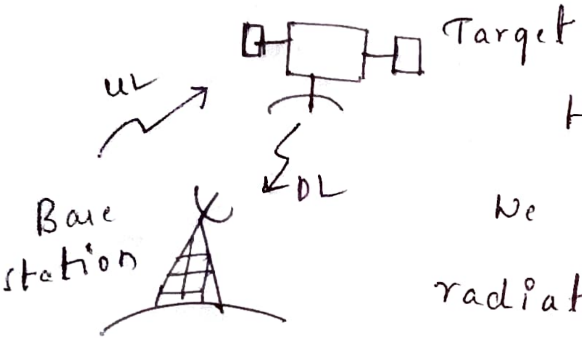
24th October 2020

UNIT-3

Radiometric principles and TV systems

Radiometry :-



Here the target will be passive

We abserve for the black body radiations of the target.

Radiometry generally deals with blackbody radiation

Here Base station is the observer.

Black body ratiadtion – the passive target in the freespace either obsorbs the signals or radiates the signal.

The observer must be able to measure the degree of radiation or obsorbtion.

In radiometry we collect information about a body based on its black body radiation

↳ In terms of power

↳ In terms of temperature

* Plank's radiation law :- If there is a target in free space, then its characterrtic is such that if an energy is incident on it, it will either absorb the energy or reradiate it.

(i) Power radiated by the body

$$\boxed{P = KTB}$$

$K \rightarrow$ Boltzman's constant

$T \rightarrow$ Temp of Body in Kelving

$B \rightarrow$ B.W of the system / reciever

emmissivity of a body (e) is the ratio of power radiated by the body to the power radiated by an ideal black body.

$$e = \frac{P_{radiated}}{P_{Black\ body}} = \frac{P_r}{KTB}$$

for a Black body emmissivity is 1

generally $0 < e < 1$

$0 \rightarrow$ no obsorbtion

$1 \rightarrow$ complete obsorption

If T_B = Black body radiation temperature (Brightness temp)

T = physical / Actual temp of a body

then $\boxed{T_B = eT}$ $\quad e \leq 1$

For Sun $\quad 6000°C < T < 1$ lakh $°C$ $\quad$ for Quite Sun its $6000°C$

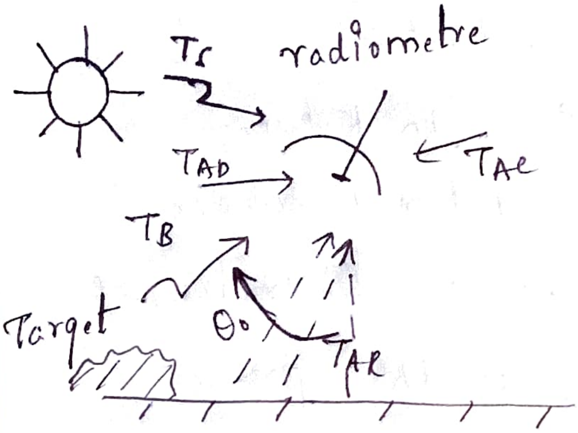
$\downarrow$

errupted sun

Satellites must be proteated by these erruption

A radiometry reciever design is very very complex. Due to various factors mentioned below

This will effect the measurement.



x (i) Sun temperature during the Day

✓ (ii) T_B - Black body temperature

x (iii) T_{AR} - temp reflected by the Atmosphere

x (iv) T_{AD} - direct radiation temp from Atmosphere

✓ → measured properly x → rejected

Accuracy of the reciever is defined by the degree of rejection of the unwanted factors

(v) T_{AE} → other environmental effects.

* Accuracy of Measuring T_B depends on –

(1) how reciever overcomes other temperature

(2) Not necessary that black body is always black. depends on brightness and colour of target

(3) observation Angle

(4) frequency at which we measure

(5) polarisation of radiations

(6) Attenuation of the cignal

(7) Radiation pattern of the Antenna
(narrow beam, broad beam, isotropic)

(8). Environmental conditions (permitivity of Atmosphere).

(9). Geographical location (elevation)

(10). Cross section apperature of the Antenna.

* Radiometry is Multidisplinary

- electrical eng
- electronics eng
- comm eng
- instrumentation
- motionography
- geophysic
- Atmospheric & space science

* Applications 6-

(1) Remote and environment

- Measurement of soil nutritional fertility help farmers to grow better crops
- oil / gas / ore exploration
- Sea mapping (To catch fish)
- Flood mapping
- Snow / ice mapping

- Monitoring wind pressure on ocean surface
- Atmospheric profiles : ozone, O_2, humidity
- temperature profile

(2). Military :-

- Target detection - target recognition
continuous surveliance, EWS - early warning system
Mapping of Geographical location.

