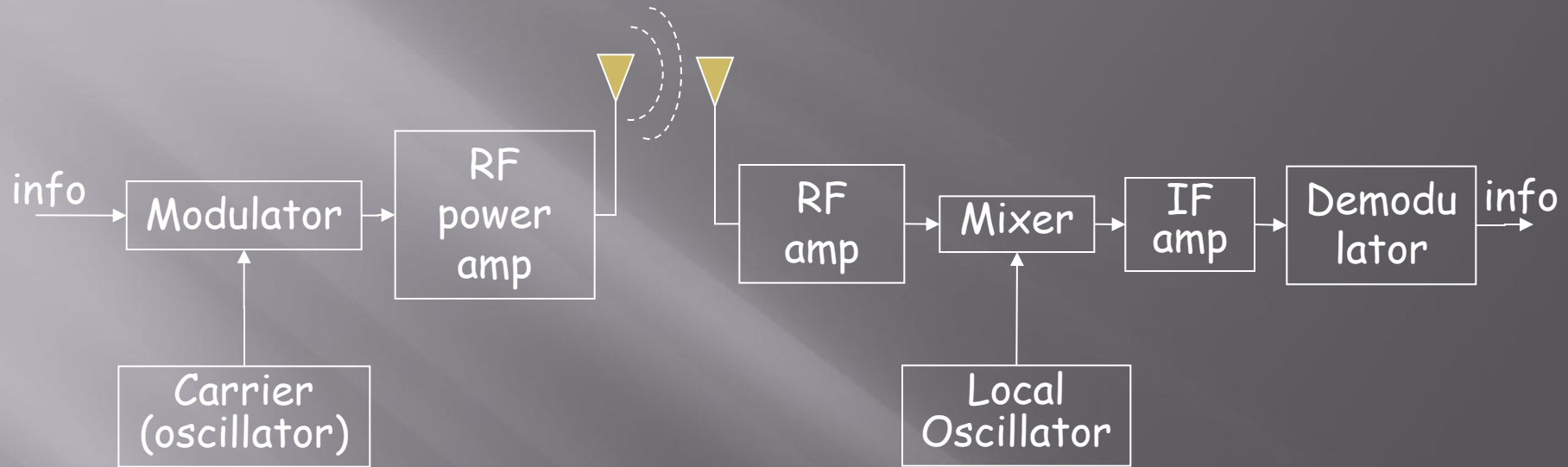


DASAR-DASAR PROSES MODULASI

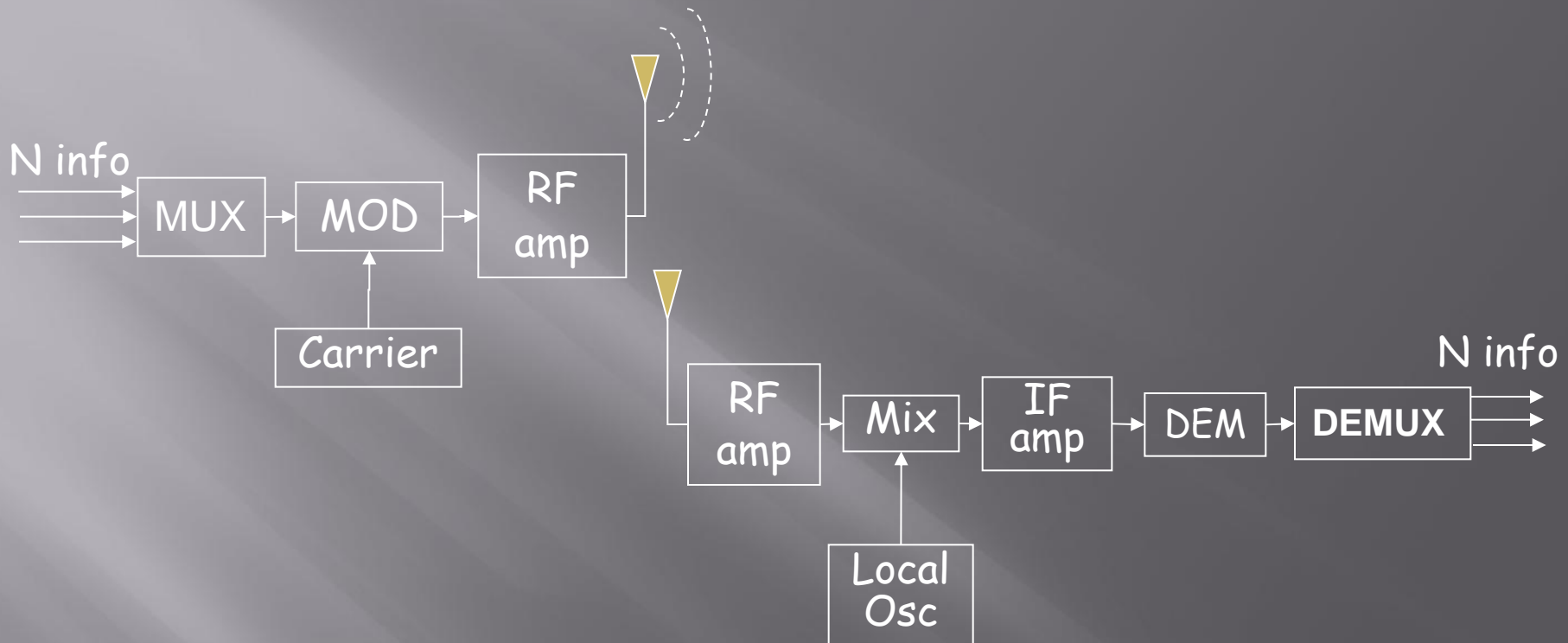
Diagram blok siskom radio



Oscillator membangkitkan gelombang **sinusoidal** dengan frekuensi yang di-set sesuai keinginan/rancangan

Informasi dikirim dengan cara "menitipkan"-nya pada suatu gelombang pembawa (**carrier**). Proses ini disebut **Modulasi**

Multiplexing – Demultiplexing



Multiplexing: mengirim lebih dari satu informasi melalui satu carrier (pembawa) Informasi yang dikirim bisa ratusan atau ribuan; secara bersama-sama memodulasi carrier. Disisi penerima dilakukan proses sebaliknya. Contoh: jaringan transmisi telepon menggunakan teknik ini.

