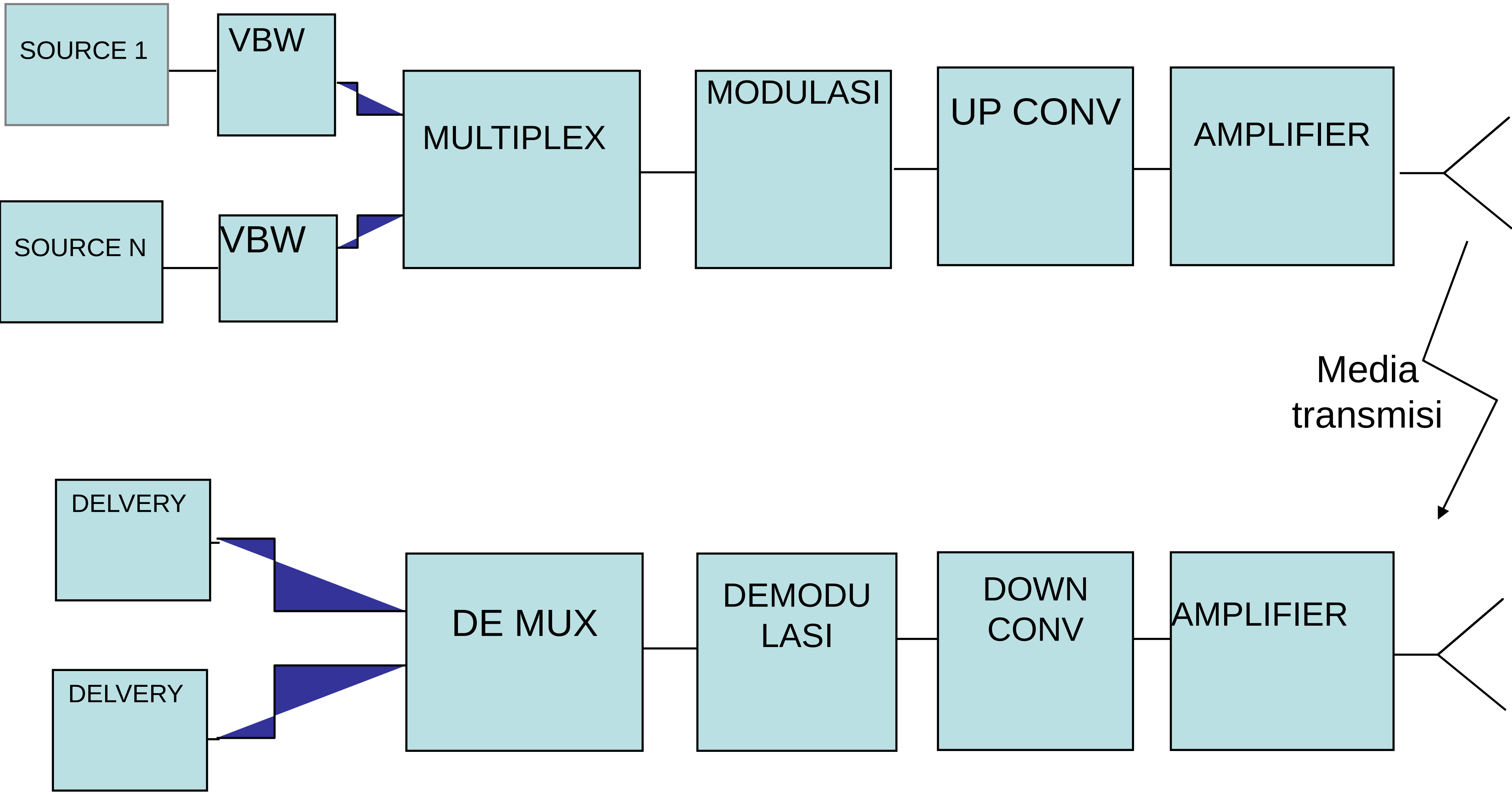
TRANSMISI


SOURCE 1
VBW
SOURCE N
VBW
MULTIPLEX
MODULASI
UP CONV
AMPLIFIER
Media
transmisi
DELVERY
DELVERY
DE MUX
DEMODU
LASI
DOWN
CONV
AMPLIFIER

Penumpangan sinyal pada carrier

- sinyal tak dapat bergerak sendiri pd jarak jauh.

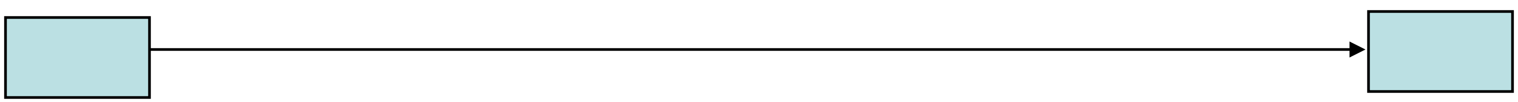
Contoh: suara kita tak dapat sampai ke Jakarta.

- Supaya sampai ke jakarta maka prosesnya sebagai berikut:

  - sinyal dirubah dalam bentuk sinyal listrik (contoh : amplifier dan loud speaker)

  - sinyal listrik ini juga tidak dapat sampai ke Jakarta .(dengan cara apa?)

  - sinyal listrik bisa disalurkan dengan kabel



Seberapa jauh sinyal ini dapat disalurkan lewat kabel?

