EE2361 - Lecture 19
10/21/16

Homework 3

Last time: PPS, write-up to be posted

→ macros which simplify PPS
→ locking PPS pins

Serial Communication

⇒ distinct from other forms, such as parallel communication on a bus

⇒ send bits in series (

⇒ parallel comm sends bits in parallel

Two main flavors of serial communication

- Synchronous

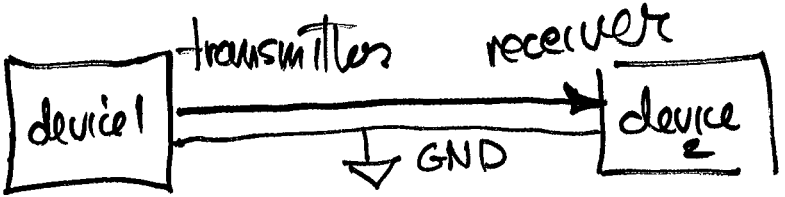
  In addition to data a clock signal is available } data, clock, ground

- Asynchronous

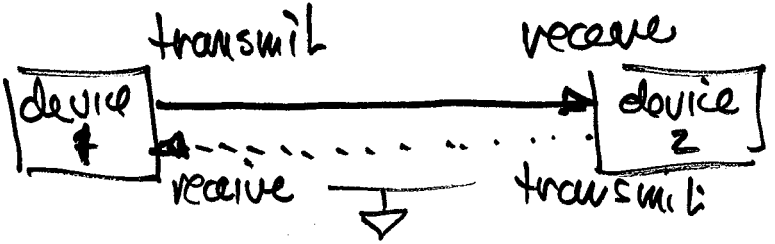
  Each device has its own clock. Use start and stop bits to synchronize the transmitter and receiver

