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HDMI for the Custom Installer



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Introduction

This document explains what the HDMI Custom Installer needs to know.

For a Consumer introduction to HDMI refer to Ivans Insight HDMI-ConsumerRev1-0

Extracts have been used from some of these resources to compile this document

HDMI Organisaton	http://www.hdmi.org
Wikipedia	http://en.wikipedia.org

Additional reference material

The following references may be of interest

Various video presentations from hdmi.org

<http://www.hdmi.org/learningcenter/presentations.aspx>

http://www.hdmi.org/learningcenter/installer_training.aspx

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HDMI – Technical explanation

What is HDMI

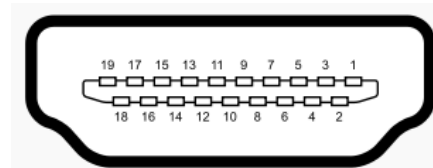
HDMI is a compact audio/video interface for transmitting uncompressed digital data. It represents a digital alternative to consumer analog standards such as Radio Frequency (RF) coaxial cable, composite video, S-video, SCART, component video, D-Terminal, and VGA. HDMI connects digital audio/video sources such as set-top boxes, Blu-ray Disc players, personal computers (PCs), video game consoles (such as the PlayStation 3 and Xbox 360), and AV receivers to compatible digital audio devices, computer monitors, and digital televisions.

HDMI supports, on a single cable, any TV or PC video format, including standard, enhanced, and high-definition video, up to 8 channels of digital audio, and a Consumer Electronics Control (CEC) connection. The CEC allows HDMI devices to control each other when necessary, and allows the user to operate multiple devices with one remote control handset. Because HDMI is electrically compatible with the signals used by Digital Visual Interface (DVI), no signal conversion needs to take place nor is there a loss of video quality when a DVI to HDMI adapter is used. As an uncompressed connection, HDMI is independent of the various digital television standards used by individual devices such as ATSC and DVB as these are encapsulations of compressed MPEG video streams (which can be decoded and output as an uncompressed video stream on HDMI).

HDMI products started shipping in autumn 2003. Over 850 Consumer Electronics (CE) and PC companies have adopted the HDMI specification (HDMI Adopters). In Europe, either DVI-HDCP or HDMI is included in the HD ready in-store labelling specification for TV sets for HDTV, formulated by EICTA with SES Astra in 2005. HDMI began to appear on consumer HDTV camcorders and digital still cameras in 2006. Shipments of HDMI are expected to exceed that of DVI in 2008, driven primarily by the CE market.

HDMI Pin Outs

Pin	Signal	Pin	Signal
1	TDMS Data 2+	11	TDMS Clock Shield
2	TDMS Data 2 Shield	12	TDMS Clock -
3	TDMS Data 2-	13	CEC
4	TDMS Data 1+	14	Reserved
5	TDMS Data 1 Shield	15	SCL
6	TDMS Data 1-	16	SDA
7	TDMS Data 0+	17	DDC CEC GND
8	TDMS Data 0 Shield	18	+5v Max 50ma
9	TDMS Data 0-	19	Hot Plug Detect
10	TDMS Clock+		



Type A (Female) HDMI

Technical Overview

HDMI supports, on a single cable, any TV or PC video format, including standard, enhanced, and high-definition video, up to 8 channels of digital audio, and the Consumer Electronics Control signal. 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 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. A HDMI connection can either be single link (Type A/C) or dual link (Type B) and can have a video pixel rate of 25 MHz to 340 MHz for a single link connection or 25 MHz to 680 MHz for a dual link connection. Video formats with rates below 25 MHz (e.g., 13.5 MHz for 480i/NTSC) are transmitted using a pixel-repetition scheme. HDMI 1.0 to HDMI 1.2a uses the CEA-861-B video standard and HDMI 1.3+ uses the CEA-861-D video standard. The CEA-861-D document defines the video timing requirements, discovery structures, and data transfer structure. The color spaces that can be used by HDMI are ITU-R BT.601, ITU-R BT.709-5, and IEC 61966-2-4. HDMI can encode the video

in xvYCC 4:4:4 (8–16 bits per component), sRGB 4:4:4 (8–16 bits per component), YCbCr 4:4:4 (8–16 bits per component), or YCbCr 4:2:2 (8-12 bits per component).

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 compressed audio stream 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 4 times 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 support is a standard feature on digital TVs while in the PC industry it can depend on the specific model. The first computer monitors with HDCP support started being released in 2005 and by February 2006 a dozen different models had been released.

Connectors

There are three HDMI connector types with Type A and Type B defined since the HDMI 1.0 specification and Type C defined since the HDMI 1.3 specification.

