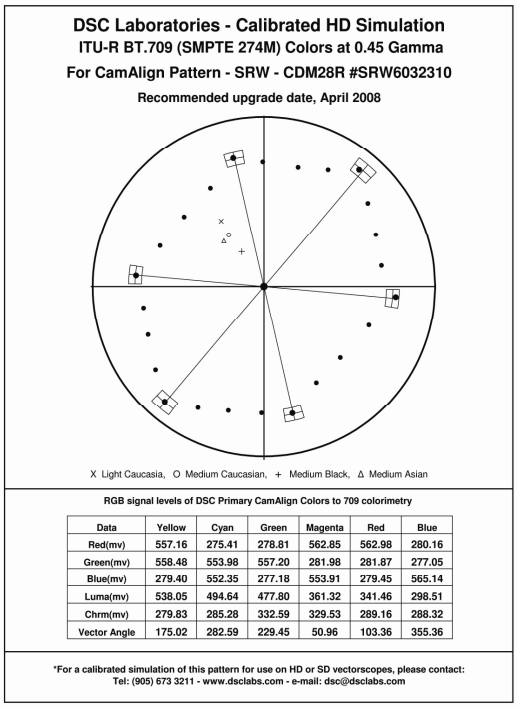
Setting up Accurate Color and Grayscale Reproduction using Precision Test Materials from DSC Laboratories

Accurate, consistent camera alignment is an objective process and advancements in measurement technologies, from precision test charts to vectorscopes and waveform monitors now make this a more easily achievable goal. Ensuring that test equipment is accurate is essential. Every item in the system plays its role from the camera, to the test pattern, to the measuring equipment and picture monitor. While any item in the production train can throw picture quality off track, the test chart is likely to be biggest culprit and waster of engineers' efforts.

An accurate test pattern provides essential information that is reflective (no pun intended) of what the camera sees. An accurate test chart does not negate, but complements an electronic signal generator by including the camera's taking characteristics. Taking characteristics is a term that will be frequently used in this document and encompasses the many elements in addition to a camera's electronic circuitry. These include the lens and adapters, the prism block, dichroic and trim filters and the color characteristics of the CCD or other chip set. Taking characteristics will also be affected by changes in the color temperature and spectral distribution of the scene lighting. Accurate evaluation of these characteristics requires two essential elements, a precision test pattern and accurate electronic measuring equipment. CamAlign (front-lit) and Combi (rear-lit) test patterns from DSC Laboratories are unique in providing meaningful test signals that facilitate camera alignment and image control. Originally designed for engineering, they are now also used in production as on-the-set references for use in post and special effects. They do this by not only providing signals that fall within their prescribed vectorscope boxes, but also at prescribed luminance levels. This enables accurate setting of a color's brightness in addition to hue and saturation levels. Individual Vectorscope and Waveform calibration sheets are available showing the virtually infinitesimal differences between similar test patterns. These are available mV and/or IRE levels. All DSC professional patterns include a serial number in the active area (to reduce theft) and a recommended replacement date which enables clients to conform to ISO requirements. Providing accurate color and grayscale values at



DSC Laboratories - Calibrated HD Simulation
ITU-R BT.709 (SMPTE 274M) Colors at 0.45 Gamma
For CamAlign Pattern - SRW - CDM28R #SRW6032310
Recommended upgrade date, April 2008

X Light Caucasia, O Medium Caucasian, + Medium Black, Δ Medium Asian

RGB signal levels of DSC Primary CamAlign Colors to 709 colorimetry

Data	Yellow	Cyan	Green	Magenta	Red	Blue
Red(mv)	557.16	275.41	278.81	562.85	562.98	280.16
Green(mv)	558.48	553.98	557.20	281.98	281.87	277.05
Blue(mv)	279.40	552.35	277.18	553.91	279.45	565.14
Luma(mv)	538.05	494.64	477.80	361.32	341.46	298.51
Chrm(mv)	279.83	285.28	332.59	329.53	289.16	288.32
Vector Angle	175.02	282.59	229.45	50.96	103.36	355.36

