# MODULATION

# WHAT IS THE MODULATION?

- ***Modulation*** is the process of encoding information from a message source in a manner suitable for transmission.
- It is generally involves translating a baseband message signal (called the source) to a bandpass signal at frequencies that are very high when compared to the base band frequency.
- The bandpass signal is called the modulated signal, and the baseband message signal is called the modulating signal.

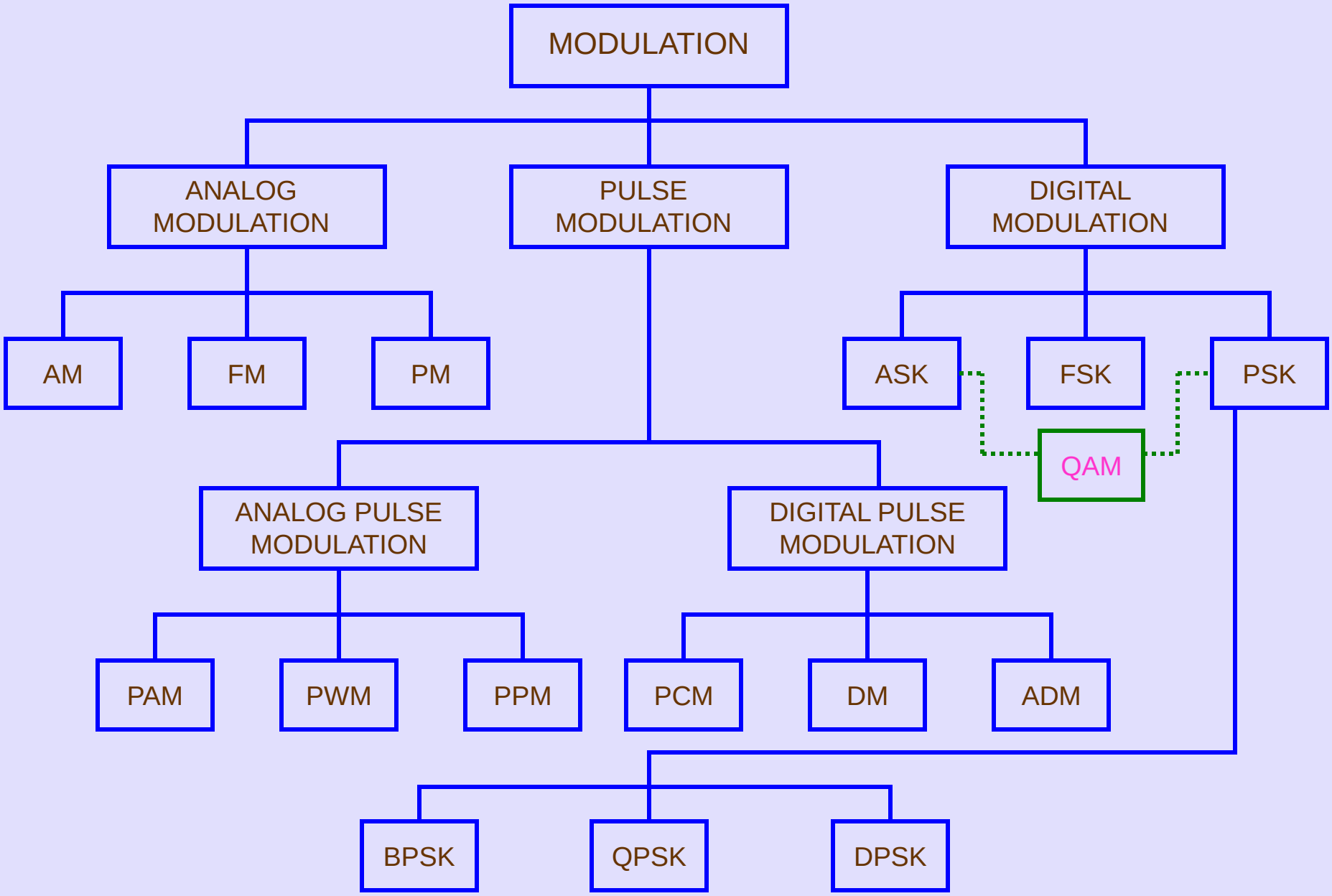
# WHAT IS THE MODULATION?

- **Modulation** may be done by varying the amplitude, phase or frequency of a high frequency carrier in accordance with the amplitude of the message signal.
- ***Demodulation*** is the process of extracting the baseband message from the carrier so that it may be processed by the intended receiver.

