# TELEVISION BROADCASTING

ENG (MRS) PN KARUNANAYAKE

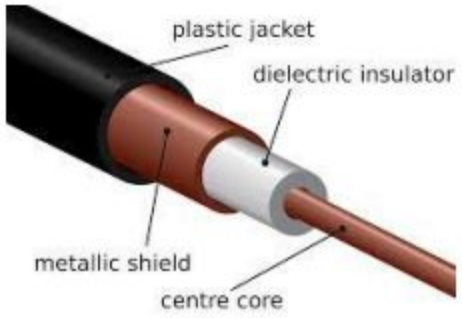
COMMUNICATION SYSTEMS

LECTURE 9

# COMPONENTS OF A TV SYSTEM

Yagi Antenna

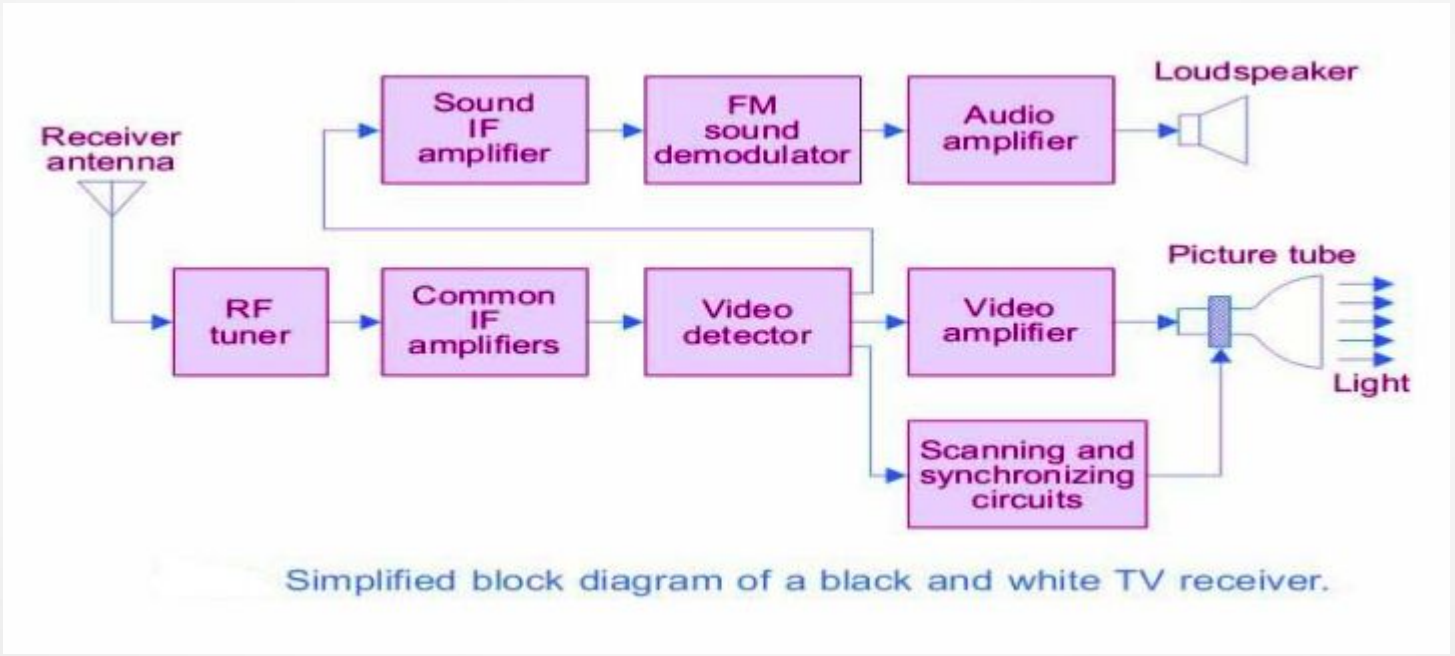
A satellite TV dish




Coaxial Cable

# Summary of Broadcasting System

- An antenna, a cable or a wire bring Radio Frequency (RF) signal to the TV monitor, which includes the levels specifying the colour and luminance of the image pixels.
- The signal is translated from  RF to IF (Intermediate Frequency) because of the easiness of handling with electronic components. Also known as a down converter (D/C).
- For example, a satellite TV signal working at Ku-band has a center frequency in the 12 GHz* range. A down converter can bring it to the IF range of 0.95 to 2.15 GHz.
- Signal is amplified by a LNA.
- In the case of satellite TV, the down converter and LNA are integrated into a device called Low Noise Block (LNB).
- set top box is required to demodulate the waveform and separate video and audio signals. The output is given as the video to the screen and the audio to the speakers.




Simplified block diagram of a black and white TV receiver.

# Summary of Broadcasting System

In the case of digital set top boxes, following components are included:

– Analog to Digital Converter,
– Matched filter,
– Decoder (if applicable),
– Demodulator.

# TV SIGNAL

- Consists of two main parts:

1. 1. Sound - Usually stereo.
2. 2. Picture - Carries color information

# SIGNAL BANDWIDTH

## Audio Signal

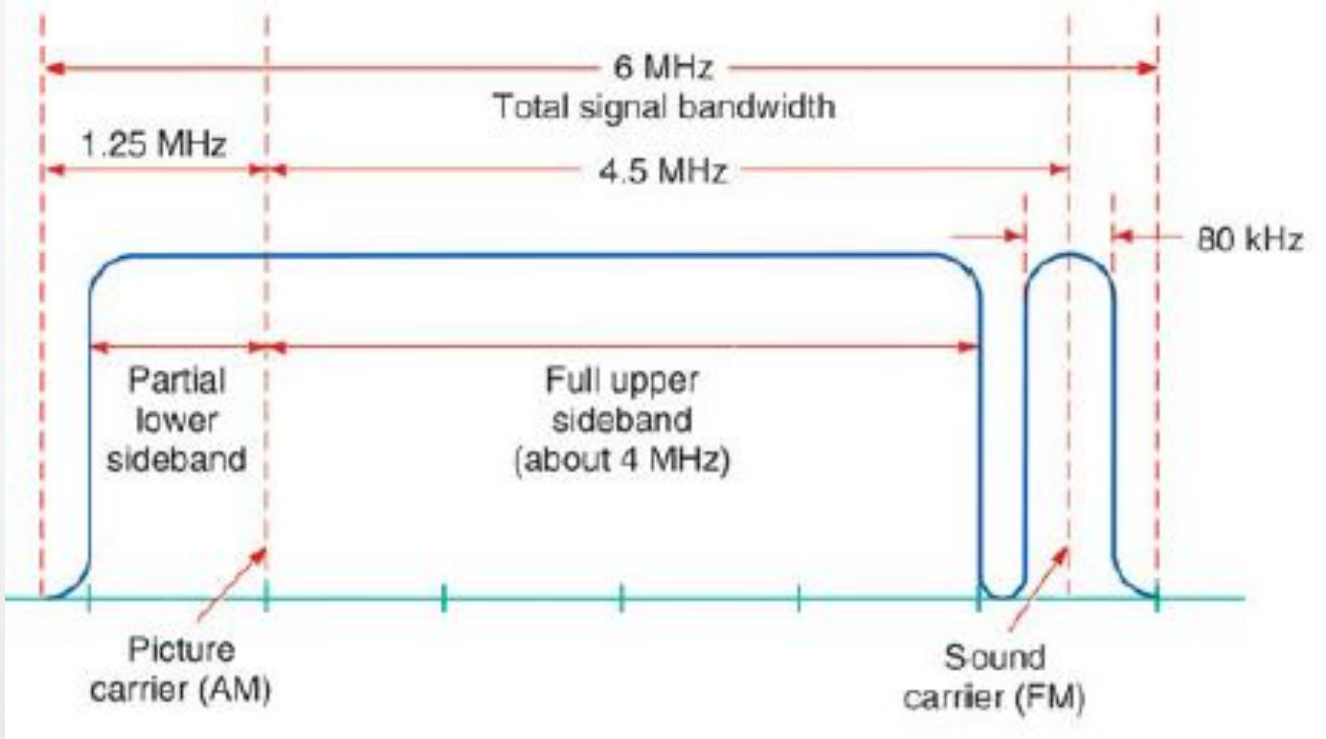
- The sound carrier is at the upper end of the spectrum.
- Frequency modulation is used to impress the sound signal on the carrier.
- The audio bandwidth of the signal is 50 Hz to 15 kHz.
- The maximum permitted frequency deviation is 25 kHz , frequency of the carrier wave can deviate up to 25 kHz above or below its nominal value.

