Industrial Communications

Getting Started with Your AT Serial Board for Windows 95

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This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC). This equipment has been tested and found to comply with the following two regulatory agencies:

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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

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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.

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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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This manual contains instructions to help you install and configure the National Instruments Plug and Play AT serial interface board and the NI serial driver software for Windows 95. The board is intended for use in personal computers equipped with 16-bit ISA slots. The NI serial driver software is intended for use with Windows 95. This manual assumes that you are already familiar with Windows 95.

Organization of the Manual

- Chapter 1, *Introduction*, explains how to use this manual, lists what you need to get started, and briefly describes the Plug and Play AT serial board and the NI serial driver software.
- Chapter 2, *Installation and Verification*, contains instructions to help you install the AT serial board, NI serial driver software, and cables.
- Chapter 3, *Configuration*, contains instructions to help you view or change the communication port settings.
- Chapter 4, *Using Your AT Serial Board,* describes how to set the hardware transceiver control mode for your Plug and Play AT-485 board and lists some general programming requirements.
- Appendix A, *Specifications,* describes the physical characteristics of the Plug and Play AT serial board and the recommended operating conditions.
- Appendix B, *Serial Port Information,* discusses the RS-232, RS-422, and RS-485 standards and explains some of the different issues involved with these types of serial communication.
- Appendix C, *Uninstalling the AT Serial Board and Driver,* explains how to uninstall your AT serial board and NI serial driver.
- Appendix D, *Troubleshooting and Common Questions,* describes how to troubleshoot problems and contains a list of common questions.

- Appendix E, *Customer Communication,* contains forms you can use to request help from National Instruments or to comment on our products and manuals.
- The *Glossary* contains an alphabetical list and 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:

AT serial board	Refers to a National Instruments AT-232 or AT-485 board for the ISA (PC AT) bus.
bold	Bold text denotes menus, menu items, or dialog box buttons or options.
bold italic	Bold italic text denotes a note, caution, or warning.
`bold monospace`	Bold text in this font denotes the messages and responses that the computer automatically prints to the screen.
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 are to be literally input 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, variables, filenames, and extensions, and for statements and comments taken from program code.
< >	Angle brackets enclose the name of a key on the keyboard—for example, <PageDown>.
-	A hyphen between two or more key names enclosed in angle brackets denotes that you should simultaneously press the named keys—for example, <Control-Alt-Delete>.
»	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.
	Abbreviations, acronyms, metric prefixes, mnemonics, symbols, and terms are listed in the *Glossary*.

Related Documentation

The following documents contain information that you may 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 Windows Software Developer Kit*, Vol.1: Overview, Microsoft Corporation
- *Microsoft Windows Software Developer Kit*, Vol.2: Functions, Microsoft Corporation
- *Microsoft Windows User's Guide*, Microsoft Corporation
- *NS16550AF Universal Asynchronous Receiver/Transmitter with FIFOs*, National Semiconductor

Customer Communication

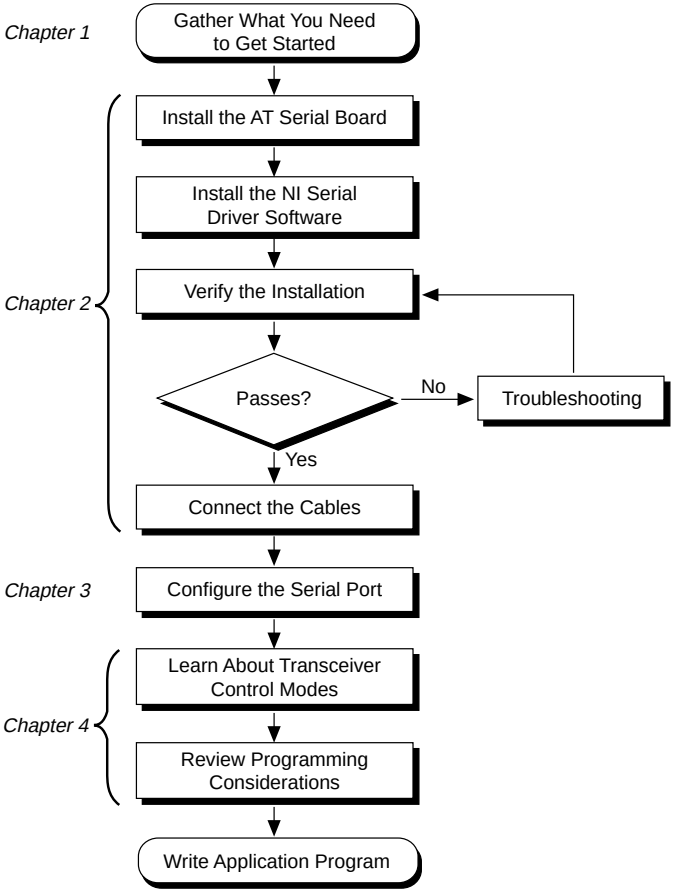
National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you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

Chapter 1

Introduction

This chapter explains how to use this manual, lists what you need to get started, and briefly describes the Plug and Play AT serial board and the NI serial driver software.

How to Use This Manual



What You Need to Get Started

Make sure you have all of the items listed before you attempt to install the Plug and Play AT serial board.

- ❑ AT-232 board (two or four port)

  or

  AT-485 board (two or four port)

- ❑ 3.5 in. high density (1.44 MB) *NI Serial Driver Software for Windows 95. Distribution Disk for the AT-232 and the AT-485*

- ❑ Microsoft Windows 95 installed on your computer

Optional Equipment

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

- DB-9 RS-485 termination connector (AT-485 boards only)
- 10-position modular jack to DB-9 cable (four-port boards only)
- 10-position modular jack to DB-25 cable (four-port boards only)
- RS-232 9-pin to 9-pin null modem cable
- RS-232 9-pin to 25-pin null modem cable

AT Serial Board Overview

The Plug and Play AT serial boards give you a variety of solutions for serial communications. The AT-232 board works with the RS-232 protocol, and the AT-485 board works with the RS-422 and RS-485 protocols. You can use an AT-232 board for serial communication up to distances of 50 ft. Using serial cable lengths up to 4,000 ft., you can connect the AT-485 with up to 31 devices.

Both boards are available with two or four ports. The two-port versions use DB-9 connectors. The four-port versions use 10-position modular jacks to provide all four connections on a single back panel. Optional cable accessories convert the 10-position modular jacks to either DB-9 or DB-25 connectors with standard pinouts.

The AT-485 board supports four hardware transceiver control modes for reliable communication with two-wire and four-wire devices. Refer

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

Both the AT-232 and AT-485 boards use standard 16550-compatible UARTs (Universal Asynchronous Receiver/Transmitters) for 100% compatibility with standard PC COM ports. The boards contain 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 A, *Specifications*, for more information about the AT serial board specifications and operating conditions.

NI Serial Driver Software Overview

The NI serial driver software for Windows 95 includes a native Windows device driver that can provide full interrupt-driven, buffered I/O for multiple COM ports. Using this driver, you can obtain a maximum baud rate of 115.2 kbytes/s, and you can use any number of serial ports under Windows 95. The NI serial driver software also provides a configuration utility, which is integrated with the Windows 95 Device Manager. Refer to Appendix A, *Specifications*, for more information about software specifications and recommended operating conditions.

