

Explanation of HDMI

High Definition Multimedia Interface

Overview

High Definition Multimedia Interface or HDMI is a digital audio/video interface capable of transmitting uncompressed streams of data. It is able to provide an interface between compatible digital audio/visual devices such as computers, monitors, televisions, set-top boxes, DVD players and game consoles. While HDMI is a proprietary specification, it has become a de facto interface standard for connecting high definition consumer electronics.

HDMI supports any TV or PC video format, including standard, enhanced or high-definition video, plus multichannel digital audio on a single cable. It is independent of the various digital television standards. It is a replacement for analogue systems such as SCART, S-Video, composite video and RF coaxial cable.

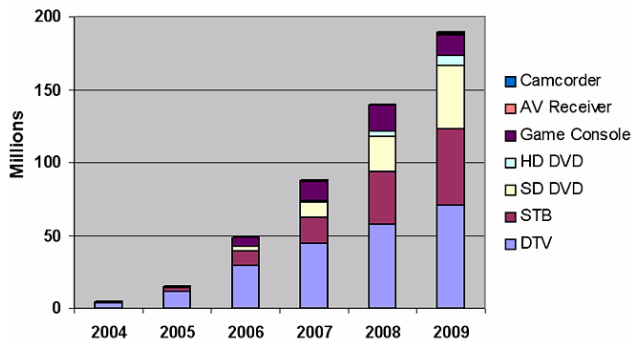


Fig 1. Global HDMI products shipped from 2004 to 2009

Supported formats

HDMI supports current analogue and digital video formats including NTSC, PAL, ATSC and DVB in resolutions of 1440p and beyond. It also supports up to 48 bit RGB and YcbCr colour spaces and refresh rates up to 120Hz.

Compressed, uncompressed and lossless audio formats are all supported by the HDMI specification including:

- Up to 8 channel uncompressed audio at up to 192kHz, 24 bit sampling rates.
- Compressed formats: DTS, DTS-EX, Dolby® 5.1 and 7.1, DVD Audio and SACD.
- Lossless formats: Dolby True HD and DTS HD Master Audio

History

DVI

DVI (Digital Visual Interface) was the forerunner of HDMI. DVI is a video interface standard designed to

maximise the image quality of digital display devices such liquid crystal computer displays and digital projectors. It was developed by an industry group, the Digital Display Working Group (DDWG) and is designed primarily for carrying uncompressed digital video data to a display. It is electrically compatible with HDMI and includes the basic functionality that HDMI was developed upon. DVI is a digital video specification only; it does not support audio.

Launched in 2002, HDMI was jointly developed by Sony, Philips, Panasonic, Hitachi, Thomson, Toshiba and Silicon Image. As of September 2006, more than 450 consumer electronics and PC manufacturing companies had become licenced HDMI adopters. Worldwide, 60 million HDMI enabled products were shipped in 2006.

Technical overview

Architecture

The key to HDMI is TMDS (Transmission Minimised Differential Signalling). It allows for transmission of huge amounts of data over a low cost shielded twisted pair cable for a total bandwidth of 10.2Gbps. TMDS was also utilised by the DVI specification.

HDMI uses three TMDS channels, each carrying one video component plus audio. Each TMDS channel is capable of a bandwidth of 3.4Gbps. In addition it has a clock channel, two data channels, 5VDC power supply and a hot plug detect which senses when an HDMI device has been connected, disconnected, powered up or powered down.

Display Data Channel (DDC)

The display data channel allows two-way data transfer between HDMI devices. HDMI compliant televisions in particular, are fitted with an EDID (Extended Display Identification Data) ROM chip. EDID is like electronic DNA. Embedded in this chip is information about the device, such as display size, resolution, aspect ratio, gamma and supported video modes, plus information about the manufacturer and model.

