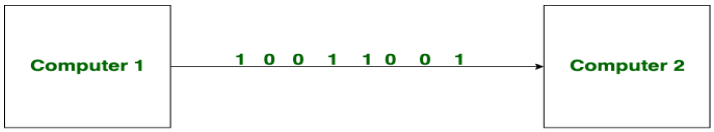
Unit-6
I/O Interface

#Explain the serial and parallel transmission/communication

Serial communication:

Serial communication is the common method of transmitting data between a computer and a peripheral device such as a programmable instrument or even another computer. In **Serial Transmission**, data-bit flows from one computer to another computer in ***bi- direction***. In this transmission **one bit flows at one clock pulse**. In Serial Transmission, 8 bits are transferred at a time having a start and stop bit. Serial transmission is used for long-distance communication. The serial port on our PC is a full duplex device.



Serial Transmission

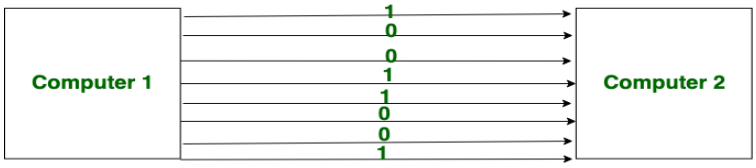
The main advantages of serial communication are:

- It is cost-effective
- It is appropriate for long-distance communication.
- More reliable

Parallel communication

In data transmission, parallel communication is a method of **conveying multiple binary digits (bits)** simultaneously. In Parallel Transmission, many bits(8 bits) are flow together simultaneously from one computer to another computer. Parallel Transmission is faster than serial transmission to transmit the bits. Parallel transmission is used for short distance.

The main advantages of Parallel transmission



Parallel Transmission

- Transmits data at a higher speed.
- Suits better for short-distance communication.
- Set of bits are transferred simultaneously.

#Differences between Serial And Parallel Transmission

1. Serial transmission requires a single line to communicate and transfer data whereas, parallel transmission requires multiple lines.
2. Serial transmission is used for long-distance communication. As against, parallel transmission is used for the shorter distance.
3. Error and noise are least in serial as compared to parallel transmission. Since one bit follows another in Serial Transmission whereas, in Parallel Transmission multiple bits are sent together.
4. Parallel transmission is faster as the data is transmitted using multiples lines. On the contrary, in Serial transmission data flows through a single wire.
5. Serial Transmission is full-duplex as the sender can send as well as receive the data. In contrast, Parallel Transmission is half-duplex since the data is either sent or received.
6. The special types of converters are required in a serial transmission system to convert the data between the internal parallel form and serial form while there is no such requirement of converters in parallel transmission systems.
7. Serial transmission cables are thinner, longer and economical in comparison with the Parallel Transmission cables.
8. Serial Transmission is simple and reliable. Conversely, Parallel Transmission is unreliable and complicated.

Comparison Chart of

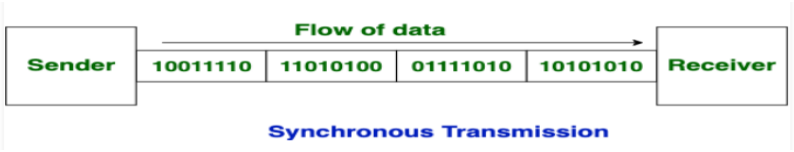
BASIS FOR COMPARISON	SERIAL TRANSMISSION	PARALLEL TRANSMISSION
Meaning	Data flows in bi-direction, bit by bit	Multiple lines are used to send data, i.e. 8 bits or 1 byte at a time
Cost	Economical	Expensive
Bits transferred at 1 clock pulse	1 bit	8 bits or 1 byte
Speed	Slow	Fast
Applications	Used for long-distance communication. E.g., Computer to computer	Short distance. E.g., computer to a printer
Number of communication channel required	Only one	N number of communication channels are needed
Need of converters	Required to convert the signals according to the need.	Not required

#Discuss synchronous and asynchronous serial data communication

As we know in Serial Transmission data is sent bit by bit, in such a way that each bit follows another. It is of two types namely, Synchronous and Asynchronous Transmission.

