

June 5, 2009

HDMI 1.4 Demystified

Xiaozheng Lu, CEO, Luxi Electronics Corp.

Today the HDMI LLC released another major HDMI specification revision, the HDMI 1.4. The discussion below is provided to help clarify this new technology and provide you with a better understanding of what you need to know when buying or selling HDMI products.

What is HDMI?

High-Definition Multimedia Interface, or HDMI, is a digital audio, video and control signal format defined by 7 of the largest consumer electronics manufacturers. Released on 12/9/2002, the installed base of HDMI devices now exceeds 600 millions. The advantages HDMI has over other signal formats are:

- Uncompressed digital signals for the highest picture and sound quality
- One cable for video, audio and control signals
- Two-way communication for easy system control
- Automatic display and source matching for resolution, format and aspect ratio
- PC compatibility

What's new in HDMI 1.4?

- 4k x 2k video format
- 3D video format
- New color space formats (sYCC601, AdobeRGB and AdobeYCC601)
- Audio Return Channel
- HDMI Ethernet
- Type D (micro) connector
- Type E (automobile) connector

Want to know more?

Read on. You don't have to understand all the technical terms here in order to grasp the overall concepts.

To understand the HDMI cable better, let's first take a look at all the signals travel inside one HDMI cable:

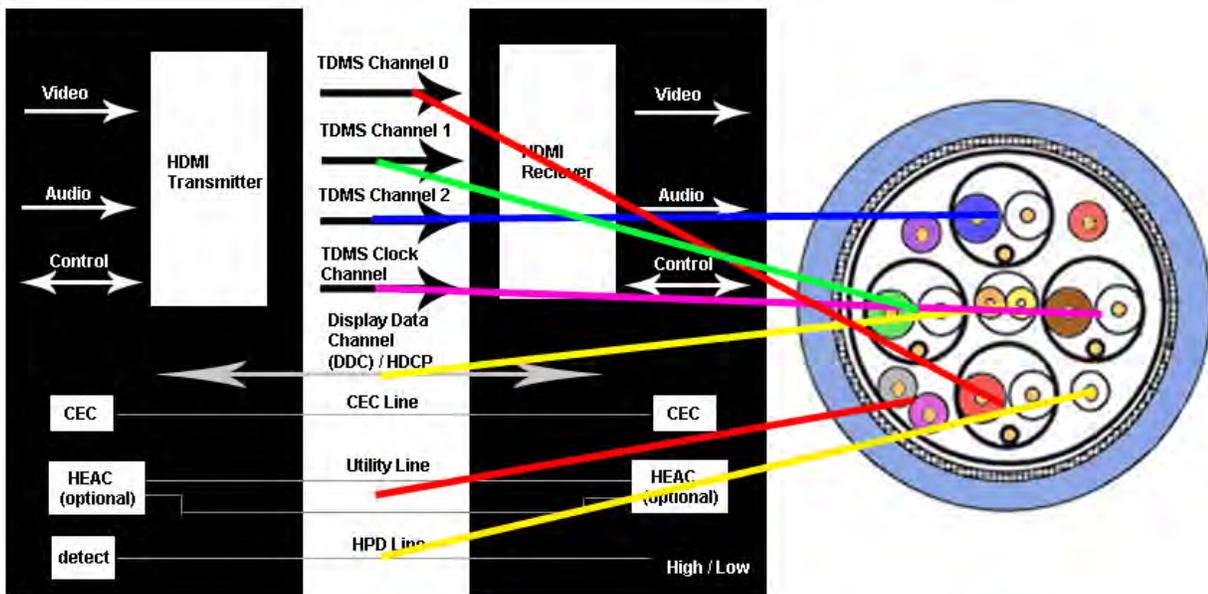


Fig. 1 HDMI signals and cable composition

- 4 TMDS (Transition Minimized Differential Signaling) signals over 4 twisted pair wires, including 3 digital video signals (RGB or YCrCb) and 1 clock signal; the digital audio signals are also multiplexed into the digital video signals.
- DDC (Display Data Channel) data and clock lines carry the two-way communication signals; the HDCP (High-bandwidth Digital Content Protection) signal also floats here.
- CEC (Consumer Electronics Control) data line distributes remote control signals for one touch system controls.
- HEAC (HDMI Ethernet and Audio return Channel) is a newly added twisted par in the HDMI 1.4 spec to carry the two way Ethernet signals and the return audio signals. One of the wires also serves the HPD function; see below.
- HPD (Hot Plug Detection) allows the source to detect a display plugged in real time.
- +5 V power line supports remote circuits for communication even when the power is not turned on.

