# SIGNAL MODULATION

AMPLITUDE AND FREQUENCY MODULATION


## Presented By

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## Submitted to

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# Overview

- Introduction
- Amplitude Modulation(AM)
- Frequency Modulation(FM)
- Application
- Pros and Cons

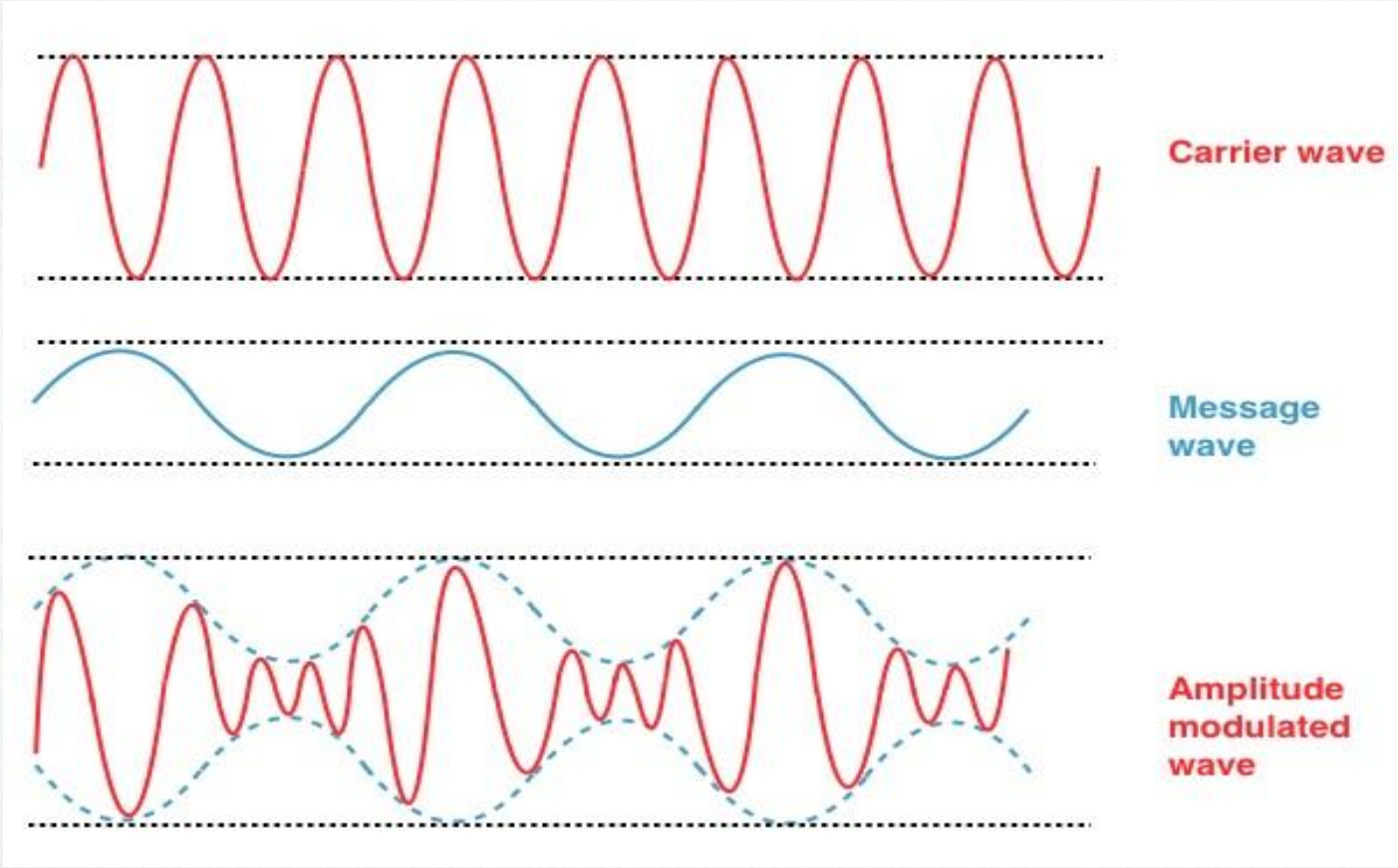
# Introduction

- Signal-
  - an electrical or electromagnetic current
  - capable to transmit message or information
- Modulation-
  - technique in which message signal is transmitted to the receiver with the help of carrier signal.

