AVR and UART – Tutorial #14

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AVR tutorial

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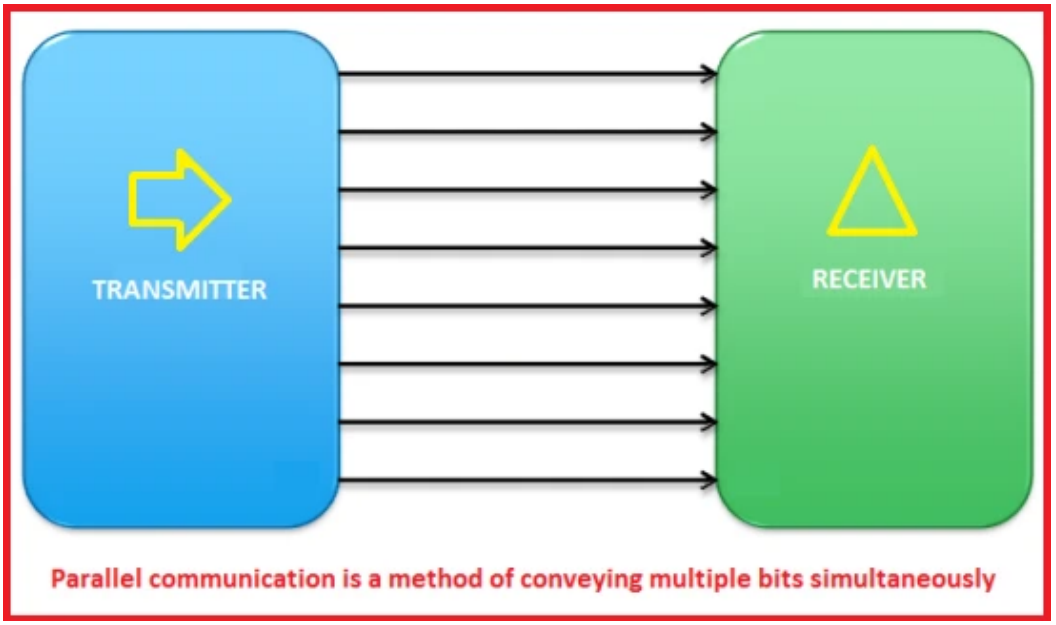
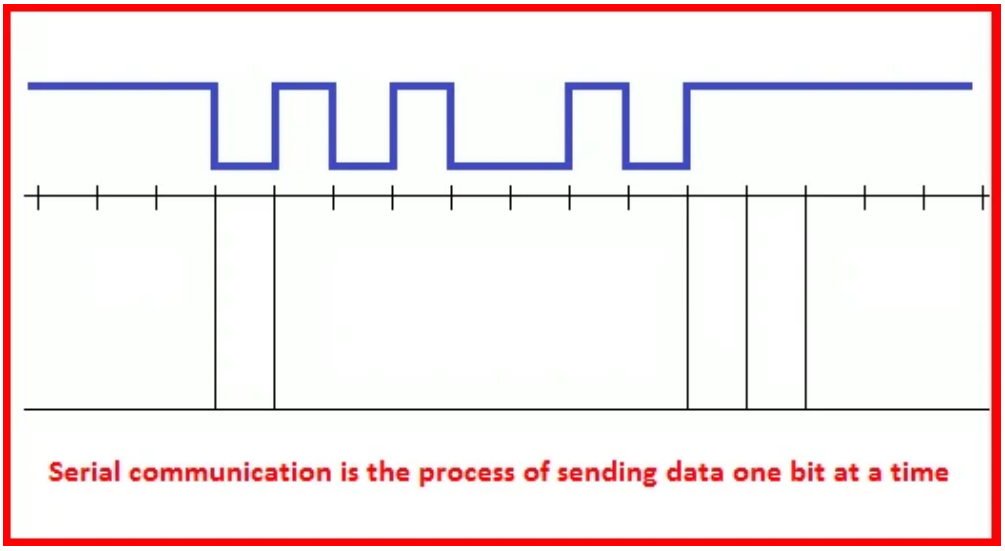
It's a well-known fact that all devices in a system need some kind of communication method to interact with each other inorder to maintain proper functioning of the whole system. In practice we can divide these communication methods in to two; Parallel communication, and serial communication.

In Parallel communication, multiple lines carry data bits from the source to destination. This is simple but the cost is very high due to multiple parallel lines.

