Lecture-32 : TDM & FDM, LINE CODING

Contents

1.1 Learning Outcomes

- The students will **learn** the basic concept of FDM , TDM &LINE CODING
- The students will be able to **draw waveform using line codes**

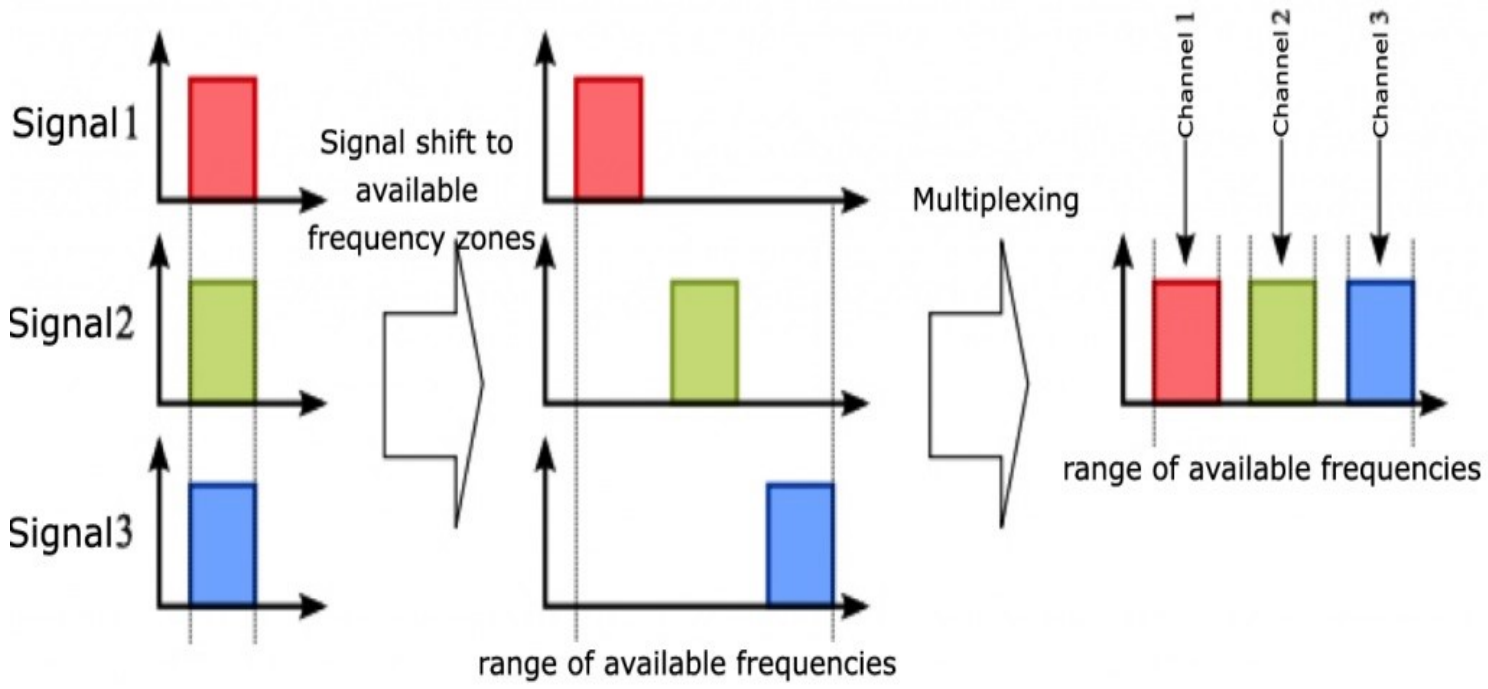
- The students will be able to **analyse** TDM &FDM using sampling theorem.

1.2 Frequency Division Multiplexing

Multiplexing is a method by which multiple analog or digital signals are combined into one signal over a shared medium.

1.2 Frequency Division Multiplexing

Frequency-division multiplexing (FDM) is a technique by which the total bandwidth available in a communication channel is divided into a series of non-overlapping frequency bands, each of which is used to carry a separate signal



1.2 Frequency Division Multiplexing

- In this a number of signals are transmitted at the same time, and each source transfers its signals in the allotted frequency range. There is a suitable frequency gap between the 2 adjacent signals to avoid over-lapping.