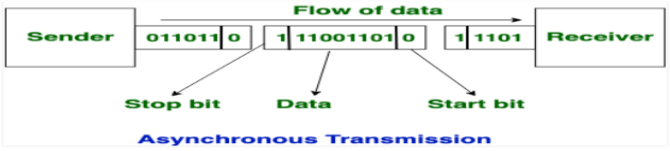
Synchronous Transmission:

In Synchronous Transmission, data is sent in form of blocks or frames. This transmission is the full duplex type. Between sender and receiver the synchronization is compulsory. In Synchronous transmission, there is no gap present between data. It is more efficient and more reliable than asynchronous transmission to transfer the large amount of data.



Asynchronous Transmission:

In Asynchronous Transmission, data is sent in form of byte or character. This transmission is the half duplex type transmission. In this transmission start bits and stop bits are added with data. It does not require synchronization.



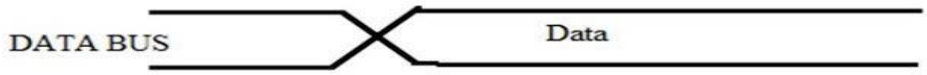
#Difference between Synchronous Transmission and Asynchronous Transmission

S.N	Synchronous Transmission	Asynchronous Transmission
1.	In Synchronous transmission, Data is sent in form of blocks or frames.	In asynchronous transmission, Data is sent in form of byte or character.
2.	Synchronous transmission is fast.	Asynchronous transmission is slow.
3.	Synchronous transmission is costly.	Asynchronous transmission is economical.
4.	In Synchronous transmission, time interval of transmission is constant.	In asynchronous transmission, time interval of transmission is not constant, it is random.
5.	In Synchronous transmission, There is no gap present between data.	In asynchronous transmission, There is present gap between data.
6.	Efficient use of transmission line is done in synchronous transmission.	While in asynchronous transmission, transmission line remains empty during gap in character transmission.
7.	Synchronous transmission needs precisely synchronized clocks for the information of new bytes.	Asynchronous transmission have no need of synchronized clocks as parity bit is used in this transmission for information of new bytes.

#What are the different ways (method) of parallel data communication? Explain.

1) Simple I/O

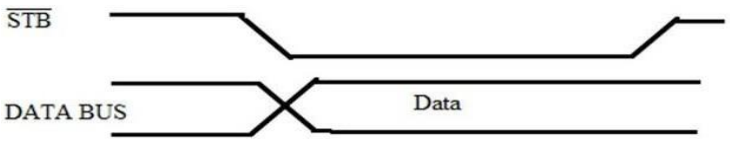
- When we need to get digital data from input device, into microprocessor, all we have to do is connect the switch to an I/O port line and read the port.
- Likewise, when we need to output data to simple display device, such as LED, all we have to do is connect the input of the LED buffer on an output port pin.



Timing diagram of simple I/O

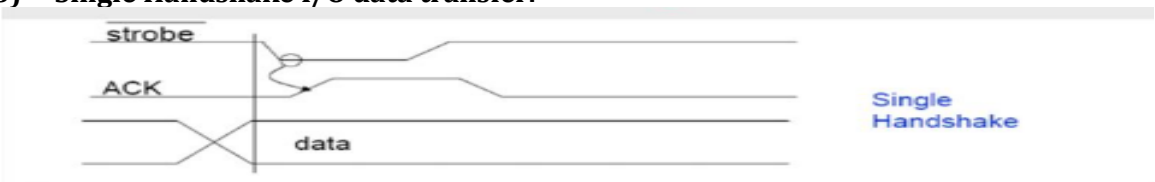
2) Strobe I/O

- In many applications, valid data is present on an external device only at a certain time, so it must be read in at that time.
- E.g. the ASCII-encoded keyboard. When a key is pressed, circuitry on the keyboard sends out the ASCII code for the pressed key on eight parallel data lines, and then sends out a strobe signal on another line to indicate that valid data is present on the eight data lines.



Timing diagram *of strobe I/O*

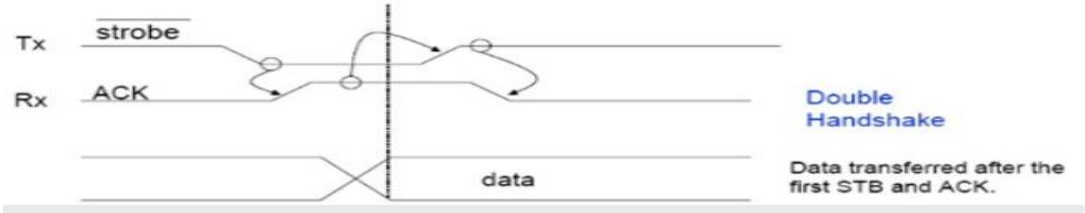
3) Single Handshake I/O data transfer.