The NI serial driver software includes the following components:

- Device driver
- Diagnostic test
- Configuration utility

Optional Programming Tools

Your kit includes the NI serial driver software for Windows 95. In addition, you can order the LabWindows®/CVI or LabVIEW software from National Instruments. LabWindows/CVI and LabVIEW include instrument driver libraries that make it easier to communicate with your serial 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 more than 300 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.

Using the AT Serial Board with Other National Instruments Products

The AT serial boards are fully compatible with standard PC serial ports. You can use standard serial I/O functions in LabVIEW and LabWindows/CVI with all AT serial boards. Refer to the LabVIEW or LabWindows/CVI documentation for more information.

Installation and Verification

Chapter 2

This chapter contains instructions to help you install the AT serial board, NI serial driver software, and cables.

System Preparation

If you have been using your AT serial board in Windows 95 with the default Windows 95 driver, you need to remove the Plug and Play serial hardware information before installing the NI serial driver software.

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. Select the **Device Manager** page.
4. Click the **View devices by type** button.
5. Click on the **+** sign next to **Ports (COM & LPT)** to display a list of all ports that Windows 95 recognizes.
6. Select a port name from the list of ports that corresponds to an AT serial board port (for example, COM 5, COM 6, COM 7, or COM 8). Figure 2-1 shows the **Ports** list in the **Device Manager** with a port selected.

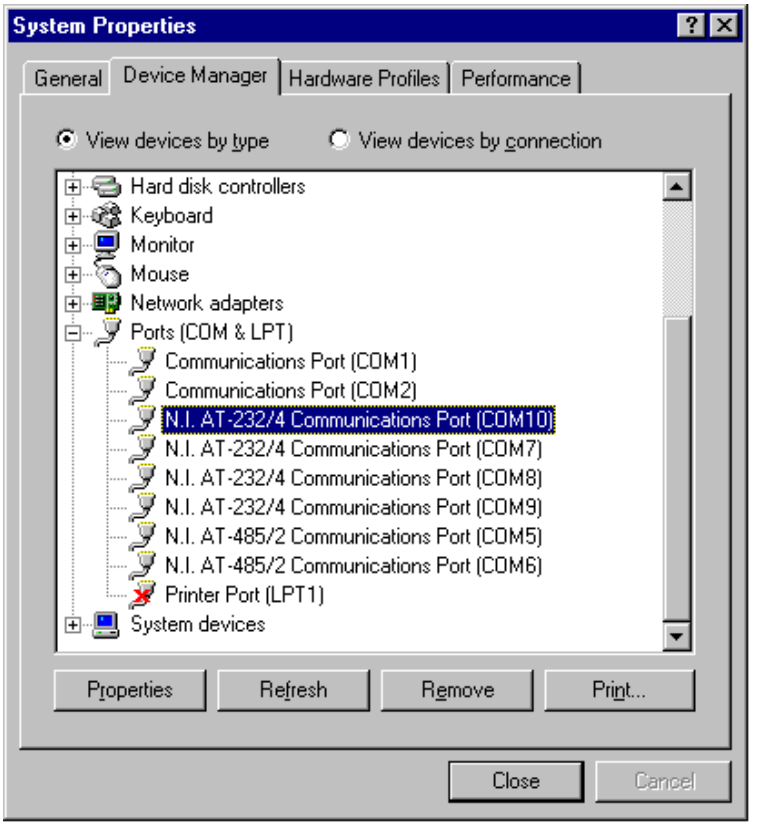


Figure 2-1. Port Selected in Device Manager

7. Click the **Remove** button, and click on **OK** to confirm the removal of the Plug and Play serial hardware information.
8. Repeat steps 6 and 7 until all AT serial board port entries are removed. Then click on **Close** to exit.

Install the AT Serial Board

Keep in mind the following naming conventions as you read through the rest of this manual.

- *AT-232* refers to a two or four-port National Instruments board with RS-232 ports for the ISA (PC AT) bus.
- *AT-485* refers to a two or four-port National Instruments board with RS-485/RS-422 ports for the ISA (PC AT) bus.
- *AT serial board* refers generically to either the AT-232 or AT-485 board in cases where the material can apply to either board.

Follow these steps to install the Plug and Play AT serial board:

Note: ***If you are installing an AT-485, you may need to adjust the value of the bias resistors, depending on your application. For more information, refer to Appendix B****, Serial Port Information.*

1. Turn off your computer. Keep the computer plugged in so that it remains grounded while you install the AT serial board.
2. Remove the top or side cover of the computer.
3. Remove the expansion slot cover on the back of the computer.
4. Insert the AT serial board into an unused slot with the serial connectors sticking out of the opening on the back panel. Make sure that you insert the board all the way into the slot. The board may seem to click firmly into place, even though it is only part of the way in. Figure 2-2 shows the installation of an AT serial board.

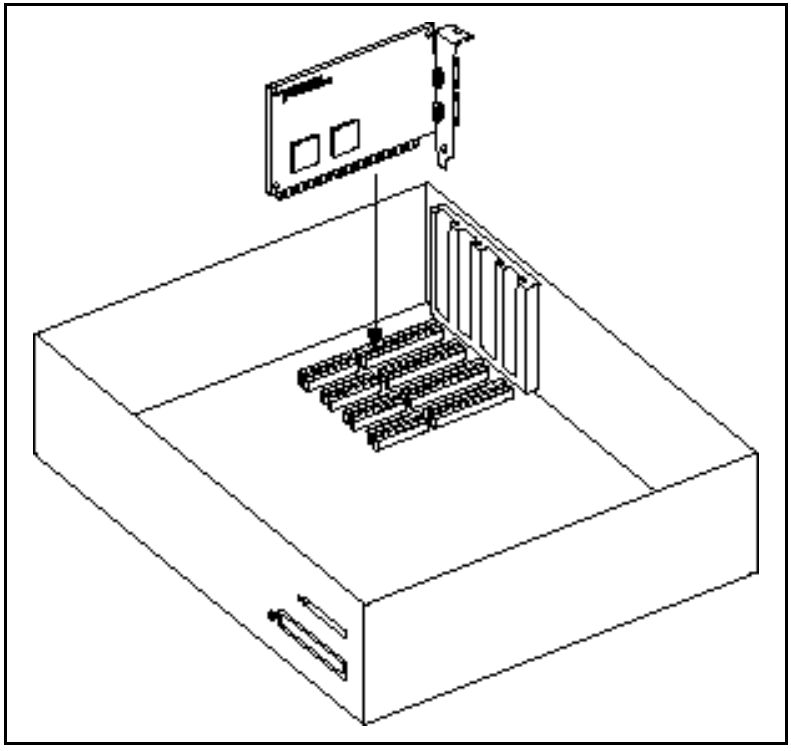


Figure 2-2. AT Serial Board Hardware Installation

5. Screw the mounting bracket of the AT serial board to the back panel rail of the computer.
6. Replace the cover, and turn on your computer.

Your hardware is now installed.

Install the NI Serial Driver

Follow these steps to install the NI serial driver.

1. With the AT serial board installed, start up your computer. Windows 95 is Plug and Play aware, so the AT serial board ports are recognized and configured as standard communication ports. Windows 95 displays a **New Hardware Found** dialog box for each port that it recognizes. For example, if you have a single two-port board, the dialog box appears twice. It prompts you to choose which driver to use and it defaults to the Windows default driver.

   If a **New Hardware Found** dialog box does not appear when you start Windows 95, make sure that you have removed the previous definitions for the ports from the Device Manager, as described in the *System Preparation* section, earlier in this chapter.