With this basic understanding of what's inside a HDMI cable, now let's take a look at the new HDMI 1.4 features one by one:

Feature 1): 4k x 2k Video Format:

First, some video basics:

- Resolution: refers to how many pixels in horizontal and vertical direction per frame. 720p has a resolution of 1280x720, while both the 1080i and 1080p are 1920x1080.
- Refresh rate: refers to how many frames or fields of pictures per second. The common rates are 30 and 60 Hz in the US, or 25 and 50 Hz in Europe. The film uses 24 Hz.
- Bit depth: refers to how many bits of data needed to encode each pixel. Common ones are 24, 30, 36 and 48 bits.
- Data rate: refers to total number of digital bits in a second for a given signal. The formula is:

Data rate = (Total number of horizontal pixels) x (Total number of vertical pixels) x (Refresh rate) x (Bit depth) x 1.1 (to 10% more for Audio and Auxiliary data)

You don't have to memorize the formula; all you need to know is that when the resolution doubles, the data rate also doubles. When the refresh rate doubles, the data rate doubles also. Further, when the bit depth doubles, the data rate also doubles.

Data rate is the single most important spec for the cables; it affects how far a cable can carry a given signal format.

4k x 2k: this is a new resolution added by HDMI 1.4; it's the short description of the 3840 x 2160 resolution; which equivalent to four 1080p images. To prevent the data rate being too high, the HDMI 1.4 limits the refresh rate of this format to 30 Hz (or 25 Hz in EU and Asia, 24 Hz for film) or half of the regular 1080p; thus the data rate is only twice of the 1080p. But 30 Hz is a trade of moving image quality.



Feature 2): 3 Dimensional Video Format

3D: 3 dimensional effects are achieved by showing two videos shot by 2 cameras side by side of the same scene, one for each eye. When the images of the two video are very close to each other, the object appears to be far away; when the image of two video are further apart, the object appears to be closer to the viewer.

Because the 3D transmits two 1080p signals, the data rate is doubled compare to regular 1080p.

There are 3 ways to achieve 3D effects with glasses, see the illustration below:



Fig. 2 Three ways to achieve 3D

Feature 3): New Color Space Standards:

A color space is a mathematical model which uses several numbers to describe a color. HDMI 1.3 added the IEC 61966-2-4 (also known as xvYCC) color space which extended to a much wider color gamut. HDMI 1.4 adds 2 more color space standards:

IEC 61966-2-1 Amendment 1 (sYCC601) color space: it is a color conversion matrix used to transform RGB values to YCC values but can represent colors outside the sRGB color gamut.

IEC 61966-2-5 (AdobeRGB, Adobe YCC601): another color space which is wider than the sRGB color gamut.

See the color space comparison below:

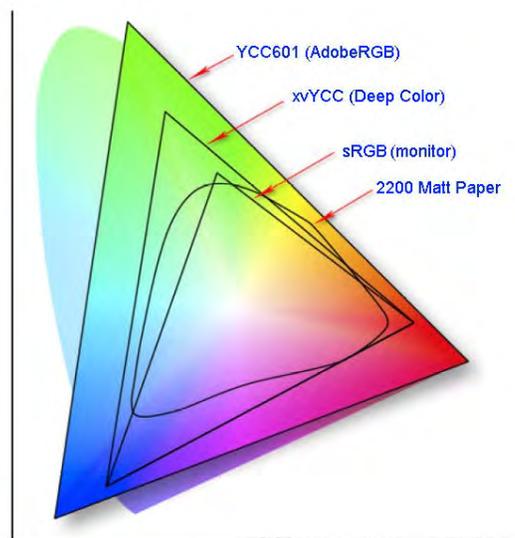


Fig. 3 Color space comparison

Feature 4) HDMI Ethernet:

Now more and more homes computer devices are connected to each other thru Ethernet and outside world via Internet; more and more AV devices also have Ethernet port for software upgrade or even AV content downloading from Internet. The HDMI 1.4 added the 100Base-T Ethernet connectivity thru the HDMI cables; so now you only need to connect one device in an AV system to the Ethernet via Cat5e cable; then the rest of the devices will be connected to the Ethernet as well thru the convenient HDMI cables. See the application diagram below.

