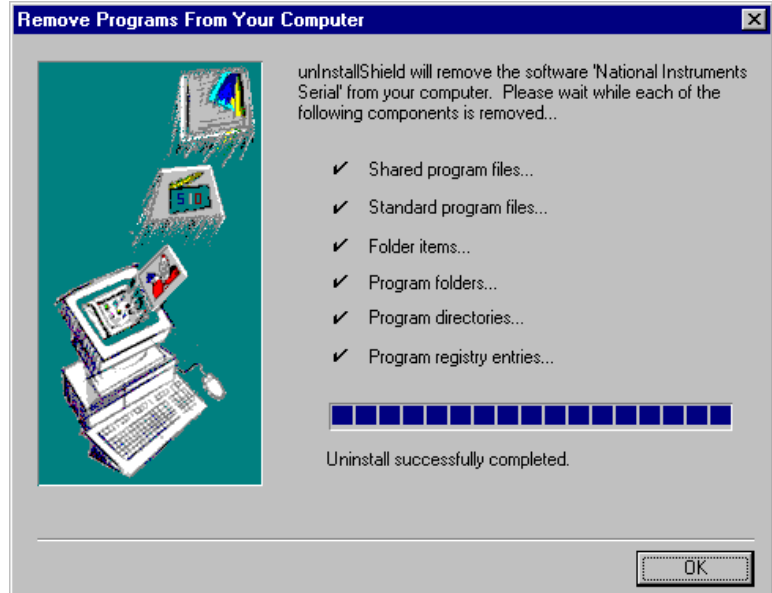
Figure B-3. Uninstallation Results

4. Shut down Windows NT, power off your computer, and remove your
    serial interfaces.

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

C

Troubleshooting and Common Questions

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

Missing Serial Port in the niports List

The serial configuration utility **niports** contains configuration information for serial hardware it is aware of that is installed in your system.

To start the configuration utility, select **Start»Settings»Control Panel**, and double-click on the **niports** icon.

If serial ports are missing from this list, make sure you selected resources for your PCMCIA card as described in the *Select Resources for the PCMCIA Card* section in Chapter 2, *Installation and Verification*.

Resolving Resource Conflicts

Resource conflicts occur when your system contains hardware that is configured to use the same resources as your serial interface. The serial driver detects some resource conflicts when it loads. When the driver detects conflicts as it loads, it records an error message describing the conflict. You can use the Event Viewer to see which resource is in conflict. To run the Event Viewer, select **Start»Programs»Administrative Tools»Event Viewer**.

After you have identified the resource that caused the conflict, use the serial configuration utility, **niports**, to reconfigure your serial interface so that it uses conflict-free resources. For more information, refer to Chapter 3, *Configuration*.

To help in the selection of conflict-free resources, Microsoft has provided a utility called Windows NT Diagnostics. This utility displays a list of the I/O port addresses, IRQ levels, and DMA channels that are currently being used in your system. Assign resources not listed by this utility to your serial interface.

To run the Windows NT Diagnostics, select **Start»Programs» Administrative Tools»Windows NT Diagnostics**.

Troubleshooting Diagnostic Messages

This section lists possible diagnostic error messages, along with solutions.

- If the **No National Instruments serial port found** error message appears, refer to Chapter 2, *Installation and Verification*, to follow these troubleshooting steps:

    1. Verify the hardware resources. To verify the hardware resources, click on the **Resources** button on the **General Port Settings** page. For more information about resource conflicts, refer to Chapter 3, *Configuration*.

    2. Verify that the National Instruments serial driver is installed. Use the Windows Explorer to display the **Properties** of serial.sys.

    3. If either the serial hardware or serial.sys file is missing, reinstall the hardware and software. You should find serial.sys in the \WinNT\system32\drivers directory.

- If the utility reports fewer ports installed than it should, refer to Chapter 2, *Installation and Verification*, and follow these troubleshooting steps:

    1. Verify the hardware resources.

    2. Verify that the National Instruments serial driver is installed. Use the Windows Explorer to display the **Properties** of serial.sys.