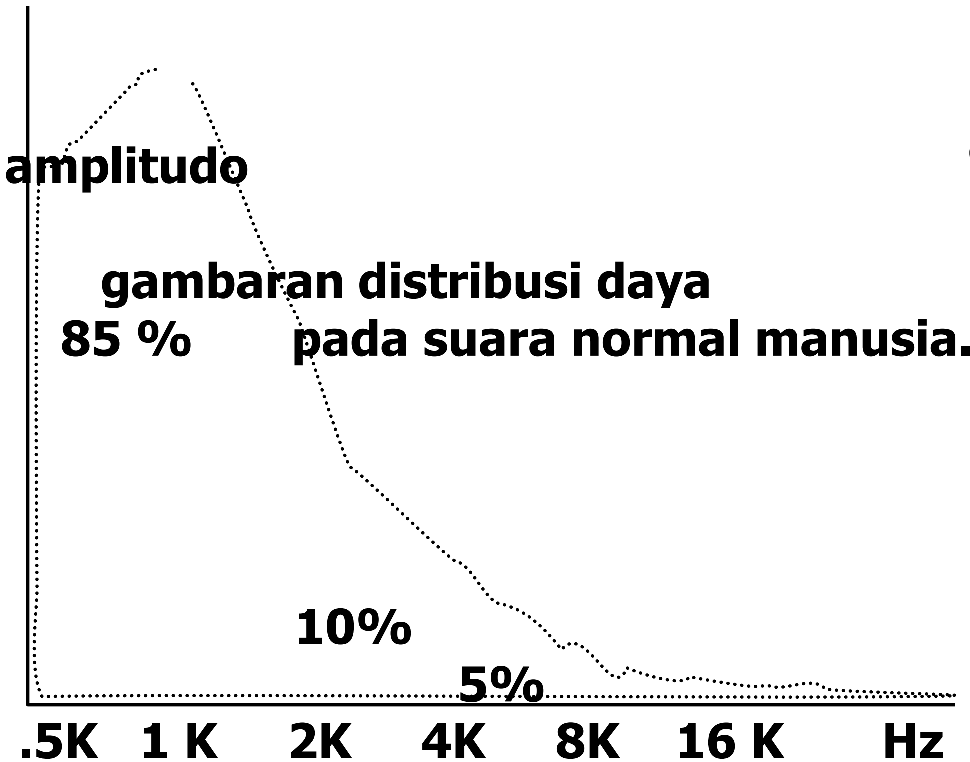
Penumpangan sinyal pada carrier

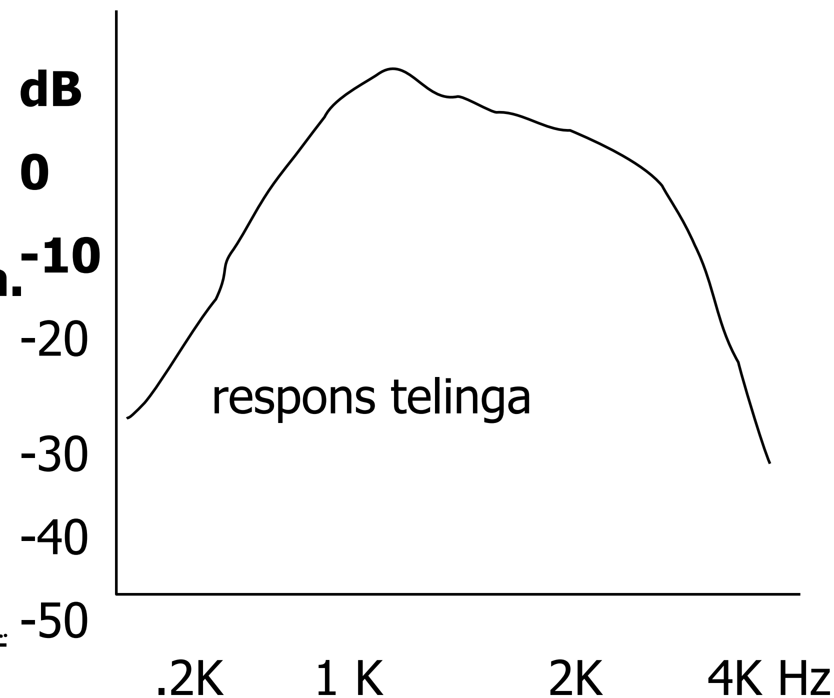
- cara yang terbaik adalah menumpangkan sinyal tersebut pada gelombang. Karena gelombang dapat bergerak pada jarak yang jauh.
- Untuk itu salah parameter gelombang harus dirubah sesuai dengan perubahan sinyal yang mau dikirim.

  Contoh gelombang cahaya. Jika suatu sumber cahaya diubah – ubah intensitasnya (terang/ gelap) maka perubahan itu dapat diterima ditempat jauh.

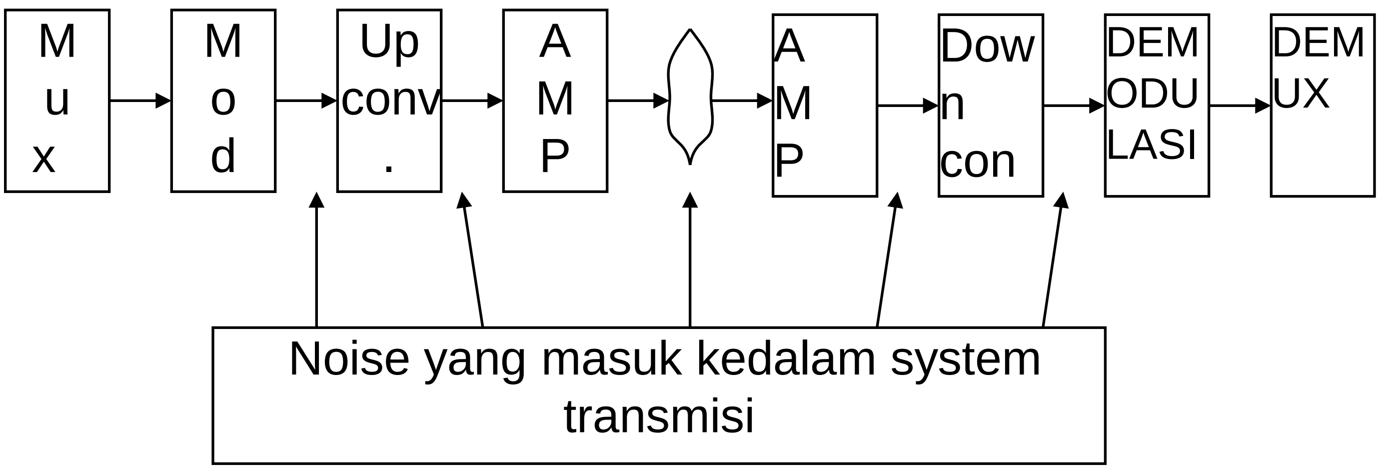
  Contoh lain: gelombang radio, jika gelombang radio dirubah – rubah amplitudonya maka perubahan amplitudo ini dapat diterima ditempat jauh.
- Sebelum lanjut marilah kita mempelajari apakah gelombang itu?

VBW


amplitudo
gambaran distribusi daya
85 %
pada suara normal manusia.
10%
5%
.5K 1 K 2K 4K 8K 16 K Hz


dB
0
-10
-20
-30
-40
-50
respons telinga
.2K 1 K 2K 4K Hz

KWALITAS TRANSMISI



Analog Digital

C/N Atau

S/N BER

Kegiatan Proses Transmisi

1. Perubahan bentuk informasi
2. Multiplexing
3. Transmisi lewat media (penyesuaian dengan media kirim)
4. Proses depacking

Kwalitas Penerimaan pada Saluran Transmisi

1. *Distorsi redaman*
2. *Distorsi phasa*
3. *Level*
4. *Noise / S/N (kwalitas)*

Parameter Transmisi pada Kanal Suara

1. *Signal Power Level*
2. *Attenuation Distortion*
3. *Delay Distortion*
4. *Noise dan Signal to Noise Ratio*
    a. *Thermal noise*
    b. *Intermodulation noise*
    c. *Crosstalk*
    d. *Impulse noise*

Sistem Modulasi

ialah peristiwa penumpangan sinyal informasi/modulasi

kedalam frekuensi gelombang carrier/pembawa.

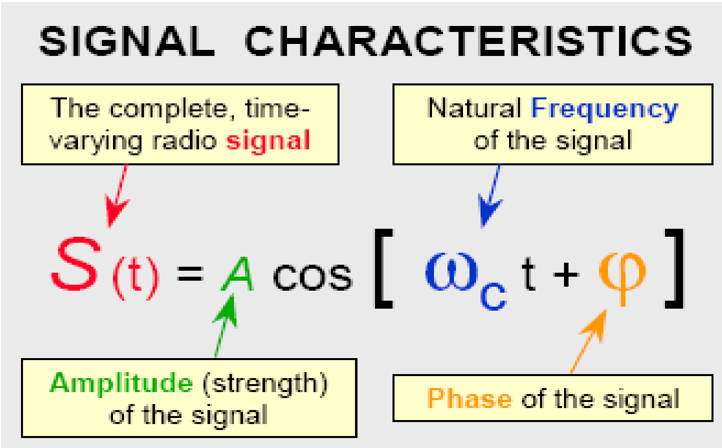
Diperlukan modulasi karena :

1. Mempermudah meradiasikan sinyal.
2. Pengiriman sinyal akan memiliki performance yang baik.
3. Mengurangi pengaruh noise dan interferensi.

Kita definisikan sinyal pembawa yang telah termodulasi :

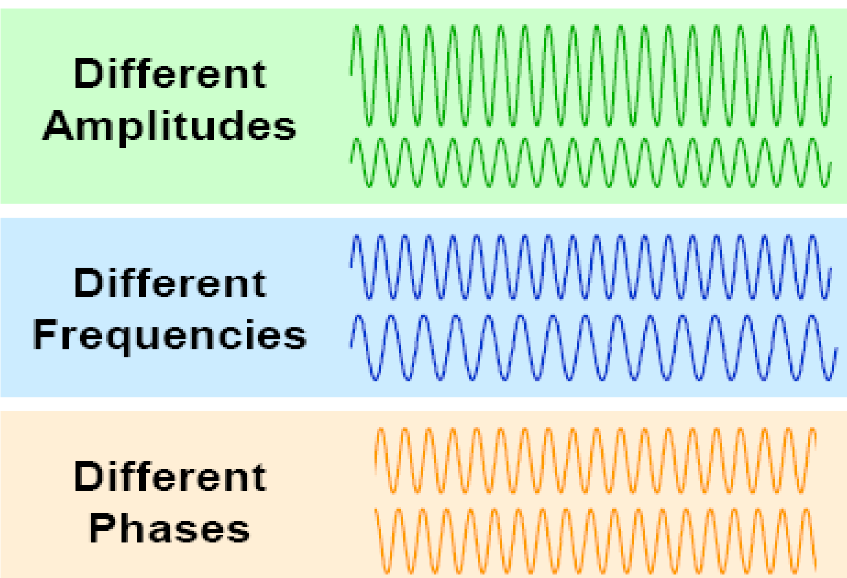
$$s(t) = A_c \cos(\theta(t))$$

Characteristics of a Radio Signal



$$S(t) = A \cos[\omega_c t + \varphi]$$

Compare these Signals:



