

Asynchronous and Synchronous Serial Communications

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Reynante Mayor



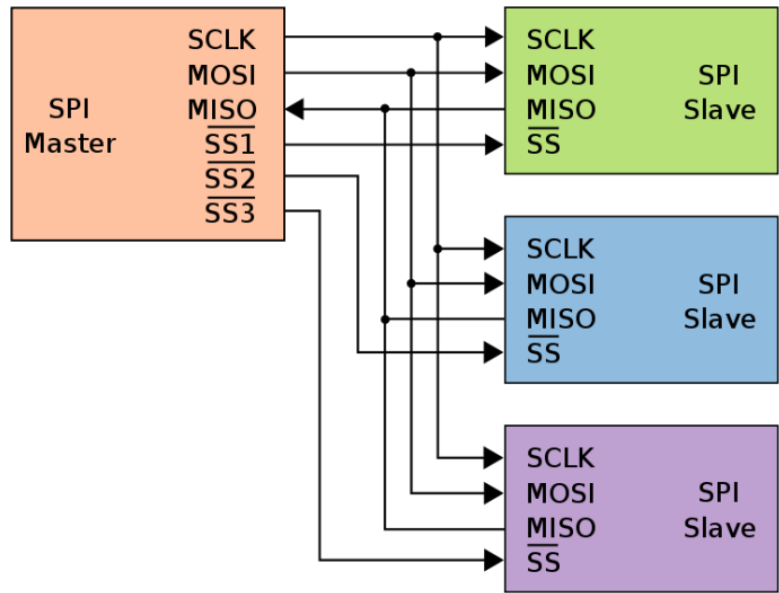
Serial Communication

Serial data communication, or you can say serial communication in general, uses communication protocols as a method for data transmission and reception.

Over the years, many serial protocols have been developed to meet certain needs of embedded systems. Ethernet and USB (universal serial bus), are a couple of the well-known computing serial interfaces.

Other common serial protocols include SPI, I2C (pronounced as I two C or I squared C). In general, these serial interfaces are sorted into two categories: Asynchronous and Synchronous.

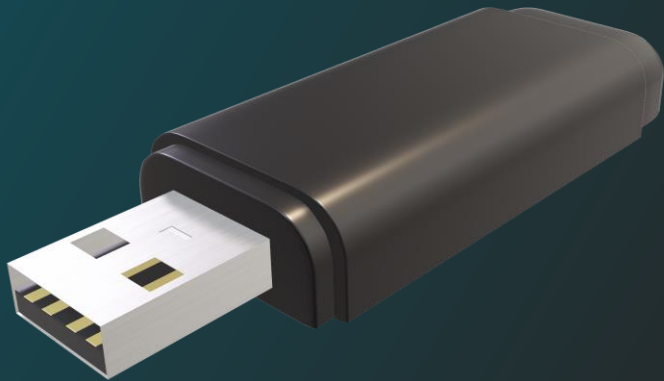




Synchronous Serial Communication

A synchronous serial interface always pairs its data line(s) with a clock signal, and all devices on a synchronous serial bus share a common clock. This makes for a more straightforward, even faster serial transfer, but it also requires at least one extra wire between communicating devices. In simple terms, this type of serial communication requires the SCLK pin to synchronize.

In synchronous method, for example, in SPI, there are 4 pins used. 2 pins are for MISO & MOSI (Master In Slave Out & Master Out Slave In), 1 pin for fixed clock (from a single master device), and 1 Data pin for each slave device. Here, SS1, SS2, and SS3 are data pins for 3 slave devices.