   Figure 2-3 shows the **New Hardware Found** dialog box.

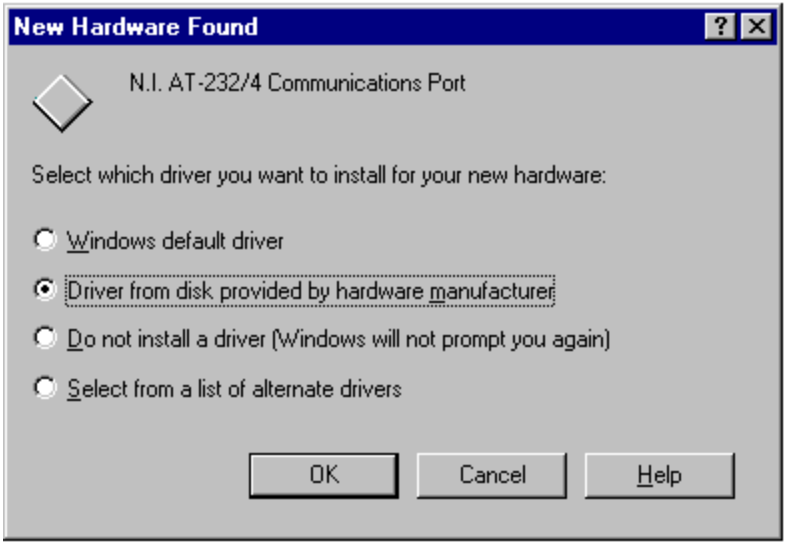


Figure 2-3. New Hardware Found Dialog Box

2. Select **Driver from disk provided by hardware manufacturer** and click on **OK**.

3. Insert the NI serial driver distribution disk into the drive that you select from the **Install From Disk** dialog box and click on **OK**. A **Select Device** dialog box appears, which lists the device models it has found that are compatible with the serial port being installed. Figure 2-4 shows the **Select Device** dialog box.

Figure 2-4. Select Device Dialog Box

4. Select the model that matches your AT serial board and click on **OK**. If you see an error message like **`niserial.vxd could not be found`**, click on **Browse** and select the drive containing the installation disk.

5. Repeat the previous steps for each port on the AT serial board.

Verify the Installation

When you begin to verify the installation, keep in mind that the serial ports built into the computer are typically named from COM1 to COM4. Windows 95 typically issues port names to the NI serial ports starting with COM5, COM6, and so on. If not enough resources are available to assign to all the NI serial ports, the port with the higher COM*x* name is left unconfigured.

Double-click on the **System** icon in the Control Panel. In the **System Properties** window that appears, select the **Device Manager** tab, and

click the **View devices by type** button at the top of the page. If necessary, double-click on the **Ports (COM & LPT)** icon to view all of the ports.

A list of the installed ports appears. If a circled exclamation point appears through the port icon, the serial port is not installed properly. A problem with the port may have occurred because Windows 95 could not acquire resources for the port, or because an interrupt request resource conflict exists. If no circled exclamation point appears, the AT serial board is installed correctly. Figure 2-5 shows an example of NI serial ports that are installed properly and Figure 2-6 shows an example of NI serial ports that are *not* working properly.

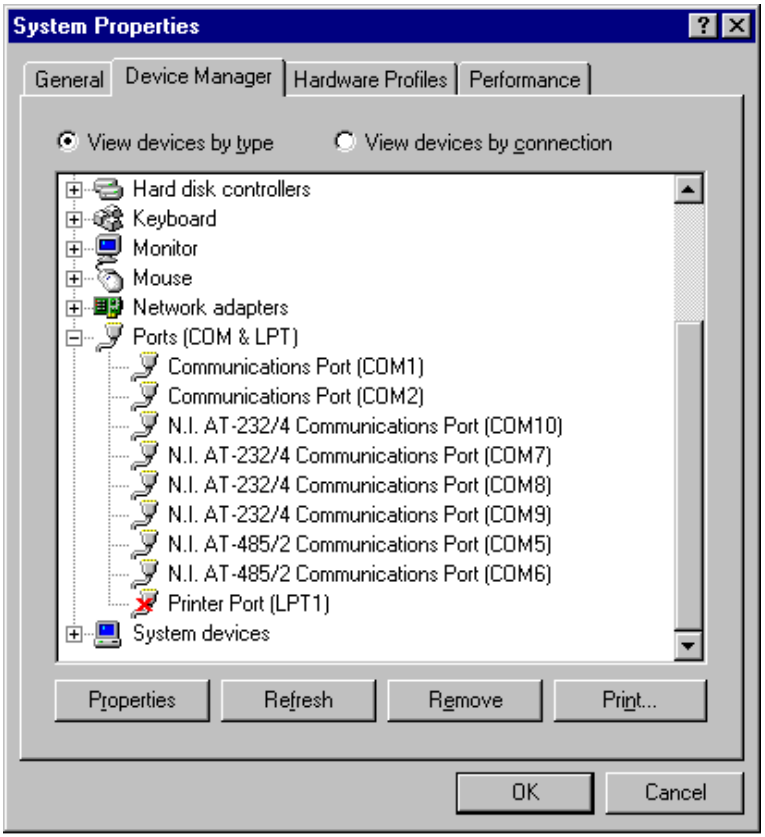


Figure 2-5. Device Manager Ports List for AT Serial Board Correctly Installed

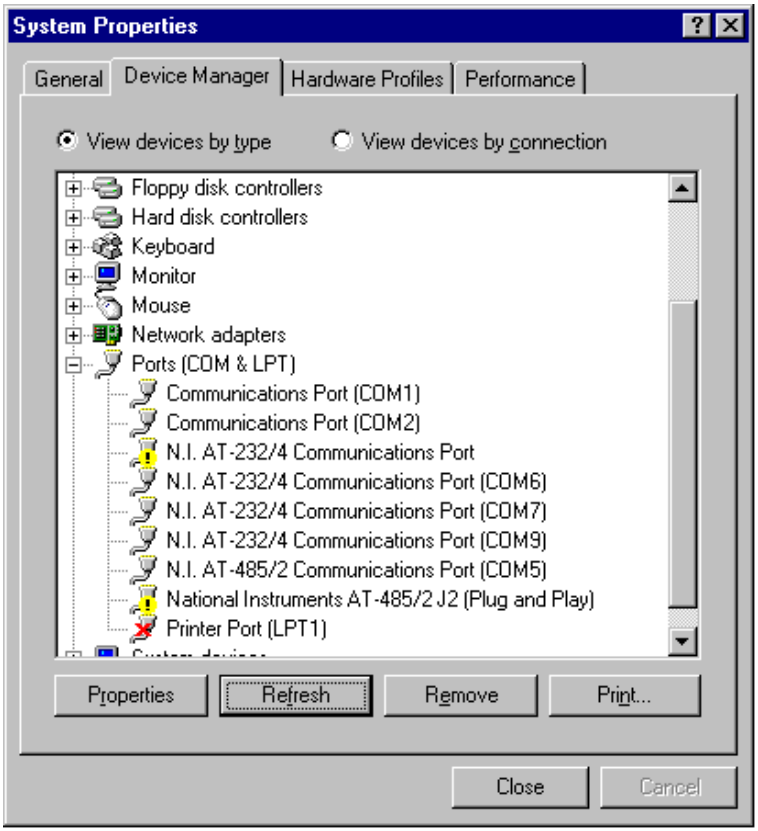


Figure 2-6. Device Manager Ports List for AT Serial Board Incorrectly Installed

Verify the Hardware Resources

For every port of the newly installed AT serial board, double-click on the name of the serial port in the Device Manager. Then click on the **Resources** tab. If the resources were assigned correctly, the **Resources** page shows which resources are assigned to your AT serial ports. If Windows 95 did not assign any resources to the port, the **Resources** page shows only a **Set Configuration Manually** button. In this case, you should free an interrupt request level so that one can be assigned to your AT serial board. Refer to the section *Freeing an Interrupt Request Level* in Appendix D, *Troubleshooting and Common Questions*.

