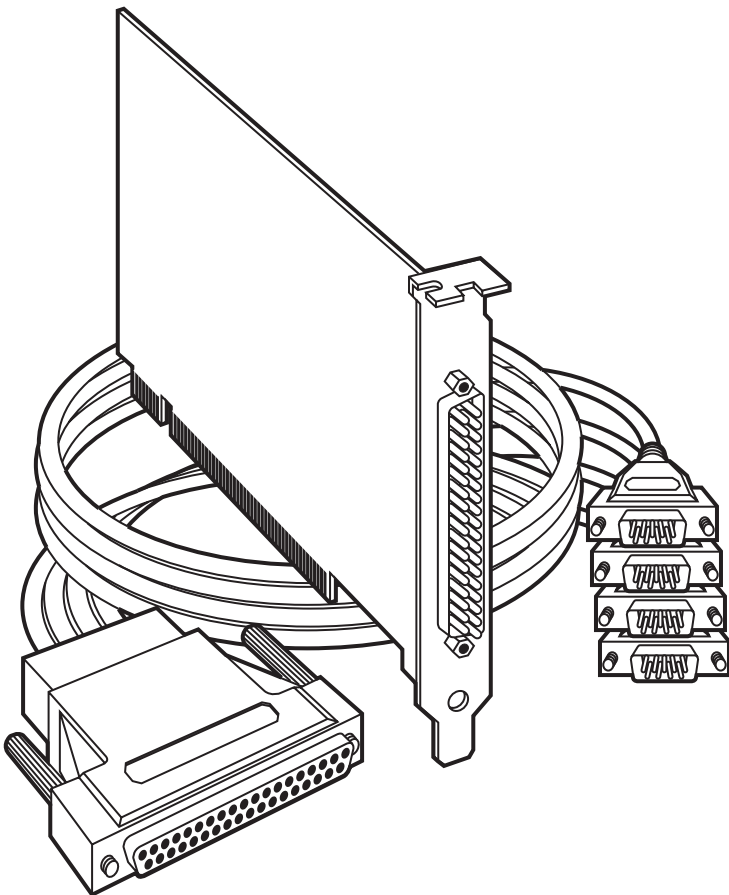




## 4-Port Serial Host Adapter PCI



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This equipment generates, uses, and can radiate radio-frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

*This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada.*

*Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.*

**EUROPEAN UNION DECLARATION OF CONFORMITY**

Products bearing the  label fulfill the requirements of the EMC directive (89/336/EEC) and of the low-voltage directive (73/23/EEC) issued by the European Commission. To obey these directives, the following European standards must be met:

- EN55022 Class A - "Limits and methods of measurement of radio interference characteristics of information technology equipment"
- EN50082-1 - "Electromagnetic compatibility - Generic immunity standard" Part 1: Residential, commercial and light industry
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Always use cabling provided with this product if possible. If no cable is provided or if an alternate cable is required, use high quality shielded cabling to maintain compliance with FCC/EMC directives.

### NORMAS OFICIALES MEXICANAS (NOM) ELECTRICAL SAFETY STATEMENT

#### INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.
2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.
3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.
4. Todas las instrucciones de operación y uso deben ser seguidas.
5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..
6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.
7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.
8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.
9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.
10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.
11. El aparato eléctrico deberá ser conectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra física y la polarización del equipo no sea eliminada.
13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.
14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.
15. En caso de existir, una antena externa deberá ser localizada lejos de las líneas de energía.
16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.
17. Cuidado debe ser tomado de tal manera que objetos líquidos no sean derramados sobre la cubierta u orificios de ventilación.
18. Servicio por personal calificado deberá ser provisto cuando:
  - A: El cable de poder o el contacto ha sido dañado; u
  - B: Objetos han caído o líquido ha sido derramado dentro del aparato; o
  - C: El aparato ha sido expuesto a la lluvia; o
  - D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o
  - E: El aparato ha sido tirado o su cubierta ha sido dañada.