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Topic: Synchronous Serial Communication

Source: <https://pijaeducation.com/communication/serial-communication-methods-synchronous-asynchronous/>

1. SYNCHRONOUS COMMUNICATION PROTOCOL

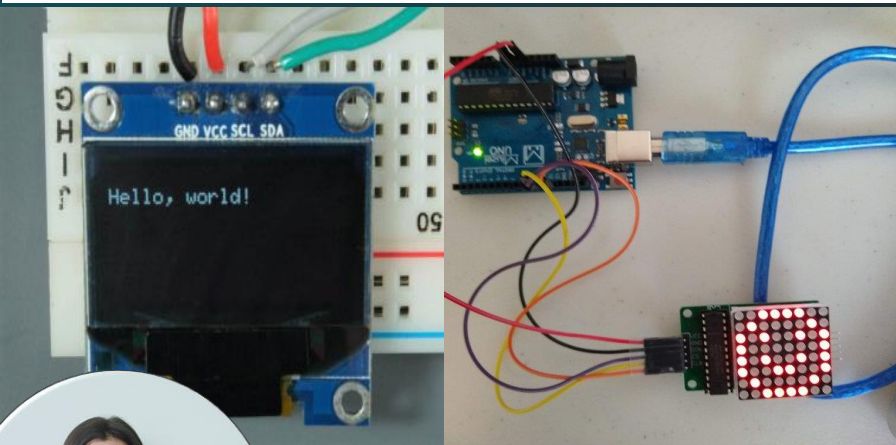
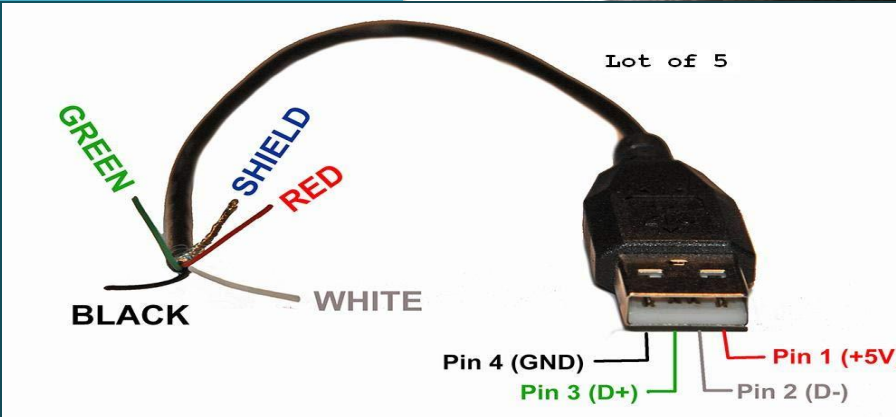
2. ASYNCHRONOUS COMMUNICATION PROTOCOL



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Source: https://www.youtube.com/watch?v=bdgCFkc_RXY



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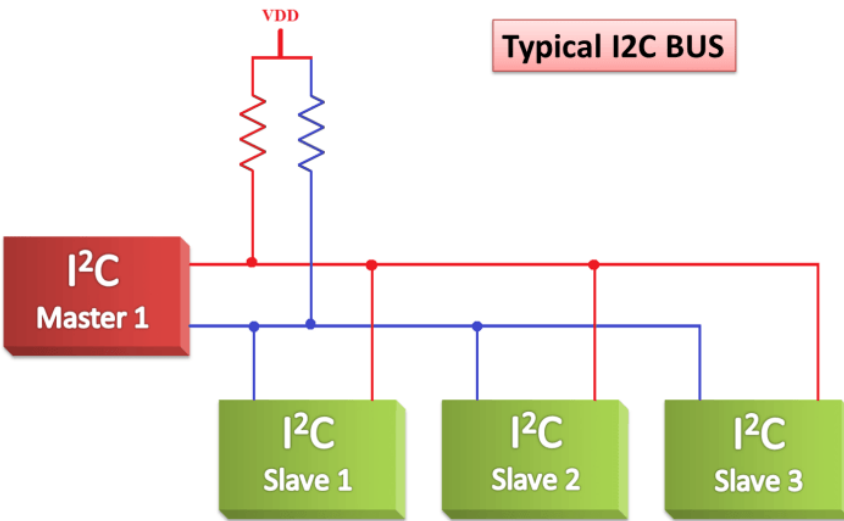
Examples of Synchronous Serial Communication Protocols

