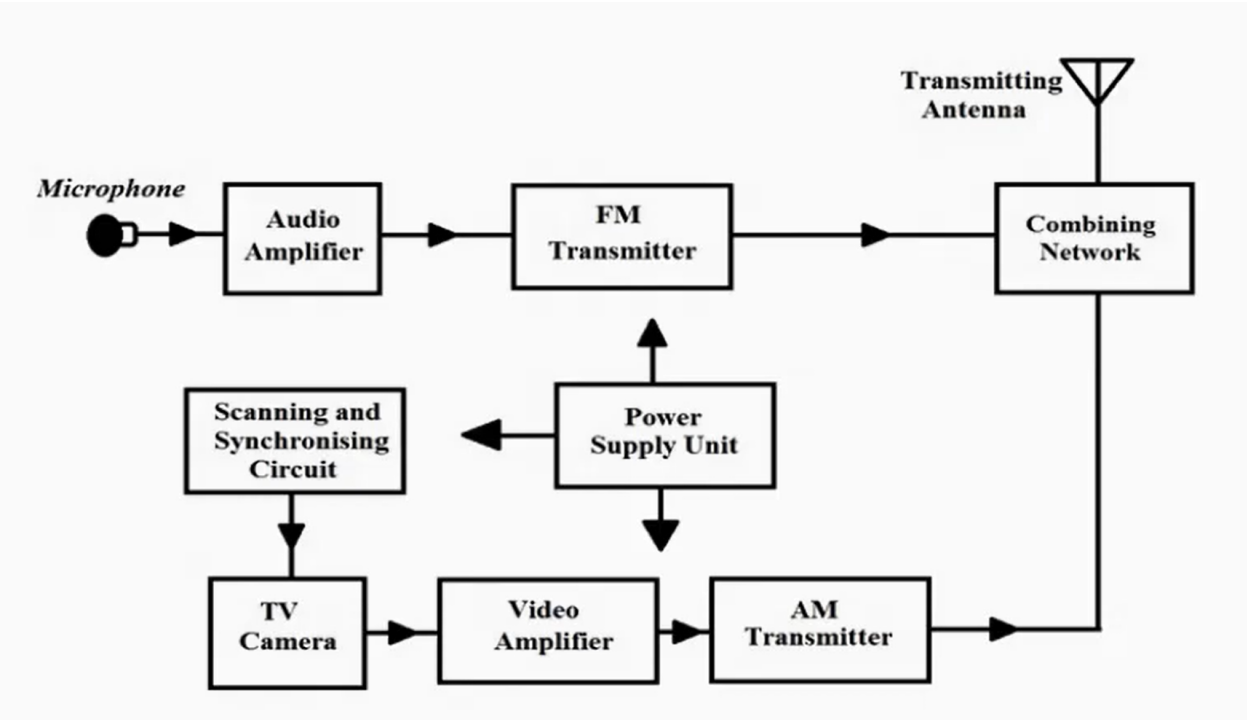
Scanning and Synchronisation in TV – Basic Concepts

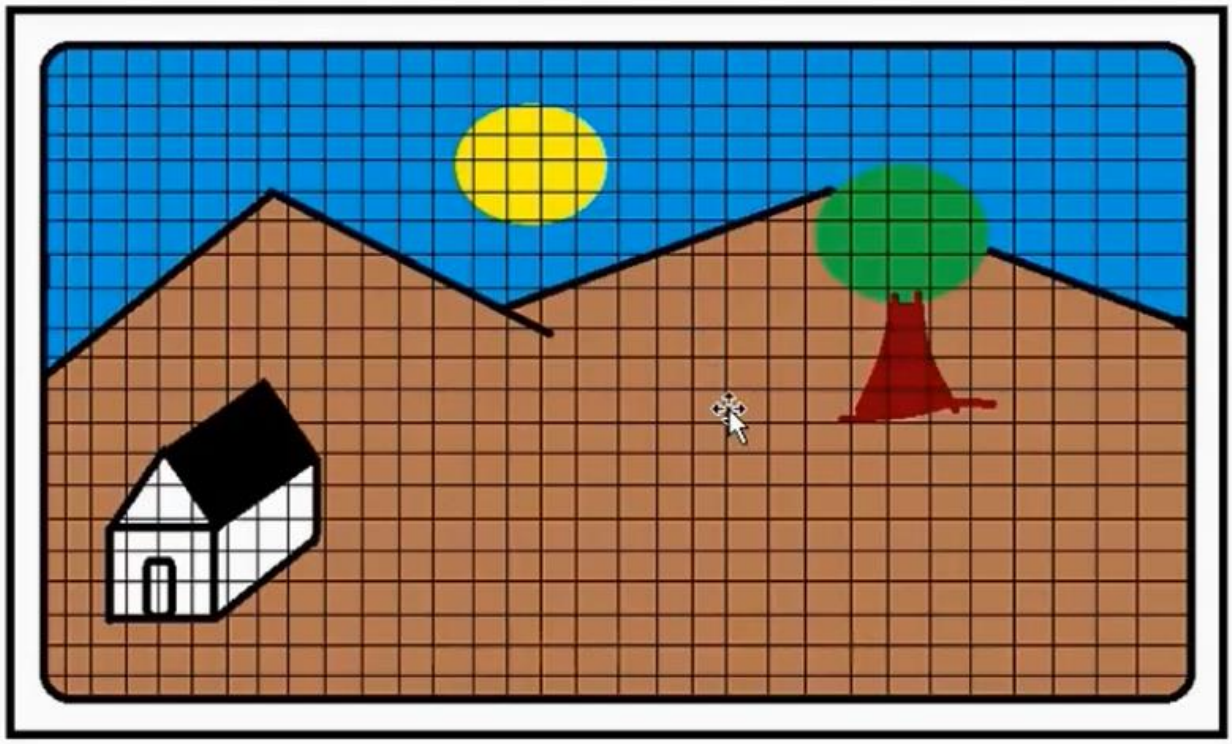
Sub : Television Engineering



Scanning Process

- ***Scanning*** is the process by which the optical image formed on a photosensitive plate of TV camera is broken into ***many small picture elements*** called as ***pixels***.
- Scanning is of two types:

  1. ***Progressive Scanning*** 2. ***Interlaced Scanning***



- The ***process of scanning is similar to the process of reading a book***. We start from left end of the page to the right, then again down to the left and this process continues for the whole page.

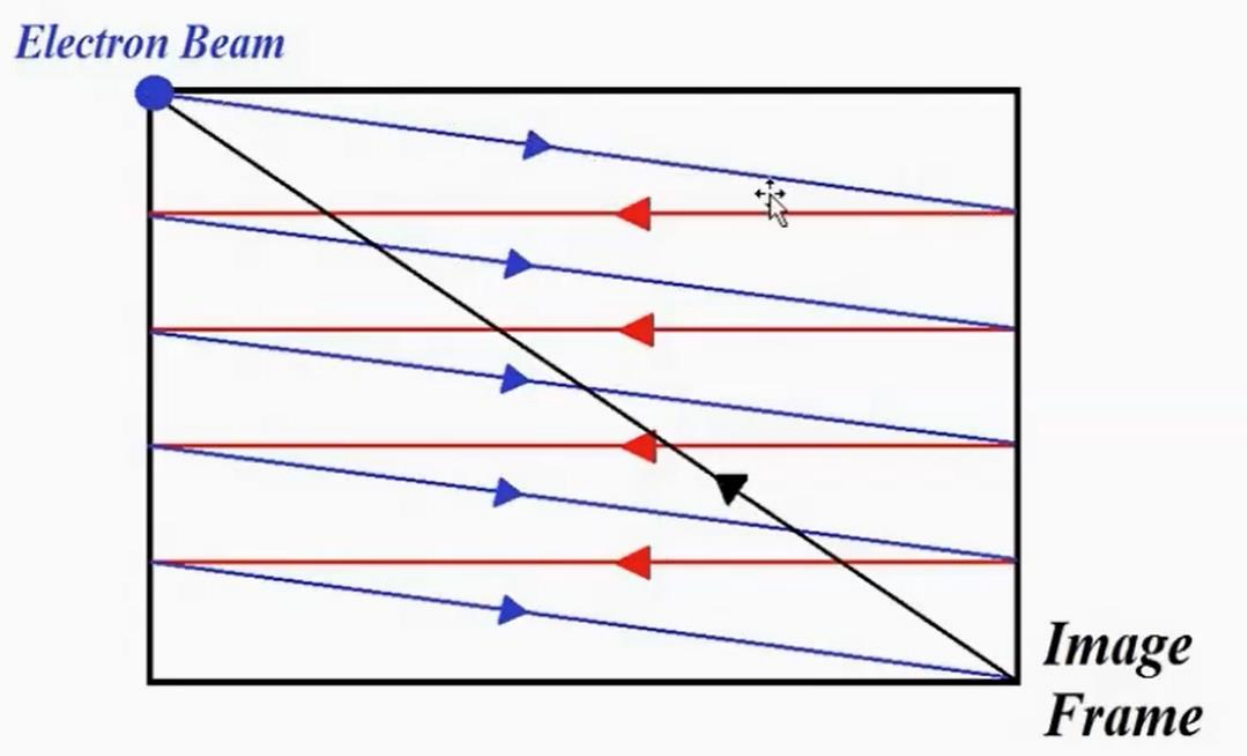
- Similarly, ***the image or picture to be transmitted is divided into a number of horizontal stripes or lines***. It is ***scanned by an electron beam***.

- Scanning is done by application of ***sawtooth waves*** to the ***horizontal and vertical deflection plates of Camera tube***.