Timing diagram of single handshake I/O

- The peripheral output some parallel data and sends STB signal to MPU.
- The MPU detects STB signal on a polled or interrupt basis and reads data bytes.
- Then the MP sends on ACK signal to the peripheral to indicate that the data has been read and the peripheral can send to next byte of data

4) Double Hand shake I/O data transfer

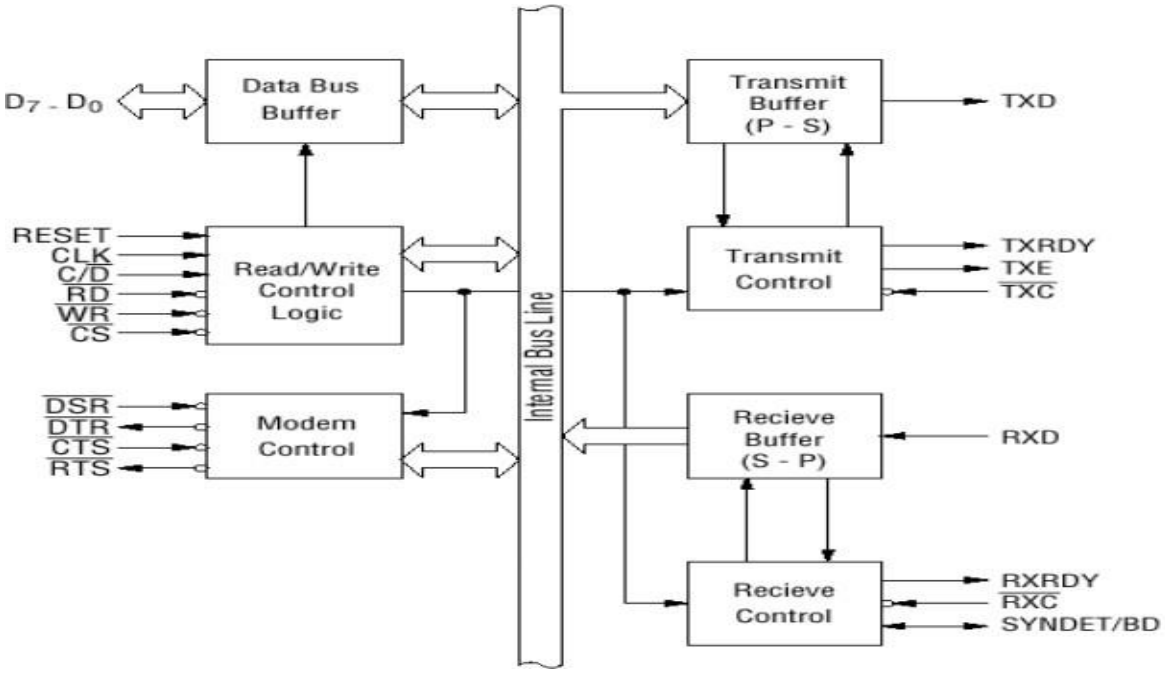


Timing diagram of single Double handshake I/O

- For data transfer where even more coordination is required between the sending system and the receiving system, a double handshake is used.
- The sending (peripheral) device asserts its STB line low to ask the receiving device whether it is ready or not for data reception.
- The receiving system raises its ACK line high to indicate that it is ready.
- The peripheral device then sends the byte of data and raises its STB line high to assure that the valid data is available for the receiving device (MP).
- When MP reads the data, it drops its ACK line low to indicate that it has received the data and requests the sending system to send next byte of data.

#Explain 8251 USART with the help of its neat block diagram.

- 8251 is a **USART (Universal Synchronous Asynchronous Receiver Transmitter)** for serial data communication.
- It acts as a **mediator** between **microprocessor** and **peripheral** to transmit serial data into parallel form and vice versa.
- It takes data serially from peripheral (outside devices) and converts into parallel data. After converting the data into parallel form, it transmits it to the CPU.
- Similarly, it receives parallel data from microprocessor and converts it into serial form. After converting data into serial form, it transmits it to outside device (peripheral).



