

H.265 10-BIT · 4:2:2 · 4:4:4

Quality matters.

We encoded the same four scenes three ways, at exactly the same bitrate: once as H.264 with 8-bit color and 4:2:0 chroma, the way most browser streams work today, and twice the way dfine.io Review streams, as H.265 with 10-bit color and 4:2:2 or 4:4:4 chroma. Then we measured what came out.

5.7×

less error in smooth gradients
10-bit 4:2:2 vs 8-bit 4:2:0

24×

less error on colored type and graphics
10-bit 4:4:4 vs 8-bit 4:2:0

2.5×

less error in saturated neon light
10-bit 4:4:4 vs 8-bit 4:2:0

1.9×

less error on skin and fabric
10-bit 4:2:2 vs 8-bit 4:2:0

01 IN PLAIN WORDS

Two numbers decide how true your picture arrives.

Bit depth sets how finely brightness and color are graded. Chroma sampling sets how many pixels carry their own color. Both decide how much of your grade survives the stream.

BIT DEPTH

1,024 steps instead of 256

8-BIT · ILLUSTRATED



10-BIT



Each color channel gets four times as many steps. Skies, studio walls, vignettes and graded shadows stay smooth instead of breaking into bands.

The upper ramp is drawn coarser than real 8-bit so the effect shows in print.

CHROMA

Color for more pixels

4:2:0



2 COLORS / 8 PX

4:2:2



4 COLORS / 8 PX

4:4:4



8 COLORS / 8 PX

4:2:0 stores one color for every four pixels, 4:2:2 one for every pair, 4:4:4 one for every pixel. Thin colored type, logos, neon and fabric keep their edges.

BANDWIDTH

The same 4 Mbit/s for all three

H.264 · 8-BIT · 4:2:0

4 Mbit/s

H.265 · 10-BIT · 4:2:2

4 Mbit/s

H.265 · 10-BIT · 4:4:4

4 Mbit/s

Every version in this test uses exactly the same bitrate. The gain comes from the format and from H.265, which packs more picture into every bit.

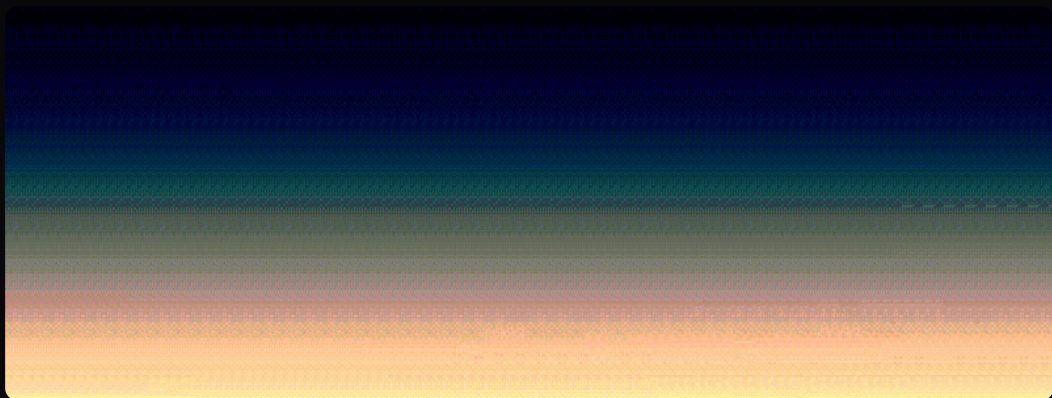


02 TEST 1 · GRADIENTS

A dusk sky, the classic stress test for 8-bit.

