PCA

Color Meter

INSTRUCTION MANUAL

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One Year Limited Warranty

★ ★ ★ ★ ★

USL, Inc. warrants that each product manufactured by it will be free from defects in material and workmanship under normal usage for a period of one (1) year after its purchase new from an authorized dealer. Our obligation under this warranty is limited to repairing or replacing any product or component which we are satisfied does not conform with the foregoing warranty and which is returned to our factory, freight paid, or serviced by one of our authorized contractors. The forgoing warranty is exclusive and in lieu of all other warranties, whether expressed or implied. Such warranty shall not apply to any product or component (A) repaired or altered by anyone other than USL, Inc. or an authorized service contractor; (B) tampered with or altered in any way or subjected to misuse, negligence or accident or (C) which has been improperly connected installed or adjusted other than in accordance with USL, Inc.'s instruction.

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Please record the following information for your records:

Model: ____________________ Serial Number: ____________

Date of Purchase: ___________

Purchased from: ___________________________________

PRELIMINARY OPERATING INSTRUCTIONS

This color analyzer measures luminance (in ft-Lamberts or candelas per square meter), chromaticity, (CIE 1931 x,y values) and correlated color temperature, cct, in Kelvin. It has an optical viewfinder with a seven degree field of view. Measurements are made within a one degree area that is indicated by a small circle in the center of the field. The measurement results are displayed within a window on your laptop computer. The software included is designed to work with Windows versions 98, ME, 2000 and XP.

GETTING STARTED

You should have: the Projection Color Analyzer, a USB cable and the software installation CD.

☞ *IMPORTANT* ☜

Install the Color Analyzer software BEFORE plugging in the cable and analyzer.

Insert the CD in the computer CD tray. The install software should automatically start. If not, go to the "Run" item on your start menu and enter X:\set up. (Where X is the letter indicating your CD drive.) Follow the instructions. After the sofrtware installation is complete, connect the Color Analyzer to the USB port of your laptop computer using the cable supplied. Next, find the little rainbow icon on your desk top.

Double click on this, the Color Analyzer icon, to start the software. If you point the analyzer at a wall or surface in the room, the laptop display will indicate the luminance and color characteristics of the light reflected from the surface.

The Color Analyzer display window, (figure one), shows the luminance, chromaticity and the correlated color temperature values on the left and a graphical display of the color characteristics on the right. The position of the small spot within the color chart shows a representation of the target color measured within the viewfinder's one-degree circle. The x and y values of chromaticity are shown on the horizontal and vertical scales respectively.

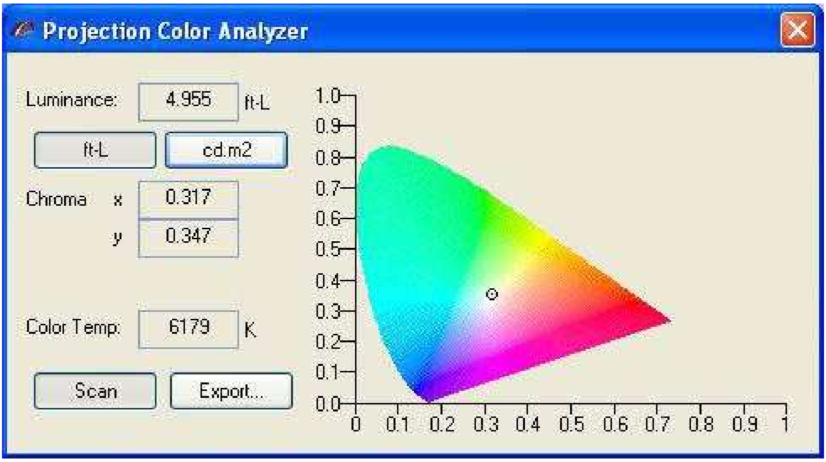

Figure 1

Luminance values can be shown in either foot-Lamberts or candelas per square meter. The choice is made by clicking on either button below the luminance value box.

A spectral graph of the light seen by the Color Analyzer is shown in figure three. This graphical representation can be displayed by first clicking on the small rainbow icon in the upper left-hand corner of the laptop display and then on the spectral graph option as shown in figure two.
The horizontal axis displays color wavelength in nanometers and the vertical axis indicates relative amplitude of the spectral components in arbitrary units.

