

ColorGauge Micro Analyzer™



Image Science Associates introduces a new system to *analyze* images captured with our 30 patch Micro and Nano targets.

Designed for customers who require consistent image quality, the **ColorGauge Micro Analyzer™** implements world-class image processing algorithms to provide *simple, accurate* feedback on the performance of your system.

Why use ColorGauge Micro Analyzer™ with the Micro and Nano Targets ?

The colors embedded in our Micro and Nano targets are designed with known CIELab values ($L^*a^*b^*$). To ensure that the captured RGB colors have been encoded accurately for a given color space, they need to be converted to CIELab to allow direct comparison with the originals. The **ColorGauge Micro Analyzer™** performs this transformation and calculates a color difference metric.

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 Micro 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.



Target Details

The Micro-Check Color Palette Kit includes two 30-patch color targets (the "Micro" and "Nano" targets) and **ColorGauge Micro Analyzer™** software. The targets are intended for extremely small field-of-view applications where color accuracy is required.

Munsell sheets are specified using the same 24 colors as those used in the X-Rite ColorChecker® Classic target with six additional neutral patches to expand the dynamic range of the target. Data extracted from the targets includes:

- Opto-Electronic Conversion Function (OECF)
- CIE Lab transformations to L*a*b*
- Delta E 1976, 1994 and 2000
- Raw digital values (RGB)
- Noise measurements are made for all neutral patches
- Grayscale neutral balance

Target sizes are:

Nano: 1 5/8" x 1 3/8"

Micro: 9/16" x 13/16"

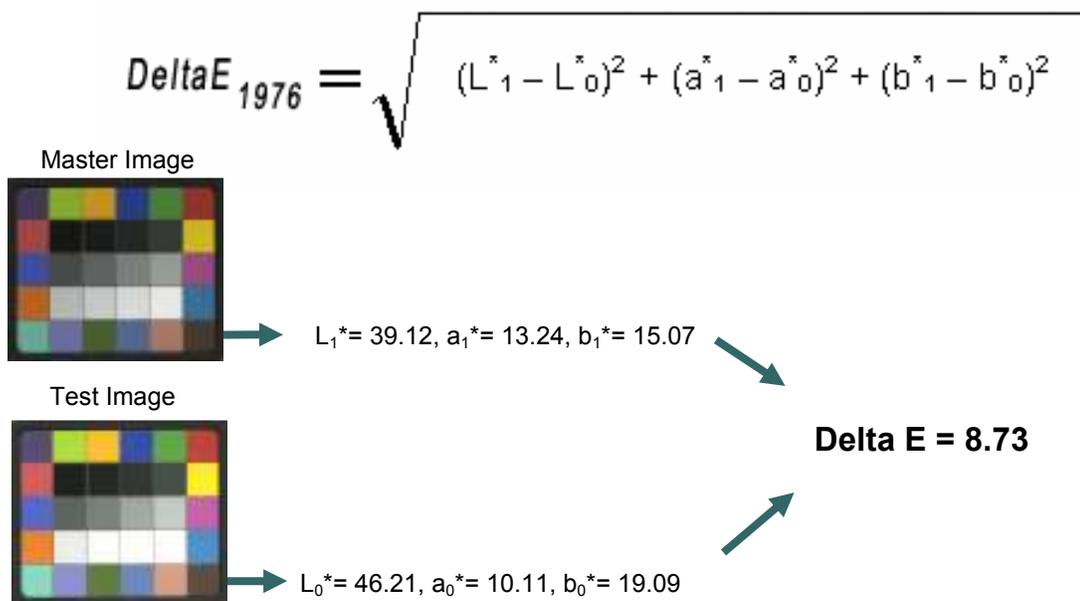


Color Analysis Details

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

The key step in this process is the conversion of camera RGB to CIELab, which requires the color model to be specified for your specific capture system. Knowing the actual CIELab values of the Micro and Nano ColorGauge targets, we are able to calculate the difference between them with the Delta E calculation.