3 ways we can configure this

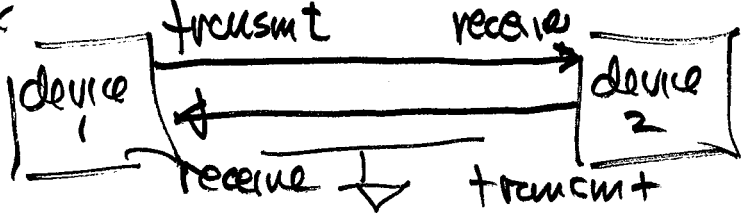
- Simplex



- Half Duplex



- Full Duplex



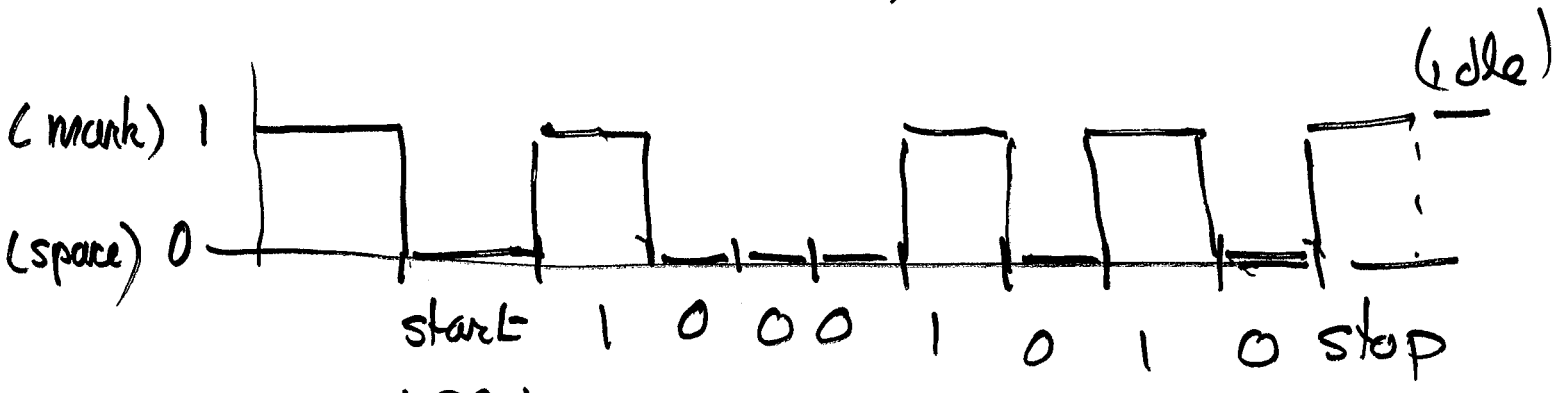
Asynchronous data frames

basic protocol

- data is organized in terms of frames
- Idle line is high
- Frame:
  - start bit (low)
  - data bits
  - (optional) parity bit
  - stop bit (high)
- the frame has an agreed upon timing and format

Example Frame

1 start bit, 8 data bits, no parity, 1 stop bit



1000 1010

Data is sent ~~LSbit~~ first

Lsbit first

Msbit first

0x 8A

0x 51

Formats

NRZ - non return to zero
NRZI - non return to zero invert
RZ - return to zero
Manchester - low/high or high/low over 1 bit time

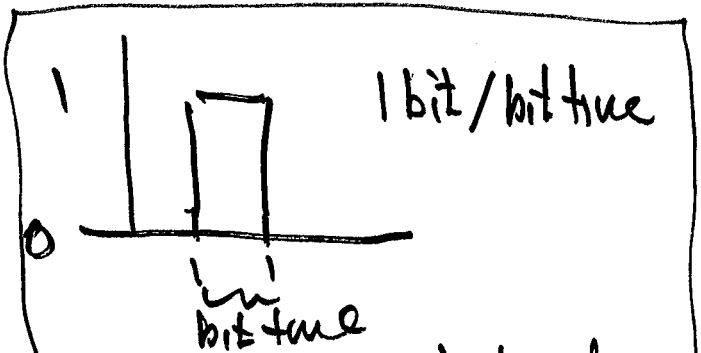
There are found in section 14.4 of the 2301 text Fundamentals of Logic Design, 7th Ed. and also in appropriate Wikipedia articles.

Data Speed ?

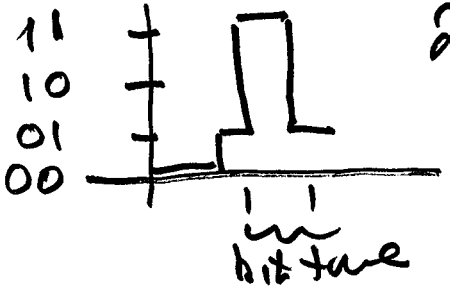
Serial Data is the no. of bits / second

data rate

We can send more than 1 bit a second
so we use Baud rate to describe the speed



we do this



baud rate ≠ bit rate

Data rate ?

Number of data bits in a frame is less than the total bits in a frame start bit, 8 data bits, stop bit

$\frac{8}{10}$ of time the frame is sending data

bytes/second 1 byte, for every 10 bit times

byte/second = $\frac{8}{10}$ of the ~~bit rate~~ ~~no bit rate~~ $\times 10$

Example : 1-start bit, 8-data bits, 1-stop bit

For this 10-bit frame sent at 10 kbs what is the data rate in bytes/second?