- Since the signals are transmitted in allotted time so this decreases the probability of collision. The frequency spectrum is divided into several logical channels, in which every user feels that they posses a particular bandwidth.

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- A number of signals are sent simultaneously on the same time allocating separate frequency band or channel to each signal. It is used in radio and TV transmission. Therefore to avoid interference between two successive channels Guard bands are used.

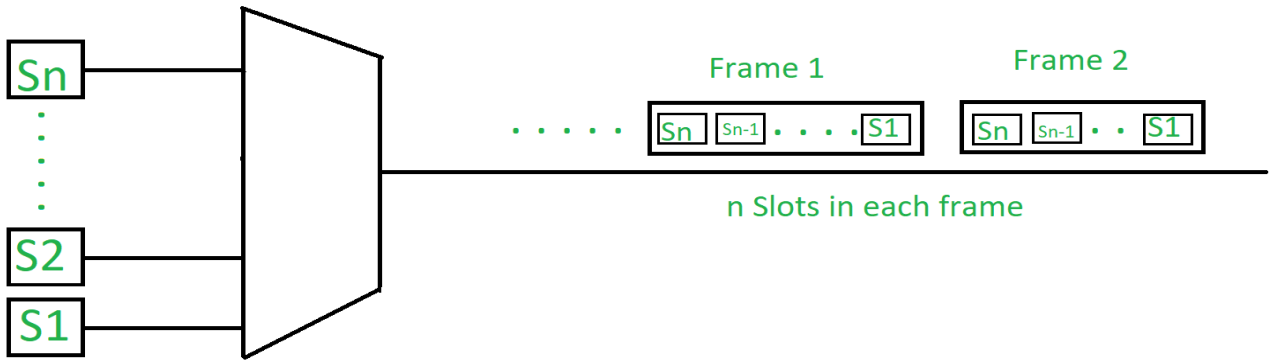
1.3 Uses And Applications

- It allows sharing of a single transmission medium like a copper cable or a fiber optic cable, among multiple independent signals generated by multiple users.

- FDM has been popularly used to multiplex calls in telephone networks. It can also be used in cellular networks, wireless networks and for satellite communications.

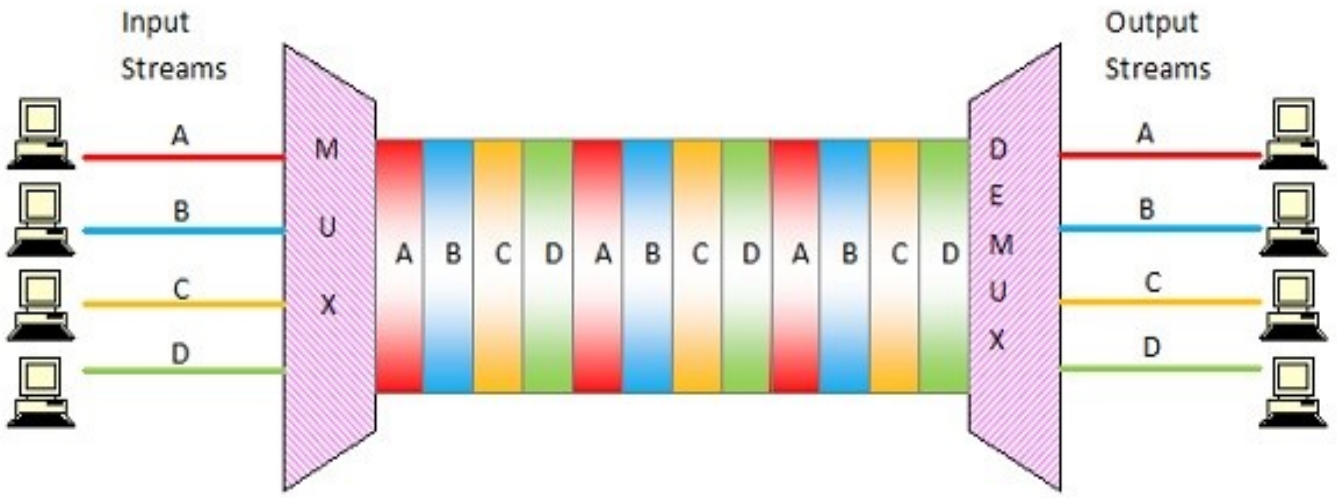
1.3 TDM

- This happens when data transmission rate of media is greater than that of the source, and each signal is allotted a definite amount of time. These slots are so small that all transmissions appear to be parallel.
- It is used in telephone systems.