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# 1. Specifications

**Communications Chip**—IC141C-R2: 16550 UART (you can remove this UART and install a 16850 or 16950 UART for better performance); IC189C: 16850 UART

**Maximum Distance**—5000 ft. (1524 m)

**Operation**—RS-422/485

**Protocol**—Asynchronous

**Speed**—460.8 kbps

**CE Approval**—Yes

**Connectors**—(1) DB37 male on card, (1) DB37 female and (4) DB9 male on included octopus cable

**Cable Length**—36" (91.4 cm)

**Power**—From the interface: +5V @ 250 mA; +12 V @ 60 mA; -12 V @ 100 mA

**Size**—Half-card

## 2. Introduction

### 2.1 Overview

The 4-Port Serial Host Adapter PCI (IC141C-R2) is a four-channel PCI Bus serial I/O adapter for the PC and compatibles supporting data rates up to 460.8 kbps.

The IC141C-R2 Adapter uses the 16550 UART. This chip features programmable baud rates, data format, and interrupt control, and a 16-byte input and output FIFO. Or, you can remove the 16550 UART on the board and install a 16850 or 16950 UART in its place. The 128-byte FIFO you get with the 16850 or 16950 UART allows the card to deliver better performance than with the 16550 UART. The IC189C Adapter already has the 16850 UART installed.

RS-422 provides excellent communications for long-distance device connections up to 4000 ft. (1219.2 m), where noise immunity and high data integrity are essential. Select RS-485 and capture data from multiple peripherals in an RS-485 multidrop network.

In both RS-485 and RS-422 modes, the card works seamlessly with the standard operating system serial driver. In RS-485 mode, our special auto-enable feature allows the operating system to view the RS-485 ports as COM ports. This lets you use the standard COM driver for RS-485 communications. Our on-board hardware automatically handles the RS-485 driver enable.

### 2.2 What's Included

The 4-Port Serial Host Adapter PCI is shipped with the following items. If any of these items are missing or damaged, contact Black Box immediately at 724-746-5500.

- 4-Port Serial Host Adapter PCI
- (3) Serial Utility Software Diskettes: (1) DOS/Linux/Win 3.1, (2) Win 95/98/2000/Me/Windows NT
- Octopus Cable providing (4) DB9 connectors
- This Manual



## 2.3 Factory-Default Settings

The factory-default settings are described in Table 2-1.

**Table 2-1. Factory-Default Settings.**

<b>Port #</b>	<b>Clock DIV Mode</b>	<b>Enable Mode</b>
Port 1	4	Auto
Port 2	4	Auto
Port 3	4	Auto
Port 4	4	Auto

To install the 4-Port Serial Host Adapter PCI using factory-default settings, skip **Chapter 3** and go on to **Chapter 4**.

For your reference, record installed 4-Port Serial Host Adapter PCI settings in Table 2-2.

**Table 2-2. Installed Settings.**

<b>Port #</b>	<b>Clock DIV Mode</b>	<b>Enable Mode</b>
Port 1		
Port 2		
Port 3		
Port 4		

## 3. Card Setup

### NOTE

In all cases J1x is for port 1, J2x for port 2, J3x for port 3, and J4x for port 4.

### 3.1 RS-485 Enable Modes

RS-485 is ideal for multi-drop or network environments. It requires a tri-state driver that will allow the electrical presence of the driver to be removed from the line. The driver is in a tri-state or high-impedance condition when this occurs. Only one driver may be active at a time; the other driver(s) must be tri-stated. The output modem-control signal Request To Send (RTS) is typically used to control the state of the driver. Some communication software packages refer to RS-485 as RTS enable or RTS block-mode transfer.

One of the unique features of the 4-Port Serial Host Adapter PCI is the ability to be RS-485 compatible without the need for special software or drivers. This ability is especially useful in Windows®, Windows NT®, and OS/2® environments, where the lower-level I/O control is abstracted from the application program. This ability means that you can effectively use the 4-Port Serial Host Adapter PCI in an RS-485 application with existing (standard RS-232) software drivers.