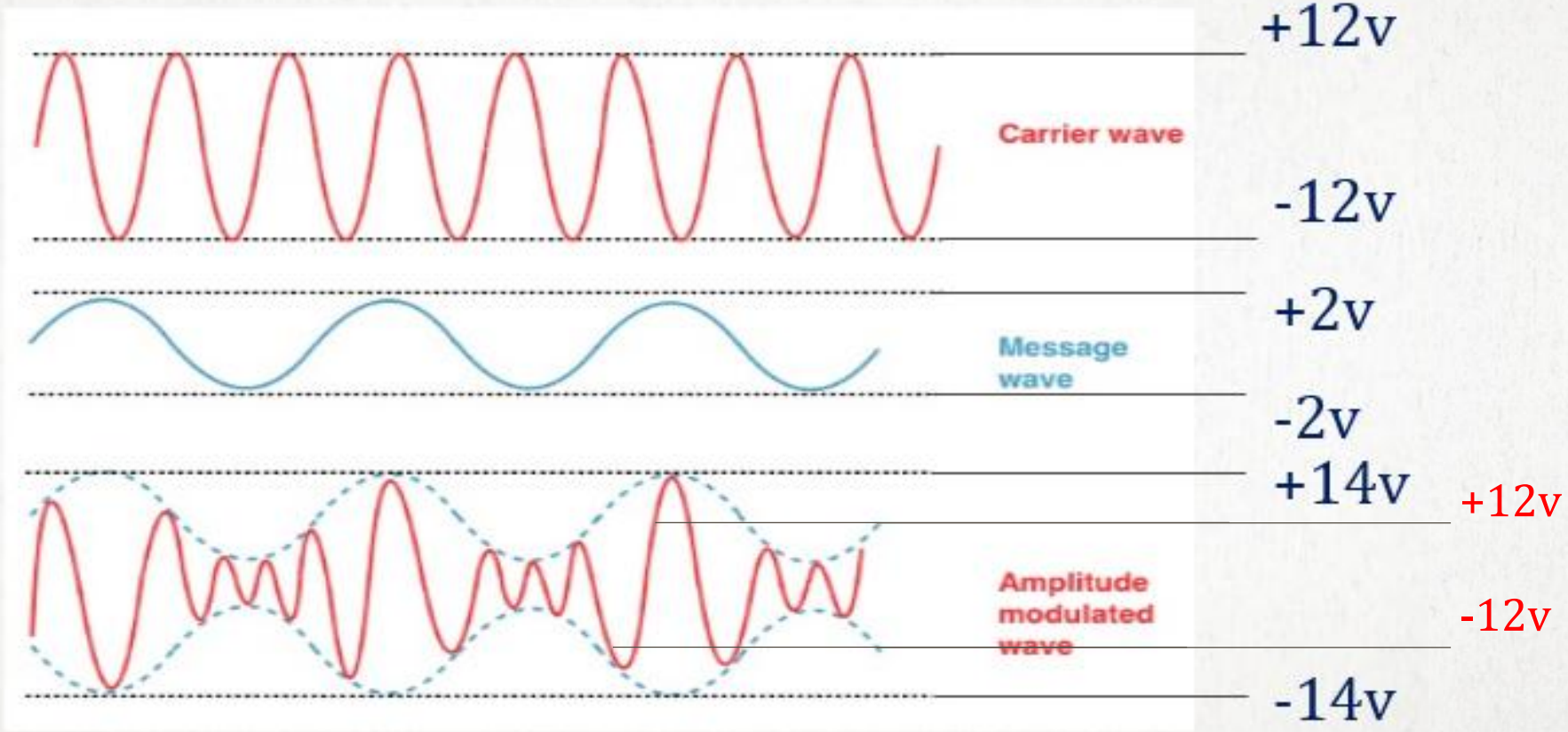
# AMPLITUDE MODULATION (AM)

- varied carrier signal amplitude according to the modulating or message signal.
- kept the signal's phase and frequency constant.

