ملخص لمادة اتصالات (1)

" Com 1 "

Power Unit

حمزة بلال وقاد

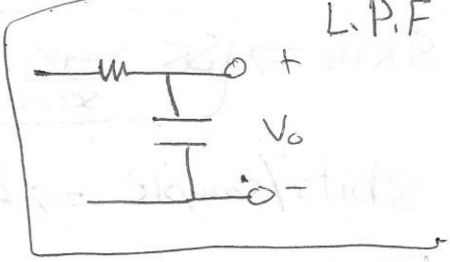
1

Attenuation:

Copper: 5-10 Km requires Amp.

Optical : 50-100Km requires Amp

Bandwidth of Channel:



1 Km Copper: $B_{ch} = (1-2)$ MHz

1 Km coax : $B_{ch} = (1-2)$ GHz

Filters:

* LPF , HPF:

$f = \frac{1}{2\pi RC}$

$B = f \Rightarrow$ LPF

$B \equiv$ undefiend $\Rightarrow$ HPF

* BPF:

$f_c = \frac{1}{2\pi\sqrt{LC}}$ $B = \frac{R}{2\pi L}$

In Gilbert Cell:

* If $I_{E_1} = I_{E_2} \longrightarrow$ output signal $= 0$

$I_{E_2} \gg I_{E_1} \longrightarrow$ signal = Carrier

$I_{E_1} \gg I_{E_2} \longrightarrow$ Signal = -Carrier

$I_{E_2} > I_{E_1} \longrightarrow$ higher +ve carrier

$I_{E_1} > I_{E_2} \longrightarrow$ higher -ve carrier

* this Represents the "Amplitude Modulation"

* c(t) to the top differintial Amps
* m(t) to the bottom differential Amp.

human Voice : $B = 4\,KHz$
misic : $B = 15-20\,KHz$

⊛ Telephony

$f_s = 8\,KHz \Rightarrow$ $8K\ \frac{sample}{second}$

8bits/sample $\Rightarrow L = 2^8 = 256$ level

PCM stream = 8K sample/sec. $\times \frac{8\ bits}{sample}$ = 64 kbit/sec

⊛ CD

16 $\frac{bit}{sample}$

$L = 2^{16} = 65.536$

QAM: Modulation: DVB, Wi-Fi, WiMAX, 3G, 4GLTE
Multiplexing: CDMA: 3G
OFDMA: Wi-Fi, WiMAX, 4GLTE

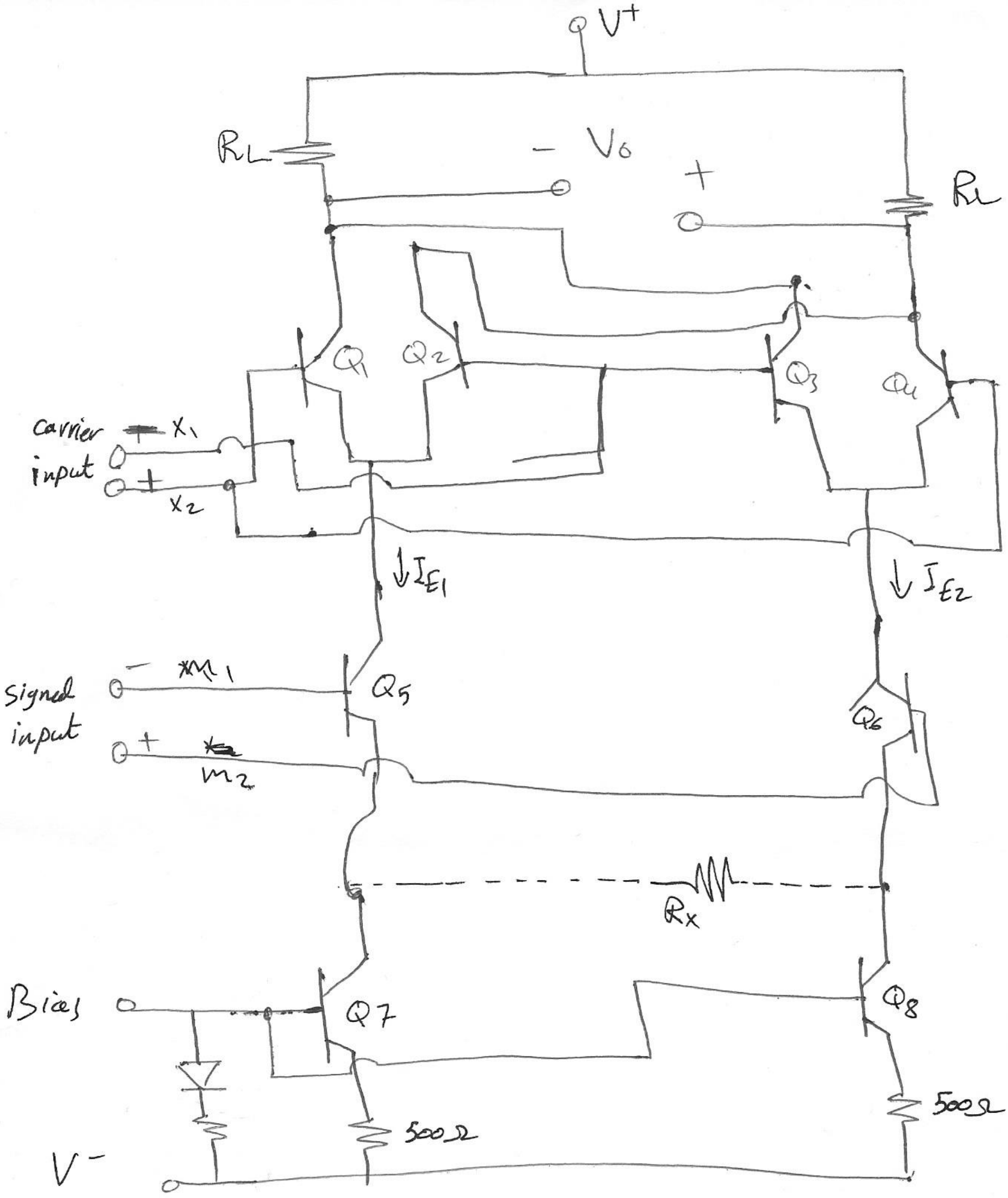
$B = 2B$

VSB:
Bandwidth = $(1+\epsilon)B$ Hz

Analog T.V.:	PAL phase Alternating line	NTSC National T.V. system Comittie
Digital TV:	DVB-S, S2, H, T Digital Vid. Broadcasting	ATSC Advanced --
	European	USA
	6 MHz 625 line	4 MHz 525 line

QAM: Chrominance

VSB+C Luminance



Gilbert Cell.