- The purpose of telecommunications is to send information from one place to another
- Our civilization exploits the transmissible nature of radio signals, using them in a sense as our "carrier pigeons"
- To convey information, some characteristic of the radio signal must be altered (I.e., 'modulated') to represent the information
- The sender and receiver must have a consistent understanding of what the variations mean to each other
- RF signal characteristics which can be varied for information transmission:
  - Amplitude
  - Frequency
  - Phase

MODULASI

SINYAL CARRIER / PEMBAWA

- $\mathbf{Y = } A \mathbf{\, sin\, (} \omega \mathbf{\, t + } \psi \mathbf{\,)} \rightarrow \omega = 2 \pi f t$

MODULASI AM

- $\mathbf{Y = } A(1 + ka_s) \mathbf{\, sin\, (} \omega \mathbf{\, t + } \psi \mathbf{\,)}$

MODULASI FM

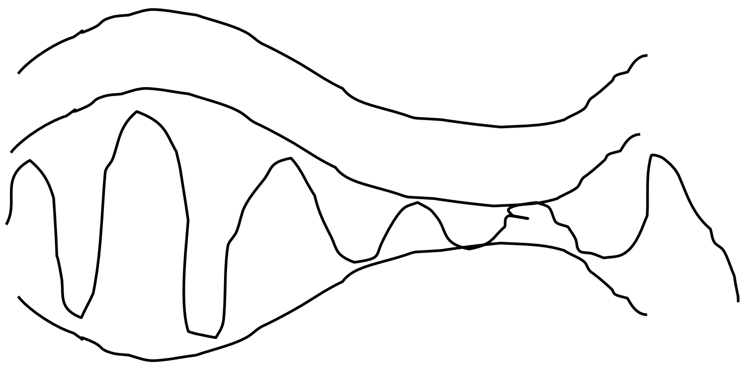
- $\mathbf{Y = } A \mathbf{\, sin\, [} \omega (1 + ka_s)\mathbf{t + } \psi \mathbf{\,]}$

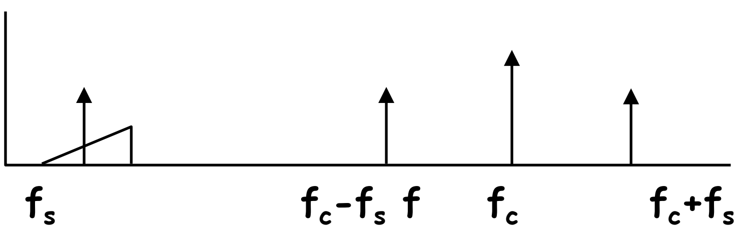
MODULASI PHASA

- $\mathbf{Y = } A \mathbf{\, sin\, [} \omega \mathbf{\, t + } \psi(1 + ka_s) \mathbf{\,]}$

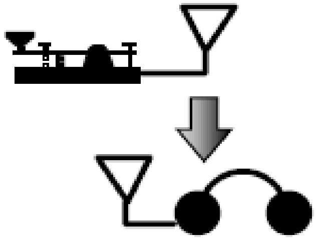
SINYAL MODULASI

- Amplitude Modulation

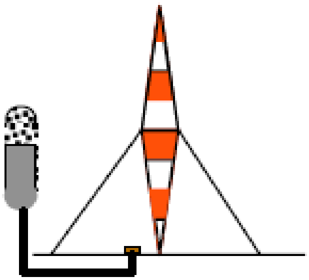




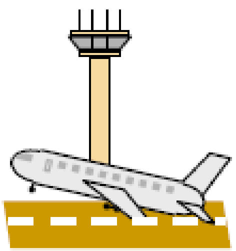
The Emergence of AM: A bit of History



- The early radio pioneers first used binary transmission, turning their crude transmitters on and off to form the dots and dashes of Morse code. The first successful demonstrations of radio occurred during the mid-1890's by experimenters in Italy, England, Kentucky, and elsewhere.

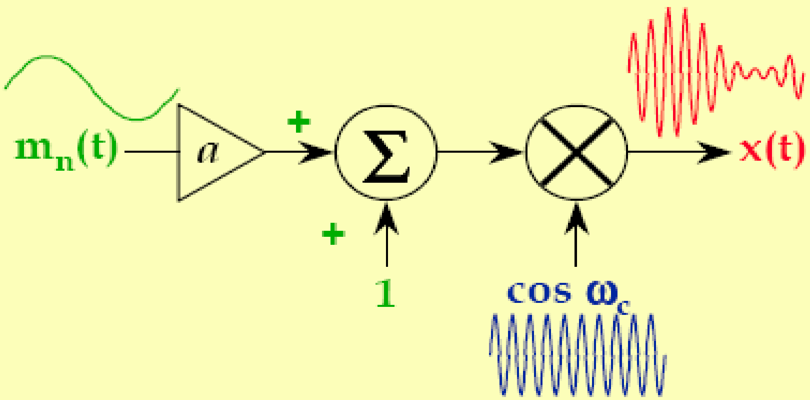


- Amplitude modulation was the first method used to transmit voice over radio. The early experimenters couldn't foresee other methods (FM, etc.), or today's advanced digital devices and techniques.
- Commercial AM broadcasting to the public began in the early 1920's.
- Despite its disadvantages and antiquity, AM is still alive:
  - AM broadcasting continues today in 540-1600 KHz.
  - AM modulation remains the international civil aviation standard, used by all commercial aircraft (108-132 MHz. band).
  - AM modulation is used for the visual portion of commercial television signals (sound portion carried by FM modulation)
  - Citizens Band ("CB") radios use AM modulation
  - Special variations of AM featuring single or independent sidebands, with carrier suppressed or attenuated, are used for marine, commercial, military, and amateur communications



Amplitude Modulation ("AM")

TIME-DOMAIN VIEW of AM MODULATOR



$$x(t) = [1 + a\,m_n(t)]\cos \omega_c t$$

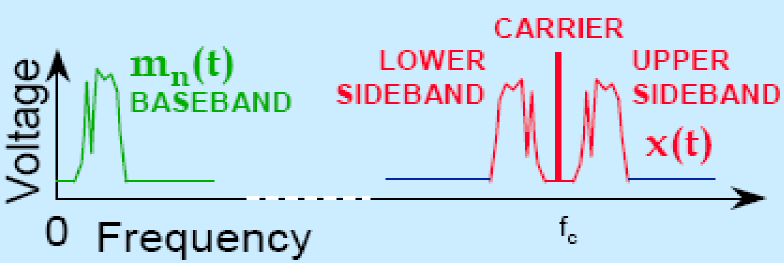
where:

a = modulation index ($0 < a <= 1$)

$m_n(t)$ = modulating waveform

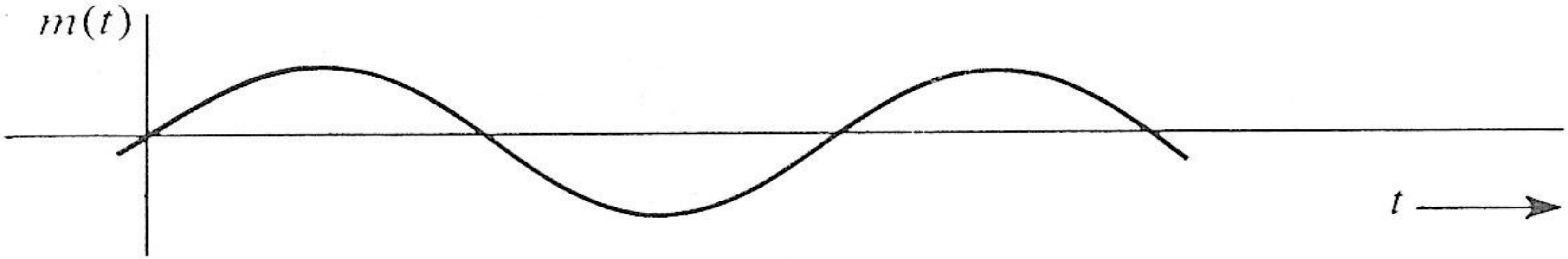
$\omega_c = 2\pi f_c$, the radian carrier freq.