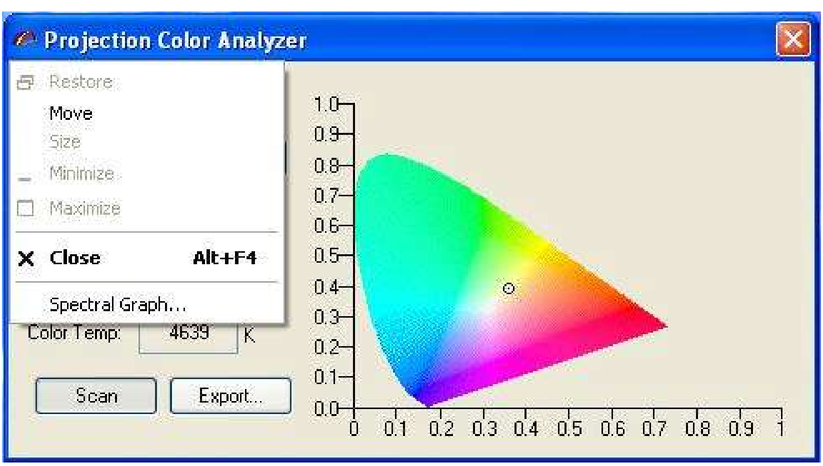

Figure 2

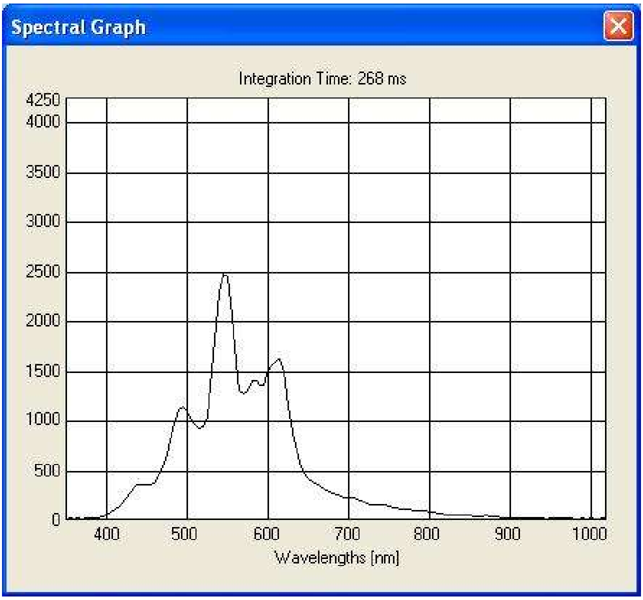

Figure 3

HOW IT WORKS

The Color Analyzer works much like a camera. Light is gathered and integrated during the exposure time. The exposure time is automatically controlled according to the amount of light received. Lower light levels require longer exposures. It is important that the Color Analyzer and the target subject not move during the exposure period. That period can be from one millisecond to several seconds.

Measurements should be made while the analyzer is mounted on a tripod in order to allow time for the exposure to be made. Normally, measurements are made and readings displayed within a few seconds. With very low light levels or after a radical change in light level, the analyzer may take up to twenty seconds to reach a stable set of readings.

The Color Analyzer repetitively scans and reports the results unless the Scan Button is depressed.

The Scan Button, at the lower left corner of the display, (see Figure 1), is used to start and stop measurements by the analyzer. The Scan Button allows you to stop the scanning and hold a set of values for reading. When the scan is again initiated, it continues until the Scan Button is clicked again. The small circle in the viewfinder indicates the portion of the target being analyzed. The viewfinder lens should be capped or shielded when precise measurements are to be made. Stray light may enter that lens and add to the readings.

The viewfinder is in focus beyond approximately 35 feet. Closer objects will be out of focus. The eyepiece lens is adjustable to accommodate differences in the eyes of users.

Measuring Color

The measurement of length and weight are relatively simple tasks. They are both one dimensional. The measurement of color is much more difficult, as is the description of color. It is multi-dimensional. The apparent or subjective color of an object or surface is also affected by many things. The color or spectral content of the light on the surface strongly affects the apparent color. For instance, sunlight, fluorescent light and tungsten light all make the color look different. There is also a significant difference in the color sensitivity of the eyes of various people. The size of the object and the colors in the background also make a difference in the apparent color.
An international commission called the CIE established a system for accurately quantizing color in 1931. This system establishes the basic attributes of color as hue, saturation and lightness. Hue refers to the actual color classification as we know it, as green, blue, red, etc. Saturation is the amount of color, or the "brightness" or vividness of that color. For instance, a subdued rust red has a lower red saturation than the bright red paint that a sports car might have. Lightness refers to the light or dark characteristics of the color. A dark blue would have lower lightness than a sky blue color, given the same hue.Based on a large amount of experimental evidence, the CIE established the color sensitivities of the human eye for the primary colors of red, green and blue, (see figure 4). The tri-color or tristimulus curves are called the color matching functions of the standard observer.