1.3 TDM

In frequency division multiplexing all the signals operate at the same time with different frequencies, but in time division multiplexing all the signals operate with same frequency at different times.

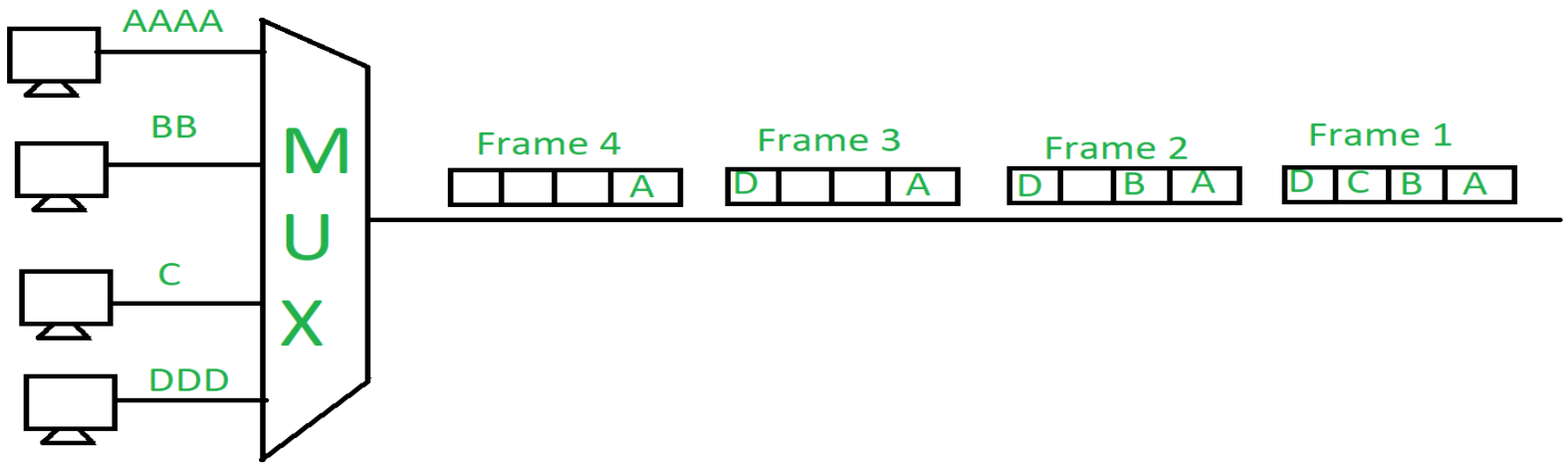


1.3 TDM

It is of following types:

➢**Synchronous TDM –**

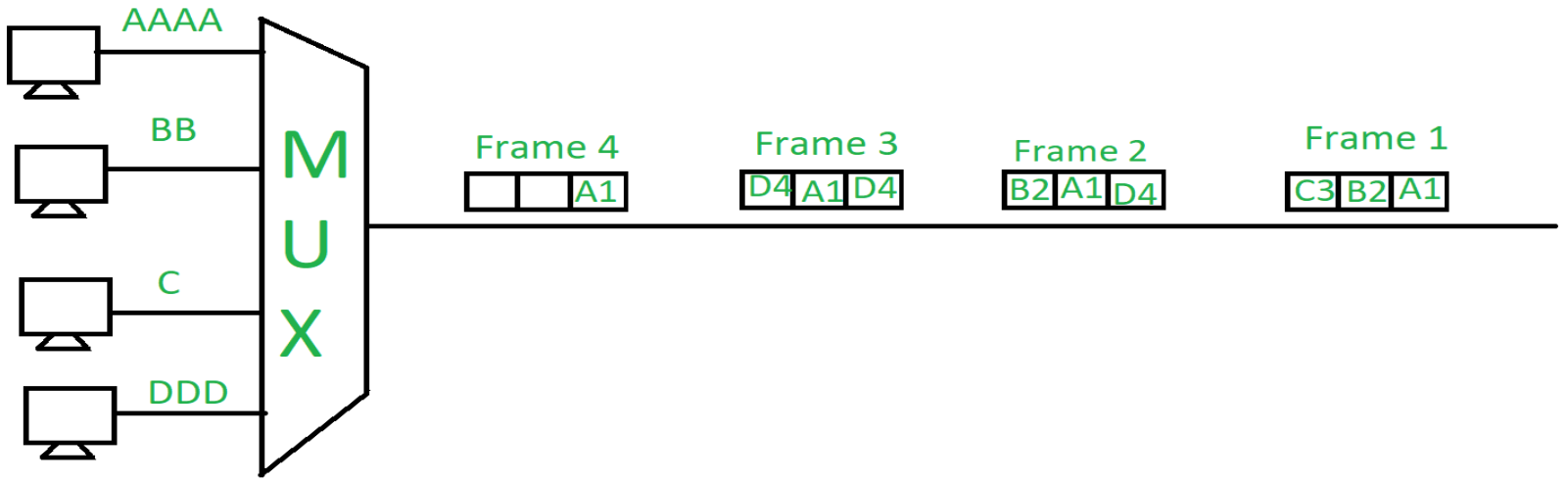
The time slots are pre-assigned and fixed. This slot is even given if the source is not ready with data at this time. In this case the slot is transmitted empty. It is used for multiplexing digitized voice stream



