BEHIND The Numbers

How to read our lab tests for TV sets

by Al Griffin

Compared with the "in the lab" box for one of our test reports on, say, an A/V receiver, the lab data for a TV review may seem skimpy. While there aren't a lot of numbers, the ones we do generate can give you a pretty good idea of what to expect from the set - particularly its color reproduction, which is arguably the most important aspect of a TV's performance.

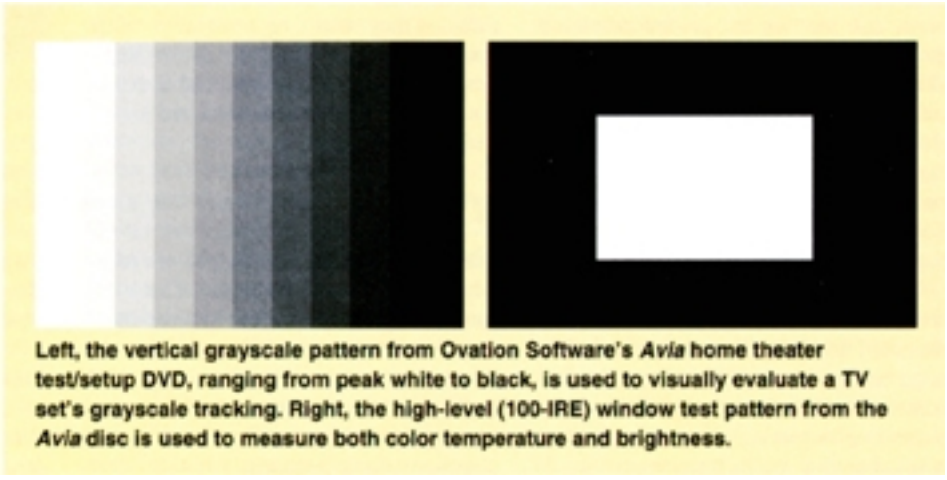
Why is accurate color reproduction important? First, you have to understand that all the colors we see (not just onscreen!) are combinations of the red, green, and blue primary colors (see "The CIE Chromaticity Diagram" on the facing page). That includes black and white - white is an equal mix of the three primaries, and all shades of gray are simply white at different values of brightness. What all this means is that the images you see on TV, just like those in real life, consist of the primary colors in different combinations, brightness values, and intensities. If the combinations aren't accurate, the images won't look natural.

For a video display to reproduce colors accurately, you need to calibrate it to accurately reproduce white. Ideally, you want your TV's picture to look the same as those on the professional monitors used in postproduction facilities where films get transferred to video. Pro monitors are calibrated to display grayscale values - the luminance range from black to peak white (see test pattern at lower left) - as close as possible to the NTSC standard for white, which is based on the color of sunlight on a summer day in the northern hemisphere. Exact definition of that standard gets fairly complicated (again, see the chromaticity diagram), but for all practical video purposes it is equivalent to a "color temperature" of 6,500 K, or kelvins.

Unfortunately, the grayscale on most TVs is factory set for a color temperature well above 6,500 K usually somewhere in the range of 8,000 to 10,000 K, which lends images an unnaturally bluish cast. When the "color" of white on a video display is wrong, it means the primary colors that make it up are being distorted, so all of the resulting images will not only look unnatural or exaggerated but also very different from those approved by a movie's director during the video transfer session.

Color Temperature

Color-temperature readings are usually taken with a TV's Low or Warm preset selected, since that's often the one that measures closest to 6,500 K. Using a Photo Research PR-650 spectroradiometer, we take readings from both high- and low-level window test patterns in the "Grayscale and Levels" section of Ovation Software's *Avia Guide to Home Theater* test DVD (see below, and also see "House Calls," page 82). The IRE scale (named for the Institute of Radio Engineers) is used to specify the light intensity of a TV picture, from black at 7.5 IRE to peak white at 100 IRE. In



Left, the vertical grayscale pattern from Ovation Software's *Avia* home theater test/setup DVD, ranging from peak white to black, is used to visually evaluate a TV set's grayscale tracking. Right, the high-level (100-IRE) window test pattern from the *Avia* disc is used to measure both color temperature and brightness.

