

CSE-3215

Data Communication

Lecture-27, 28

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ANALOG AND DIGITAL

Analog-to-analog conversion is the representation of analog information by an analog signal. One may ask why we need to modulate an analog signal; it is already analog. Modulation is needed if the medium is bandpass in nature or if only a bandpass channel is available to us.

An example is radio. The government assigns a narrow bandwidth to each radio station. The analog signal produced by each station is a low-pass signal, all in the same range. To be able to listen to different stations, the low-pass signals need to be shifted to different ranges.

Topics to be discussed in this section:

Amplitude Modulation

Frequency Modulation

Phase Modulation

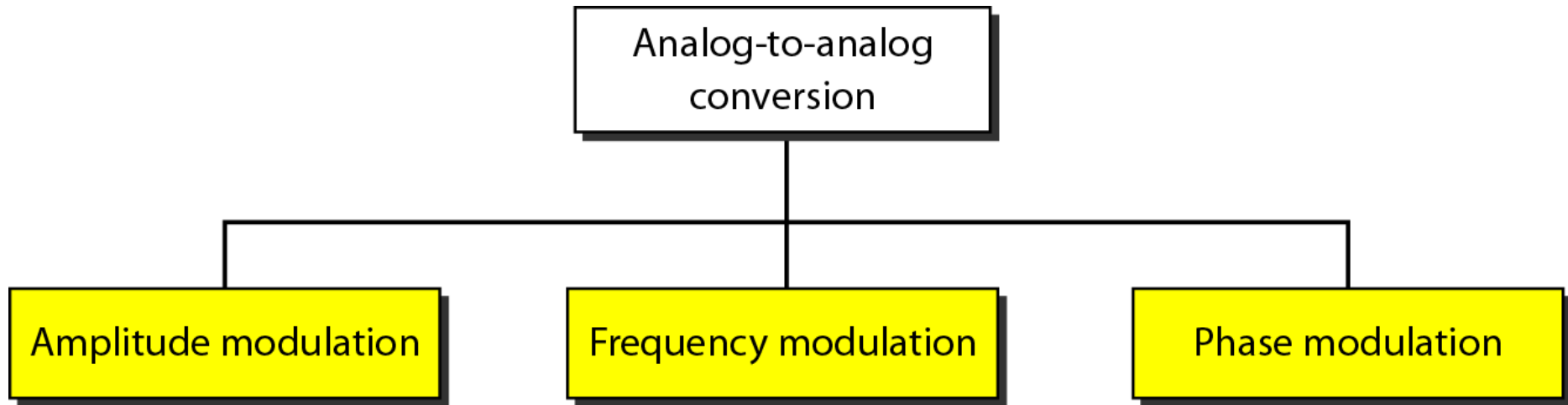


Figure 1 *Types of analog-to-analog modulation*

Amplitude Modulation

- In AM transmission, the carrier signal is modulated so that its amplitude varies with the changing amplitudes of the modulating signal.
- The frequency and phase of the carrier remain the same; only the amplitude changes to follow variations in the information.