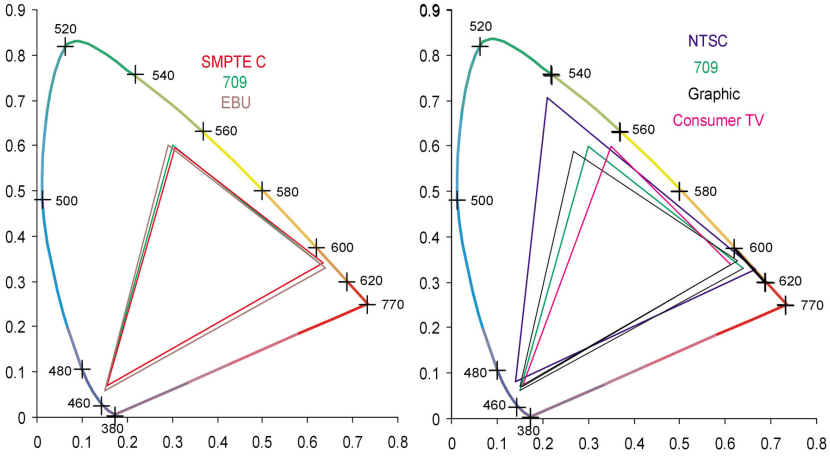
*For a calibrated simulation of this pattern for use on HD or SD vectorscopes, please contact:
Tel: (905) 673 3211 - www.dsclabs.com - e-mail: dsc@dsclabs.com

the correct luminance is particularly helpful when setting up a camera to a particular colorspace. While DSC uses the International Standard ITU-R BT.709, calibration sheets can also be provided in EBU and SMPTE C.

For the purposes of this experiment, the Tektronix WFM7100 was used to simulate a pre-production camera set up, an on-set single camera shoot and an on-set multi-camera shoot.

Camera Reproduction

Typically the aim is to reproduce the image on a monitor or television set as closely as possible to the original scene. To achieve this, the camera converts data from an accurate test chart via a camera's CCD chip set to digital voltage levels. The characteristics of the grayscale and color steps can then be adjusted using the camera's set up controls and color matrices. Optimizing the image signals largely depends on the adjustment capability of the individual make and model of camera. In addition to an accurate test chart a precision waveform/vectorscope/spectrum analyzer is vital to this operation.



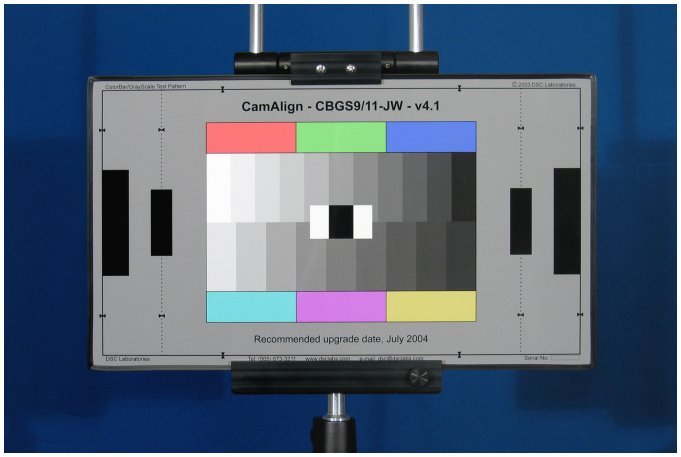
All DSC color patterns are designed to the latest International Colorimetry Standard ITU-R BT.709, (SMPTE 274M) which replaces a number of previous standards. Note the excellent wide color gamut of the old NTSC standard above. Regrettably when TV sets were made to this standard they didn't sell, because the picture was too dim and had to be viewed in a darkened room. For this reason, the colorimetry component of the NTSC standard was replaced by SMPTE C which had a greatly reduced, but much brighter color gamut. For 25 years DSC made charts to both SMPTE C and the EBU standard. It is interesting to note that while the industry has been concerned about the relatively small colorimetry differences between television systems, (above left), until recently little has been said about the large differences between various makes of monitors and TV sets (above right).