FREQUENCY-DOMAIN VIEW

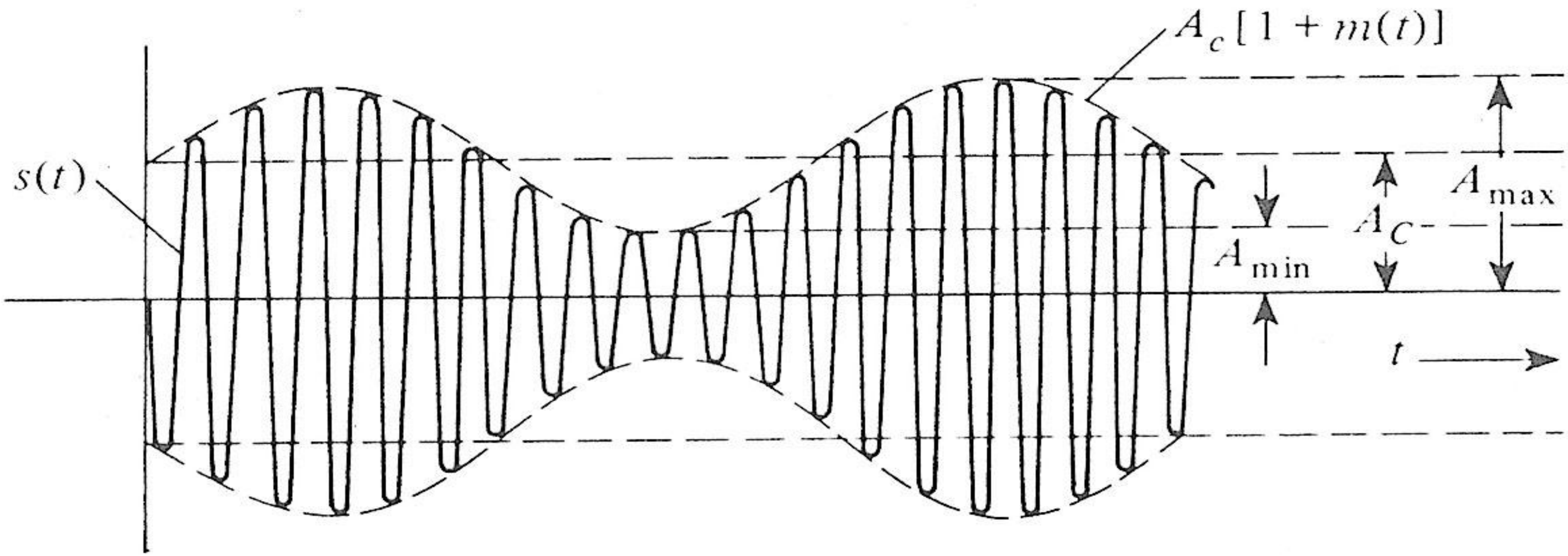


- AM is "linear modulation" -- the spectrum of the baseband signal translates directly into sidebands on both sides of the carrier frequency
- Despite its simplicity, AM has definite drawbacks which complicate its use for wireless systems:
  - Only part of an AM signal's energy actually carries information (sidebands); the rest is the carrier
  - The two identical sidebands waste bandwidth
  - AM signals can be faithfully amplified only by linear amplifiers
  - AM is highly vulnerable to external noise during transmission
  - AM requires a very high C/I (~30 to 40 dB); otherwise, interference is objectionable

