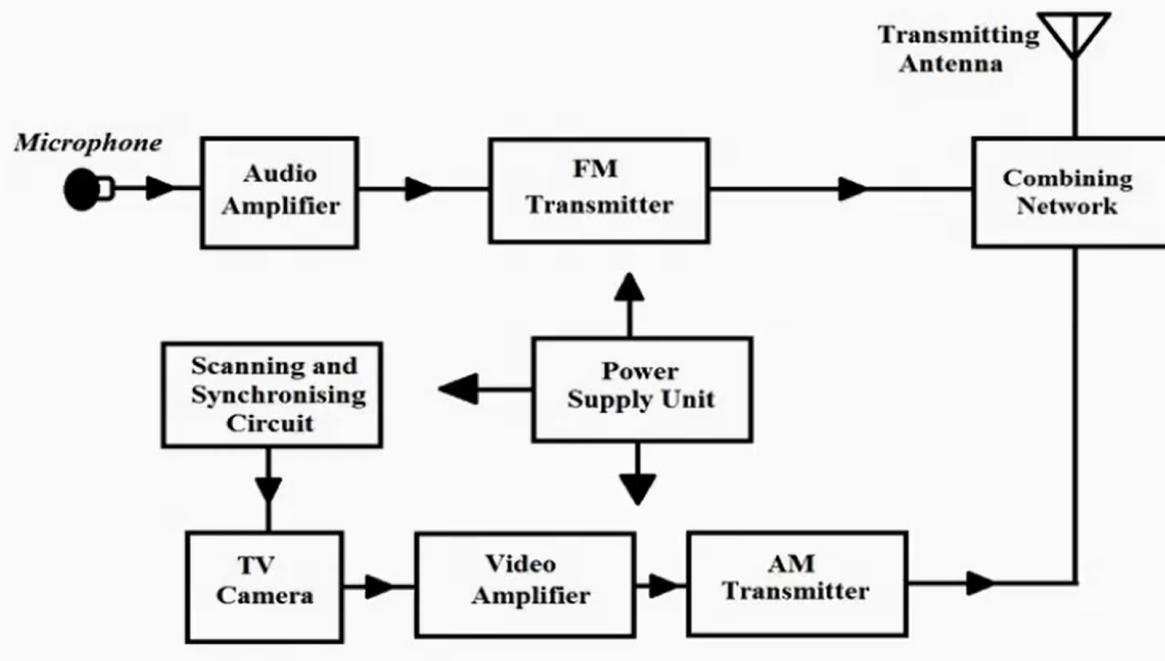


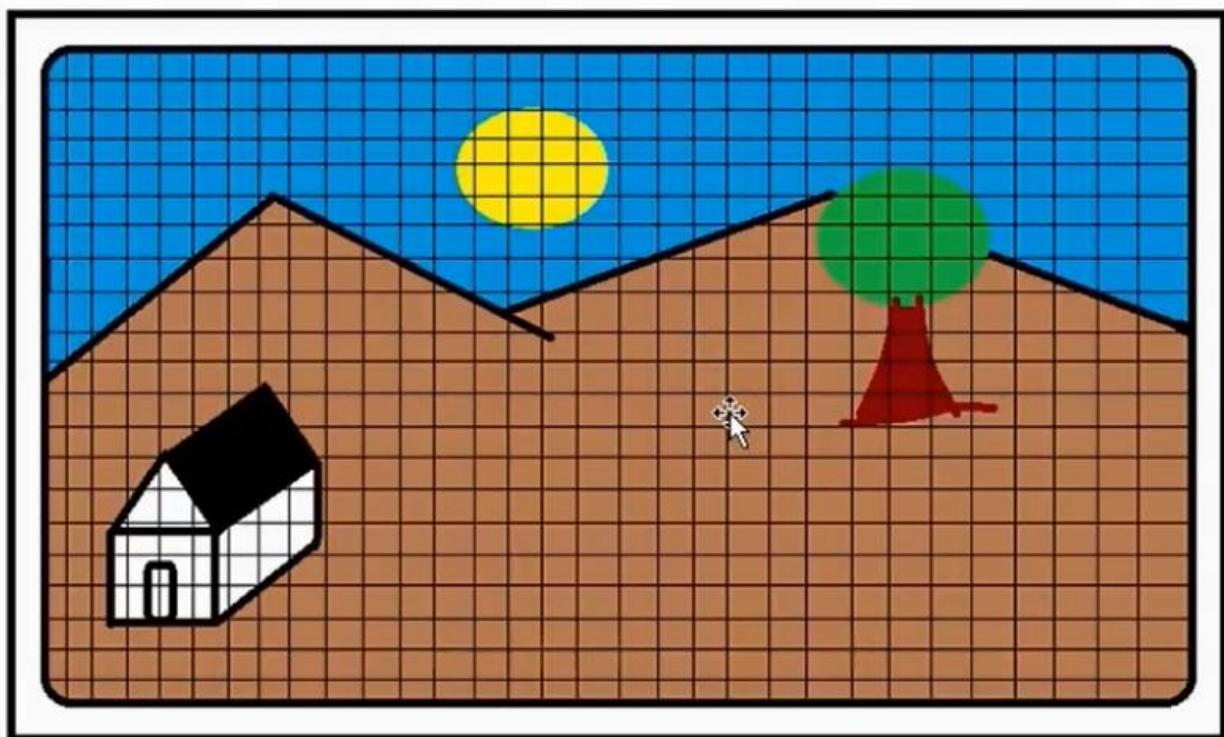
Scanning and Synchronisation in TV – Basic Concepts

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**

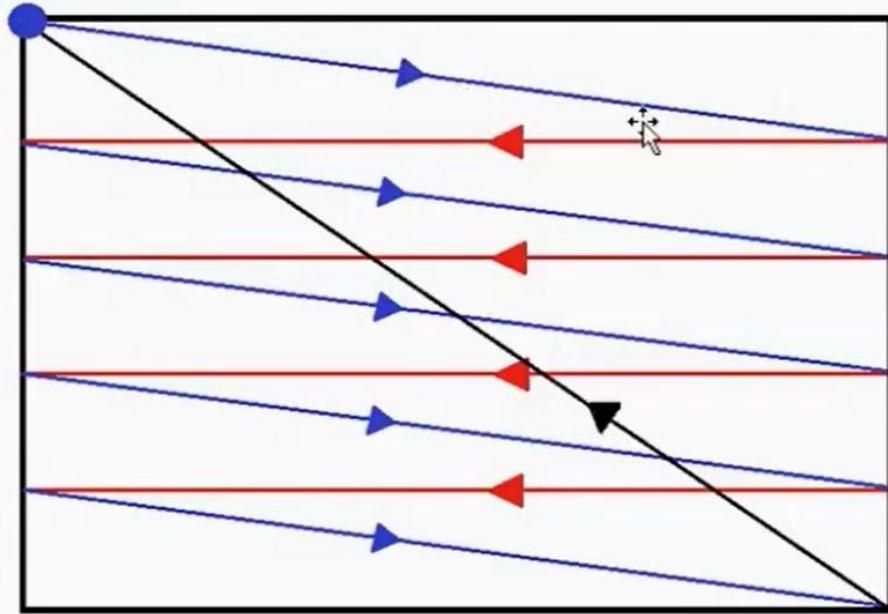


- The process of scanning is similar to the process of reading a book. We start from left end of the page to the right, then again down to the left and this process continues for the whole page.
- Similarly, the image or picture to be transmitted is divided into a number of horizontal stripes or lines. 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