# AMPLITUDE MODULATION (AM)



# AMPLITUDE MODULATION (AM)



# Mathematical Expression

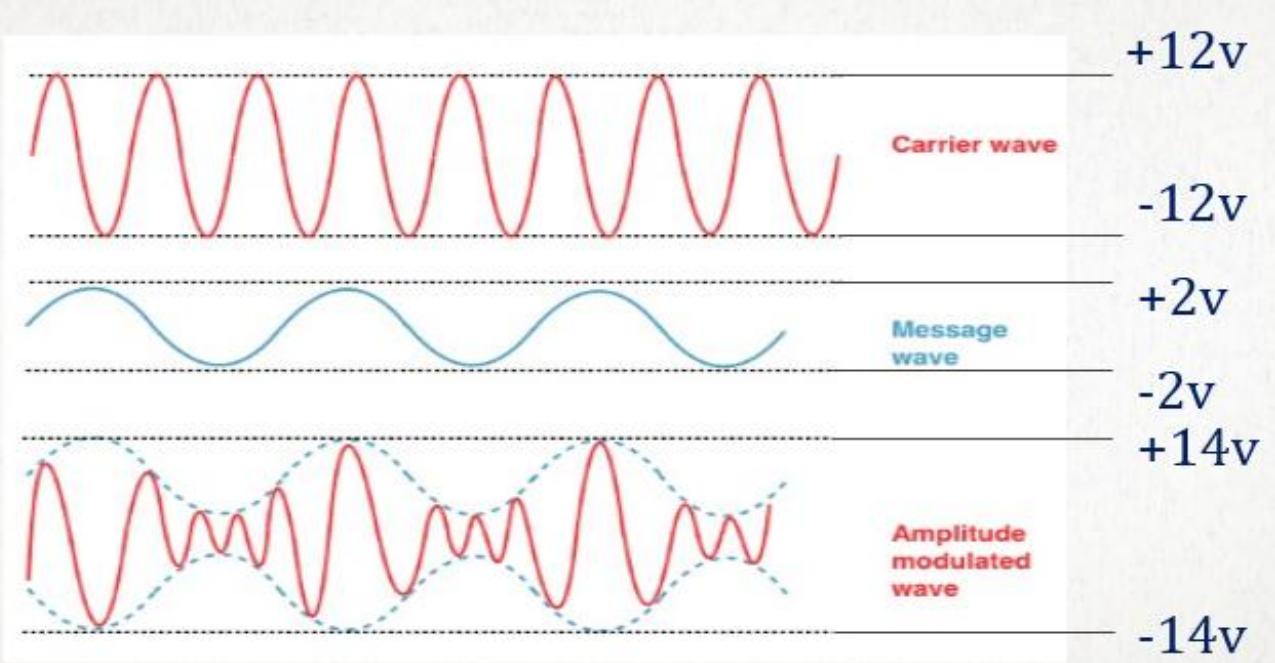
- AM Signal

Carrier signal,

$$C(t) = A_C \sin\omega_C t$$

Modulating signal,

$$m(t) = A_m \sin\omega_m t$$




The equation of Amplitude Modulated wave,

$$C_m(t) = (A_C + A_m \sin\omega_m t) \sin\omega_C t$$

# Mathematical Expression

$\therefore C_m(t) = A_C(1 + A_m/A_c \sin\omega_m t) \sin\omega_C t$

$A_m/A_c = \mu$ $\mu$ = Modulation index

$C_m(t) = A_C(1 + \mu \sin\omega_m t) \sin\omega_C t$

$C_m(t) = A_C \sin\omega_C t + \mu A_C \sin\omega_m t \cdot \sin\omega_C t$

$\therefore C_m(t) = A_C \sin\omega_C t + \mu A_c/2 \cos(\omega_C - \omega_m)t - \mu A_c/2 \cos(\omega_C + \omega_m)t$

It is a combination of 3 waves moving together with frequencies $\omega_C$, $(\omega_C - \omega_m)$ and $(\omega_C + \omega_m)$.