Amplitude Modulated Carrier

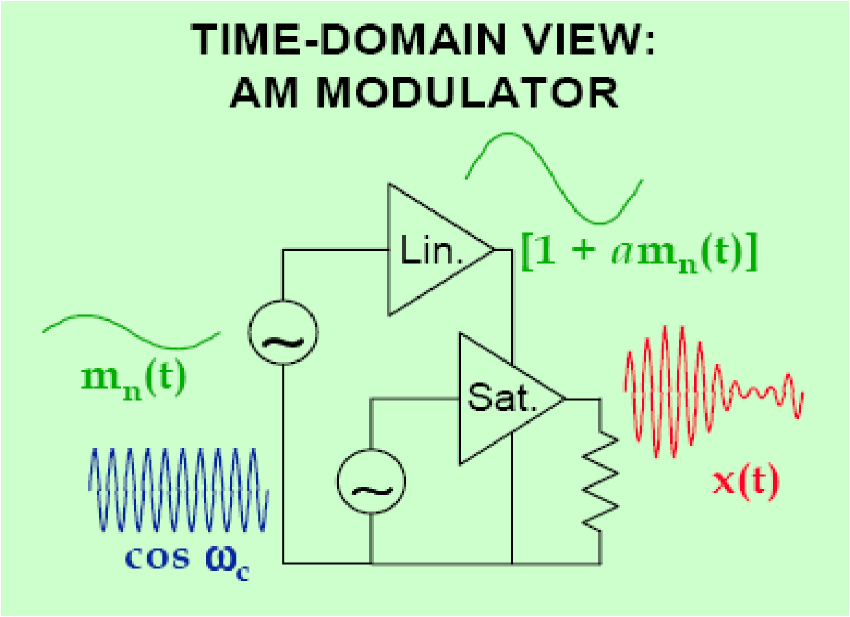


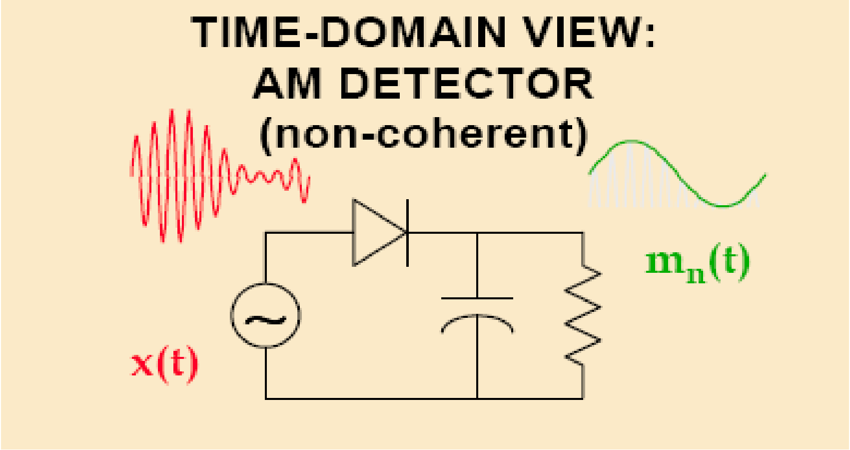
(a) Sinusoidal Modulating Wave



(b) Resulting AM Signal

An AM Modulator and Detector

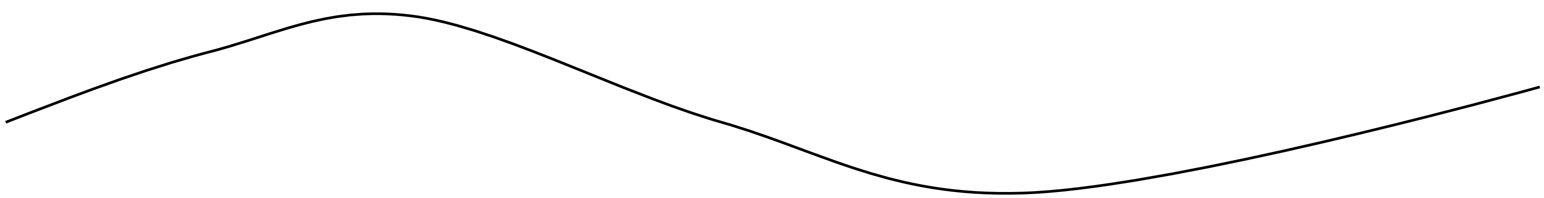




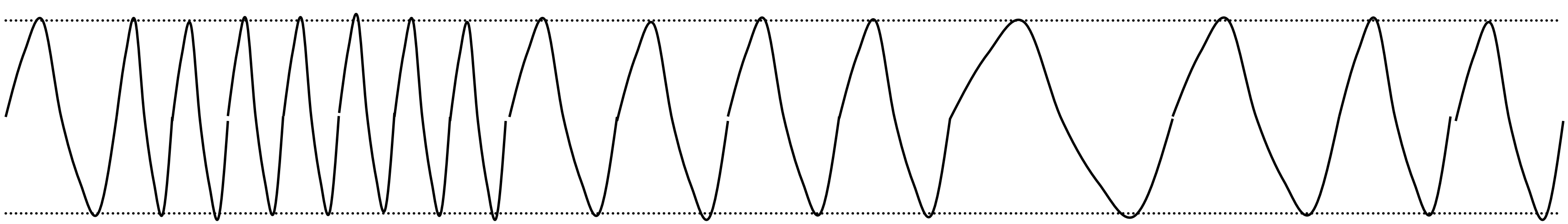
- AM modulation can be simply accomplished in a saturated amplifier
  - superimpose the modulating waveform on the supply voltage of the saturated amplifier
- AM de-modulation (detection) can be easily performed using a simple envelope detector
  - example: half-wave rectifier
  - this “non-coherent” detection works well if S/N >10 dB.
- AM demodulation can also be performed by coherent detectors
  - incoming signal is mixed (multiplied) with a locally generated carrier
  - enhances performance when S/N ratio is poor (<10 dB.)

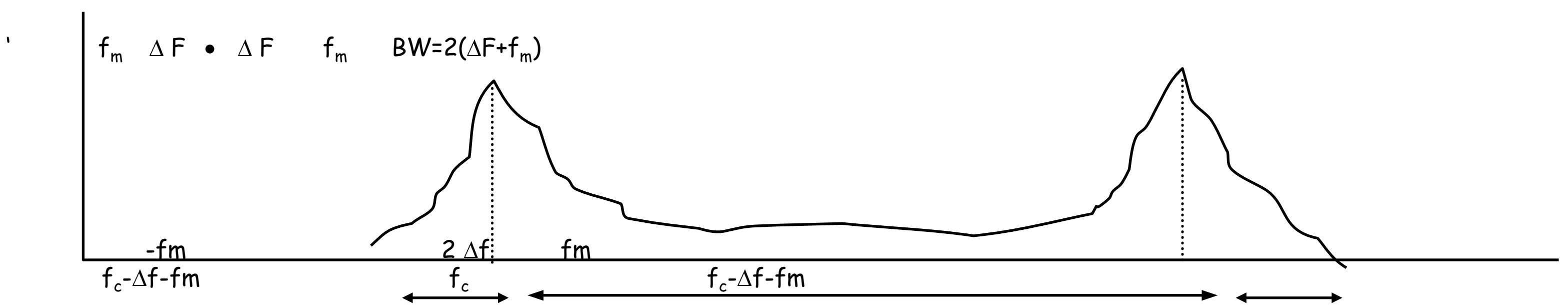
Frequency Modulation

Sinyal pemodulasi pembawa



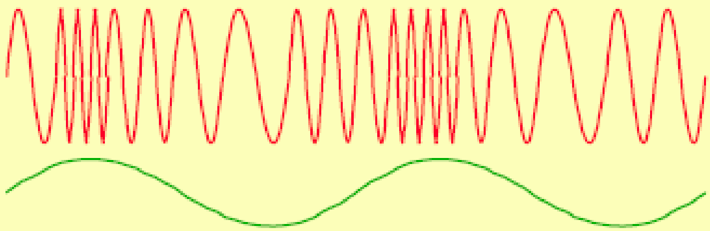
Gelombang pembawa yang telah dimodulasi, semakin tinggi amplitudo sinyal semakin kecil perioda pembawa.





Frequency Modulation ("FM")

TIME-DOMAIN VIEW



$$s_{FM}(t) = A\cos\left[\omega_c t + \int_{t_0}^{t} m_\omega m(x)\,dx + \varphi_0\right]$$

where:

A = signal amplitude (constant)

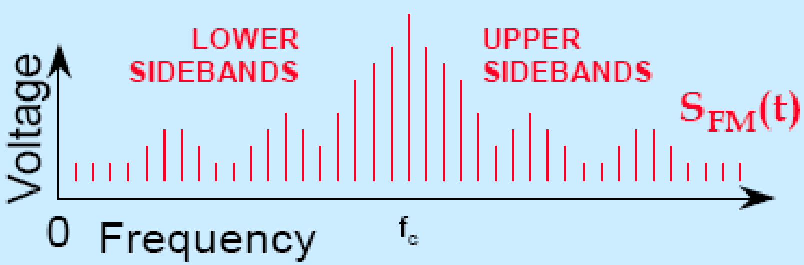
ω_c = radian carrier frequency

m_ω = frequency deviation index

$m(x)$ = modulating signal

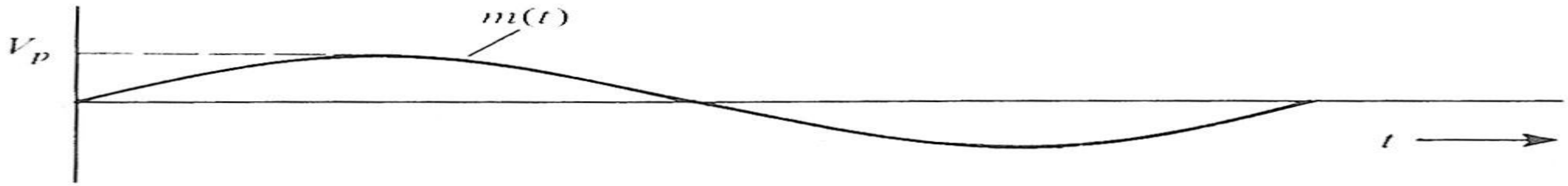
φ_0 = initial phase

FREQUENCY-DOMAIN VIEW

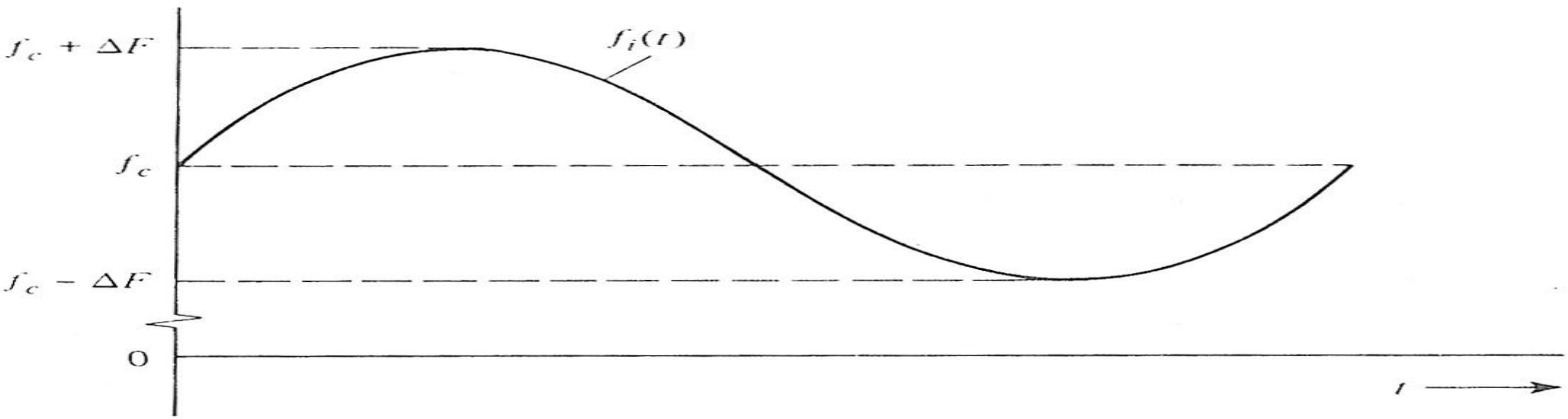


- Frequency Modulation (FM) is a type of *angle* modulation
  - in FM, the instantaneous frequency of the signal is varied by the modulating waveform
- Advantages of FM
  - the amplitude is constant
    - simple saturated amplifiers can be used
    - the signal is relatively immune to external noise
    - the signal is relatively robust; required C/I values are typically 17-18 dB. in wireless applications
- Disadvantages of FM
  - relatively complex detectors are required
  - a large number of sidebands are produced, requiring even larger bandwidth than AM