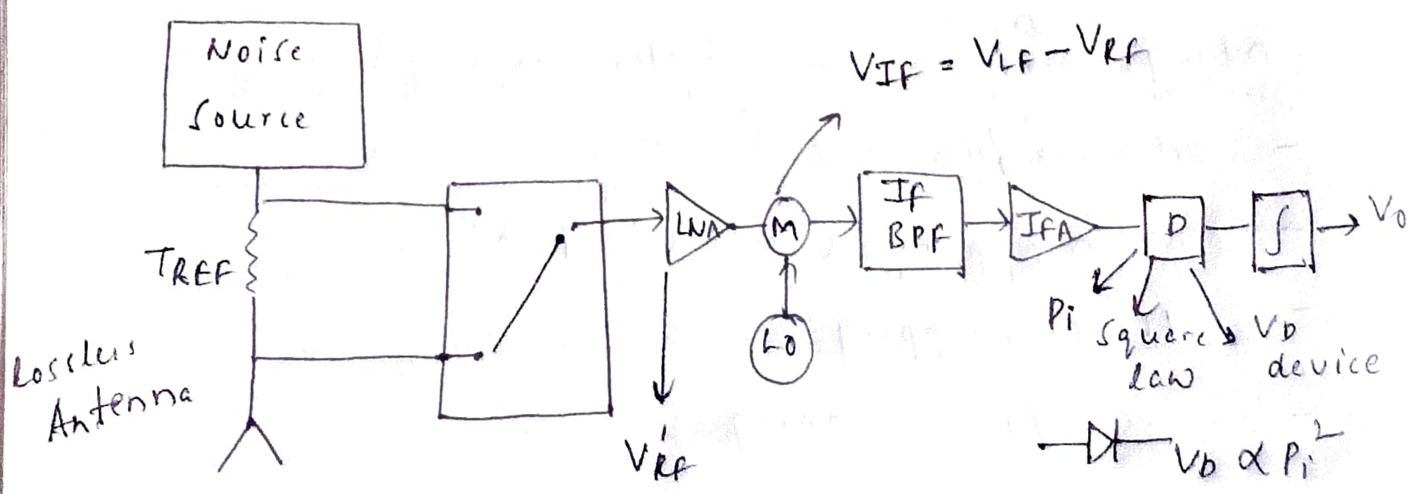
(3) Astronomy :-

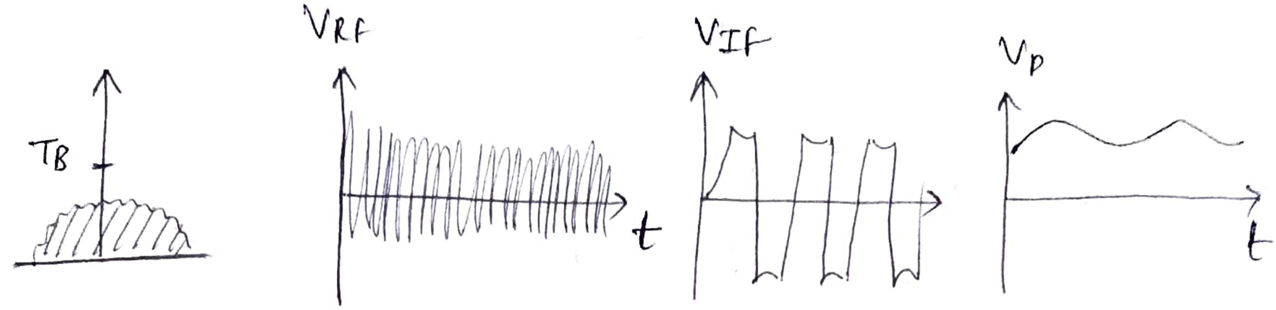
- Deep space tracking of heavenly bodies
- planetary motion, heavenly body motion,

* Radiometric reciever :-

Modes of operation
→ CM - caliberation mode
→ AM - actual mode.

TREF → Ressistance of the Antenna (depends on temp).





RF can't be measured directly, so it is converted to IF and then measured.

