**** Cabo Video Composto:***

Composite video, also called CVBS (Composite Video Blanking and Sync), is the format of an analog television (picture only) signal before it is combined with a sound signal and modulated onto an RF carrier.

It is usually in a standard format such as NTSC, PAL, or SECAM. It is a composite of three source signals called Y, U and V (together referred to as YUV) with sync pulses. Y represents the brightness or *luminance* of the picture and includes synchronizing pulses, so that by itself it could be displayed as a monochrome picture. U and V between them carry the color information. They are first mixed with two orthogonal phases of a color carrier signal to form a signal called the *chrominance*. Y and UV are then added together. Since Y is a baseband signal and UV has been mixed with a carrier, this addition is equivalent to frequency-division multiplexing.

Composite video can easily be directed to any broadcast channel simply by modulating the proper RF carrier frequency with it. Most analogue home video equipment records a signal in (roughly) composite format: LaserDiscs store a true composite signal, while VHS tapes use a slightly modified composite signal. These devices then give the user the option of outputting the raw signal, or modulating it on to a VHF or UHF frequency to appear on a selected TV channel. In typical home applications, the composite video signal is typically connected using an RCA jack, normally yellow (often accompanied with red and white for right and left audio channels respectively). BNC connectors and higher quality co-axial cable are often used in more professional applications.

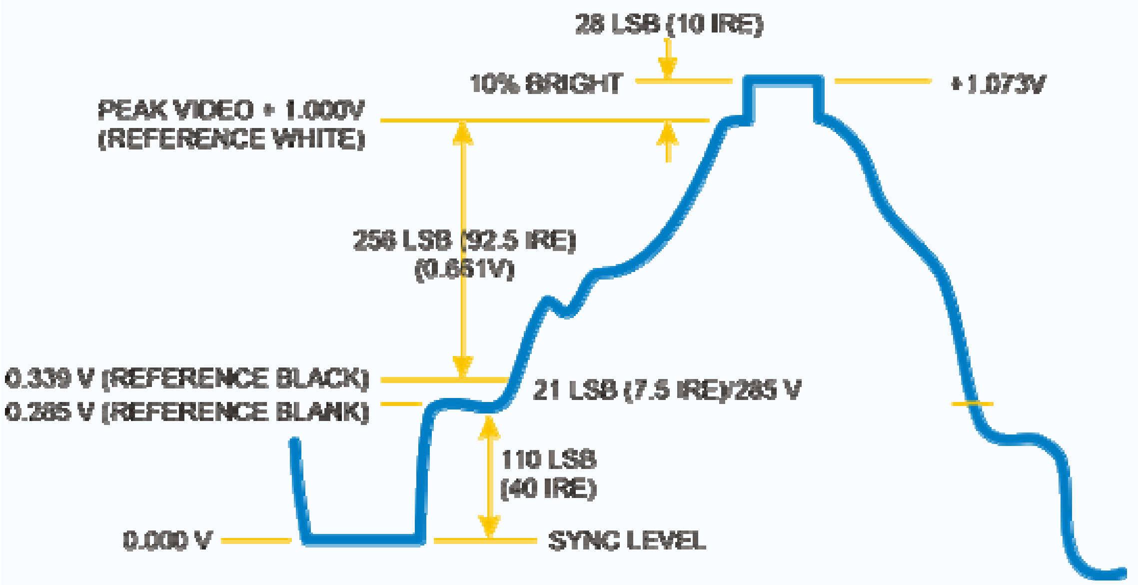
In Europe, SCART connections are often used instead of RCA jacks — though SCART can also carry far superior RGB component video signals (and to a lesser extent, S-Video), so where available, RGB is used instead of composite video with computers, video game consoles, and DVD players.

Some devices that connect to a TV, such as VCRs, older videogame consoles and the home computers of the 1980s, naturally output a composite signal. This may then be converted to RF with an external box known as an RF modulator that generates the proper carrier (often for channel 3 or 4 in North America, channel 36 in Europe). The RF modulator is preferably left outside the console so the RF doesn't interfere with the components inside the machine. VCRs and similar devices already have to deal with RF signals in their tuners, so the modulator is located inside the box. Also, most early home computers usually employed an internal RF modulator. The process of modulating RF with the original video signal, and then demodulating the original signal again in the TV, introduces several losses into the signal. RF is also "noisy" because of all of the video and radio signals already being broadcast, so this conversion also typically adds noise or interference to the signal as well. For these reasons, it is typically best to use composite connections instead of RF connections if possible. Almost all modern video equipment has at least composite connectors, so this typically isn't a problem; however, older video equipment and some very low-end modern televisions have only RF input (essentially the antenna jack); while RF modulators are no longer common, they are still widely available to translate baseband signals for older equipment.

However, just as the modulation and demodulation of RF loses quality, the mixing of the various signals into the original composite signal does the same, causing a checkerboard video artifact knowns as dot crawl. Dot crawl is an infamous defect that results from crosstalk due to the intermodulation of the chrominance and luminance components of the signal. This is usually seen when chrominance is transmitted with a high bandwidth, and its spectrum reaches into the band of the luminance frequencies. This has led to a proliferation of systems such as S-Video and component video to separate out one or more of the mixed signals.

