

## Dive into the Details of HDMI

HDMI (the acronym stands for High-Definition Multimedia Interface) is one of the consumer electronics industry's more remarkable innovations. This de facto HDTV interface enables the transmission of high-definition digital video, up to eight channels of digital audio, HDCP encryption, the Consumer Electronics Control (CEC) protocol, and five volts of electrical power over a single cable.

HDMI 1.0, introduced in December 2002, had all of these features. The latest version, HDMI 1.3c, boasts several more, including support for Deep Color, auto lip sync, and the two high-definition multichannel audio formats used in Blu-ray discs. Let's take a look at how HDMI accomplishes all this while remaining backward-compatible with the earlier DVI standard.



### As the Version Turns

As with DVI, HDMI relies on Transition Minimized Differential Signaling (TMDS) to encode and transmit digital video, but HDMI uses TMDS to encode and transmit digital audio as well. TMDS uses a technique called differential signaling to reduce electromagnetic interference, which enables signals to travel faster with less chance of error.

The sending device—a Blu-ray disc player, for instance—encodes the digital signal and transmits it along with an inverse copy using two separate bundles of copper wire (as with Cat-5 Ethernet cables, HDMI uses twisted-pair wiring to reduce noise. Noise induced in one half-twist has a propensity to cancel noise induced in a neighboring half-twist). The receiving device—an HDTV, for example—decodes the signal, measures the difference between it and the inverse copy, and uses this information to compensate for any in-transit signal loss.

Each new version of the HDMI standard has used the same basic type of cable and the same 19-pin connector, but each iteration has increased the standard's bandwidth capabilities and introduced new features (some of which are optional). HDMI 1.0, for instance, supported a maximum pixel clock rate of 165MHz (4.95Gb/s of bandwidth), which was sufficient for delivering HDTV at 1080p at a 60Hz refresh rate and WUXGA resolution (1920x1200), also at a 60Hz refresh rate.

HDMI 1.1 added support for DVD Audio and HDMI 1.2 added support for Super Audio CD. HDMI 1.3 more than doubled the pixel clock rate to 340MHz (bandwidth of 10.2Gb/s), which enabled even higher-resolution displays, such as WQXGA (2560x1600), using a single digital link. Type A HDMI connectors (the most common) and Type C connectors (designed for digital camcorders) use single links; a Type B HDMI connector uses a dual link, but since the single-link connectors are capable of such high bandwidth, Type B connectors are not currently in production.

HDMI 1.3 also added support for Deep Color and the xvYCC color space. Deep Color describes a method of using an extremely high number of shades, hues, and luminosity to increase the number of colors that can be displayed from millions to billions. Deep Color utilizes 30-, 36-, or 48-bit depths,

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compared to the 24-bit color on tap in HDMI 1.0. The xvYCC color space, also known as x.v.Color, represents color using the full range of values (0 to 256) in an 8-bit space. RGB colors are represented by a subset of the values (16 to 235) in an 8-bit space in order to compensate for the limitations of analog displays.

### Audio Enhancements

HDMI 1.0 supports eight channels of LPCM (linear pulse code modulation) encoded at sampling rates up to 192kHz and with 24-bit resolution. HDMI 1.3 added support for eight-channel surround-sound streams encoded using the lossless compression algorithms Dolby TrueHD and DTS-HD Master Audio. All HDMI versions carry the older Dolby Digital and DTS lossily compressed bit streams, too.

Complex video processing can sometimes cause latency, resulting in the audio signal arriving at its destination before the video signal does. When this occurs, the actors in the movie will look as though they're speaking a different language and the soundtrack was poorly dubbed. HDMI 1.3 added a feature called auto lip sync that can automatically prevent this from happening.

All HDMI versions support a set of control functions known as CEC (Consumer Electronics Control) commands, although the specifications for the commands themselves weren't completely spelled out until HDMI 1.2a was finalized. CEC commands utilize HDMI's capacity for bidirectional communication to permit a single remote control to operate multiple devices connected with an HDMI cable. One touch play, for instance, will automatically trigger the necessary commands for the entire home-theater system to power up and begin playing when the Blu-ray disc player's Play button is pushed. The addition of a few CEC commands and a few arcane details are all that distinguish HDMI 1.3 from HDMI 1.3a, 1.3b, and 1.3c.