Q_1 & Q_2 amplifies $(X_1 - X_2) \equiv G[-C(t)]$

Q_1 & Q_4 amplifies $X_2 - X_1 \equiv G(C(t))$

Q_5 & Q_6 amplifies the message $G\,m(t)$

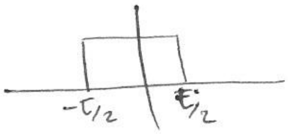
R_x : controll I_x & I_x controll the Gain

$$V_o = \frac{R_L}{R_x V_T}(X_2 - X_1)(m_2 - m_1)$$ ⟹ mixer & Amplifier

$V_T \equiv 0.026$

B) Signals:

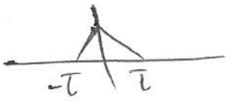
① $\text{rect}\left(\frac{t}{\tau}\right)$



$\underline{dc}$

$\text{rep}_T\left(A\,\text{rect}\left(\frac{t}{\tau}\right)\right) = \frac{A\tau}{T}$

② $\Delta\left(\frac{t}{\tau}\right) =$



$\text{rep}_{T}\left(\Delta\left(\frac{t}{\tau}\right)\right) \rightarrow dc = \frac{A\tau}{T}$

③ إذا كان أي شيء نازل نصفه تحت ونص فوق
الصفر بيصير
DC = 0

Power spectral Density:

$$P_x = \frac{1}{N}\sum_n x_n^2$$

$$S_x(\omega) = \lim_{T\to\infty} \frac{1}{T}|X_T(\omega)|^2$$

avg power:

$$P_x = \lim_{T\to\infty} \frac{1}{T}\int_{-T/2}^{T/2} |x(t)|^2\,dt = \frac{1}{2\pi}\int_{-\infty}^{\infty} S_x(\omega)\,d\omega$$

مجموع

DC & Avg power:

time Domain:

DC متوسط الموجة

Avg power $= \frac{A^2}{2}$

Frequency Domain:

DC : α_0 الشيء اللي على الزيرو

Avg power $= S_x(\omega)$

(signals & Mathmatics)

⊛ Notes:

⊛ $P_{\infty} = \frac{1}{T} \int_{T} |m(t)^2| \, dt$

Digitization:

① Sampling:

Ideal / natural / practical / S/H

Tx $m(t)$ ⟶ [LPF] ⟶ $x(t)$ ⟹ Rx $x(t)$ ⟶ [LPF] ⟶ [$P^{-1}(f)$] ⟶ $m(t)$

LPF: Anti Aliassing

Rx LPF: takes 1 copy

$P^{-1}(f)$: equilaizer sinc(t)

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② Quantization

L: controll noise, control # of bits persample

$$SQNR = \frac{3L^2}{K_m^2}$$

$$K_m^2 = \frac{Peak^2}{(rms)^2}$$

Quantization error $= [0, \Delta V] = m_s(t) - m_{sq}(t)$ Rule = truncate ⟶ ?

Quantization error $= [-\frac{\Delta V}{2}, \frac{\Delta V}{2}]$ Rule = approx.

A-law ⟶ Europe, μ-law ⟶ USA, μlaw better.

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③ Mapping:

$$f_o = f_s \times \log_2(L)$$

$$T_o = T_s / \log_2(L)$$

$f_o \equiv [bps]$

$f_s \equiv \frac{sample}{second}$

$\log_2(L) \equiv \frac{bits}{sample}$

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④ Coding:

source: ⟶ Huffman, RLE ⟶ coulors

Audio compression:
- Landline (PCM) 64 kbps
- Linear prediction coding (LPC) 13 kbps
- code-excited --- (CELP) 12.2 kbps
- FS 1016 4.8 kbps

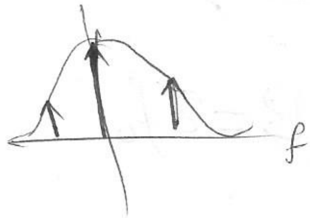
Video

MPEG	ITU-T
MPEG1	H 261
MPEG2	H 263
MPEG4	H 264

Line Coding:

1) Unipolar (NRZ & RZ)

$ 1 → 5V
0 → 0V



B → NRZ → f_o
B → RZ → $2f_o$

2) Polar (NRZ & RZ)

1 → 5V
0 → −5V

NRZ-L
1 → −5V
0 → 5V

B: NRZ ⇒ f_o
RZ ⇒ $2f_o$

3) Non-Return-to-Zero-Inverted (NRZI)

1 → +5, −5, 5, −5
0 → لا تغير

4) Bipolar (AMI)

1 → +5, −5, +5, −5 V
0 → 0V

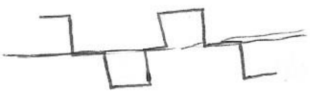
$B = f_o$

5) Duobinary:

1 → +5 → even or zero
−5 → odd
0 → 0V

$B = \frac{f_o}{2}$

6) MLT-3

1 ⇒  8.1)