1) *Read/Write Control Logic*

- The control logic interfaces the chip with the processor, and monitors the data flow. It controls the overall working by selecting the operation to be done.

2) *Data bus buffer*

- This block helps in interfacing the internal data bus of 8251 to the system data bus. The data transmission is possible between 8251 and CPU by the data bus buffer block.

3) *Transmit Buffer*

- This block is used for parallel to serial converter that receives a parallel byte for conversion into serial signal and further transmission onto the common channel.
  - **TXD**: It is an output signal, if its value is one, means transmitter will transmit the data.

4) *Transmit control*

- This block is used to control the data transmission with the help of following pins:

- **TXRDY**: It means transmitter is ready to transmit data character.
- **TXEMPTY**: An output signal which indicates that TXEMPTY pin has transmitted all the data characters and transmitter is empty now.
  TXC: An active-low input pin which controls the data transmission rate of transmitted data.

5) Receive buffer

- This block acts as a buffer for the received data.
  - **RXD**: An input signal which receives the data.

6) Receive control

- This block controls the receiving data.
  - **RXRDY**: An input signal indicates that it is ready to receive the data.
  - **RXC**: An active-low output signal which controls the data transmission rate of received data.
  - **SYNDET/BD**: An input or output terminal.

7) Modem control (modulator/demodulator)

- A device converts analog signals to digital signals and vice-versa and helps the computers to communicate over telephone lines or cable wires. The following are active-low pins of Modem.
  - **DSR**: Data Set Ready signal is an input signal.
  - **DTR**: Data terminal Ready is an output signal.
  - **CTS**: It is an input signal which controls the data transmit circuit.
  - **RTS**: It is an output signal which is used to set the status RTS.

#Explain 8255PPI with the help of a neat block diagram.

- **PPI 8255** is a general purpose programmable I/O device designed to interface the CPU with its outside world such as keyboard.
- We can program it according to the given condition. It can be used with almost any microprocessor.
- It consists of **three 8-bit bidirectional I/O ports i.e. PORT A, PORT B and PORT C**. We can assign different ports as input or output functions.
- 8255A has three ports, i.e., PORT A, PORT B, and PORT C.
  - **Port A** contains one 8-bit output latch/buffer and one 8-bit input buffer.
  - **Port B** is similar to PORT A.
  - **Port C** can be split into two parts, i.e. PORT C lower (PC0-PC3) and PORT C upper (PC7-PC4) by the control word.