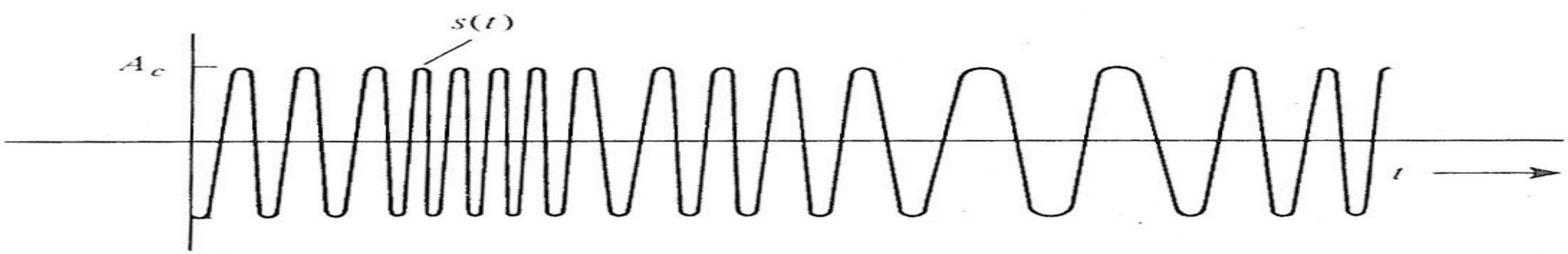
Frequency Modulated Carrier



(a) Sinusoidal Modulating Signal



(b) Instantaneous Frequency of the Corresponding FM Signal



(c) Corresponding FM Signal

The History of FM

Edwin Howard **Armstrong**
1890 - 1954

Major Edwin H. Armstrong was one of the most famous inventors in the early history of radio. In 1918, he invented the superheterodyne circuit -- and implemented the basic mixing principle of heterodyne frequency conversion used in virtually all modern radio receivers.

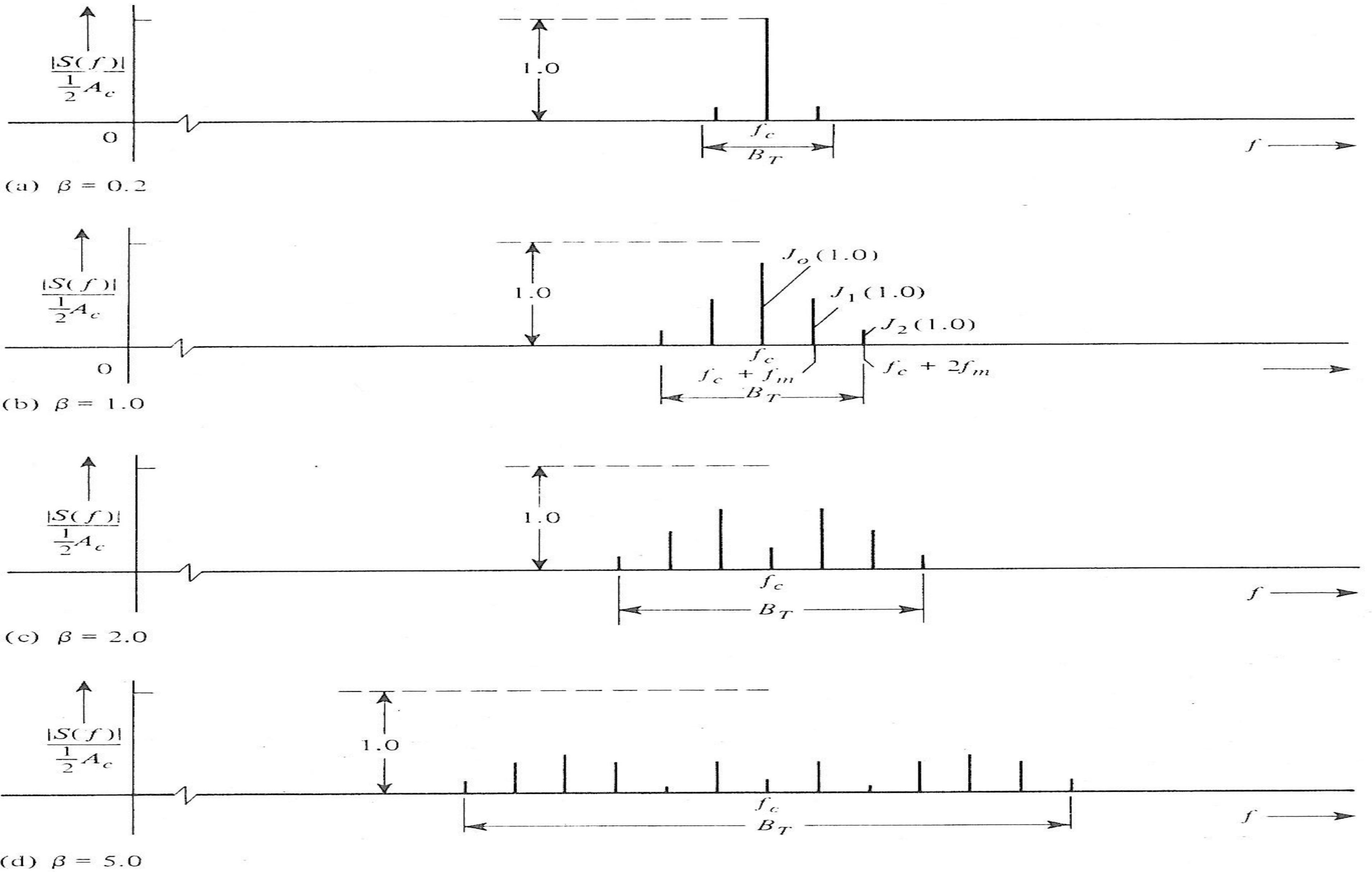
In 1933, he invented wide-band frequency modulation. Armstrong's primary motivation was to improve the audio quality of broadcast transmission, which had suffered from noise and static because of its use of AM modulation.

Promotion and commercial development of FM placed Armstrong at odds with David Sarnoff and Radio Corporation of America. Sarnoff and RCA were promoting another modern development, television, and saw more business potential in TV than in Armstrong's FM.

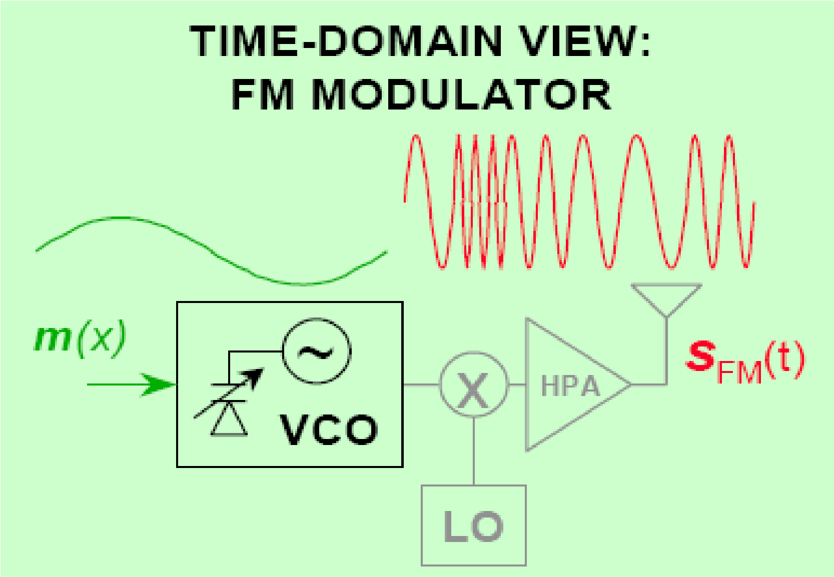
In addition, perhaps with RCA influence, the US FCC decided to change the frequencies allocated for FM broadcasting, obsoleting all of the hundreds of FM transmitters and over 500,000 FM receivers previously manufactured.