# AMPLITUDE MODULATION APPLICATIONS

- ✓ Used to carry message signals in early telephone lines.
- ✓ Used in Navy and Aviation for communications as AM signals can travel longer distances.
- ✓ Widely used in amateur radio.

# AM PROS AND CONS

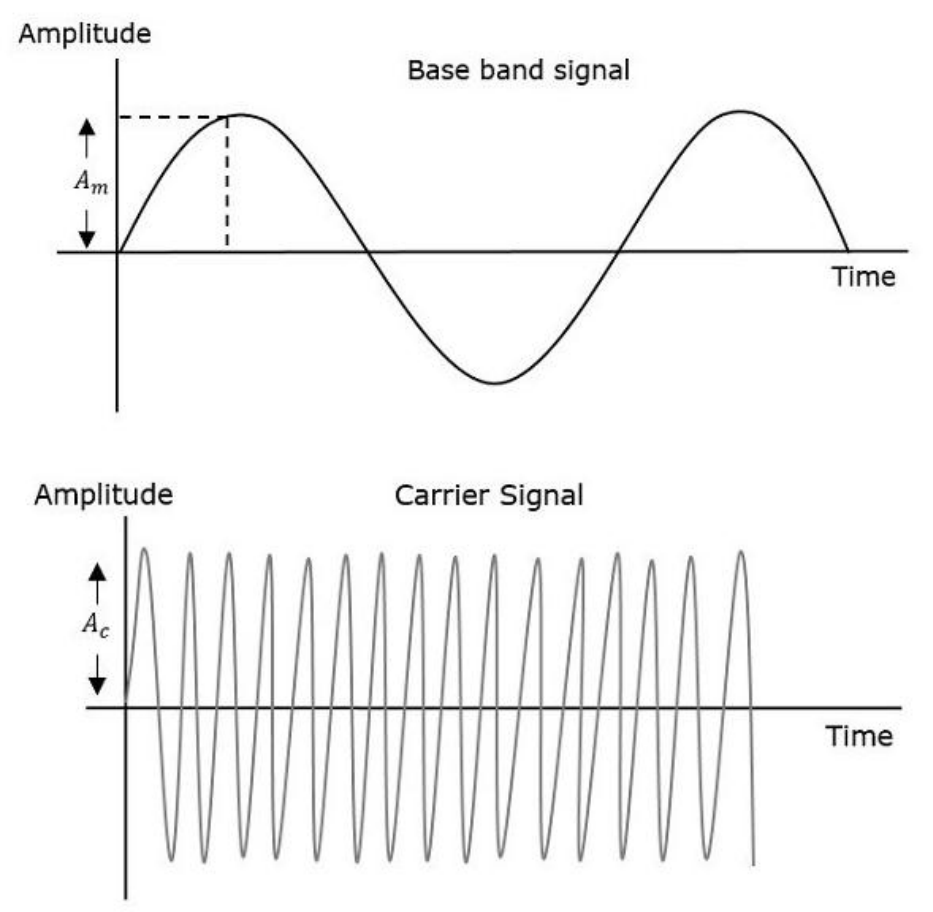
- simple to implement
- lower bandwidth
- can propagate longer distances