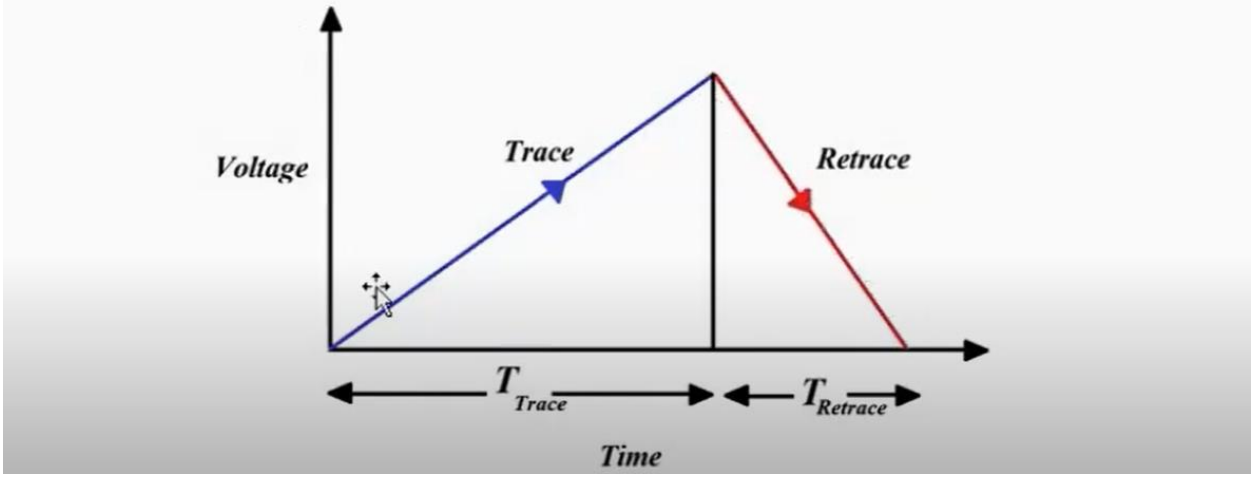
Progressive Scanning

- ***Progressive Scanning*** is also called as ***Direct Scanning***.

- Here, an electron beam scans the picture frame from left to right and goes from top to bottom until it reaches the extreme right at the bottom.



Sawtooth Scanning Waveforms



- One complete scan of a picture frame at the transmitter produces one complete picture frame at the receiver side.

- The ***no. of scanning lines can vary***. It generally has values such as ***405, 525, 625, 819*** .

- This method is simple but produces ***Flicking effect***.

Interlaced Scanning

- Interlaced Scanning is used to remove the ***Flicking effect***. Here, each picture frame is shown twice.

- The ***picture frame consisting of any no. of scanning lines*** is divided into ***two groups or fields***.

- Each field consists of ***one-half of the scanning lines***.

Interlaced Scanning

- Interlaced Scanning is used to remove the ***Flicking effect***. Here, each picture frame is shown twice.
- The ***picture frame consisting of any no. of scanning lines*** is divided into ***two groups or fields***.
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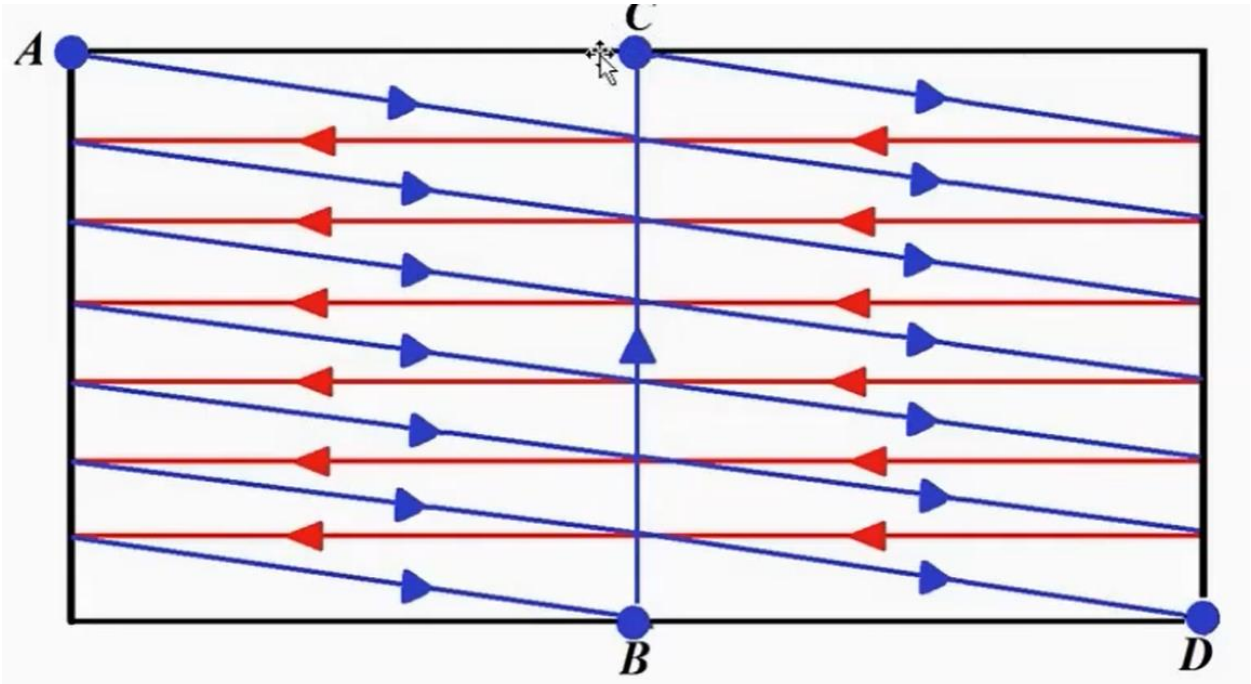
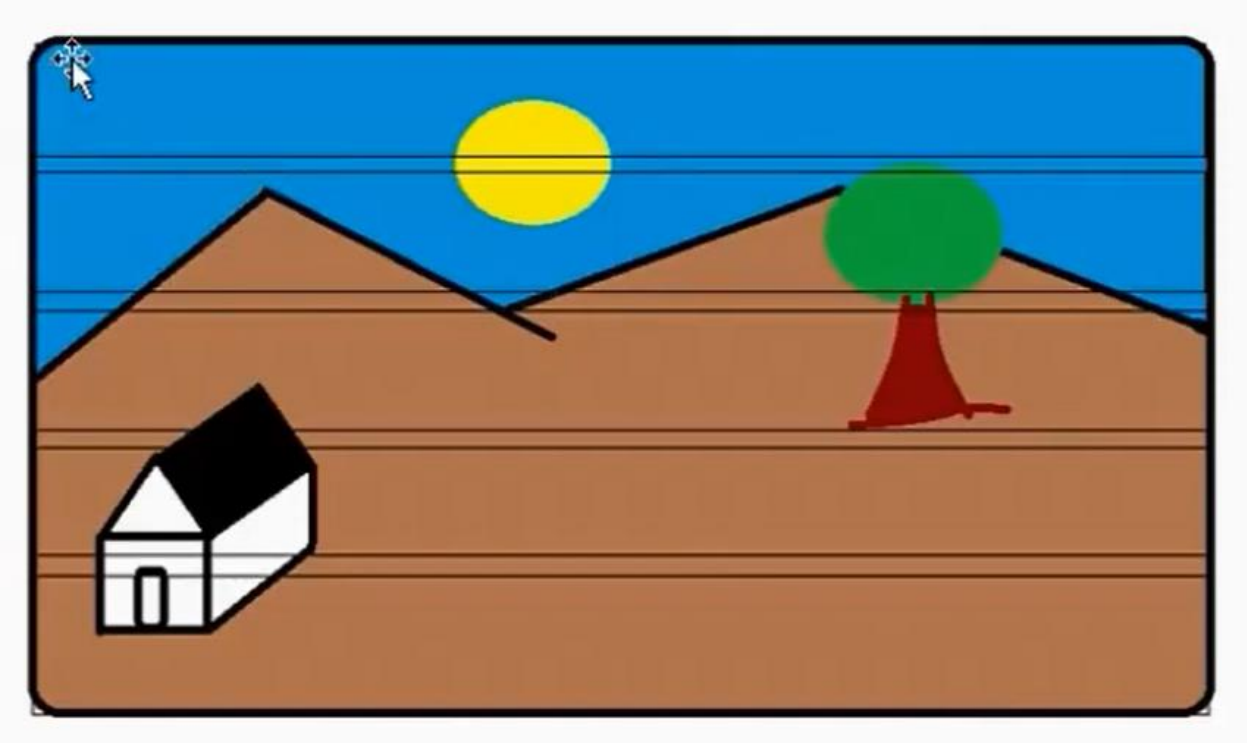
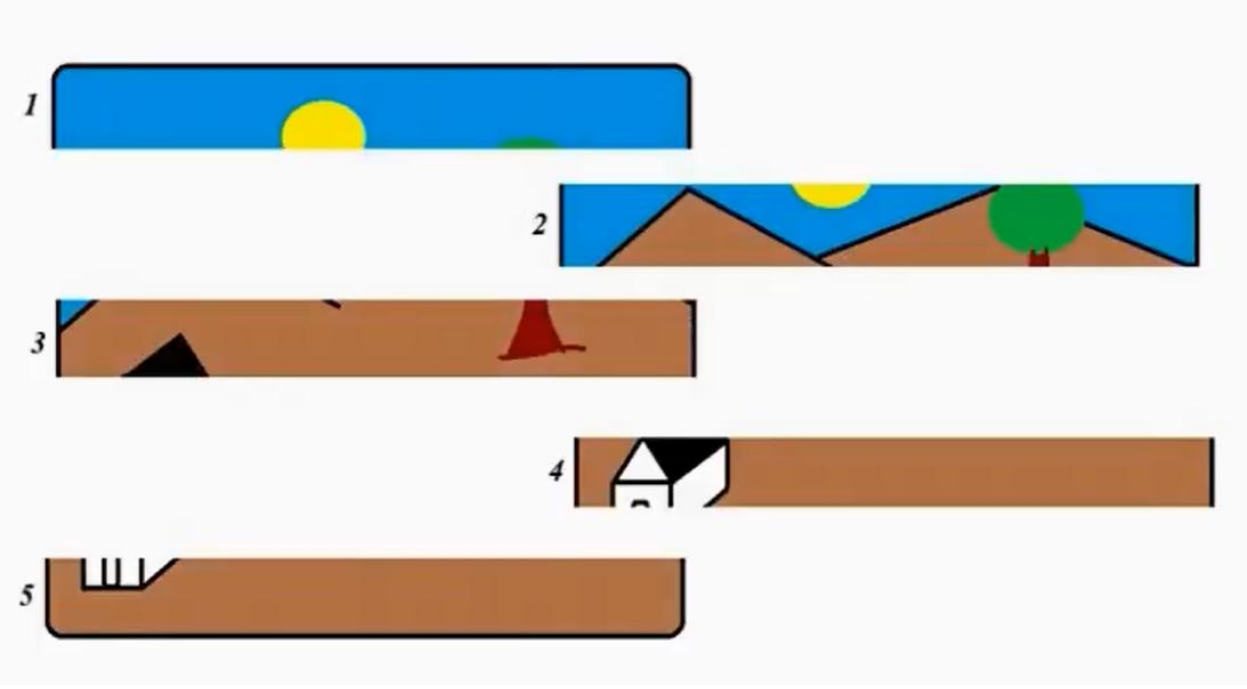





1
2
3
4
5

- There are two main TV systems using Interlace scanning: ***NTSC*** and ***PAL***.

