

HDMI® Cable Speed for 4K / UltraHD

Introduction

4K, UltraHD, 2160p, whatever the name, it's four times the pixel resolution of 1080p, transmitting at **double** the bandwidth through HDMI. To understand the bandwidth requirements we'll need to explore how this new format is currently defined in the HDMI specification. From here on we'll standardise to call it 2160p.

HDMI Specification

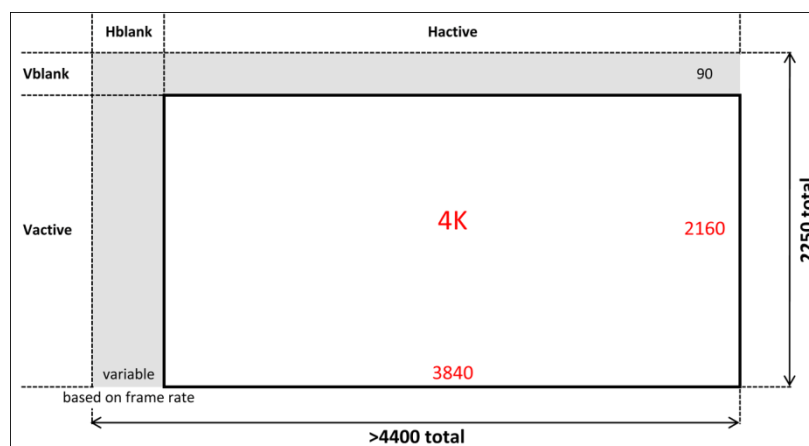
Originally defined as '4K', 2160p was first detailed for consumer application in the CE space in the 2009 release of the v1.4 HDMI specification, encompassing frame rates from 24 to 30fps. The specification defined the initial format iterations and bandwidth, as follows;

Active Pixel Resolution	Frames per Second	Clock / Aggregate Data Rate
4,096 x 2,160*	24p	297MHz / 8.91Gbps
3,840 x 2,160	23.98/24p	297MHz / 8.91Gbps
3,840 x 2,160	25p	297MHz / 8.91Gbps
3,840 x 2,160	29.97/30p	297MHz / 8.91Gbps

* SMPTE Standard

TMDS Clock

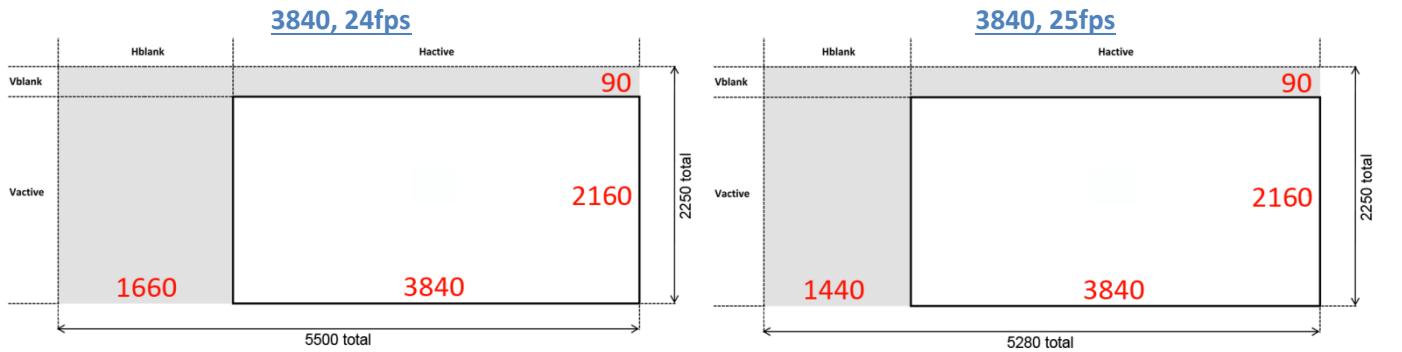
You will notice that all four main formats of 2160p, as defined by HDMI, employ the same Clock (297MHz) and resulting data rates (Clock x10 = 2.97Gbps/channel, x3 channels = 8.91Gbps aggregate). How is that so? Logically they should each be different as each has a different set of numbers, right? The answer lies quite literally in what you can't see. The resolution referred to in the table above is the **Active Video**. However there are a significant number of pixels in the **Blanking** regions as well, and that's where the 'padding' absorbs the differences to make all combinations the same bandwidth. Here's a simplified depiction;