- ❑ **USART** (Universal Synchronous-Asynchronous Receiver-Transmitter)
- ❑ **USB** (Universal Serial Bus)
- ❑ **RS232 ()** : The **RS-232** spec provides for both **synchronous** and **asynchronous** but PC's use a **UART chip** such as a 16450, 16550A, or 16650 and can't deal with **sync**.
- ❑ **I2C or I²C** (Inter-Integrated Circuit, pronounced as "I squared C" or "I two C")
- ❑ **SPI** (Serial Peripheral Interface)

Source: <https://pijaeducation.com/communication/serial-communication-methods-synchronous-asynchronous/>



Examples of Synchronous Serial Communication Protocols: I²C (Inter Integrated Circuit)

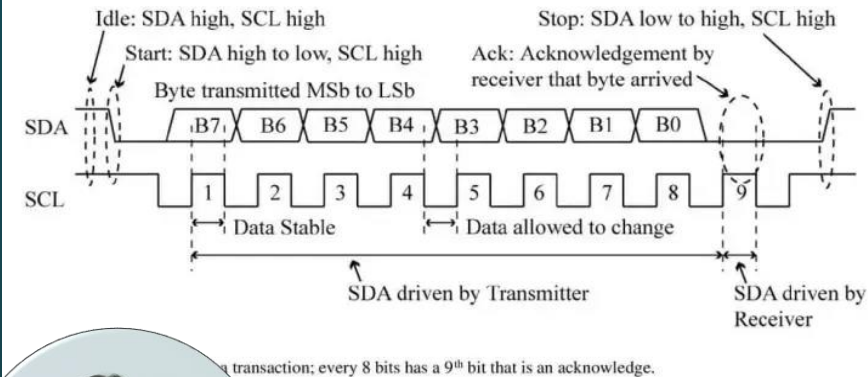


I²C – Inter Integrated Circuit (Inter IC) is a multi-master, multi-slave single-ended serial computer bus. Simply it's a one-to-many connection with in-band addressing in the messages.

In brief, I²C is a **synchronous** protocol and it is the one which has some “intellect” in it while other protocols dumbly shifted bits in and out.

- I²C uses only **2 wires for signal**, one for the **clock (SCL)** and one for the **data (SDA)**, 3 if include ground & 4 if you also include power but they are usually available on PCBs. It allows connection to (ideally) 128 devices (practically approx. 112 devices, while other address reserves for some other purposes). This saves a ton of PCB wiring
- That means, **master and slave send data over the same wire**, controlled by the master who creates the clock signal
- I²C doesn't use separate Slave Selects to select a particular device, but has **addresses** to identify slave device

I²C Bus Transfer



transaction; every 8 bits has a 9th bit that is an acknowledge.

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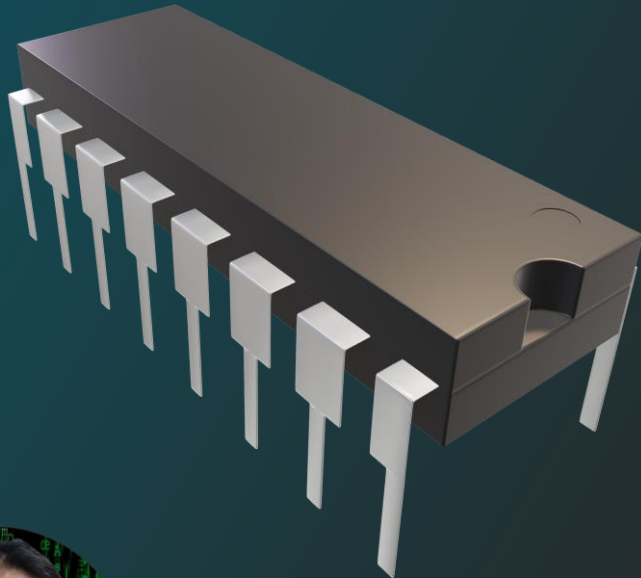
Source: <https://pijaeducation.com/communication/i2c-inter-integrated-circuit/>



