ColorGauge SG Analyzer™

Image Science Associates introduces a new system to ***analyze*** images captured with the X-Rite Digital ColorChecker® SG target

Designed for customers who need to verify their compliance with existing color spaces, the **ColorGauge SG Analyzer™** implements world-class image processing algorithms to provide ***simple***, ***accurate*** feedback on the image quality performance of your system.

Why use ColorGauge SG Analyzer™ with the X-Rite Digital ColorChecker® SG Target ?

Typically, the ColorChecker® SG target is used to ***create*** ICC profiles for a unique image capture system. The ICC profile ensures that the RGB digital values are accurately converted to a common, useable color connection space. But what if your customer requires images to be captured in a specified color space such as sRGB or Adobe RGB and tagged as such?

In this case, you will need to ensure that your system is configured properly to encode RGB values that the ICC profile requires. Adobe RGB, for instance, is defined for RGB images that have been captured with D65 lighting and have a tonescale gamma of 2.2. But how much deviation from aim values can be tolerated before images are deemed unacceptable? Furthermore, how much can non-neutral patches vary from their aim and still be used?

The **ColorGauge SG Analyzer™** answers these questions by providing a simple metric, Maximum Delta E, which can be used by system engineering, quality control, and purchasing teams to ensure that customer expectations are clearly understood and consistently verified.

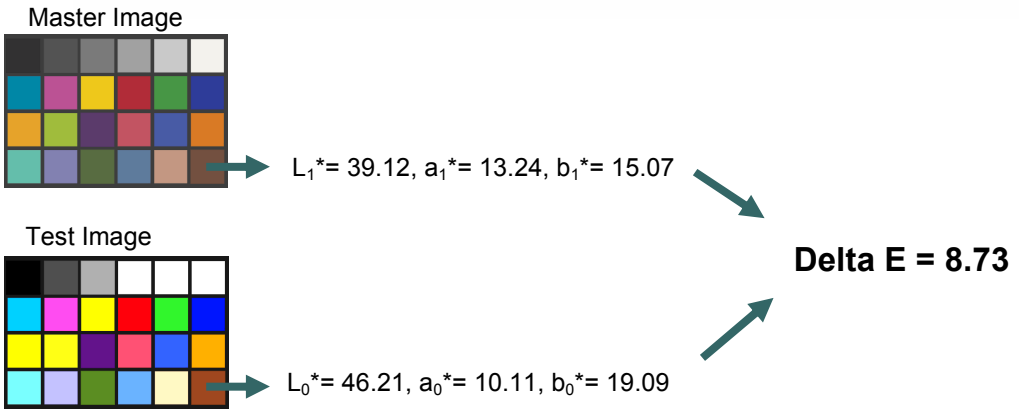
Color Analysis Details

ColorGauge SG Analyzer™ employs the "Delta E" method recommended by the International Commission on Illumination (CIE) to evaluate the visual color difference in between two color samples.

The key step in this process is the conversion of camera RGB to L*a*b*, which requires the color model to be specified for your specific capture system. Since we know the actual CIELab values of the ColorChecker SG target, we are able to calculate the difference between them with the Delta E calculation.

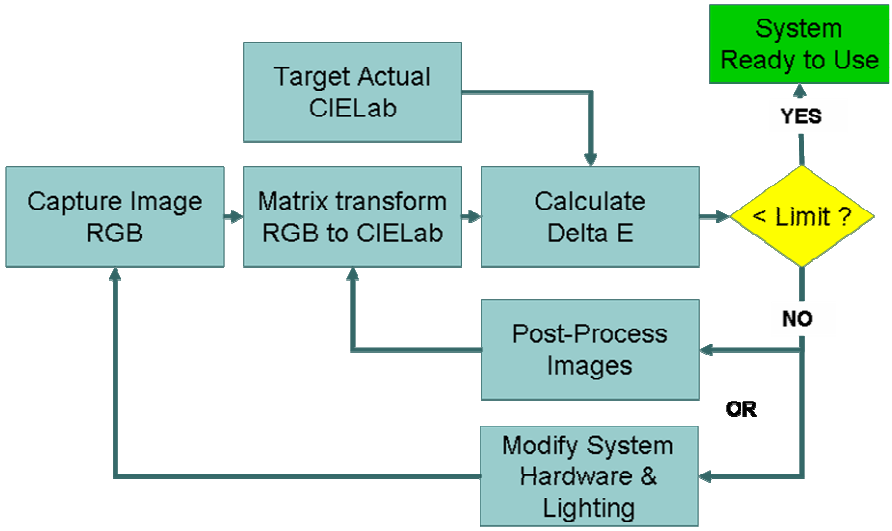
An example is shown below using the formula developed in 1976. Subsequent (and more complicated) versions in 1994 and 2000 are also selectable in the software. As the formula shows, if calculated L* a* b* values from the camera RGB values match the actual L*a*b* values of the target exactly, the calculated Delta E is zero. Larger differences in L*a*b* result in increasingly higher Delta E values.