HDCP

HDCP (High-bandwidth Digital Content Protection) is a digital content protection developed by Intel and accommodated by HDMI. HDCP uses the DDC channel to establish a digital handshake between the source and receiving devices. The authentication is performed by exchanging the unique key that is stored in every HDMI device. The source device then begins to encrypt and transmit the data. The encryption algorithm randomly re-authenticates about every two seconds to provide a high level of security. If the authentication fails at

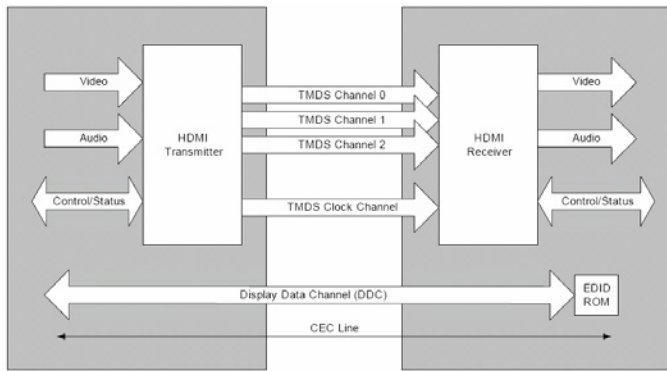


Fig 2. HDMI channel transmission architecture

any point, the transmission will either be turned off or continued at a lower resolution.

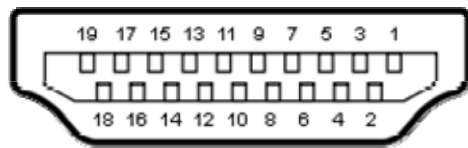
HDCP is only required for encrypting protected commercial content, such as copyright movies or pay-per-view programming. It is not required for standard definition DVDs or free-to-air HDTV content. The Federal Communications Commission is attempting to mandate that all digital broadcasts in the US will be HDCP encrypted by 2009.

Consumer Electronic Control (CEC)

CEC is also a two way data transfer and allows devices in a system to communicate with each other. CEC may be used for system control and one-touch remote control, for example, when a DVD player is switched on, the system also turns on the AV receiver, selects the correct input and turns on the display device.

Connectors

There are three types of connectors included in the HDMI specification: Type A, B and C. The standard 19-pin connector found on most consumer HDMI devices is the Type A connector. The Type C connector carries the same pin assignments, but is physically smaller and is intended for use on portable devices such as video and still digital cameras. Type B is a 29-pin connector that is not included on any commercial devices.



- Pin 1 TMDS data 2+
- Pin 2 TMDS data 2 shield
- Pin 3 TMDS data 2-
- Pin 4 TMDS data 1+
- Pin 5 TMDS data 1 shield
- Pin 6 TMDS data 1-
- Pin 7 TMDS data 0+
- Pin 8 TMDS data 0 shield
- Pin 9 TMDS data 0-
- Pin 10 TMDS clock+
- Pin 11 TMDS clock shield
- Pin 12 TMDS clock-
- Pin 13 CEC
- Pin 14 Reserved
- Pin 15 SCL
- Pin 16 SDA
- Pin 17 DDC/CEC ground
- Pin 18 +5V
- Pin 19 Hot plug detect

Versions

All versions are backward compatible with earlier versions of HDMI and with DVI. All version support 1080p.

Blu-ray and HD DVD are also supported by all versions.

Version 1.0

- Released December 2002.
- Single-cable digital audio/video connection with a maximum bit-rate of 4.9Gbps. Supports up to 165Mpixels/sec video (1080p, 60Hz) and 8-channel, 192kHz, 24-bit audio.

Version 1.1

- Released May 2004.
- Added support for DVD Audio.

Version 1.2

- Released August 2005.
- Added support for One Bit Audio, used on SACDs, up to 8 channels.
- Availability of HDMI Type A connector for PC sources.
- Ability for PC sources to use native RGB colour while retaining the option to support YcbCr
- Requirement for HDMI 1.2 and later displays to support low-voltage sources.