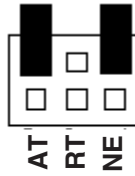
Headers J1B – J4B are used to control the RS-485 mode functions for the driver circuit. The selections are “RTS” enable (marked “RT”) or “Auto” enable (marked “AT”). The “Auto” enable feature automatically enables/disables the RS-485 interface. The “RTS” mode uses the “RTS” modem-control signal to enable the RS-485 interface and provides backward compatibility with existing software products.

Position 3 (marked “NE”) of J1B – J4B is used to control the RS-485 enable/disable functions for the receiver circuit and determine the state of the RS-422/485 driver. The RS-485 “Echo” is the result of connecting the receiver inputs to the transmitter outputs. Every time a character is transmitted, it is also received. This can be beneficial if the software can handle echoing (i.e. using received characters to throttle the transmitter), but it can confuse the system if the software does not. To select the “No Echo” mode, select position “NE.”

For RS-422/530/449 compatibility, remove the jumpers at J1B – J4B.

Examples on the following pages describe all of the valid settings for J1B – J4B.

**3.2 Interface Mode Examples J1B – J4B**



**Figure 3-1. Headers J1B – J4B, RS-422.**



**Figure 3-2. Headers J1B – J4B, RS-485 “Auto” Enabled, with “No Echo.”**



**Figure 3-3. Headers J1B – J4B, RS-485 “Auto” Enabled, with “Echo.”**



Figure 3-4. Headers J1B – J4B, RS-485 “RTS” Enabled, with “No Echo.”



Figure 3-5. Headers J1B – J4B, RS-485 “RTS” Enabled, with “Echo.”

### 3.3 Address and IRQ Selection

The 4-Port Serial Host Adapter PCI is automatically assigned I/O addresses and IRQs by your motherboard BIOS. Only the I/O addresses may be modified by the user. Adding or removing other hardware may change the assignment of I/O addresses and IRQs.

### 3.4 Line Termination

Typically, each end of the RS-485 bus must have line terminating resistors (RS-422 terminates the receive end only). A 120-ohm resistor is across each RS-530/422/485 input in addition to a 1 K-ohm pull-up/pull-down combination that biases the receiver inputs. Headers J1A – J4A allow you to customize this interface to your specific requirements. Each jumper position corresponds to a specific portion of the interface. If multiple 4-Port Serial Host Adapters are configured in an RS-485 network, only the boards on each end should have jumpers T, P, and P ON. Refer to the following table for each position’s operation:

**Table 3-1. Line Termination Jumper Position Functions.**

Name	Function
P	Adds or removes the 1K-ohm pull-down resistor in the RS-422/RS-485 receiver circuit (Receive data only).
P	Adds or removes the 1K-ohm pull-up resistor in the RS-422/RS-485 receiver circuit (Receive data only).
T	Adds or removes the 120-ohm termination.
L	Connects the TX+ to RX+ for RS-485 two-wire operation.
L	Connects the TX- to RX- for RS-485 two-wire operation.

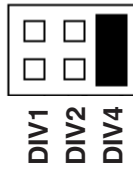


**Figure 3-6. Headers J1A – J4A, Line Termination.**

### 3.5 Clock Modes

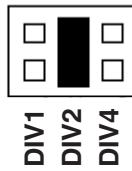
The 4-Port Serial Host Adapter PCI employs a unique clocking option that allows you to select from divide-by-4, divide-by-2 and divide-by-1 clocking modes. These modes are selected at Headers J1C through J4C.

To select the baud rates commonly associated with COM ports (2400, 4800, 9600, 19.2, ... 115.2 kbps), place the jumper in the divide-by-4 mode (marked DIV4).



**Figure 3-7. Clocking Mode “Divide By 4.”**

To double these rates up to a maximum rate of 230.4 kbps, place the jumper in the divide-by-2 (marked DIV2) position.