When used for connecting a video source to a video display where both support 4:3 and 16:9 display formats, the PAL television standard provides for signalling pulses that will automatically switch the display from one format to the other. The Composite video connection supports this operation. However the NTSC television standard has no such provision, and thus the display will have to be manually switched.

Composite video is often designated by the **CVBS** acronym, meaning either "Color, Video, Blank and Sync", "Composite Video Baseband Signal", "Composite Video Burst Signal", or "Composite Video with Burst and Sync".



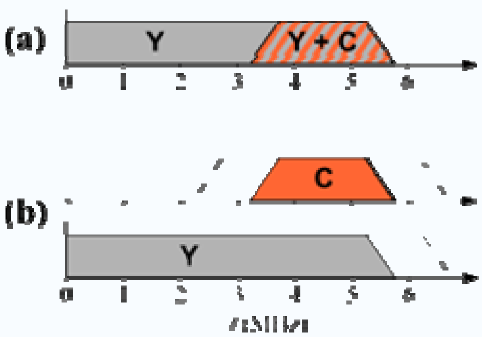
From Wikipedia, the free encyclopedia

**** S-Video:***

Separate video, abbreviated **S-Video** and also known as **Y/C** (or *erroneously*, S-VHS and "super video") is an analog video signal that carries the video data as two separate signals (brightness and color), unlike composite video which carries the entire set of signals in one signal line. S-Video, as most commonly implemented, carries high-bandwidth 480i or 576i resolution video, i.e. standard definition video. It does not carry audio on the same cable.

The 4-pin Mini-DIN connector (shown at right) is the most common of several types of S-Video connectors. Other S-Video connector variants include 7-pin locking "dub" connectors used on many professional S-VHS machines, and dual "Y" and "C" BNC connectors, often used for S-Video patch bays. Early Y/C video monitors often used RCA connectors that were switchable between Y/C and composite video input. Though the connectors are different, the Y/C signals for all types are compatible.

Overview



Y/C signal comparison between composite (a) and S-video (b).

The luminance (Y; greyscale) signal and modulated chrominance (C; colour) information are carried on separate synchronized signal/ground pairs.

In composite video, the luminance signal is low-pass filtered to prevent crosstalk between high-frequency luminance information and the color subcarrier. S-Video separates the two, and detrimental low-pass filtering is unnecessary. This increases bandwidth for the luminance information, and also subdues the color crosstalk problem. The infamous dot crawl is eliminated. This means that S-Video leaves more information from the original video intact, thus having a much-improved image reproduction compared to composite video.

Due to the separation of the video into brightness and colour components, S-Video is sometimes considered a type of component video signal, although it is also the most inferior of them, quality-wise, being far surpassed by the more complex component video schemes (like RGB). What differentiates S-Video from these higher component video schemes is that S-Video carries the colour information as one signal. This means that the colours have to be encoded in some way, and as such NTSC, PAL and SECAM signals are all decidedly different through S-Video. Thus, for full compatibility the used devices not only have to be S-Video compatible but also compatible in terms of colour encoding.

When used for connecting a video source to a video display where both support 4:3 and 16:9 display formats, the PAL television standard provides for signalling pulses that will automatically switch the display from one format to the other. The S-video connection transparently supports this operation. The S-Video connection also has general provision for widescreen signalling through a DC offset applied to the chrominance signal; however, this is a more recent development, and is not widely supported.

Connector

S-Video signals are generally connected using 4 pin mini-DIN connectors using a 75 ohm termination impedance. Apart from the impedance requirement, these cables are equivalent to regular mini-DIN cables (like Apple's ADB); these cables can be used for S-Video transfer if no other cable is available, but picture quality may not be as good. Due to the wide use of S-Video connections for DVD players, S-Video cables are fairly inexpensive compared to component or digital connector cables, and are routinely available in places where the higher-bandwidth cables are not.

The mini-DIN pins, being weak, sometimes bend. This can result in the loss of color, or other corruption (or loss) in the signal. A bent pin can be forced back into shape, but this carries the risk of further damage, or even the pin breaking off.

Before the mini-DIN plug became standard, S-Video signals were often carried through different types of plugs. For example, the Commodore 64 home computer of the 1980s, one of the first widely available devices to feature S-Video output, used an 8-pin DIN connector on the computer end and a pair of RCA plugs on the monitor end. The S-Video connector is the most common video-out connector on laptop computers, however many devices with S-Video outputs also have composite outputs.

S-Video and audio (mono or stereo) can be transferred through SCART connections as well. However, it was not part of the original SCART standard, and not every SCART-compatible device supports it for this reason. Also, S-Video and RGB are mutually exclusive through SCART, due to the S-Video implementation using the pins allocated for RGB. Most SCART-equipped televisions or VCRs (and almost all of the older ones) do not actually support S-Video, resulting in a black-and-white picture if such a connection is attempted, as only the luminance signal portion is usable. Generally, a black-and-white picture in itself can also be a sign of incompatible colour encoding--for example NTSC material viewed through a PAL-only device.

A hack exists to possibly attain color on devices that do not support S-Video through SCART. This is done via joining the pins 15 and 20 in the SCART connector (either directly or using a 470pF capacitor), but may not yield optimal results.

A similar hack also allows color. This connects the Y and C (3 and 4) pins on the S-Video connector.