When you have finished verifying the hardware resources, proceed to the next section, *Verify the Driver Installation*.

Verify the Driver Installation

For every port of the newly installed AT serial board, double-click on the name of the serial port in the Device Manager. Then click on the **Driver** tab. If the NI serial driver is correctly installed, the **Driver** page shows the `niserui.dll` and `niserial.vxd` files installed. If no drivers are installed or if the Windows 95 drivers `serial.dll` and `serial.vxd` are installed instead, refer to the section *System Preparation*, earlier in this chapter.

Determine Which Physical Port Is Associated with COMx

For every port of the newly installed AT serial board, double-click on the name of the serial port in the Device Manager. Then click on the **Port Settings** tab. The top of this page displays the serial number of the AT serial board, and the physical port number starting at 1. On all AT serial boards, PORT1 refers to the top port, PORT2 refers to the next port down, and so on.

When you have finished verifying the driver installation and physical port, proceed to the next section, *Verify the Installation Using serdiag*.

Verify the Installation Using serdiag

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

To run `serdiag`, choose **Start»Run»a:serdiag.exe**, where **a** is the drive containing the installation disk. You may copy `serdiag.exe` onto your hard drive for future use.

If `serdiag` completes with no failures, your serial hardware and software have been installed properly. If it fails, refer to Appendix D, *Troubleshooting and Common Questions*, for troubleshooting instructions.

Connect the Cables

You can use the two-port AT serial boards with the standard DB-9 connector found on most serial cables. To use the DB-9 connector with the four-port AT serial boards, you need the 10-position modular jack to DB-9 cable available from National Instruments. You can also use a DB-25 connector with the four-port AT serial boards by ordering the 10-position modular jack to DB-25 cable from National Instruments.

Figure 2-7 and Table 2-1 give the pin locations and descriptions of the DB-9 connector, which is found on the two-port AT serial board and the 10-position modular jack to DB-9 cable.

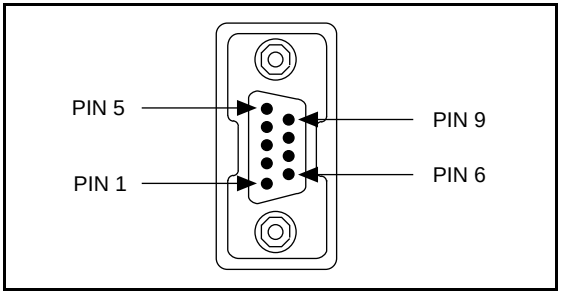


Figure 2-7. DB-9 Connector Pin Locations

Table 2-1. DB-9 Pin Descriptions

DB-9 Pin	AT-232 Signal	AT-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-

Figure 2-9 and Table 2-2 give the pin locations and descriptions of the 10-position modular jack, which is found on the four-port AT serial board.

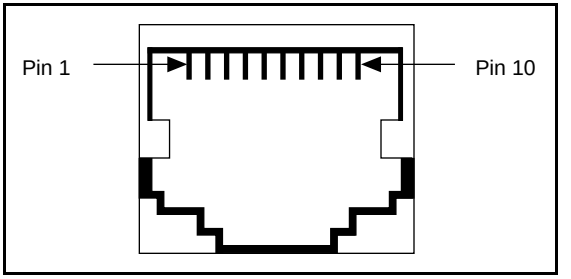


Figure 2-8. 10-Position Modular Jack Pin Locations

Table 2-2. 10-Position Modular Jack Pin Descriptions

10 Position Modular Jack	AT-232 Signal	AT-485 Signal
Pin 10	DCD	GND
Pin 9	RXD	CTS+ (HSI+)
Pin 8	TXD	RTS+ (HSO+)
Pin 7	DTR	RXD+
Pin 6	GND	RXD-
Pin 5	DSR	CTS- (HSI-)
Pin 4	RTS	RTS- (HSO-)
Pin 3	CTS	TXD+
Pin 2	RI	TXD-
Pin 1	No Connect	No Connect

Figure 2-9 and Table 2-3 give the pin locations and descriptions of the DB-25 connector, which is on the optional 10-position modular jack to DB-25 cable.

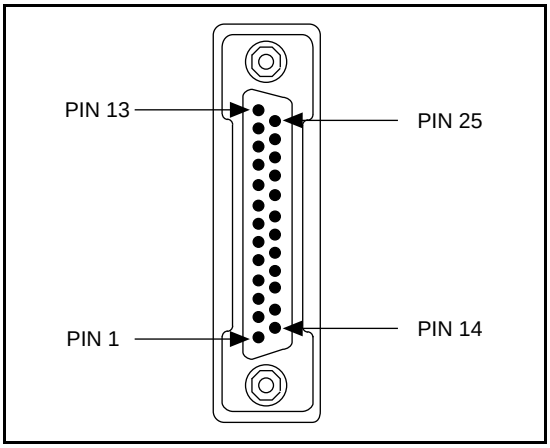


Figure 2-9. DB-25 Connector Pin Locations

Table 2-3. DB-25 Pin Descriptions

DB-25 Pin	AT-232 Signal	AT-485 Signal
Pin 2	TXD	RTS+ (HSO+)
Pin 3	RXD	CTS+ (HSI+)
Pin 4	RTS	RTS- (HSO-)
Pin 5	CTS	TXD+
Pin 6	DSR	CTS- (HSI-)
Pin 7	GND	RXD-
Pin 8	DCD	GND
Pin 20	DTR	RXD+
Pin 22	RI	TXD-
Pins not listed in this table are No Connect.		

Figure 2-10 shows how to connect the cables when you install a four-port version of the AT serial board.

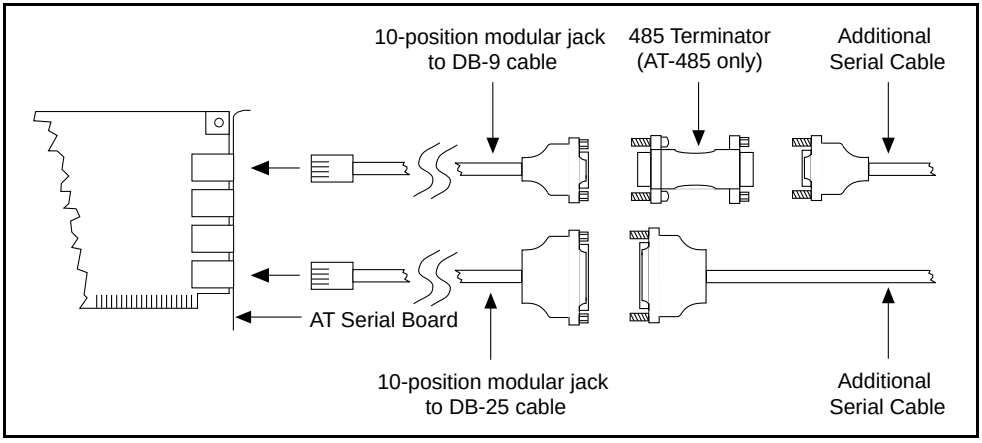


Figure 2-10. Connecting the Cables to Your Four-Port AT Serial Board

Connecting Two-Wire Devices

The AT-485 boards are designed to work with either two- or four-wire devices. If you are using a two-wire device, refer to the device's 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 AT-485 using half-duplex communication, you need a single twisted pair of wires. At the AT-485, you should connect the TXD+ and RXD+ signals (pins 8 and 4 on a DB-9 connector, pins 5 and 20 on a DB-25 connector) together and to one wire. You should 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, pins 22 and 7 on a DB-25 connector) to the second wire.