- Type A connector has 19 pins with bandwidth to support all SDTV, EDTV, and HDTV modes. The plug's outside dimensions are 13.9 mm wide by 4.45 mm high. Type A is electrically compatible with single link DVI-D.
- Type B connector has 29 pins (21.2 mm by 4.45 mm) and can carry double the video bandwidth of Type A for use with very high-resolution future displays such as WQXGA(3840×2400). Type B is electrically compatible with dual link DVI-D but has not yet been used in any products.
- Type C mini-connector is intended for portable devices. It is smaller than the Type A connector (10.42 mm by 2.42 mm) but has the same 19 pin configuration. The number of pins is the same but the signal assignment is different because of the different shielding requirements due to the signals being in a single row. The differences are that all positive signals of the differential pairs are swapped with their corresponding shield, DDC/CEC Ground is assigned to pin 13 instead of 17, CEC is assigned to pin 14 instead of 13, and the reserved pin is assigned to pin 17 instead of 14. The Type C mini-connector can be connected to a Type A connector using a Type A-to-Type C connector cable.

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 an HDMI cable depends on the construction quality and the materials used in the cable. Adaptive equalization can be used to compensate for the signal attenuation and intersymbol interference caused by long cables.

To reduce the confusion about which cables support which video formats, HDMI 1.3 defines two categories of cables:

- Category 1 certified cables, which have been tested at 74.5 MHz (1080i/720p).
- Category 2 certified cables, which have been tested at 340 MHz (1600p).

Category 1 HDMI cables are to be marketed as "Standard" HDMI cables, and Category 2 HDMI cables are to be marketed as "High-Speed" HDMI cables.^[1] This labeling guideline for HDMI cables went into effect on October 17, 2008. 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 cable of about 5 meters can be manufactured to Category 1 specifications easily and inexpensively by using 28 AWG (0.081 mm²) conductors. With better quality construction and materials, including 24 AWG (0.205 mm²) conductors, an HDMI cable can reach lengths of up to 15 meters. 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. HDMI extenders that are based on dual Category 5/Category 6 cable can extend HDMI to 250 meters while HDMI extenders based on optical fiber can extend HDMI to 300 meters.

DVI Compatibility

A DVI signal is electrically compatible with an HDMI video signal; no signal conversion needs to take place when an adapter is used, and consequently no loss in video quality occurs. As such HDMI is backward compatible with Digital Visual Interface digital video (DVI-D or DVI-I, but not DVI-A) as 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. However, the audio and remote-control features of HDMI will not be available. Additionally, not all devices with DVI input support High-bandwidth Digital Content Protection (HDCP). Without such support by the device, an HDCP-enabled signal source will suppress output and so prevent the device from receiving HDCP-protected content. All HDMI devices must support sRGB encoding.

HDCP

HDMI can use HDCP to encrypt the signal if required by the source device. CSS, CPPM, and AACS requires the use of HDCP on HDMI when playing back encrypted DVD-Video, DVD-Audio, and Blu-ray Disc. 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. HDCP allows for up to 127 devices to be connected together with up to 7 levels using a combination of sources, sinks, and repeaters. A simple example of this is several HDMI devices connected to an HDMI AV receiver that is connected to an HDMI display.

There are devices called HDCP strippers which can remove the HDCP information from the video signal and allows the video to be playable on non-HDCP compliant displays. An example of an HDCP stripper for HDMI is the HDfury2 which can convert the video to VGA or component video and the audio to stereo analog or digital TOSLINK.

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 only support the 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 and Blu Ray Disc Players

Blu-ray Disc, introduced in 2006, offers new high-fidelity audio features that require HDMI for best results. Dolby Digital Plus, Dolby TrueHD, and DTS-HD Master Audio use bitrates exceeding S/PDIF's capacity.^[120] HDMI 1.3 can transport Dolby Digital Plus, TrueHD, and DTS-HD bitstreams in compressed form. This capability allows for an AV receiver with the necessary decoder to decode the compressed audio stream. The Blu-ray specification does not support video encoded with either Deep Color or xvYCC so HDMI 1.0 can transfer Blu-ray discs at full video quality.

Blu-ray permits secondary audio decoding whereby the disc content can tell the player to mix multiple audio sources together before final output. Some Blu-ray players can decode all of the audio codecs internally and can output LPCM audio over HDMI. Multi-channel LPCM can be transported over an HDMI connection and as long as the AV receiver supports multi-channel LPCM audio over HDMI, and supports HDCP, the audio reproduction is equal in resolution to HDMI 1.3 bitstream output. Some low cost AV receivers, such as the Onkyo TX-SR506, do not support audio processing over HDMI and are labelled as "HDMI pass through" devices.