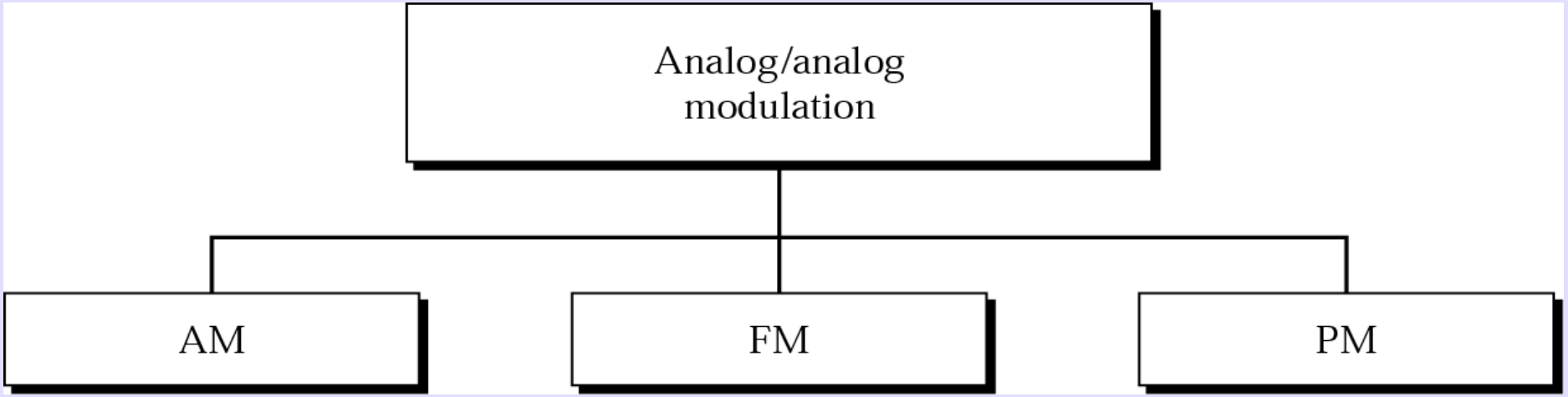
# Why we modulate signals?

- In order to ease propagation process and use an antenna of a suitable length.
- To decrease the Antenna size.
- To transmit the audio signal to far distance.
- To reduce the noise and interference.
- Multiplexing and de multiplexing.

# TYPES OF MODULATION



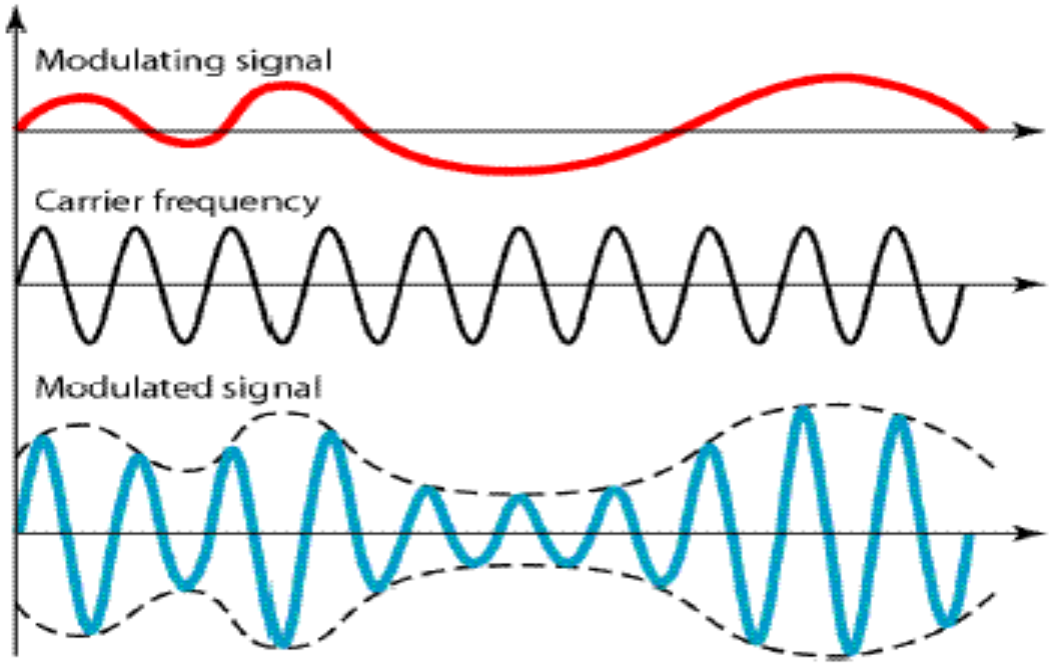
## *Types of analog-to-analog modulation*




❖In analog modulation both the carrier and modulating signals are analog.