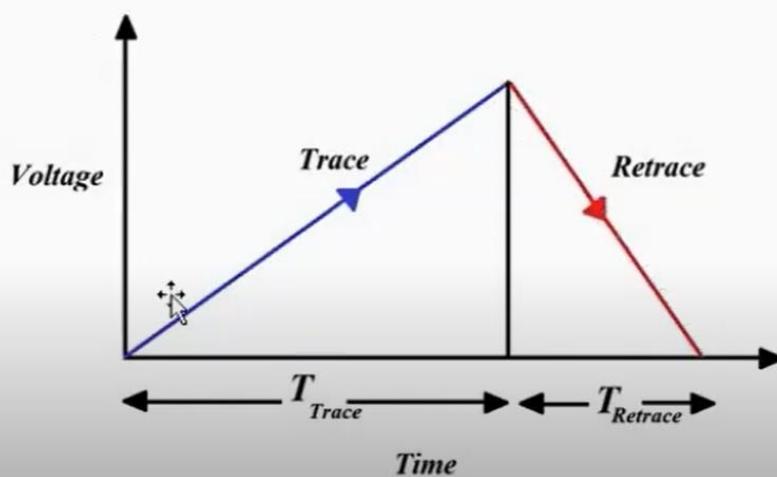
- Progressive Scanning is also called as Direct Scanning.
- Here, an electron beam scans the picture frame from left to right and goes from top to bottom until it reaches the extreme right at the bottom.

Electron Beam



*Image
Frame*

Sawtooth Scanning Waveforms



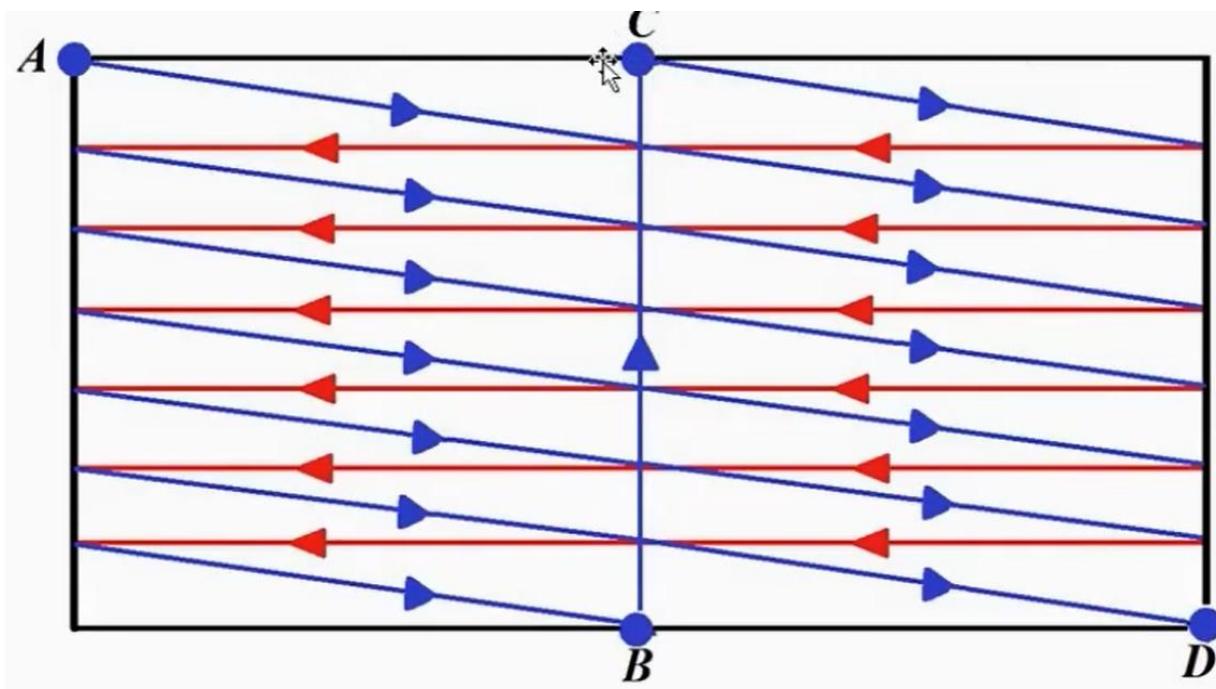
- One complete scan of a picture frame at the transmitter produces one complete picture frame at the receiver side.
- The *no. of scanning lines can vary*. It generally has values such as **405, 525, 625, 819**.
- This method is simple but produces **Flicking effect**.