**Figure 3-8. Clocking Mode “Divide By 2.”**

## 4-PORT SERIAL HOST ADAPTER PCI

### 3.5.1 BAUD RATES AND DIVISORS FOR THE “DIV1” MODE

Table 3-2 shows some common data rates and the rates you should choose to match them if using the adapter in the “DIV1” mode.

**Table 3-2. Baud Rates for the “DIV1” Mode.**

<b>For This Data Rate</b>	<b>Choose This Data Rate</b>
1200 bps	300 bps
2400 bps	600 bps
4800 bps	1200 bps
9600 bps	2400 bps
19.2 kbps	4800 bps
57.6 kbps	14.4 kbps
115.2 kbps	28.8 kbps
230.4 kbps	57.6 kbps
460.8 kbps	115.2 kbps

If your communications package allows the use of baud-rate divisors, choose the appropriate divisor from Table 3-3.

**Table 3-3. Baud-Rate Divisors for the “DIV1” Mode.**

<b>For This Data Rate</b>	<b>Choose This Divisor</b>
1200 bps	384
2400 bps	192
4800 bps	96
9600 bps	48
19.2 kbps	24
38.4 kbps	12
57.6 kbps	8
115.2 kbps	4
230.4 kbps	2
460.8 kbps	1



## 4-PORT SERIAL HOST ADAPTER PCI

### 3.5.2 BAUD RATES AND DIVISORS FOR THE “DIV2” MODE

Table 3-43 shows some common data rates and the rates you should choose to match them if using the adapter in the “DIV2” mode.

**Table 3-4. Baud Rates for the “DIV2” Mode.**

<b>For This Data Rate</b>	<b>Choose This Data Rate</b>
1200 bps	600 bps
2400 bps	1200 bps
4800 bps	2400 bps
9600 bps	4800 bps
19.2 kbps	9600 bps
38.4 kbps	19.2 kbps
57.6 kbps	28.8 kbps
115.2 kbps	57.6 kbps
230.4 kbps	115.2 kbps

If your communications package allows the use of baud-rate divisors, choose the appropriate divisor from Table 3-5.

**Table 3-5. Baud-Rate Divisors for the “DIV2” Mode.**

<b>For This Data Rate</b>	<b>Choose This Divisor</b>
1200 bps	192
2400 bps	96
4800 bps	48
9600 bps	24
19.2 kbps	12
38.4 kbps	8
57.6 kbps	4
115.2 kbps	2
230.4 kbps	1

# 4. Installation

### IMPORTANT

You **MUST** set up the operating system **BEFORE** you physically install the Card.

## 4.1 Setting Up the Operating System

If you are installing the PCI adapter in DOS, OS/2®, or QNX, please refer to the appropriate directory on one of the Serial Utilities Disks for instructions.

### 4.1.1 WINDOWS 3.1x

Refer to the Win3x.hlp file in the \Win31 directory on the appropriate Serial Utilities disk.

### 4.1.2 WINDOWS 95/98 USERS

If you are installing the PCI card in Windows 95/98, run setup on the appropriate Serial Utilities Diskette before installing the card. Power down the computer and install the adapter. The resources are automatically configured for the PCI card. Refer to the appropriate help file in the Black Box folder located in the **Start, Programs** menu for changing those resources.

#### *Selecting the PCI COM Number in Windows 95 or 98*

On a 4-port board, Windows will by default define the ports sequencing in ascending order starting at COM5 if no COM5 exists. If there is a COM5, etc., the next available COM number will be assigned to the first port with all additional ports following in ascending order.

However, some software packages are limited to recognizing COM numbers from COM1 through COM4. If you're using one of these packages, you might want to reassign ports 3 and 4 to COM3 and COM4. (Remember that Windows has already assigned ports 1 and 2 to addresses arbitrarily chosen for COM5 and COM6.)

Follow the steps listed below to change the first two ports so that Windows assigns them COM3 and COM4.

1. Double-click the "Systems" icon in the control panel or right-click on "My Computer" and choose "Properties" to bring you to "System Properties."