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

Configuration

Chapter 3

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 95 Device Manager. You can use it to examine or modify the configuration of the serial port.

Follow these steps to configure the serial port. Repeat the configuration procedure for each serial port in your system.

1. Select **Start»Settings»Control Panel** and double-click on the **System** icon. The **System Properties** window appears.
2. Select the **Device Manager** tab, and click the **View devices by type** radio button at the top of the page.
3. Double-click the **Ports (COM & LPT)** icon.
4. Double-click on the name of the port you want to configure.

You can now view or change information about your serial port.

- Click on the **Resources** tab to view information about the hardware resources assigned to the serial port.
- Click on the **Port Settings** tab to view information about the software configuration for the serial port. Refer to the next section, *Communication Port Settings*, for more information.
- Within the **Port Settings** page, click on the **Advanced** button to change the RS-485 transceiver mode and to enable or disable the FIFOs on the serial board. Refer to the next section, *Communication Port Settings*, for more information.

Note: ***If you use two-wire TxRdy mode, FIFOs must be enabled. Transceiver modes apply to RS-485 boards only. For more information about transceiver modes, refer to Chapter 4,*** *Using Your AT Serial Board.*

After you have selected the serial port parameters for the current port, click on the **OK** button to save the changes or click on **Cancel** to exit the dialog box without saving changes.

Communication Port Settings

In the **Port Settings** page, you can change any of the settings by clicking on the arrow button to the right of the setting. When you click on the arrow button, a list of valid values for that setting appears. Select the desired setting from the list. Figure 3-1 shows the **Port Settings** page. The following paragraphs describe the port settings available in the Device Manager **Port Settings** page.

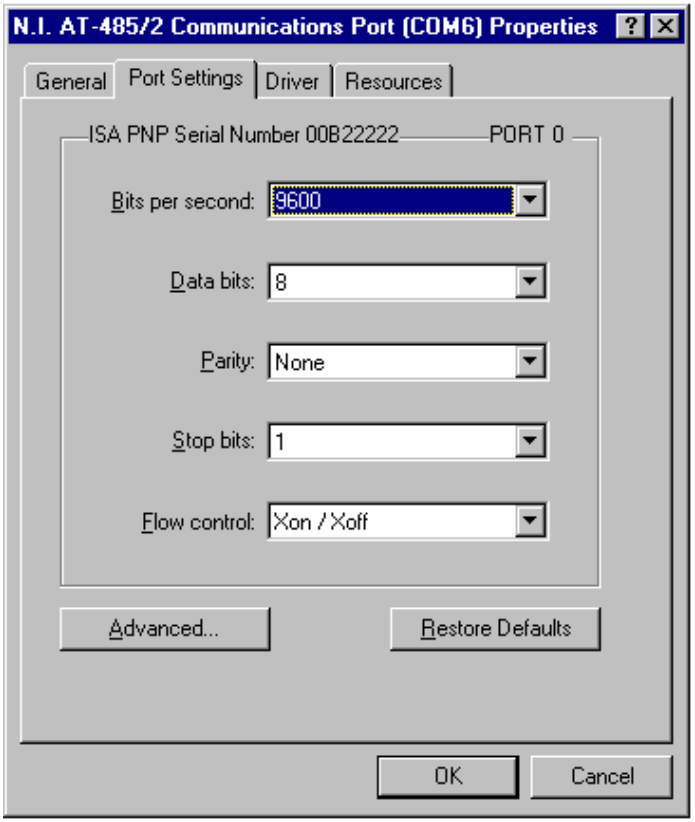


Figure 3-1. Port Settings Page

Bits per Second

Bits per second, or baud rate, is the speed for a serial port.

Data Bits

Data bits is the number of data bits in a single serial byte.

Parity

Parity is the specification for even, odd, or no parity bits in each transmitted byte.

Stop Bits

Stop bits is the number of terminating bits on the end of each transmitted serial byte.

Flow Control

Flow control is a method for temporarily halting the stream of serial bytes to prevent overflow.

Advanced Port Settings

You can view or change the advanced port settings by clicking on the **Advanced** button on the **Port Settings** page. Figure 3-2 shows the **Advanced Port Settings** dialog box. The following sections describe the advanced port setting options.

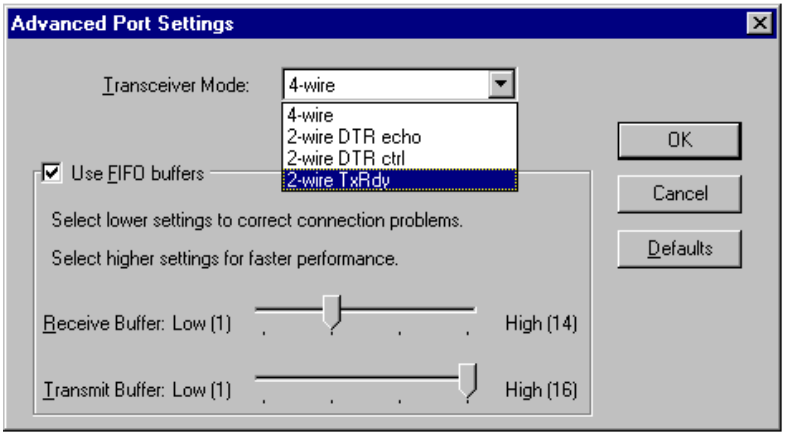


Figure 3-2. Advanced Port Settings Dialog Box

Transceiver Mode

The transceiver mode selection is available by clicking on the **Advanced** button on the **Port Settings** page. It shows the transceiver mode in use, and applies only to AT-485 boards. See Chapter 4, *Using Your AT Serial Board*, for more information about transceiver modes.

FIFO Buffers

The FIFO buffer control is available by clicking on the **Advanced** button on the **Port Settings** page. FIFO buffers are present on the 16550-compatible UARTs: one for the transmitter and one for the receiver, to minimize system overhead and maximize system efficiency. Select lower settings to correct connection problems and higher settings for faster performance.

Note: ***If you want your AT serial board ports to use the names* COM1, COM2, COM3, *or* COM4, *see the* Common Questions *section of Appendix D,*** *Troubleshooting and Common Questions*.

Chapter 4

Using Your AT Serial Board

This chapter describes how to set the hardware transceiver control mode for your Plug and Play AT-485 board and lists some general programming requirements.

Advanced Transceiver Control (AT-485)

The Plug and Play AT-485 board supports four modes of hardware transceiver control. (Transceiver modes apply only to the AT-485 boards.) You 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

You should 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

You 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 a two-wire system, 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. You 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, this mode solves the problem of receiving 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.***

Setting the Transceiver Control Mode

The recommended method for setting the transceiver control mode is with the serial configuration utility located in the Windows 95 Device Manager. For more information, refer to the *Communication Port*

Settings section in Chapter 3, *Configuration*. The mode you select in the Device Manager is automatically configured when you open a port on an AT serial board. You can also set the hardware transceiver control mode from within a DOS application. For each port you want to control, write the control byte for the mode you want to select to the scratch register of the UART. Table 4-2 shows the control bytes for each mode.