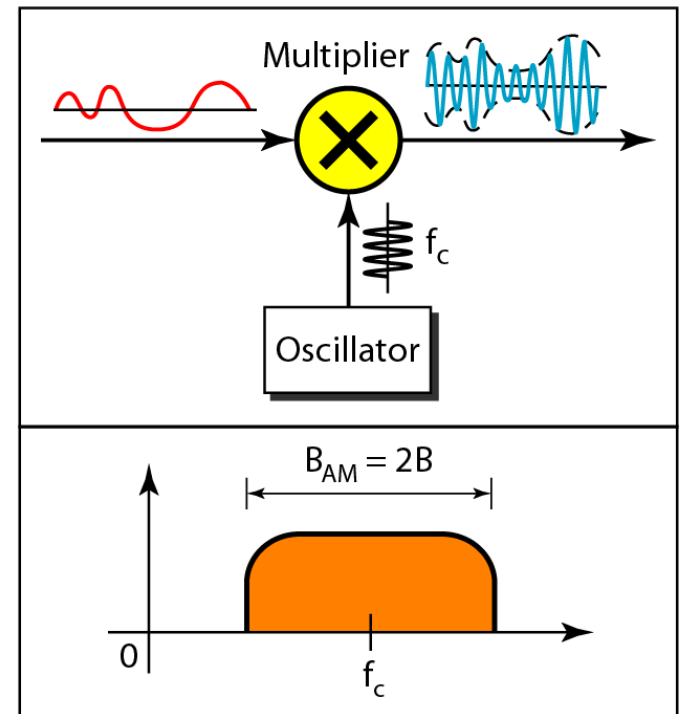
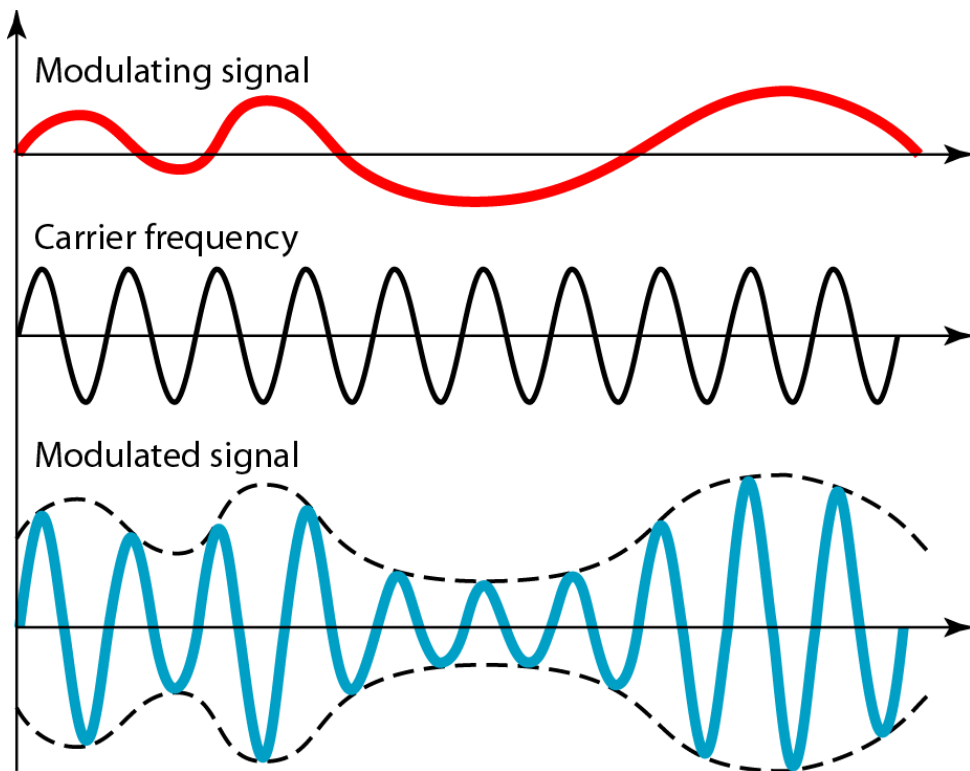