2. Choose the Device Manager tab and double-click on the “Multi-Function Adapter” heading. This will show all the information concerning the Adapter.
3. Choose the “Resources” tab, which will show all resources assigned to the Adapter. Uncheck the “Use Automatic Settings” box.
4. There are five input/output (I/O) ranges listed. The first I/O range is for the PCI bus and should not be changed. The fourth and fifth I/O ranges (the last addresses in the list) are the ones that you need to change in order to have the ports on the board numbered as COM3, COM4, COM5, and COM6. Double-click on the fourth I/O range, which will allow you to change the address. Highlight the entire I/O range and type **03e8-03ef** for COM3. Click OK. Windows will inform you that you have made modifications that may affect other devices. Click OK.
5. Next, double-click on the fifth I/O range. Highlight the entire I/O range and type **02e8-02ef** for COM4. Again, Windows will inform you that you have made modifications that may affect other devices. Click OK.
6. Port 1 is COM5, Port 2 is COM6, Port 3 is COM3, and Port 4 is COM4.

### 4.1.3 WINDOWS NT

If you are installing a PCI card in Windows NT, run setup on the appropriate Serial Utilities Diskette before installing the card. After the software installation is complete, power down the computer, install the card, then power up. Since resource allocation is automatic, the installation is now complete.

### 4.1.4 DOS

Refer to the Readme.txt file found in the \DOS directory on the appropriate Serial Utilities disk.

### 4.1.5 OTHER OPERATING SYSTEMS

Refer to the appropriate directory on the Serial Utilities software.

## 4.2 Installing the Hardware

You can install the Serial Interface Adapter in any of the PCI expansion slots. It contains several jumper straps for each port that you must set for proper operation.

1. Power off the PC. Disconnect the power cord.

## 4-PORT SERIAL HOST ADAPTER PCI

2. Remove the PC cover.
3. Locate an available PCI slot and remove the blank metal slot cover.
4. Gently insert the Adapter into the slot. Make sure that it is seated properly.
5. For the IC141C, connect the DB37 female connector end of the octopus cable to the DB37 male connector on the card.
6. Replace the screw.
7. Replace the cover.
8. Connect the power cord.

## 5. Technical Description

### 5.1 Interrupts

A good analogy of a PC interrupt is a telephone ringing. The phone “bell” is a request for us to stop what we are currently doing and take up another task (speak to the person on the other end of the line). This is the same process the PC uses to alert the CPU that a task must be performed. The CPU, upon receiving an interrupt, makes a record of what the processor was doing at the time and stores this information on the “stack”; this allows the processor to resume its predefined duties after the interrupt is handled, exactly where it left off. Every main sub-system in the PC has its own interrupt, frequently called an IRQ (short for Interrupt ReQuest).

### 5.2 Why Use an ISP?

The Interrupt Status Port (ISP) is a read-only 8-bit register that sets a corresponding bit when an interrupt is pending. Port 1 interrupt line corresponds with Bit D0 of the status port, Port 2 with D1, etc. The use of this port means that the software designer now only has to poll a single port to determine if an interrupt is pending.

The ISP is at Base+7 on each port (Example: Base=280 Hex, Status Port=287, 28F...etc.). The Adapter will allow any one of the available locations to be read to obtain the value in the status register. Both status ports on the Adapter are identical, so either one can be read. Example: This indicates that Channel 2 has an interrupt pending.

Bit Position:	7	6	5	4	3	2	1	0
Value Read:	0	0	0	0	0	0	1	0

**5.3 Connector Pin Assignments****Figure 5-1. RS-422/485 Connector Pin Assignments.**

<b>Signal</b>	<b>Name</b>	<b>Pin #</b>	<b>Mode</b>
GND	Ground	5	—
TX +	Transmit Data Positive	4	Output
TX-	Transmit Data Negative	3	Output
RTS+	Request To Send Positive	6	Output
RTS-	Request To Send Negative	7	Output
RX+	Receive Data Positive	1	Input
RX-	Receive Data Negative	2	Input
CTS+	Clear To Send Positive	9	Input
CTS-	Clear To Send Negative	8	Input

# Appendix A: Troubleshooting

## A.1 Using the Serial Utility Diskettes

Three Serial Utility diskettes come with the Serial Host Adapter for use in troubleshooting. If you still cannot solve a problem after reading this chapter, call for technical support.

