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## MONITOR COLOR MATCHING

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## **Monitor Color Matching**

**Abstract:** Color matching between two or more monitors is achieved without the use of a host computer by a main monitor retrieving, at power-up, color information from daisy-chained monitors, comparing the retrieved data to its own color data, determining needed color adjustments, and commanding the main and/or daisy-chained monitors to perform the applicable color adjustments.

This disclosure relates to the field of displays.

A technique is disclosed that color matches two or more monitors at lower cost.

Many customers work with multiple computer monitors. In some cases, they use multiple monitors with a single computer in their workspace. In other cases, they work in an open or shared workspace environment where a particular worker may use a different monitor, or set of monitors, each workday.

Up to now, in order to color match two monitors, they generally need to be calibrated to a specified standard such as, for example, sRGB or DCI. Unfortunately, however, this is an expensive and time-consuming solution, as it requires a more costly scaler (video processor) inside the monitor with a graphics processor capable of adjusting its color engine, and a higher end panel that also can meet the target color standard. It also requires additional time at the production line for the calibration process. As a result, this expensive solution is typically used only on very high-end monitor models.

Another solution is to characterize the color properties (R,G,B and White point) for the two monitors using external colorimeters, and then adjust the color gain factors to match these two to one another. While lower cost, this is difficult to implement in the corporate environment due to the large mix of monitor models, panels used, and the need to update the firmware on each affected monitor to permanently set the adjustment values. Further, in the event of a monitor failure or replacement, the process needs to be redone, to effectively match the new set. Moreover, this approach is unsuitable for use in open or shared workspace environments with different monitors used every day.

In many situations, however, it is more important to a user that the colors on two or more monitors match, even if the matched colors are not accurate against a color standard.

According to the present disclosure, color matching between two or more monitors is achieved without the use of a host computer.

Many of the newer corporate workspaces consist of two or more monitors on a desk setup. The main monitor is usually either a docking monitor, or a monitor capable of Multistream (MST) support (via DP interface, USB Type-C interface, Thunderbolt, or other video/graphics interfaces that support multistreaming). The additional monitor(s) Daisy Chain (Multistream) out of the Main Monitor, as the goal is to have a "Single cable connection" from the Desk Setup, back to the Worker's (end customer) Host PC. Each supported monitor model will have its R,G,B and whitepoint characterized and the factory, and included as part of the EDID information for the monitor.

In the disclosed technique, upon power-up, the Main Monitor retrieves the EDID color information from each of the Daisy-Chained monitors via the DDC-CI data channel. It then compares this retrieved data to its own color information and derives the needed adjustments (for itself and/or Daisy-Chained monitors) via a pre-determined algorithm.

The Main Monitor then adjusts the Color gains via DDC-CI/VCP commands on its own monitor and/or on any of the Daisy-Chained monitors, in order to accomplish the color matching.

Because this technique is performed at each power-on or wake-up event, it doesn't matter if the host computer is different, or if monitor configurations have changed in-between work sessions. The technique creates the necessary adjustment color gain values for that session in real-time. The color matching is implementable with two or more monitors, the limiting factor being the data/video carrying capabilities of the interface.

In some configurations, an added feature is provided on the monitor OSD to allow the user to further customize or adjust the gain values on any of the monitors, if an even closer color match between monitors than the one calculated algorithmically is desired. These additional adjustments are then taken into account by the algorithm while the same monitors are in use on the work configuration.

For other desk space arrangements (for example, multiple monitors attached to a docking station, and then the host computer also attached to a docking station; or multiple monitors attached directly to the host computer, the same solution and real-time algorithm is implemented on an application run on the host computer. The application would be installed on each host computer that wishes to take advantage of the color matching feature.

The disclosed technique advantageously provides a lower-cost solution to achieve color matching between two or more monitors. It is easy to deploy in the corporate environment, inexpensive to implement in the consumer or home environment (no need to buy colorimeters), and is independent of the monitor model, age, panel used, size or resolution.

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