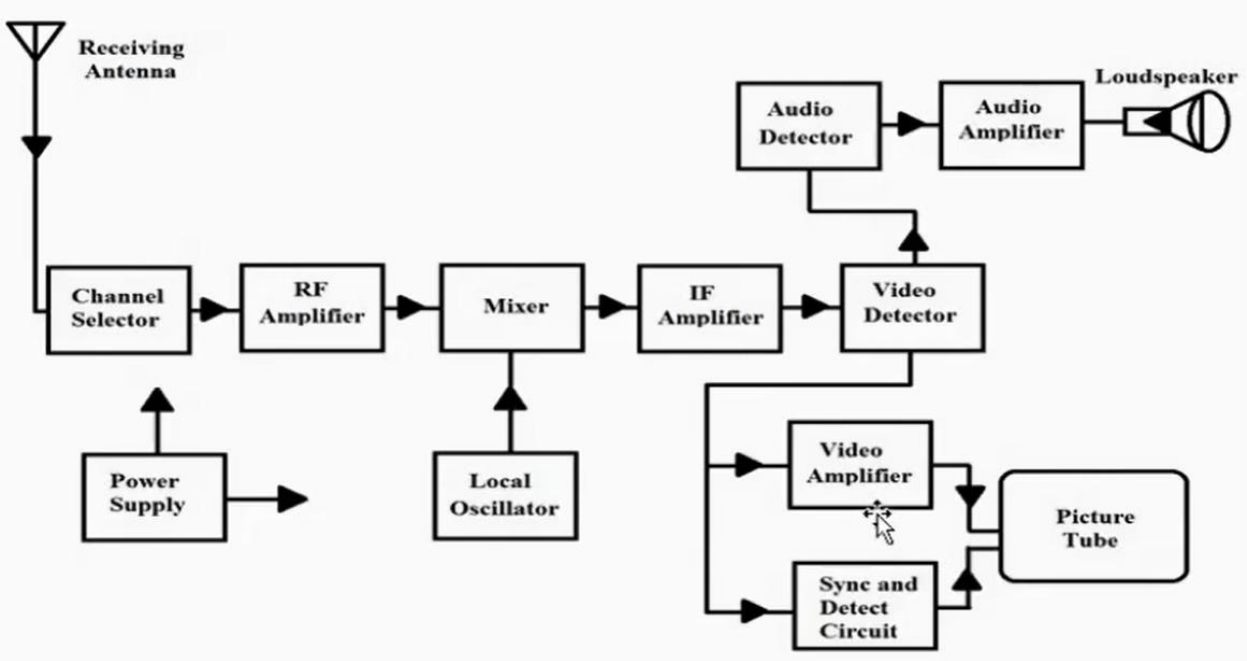
- NTSC is based on a system of ***525-lines, 60 fields, and 30 frames-per-second at 60Hz***.

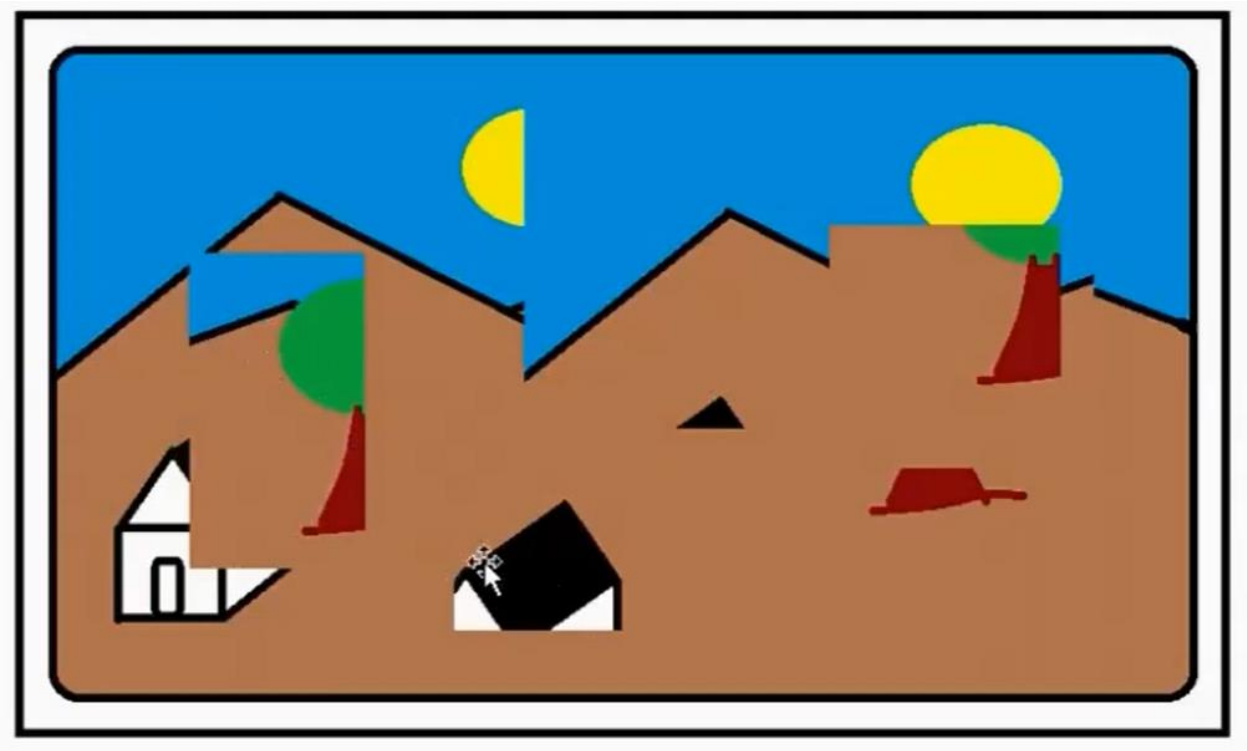
- PAL is based on a system of ***625 lines, 50 fields, and 25 frames-per-second at 50Hz***.

Synchronisation

- It is the process by which the ***horizontal and vertical sweeps of the electron beam*** at both the ***camera (transmitter)*** and ***picture tube (receiver)*** are ***kept in step with each other***.

- So ***separate synchronising signals are transmitted along with the picture information***. They are also called as ***timing pulses*** and are ***rectangular in shape***.


Receiving Antenna
Audio Detector
Audio Amplifier
Loudspeaker
Channel Selector
RF Amplifier
Mixer
IF Amplifier
Video Detector
Power Supply
Local Oscillator
Video Amplifier
Picture Tube
Sync and Detect Circuit



Composite Video Signal

- The composite video signal consists of:

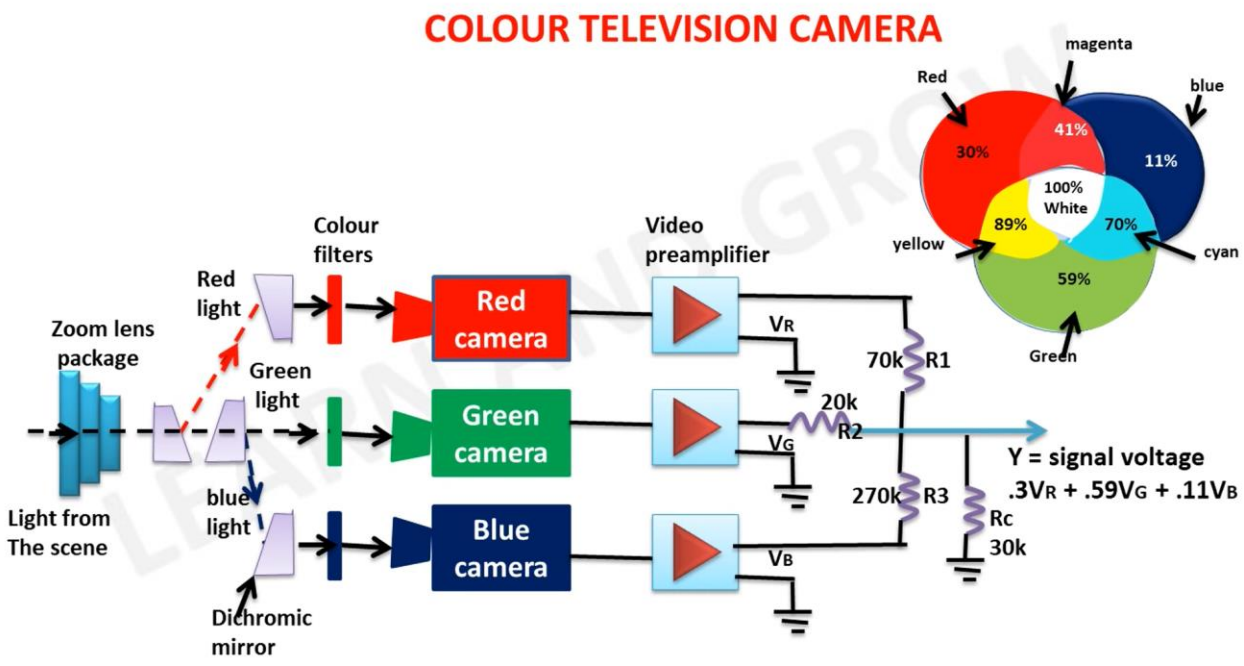
1. **Video signal *(picture information or pixels)***
2. **Horizontal (line) and Vertical (field) synchronising pulses**
3. **Blanking pulses**
4. **Equalising pulses**

Blanking

- The process of making the retrace of the electron beam invisible is called as ***blanking***.