1.3 TDM

➢**Asynchronous (or statistical) TDM –**

The slots are allocated dynamically depending on the speed of source or their ready state. It dynamically allocates the time slots according to different input channel's needs, thus saving the channel capacity.



1.3 TDM

Advantages

- TDM systems are more flexible than frequency division multiplexing.
- Time division multiplexing circuitry is not complex.
- Problem of cross talk is not severe.
- Full available channel bandwidth can be utilized for each channel.

Disadvantages

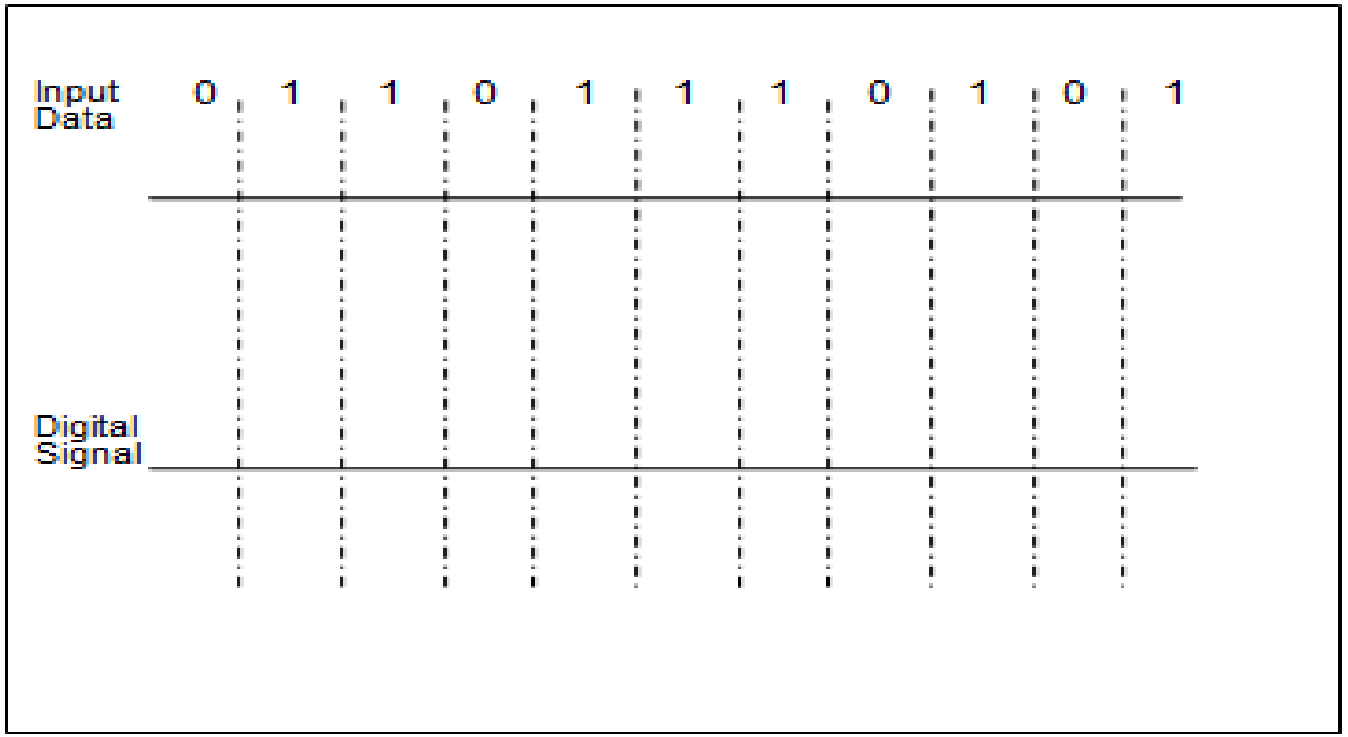
- Synchronization is required in time division multiplexing.
- Complex to implement.
- Due to slow narrowband fading, all the TDM channels may get wiped out.