1. Identify all I/O adapters currently installed in your system, including your on-board serial ports, controller cards, sound cards, etc. Identify the I/O addresses used by these adapters, as well as the IRQ (if any).
2. Configure your Serial Host Adapter so that there is no conflict with currently installed adapters. No two adapters can occupy the same I/O address.
3. Make sure the Adapter is using a unique IRQ. While the Adapter does allow the sharing of IRQs, many other adapters (SCSI adapters and on-board serial ports) do not. The IRQ is typically selected via an on-board header block. Refer to **Chapter 3** for help in choosing an I/O address and IRQ.
4. Make sure the Adapter is securely installed in a motherboard slot.
5. When running DOS, Windows 3.x or other operating systems, refer to the appropriate Serial Utilities Disk and this manual to verify that the Adapter is configured correctly. The supplied software contains a diagnostic program “SSD” that runs under DOS and will verify if an adapter is configured properly. This diagnostic program is easy to use. Refer to the README.TXT file on the supplied diskette for detailed instructions on using “SSD.”
6. For Windows 95/98 and Windows NT, the diagnostic tool “WinSSD” is installed in the Adapter folder on the Start Menu during the startup process. First find the ports using the Device Manager, then use “WinSSD” to verify that the ports are working.

## A.2 Calling for Technical Support

If the procedures described in **Section A.1** do not solve your problem, call Black Box Technical Support at 724-746-5500. Have the following information ready when you call:

1. Current adapter settings. If possible, have the Adapter installed in a computer ready to run diagnostics.
2. This user manual for reference.



# Appendix B: Electrical Interface

## B.1 RS-422

The RS-422 specification defines the electrical characteristics of balanced-voltage digital interface circuits. RS-422 is a differential interface that defines voltage levels and driver/receiver electrical specifications.

On a differential interface, logic levels are defined by the difference in voltage between a pair of outputs or inputs. In contrast, a single-ended interface, for example RS-232, defines the logic levels as the difference in voltage between a single signal and a common ground connection.

Differential interfaces are typically more immune to noise or voltage spikes that may occur on the communication lines. Differential interfaces also have greater drive capabilities that allow for longer cable lengths. RS-422 is rated up to 10 Megabits per second and can have cabling 4000 feet (1220 m) long.

RS-422 also defines driver and receiver electrical characteristics that will allow 1 driver and up to 32 receivers on the line at once. RS-422 signal levels range from 0 to +5 volts. RS-422 does not define a physical connector.

## B.2 RS-485

RS-485 is backward-compatible with RS-422; however, it is optimized for party-line or multi-drop applications. The output of the RS-422/485 driver is capable of being Active (enabled) or Tri-State (disabled). This capability allows multiple ports to be connected in a multi-drop bus and selectively polled. RS-485 allows cable lengths up to 4000 feet (1220 m) and data rates up to 10 Megabits per second. The signal levels for RS-485 are the same as those defined by RS-422.

RS-485 has electrical characteristics that allow for 32 drivers and 32 receivers to be connected to one line. This interface is ideal for multi-drop or network environments. The RS-485 tri-state driver (not dual-state) will allow the electrical presence of the driver to be removed from the line. Only one driver may be active at a time; the other driver(s) must be tri-stated.

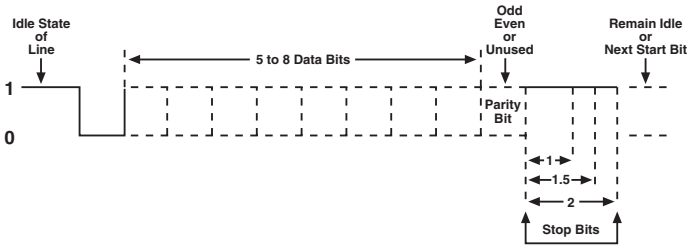
RS-485 can be cabled in two ways, two-wire and four-wire mode. Two-wire mode does not allow for full-duplex communication, and requires that data be transferred in only one direction at a time. For half-duplex operation, the two transmit pins should be connected to the two receive pins (Tx+ to Rx+ and Tx- to Rx-). Four-wire mode allows full-duplex data transfers. RS-485 does not define a connector pinout, a set of modem control signals, or a physical connector.