Specifications

The 4-pin mini-DIN connectors seem to be common on TVs, VCRs, and DVD players. The 7-pin quasi-DIN connectors seem to be more common on computers. The 7-pin socket accepts the 4-pin plug and the S-video signals are available on the matching pins. When a 7-pin plug is inserted, one of the extra pins carries a composite CVBS video signal for non S-video displays. Some graphics cards require the remaining two pins to be shorted together to enable the CVBS mode.

The 7-pin plug has a longer locating lug making it difficult (but not impossible) to insert it in a 4 pin socket. Damage to the plug and socket is inevitable if the plug is forced into the socket.

A 7-pin quasi-DIN can also transmit Y'PbPr or RGB component video, though the outputs are usually 3 RCA jacks. Such cables are often provided with video cards.

Usage

S-Video is commonly used in USA, Canada, Australia, and Japan, found there on consumer TVs, DVD players, high-end video cassette recorders, Digital TV receivers, DVRs, and game consoles. Almost all TV-out connectors on graphics cards are S-Video, even in Europe, where the standard failed to make a significant impact due to the preference for the higher-quality RGB signal provided by SCART.

S video cables are used for computer to TV output for business or home usage. Because it is very simple to convert S-Video to composite signal (just the logical merging of the two through a filter capacitor is required), many electronics retailers offer converter adaptors for signal conversion. No conversion will improve image quality, but will allow connecting to otherwise-incompatible devices. Converting composite signal to S-Video is a little harder, because once Luminance and Color are merged together it's hard to take them apart without losses.

Due to a lack of bandwidth, S-Video connections are generally not considered suitable for high-definition video signals. As a result, HD sources are generally connected to a monitor by way of analog component video or wideband digital methods (usually HDMI or DVI).

The situation with VCRs is a bit unusual; the common S-Video connector was designed for Super VHS VCRs as a high-bandwidth video connection, and has been used for the same purpose on a great number of other consumer devices, coming into greatest prominence with the rise of the DVD format. Many digital, Hi-8, and S-VHS-C camcorders support S-Video out as well, but standard VHS VCRs do not put out a high enough resolution signal to saturate an S-Video connection, and therefore most such units, even those in combination units with DVD players (which commonly use S-Video or component outputs), require the output from the VHS deck to go through a composite video or RF connection.

**** Component Video :***

Component video is a video signal that has been split into two or more components. In popular use, it refers to a type of analog video information that is transmitted or stored as three separate signals. Component video can be contrasted with *composite* video (such as NTSC or PAL) in which all the video information is combined into a single line level signal.

Analog component video

Reproducing a video signal on a display device (for example, a CRT) is a straightforward process complicated by the multitude of signal sources. LaserDisc, DVD, VHS, computers and video games all store, process and transmit video signals using different methods, and often each will provide more than one signal option. One way of maintaining signal clarity is by separating the components of a video signal so that they do not interfere with each other. When a signal is separated this way it is called 'component video'. S-Video, RGB and Y'PbPr signals comprise two or more separate signals: hence, all are 'component video' signals. For most consumer-level applications, analog component video is used. Digital component video is slowly becoming popular in both computer and home-theatre applications. Component video is capable of producing signals such as 480i, 480p, 576i, 576p, 720p, 1080i and 1080p.

RGB Analog Component Video

The various RGB (Red, Green, Blue) analog component video standards (e.g. RGBS, RGBHV) typically offer the best analog video signals available in consumer electronics. RGB uses no compression and offers no real limit in color depth or resolution. Most modern computers offer this signal via the VGA port. Many televisions, especially in Europe and Japan, utilize RGB via the SCART connector. All arcade games, excepting early vector and black and white games, use RGB monitors.

Analog RGB is slowly falling out of favor as computers obtain better clarity using Digital (DVI) video and home theater moves towards HDMI. RGB has been largely ignored, despite its quality and suitability, as it cannot easily be applied with Digital Rights Management. RGB was never popular in North America for consumer electronics, as S-video was considered sufficient.

RGB typically requires additional conductors for synchronizing the video display. Several methods are used:

- composite sync, where the horizontal and vertical signals are on one wire (RGBS)
- separate sync, where the horizontal and vertical are on one wire each (RGBHV)
- sync on green, where a composite sync signal is overlayed on the green wire (SoG or RGsB).

Composite sync is common in the European SCART connection scheme. Sometimes a full composite video signal may also serve as the sync signal, though often computer monitors will be unable to handle the extra video data. A full composite sync video signal requires four wires - Red, Green, Blue, Sync. If separate cables are used, the sync cable is usually colored white (or yellow, as is the standard for composite video).

Separate sync is most common with VGA, used worldwide for analog computer monitors. This is sometimes known as RGBHV, as the horizontal and vertical synchronization pulses are sent in separate channels. This mode requires five conductors. If separate cables are used, the sync lines are usually yellow(V) and white(H) or yellow(V) and black(H).

Sync on Green (SoG) is the least common, and while many VGA monitors support it, most do not. Sony is a big proponent of SoG, and most of their monitors (and their Playstation 2 video game console) use it. SoG devices require additional circuitry to remove the sync signal from the green line. A monitor that is not equipped to handle SoG will display an image with an extreme green tint, if any image at all, when given a SoG input.