1.3 TDM

Sr no.	FDM	TDM
1.	The signals which are to be multiplexed are added in the time domain . But they occupy different slots in the frequency domain .	The signals which are to be multiplexed can occupy the entire bandwidth in the time domain .
2.	FDM is usually preferred for the analog signals .	TDM is preferred for the digital signals .
3.	Synchronization is not required .	Synchronization is required .
4.	The FDM requires a complex circuitry at Tx and Rx .	TDM circuitry is not very complex .
5.	FDM suffers from the problem of crosstalk due to imperfect BPF .	In TDM the problem of crosstalk is not severe .
6.	Due to bandwidth fading in the Tx medium , all the FDM channels are affected .	Due to fading only a few TDM channels will be affected .
7.	Due to slow narrowband fading taking place in the transmission channel may be affected in FDM .	Due to slow narrowband fading all the TDM channels may get wiped out .

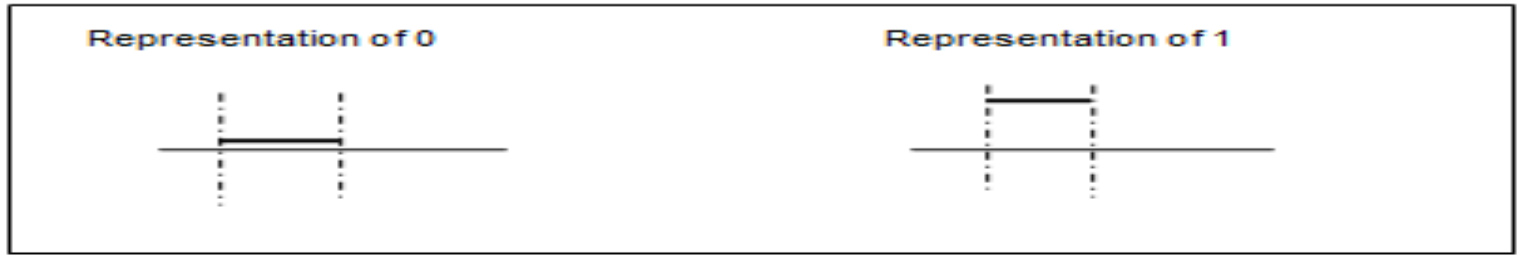
1.3 LINE CODING

Line Coding Layout



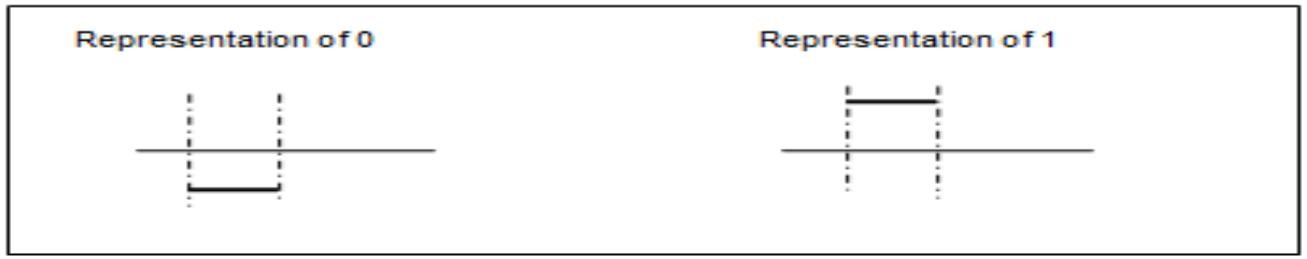
1.3 LINE CODING

Step 1: unipolar NRZ (Non Return to Zero)



