MODULATION

Introduction to Telecommunications

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1

History

- Until the radio came along, long-distance communication was carried on by way of the telegraph and before that the Pony Express.
- Two wires were stretched across the nation; at various points taps were attached to run a solenoid that made licks.
- A code was devised so that people could read the dots and dashes or clicks.
- Once the ability to transmit across the ocean and for long distances without wires was established, people were not satisfied to send dots and dashes but wanted to be able to talk with someone many miles away without having an operator in between to intercept the words/

2

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- It was really difficult to transmit the audio frequencies for any distance.
- Even 200-watt amplifiers can be heard only a few city blocks away from the source
- This limitation on the audio led to experiments with the radio carrier wave.
- They already knew that the radio frequencies would travel great distances.

3

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- Now they had to put the audio on top of it and then get rid of the carrier and amplify the audio after it arrived at the destination.
- The purpose of modulation is to impose the desired data information onto the carrier. The carrier acts as the vehicle for the data, which is like the passenger.
- They both travel on road way called the channel
- The message signal is referred to as the modulating wave and the result of the modulation process is referred to as the modulated wave.

4

Analog Modulation

* Modulation falls into three categories
  * AM- Amplitude Modulation
  * FM- Frequency Modulation
  * PM- Phase Modulation
  * Each type of modulation primarily varies a single specific characteristic of the carrier.

5

Amplitude Modulation

* AM is the oldest and simplest form of modulation
* The Data causes the amplitude of the carrier to vary
* The amplitude of the constant frequency carrier is varied or modulated by the amplitude of the information bearing signal.
* Figure shows
* (a)- the carrier
* (b)- Message signal
* (c)- AM signal

6

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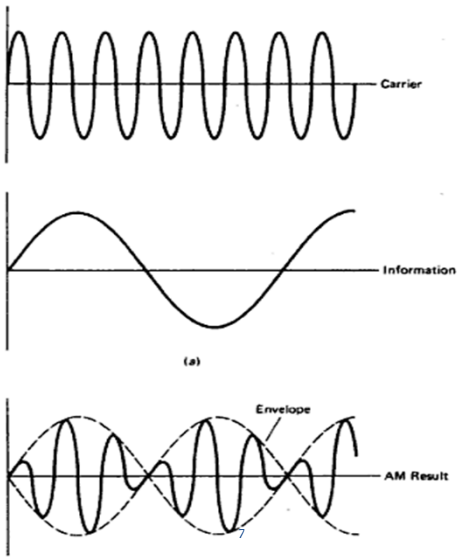

7

Frequency Modulation

* FM was developed by Major Edward H. Armstrong during the 1930s and 1940s.
* The modulating signal causes the frequency of the carrier to vary in proportion to the amplitude and frequency of the modulating signal.
* Figure shows
* (a)- the carrier
* (b)- Message signal
* (c)- FM signal

8

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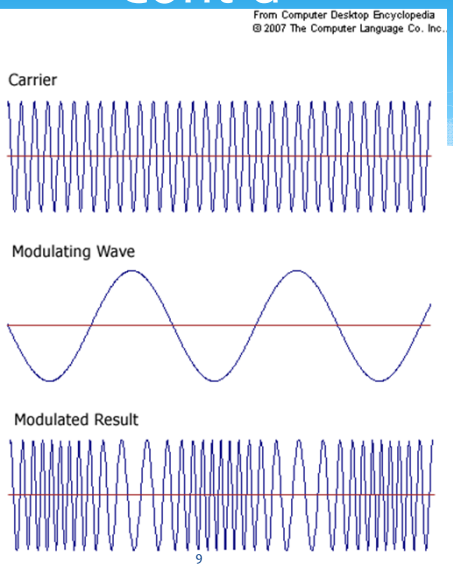
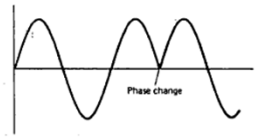


9

Phase Modulation

* In PM, the modulating signal does not directly affect the frequency or amplitude of the carrier.
* The phase of the carrier signal changes in accordance to the message signal



10

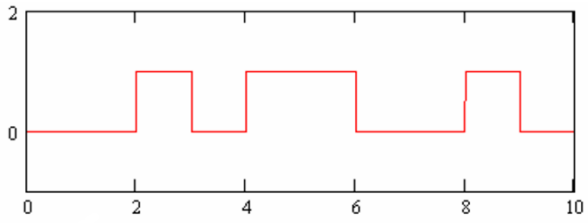
DIGITAL MODULATION

* ASK – Amplitude Shift Keying
* FSK - Frequency Shift Keying
* PSK- Phase Shift Keying