→ In measurement/ Actual mode :- $T_B \rightarrow$ Brightness temp

$K \rightarrow$ Boltzman const

power measured = $P_A = K T_B B \rightarrow ①$ BW → BW of reciever

$T_R \rightarrow$ effective noise temp of reciever

$P_R = K T_R B$

If G is the gain of the reciever, $V_o = G K B (T_B + T_R) \rightarrow ②$

divide ② by ① $\frac{V_o}{P_A} = \frac{G}{T_B}(T_B + T_R)$

$V_o = P_A \left(1 + \frac{T_R}{T_B}\right)$

Errors :-

(1) ΔT_N :- error in measurement T_B due to noise fluctuations

$\Delta T_N = \frac{T_B + T_R}{\sqrt{BT}}$ with $\tau \uparrow$; $\Delta T_N \downarrow$

(2). ΔT_G :- Random changes in the system gain

$$\Delta T_G = (T_B + T_R)\,\frac{\Delta G}{G}$$

eg:- $f = 10\,GHz$ $\quad B = 100\,MHz$

$T_R = 500^\circ K$ $\quad \tau = 0.01s$

$\Delta G/G = 0.01$ $\quad T_B = 300K$

$\Delta T_N = 0.8^\circ K$ $\quad \Delta T_G = 8^\circ K$

'Dickenells' Reciever → -ve f/b.

* TV principles :-

distance, seeing

Invented by Joseph Baired

Monochrome - Black & white.

↳ Primary standard (Global) (2 stds)

↳ derived standards (adopted by a country) (3 stds).

Monitoring Agencies - ITN

FCC - Federal comm commision

IEEE, CCIR - Consultative committe Internationale Radio

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(6) polarity negative modulation

(Black has more Amp than white signal)

Parameter	American Std	European Std (India)
(1) Field frequency	60Hz	50Hz
(2). Lines per frame	525	625
(3) Frame repetation frequency	30Hz	25Hz
(4). Interlace ratio	2:1	2:1
(5) Line frequency	525×30 ≈ 15750Hz	15625Hz
(6) BW of TV channel	6MHz	7MHz
(7). Allowable video BW	4.2MHz	5MHz
(8). Inter carrier seperation	4.5MHz	5.5MHz
(9). Δf - freq deveation	25 KHz	50KHz
(10). Colour Subcarrier freq	3.58 MHz	4.43MHz

Similarities

(1) Sound signal Mod	FM	FM
(2) Picture signal Mod	AM	AM
(3) Type of Txn	VSB	VSB
(4). Interlace ratio	2:1	2:1
(5). Aspect ratio (AR) horizontal dimension wrt Vertical dimen of screen	4:3	4:3

* Derived standards

(1) National TV system committee :- (NTSC)
(M-format)
1967 - USA

Used in USA, Japan, Korea, South America, Canada

- 110V AC
- 60Hz basic freq
- Video BW 4MHz
- Noise is high
- Active lines 486 (525 - overheads (39))
- Interlace scanning to avoid flickering in signal

(2). SECAM :- "Sequential colour Avec Memory"
French word. 1970 -

France, Belgium, Africa, Iran, Iraq

- 625 line per frame, 25 Fps
- 220V AC
- 6MHz channel BW

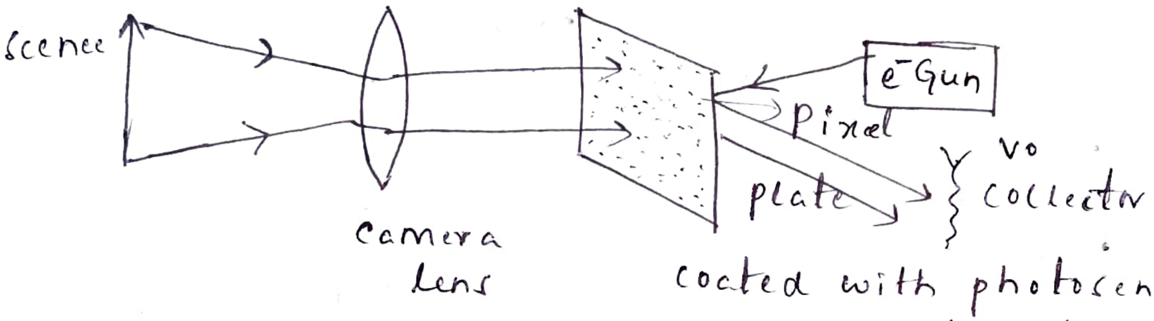
drawback is very high noise

(3). PAL : phase Alternation by line
India, Britain, Europe, Western Europe,
Germany developed this in 1967

- Video BW 5MHz, 230V AC 50Hz
- lines in frame 625
- Noise effect is minimum

* Principle of Scanning:-

converting the visual info into electrical signal



coated with photosensitive material

cadmium sulphide (cds).