Asynchronous Serial Communication

In Asynchronous Serial communication, data transfer takes place without any need or support from an external clock signal, or in other words, in this case, you do not need a clock for communicating with other devices. For example, UART, RS232, etc. are Asynchronous serial communication methods.

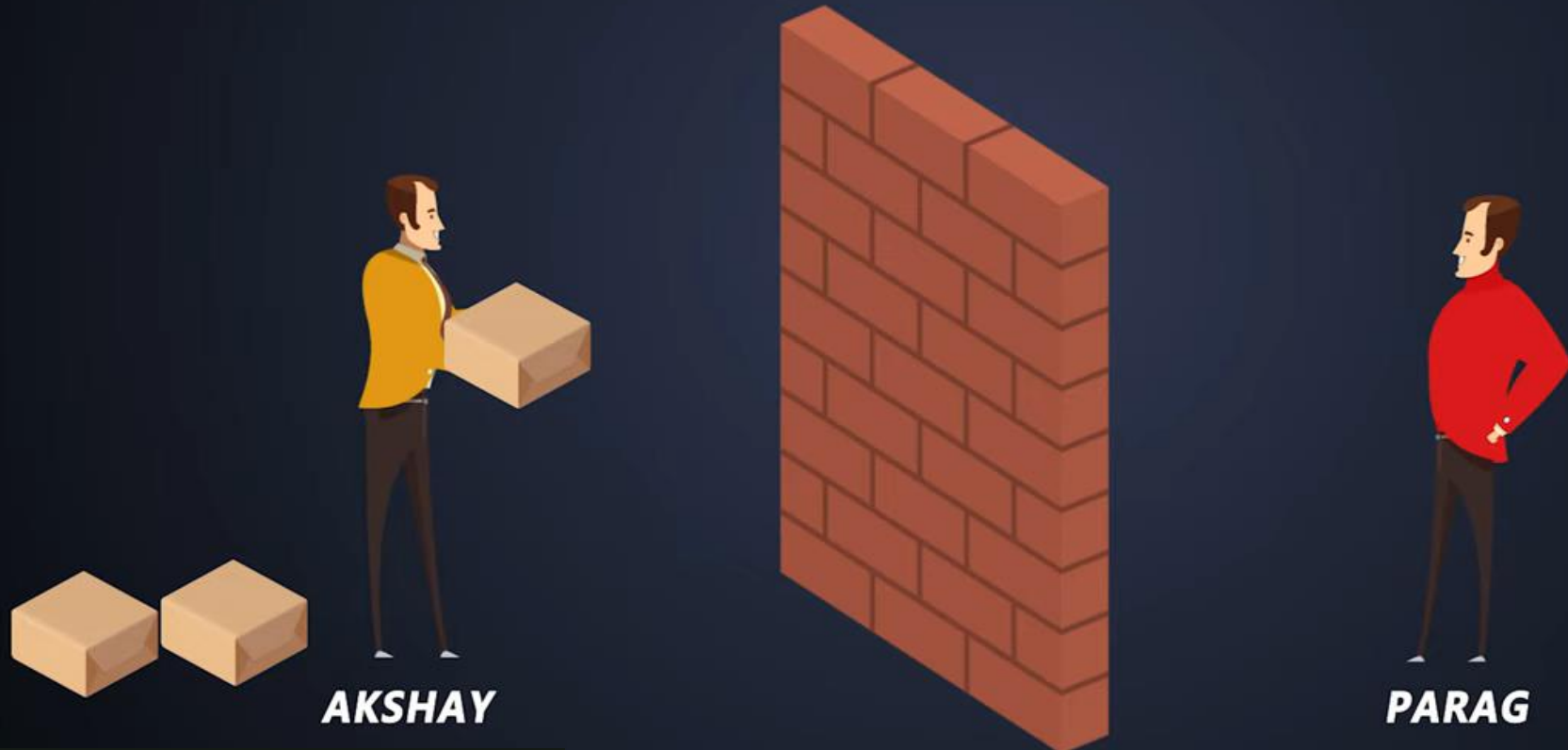
Usually RS232, RS422 & RS485 have two wires RX and TX with predefined data rate (also called baud rate) and no predetermined master or slave device.