8255A Block Diagram

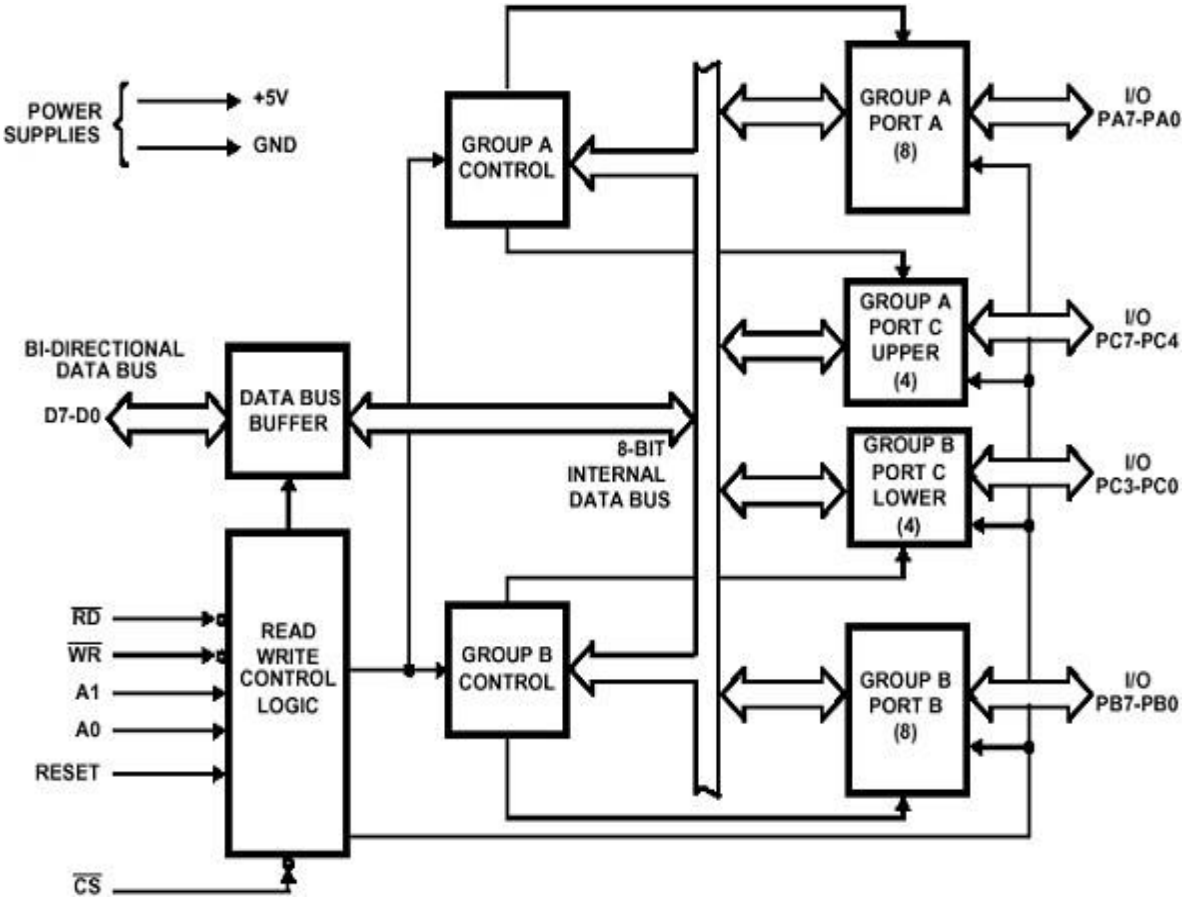


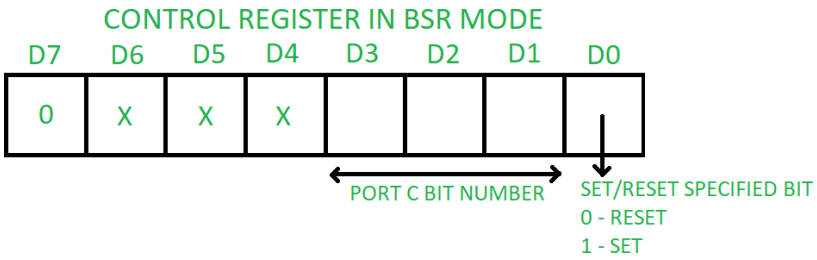
Fig: Block Diagram of 8255A PPI

- It consists of 40 pins and operates in +5V regulated power supply.
- Port C is further divided into two 4-bit ports i.e. port C lower and port C upper and port C can work in either BSR (bit set rest) mode or in mode 0 of input-output mode of 8255.
- Port B can work in either mode or in mode 1 of input-output mode.
- Port A can work either in mode 0, mode 1 or mode 2 of input-output mode.
- It has two control groups, control group A and control group B. Control group A consist of port A and port C upper. Control group B consists of port C lower and port B.

#Explain the Operating modes of 8255A /Explain Bit set reset (BSR) mode & Input/output Mode

1) **Bit set reset (BSR) mode *:***

- If MSB of control word (D7) is 0, PPI works in BSR mode. In this mode only port C bits are used for set or reset.
- The contents of the **control register** are called the **control word** that specifies the input/ output functions of each port.



2) Input/output Mode

There are three types of the input/output mode. They are as follows:

Mode 0

- In this mode all the three ports (port A, B, C) can work as simple input function or simple output function. In this mode there is no interrupt handling capacity.

Mode 1

- In this mode either port A or port B can work as simple input port or simple output port, and port C bits are used for handshake signals before actual data transmission. It has interrupt handling capacity.
- **Example**: A CPU wants to transfer data to a printer. In this case since speed of processor is very fast as compared to relatively slow printer, so before actual data transfer it will send handshake signals to the printer for synchronization of the speed of the CPU and the peripherals.

Mode 2

- Bi-directional data bus mode. In this mode only port A works, and port B can work either in mode 0 or mode 1. 6 bits ports C are used as handshake signals. It also has interrupt handling capacity.

#What is RS 232 interface? Explain with DTE and DCE.

RS232 is a standard protocol used for serial communication, it is used for connecting computer and its peripheral devices to allow serial data exchange between them. In simple terms RS232 defines the voltage for the path used for data exchange between the devices. It specifies common voltage and signal level, common pin wire configuration and minimum, amount of control signals.

