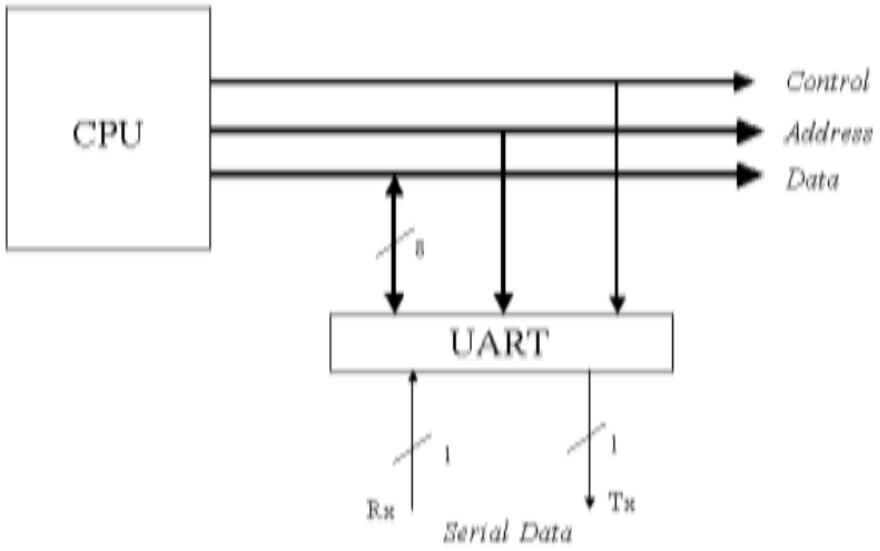
Study about UART:

- Parallel communication implies sending multiple bits of data over multiple wires.
- Serial communication implies sending data bit by bit over a single wire.
- Serial transmission is commonly used with modems and for communication between computers and other devices.
- Because of the difficulty of synchronizing data bits sent in parallel over long distances and reduction in the cost of the communication equipment over longer distance, serial communication is used.
- The Universal Asynchronous Receiver/Transmitter (UART) controller is the key component of RS232 system.
- The UART takes data and transmits the individual bits in a sequential fashion. At the destination, UART reassembles the bits into complete bytes.
- (UART) An integrated circuit, on motherboard used for serial communications, containing a transmitter (parallel to serial converter) and a receiver (serial to parallel converter), each clocked separately.



- The parallel side of a UART's usually connected to the bus of a computer.
- When the computer writes a byte to the UART's Transmit Data Register (TDR), the UARTs will start to transmit it on the serial line.
- The UART's status register contains a flag bit which the computer can read to see if the UART is ready to transmit another byte.
- Another status register bit says whether the UART has received a byte from the serial line, in which case the computer should read it from the Receive Data Register (RDR).

Serial communication:

- There are two primary forms of serial transmission: Synchronous and asynchronous. Depending on the modes that are supported by the hardware, the name of the communication sub system will usually include an A if it supports Asynchronous communications, and a S if it supports Synchronous communications. Both forms are

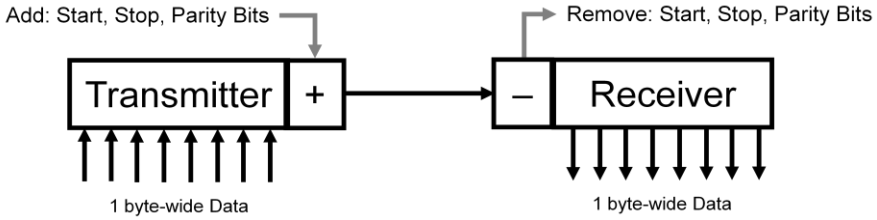
described below. Some common acronyms are: UART Universal Asynchronous receiver/Transmitter USART Universal Synchronous-Asynchronous receiver/Transmitter.

Synchronous Transmission:

- Synchronous serial transmission requires that the sender and receiver share a clock with one another, or that the sender provide a strobe or other timing signal so that the receiver knows when to "read" the next bit of the data. Like processors, memory and I/O connected with the same clock. In microprocessor read cycle puts the address of memory location or I/O. In next cycle Memory or I/O needs to put data on data bus. When device is activated by sending the address of it, in next clock cycle it has to send data. Synchronous communication is usually more efficient because only data bits are transmitted between sender and receiver, and synchronous communication can be more costly if extra wiring and circuits are required to share a clock signal between the sender and receiver.