Sinyal pembawa (carrier)

- ▣ adalah gelombang **sinusoidal** (**frekuensi tunggal**) yang ditulis sbb:

$$E_c(t) = A \cos (\omega_c t + \theta)$$

dimana:

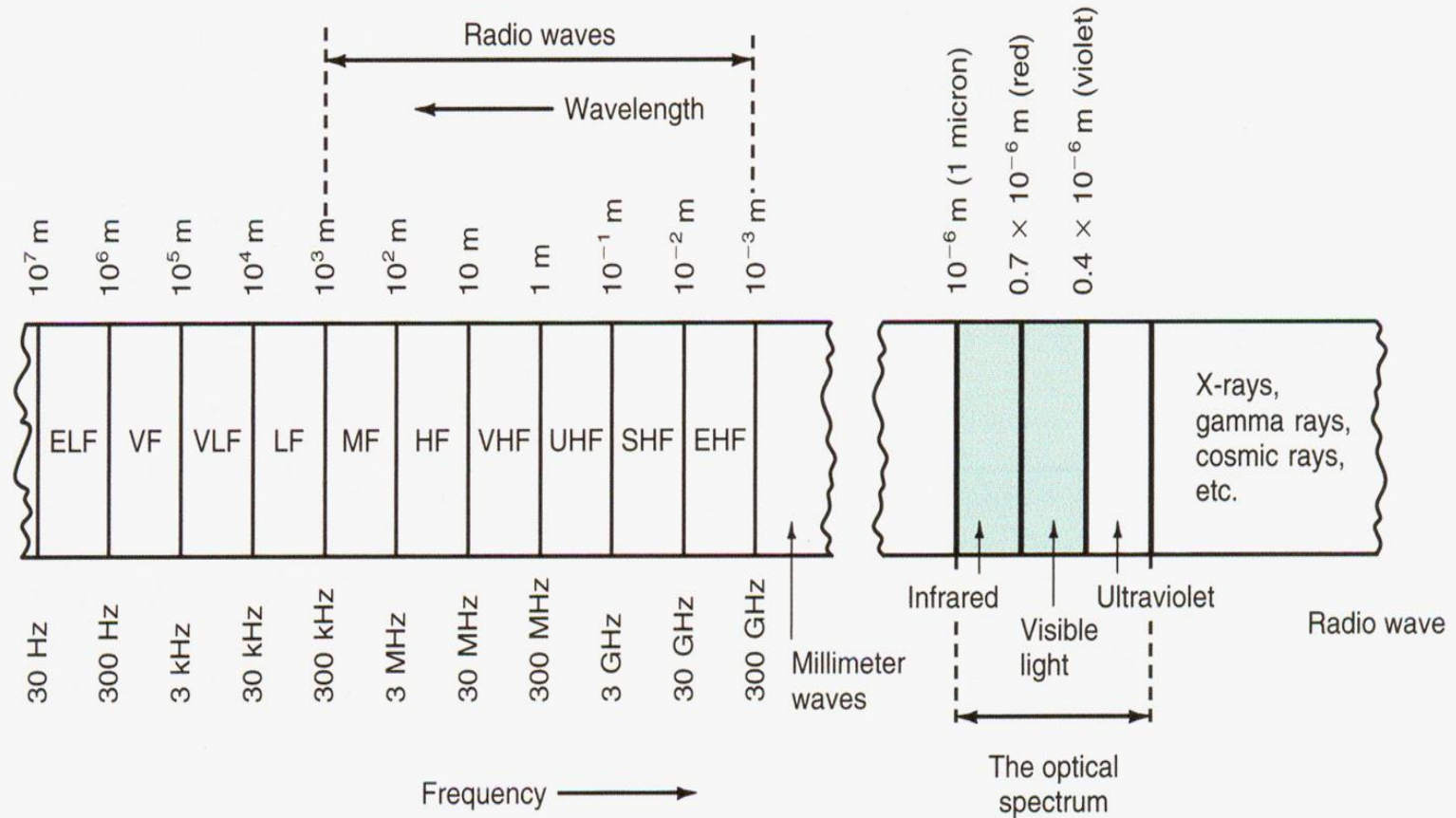
A = **amplitudo** → konstan

ω_c = **frekuensi** carrier → konstan

θ = **phase** carrier → konstan

dari ekspresi matematik di atas terlihat bahwa ada **3 parameter yang bisa diubah-ubah agar mengikuti perubahan level/tegangan sinyal informasi**; yaitu amplitudo, frekuensi, dan phase.

Spektrum frekuensi di alam



Panjang gelombang

EXAMPLE 1-1



Find the wavelengths of (a) a 150-MHz, (b) a 430-MHz, (c) an 8-MHz, and (d) a 750-kHz signal.

a. $\lambda = \frac{300}{150} = 2 \text{ m}$

b. $\lambda = \frac{300}{430} = 0.697 \text{ m}$

c. $\lambda = \frac{300}{8} = 37.5 \text{ m}$

d. For Hz (750 kHz = 750,000 Hz):

$$\lambda = \frac{300,000,000}{750,000} = 400 \text{ m}$$

For MHz (750 KHz = 0.75 MHz):