# SIGNAL BANDWIDTH

**Video Signal.**

- The picture information is transmitted on a separate carrier located 4.5 MHz lower in frequency than the sound carrier.
- The video signal derived from a camera is used to amplitude-modulate the picture carrier.
- Different methods of modulation are used for both sound and picture information so that there is less interference between the picture and sound signals.
- Further, amplitude modulation of the carrier takes up less bandwidth in the spectrum, and this is important when a high-frequency, content-modulating signal such as video is to be transmitted.

# SIGNAL BANDWIDTH



# SIGNAL BANDWIDTH

- The full upper sidebands of the picture information are transmitted, but a major portion of the lower sidebands is suppressed to conserve spectrum space. (Only a vestige of the lower sideband is transmitted).
- The color information in a picture is transmitted by way of frequency-division multiplexing techniques.
- Two color signals derived from the camera are used to modulate a 3.85-MHz subcarrier which, in turn, modulates the picture carrier along with the main video information.
- The color subcarriers use double-sideband suppressed carrier AM.
- The video signal can contain frequency components up to about 4.2 MHz. Therefore, if both sidebands were transmitted simultaneously, the picture signal would occupy8.4 MHz. The vestigial sideband transmission reduces this excessive bandwidth. The total bandwidth allocated to a TV signal is 6 MHz.

# SIGNAL BANDWIDTH

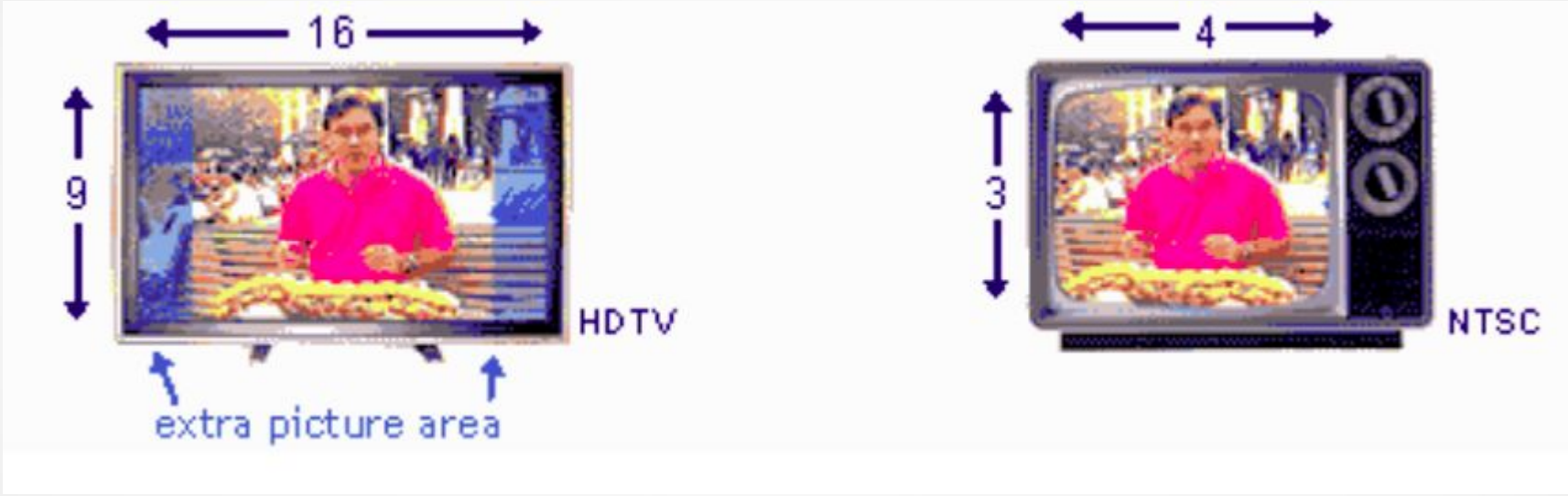
- In a TV signal, the sound is frequency-modulated, and the picture is amplitude-modulated.
- Different methods of modulation are used to minimize interference between the picture and sound signals.