Brightness of pixel varies with the intensity of incident beam.

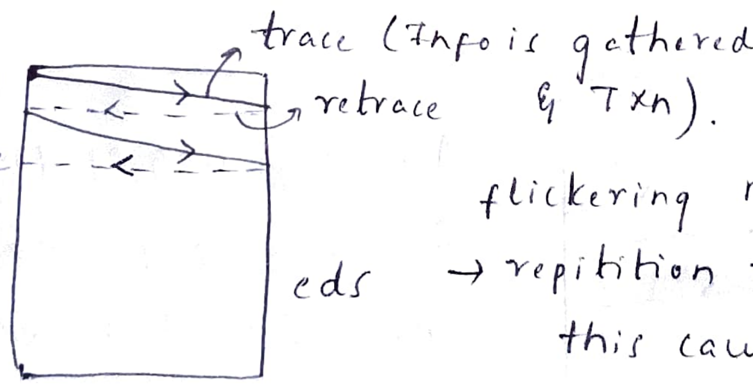
When e^- hit screen, its velocity changes. Hence, V_0 is a result of the reflected e^- from the plate.

Method I

progressive scanning

very slow process

to cover 525 / 625 lines



flickering must be overcome

→ repitition rate is low here

this causes flickering.

Method-II

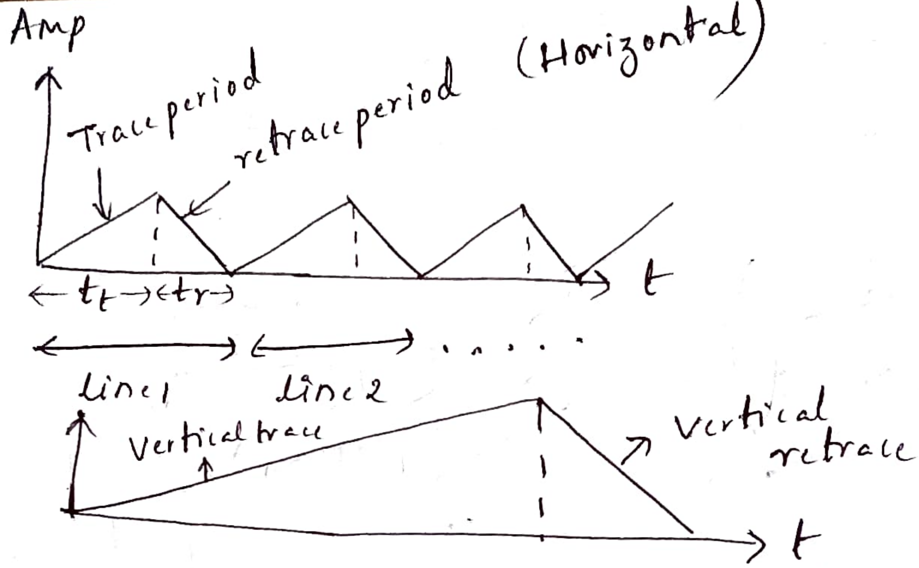
Interlace Scanning

odd | even

Here scanning is double time

Hence frame rate increases.

Hence problem of flickering is solved.

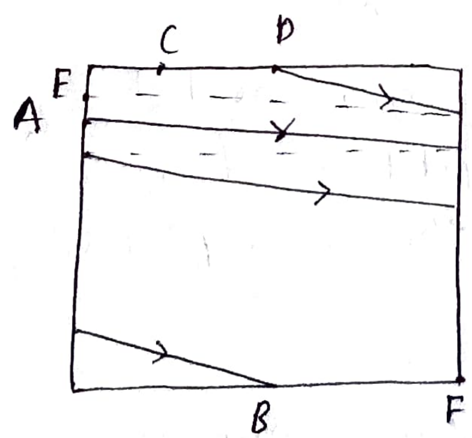


Using sawtooth generator both for vertical & Horizontal, the scanning waveform is generated.

* Interlaced scanning :-

① odd field

② even field



A is begining of field 1

B is end of field 1

BC - Vertical blanking

D - time period at which Vertical blanking is removed and Horizontal blanking is applied

F - is the end of field 2.