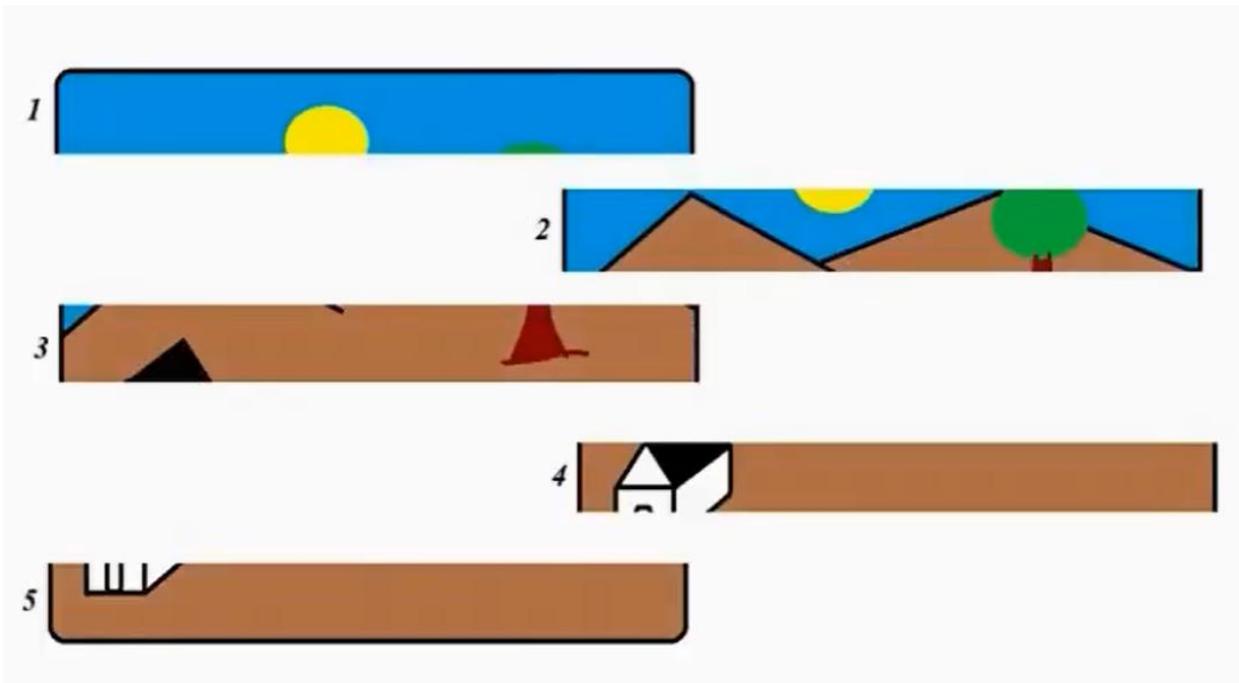
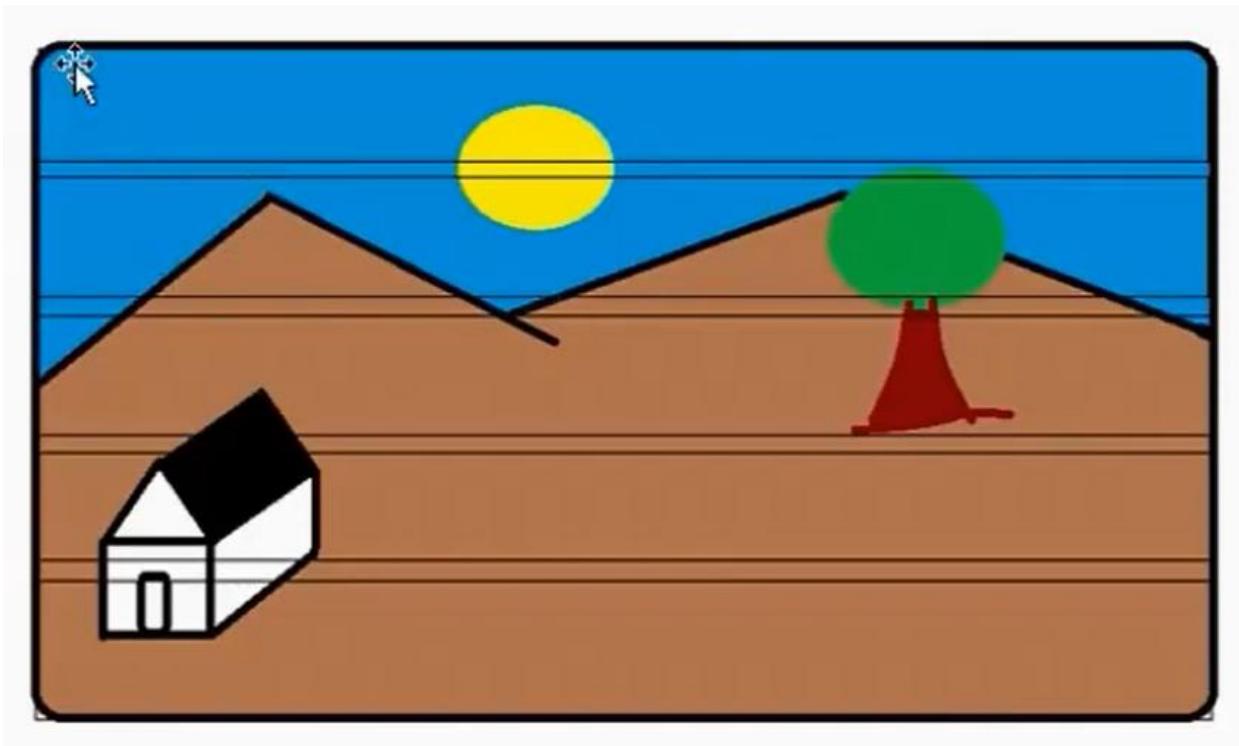
Interlaced Scanning

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

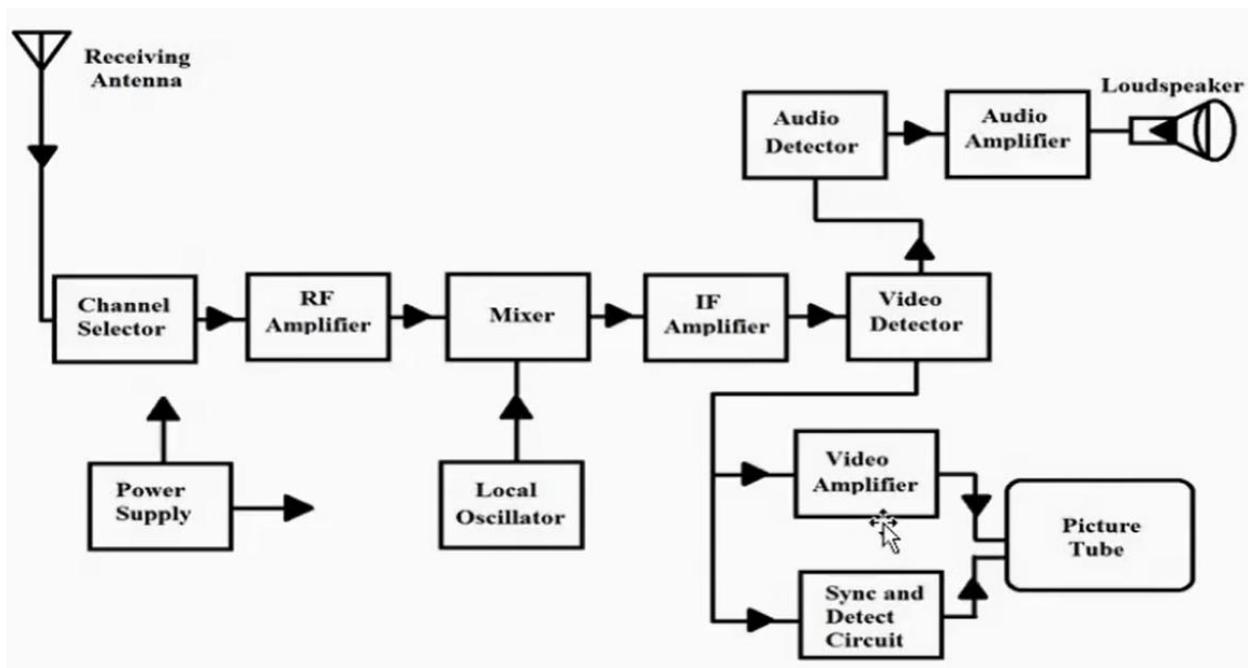




- There are two main TV systems using **Interlace scanning**: **NTSC** and **PAL**.
- **NTSC** is based on a system of **525-lines, 60 fields, and 30 frames-per-second at 60Hz**.
- **PAL** is based on a system of **625 lines, 50 fields, and 25 frames-per-second at 50Hz**.

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**.