$$\lambda = \frac{300}{0.75} = 400 \text{ m}$$

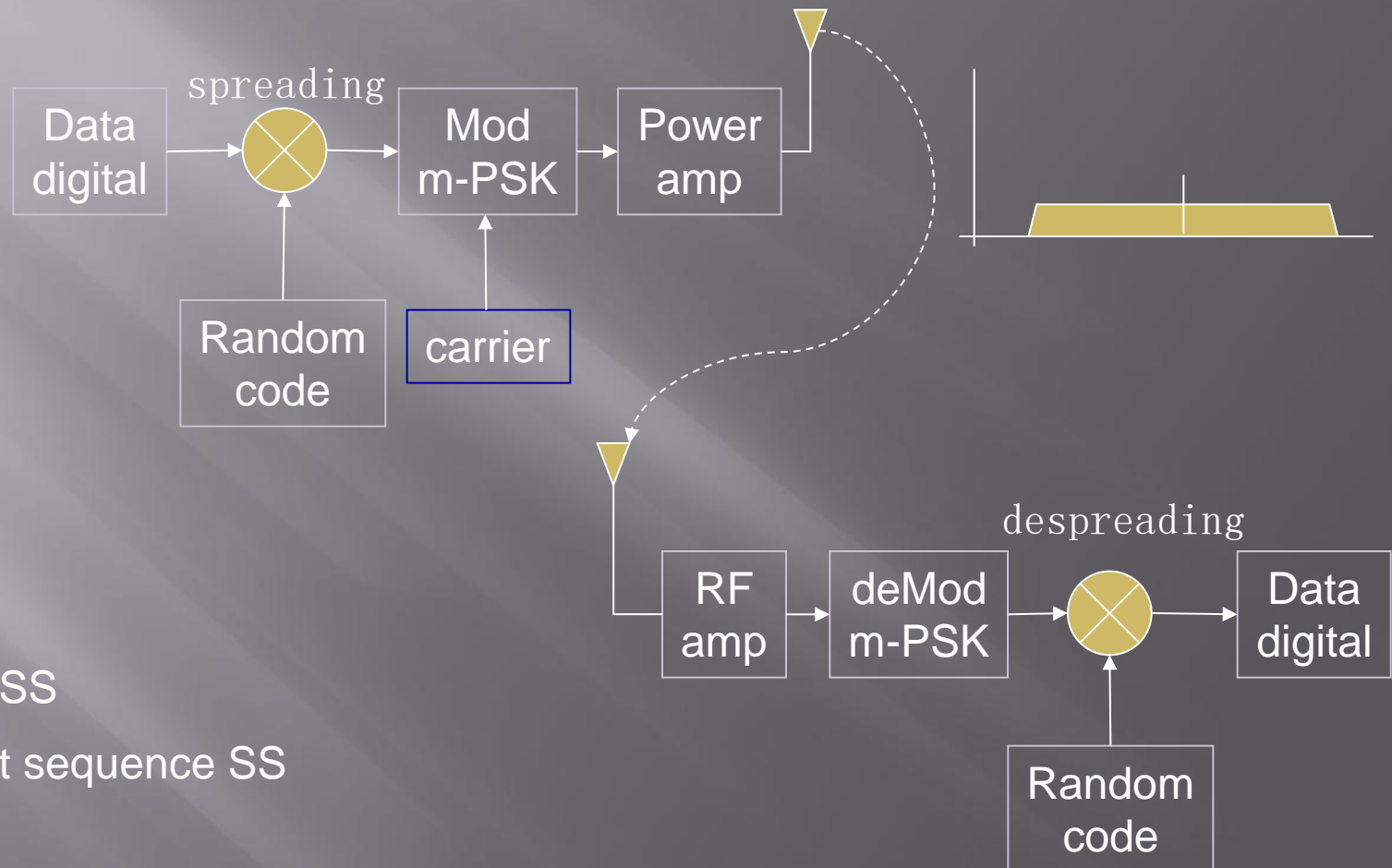
Macam-2 Teknik Modulasi: analog

- ▣ Modulasi AMPLITUDO (AM)
 - Amplitude modulation full carrier → utk radio broadcast
 - Double sideband suppressed carrier (DSB-SC) → utk komunikasi radio
 - Single sideband (SSB) → USB (upper sideband), LSB (lower sideband), ISB (independent sideband) → utk komunikasi radio
 - Vestigial sideband (VSB) → utk pemancar TV
- ▣ Modulasi Frekuensi (FM)
 - Narrowband FM (bandwidth < 20 kHz) dan wideband FM (bandwidth = 150 kHz)
- ▣ Modulasi Phase (PM) → disebut juga indirect FM

Macam-2 Teknik Modulasi: digital

- ▣ Amplitude shift keying (ASK) atau On-Off Keying (OOK)
- ▣ Frequency shift keying (FSK):
FSK → MSK → GMSK
GMSK = Gaussian Minimum Shift Keying
- ▣ Phase shift keying (PSK):
- ▣ BPSK → QPSK → 8PSK → 16PSK → 32PSK
- ▣ 8QAM → 16QAM → 32QAM → 64QAM → 128QAM → dst
- ▣ Teknik modulasi gabungan PSK dan digital signal processing menghasilkan modulasi yang sangat efisien, misalnya modulasi CCK, DMT, dsb.
- ▣ Yang diharapkan adalah efisiensi bandwidth & daya

Teknik modulasi spread-spektrum (SS)



DS-SS

Direct sequence SS

Ilustrasi beberapa jenis sinyal

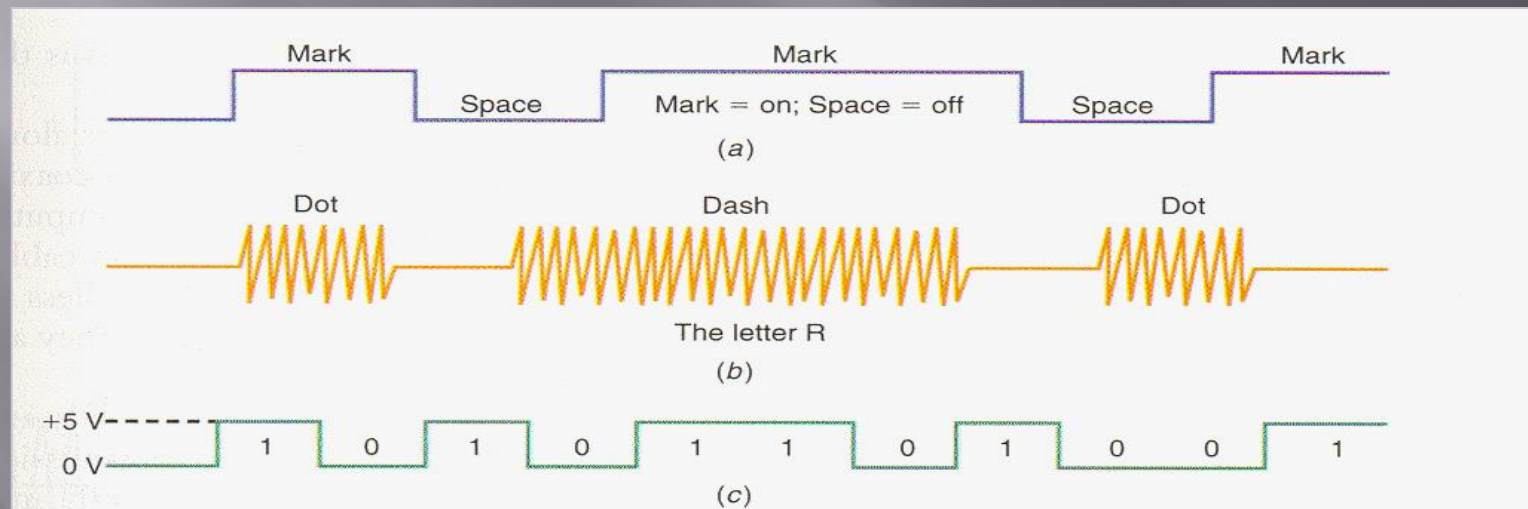
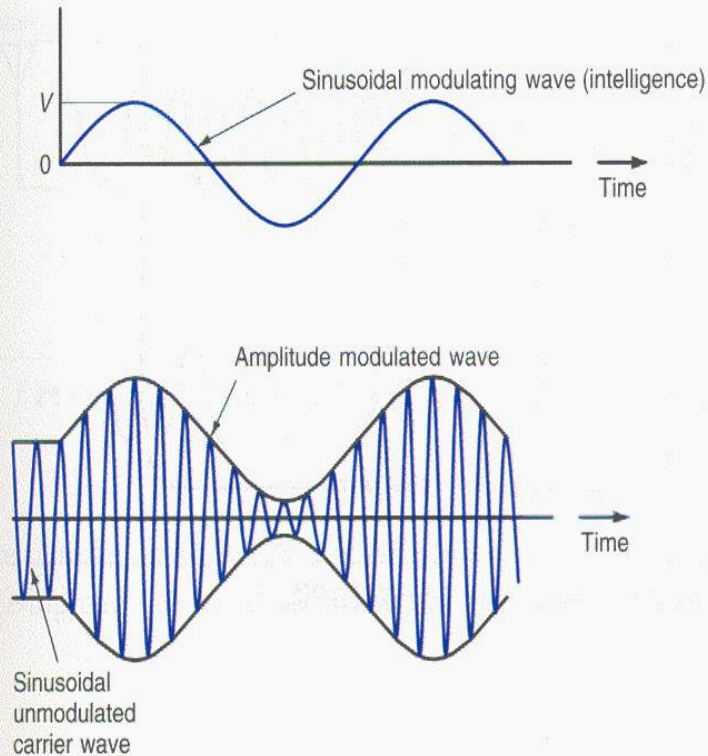
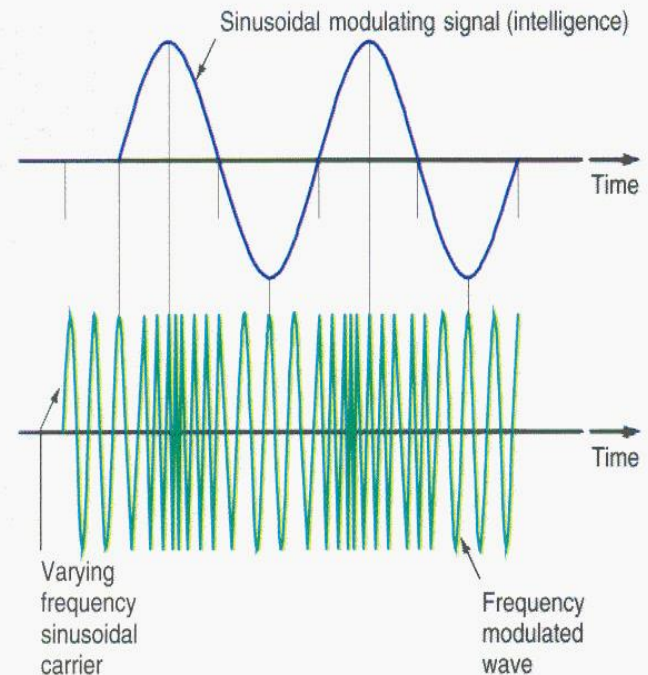