E - is start of trial 2 (even).

Field 1 → 1 - 242

Field 2 → 243 - 504

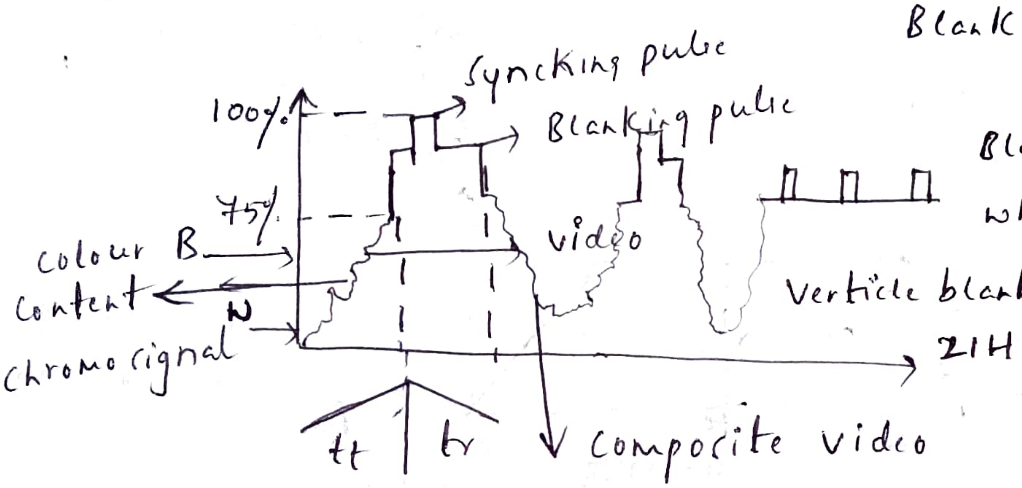
$$\begin{array}{r} 525 \\ -\ 504 \\ \hline 21 \end{array}$$

21 lines lost due to Horizontal & vertical blanking

Two type of signals transmitted

→ blanking (Horiz, Vert).

→ Synchronisation signal



Blanking level at 75%.

Black 67.5%.

white 12.5%.

(video + Brightness + colour + Horizontal & vertical blanking

We also transmit equilisation pulse.

→ Composite video :-

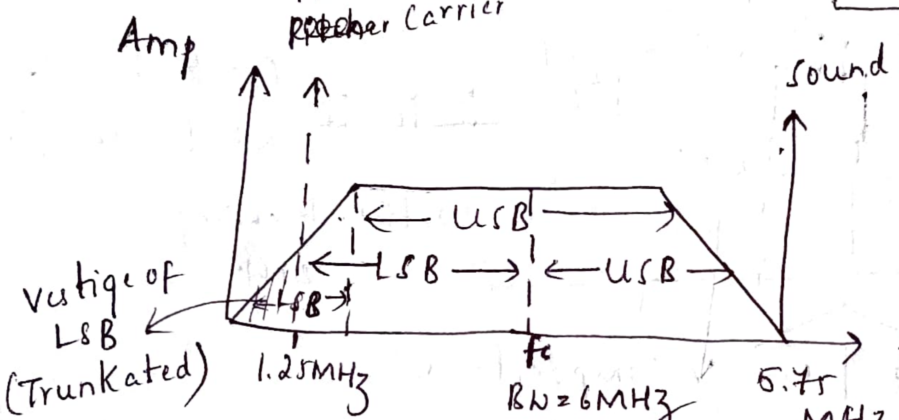
- → video info
  - → luminous signal
    - → black level
    - → white level
    - → grey level
  - → chroma
    - → R
    - → G
    - → B
- → Blanking
  - → Horizontal
  - → Vertical
- → Synchronisation
  - → Horizontal
  - → Verticle
- → equilisation signal

* VSB Transmission :-

Video → A.M (DSBFC, DSBSC, SSBSC)

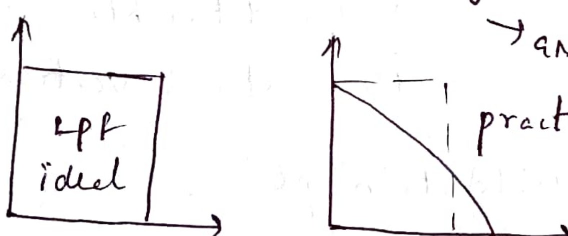
VSB → Vestigial Side Band Txn

→ $\boxed{\text{C3F Modulation}}$



We save B.W of about 3MHz

→ 9MHz (for other method).