$Y'P_bP_r$ Analog Component Video

Further types of component analogue video signals do not use R,G,B components but rather a colorless component, termed luma, combined with one or more color-carrying components, termed chroma, that give only color information. Both the S-Video component video output (two separate signals) and the $Y'P_bP_r$ component video output (three separate signals) seen on DVD players are examples of this method.

Converting video into luma and chroma allows for chroma subsampling, a method used by JPG images and DVD players to reduce the storage requirements for images and video. The $Y'P_bP_r$ scheme is usually what is meant when people talk of **component video** today. Many consumer DVD players, plasma displays, video projectors and the like, use this form of color coding.

These connections are commonly and mistakenly labeled with terms like "YUV" and Y, B-Y, R-Y. This is inaccurate since Y'UV, $Y'P_bP_r$, and Y' B'-Y' R'-Y' differ in their scale factors[1].

In component video systems, additional synchronization signals may need to be sent along with the images. The synchronization signals are commonly transmitted on one or two separate wires, or embedded in the blanking period of one or all of the components. In computing, the common standard is for two extra wires to carry the horizontal and vertical components ('separate syncs'), whereas in video applications it is more usual to embed the sync signal in the Y' component ('sync on luma').

When used for connecting a video source to a video display where both support 4:3 and 16:9 display formats, the PAL television standard provides for signalling pulses that will automatically switch the display from one format to the other. However $Y'P_bP_r$ does not support this operation.

Connectors Used

- D-Terminal: Used mostly on Japanese electronics.

- Three BNC or RCA connectors: Typically colored red (Pr), green (Y), and blue (Pb).
- SCART used in Europe.

S-Video Analog Component Video

S-Video (S for Separate) is another type of component video signal (transferring Y'UV when used for PAL video and Y'IQ when used for NTSC video), because the luma (Y') and chroma (UV or IQ) signals are transmitted on separate wires. This connection type is not being used for high definition standards as the carrier frequency of the colour signal modulation would have to be adjusted.

Technical

Examples of international component video standards are:

- RS-170 RGB (525 lines, based on NTSC timings, now EIA/TIA-343)
- RS-343 RGB (525, 625 or 875 lines)
- STANAG 3350 Analogue Video Standard (NATO military version of RS-343 RGB)

Troubleshooting

- The settings on many DVD players and TVs may require that you designate the type of input/output being used, or the image may not be properly displayed. Progressive scan is often not enabled by default, even when component video output is selected.

- If the color of the picture is wrong, it's often because one or more cables may not be plugged in properly. Check to make sure your cables aren't loose, and are plugged into the right sockets.

- Modern game systems (like the PlayStation 2, GameCube, Xbox, Wii, Xbox 360 & the PlayStation 3) use the same connector pins for both RGB and component video, with a software or hardware switch to determine which signal is generated. A common complaint, especially with the PS2, is that the RGB signals are very green, with very dark reds and blues. This is because the system menu has not been changed from Component to RGB. This problem also occurs when trying to play back DVD's on the PS2 using the RGB-output. Sony knowingly applied this as a kind of copyright protection, considering the basic composite output of the PS2 did not output sufficient quality for any practical DVD duplication.

***** DVI:**

The **Digital Visual Interface** (**DVI**) is a video interface standard designed to maximize the visual quality of digital display devices such as flat panel LCD computer displays and digital projectors. It was developed by an industry consortium, the Digital Display Working Group (DDWG). It is designed primarily for carrying uncompressed digital video data to a display. It is partially compatible with the HDMI standard in digital mode (DVI-D).

Overview

The DVI interface uses a digital protocol in which the desired illumination of pixels is transmitted as binary data. When the display is driven at its native resolution, it will read each number and apply that brightness to the appropriate pixel. In this way, each pixel in the output buffer of the source device corresponds directly to one pixel in the display device, whereas with an analog signal the appearance of each pixel may be affected by its adjacent pixels as well as by electrical noise and other forms of analog distortion.

Previous standards such as the analog VGA were designed for CRT-based devices and thus did not use discrete time display addressing. As the analog source transmits each horizontal line of the image, it varies its output voltage to represent the desired brightness. In a CRT device, this is used to vary the intensity of the scanning beam as it moves across the screen.

However, when using digital displays (such as LCD) with analog signals (such as VGA), there is an array of discrete pixels and a single brightness value must be chosen for each. The decoder does this by sampling the voltage of the input signal at regular intervals. When the source is also a digital device (such as a computer), this can lead to distortion if the samples are not taken at the center of each pixel, and there are also problems with crosstalk.

Technical discussion

The data format used by DVI is based on the PanelLink serial format devised by the semiconductor manufacturer Silicon Image Inc. This uses Transition Minimized Differential Signaling (TMDS). A single DVI link consists of four twisted pairs of wire (red, green, blue, and clock) to transmit 24 bits per pixel. The timing of the signal almost exactly matches that of an analog video signal. The picture is transmitted line by line with blanking intervals between each line and each frame, and without packetization. No compression is used and there is no support for only transmitting changed parts of the image. This means that the whole frame is constantly re-transmitted. The specification (see below for link) does, however, include a paragraph on "Conversion to Selective Refresh" (under 1.2.2), suggesting this feature for future devices.

