

Mechatronics Engineering

UART PROTOCOL

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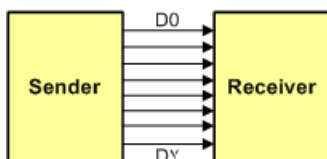


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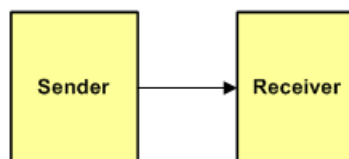
Parallel vs. Serial

- Parallel
 - For short distances
 - Not applicable for long distances
 - More expensive
 - Cross-talk problem

Parallel Transfer



Serial Transfer



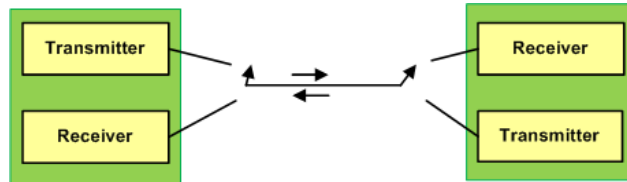
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Direction

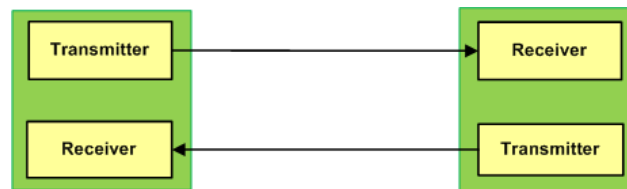
- Simplex



- Half Duplex



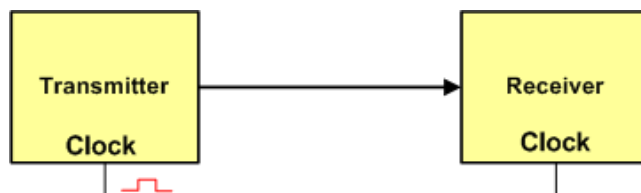
- Full Duplex



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Synchronization

- Synchronous

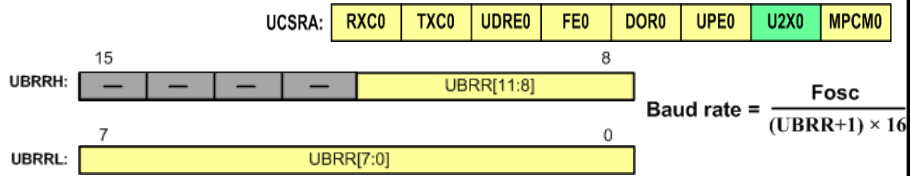


- Asynchronous



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Baud rate



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Example: Find the UBRR value for 9600bps.

■ Solution:

$$\text{Baud rate} = \frac{F_{osc}}{(UBRR+1) \times 16} \Rightarrow 9600 = \frac{16 \text{ MHz}}{(UBRR+1) \times 16}$$

$$\Rightarrow (UBRR+1) = \frac{1 \text{ MHz}}{9600} = 104.166 \Rightarrow UBRR = 103$$



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Program: sending character 'G' continuously

```
#include <avr/io.h>

void usart_init (void)
{
    UCSRB = (1<<TXEN0);
    UCSRC = (1<<UCSZ01)|(1<<UCSZ00);
    UBRR0L = 103; //baud rate = 9600bps
}

void usart_send (unsigned char ch)
{
    while (!(UCSR0A & (1<<UDRE0))); //wait until UDR0 is empty
    UDR0 = ch; //transmit ch
}

int main (void)
{
    usart_init(); //initialize the USART

    while(1) //do forever
        usart_send ('G'); //transmit 'G' letter

    return 0;
}
```



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Program 2: It receives bytes of data serially and puts them on Port B.

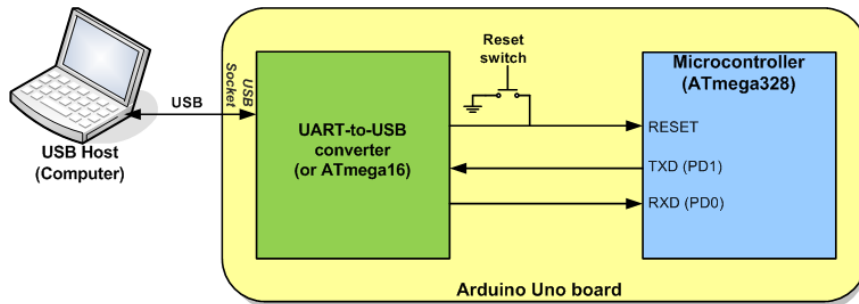
```
#include <avr/io.h>
int main (void)
{
    DDRB = 0xFF; //Port B is output
    UCSRB = (1<<RXEN0); //initialize USART0
    UCSRC = (1<<UCSZ01)|(1<<UCSZ00);
    UBRR0L = 103;

    while(1)
    {
        while (!(UCSR0A & (1<<RXC0))); //wait until new data
        PORTB = UDR0;
    }
    return 0;
}
```



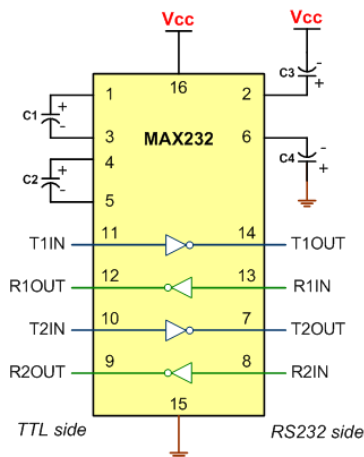
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USB to serial converter in Arduino

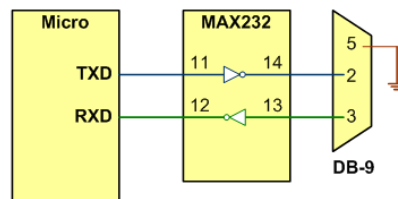
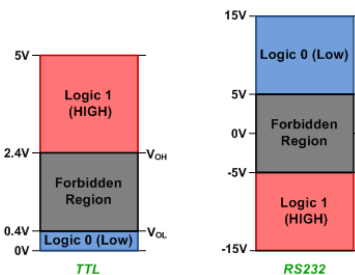


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MAX232



(a) Inside MAX232



(b) MAX232 Connection to the Microcontroller / Microprocessor



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