0 ⇒ 0V

$B = 0.9 f_o$

7) Manchester ~~8~~

$B = 2f_0$

$1 \Rightarrow$ 

$0 \Rightarrow$ 

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8) M-ary Code

00	-5	M = 4 Levels
01	-10	
10	5	
11	10	

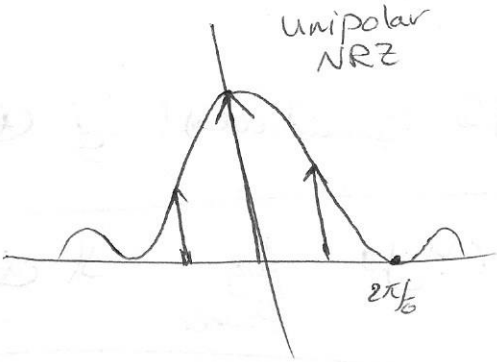
$$\underset{[\text{baud}]}{\text{Symbol Rate}} = \frac{1}{\log_2(M)} \times \underset{[\text{bits/sec}]}{\text{dat bit rate}}$$

$f_{symbol} \equiv \text{baud Rate} \equiv \text{Bandwidth}$

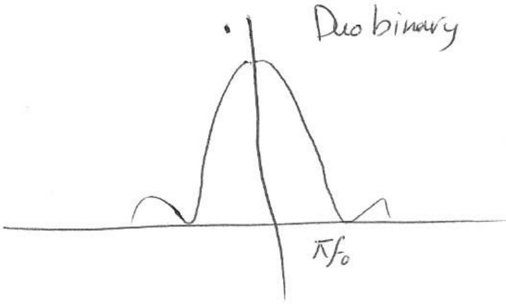
⊗ Pulse shaping :

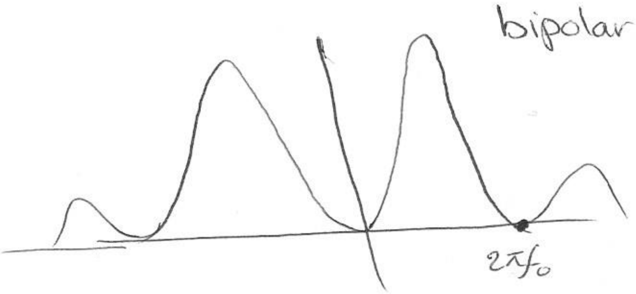
Bandwidth by using decaying Cosine with polar

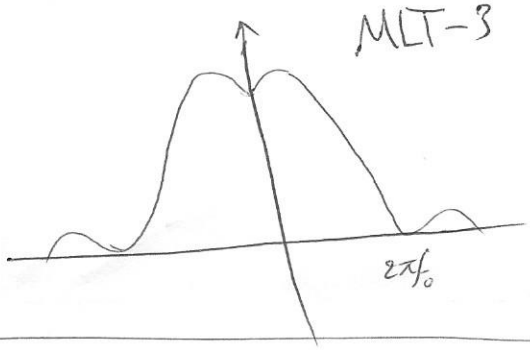
$$\frac{(1+\alpha) f_0}{2}$$

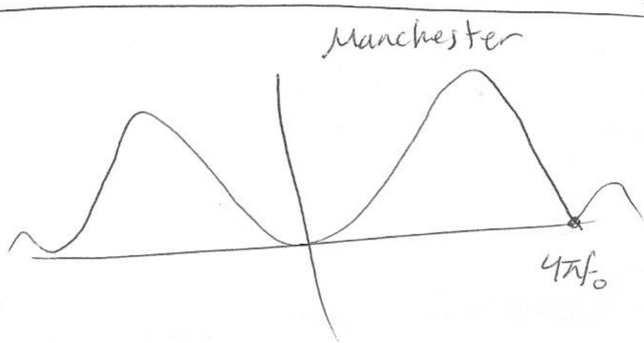

unipolar
NRZ
2πf0

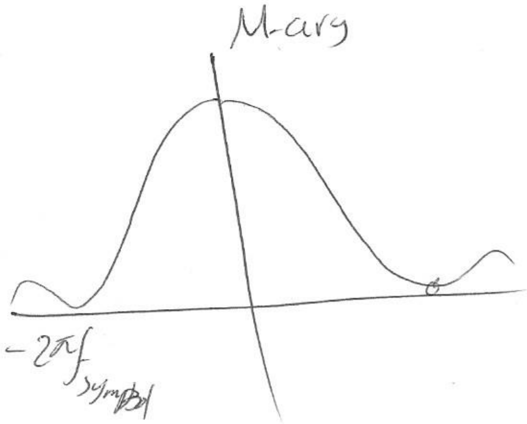

polar NRZ
2πf0


Duobinary
πf0


bipolar
2πf0

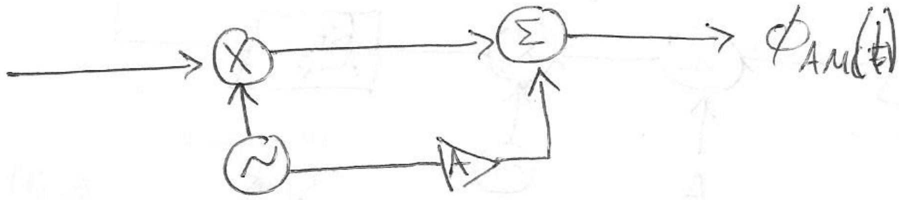

MLT-3
2πf0


Manchester
4πf0


M-ary
-2πf symbol

AM : modulators :

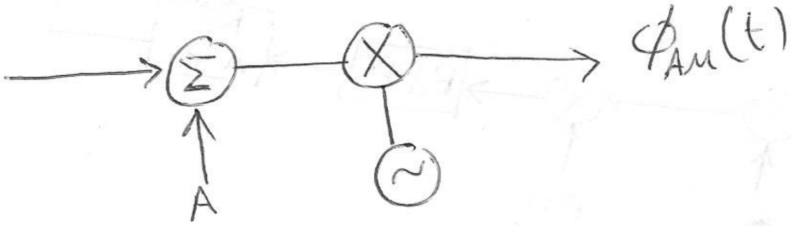
1)