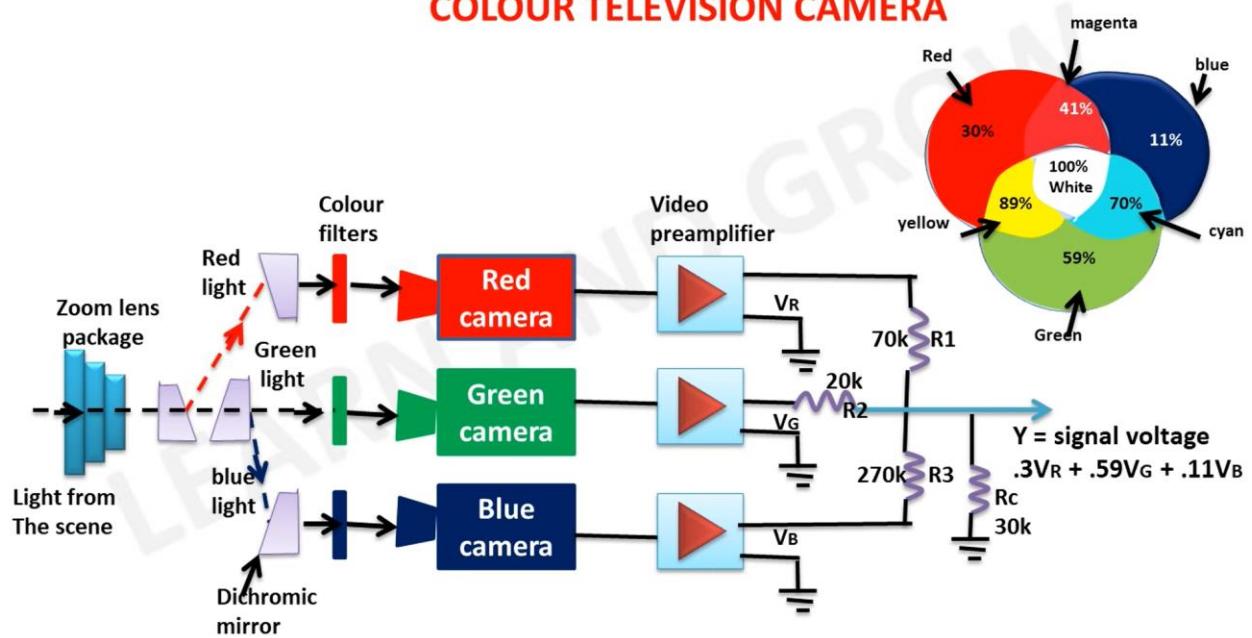
Composite Video Signal

- 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 =

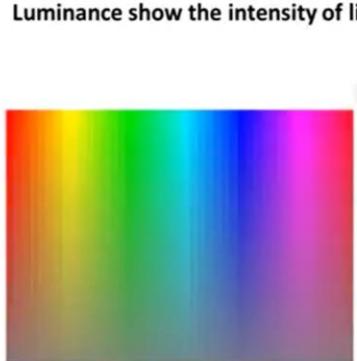
100% WHITE LIGHT adjust a value of 1 volt



LEARN AND GROW

LUMINANCE =

Brightness

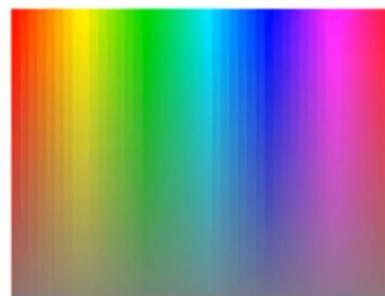


HUE =

COLOUR

Colour of object show by hue it is also called tint

Red apple has red hue .

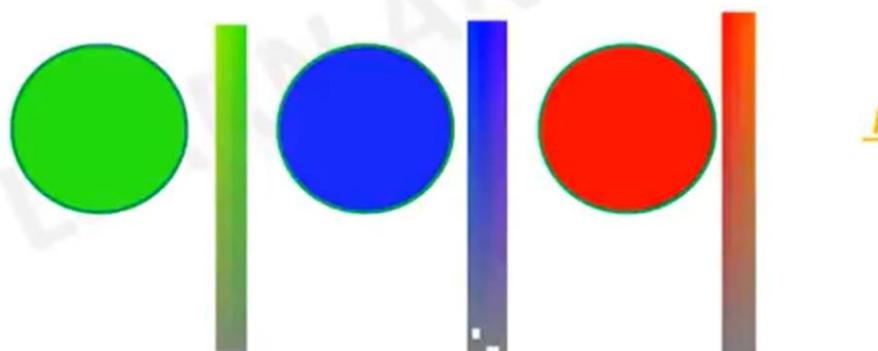


SATURATION =

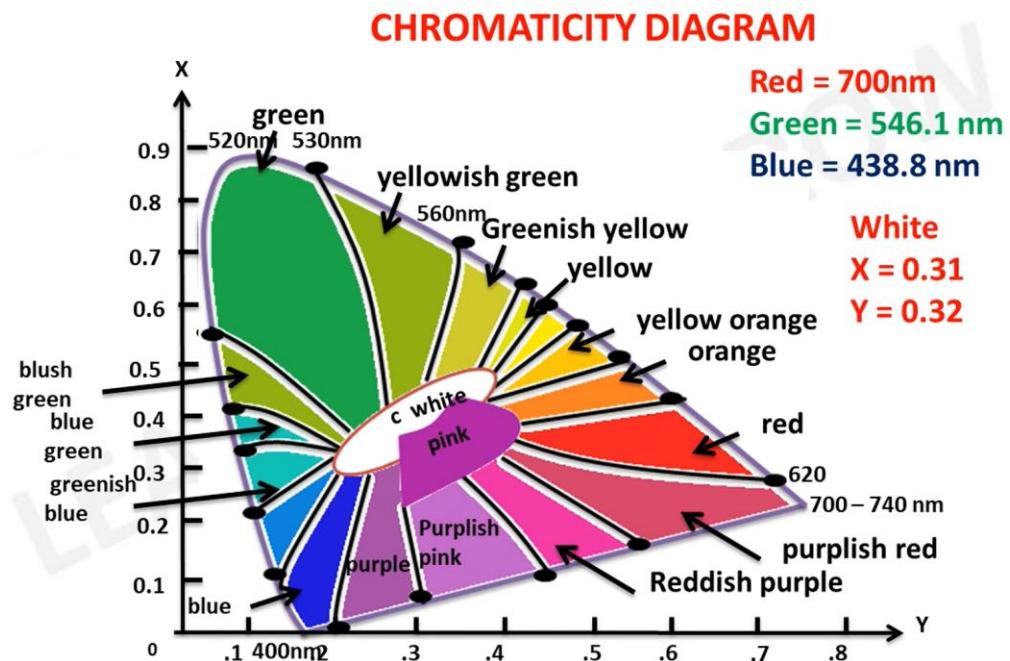
PURITY OF COLOUR

HOW colour dilute by white

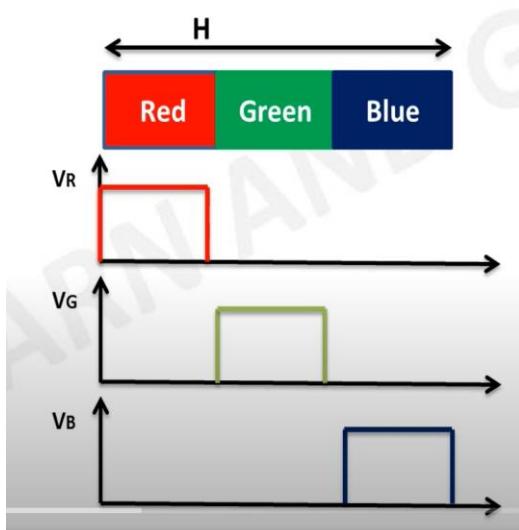
No any white colour present in saturated colour .