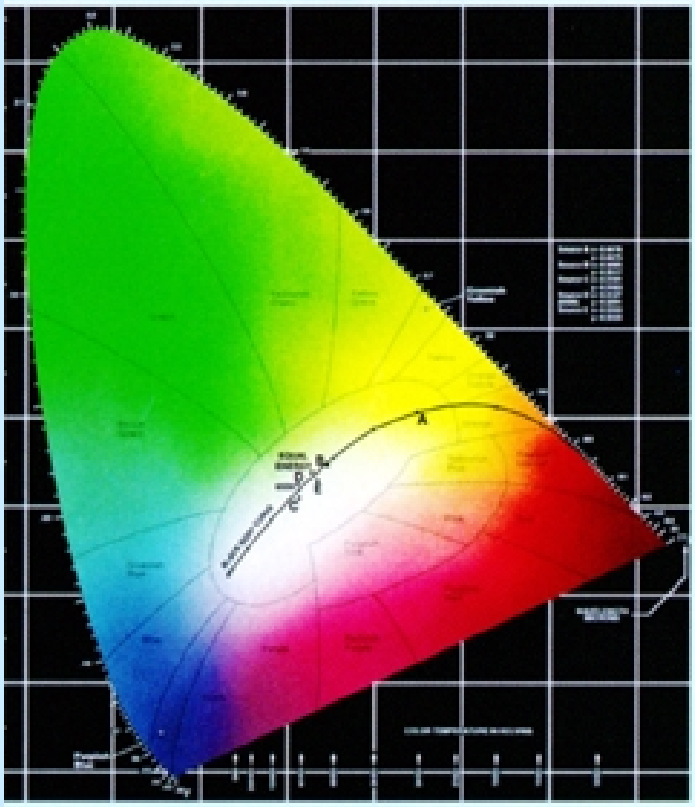
The CIE Chromaticity Diagram

All the colors we see are a mix of the primary colors of red, green, and blue, which form the vertices of the standard triangular "chromaticity" diagram reproduced here. The Commission International De l'Eclairage (illumination), or CIE, created this representation of "color space" in 1931, and it is now used in all industries involved with color imaging, from video to photography and printing. Point D, slightly to the left of center, is the NTSC standard white, which is exactly defined by its coordinates in the diagram: x = 0.3127, y = 0.3290.

The curved black line cutting through the center represents the color of light emitted by a "black body" heated to various temperatures (think of an iron rod heated by a blacksmith), as measured on the "absolute" Kelvin scale, where 0 K = a total absence of heat. If white on a video display falls to the right of D in the diagram, it has a lower color temperature, which yields a reddish grayscale, while a white that falls to the left of D has a higher color temperature, which gives a bluish bias to images on that display.

While Point D itself doesn't actually fall on the black-body curve, it's close enough to the 6,500-K point on the curve for this color temperature to be used as a loose definition of the standard, which is sometimes referred to as D6500 for that reason.

- A.G.



general, a 20-IRE pattern is used for the low-window measurement and a 100-IRE pattern for the high-window measurement, although the exact patterns used will vary with the type of set being tested. For example, an 80-IRE pattern is used for high window measurements on rear-projection TVs, while a 30-IRE pattern may be required for the low-window measurement on a set with weak light output.

"Before calibration" readings indicate the set's color temperature after its user-accessible picture controls (brightness, contrast, color, tint, and sharpness) have been optimally adjusted. Since the numbers obtained at this point rarely come close to 6,500 K, we usually have to make additional adjustments in the set's service menu using manufacturer-supplied service codes. These adjustments are based on readings by the radiometer, which provides both x and y values on the CIE chromaticity diagram and correlated color-temperature readings in kelvins.

The "after calibration" readings indicate the set's color temperature after service menu adjustments have been performed. In most cases, the high- and low-window numbers will now be within ±100 K of the NTSC standard. For a really accurate calibration, however, the set must yield similar readings at other points of the grayscale, from 20 to 100 IRE. Although we take a full set of measurements at 10-IRE increments as part of our test procedure, we only print the high- and low-window numbers, but the others also figure in the overall assessment of the set's "grayscale tracking" given in the notes part of the lab box.

Brightness

Brightness readings, taken from the high level window pattern from the Avia DVD, are given in footlamberts (ftL), a unit representing the amount of light emitted by a source in an area of 1 square foot. TV manufacturers tend to set brightness and contrast levels extremely high at the factory, so a set's "before calibration" brightness measurement will often be higher than its "after calibration" measurement.

A properly calibrated direct-view TV in a dimly lit environment should deliver about 30 ftL of brightness. Acceptable levels for projection TVs may be even lower - around 20 to 30 ftL for a rear-projection model and 10 to 15 ftL for a front projector. To put those numbers in perspective, the THX Theater Alignment Program (TAP) guidelines for certifying movie theaters call for 16 ftL ±2 ftL measured at center screen. Most theaters fail to meet the TAP spec, however, measuring only 8 to 9 ftL on average.

S&V

in the lab

Color Temperature
(Low setting before/after calibration)
low window ..... 9,526/6,529 K
high window ..... 8,180/6,438 K
["after" figures should be as close as possible to 6,500 K]

Brightness
(before/after calibration) ..... 47.2/31.9 ftL
["after" figure should be near 30 ftL for a direct-view TV, around 20 to 30 ftL for a rear-projection TV, and 10 to 15 ftL for a front projector]

The notes section is where the reviewer puts the figures above in context and comments on other aspects of measurable performance, such as grayscale tracking, resolution with DVD test patterns, ability to hold black, color decoding errors, picture geometry, focus, screen convergence, overscan, and comb filtering (relevant only with a composite-video connection).