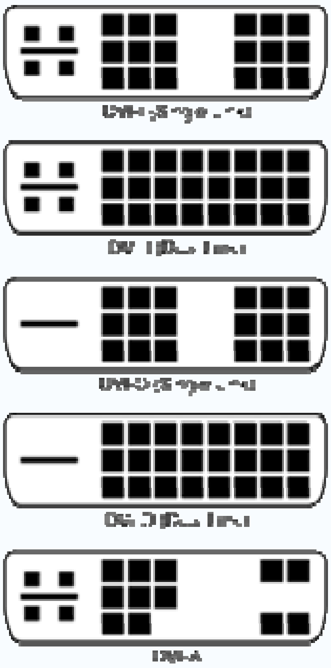
With a single DVI link, the largest resolution possible at 60Hz is 2.75 megapixels (including blanking interval). For practical purposes, this allows a maximum screen resoultion at 60Hz of 1854 x 1483 pixels (standard 1.25 ratio) or 2212 x 1243 (widescreen 1.77 ratio). The DVI connector therefore has provision for a second link, containing another set of red, green, and blue twisted pairs. When more bandwidth is required than is possible with a single link, the second link is enabled, and alternate pixels may be transmitted on each, allowing resolutions up to 4 megapixels at 60Hz. The DVI specification mandates a fixed single link cutoff point of 165MHz, where all display modes that require less than this must use single link mode, and all those that require more must switch to dual link mode. When both links are in use, the pixel rate on each may exceed 165MHz. The second link can also be used when more than 24 bits per pixel is required, in which case it carries the least significant bits.

Like modern analog VGA connectors, the DVI connector includes pins for the display data channel. DDC2 (a newer version of DDC) allows the graphics adapter to read the monitor's extended display identification data (EDID). If a displays supports both analog and digital signals in one input, each input can host a distinct EDID. If both receivers are active, analog EDID is used.

Extensions

In Radeon HD, audio signals are carried through DVI when the video card detects a connected HDMI display, which is connected via the supplied HDMI adapter.[1]

Connector



DVI connector pins (view of plug)

Color coded DVI connector with pin descriptions

The DVI connector usually contains pins to pass the DVI-native digital video signals. In the case of dual-link systems, additional pins are provided for the second set of data signals.

As well as digital signals, the DVI connector includes pins providing the same analog signals found on a VGA connector, allowing a VGA monitor to be connected with a simple plug adapter. This feature was included in order to make DVI universal, as it allows either type of monitor (analog or digital) to be operated from the same connector.

The DVI connector on a device is therefore given one of three names, depending on which signals it implements:

- **DVI-D** (digital only)
- **DVI-A** (analog only)
- **DVI-I** (digital & analog)

The connector also includes provision for a second data link for high resolution displays, though many devices do not implement this. In those that do, the connector is sometimes referred to as **DVI-DL** (dual link).

The long flat pin on a DVI-I connector is longer than the same pin on a DVI-D connector, so it is not possible to connect a male DVI-I to a female DVI-D by removing the 4 analog pins.

DVI is the only widespread video standard that includes analog and digital transmission options in the same connector[*citation needed*]. Competing standards are exclusively digital: these include a system using low-voltage differential signaling (LVDS), known by its proprietary names FPD (for Flat-Panel Display) Link and FLATLINK; and its successors, the LVDS Display Interface (LDI) and OpenLDI.

Some new DVD players, TV sets (including HDTV sets) and video projectors have DVI/HDCP connectors; these are physically the same as DVI connectors but transmit an encrypted signal using the HDCP protocol for copy protection. Computers with DVI video connectors can use many DVI-equipped HDTV sets as a display; however, due to Digital Rights Management, it is not clear whether such systems will eventually be able to play protected content, as the link is not encrypted.

USB signals are not incorporated into the connector, but were earlier incorporated into the VESA Plug and Display connector used by InFocus on their projector systems, and in the Apple Display Connector, which was used by Apple Computer until 2005.

Specifications

Digital

- Minimum clock frequency: 21.76 MHz
- Maximum clock frequency in single link mode: Capped at 165 MHz (3.7 Gbit/s)

- Maximum clock frequency in dual link mode: Limited only by cable quality (more than 7.4 Gbit/s)
- Pixels per clock cycle: 1 (**single link**) or 2 (**dual** link)
- Bits per pixel: 24

- Example display modes (**single link**):
    - HDTV (1920 × 1080) @ 60 Hz with 5% LCD blanking (131 MHz)
    - UXGA (1600 × 1200) @ 60 Hz with GTF blanking (161 MHz)
    - WUXGA (1920 × 1200) @ 60 Hz (154 MHz)
    - SXGA (1280 × 1024) @ 85 Hz with GTF blanking (159 MHz)
    - WXGA+ (1440 x 900) @ 60 Hz (107 MHz)
- Example display modes (**dual link**):
    - QXGA (2048 × 1536) @ 75 Hz with GTF blanking (2×170 MHz)
    - HDTV (1920 × 1080) @ 85 Hz with GTF blanking (2×126 MHz)
    - WQXGA (2560 × 1600)@ 60 Hz with GTF blanking (2x174 MHz) (30" Apple, Dell, HP, Quinux, and Samsung LCDs)
    - WQUXGA (3840 × 2400) @ 33 Hz with GTF blanking (2x159 MHz)

GTF (General Timing Formula) is a VESA standard which can easily be calculated with the Linux gtf utility.