# GENERATING THE VIDEO SIGNAL

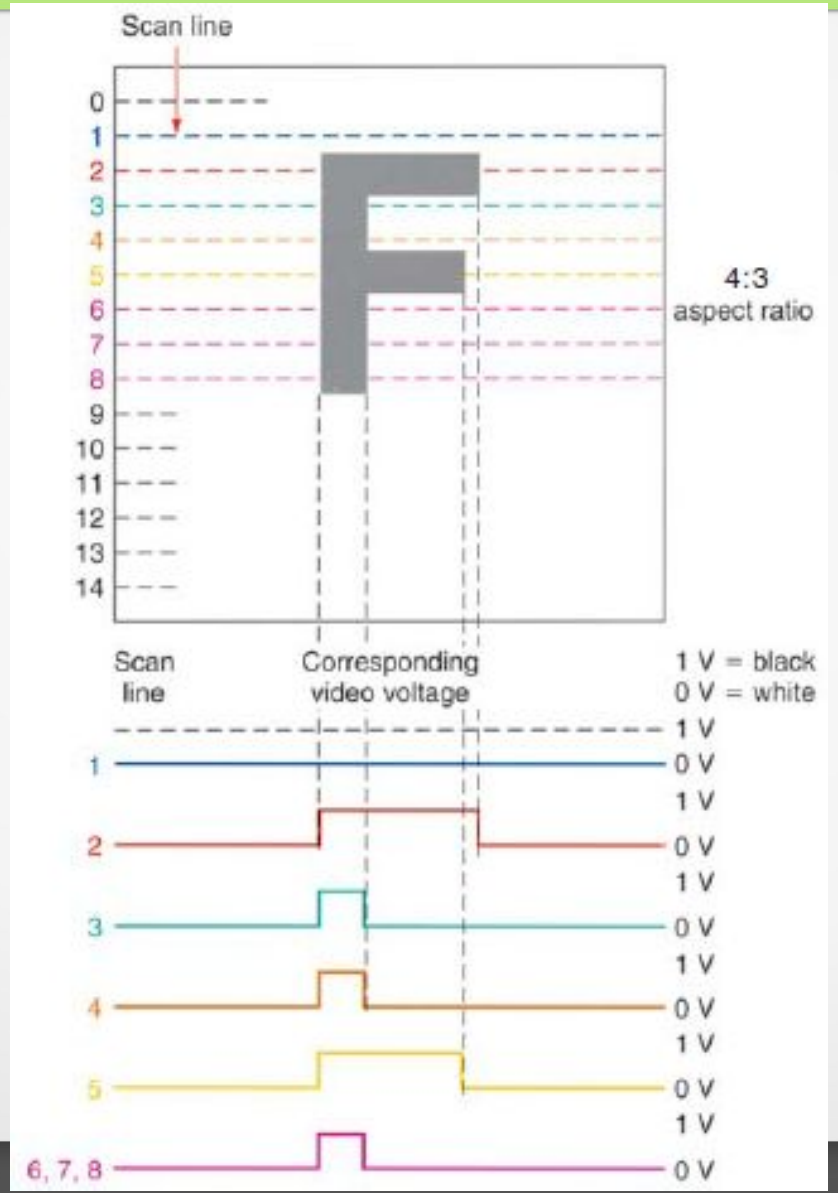
- The scene is divided into smaller segments that can be transmitted serially over a period of time.
- Human visual system can process 10 to 12 images per second. In order to perceive any motion, the number of still images (called frames) requires to exceed ten.
- The number of frames per second (frame rate) for the movies was established as 24 frames persecond. For the TV the frame rates are 30 in North America and Japan, and 25 in most other places. Higher rate (60 and 120) have been added in more recent versions of the standard.
- Again, it is the job of the camera to subdivide the scene in an orderly manner so that an acceptable signal is developed. **This process is known as *scanning*.**

# PRINCIPLES OF SCANNING

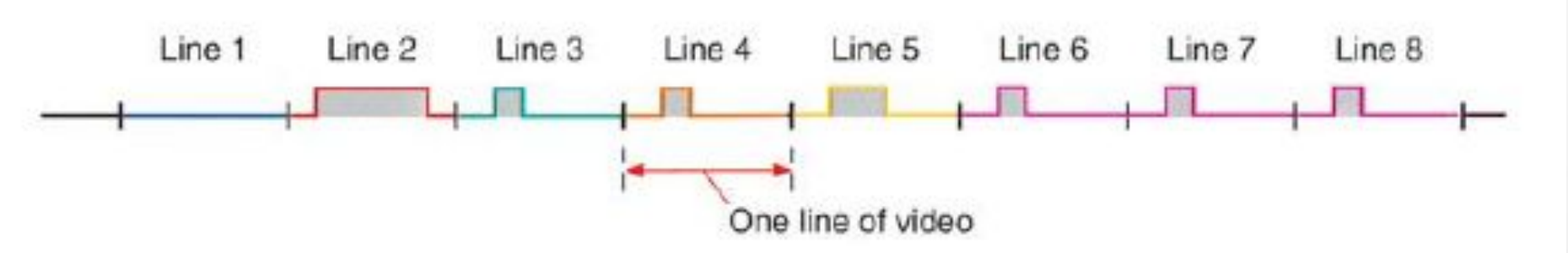
- Scanning is a technique that divides a rectangular scene into individual lines.
- The standard TV scene dimensions have an aspect ratio of 4:3; that is, the scene width is 4 units for every 3 units of height.
- To create a picture, the scene is subdivided into many fine horizontal lines called *scan lines.*
- Each line represents a very narrow portion of light variations in the scene.
- The greater the number of scan lines, the higher the resolution and the greater the detail that can be observed.


16
9
HDTV
extra picture area
4
3
NTSC

# SIMPLIFIED EXPLANATION OF SCANNING



# SIMPLIFIED EXPLANATION OF SCANNING



# LUMINANCE (*Y* ) SIGNAL

- Since the scene contains colors, there are different levels of light along each scan line.
- This information is transmitted as different shades of gray between black and white.
- Shades of gray are represented by some voltage level between the 0- and 1-V extremes represented by white and black.
- The resulting signal is known as the *brightness,* or *luminance, signal* and is usually designated by the letter *Y.*