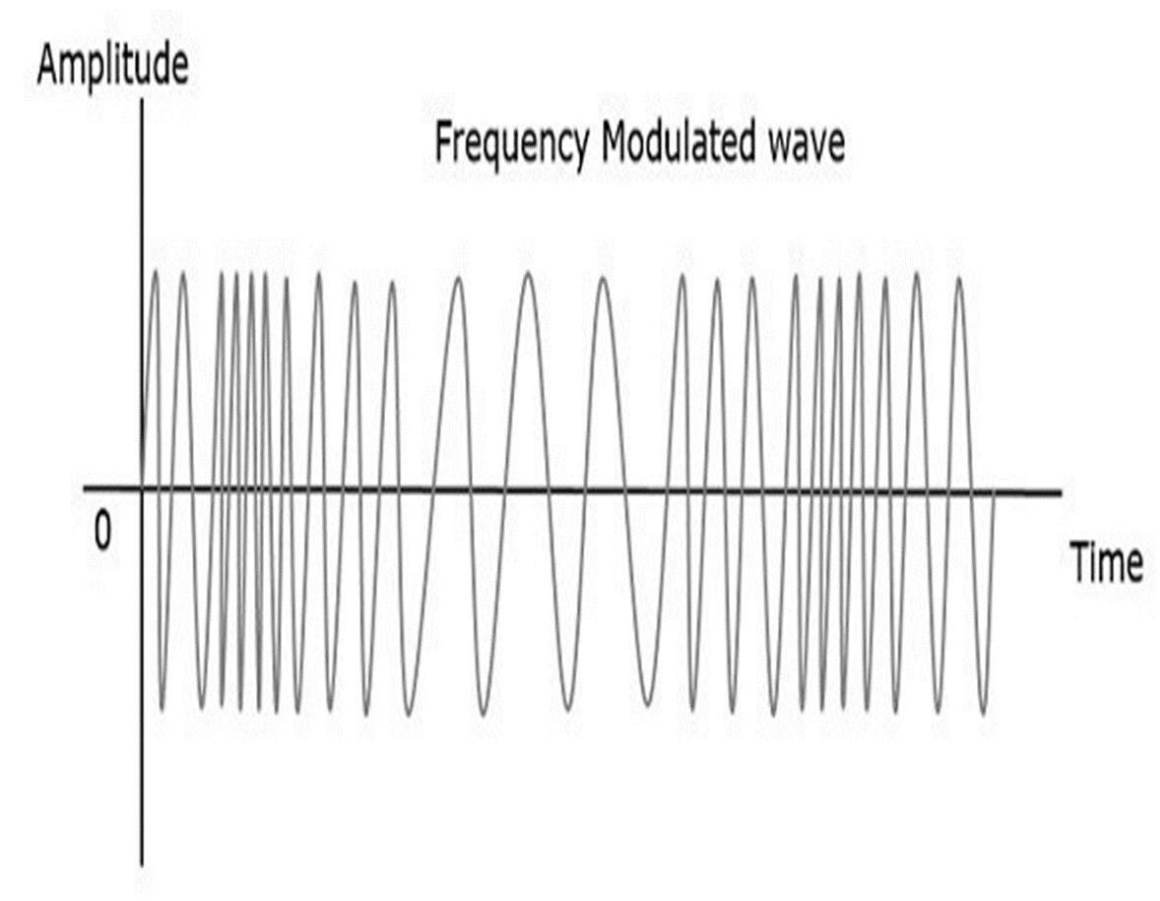
- inefficient in terms of its power usage
- poorer sound quality
- not very good at dealing with interference/noise

# FREQUENCY MODULATION (FM)

- The frequency of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.
- The amplitude and the phase of the carrier signal remains constant.

# FREQUENCY MODULATION (FM)



# Mathematical Expression

Baseband Signal

$$ym = Am\,sin(2\pi fmt)$$

Carrier Signal

$$yc = Ac\,\sin(2\pi fct)$$

Frequency Modulation Output

$$\mathrm{yfm} = Ac\,\sin[2\pi[\mathrm{fc} + \mathrm{kfAm}\,\sin(2\pi\mathrm{fmt})]\mathrm{t}]$$

# APPLICATION OF FREQUENCY MODULATION

- Mobile communications such as police wireless, ambulances, taxicabs, etc.
- Entertainment, broadcasting applications such as FM radio, TV, etc.

# FM PROS

- ***Resilience to noise***
- ***Easy to apply modulation at a low power stage of the transmitter***
- ***It is possible to use efficient RF amplifiers with frequency modulated signals***

# FM CONS

- *FM has poorer spectral efficiency than some other modulation formats*
- *Requires more complicated demodulator*
- *Some other modes have higher data spectral efficiency*
- *Sidebands extend to infinity either side*

# Questions or Suggestions

# Thank You!

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