Version 1.2a

- Added Consumer Electronic Control (CEC) features

Version 1.3, 1.3a

- Released 2006
- Increases bandwidth to 10.2 Gbps
- Supports 30-bit, 36-bit, and 48-bit YCbCr colour
- Incorporates automatic audio syncing (lip sync) capability
- Availability of Type C connector

Version 1.4

- Released 2009
- HDMI Ethernet channel
- 3D support
- 4K x 2K support
- More colour spaces
- New connectors
- Transfer speeds up to 100Mbps

Transmission limitations

HDMI is capable of transmitting high-definition television at 2.2Gbps from a total available bandwidth of 5Gbps.

The HDMI specification doesn't set a maximum cable length, rather it sets a minimum electrical level that must be attained. For most HDTV transmission, any HDMI cable up to 5 metres is adequate; most cables will work up to 8 metres, and some well manufactured cables will work at up to 10 metres or more. For 1080p, where signals are running at such high speed, it is difficult to a cable to maintain a signal level above 5 metres.

An active extender requires an external power supply, fully resets, decodes and retimes the signal and is suitable for cable runs of 5 – 10 metres. Multiple extenders may be used for very long cable runs.

Cable extenders are available and are either passive or active. A passive extender requires no external power, uses an equaliser to boost, but not to fully reset the signal and is suitable for shorter extensions of 3 -5 metres.

Installation

HDMI is a point-to-point interconnection system. It can't be used as a bus or a network. Because it uses highspeed digital signalling, with strict timing tolerances, cables cannot be split, spliced or field-terminated. HDMI cables are all male-to-male, with female sockets on equipment.

HDMI to DVI interoperability

HDMI and DVI are electrically compatible. There are a variety of purely mechanical, passive HDMI to DVI connectors available. An HDMI source may be connected to a DVI display or receiver, however only the video signals are transmitted through the HDMI cable: the audio is provided by separate analogue outputs.

Advantages

HDMI is able to offer significant benefits over analogue video and audio connections:

- Uncompressed, therefore lossless transmission. True bit-for-bit fidelity.
- No digital to analogue conversions
- Consolidates cable connections. One HDMI cable replaces up to 11 analogue cables
- Digital encryption for secure content protection
- Transmits native TV aspect ration without conversion
- Supports all existing video and audio formats
- Supports all HDTV resolutions up to 1440p
- Supports RGB and YCbCr colour at up to 48 bit

colour depth

- Supports up to 8 channel uncompressed audio, at 192kHz, 24bit sampling rates
- Supports compressed audio formats – DVD audio, SACD, Dolby® Digital 5.1, 7.1, DTS, DTS-EX, Dolby True HD and DTS HD Master Audio
- Built-in two way information sharing allows system control and single button remote control
- Support for PC based components

Criticisms

The main objection that some in the industry have to HDMI is that the Digital Rights Management (DRM) restrictions under HDCP are too restrictive. Legal precedent has been set by most jurisdictions that copying material for private use constitutes 'fair use' and does not constitute breach of copyright. If HDCP is adopted as proposed, it will prevent even this limited use of protected material in the format it was broadcast, if at all.

Some observers feel that the DRM restrictions serve the interests of major studios and content providers, not consumers and that HDCP operates from an assumption that every user is likely to steal protected content.

On the surface, it may seem an option is to simply watch HDTV with the existing analogue connections: this defeats the purpose of having high-definition content in the first place as the analogue connections are limited to 480p resolution. If the FCC and Motion Picture Association of America in the US have their way, any television displaying a program encoded with HDCP not connected through DVI or HDMI may have the definition downgraded to 480i, thereby losing all the advantages of high-definition altogether.

The real issue with this is that there are millions of HDTVs sold to consumers in the last 5 – 10 years as 'HD ready' or 'HD compatible'. Since HDMI and HDCP did not exist when many of these units were bought, the absence of any HDMI connection means that the restriction placed on the delivery of high-definition content will preclude them receiving the level of performance they paid for.

From January 2005, the European Industry Association for Information Systems required that HDCP is a mandatory component of the 'HD Ready' label.

Logo and trademark

The HDMI logo, trademark and all intellectual property rights of the specification are the property of HDMI Licensing LLC.