$m = \frac{m(t)_{min}}{A}$

- $m<1$ under
- $m=1$ critical
- $m>1$ over

2)



Power :

$$\overline{\phi^2_{AM}} = \tfrac{1}{2}\overline{m^2(t)} + \frac{A^2}{2} + A\overline{m(t)}$$

($A\overline{m(t)} = 0$ if DC = 0)

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tone modulation $\quad \eta = \frac{m^2}{m^2+2}$ $\quad$ η : power efficiency

only in tone

$$\eta = \frac{\text{usefull power}}{\text{total power}}$$

(*) human voice
$m=1 \Rightarrow \eta = 25\%$

(C)

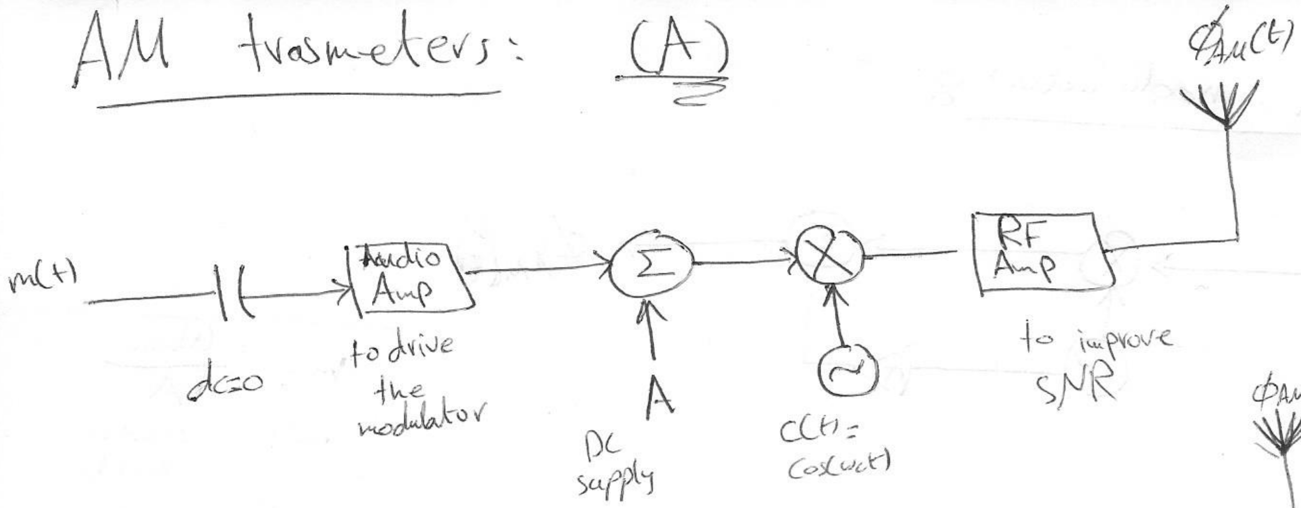
Gilbert cell unbalanced mode, the gain of the top 2 dofferential amps is unbalanced, which add a residual carrier in the out put signal.

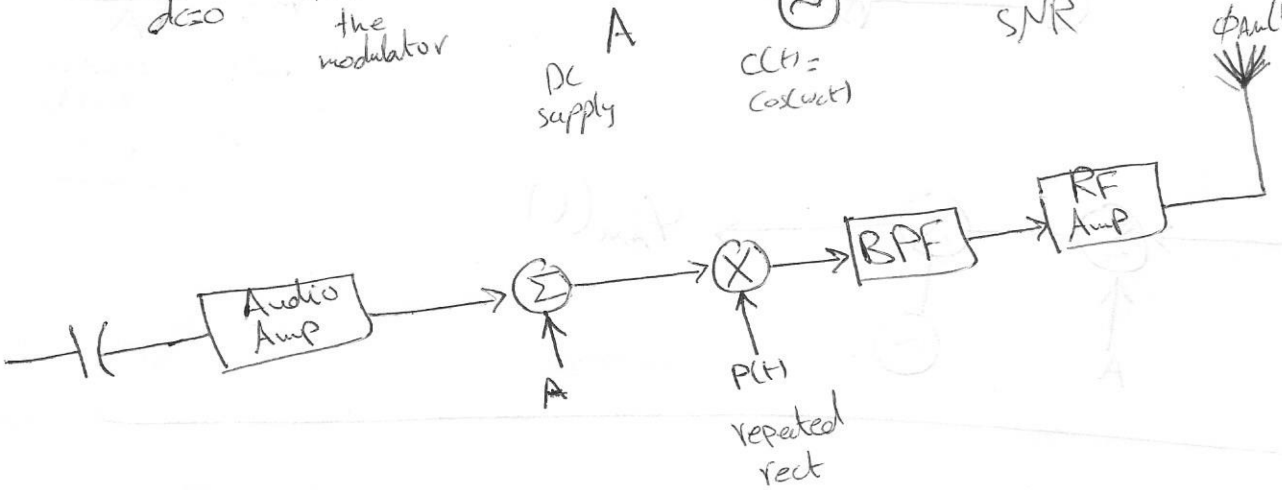
4 modes :

- balanced
  - leniear : $K_1 m(t)\cos(w_c t)$
  - switching : $K_1 m(t)\, p(t)$
- unbalanced
  - leniear : $K m(t)\cos(w_c t) + A\cos(w_c t)$
  - switching : $K m(t)\, p(t) + A\, p(t)$

$\Leftrightarrow$

AM trasmeters: (A)