Grayscale adjustment using WFM7100 Waveform Monitor

While it is a relatively simple procedure to set up correct exposure levels using a grayscale chart, failure to use a truly neutral grayscale can result in serious tracking errors. Typical grayscale charts are more yellow in the light steps, approaching neutral towards black. Use of such charts produces images that are artificially blue or cold-looking in the lighter tones. This is the last thing you need in an image, because viewers prefer warm looking pictures. Patented technology from DSC Labs has eliminated this problem by making every step of the grayscale neutral.

In using a grayscale test pattern, both dynamic range and progression between steps become important. In the early days of television, the dynamic range of a camera was limited to about 25:1 and grayscale patterns had a correspondingly low dynamic range. Unfortunately such 9 step test charts are still being sold to align modern cameras having a dynamic range of 3000:1 or higher.

The progression rate between typical 9 step charts and a modern 11 step pattern is also different. The 9 step is log in terms of reflectivity while the 11 step is designed to produce steps that are linear in voltage.



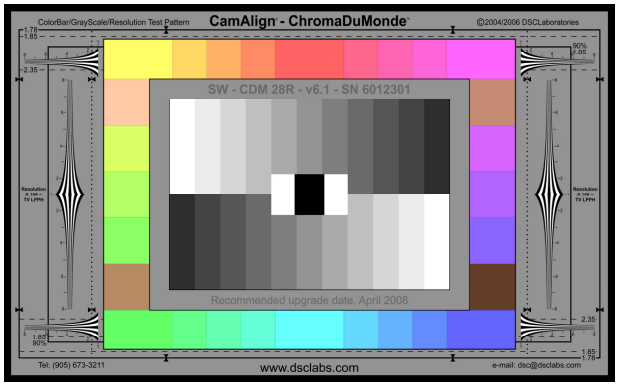
The lightest step on a 9 step chart reflects 60% of the light falling on it compared to 90% from the white chip of an 11 step chart. The chart on the left combines both 11 step (top) and 9 step grayscales (below). Note how the 11 step pattern has greater dynamic range; the white chip being lighter and the darkest chip being darker than the 9 step. The different densitometric curves between test patterns result in significantly different image reproduction from cameras aligned to a nine or 11 step chart. Aligning to inaccurate grayscales of limited dynamic range can result in poor quality images that are virtually beyond redemption.

While every engineer and DP has his/her own technique for aligning a camera, they will typically use the following procedure.

With a camera focused and framed on an evenly lit ChromaDuMonde, or back-lit Combi pattern, the Iris is set to mid scale (typically between f4 and f8) and the exposure/iris is adjusted to set the white chip of the DSC grayscale to 700mv (100 IRE). Tracking of RGB channels should also be checked to ensure neutral reproduction across the grayscale. White and black balances are then set. Incidentally, because all DSC colors combine to produce a neutral color balance, most cameras will white balance on a DSC color chart as accurately as on a TrueWhite card. The true black chip of the CamAlign or ChromaDuMonde grayscale is normally set close to 0 mV - Note: NTSC in North America uses a black level set up of 7.5 IRE above true black. The Gamma or crossover step of the 11 step chart is typically adjusted to produce a straight line; this results in accurate grayscale reproduction. It is important to note that while a camera may reproduce a grayscale perfectly, it says nothing about its color reproduction which could still be very poor.

