How Serial Ports Work

by Jeff Tyson

Considered to be one of the most basic external connections to a computer, the **serial port** has been an integral part of most computers for more than 20 years. Although many of the newer systems have done away with the serial port completely in favor of USB connections, most modems still use the serial port, as do some printers, PDAs and digital cameras. Few computers have more than two serial ports.

Two serial ports on the back of a PC

Essentially, serial ports provide a standard connector and protocol to let you attach devices, such as modems, to your computer. In this edition of **How Stuff Works**, you will learn about the difference between a parallel port and a serial port, what each pin does and what flow control is.

UART Needed

All computer operating systems in use today support serial ports, because serial ports have been around for decades. Parallel ports are a more recent invention and are much faster than serial ports. USB ports are only a few years old, and will likely replace both serial and parallel ports completely over the next several years.

The name "serial" comes from the fact that a serial port "serializes" data. That is, it takes a byte of data and transmits the 8 bits in the byte one at a time. The advantage is that a serial port needs only one wire to transmit the 8 bits (while a parallel port needs 8). The disadvantage is that it takes 8 times longer to transmit the data than it would if there were 8 wires. Serial ports lower cable costs and make cables smaller.

Before each byte of data, a serial port sends a start bit, which is a single bit with a value of 0. After each byte of data, it sends a stop bit to signal that the byte is complete. It may also send a parity bit.

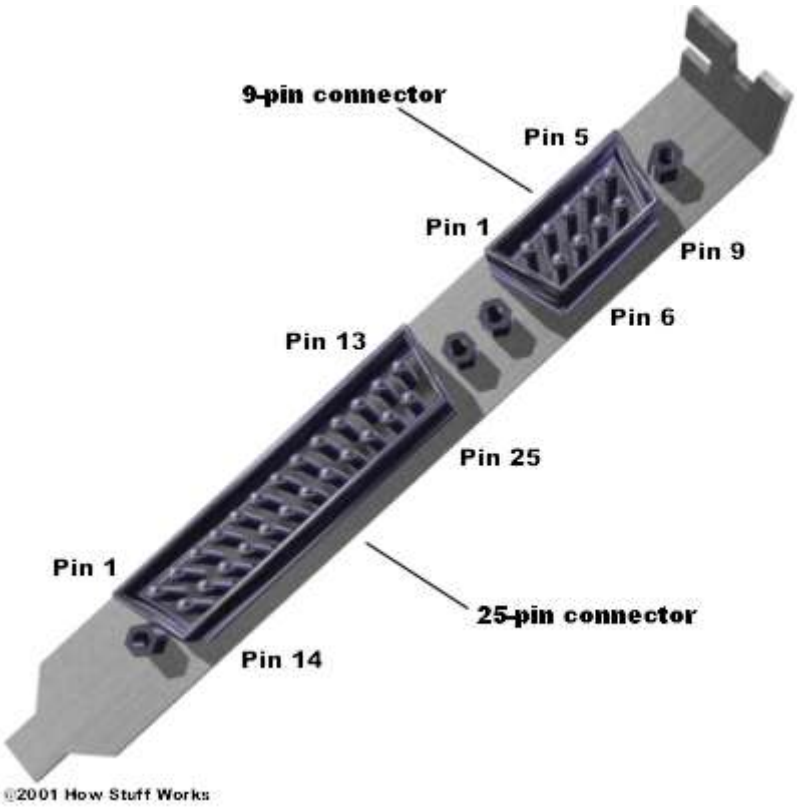
Serial ports, also called **communication (COM) ports**, are **bi-directional**. Bi-directional communication allows each device to receive data as well as transmit it. Serial devices use different pins to receive and transmit data -- using the same pins would limit communication to **half-duplex**, meaning that information could only travel in one direction at a time. Using different pins allows for **full-duplex** communication, in which information can travel in both directions at once.

This 40-pin Dual Inline Package (DIP) chip is a variation of the National Semiconductor NS16550D UART chip.

Serial ports rely on a special controller chip, the **Universal Asynchronous Receiver/Transmitter (UART)**, to function properly. The UART chip takes the parallel output of the computer's system bus and transforms it into serial form for transmission through the serial port. In order to function faster, most UART chips have a built-in buffer of anywhere from 16 to 64 kilobytes. This buffer allows the chip to cache data coming in from the system bus while it is processing data going out to the serial port. While most standard serial ports have a maximum transfer rate of 115 Kbps (kilobits per second), high speed serial ports, such as **Enhanced Serial Port (ESP)** and **Super Enhanced Serial Port (Super ESP)**, can reach data transfer rates of 460 Kbps.

