

GOMAX FORUM

High-Definition Multimedia Interface (HDMI)

(Reference Wikipedia)

Overview

HDMI supports, on a single cable, any TV or PC video format including standard, enhanced, and high-definition video along with up to 8 channels of digital audio. HDMI encodes the video data into TMDS for uncompressed digital transmission over HDMI.

HDMI devices are manufactured to adhere to various versions of the specification, where each version is given a number such as 1.0, 1.2, or 1.3a. Each subsequent version of the specification uses the same kind of cable but increases the bandwidth and/or capabilities of what can be transmitted over the cable. For example the previous maximum pixel clock rate of HDMI interface was 165 MHz which was sufficient for supporting 1080p at 60 Hz and WUXGA (1920x1200) at 60 Hz. HDMI 1.3 increased that to 340 MHz which allows for higher resolution, such as WQXGA (2560x1600), across a single digital link.

HDMI supports up to 8 channels of audio at sample sizes of 16-bit, 20-bit, and 24-bit with sample rates of 32 kHz, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, and 192 kHz. HDMI also supports any IEC61937-compliant audio stream compressed audio streams such as Dolby Digital and DTS and up to 8 channels of one-bit DSD audio, which is used on Super Audio CDs, at rates up to 4x that of Super Audio CD. With version 1.3, HDMI supports lossless compressed audio streams Dolby TrueHD and DTS-HD Master Audio.

In the U.S., HDCP (High-bandwidth Digital Content Protection) support is a standard feature on digital TVs while in the PC industry it is becoming more common but still depends on the specific model.

The HDMI Founders are Hitachi, Matsushita Electric Industrial (Panasonic / National / Quasar), Philips, Silicon Image, Sony, Thomson (RCA), and Toshiba. Digital Content Protection, LLC (a subsidiary of Intel) provides HDCP for HDMI. HDMI also has the support of motion picture producers Fox, Universal, Warner Bros., and Disney, system operators DirectTV and EchoStar (Dish Network), CableLabs, and Sharp and others.[1]

Cable Length

The HDMI specification does not define a maximum cable length, but because of signal attenuation there is an upper limit to how long HDMI cables can be made. The length of the HDMI cable made depends on the construction quality and materials that were used. The signal attenuation and intersymbol interference (ISI) which is caused by long cables can be compensated by using adaptive equalization.

HDMI 1.3 has defined two categories of cables: Category 1 certified cables which have

been tested at 74.5 MHz (1080i/720p) and Category 2 certified cables which have been tested at 340 MHz (1600p) to reduce the confusion about which cables support which video formats. A Category 1 HDMI cable will be marketed as a "Standard HDMI cable" and a Category 2 HDMI cable will be marketed as a "High Speed HDMI cable". Category 1 and 2 cables can either meet the required parameter specifications for inter-pair skew, far-end crosstalk, attenuation, and differential impedance or they can meet the required non-equalized/equalized eye diagram requirements. A cheaply made cable of about 5 meters (16 ft) can be manufactured to Category 1 specifications using 28 AWG conductors. With better quality construction and materials (24 AWG conductors) an HDMI cable can reach lengths of up to 15 meters (49 ft). The HDMI website has stated that many HDMI cables under 5 meters of length that were made before the HDMI 1.3 specification can work as a Category 2 cable but cautions that only Category 2 tested cables are guaranteed to work. Long cable lengths can cause instability of HDCP and blinking on the screen due to the weakened DDC signal which HDCP requires. *HDCP DDC signals must be multiplexed with TMDS video signals to be compliant with HDCP requirements for HDMI extenders based on a single Category 5/Category 6 cable.* Several companies offer amplifiers, equalizers, and repeaters that can string several standard HDMI cables together. Active HDMI cables use electronics within the cable to boost the signal and allow for HDMI cables of up to 30 meters (98 ft). HDMI extenders that are based on dual Category 5/Category 6 cable can extend HDMI to 50 meters (164 ft) while HDMI extenders based on optical fiber can extend HDMI to 100+ meters (328 ft).