- For this, ***blanking pulses*** are also transmitted.

COLOUR TELEVISION CAMERA



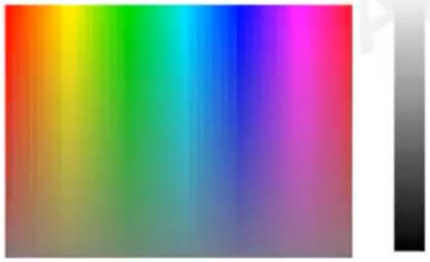
GAMA CORRECTION =

100% WHITE LIGHT adjust a value of 1 volt

LEARN AND GROW

LUMINANCE = **Brightness**

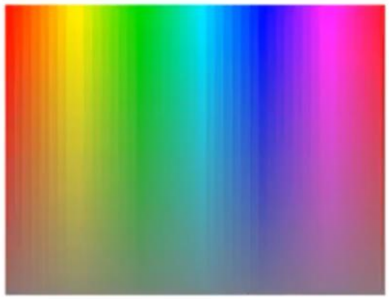
Luminance show the intensity of light.



HUE = **COLOUR**

Colour of object show by hue it is also called tint

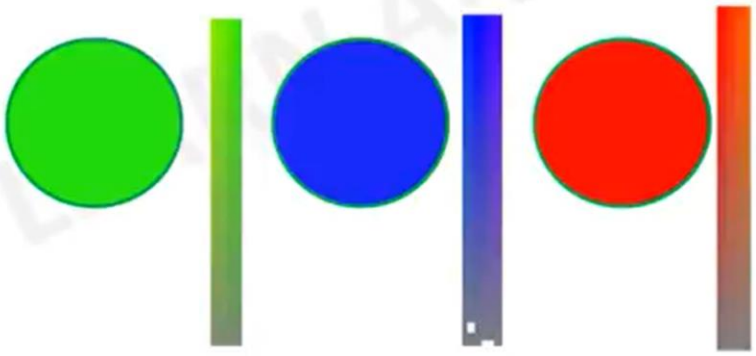
Red apple has red hue .



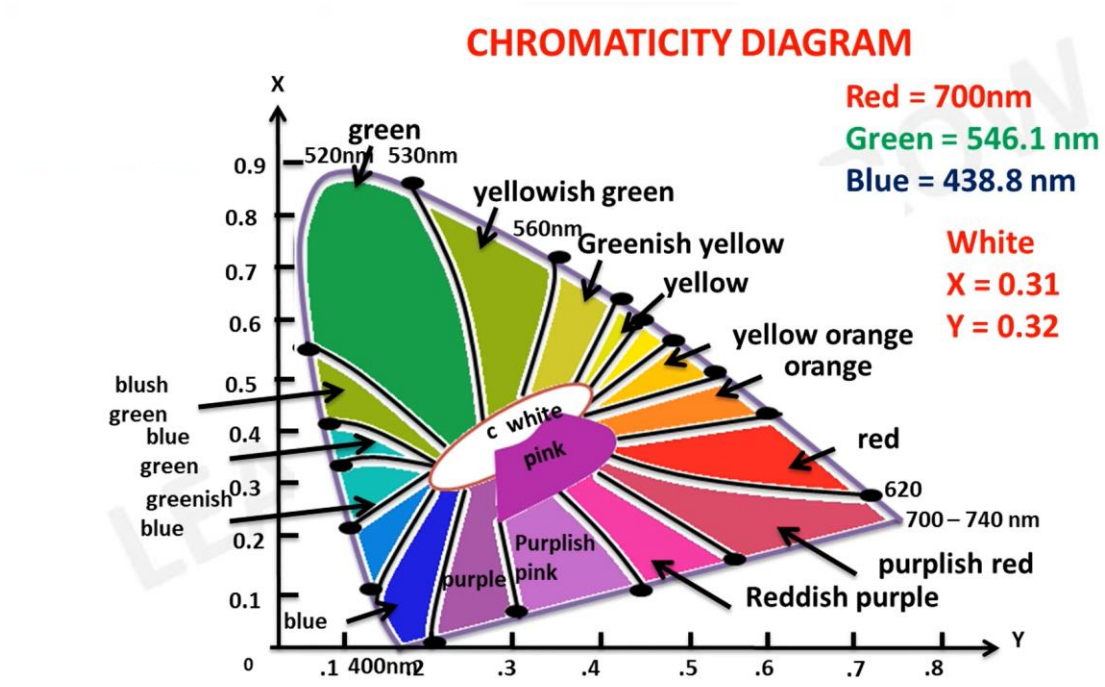
SATURATION = **PURITY OF COLOUR**

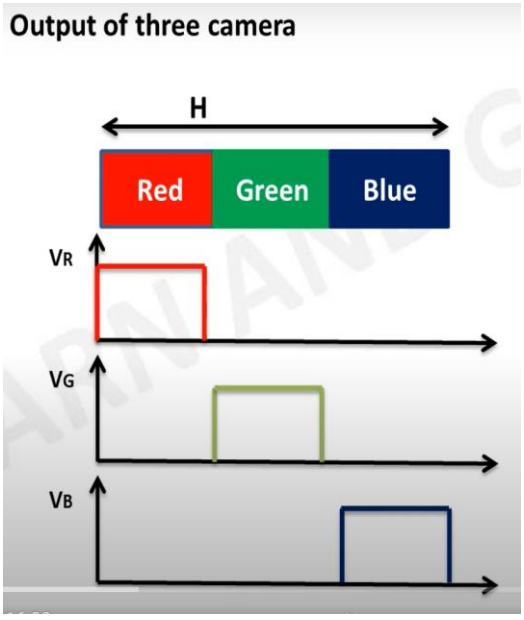
HOW colour dilute by white

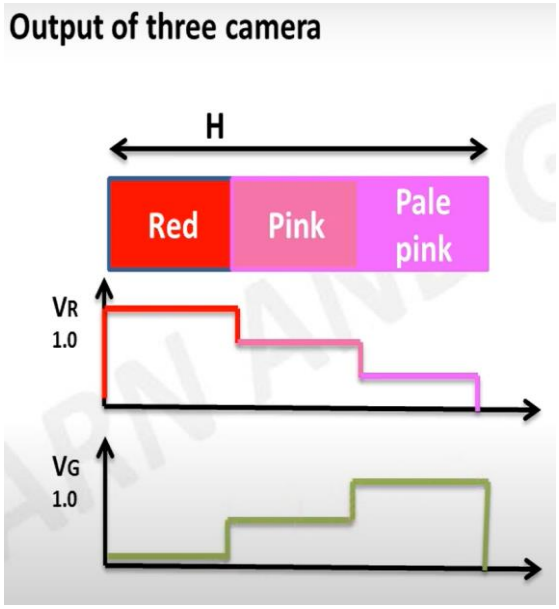
No any white colour present in saturated colour .



