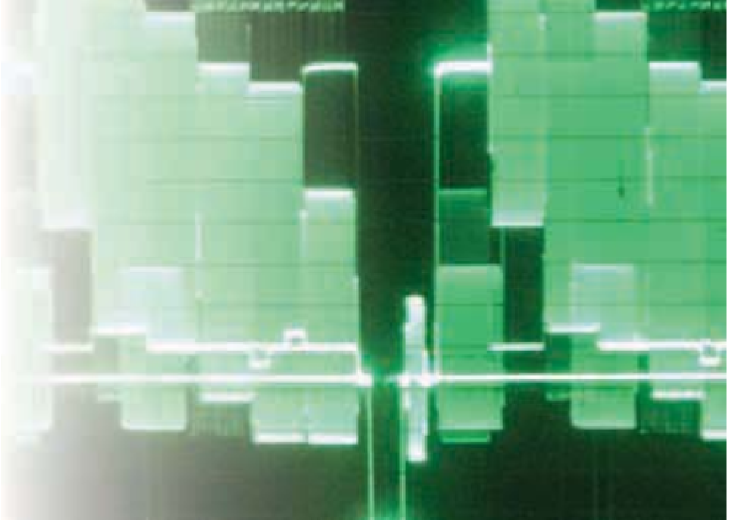


Chapter 25

Getting Technical

Important Terms

cathode ray tube (CRT)
DLP (digital light processing)
field
frame
genlock
high-definition (HD)
HiDef
HDV
interlace
LCD (liquid crystal display)
letterbox
OLED (organic light emitting diode)
plasma
progressive scan technology
standard definition (SD)
sync generator
vectorscope
waveform monitor

Objectives

After completing this chapter, you will be able to:

- Summarize how the television picture is produced.
- Explain the function and importance of sync to video equipment during production.
- Identify the differences between standard definition television and high-definition television.
- Understand the difference between interlace and progressive scan technology.
- Recall how each of the digital television technologies discussed create an image on screen.

Introduction

Even though current television technology is being tremendously impacted by the digital revolution, the most common consumer television receivers found throughout the country are still analog. Digital television signals were broadcast in conjunction with analog television signals from 2000 until 2009. The Federal Communications Commission mandated that analog signals cease to be broadcast as of June 12, 2009.

This chapter provides an overview of the technical aspects of the analog video signal as a general perspective for typical production personnel. The basics of digital video systems are also presented, including some of the most common digital video receiver options. Having a basic understanding of the video signal is helpful when troubleshooting problems during a program shoot.

This chapter is not intended to be an introduction to video engineering. A video engineer is extremely knowledgeable in the intricacies of television signals from an electronics perspective. Students with an aptitude for electronics may find a rewarding career as a video engineer.

Analog Television

cathode ray tube (CRT): A video display device that creates an image using a cathode that fires electrons at a phosphor-coated surface, which results in glowing dots on the screen.

A *CRT (cathode ray tube)* is a type of video display device that creates the on-screen image using a cathode that fires electrons at a phosphor-coated surface. When a phosphor is struck by an electron, it glows for a fraction of a second. Consumers commonly refer to a CRT television as a "picture tube" television. If we were to saw the picture tube of an analog CRT television set in half lengthwise, we could see the phosphor coating inside of the front piece of glass. The cathode is positioned at the back of the picture tube and "fires" a ray or beam of electrons through the tube, **Figure 25-1**. When the electrons hit the back of the television screen, they produce a glowing dot. Wire coils wrapped around the back of the tube serve as electromagnets that vary their magnetic strength to "steer" the beam of electrons. The trajectory of the beam can be bent after firing to sweep the entire phosphor-coated surface of the screen, instead of just the very center of the screen. The electromagnet, in essence, changes the course of the electron beam from a straight pitch to the screen, to a "curve ball."

Assistant Activity

Stand closely to a television screen and notice that each picture is actually made up of glowing vertical bars or dots. All of the glowing dots create a picture just like all the pieces of a mosaic create a larger picture. Now try to imagine just how many dots there are in one picture!

Closer inspection of the television screen reveals that the glowing dots are arranged in horizontal lines. There are 525 lines of dots on an analog television screen, but only 486 lines are visible. The remaining 39 lines are at the very top and bottom of the screen. If you have ever seen a television picture "roll," (the image visually scrolls up or down, on a television screen), the black bar between each rolling picture contains the 39 lines that are not normally visible on the screen. The 39 lines are black, having no luminance, but they contain information about how the television set creates the image. Those lines also include the information to place closed

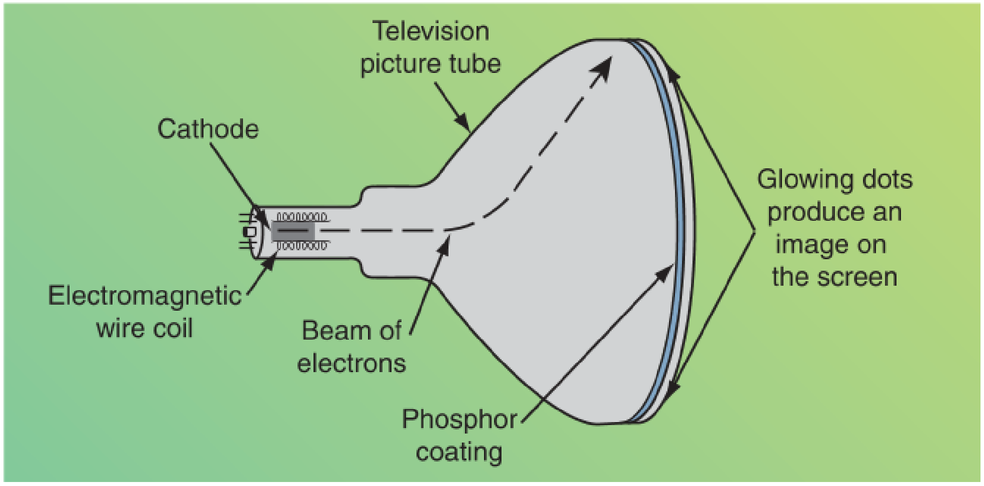


Figure 25-1. The cathode "fires" a ray of electrons at the phosphor-coated television screen, which produces glowing dots.

captioning on the screen when the option is activated by the viewer. This information is relevant to the responsibilities of a video engineer and will be addressed in advanced television production courses.