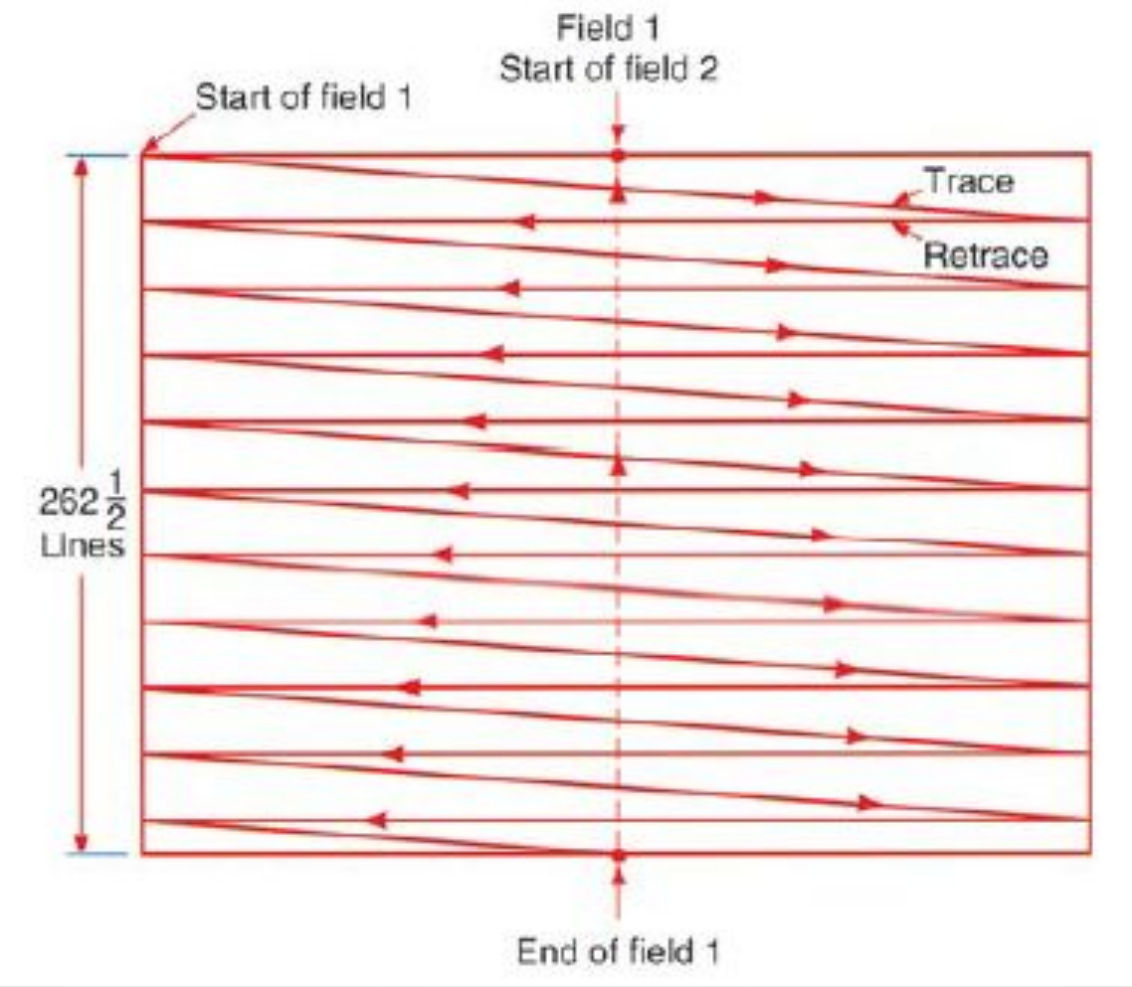
# FIELD

- The scene is scanned twice.  One complete scanning of the scene is called a *field* and contains 262 ½ lines.
- The entire field is scanned in 1/60 s for a 60-Hz field rate. In color TV the field rate is 59.94 Hz.
- Then the scene is scanned a second time, again using 262 ½  lines.
- This second field is scanned in such a way that its scan lines fall between those of the first field. This produces what is known as *interlaced scanning,* with a total of
- 2x262 ½ =525 lines
- 
- **Two interlaced fields produce a complete frame of video.**

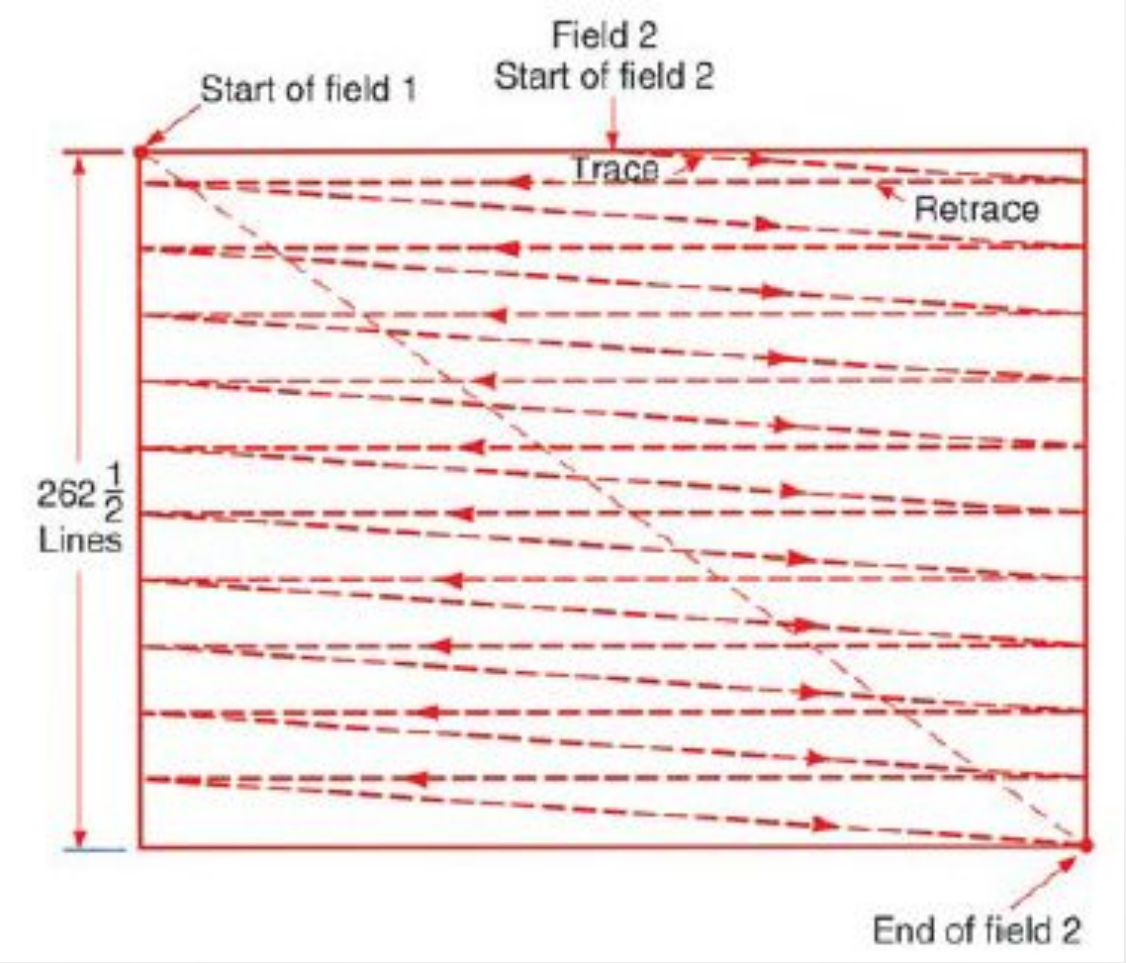
# INTERLACED SCANNING

- Interlaced scanning is used to reduce flicker, which is annoying to the eye.
- This rate is also fast enough that the human eye cannot detect individual scan lines and therefore sees a stable picture.