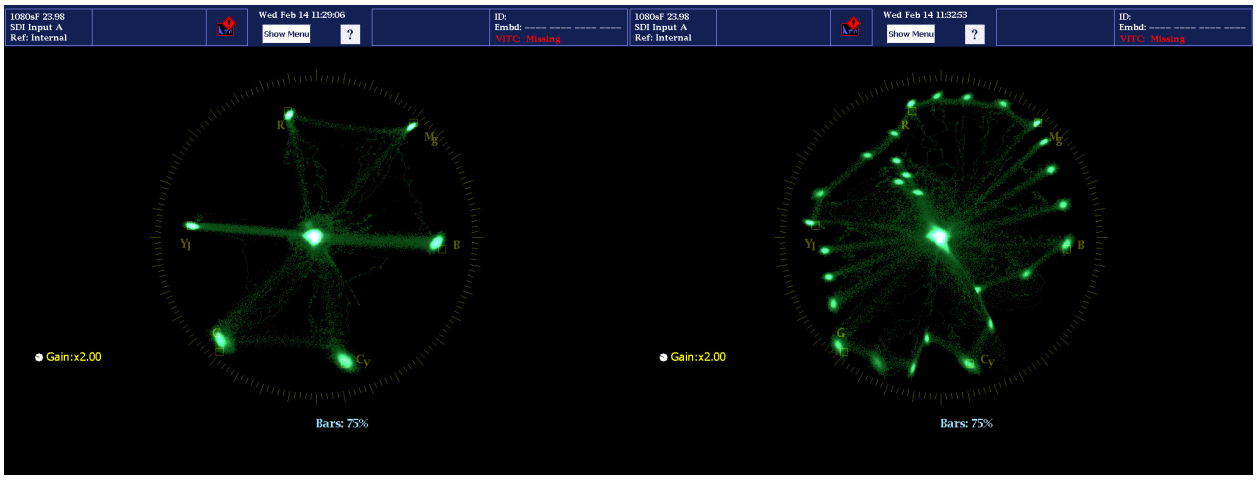
Color adjustment using WFM7100 Vectorscope

As good engineering practice, all DSC color bars are designed to represent saturation levels found in real life. Consequently when a vectorscope is adjusted for 75% electronic color bars, CamAlign and ChromaDuMonde color signals will fall short of the boxes. However, a simple 2x increase in vectorscope gain will place all primary color signals in their boxes when a camera is reproducing colors accurately.

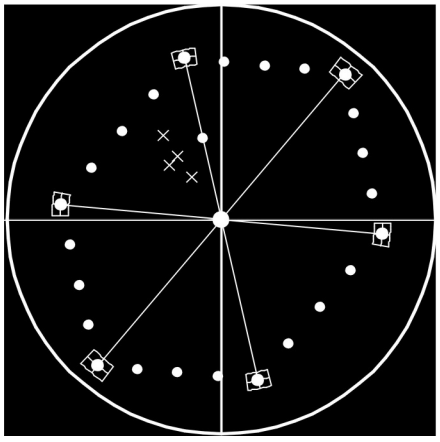


This ChromaDuMonde has a total of 28 colors – the primary colors in the corners and center upper and lower fall into their respective vectorscope boxes. The other colors form straight rows between the primaries. With the advanced multi-matrix settings of modern cameras, it is possible to line up each primary in its box, but inadvertently reduce the overall color gamut.

In the image (above left) a camera was aligned to a 6 color CamAlign pattern using the multi-

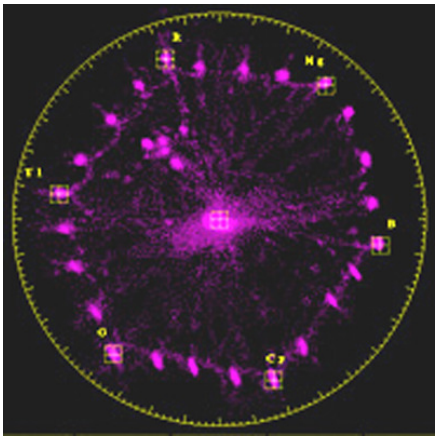


matrix menu. Changing the chart to a 28 color ChromaDuMonde produced the image (above right). Note that, while the primaries are still correctly placed, many of the other colors are severely skewed and distorted.



The image on the left shows a DSC computer prediction of the 28 color ChromaDuMonde chart.

The picture on the right is vectorscope image of the same chart on a well aligned camera.