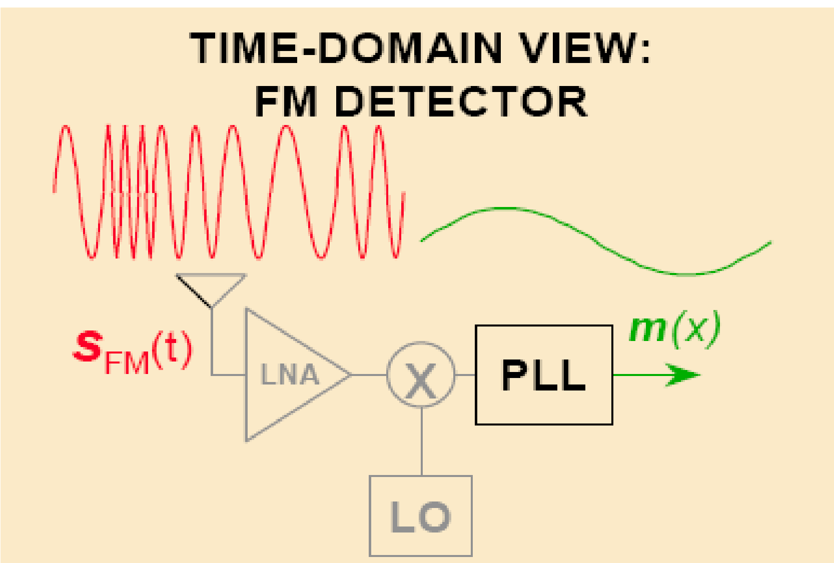
In 1954, despondent over these setbacks, Armstrong took his life. But today, the technology he started is used not only in broadcasting and the sound portion of TV, but also in all land mobile and first-generation analog cellular systems.

Spektrum Frekuensi FM



An FM Modulator and Detector





- FM modulation can be accomplished in tuned or voltage-controlled oscillator
  - the modulating signal varies a reactance (varactor, etc.) or otherwise changes the frequency of the oscillator
  - the modulation may be performed at a low intermediate frequency, then heterodyned to a desired communications frequency
- FM de-modulation (detection) can be performed by any of several types of detectors
  - Phase-locked loop (PLL)
  - Pulse shaper and integrator
  - Ratio Detector

Media transmisi

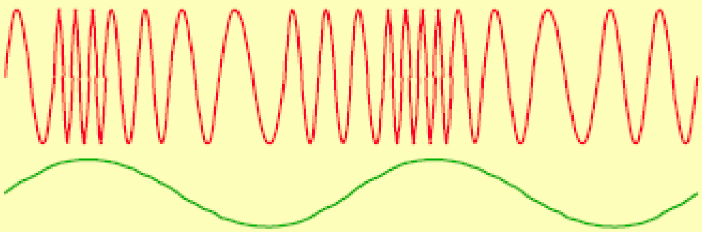
- Getaran sinyal pembawa itu harus disampaikan kepada penerima
- Proses penyampaian ini harus dilakukan melalui suatu media
- Analogi dengan pembawa truk maka maka jalan rayanya disebut media transmisi
- Proses perambatan sinyal gelombang pembawa dari satu tempat ketempat lain disebut propagasi.
- Didalam media, carrier dalam bentuk gelombang pembawa. (carrier wave).

Modulasi Phasa dan Modulasi Frekuensi

- Proses penumpangan sinyal informasi pada sinyal carrier :
  - Menumpangkan Info ke komponen ***phasa*** dari sinyal carrier → Phase Modulation (PM)
  - Menumpangkan Info ke komponen ***frekuensi*** dari sinyal carrier → Frequency Modulation(FM)

Phase Modulation ("PM")

TIME-DOMAIN VIEW



$$s_{PM}(t) = A \cos\left[\omega_c\, t + m_\omega\, m(x) + \varphi_0\right]$$

where:

A = signal amplitude (constant)

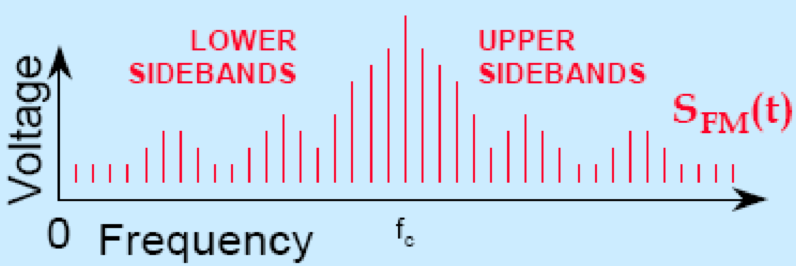
ω_c = radian carrier frequency

m_ω = phase deviation index

$m(x)$ = modulating signal

φ_0 = initial phase

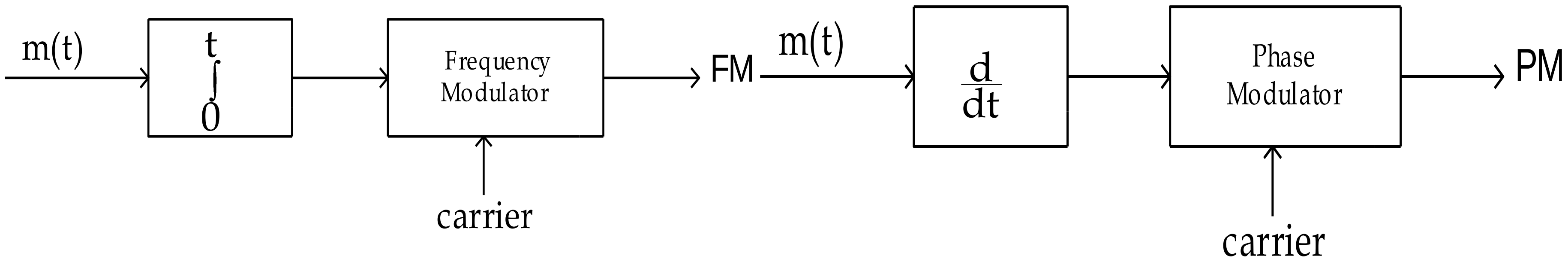
FREQUENCY-DOMAIN VIEW

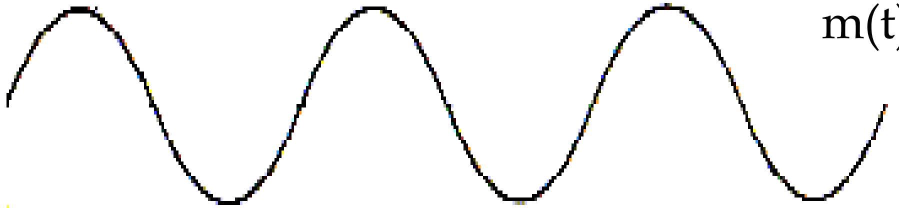


- Phase Modulation (PM) is a type of *angle* modulation, a "sister" of FM
  - the instantaneous *phase* of the signal is varied according to the modulating waveform
- Advantages of PM: similar to FM
  - the amplitude is constant
    - simple saturated amplifiers can be used
    - the signal is relatively immune to external noise
    - the signal is relatively robust; required C/I values are typically 17-18 dB. in wireless applications
- Disadvantages of PM
  - relatively complex detectors are required
  - a large number of sidebands are produced, requiring even larger bandwidth than AM

