# Flanders Scientific Inc.

## Perceptual Matching Using BoxIO and LiveGrade Pro
**1.0**

## The Challenge:

Two monitors of different display technologies calibrated identically may still not perceptually color match as well as a viewer would want or expect. This phenomenon can be exacerbated by lower quality measuring devices, but even when using the best equipment and software available perceptual color differences between display technologies can remain. This is most often attributable to varying spectral power distributions between these devices and the inability of available color matching functions (CMFs) to accurately predict a match for all observers.

## Solutions:

One potential way to improve perceptual color matching between displays is to employ an alternate CMF. The most notable deployment of such an alternate CMF has been the recent wide-scale use of the Judd-Vos Modified CMF to match the white point of top emission RGB OLED to the measured white point of legacy reference CRT displays. For many observers this alternate CMF has provided improved color matching of their top emission RGB OLEDs to other display technologies. However, this approach has not always proved effective for all observers nor does it necessarily work for other display technologies.

Another popular and effective option allowing for better and more personalized display matching for an observer has been to allow that observer to perform a perceptual color match of the white point of any given display to another, measure this customized white point, and then use this customized white point as the modified white point target for a volumetric 3D LUT based calibration. This process is detailed in our "Perceptual Color Matching Using LightSpace CMS" guide. This process has proved effective at offering even better color matching between displays than a generic alternate CMF. However, this weighted white point modification is a somewhat coarse adjustment that primarily targets the overall white balance appearance of a display with little additional fine-tuned control.

A third approach, outlined in this document, allows for even greater observer control over display matching parameters by utilizing a LUT device (e.g. BoxIO) along with Pomfort's LiveGrade Pro. LiveGrade Pro allows users to control multiple parameters of color matching by applying those manipulations in real time as a 3D LUT to the connected LUT device. This process *does not eliminate the need for proper calibration* of displays, rather it is suggested as a supplement to calibration in applications where greater fine tuned control of observer dependent display matching is desired. One of the largest benefits to this method is allowing the observer, often a colorist, to make

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perceptual adjustments using toggles and control surfaces that will appear very familiar to them.

**The Process:**

A diagram showing the typical hardware connectivity between source, BoxIO, and monitors is shown below. The basic concept is to connect the source playing the perceptual match test image to BoxIO's input. This is typically your color grading or editing system. Then connect the clean loop through of BoxIO (unmanipulated image) to the monitor that will serve as the reference display. Lastly, connect the processed output to the monitor that will be perceptually adjusted.

# Perceptual Matching Diagram
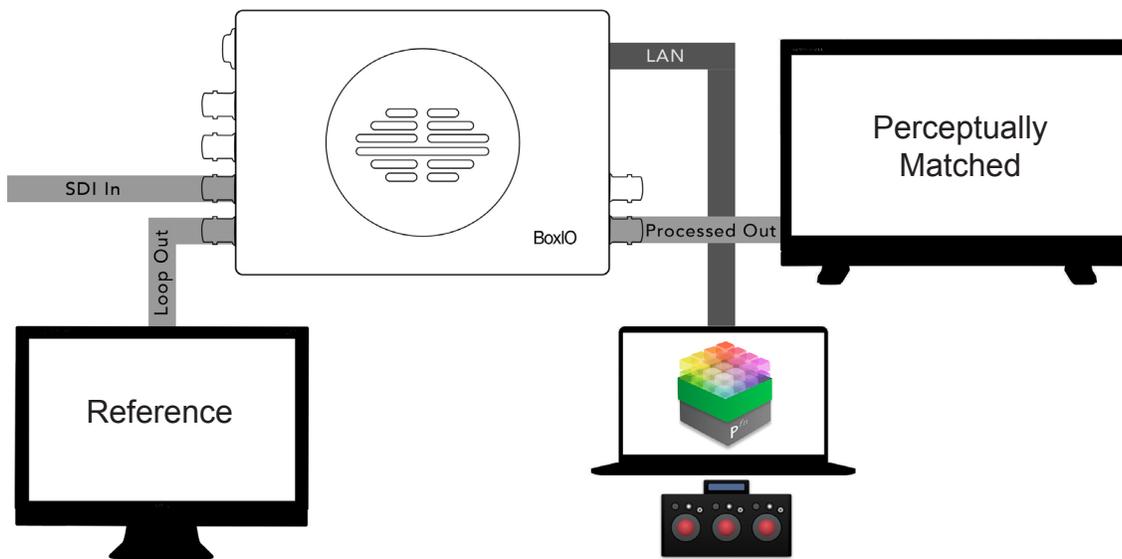


A reference test chart should be used for the matching process. FSI's Perceptual Matching Chart is one possible reference image, but operators may elect to use a different test image.

Next the operator will connect LiveGrade Pro to BoxIO. LiveGrade Pro controls BoxIO via an ethernet connection. LiveGrade may be run from the same computer playing the test source or from a completely separate computer, whatever the operator prefers. While connected the operator can manipulate the image using the controls available within LiveGrade. LiveGrade Pro is compatible with many popular control surfaces allowing colorists to use familiar equipment to make adjustments.

The LUT on BoxIO updates in real time as adjustments are made allowing for smooth and seamless adjustments without delay.

Once complete the user should permanently store the LUT on BoxIO from within LiveGrade by selecting Library -> Permanently Store Look on Device -> and then selecting an available memory slot on BoxIO.

For more information on BoxIO usage with LiveGrade Pro please see the LiveGrade Pro user manual.

## Limitations:

The perceptual matching process is best suited to environments where two displays with different spectral power distributions must be used in the same environment. In applications where a single display will be used we strongly suggest calibrating to a known standard with no modification or alternate CMF.

When matching displays using the process outlined here it is important to keep in mind that compatible adjustments are limited to those that can be accurately represented by a 3D LUT. Additionally, aggressive changes can induce image artifacts so adjustments should be reviewed to make sure no unwanted artifacts appear. The FSI Perceptual Match Chart, if used, should reveal potential artifacts fairly clearly. Additionally, BoxIO can operate in trilinear or tetrahedral LUT interpolation modes. Tetrahedral is strongly suggested for this application to improve visual performance.

Adjustments made via LiveGrade Pro can greatly minimize the perceptual gap between two different display technologies. However, some differences may be impossible to properly mimic. For example, contrast can always be reduced on a higher contrast display, but a lower contrast display may not be perfectly matchable to a higher contrast display. Similarly, large color gamut differences are difficult to account for and these are best handled by ensuring the two displays can achieve approximately the

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same color gamut and are calibrated as such to start.

**Notes:**

If using BoxIO for both a calibration LUT and perceptual matching LUT the calibration LUT should be used in the second position with the perceptual matching LUT in front of it using BoxIO's LUT stacking capability.