Video Signal Fundamentals Help

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This help file describes fundamental video signal concepts including the components of a composite video signal, the significance of the different video formats, scanning and active imaging, color coding, and video levels.

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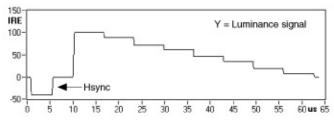
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Video Fundamentals Generating Composite Video Signals

A composite video signal is a signal in which all the components needed to generate a video signal are embedded in a single signal. The three main components that together form a composite signal are as follows:

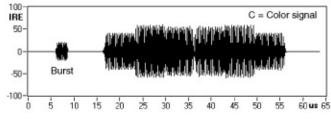
- The luma signal (or luminance)—Contains the intensity (brightness or darkness) information of the video image
- The chroma signal—Contains the color information of the video image
- The synchronization signal—Controls the scanning of the signal on a display such as the TV screen

The monochrome composite signal is built of two components: luma and synchronization. The luma signal, which is usually called the *Y* signal, is shown in the following figure.



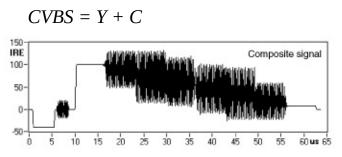
Monochrome Composite Video Signal (Luma Steps from White to Black)

The chroma signal by itself, which is usually called the *C* signal, is shown in the following figure.



Color Information Signal for a Color Bar Line (Including the Color Burst)

The composite color video signal, often called the Color Video, Blank, and Sync (CVBS) signal, is the sum of *Y* and *C*.



Color Composite Video Signal for a Color Bar Line

The two components *Y* and *C* can also be distributed separately as two independent signals. These two signals together are called either Y/C or S-video.

$$Y/C = S$$
-video

Video Fundamentals Different Video Formats

The definition of the composite video signal differs from country to country. Three main video formats exist worldwide:

- M-NTSC—Mainly used in the USA and Japan
- B/G-PAL—Used in most of Europe, parts of Africa, and some other countries such as Australia
- SECAM—Used in France, the former Soviet Union, and parts of the Middle East

Three other formats, M-PAL, N-PAL, and Combination N-PAL, are used in some countries in South America.

Video Fundamentals Scanning Speed

The scanning speed is the number of video frames generated per second. The scanning speed and the number of lines per frame depend on the video format. The prefix M in the M-NTSC and M-PAL formats refers to a scanning speed of approximately 30 frames per second and a scanning system of 525 lines per complete frame. All other formats specify a rate of 25 frames per second and 625 lines per frame.

Video Fundamentals Color Coding

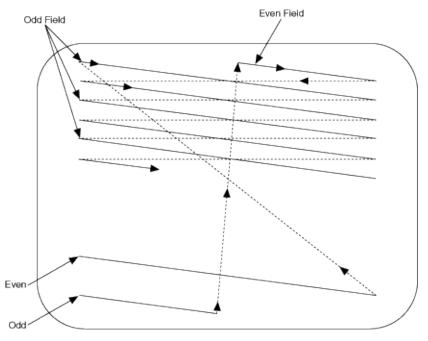
The color information signal C that, together with Y, forms the composite video signal is a modulated signal. The modulation type depends on the video format.

For all PAL and NTSC formats, the coding is based on the Quadrature Amplitude Modulation (QAM) concept, where 2-color components are amplitude modulated in quadrature and then combined. The modulation must be decoded, so to keep track of the absolute phase needed to decode the color information, a reference signal, called the color burst, is inserted at the beginning of each line, right after the horizontal synchronization pulse. The insertion signal is shown in the <u>Complete NTSC Frame Scan</u> image.

For the SECAM format, the 2-color components are frequency modulated using two different subcarrier frequencies and are sequentially distributed on alternated video lines. SECAM does not need a color burst signal.

Video Fundamentals Interlaced Scanning

All composite video systems display the video image on a TV screen using an interlaced scanning technique. The following figure shows the interlaced scanning concept.



The analog video signal includes synchronization pulses that control the scanning line-by-line from left to right and field-by-field from top to bottom. The pulses that control the line-by-line scanning are called the horizontal synchronization pulses (Hsync). The pulses that control the vertical scanning are called the vertical synchronization pulses (Vsync).

Two interlaced fields compose a <u>complete frame</u>. The first field, called the odd field, scans the odd lines of the video image. The second field, called the even field, scans the even lines of the video image. The process repeats for every frame.