Figure 2 *Amplitude modulation*

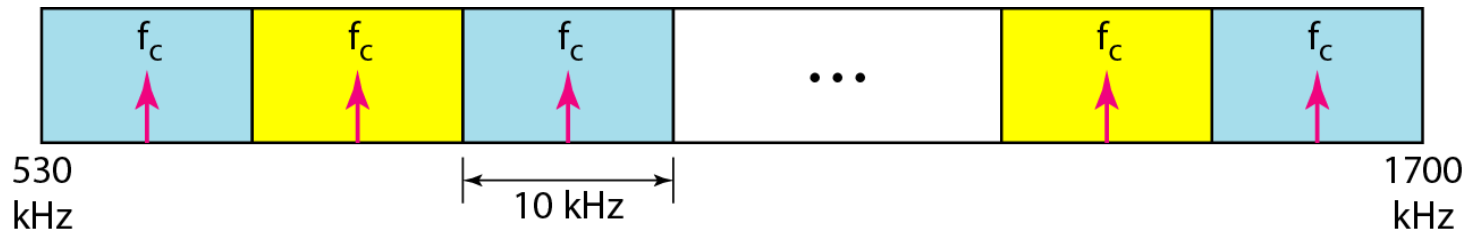


Figure 3 *AM band allocation*

Note

The total bandwidth required for AM
can be determined
from the bandwidth of the audio
signal: $B_{AM} = 2B$.

Frequency Modulation

- In FM transmission, the frequency of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and phase of the carrier signal remain constant, but as the amplitude of the information signal changes, the frequency of the carrier changes correspondingly.

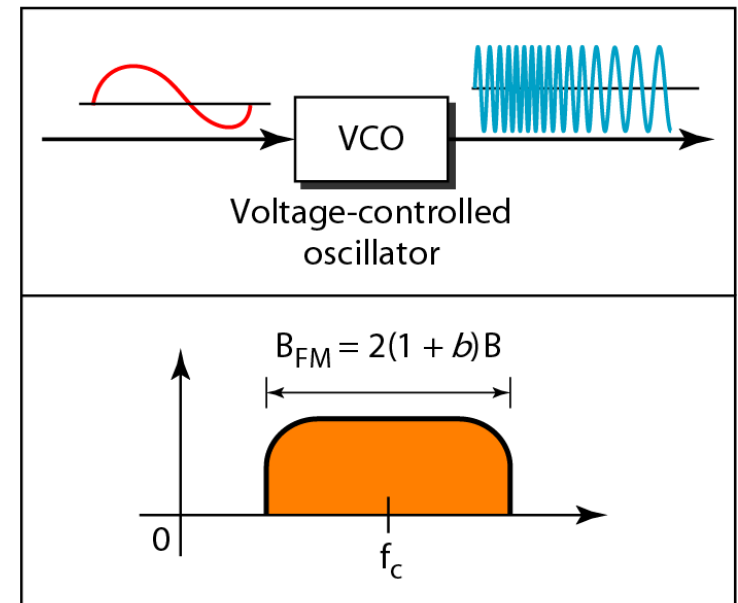
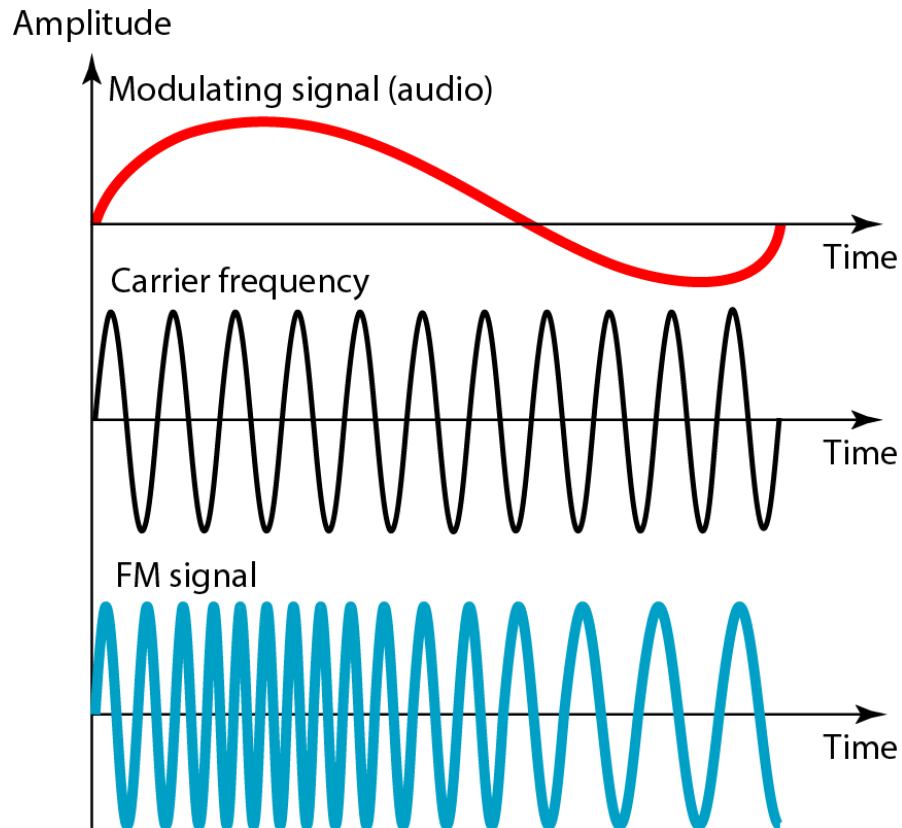