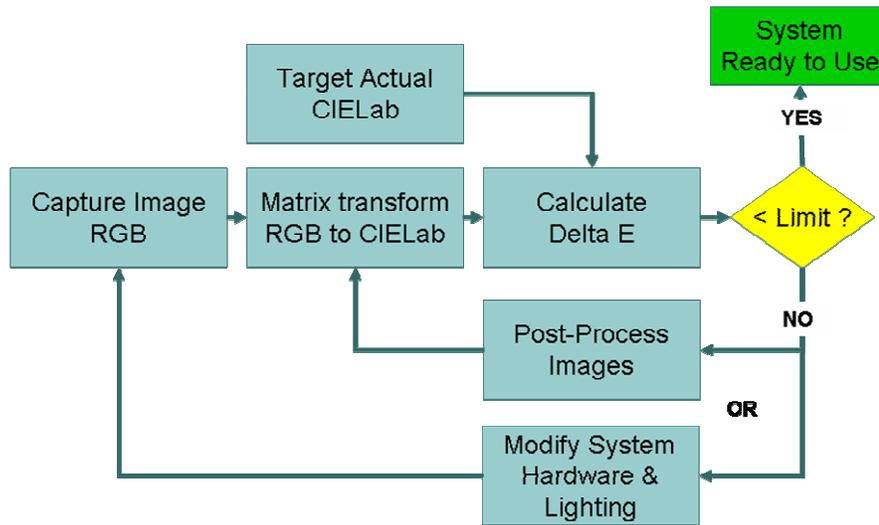
An example is shown below using the formula developed in 1976. Subsequent (and more complicated) versions in 1994 and 2000 are also selectable in the software. As the formula shows, if calculated CIELab values from the camera RGB values match the actual CIELab values of the target exactly, the calculated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



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 Micro Analyzer™



Target Actual CIELab: These values can be measured with a spectrophotometer. Nominal values for the Micro and Nano targets have been included with the ColorGauge Micro 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 30 color patches.

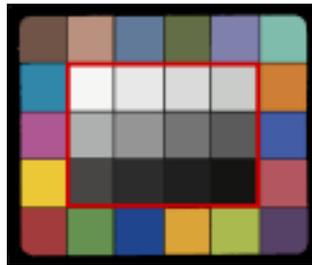
Calculate Delta E: ColorGauge™ uses the Target Actual $L^* a^* b^*$ and the transformed image $L^* a^* b^*$ values to calculate the Delta E for the version specified by the user (1976, 1994 or 2000). Delta E ranges from 0 to 100. Theoretically, a change of one Delta E correlates to one "just noticeable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

Post-Process Images: The captured 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.

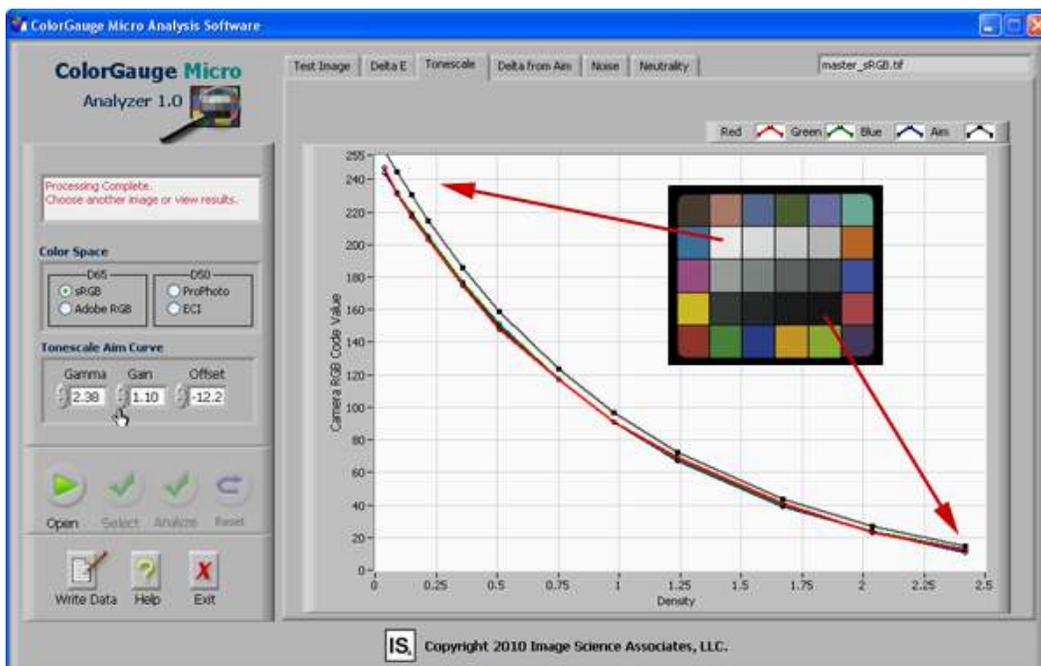
Modify System Hardware & Lighting: Camera settings such as the shutter speed, aperture and many other parameters can be adjusted to reduce the Delta E to an acceptable level. The light source, position and intensity can also be adjusted to improve the image.