$$DeltaE_{1976} = \sqrt{(L^*_1 - L^*_0)^2 + (a^*_1 - a^*_0)^2 + (b^*_1 - b^*_0)^2}$$



By specifying the maximum-allowable Delta E for any patch, a means is available to constrain variation for these four standard color spaces: sRGB, Adobe RGB, ProPhoto and ECI. This ensures that image specifications are communicated without ambiguity and can be verified by the end user of the image.

Workflow using ColorGauge SG Analyzer™



Target Actual CIELab: These values can be measured with a spectrophotometer or obtained from X-Rite. Nominal values for the Digital ColorChecker® SG target have been included with the ColorGauge SG Analyzer™ program.

Matrix Transform RGB to CIELab: Depending on the user's choice of color space (sRGB, Adobe RGB, ProPhoto or ECI), ColorGauge™ calculates L* a* b* values for each of the 140 color patches.

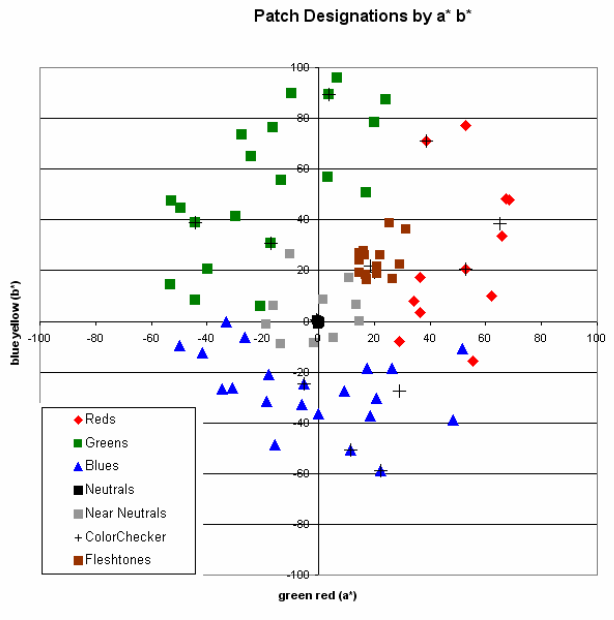
Calculate Delta E: ColorGauge™ uses the Target Actual L*a*b* and the transformed image L*a*b* values to calculate the Delta E for the version specified by the user (1976, 1994 or 2000). Delta E ranges from 0 to 100. Theoretically, a change of one Delta E correlates to one "just noticeable difference (JND)" in color difference.

Post-Process Images: The captured Digital ColorChecker® SG image can be adjusted using a photo editor such as Adobe Photoshop® then re-read by ColorGauge™ to determine the color accuracy. By applying these adjustments to images captured under the same conditions, images can be processed to yield acceptable images.

Modify System Hardware & Lighting: Camera settings such as the shutter speed, aperture and many other parameters can be adjusted to reduce the Delta E to an acceptable level. The light source, position and intensity can also be adjusted to improve the image.

Color Categories

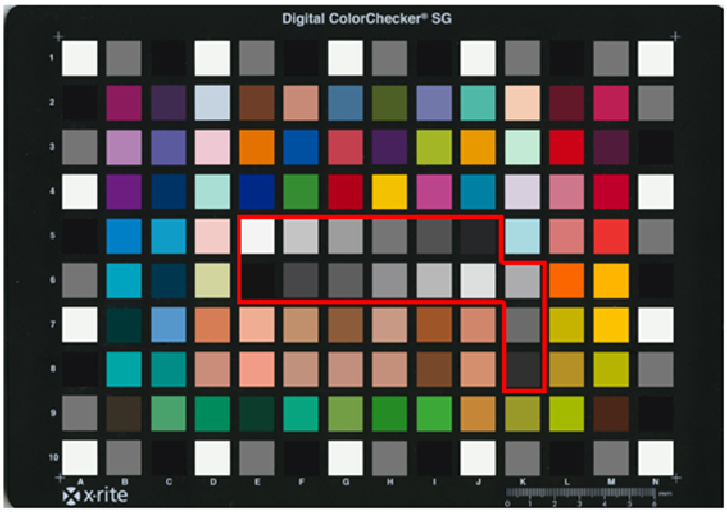
ColorGauge SG Analyzer™ presents Delta E values by color category to provide a quick diagnosis of any problem sources. The categories include: neutrals, near-neutrals, fleshtones, ColorChecker colors, reds, greens and blues. The plot below shows each patch by a* b*.