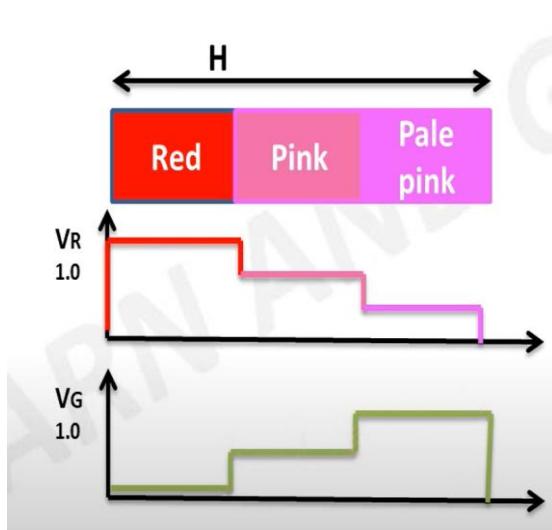
Hue + Saturation = Chrominance



Output of three camera

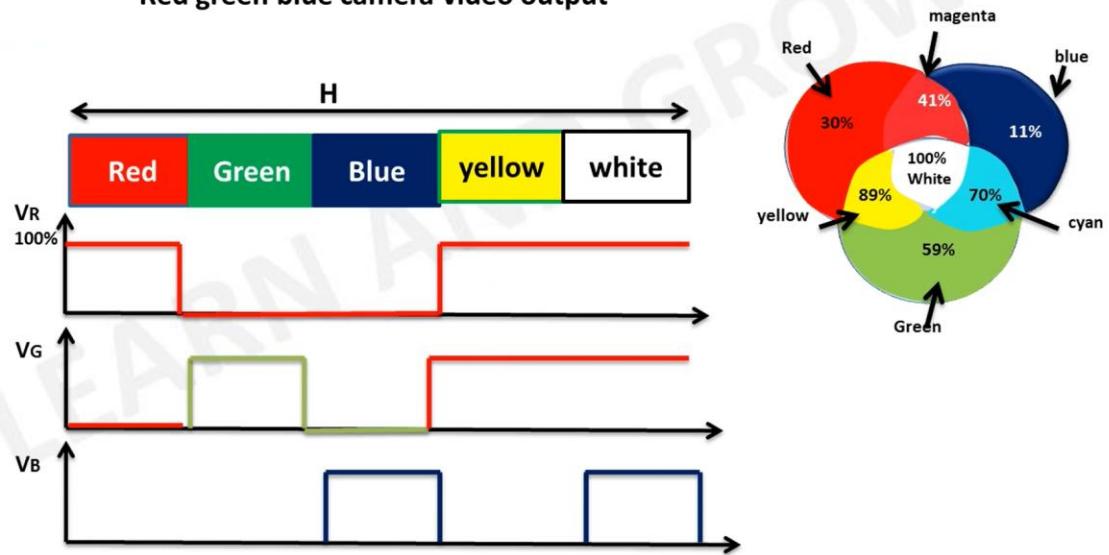


Output of three camera



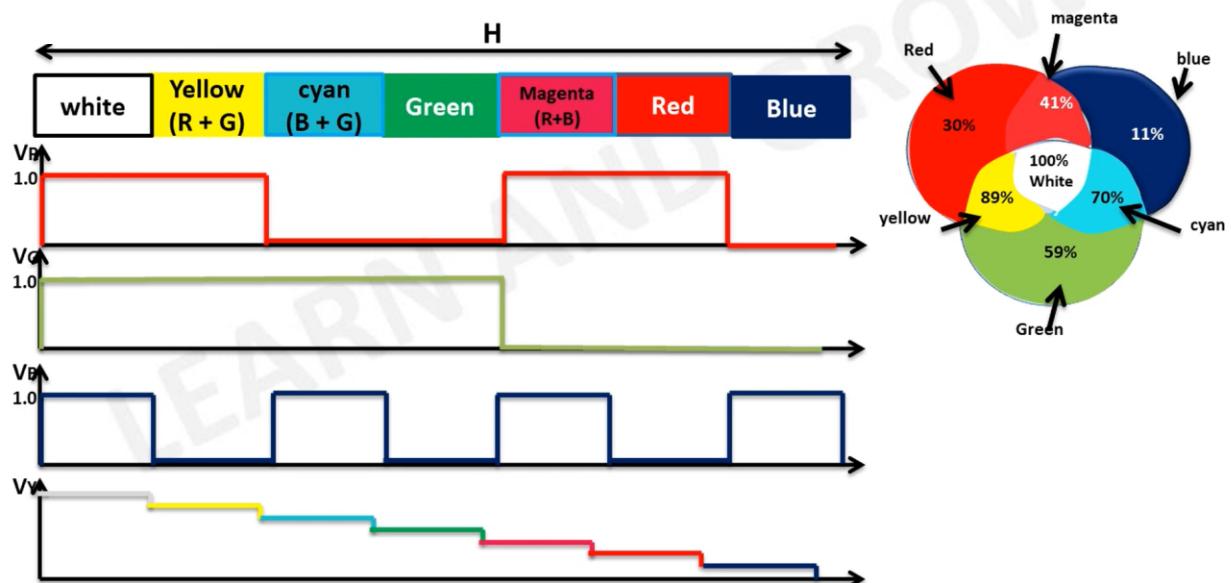
LUMINANCE SIGNAL AMPLITUDE

Red green blue camera video output



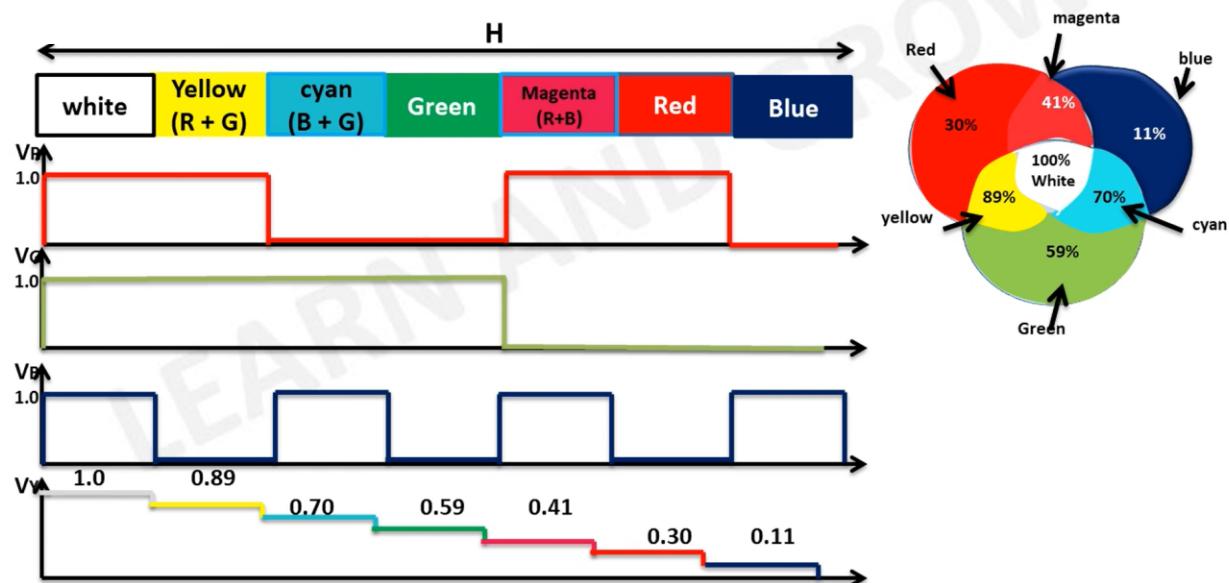
LUMINANCE SIGNAL AMPLITUDE

Formation of luminance Y video signal with matrix .