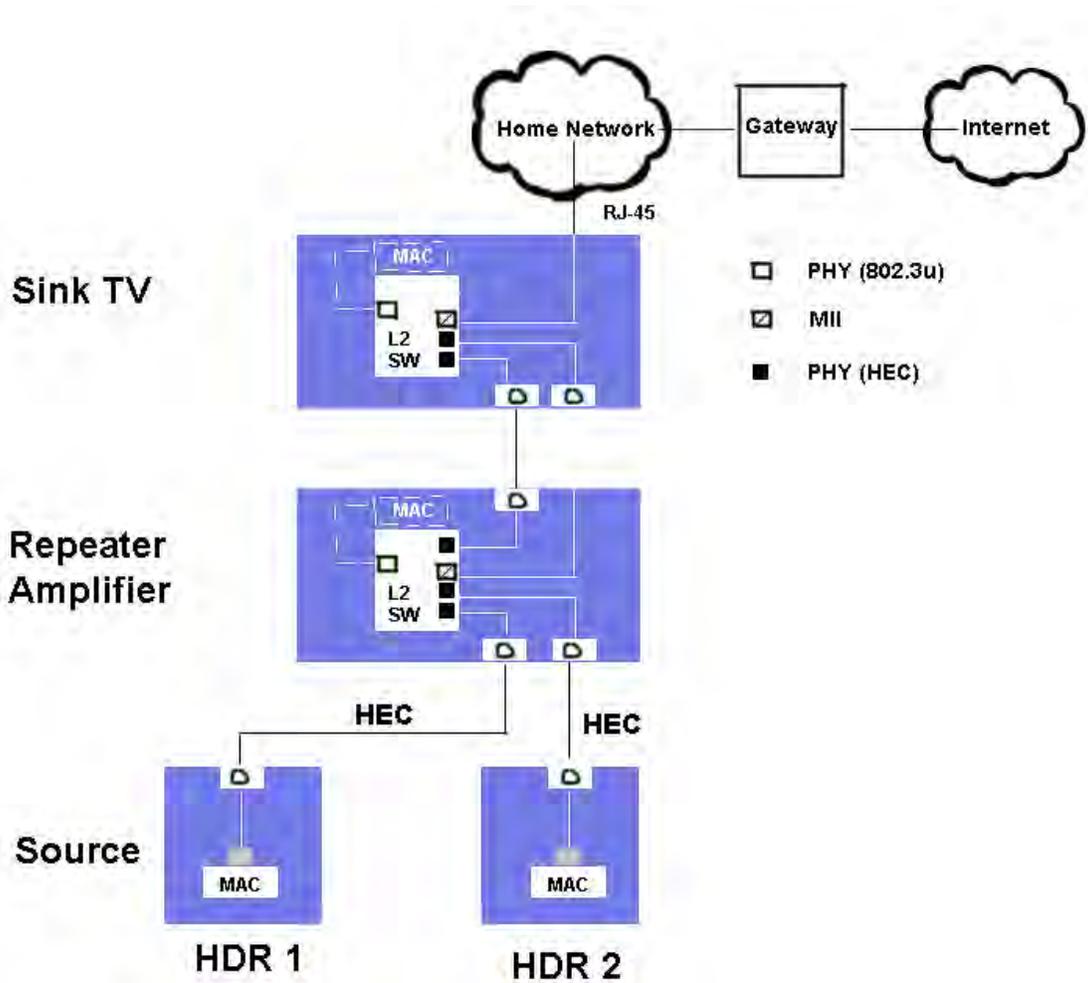


Fig. 4 HDMI Ethernet application diagram

Feature 5) Audio return channel:

Sometimes the users choose to use the DTV tuner in the HDTV to receive the over the air or cable signals; in the past, there's no easy way for them to feed the audio signal to the surround sound receiver for a better audio reproduction. HDMI 1.4 solved this problem by supplying an audio return channel from TV back to the receiver. This feature can also help to address the lip sync problem when the video and audio go thru different path.

HDMI Ethernet and Audio return Channel (HEAC) twisted pair:

This is the most significant change to the cable structure by the HDMI 1.4. Previously the pin 14 was not used; pin 19 was for HPD (Hot Plug Detection). Now

the HDMI 1.4 uses these 2 pins to connect a new shielded twisted pair wires to carry Ethernet and return audio signals.

Feature 6) and 7): Type D and E connectors



Fig. 5 HDMI plug types

- Type A plug: the most common HDMI plug, 13.9 mm wide, 19 pins, designed with one set digital video TMDS lines (Single-Link)
- Type B plug: the seldom used HDMI plug, 21.2 mm wide, 29 pins, designed with two sets of digital video TMDS lines (Dual-Link) for higher data rates
- Type C plug: the mini HDMI plug, 10.4 mm wide, 19 pins, designed with one set of digital video lines (Single-Link) for small portable devices
- Type D plug: the micro HDMI plug, 5.83 mm wide, 19 pin, about half of the size of the Type C plug, designed for mobile phones and other even smaller devices.
- Type E plug: the automobile HDMI plug, 17.9 mm wide, is a lockable connector designed for the applications in cars and trucks. It only support up to 2 Gbps signal (720p or 1080i).