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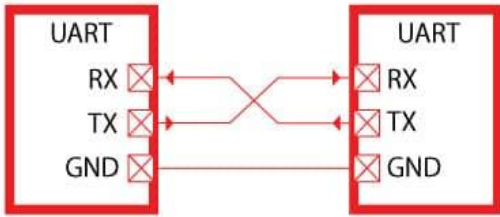
2. ASYNCHRONOUS COMMUNICATION PROTOCOL



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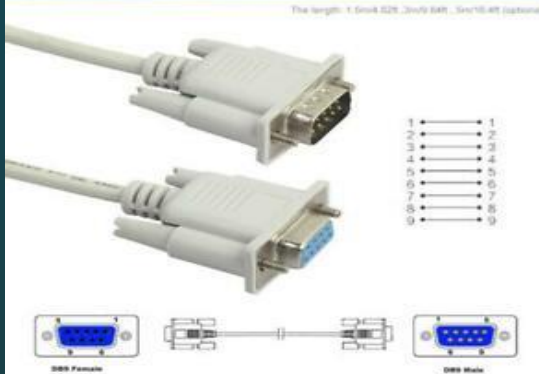
Source: https://www.youtube.com/watch?v=bdgCFkc_RXY



Examples of Asynchronous Serial Communication Protocols

- ❑ UART (Universal Asynchronous Receiver-Transmitter) (used in Arduino)
- ❑ RS232 (used in PC)
- ❑ CAN (Control Area Network Bus) : According to Wikipedia, CAN does not include a clock in the data transmission. All nodes on the CAN network must operate at the same bit rate, and the error between each node's internal clocks must be within tolerance, for the nodes on the network to communicate. This is the same as a PC's RS-232 serial port which is considered as asynchronous.

Serial RS232 DB9 Male to Female Cable



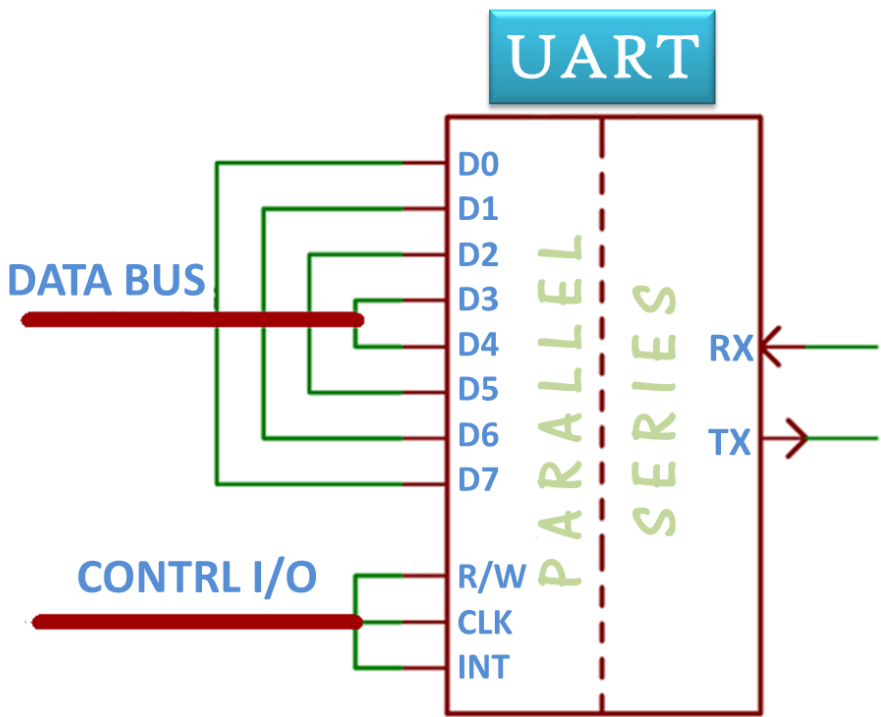
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Examples of Asynchronous Serial Communication Protocols: UART – Universal Asynchronous Receiver Transmitter