DisplayPort

Another audio/video interface is DisplayPort, which had version 1.0 approved in May 2006 and is supported in several computer monitors. The DisplayPort website states that DisplayPort is expected to complement HDMI.^[125] Most of the DisplayPort supporters are computer companies such as Dell which has released several computer monitors that support both DisplayPort and HDMI. DisplayPort has an advantage over HDMI in that it is currently royalty free, while the HDMI royalty is 4 cents per device and has an annual fee of \$10,000 for high volume manufacturers. HDMI has a few advantages over DisplayPort such as support for the xvYCC color space, Dolby TrueHD and DTS-HD Master Audio bitstream support, Consumer Electronics Control (CEC) signals, and electrical compatibility with DVI.

Connecting multiple HDMI devices

Interoperability

While interoperability issues between HDMI-linked devices still create the occasional challenge for the installer, such problems are rare, and getting rarer – and are mostly limited to first-generation devices. But the CE industry remains an industry in transition, experiencing a learning curve as their devices become more complex and home theater systems become more interdependent. Designing and installing firmware, for instance, while a routine business for PC developers is still relatively new in the CE world, and manufacturers still occasionally get it wrong.

EDID Implementation Issues

One key area of interoperability for HDMI-connected devices is the ability to effectively communicate EDID data via the DDC channel. If the sink device (the HDTV or projector) has its EDID ROM coded incorrectly, or if a source or repeater device fails to read it properly, the system will fail in its attempts to auto-negotiate the proper video and audio modes. Symptoms of this problem include incorrect color space and/or the wrong resolution. Some installers take a small, reliable 1080p set along on installation calls to troubleshoot for this – if it doesn't look right, the problem is most likely in the source device; if it looks good, the problem is probably in the sink. Regardless of which component is to blame, the issue can probably be resolved with a firmware update from the manufacturer.

HDCP Implementation Issues

The HDCP handshake is critical to components working together properly in an HDMI/HDCP enabled system. Problems tend to arise in two areas of implementation, and nearly always in the source device. First, sources need to support an HDCP function called “authenticate forever.” In other words, the source must consistently send a signal inquiring if its HDMI input is selected, even while another input is in use. If a source device times out and stops inquiring, an HDCP authentication failure will probably result. Second, source devices need to properly implement the HDCP repeater function if there's going to be a repeater device installed in the system, i.e., an A/V receiver. Otherwise, switching between source devices can result in an HDCP authentication failure. Once again, a firmware upgrade to the source device will probably solve the problem.

Interoperability Issues

The HDMI licensing group is actively working within the industry to educate on these issues and help make product interoperability a top priority for everyone. In the spring of 2007, Digital-CP (the company that licenses HDCP), released a compliance testing specification for HDCP. HDCP testing is now required for all products that undergo HDMI testing. Industry initiatives are also helping to address the problem, such as “PlugFest” events, where manufacturers come together and self-test their devices for interoperability. There are also outside testing and certification programs, such as the Simplay HD program, that are designed to provide interoperability and performance measurements and help ensure wider interoperability.

iLED HDMI Products

HDMI Extenders

The **HDMI Extender** is a single or pair of active devices that are powered with an external power source or with the 5V DC power from the HDMI source. Plain copper HDMI cable is capable of 12 to 15 meters. HDMI extenders based on dual Category 5e/Category 6 cable can extend HDMI to 50 meters while HDMI extenders based on optical fiber can extend HDMI to 100+ meters.

To use longer HDMI cable or cables, active boosters are necessary to compensate for losses and to remove the intersymbol interference. HDMI cable becomes thicker, stiffer and heavier with increasing cable length, however, making it difficult to use in many applications. Many companies developed the HDMI over UTP type extender to use CAT-5 or CAT-6 cable, which is much thinner, softer, and lighter. Most extenders use two cables to extend the 4-pairs of TMDS signals for video, and two or three control signals for the DDC and HDCP. To avoid EMI problems, most HDMI over UTP extenders recommend CAT-6 cables.

Care must be taken when using HDMI extenders that draw their power from the HDMI DC power source. As detailed above, 50ma is the maximum available. This is often exceeded by HDMI powered extenders leading to erratic image quality and product failure.

iLED stocks the following HDMI extenders. Both are externally powered.

- eZi-HDMI-EX001 allows maximum lengths of 60m for 1080p or 120m for 1080i over 2 x CAT5e/CAT6 cables.
- eZi-HDMI-EX002 allows maximum lengths of 30m for 1080p or 50m for 1080i over 2 x CAT5e/CAT6 cables.