    3. Check the hardware installation to make sure the correct number of boards/ports are installed.

- If the **I/O address test failed, Interrupt test cannot be performed** error message appears, verify the hardware resources as described in Chapter 3, *Configuration.* If the test still fails, you probably have an I/O address conflict with other boards in your system. Use the niports configuration utility to change the base I/O addresses assigned to your ports. For more information, refer to Chapter 3, *Configuration.*

- If the **Interrupt test failed** error message appears, verify the hardware resources as described in Chapter 3, *Configuration.* If the test still fails, you probably have an IRQ conflict with the boards in your system. Use the niports configuration utility to change the IRQ level assigned to your port. For more information, refer to Chapter 3, *Configuration.*

Common Questions

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

Double-click on the **niports** icon under **Start»Settings»Control Panel** to display a list of installed ports.

What do I do if the diagnostic test fails with an error?

Refer to the troubleshooting sections of this manual for specific information about what might cause the test to fail.

How can I determine which port is associated with COM*x*?

Refer to the section *Determine Which Physical Port Is Associated with COMx*, in Chapter 2, *Installation and Verification*.

How can I change the COM numbers of my National Instruments serial ports?

Refer to the *General Port Settings* section in Chapter 3, *Configuration*.

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

The Read Me file lists the version of the software. To read the file, select **Read Me** under **Start»Programs»National Instruments Serial.**

D

Specifications

This appendix describes the characteristics of the serial hardware, the
NI-Serial software, and the recommended operating conditions.

Hardware Specifications

Table D-1. Physical Characteristics of the PCMCIA Serial Cards

Characteristic	Specification
Dimensions	85.6 by 54.0 by 0.5 cm (3.370 by 2.126 by 0.197 in.)
I/O Connector	Special Cable with DB-9 Dsub Connector and Converter for PC Card
Power Requirement (from PCMCIA expansion slot)	
PCMCIA-232	+5 VDC 40 mA Typical
PCMCIA-485	+5 VDC 100 mA Typical
PCMCIA-232/2	+5 VDC 60 mA Typical
PCMCIA-485/2	+5 VDC 100 mA Typical
PCMCIA-232/4	+5 VDC 60 mA Typical

Table D-2. Environmental Characteristics of the Serial Hardware

Characteristic	Specification
Operating Environment Component Temperature Relative Humidity	 0 to 70° C 10 to 90%, noncondensing
Storage Environment Temperature Relative Humidity	 –40 to 120° C 5 to 90%, noncondensing
EMI	FCC Class A Verified

Software Specifications

Table D-3. Software Characteristics

Characteristic	Specification
Maximum Serial Transfer Rate	115,200 bps*
* Actual speed may vary considerably from speed shown due to system and instrumentation capabilities.	

E

Technical Support Resources

Web Support

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

NI Developer Zone

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

Customer Education

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

System Integration

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

Worldwide Support

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

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

Glossary

Prefix	Meaning	Value
p-	pico-	10^{-12}
n-	nano-	10^{-9}
μ-	micro-	10^{-6}
m-	milli-	10^{-3}
k-	kilo-	10^{3}
M-	mega-	10^{6}
G-	giga-	10^{9}
t-	tera-	10^{12}

°	degrees
%	percent
Ω	ohms
A	amperes
ANSI	American National Standards Institute
b	bits
B	bytes
baud	bits per second
bps	bits per second
C	Celsius
COM	Computer Output Microform
CTS	Clear To Send
DB-*xx*	subminiature D connector (where *xx* is the number of pins)

DCD	Data Carrier Detect
DCE	Data Communications Equipment or Data Circuit-Terminating Equipment
DMA	direct memory access
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready (where the overscore denotes that the signal is active low)
EIA	Electronic Industries Association
EMI	electromagnetic interference
FCC	Federal Communications Commission
FIFO	first-in-first-out
ft.	feet
GND	Ground
HSI	Handshake Input
HSO	Handshake Output
Hz	hertz
IEEE	Institute of Electrical and electronic Engineers
in.	inches
I/O	input/output
IRQ	interrupt request
ISA	Industry Standard Architecture
Kbaud	kilobits per second
m	meters

MB	megabytes of memory
PC	personal computer
PCI	Peripheral Components Interconnect
PCMCIA	Personal Computer Memory Card International Association
PnP	Plug and Play
RAM	random-access memory
RI	Ring Indicator
RX	Receive
RXD	Receive Data
RTS	Request to Send
s	seconds
SCSI	Small Computer Systems Interface
TX	Transmit
TXD	Transmit Data
TXRDY	Transmit Ready (where the overscore denotes that the signal is active low)
UART	universal asynchronous receiver/transmitter
V	volts
VDC	volts direct current
VXI	VME eXtensions for Instrumentation

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