11

ASK – Amplitude Shift Keying

* In ASK, the amplitude of Carrier is changed in response to the message signal



Baseband information sequence – 0010110010

12

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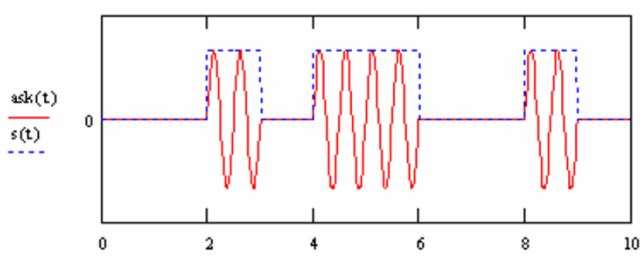
$$ASK(t) = s(t)\sin(2\pi ft)$$



Binary ASK (OOK) signal

13

FSK-Frequency Shift Keying

* In FSK, The frequency of carrier signal is changed in response to the message signal
* For bit pattern 1 the frequency f1 is used, where is f2 is used for bit pattern 0

$$FSK(t) = \begin{cases} \sin(2\pi f_1 t) & for\ bit\ 1 \\ \sin(2\pi f_2 t) & for\ bit\ 0 \end{cases}$$

14

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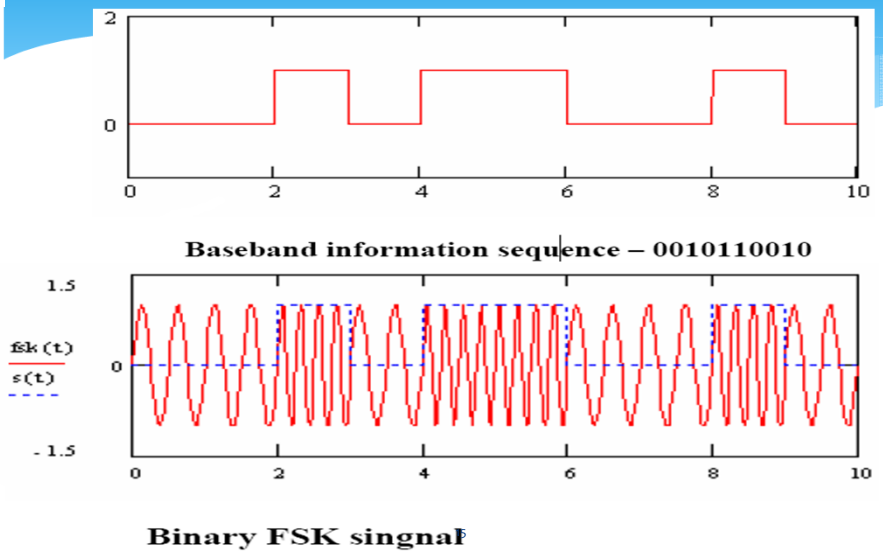

Binary FSK singnal

PSK- Phase Shift Keying

* In PSK, we change the phase of Sinusoidal carrier to indicate information.

$$PSK(t) = \begin{cases} \sin(2\pi f t) & for\ bit\ 1 \\ \sin(2\pi f t + \pi) & for\ bit\ 0 \end{cases}$$

16

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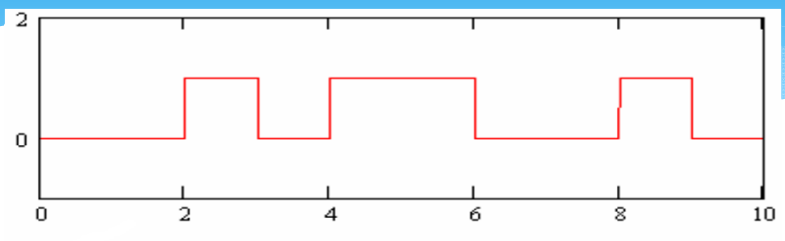
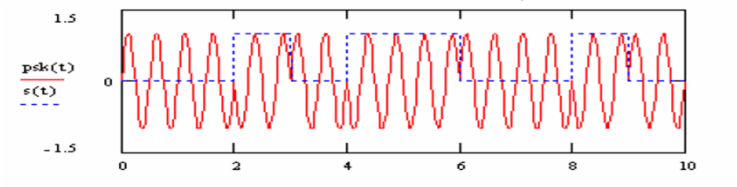


Baseband information sequence – 0010110010



Binary PSK Carrier (Note the 180° phase shifts at bit edges)