# INTERLACED SCANNING



# INTERLACED SCANNING



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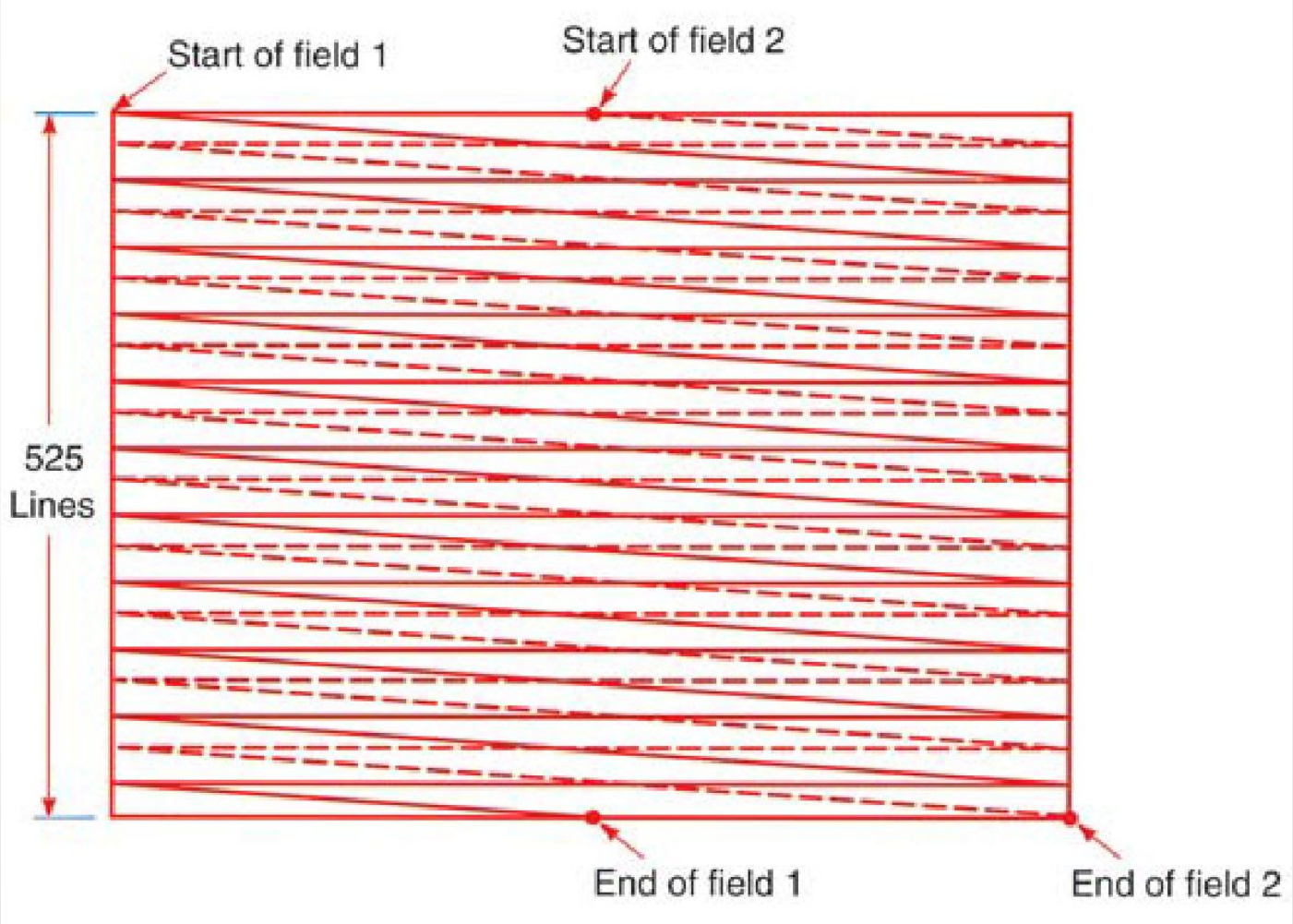


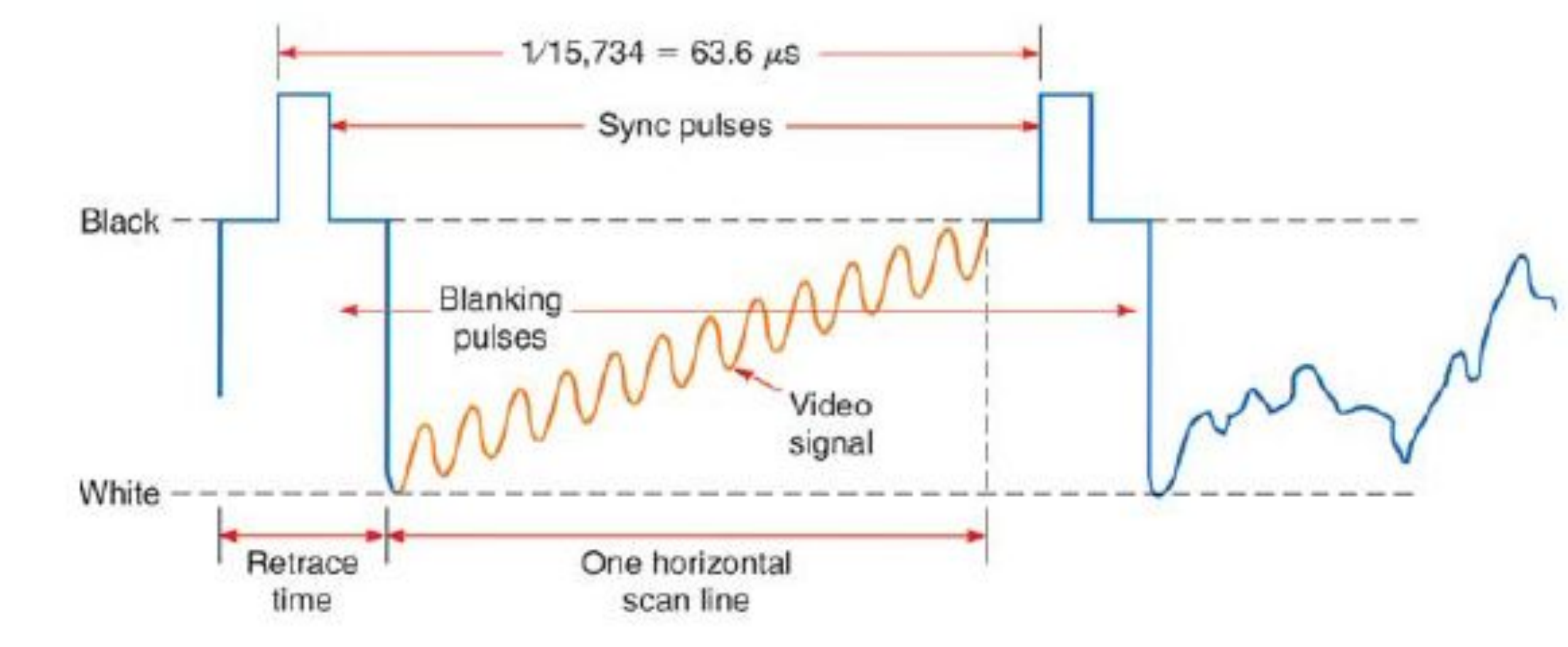
# AT TV RECEIVER

- To ensure that the receiver stays exactly in synchronization with the transmitter, special horizontal and vertical sync pulses are added to and transmitted with the video signal.
- After one line has been scanned, a horizontal blanking pulse comes along.
- The blanking pulse is used to cut off the electron beam in the picture tube during the time the beam must retrace from right to left to get ready for the next left-to-right scan line.

