Q.2 a. Explain the working of Television broadcasting system with a neat block diagram. (8)

Answer:

1-2 TELEVISION BROADCASTING

The term *broadcast* means "to send out in all directions." As shown in Fig. 1-5, the transmitting antenna radiates electromagnetic radio waves which can be picked up by the receiving antenna. The television transmitter has two functions: visual and aural transmission. Both the AM picture signal and the FM sound signal are emitted from the common radiating antenna. The service area is about 75 mi [121 km] in all directions from the transmitter.

In visual transmission, the camera tube converts the light image to a video signal. The camera tube is a cathode-ray tube (CRT), with a photoelectric image plate and an electron gun enclosed in a vacuum glass envelope. A common type is the vidicon shown in Fig. 1-6. Basically, the camera tube takes an optical image of the scene on its photoelectric plate, which is scanned in horizontal lines by the electron beam. The scanning goes from left to right and top to bottom, as viewed by the camera. It takes $\frac{1}{30}$ s to scan the entire picture frame, comprising a total of 525 scanning lines. As a result, the output of the camera tube is a sequence of electrical variations—the video signal—that corresponds to the picture information. The video signal is

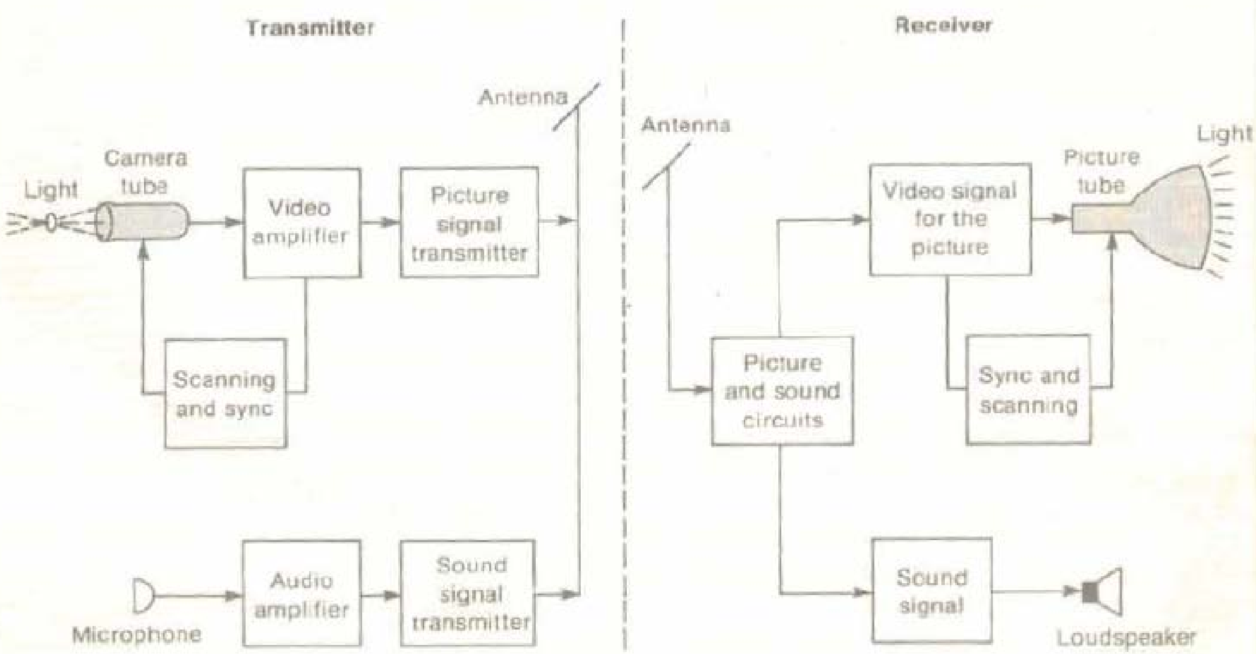


Fig. 1-5 Block diagram of television broadcasting system

Fig 1-6 Vidicon camera tube. Length is 6 in. [152.4 mm]. (*RCA*)

amplified, and synchronizing pulses are added. Amplitude modulation of the picture carrier results in the AM picture signal.

The receiving antenna intercepts both the picture and the sound carrier signals. The signals are amplified and then detected to recover the original modulation. The video detector output includes the video signal needed to reproduce the picture.

Then the detected video signal is amplified enough to drive the grid-cathode circuit of the picture tube. As shown in Fig. 1-7, the picture tube is very similar to the CRT used in an oscilloscope. The glass faceplate at the front has a fluorescent coating on its inside surface. The narrow neck contains the electron gun. When the electron beam strikes the phosphor screen, light is emitted.

Assume that video signal voltage makes the control grid less negative. Then the beam current increases, making the spot of light brighter. The maximum light output is peak white in the picture.

For the opposite case, more negative voltage decreases the beam current and brightness. When the grid voltage is negative enough to cut off the beam current, there is no light output. This value corresponds to black on the screen.

The block diagram in Fig. 1-5 illustrates the system for monochrome. In color television, a color camera and a color picture tube are used. The color camera provides video signals for the red, green, and blue picture information. Similarly, the color picture tube reproduces the image in red, green, and blue with all their color mixtures including white.

b. Explain horizontal and vertical blanking. (8)

Answer:

2-8 HORIZONTAL AND VERTICAL BLANKING

In television, *blanking* means "going to black." As part of the video signal, the blanking voltage is at the black level. Video voltage at the black level cuts off beam current in the picture tube to blank out light from the screen. The purpose of the blanking pulses is to make invisible the retraces required in scanning. Horizontal pulses at 15,750 Hz blank out the retrace from right to left for each line. Vertical pulses at 60 Hz blank out the retrace from bottom to top for each field.

The time needed for horizontal blanking is approximately 16 percent of each horizontal (H) line. The total horizontal time is 63.5 μs, including trace and retrace. The blanking time for each line, then, is $63.5 \times 0.16 = 10.2$ μs. This H blanking time means that the retrace from right to left must be completed within 10.2 μs, before the start of visible picture information during the scan from left to right.

The time for vertical (V) blanking is approximately 8 percent of each V field. The total vertical time is $\frac{1}{60}$ s, including the downward trace and upward retrace. The blanking time for each field, then, is $\frac{1}{60} \times 0.08 = 0.0013$ s. This V blanking time means that within 0.0013 s the vertical retrace must be completed from bottom to top of the picture.

The retraces occur during the blanking time because of synchronization of the scanning. The synchronizing pulses determine the start of the retraces. Each horizontal synchronizing pulse is inserted in the video signal within the time of the horizontal blanking pulse. Also each vertical synchronizing pulse is inserted in the video signal within the time of the vertical blanking pulse.

In summary, first a blanking pulse puts the video signal at the black level; then a synchronizing signal starts the retrace in scanning. This sequence applies to blanking both the horizontal and the vertical retraces.

Q.3 a. Explain, with neat diagrams, magnetic deflection used in television picture tubes. (10)

Answer:

4-6

MAGNETIC DEFLECTION

All picture tubes, either color or monochrome, use magnetic deflection with *V* and *H* scanning coils in an external yoke around the neck of the tube, rather than electrostatic deflection with internal deflection plates. The electrostatic deflection plates take sawtooth voltage. For the magnetic scanning coils, sawtooth current is required.

Deflection is much easier for magnetic scanning, especially with the very high anode voltage used for picture tubes. In electrostatic scanning, the deflection angle is inversely proportional to the amount of high voltage. For example, increasing the anode voltage nine times reduces the deflection angle by one-ninth. For magnetic scanning, however, the deflection angle is inversely proportional to the square root of the high voltage. Thus, increasing the anode voltage by nine times reduces the deflection angle only by one-third. The conclusion is, then, that a picture tube with electrostatic deflection would have too small a deflection angle and the tube would be much too long.

In magnetic scanning, two pairs of deflection coils are used (see Fig. 4-7) which are mounted externally around the neck of the tube just before the bell. The pair of coils above and below the beam axis produces horizontal deflection; the coils to the left and right of the beam produce vertical deflection. This perpendicular displacement results because the current in each coil has a magnetic field that reacts with the magnetic field of the electron beam. The resulting force deflects the electrons at right angles to both the beam axis and the deflection field.

To analyze the deflection, remember that the reaction between two parallel fields always exerts a force toward the weaker field. Consider first the horizontal deflection coils in Fig. 4-7. The windings are in a horizontal plane above and below the beam axis. By the left-hand rule, the thumb points in the direction of the field inside a coil when the fingers curve in the direction of the electron flow around the coil. Therefore, the deflection field for the horizontal windings is downward. When the direction of the electron beam is into the paper, as indicated by the cross in the center, the magnetic field of the beam has lines of force counterclockwise around the beam in the plane of the paper. To the left of the beam axis, the magnetic field of the beam is downward, in the same direction as the deflecting field; to the right of the beam axis, the magnetic field of the beam is upward, in the direction opposite that of the deflecting field. The electron beam is deflected to the right, therefore, as the resultant force moves the beam toward the weaker field. In a similar manner, the vertical deflection coils deflect the electron beam downward. Deflecting currents for both sets of coils are applied simultaneously, forcing the beam to the lower right in this example.