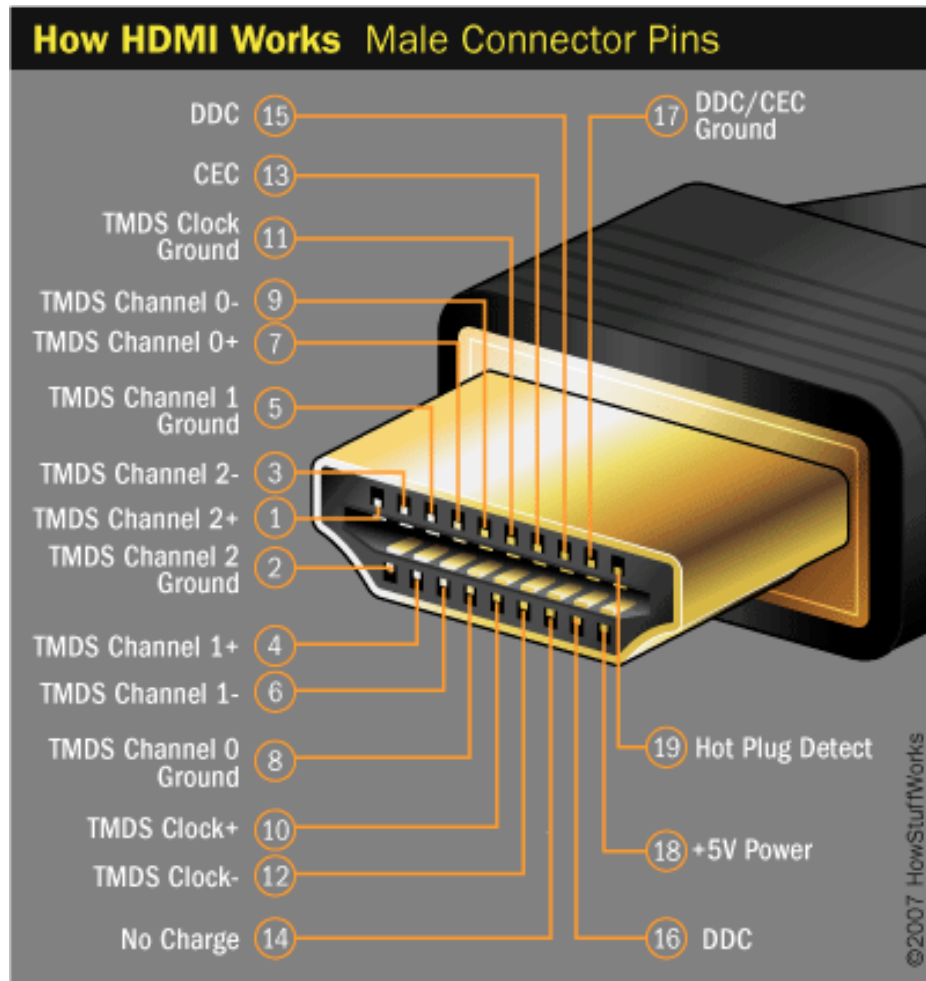
### Know Your Options

When shopping for HDMI equipment, be aware that some features—including support for Deep Color, the xvYCC color space, and even Dolby TrueHD and DTS-HD Master Audio—are optional. Although the HDMI spec does not spell out a maximum cable length, there are two types of HDMI 1.3 cable: Standard, or Category 1, cable has been tested to perform at speeds of 75MHz, which is the equivalent of a 1080i signal. Such cables typically max out at about five meters (16 feet) and are manufactured using 28 AWG copper wire, although neither of these factors are part of the official HDMI 1.3 spec.