Hue + Saturation = Chrominance

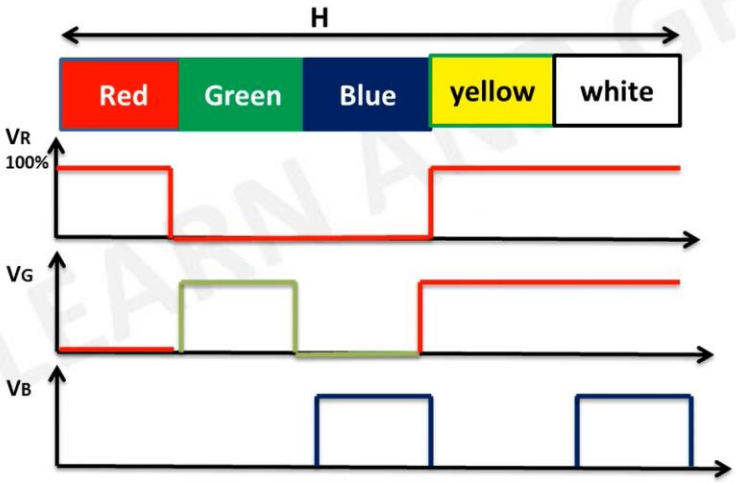


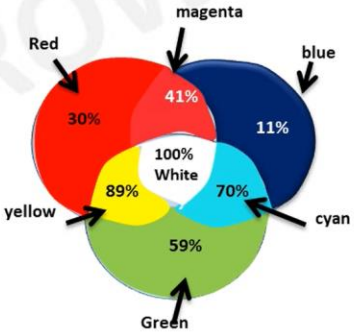




LUMINANCE SIGNAL AMPLITUDE

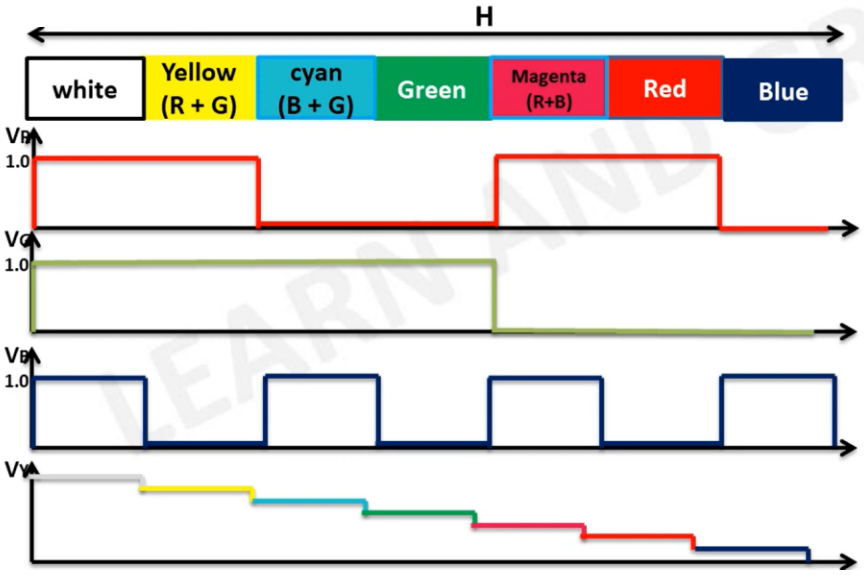
Red green blue camera video output

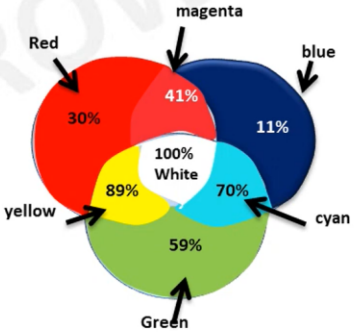




LUMINANCE SIGNAL AMPLITUDE

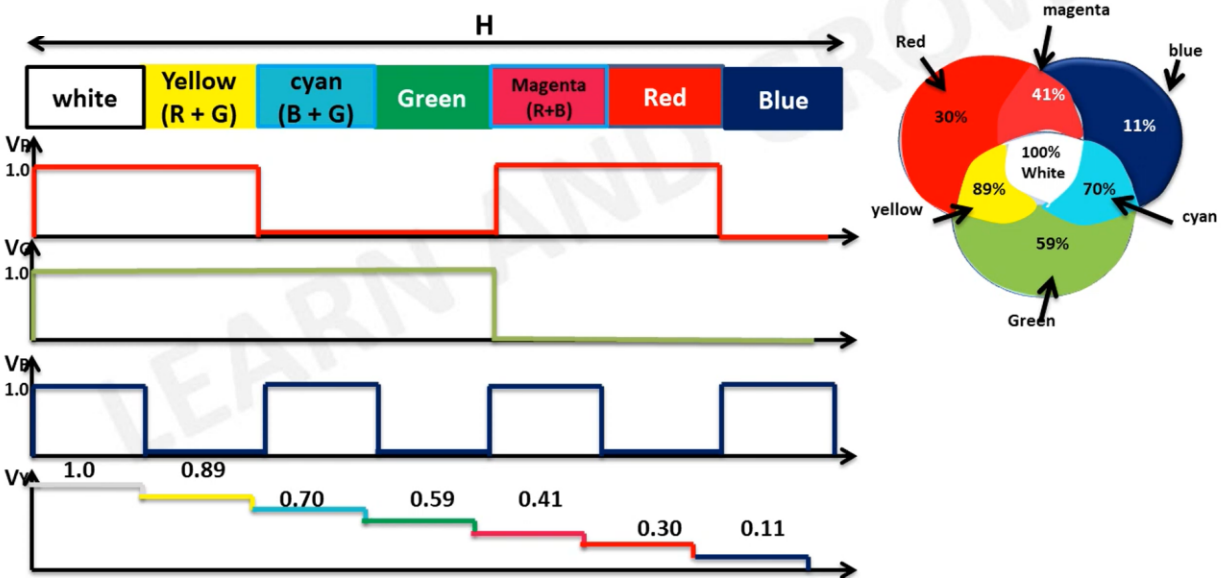
Formation of luminance Y video signal with matrix .



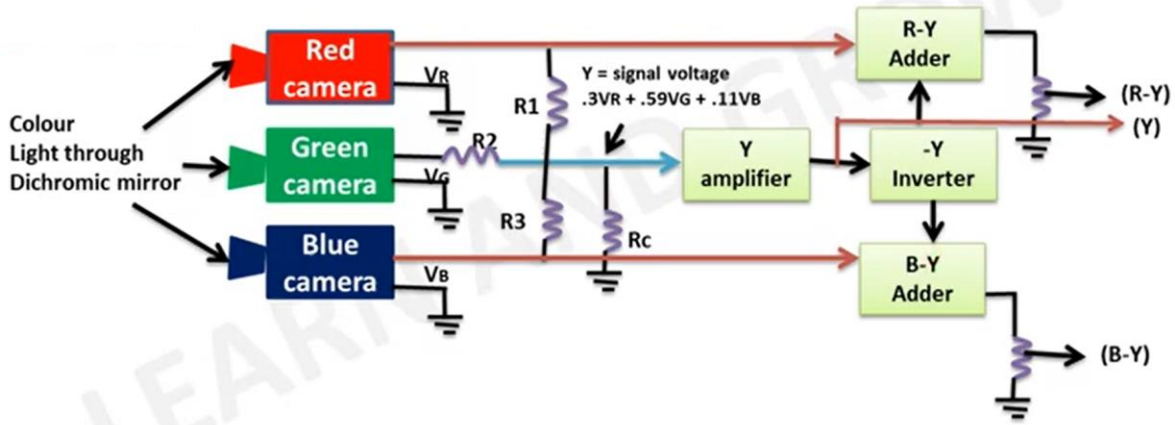


LUMINANCE SIGNAL AMPLITUDE

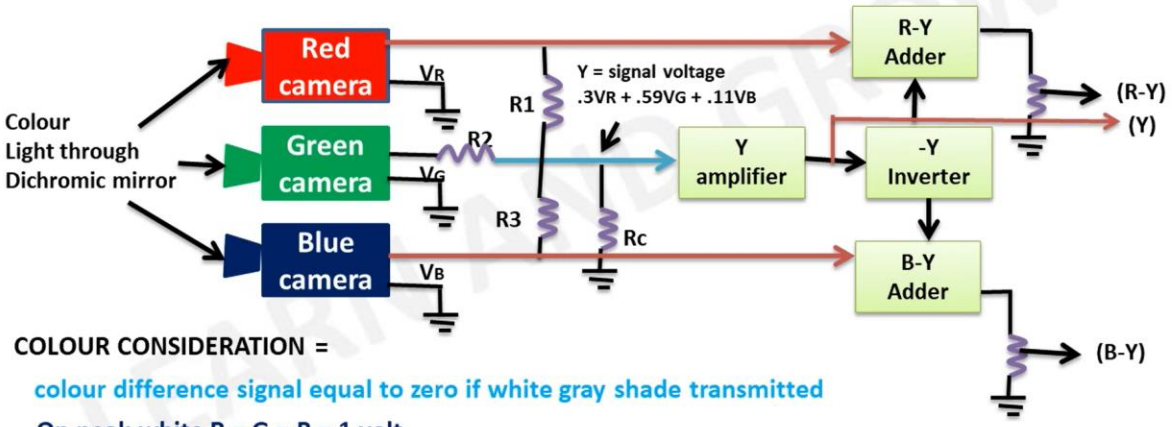
Formation of luminance Y video signal with matrix .



PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



COLOUR CONSIDERATION =

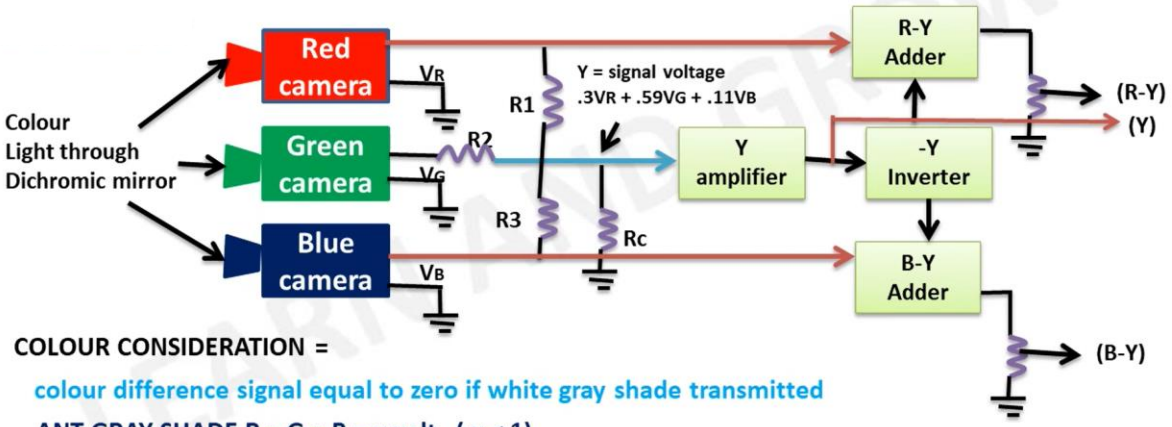
colour difference signal equal to zero if white gray shade transmitted

On peak white R = G = B = 1 volt

$Y = .59G + .3R + .11B$ $Y = .59 + .3 + .11 = 1$volt

$(R - Y) = 1 - 1 = 0$ volt $(B - Y) = 1 - 1 = 0$ volt

PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



COLOUR CONSIDERATION =

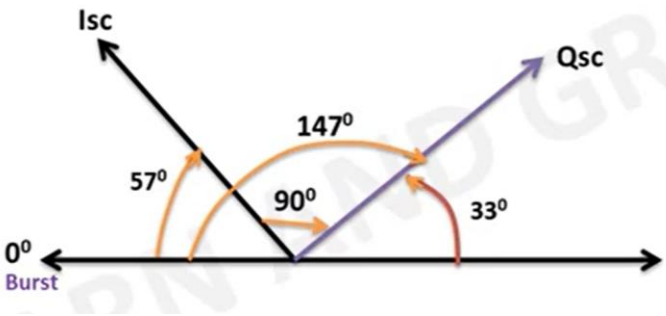
colour difference signal equal to zero if white gray shade transmitted