The actual deflection coils are wound in the form of a saddle, and the four coils in one assembly are called the *deflection yoke*. Figure 4-8

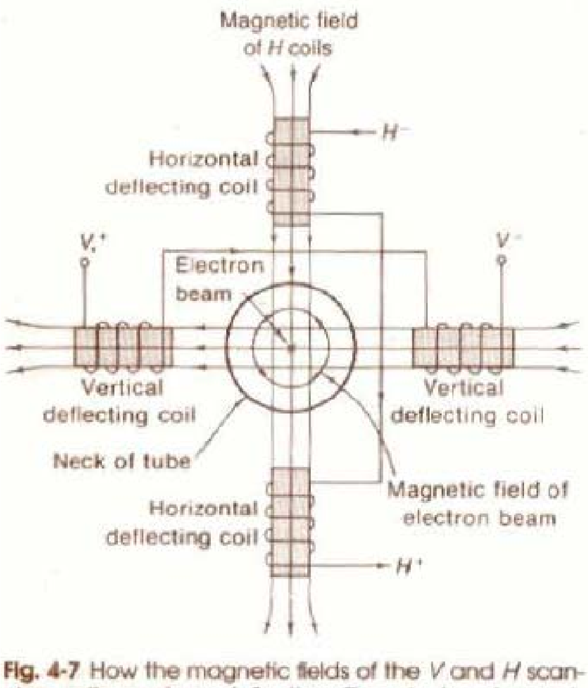


Fig. 4-7 How the magnetic fields of the *V* and *H* scanning coils produce deflection. The electron beam is deflected down and to the right for the electron flow shown in the coils.

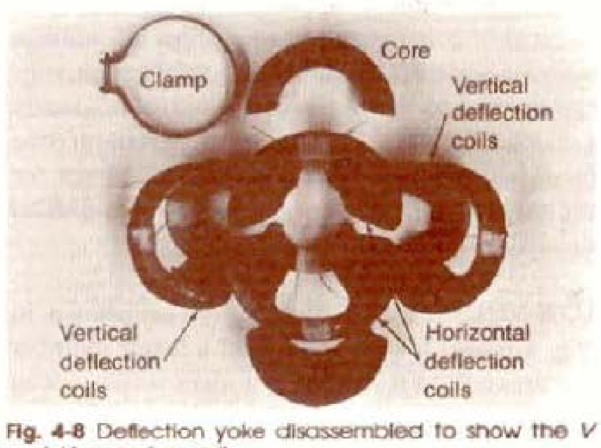


Fig. 4-8 Deflection yoke disassembled to show the *V* and *H* scanning coils.

shows the coils from a typical yoke; they are separated for inspection but are in the correct relative position. A ring formed of two segments of ferrite core material is clamped around the outside of the coils. This ring completes the external path for magnetic flux lines so that the total reluctance of the magnetic circuit is minimized. The largest air-and-vacuum gap in the magnetic circuit is formed by the neck of the picture tube itself.

One mark of progress in picture tubes has been the trend toward a narrower neck, made possible by improved electron guns. A narrower neck results in a shorter gap, which means reduced reluctance in the magnetic path. A higher flux density is produced for a given amount of current in the coils, resulting in greater deflection sensitivity. These advantages can be used for a large deflection angle to shorten the picture tube, to conserve the deflection power, or to do both.

b. Write the precautions to be taken while handling the picture tubes. (6)

Answer:

24-11

PICTURE TUBE PRECAUTIONS

The picture tube is extremely dangerous because it is a large, evacuated glass bulb. A crack or puncture results in a violent inrush of air called an *implosion,* but the kinetic energy of the broken glass causes a subsequent explosion. You should always wear eye protection, such as goggles or a face shield, when handling a picture tube. Also, wear heavy gloves that provide a secure grip.

In large-screen sets, the picture tube can be extremely heavy and awkward to handle. In this case, it is better to put the set face down on a blanket or carpet and lift or lower the picture tube vertically into place. Never handle the picture tube by its neck. Be sure the delicate neck does not strike the cabinet or any chassis bracket while you are installing or removing the picture tube.

HIGH-VOLTAGE PRECAUTIONS The glass dielectric for the anode capacitance of the picture tube has extremely low leakage. Out of the set, the anode can retain a charge of several thousand volts for weeks at a time. Accidental contact with the ultor button of a charged picture tube, in itself, seldom gives a dangerous electric shock. However, the person's physical reaction may cause the tube to be dropped, and the consequences can be disastrous.

Always discharge the picture tube before removing it. To do this, connect a clip lead between the chassis ground and the metal shank of a plastic-handled screwdriver. Then, holding the screwdriver by its plastic handle, touch the ultor button under the rubber cap of the high-voltage connector. You will hear a snap when the tube is discharged.

Do not trust picture tubes that are stored temporarily out of the set. Ground the ultor button, using the clip-lead and screwdriver technique, but hold the end of the clip lead against the outer Aquadag coating before and during contact of the blade with the ultor button.

X-RADIATION X-rays are invisible radiation with wavelengths much shorter than those of visible light. Prolonged exposure to x-rays can be harmful. The x-rays are produced when a metal anode is bombarded by high-velocity electrons, generally with an anode voltage above 16 kV.

Color picture tubes with an anode voltage of 20 to 30 kV can produce soft x-rays. This radiation is easier to shield than hard x-rays which are produced with much higher accelerating voltages—up to 100 kV. Lead and leaded glass are used for shielding against x-ray penetration in general. For soft x-rays, some attenuation is provided by wood, cardboard, pressed paper, metals, and glass.

The main sources of x-rays in a television receiver are the picture tube (especially from the metal shadow mask) and the high-voltage rectifier tube, if used. However, when solid-state devices are used for the high-voltage supply, they do not produce x-rays. Picture tubes with an improved faceplate for x-ray shielding may have the letter V in the type designation or the prefix letters XR. Always make sure that an exact replacement tube is used, so that a set that requires a leaded-glass faceplate is not used with a CRT made of conventional glass.

Television receivers are designed to limit the x-ray level below the value set by the U.S. Department of Health, Education, and Welfare. The limit is 0.5 milliroentgen per hour (mR/h) as measured at a point 2 in. [51 mm] from any surface of the receiver. This dosage is extremely small, just above the normal background level.

HOLD-DOWN CIRCUIT For protection against x-ray radiation from color picture tubes, the main problem is not allowing the anode voltage to exceed the recommended value. The receiver should not be able to produce a viewable picture when the high voltage exceeds a specified limit. In one method, the high voltage is cut off, resulting in no brightness. In another method, the horizontal sweep frequency is increased. This effect makes the picture be out of horizontal sync and reduces the high voltage. Either system is called a *hold-down circuit* because it limits the amount of high voltage. A typical hold-down circuit is explained in Fig. 16-27.

Q.4 a. Explain interlaced scanning pattern used TV systems. (10)

Answer:

6-2 INTERLACED SCANNING PATTERN

The scanning procedure that has been universally adopted employs horizontal linear scanning in an odd-line interlaced pattern. The FCC scanning specifications for U.S. television broadcasting provide a standard scanning pattern that includes a total of 525 horizontal lines in a rectangular frame having a 4:3 aspect ratio. The frames are repeated at a rate of 30 per second with two fields interlaced in each frame.

INTERLACING PROCEDURE Interlaced scanning can be compared with reading the interlaced lines written in Fig. 6-4. Here the information on the page is continuous if you read all the odd lines from top to bottom and then go back to the top to read all the even lines from top to bottom. If the whole page were written and read in this interlaced pattern, the same amount of information would be available as when it was written in the usual way, with all the lines in progressive order.

For the interlaced scanning, first all the odd lines are scanned from top to bottom, and the

The horizontal scanning lines are interlaced in
the odd lines are scanned, omitting the even lines.
the television system in order to provide two
Then the even lines are scanned to complete the
views of the image for each picture frame. All
whole frame without losing any picture information.

Fig. 6-4 An example of interlaced lines. Read the first and odd lines and then the second and even lines.

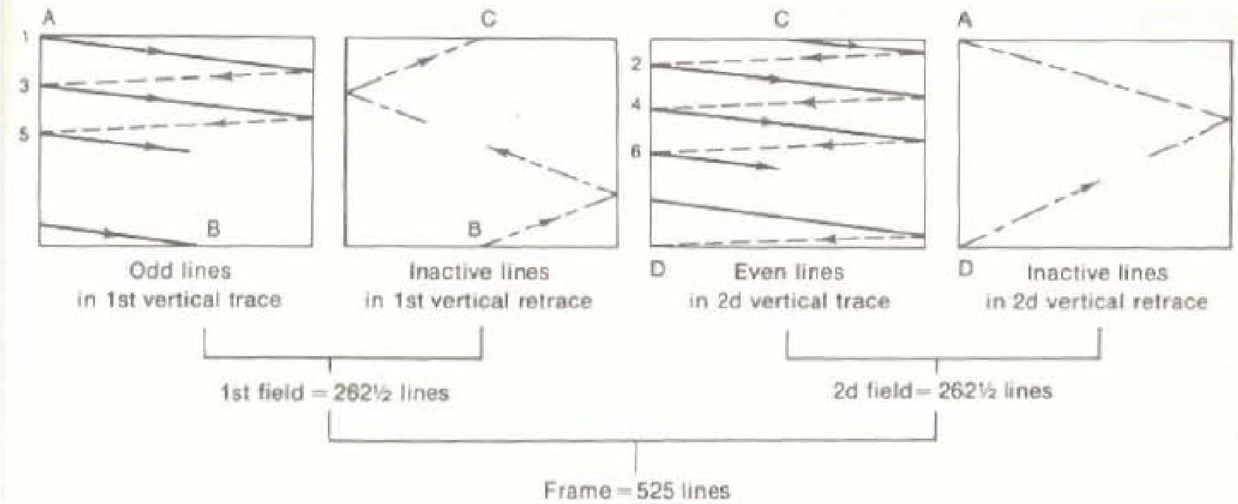


Fig. 6-5 Details of odd-line interlacing with two fields in one frame.

even lines are skipped. After this vertical scanning cycle, a rapid vertical retrace causes the electron scanning beam to return to the top of the frame. Then all the even lines that were omitted in the first scanning are scanned from top to bottom.