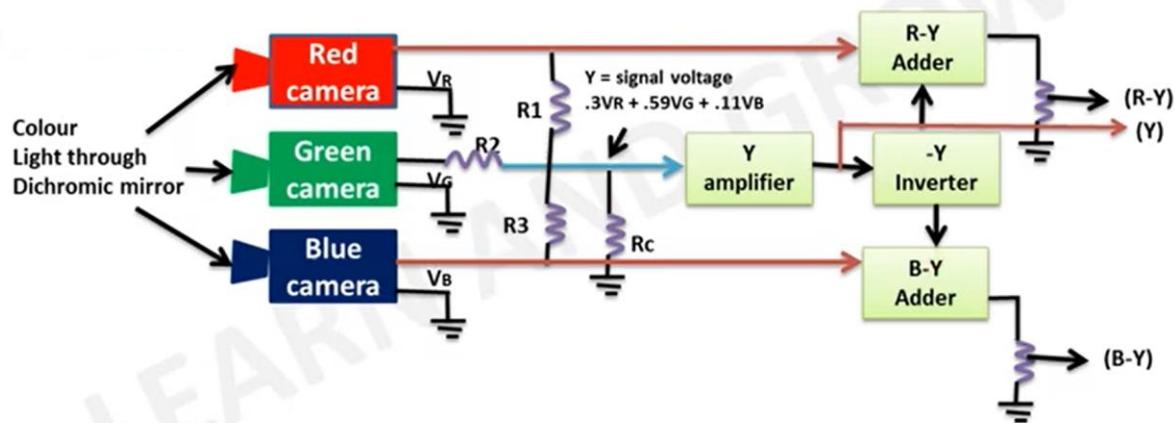


LUMINANCE SIGNAL AMPLITUDE

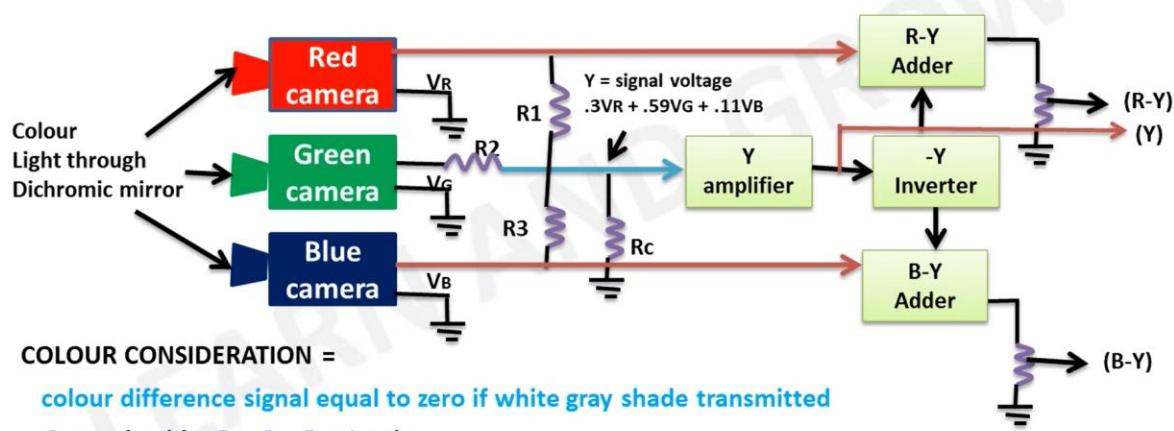
Formation of luminance Y video signal with matrix .



PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



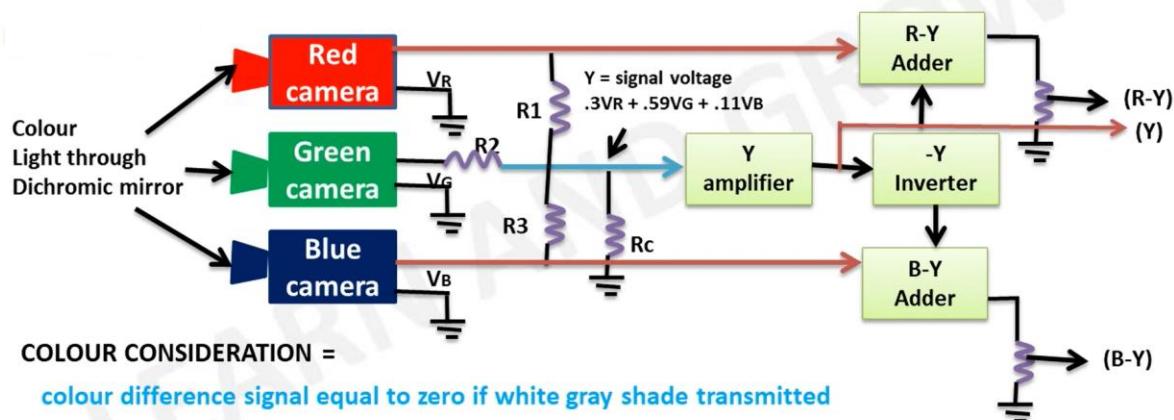
$$Y = .59G + .3R + .11B$$

$$Y = .59 + .3 + .11 = 1\text{ volt}$$

$$(R - Y) = 1 - 1 = 0 \text{ volt}$$

$$(B - Y) = 1 - 1 = 0 \text{ volt}$$

PRODUCTION OF COLOUR DIFFERENCE VOLTAGE



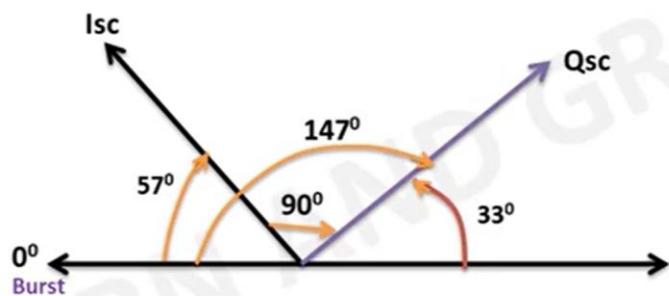
$$Y = .59v + .3v + .11v$$

$$Y = .59 + .3 + .11 = v \text{ volt}$$

$$(R - Y) = v - v = 0 \text{ volt}$$

$$(B - Y) = v - v = 0 \text{ volt}$$

NTSC COLOUR TELEVISION SYSTEM



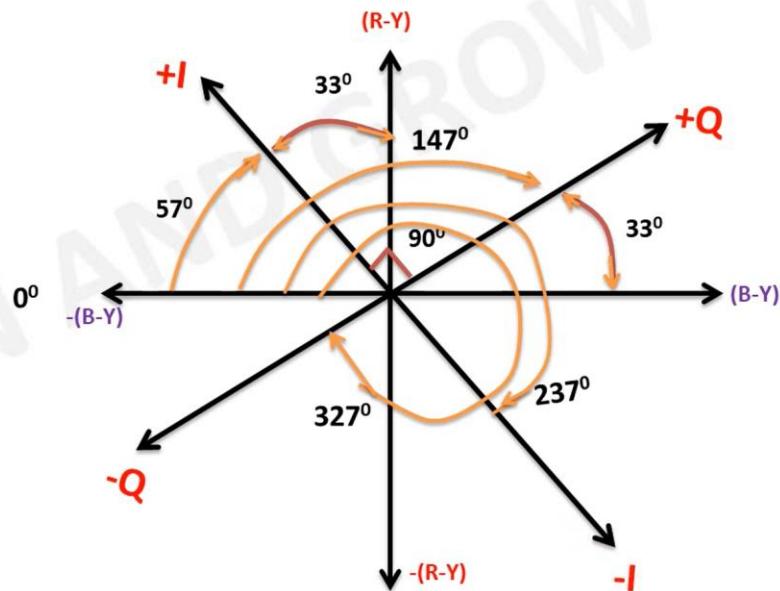
NTSC COLOUR TELEVISION SYSTEM

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

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

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

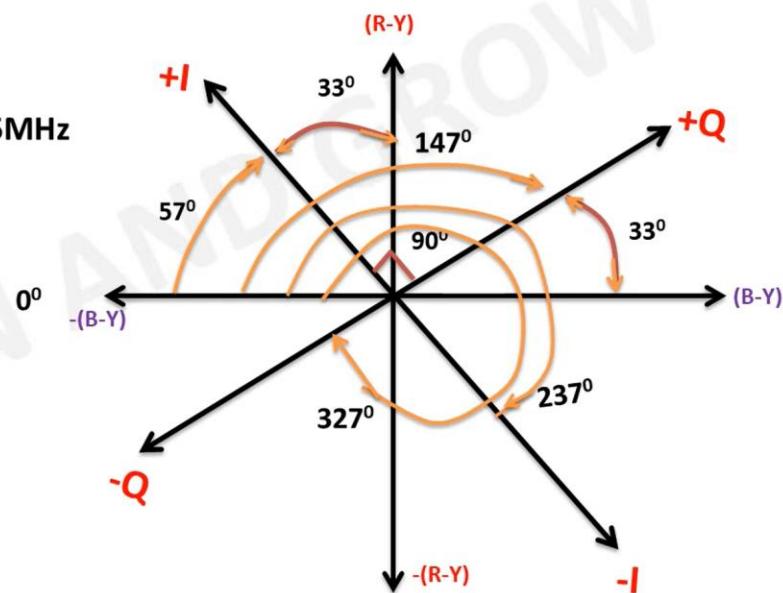
$$Q = 0.48(R - Y) - 0.41(B - Y)$$



NTSC COLOUR TELEVISION SYSTEM

I signal allow frequency 1.5MHz

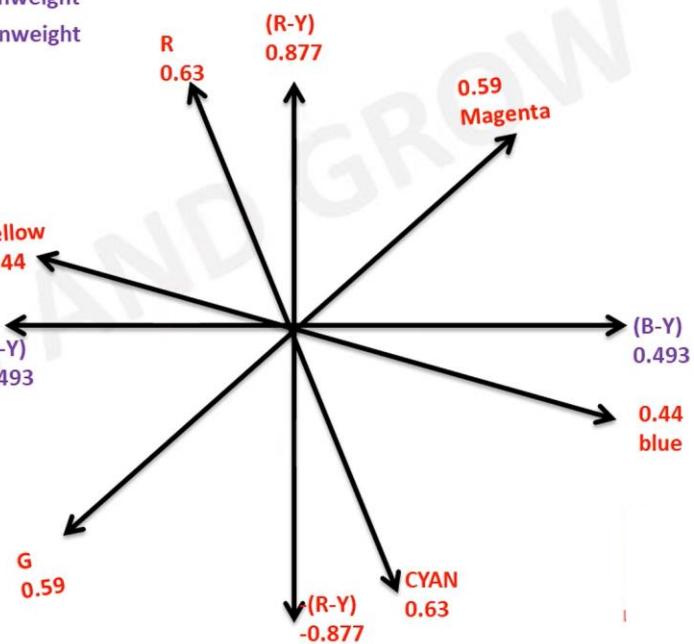
$Q \pm 0.5MHz$

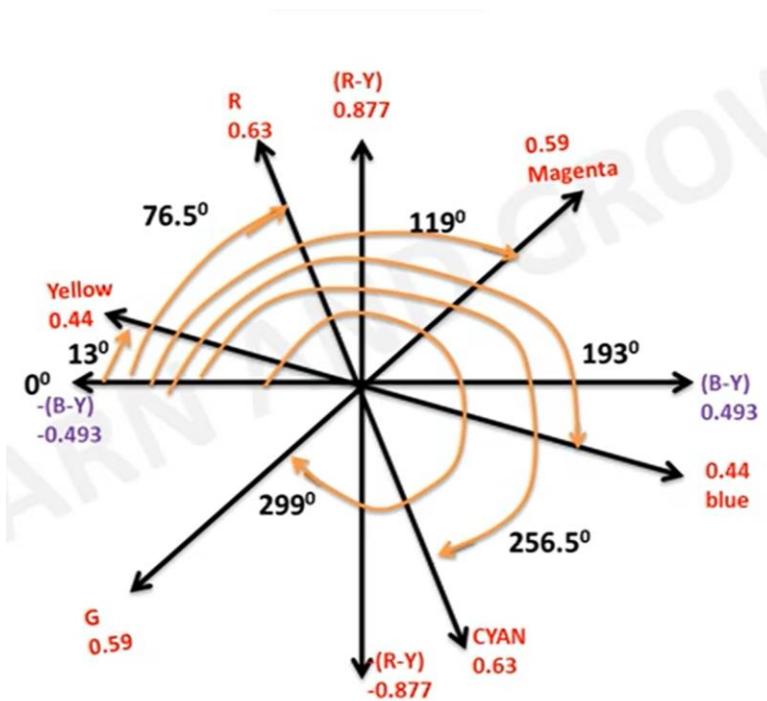


$$(B-Y)\text{weighted} = 0.493(B-Y) \text{ unweight}$$

$$(R-Y)\text{weighted} = 0.877(R-Y) \text{ unweight}$$

COLOUR	B-Y	R-Y	Csc
white	0	0	0
Yellow (R + G)	-0.4385	+0.096	0.44
cyan (B + G)	+0.148	-0.614	0.63
Green	-0.29	-0.517	0.59
Magenta (R+B)	+0.29	+0.517	0.59
Red	-0.148	+0.614	0.63
Blue	+0.4385	-0.096	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. Its 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. Its 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, Cyprus, 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

