What is Serial communication?

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Introduction

Serial communication is a way enables different equipments to communicate with their outside world. It is called serial because the data bits will be sent in a serial way over a single line.
A personal computer has a serial port known as communication port or COM Port used to connect a modem for example or any other device, there could be more then one COM Port in a PC.
Serial ports are controlled by a special chip called UART (Universal Asynchronous Receiver Transmitter). Different applications use different pins on the serial port and this basically depend of the functions required. If you need to connect your PC for example to some other device by serial port, then you have to read instruction manual for that device to know how the pins on both sides must be connected and the setting required.

Advantages of serial communication

Serial communication has some advantages over the parallel communication. One of the advantages is transmission distance, serial link can send data to a remote device more far then parallel link. Also the cable connection of serial link is simpler then parallel link and uses less number of wires.
Serial link is used also for Infrared communication, now many devices such as laptops & printers can communicate via inferred link.

Types of connectors

There are two sizes of connectors 9 pin and 25 pin, both they called D-Type plug. D-Type plug could be either Mail or Female. Fig (1) shows photos for these types.

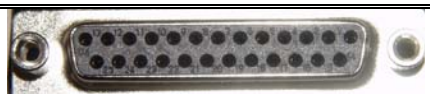
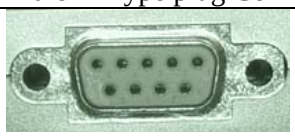
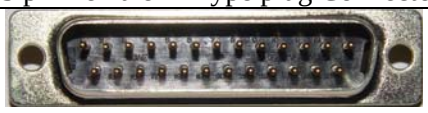
 9 pin Male D-Type plug Connector	 25 pin Female D-Type plug Connector
 9 pin Female D-Type plug Connector	 25 pin Male D-Type plug Connector

Fig (1): Types of connectors

Pins Description

Function	Pin Symbol	9 pin no.	25 pin no.
Receive Data (Serial data input)	RD	3	2
Transmit Data (Serial data output)	TD	2	3
Request to send (acknowledge to modem that UART is ready to exchange data)	RTS	7	4
Clear to send (Modem is ready to exchange data)	CTS	8	5
Data ready state (UART establishes a link)	DSR	6	6

Signal ground	SG	5	7
Data Carrier detect (This line is active when modem detects a carrier	DCD	1	8
Data Terminal Ready.	DTR	4	20
Ring Indicator (Becomes active when modem detects ringing signal from PSTN	RI	9	22

Table (1): Pin description of 25 & 9 pin D-Type plug.

DTE & DCE

Devices that use serial cables for their communication are split into two categories.

1. DTE (Data Terminal Equipment). Examples of DTE are computers, printers & terminals.
2. DCE (Data Communication Equipment). Example of DCE is modems.

Communication methods

There are two methods for serial communication, Synchronous & Asynchronous.

(A) Synchronous serial communication:

In Synchronous serial communication the receiver must know when to “read” the next bit coming from the sender, this can be achieved by sharing a clock between sender and receiver.

In most forms of serial Synchronous communication, if there is no data available at a given time to transmit, a fill character will be sent instead so that data is always being transmitted. Synchronous communication is usually more efficient because only data bits are transmitted between sender and receiver, however it will be more costly because extra wiring and control circuits are required to share a clock signal between the sender and receiver.

(B) Asynchronous serial communication:

Asynchronous transmission allows data to be transmitted without the sender having to send a clock signal to the receiver. Instead, special bits will be added to each word in order to synchronize the sending and receiving of the data.

When a word is given to the UART for Asynchronous transmissions, a bit called the "Start Bit" is added to the beginning of each word that is to be transmitted. The Start Bit is used to alert the receiver that a word of data is about to be sent, and to force the clock in the receiver into synchronization with the clock in the transmitter.