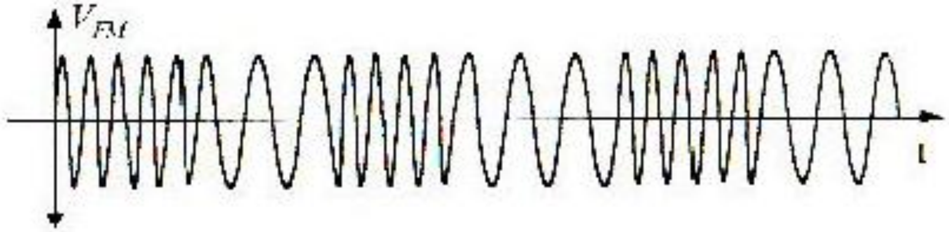
MODULASI FASA

RELASI FM & PM

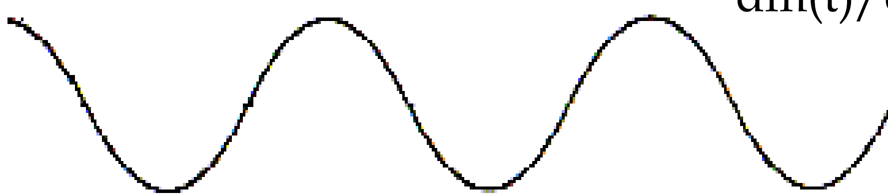




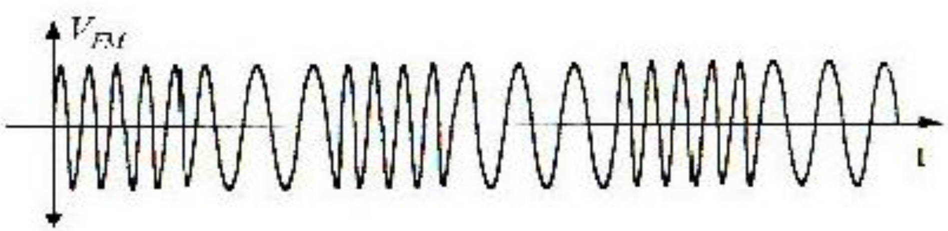
m(t)



FM



dm(t)/dt

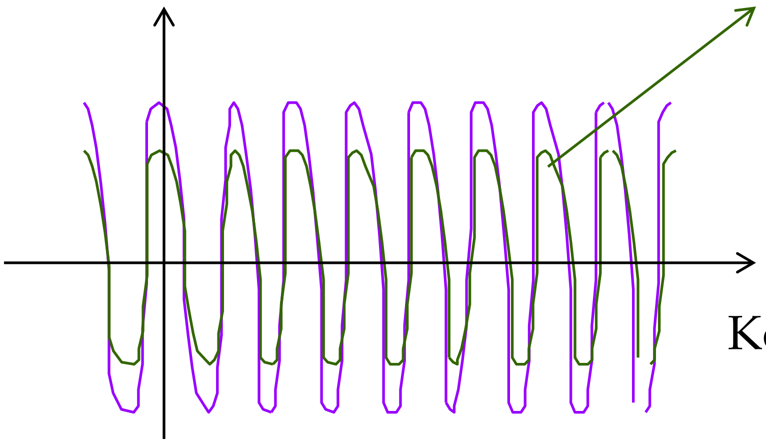


PM

Contoh Phase Modulation

A sin ($2\pi f_p t + \theta + 90^o$)

B cos ($2\pi f_p t + \varphi$)



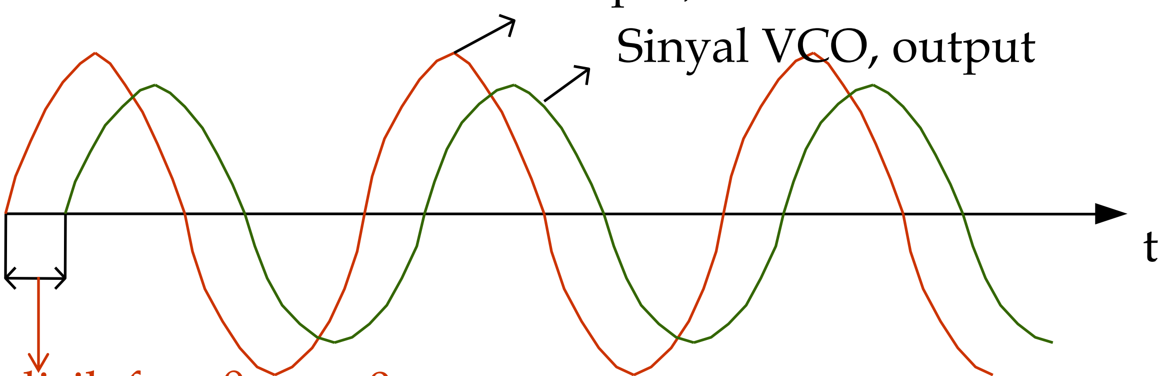
$\theta - \varphi = 0$

Kondisi dimana Vo “locked” pd Vi

Mekanisme koreksi pada PLL : $\theta \neq \varphi$

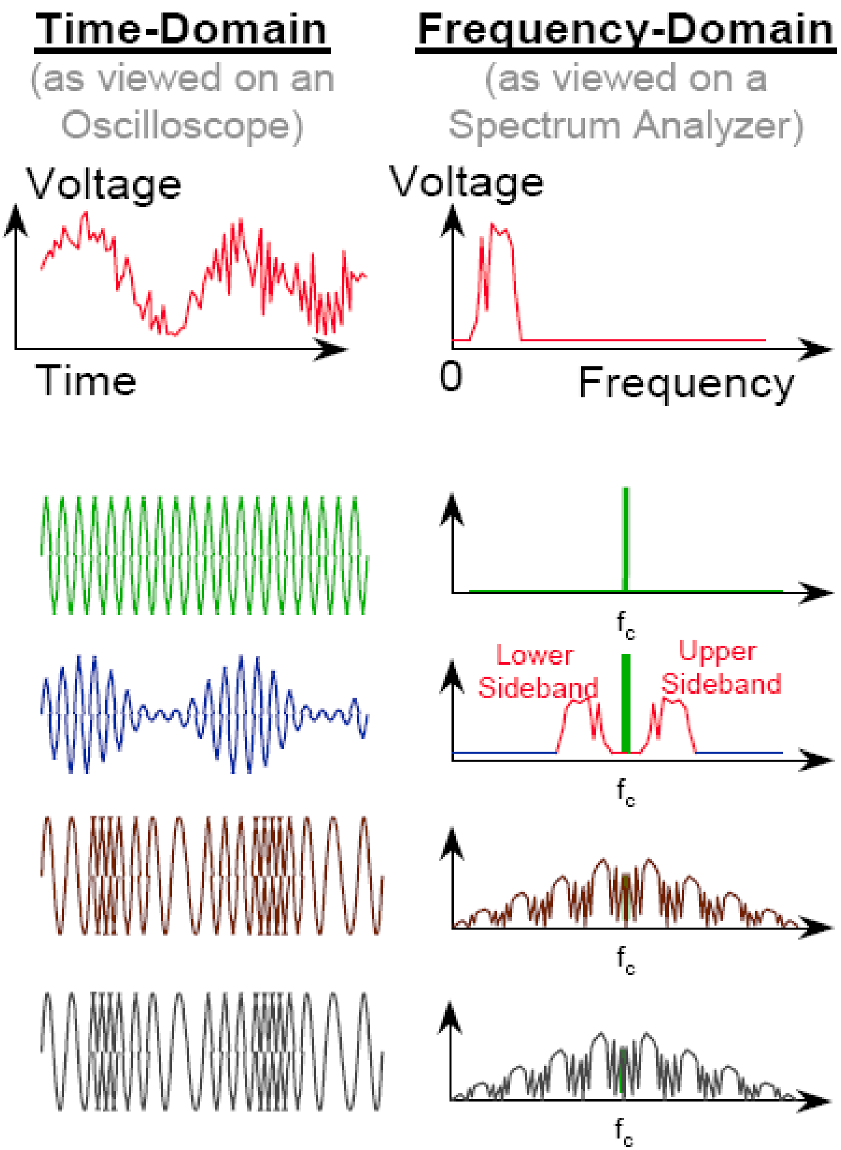
Input, ref

Sinyal VCO, output



Selisih fasa $\theta - \varphi > 0$

Modulation and Occupied Bandwidth



- **The bandwidth occupied by a signal depends on:**
  - **input information bandwidth**
  - **modulation method**
- **Information to be transmitted, called "input" or "baseband"**
  - bandwidth usually is small, much lower than frequency of carrier
- **Unmodulated carrier**
  - the carrier itself has **Zero** bandwidth!!
- **AM-modulated carrier**
  - Notice the upper & lower sidebands
  - total bandwidth = 2 x baseband
- **FM-modulated carrier**
  - Many sidebands! bandwidth is a complex mathematical function
- **PM-modulated carrier**
  - Many sidebands! bandwidth is a complex mathematical function