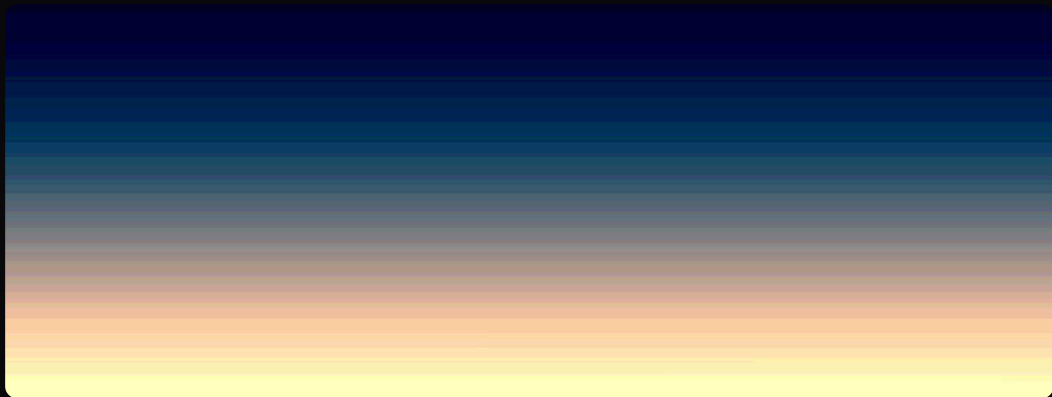
8-bit 4:2:0

H.264 · USUAL
STREAM



10-bit 4:2:2

REVIEW DEFAULT



A smooth 16-bit sky, streamed at 4 Mbit/s. Crops from frame 90 with the contrast boosted about twelve times, the same for both, so the steps show on paper and on any screen.

5.7×

less error with 10-bit 4:2:2. The bands of the 8-bit stream disappear.

PSNR DB	8-BIT 4:2:0	10-BIT 4:2:2
Brightness	55.7	73.9
Color Cb	58.8	71.6
Color Cr	59.3	73.2
Average	57.6	72.8

Higher is better. 6 dB halves the error.

And 4:4:4? It adds color detail, not smoother gradients. See page 4.

03 TEST 2 · COLORED TYPE, GRAPHICS AND NEON

Red on blue: where 4:2:0 runs out of color.

Supers, titles, logos and keys live on fine colored edges. Enlarged 600 %, without smoothing.

Original
16-BIT MASTER

8-bit 4:2:0
H.264 · USUAL
STREAM

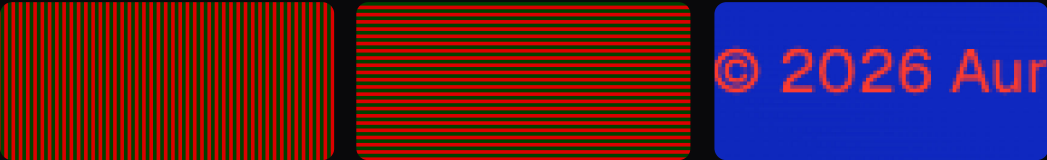
10-bit 4:2:2
REVIEW DEFAULT

10-bit 4:4:4
REVIEW · OPTIONAL

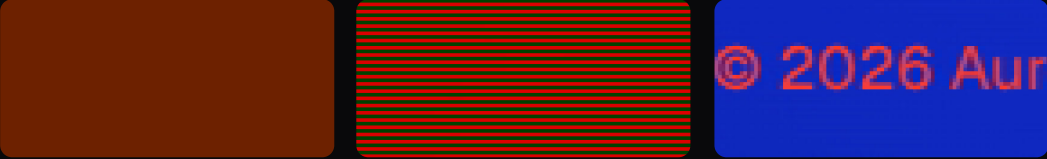
FINE VERTICAL COLOR

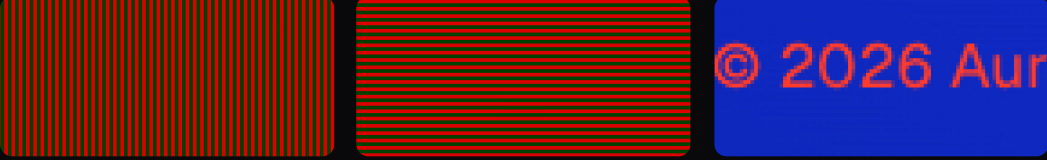
FINE HORIZONTAL COLOR

SMALL COLORED TYPE









Red and green stripes of equal brightness, one pixel each, and a 17 px legal line, enlarged 600 % without smoothing. Where a stream thins out color, the stripes turn flat brown and the red type goes dull.

24x

less error on colored type and graphics with 4:4:4. Supers, titles, logos and keys stay sharp in color, in Chrome and over SDI (page 5).

