DISPLAY MEASUREMENT AND CONTROL
CALIBRATION OF PROFESSIONAL DISPLAY

Why Is Display Calibration Necessary?

Calibration of professional display is an essential component of all broadcast, production, post production and content creation workflows. It enables artists, producers and directors to work with their professional monitors or digital projectors matched to a reference standard (e.g., broadcast monitor) so that the color reproduction of images from monitors/projectors in the facility can be consistent.

Regarding display calibration, there are two objectives involved: (1) white point or generally known as color temperature and (2) gamma or luminance target. For calibration accuracy and consistency, a colorimeter or spectroradiometer is essential.

The followings are the common reasons for performing display calibration.

- Establish the display's 'white point' and luminance level for different application.
- Color change due to display aging.
- Change in ambient lighting conditions.
- Prepare a display for profiling/characterization.

The White Point

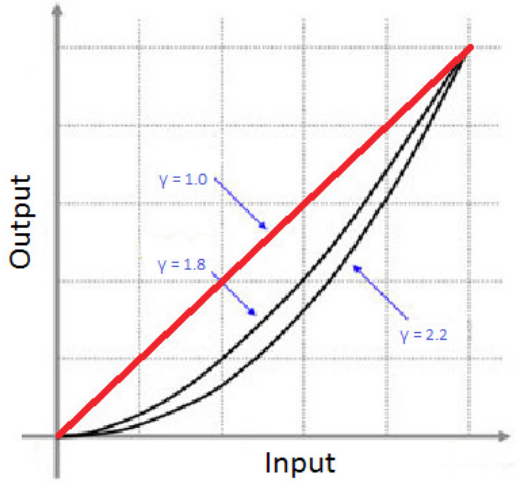
The white point is the calibration setting on a monitor that determines the color temperature of the brightest white. Color temperature is expressed in Kelvin, e.g. 6500K. The white point can also be specified by a set of tristimulus values or chromaticity coordinates (e.g., xy chromaticity coordinates) that serve to define the color "white" in image capture, encoding, or reproduction.

In displays, the light output for red (R), green (G) and blue (B) must be adjusted to reproduce white point correctly. This display white point has to correspond to the industry standard white reference (e.g., 6500K or 9300K on the Kelvin temperature scale). SMPTE 196M defines the white point for a movie theatre as 5400K and Digital Cinema Initiative (DCI) specifies its white point using CIE Chromaticity Coordinates at x=0.314 and y=0.351

Gamma

Gamma is a measure of the gradation from light to dark on a monitor. Most display monitors exhibit a non-linear response function with respect to input voltage. In most cases, this response function follows a power law relationship whose exponent is the Greek letter gamma (γ).

The below diagram shows curves adjusted to the standard Windows gamma value of 2.2 and the standard gamma value for Mac OS of 1.8.



As the color reproduction of a display monitor is generally based on a combination of three primary colors: red (R), green (G), and blue (B), to obtain consistent color reproduction from light to dark shades, individual gamma correction for red, green, and blue channels is needed.

Monitor Grayscale Test Image is useful for evaluating gamma rating. Correct gamma correction will deliver smooth gradients from black to white with no color banding, as shown;

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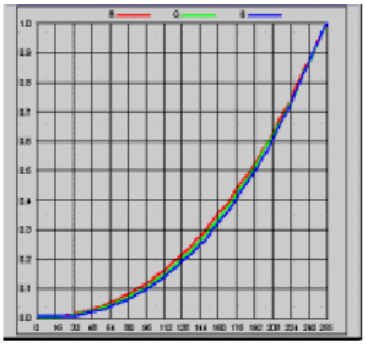
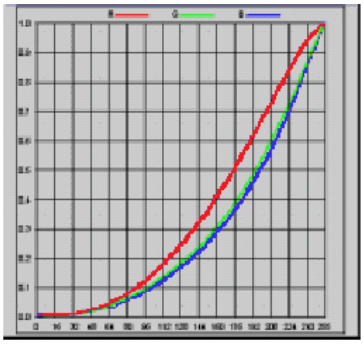
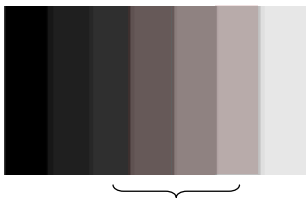


Smooth gradients with no color banding (All RGB channels exhibit similar gamma curve)





Intermediate red tone is strong here (The gamma value for R channel is lower as compared to G & B channel)

Challenges Faced

Due to the vast range of display devices (such as CRT, Plasma display, LCD and the latest digital HD projectors) used in the same facility, ensuring color consistency for all these displays throughout a facility is an uphill task. Using low to mid-range of colorimeter or spectroradiometer as calibration instrument, color variance among different display devices may still appear even though their chromaticity measurement data are similar. This is largely due to the accuracy for calibration of the instrument used.

A colorimeter is a device that uses photo detector with filters whose spectral sensitivity are matched to the CIE tri-stimulus color matching functions. Hence, the accuracy of such devices depends on how closely these filters matched the CIE tri-stimulus color matching functions.

Generally, a spectroradiometer is more accurate than a colorimeter. Spectroradiometer is designed to measure light energy at various wavelength bands across the entire spectrum of visible light. The measurement error associated with filtered colorimeters is avoided in spectroradiometer. On the other hand, as spectroradiometer measures large number of bands, they will tend to introduce higher signal to noise ratio. Hence, the accuracy performance of spectroradiometer largely depends on the sensitivity of the sensors and its spectral bandpass resolution.

To overcome the color variances among different display devices, a high end colorimeter with filters that closely match to CIE tri-stimulus color matching functions or spectroradiometer with adequate sensitivity and low spectral bandpass resolution of 5nm or less is required.

Important Considerations

Important considerations when selecting the calibration are:

- Calibrator designed for CRT monitor are usually not suitable for measurement of LCD monitor due to its wide viewing angle and calibration method.
- High absolute accuracy is particularly important if different display types (e.g., CRT, LCD, PRJ) are used in the facility to achieve color consistency.
- High sensitivity in the dark level is essential for true color reporudction even in low luminance level.
- Professional monitors should be calibrated at least once evey 200 to 300 hours or in ordinary usage, once per month.

Konica Minolta offers a wide range of colorimeters and spectroradiometer for professional display calibration. For more information on display measuring instruments, please visit Konica Minolta website at http://sensing.konicaminolta.asia/applications/display-light-measurement/

You can visit this website at https://wwws.konicaminolta.net/instruments/registration_index/ to download our education handbook, The Language of Light, which explains basic concepts of photometry and colorimetry in an easy approach. This handbook also gives an overview on photometric and colorimetric instrumentations and addresses important considerations on instrument's selection.