# *Amplitude Modulation (AM)*

- Amplitude of carrier signal varies with changing amplitude of input/modulating signal; frequency and phase remain unchanged



# Advantages of AM

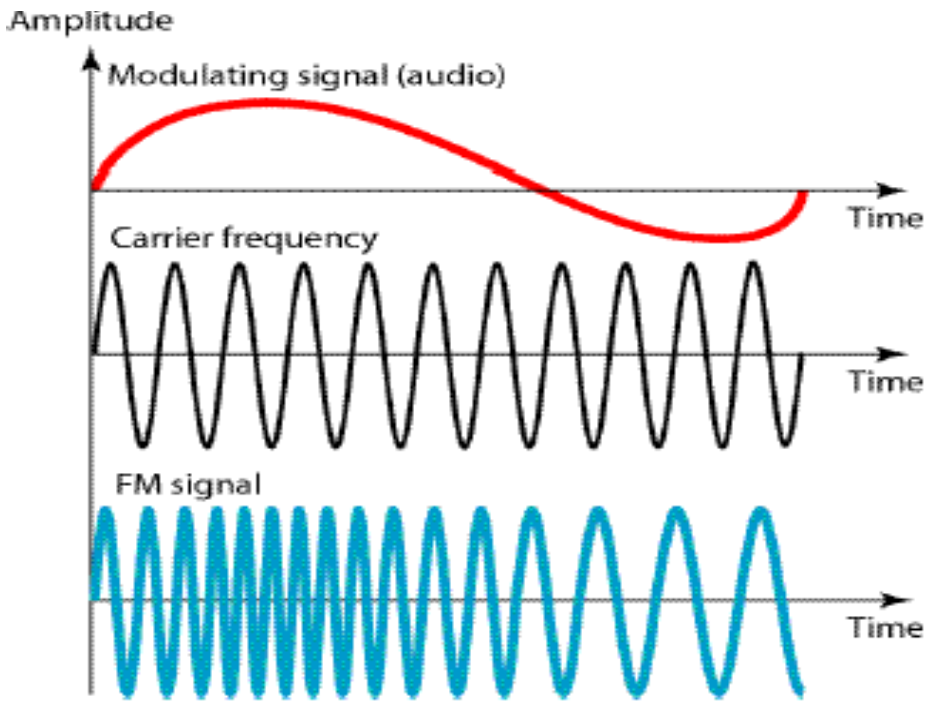
- It is simple to implement.
- It can be demodulated using a circuit consisting of very few components.
- AM receivers are very cheap as no specialized components are needed.

# Disadvantages of AM

- It is not efficient in terms of its power usage.
- It is not efficient in terms of its use of bandwidth, requiring a bandwidth equal to twice that of the highest audio frequency.
- It is prone to high levels of noise because most noise is amplitude based and obviously AM detectors are sensitive to it.

# *Frequency Modulation (FM)*

- **Frequency of carrier signal varies with changing frequency of input/modulating signal; amplitude and phase remain unchanged**