Developing the Technology

During the early development of television systems, electrons were sprayed on the back of a phosphor-coated screen to create a picture from the resulting glowing dots. There were understandable limitations to this technology. The pioneers of television determined that the standard used in this country would be to horizontally spray each individual line until all 525 lines were sprayed. The beam would then return to the top of the screen and begin again. This system is very much like typing a paper on a typewriter. The typewriter "sprays" the letters across the page until it reaches the end of the right edge of the page, returns to the left edge on the next line and sprays letters to the end of the right edge, returns to the left edge on the next line, and so on.

By the time the cathode ray sprayed the bottom line of the television screen, the top of the screen had already dimmed out to black. Remember that phosphor glows only for a fraction of a second. No matter what they tried, the television pioneers could not move the beam fast enough to go all the way to the bottom of the screen and return to the top to respray before the top line dimmed out. There were just too many dots on the screen to be lit up.

It was then decided to try spraying every other line with the cathode ray. This allows the beam of electrons to reach the bottom of the screen in half the time. The cathode ray then returns to the top of the screen and sprays the lines skipped on the first pass. So, the first pass sprays all the odd lines (1, 3, 5, 7) and the second pass sprays the even lines (2, 4, 6, 8). The concept of alternately firing odd and even lines is called ***interlace***, **Figure 25-2**. After some experimentation, it was determined that the second set of lines was sprayed just before the first set dimmed out. This gives the illusion of a continuous picture. In fact, an interlaced image is two pictures that "jump" up and down a fraction of an inch at such a fast pace that they appear to be one image. The picture clarity does suffer, unfortunately, with this process. The television pioneers decided that firing half of the lines in each pass

interlace: The process in which the cathode ray fires all the odd lines on a television screen in one pass and returns to the top of the screen to fire all the even lines in the second pass.

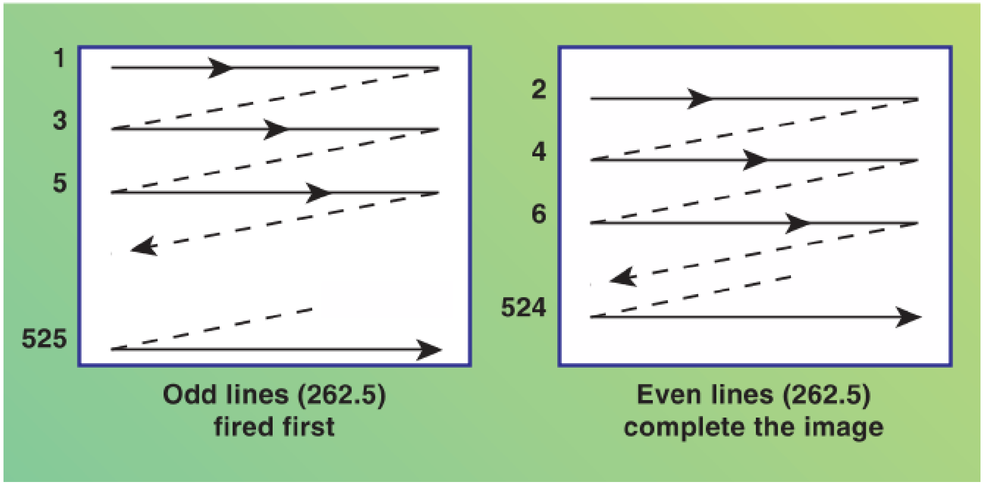


Figure 25-2. Interlace is the process of firing all the odd lines and returning to the top of the screen to fire all the even lines.

still produced an acceptable picture quality and they made it the national standard. This standard came to be known by the initials of the committee that created it: NTSC (National Television Standards Committee).

Frames and Fields

field: One entire pass of the electron beam, spraying every other line from the top to the bottom of the screen.

frame: Two consecutive passes of the cathode ray; every line on the television screen sprayed with electrons. Two complete fields create one frame.

The amazing part of the interlace process is the speed at which it must occur. Remember that only every other line is fired in a single pass of the cathode ray. One entire pass of the electron beam, spraying every other line from the top to the bottom of the screen, is called a *field*. After one field is fired, the beam returns to the top to fire the second field, **Figure 25-3**. Two complete fields create one *frame*. There are 60 fields of 262.5 lines per second or 30 frames of 525 lines per second. This amounts to a total of 15,750 lines fired every second! Each field is slightly different than the preceding field. The slight change in odd and even fields, along with the rapid flashing of the fields, creates the illusion of motion pictures. This amazing technology is more than 70 years old and currently remains the standard for most television sets in this country.

Sync

If the picture tube is like an amazingly fast ray gun that fires electrons, then the television camera can be compared to an amazingly fast vacuum cleaner wand that sucks up the electrons to be fired later at the phosphor on the screen. This preposterous analogy works in explaining the sync signal.