The Serial Connection

The external connector for a serial port can be either 9 pins or 25 pins. Originally, the primary use of a serial port was to connect a modem to your computer. The pin assignments reflect that. Let's take a closer look at what happens at each pin when a modem is connected.



Close-up of 9-pin and 25-pin serial connectors

9-pin connector:

1. **Carrier Detect** - Determines if the modem is connected to a working phone line.
2. **Receive Data** - Computer receives information sent from the modem.
3. **Transmit Data** - Computer sends information to the modem.
4. **Data Terminal Ready** - Computer tells the modem that it is ready to talk.
5. **Signal Ground** - Pin is grounded.
6. **Data Set Ready** - Modem tells the computer that it is ready to talk.
7. **Request To Send** - Computer asks the modem if it can send information.
8. **Clear To Send** - Modem tells the computer that it can send information.

9. **Ring Indicator** - Once a call has been placed, computer acknowledges signal (sent from modem) that a ring is detected.

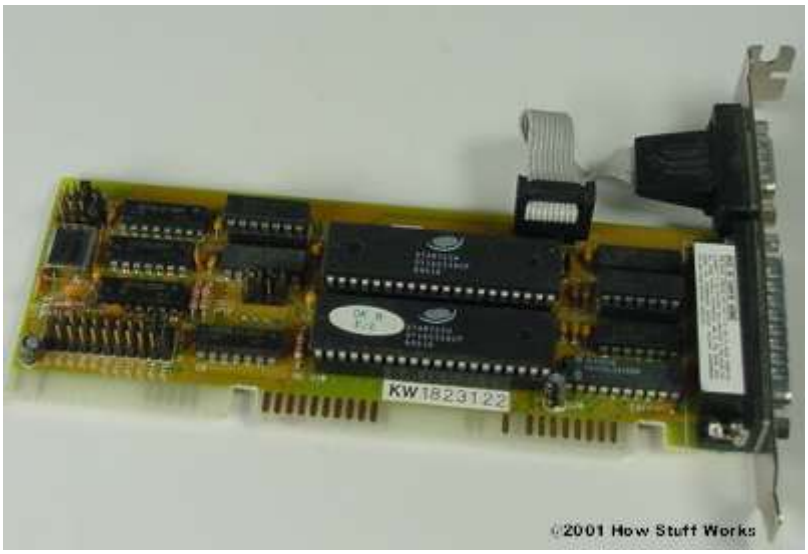
25-pin connector:

1. Not Used
2. **Transmit Data** - Computer sends information to the modem.
3. **Receive Data** - Computer receives information sent from the modem.
4. **Request To Send** - Computer asks the modem if it can send information.
5. **Clear To Send** - Modem tells the computer that it can send information.
6. **Data Set Ready** - Modem tells the computer that it is ready to talk.
7. **Signal Ground** - Pin is grounded.
8. **Received Line Signal Detector** - Determines if the modem is connected to a working phone line.
9. Not Used: Transmit Current Loop Return (+)
10. Not Used
11. Not Used: Transmit Current Loop Data (-)
12. Not Used
13. Not Used
14. Not Used
15. Not Used
16. Not Used
17. Not Used
18. Not Used: Receive Current Loop Data (+)
19. Not Used
20. **Data Terminal Ready** - Computer tells the modem that it is ready to talk.
21. Not Used
22. **Ring Indicator** - Once a call has been placed, computer acknowledges signal (sent from modem) that a ring is detected.
23. Not Used
24. Not Used
25. Not Used: Receive Current Loop Return (-)

Voltage sent over the pins can be in one of two states, **On** or **Off**. On (binary value "1") means that the pin is transmitting a signal between -3 and -25 volts, while Off (binary value "0") means that it is transmitting a signal between +3 and +25 volts...

Going With The Flow

An important aspect of serial communications is the concept of **flow control**. This is the ability of one device to tell another device to stop sending data for a while. The commands Request to Send (RTS), Clear To Send (CTS), Data Terminal Ready (DTR) and Data Set Ready (DSR) are used to enable flow control.



A dual serial port card

Let's look at an example of how flow control works: You have a modem that communicates at 56 Kbps. The serial connection between your computer and your modem transmits at 115 Kbps, which is over twice as fast. This means that the modem is getting more data coming from the computer than it can transmit over the phone line. Even if the modem has a 128K buffer to store data in, it will still quickly run out of buffer space and be unable to function properly with all that data streaming in.

With flow control, the modem can stop the flow of data from the computer before it overruns the modem's buffer. The computer is constantly sending a signal on the Request to Send pin, and checking for a signal on the Clear to Send pin. If there is no Clear to Send response, the computer stops sending data, waiting for the Clear to Send before it resumes. This allows the modem to keep the flow of data running smoothly.