* Colour Txn :- (Principles of Colour Txn)

→ Requirement of 6MHz BW

→ colours in correct shades

→ compatibility

We basically process the primary colours (RGB).
(principle of colour Txn).

83.3% of RGB → white colour

We cannot txn RGB (they get phase shifted) so we txn

Y, I, Q → Psuedo signals which can be ~~txn~~

Y → Luminous (Brightness).

I → Inphase

Q → Quadrature phase

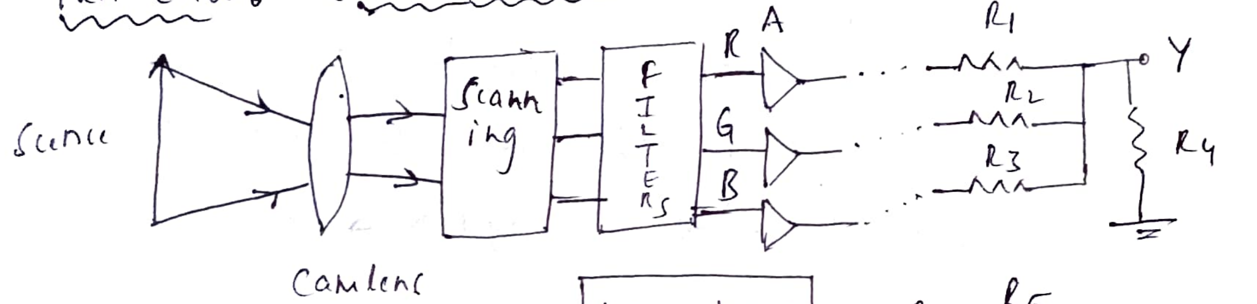
For Y signal $= 0.3R + 0.59G + 0.11B$ — NTSC standard.

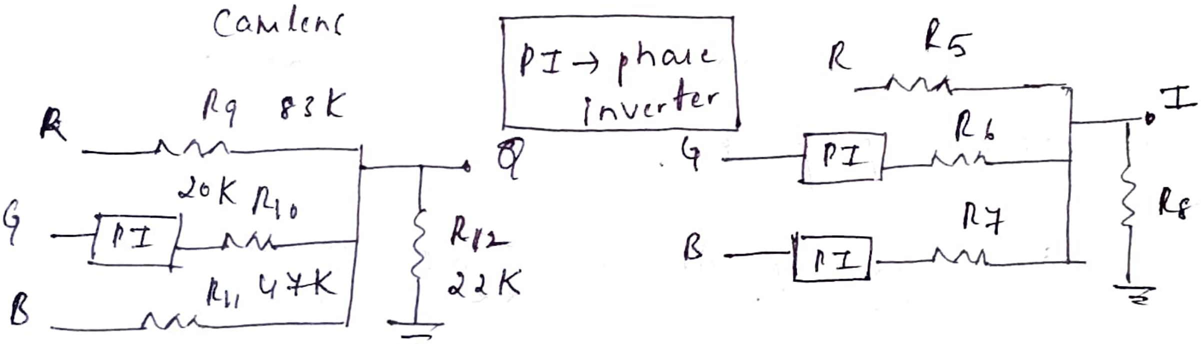
I signal $= 0.6R - 0.28G - 0.32B$

Q signals $= 0.21R - 0.52G + 0.31B$

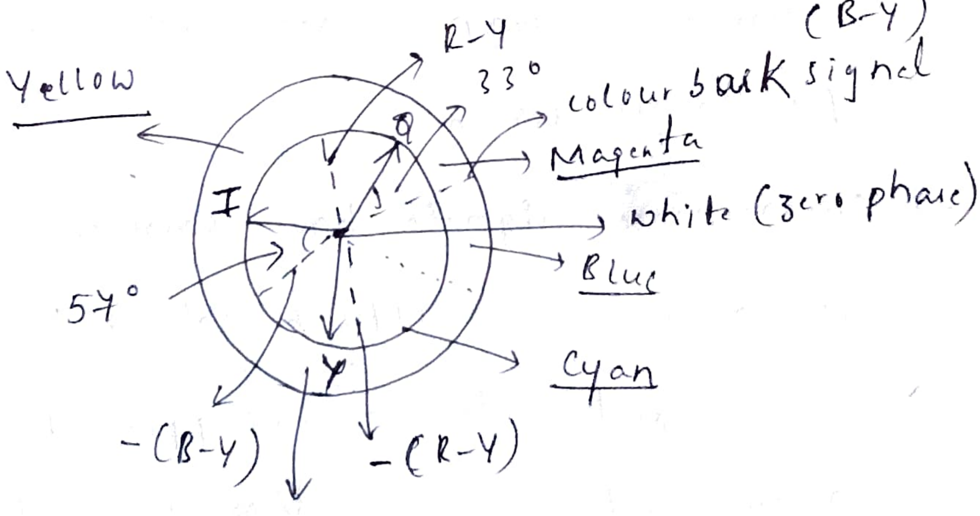
Colour Matrix generates YIQ signals from RGB signals