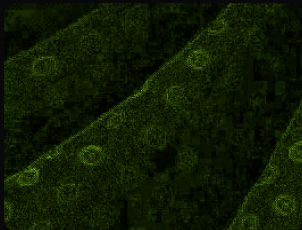
PSNR DB	4:2:0 8	4:2:2 10	4:4:4 10
GRAPHICS CHART			
Color Cb	35.3	39.9	58.3
Color Cr	27.6	30.8	58.3
Average	31.7	35.1	59.3
NEON ALLEY			
Color Cr	39.1	41.8	49.3
Average	42.8	45.5	50.6

Red sits mostly in the Cr channel, which is why 4:2:0 loses it first.

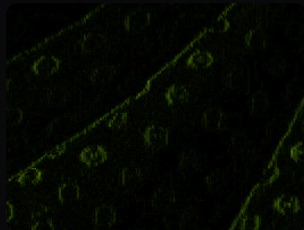
04 TEST 3 · SKIN AND FABRIC · THROUGH THE REAL PATH

Skin, silk, and what actually reaches the viewer.

The grade your client signs off, and a check of the whole chain from Studio to the browser.



Error map 8-BIT 4:2:0



Error map 10-BIT 4:2:2



Error map 10-BIT 4:4:4

PORTRAIT · PSNR DB	4:2:0 8	4:2:2 10	4:4:4 10
Brightness	52.5	59.5	59.9
Average	52.7	58.5	58.5

1.9× less error on skin and silk, here on a silk scarf at 400 %. The error maps show the difference to the master, amplified 24×: the brighter, the more the stream lost.

How we tested

- Four 1080p scenes, 6 s at 30 fps, a slow pan across a 16-bit master: a synthetic gradient, a graphics chart and two scenes generated as 4K stills.
- Reference encoders x264 and x265, preset slow, constant 4 Mbit/s, a keyframe every 2 s. PSNR per channel against the master over all 180 frames, measured at the decoder output. On the gradient, 4:4:4 averages 70.7 dB.
- dfine.io Studio encodes on the Mac's own hardware in real time, so its numbers differ from the reference encoders.

Through the real path

From dfine.io Studio 1.2 through the dfine.io cloud infrastructure into the Review app, checked with a test chart of 1 px red and green stripes and a grey ramp of 128 ten-bit steps.

- The stream leaves Studio as H.265 4:2:2 10-bit, or 4:4:4 10-bit with one box. With the box, the receiver gets all 128 ramp steps and every 1 px color column.
- The dfine.io cloud infrastructure passes the 10-bit stream on unchanged.
- Chrome receives every 4:4:4 color column. Firefox shows no H.265 picture.
- In the live meeting, Chrome always shows the picture in 8 bit, also with HDR content visible, and keeps every 4:4:4 color column. Chrome reaches 10 bit only for file playback, and only while HDR content is visible.
- Safari on Mac, iPhone and iPad shows the default 4:2:2 stream in correct color. With the optional 4:4:4 stream it can show false colors in very fine color patterns; normal footage looks right. On screen it shows 8 bit, a little more while HDR content is visible.
- 4:4:4 is meant for playout:** over SDI every color column arrives (07). In the browser only Chrome keeps them, in 8 bit.
- Over SDI to your reference monitor, true 10 bit:** Studio plays the stream out with 107 of the 108 ten-bit steps in the measured part of the test ramp, against 28 for an 8-bit control. With 4:4:4 at both ends, the sender's box and Playout's box, the output is RGB 4:4:4 10-bit and every 1 px color stripe arrives. Measured on an UltraStudio HD Mini at 1080p25; card and monitor must support RGB 4:4:4 over SDI.
- Studio sends 10-bit H.265 on Macs whose hardware encodes HEVC 4:2:2 10-bit, and H.264 8-bit otherwise. Streaming Classic stays on H.264 8-bit.

Method: the chart as source, the bitstream read at the receiver, a half-float window capture and an SDI loopback that count the ramp's steps, each checked against a 10-bit and an 8-bit control.



Quality matters.

Stream your timeline into a review room: review the grade live in the browser, and send true 10 bit to your reference monitor.

dfine.io →

[Book a 15-minute quality demo · stefan.king@dfine.io](mailto:stefan.king@dfine.io)

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