Television

Setting standards & what they mean

Choosing a TV is easy if you realise that the best TV in terms of picture is the one most faithful to the intended presentation of content

The TV market is a bewildering place: every year we're bombarded by a fresh spate of marketing buzz words and hyperbole. Hopefully this article will make the process of choosing a TV a little easier by helping you see past the marketing, and understanding a simple fact — the best TV in terms of picture is the one that is most faithful to the intended presentation of the content.

We all need standards.

A fair question would be, how would we know? The answer is simple: there are standards in place. Displays used by professionals during the production process all tightly adhere to these standards. What one person sees in one studio matches another across the globe.

When we talk of display calibration, this is the goal — to match our displays to the ones used by content creators, so we can view their work in our homes as they intended for us to view them. The standard that defines image reproduction for HDTV is BT.709, also known as Rec. 709.

The standards for TV haven't really changed much over the decades. The panel technology has progressed, but the underlying picture characteristics have remained essentially the same.

The meaningful changes HD made over the previous SD standard (BT.601) were the new 720i/p and 1080i/p resolutions, and refresh rate support for 24 fps content. The unambitious nature of the standard is not surprising, given HDTV was originally developed with CRT displays in mind.

The Greyscale

The foundation of our image is the greyscale. TV images are in fact black and white with a lower-resolution colour overlay — all the detail comes from the underlying black and white image.

The 8-bit colour system we currently use limits our video system to a colour depth of 256 possible shades — black is defined as level 16 and peak white as level 235. On a correctly adjusted display, nothing should be visible below level 16 in order to make the most of our display's black depth.

A deep black level is important: the darker the shadow detail, the more relief can be brought to images and the richer colours can be rendered (as it's the greyscale backing the colour overlay that gives it its shade).

Black level should also not be set any higher than 16 or shadow detail will be lost. All the levels from 16 to 235 must be visible, though it's not an issue if your TV displays levels above 235 — it's the clipping of white detail below 235 that you want to avoid.

You can confirm your black level through the THX Optimiser found on a number of BDs and DVDs, or by searching for the free calibration disc AVS-HD 709 online. The Brightness setting adjusts the level of black and Contrast/Picture the level of white on your display.

Depending on your display type, Contrast/Picture or the Backlight settings are responsible for setting your display's peak light output. It should be set as bright as your viewing environment comfortably allows.

On displays where Contrast/Picture are used to adjust light output, one should look at a greyscale pattern while adjusting. If the white portion of the greyscale begins to discolour, back down until it returns to a neutral tone.

Now, with the dynamic range defined, it's the accuracy of the greyscale that needs to be looked at. The correct colour temperature of a TV's light output is 6500K (more accurately D65 on the CIE chart). This gives the

display a neutral base from which to generate its images.

Lower the temperature, and the greyscale will take on a reddish/yellow appearance. Raise the temperature and it takes on a colder, blue tint. If the colour temperature is not correct, it is not possible for the TV to display accurate colour — everything will be tinted by the underlying greyscale.

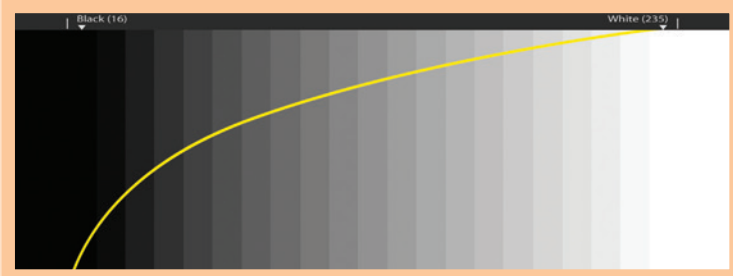
The greyscale also needs to be uniformly within tolerance of D65, because if the colour temperature deviates to too high a degree at different steps along the greyscale, we pick up on the levels that are off-colour in gradient areas like skin, smoke or sky.

The last area of greyscale performance is what's commonly referred to as gamma, though the correct term is electro-optical transfer function or EOTF. Gamma often gets confused with the Brightness adjustment, because it can seem to have a similar effect, but really they're quite different.

Brightness and Contrast set the level limits of our display's greyscale, while gamma works within those limits to adjust the slope at which light (optical) rises through the levels (electro) of the greyscale.

The gamma standard for flat panel displays is BT.1886, and since the HDTV standards we use today are based on CRT technology, its purpose is to emulate the natural gamma curve of a CRT.

While it depends somewhat on your TV's black level, typically it rises sharply out of the early black portion of the greyscale, then enters a gentle slope towards white. This makes for a larger difference between the brightness of individual levels at the very low end of the greyscale in order for us to distinguish detail better in the dark portion of the picture.



Colour Reproduction

Our eyes contain two kinds of photoreceptors, rods and cones — rods pick up black and white information, while cones detect colour. Since we have more rods than cones, we are more sensitive to luminance (black and white) than we are to chrominance (colour) information, which is why colour information is encoded at a lower resolution (no sense in wasting bandwidth).

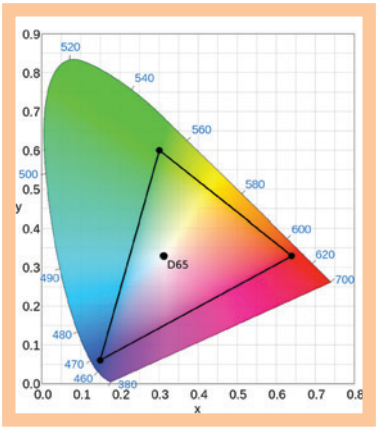
Cones are sensitive to three wavelengths of light, corresponding to red, green and blue. Looking at the difference between the signals received across the cones is what allows us to see a continuous range of colour — this is the same way TV colour operates.

Colour consists of three components:

Brightness: the black and white picture information.

Hue: the dominant wavelength, that is to say the tint of the colour.

Saturation: the degree of purity at which we find each colour, from exclusively red, green or blue (maximum saturation) to an even distribution of all three colours (minimum saturation / white)



This is the CIE diagram. It's a representation of all the colours the human eye can perceive. The CIE diagram goes from low saturation at its centre (white) to high saturation along the edge. It concerns itself only with the colour components Hue and Saturation. The triangle you see placed within the chart is the border of our HDTV's colour gamut (range). The three co-ordinates that make up the triangle are our TV's three colours — red, green and blue (RGB) — at maximum saturation (minimum saturation at the triangle's D65 centre).

Once red, green and blue have been set to their correct co-ordinates at maximum saturation, the rest of our colours should fall into place on a correctly operating HDTV. The hue is derived by the relative adjustment of two adjacent colours, the resulting hue being any point between them along the triangle's edge.

The saturation is adjusted by the combination of all three: the more even the mix, the lower the saturation. If R,G and B are set to any other colour co-ordinates at maximum saturation outside of tolerance of what BT.709 specifies, all resulting colours will be wrong — wide/expanded gamut HDTV options are great for marketers, but not for picture accuracy.

Jason Roos