Txn End :- (Colour Matrix)





Reciever End :- Here there is a colour disk



The diagram has mistakes

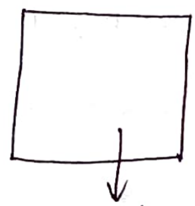
Suppose $Q = 0$, $I = I_{max}$ and → we get saturated reddish orange colour

Suppose $Q = 0$, $I < I_{max}$ → paler shade of orange

Suppose $I = 0$, $Q = -Q_{max}$ → saturated yellowish green

Pure Blue → $0.8Q - 0.6I$

colour picture tube → cathode Ray tube



TV

phospours (phosporiscence is the principle of TV screen work).

When light is incident, the molecule glows for some time (persistence) ~~of~~ longtime → long persistence

In medical scanners, ecg, CT scans use long persistence phospours.

* Limitations of Analog Txn:-

→ luminous (Brightness) + chrominance (Colour) + sound → signal

luminous signals have smaller resolution for larger screens.

→ chrominance signals have smaller resolution along Horizontal (result in colour mixing / smeering effect)

→ 4:3 aspect ratio is insufficient for ocean pictures, they req ~~[illegible]~~, 16:9 etc. 32:18

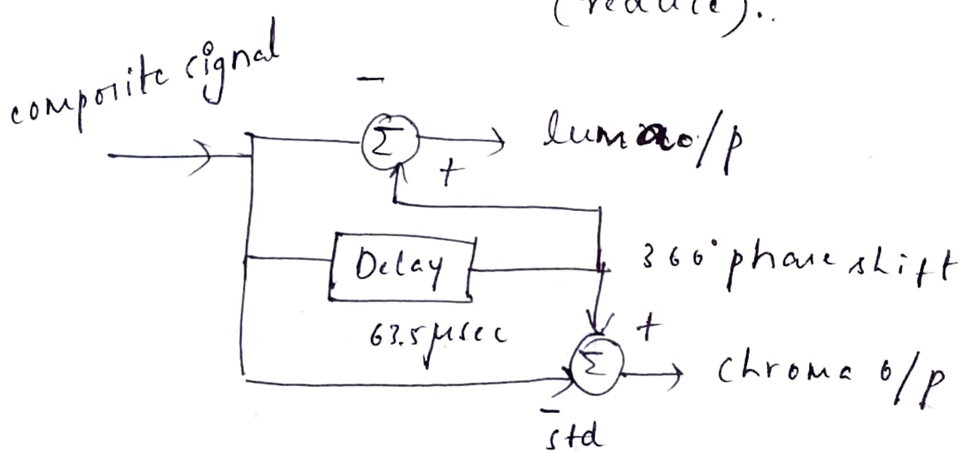
→ Cross luminensence

To conserve BW in 6MHz we interlink cromo & luminous channels which results in cross luminiscence.

→ Interlace scanning not suitable for α-numeric displays.

* Digital systems:- (Overcoming problems).

→ Comb filters → we can seperate luminence & chrominence to prevent cross luminence (reduce).



→ Adding additional std line will improve the vertical resolution.

→ Using DSP we can reduce most of disadvantages by signal processing (better Quality).

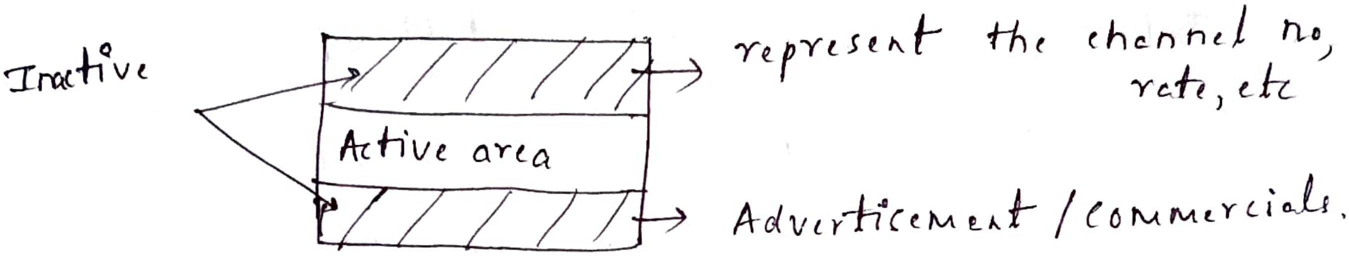
→ Digital form will reduce noise, interference, distortion.