Analog

- RGB bandwidth: 400 MHz at -3 dB

**** HDMI:***

The **High-Definition Multimedia Interface** (**HDMI**) is an all-digital audio/video interface capable of transmitting uncompressed streams. HDMI is compatible with High-bandwidth Digital Content Protection (HDCP) Digital Rights Management technology. HDMI provides an interface between any compatible digital audio/video source, such as a set-top box, a DVD player, a PC, a video game console, or an AV receiver and a compatible digital audio and/or video monitor, such as a digital television (DTV). In 2006, HDMI began to appear as a feature on prosumer HDTV camcorders and even high-end digital still cameras.[1][2][3]

It is a modern replacement for older analog standards such as RF - coaxial cable, composite video, S-Video, SCART, component video and VGA, and the consumer electronics replacement for older digital standards such as DVI (DVI-D & DVI-I). In the computer world, HDMI is already found on many peripherals and a few newer video cards, with adoption rapidly increasing.

General notes

HDMI supports any TV or PC video format, including standard, enhanced, or high-definition video, plus multi-channel digital audio on a single cable. It is independent of the various DTV standards such as ATSC, and DVB (-T,-S,-C), as these are encapsulations of the MPEG movie data streams, which are passed off to a decoder, and output as uncompressed video data on HDMI. HDMI encodes the video data into TMDS for transmission digitally over HDMI.

Devices are manufactured to adhere to various versions of the specification, where each version is given a number, such as *1.0* or *1.3*. Each concurrent version of the specification uses the same cables, but increases the throughput and/or capabilities of what can be transmitted over the cable. For example, previously, the maximum pixel clock rate of the interface was 165 MHz, sufficient for supporting 1080p at 60 Hz or WUXGA (1920x1200), but HDMI 1.3 increased that to 340 MHz, providing support for WQXGA (2560x1600) and beyond across a single digital link. See the *Versions* section for details.

HDMI also includes support for 8-channel uncompressed digital audio at 192 kHz sample rate with 24 bits/sample as well as any compressed stream such as Dolby Digital, or DTS. HDMI supports up to 8 channels of one-bit audio, such as that used on Super Audio CDs at rates up to 4x that used by SuperAudio CD. With version 1.3, HDMI now also supports lossless compressed streams such as Dolby TrueHD and DTS-HD Master Audio.

HDMI is backward-compatible with the single-link Digital Visual Interface carrying digital video (DVI-D or DVI-I, but not DVI-A) used on modern computer monitors and graphics cards. This means that a DVI-D source can drive an HDMI monitor, or vice versa, by means of a suitable adapter or cable, but the audio and remote control features of HDMI will not be available. Additionally, without support for High-bandwidth Digital Content Protection (HDCP) on the display, the signal source may prevent the end user from viewing or recording certain restricted content.

In the USA, on digital TVs with built-in digital (ATSC) tuners, HDCP-support is a standard feature on all but the cheapest digital TVs (which lack HDMI altogether.) Among the PC-display industry, where computer displays rarely contain built-in tuners, HDCP support is absent from many models. For example, the first LCD-monitors with HDMI connectors did not support HDCP, and few compact-LCD monitors (17" or smaller) support HDCP.

The HDMI Founders include consumer electronics manufacturers Hitachi, Matsushita Electric Industrial (Panasonic/National/Quasar), Philips, Sony, Thomson (RCA), Toshiba, and Silicon Image. Digital Content Protection, LLC (a subsidiary of Intel) is providing HDCP for HDMI. In addition, HDMI has the support of major motion picture producers Fox, Universal, Warner Bros., and Disney, and system operators DirecTV and EchoStar (Dish Network) as well as CableLabs and Samsung.

Specifications

HDMI defines the protocol and electrical specifications for the signaling, as well as the pin-out, electrical and mechanical requirements of the cable and connectors.

Connectors

The HDMI Specification has expanded to include three connectors, each intended for different markets.

The standard Type A HDMI connector has 19 pins, with bandwidth to support all SDTV, EDTV and HDTV modes and more. The plug outside dimensions are 13.9 mm wide by 4.45 mm high. Type A is electrically compatible with single-link DVI-D.

A higher resolution version called Type B is defined in HDMI 1.0. Type B has 29 pins (21.2 mm wide), allowing it to carry an expanded video channel for use with very high-resolution future displays, such as WQSXGA (3200x2048). Type B is electrically compatible with dual-link DVI-D, but is not in general use.

The Type C mini-connector is intended for portable devices. It is smaller than Type A (10.42 mm by 2.42 mm) but has the same 19-pin configuration.

Cable

Each channel in HDMI can be purposed to carry audio, video, multimedia, or device-controlling signals, or a combination of these signals.

Adaptor cables - from Type A to Type C - are available.