Video Blanking (HDMI Data Island Periods)

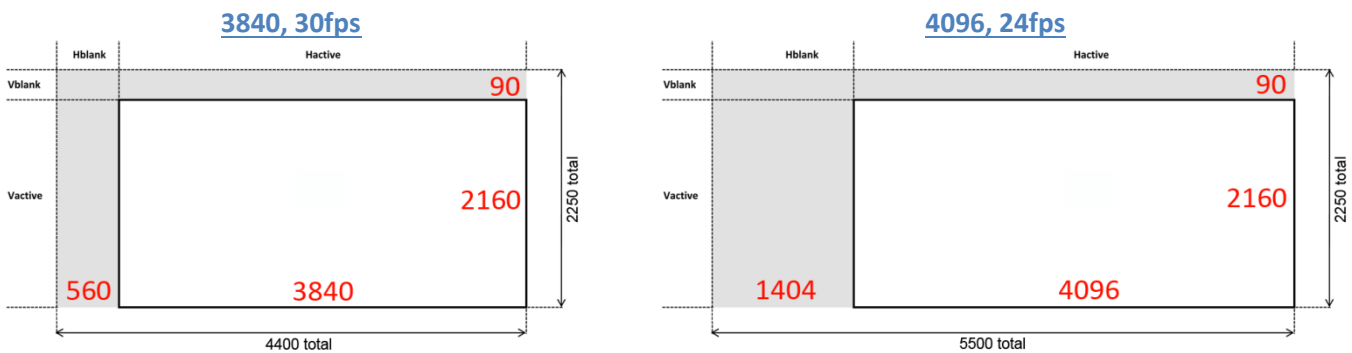
All 2160p formats, as listed in the table above, comprise a total of **2,250 pixels** of Vertical resolution (Vres), being 2,160 of active video (what appears on screen) and a fixed 90 pixels of vertical blanking (that you can't see). The Horizontal resolution (Hres) comprises either 3,840 or 4,096 pixels of active video, with the main variable being frame rate. This variability is taken up in the Horizontal Blanking to ensure that each format combination produces the same bandwidth. 'Blanking' is packaged in the "Data Island" & "Control" Periods in HDMI's TMDS stream.

Following is a simplified graphical representation to show the difference in Hblank for each combination of active video (3840 or 4096) and frame rate (24,25 or 30fps). For the record, 0.1% reduction formats are also supported - eg; 23.98, 29.97fps, etc – but are not covered here.



5500 (H) x 2250 (V) x 24 (fps) = 297,000,000 (297MHz)

5280 (H) x 2250 (V) x 25 (fps) = 297,000,000 (297MHz)



4400 (H) x 2250 (V) x 30 (fps) = 297,000,000 (297MHz)

5500 (H) x 2250 (V) x 24 (fps) = 297,000,000 (297MHz)

HDMI Cable suitability

A good quality, certified “High Speed HDMI Cable” is required to achieve 2160p support (to 30fps). The challenge is in finding an HDMI cable that is labelled High Speed that *really is* High Speed. There exists in the market a proliferation of mislabelled cables due to the pre-2010 legacy of 1080p being the benchmark, and the baseless misunderstanding that ‘1080p’ and ‘High Speed’ meant the same thing. 1080p produces 4.45Gbps data rate, 2160p is 8.91Gbps, and a genuine High Speed cable should be tested to 10.2Gbps.

Bottom Line

As defined in the current HDMI specification, 2160p (aka 4K or UltraHD) is four times the pixel resolution of 1080p60, but at a maximum of 30 frames per second is only half the frame rate. The result is therefore double the bandwidth. Operation of HDMI devices are simplified with fewer Clocks and a greater subset of formats under each, wherein differences in pixels per second are taken up in the ‘Blanking’ region of the signal. The 297MHz, or 8.91Gbps rate of 2160p is supported by genuine certified High Speed HDMI Cables or extenders with such specified bandwidth.