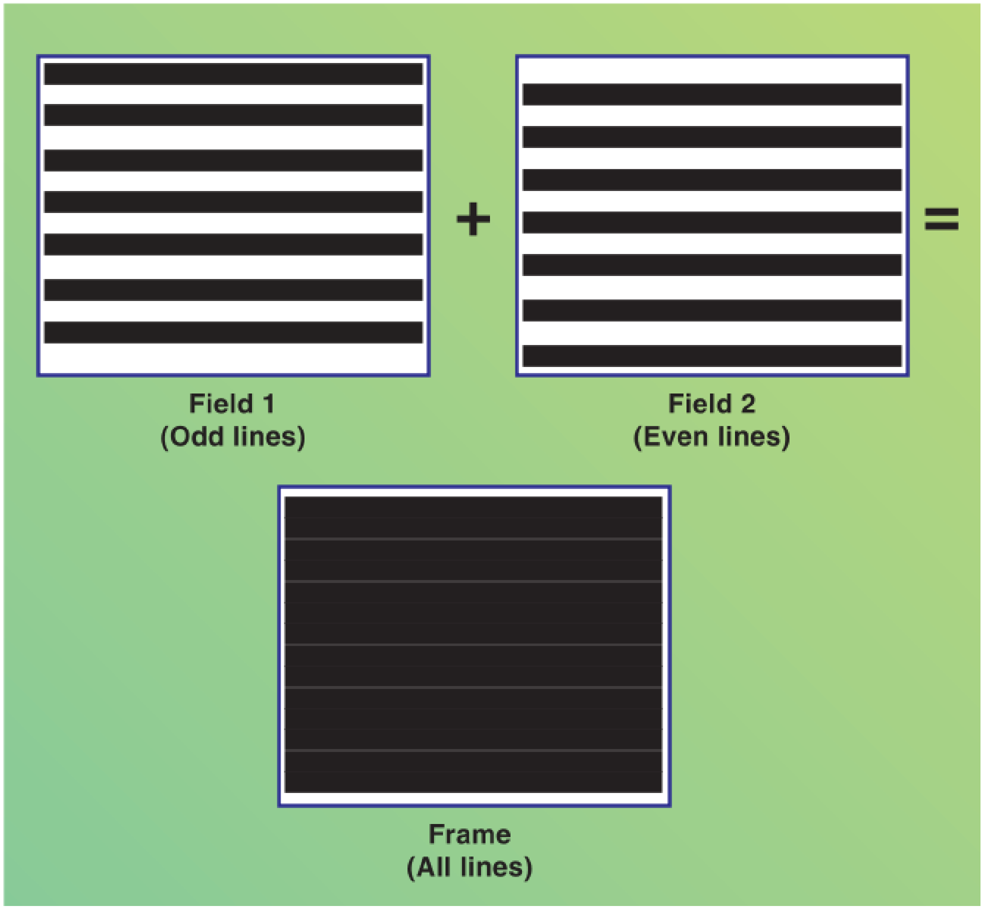


Figure 25-3. Each pass of the cathode ray "sprays" half of the lines on the television screen with electrons, which creates a field. Two consecutive fields sprays every line on the screen and creates a frame.

If the "vacuum wand" in the camera is pointed at the upper-right corner of the image, how does the "ray gun" in the television set know to aim itself at the upper-right corner of the screen? If the cathode ray were aimed at a different place on the screen, the television screen would display a collection of multicolored dots resembling confetti. The sync pulse is the means by which the cathode ray in the television picture tube is tied to video camera's "vacuum wand."

Even though the scanning rate on each piece of equipment is identical, individual pieces of equipment are powered up at different times. Therefore, the "vacuum wand" in camera 1 may be pointed at the top right corner and the "vacuum wand" in camera 2 may be pointed at the middle of the picture. If the SEG is used to switch between camera 1 and camera 2, the picture will roll or otherwise glitch because the cathode ray is forced to skip large chunks of the picture. The sync pulse overrides the internal timing of each piece of equipment and sets everything scanning in the same place at the same time.

The importance of sync becomes greater as additional cameras are added to a shoot. All the cameras on a shoot must be tied to one sync signal, otherwise the image will jump or be briefly distorted every time the TD switches from one camera to another. The *sync generator* is a device that provides a synchronization signal to all the video equipment in the television production facility. In small studio facilities, the sync generator is usually built into the SEG, which is often used to provide the signal to all the necessary gear. This output signal is usually labeled "sync out," "black burst," or "genlock." The sync generators built into some cameras must be turned off to allow the camera to "listen" to the external sync source. *Genlock* is a module that overrides the internal sync of an individual piece of equipment to synchronize the equipment with the signal provided by the sync generator. In larger facilities, every piece of gear in the facility is commonly connected to a separate, large sync generator. A large sync generator puts out a sync signal referred to as "house sync," because it covers the entire production house.

sync generator: A device that provides a synchronization signal to all the video equipment in the television production facility.

genlock: A module built into video equipment that overrides the internal sync of an individual piece of equipment to synchronize the equipment with the signal provided by the sync generator.

Visualize This

Imagine a marching band without a drum section to keep the beat while marching in a parade. After the band stops playing a piece of music, they would be marching in total silence before the next song begins. Without a drum beat, it would not take long for band members to get out of step with each other. The drum beat, like the sync pulse, keeps everyone in step.

Monitoring Video Signal Quality

The waveform monitor and vectorscope are two pieces of testing equipment that allow an engineer to examine the quality and strength of the video signal. The *waveform monitor*, **Figure 25-4**, measures every aspect of an image, as well as the brightness and darkness of the video signal. The *vectorscope*, **Figure 25-5**, graphically measures the way the colors are structured in the signal.

waveform monitor: A piece of testing equipment that measures every aspect of an image, including the brightness and darkness of the video signal.

vectorscope: A piece of testing equipment that graphically measures the way the colors are structured in the video signal.

Color bars are a series of colors on a chart, including black and white, which can be shot by a camera or may be internally generated by the camera, SEG, CCU, or several other pieces of gear. See **Figure 25-6**. The purpose of color bars is to verify that all the cameras on a shoot are "seeing" the same shade of a color when pointed at the same object. The output from two or more cameras can be simultaneously brought into the waveform monitor and vectorscope. This allows the operator to adjust the CCU for each camera to match the output to an industry standard. The colors on the color bar chart should be memorized. The colors, displayed from left to right, are:

- White
- Yellow
- Cyan (a light blue)
- Green
- Magenta
- Red
- Blue (navy blue)
- Black

Figure 25-4. The waveform monitor measures every aspect of the television signal except color strength.

Figure 25-5. The vectorscope graphically measures a signal's color strength and adherence to industry standard settings.