FIG. 1-6 Digital signals. (a) Telegraph (Morse code). (b) Continuous wave (CW) code. (c) Serial binary code.

Ilustrasi Modulasi AM & FM

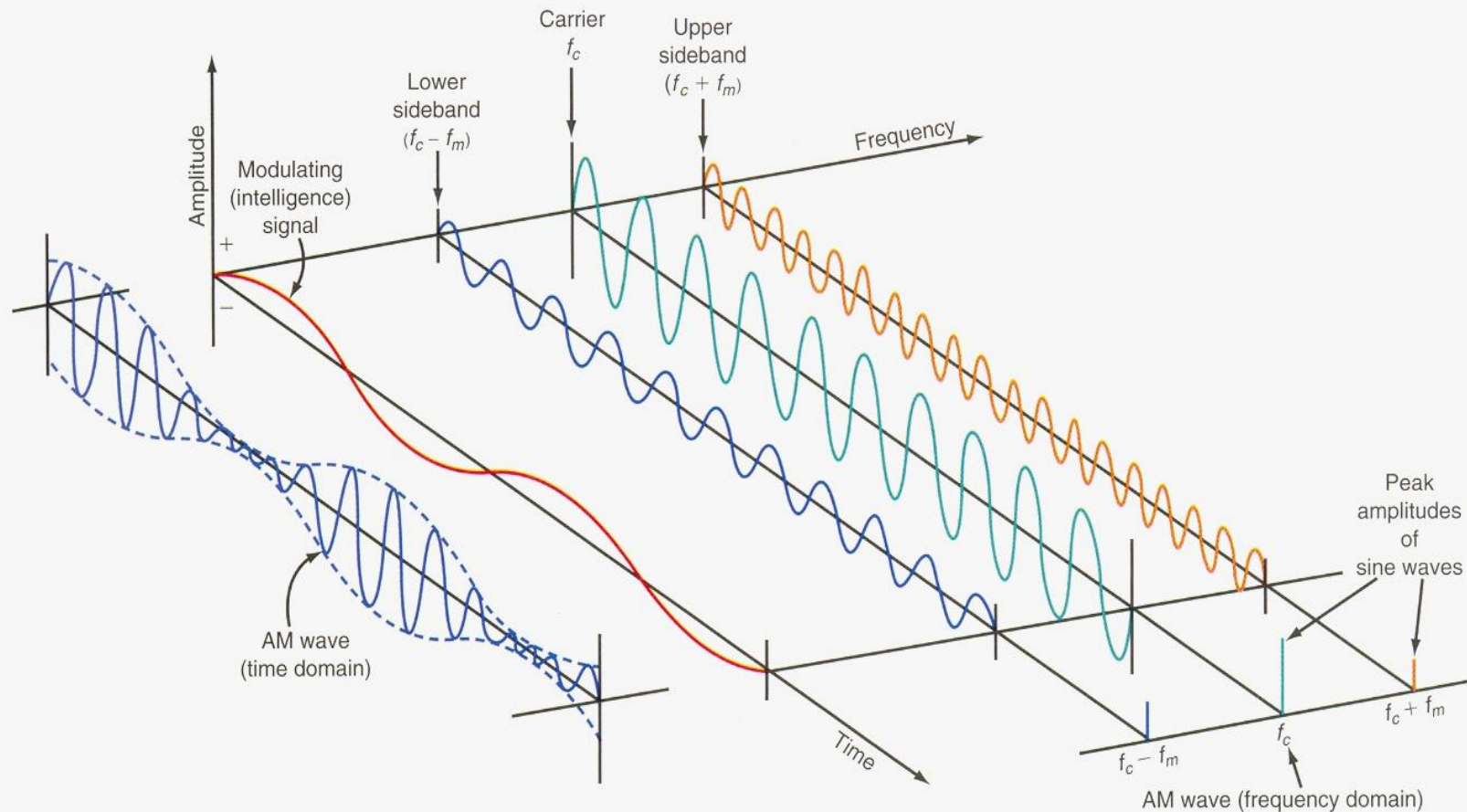


(a)