UART chip is included in the ATMEGA328 microcontroller used in Arduino, which facilitates serial communication. It is a chip (block of circuitry, hardware part) responsible for implementing serial communication.

It acts as an intermediary between parallel and serial interfaces. On one end of the UART there is a bus of eight-or-so data lines (additionally some control pins), on the other side two serial wires – RX and TX.

UARTs are responsible for both sending and receiving serial data:

1. On the transmitter side, a UART must create the data packet (appending sync and parity bits) and send that packet out the TX line with precise timing (according to the set baud rate).
2. On the receiving end, the UART has to sample the RX line at rates according to the expected baud rate, pick out the sync bits, and spit out the data.



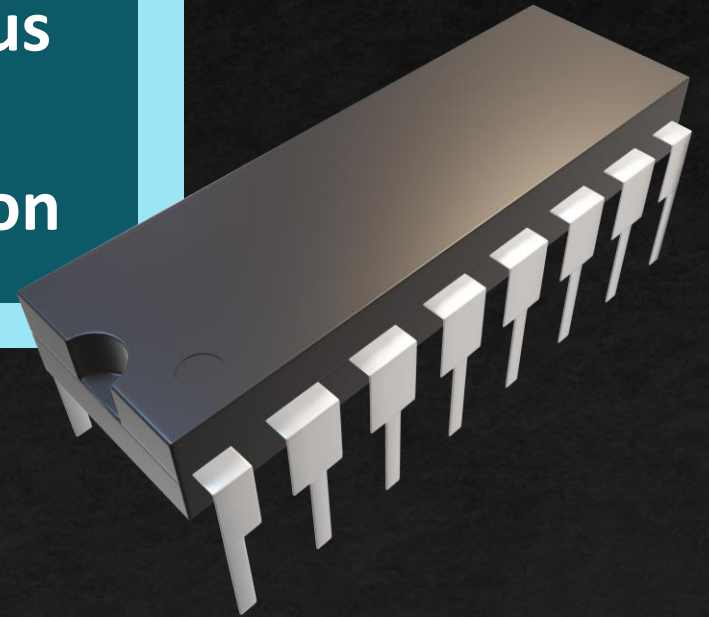
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Source: <https://pijaeducation.com/communication/uart/>