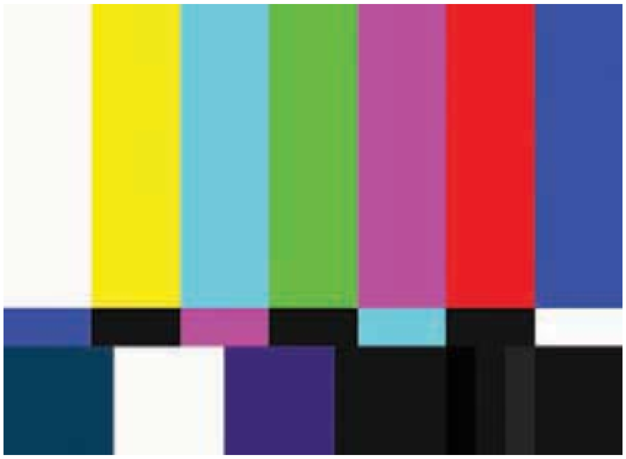


Figure 25-6. The color bars are used to provide an industry-wide standard for color reproduction.

When the color bar chart is activated on a camera, the colors should appear on the monitor. If the colors do not appear in order, it is likely that the monitor's color or tint settings need adjustment. It is important to make the necessary adjustments before beginning a shoot, otherwise colors in the program will be skewed on the monitor. If you view the monitor and see an incorrect color scheme, you might assume the camera is not functioning properly and choose to delay or cancel the shoot unnecessarily. In fact, the tint or color knob on the monitor may have been accidentally bumped and simply needs to be adjusted.

Digital Television Technology

The Federal Communications Commission decreed that all television stations in the country must cease broadcasting analog signals and broadcast only digital signals, based on the guidelines and timeframe the FCC provided. This sounds like a very good change, and it is, for the most part. However, every piece of analog-based television equipment in production houses, studios, cable systems, and private homes will fade into disuse as digital systems provide improved quality and abilities. This means that every television set in every home will be replaced by a digital television, as analog sets are no longer manufactured. Those who do not want to purchase a digital television set may either purchase an ASTC tuner or subscribe to a cable television company that offers analog service. An ASTC (Advanced Standards Television Committee) tuner is a conversion box connected to the television that converts digital broadcast signals to analog signals. Cable television companies convert the digital signals to analog before they are sent through the cable system to customers. However, cable companies will likely offer analog service only as long as it is profitable for them to do so. As soon as demand for analog service dips low enough to be unprofitable, the service will no longer be offered.

Video Format

Many broadcast programs are now broadcast in 16:9 format. If a 16:9 format program is viewed on a 4:3 screen, it appears in letterbox format. An image displayed in *letterbox* means that the original program was shot in a wide screen video or film format (16:9 aspect ratio or higher) instead of the

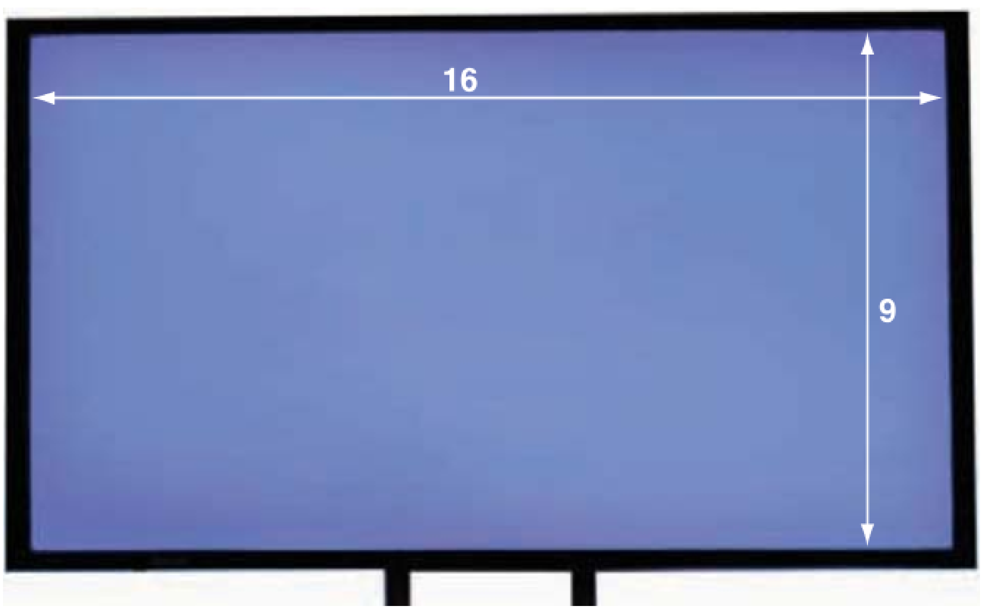
letterbox: A video display format that allows a program originally shot using a wide screen film or video format to be displayed in 16:9 aspect ratio.

analog television 4:3 aspect ratio, **Figure 25-7**. To squeeze a very wide picture onto an almost square screen without distorting the image, the entire picture is shrunk until the left and right edges of the image are touching the left and right edges of the screen. The top and bottom of the image also move toward the center of the screen. This creates an image that is short and wide.

The 16:9 television format is now standard. 4:3 aspect ratio television screens are no longer manufactured for the consumer market. For a short

Figure 25-7. A letterboxed image would appear considerably smaller on a 4:3 format television. Notice that the 16:9 format television is in the shape of a letterboxed image.

4:3 format television



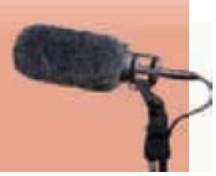
16:9 format television

time, 4:3 aspect ratio digital televisions were manufactured. On these televisions, the picture is still letterboxed. On 4:3 aspect ratio analog television sets with an ASTC tuner, the converter box offers the options of either 100% letterbox images or 4:3 aspect ratio (the left and right sides of the picture are cut off). If watching a program in 4:3 aspect ratio (typically produced prior to 2000) on a 16:9 television screen, the image will not be letterboxed, but display black vertical bars on the left and right sides of the screen to fill up the space on the 16:9 screen. If the 4:3 image were stretched to fill the entire 16:9 screen, the image would likely be comically distorted.

The shape of a 16:9 television more closely matches the shape of the broadcast picture. Therefore, the television picture does not appear to be letterboxed at all. Normally, there is not a black bar at the top and bottom of the screen because the entire television screen is in the letterbox shape. However, some films are shot in aspect ratios considerably larger than 16:9. Even when displayed on a 16:9 screen, these films are likely to be letterboxed so the entire image fits on the screen from left to right.