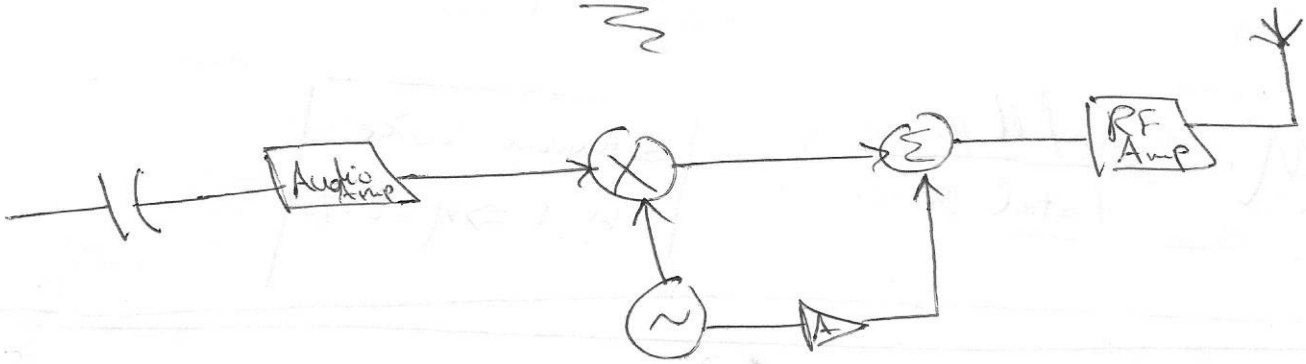


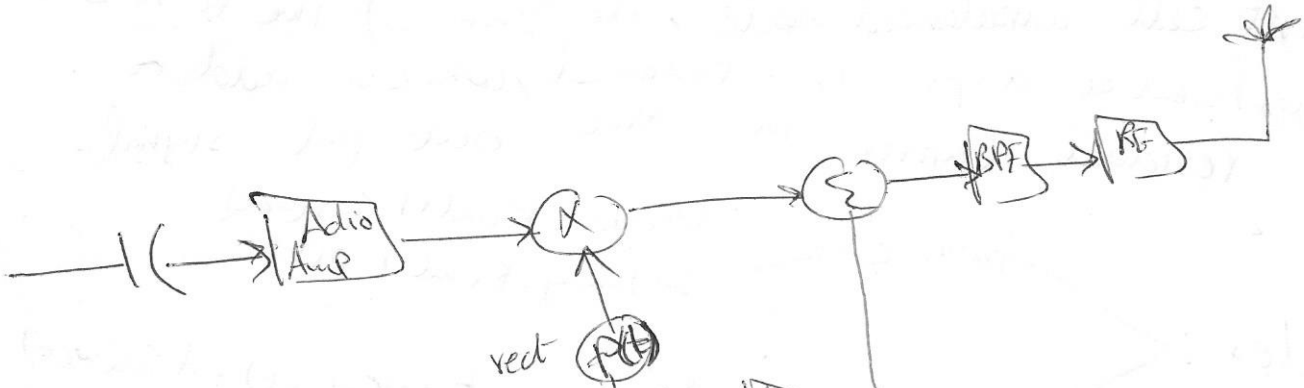
Design(A) ⇒ $[m(t)+A]\cos(w_c t)$

RF Amplifier ⇒ Antenna matching for the maximum power tranfer

RF: Radio frequency

(B)



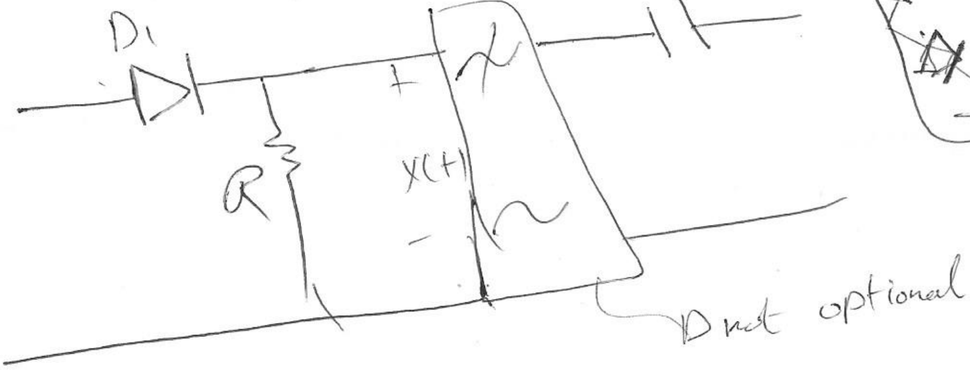


AM: Demodulators

(A) Envelope detector

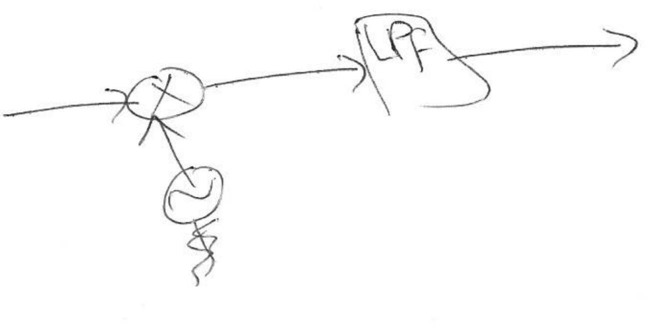
$$\frac{1}{f_c} \ll \tau \ll \frac{1}{B}$$

(B) Rectifier Detector:



half wave → $y(t) = \frac{(m(t)+A)}{\pi}$ | Full wave: $y(t) = \frac{2}{\pi}(m(t)+A)$

(C) synchronous Detector



Bandwidth:

FM & AM: $B = 2B + 2\Delta f = 2B(\beta+1)$ where $\boxed{\beta = \frac{\Delta f}{B}}$

if $\beta \gg 1$ wide band FM (WBFM)

$\beta \ll 1$ (NBFM)

---

tone → $(\beta+1)$ = # of significant pairs ≥ 0.1 J_n

so Bandwidth = $2W_m \times$ SSP (radians) → $\beta+1$

$2B \times (\beta+1)$ Hz

FM Radio ⇒ $\beta = 5$

$K_m = \frac{m_p(t)^2}{m_{rms}(t)^2}$

So we exchange Bandwidth for SNR ⇐ $\beta \uparrow$ ⇒ Bandwidth ↑, Quality ↑

$K_m^2 = 2$ for human voice

$$SNR = \frac{3\beta^2}{K_m^2}\left(\frac{S_{in}}{N_o B}\right)$$

$$S_{in} = \frac{A^2}{2}$$

$\text{rect}\left(\frac{t}{\tau}\right) \longrightarrow \tau \,\text{sinc}\left(\frac{w\tau}{2\pi}\right)$ $\tau \equiv$ width

