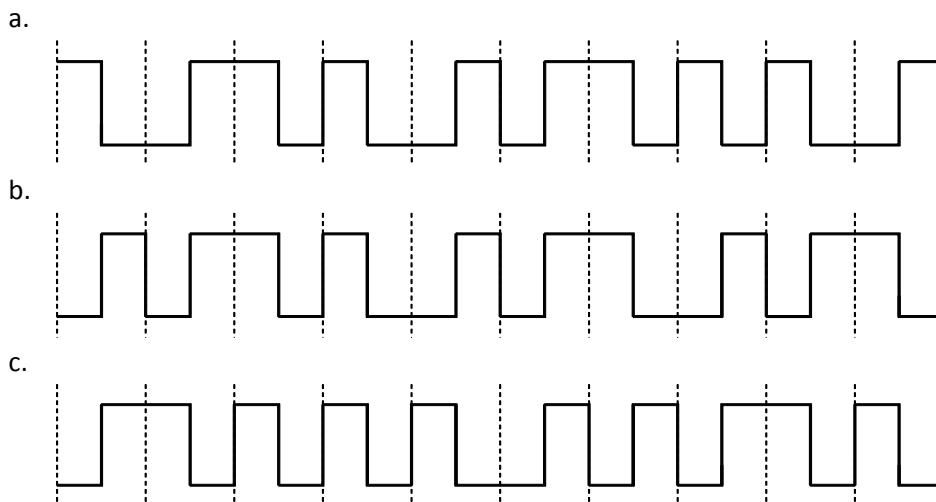


### Exercise 1: Coding and multiplexing

1. Calculate the bit rate for the following signals:
  - a. A signal where the duration of a bit is 1 millisecond.
  - b. A signal where the duration of a bit is 2 microseconds.
2. What is the duration of a bit in the following signals?
  - a. A signal with bit rate 100 kbps.
  - b. A signal with bit rate 2 Mbps.
3. Assume that we want to transmit a bit sequence consisting of 10 zeros. Code the sequence with the following line coding schemes:
  - a. NRZ
  - b. Manchester
  - c. Differential Manchester

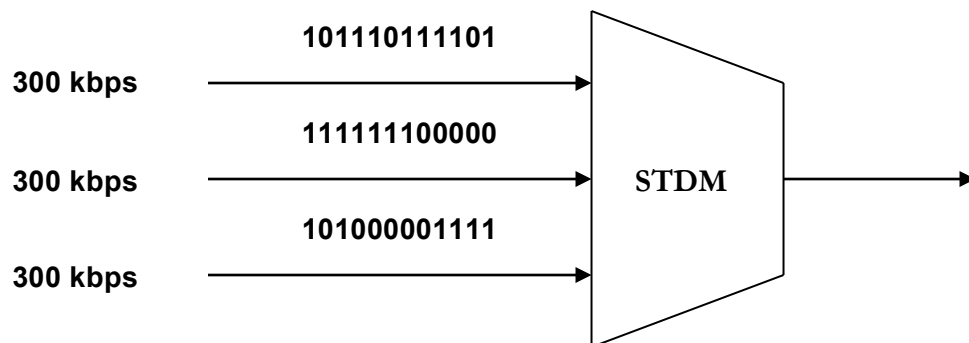
4. The wave forms shown below are Manchester coded bit sequences. Decode them!



5. Do exercise 4 again, now assuming that Differential Manchester has been used.
6. Assume that we want to transmit the binary sequence 0101110.
  - a. Draw the wave form assuming Manchester encoding.
  - b. Draw the wave form assuming Differential Manchester encoding.

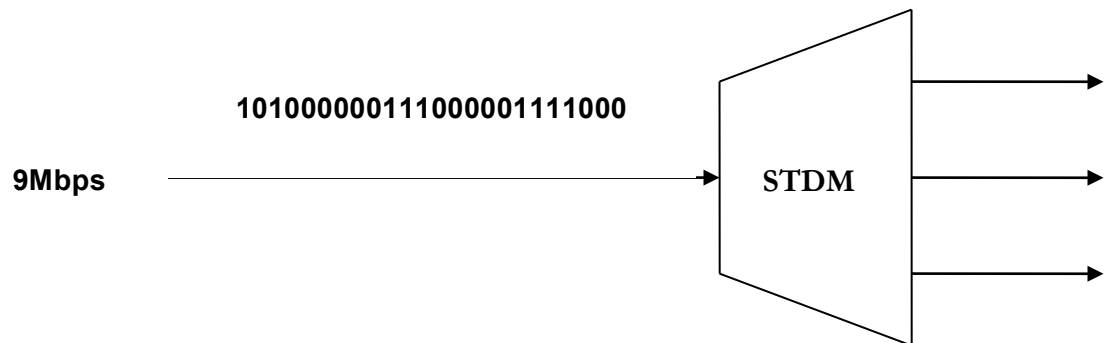
Assume in both cases that the first signal is a transfer from a high signal level to a low signal level, irrespective if it is a data signal or a clock signal.

7. A physical link with five connections is multiplexed with FDM. Each connection requires a channel with a bandwidth of 4 000 Hz. Between each channel there is a 200 Hz guard band. Calculate the minimum total bandwidth of the link.
  
8. Assume that three connections are multiplexed with FDM on a link that has a total bandwidth of 7900 Hz. What is the maximal bandwidth for each connection if there must be a 200 Hz guard band between the channels?
  
9. Assume that 100 connections are multiplexed with Synchronous TDM and each connection requires 14.4 kbps.
  - a. What is the minimum required bit rate on the link?
  - b. Assume that only 70 connections transfer data at the same time. How much of the bandwidth will be unused?
  
10. Assume that four connections are multiplexed with STD. Each time slot allows one ASCII character. What will be transmitted on the link if the senders want to transmit the following characters: Sender 1: T E G; Sender 2: A; Sender 3: C D; Sender 4: E F I L?
  
11. What will be transmitted on the link in exercise 10 if statistical multiplexing is used and all connections have the same priority?
  
12. The figure below shows a multiplexor for Synchronous TDM. Assume that a frame consists of 3 time slots, that each time slot contains 3 bits, and that each frame starts with a framing bit, alternating between 0 and 1. Answer the following questions:



- a. What is the bit sequence on the outgoing link?
- b. What is the bit rate on the outgoing link?
- c. What is the duration of a bit on the outgoing link?
- d. What is the duration of a frame on the outgoing link?

13. The figure below shows a demultiplexor for Synchronous TDM. Assume that each frame consists of 3 time slots, that each time slot contains 4 bits, and that there are no framing bits. Answer the questions below.



- a. What are the bit sequences on the outgoing links?
- b. What are the bit rates for each outgoing links?