

4:4:4

What is Chroma Subsampling?



Compression

As displays have gotten more advanced, supporting ever higher resolutions and faster refresh rates, one of the biggest limiting factors in their development has been the available bandwidth of the connections to the devices. After all, what good is a display that has no way to transfer the signal from the source to the device? One of the easiest ways to transfer more data is to compress the image, which allows for more information to be sent through the cable than it could normally support. But is that a good thing? The direct answer is yes.



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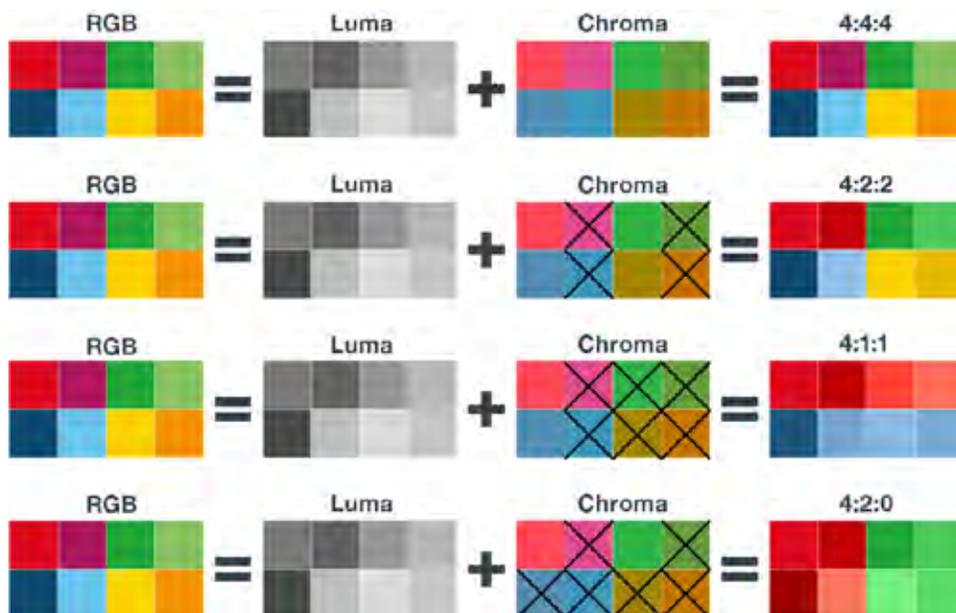
Chroma subsampling involves the reduction of color resolution in video signals in order to save bandwidth. The color component information (chroma) is reduced by sampling chroma at a lower rate than the brightness (luma). Even though the color information is discarded, by nature, human eyes are much more sensitive to variations in brightness than in color.

Continuous tone (real life) images are less impacted by subsampling than manufactured (computer) imagery. That's because natural images have a lower spatial frequency, in other words the images are embodied by large and coarse/uneven features. The uneven or textured features make it difficult to notice the effects of subsampling. Manufactured images have a higher spatial frequency, with sharp edges and fine details, but most humans are unable to notice differences between subsampling rates at typical viewing distances.

4:4:4 VS 4:2:2 VS 4:2:0

The first number (in this case 4), refers to the size of the sample. The two following numbers both refer to chroma. They are both relative to the first number and define the horizontal and vertical sampling respectively. Luma is always sampled at full rate, meaning, every pixel always includes Luma regardless of the type of Chroma sampling used.

A digital video signal using 4:4:4 Chroma Subsampling includes full Luma value and full value for each color (Red, Green and Blue) for every pixel. In a four wide by two tall section of pixels 4:2:2 sampling includes half of the chroma information reducing the overall bandwidth by one third by sampling (providing individual) values for only half of the horizontal pixels in the section and all vertical pixels. Taking subsampling a step further 4:2:0 cuts bandwidth (amount of data) in half by sampling half of the horizontal pixels and ignores the color values in the second row of pixels.



When Does It Matter?

Artifacts from chroma subsampling are visibly noticeable with text atop a flat color. The impact is far less visible in videos and photos. This matters when connecting your computer to a display, as you don't want your text to be blurry to the point of being unreadable. It is important to note that subsampling on a PC requires using the YCbCr/YUV colorspace as RGB colorspace is always 4:4:4.