HDMI Splitters

HDMI Splitters allow 1 HDMI signal to connected to more than 1 display device simultaneously

iLED stocks the following HDMI splitters. All are externally powered and comes complete with Power Supply.

- eZi-HDMI-SP001. 1 HDMI input to 8 HDMI outputs.
- eZi-HDMI-SP002. 1 HDMI input to 4 HDMI outputs
- eZi-HDMI-SP003. 2 HDMI inputs to 8 HDMI outputs. Select which input to which output.

HDMI Switchers

HDMI Switchers allow multiple HDMI sources to be connected to 1 display device. Most installations require the switcher to be controllable. The most cost effective is an IR controllable device

iLED stocks the following HDMI Switchers. All are externally powered and comes complete with Power Supply and Infra Red Remote Control.

- eZi-HDMI-SW002. 5 HDMI input to 1 HDMI outputs
- eZi-HDMI-SW002. 4 HDMI input to 1 HDMI outputs
- eZi-HDMI-SW002. 3 HDMI input to 1 HDMI outputs

HDMI Matrix Switchers

HDMI Matrix Switchers allow any input to be switched to any output.

Most installations require the switcher to be controllable. The most cost effective is an IR controllable device.

iLED stocks the following HDMI Matrix Switchers. The unit is externally powered and comes complete with Power Supply and Infra Red Remote Control.

- eZi-HDMI-MX001. 4 HDMI inputs to 4 HDMI outputs. RS232 Control Port. 19inch Rack mount plates are included
- eZi-HDMI-MX002. 4 HDMI inputs to 4 HDMI outputs. Limit of 2 simultaneous outputs per input

HDMI Scalers

HDMI scalars convert the various multimedia audio and video formats to HDMI.

iLED stocks the following HDMI Scaler/s. The unit is externally powered and comes complete with Power Supply and Infra Red Remote Control.

- eZi-HDMI-CV001. RCA Composite input / S-Video Input to HDMI output – 720P.
- eZi-HDMI-CV002. Input: 2-way Composite Video, 2-way Component Video, 1-way SCART, 1-way S-Video, 1-way VGA, and 2-way HDMI, 2-way Stereo Audio
- eZi-HDMI-CV003. SCART to HDMI 720P
- eZi-HDMI-CV004. Input VGA up to 1280x960, Component Video, Audio L/R. Output HDMI up to 1080P
- eZi-HDMI-CV005. Input VGA up to 1920x1080@60Hz, Audio L/R. Output HDMI 1.3
- eZi-HDMI-CV006. Input: 1 Component Video (YPbPr) and 1 x Audio L/R or 1 Component Video (YPbPr) and 1 x SPDIF. Output HDMI 1.3

What can iLED do

iLED provides HDMI extenders over CAT5e as well as HDMI switchers, HDMI splitters, HDMI matrix switchers and HDMI Scalers. We have demonstration facilities at our Johannesburg office as well as technical expertise to assist you with solving your HDMI problems using our equipment.

iLED is continually updating and adding to our product range and knowledge base. Please visit our website for additional information and products.

Glossary

HDMI	High Definition Multimedia Interface
HDCP	High-bandwidth Digital Copy Protection
SCART	French Standard 21Pin AV Connector
D-Terminal	Japanese analog Video Connector
VGA	Video Graphics Array. 15 pin video connector
S-Video	Separate Video. Round 4pin video connector
CEC	Consumer Electronics Control
DVI	Digital Visual Interface
ATSC	Advanced Television systems committee
DVB	Digital video Broadcasting
MPEG	Moving Picture Experts Group
CE	Consumer Electronics Control
EICA	European Information, Communication and Consumer Electronics Technology Industry Associations
SES Astra	Corporate subsidiary of SES
TMDS	Transmission Minimised Differential Signalling
NTSC	National Television Standards Committee
DTS	Digital Theatre System
DSD	Direct Stream Digital
SDTV	Standard Definition Television
EDTV	Enhanced Definition Television
HDTV	High Definition Television
DDC	Display Data Channel
CSS	Content Scramble System
CPRM	Content Protection for Recordable Media
AACS	Advanced Access Content System
TOSLINK	Toshiba Optical Link
EDID	Extended display Identification Data
ROM	Read Only Memory
A/V	Audio / Video

Online Resources

For detailed technical information and assistance on potential problems when using HDMI, I have found the following online resources helpful

HDMI Organisation	http://www.hdmi.org
Wikipedia	http://en.wikipedia.org/wiki/High-bandwidth_Digital_Content_Protection
Industry Resource	http://www.videsignline.com/howto/198900437
iLED	http://www.iled.co.za