# Appendix C: Asynchronous Communication

Serial data communications implies that individual bits of a character are transmitted consecutively to a receiver that assembles the bits back into a character. Data rate, error checking, handshaking, and character framing (start/stop bits) are pre-defined and must correspond at both the transmitting and receiving ends.

Asynchronous communication is the standard means of serial data communication for PC and compatible computers. The original PC was equipped with a communication or COM port that was designed around an 8250 Universal Asynchronous Receiver Transmitter (UART), which allows asynchronous serial data to be transferred through a simple and straightforward programming device. The Serial Host Adapter uses much newer UARTs that also feature buffering. (The IC141C-R2 uses a 16550 UART. Optionally, you can remove the 16550 UART and replace it with a 16950 UART for better performance).

Asynchronous communication works this way: A start bit, followed by a pre-defined number of data bits (5, 6, 7, or 8) defines character boundaries for asynchronous communication. The end of the character is defined by the transmission of a pre-defined number of stop bits (usually 1, 1.5, or 2).



**Figure C-1. Asynchronous Communication Bit Diagram.**

An extra bit used for error detection is often appended before the stop bits. This special bit is called the parity bit. Parity is a simple way to determine if a data bit has been lost or corrupted during transmission. There are several methods for implementing a parity check to guard against data corruption. Common methods are called (E)ven Parity or (O)dd Parity. Sometimes parity is not used to detect errors on the data stream (this is called [N]o Parity). Because each bit in asynchronous communication is sent consecutively, it is wrapped (framed) by pre-

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defined bits to mark the beginning and end of the serial transmission of the character. The data rate and communication parameters for asynchronous communication have to be the same at both the transmitting and receiving ends. The communication parameters are baud rate, parity, number of data bits per character, and stop bits—for example, 9600, N, 8, 1.

# Appendix D: Board Layout

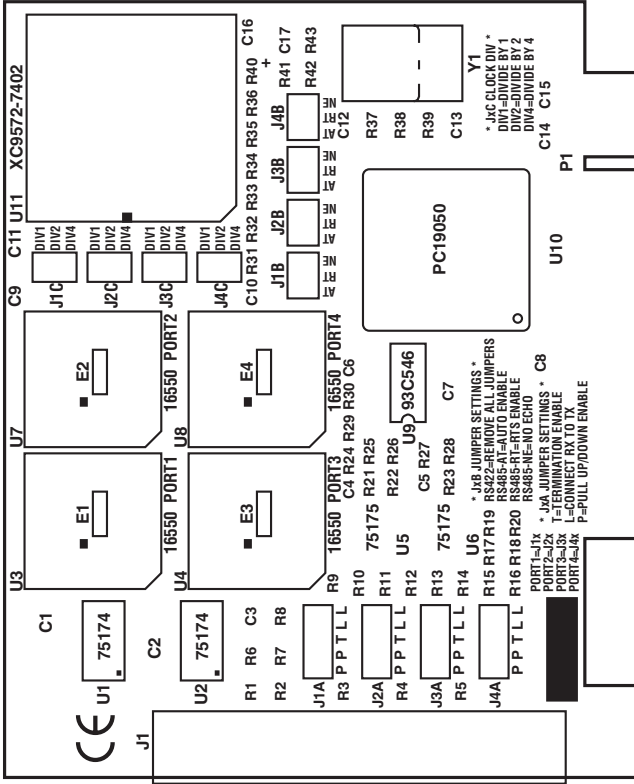


Figure D-1. Board Layout.

## NOTES



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