ANT GRAY SHADE R = G = B = v volt (v < 1)

$Y = .59v + .3v + .11v$ $Y = .59 + .3 + .11 = v$ volt

$(R - Y) = v - v = 0$ volt $(B - Y) = v - v = 0$ volt

NTSC COLOUR TELEVISION SYSTEM



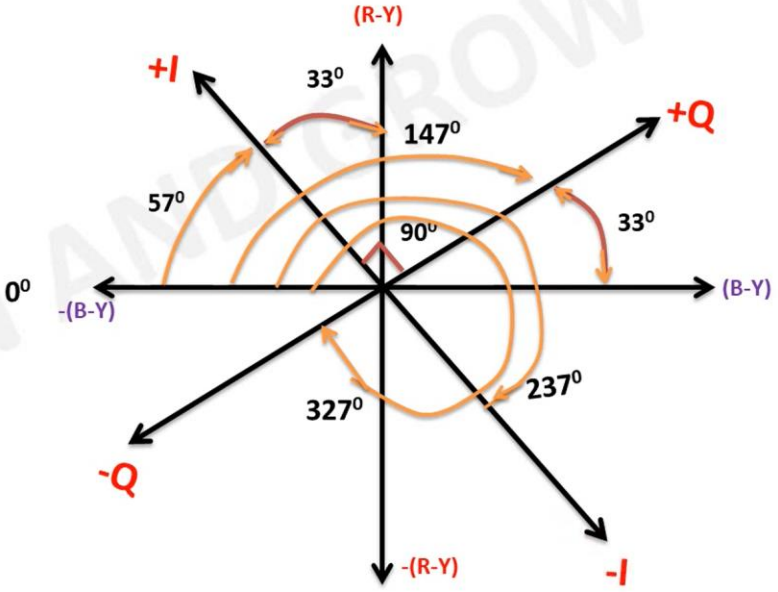
NTSC COLOUR TELEVISION SYSTEM

$I = 0.60R - 0.28G - 0.32B$

$I = 0.74(R - Y) - 0.27(B - Y)$

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

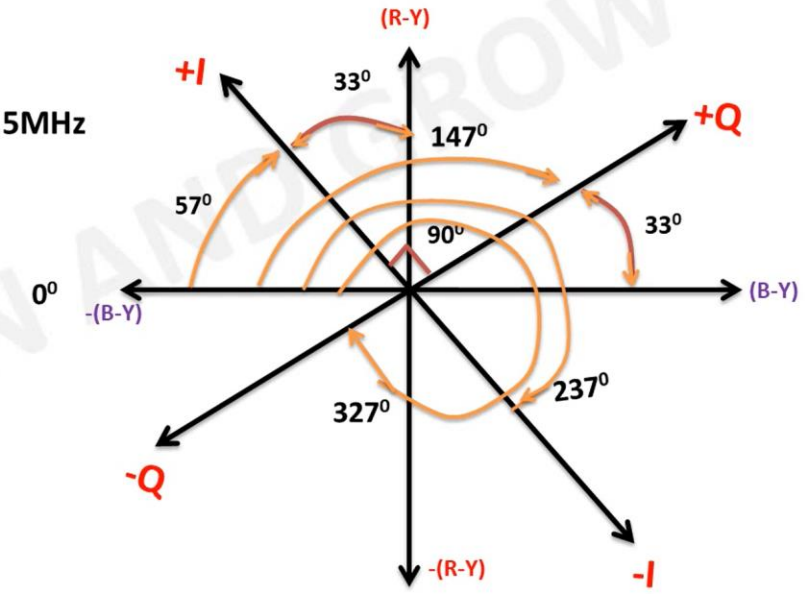
$Q = 0.48(R - Y) - 0.41(B - Y)$



NTSC COLOUR TELEVISION SYSTEM

I signal allow frequency 1.5MHz

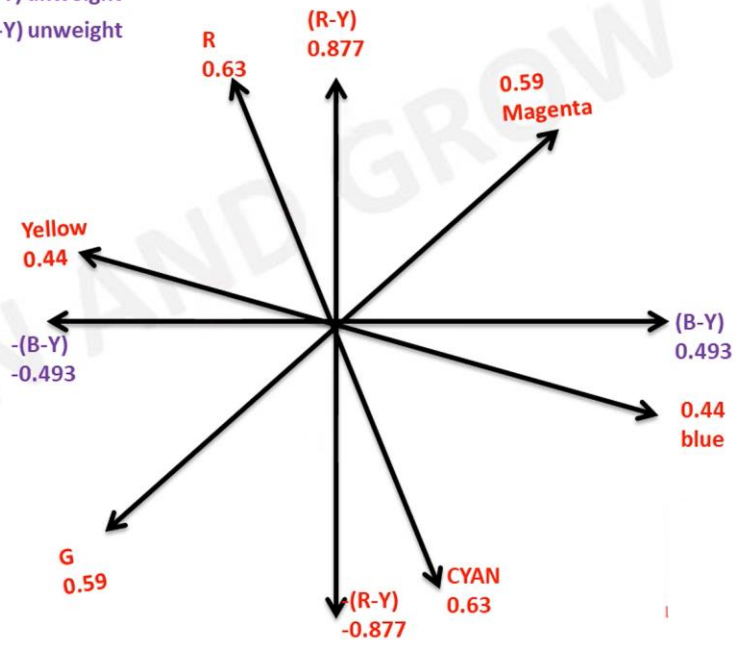
$Q \pm 0.5MHz$

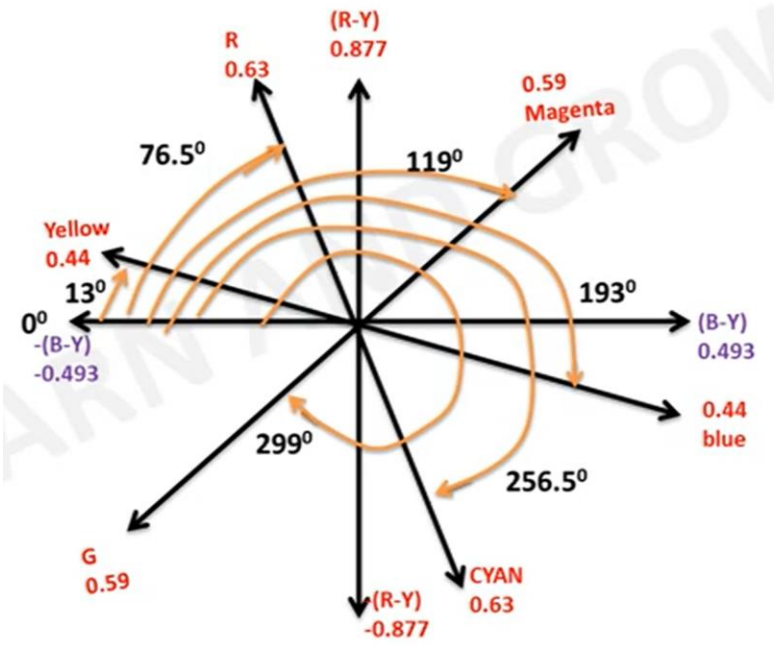


(B-Y)weighted = 0.493(B-Y) unweight

(R-Y)weighted = 0.877(R-Y) unweight

COLOUR	B-Y weight	R-Y weight	Csc
white	0	0	0
Yellow (R + G)	-.4385	+.096	0.44
cyan (B + G)	+.148	-.614	0.63
Green	-.29	-.517	0.59
Magenta (R+B)	+.29	+.517	0.59
Red	-.148	+.614	0.63
Blue	+.4385	-.096	0.44
Black	0	0	0





There are only three television standards in the world: **NTSC**, **PAL**, and **SECAM**. Each has their own attributes and they are not compatible with each other.

NTSC (National Television Standards Committee) is the oldest existing standard, developed in the USA and first used in 1954. It's parameters are as follows:

Lines: 625

Frame rate: 29.97 Hz

Picture resolutions: 720 x 480; 704 x 480; 352 x 480; 352 x 240

The Countries that support NTSC video are as follows:

Antilles, Netherlands, Bahamas, Barbados, Belize, Bermuda, Bolivia, Burma, Canada, Chile, Columbia, Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, Grenada, Guatemala, Honduras, Jamaica, Japan, Mexico, Panama, Peru, Philippines, Puerto Rico, South Korea, Surinam, Taiwan, Tobago, Trinidad, United States of America, Venezuela.

PAL (Phase Alternating Line) was developed in 1967 by the United Kingdom & Germany. PAL standard utilizes a wider channel bandwidth than NTSC which allows for better picture quality. It's Parameters are as follows:

Lines: 525

Frame rate: 25 Hz

Picture resolution: 720 x 576; 704 x 576; 352 x 576; 352 x 288

The countries that support PAL are as follows:

Algeria, Andorra, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Belgium, Botswana, Brazil, Brunei, Cameroon, China, Denmark, Ethiopia, Fiji, Finland, Germany, Ghana, Gibraltar, Hong Kong, Iceland, India, Indonesia, Ireland, Israel, Italy, Jordan, Kenya, Kuwait, Lesotho, Liberia, Luxemburg, Malawi, Malaysia, Maldives, Malta, Mozambique, Namibia, Netherlands, New Zealand, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Paraguay, Portugal, Qatar, Rumania, Seychelles, Sierra Leone, Singapore, Somalia, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Syria, Tanzania, Thailand, Turkey, Uganda, United Arab Emirates, United Kingdom, Uruguay, Yemen, Yugoslavia, Zambia, Zimbabwe.