$\cos(w_0 t) \longrightarrow \pi\delta(w-w_0) + \pi\delta(w+w_0)$

$\sin(w_0 t) \longrightarrow \pi j\delta(w+w_0) - j\pi\delta(w-w_0)$

$e^{\pm j w_0 t} \longrightarrow 2\pi\delta(w \mp w_0)$

$\Delta\left(\frac{t}{\tau}\right) \longrightarrow \tau \,\text{sinc}^2\left(\frac{w\tau}{2\pi}\right)$ $\tau \equiv$ double the width

Calculation the amplitude of rep. rect.

FM & PM :

$w \overset{is}{\Longrightarrow}$ slop of θ

FM:

$w_i(t) = K_f m(t)$

$\theta_i(t) = K_f \int_{-\infty}^{t} m(t)dt$

PM:

$w_i = w_c + K_p m'(t)$

$\theta_i = K_p m(t)$

$\Delta f = \frac{f_{max} - f_{min}}{2}$ $\Delta\theta = \frac{\theta_{max} - \theta_{min}}{2}$

FM

$\Delta f = \frac{K_f}{2\pi}\left[\frac{m(t)_{max} - m(t)_{min}}{2}\right]$

$\Delta\theta = K_f \frac{\int m(t)dt_{max} - \int m(t)dt_{min}}{2}$

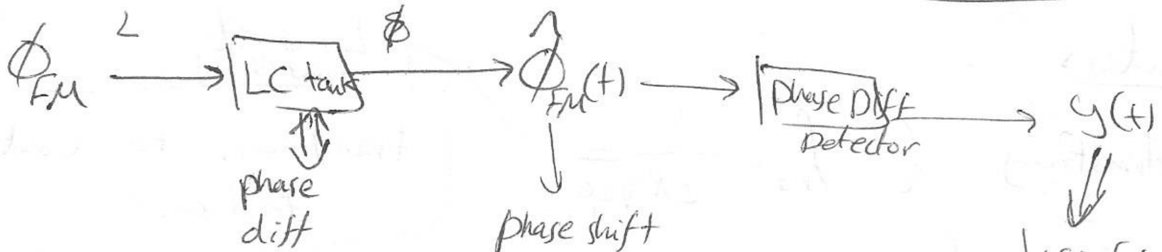
PM

$\Delta f = \frac{K_p}{2\pi}\left[\frac{m'(t)_{max} - m'(t)_{min}}{2}\right]$

$\Delta\theta = K_p \left(\frac{m(t)_{max} - m(t)_{min}}{2}\right)$ rad

② Quadrature Detector:

FM $\xrightarrow{\sim}$ PM

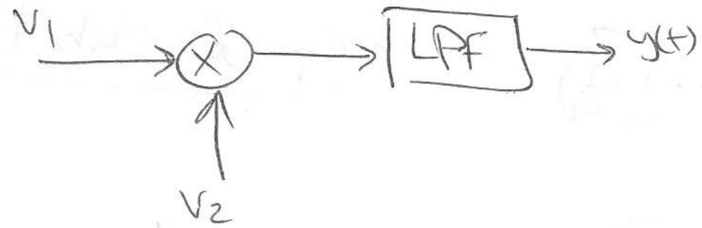


$\frac{1}{2}\sin(\Delta\theta) \approx \frac{1}{2}\Delta\theta$

mean value theorem

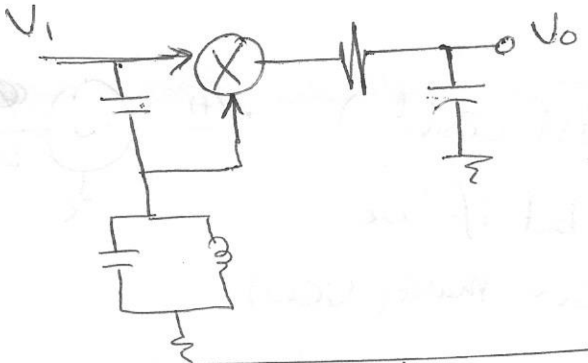
$|\Delta\theta| \ll 1$

⊛ phase detector



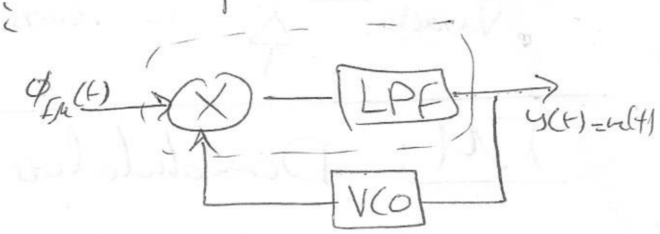
$V_1 = \cos(w_i t)$

$V_2 = \cos(w_i t + \Delta\theta - \pi/2)$



③ Phase-Looked Loop (PLL):

يقارن ال $\phi(t)$ مع $\phi(t-1)$ قبلاً دخل الزمن



Stability of transmition.

⊛ FM Modulators & Demodulators.