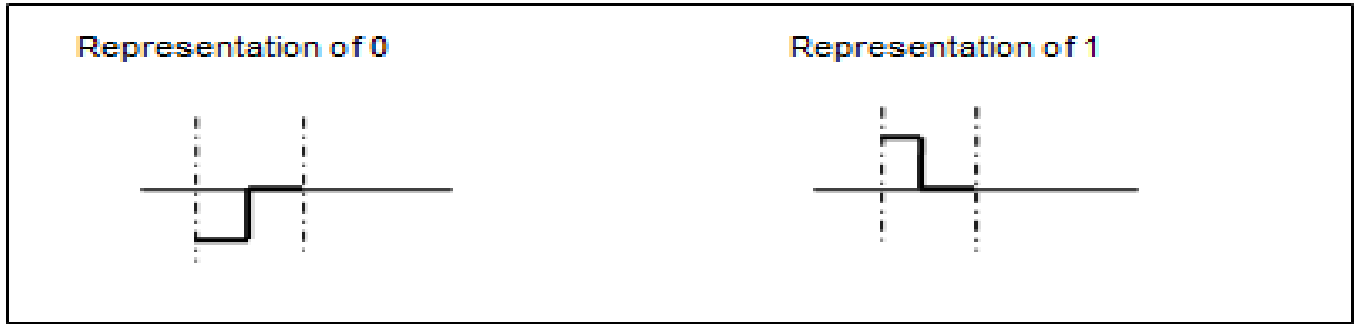
1.3 LINE CODING

Step 2: Polar NRZ (Non Return to Zero)



1.3 LINE CODING

Step 3: Polar RZ (Return to Zero)



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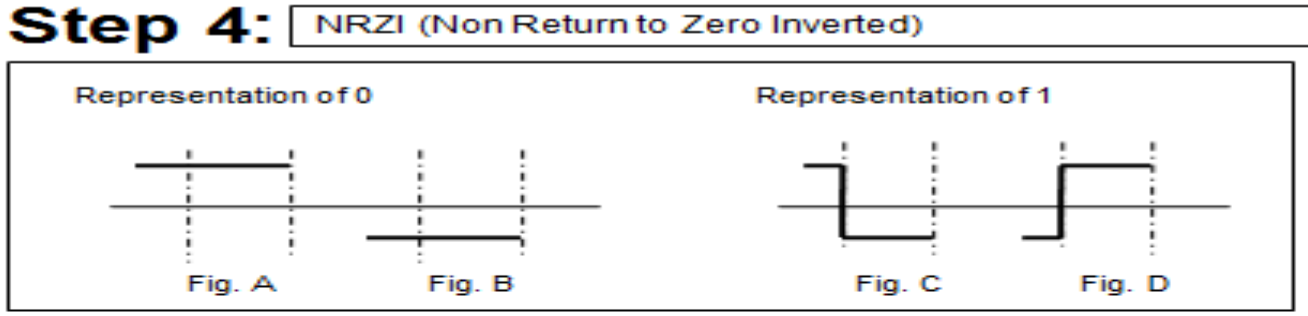
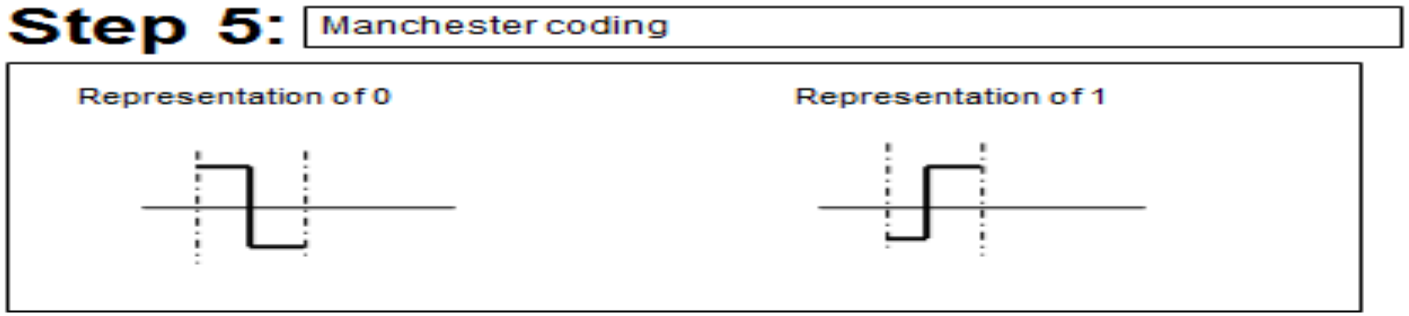
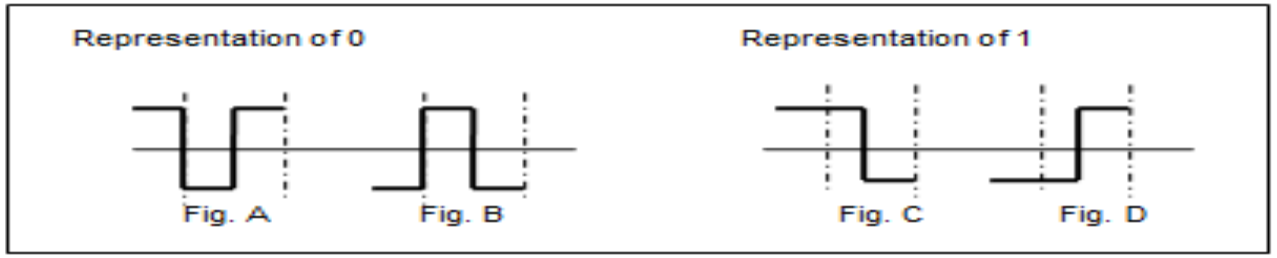