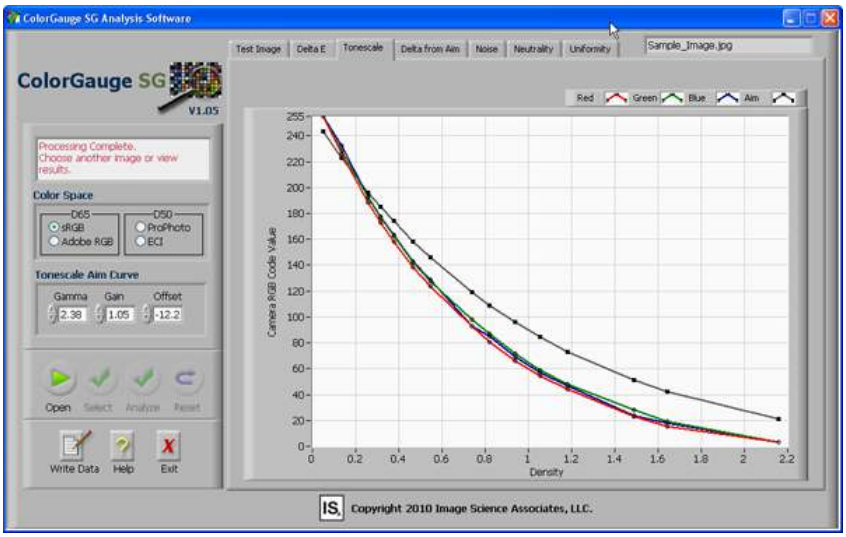
Maximum Delta E is reported for each category. Once data is presented, it is recalculated automatically if either the color space or the Delta E method is changed. This provides a visually intuitive instruction for comparing these parameters.

Tonescale Analysis Details

Measurement of the neutral patches in the ColorChecker® SG target is given special attention due to the need for the system to accurately record these colors. The **ColorGauge SG Analyzer™** plots the digital code values of these patches against its neutral density value, often referred to as the OECF* curve.



An aim curve for these patches is specified by the color space using a gamma, gain and offset. Parameters are displayed on the user interface along with a reference line on the tonescale plot to indicate relative performance of the test image.



OECF = Opto-Electronic Conversion Function

Noise & Neutrality Details

Noise is simply calculated as the standard deviation of the digital code values for each of the neutral patches. It is calculated for all three color channels, resulting in a total of forty-five noise measurements (15 red, 15 green, 15 blue).

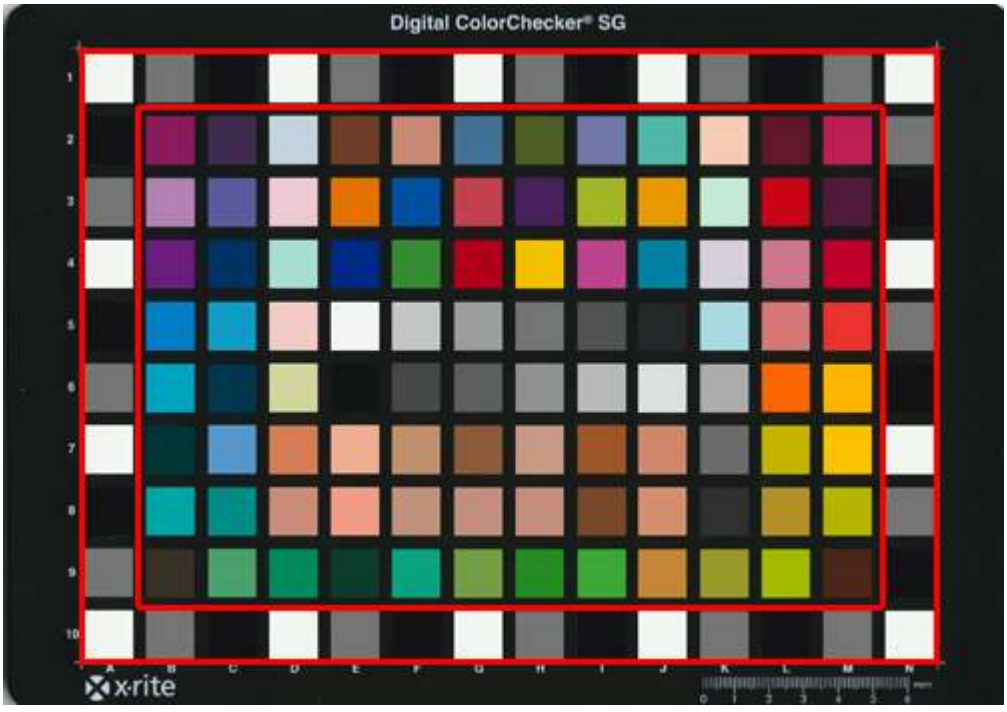
The difference in average digital code value for any particular neutral patch is calculated as the "neutrality" or "white balance" of the patch. For instance, if a patch measures: R=128, G=128,B=128 then the neutrality would be zero. Neutrality is measured against the green channel, i.e. (Avg. Green – Avg. Red) and (Avg. Green – Avg. Blue).