→ compression methods have increased the capacity of system
JPEG, MPEG, dolby coding,

→ Correlation / Convolution to reduce eff of noise.

→ picture in picture (viewing multiple channels).

→ letter boxing possible :-



→ In short dist comm, → PCR, DVD. we can use seperate channel for voice, video, audio, intensity. ~~[illegible]~~ brigtness to avoid the mixing.

* DTV standards :-

→ Primary
→ Broadcasting / derived

(1). resolutions NH	Nv (No of pixel elements)	Aspect ratio	Pixel shape
(a) SDD 704	480	4:3	square
(b). EDTV (1985) 1280	720	16:9	square
(c) HDTV IDTV 1920	1080	16:9	rectangle

FRR / Scanning	picture Quality	Bit rate
→ 24 fps, 30 fps, 60 p	moderate	225 Mbps
→ 24 fps, 30 p, 60 p	Better	932 Mbps
→ 24 p, 30 p, 30 p	best	1.5 Mbps.

→ DVB – digital video broadcasting

↳ DVB.S → satellite

↳ DVB.T → Terrestrial (8MHz, video comp, MPEG 2

↳ DVB.C → cable TV

↳ DVB-H →

→ ATSC → Advanced TV system

→ ISDB →

* Comparison of DVB-methods :-

Parameters	DVB-S	DVB-T	DVB-C
(1) Interface with physical layer	Syncronous parallel Interface Asynchronous series Interface.		
(2) Modulation	Single wave QPSK	OFDM QAM	OFDM
(3). Channel coding	← linear +BCH prediction coding →		
(4). Type of transforms	NA	DFT	Inverse FFT
(5). Interleave	Bit	← Bit.f.t →	

Parameter	Analog TV	Digital TV
(1) Modulation format	AM, FM	QAM, OFDM
(2) Signal format	composite video	packets
(3). Type of Txn	YIQ	Y, B-Y, R-Y
(4). Type of spectrum used for Txn	AM-VSB	8VSB, TCM, MPEG-2, AVC
(5). Channel B.W	← 6MHz + Audio →	
(6). Signal distortions	Max	Nil
(7) Type of Screens	LED, phosphours	LCD, plasma
(8). Aspect ratio	4:3	16:9
(9). Scanning	Interlaced	Interlaced/progressive
(10). Quality of signal	Moderate	Best.

* HDTV Principles :-

→ Eye is tolerant to Quantisation noise While discretising the signal, the step size of signal is very small. And eye is unable to distinguish the steps.

→ No of bits used for sampling 8 to 10 sample.

→ In case of Audio we use 14 to 18 bit/sample.

~~Here~~, ear has less tolerance.

→ If m is no of bits for coding information

$$m = \frac{f_b}{N_{PT} R_F}$$

f_b → bit rate

N_{PT} → No of pixels / frame which includes both luminiscense (Y) & chrominance (C) signal.

R_F → frame repetation rate.

→ Resolution depends on the horizontal & vertical resolution of the pixels.

resolution of frame. $\boxed{N_{PL} = N_H \times N_V}$

N_H → No of pixels in Horizontal direction

N_V → No of pixels in verticle direction

$$\boxed{N_{PT} = 1.5 N_{PL}}$$

Consider an example:- Video has $\overset{H \times V}{640 \times 480}$ pixels/frame. It uses 8 bits/sample, frame repetation rate is 30Hz and it uses a progressive scanning.

Determine the Approx bit rate.

Sol:-

$N_{PL} = N_H \times N_V = 307.2 \times 10^3$ pixels

$m = 8$, $R_f = 30$

$N_{PT} = 1.5 N_{PL} = 460.8 \times 10^3$ pixels.

bitrate $f_b = N_{PT} \, m \, R_f = 110.6$ mbps

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* ~~Compression Methods~~:-   RADARS :-