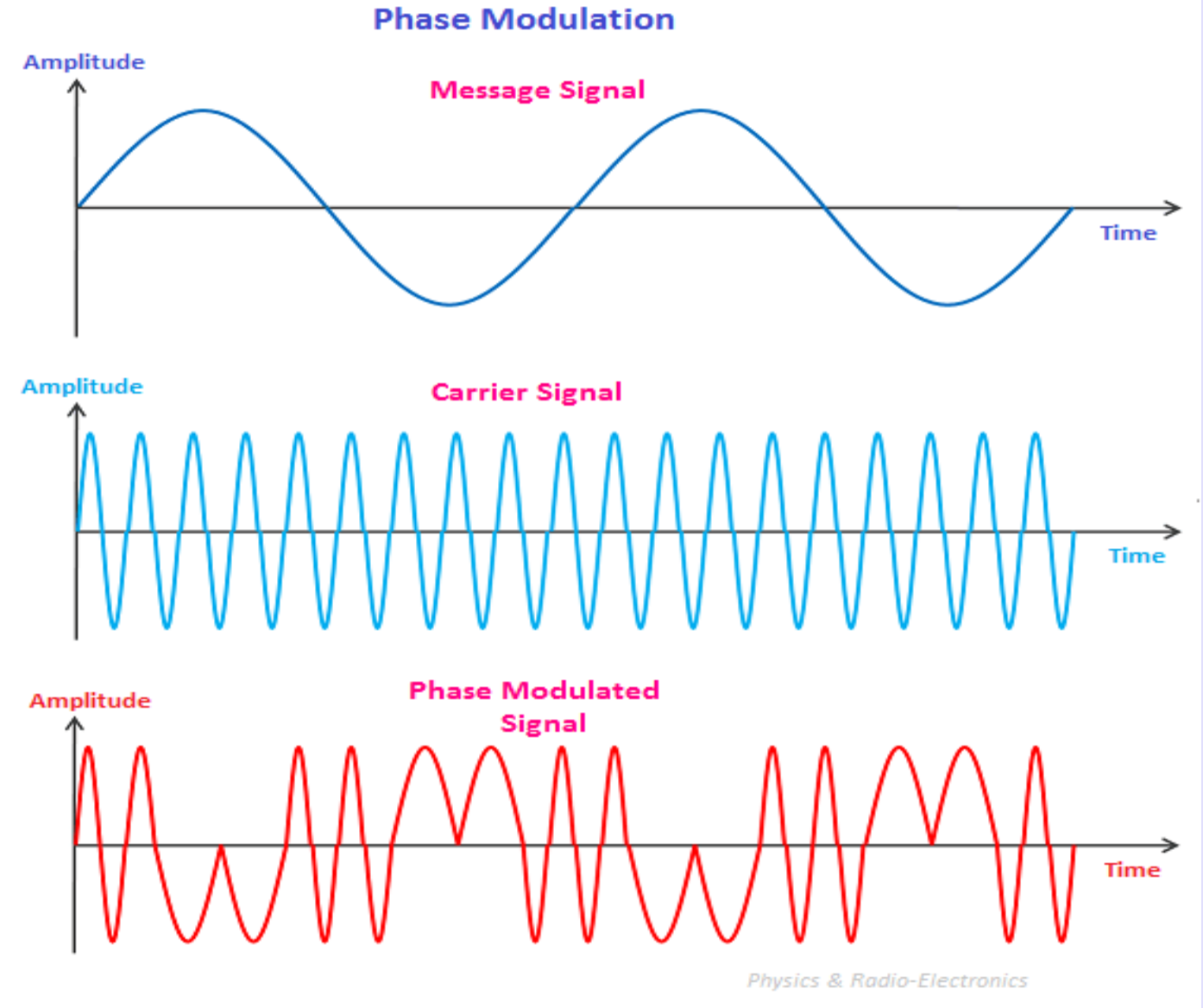
# Advantages of FM

- The noise power decrease as signal power increase so the signal to noise ratio of frequency modulation is high.
- Frequency modulation uses line of sight communications so the range of communication is around our planet.
- Same frequency channels can be used around the world, as frequency modulation is having number of sidebands.
- Frequency modulation requires less radiated power.

# Disadvantages of FM

- The bandwidth requirement for frequency modulation is very high as compared with amplitude modulation.
- Transmitter and Receiver are more complex in frequency modulation.