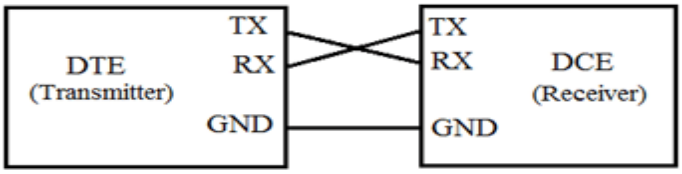


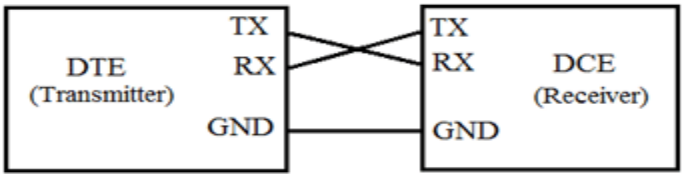
Fig: RS-232

- **DTE** - A DTE stands for data terminal equipment is an end instrument that convert user information into signals or reconverts the receive signal. A male connector is used in DTE and has pin out configuration.

- **DCE** - A DCE stands for data communication equipment's. It sits between the DTE and data transmission circuit for example modem. A DCE device uses a female connector which has holes on the surface to hold male connector.

#How RS232 Works? When it Interconnection between DTE-DCE and its application

- **RS232** works on the **two-way communication** that exchanges data to one another. There are two devices connected to each other, **(DTE) Data Transmission Equipment& (DCE) Data Communication Equipment** which has the pins like **TXD, RXD, and RTS & CTS**.
- Now, from **DTE source, the RTS generates** the request to send the data. Then from the other side DCE, the CTS, **clears the path for receiving the data**.
- After clearing a path, it will give a signal to **RTS of the DTE** source to send the signal. Then the bits are transmitted from **DTE to DCE**.
- Now again from **DCE source**, the request can be generated by **RTS and CTS of DTE** sources clears the path for receiving the data and gives a signal to send the data.
- This is the whole process through which data transmission takes place.



TXD	TRANSMITTER
RXD	RECEIVER
RTS	REQUEST TO SEND
CTS	CLEAR TO SEND
GND	GROUND

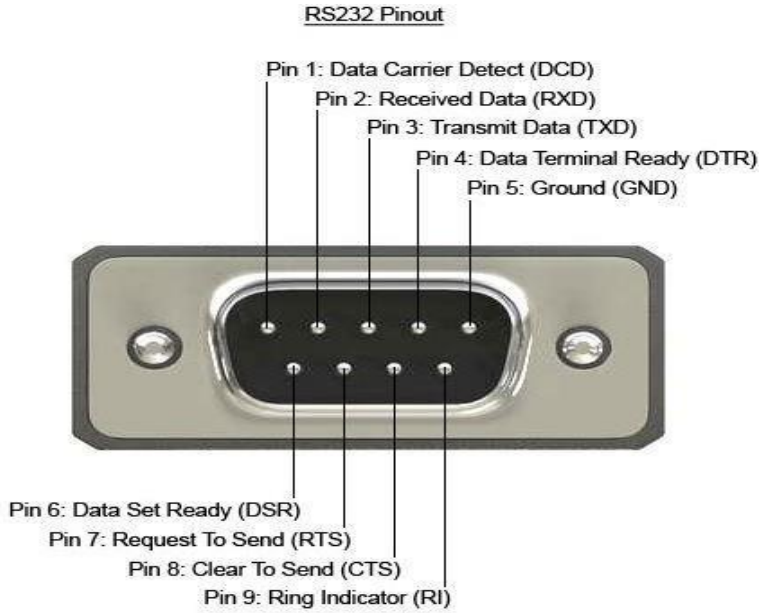
Application of RS-232

- RS232 serial communication is used in old generation PCs for connecting the peripheral devices like mouse, printers, modem, scanner etc.
- Nowadays, RS232 is replaced by advanced USB.
- It is still used by some microcontroller boards, receipt printers, point of sale system (PoS), etc.

#Draw the RS-232 Pin Configuration – 9 pin MALE Connector

The most commonly used type of serial cable connectors is 9-pin connectors DB9 and 25-pin connector DB-25. Each of them may be a male or female type. Nowadays most of the computers use the DB9 connector for asynchronous data exchange. The maximum length of the RS-232 cable is 50ft.