Figure 4 *Frequency modulation*

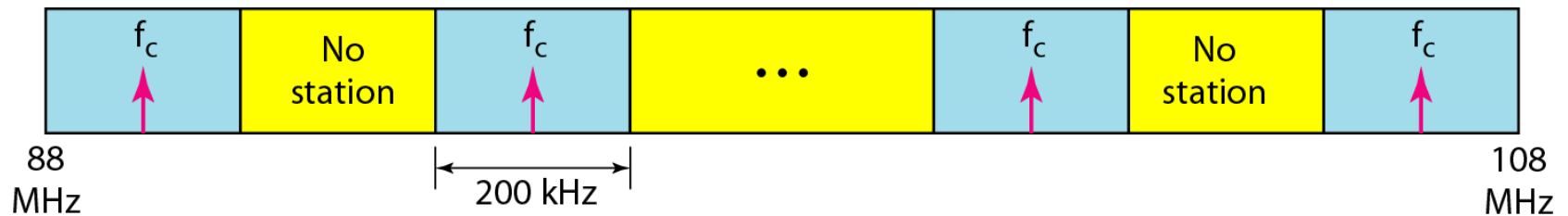


Figure 5 *FM band allocation*

Note

The total bandwidth required for FM can be determined from the bandwidth of the audio signal: $B_{FM} = 2(1 + \beta)B$.

Phase Modulation

- In PM transmission, the phase of the carrier signal is modulated to follow the changing voltage level (amplitude) of the modulating signal.
- The peak amplitude and frequency of the carrier signal remain constant, but as the amplitude of the information signal changes, the phase of the carrier changes correspondingly.
- It can be proved mathematically that PM is the same as FM with one difference.
- In FM, the instantaneous change in the carrier frequency is proportional to the amplitude of the modulating signal; in PM the instantaneous change in the carrier frequency is proportional to the derivative of the amplitude of the modulating signal.