1.3 LINE CODING



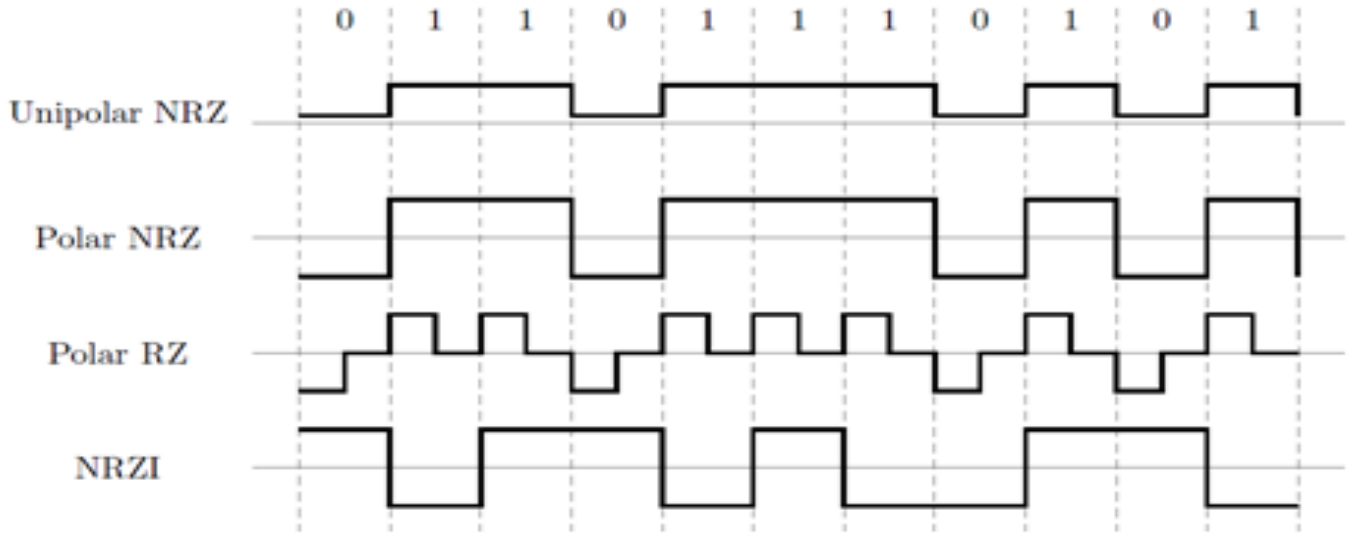
1.3 LINE CODING

Step 6: Differential Manchester coding



1.3 LINE CODING

Illustration of different line coding schemes



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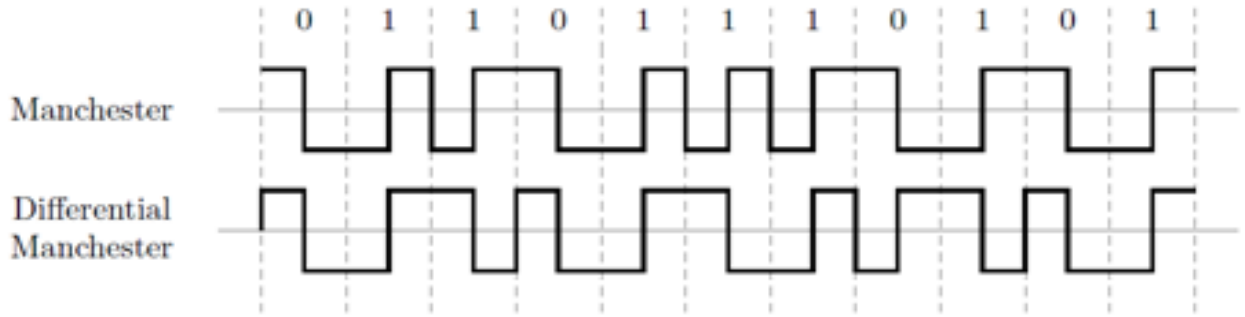
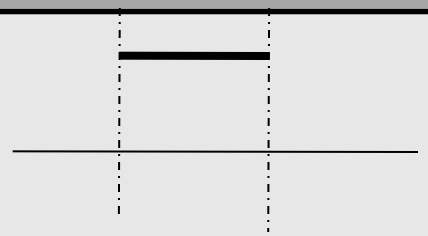
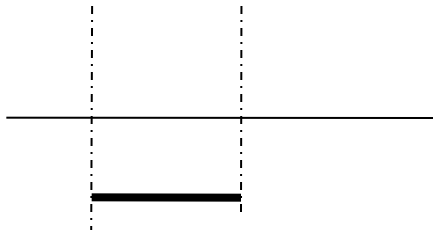
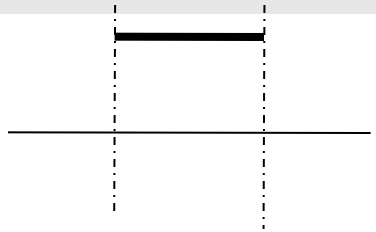
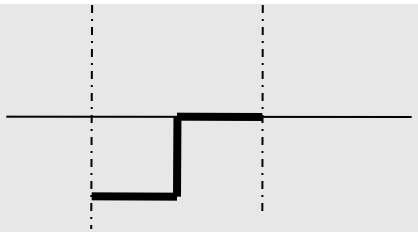