Tonescale Analysis Details

Measurement of the neutral patches in the Micro and Nano targets is given special attention due to the need for the system to accurately record these colors. The **ColorGauge Micro 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

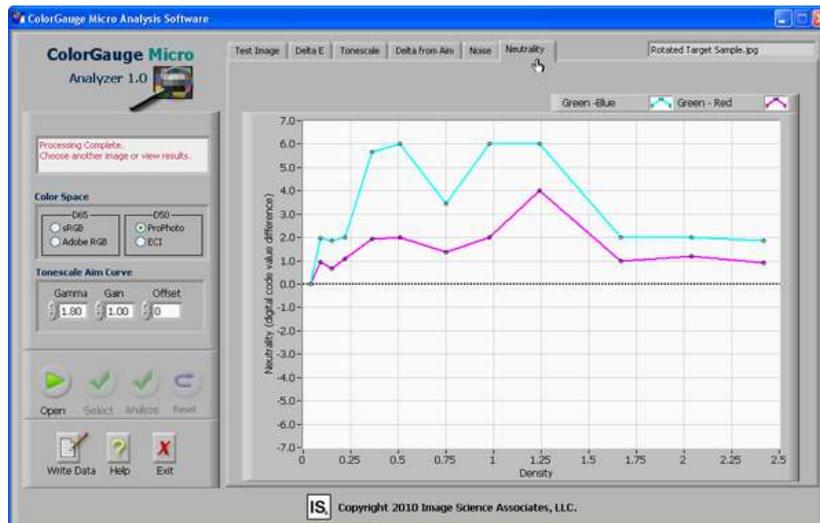


Noise & Neutrality Details

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 thirty-six noise measurements (12 red, 12 green, 12 blue).



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



Easy-to-Use Graphical Interface

ColorGauge Micro 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 CIE Lab 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 select 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 CIE Lab, i.e. sRGB, Adobe RGB, ProPhoto or ECI
- ✓ Formula version used to calculate Delta E (1976, 1994 or 2000)

Tonescale Results for twelve (12) 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 twenty-four (30) 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)

Minimum System Recommendations:

Microsoft Windows® 2000 or above
1 GHz processor speed or higher
500 Mb RAM or greater

For Macintosh OS, the ColorGauge Micro 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 toll free at 1-888-801-6626



Other Products from Image Science Associates

ColorGauge CLS and ColorGauge SG Analyzers

The ColorGauge Classic Analyzer™ works on images captured with the 24-patch X-Rite Digital ColorChecker® Classic target. Analyses include:

- Delta E 1976, 1994 and 2000
- sRGB, Adobe RGB, ProPhoto and ECI color spaces
- Tonescale, noise and neutrality



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.