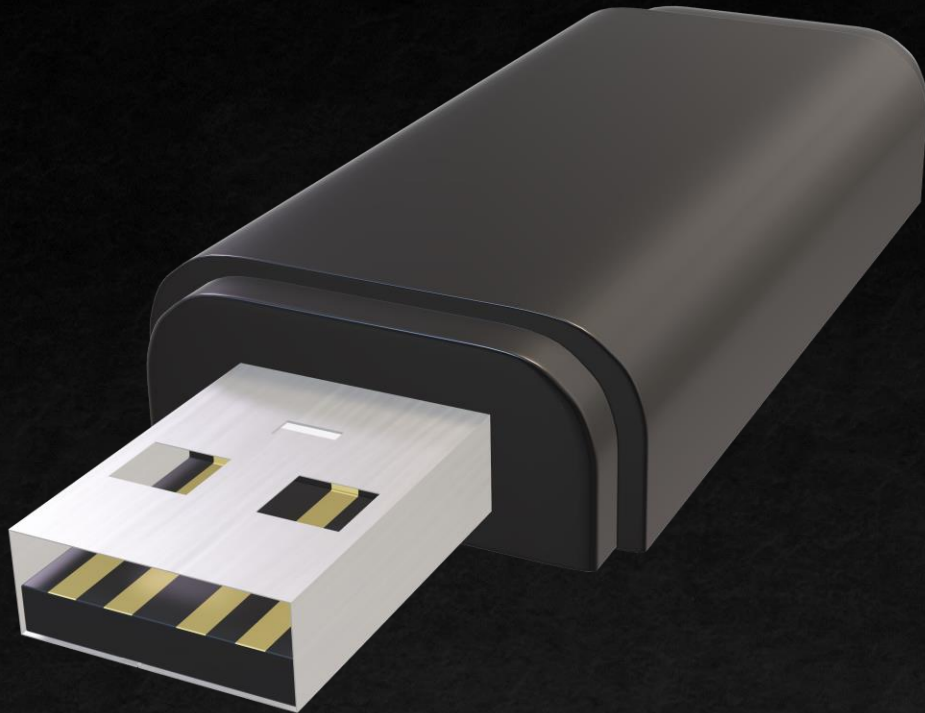
Difference between Synchronous and Asynchronous Serial Transmission



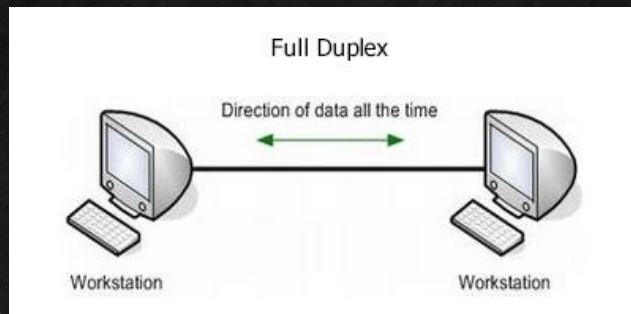
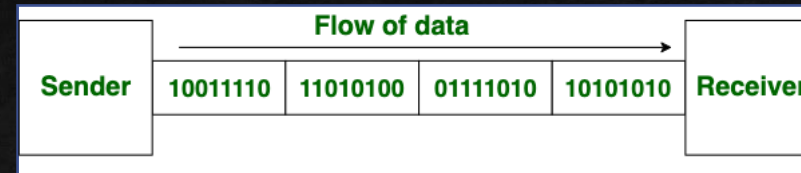
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Topic: Difference Between Synchronous &
Asynchronous Serial Communication

Synchronous Serial 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.



- ☐ In Synchronous transmission, Data is sent in form of blocks or frames.
- ☐ Synchronous transmission is fast.
- ☐ Synchronous transmission is costly.
- ☐ In Synchronous transmission, time interval of transmission is constant. In Synchronous transmission, there is no gap present between data.
- ☐ Efficient use of transmission line is done in synchronous transmission.
- ☐ Synchronous transmission needs precisely synchronized clocks for the information of new bytes.