Each frame becomes divided into two fields. The first and all the following odd fields contain the odd lines in the frames. The second and all the even fields include the even scanning lines. Given two fields per frame and 30 complete frames scanned per second, the field repetition rate is 60 per second and the vertical scanning frequency is 60 Hz. In fact, doubling the vertical scanning frequency from the 30-Hz frame rate to the 60-Hz field rate is what makes the beam scan every other line in the frame.

ODD-LINE INTERLACING The geometry of the standard odd-line interlaced scanning pattern is illustrated in Fig. 6-5. Actually, the electron gun aims the beam at the center, which is where the scanning starts. For convenience, however, we can follow the motion by starting at the upper left corner of the frame at point A. For this line 1, the beam sweeps across the frame with uniform velocity to cover all the picture elements in one horizontal line. At the end of this trace, the beam retraces rapidly to the left side of the frame, as shown by the dashed line, to begin scanning the next horizontal line.

Note that the horizontal lines slope downward in the direction of scanning because the vertical deflection signal simultaneously produces a vertical scanning motion, which is very slow compared with horizontal scanning. Also note that the slope of the horizontal trace from left to right is greater than the slope during retrace from right to left. The reason is that the faster retrace does not allow the beam as much time to be deflected vertically.

After line 1 is scanned, the beam is at the left side, ready to scan line 3, omitting the second line. This line skipping is accomplished by doubling the vertical scanning frequency from 30 to 60 Hz. Deflecting the beam vertically at twice the speed necessary to scan 525 lines produces a complete vertical scanning period for only 262½ lines, with alternate lines left blank. The electron beam scans all the odd lines, then, finally reaching a position, such as point B in Fig. 6-5, at the bottom of the frame.

At time B the vertical retrace begins because of flyback on the vertical sawtooth deflection signal. Then the beam returns to the top of the frame to begin the second, or even, field. As shown in Fig. 6-5, the beam moves from point B up to C, traversing a whole number of horizontal lines.

This vertical retrace time is long enough for the beam to scan several horizontal lines. We can call these *vertical retrace lines*, meaning complete horizontal lines scanned during vertical flyback. Note that the vertical retrace lines slope upward, because the beam is moving up while it scans horizontally. The upward slope of the vertical retrace lines is greater than the downward slope of the lines scanning during vertical trace because the flyback upward is much faster than the trace downward. Any lines scanned during vertical retrace are not visible, though, because the electron beam is cut off by blanking voltage during the vertical flyback time. The vertical retrace lines are *inactive* because they are blanked out.

Horizontal scanning of the second field begins with the beam at point C in Fig. 6-5. This point is at the middle of a horizontal line because the first field contains 262½ lines. After scanning a half-line from point C, the beam scans line 2 in the second field. Then the beam scans between the odd lines—it scans the even lines that were omitted during the scanning of the first field. The vertical scanning motion is exactly the same as in the previous field, which means that all the horizontal lines have the same slope downward in the direction of scanning. As a result, all the even lines in the second field are scanned down to point D. Points D and B are a half-line away from each other because the second field started at a half-line point.

The vertical retrace in the second field starts at point D in Fig. 6-5. From here, vertical flyback causes the beam to return to the top. Since there are a whole number of vertical retrace lines, the beam finishes the second vertical retrace at A. The beam will always finish the second vertical retrace where the first trace started because the number of vertical retrace lines is the same in both fields. At point A, then, the scanning beam has just completed two fields, or one frame, and is ready to scan the third field.

All odd fields begin at point A. All even fields begin at point C. Since the beginning of the even-field scanning at C is on the same horizontal level as A with a separation of one-half line, and since the slope of all the lines is the same, the even lines in the even fields fall exactly between the odd lines in the odd fields. To achieve this odd-line interlace, the starting points at the top of the frame must be separated by exactly one-half line. //

b. Explain "Flicker" in Television systems. (6)

Answer:

6-4
FLICKER

Interlaced scanning is used because the flicker effect is negligible when 60 views of the picture are presented each second. Although the frame repetition rate is still 30 per second, the picture is blanked out during each vertical retrace, or 60 times per second. So the change from black between pictures to the white picture is too rapid to be noticeable.

If progressive scanning were used instead of interlaced scanning—all the lines in the frame being scanned in progressive order from top to bottom—there would be only 30 blank-outs per second, and objectionable flicker would result. Scanning 60 complete frames per second in a progressive pattern also would eliminate flicker, but the horizontal scanning speed would be doubled, which would double the video frequencies corresponding to the picture elements in a line.

Although the increased blanking rate found in interlaced scanning largely eliminates flicker in the image as a whole, the fact that individual lines are interlaced can cause flicker in small areas of the picture. Any one line in the image is illuminated 30 times per second, which makes the flicker rate of a single line half of that for the interlaced image as a whole.

The lower flicker rate for individual lines may cause two effects in the picture—*interline flicker* and *line crawl*. Sometimes interline flicker is evident as a blinking of thin, horizontal objects in the picture, such as the roof line of a house. Line crawl is an apparent movement of the scanning lines upward or downward through the picture; it is a result of the successive illumination of adjacent lines. These effects may be noticed in bright parts of the picture because the eye perceives flicker more easily at high brightness levels.

Q.5 a. Explain "colour addition" used in colour TV system. (8)

Answer:

8-2 COLOR ADDITION

Almost any color can be produced by adding red, green, and blue in different proportions. The additive effect is obtained by superimposing the individual colors. In a tricolor picture tube, the red, green, and blue information on the screen is integrated by the eye to provide the color mixtures in the actual scene. The persistence of the image provides the effect of color mixing.

ADDITIVE COLOR MIXTURES The idea of adding colors is shown in color plate VII. The three circles in red, green, and blue overlap partially. Where the circles are superimposed, the color shown is the mixture produced by adding the primary colors. At the center, all three color circles overlap, resulting in white.

Where only green and blue add, the result is a greenish blue mixture called *cyan*. Some people might consider this color just blue or perhaps turquoise. However, *cyan* is the name to remember for this green-blue mixture.

When only red and blue are added, the bluish red color is called *magenta*. This color is similar to violet or purple, but magenta has more red.

Yellow is an additive color mixture with approximately equal parts of red and green. More red and less green produce orange.

Similarly, practically all natural colors can be produced as mixtures of red, green, and blue, including the so-called neutral colors, such as white and gray.

PRIMARY COLORS The primary colors are combined to form different mixtures. The only requirement is that no primary can be recreated by mixing the other primaries. Red, green, and blue are the primary colors used in television because they produce a wide range of color mixtures when they are added together. Therefore, red, green, and blue are additive primaries.

COMPLEMENTARY COLORS The color that produces white light when it is added to a primary is called its *complement.* For instance, yellow, when added to blue, produces white light. Therefore, yellow is the complement of the blue primary.

The fact that yellow plus blue equals white follows because yellow is a mixture of red and green. Therefore, the combination of yellow and blue actually includes all three primaries.

Similarly, magenta is the complement of green, and cyan is the complement of red. Sometimes the complementary colors cyan, magenta, and yellow are referred to as *minus red, minus green,* and *minus blue,* respectively, because each can be produced as white light minus the corresponding primary.

A primary and its complement can be considered to be opposite colors. The reason is that the complement of any primary contains the other two primaries. This idea is illustrated by the color circle in Fig. 8-6, where the dashed lines connect each primary and its opposite complementary color.

The hue of the complementary colors can be seen in color plate VII. Cyan is a greenish blue,

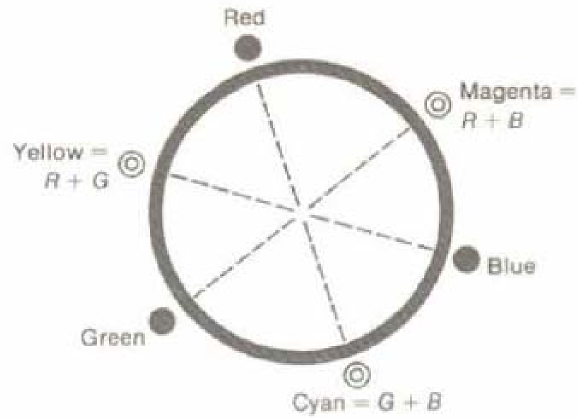


Fig. 8-6 Color wheel showing primary colors red, green, and blue with their opposite, or complementary, colors cyan, magenta, and yellow.

and magenta is a purplish red. When considered as primary colors in a subtractive system, these colors are often labeled simply blue, red, and yellow. However, this blue is really cyan with green and blue; the red is magenta, combining blue and red; the yellow combines green and red.