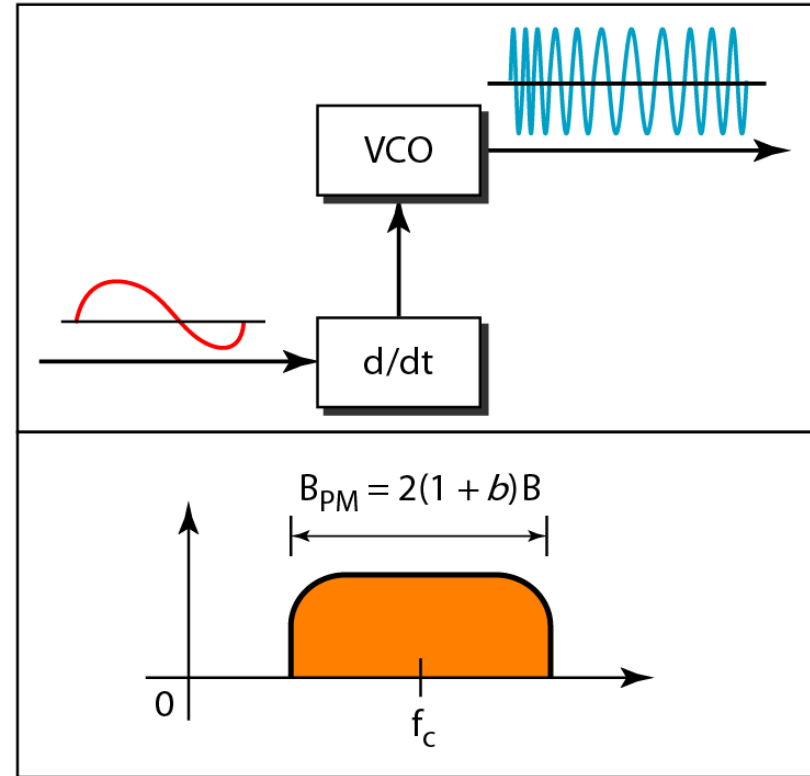
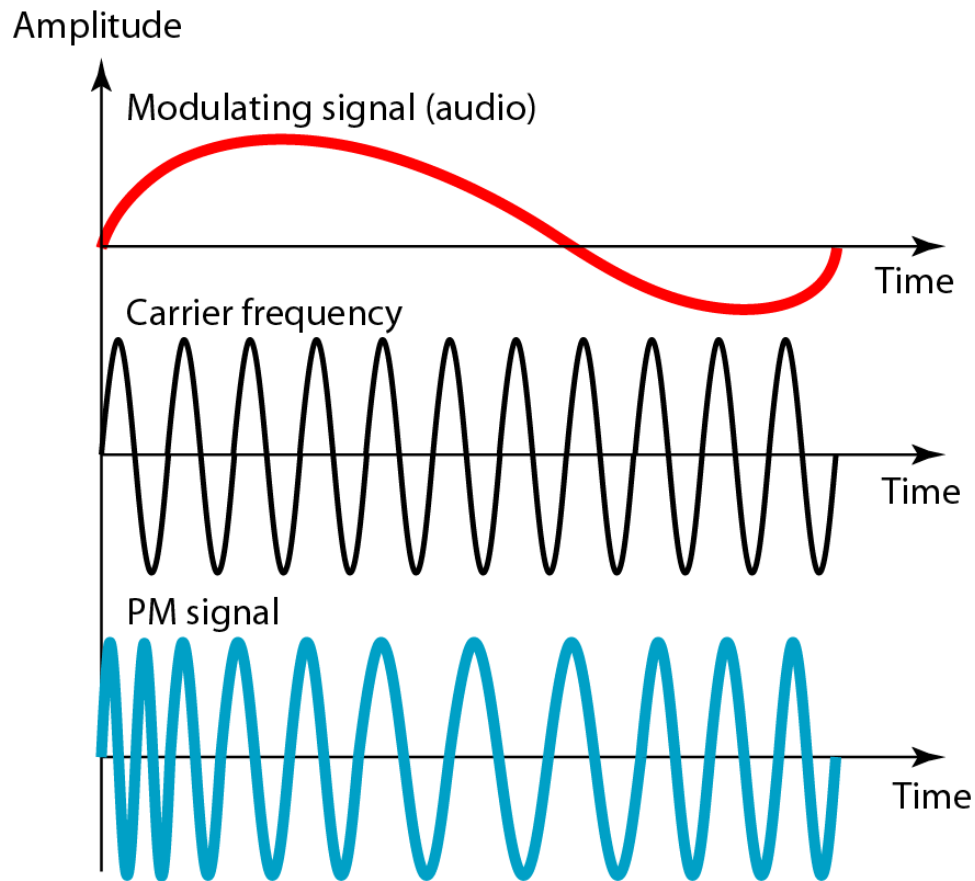


Figure 6 *Phase modulation*

Note

The total bandwidth required for PM can be determined from the bandwidth and maximum amplitude of the modulating signal:

$$B_{PM} = 2(1 + \beta)B.$$

That's all for today

Thank You