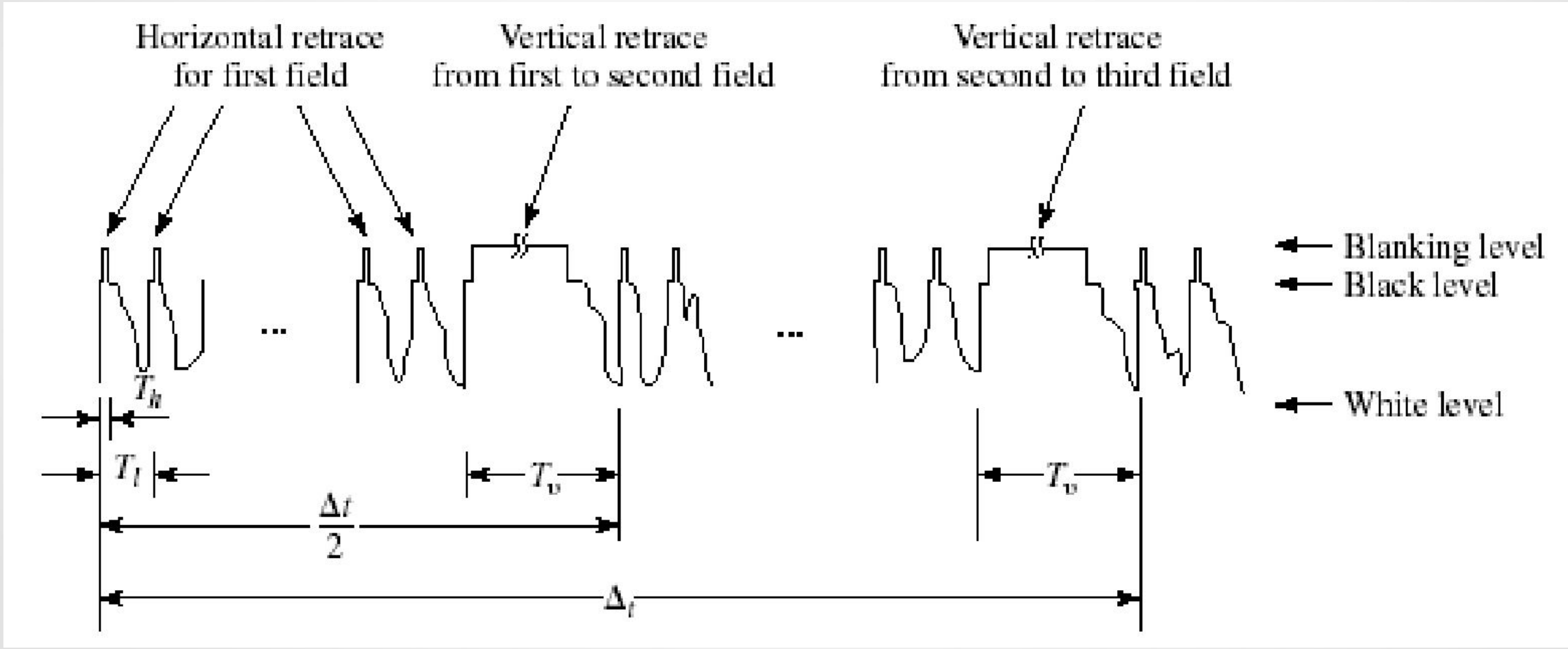
# AT TV RECEIVER

- At the end of each field, the scanning must retrace from bottom to top of the scene so that the next field can be scanned.
- This is initiated by the vertical blanking and sync pulses.
- The entire vertical pulse blacks out the picture tube during the vertical retrace.
- The pulses on top of the vertical blanking pulse are the horizontal sync pulses that must continue to keep the horizontal sweep in sync during the vertical retrace.

# TV SIGNAL


1/15,734 = 63.6 μs
Sync pulses
Black
Blanking pulses
Video signal
White
Retrace time
One horizontal scan line

# TV MONOCHROME SIGNAL



# RELATIONSHIP BETWEEN RESOLUTION AND BANDWIDTH

- The *resolution* of the picture refers to the amount of detail that can be shown.
- Pictures with high resolution have excellent *definition,* or distinction of detail, and the pictures appear to be clearly focused.
- A picture lacking detail looks *softer,* or somewhat out of focus.
- , the greater the defiThe *bandwidth* of a video system determines the resolution. The greater the bandwidthnition and detail.

# RELATIONSHIP BETWEEN RESOLUTION AND BANDWIDTH

- The National Television Standards Committee (NTSC) system restricts the bandwidth in the United States to 4.2 MHz.
- This translates to a period of 238 ns.
- The width of a line is one-half this value, 0.119 s.
- Horizontal sweep interval is about 63.6 . About 10 of this interval is taken up by the horizontal blanking interval, leaving 53.6 for the video.
- The approximate horizontal resolution $R_H$ is about 450 lines.

# VERTICAL RESOLUTION

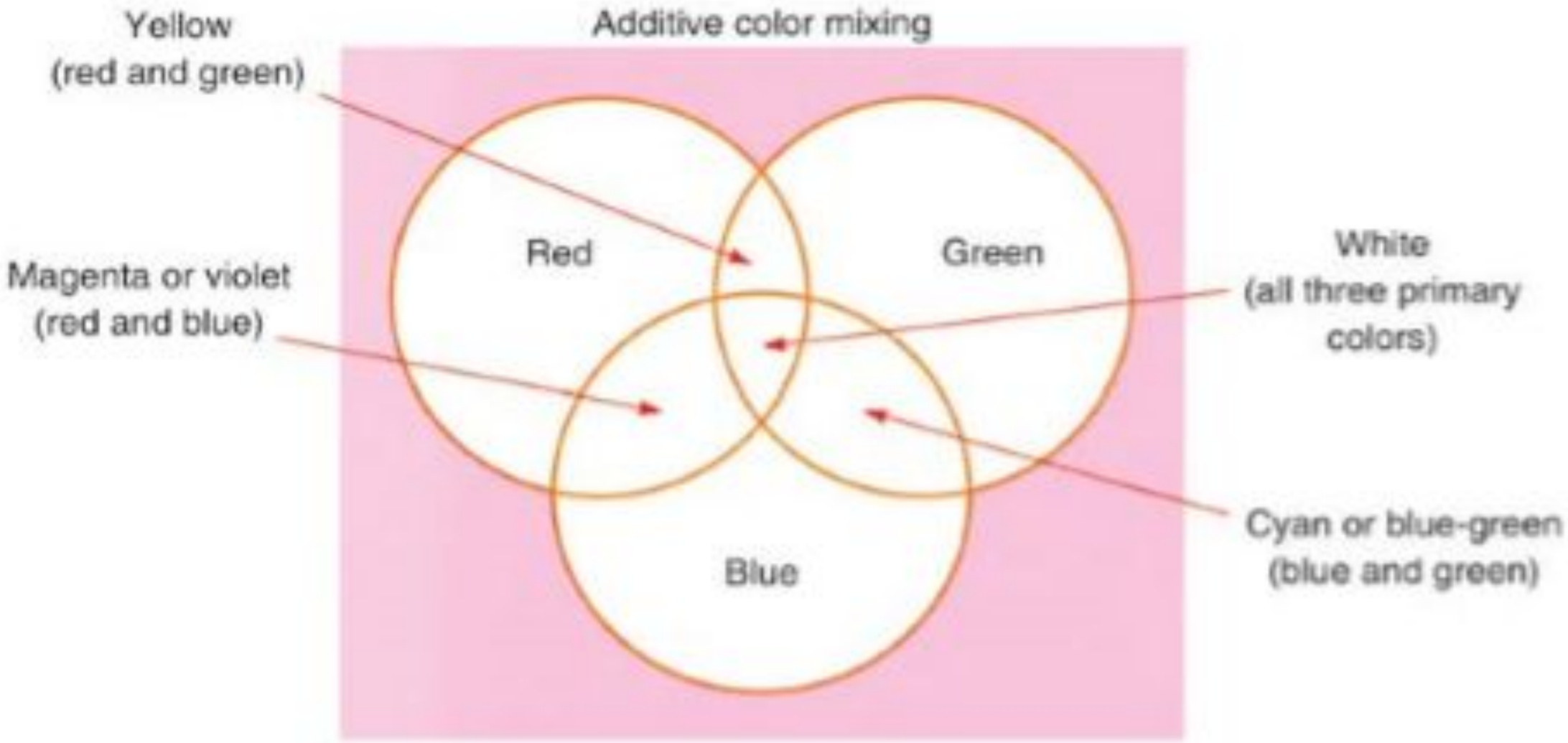
- The vertical resolution is the number of horizontal lines that can be distinguished.
- Only about 480 to 495 horizontal lines are shown on the screen.
- The vertical resolution is about 0.7 times the number of actual lines *:*

Vertical resolution refers to the number of distinct horizontal lines that can be displayed from top to bottom across the height of the screen. Horizontal resolution refers to the number of distinct vertical lines that can be displayed from left to right across the width of the screen. It measures the level of detail or clarity in the horizontal direction.