Table 4-2. Transceiver Mode Control Bytes

Transceiver Mode	Control Byte
Four-wire mode	0x00
Two-wire mode: $\overline{\text{DTR}}$ with echo	0x01
Two-wire mode: $\overline{\text{DTR}}$ controlled	0x02
Two-wire mode: $\overline{\text{TXRDY}}$ auto control	0x03

The scratch register is located at offset 7 from the base address of the port. For example, if COM2 were located at base address 0x3F8, and you wanted to set the AT-485 board to two-wire mode with $\overline{\text{DTR}}$ control, you would write a 0x02 to I/O address 0x3FF. The AT-485 board would immediately switch to the two-wire mode with $\overline{\text{DTR}}$ control.

Setting the Transceiver Mode with EscapeComm

The NI serial driver software extends the Windows function `EscapeComm` for programming the transceiver control mode. Table 4-3 lists the `EscapeComm` function codes for setting different transceiver modes.

Table 4-3. EscapeComm Function Codes

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

General Programming Requirements

Once installed, the NI serial driver software is integrated into the standard Windows 95 communications software. NI serial ports are used like any other Windows 95 communications (COM) port. Windows 95 has standard communication functions for use within either 16-bit (Win16) applications or 32-bit (Win32) applications.

Setting the Maximum Baud Rate for a 16-Bit Application

To select 115,200 baud from a 16-bit (Win16) application written in C, you should define the following constant in your program:

```
#define CBR_115200 0xff20
```

You can then use this constant as you would any other baud rate value in your Windows communication calls. For example, you can place it into a DCB structure and pass it to `SetCommState`.

For a Win32 application, do not use the constant shown here for 115,200 baud. Use the constant defined in the Win32 communications header file provided with your compiler.

Other Programming Points

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 *Windows Software Development Kit, Vol. 1: Overview*, and *Vol. 2: Functions*.

Appendix

A

Specifications

This appendix describes the physical characteristics of the Plug and Play AT serial board and the recommended operating conditions.

Hardware Specifications

Table A-1. Physical Characteristics of the Two-Port AT Serial Board

Characteristic	Specification
Dimensions	10.67 by 16.51 cm (4.2 by 6.5 in.)
I/O Connector	DB-9
Power Requirement (from PC AT I/O channel)	
AT-485	+5 VDC 390 mA Typical 510 mA Maximum
AT-232	+5 VDC 260 mA Typical 340 mA Maximum

Table A-2. Physical Characteristics of the Four-Port AT Serial Board

Characteristic	Specification
Dimensions	10.67 by 16.51 cm (4.2 by 6.5 in.)
I/O Connector*	10-position modular jack
Power Requirement (from PC AT I/O channel)	
AT-485	+5 VDC 600 mA Typical 780 mA Maximum
AT-232	+5 VDC 340 mA Typical 450 mA Maximum
* The four-port AT serial board requires a cable to convert the 10-position modular jack to either DB-9 or DB-25 connectors.	

Table A-3. Environmental Characteristics

Characteristic	Specification
Operating Environment Component Temperature Relative Humidity	 0° to 40° C 10% to 90%, noncondensing
Storage Environment Temperature Relative Humidity	 -20° to 70° C 5% to 90%, noncondensing
EMI	FCC Class B Certified

Software Specifications

Table A-4. Software Characteristics

Characteristic	Specification
Maximum Serial Transfer Rate	115,200 baud*
Space Required for NI Serial Driver Software	30 KB (.03 MB)
* Actual speed may vary considerably from speed shown due to system and instrumentation capabilities.	

Appendix B

Serial Port Information

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

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 kb/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 Mb/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.

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

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

Feature	RS-232	RS-422	RS-485
Type of transmission lines	Unbalanced	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 kb/s	10 Mb/s	10 Mb/s
Maximum CMV	± 25 V	+6 to -.25 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

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 bidirectional 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 B-1 shows a typical full-duplex system.

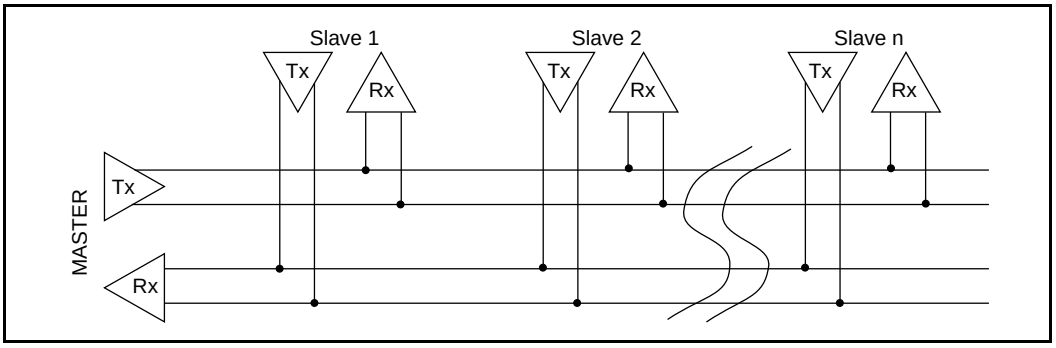


Figure B-1. Typical Full-Duplex System

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 B-2 shows a typical half-duplex system.

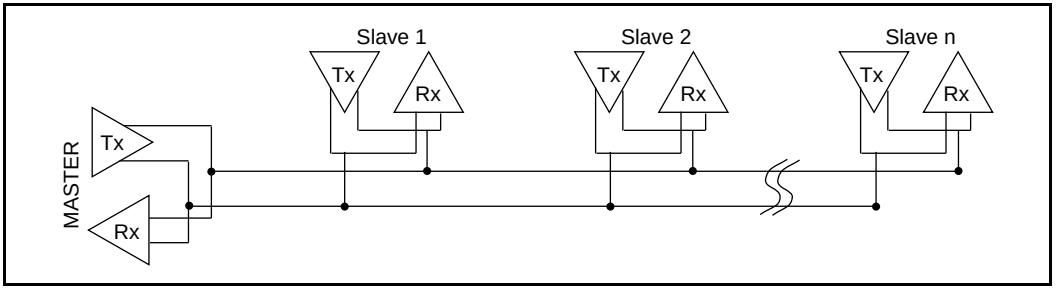


Figure B-2. Typical Half-Duplex System

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 would 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 B-3 shows a multidrop network using terminating resistors.

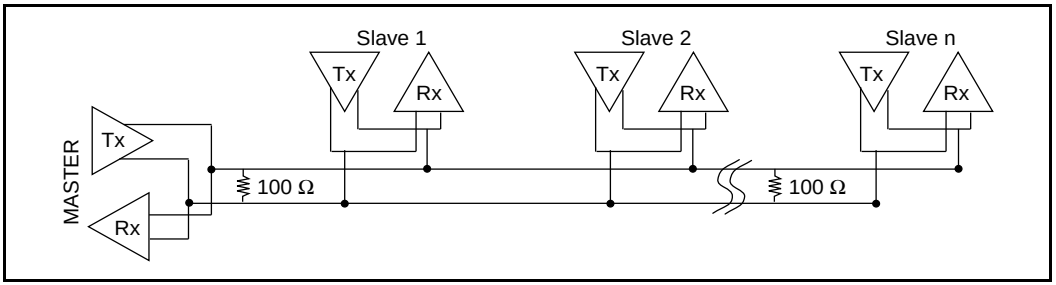


Figure B-3. Multidrop Network Using Terminating Resistors

Bias Resistors

A transmission line enters an indeterminate state if no nodes are transmitting on it. This indeterminate state can cause the receivers to receive invalid data bits from noise picked up on the cable. To prevent these data bits, you should force the transmission line into a known state. By installing two 620 Ω bias resistors at one node on the transmission line, you can create a voltage divider that forces the voltage between the differential pair to be less than 200 mV, the threshold voltage for the receiver. You should only install these resistors on one node.