⊛ ocilators

a) Armstrong $f_c = f_{r_2} = \frac{1}{2\pi\sqrt{L_1 C}}$ ← L الكمش trans الك — transformer to control feed back

b) Hartley $f_r = \frac{1}{2\pi\sqrt{(L_1+L_2)C}}$ auto ترا ال transformer

c) Coplits $f_r = \frac{1}{2\pi\sqrt{L_1\left(\frac{C_1 C_2}{C_1+C_2}\right)}}$ → Duality

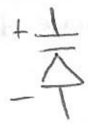
d) Clapp $f_r = \frac{1}{2\pi}\sqrt{\frac{1}{L}\left(\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}\right)}$ — C_3 for stability

✗ others: ~~Ring, Pierce, Relaxation, schmitt trigger, wien-Bridge, Multivibrator~~

FM Modulators:

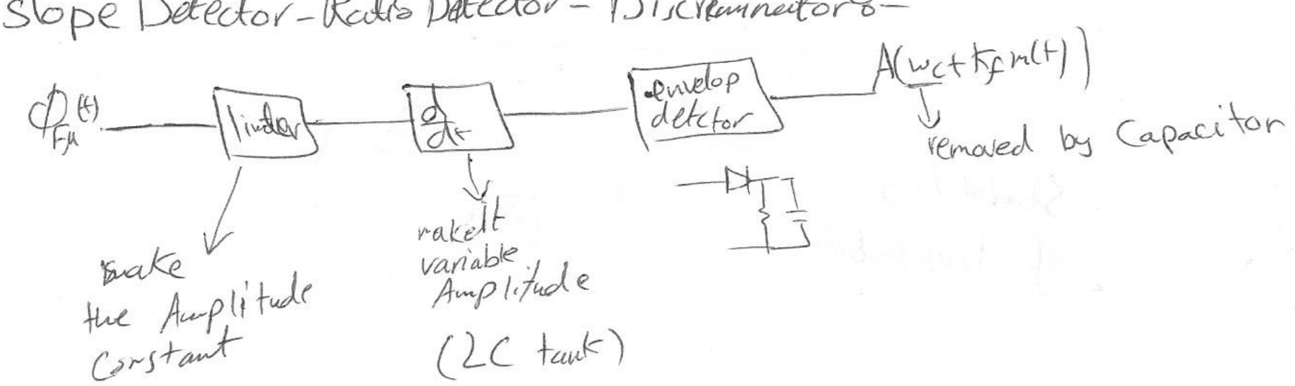
⊛ called VCO (Voltage Controlled ocsilator):

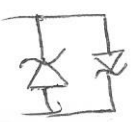
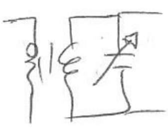
the LC tank controls the f_c but if we make C variable we can make (VCO)

Varactor  in reverse Bias the capacitance ∝ m(t).

FM: Demodulators

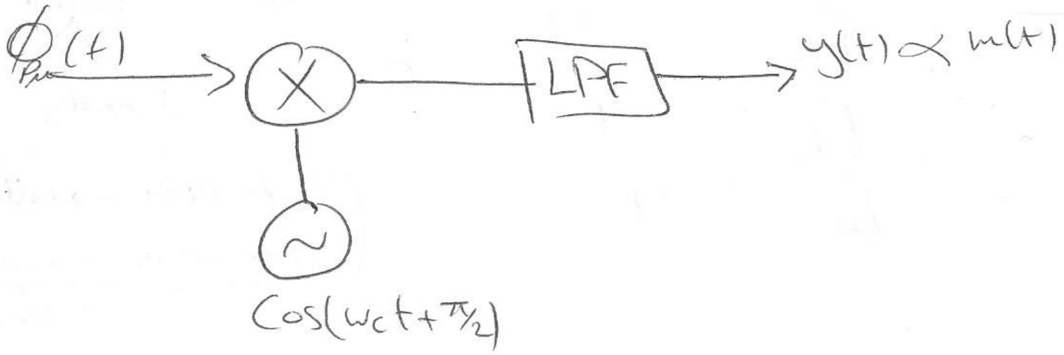
① Slope Detector - Ratio Detector - Discriminators -



clipper  

FM ⇒ FM + AM

PM Demodulator



Digital: TDM:

① New Bandwidth $\equiv B_1 + B_2 + \cdots$

② : bit interveeling 1 bit from A then 1 bit from B ——
word intervealing 8 bit 8 bit ——

③ if PCM stream is ex: 64K, 128K take 1 bit from A & 2 bits from B

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④ TDM Hierarchy Standards:-

US → Bipolar

	US	Europe	
low bit PDH ←	T_1	E_1	Semi synchronous
high bit SDH ←	SONET OC-3, OC-12, OC-45	SDH	Synchronous Digital Hierarchy

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US: T_1  24 calls

64K (bit/sec)
$B = 1.544\,MHz$

T_2 4 inputs

T_3 7 inputs

T_4 6 inputs

we add more bits for managment

T_1 : word intervealing
T_2 & up bit intervealing

4032 calls

Using Bipolar

Europe

E_1	32	30 → calls	2 → controll (1 signalling, 1 sync.)
E_2	4		
E_3	4		
E_4	4		

30×4×4×4 → calls

34×4×4×4 → lines → for Bandwidth

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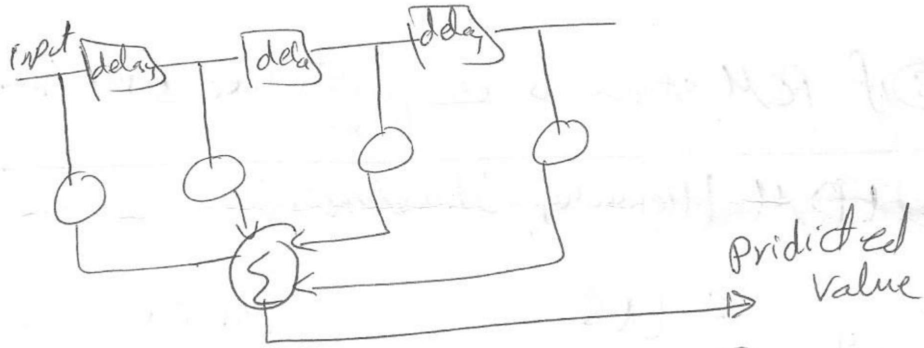
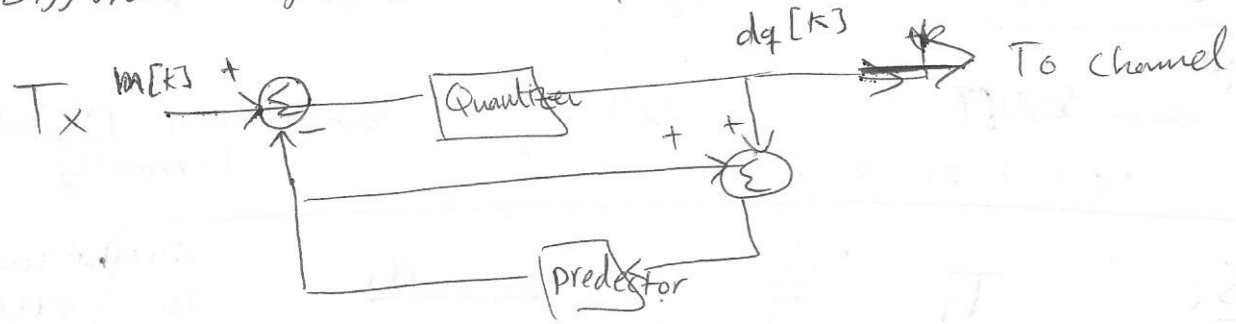
prediction