A cable certified as High Speed or Category 2 has been tested to perform at speeds of 340MHz and can handle 1080p signals and increased color depths. High Speed HDMI cables can also accommodate higher-resolution displays (e.g., 2560x1600). These cables are manufactured using heavier gauge wire—26- or even 24 AWG—and are capable of running longer distances. Longer cable runs can be achieved by using repeaters, which use electrical power to boost the HDMI

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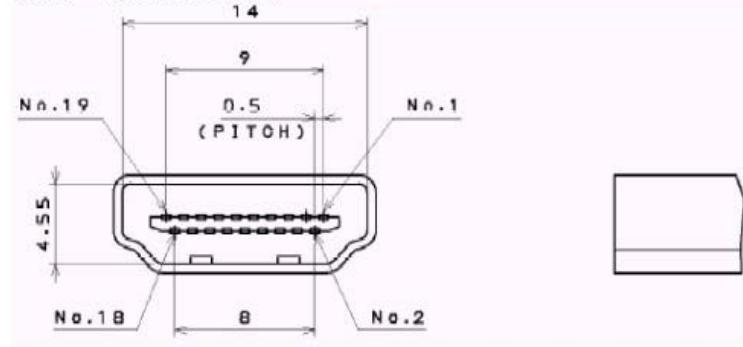
signal; “active” cables, which operate in a similar fashion; and extenders, which use fiber-optic or Cat-5 cable.



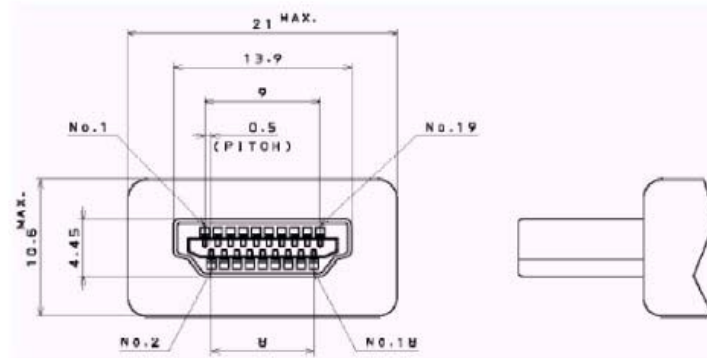
	HDMI VERSION				
	1.0	1.1	1.2, 1.2a	1.3	1.3a, 1.3b, 1.3b1, 1.3c
<b>SUPPORTED FEATURES</b>					
Standard RGB Color Space	Yes	Yes	Yes	Yes	Yes
YCbCr Color Space	Yes	Yes	Yes	Yes	Yes
36-bit Deep Color	No	No	No	Yes	Yes
48-bit Deep Color	No	No	No	Optional	Optional
xvYCC (aka x.v.Color) Color Space	No	No	No	Optional	Optional
1920x1200 resolution at 60Hz using a single link	Yes	Yes	Yes	Yes	Yes
2560x1600 resolution at 60Hz using a single link	No	No	No	Yes	Yes
Auto Lip Sync	No	No	No	Yes	Yes
DVD_Audio (DVD-A)	No	Yes	Yes	Yes	Yes
Super Audio CD (SACD)	No	No	Yes	Yes	Yes
Eight-channel LPCM audio (192kHz/24bit)	Yes	Yes	Yes	Yes	Yes
Dolby TrueHD/ DTS-HD Master Audio	No	No	No	Optional	Optional

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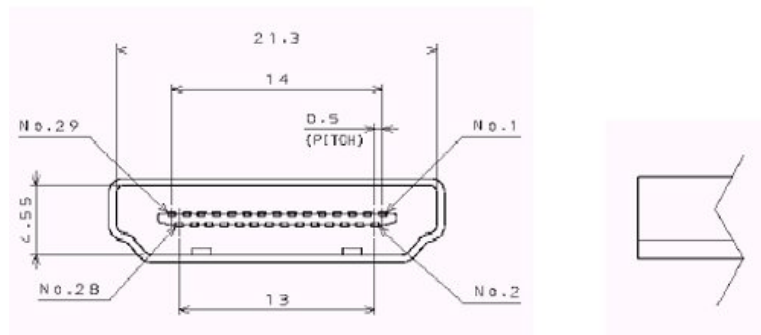
## 4.1.4.1 Type A Receptacle



## 4.1.4.2 Type A Plug



## 4.1.4.3 Type B Receptacle



## 4.1.4.4 Type B Plug