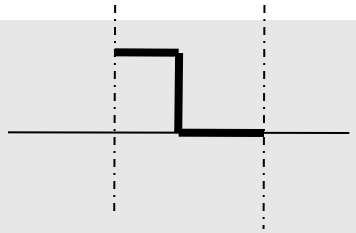
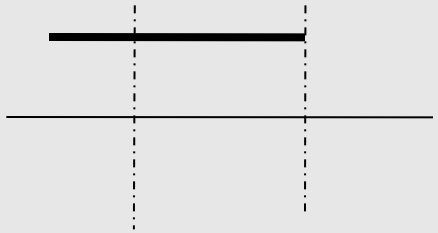
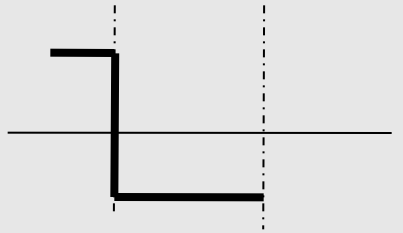
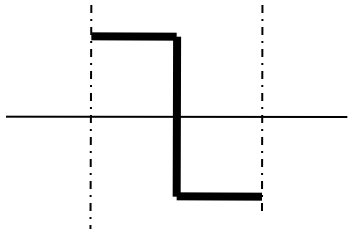
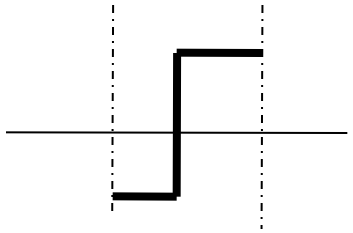


Assumption: The signal level to the left of the bit is high

Line coding Scheme	Representation of 0	Representation of 1
Unipolar NRZ		
Polar NRZ		
Polar RZ		

Line coding Scheme	Representation of 0	Representation of 1
NRZI		
Manchester		
Differential Manchester