# *Phase Modulation (PM)*



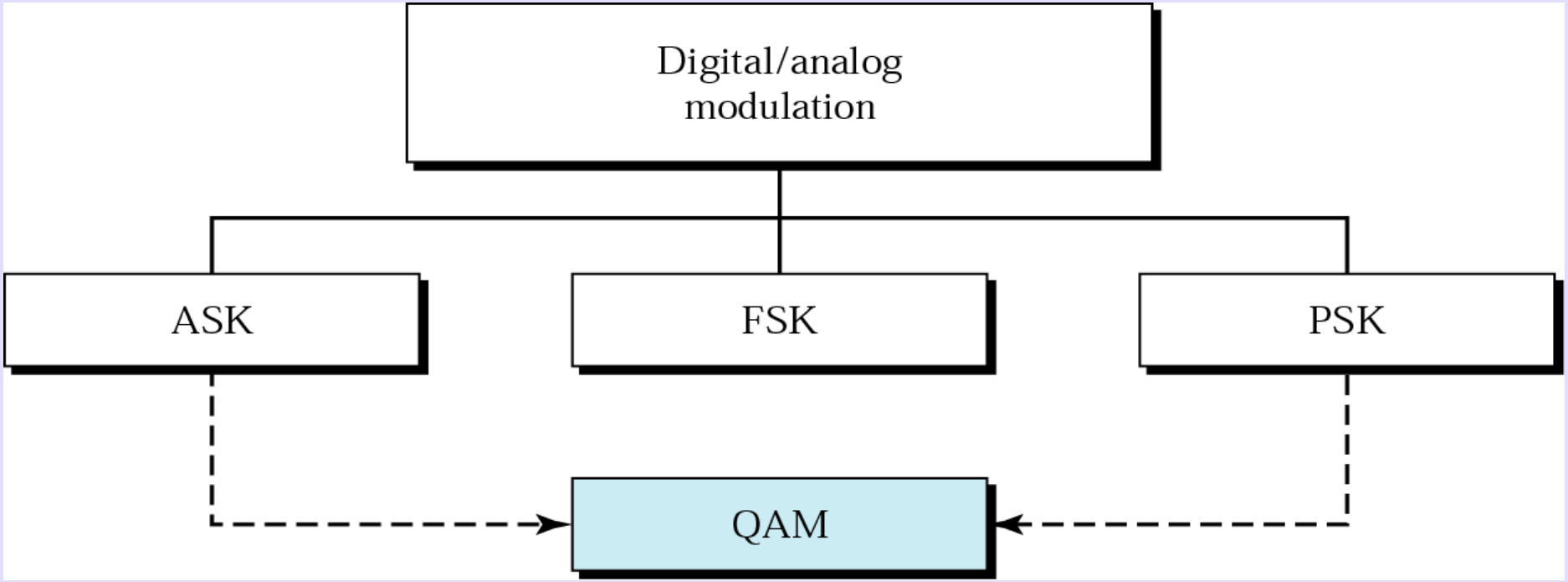
# Advantages of PM

- Improved signal to noise ratio.
- Less radiated power.
- Only 1 frequency used.
- Easy to detect loss of carrier

# Disadvantages of PM

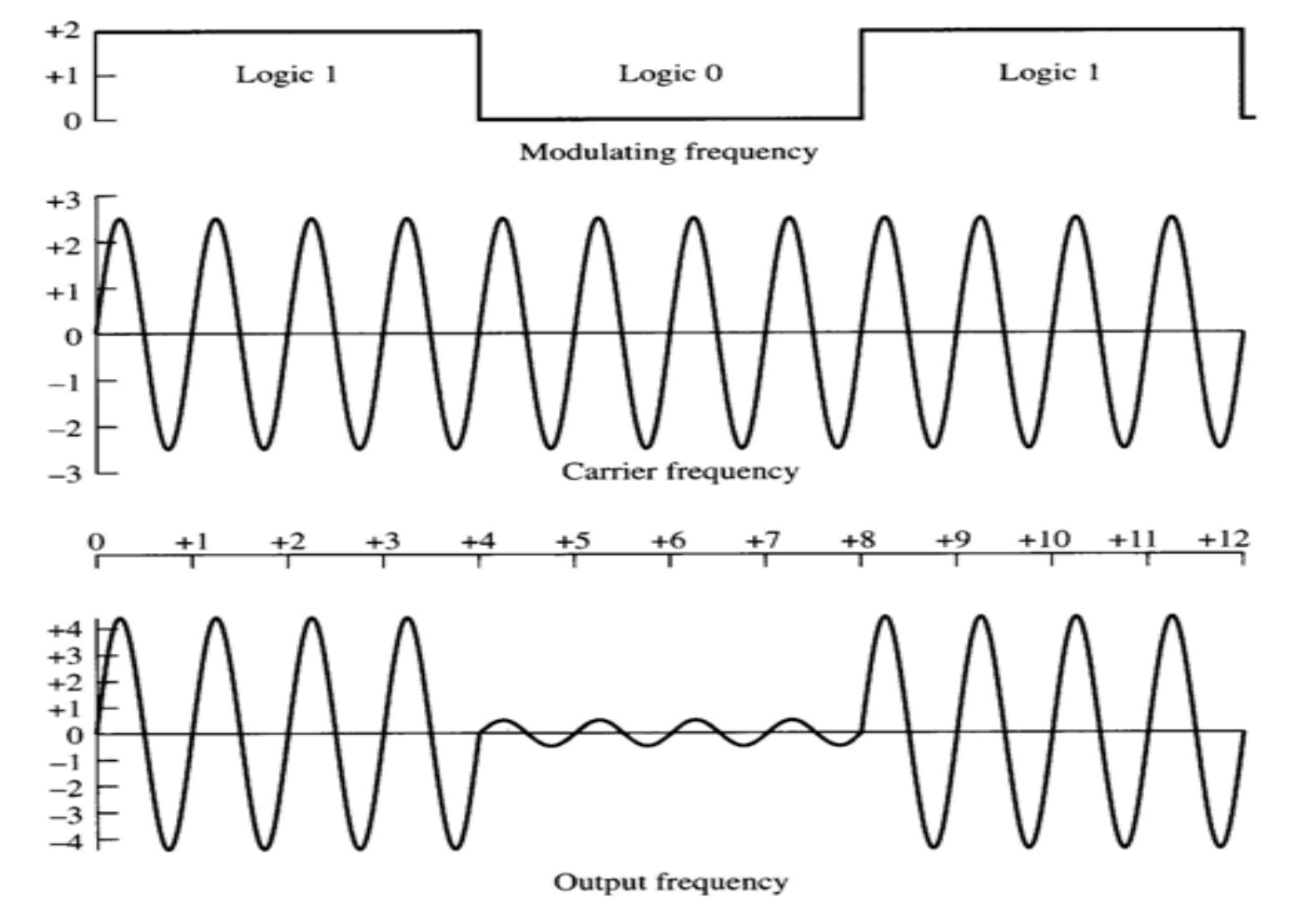
- Complex circuitry required to generate and detect phase changes
- We need frequency multiplier to increase phase modulation index