DDC (Display Data Channel)

The Display Data Channel is a communication channel based on the I2C bus specification. HDMI specifically requires support for the Enhanced Display Data Channel (E-DDC) which is used by the HDMI source device to read the E-EDID data from the HDMI sink device to learn what audio/video formats it supports. HDMI requires that the E-DDC support I2C standard mode speed (100 kbit/s) and allows optional support for fast mode speed (400 kbit/s). HDMI has 3 separate communication channels which are the DDC, TMDS, and the optional CEC.

TMDS (Transition Minimized Differential Signaling)

TMDS on HDMI 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.

Both HDMI and DVI use TMDS to send 10-bit characters that are encoded using 8b/10b encoding for the Video Data Period and 2b/10b encoding for the Control Period. HDMI adds the ability to send audio/auxiliary data using 4b/10b encoding for the Data Island Period. Each Data Island Period is 32 pixels in size and contains a 32-bit Packet Header, which includes 8-bits of BCH ECC parity data for error correction, and describes the contents of the packet.

Content protection

HDMI can use HDCP to encrypt the signal if required by the source device. The HDCP Repeater bit controls the authentication and switching/distribution of an HDMI signal. According to HDCP Specification 1.2 beginning with HDMI CTS 1.3a, any system which implements HDCP must do so in a fully-compliant manner. HDCP testing which was previously only a requirement for optional tests such as the "Simplay HD" testing program is now part of the requirements for HDMI compliance.

HDMI Versions

HDMI devices are manufactured to adhere to various versions of the specification, where each version is given a number such as 1.0, 1.2, or 1.3a. Each subsequent version of the specification uses the same kind of cable but increases the bandwidth and/or capabilities of what can be transmitted over the cable. A product listed as having an HDMI version does not necessarily mean that it will have all of the features that are listed for that version since some HDMI features are optional such as Deep Color and xvYCC (which is branded by Sony as "x.v.Color").

HDMI 1.0 was released December 9, 2002 and is a single cable digital audio/video connector interface with a maximum TMDS bandwidth of 4.9 Gbit/s. It supports up to 3.96 Gbit/s of video bandwidth (1080p60 Hz or UXGA) and 8 channel LPCM/192 kHz/24-bit audio. **HDMI 1.1** was released on May 20, 2004 and added support for DVD Audio. **HDMI 1.2** was released August 8, 2005 and added support for One Bit Audio, used on Super Audio CDs, at up to 8 channels. It also added the availability of HDMI Type A connector for PC sources, the ability for PC sources to use native sRGB color-space while retaining the option to support the YCbCr color space, and required HDMI 1.2 and later displays to support low-voltage sources. **HDMI 1.2a** was released on December 14, 2005 and fully specifies Consumer Electronic Control (CEC) features, command sets, and CEC compliance tests.

HDMI 1.3 was released June 22, 2006 and increased the single-link bandwidth to 340 MHz (10.2 Gbit/s). It ***optionally*** supports Deep Color with 30-bit, 36-bit, and 48-bit xvYCC, sRGB, or YCbCr compared to 24-bit sRGB or YCbCr in previous HDMI versions. It ***optionally*** supports output of Dolby TrueHD and DTS-HD Master Audio streams for external decoding by AV receivers. It incorporates automatic audio syncing (Audio video sync) capability. It defined cable Categories 1 and 2 with Category 1 cable being tested up to 74.25 MHz and Category 2 cable being tested up to 340 MHz. It also added the new Type C mini-connector for portable devices. **HDMI 1.3a** was released on November 10, 2006 and had Cable and Sink modifications for Type C, source termination recommendations, and removed undershoot and maximum rise/fall time limits. It also changed CEC capacitance limits, clarified sRGB video quantization range clarification, and CEC commands for timer control brought back in an altered form, audio control commands added. **HDMI 1.3b** was released on March 26, 2007 and added HDMI compliance testing revisions. ***HDMI 1.3b has no effect on HDMI features, functions, or performance since the testing is for products based on the HDMI 1.3a specification.*** **HDMI 1.3b1** was released on November 9, 2007 and added HDMI compliance testing revisions which added testing requirements for HDMI Type C

