Worksheet 2: Intersymbol Interference

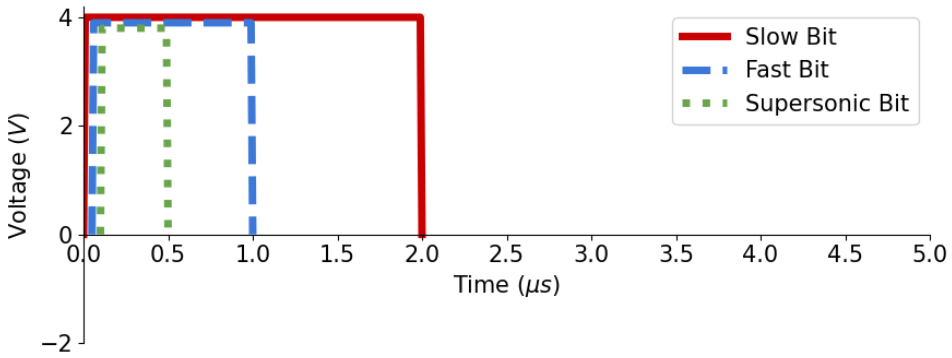
Directions

Please form small groups and work out the answer to the question. The TA will walk around to help you. At the end, the TA will discuss the correct answer. Doing this will help you prepare for the HW—a variant will be asked in the midterm. This worksheet will take some work, but at the end, you should have a good idea about how bits are sampled and what intersymbol interference means.

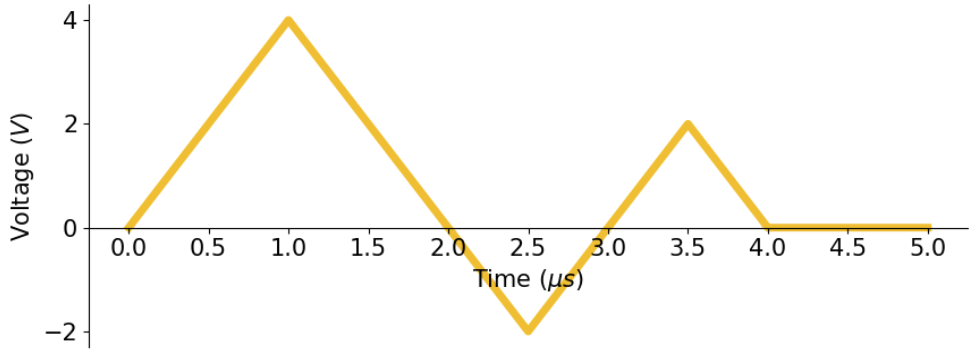
System Response

Pretend you're sending a signal over a wire. You have three options:

1. a slow bit (high for **2 µs**),
2. a fast bit (high for **1 µs**),
3. and a "supersonic" bit (high for **0.5 µs**).



No matter which option you choose, the receiver will always receive the following response, which is meant to approximate the `sinc` function:



The previous response:

- rises to **4 V** at **1 µs**,
- falls to **0 V** at 2 **µs**,
- then falls to **-2 V** at **2.5 µs**,
- climbs to **0 V** at **3 µs**,
- rises to **2 V** at **3.5 µs**,
- falls to **0 V** at **4 µs**,
- and finally remains at **0 V**.

Assume that:

- a **1** is encoded as a **4 V** signal,
- a **0** is encoded as **0 V**, and
- the output to a **0 V** input of **any bit width** is also **0 V** for all time.

If at any sampling instant, the receiver measures a voltage of **2 V** or more, it assumes it received a **1**. Otherwise, it assumes it has received a **0**. The sender will now send a bit pattern of **101**.

Questions

A. The sender sends bits at the slow rate of once every **2 µs**: 3 bits at times **0**, **2**, and **4 µs** respectively. The sampling instants the receiver uses are **1**, **3**, and **5 µs** respectively for the 3 bits.

   Use paper and color pens (or use dashed and dotted and solid fonts) to draw the 3 bits: the first bit as **red**, the second in **blue**, and the third in **black**.

   At any sampling instant, the receiver measures the output voltage as the sum of the voltage values of the red, blue, and black waves.
   Write down the measured outputs. What bits does the receiver output?

B. Follow the same instructions as in part A, but now using the "fast bit" of width **1 µs**. The sender sends its 3 bits at times **0**, **1**, and **2 µs**. The sampling instants the receiver uses are **1**, **2**, and **3 µs** respectively for the 3 bits.
   Write down the measured outputs. What bits does the receiver output?

C. Follow the same instructions as in part A, but now using the "supersonic bit" of width **0.5 µs**. Remember, the supersonic bits have the same response as the other bits. The sender sends its 3 bits at times **0**, **0.5**, and **1 µs**. The sampling instants the receiver uses are **1**, **1.5**, and **2 µs** respectively for the 3 bits. Clearly, the sender is being cheeky, and you should see intersymbol interference (at which sampling instants?).
   Write down the measured outputs. What bits does the receiver output?