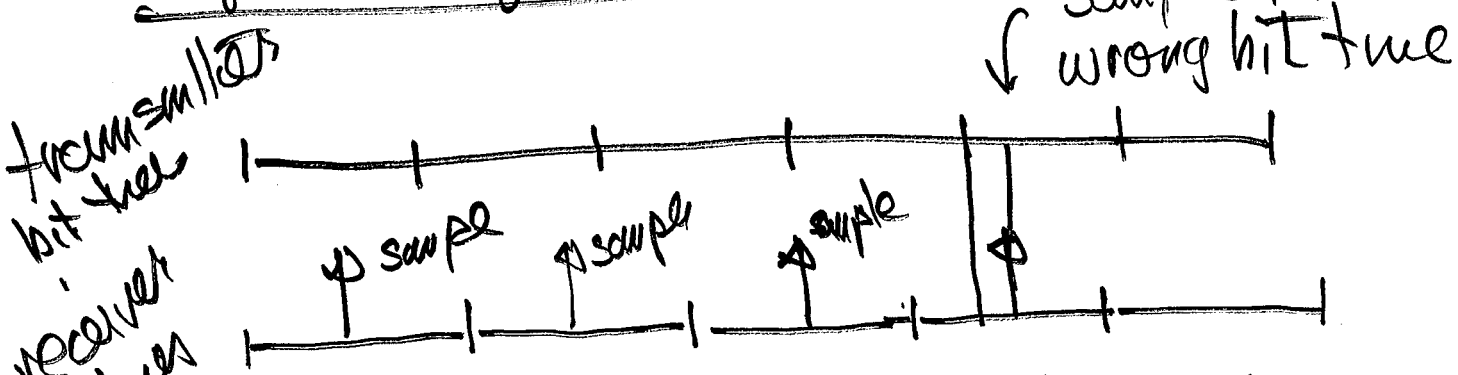
$$\frac{8 \text{ data bits}}{10 \text{ bits frame}} \times 10^3 \text{ frames/sec}$$

$$= 8 \times 10^3 \text{ data bits/sec}$$

$$= \frac{1 \text{ byte}}{8 \text{ bits}} \times \frac{\text{bits}}{\text{sec}} = \frac{1}{8} 8 \text{ kbs} = 1 \text{ kBs}$$

$$1 \text{ kBs} = 10^3 \text{ Bytes/sec}$$

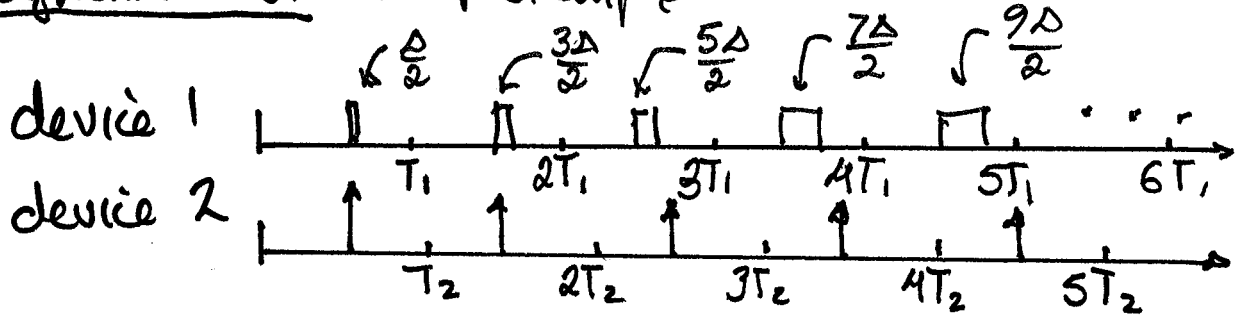
Synchronization



How much error can we tolerate for our ten bit frame?

~ 5.3% error in the clock frequencies

Asynchronous timing example



Assume the clocks start at $t=0$, device 2 has a slower clock so $T_2 > T_1$. Let $T_2 = T_1 + \Delta$. If we sample at the midpoint device 2 will sample device 1 bit times with errors of $\frac{\Delta}{2}, \frac{3\Delta}{2}, \frac{5\Delta}{2}, \ldots$ etc. or $\left(\frac{\Delta}{2} + n\Delta\right)$, $n = 0, 1, \ldots$

For 10 bit times how large can Δ be to avoid sampling in the wrong bit time?

Require $\left(\frac{\Delta}{2} + 9\Delta\right) < \frac{T_1}{2} \Rightarrow \Delta < \frac{1}{19} T_1 \Rightarrow \boxed{\frac{\Delta}{T_1} < 5.3\%}$