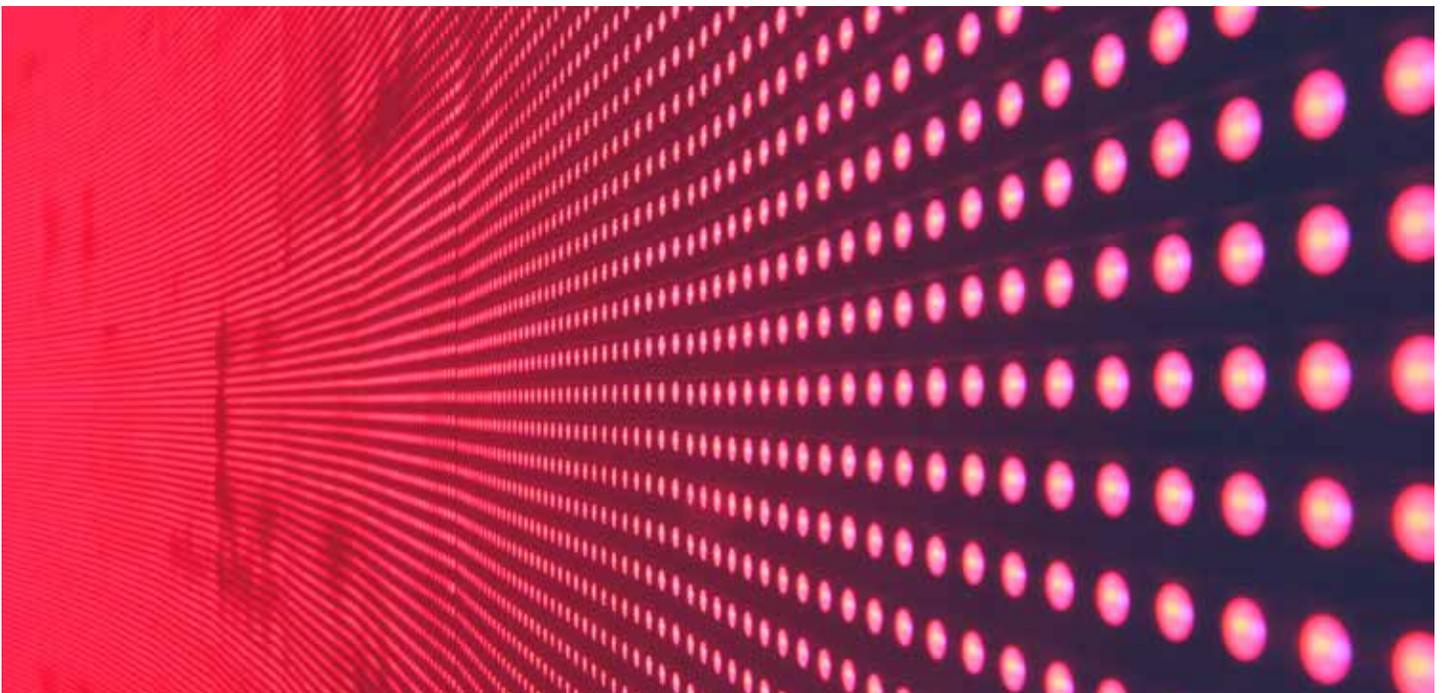
In Video (Phone/Sport Camera)

When it comes to video on a phone or a sport camera, 4:2:0 subsampling has been an industry standard for a long time now, and it isn't without reason. The benefits of having full color in video are debatable, especially at 4k. It would be tough to recognize the difference between a full 4:4:4 sequence and the same content in 4:2:0.

4:2:0 is almost lossless visually, which is why it can be found used in Blu-ray discs and a lot of modern video cameras. Remember, the higher the resolution and pixel density of future displays, the less apparent subsampling artifacts become.

In Video Games

While some PC games that have a strong focus on text might suffer from using chroma subsampling, most of them are either designed with it in mind or implement it within the game engine. Chroma subsampling significantly reduces disk space to help make video games more distributable online.



In Data Driven Content

In data driven content, like CAD drawings and highly detailed content, adaptive luma subsampling improves image quality both quantitatively and qualitatively when compared with the sole use of uniform chroma subsampling. This is one reason why RGB 4:4:4 is desired, to showcase correct pixel content.

How To Test For Chroma Subsampling

Testing for chroma subsampling is very easy. Just open up a test pattern (jpg option found here: <http://www.dexonusa.com/wp-content/uploads/2019/12/dexon-usa-resolution-test-pattern-scaled.jpg>), then observe it and check if any of the lines and text are blurred together.

If the text does not blend together and shows artifacting, then the TV and mode you are using does not use chroma compression and is showing chroma 4:4:4.

It's also important to make sure that Windows scaling is set to 100%. With larger, high-resolution displays, it is common for Windows to scale UI elements at 150% or more, and this can cause false positives when testing for Chroma Subsampling.

How to get the best results

Most displays today allow you to enable chroma 4:4:4. Different brands place these settings in different areas of their menus. It is wise to refer to the manufacturer's manual to find the correct setting.

About DEXON Systems

DEXON Systems Ltd. is the developer and manufacturer of advanced videowall controllers for multi-screen video display products. The company has grown to be a leading videowall technology and solution supplier since its establishment in 1990. DEXON Systems works in close cooperation with system integrator partners having thousands of 24/7 operating mission critical control rooms all over the world.

DEXON USA is the North American partner providing sales, support, system design and training for DEXON Systems' projects. DEXON USA brings to the table deep technical experience in video processors, matrix routers and AV control systems along with extensive applications development and design resources.

Check out dexonusa.com for more industry relevant resources.