Talk the Talk

When referring to aspect ratio in writing, the first number is always the width and the second number is always the height. Additionally, the two numbers are always written with a colon between them (4:3 or 16:9). Do not use an *x* between the numbers when writing an aspect ratio.



When speaking an aspect ratio aloud, say "four by three" or "sixteen by nine."

Progressive Scan

Televisions with ***progressive scan technology*** are capable of painting every line on the screen, instead of every other line, before the top lines on the screen fade out, **Figure 25-8**. This technology doubles the sharpness and clarity of the picture. Moreover, 16:9 television screens are shaped very similarly to 35mm motion picture film, which allows progressive scan televisions to rival the film theater in picture quality.

progressive scan technology: The process in which every line on a television screen is fired in one pass, instead of every other line. The system moves fast enough to fire every line on the screen before the lines at the top of the screen begin to fade.

An HD camera with progressive scan technology may offer an option of recording at "native" frame rate. With progressive scan technology, there

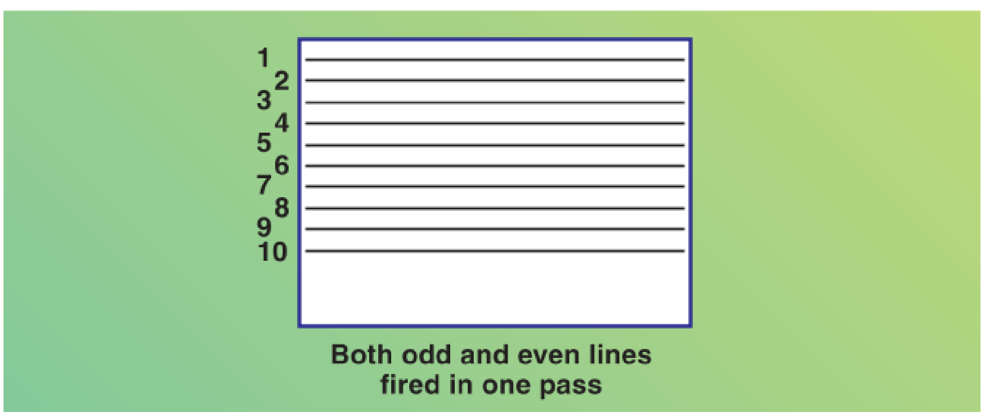


Figure 25-8. Progressive scan technology allows the beam of electrons to move rapidly enough to scan every line on the screen and return to the top line before it has dimmed out.

are still two fields that create one frame. However, unlike analog television, both of the fields in a frame are identical. Each second still contains 60 fields, but there are only 30 different pictures. Using progressive scan, there are 30 *pairs* of pictures. Native frame technology records only one field for each pair of fields. This doubles the amount of video that can be recorded onto the same amount of hard drive space. In playback, each single field is automatically doubled by the native frame technology.

Image Definition

standard definition (SD): A digital television in 4:3 aspect ratio format that displays images using 720 x 480 lines of resolution.

high-definition (HD): A digital television in 16:9 aspect ratio format. 1080 x 720 and 1920 x 1080 are common resolution formats. Also noted as *HiDef*.

Standard definition (SD) is the term applied to a digital television in 4:3 aspect ratio format. Digital television uses scanning lines, just like analog television. However, digital television has clearly organized rows and columns of pixels. In SD, there are 720 columns of pixels and 480 rows of pixels; noted as 720 x 480.

High-definition (HiDef or HD) is a digital television in 16:9 aspect ratio format. There are two widely accepted formats of HD television:

- 1080 x 720 (1080 columns of pixels wide and 720 rows of pixels tall)
- 1920 x 1080 (1920 columns of pixels wide and 1080 rows of pixels tall)

Talk the Talk

When referring to the number of pixels on a television screen in writing, the first number is the width and the second number is the height. Additionally, the two numbers are always written with an *x* and standard spacing between them (1080 x 720).

When speaking the number of pixels aloud, say “seven twenty by four eighty,” “ten eighty by seven twenty,” or “nineteen twenty by ten eighty.”

These expressions, written and spoken, are standard among industry professionals.

The sharpness of a video picture is determined by the number of pixels that make up the image. To obtain the total number of pixels in an image, multiply the number of pixel columns by the number of pixel rows. The higher the number of pixels, the sharper the image. Image quality is strikingly different between SD and HD video. Note the difference in total pixels between the SD format and the HD formats presented in the chart that follows:

Image formats and Pixels

Image Format	Pixel Dimensions	Total Pixels
SD	720 X 480	345,600
HD	1080 X 720	777,600
HD	1920 X 1080	2,073,600

HDV recording technology uses MPEG compression to record a 1440 x 1080 image using only 19 megabits of hard drive space per second. SD recording typically requires 25 megabits of hard drive space per second, compressed HD recording requires 100+ megabits per second, and full uncompressed HD requires 1.5 gigabits per second. This means that an HDV camera can record a "compressed HD format" quality picture using less hard drive space than an SD camera. "Compressed HD format" means that when the HDV signal is compressed and then uncompressed in an editor, a noticeable picture quality loss occurs when converting between various video resolutions or formats. In true HD, converting from one video resolution to another does not have any ill effects on the image. Many moderately priced consumer and professional cameras are HDV cameras.

HDV: Video recording technology that uses MPEG compression to record a 1440 x 1080 image using only 19 megabits of recording memory space per second.

Video Recording Options

Many camcorders have options to record in formats other than 4:3. There may be a switch or a menu setting option called "letterbox." Choosing this setting, however, does not guarantee the footage will be recorded in widescreen format. The "letterbox" option may merely be a 4:3 format image with a black bar at the top and bottom of the screen. This produces a lower quality, smaller picture because fewer pixels are used to create the image. Always check the owner's manual for details on specific features and operations. Video cameras and available features are constantly changing.