Figure B-4 shows a transmission line using bias resistors.

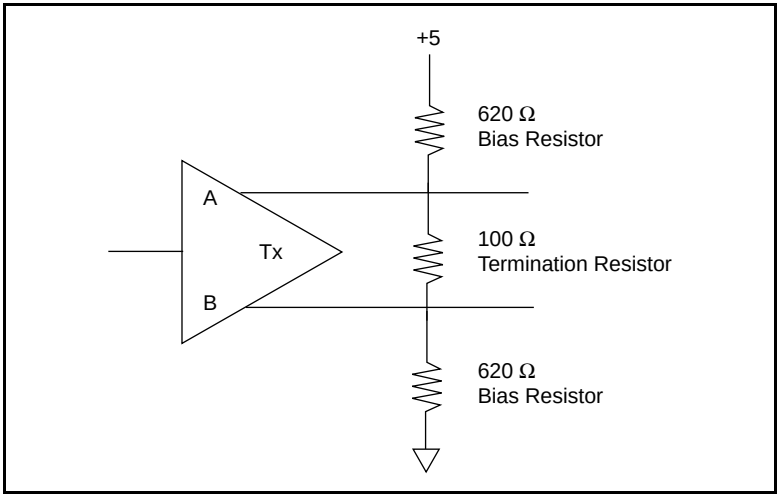


Figure B-4. Transmission Line Using Bias Resistors

Rather than using two 620 Ω resistors at one node, you can also increase the value of the resistors and put them at every node. For instance, if there are eight nodes in a system, you can use 4.7 kΩ resistors at each node to effectively achieve the same result.

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 B-5 shows straight-through cabling in a DTE-to-DCE interface.

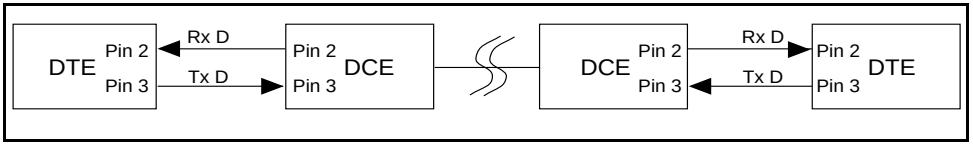


Figure B-5. Straight-Through Cabling in a DTE-to-DCE Interface

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 were wired together using a straight-through cable, one transmitter would be connected to the other transmitter, and one receiver would be connected to the other receiver. In this setup, no transmissions could 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 AT serial port to another.

Figure B-6 shows null-modem cabling in a DTE-to-DCE interface.

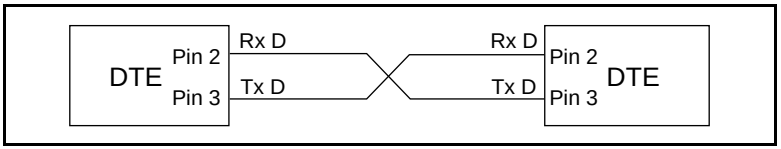


Figure B-6. Null-Modem Cabling in a DTE-to-DCE Interface

Uninstalling the AT Serial Board and Driver

Appendix

C

This appendix explains how to uninstall your AT serial board and NI serial driver.

Before physically removing the AT serial board from the computer, you must remove the hardware information from the Windows 95 Device Manager. Follow these steps to uninstall the AT serial board.

1. Double-click the **System** icon under **Start»Settings»Control Panel**. The **System Properties** dialog box appears.
2. Select the **Device Manager** tab, and click the **View devices by type** button.
3. Double-click on the **Ports (COM & LPT)** icon.
4. Select the port to remove from the list of ports as shown in Figure C-1.

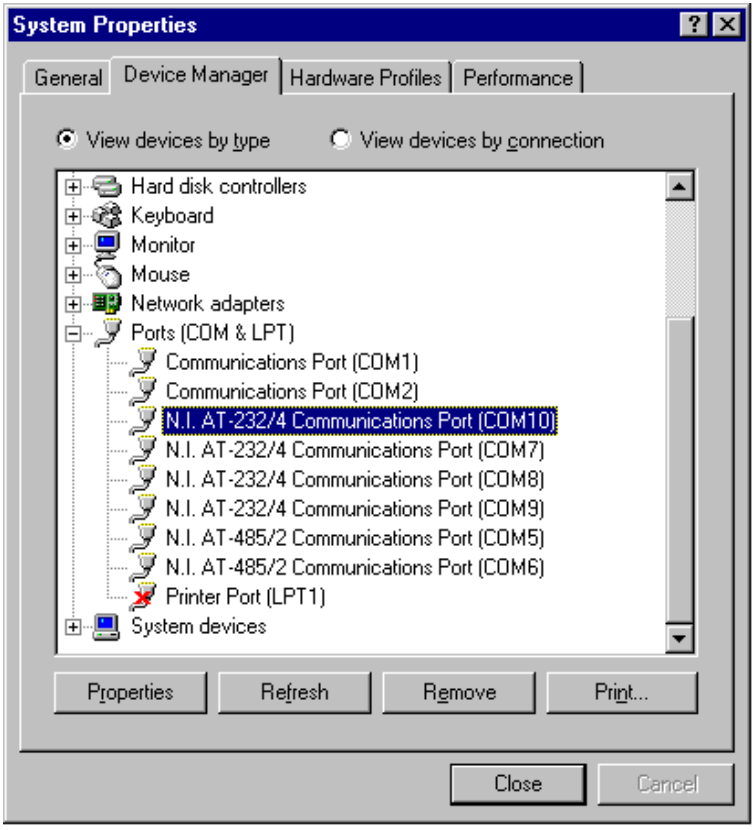


Figure C-1. Selecting an Interface to Uninstall

5. Click the **Remove** button.
6. Shut down your computer and physically remove the AT serial board.

Troubleshooting and Common Questions

Appendix
D

This appendix describes how to troubleshoot problems and contains a list of common questions.

Freeing an Interrupt Request Level

To free an interrupt request level for the serial port, you must disable a device that is using an interrupt request level. To view the system-wide allocation of interrupt request resources and remove a device, perform the following steps.

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. Select the **Device Manager** page.
4. Double-click on the **Computer** icon at the top of the Device Manager list of devices.
5. Click on the **View Resources** tab.
6. Select the **Interrupt Request (IRQ)** button. By scanning through the list of interrupt request settings, you can determine which devices are using which interrupt request levels.
7. When you have located a device which you are not currently using, click **Cancel** to exit the **Computer Properties** window.
8. Double-click on the icon for the device in the Device Manager list of devices. In the **Device usage** field on the **General** page, checkmarks appear to the left of the current configuration, usually **Original Configuration (Current)**.
9. Click on the checkbox to remove the checkmark, then click on **OK**.
10. Restart Windows 95 so it can correctly assign resources to the serial port. Then refer to the *Verify the Hardware Resources* section of Chapter 2, *Installation and Verification*.