Type of HDMI cables

HDMI 1.4 specification divided the HDMI cables into 5 categories:

- Category 1 Standard cable without HEAC: the cable meets test spec with a max clock frequency of 74.25 MHz (or roughly 2 Gbps, or 720p and 1080i)
- Category 2 High Speed cable without HEAC: the cable meets test spec with a max clock frequency of 340 MHz (or roughly 8 Gbps, or 4k x 2k and 3D)
- Category 1 Standard cable with HEAC: the cable meets test spec with a max clock frequency of 74.25 MHz (or roughly 2 Gbps, or 720p and 1080i)
- Category 2 High Speed cable with HEAC: the cable meets test spec with a max clock frequency of 340 MHz (or roughly 8 Gbps, or 4k x 2k and 3D)
- Category 1 Standard automotive cable: the cable used in cars and trucks which meets the test spec with a max clock frequency of 74.25 MHz (or 2 Gbps, or 720p and 1080i)

Summary: the Impact of HDMI 1.4 to the existing HDMI products

Electronics devices which encode and decode HDMI signals:

To take advantage of the new HDMI 1.4 features, every one of the electronics device in a system needs to be HDMI 1.4 compliant. If any of them is not HDMI 1.4 compliant, the whole system down grade to the common signal format all devices are compatible with; this is called backwards compatible.

Passive products like HDMI cables and the electronics devices which only pass thru the HDMI signals:

These products do not participate in the initial handshaking (communication) to determine the system compatibility; so they can not ask the system to downgrade if they are not HDMI 1.4 compatible.

For passive cables, the 4k x 2k and 3D formats would double the signal data rate thus would reduce the max length they can transmit by half. You may see many systems which worked just fine before all of a sudden go dark after device upgrade or a new movie is inserted. It's always a good idea to buy cables with more headroom. See the chart in the next page:

For the pass thru electronics, if the max data rate they can handle is less than the new 4k x 2k or 3D required, the signal won't pass them regardless of the cable length.

For the existing, relatively short and well build cables, and pass thru electronics with very high data rate, they should be compatible with the HDMI 1.4's first 3 features. The HDMI Ethernet and return audio requires new cables and products with one extra twisted pair; the Type D and E are physically different products or cables all together.

		HDMI cable max data rate												
Length (m)	Brand	1.0	2.0	3.0	4.5	6.0	7.5	9.0	12.0	15.0	20.0	25.0	30.0	35.0
		A	93	47	32	32	23	19	16	12	9	7	6	5
B	32	26	18	18	13	11	9	7	5	4				
C	21	15	10	10	8	6	5	4						
D	12	6	4	5	4									
Color coding:	2	1080i, Satellite/cable STBs, DVD players				12	Not in use yet							
	4	1080p, Blu-ray players, PS3, Xbox 360				16	Not in use yet							
	6	1080p 36-bit deep color				32	Not in use yet							
	8	4k x 2k, 3D, 1080p 48-bit deep color												
						Note:	All numbers are nominal transfer data rate in Gbps							
	Here are more signal formats:													
HDMI 1.2	720p/1080i	24 Hz	60 Hz	120 Hz	© 2009 Luxi Electronics. All rights reserved.									
	24-bit	0.8	2	4										
HDMI 1.3	1080p	24 Hz	60 Hz	120 Hz										
	24-bit	1.6	4	8										
	36-bit	2.4	6	12										
	48-bit	3.2	8	16										
HDMI 1.4	4k x 2k	30 Hz	60 Hz	120 Hz										
	24-bit	8	16	32										
	3D 1080p	24 Hz	60 Hz	120 Hz										
	24-bit	3.2	8	16										

The edge of technologies is constantly moving forward and won't stop. Because if it's not, the prices of the high tech products would keep falling to pennies based on the Moore's law. Manufacturers have to come out a new technology every 2 years or 3 to boost the prices of the products to counter the Moore's law. So instead of complaining about the new technologies, let's embrace them, learn them and enjoy them.

Hopefully, this has served to clarify your understanding of the many facts of HDMI.

Should you have any questions or concerns, please do not hesitate to contact us by email: xlu@luxielectronics.com

Thank you