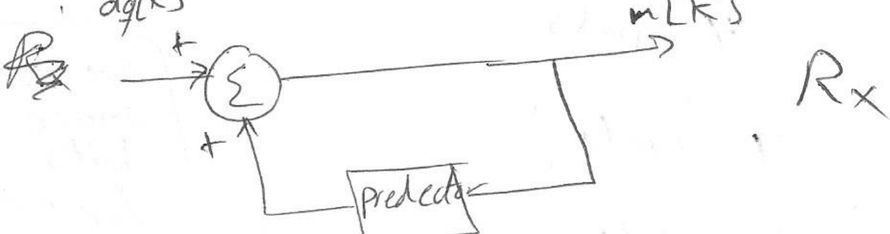
① Tylor series : $m[k+T_s] = m(t) + \frac{T_s}{1!} m'(t) + \frac{T_s^2 m''(t)}{2!}$

② pridector



③ Differential pulse code Modulation: (DPCM)

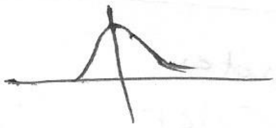




ADPCM	DCM	DPCM
Adaptive (L) changing	L fixed ΔV fixed	L fixed ΔV changing
16k bps	64 kbps	32 K(bps)

⊛ Noise — AWGN

time domain: → Gaussian, Mean = 0, variance = σ^2



Frequency domain →

$N_0 = 4KT$

K: Boltzman's const.

↑ power spectral Density.

SNR_{in} : هو طا ال signal توصل لي آخر ال channel بين قبل ما نعالجها Demodulation

SNR_{out} : تبع ال signal بعد ما نعالجها كل شيء زاد

§ noise power $= \frac{1}{2\pi}\int_{-\infty}^{\infty} \frac{N_0}{2}\, d\omega$

> عندما نستعمل ال dB بكون بال Radians/sec

$NF = SNR_{IN} - SNR_{out}$ [dB]

> −ve NF means improvements in out

> لما نعمل ال shift left / shift Right بنضرب 2 $(\frac{1}{2})^2$
>
> $\frac{V^2}{R} \equiv$ Power لأن نقول

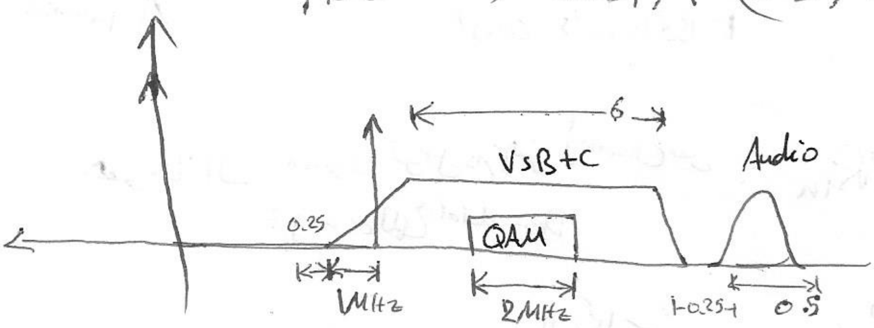
TV channel:

- Vid.
- Audio.

notes

⊛ Color: RGB ⟶ YUV ⟹

- Y → VSB+C
- U&V → 1MHz each QAM (2MHz)
- Audio ⟶ FM (0.5 MHz)



PAL TV channel total B = 8MHz

Hetrodyne:

up conversion $\omega_{LO} = \omega_c + \omega_I$

down conversion $\omega_{LO} = \omega_c - \omega_I$

$A_{new} = \frac{A_{old}}{2}$ (Amplitude)

but if we used $rep_T(rect)$

$A_{new} = \frac{1}{T} A_{old}$

SNR:

in digital BER means 1 error per the number

good quality ⟹ $BER \leq 10^{-6}$

$\frac{P_2}{P_1}[dB] = 10 \log_{10}\left(\frac{P_2}{P_1}\right)$

Voice: $SNR \geq 30\,dB$ ⇒ Good Quality

Video: $SNR \geq 50\,dB$ ⇒ Good Quality

⊛ Super hetrodyne:

① AM:

$B = 535 - 1700$ KHz

station: Europe: $8 + 1 = 9$ KHz per channel (1 → Guard)

US: $8 + 2 = 10$ KHz per channel.

$If = 455$

RF filter Max $= 2(If - B)$

② FM:

Broad-Cast Range: 88- 108 MHz

$If = 10.7$ MHz

③ TV:

Broadcast Range:
- VHF ⇒ 30 - 300 MHz
- UHF ⇒ 300 MHz - 3 GHz

$If = 40$ MHz

$\beta = \frac{\Delta f}{B}$ $\beta + 1 =$

FM Radio $\beta = 5$ (β → Modulation index)

$K_m = \frac{mp^2}{Vms^2}$