Uniformity Measurement Details

The measurement for uniformity also utilizes the Delta E calculation to estimate differences in color across the target. First, RGB digital values are converted to L*a*b* using the specified color space. But rather than comparing these L*a*b* values to the reference values for each patch, they are compared to the values from the other values for that color (white, gray or black).

Maximum Delta E (1976) is calculated for the white (14), gray (16) and black (14) patches making up the perimeter of the target. For each color, Delta E is calculated between all patch combinations and the maximum Delta E is reported. The patches that resulted in the maximum Delta E are reported along with the measured value.

$$DeltaE_{1976} = \sqrt{(L^*_1 - L^*_0)^2 + (a^*_1 - a^*_0)^2 + (b^*_1 - b^*_0)^2}$$



Easy-to-Use Graphical Interface

ColorGauge SG Analyzer™ employs familiar programming controls to guide users through the analysis process.

1. **Instruction box** provides step-by-step guidance.
2. **Color space selections** for CIELab conversion.
3. **Tonescale Aim Curve** parameters are defined by color space but can be adjusted for debugging purposes.
4. **Analysis controls** walk the user through the process.
5. **Program controls** allow data to be written to file, access to help files and program termination.
6. **Image controls** allow the user to zoom in and out, draw regions-of-interest and selects sub-regions to adjust, if necessary.
7. Interactive **image display**
8. **Results categories** are displayed graphically in individual tabs
9. **Image information** including size, magnification, bit depth, RGB code value and position.
10. **Image Name**

Results Output

Each image has individual test results saved as a tab-delimited text file. The text file contains quite a bit more information than is displayed in the user interface. Included in the text file are:

Test Parameters:

- ✓ Analyzed image Name
- ✓ Date and time the image was analyzed
- ✓ Color space definition used to convert RGB digital values to CIELab, i.e. sRGB, Adobe RGB, ProPhoto or ECI
- ✓ Formula version used to calculate Delta E (1976, 1994 or 2000)

Tonescale Results for fifteen neutral patches:

- ✓ Average red, green and blue (RGB) digital values
- ✓ Standard deviation of red, green and blue (RGB) digital values
- ✓ Neutrality (average green – blue, average green – red) of digital values

Color Results for all 140 patches:

- ✓ Average red, green and blue (RGB) digital values
- ✓ L* a* b* values based on the specified color space
- ✓ Delta E and Delta Eab (a*, b* only)

Uniformity Results for perimeter uniformity patches:

- ✓ Maximum Delta E between white patches
- ✓ Maximum Delta E between gray patches
- ✓ Maximum Delta E between black patches
- ✓ Patch numbers for white, gray and black that resulted in max. Delta E

Minimum System Recommendations:
Microsoft Windows® 2000 or above
1 GHz processor speed or higher
500 Mb RAM or greater

For Macintosh OS, the ColorGauge SG Analyzer™ can be run using Windows simulator programs such as Parallels Desktop®

Visit our website at
www.ImageScienceAssociates.com to
sign up for an informational Webex seminar.

Or call us tool free at 1-888-801-6626

webex™

Other Products from Image Science Associates

Micro and Nano Color Palettes

The Micro-Check Color Palette Kit includes two 30-patch color targets and analysis software. These targets are intended for extremely small field-of-view applications where color accuracy is required. The colors are identical to those used in the GoldenThread™ system.

Target sizes are: 1 5/8" x 1 3/8" and 9/16" x 13/16"

GoldenThread™ Analysis System

The GoldenThread™ System includes two "Gold Standard" quality targets that incorporate all the necessary features to specify and assess the quality of your imaging system, including:

- Spatial Frequency Response and color plane registration
- Opto-Electronic Conversion Function (OECF), color neutrality, and noise
- Color encoding accuracy
- All data is saved to individual reports in Microsoft Excel and to appended reports in a Microsoft Access database

X-Large and X-small Object Targets

Object level targets are also available in 4.6" and 18.5" versions for extra-small and extra-large fields of view. These targets are identical to the standard object target except for their size.