A *subtractive system* is used in color photography. In this method, mixtures are obtained by subtracting individual primary colors from white light by means of color filters. Thus cyan, magenta, and yellow are the subtractive primary colors used to filter out red, green, and blue, respectively.

In summary, the additive primaries for color television and their complementary colors are:

PRIMARY COLOR	COMPLEMENTARY COLOR
Red	Cyan
Green	Magenta
Blue	Yellow

Furthermore, the components of the complementary colors are

Cyan = blue + green
Magenta = red + blue
Yellow = red + green

ADDING COLOR VOLTAGES What you see on the screen is the superimposed combination of red, green, and blue. This effect is most obvious when you look at a raster alone, without any picture. If the blue gun is cut off by adjusting either the bias or the screen-grid voltage, then the electron beams of the red and green guns can produce a yellow raster. If there is more red and less green, you see the raster color become orange.

Similarly, the blue and green guns operating without the red gun produce cyan; or the red and blue guns alone produce magenta. With all three guns operating to reproduce red, green, and blue in the correct proportions, the raster is white.

All three guns are cut off to reproduce black, which is just the absence of light. Black is the same in color or monochrome.

COMPLEMENTARY VOLTAGE POLARITIES Another important feature of color video voltages is the fact that opposite polarities correspond to complementary colors. To illustrate this idea, assume that the blue video voltage has the polarity that increases the beam current of the blue gun. More blue video voltage produces more beam current from the blue gun, to reproduce more blue in the raster and picture. Although all three guns are operating, in this example we are looking only at the effect of blue. Note now that the opposite polarity of the blue video voltage decreases the beam current. Then less beam current from the blue gun reduces the amount of blue on the screen. The same effect is achieved by increasing the red and green, which is a yellow combination. Furthermore, yellow is the complement of blue. The result, then, is that reversing the polarity of a color video voltage causes a change to its complementary color.

b. Explain (i) Hue (ii) Saturation (iii) Chrominance (iv) Luminance (8)

Answer:

HUE The color itself is its hue, or tint. Green leaves have a green hue; a red apple has a red hue. The color of any object is distinguished primarily by its hue. Different hues result when different wavelengths of the light produce the visual sensation in the eye.

SATURATION Saturated colors are vivid, intense, deep, or strong. Pale or weak colors have little saturation. The saturation indicates how little the color is diluted by white. For example, vivid red is fully saturated. When the red is diluted by white, the result is pink, which is really a desaturated red. Note that a fully saturated color has no white.

CHROMINANCE This term is used to combine both hue and saturation. In color television, the 3.58-MHz color signal, specifically, is the chrominance signal. In short, the chrominance includes all the color information, without the brightness. The chrominance and brightness together specify the picture information completely. Chrominance is also called *chroma*.

We can reserve the term *chrominance*, or *chroma*, for the 3.58-MHz modulated subcarrier signal. This *C* signal contains the hue and saturation for all the colors. Its frequency is 3.58 MHz. However, before modulation and after demodulation, the color information is in the red, green, and blue color video signals. The range of these modulation frequencies, or the baseband for color, can be considered practically as 0 to 0.5 MHz.

Let us summarize these important differences in the frequency ranges:

C signal: Includes side frequencies above and below the 3.58-MHz modulated subcarrier, mainly 3.08 to 4.08 MHz.

R, G, and B video signals: Include baseband frequencies of 0 to 0.5 MHz.

R − Y, B − Y, and G − Y video signals: Also include the baseband frequencies of 0 to 0.5 MHz. However, these symbols are color mixtures because each has the color components of the −*Y* signal.

LUMINANCE The luminance indicates the amount of light intensity, which is perceived by the eye as brightness. In a black-and-white picture, the lighter parts have more luminance than the dark areas.

Different colors also have shades of luminance, however, since some colors appear brighter than others. This idea is illustrated by the relative luminosity curve in color plate VIII*b*. The curve shows that the green hues between cyan and orange have maximum brightness.

The luminance really indicates how the color will look in a black-and-white reproduction. Consider a scene being either photographed on black-and-white film or televised in monochrome. The picture includes a colorful costume with a dark red skirt, yellow blouse, and a light blue hat. For the same illumination, these different hues will have different brightness values and so will be reproduced in different shades of monochrome.

As shown by the graph in color plate VIII for relative brightness values of different hues, dark red has low brightness, yellow has high brightness, and blue has medium brightness. Therefore, the monochrome picture reproduction will show a white blouse (for yellow) with a black shirt (for dark red) and a gray hat (for light blue). The relative brightness variations for different hues make it possible to reproduce scenes that are naturally in color as similar pictures in black and white.

In color television, the luminance information is in the luminance, or *Y*, signal. This abbreviation should not be confused with yellow, because the luminance signal contains only the brightness variations for all the information in the picture.

The *Y* signal components are 30 percent red, 59 percent green, and 11 percent blue. These percentages approximate the brightness sensation of human vision for different colors. As a result, a monochrome picture produced by the *Y* signal looks correct in shades of gray and white.

Q.6 a. Explain the types of colour video signals. (10)

Answer:

8-8 TYPES OF COLOR VIDEO SIGNALS

The main types of color video signals must include the primary colors, as the system starts with *R*, *G*, and *B* voltages for the camera tube and finishes with *R*, *G*, and *B* at the picture tube. However, color mixtures are used for encoding and decoding. The reason is that two color-mixture signals can have all the color information of the three primary colors, allowing the third signal to be *Y* signal for luminance.

I SIGNAL This color video voltage is produced in the transmitter matrix as the following combination of red, green, and blue:

$$I = 0.60R - 0.28G - 0.32B \qquad (8\text{-}2)$$

The minus sign indicates the addition of video voltage of negative polarity. For instance, $-0.32B$ means 32 percent of the total blue video signal but inverted from the polarity that reproduces blue.

With $+I$ polarity, the signal includes red and minus blue, or yellow. They add to produce orange.

For the $-I$ signal, the polarity is reversed for all the primary components. Thus the combination includes green and blue for cyan, with minus red, which is cyan.

As a result, opposite polarities of the I video signal represent the complementary colors orange and cyan, approximately. These hues are in color plate IX, which shows the main color video voltages.

Note that the negative components of $-0.28G$ and $-0.32B$ total -0.60, which equals the positive value of $0.60R$. These values are chosen to make the amplitude of the I video signal become zero for white.

Q SIGNAL The primary color voltages are combined in the transmitter matrix in the following proportions for the Q signal:

$$Q = 0.21R - 0.52G + 0.31B \qquad (8\text{-}3)$$

With $+Q$ polarity, this signal includes minus green, or magenta, with red and blue. They combine to form purple hues.

For the $-Q$ signal, this polarity includes mainly green with minus blue, or yellow. The combination is yellow-green.

As a result, opposite polarities of the Q signal represent the complementary colors purple and yellow-green. See color plate IX.

Note that the positive components of $0.21R$ and $0.31B$ total 0.52, to equal the negative component of $-0.52G$. These values are chosen to make the amplitude of the Q signal zero for white.

Both the I and Q signals are zero for white, since there is no chrominance information in white. The luminance information for shades of white is contained in the Y signal.

$B - Y$ SIGNAL The hue of this signal is mainly blue, but it is a color mixture because of the $-Y$ component. When we combine 100 percent blue with the primary components of the Y signal, we get

$$B - Y = 1.00B - (0.30R + 0.59B + 0.11B)$$
$$= -0.30R - 0.59G + 0.89B \qquad (8\text{-}4)$$

Note that $-R$ and $-G$, when combined, equal the complement of yellow, which is blue. However, a little more minus green shifts the hue toward magenta, resulting in a purplish blue.

When the $B - Y$ signal is combined with the Y signal in the picture tube, it reproduces the blue information. The effect is $B - Y + Y = B$.

$R - Y$ SIGNAL The hue of $R - Y$ is a purplish red. Combining red with the primary components of the Y signal results in

$$R - Y = 1.00R - (0.30R + 0.59G + 0.11B)$$
$$= 0.70R - 0.59G - 0.11B \qquad (8\text{-}5)$$

The minus green is magenta, which is combined with red to produce a purple-red for positive polarity of the $R - Y$ signal. The opposite polarity of the $R - Y$ signal has the hue of cyan-blue.

When the $R - Y$ signal is combined with the Y signal in the picture tube, it reproduces the red information. The effect is $R - Y + Y = R$.

$G - Y$ SIGNAL Combining the $-Y$ signal and 100 percent G results in

$$G - Y = 1.00G - (0.30R + 0.59G + 0.11B)$$
$$= -0.30R + 0.41G - 0.11B \qquad (8\text{-}6)$$

The hue of the $G - Y$ signal is a bluish green. The opposite polarity is a purplish red. When the $G - Y$ signal is added to the Y signal in the color picture tube, the green information is reproduced. The effect is $G - Y + Y = G$.

In the receiver, $G - Y$ video is obtained by combining $R - Y$ and $B - Y$ in the following proportions:

$$G - Y = -0.51(R - Y) - 0.19(B - Y) \quad (8\text{-}7)$$

This combination is formed in the $G - Y$ amplifier stage.