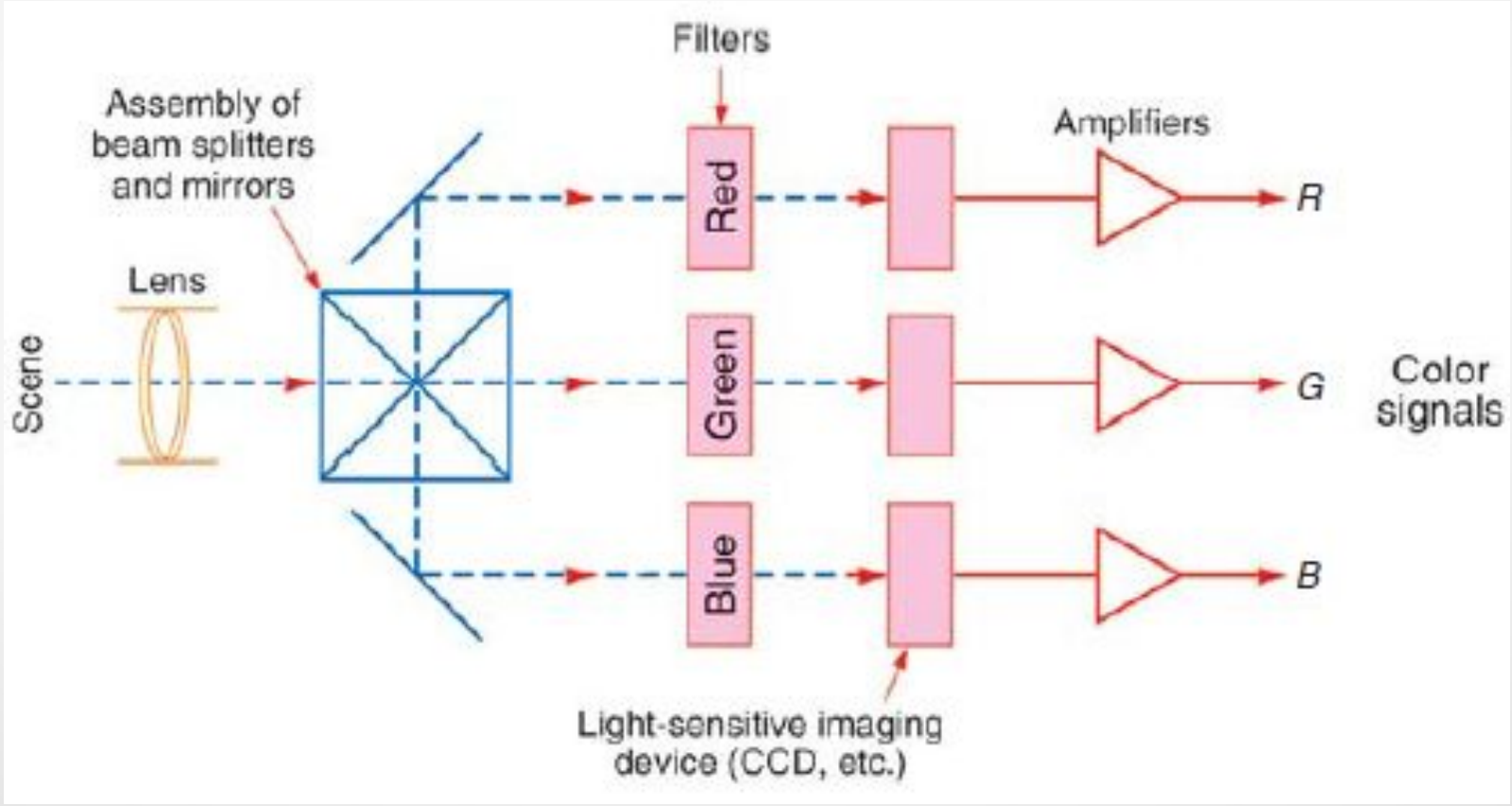
$$R_V = 0.7NL$$

# COLOR SIGNAL GENERATION

- Colour signal generation is done by dividing the light in each scan line into three separate signals, each representing one of the three basic colors, red, green, or blue.
- The red light in the scene passes through the red filter, the green through the green filter, and the blue through the blue filter.
- The result is the generation of three simultaneous signals (*R, G,* and *B*) during the scanning process by the light-sensitive imaging devices.


Additive color mixing
Yellow
(red and green)
Red
Green
Magenta or violet
(red and blue)
White
(all three primary
colors)
Blue
Cyan or blue-green
(blue and green)

# GENERATION OF COLOUR SIGNAL BY THE CAMERA



# COLOUR SIGNAL

- The R, G, and B signals also contain the basic brightness or luminance information.
- If the color signals are mixed in the correct proportion, the result is the standard B&W video or luminance Y signal.
- The Y signal can be generated by scaling each color signal with a tapped voltage divider and adding the signals.
- Y signal is made up of 30% red, 59% green, and 11% blue. The resulting Y signal is what a B&W TV set will see.

# COLOUR SIGNAL

- The color signals must also be transmitted along with the luminance information in the same bandwidth allotted to the TV signal.
- This is done by a frequency-division multiplexing technique.
- Instead of all three color signals being transmitted, they are combined into I and Q color signals.
- These signals are made up of different proportions of the R, G, and B signals according to specifications.