mini-connector. HDMI 1.3b1 has no effect on HDMI features, functions, or performance since the testing is for products based on the HDMI 1.3a specification. **HDMI 1.3c** was released on August 25, 2008 and added HDMI compliance testing revisions which changed testing requirements for active HDMI cables. HDMI 1.3c has no effect on HDMI features, functions, or performance since the testing is for products based on the HDMI 1.3a specification.

Note that a given product may choose to implement a subset of the given HDMI version. Certain features such as Deep Color and xvYCC support are optional.

HDMI version	1.0–1.2a	1.3+
Maximum signal bandwidth (MHz)	165	340
Maximum TMDS bandwidth (Gbit/s)	4.95	10.2
Maximum video bandwidth (Gbit/s)	3.96	8.16
Maximum audio bandwidth (Mbit/s)	36.86	36.86
Maximum Color Depth (bit/px)	24	48 ^[A]
Maximum resolution over single link at 24-bit/px ^[B]	1920×1200p60	2560×1600p75
Maximum resolution over single link at 30-bit/px ^[C]	N/A	2560×1600p60
Maximum resolution over single link at 36-bit/px ^[D]	N/A	1920x1200p75
Maximum resolution over single link at 48-bit/px ^[E]	N/A	1920×1200p60

HDMI version	1.0	1.1	1.2 1.2a	1.3	1.3a 1.3b 1.3b1 1.3c
sRGB	✓	✓	✓	✓	✓
YCbCr	✓	✓	✓	✓	✓
8 channel LPCM/192 kHz/24-bit audio capability	✓	✓	✓	✓	✓
Blu-ray Disc video and audio at full resolution ^[F]	✓	✓	✓	✓	✓
Consumer Electronic Control (CEC) ^[G]	✓	✓	✓	✓	✓
DVD-Audio support	✗	✓	✓	✓	✓
Super Audio CD (DSD) support ^[H]	✗	✗	✓	✓	✓
Deep Color	✗	✗	✗	✓	✓
xvYCC	✗	✗	✗	✓	✓
Auto lip-sync	✗	✗	✗	✓	✓
Dolby TrueHD bitstream capable	✗	✗	✗	✓	✓
DTS-HD Master Audio bitstream capable	✗	✗	✗	✓	✓
Updated list of CEC commands ^[I]	✗	✗	✗	✗	✓

- A** 36-bit support is mandatory for Deep Color compatible CE devices with 48-bit support being optional.
- B** Maximum resolution is based on CVT-RB blanking which is a VESA standard for non-CRT based displays. Using CVT-RB blanking 1920x1200 would have a video bandwidth of 3.69 Gbit/s and 2560x1600 would have a video bandwidth of 8.12 Gbit/s.
- C** Using CVT-RB blanking would have a video bandwidth of 8.12 Gbit/s.
- D** Using CVT-RB blanking would have a video bandwidth of 7.91 Gbit/s.
- E** Using CVT-RB blanking would have a video bandwidth of 7.39 Gbit/s.
- F** Even for a compressed audio codec that a given HDMI version can not transport the source device may be able to decode the audio codec and transmit the audio as uncompressed LPCM.
- G** CEC has been in the HDMI specification since version 1.0 but only began to be used in CE products with HDMI version 1.3a.
- H** Playback of SACD may be possible for older HDMI versions if the source device (such as the Oppo 970) converts to LPCM.
- I** Large number of additions and clarifications for CEC commands. One addition is CEC command allowing for volume control of an AV receiver.