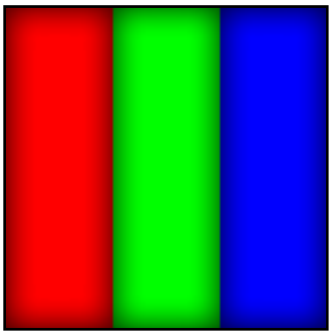
Understanding the HP DreamColor LP2480zx Display's 30-bit Panel

HP DreamColor

What is the bit precision of a display



All LCD monitors operate by presenting just three primary colors to the eye: red, green, and blue. Each pixel on the display is implemented as three sub-pixels, one for each primary color (see the illustration on the left). The color of the pixel is controlled by liquid crystal cells (of which there is one per sub-pixel) which modulate the amount of light which passes through the sub-pixel to the user's eye. For example, if the pixel is red, the red sub-pixel passes maximum light, while the green and blue sub-pixels pass no light. If the pixel is mid-gray, all three sub-pixels pass an equal, medium amount of light.

The bit-precision of the display determines how many steps of brightness are possible. A display which supports 6 bits per sub-pixel will provide 64 (2^6) steps from darkest to brightest; a display which supports 8 bits will provide 256 (2^8) steps. The HP DreamColor LP2480zx display supports 10 bits per sub-pixel, giving 1024 (2^{10}) steps. The bit-precision is a result of the design of the electronics which control the liquid crystal cells in the panel.

Since there are three sub-pixels, the maximum number of colors that a pixel can present is

$2^n \times 2^n \times 2^n$

where n is the bit-precision of a sub-pixel. Therefore, an 8-bit design gives

$2^8 \times 2^8 \times 2^8 = 16.7$ million colors

The HP DreamColor LP2480zx display, with its 10-bit design, gives a palette of

$2^{10} \times 2^{10} \times 2^{10} = 1.07$ billion colors

By the way, while many people talk about "an 8-bit panel" or "a 10-bit panel", it's also common to refer to the total number of bits needed to define a red-green-blue pixel. Therefore, it's valid (and preferred) to refer to the HP DreamColor LP2480zx display's panel as "a 30-bit panel." 30 is 10 + 10 + 10, which takes account of the 10 bits for each sub-pixel.

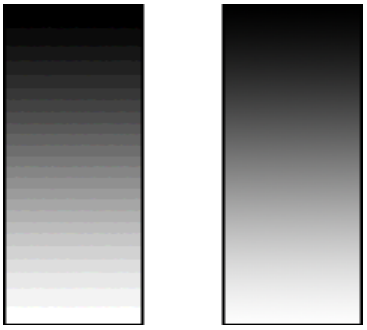
Many consumer displays have low-cost 18-bit panels. Most professional displays (such as the HP LP2465 or Apple's Cinema HD 23" display) have 24-bit panels. The HP DreamColor LP2480zx display is one of a small number of high-end displays with a true 30-bit panel. The higher the bit-precision of a display, the better able it is to represent colors accurately.

The Benefits of 30-bit

It might seem that a 24-bit panel, which offers 16.7 million colors, would be sufficient. For most purposes, that's true. However, there are cases where 8-bits per sub-pixel is not enough. Consider a grayscale image. Gray (including white and black) is produced when the three sub-pixels (red, green, and blue) are equally bright. This means that the values for the three sub-pixels are the same: 35/35/35, for example. With 8-bits per sub-pixel, gray can go from 0/0/0 (black) to 255/255/255 (white). Therefore, there are only 256 levels of gray possible. This can lead to "banding,' which is an effect that arises because the step between adjacent levels of gray is big enough for the eye to detect. It can be a problem in certain kinds of visualization, such as 3D

rendering for automotive styling. With a 30-bit panel, there are 1024 levels of gray, and it's almost impossible for the eye to detect the step between adjacent levels.

Also, there are cases where images can have greater bit-precision than 24 bits, especially where subtle detail is important. Examples are: satellite imagery for intelligence agencies, or medical imagery for, say, mammography.



Gray banding (left, exaggerated) is eliminated by the 30-bit panel (right)

30-bit World

The HP DreamColor LP2480zx display's 30-bit panel can display 30-bit content accurately, without losing precision. However, to achieve this you must have a complete 30-bit chain, with all components able to handle
30-bit pixels:

application → operating system → graphics driver →graphics card → DisplayPort cable → LP2480zx display

At the time of writing this paper (July 2008), few commercial applications are able to display 30-bit images, and 30-bit-capable graphics cards are in the prototype stage. The DisplayPort connection is already 30-bit capable. Over time, applications, cards, and drivers will reach the market and provide a full 30-bit path from application to display.

24-bit world

For most users, color will remain at 24-bit precision. For example, if your graphics card doesn't have a DisplayPort output, then DVI will probably be in use. DVI is limited to 24 bits.

The good news is that the HP DreamColor LP2480zx display's 30-bit panel delivers a benefit even when displaying 24-bit pixels. The internal electronic system in the display, known as the HP DreamColor Engine, adjusts pixel colors and luminances to map them accurately to the user's selected standard color space (sRGB, Adobe RGB, etc). This engine operates at very high (36-bit) precision, and the results are displayed at 30-bit precision on the panel. This means that the 30-bit panel improves the ability of the display to show exactly the correct color for every pixel. A 24-bit panel would introduce larger deviations from accuracy, which can give rise to banding and other undesirable effects.

For Further Information

http://en.wikipedia.org./wiki/Color_depth

For more information

http://www.hp.com/go/displays
HP displays

http://h30267.www3.hp.com/country/us/en/dreamcolor
HP DreamColor Technologies

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