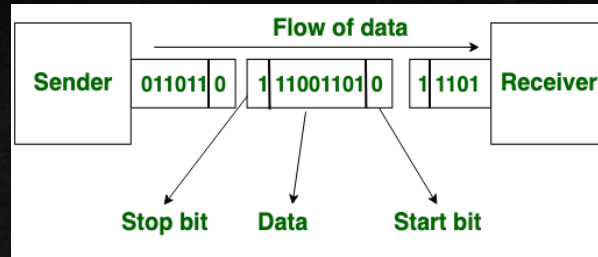
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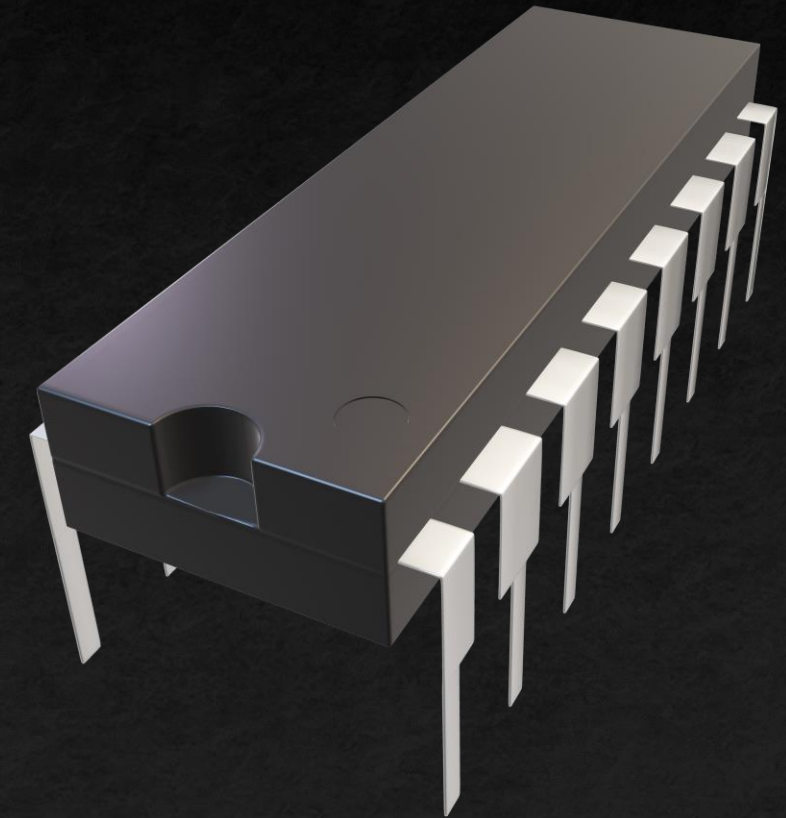
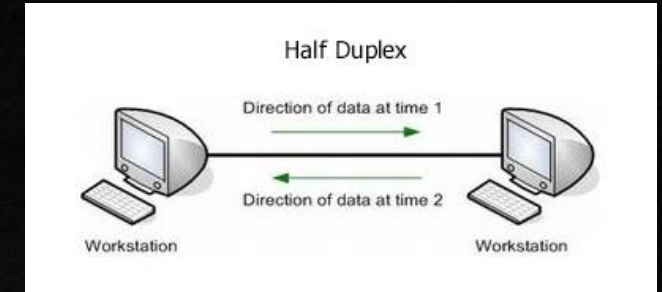
Source: <https://www.geeksforgeeks.org/difference-between-synchronous-and-asynchronous-transmission/>

Asynchronous Serial 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.



- ❑ In asynchronous transmission, Data is sent in form of byte or character.
- ❑ Asynchronous transmission is slow.
- ❑ Asynchronous transmission is economical.
- ❑ In asynchronous transmission, time interval of transmission is not constant, it is random.
- ❑ In asynchronous transmission, there is presence of gap between data.
- ❑ In asynchronous transmission, transmission line remains empty during gap in character transmission.
- ❑ Asynchronous transmission have no need of synchronized clocks as parity bit is used in this transmission for information of new bytes.



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Topic: Difference Between Synchronous & Asynchronous Serial Communication

Source: <https://www.geeksforgeeks.org/difference-between-synchronous-and-asynchronous-transmission/>

Conclusion

Serial Communication is the vital part in the area of Electronics and Embedded Systems. The rate of data transfer is critical if two devices want to exchange information on the same bus. Hence, it is necessary to choose a valid serial protocol for any application.

Learning Assessment: (Quiz)

<https://forms.gle/FhzzFmnWyvKMZBkVA>



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