Recording options labeled "squeeze," "anamorphic," or "stretch" indicate that the images will be recorded in 16:9 format. If an image recorded in this format is viewed on a 4:3 screen, the people and objects in the shot will be very tall and thin because the left and right sides of the screen are "squeezed" into the frame. If viewed on a 16:9 screen, however, the images appear normal. A non-linear editor with the proper software enabled can normalize squeezed footage during the editing process. Normalizing the footage results in higher quality images because more of the pixels are used to create the image.

PRODUCTION NOTE

With television stations broadcasting digital signals, analog VCRs cannot record the broadcast digital signals. Digital VCRs have this capability, but DVRs and DVD recorders are completely replacing VHS recording technology. It is not necessary to replace existing DVD players, as long as the model has a digital output—older DVD players only have an analog output.

Digital Televisions

All digital televisions use pixels to create the picture. Pixels are arranged in lines, which may be scanned in an interlace (every other line) or a progressive (every line in order) pattern. To differentiate between progressive and interlace systems, television sets are given a designation to indicate the number of horizontal scan lines followed by the lowercase letter *p* or *i*, such as 720p or 1080i. Each pixel is colorized to create a tiny dot on the screen. Combining hundreds of thousands of dots creates a picture. Televisions with the highest number of pixels displayed create the best possible image. The number of pixels is typically expressed as "total resolution" on the specifications sheet in the television's instruction manual.

LCD Televisions

LCD (liquid crystal display): A television that contains a thin layer of liquid crystal between the pixel layer and the surface of the television screen. The liquid crystal layer controls each color contained in each pixel in the television image.

LCD (liquid crystal display) televisions contain a thin layer of liquid crystal between the pixel layer and the surface of the television screen. The liquid crystal layer controls each color contained in each pixel in the television image. Each pixel contains three tiny vertical bars—one each of red, green, and blue (RGB). A bright white light source (either fluorescent or LED light) inside the back of an LCD television illuminates the color bars in each pixel. The color bars act like color filters, turning the white light from the source into colored light. Until an electrical charge is applied, the liquid crystal layer in front of each color bar is clear and displays the full intensity of the color bar on screen. An electrical charge applied to the liquid crystal layer affects the opacity of the liquid crystals, which changes or blocks the intensity of colored light displayed and creates the image on the television screen, **Figure 25-9**. The amount of electric charge can vary, which varies the opacity of the liquid crystal layer. By combining the three pixel colors, RGB, and varied opacity levels of liquid crystals, any color and shade can be created.

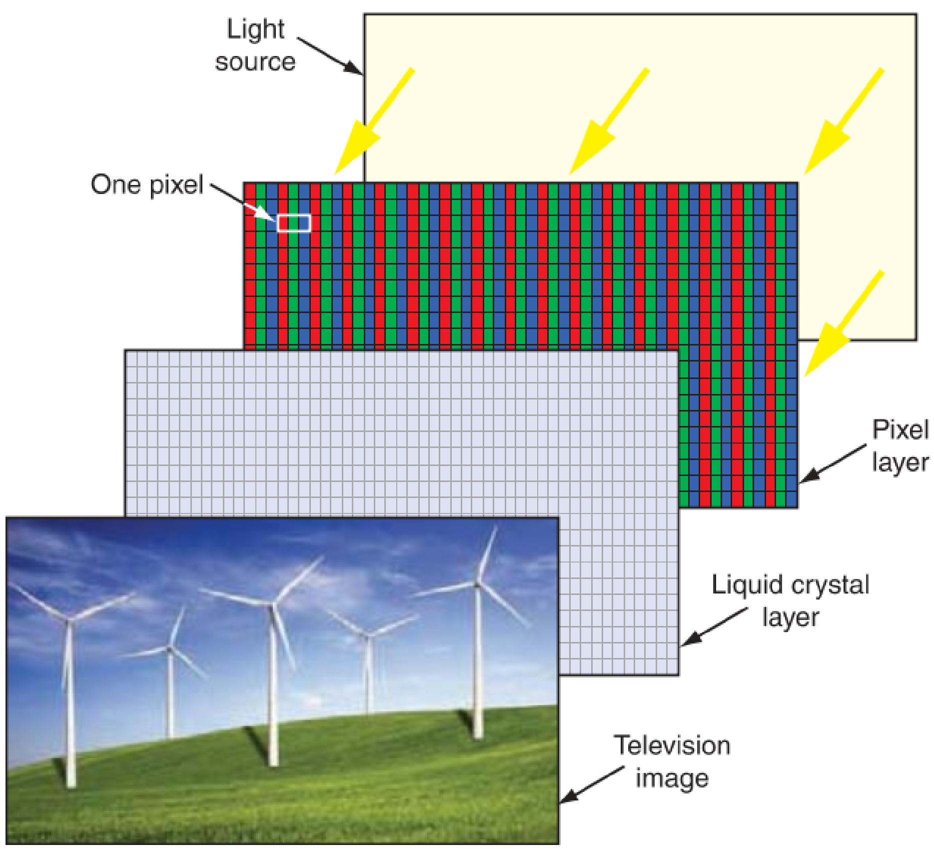


Figure 25-9. In simple terms, the picture on an LCD screen is created when light passes through the color bars in the pixel layer and electrical charges in the liquid crystal layer change the colored light, which create image pixels displayed on the television screen.

Visualize This

If light through the red bar in a pixel is bright red (with a clear liquid crystal), light through the green bar is completely opaqued (blocked by a liquid crystal), and light through the blue bar is bright blue (with a clear liquid crystal), the pixel will appear bright purple (a combination of full intensity red and blue). If the electrical charge applied to the liquid crystals in front of the red and blue bars changes and darkens the liquid crystals to 50%, the pixel will appear a deeper royal purple.

LCD televisions are very thin and can be hung on the wall like a picture with special mounting hardware. However, LCD televisions have a relatively narrow viewing angle. The image on an LCD screen is clearest when viewed directly from the center to no more than 40° off the center of the screen. When viewed from greater angles to the side of the television, the image rapidly deteriorates. LCD televisions have difficulty reproducing deep, dark blacks on screen; dark gray tones are usually the closest LCD televisions can display. However, most consumers do not even notice the dark gray instead of deep black in the images displayed.