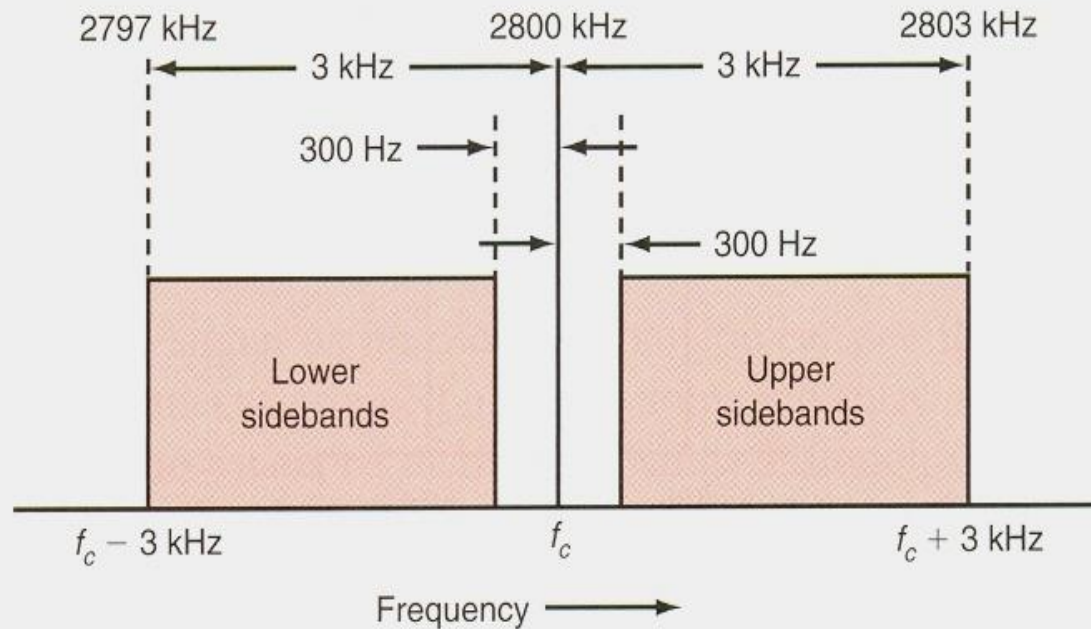
(b)

Komponen frekuensi dalam sinyal AM



► FIG. 3-8 The relationship between the time and frequency domains.

Spektrum frekuensi sinyal AM



► FIG. 3-9 The upper and lower sidebands of a voice modulator AM signal.

Spektrum sinyal AM dalam praktek

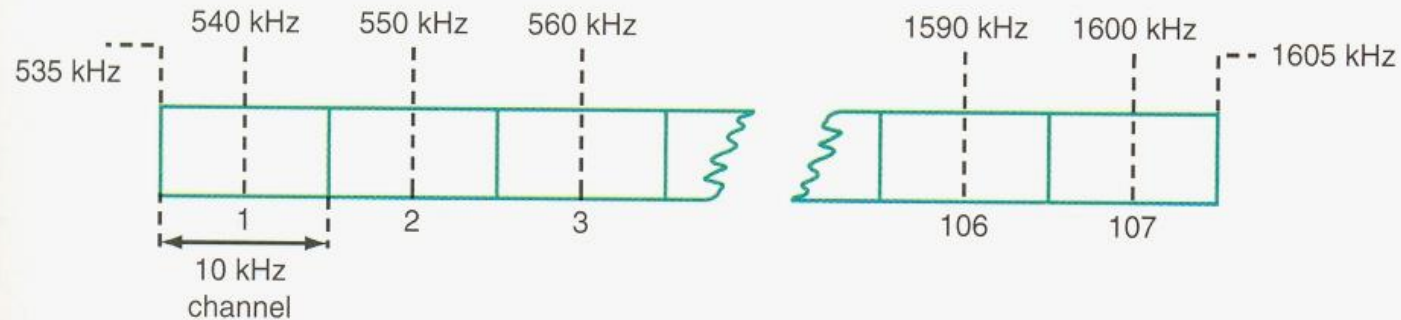
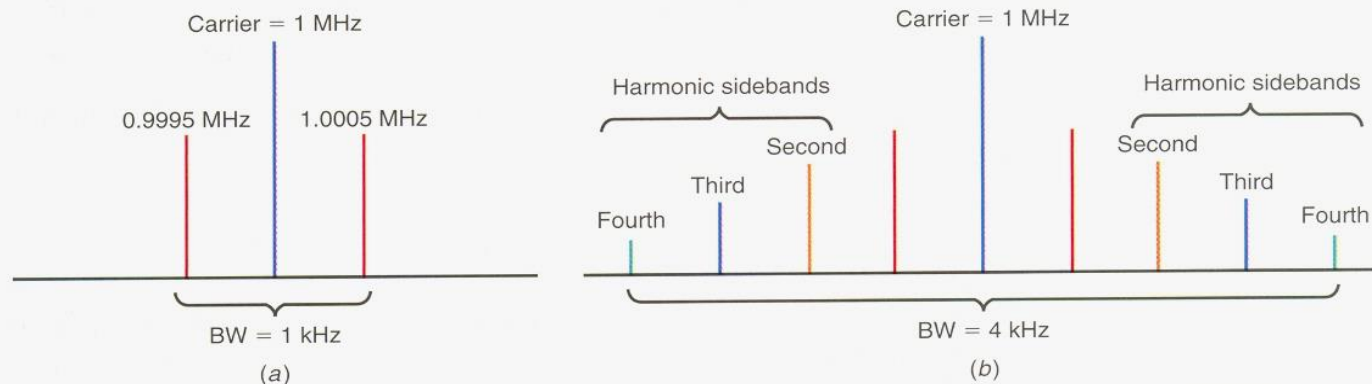
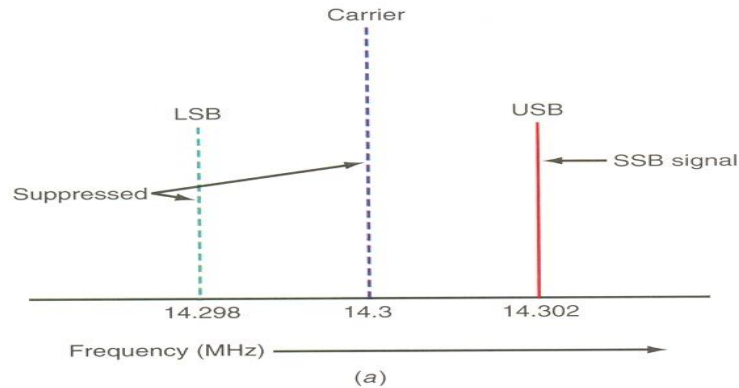


FIG. 3-10 Frequency spectrum of AM broadcast band.

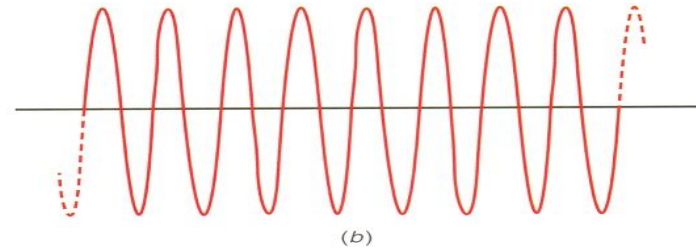


3-14 The effect of overmodulation and distortion on AM signal bandwidth. (a) Sine-wave of 500 Hz modulating a 1-MHz carrier. (b) Distorted 500-Hz sine wave with significant second, third, and fourth harmonics.

