BrightSign®

# TECHNICAL NOTES

## 4K Video Quality Overview

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# INTRODUCTION

Use this document to learn how color space, bit depth, and video compression relate to 4K video output. This tech note also outlines best practices for encoding 4K video.

# BACKGROUND

## Color Space

Each frame in a digital video, like a digital image, is made up of numerous individual pixels. To encode, store, and transmit these pixels, we represent them as numerical values. For digital video, there are two popular systems for representing a pixel as a numerical value:

- **RGB (Red, Green, Blue)**: The pixel is made up of three distinct color values, which are then combined on the display to create the visual quality of the pixel. The amount of data used to represent each color value is the same.
- **YCbCr (Luma, Blue difference, Red difference)**: The pixel is made up of a luma value, which represents the brightness of the pixel, and two color difference values, which when combined represent the color of the pixel. Unlike the RGB system, the amount of data used to represent the Y (luma) value can be different from the amount used to represent the Cb and Cr (color) values.

The YCbCr system takes advantage of a crucial factor in human vision: We can discern differences in light (luma) much more finely than differences in color (chroma). This means that YCbCr allows us to reduce the amount of data dedicated to representing color, while keeping the amount of data used to represent light the same, thereby reducing the total amount of data needed to display a video. This advantage is key to understanding the purpose of chroma subsampling.

## Chroma Subsampling

YCbCr chroma subsampling ratios such as 4:4:4, 4:2:2, and 4:2:0 represent how much data of a pixel is dedicated to color:

- **4:4:4** – The same amount of data is dedicated to color values as for the light value. In fact, this ratio can refer to either an RGB or YCbCr value because, in this case, there is little difference between the two.
- **4:2:2** – Half of all color information is being preserved compared to the 4:4:4 ratio. As a result, the amount of data required for storing, decoding, and displaying the video is reduced by ⅓.
- **4:2:0** – One quarter of all color information is being preserved compared to the 4:4:4 ratio. As a result, the amount of data required for the video is reduced by ½.

### Bit Depth

Bit depth is the other major factor in determining the size and color quality of a video. The bit depth of a video determines how many bits can be used to describe the RGB or YCbCr quality of each pixel. For example, an 8-bit video depth means that each Y, Cb, and Cr value for a pixel can have one of 256 values, while a 10-bit video depth expands the possible values to 1024 (the same rules apply for an RGB video).

It is important to note that reducing the bit depth and adding chroma subsampling both reduce the data rate of the video, negatively affecting video quality. These losses in quality occur on top of any losses that result from the compression of the video codecs themselves.

## APPLICATION

Video codecs support different combinations of bit depth and chroma subsampling. Furthermore, HDMI standards support their own sets of bit depth and chroma subsampling. To ensure optimum video quality, you will need to consider the capabilities of both the video codec and the HDMI output.

### Encoding

The HD (H.264), 4K (H.265), and JPEG standards define what chroma subsampling and bit depth can be used when encoding media. BrightSign 4Kx42 players support the following values:

- **H.264**: 4:2:0 subsampling with 8 bits of depth (Main Profile and High Profile)
- **H.265**: 4:2:0 subsampling with 8 bits (Main Profile) or 10 bits (Main 10 Profile) of depth

**Note**: *Main 10 is the maximum video quality offered by the H.265 version 1 codec.*

- **JPEG**: 4:4:4 subsampling with 8 bits of depth

## HDMI Output

Once the video is decoded by the player, it is then output to the display over HDMI. At this point, a second set of subsampling and bit-depth values are chosen to best match the capabilities of the screen that is connected to the BrightSign player.

BrightSign 4Kx42 players can output the following values over HDMI:

| Resolution | 8 Bit | 10 Bit | 12 Bit |
|---|---|---|---|
| 4Kp24<br>4Kp25<br>4Kp30 | 4:4:4 (RGB)* | 4:4:4 (RGB) | 4:4:4 (RGB) |
| 4Kp50<br>4Kp60 | 4:4:4 (RGB)<br>4:2:0 | 4:2:0 | 4:2:2<br>4:2:0 |

*This is the only 4K video profile supported over HDMI 1.4 by 4Kx42 players.

## Best Practices for Encoding

The following are video encoding guidelines for achieving the best 4K video quality allowed by your display:

**HDMI 1.4**

- Frame rate: 30p
- Color space: 4:2:0
- Color depth: 8 bit (Main Profile)

**HDMI 2.0, 8-bit color**

- Frame rate: 60p
- Color space: 4:2:0
- Color depth: 8 bit (Main Profile)

**HDMI 2.0, 10-bit color**

- Frame rate: 60p
- Color space: 4:2:0
- Color depth: 10 bit (Main 10 Profile)

**HDMI 2.0, 12-bit color**

- Frame rate: 60p
- Color space: 4:2:0
- Color depth: 10 bit (Main 10 Profile)