SUMMARY OF COLOR VIDEO SIGNALS The color-mixture voltages are all related since each is a combination of R, G, and B. As additional examples, the I and Q signals can be specified in terms of the color-difference signals as follows:

$$I = -0.27(B - Y) + 0.74(R - Y) \quad (8\text{-}8)$$
$$Q = 0.41(B - Y) + 0.48(R - Y) \quad (8\text{-}9)$$

All these video signals are color mixtures. They combine R, G, and B so that two mixtures can contain all the color information of the three primaries.

Note the difference between these color video voltages, without modulation, and the 3.58-MHz modulated C signal. There is only one C signal, always at 3.58 MHz. This signal is encoded with the chrominance information as hue and saturation, corresponding to the phase and amplitude of the modulation on the 3.58-MHz color subcarrier signal.

However, the different color video signals exist before modulation of the 3.58-MHz color subcarrier signal at the transmitter and after demodulation at the receiver. The color video signals and their main features are summarized in Table 8-2. The colors listed are for positive signal voltage. The opposite polarity for each signal has the opposite hue. You can see these hues in the color circle diagram in color plate IX. The bandwidth is 0.5 MHz for all except the I signal.

RELATIVE GAIN VALUES The amplitudes of the color video signals are modified in transmission to prevent modulation past the maximum white and black levels. For instance, yellow with high luminance can overmodulate white; blue with low luminance can overmodulate black. As a result, the receiver must compensate with the following proportions of gain:

$$B - Y \text{ gain} = \frac{1}{49} = 2.04\%$$

$$R - Y \text{ gain} = \frac{1}{87.7} = 1.14\%$$

$$G - Y \text{ gain} = \frac{1}{142.3} = 0.70\%$$

For example, the receiver gain for the $B - Y$ signal is almost double the gain for the $R - Y$ signal. The reason is that, in modulation at the transmitter, the $B - Y$ component is reduced to 49 percent of its normal level.

TABLE 8-2
TYPES OF COLOR VIDEO SIGNALS

NAME	HUE	BANDWIDTH, MHz	NOTES
$B - Y$	Blue	0–0.5	Opposite phase from color sync
$R - Y$	Red	0–0.5	In quadrature with $B - Y$
$G - Y$	Green	0–0.5	Combines $B - Y$ and $R - Y$
I	Orange	0–1.3	Maximum color bandwidth
Q	Purple	0–0.5	In quadrcture with I

b. Explain the "Colour Sync Burst". (6)

Answer:

8-9 COLOR SYNC BURST

Figure 8-15a shows the details of the 3.58-MHz color sync burst transmitted as part of the total composite video signal. The color burst synchronizes the phase of the 3.58-MHz color oscillator in the receiver. Then the 3.58-MHz color subcarrier signal is reinserted in the synchronous demodulators to detect the chrominance signal.

The phase of the reinserted oscillator voltage determines the hues in the detector output. Therefore, the color sync is necessary to establish the correct hues for the demodulators. Then the color automatic frequency control (AFC) can hold the hue values steady. Without color synchronization, the picture has drifting color bars. The effect of no color sync is shown in color plate VI.

The burst is 8 to 11 cycles of the 3.58-MHz subcarrier, transmitted on the back porch of each horizontal blanking pulse. The peak value of the burst is one-half the sync pulse amplitude. Peak-to-peak burst equals the amplitude of sync. However, the average value of the burst coincides with the blanking level. This value corresponds to zero for deflection sync. As a result, the color burst does not interfere with synchronization of the deflection oscillators.

The burst and *C* signal are both 3.58 MHz. However, the burst is on during blanking time only, when there is no picture information. The *C* signal is on during visible trace time for the color information in the picture. This comparison is illustrated in Fig. 8-15*b*. The oscilloscope photograph of the video signal in Fig. 8-9 also shows the color sync burst on the back porch of *H* sync.

The presence or absence of the burst determines how a color receiver recognizes whether a program is in color or monochrome.

Q.7 a. Explain the tests for streaking. (6)

Answer:

9-3 TESTS FOR STREAKING OR SMEAR IN THE PICTURE

Streaking is mainly a problem of phase distortion for middle and low video frequencies, from about 100 kHz down. The streaking, or smearing, shows as a continuation of a wide bar of picture information after a sharp change to the opposite color. As examples, a wide black bar can show streaks to the right into a white area. Or white can be smeared into black areas. An example of streaking in the picture is shown in Fig. 9-2.

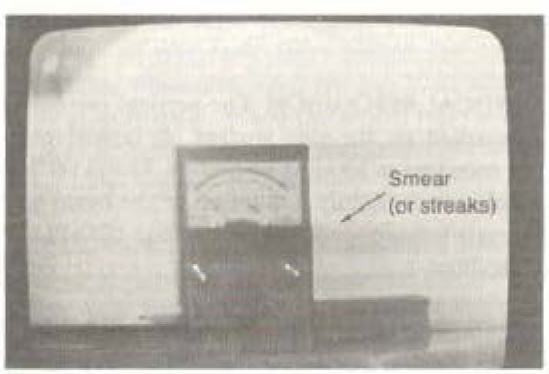


Fig. 9-2 Smear in the picture.

The cause of streaking is phase distortion for video signal frequencies of 10 to 100 kHz. In the video signal, phase distortion can be seen as a tilt in the square wave of the picture information. Phase distortion in an amplifier means that the phase-angle shift is not proportional to the frequency.

BARS IN THE TEST PATTERN TO CHECK STREAKING In the EIA test pattern of Fig. 9-1, note the two wide, black bars at the top of the large white disk and the two bars at the bottom. The frequency at which the phase distortion and smearing can be checked is related to the width of these bars. For example, the phase distortion at 100 kHz shows as streaking of the shortest bar, at the bottom of the white disk. The longest bar, which is second from the top, can indicate streaking for 30 kHz. This bar is about 3⅓ times wider than the shortest bar for a frequency 0.3 times lower, compared with the shortest bar. The intermediate values are 50 kHz for the top bar and 60 kHz for the bar second from the bottom.

b. Explain (i) aspect Ratio (ii) Contrast Range with respect to EIA Test Pattern. (4)

Answer:

ASPECT RATIO Note the square formed by the four bars of gray-scale chips placed just inside the central white disk. Each bar has 10 numbered steps of gray scale. When the aspect ratio is correct, at 4:3, this border of the gray-scale chips is a perfect square.

CONTRAST RANGE The 10 numbered steps of gray-scale chips have reflectances that range from a maximum for peak white to about one-thirtieth of that value. When the video signal processing is linear, it should be possible to distinguish 10 distinct shades from white through gray to black.

c. Explain the tests for Ringing. (6)

Answer:

9-4
TESTS FOR RINGING IN THE PICTURE

Frequency distortion in the form of too much relative gain for some high video frequencies results in ringing or overshoot. Typically, the excessive gain is in the frequency range of 2 to 4 MHz. The amplifier is just short of being an oscillator circuit, but it can be shock-excited into several cycles of oscillations by an abrupt transient variation in the video signal. Ringing can be seen in the test pattern as an increase in contrast at some point in the vertical wedges. Divide the number of resolution lines by 80 to get the frequency at which the ringing occurs. An example of ringing in the picture is shown in Fig. 9-3.

In addition, a number of abrupt horizontal scanning transitions are provided by vertical black dashes in the white disk of the EIA pattern. In Fig. 9-1, there are two groups of these dashes, one in the upper right quadrant and the other at the lower left. The thickness of each vertical dash represents a single line for horizontal resolution that ranges from 100 to 300 and 350 to 550. A thinner line corresponds to higher resolution. In the lower left quadrant, the 300 at the bottom of the group of five dashes is for the bottom dash. Then the dashes get thicker, progressing to 100-line resolution for the widest dash at the top of the group.

In the upper right quadrant, the 350 at the top of the group of five dashes is for the top dash. Then the dashes get thinner, progressing to 550-line resolution for the thinnest dash at the bottom of the group.

Ringing in the picture shows as greater contrast, with multiple lines trailing to the right for

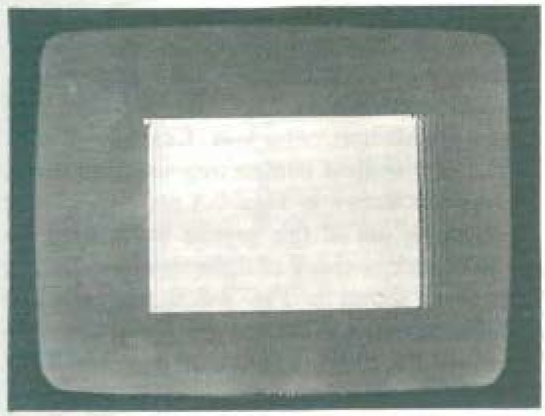


Fig. 9-3 Ringing in the window signal. Note the multiple outlines.

each of the ringing cycles. Since each individual dash represents a particular frequency, the ringing condition appears worst where the burst of energy matches the frequency at which ringing occurs in the video amplifier circuit. Once again, convert the line-resolution number in the test pattern to its video frequency by dividing by 80.

For example, suppose that the ringing occurs at the marker for 300-line resolution. The corresponding video frequency is 300/80 = 3.75 MHz. This value is the frequency at which the video amplifier circuit is ringing.