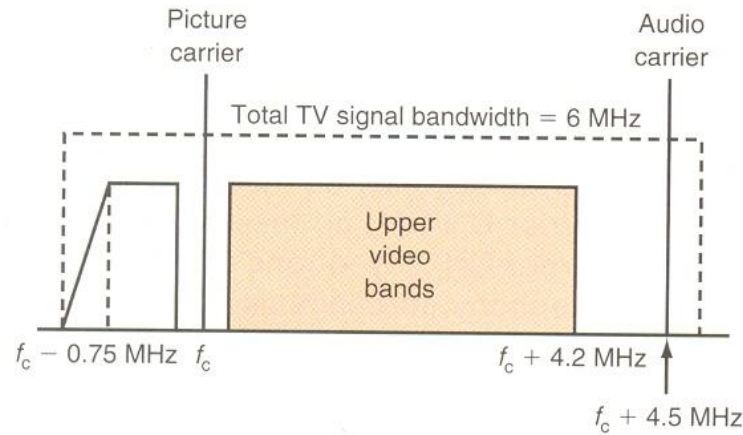
Single sideband (SSB) & VSB



SSB signal
14.302-MHz sine wave



3-17 An SSB signal produced by a 2-kHz sine wave modulating a 14.3-MHz sine-wave carrier.



3-18 Vestigial sideband transmission of a TV picture signal.

Modulasi ASK (amplitude shift keying)

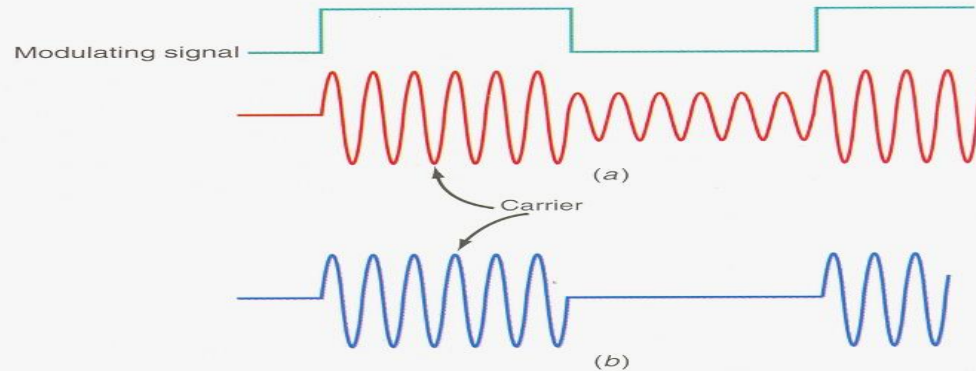


FIG. 3-12 Amplitude modulation of a sine-wave carrier by a pulse or rectangular wave is called amplitude shift keying (ASK). (a) Fifty percent modulation. (b) One hundred percent modulation.

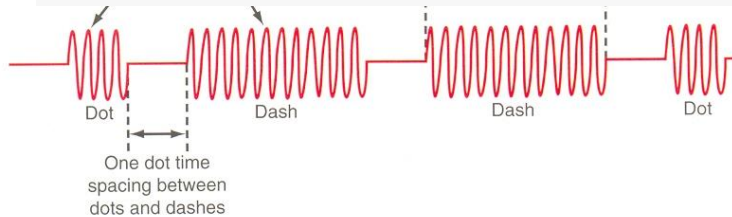
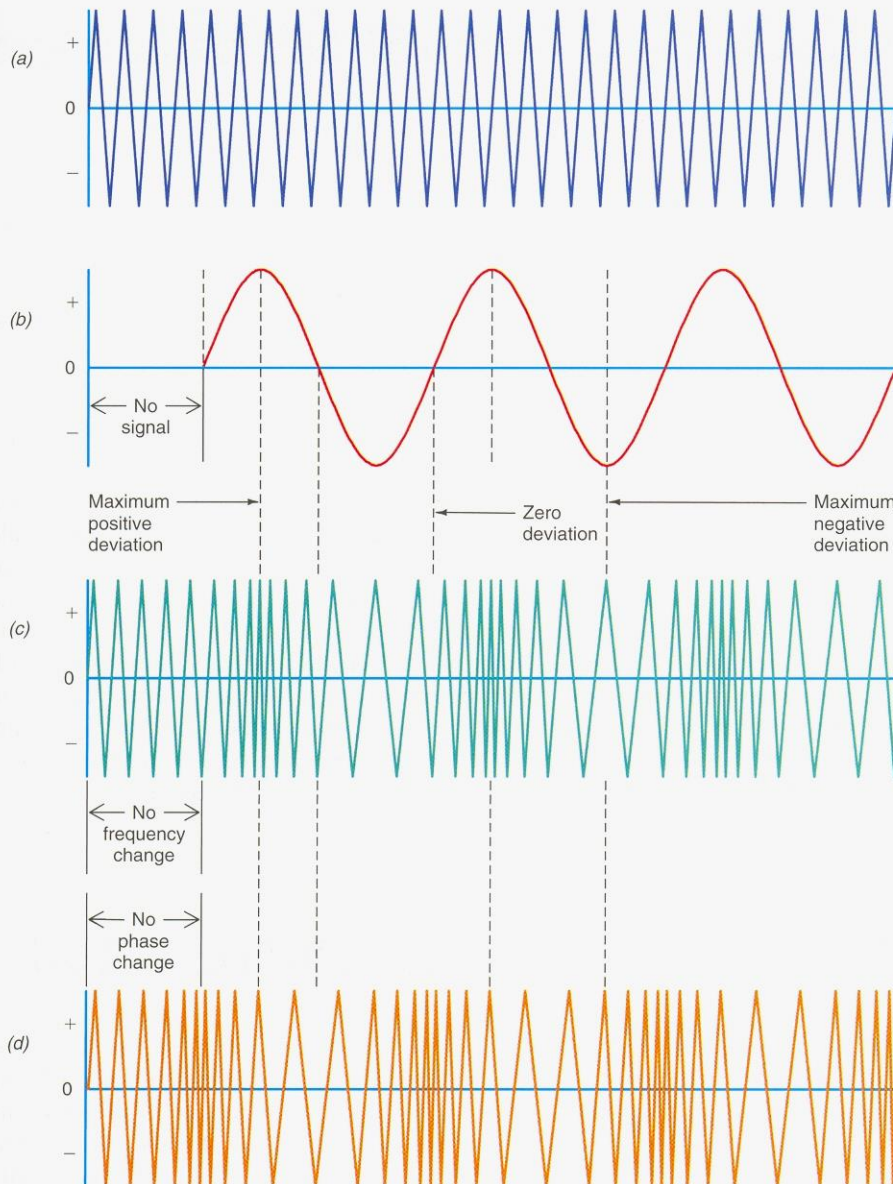
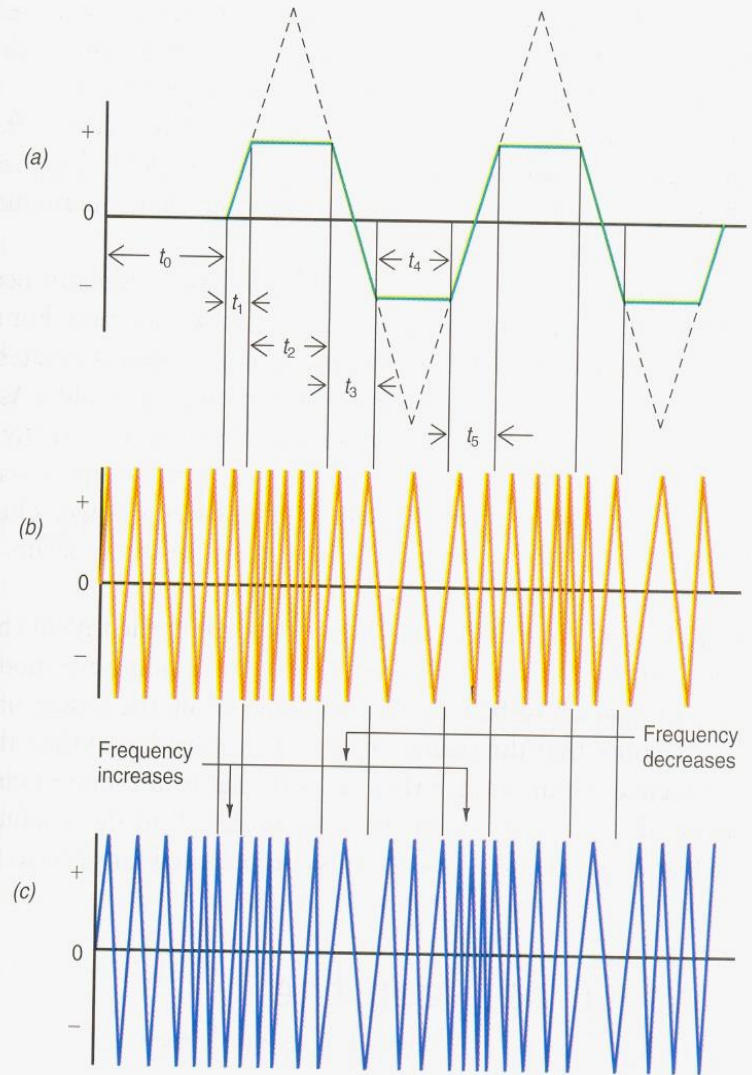