TMDS channel

The Transition Minimized Differential Signaling (TMDS) channel:

- Carries video, audio, and auxiliary data via one of three modes called the *Video Data Period*, the *Data Island Period*, and the *Control Period*. During the Video Data Period, the pixels of an active video line are transmitted. During the Data Island period (which occurs during the horizontal and vertical blanking intervals), audio and auxiliary data are transmitted within a series of packets. The Control Period occurs between Video and Data Island periods.
- Signaling method: Formerly **according** to DVI 1.0 spec. Single-link (Type A HDMI) or dual-link (Type B HDMI).
- Video pixel rate: 25 MHz to 340 MHz (Type A, as of 1.3) or to 680 MHz (Type B). Video formats with rates below 25 MHz (e.g. 13.5 MHz for 480i/NTSC) transmitted using a pixel-repetition scheme. From 24 to 48 bits per pixel can be transferred, regardless of rate. Supports 1080p at rates up to 120 Hz and WQSXGA [4].
- Pixel encodings: RGB 4:4:4, YCbCr 4:4:4 (8-16 bits per component); YCbCr 4:2:2 (12 bits per component)
- Audio sample rates: 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, 192 kHz.
- Audio channels: up to 8.
- Audio streams: any IEC61937-compliant stream, including high bitrate (lossless) streams (Dolby TrueHD, DTS-HD Master Audio).

Consumer Electronics Control channel

The Consumer Electronics Control (CEC) channel is optional to implement, but wiring is mandatory. The channel:

- Uses the industry standard AV Link protocol
- Used for remote control functions.
- One-wire bidirectional serial bus.
- Defined in HDMI Specification 1.0, updated in HDMI 1.2a, and again in 1.3a (Added timer and audio commands).

This feature is used in two ways:

- To allow the user to command and control multiple CEC-enabled boxes with one remote control, and
- To allow individual CEC-enabled boxes to command and control each other, without user intervention.

An example of the latter is to allow the DVD player, when the drawer closes with a disk, to command the TV and the intervening A/V Receiver (all with CEC) to power-up, select the appropriate HDMI ports, and auto-negotiate the proper video mode and audio mode. No remote control command is needed. Similarly, this *type* of equipment can be programmed to return to sleep mode when the movie ends, perhaps by checking the real-time clock. For example, if it is later than 11:00pm, and the user does not specifically command the systems with the remote control, then the systems all turn off at the command from the DVD player.

Content protection

- According to High-bandwidth Digital Content Protection (HDCP) Specification 1.2.
- Beginning with HDMI CTS 1.3a, any system which implements HDCP must do so in a fully-compliant manner. HDCP compliance is itself part of the requirements for HDMI compliance.[5][6]
- The Hdmi repeater bit controls the authentication and distribution from a single source to multiple displays.

Versions

HDMI connector (left) compared to USB connector (right)

Devices are manufactured to adhere to various versions of the specification, where each version is given a revision number. Each concurrent version of the specification uses the same cables, but increases the throughput and capabilities of what can be transmitted over that cable. The need for a new HDMI cable if you already have one really depends on the cable (which also has a HDMI rating). The main thing to consider is if any current cable would be able to handle the increased bandwidth - for example (10.2 GBPS) that comes with version 1.3. Cable compliance testing is included in the HDMI Compliance Test Specification (see TESTID 5-3), with "Category 1" and "Category 2" defined in the HDMI Specification 1.3a (Section 4.2.6).

A product listed as having an HDMI version does not necessarily mean that it will have all of the features listed under the version classification, indeed some of the features are optional. For example in HDMI v1.3 it is optional to support the xvYCC wide colour standard. This means if you have bought a camcorder that supports the wide colour space (which for example is branded by Sony as "x.v.Color") you have to specifically check that the display supports both HDMI v1.3 and the xvYCC wide colour standard.

HDMI 1.0

Released December 2002.

- Single-cable digital audio/video connection with a maximum bitrate of 4.9 Gbit/s. Supports up to 165Mpixels/s video (1080p60 Hz or UXGA) and 8-channel/192 kHz/24-bit audio.

HDMI 1.1

Released May 2004.

- Added support for DVD Audio.

HDMI 1.2

Released August 2005.

- Added support for One Bit Audio, used on Super Audio CDs, up to 8 channels.
- Availability of HDMI Type A connector for PC sources.
- Ability for PC sources to use native RGB color-space while retaining the option to support the YCbCr CE color space.
- Requirement for HDMI 1.2 and later displays to support low-voltage sources.

HDMI 1.2a

Released December 2005.

- Fully specifies Consumer Electronic Control (CEC) features, command sets, and CEC compliance tests.

HDMI 1.3

Released 22 June 2006.[7] [8]

- Increases single-link bandwidth to 340 MHz (10.2 Gbit/s)
- *Optionally* supports 30-bit, 36-bit, and 48-bit xvYCC with Deep Color or over one billion colors, up from 24-bit sRGB or YCbCr in previous versions.
- Incorporates automatic audio syncing (lip sync) capability.
- Supports output of Dolby TrueHD and DTS-HD Master Audio streams for external decoding by AV receivers.[9] TrueHD and DTS-HD are lossless audio codec formats used on HD DVDs and Blu-ray Discs. If the disc player can decode these streams into uncompressed audio, then HDMI 1.3 is not necessary, as all versions of HDMI can transport uncompressed audio.
- Availability of a new mini connector for devices such as camcorders.[10]

HDMI 1.3a

Released 10 November 2006.[11]

- Cable and Sink modifications for Type C
- Source termination recommendation
- Removed undershoot and maximum rise/fall time limits.
- CEC capacitance limits changed
- RGB video quantization range clarification
- CEC commands for timer control brought back in an altered form, audio control commands added.
- Concurrently released compliance test specification included.