Plasma Televisions

Plasma televisions use phosphor and rare gases to light the pixels that create an image. The pixels inside a plasma television are a combination of three tiny fluorescent light cells—one each of red, green, and blue (RGB). Each cell is coated with phosphor and contains a mixture of neon, xenon, and other gases, called *plasma*. See **Figure 25-10**. The fluorescent light cells within each pixel receive an electrical charge that excites the plasma

plasma: A television that uses phosphor and rare gases to light the pixels that create an image.

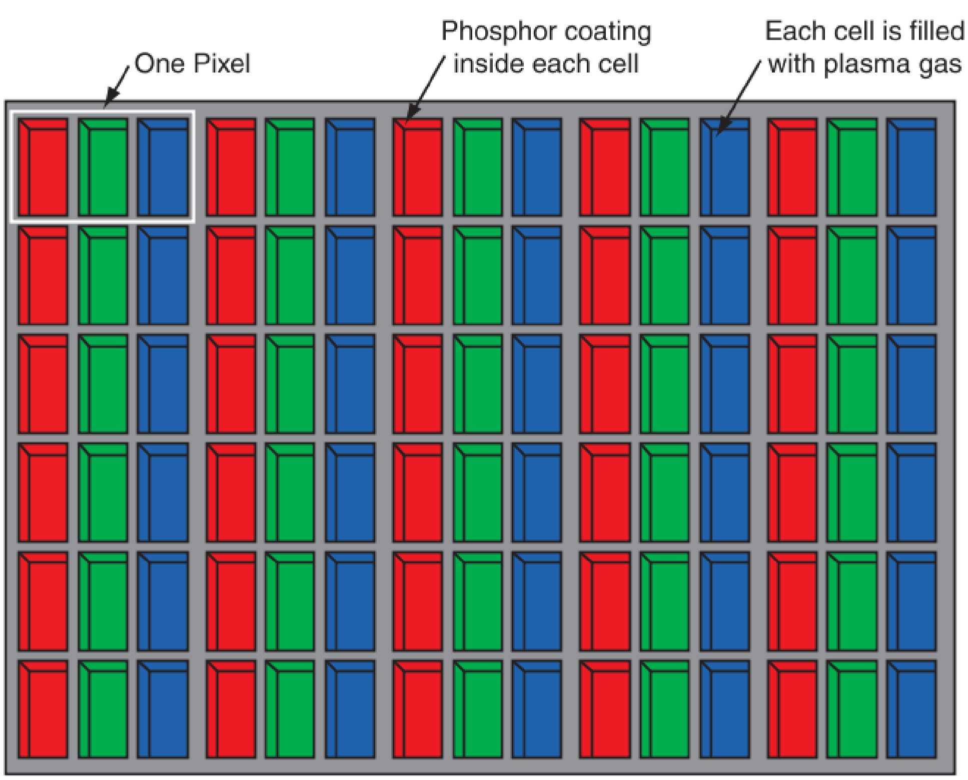


Figure 25-10. The pixel layer in plasma televisions is comprised of phosphor-coated cells filled with plasma gas. The cells function as tiny fluorescent lights when excited by an electrical charge.

gases. The gases generate light photons when excited, which interact with the phosphor coating and emit colored light. Varying the strength of the electrical charge changes the intensity of the color and light output. The RGB combination determines the output color of the pixel.

Plasma televisions are very thin and can be hung on the wall like a picture with special mounting hardware. A plasma screen is very bright and the image is more detailed compared to an LCD screen. However, the overall output of a plasma screen compared to an LCD screen may not be noticeable to most consumers. The image on a plasma television screen is clearest when viewed directly from the center to no more than 80–85° off the center of the screen. Viewing the screen from greater angles to the side of the television causes the image to rapidly deteriorate. Seating arranged in a semicircle provides the best quality image on a plasma screen for multiple viewers.

DLP Televisions

DLP (digital light processing): A television that uses a light projection system to create the image on screen.

DLP (digital light processing) televisions use a light projection system to create the image on screen. A light source inside the DLP television projects very bright light through color filters and onto a digital micromirror device (DMD) chip, **Figure 25-11**. The DMD chip contains millions of tiny mirrors on the surface that reflect colored light through the projection lens and on to the back of the television screen. DLP televisions are available with either a single DMD chip or with three DMD chips (one for each color—RGB). A three-chip DLP television has considerably better color and clarity than the single chip screen, but also has a higher price tag.

The image on a DLP is best when viewed directly from the center to no more than 60° off the center of the screen. There are almost no size limitations to DLP televisions. As long as the internal projection bulb or bulbs are bright enough, the on-screen image can be huge. The projection lamps do, however, have a finite lifespan and are rather expensive to replace.

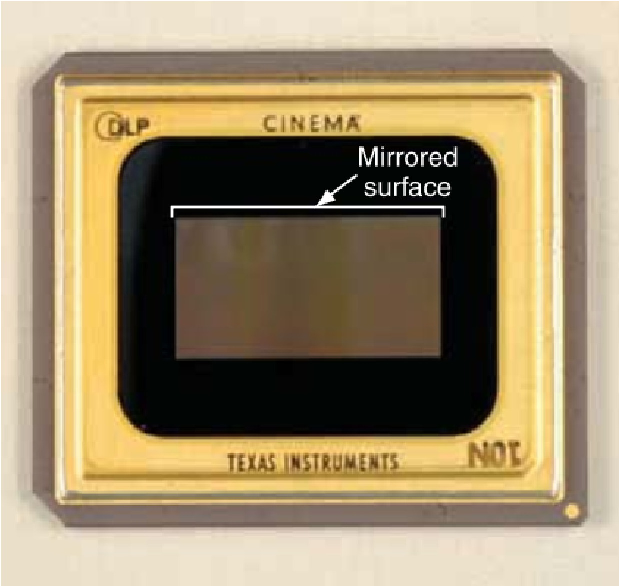


Figure 25-11. The DLP Cinema® chip is a DMD chip used in DLP televisions. The mirrored surface on the chip measures approximately 11mm x 8mm and contains hundreds of thousands of tiny, individual mirrors. *(Texas Instruments Incorporated)*

OLED Televisions

OLED televisions are incredibly thin and energy efficient. ***OLEDs (organic light emitting diodes)*** are a type of LED in the form of a layer of film made from organic compounds. The compounds emit light when stimulated by an electrical current. OLED televisions have several advantages over other television technologies, which result in superior picture quality:

- OLEDs generate light, so the televisions do not require a backlight. This allows the televisions to reproduce true black tones more realistically and reduces power consumption.
- The display on OLED televisions can refresh at a much faster rate than LCD screens.
- OLED technology can produce contrast ratios of 1,000,000:1—much higher than traditional LCD displays.
- Quality viewing on an OLED screen extends as far out as 90° from the center of the screen.