FIG. 3-13 Sending the letter P by Morse code. An example of ON-OFF keying (OOK).

Ilustrasi FM & PM



► FIG. 5-1 FM and PM signals. The carrier is drawn as a triangular wave for simplicity, but in practice it is a sine wave. (a) Carrier. (b) Modulating signal. (c) FM signal. (d) PM signal.



3 A frequency shift occurs in PM only when the modulating-signal amplitude v is non-zero. (a) Modulating signal. (b) FM signal. (c) PM signal.

Indirect FM (modulasi PM)

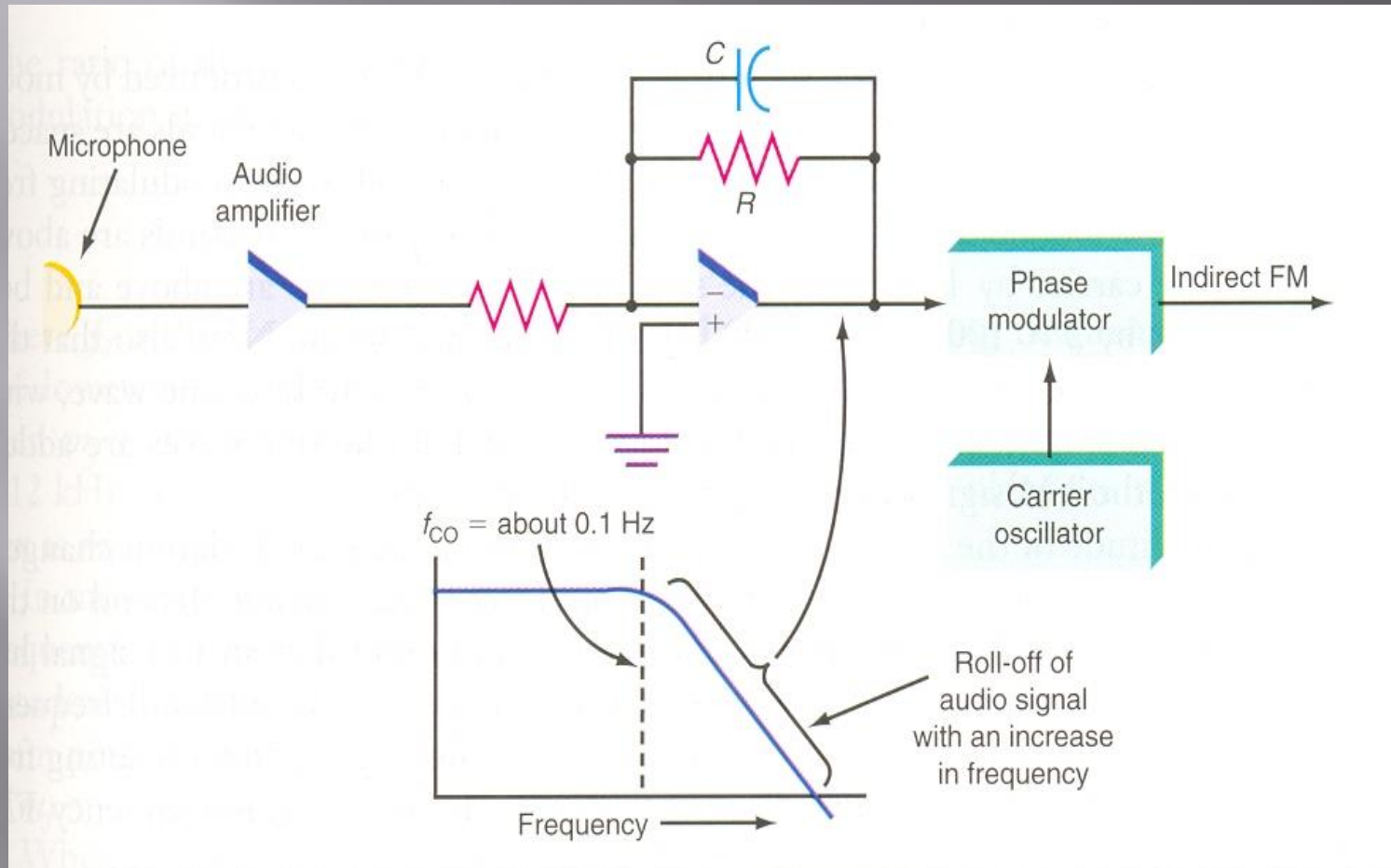
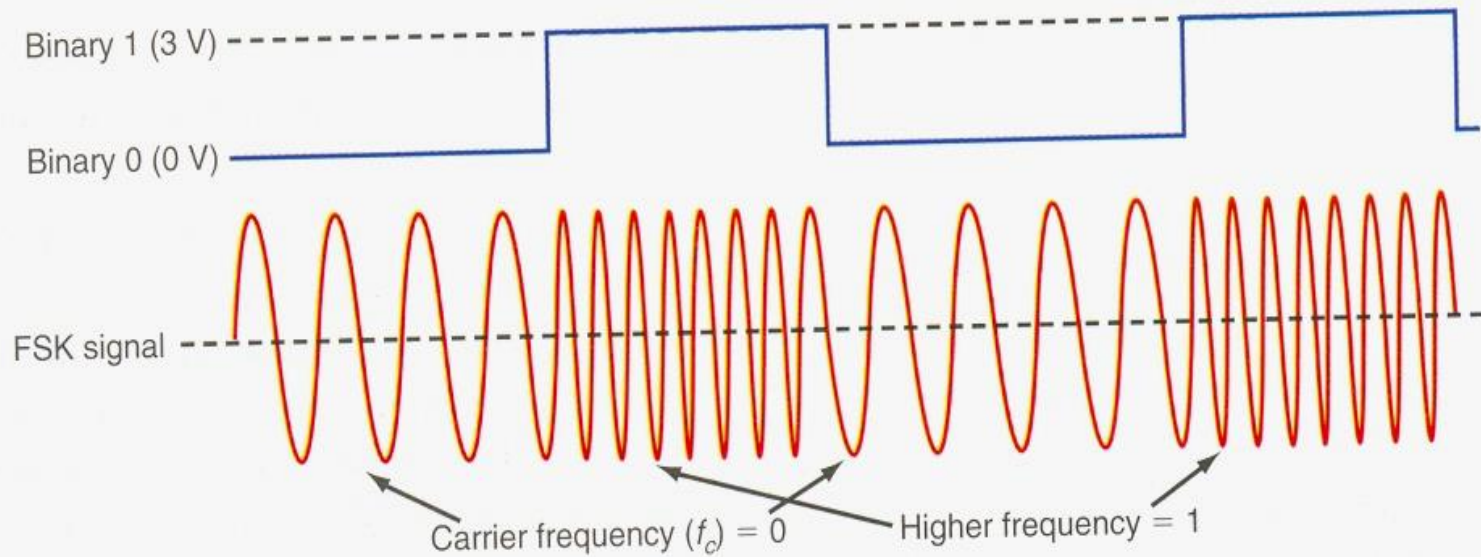