SECAM (Sequential couleur memoire) was developed in France in 1967. SECAM uses the same bandwidth and resolution (720x576) as PAL but transmits the color information sequentially. Take note that only a handful of products support SECAM.

The countries that support SECAM are as follows:

Afghanistan, Benin, Burkina Faso, Bulgaria, Burundi, Central African Republic, Chad, Congo, Czechoslovakia, Djibouti, Egypt, France, French Guiana, Gabon, Greece, Guadalupe, Guinea, Gyprus, Haiti, Hungary, Iran, Iraq, Ivory Coast, Lebanon, Libya, Madagascar, Mali, Martinique, Mauritius, Mauritania, Monaco, Morocco, Niger, North Korea, Poland, Russia, Rwanda, Saudi Arabia, Senegal, Syria , Togo, Tunisia, Vietnam, Western Samoa, Zaire.

Chapter Name : Colour Television

Topic Name : Compatibility in Colour Television

- Compatibility implies that the colour television signal must produce a normal black and white picture on a monochrome receiver without any modification of the receiver circuitry and a colour receiver must be able to produce a black and white picture from a normal monochrome signal. This is referred to as reverse compatibility

Chapter Name : Colour Television

Topic Name : Compatibility in Colour Television

Must meet the following requirements:

(1) It should occupy the same bandwidth as the corresponding monochrome signal.

(2) The location and spacing of picture and sound carrier frequencies should remain the same.

(3) The colour signal should have the same luminance (brightness) information as would a monochrome signal, transmitting the same scene.

Chapter Name : Colour Television

Topic Name : Compatibility in Colour Television

(4) The composite colour signal should contain colour information together with the ancillary signals needed to allow this to be decoded.

(5) The colour information should be carried in such a way that it does not affect the picture reproduced on the screen of a monochrome receiver.

(6) The system must employ the same deflection frequencies and sync signals as used for monochrome transmission and reception

Topic Name : Colour Television Standards

The two mains power frequencies worldwide are 50Hz and 60Hz. This meant that there was an immediate division in the TV standards - the one with 25 frames per second (50 Hz) and 30 frames per second (60 Hz). Most of the compatibility problems between TV standards across the world stem from this basic difference in frequencies

Chapter Name : Colour Television

Topic Name : Colour Television Standards

NTSC (National Television Standards Committee)

The majority of 60Hz based countries use a technique known as NTSC originally developed in the United States by a focus committee called the National Television Standards Committee. NTSC works perfectly in a video or closed circuit environment but can exhibit problems of varying colour when used in a broadcast environment.

Chapter Name : Colour Television

Topic Name : Colour Television Standards

PAL (Phase Alternate Lines)

This hue change problem is caused by shifts in the colour sub-carrier phase of the signal. A modified version of NTSC soon appeared which differed mainly in that the sub-carrier phase was reversed on each second line; this is known as PAL, standing for Phase Alternate Lines. PAL has been adopted by a few 60Hz countries, most notably Brazil

Chapter Name : Colour Television

Topic Name : Colour Television Standards

SECAM

Amongst the countries based on 50Hz systems, PAL has been the most widely adopted. PAL is not the only colour system in widespread use with 50Hz; the French designed a system of their own -primarily for political reasons to protect their domestic manufacturing companies - which is known as SECAM, standing for Sequential Couleur Avec Memoire. The most common facetious acronym is System Essentially Contrary to American Method

Chapter Name : Colour Television

Topic Name : Colour Television Standards

- Since India adopted the 625 line CCIR (B standards) monochrome system it has chosen to introduce the PAL system* (B & G standards) because of compatibility between the two , and also due to its somewhat superior performance over the other two systems

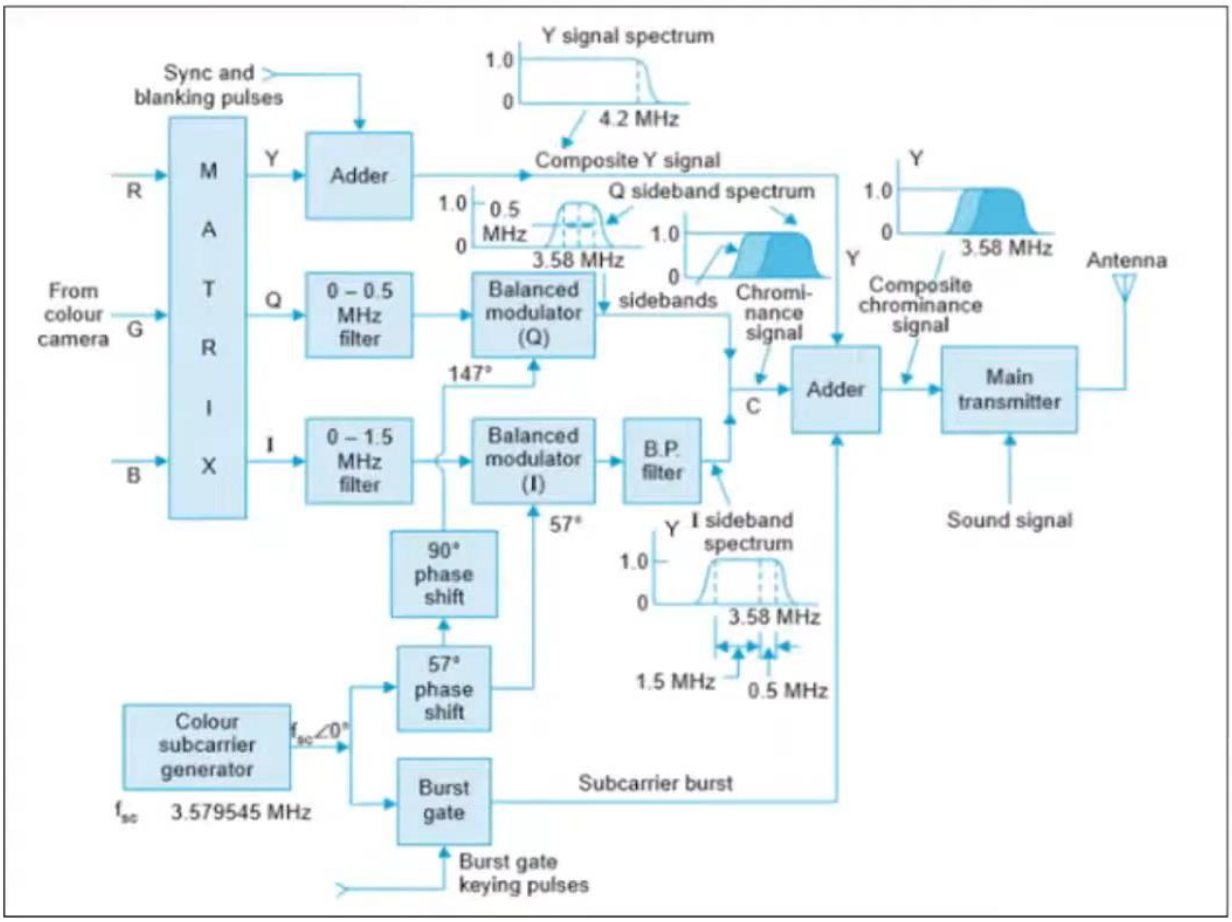
- In many respects transmission and reception techniques employed in the NTSC and PAL systems are similar. These are, therefore, treated together before going into encoding and decoding details of each system. The SECAM system, being much different from the other two

Topic Name : Basic Characteristics of NTSC

National Television Standard Committee (NTSC) has below basic characteristics :

- This system uses 525 lines per picture (frames)
- Field Frequency for these system is 59.94 nominal value as field/sec
- It uses line frequency fh 15734.264±0.0003%
- Assumed gamma of display device as 2.2
- Nominal video bandwidth of NTSC standard is 4.2Mhz

Topic Name : Block Diagram of NTSC Encoder



Encoding of Colour Picture Information

- Figure illustrates the encoding process of colour signals at the NTSC transmitter
- A suitable matrix is used to get both I and Q signals directly from the three camera outputs
- Since I = 0.60R – 0.28G – 0.32B, the green and blue camera outputs are inverted before feeding them to the appropriate matrix. Similarly for Q = 0.21R – 0.52G + 0.31B, in invertor is placed at the output of green camera before mixing it with the other two camera outputs

- ❑ The sideband restricted output from the *I* modulator combines with the output of *Q* modulator to form the chrominance signal
- ❑ It is then combined with the composite *Y* signal and colour burst in an adder to form composite chrominance signal
- ❑ The output from the adder feeds into the main transmitter and modulates the channel picture carrier frequency
- ❑ Note that colour subcarrier has the same frequency (3.579545 MHz) for all the stations whereas the assigned picture carrier frequency is different for each channel

Topic Name : Basics of PAL

PAL system majorly known as Phase Alternating Line is having following features :

- It is first adopted by Europe
- It is compatible with Europe's 625 line, 50 fields per second, 2:1 interlaced monochrome standard
- It is a modification of NTSC to overcome high order of phase and amplitude integrity requirements to avoid colour distortion. It implements this by line-by-line reversal of the phase of one of the colour components

- U & V signals (defined above) are used in transmission and the modulation is phase quadrature balanced modulation. The phase of the V is reversed on every other line so any colour sub-carrier phase errors are cancelled. Hence, hue errors are corrected by phase alternation
- The colour sub-carrier frequencies are different for different versions of PAL as defined below

Phase Alternating Line (PAL) is a colour encoding system for analogue television used in broadcast television systems. The basic characteristics are :

- This system uses 625 lines per picture (frames)
- Field Frequency for these system is 50 nominal value as field/sec
- It uses line frequency fh 15625±0.0001%
- Assumed gama of display device as 2:8
- Nominal video bandwidth of PAL standard is 5Mhz