# I & Q SIGNALS

$I$ = 60 percent red, 28 percent green, −32 percent blue

$Q$ = 21 percent red, −52 percent green, 31 percent blue

- The I and Q signals are referred to as the chrominance signals.
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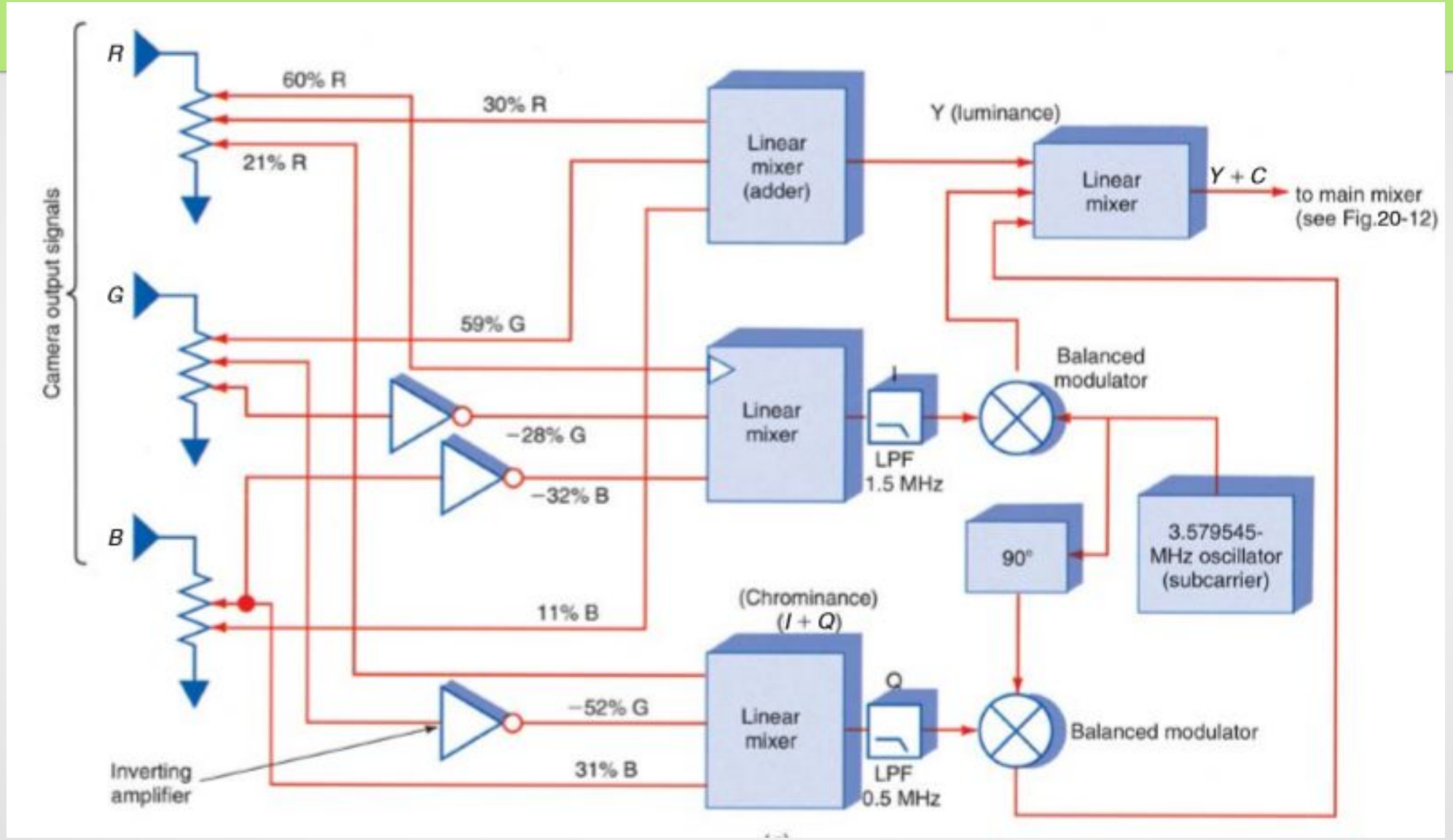
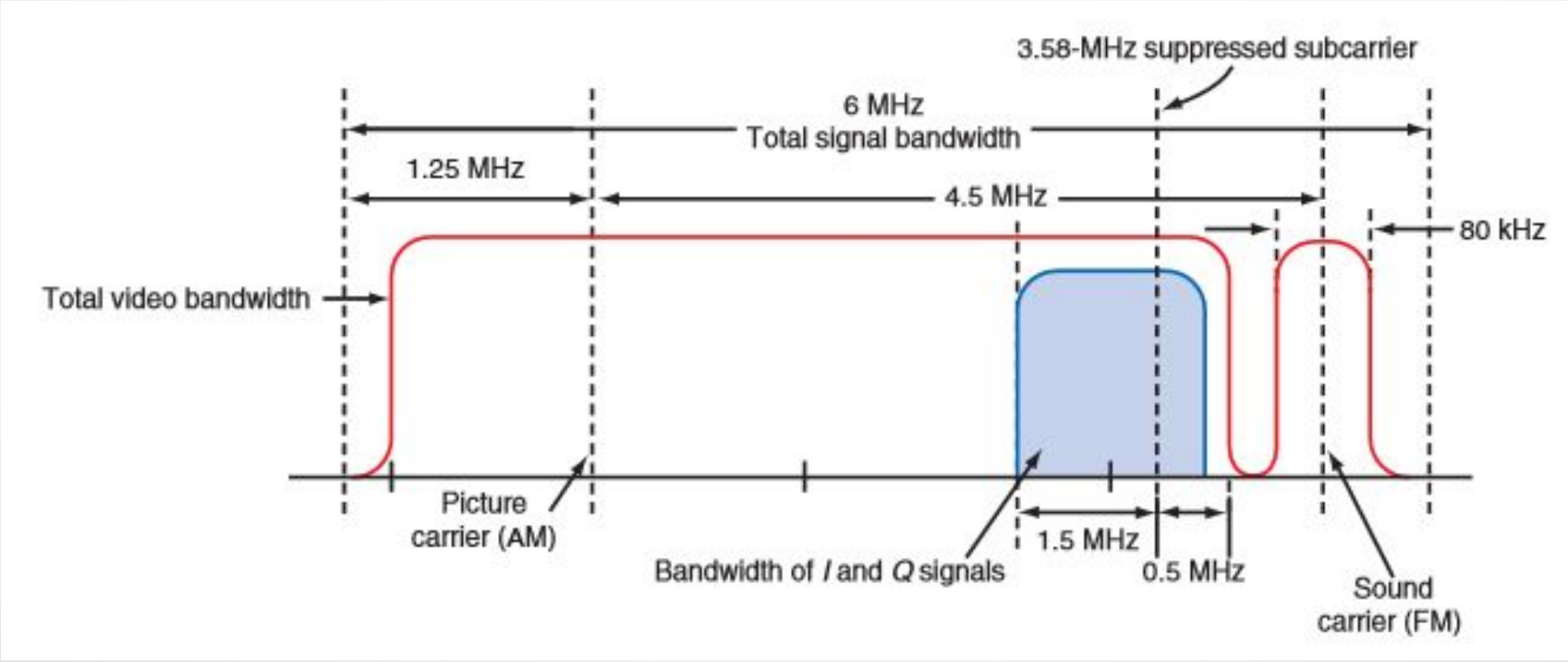
- To transmit them, they are phase-encoded (they are used to modulate a subcarrier which is in turn mixed with the luminance signal to form a complete, or composite, video signal).


Camera output signals
R
G
B
60% R
30% R
21% R
59% G
−28% G
−32% B
11% B
−52% G
31% B
Inverting amplifier
Linear mixer (adder)
Linear mixer
Linear mixer
Linear mixer
Y (luminance)
Y + C
to main mixer (see Fig.20-12)
Balanced modulator
LPF 1.5 MHz
LPF 0.5 MHz
90°
3.579545-MHz oscillator (subcarrier)
(Chrominance) (I + Q)
Q
Balanced modulator


3.58-MHz suppressed subcarrier
6 MHz
Total signal bandwidth
1.25 MHz
4.5 MHz
80 kHz
Total video bandwidth
Picture
carrier (AM)
Bandwidth of I and Q signals
1.5 MHz
0.5 MHz
Sound
carrier (FM)