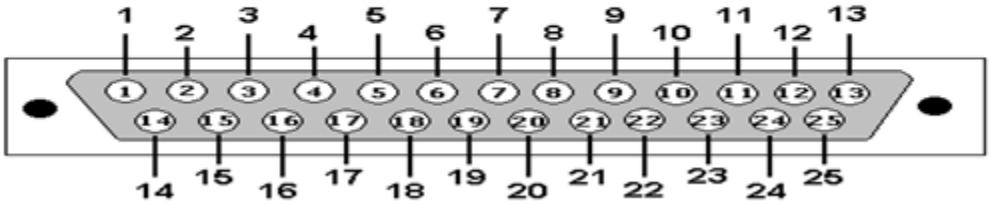
New RS232 has nine pins as mentioned earlier. These nine pins are arranged in the port as shown in **RS232 Connector Pin out**. The DCE and DTE ports are exactly similar except for the direction of data flow. These nine pins are roughly divided in to three categories and we will discuss each category below.



Pin Number	Pin Name	Description
DATA pins (Data flow takes through these pins)		
2	RXD	Receive Data (Data is received though this pin)
3	TXD	Transmit Data (Data is transmitted through this pin)
CONTROL pins (These pins are for establishing interface and to avoid data loss)		
1	CD	Carrier Detect(Set by MODEM when answer is received by remote MODEM)
4	DTR	Data Terminal Ready(Set by PC to prepare MODEM to be connected to telephone circuit)
6	DSR	Data Set Ready(Set by MODEM to tell PC it is ready to receive and send data)
7	RTS	Request To Send(Set by PC to tell MODEM that MODEM can begin sending data)
8	CTS	Clear To send(Set by MODEM to tell PC that it is ready to receive data)
9	RI	Set by MODEM to tell PC a ringing condition has been detected.
REFERENCE		
5	GND	Ground (Used as reference for all pin voltage pulses)

#Explain the RS 232 PIN description

RS232 Pin Description



It is a 25-pin connector, each pin has its function is as follows.
PIN 1*: (Protective Ground);* It is a ground Pin.
PIN 2: Transmit Data.
PIN 3: Receive Data.
PIN 2 & PIN 3: These pins are the most important pins for data transmitting and receiving. The 1 & 2-pins are used to data transmission and pin-3 used to data receiving purpose.
PIN 4: Request to send.
Pin 5*:* Clear to send.
PIN 6*:* Data Set Ready.
PIN *20:* Data terminal Ready.
PIN 4, PIN 5, PIN 6, PIN 20: These pins are the handshaking pins(flow of control). Normally terminals cannot transmit the data until clear to send transmission is received from the DCE.
PIN 7: This pin is the common reference for all signals, including data, timing, and control signals. The DCE and DTE work properly across the serial interface and the pin-7 must be connected both ends without interface would not work.
PIN 8: This pin is also known as received line signal detector carrier detect. This signal is activated when a suitable carrier is established between the local and remote DCE devices.
PIN9: This pin is a DTE serial connector, this signal follows the incoming ring to an extent. Normally this signal is used by DCE auto-answer mode.
PIN 10: Test Pin.
PIN 11: standby select.
PIN 12: Data Carrier Detect.
PIN 13: Clear to send.
PIN 14: Transmit data.
PIN 15: Transmit clock.
PIN 17: Receive clock.
PIN 24: External Clock.
PIN 15, 17, 24; Synchronous modems use the signals on these pins. These pins are controlled bit timing.
PIN 16: Receive data.
PIN 18: Test Pin.
PIN 19: Request to send.
PIN 21: (Signal Quality Detector); This pin Indicates the quality of the received carrier signal because the transmitting modem must be sent 0 or either 1 at each bit time, the modem controls the timing of the bits from the DTE.
PIN 22: (Ring Indicator): The ringing indicator means the DCE informs the DTE that the phone is ringing. All the modems designed for directly connected to the phone network equipped with the auto-answer.
PIN 23: Data Signal Rate Detector

Exam Questions:

1) How DTE and DCE are wired using RS 232 cable? Explain the process of double handshaking I/O.
2) Explain the Operating modes of 8255A /Explain Bit set reset (BSR) mode & Input/output Mode
3) What are the different ways (method) of parallel data communication? Explain.
4) Difference between Synchronous Transmission and Asynchronous Transmission

**********Good Luck**********