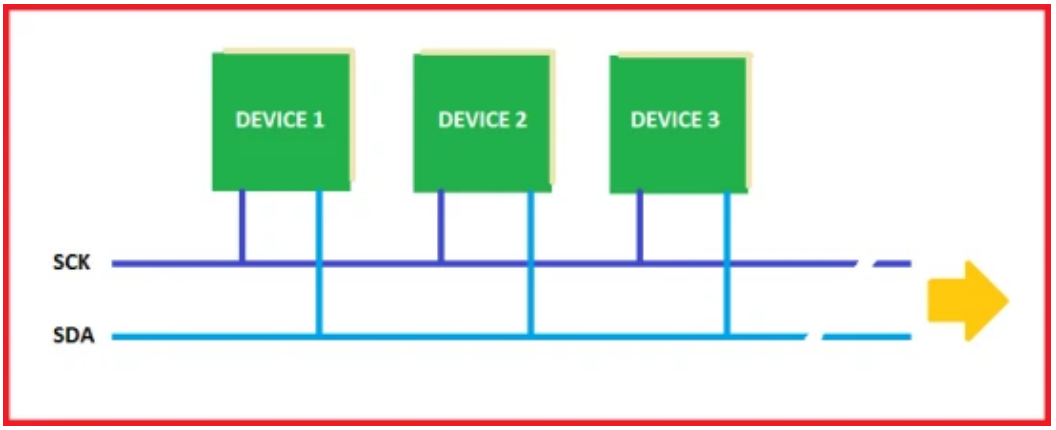


In Serial mode only one line carries the data bits from source to destination and transmits them in a serial (one after one) manner (note that serial communication may also use more than one line for syncronization). Literally, in serial communication , a sequence of bits are travelling through the track like a train!



Serial communication can be of two types; Asynchronous communication, and Synchronous communication. In Asynchronous communication, receiver has no prior intimation about the arrival of databits/packets, and because of this receiver needs some other information (like baud/bit rate, packet size, parity type, number of stop bits, etc) as well. In Synchronous communication, besides the single data line, it has one or more other lines for synchronization. The extra lines carry either Clock or any other crucial information.

Synchronous communication can be divided into two two types; Serial Pripheral Interface (SPI), and Inter Integrated Circuit Communication (I2C). I2C bus is just a Two Wire Interface (TWI) with two wires, called SCL/SCK (Serial Clock) and SDA (Serial Data). The clock line (SCK) is used to synchronize all data transfers over the I2C bus.The SCL/SCK & SDA lines are connected to all devices on the I2Cbus. There needs to be a third wire which is just the ground (0V). There may also be a 5Volt wire distributing power to the devices. I will try to shed some light on the I2C bus in a forthcoming chapter.

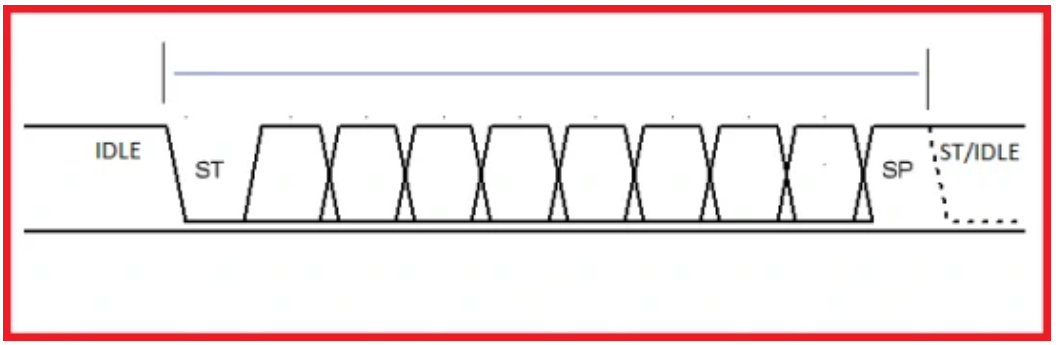


The AVR UART

Universal Asynchronous Receiver Transmitter (UART) is a popular example of serial asynchronous communication. In UART, the arrival of packet is indicated by a “Start bit” appended by the beginning of every packet, and the end of packet is indicated by a (one or more) “Stop bit”. UART can be defined as a programmable piece of hardware that can communicate with other asynchronous serial devices in an asynchronous serial mode. UART works in “Full Duplex” mode because receiving and transmitting is done on independent pins named as RXD and TXD respectively.

The AVR UART transmits one character pack at a time. Each of these packet contains one Start bit followed by 5 -9 Data bits followed by (optional) Parity bits, which is finally followed by one (or two) Stop bits. When there is nothing to transmit the transmission line remains in High (H) state which is the Idle state of the line. When transmitter gets some packet to transmit,it pulls the line to Low (L) level to transmit the Start Bit (ST).

After receiving this, the receiver prepares itself to handle the upcoming Data bits. As receiver knows the baud rate (bit rate), it starts sampling the line after every bit delay (also known as Bit length/Bit duration, which is the inversion of Bit rate). Bit delay indicates the amount of time the line represents one (1) bit. After the completion of reception of the reception of total Data bits, receiver expects one Parity (either odd,even or no parity) bit. After this the receiver looks for one (or more) logic-high (H) state Stop bits (SP). The whole process is followed by either the next Start bit, or by the IDLE signal. Frame structure is shown below.



AVR UART Registers

Configuration of AVR UART requires access to some registers, which are:

- USART Band Rate Register – UBRRH &UBRRL
- USART Control and Status Register A – UCSRA
- USART Control and Status Register B – UCSRB
- USART Control and Status Register C – UCSRC
- USART Data Buffer Register – UDA

Here, note that many UART comes with Synchronous communication facility, and this harware block is known as “Universal Synchronous/Asynchronous Receiver Transmitter” (USART). AVR USART is fully compatible with the AVR UART for transmitter operation, receiver operation, band rate generation, etc.

→ Part 15: **AVR UART Configuration**