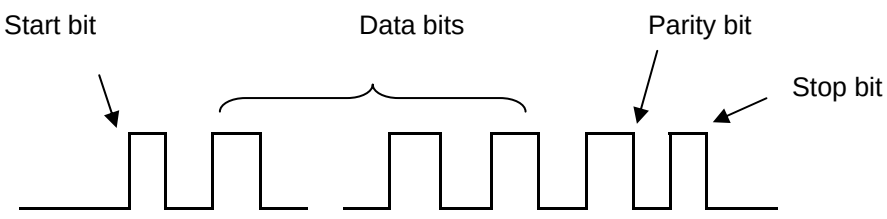


Fig (2): Example of serial data transmission

After the Start Bit, the individual bits of the word of data are sent, each bit in the word is transmitted for exactly the same amount of time as all of the other bits

When the entire data word has been sent, the transmitter may add a Parity Bit that the transmitter generates. The Parity Bit may be used by the receiver to perform simple error checking. Then at least one Stop Bit is sent by the transmitter.

If the Stop Bit does not appear when it is supposed to, the UART considers the entire word to be garbled and will report a Framing Error.

The standard serial communications hardware in the PC does not support Synchronous operations.

Handshaking

Handshaking is a procedure used to check the link between DTE & DCE before transmitting of data. Data is transmitted and received on pins 2 and 3 respectively (for both types 25 & 9 pin).

1. DTE would request to send data to DCE (RTS).
2. The DCE will indicate to DTE that it is ready and clear to send data (CTS).

Both RTS and CTS therefore used to control data flow between DTE & DCE. Data Set Ready (DSR) is an indication from the DCE (i.e., the modem) that it is ON. Similarly, DTR (i.e., the PC) indicates to the Data Set that the DTE is on. Data Carrier Detect (CD) indicates that a good carrier is being received from the remote modem.

Baud rate

Baud rate is a measurement of transmission speed in asynchronous communication, it represents the number of bits that are actually being sent over the serial link. The Baud count includes the overhead bits Start, Stop and Parity that are generated by the sending UART and removed by the receiving UART.

Type of cables

(A) Modem Cable:

A normal modem cable runs straight through with pin 1 to pin 1, pin 2 to pin 2 etc. The end that will be connected to the terminal or PC is a female connector, and the end that will be connected to the modem is male connector. However, is if PC DTE is a nine pin connector then connection in table 1 must be applied.

Signal Description	9-pin DTE	25-pin DCE	Remarks
Carrier Detect (CD)	1	8	from Modem
Receive Data (RD)	2	3	from Modem
Transmit Data (TD)	3	2	from Terminal/Computer
Data Terminal Ready (DTR)	4	20	From Terminal/Computer
Signal Ground (SG)	5	7	from Modem
Data Set Ready (DSR)	6	6	from Modem
Request to Send (RTS)	7	4	From Terminal/Computer
Clear to Send (CTS)	8	5	from Modem
Ring Indicator (RI)	9	22	from Modem

Table (2): Connecting 9 pin to 25 pin for Async data

(B) Null Modem Cables

When you need to connect two equipments with both (DTE) or both (DCE), for example connecting two PC's, then in this case you have to use the cable with below pin connection (25 to 25). And this is called Null modem cable.

	D-Sub 1	D-Sub 2	
Recieve Data (RD)	3	2	Transmit Data
Transmit Data	2	3	Receive Data
Data Terminal Ready	20	6+8	Data Set Ready + Carrier Detect
System Ground	7	7	System Ground
Data Set Ready + Carrier Detect	6+8	20	Data Terminal Ready
Request to Send	4	5	Clear to Send
Clear to Send	5	4	Request to Send

Table (3): Connecting 25 pin to 25 pin for Null modem

Signal description	Pin no.		Signal description
Recieve Data	2	3	Transmit Data
Transmit Data	3	2	Recieve Data
Data Terminal Ready	4	6+1	Data Set Ready + Carrier Detect
System Ground	5	5	System Ground
Data Set Ready + Carrier Detect	6+1	4	Data Terminal Ready
Request to Send	7	8	Clear to Send
Clear to Send	8	7	Request to Send

Table (4): Connecting 9 pin to 9 pin for Null modem

	9 pin	25 pin	
Recieve Data	2	2	Transmit Data
Transmit Data	3	3	Recieve Data
Data Terminal Ready	4	6+8	Data Set Ready + Carrier Detect
System Ground	5	7	System Ground
Data Set Ready + Carrier Detect	6+1	20	Data Terminal Ready
Request to Send	7	5	Clear to Send
Clear to Send	8	4	Request to Send

Table (5): Connecting 9 pin to 25 pin for null modem