Selecting Conflict-Free Resources

When the resources shown under the Device Manager indicate a conflict with another device, you can often correct the problem by manually selecting conflict-free resources. Follow these steps to manually change the resources of an NI serial port.

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. Select the **Device Manager** page, and click the **View devices by type** button at the top of the page.
4. Double-click the **Ports (COM & LPT)** icon. A list of installed ports appears.
5. Double-click on the name of the serial port, then click on the **Resources** tab.
6. Uncheck the **Use automatic settings** checkbox and click on the **Change Setting** button. If the system does not allow you to change settings, select the configuration that gives you a conflict-free base I/O address and interrupt level from the **Setting based on:** list box.
7. Click on **OK** to close the Device Manager. Your conflict problem should be solved.

Troubleshooting serdiag Messages

This section lists possible `serdiag` error messages, along with solutions.

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

1. Verify the hardware resources.
2. Verify that the National Instruments serial driver is installed and not the Windows 95 driver.
3. If either the AT serial board or `niserial.vxd` file is missing, reinstall the hardware and software.

`Lesser number of ports found than expected`
If this error message appears, refer to Chapter 2, *Installation and Verification*, to follow these troubleshooting steps:

1. Verify the hardware resources.
2. Verify that the National Instruments serial driver is installed and not the Windows 95 driver.
3. Check the hardware installation to make sure the correct number of boards/ports are installed.

`I/O address test failed, Interrupt test cannot be performed.`
If this error message appears, verify the hardware resources as described in Chapter 2, *Installation and Verification*. If the test still fails, you probably have an I/O address conflict with legacy boards. Refer to the next section, *Resolving Resource Conflicts with Legacy Boards*.

`Interrupt test failed`
If this error message appears, verify the hardware resources as described in Chapter 2, *Installation and Verification*. If the test still fails, you probably have an interrupt level conflict with legacy boards. Refer to the next section, *Resolving Resource Conflicts with Legacy Boards*.

Resolving Resource Conflicts with Legacy Boards

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 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 I/O, IRQ, and DMA resources for legacy boards.

Common Questions

How can I determine which type of AT serial board I have installed?

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. Select the **Device Manager** page, and click the **View devices by type** button at the top of the page.
4. Double-click the **Ports (COM & LPT)** icon. A list of installed ports appears.

How can I determine which version of the NI serial driver software I have installed?

1. Select **Start»Settings»Control Panel**.
2. Double-click on the **System** icon.
3. Select the **Device Manager** page, and click the **View devices by type** button at the top of the page.
4. Double-click the **Ports (COM & LPT)** icon. A list of installed ports appears.
5. Double-click on the name of the serial port and click on the **Driver** tab to see the driver version number.

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 name National Instruments serial ports COM1, COM2, COM3, or COM4?

The following table lists standard DOS-base addresses for serial ports.

COM Port	Base Address
COM1	3f8
COM2	2f8
COM3	3e8
COM4	2e8

In most cases, Windows 95 does not assign names COM1 through COM4 to the AT serial board. Rather, it names the ports starting with COM5. If you assign any of the base addresses in this table to a National Instruments serial port, Windows 95 automatically changes the COM port name to the corresponding one listed in this table. You do not need to change the IRQ setting for this name change to occur. To change the base address, refer to the section *Selecting Conflict-Free Resources* earlier in this appendix.

What information should I have before I call National Instruments?

When you call National Instruments, you should have the results of `serdiag`. Also, make sure you have filled out the configuration form in Appendix E, *Customer Communication*.

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

National Instruments provides comprehensive technical assistance around the world. In the U.S. and Canada, applications engineers are available Monday through Friday from 8:00 a.m. to 6:00 p.m. (central time). In other countries, contact the nearest branch office. You may fax questions to us at any time.

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 or (800) 327-3077
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: 1 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.

FaxBack Support

FaxBack is a 24-hour information retrieval system containing a library of documents on a wide range of technical information. You can access FaxBack from a touch-tone telephone at the following number: (512) 418-1111

E-Mail Support (currently U.S. only)

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

GPIB:	gpib.support@natinst.com
DAQ:	daq.support@natinst.com
VXI:	vxi.support@natinst.com
LabVIEW:	lv.support@natinst.com
LabWindows:	lw.support@natinst.com
HiQ:	hiq.support@natinst.com
VISA:	visa.support@natinst.com

Fax and Telephone Support

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

	Telephone	Fax
Australia	03 9 879 9422	03 9 879 9179
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Canada (Ontario)	519 622 9310	
Canada (Quebec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 26 02
Finland	90 527 2321	90 502 2930
France	1 48 14 24 24	1 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Italy	02 413091	02 41309215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	95 800 010 0793	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

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 will reproduce the problem _____

_____

_____

Hardware and Software Configuration Form

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

National Instruments Products

- Plug and Play AT Serial Board and Revision Number
- – AT-232 Board Revision _____

  Two Port _____ Four Port _____
- or
- – AT-485 Board Revision _____

  Two Port _____ Four Port _____
- NI Serial Driver Software Revision Number on Distribution Disk _____
- Board Settings

	Base I/O Address	Interrupt Level
COM1	_____	_____
COM2	_____	_____
COM3	_____	_____
COM4	_____	_____
COM5	_____	_____
COM6	_____	_____
COM7	_____	_____
COM8	_____	_____
COM9	_____	_____

Other Products

- Computer Make and Model _____
- Microprocessor _____
- Clock Frequency _____
- Type of Monitor Card Installed _____
- Windows Version _____
- Application Programming Language (Microsoft C, Visual Basic for Windows) _____

  _____
- Number of Serial Ports in System

  Built In_____ Adapter Cards _____

- Other Boards in System _____
- Base I/O Address of Other Boards _____
- Interrupt Level of Other Boards _____

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: Getting Started with Your AT Serial Board for Windows 95

Edition Date: April 1996

Part Number: 321242A-01

Please comment on the completeness, clarity, and organization of the manual.

_____

_____

_____

_____

_____

_____

_____

If you find errors in the manual, please record the page numbers and describe the errors.

_____

_____

_____

_____

_____

_____

_____

Thank you for your help.

Name _____

Title _____

Company _____

Address _____

_____

Phone (_____) _____

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

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

Glossary

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

°	degrees
%	percent
Ω	ohms
A	amperes
ANSI	American National Standards Institute
b	bits
baud	bits per second
C	Celsius
COM	Computer Output Microform
DB-*xx*	subminiature D connector (where *xx* is the number of pins)
DCE	Data Communications Equipment or Data Circuit-Terminating Equipment
DMA	direct memory access
DTE	Data Terminal Equipment
$\overline{\text{DTR}}$	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
Hz	hertz
I/O	input/output
IEEE	Institute of Electrical and Electronic Engineers
in.	inches

IRQ	interrupt request
ISA	Industry Standard Architecture
legacy board	ISA board whose system resources are chosen by changing physical switches or jumpers on the board
m	meters
MB	megabytes of memory
PC	personal computer
RAM	random-access memory
RX	Receive
s	seconds
TX	Transmit
$\overline{\text{TXRDY}}$	Transmit Ready (where the overscore denotes that the signal is active low)
UART	universal asynchronous receiver/transmitter
V	volts
VDC	volts direct current