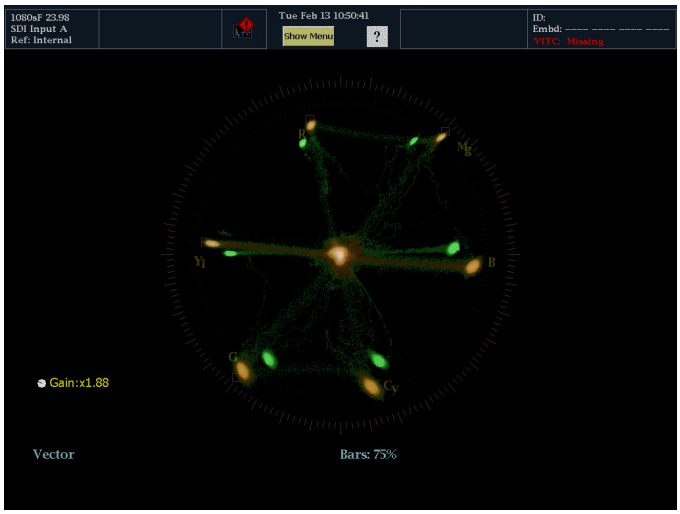


When aligning a camera's matrix, increasing or decreasing the sensitivity of a particular color can affect the positioning of many other colors – consequently the process requires considerable patience. This is only possible using DSC charts because every primary DSC color has the same RGB level combinations as every other primary color. If patterns were made with different luminance relationships, color matrix adjustment would displace the gamut showing a false primary as true, further distorting the working colorspace. This is exemplified when adjusting a camera's color matrix settings. Typically an individual color cannot be adjusted without

affecting others. Adjusting B-Y, R-B, etc. settings tends to move *all* colors on the vectorscope, some more than others, and it takes both skillful "tweaking" and patience to optimize a camera for accurate reproduction. A fact that should always be taken into consideration is that if one or more colors in the chart are incorrect in any parameter, Hue, Saturation or Luminance, accurate reproduction becomes mission impossible. For this reason test charts should be kept current and replaced in a timely manner. The bottom line is; aligning to an inaccurate grayscale or color chart is worse than using factory presets – much like the common error of white balancing to a sheet of ordinary white paper.

Camera Matching

Camera matching becomes impossible without an accurate test pattern and analytical tools. No two cameras are identical which makes it unreliable to upload the settings from one camera to another. The only way to match cameras effectively is to adjust the matrix settings of each camera using the *same precision test chart under the identical lighting condition*. Set exposure levels and white balance (*which as previously noted can be done using any CamAlign or ChromaDuMonde chart)* then align the colors on a vectorscope, finally match the second and additional cameras to a freeze frame of that pattern.



In this example, accessing the USB Buffer through the WFM7100 Capture menu will take a snap shot of the current configuration and create a pale brown overlay when going back into the Vector Display mode. With the first camera still connected to the WFM7100, the second camera can view the same chart, and be effectively matched to the first camera's image.

Ensure that the camera stays connected to the scope, as the WFM does not have an internal signal generator, and will not be able to reload the images from the USB Buffer without computing the format of the original capture.

Occasionally a DP may want to divert from accurate reproduction for a special "look" or effect. However, by first aligning to a DSC pattern, the working colorspace becomes a wide and accurate baseline from which prescribed deviations may be dialed in to produce the desired "look".

Conclusion

While engineers have been using DSC test patterns for over 40 years, during the past 10 years production teams have come to realize the benefits of these products as production standards. Now not only the favorite of Hollywood, CamAlign and ChromaDuMonde can be seen in leading production centers world wide.

Recording a few seconds of a DSC test pattern on the set, at the head or tail of a scene, captures virtually everything a colorist needs to know to color correct or match scenes. Secondary colors

from a DSC ChromaDuMonde pattern are especially useful when shot on set as they enable changes in lighting or exposure to be corrected in post with speed and efficiency.

Users of CamAlign and CDM patterns are encouraged to submit technical suggestions for possible posting on the DSC website at www.dsclabs.com. Visit the DSC TechTips section to get user reports on many different chart and camera configurations.