Actually, a small amount of ringing may be permissible, for it improves the contrast for high-frequency details at the vertical edges of the objects in the scene. When it produces trailing outlines, however, the excessive ringing is objectionable. Generally the ringing is caused by stray resonance effects in the video amplifier circuit.

Q.8 **Draw a neat block diagram of Black and White TV receiver and explain the function of each block briefly. (16)**

Answer:

12-1 FUNCTIONAL BLOCKS FOR THE SIGNAL

Figure 12-3 shows the block diagram for a monochrome receiver. Those blocks in the shaded area indicate the RF-IF signal circuits. The receiver is basically a superheterodyne circuit. A local oscillator stage in the RF tuner, or front end, beats the RF signal down to the intermediate frequencies for the IF amplifier. Then all RF signals for different stations are converted to the same IF values of the receiver. The standard IF values for television receivers are:

45.75 MHz for the picture IF carrier signal
41.25 MHz for the sound IF carrier signal

Most of the signal amplification in the receiver is done by the IF amplifier sections.

The video signal first appears at the output of the video detector. The detector has modulated IF signal input and baseband signal output.

SOUND SIGNAL Included in the video detector output is a 4.5-MHz sound signal. This signal is produced by a second heterodyning process in which the sound IF signal at 41.25 MHz beats against the picture IF carrier at 45.75 MHz. The frequency difference is 45.75 − 41.25 = 4.5 MHz. The receiver is actually a double superheterodyne for the sound signal. In the video detector, the IF picture carrier serves as a local oscillator that beats with the IF sound signal.

The 4.5-MHz sound is still an FM signal with the original frequency modulation, but at a lower center frequency. Most important, the sound signal is independent of the exact local oscillator frequency in the RF tuner of the receiver, because 4.5 MHz is the difference between the carrier frequencies produced by the transmitter.

The sound signal is extracted by a 4.5-MHz trap and coupled to a narrowband IF amplifier tuned to 4.5 MHz. Then the original frequency modulation is recovered by an FM detector, such as the ratio detector, to produce the desired audio output. An audio amplifier provides the power needed to drive the loudspeaker. The front-panel volume control is usually at the input to the audio amplifier.

VIDEO DETECTOR OUTPUTS The detector is just a small semiconductor diode, but because of rectification the following three signals result:

1. Composite video signal for the video amplifier that drives the picture tube. In addition, the video amplifier supplies the signal for:
   a. The sync separator that strips the synchronizing pulses from the composite video signal
   b. The automatic gain control (AGC) circuit that controls the gain of the RF and IF stages
2. The 3.58-MHz chroma signal is used in the color circuits of color television receivers.
3. The 4.5-MHz FM sound signal is coupled to the 4.5-MHz sound IF section.

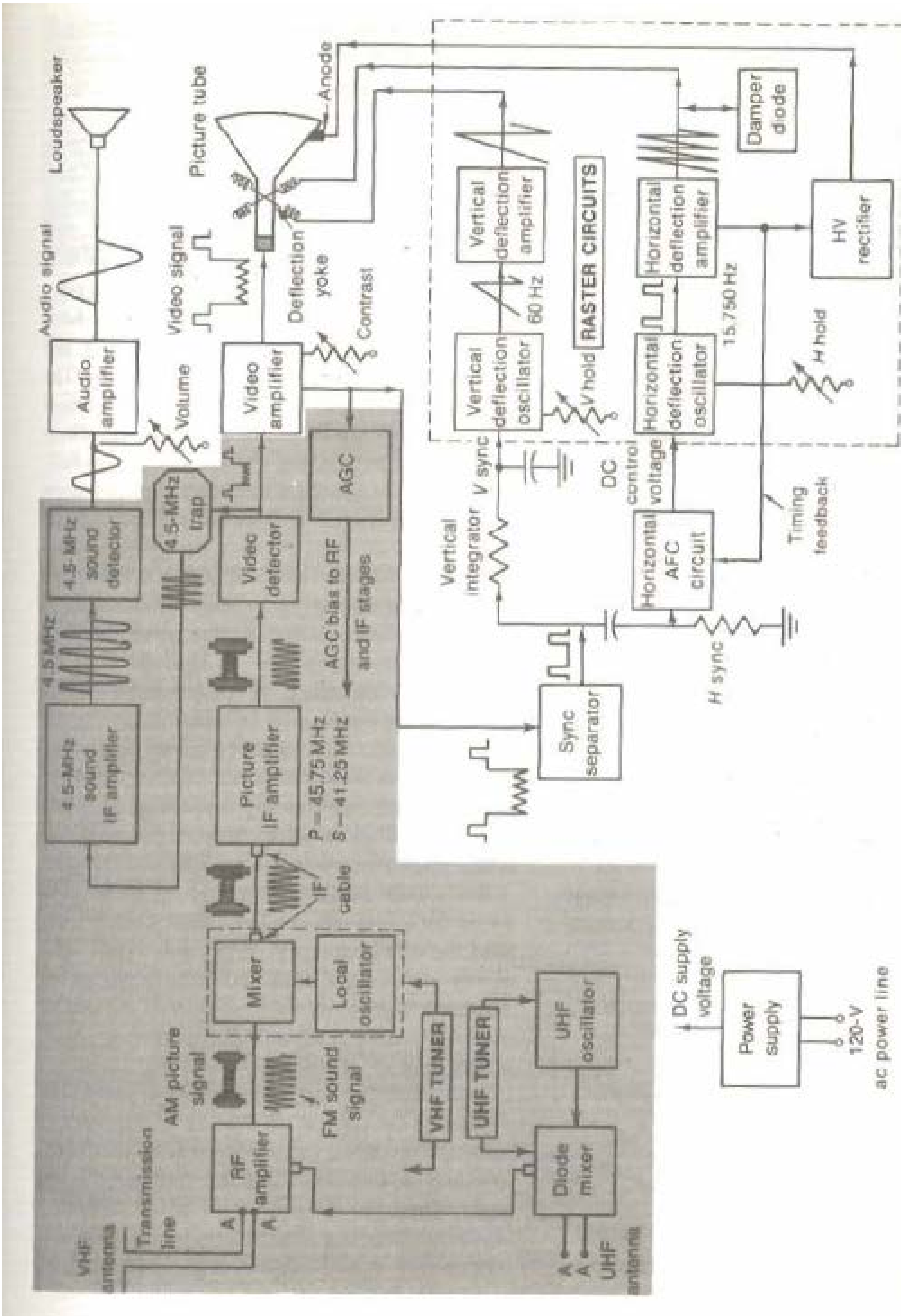
The video and chroma signals are produced as the detector recovers the modulation on the picture carrier signal.

VIDEO SIGNAL PATH The video signal for the picture tube controls the beam current and thus the brightness of the scanning spot. As a result, the intensity modulation of the beam reproduces the picture information. The video amplifier develops enough signal voltage, up to 200 V p-p, to drive the picture tube from cutoff for black and then close to zero grid-cathode voltage for peak white.

A front-panel contrast control varies the gain of the video amplifier. Adjusting the p-p ac signal drive for the picture tube varies the contrast. Note that the brightness control adjusts the dc bias.

SYNC SIGNAL PATH The sync separator is an amplifier circuit that is held in cutoff but made to conduct when the sync pulses are present. The input signal is the composite video signal from the video amplifier. The output is stripped sync, for both *V* and *H* scanning, without the picture information.

Then the separated sync is coupled to the vertical and horizontal scanning oscillators. The feed to the *H* deflection oscillator is total sync, since the phase-lock loop system that controls synchronization of the horizontal oscillator is unaffected by the wide vertical sync pulses. However, the feed to the *V* deflection oscillator contains an *RC* integrator circuit. This network is a low-pass filter because of the shunt capacitor. The integrator is not affected by the narrow horizontal sync pulses, but it builds up the required pulse output for the *V* sync. The capacitor is charged by the wide vertical pulse.



Q.9 **Write short notes on any TWO of the following:** **(16)**

(i) Safety aspects in TV receivers
(ii) Raster Distortions
(iii) Projection TV systems

Answer:

16-1 SAFETY

When you are working on a TV chassis outside its protective cabinet, there are several potential sources of electric shock. First, the high-voltage supply of 10 to 30 kV is a danger. This high dc voltage can cause a jolting shock. Also the ac input to the high-voltage rectifier can produce a serious skin burn. In terms of safety, though, the high-voltage power supply has the advantages of poor regulation and limited load current because the high-voltage rectifier is fed from the horizontal output circuit. The dc output drops sharply when it is partially short-circuited by someone touching the high-voltage circuit.

Although the low-voltage supply has much lower dc output voltage, a line-connected rectifier can supply appreciable current. The scanning-voltage rectifiers have limited output because they are supplied from the horizontal output circuit. In general, more than 30 V is usually required to produce enough current through the body to create an electric shock.

A real shock hazard exists from any exposed power-line voltage. One side of all 120-V electrical service is returned to earth ground in the power distribution system. Should someone come in contact with the other side, which is the hot side, the result is a 120-V difference in potential, as illustrated in Fig. 16-1. How serious the electric shock can be depends on the series resistance that determines the amount of current through the person's body. The *R* can be low when the person is on a damp, concrete floor, as in Fig 16-1*a*. The higher *R* in Fig. 16-1*b* corresponds to a dry rubber mat on a dry wood floor.