The organic compounds used in OLED technology do have a limited lifespan compared to other television technologies. Blue OLEDs, in particular, have the shortest lifespan in an RGB display. Additionally, the organic compounds can be damaged by water, such as condensation and humidity.

OLED (organic light emitting diode): A television that uses a type of LED in the form of a layer of film made from organic compounds to create the image on screen.

Visualize This

Because an OLED screen is so thin, it can be flexible. A flexible screen opens the door to brand new uses of video. In the *Harry Potter* movies, the newspaper read by witches and wizards contained moving pictures with the printed articles. Imagine if your daily newspaper had video embedded right on the page!

Each of the digital televisions presented create the television picture in different ways, which affects the best field for viewing, **Figure 25-12**. Consider the type of digital television you will be watching when choosing "the best seat in the house"!

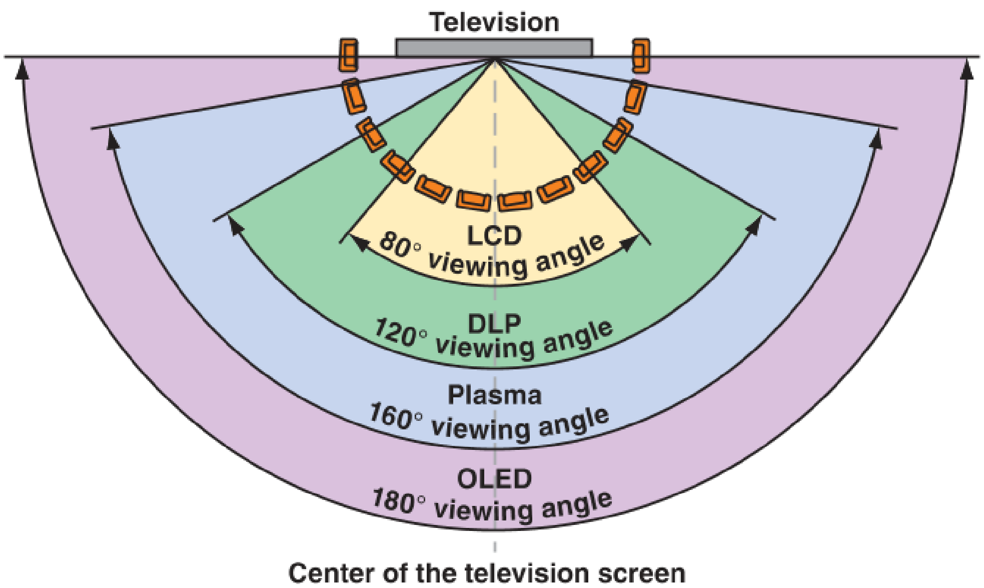


Figure 25-12. This illustration presents the best viewing area for an undistorted image on each digital television discussed in this chapter.

Wrapping Up

Upon completion of the FCC's mandated digital conversion, digital 16:9 television formats became a unified standard of television technology. This milestone marked a new video age. Comprehensive knowledge of upcoming technology is vital to success in the television industry. Articles published in various trade magazines are good resources in keeping current with industry technology. The reach of technology is constantly expanding—all the technology we know today may be obsolete tomorrow!

Review Questions

Please answer the following questions on a separate sheet of paper. Do not write in this book.

1. How many fields create one frame?
2. What is the function of the sync signal?
3. List the colors on a color bar chart, as displayed from left to right.
4. Summarize the difference in total number of pixels between SD and HD video formats.
5. Explain how progressive scan technology differs from interlace.
6. How do the liquid crystals in an LCD television change the pixel colors?
7. How do the pixels on plasma televisions emit light?

Activities

1. Research the development of the cathode used in television picture tubes. Report on other methods and devices that were created for the same purpose.
2. Search the Federal Communications Commission Web site for facts about digital broadcasting. Make note of any items related to the conversion that you did not know or that you found surprising. Be prepared to share this information with the class.

STEM and Academic Activities

Science

1. Phosphor substances are used to create the picture on many types of televisions. What phosphorescent compounds are used in televisions? What other applications are common for phosphorescent compounds?

Technology

2. How do 3-D televisions create a three-dimensional image on the screen? Explain how 3-D televisions operate differently from traditional television displays.

Engineering

3. A vectorscope measures how colors are structured in a video signal. How does a vectorscope take this measurement? How is the data received from the vectorscope used by a technician or engineer?

Language Arts

4. Watch a movie on DVD in both standard and letterbox formats. List scenes that were different from one format to the other. Did the differences in scenes from one format to the other affect the plot or action in the movie?

Social Science

5. After June 12, 2009, people could no longer watch analog TV. How did the conversion from analog broadcast signals to digital broadcast signals affect television sales? What accommodations were made for people that could not afford to purchase a new television?

Congratulations!

You have successfully completed this text! Hopefully, you have created a dictionary of terms that can be used as a reference throughout your career. You have learned an entirely new language and should be practicing its usage every day.

This is not the end of your course of study to enter and succeed in the broadcast journalism and television production industries. You are now armed with enough basic information about the entire system to launch into many different directions of study. Never stop learning about new gear and technologies. The technology will not stop changing because you finally mastered it. Technology always marches onward. Remember that knowledge, enthusiasm, hard work, networking, "talking the talk," flexibility, and responsibility are the keys to entry and longevity in this industry. Good luck to you!

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Thank you to everyone involved in the creation of this text.