Video Fundamentals Gray Scale Image and Extracted Line Profile

The <u>Complete NSTC Frame Scan</u> image simulates the video display that would appear on a television screen if the following conditions were true:

- The television could show the entire line instead of just the <u>active image</u> part.
- The television was not interlacing the two fields to form a complete image frame, but instead was displaying a progressive scanning, line by line, of the entire frame.

The scanning starts (line-by-line from top to bottom) with a number of lines that represent the vertical synchronization pattern for the odd field. Immediately after the vertical synchronization pattern for the odd field, optional insertion test signals (ITS) are inserted. Finally, the actual odd field active image displays.

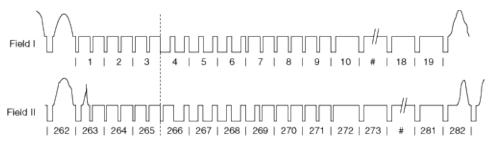
The process repeats for the even field, forming the complete frame.



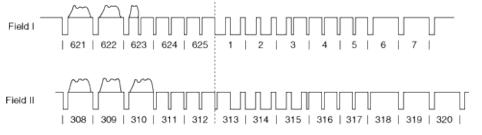
Note Most lines start with a horizontal synchronization pulse followed by the color burst pattern. Then the active image (or the ITS) displays as an intensity change, where a higher signal level corresponds to brighter intensity.

The extracted line profile example at the bottom of the figure shows an actual video signal line extracted from the even field. Refer to <u>Video Levels</u> for more information about video levels.

Horizontal synchronization pulses are basically simple negative pulses, which are pulses going below the level of the luminance signal. However, the vertical synchronization signals are composed of pulse trains distributed on several lines, and the pulse trains are different for odd and even fields. The following figures show the vertical synchronization patterns for both fields and for the three main video formats.



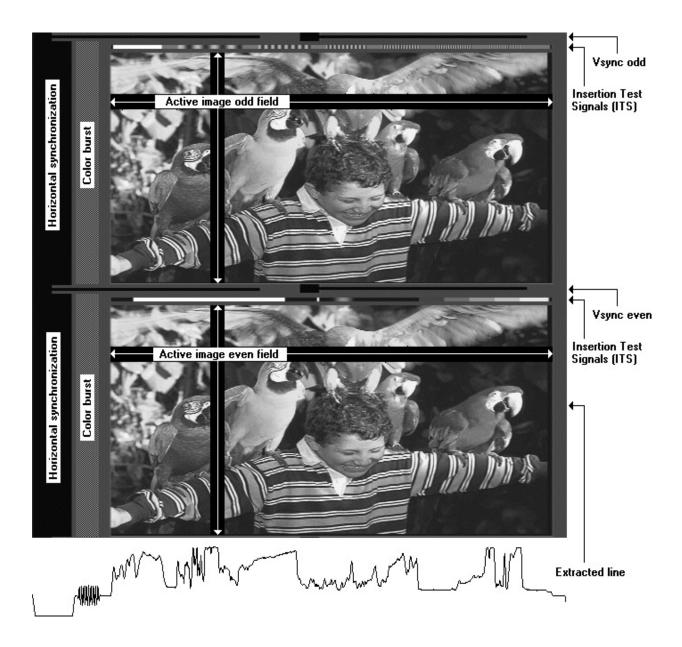
Vertical Blanking and Synchronization Signal for NTSC



Vertical Blanking and Synchronization Signal for PAL and SECAM

Video Fundamentals Complete NTSC Frame Scan

The following figure shows the result of scanning all 525 lines that compose a complete NTSC frame.



Video Fundamentals Active Image

The active video image resulting from the scanning always has an aspect ratio (horizontal/vertical) of 4/3, independent of the video format. The <u>color</u> <u>composite video signal</u> shows that the scanning process requires some additional room on the left and right sides of each line, as well as on the top and bottom of the active video image region. This additional room includes the synchronization signals, color bursts, and other format-specific information, like the ITS, which are not part of the active video image. Approximately 90% of all the lines and 80% of each line can transmit the active image information. The exact values depend on the video format, as shown in the following table.

Video Format	Lines/Frame	Active Lines	Frame Rate	Line Duration	Active Line Duration
M-NTSC/M-PAL	525	480/486	29.97 frames/sec	63.55 μs	52.2 μs
All others	625	576	25.00 frames/sec	64.00 μs	52.0 μs

Active Lines represents the number of lines that are actually used to transmit the image information. For example, only 480 lines out of 525 lines/frame transmit the image information in NTSC. Likewise, on each line, the image information is transmitted only during the active lines sequence, which is shorter than the entire line duration. For example, of 63.55 μ s only 52.2 μ s are the active line duration in NTSC. Frame rate is the scanning speed described in <u>Scanning Speed</u>.