However, the grounded objects that are all around us can supply a low-resistance grounded path. Examples are appliances with a three-wire grounded plug. The third wire goes to earth ground through the power distribution system, in order to ground the metal case. A bench oscilloscope is usually grounded. Touching the case and the hot side of the power line will produce a serious shock. Other grounded objects are heating radiators, hot- and cold-water pipes, and the appliances that are grounded to them.

ISOLATION OF A POWER TRANSFORMER A power supply that uses a transformer with separate primary and secondary windings provides isolation from the power line. Either side of the secondary may be connected to the chassis, but it will not be hot with respect to the ac power line. This connection is a chassis ground but not earth ground.

Figure 16-2 illustrates the isolation with a power transformer. The primary has one side at earth ground. However, either side of the secondary has 0 V to earth ground. The 120 V across

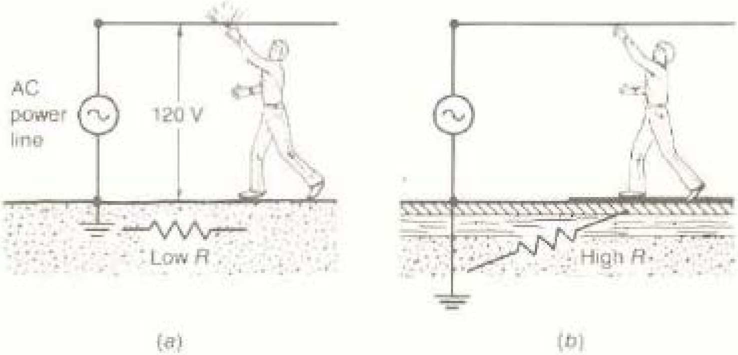


Fig. 16-1 Shock hazard from hot side of ac power line depends on resistance in ground return. (*a*) Low resistance on a damp floor. (*b*) High resistance with insulating mat on dry floor.

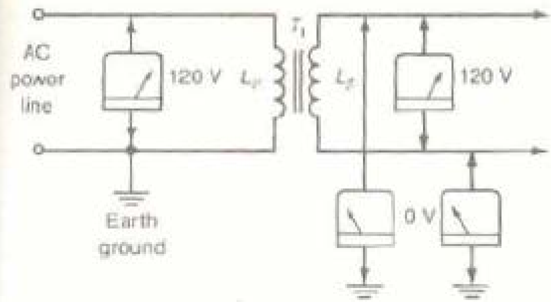


Fig. 16-2 Transformer with separate secondary winding provides isolation from ac power line. Meters in the secondary show 120 V across winding L_S but 0 V from either side to ground.

L_S is a result of electromagnetic induction produced by the current in L_P, which is independent of any ground connections.

TV monitors usually have a power transformer for isolation, so that the chassis ground can be used as a common connection for the jacks that take coaxial cable input. The outer conductor of the cable is grounded to its plug, the input jack, and the monitor chassis. If power transformers are not used, other forms of isolation must be provided for the cable feeds. One method uses the electro-optical coupler shown in Fig. 16-3.

Although transformer-powered equipment is assumed to be inherently safe, keep in mind that the isolation between the primary and secondary windings is provided by only a thin layer of insulation, which is usually varnished paper. A puncture of this thin layer, caused by arc-over or an undetected pinhole, can result in a hot chassis. Then all cables connected to the equipment become a real hazard for electric shock.

STATIC DISCHARGE A resistor of 1 or 2 MΩ often is connected from the chassis to one side of the ac power line, with or without a power transformer. This R is between chassis ground for the B-minus return and earth ground through the power line. The purpose is to drain off static

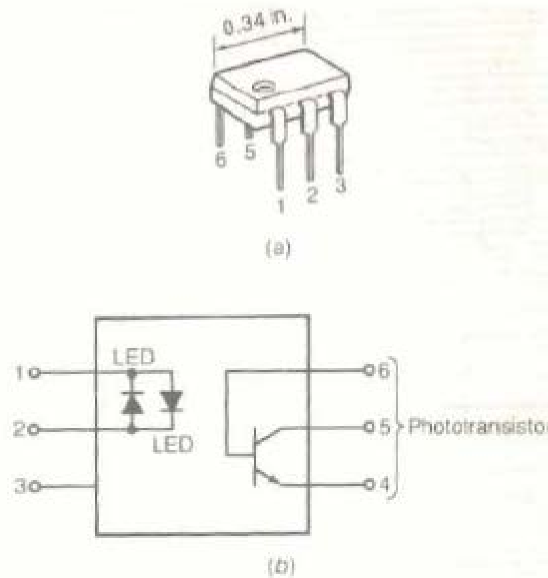


Fig. 16-3 Electro-optical coupler, used for isolation of ground return with coaxial cable connection. (a) Outline. (b) Pin connections. (*Motorola Semiconductor Products*)

charge through R and the power wiring to earth ground. An example is several thousand volts accumulated by the action of dry snow blowing across an outdoor antenna. The antenna input terminals have a dc path to chassis ground.

RF BYPASS CAPACITOR A capacitor of about 0.1 μF may be connected from chassis ground to the power line for earth ground. The purpose of this bypass capacitor is to keep the chassis from being a source of RF interference. Such a capacitor must have special voltage ratings. Also, it is designed to prevent any fire hazard in case of a failure. An exact replacement is necessary.

SAFETY-SENSITIVE COMPONENTS It is standard practice to identify these special components by shading in the diagram as in Fig. 16-4 or some other keying system. Included are RC networks and LC filters for the ac power input connections and components in the high-voltage supply. Their special characteristics are related to fire hazard, arcing, or x-ray emission. When replacement is necessary, use the manufacturer's part numbers. *Make no substitutions.*

HOT CHASSIS Many TV receivers do not have a power transformer. They rectify the ac line voltage directly to provide the dc supply voltage. Two examples of such a line-connected power supply are shown in Fig. 16-5. The advantages are less weight and space and greater economy for the receiver. However, the chassis could be hot with ac line voltage because of the connection to one side of the power line.

For the half-wave rectifier circuit in Fig. 16-5*a*, the B-minus return of the power supply is connected directly to the ac input. This chassis could be at the 120-V potential if the power plug were inserted with the chassis side connected to the hot side of the ac power.

In the bridge rectifier circuit in Fig. 16-5*b*, the chassis is always at a potential above earth ground that is one-half the ac line voltage. This potential is 60 V for 120-V ac input.

Note the *LC* filters in Fig. 16-5*a* and *b* to reduce the RF interference. Generally these components are shaded in schematic diagrams to indicate safety-related parts at risk for fire hazard.

Hot-chassis receivers use heavy blocks of insulation to insulate the chassis from the cabinet. No fasteners accessible from outside the cabinet make any direct electric connection to the chassis. In addition, the controls are isolated by the use of plastic knobs and plastic shafts. A special problem is the use of input and output jacks grounded to the chassis. Television receivers undergo strict tests by Underwriters Laboratories, in terms of shock hazard and fire protection.

6-5 RASTER DISTORTIONS

Since the picture information is reproduced on the scanning lines, distortions of the raster are in the picture also. A rectangular raster, correct proportions of width to height, and uniform deflection are required to get a good picture.

INCORRECT ASPECT RATIO Two cases of raster distortion are illustrated in Fig. 6-7. In Fig. 6-7*a*, the raster is not wide enough for its height, compared with the 4:3 aspect ratio used in the camera tube. So the people in the picture will look too tall and too thin—they will suffer from the same geometric distortion as the raster. This raster needs more width.

In Fig. 6-7*b*, the raster is not high enough for its width, and so the people in the picture will look too short. This raster needs more height.

In Fig. 6-7*a* or *b*, generally the trouble is caused by insufficient output from the horizontal or vertical deflection circuit.

PINCUSHION AND BARREL DISTORTION If deflection is not uniform at the edges of the raster, compared with its center, the raster will not have straight edges. The scanning lines bowed inward in Fig. 6-8*a* illustrate this effect, called *pincushion distortion*. And *barrel distortion* is shown in Fig. 6-8*b*.

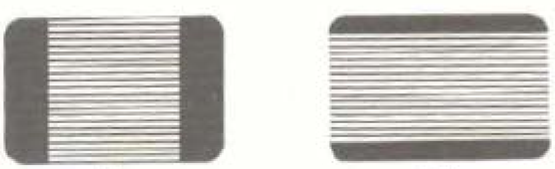

(*a*) (*b*)

Fig. 6-7 Incorrect aspect ratio in raster. Black areas show areas of the screen not covered by the scanning lines. (*a*) Insufficient width. Too much black area at left and right sides. (*b*) Insufficient height. Too much black area at top and bottom.

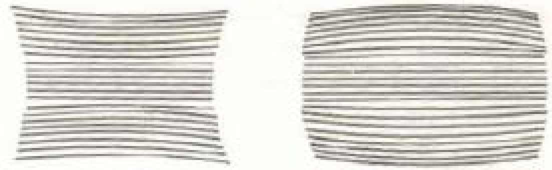

(*a*) (*b*)

Fig. 6-8 (*a*) Pincushion effect in raster. (*b*) Barrel distortion.

Pincushion distortion is a problem with large-screen picture tubes. Since the faceplate is almost flat, the distance from the point of deflection to the corners of the screen is greater. The electron beam is deflected more at the corners than at the center, which gives a raster with stretched-out corners.