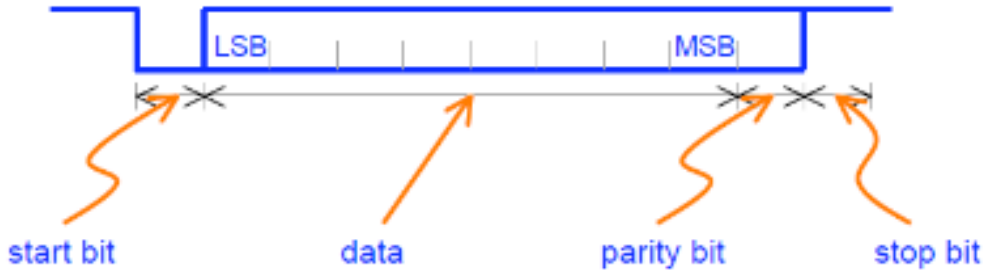
Asynchronous Serial Transmission:

- Asynchronous transmission allows data to be transmitted without the sender having to send a clock signal to the receiver. Instead, the sender and receiver must agree on timing parameters in advance and special bits are added to each word which is used to synchronize the sending and receiving units.
- 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.
- After the Start Bit, the individual bits of the word of data are sent, with the Least Significant Bit (LSB) being sent first.
- Each bit in the transmission is transmitted for exactly the same amount of time as all of the other bits, and the receiver "looks" at the wire at approximately halfway through the period assigned to each bit to determine if the bit is a 1 or a 0.
- For example, if it takes two seconds to send each bit, the receiver will examine the signal to determine if it is a 1 or a 0 after one second has passed, then it will wait two seconds and then examine the value of the next bit, and so on.



- The sender does not know when the receiver has "looked" at the value of the bit. The sender only knows when the clock says to begin transmitting the next bit of the word.
- 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.

- When the receiver has received all of the bits in the data word, it may check for the Parity Bits (both sender and receiver must agree on whether a Parity Bit is to be used), and then the receiver looks for a Stop Bit.
- 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 to the host processor when the data word is read.
- The usual cause of a Framing Error is that the sender and receiver clocks were not running at the same speed, or that the signal was interrupted.
- Regardless of whether the data was received correctly or not, the UART automatically discards the Start, Parity and Stop bits.
- If the sender and receiver are configured identically, these bits are not passed to the host.
- If another word is ready for transmission, the Start Bit for the new word can be sent as soon as the Stop Bit for the previous word has been sent.
- If another byte is received before the previous one is read, the UARTs will signal an "overrun" error via another status bit.
- Data transmission is made by the UART in a serial way, by 11-bit blocks:
    - A 0 bit marks the starting point of the block
    - Eight bits for data
    - One parity bit
    - A 1 bit marking the end of the block
- The transmission and reception lines should hold a 1 when no data is transmitted. The parity bit is set to 1 or 0, depending on the number of 1's.
- The transmission speed is fixed, measured in bauds-symbols per second.
- Baud rate by definition means the number of times a signal in a communications channel changes state.



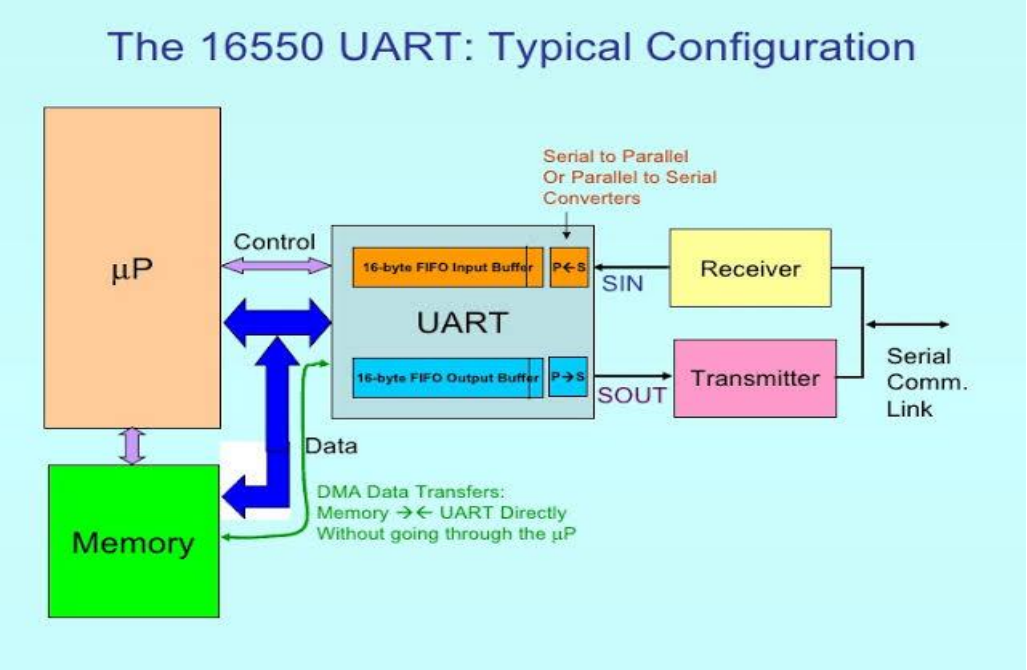
UART transmission

Other UART Functions:

- In addition to the basic job of converting data from parallel to serial for transmission and from serial to parallel on reception, a UART will usually provide additional circuits for signals that can be used to indicate the state of the transmission media, and to regulate the flow of data in the event that the remote device is not prepared to accept more data.
- For example, when the device connected to the UART is a modem, the modem may report the presence of a carrier on the phone line while the computer may be able to instruct the modem to reset itself or to not take calls by raising or lowering one more of

these extra signals. The function of each of these additional signals is defined in the EIA RS232 -C standard.

- Along with serial output data pin(used at transmitter), and serial input data pin (used at receiver),it has 8 data lines and address lines, chip select lines, control lines for read and write instruction, interrupt pin connected to microprocessor. It also can be connected directly to the memory using DMA.

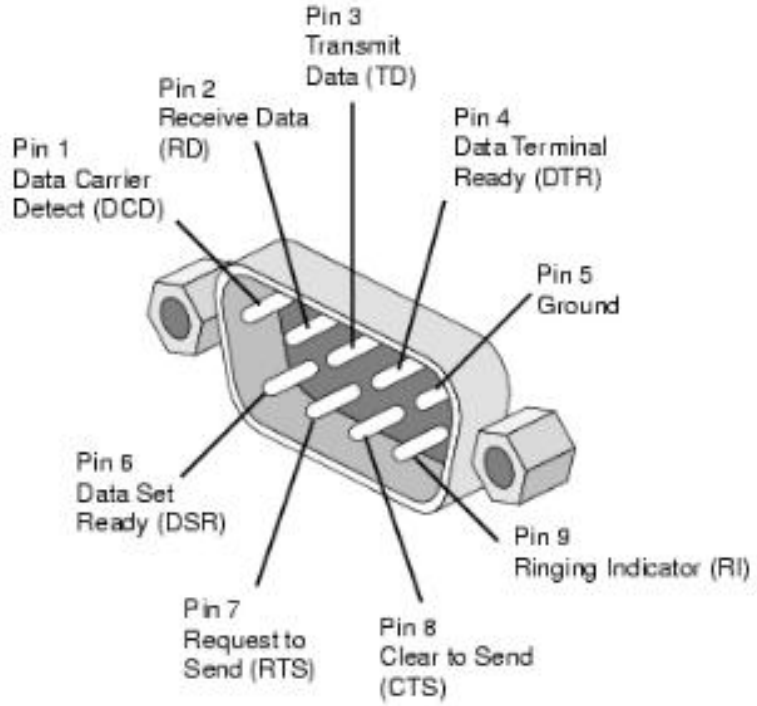


DCE and DTE Devices

- DTE- data terminal equipment & DCE-data communication equipment
- Device that connects to interface is called DCE(modem,switch,hub) and device to which it is connected it is called DTE(PC)

RS232 -C Bit Assignments (Marks and Spaces):

- In RS232-C, a value of 1 is called a Mark and a value of 0 is called a Space.
- When a communication line is idle, the line is said to be "Marking", or transmitting continuous 1 value.
- The Start bit always has a value of 0 (a Space).
- The Stop Bit always has a value of 1 (a Mark).
- This means that there will always be a Mark (1) to Space (0) transition on the line at the start of every word, even when multiple word are transmitted back to back.



Pin Number	Abbreviation	Function
3	TxD	Serial Data output
2	RxD	Serial Data Input
8	CTS	Clear to send-Receiver is ready-flow control
1	DCD	Data carrier detect-When receiver is modem and is connected to another modem and gets signal from another modem. Carrier Detect is used by a modem to signal that it has a made a connection with another modem, or has detected a carrier tone
6	DSR	Data set ready- receiver is ready to establish a link- device is powered on and ready to transmit
4	DTR	Data terminal ready-Tells receiver transmitter is ready to establish a link-device is powered on and ready to transmit
7	RTS	Ready to send-Transmitter is ready to transmit-flow control
9	RI	Ring indicator- When receiver is modem and it gets call from PSTN-public switch telephone network
5	SG	Signal Ground

For DTE to DTE connection only three lines are useful-TxD, RxD and GND.