HDMI 1.3b

Released 26 March 2007.

Cable length

The HDMI specification does not define a maximum cable length. As with all cables, signal attenuation becomes too high at a certain length. Instead, HDMI specifies a minimum performance standard. Any cable meeting that specification is compliant. Different construction quality and materials will enable cables of different lengths. In addition, higher performance requirements must be met to support video formats with higher resolutions and/or frame rates than the standard HDTV formats.

The signal attenuation and intersymbol interference caused by the cables can be compensated by using Adaptive Equalization.

HDMI 1.3 defined two categories of cables: Category 1 (standard or HDTV) and Category 2 (high-speed or greater than HDTV) to reduce the confusion about which cables support which video formats. Using 28 AWG, a cable of about 5 metres (~16 ft) can be manufactured easily and inexpensively to Category 1 specifications. Higher-quality construction (24 AWG, tighter construction tolerances, etc.) can reach lengths of 12 to 15 metres (~39 to 49 ft). In addition, active cables (fiber optic or dual Cat-5 cables instead of standard copper) can be used to extend HDMI to 100 metres or more. Some companies also offer amplifiers, equalizers and repeaters that can string several standard (non-active) HDMI cables together.

HDMI and high-definition optical media players

Both introduced in 2006, Blu-ray Disc and HD DVD offer new high-fidelity audio features that require HDMI for best results. Dolby Digital Plus (DD+), Dolby TrueHD and DTS-HD Master Audio use bitrates exceeding TOSLINK's capacity. HDMI 1.3 can transport DD+, TrueHD, and DTS-HD bitstreams in compressed form. This capability would allow a preprocessor or audio/video receiver with the necessary decoder to decode the data itself, but has limited usefulness for HD-DVD and BluRay.

HD-DVD and BluRay permit "interactive audio", where the disc-content tells the player to mix multiple audio sources together, before final output. Consequently, most players will handle audio-decoding internally, and simply output LPCM audio all the time. Multichannel LPCM can be transported over an HDMI 1.1 (or higher) connection. As long as the audio/video receiver (or preprocessor) support multi-channel LPCM audio over HDMI, and support HDCP, the audio reproduction is equal in resolution to HDMI 1.3.

Many low-end audio receivers do not support audio over HDMI, and are sometimes labeled "HDMI passthrough" devices. In the future, it is likely that most devices claiming HDMI 1.1 as a feature will support at least 5.1 LPCM over HDMI.

Criticism

HDMI has been criticized for implementing part of a growing DRM process in home audio/video. See, for instance:

- HDTV and HDCP and DRM Questions
- DRM Blog
- HDMI, the Manchurian DRM

Among consumers, criticism revolves around an 'image-constraint' policy: HDMI-players have a mechanism in place to authenticate downstream displays, and deliberately downsample (degrade) picture-quality to "untrusted" or revoked devices. This capability was developed at the behest of major studios, who desire a high-level of security and output-control to prevent image piracy. Aware of a potential consumer backlash, the major studios (which form the backbone of the motion picture industry) have announced that the image-constraint policy will not be activated for several years.

Among manufacturers, the HDMI specification has been criticized as lacking in functional usefulness. The public specification devotes many pages to the lower-level protocol layers (physical, electrical, logical), there is inadequate documentation for the system framework. HDMI-peripherals include audio/video sources, audio-only receivers, audio-video receivers, video-only receivers, repeaters (which have more downstream ports than upstream ports), and switchers (which have more upstream ports than downstream ports.) The specification stops short of offering examples of system behavior involving multiple HDMI-devices, leaving implementation to the product engineer's interpretation. Even between devices which use chips from Silicon Image (a promoter and supplier of HDMI IP and silicon), interoperability is not assured. The industry is working to improve through plugfest events (i.e. manufacturer conferences) and more comprehensive design-validation services.

Closed Captioning problems

According to the Sacramento Bee: "If an HDTV set is hooked to a cable box through a connection called HDMI, captions won't be displayed at all."

According to the HDMI Specification, all video timings carried across the link for standard video modes (such as 720p, 1080i, etc) must have horizontal and video timings matching those defined in the CEA-861D Specification. Since those definitions allow only for the visual portion of the frame (or field, for interlaced video modes), there is no line transmitted for closed captions. Line 21 is not part of the transmitted data as it is in analog modes. For HDMI it is but one of the non-data lines in the vertical blanking interval.

Although an HDMI display is allowed to define a 'native mode' for video, which could expand the active line count to encompass Line 21, most MPEG decoders cannot format a digital video stream to include extra lines (they send only vertical blanking). Even if it were possible, the closed captioning character codes would have to be encoded in some way into the pixel values in Line 21. This would then require the receiver logic in the display to decode those codes and construct the captions.

It is possible, although not standardized, that some measure of content in text form can be transmitted from Source to Sink using CEC commands, or using InfoFrame packets. Again, as there is no standardized format for such data it would likely work only between a source and sink system from the same manufacturer. Such uniqueness goes against the standardization mission of HDMI, which is focused in part on interoperability.

Of course, it is possible that a future enhancement of the HDMI Specification may encompass closed caption transport.