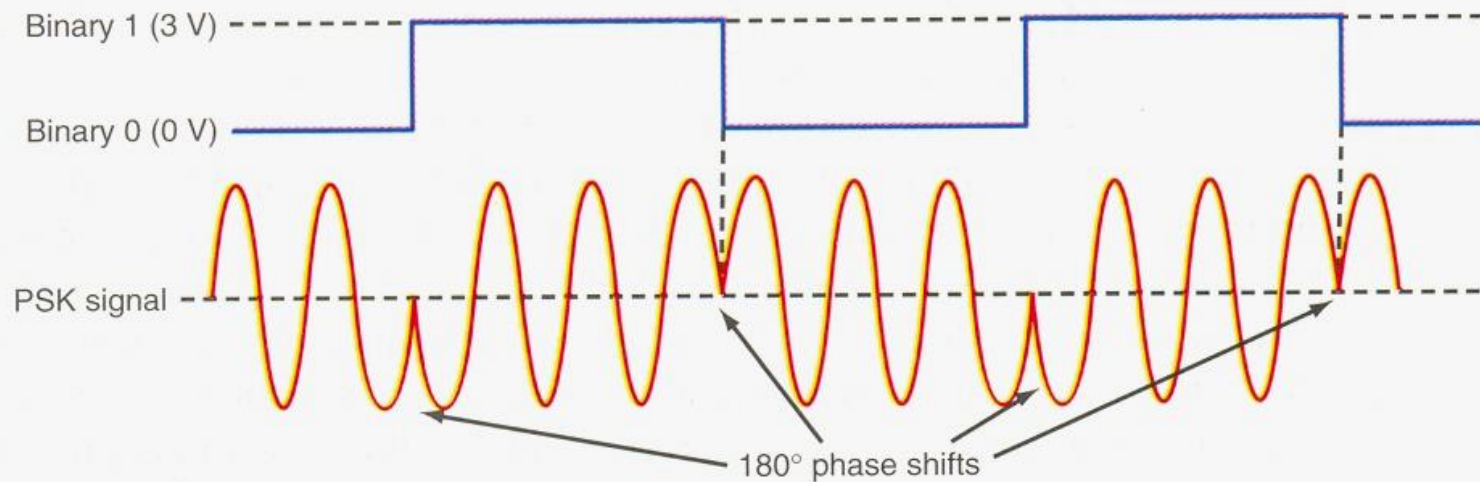
FIG. 5-5 Using a low-pass filter to roll off the audio modulating-signal amplitude with frequency.

Modulasi FSK (frequency shift keying)



► FIG. 5-2 Frequency-modulating of a carrier with binary data produces FSK.

Modulasi PSK (phase shift keying)



► FIG. 5-6 Phase modulation of a carrier by binary data produces PSK.

Aplikasi modulasi di sekitar kita

Application	Type of modulation
AM broadcast radio	AM
FM broadcast radio	FM
FM stereo multiplex sound	DSB (AM) and FM
TV sound	FM
TV picture (video)	AM, VSB
TV color signals	Quadrature DSB (AM)
Cellular telephone	FM, FSK, PSK
Cordless telephone	FM, PSK
Fax machine	FM, QAM (AM plus PSK)
Aircraft radio	AM
Marine radio	FM and SSB (AM)
Mobile and handheld radio	FM
Citizens' band radio	AM and SSB (AM)
Amateur radio	FM and SSB (AM)
Computer modems	FSK, PSK, QAM (AM plus PSK)
Garage door opener	OOK
TV remote control	OOK
VCR	FM
Family Radio service	FM

Pusat layanan info-darurat



Sekolah Terbuka melalui radio dua arah

- A rural Australian child attends class via shortwave radio.



Contoh perangkat radio komunikasi 2-arah