## *Types of digital-to-analog modulation*



# AMPLITUDE-SHIFT KEYING WAVEFORM

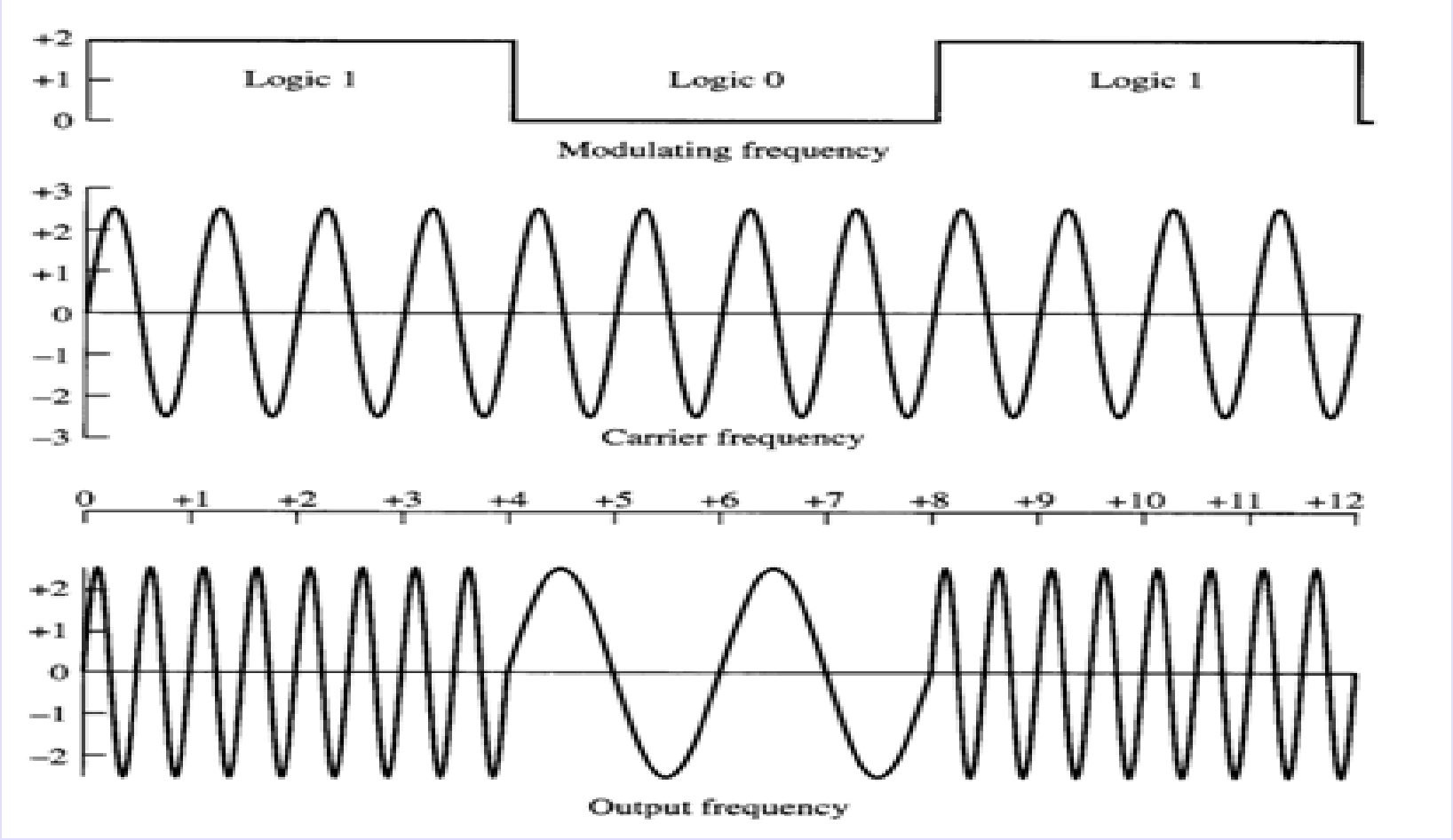
In ASK, Both frequency and phase remain constant while the amplitude changes. The amplitude of the carrier assumes one of the two amplitudes dependent on the logic states of the input bit stream.