Topic Name : Functional Block Diagram of PAL Encoder & its Working

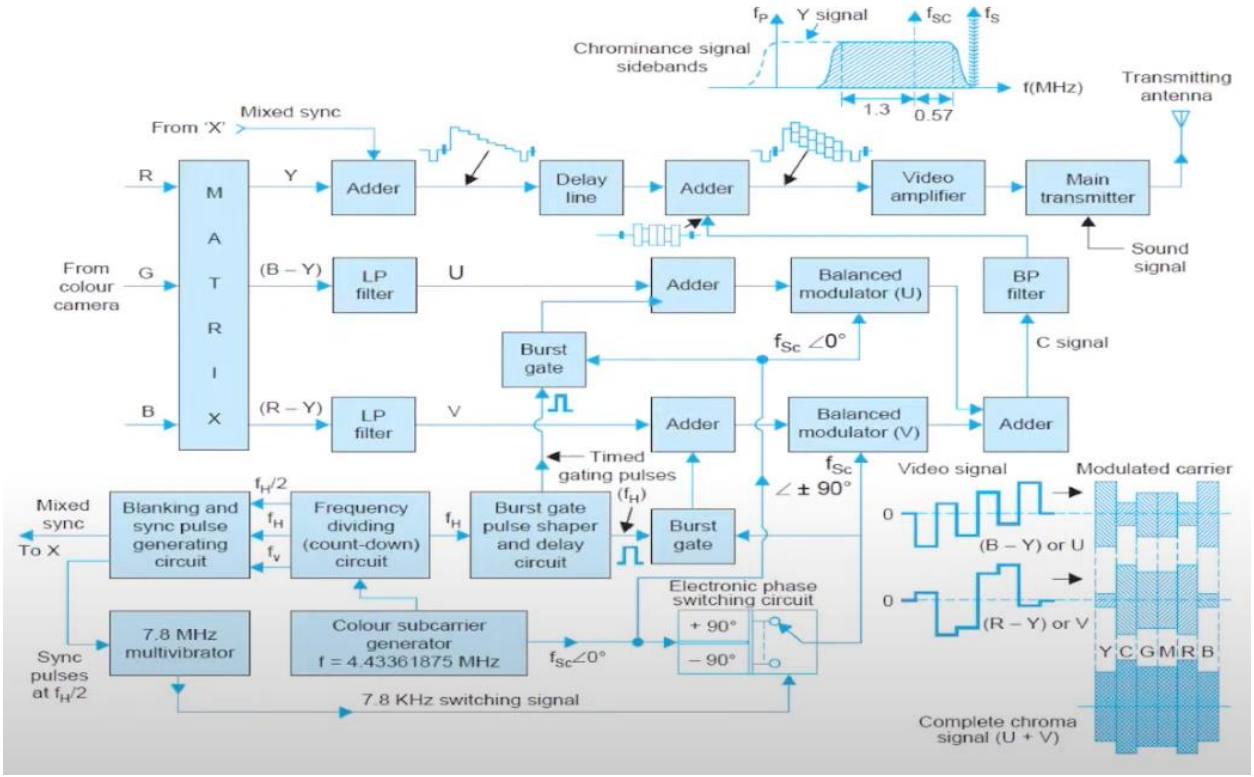


Figure shows the functional block diagram of PAL encoder.

- The gamma corrected *R, G* and *B* signals are matrixed to form the *Y* and the weighted colour difference signals
- The bandwidths of both $(B - Y)$ and $(R - Y)$ video signals are restricted to about 1.3 MHz by appropriate low pass filters
- The weighted colour difference video signals from the filters are fed to corresponding balanced modulators
- Since one switching cycle takes two lines, the square wave switching signal from the multivibrator to the electronic phase switch is of half-line frequency *i.e.*, approximately 7.8 KHz

Topic Name : Advantages & Disadvantages of NTSC & PAL

Advantages of NTSC

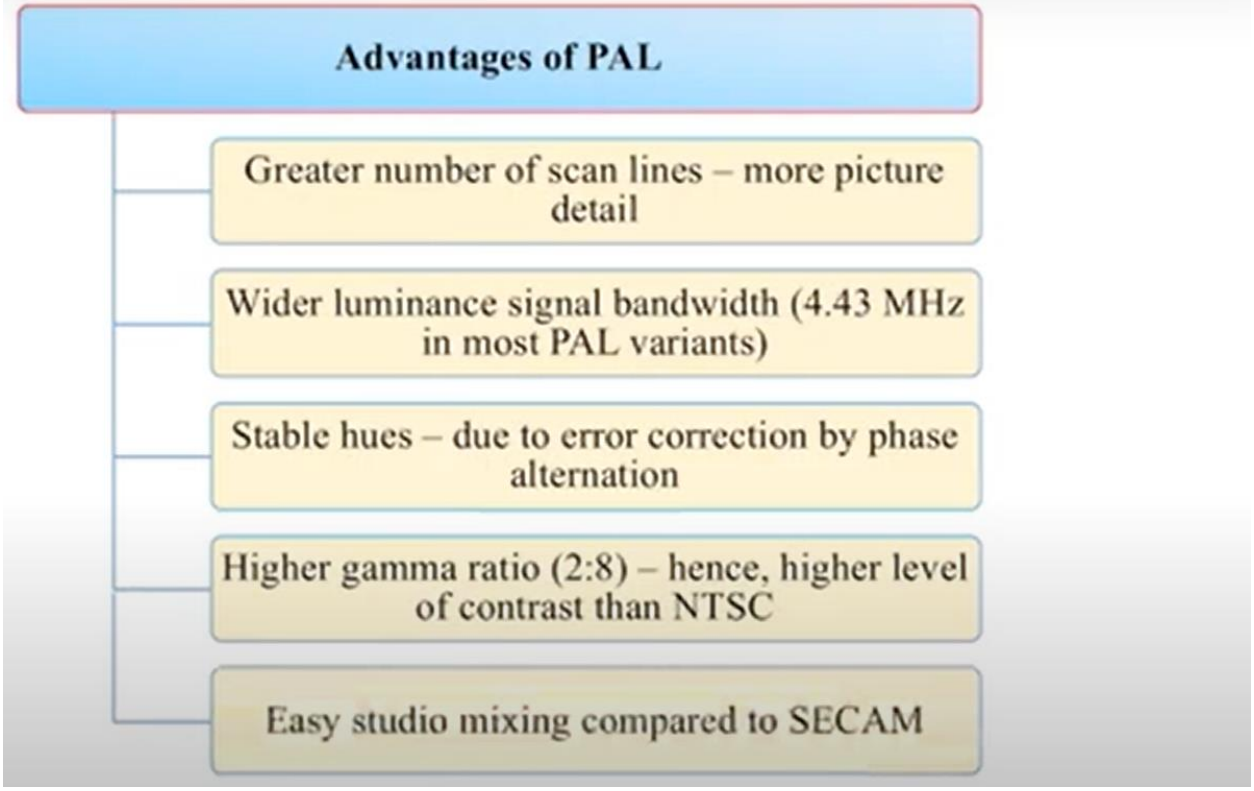
- Higher frame rate – reduces visible flicker
- Less inherent picture noise – better S/N ratio
- Simpler circuits than PAL & SECAM
- Easy studio mixing
- Less costly than PAL

Topic Name : Advantages & Disadvantages of NTSC & PAL

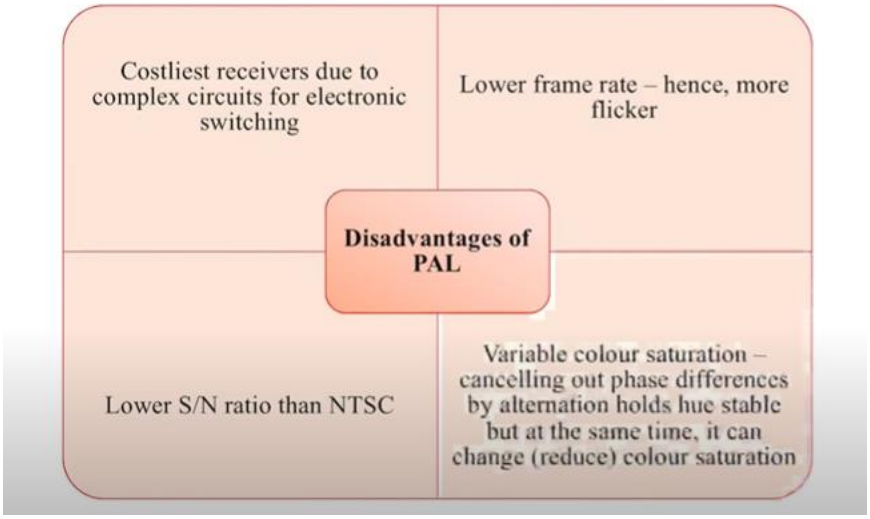
Disadvantages of NTSC

- Lower gamma ratio (2.2 as opposed to 2.8 in PAL systems)
- Susceptible to hue fluctuations
- More costly than SECAM
- Small luminance signal bandwidth (3.85 MHz) – increased likelihood of interference
- Lower number of scan lines – means reduced quality on large TV screens

Topic Name : Advantages & Disadvantages of NTSC & PAL



Topic Name : Advantages & Disadvantages of NTSC & PAL



Parameter	NTSC	PAL	SECAM
Developed/adopted in	US	Europe(UK)	France
Number of lines	525	625	625
Frames/second	60	50	50
Color info transmission	U & V or I & Q are used	U & V are used	Db & Dr are used

Parameter	NTSC	PAL	SECAM
Sub-carrier Frequency	3.58 MHz	4.43 Mhz	4.25 or 4.4 MHz
Color Burst	9 cycles of sub-carrier frequency	10 cycles of sub-carrier frequency	burst cycles of red and blue sub-carrier frequency
Variants	4.43, J, M	B, D, G, H, I, N, M & N_c	B, G, D, K, K_1, L
Cost	Medium Cost	Most Expensive	Least Expensive
Studio Mixing	Easiest	Medium Ease	Difficult