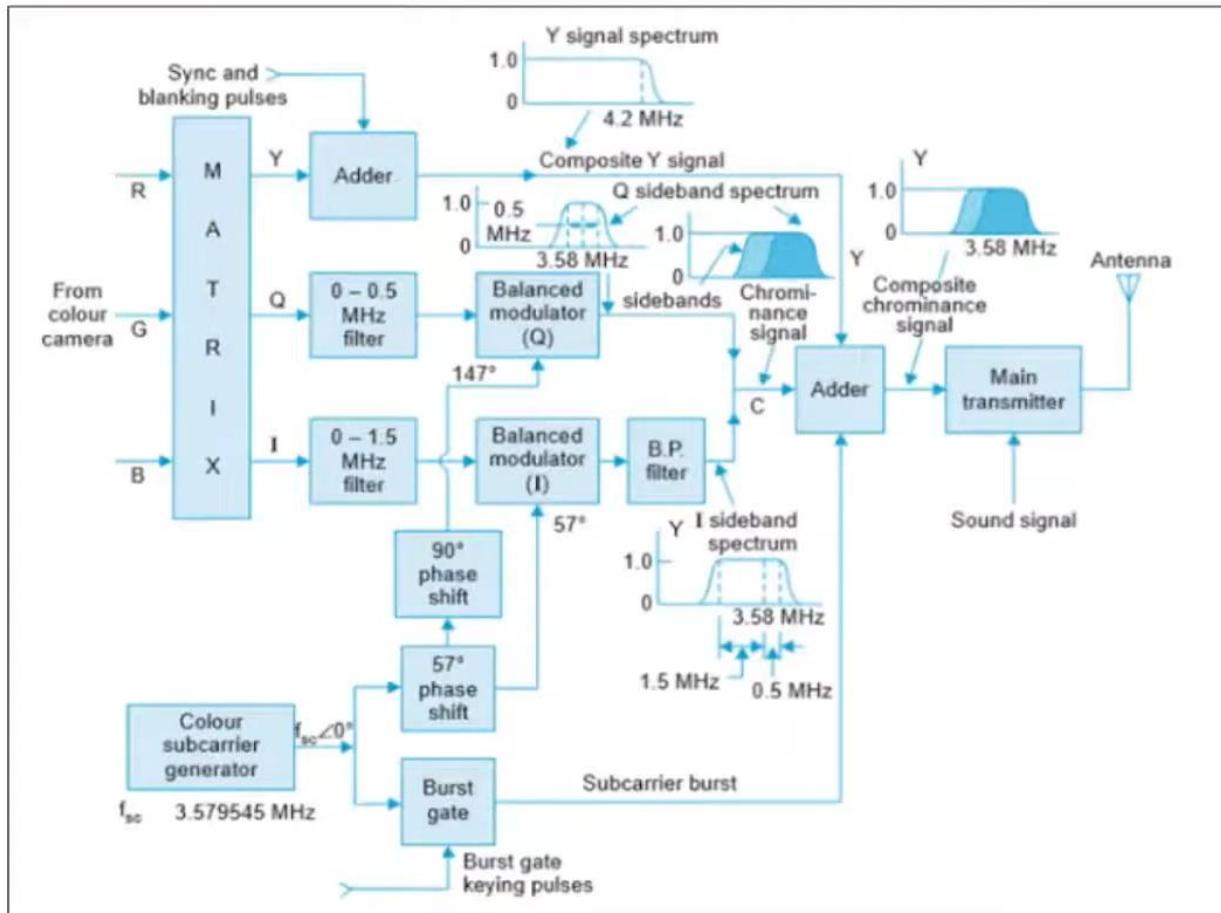
- ❖ In many respects transmission and reception techniques employed in the **NTSC** and **PAL** systems are similar. These are, therefore, **treated together** before going into **encoding** and **decoding details** of each system. The SECAM system, being much different from the other two

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 f_l 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 $Q = 0.21R - 0.52G + 0.31B$, an inverter 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 $f_h = 15625 \pm 0.0001\%$
- Assumed gamma of display device as **2.8**
- Nominal video bandwidth of PAL standard is **5Mhz**

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

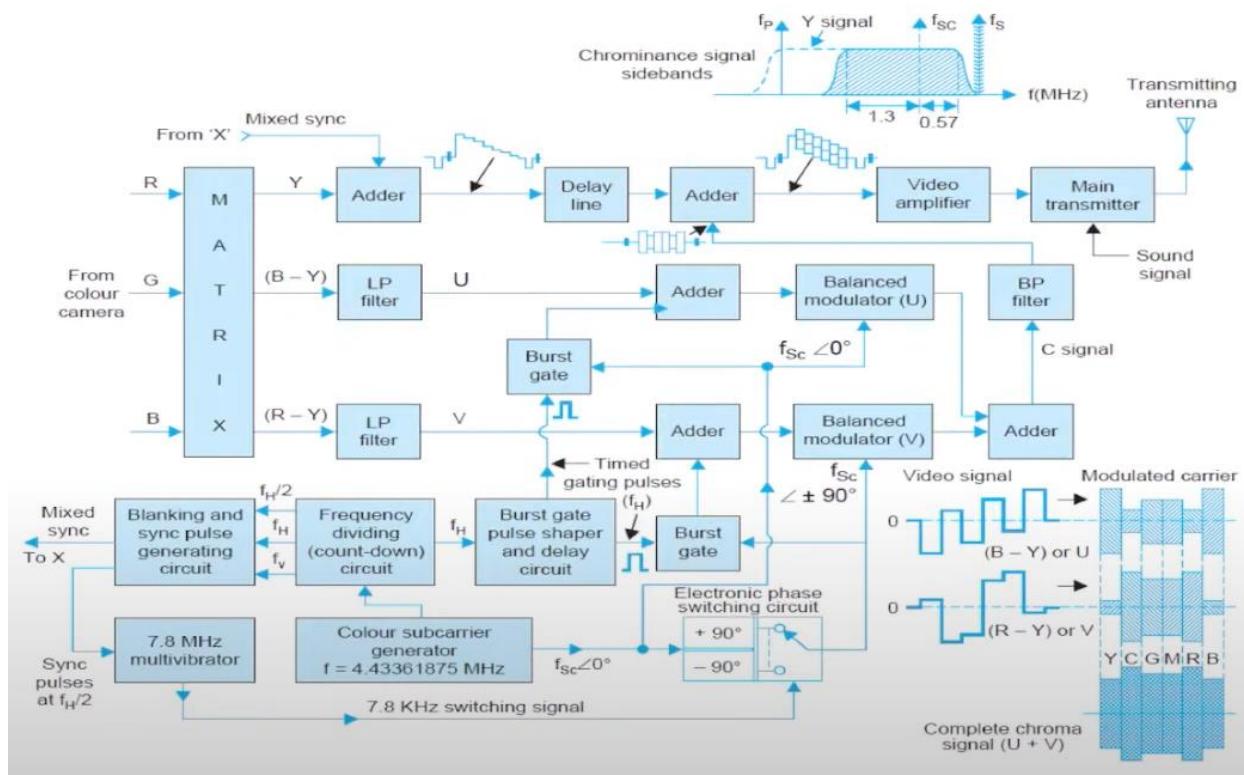


Figure shows the functional block diagram of PAL encoder.

- 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

Susceptible to hue fluctuations

Lower gamma ratio (2.2 as opposed to 2.8 in PAL systems)

More costly than SECAM

Small luminance signal bandwidth (3.85 MHz) – increased likelihood of interference

Disadvantages of NTSC

Lower number of scan lines – means reduced quality on large TV screens

Topic Name : Advantages & Disadvantages of NTSC & PAL

Advantages of PAL

Greater number of scan lines – more picture detail

Wider luminance signal bandwidth (4.43 MHz in most PAL variants)

Stable hues – due to error correction by phase alternation

Higher gamma ratio (2:8) – hence, higher level of contrast than NTSC

Easy studio mixing compared to SECAM

Topic Name : Advantages & Disadvantages of NTSC & PAL

Costliest receivers due to complex circuits for electronic switching

Lower frame rate – hence, more flicker

Disadvantages of PAL

Lower S/N ratio than NTSC

Variable colour saturation – cancelling out phase differences by alternation holds hue stable but at the same time, it can change (reduce) colour saturation

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