# AMPLITUDE-SHIFT KEYING

- Amplitude-shift keying (ASK) refers to the digital modulation technique.
- In digital information alternates the amplitude of the carrier between two distinct levels.
- The digital modulation method is also referred to as ON-OFF keying, (OOK). The ON state represents binary 1; the OFF state represents binary 0.
- In ASK output signal is the product of the two-level unipolar information signal and the carrier signal.
- Amplitude-shift keying is perhaps the simplest of all digital modulation schemes. The advantage is a reduction in the amount of energy required to transmit information.

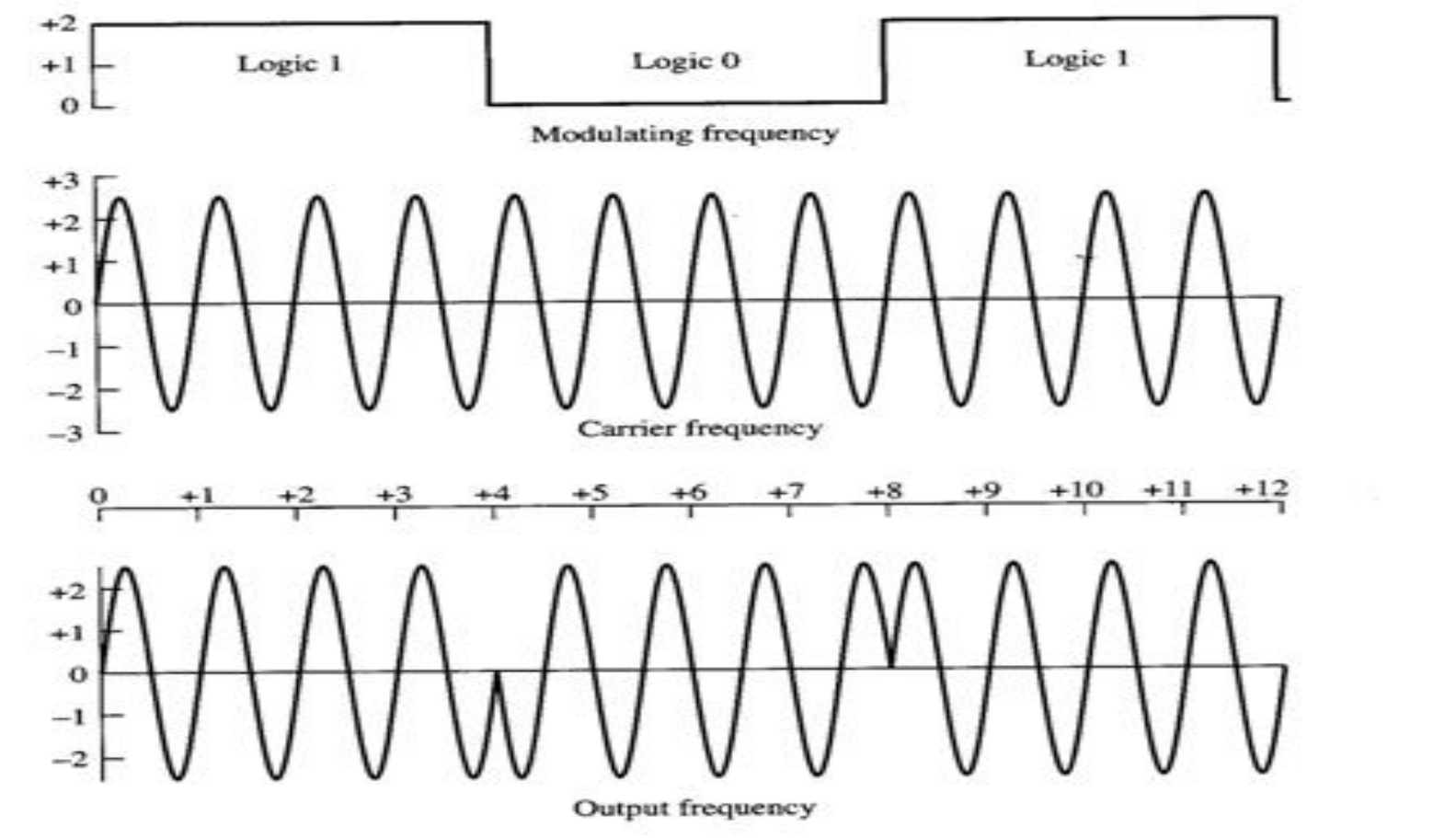
# FREQUENCY-SHIFT KEYING WAVEFORM



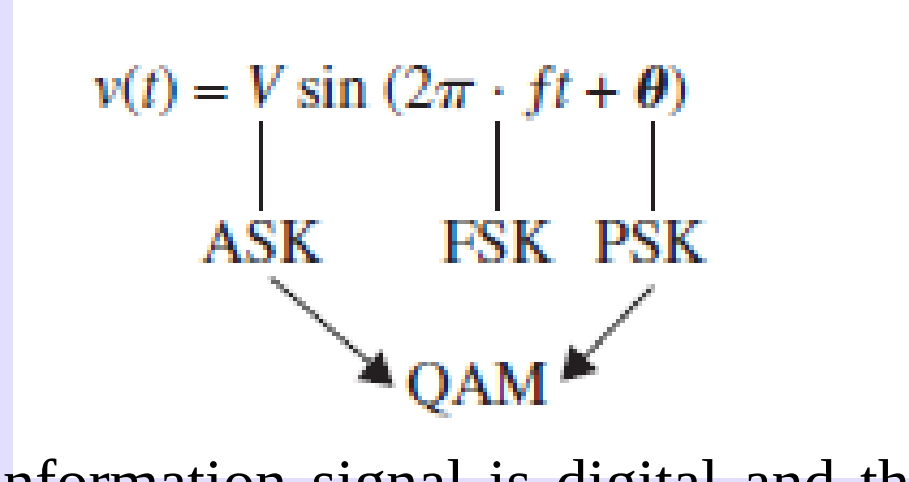
# FREQUENCY-SHIFT KEYING

- Frequency-shift keying (FSK) refers to the digital modulation technique.
- In digital information alternates the frequency of the carrier between two distinct levels, amplitude and phase remain constant.
- The frequency of the signal during each bit duration is constant, and it's value depends on the bit (0 or 1).
- In frequency-shift keying modulation incorporates two carrier frequencies for the transmission of two bits of binary data.
- In FSK Carrier frequency $f_1$ corresponds to bit 1, and carrier frequency $f_2$ corresponds to bit 0.

# PHASE-SHIFT KEYING



# *Quadrature amplitude modulation (QAM)*




•In the above Equation, if the information signal is digital and the amplitude (*V) of* the carrier is varied proportional to the information signal, a digitally modulated signal called *amplitude shift keying (ASK) is produced.*

•*If the frequency (f) is varied proportional* to the information signal, *frequency shift keying (FSK) is produced, and*

•*if the phase of the* carrier (θ) is varied proportional to the information signal, *phase shift keying (PSK) is produced.*

•If both the amplitude and the phase are varied proportional to the information signal, *quadrature amplitude modulation (QAM) results.*