The pincushion distortion can be corrected, however, by a compensating magnetic field. Small permanent magnets are mounted on the deflection yoke in monochrome picture tubes. In color picture tubes, the deflection current in the yoke is modified by pincushion correction circuits, or specially designed yokes are used.

TRAPEZOIDAL DISTORTION In Fig. 6-9*a*, the scanning lines are wider at the top than at the bottom. This raster is shaped like a keystone, or a trapezoid. A trapezoid has two opposite edges that are not parallel. In the raster this effect is called *keystoning*, which is a form of trapezoidal distortion. The cause is nonsymmetric deflection, either left to right (as in Fig. 6-9*a*) or top to bottom (as in Fig. 6-9*b*). In picture tubes,

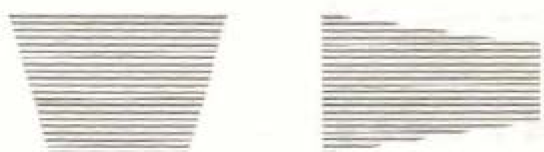

(*a*) (*b*)

Fig. 6-9 Trapezoidal raster. (*a*) Keystoned sides caused by unsymmetric horizontal deflection. (*b*) Keystoning at top and bottom caused by unsymmetric vertical deflection.

the scanning symmetry is provided by the balanced coils in the yoke for scanning. The problem of trapezoidal raster is caused by a defective deflection yoke.

NONLINEAR SCANNING The sawtooth waveform with its linear rise for trace time produces linear scanning, since the beam is made to move with constant speed. With nonlinear scanning, however, the beam moves too slowly or too fast. If the spot being scanned moves too slowly at the receiver, compared with scanning in the camera tube, then the picture information is crowded together. Or, if the scanning is too rapid, then the reproduced picture information is spread out. Usually, nonlinear scanning creates both effects at opposite ends of the raster. Nonlinear scanning is illustrated in Fig. 6-10 for a horizontal line with picture elements spread out at the left and crowded at the right. When the same effect occurs for all the horizontal lines in the raster, the entire picture is spread out at the left side and crowded at the right side. When there are people in the picture, a person at the left appears too wide and someone at the right looks too thin.

The vertical scanning motion must be uniform also. Otherwise, the horizontal lines will be bunched at the top or bottom of the raster and spread out at the opposite end. This effect is illustrated in Fig. 6-11 for spreading at the top and crowding at the bottom. So a person in this picture will appear distorted, having a long head and short legs. Scanning nonlinearity is caused by amplitude distortion of the sawtooth waveform in the deflection amplifier circuits.

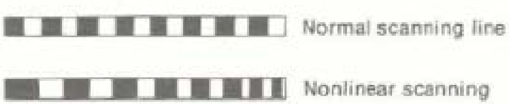


Fig. 6-10 Crowding at right side caused by nonlinear horizontal scanning.

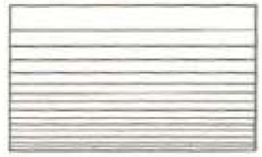


Fig. 6-11 Crowding at bottom caused by nonlinear vertical scanning.

POOR INTERLACED SCANNING In each field, the vertical trace must start exactly a half-line from the start of the previous field for odd-line interlacing. If the downward motion is slightly displaced from this correct position, the beam begins scanning too close to one of the lines in the previous field, instead of scanning exactly between lines. This incorrect starting position produces a vertical displacement between odd and even lines that is carried through the entire frame. As a result, pairs of lines are too close, and there is extra space between pairs. So you see too much space between the white scanning lines. This defect in interlaced scanning is called *line pairing*. In the extreme case, lines in each successive field are scanned exactly on the previous field lines. Then the raster contains only half of the usual number of horizontal lines.

When the picture has diagonal lines as part of the image, poor interlaced scanning makes them appear to be interwoven in the moiré effect shown in Fig. 6-12. This effect, also called *fishtailing*, is more evident in diagonal picture information, as the interlacing varies in successive frames.

Poor interlaced scanning is caused by inaccurate vertical synchronization. Although the period of a field is $\frac{1}{60}$ s, which is a relatively long time, vertical scanning in every field must be timed much more accurately to achieve good interlacing. If the vertical timing is off by 0.25 μs in one field compared with the next, then the interlaced fields are shifted the distance of one picture element.

Fig. 6-12 Example of faulty interlacing. The line divisions in horizontal wedges of test pattern are interwoven in a moiré effect.

4-10 TELEVISION PROJECTION SYSTEMS

The method used in TV projection systems is just the reverse of that in a three-tube color camera with separate pickup tubes. To reproduce the picture, separate red, green, and blue images are registered on a common reflecting screen. The viewer sees the resulting light mixtures as a big, beautiful color picture. Screen sizes are 2 × 3 and 4 × 5 ft [0.6 × 0.9 and 1.2 × 1.5 m], up to 9 × 12 ft [2.7 × 3.7 m], as big as a movie screen.

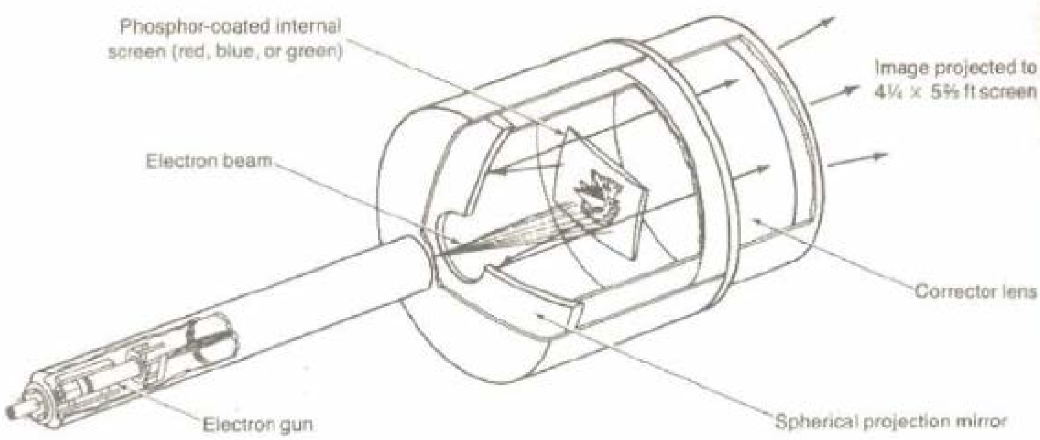


Fig. 4-17 Light-guide picture tube for the Advent TV projection system [*Advent Corporation*]

The advantage of projection is that the picture is much larger than that in direct-view tubes. A big picture looks real. However, the problem with TV projection is the production of enough brightness. When the picture area is increased 10 times, then 10 times more light is needed to achieve the same overall brightness. Another factor is that the larger picture still has the same number of scanning lines and the same maximum resolution with a 4-MHz video signal. In our standard television system, the horizontal scanning lines are easily visible. Also, the image does not look as sharp as a picture on a small screen that contains the same number of details and has stronger contrast. New systems are being considered with satellite television, though, that could provide a very high definition (VHD) picture for projection systems. More scanning lines and a wider frequency range for the signal are planned, in special transmission channels.

TV projection systems use small-screen picture tubes built to produce very intense light output. The screen size is generally 1 to 5 in., and the anode high voltage is 30 to 80 kV. The height, width, and scanning linearity for the raster are critical. Each tube has its own deflection system, and the three rasters must match precisely so that the images will remain in register at all points on the screen. //

CODE DE-68 SUBJECT Television Engineering

(Marking Scheme)

MODERATION-I

Q.		Unit, Text Book, Page Contents
Q.2	a. Block Diagram Transmit and Receive — 4 marks Explaination — 4M of each block b. Horizontal Blanking — 4 marks Vertical " — 4 marks Time values ↑	
Q.3	a. Diagram with H and V deflection – 3 marks Explaination using interaction of forces – 7 marks 1M b. Explain with Keywords — High Voltage — 2M X- radiation — 2M Hold-down CKt — 2M	
Q.4	a. Diagram – 4 Marks Explaination – 6 marks [Odd-line, Vertical Trace lines, Even fields] b. Defination – 2 marks Explaination – Progressive Vs. Interlaced Scanning — 4M	

165/10

		Unit, Book, No./ No.
Q.5	a. Description using Additive colour – 2M 2M Primary " 2M b. Complementary " – 2M 2M for each description	
Q.6	a. Definition – 2M Types – I-Signal 1 M B-Y – 2 M Q " 1 M R-Y – 2 M } 10M G-Y – 2 M b. Explaination of 3.58 MHz Color Sync Burst. – 6 marks	
Q.7	a. Definition – 2M Frequency Explaination – 4M } 6M. b. Definition with correct ratio (4:3) – 4M c) Description with method of test – 6M	
Q.8	a. Block Diagram – 6 Marks Explaination with each block – 10 Marks. b.	
Q.9	a. Safety Explaination – Shock – 2M 2M Precaution – 2M Low Voltage – 2M b. Raster Definition – 2M Incorrect Aspect Ratio – 2M Pin Cushion and Barrel – 2M Trapezoidal – 2M	

c) Projection TV System – Diagram 2M
Explaination – 6M

MODERATION

TEXT BOOK

I. Basic Television and Video Systems, Bernard Grob and Charles E. Herndon, Sixth Edition, 1999, McGraw Hill International Edition