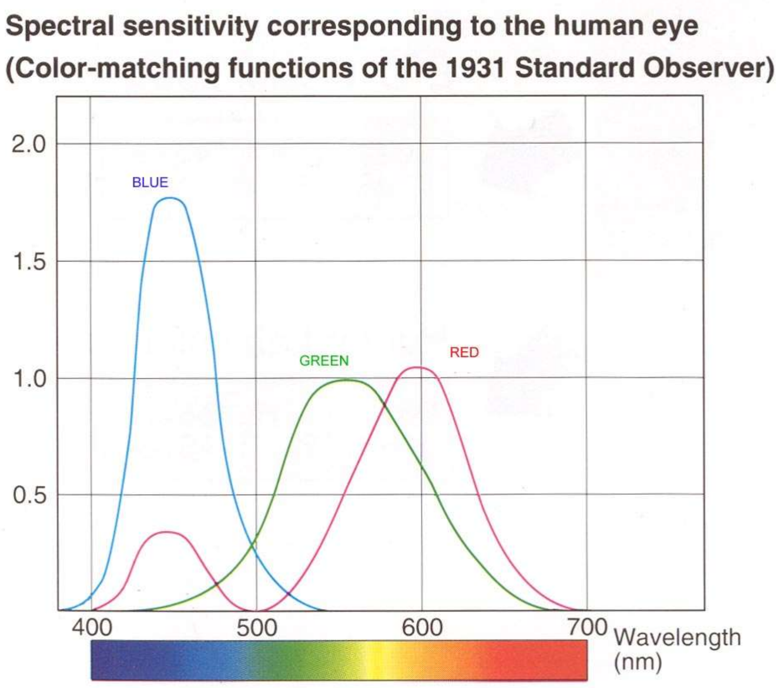

Figure 4

The CIE also established a chromaticity diagram for displaying the region of human color sensitivity (see figure 1). This diagram displays the hue and saturation of colors in terms of the chromaticity coordinates, x (horizontal scale) and y (vertical scale). Lightness is not indicated on this two dimensional chart. The approximate center of the chart, (~x=.31 and y=.360), indicates no color, thus no saturation. Saturation increases toward the outer limits of the curve. For example, (~x=.45, y=.55) indicates a highly saturated yellow and (~x=.12 and y=.12) indicates a highly saturated blue.
This color system is often called the “Yxy” system, where Y is the lightness or luminance and x,y denote the color chromaticity as referred to in the x,y chromaticity diagram.

We use the Yxy system for reflected light, such as the light reflected from a screen or wall or other reference surface. The luminance, Y is expressed in foot - Lamberts or Candelas per square meter and the chromaticity in terms of x and y.

Figure 5 shows the black body locus which indicates the relationship of color temperature values to the chromaticity values x and y.

The following section lists some commonly used terms and definitions that are applicable to making measurements of light and color.

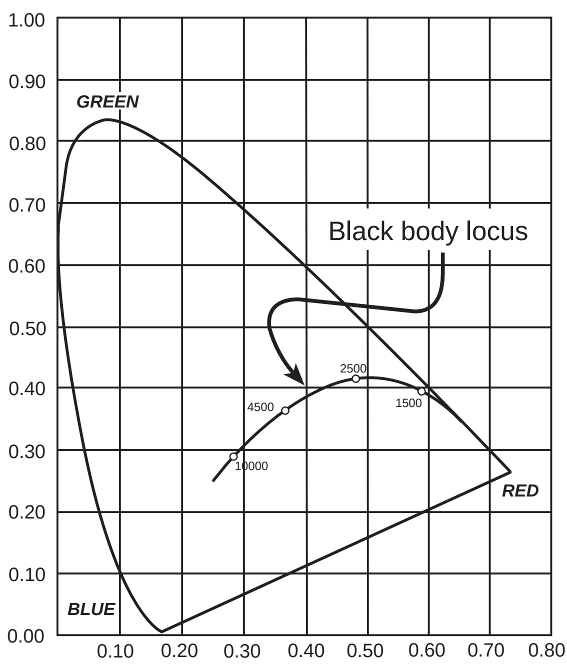

Figure 5

TERMINOLOGY

1. Luminance

Luminance is a term used to describe the amount of light reflected from a surface. An often used synonym is brightness. The unit of luminance is the foot-Lambert in English units, or the candela per square meter in metric units. One foot-Lambert equals 3.462 cd/sq.meter.
The PCA color meter measures luminance and displays the results on the laptop display.

2. Illuminance

Illuminance is the light flux per unit area falling on a surface. The English unit of illuminance is the footcandle, (lumens per square foot), the metric unit is the lux, (lumens per square meter). One footcandle equals 10.76 lux. The PCA can measure illuminance with the aid of a “Reflectance Standard”. The reflectance standard is placed on the surface and the color meter is focused on the reflectance standard. The luminance reading in foot-Lamberts then translates directly to footcandles. Luminance readings in candelas per sq. meter must be multiplied by 3.14 to obtain the illuminance in lux.

3. Lumen

This is the unit of luminous flux weighted by the photopic amplitude vs wavelength function.

4. Color Temperature

The term "color temperature" refers to the concept of an ideal black body. The color of the radiation from the black body varies directly with the temperature. As the temperature goes up, the radiation changes from red through orange and yellow to white. The absolute temperature in degrees Kelvin is referred to as the color temperature. The locus of the black body color temperature is shown on the chromaticity diagram in figure 5.

5. Correlated Color Temperature

Since “color temperature” is based upon an ideal black body concept, it cannot be measured directly. It is possible, however, to derive a correlated color temperature (cct), value from the x and y coordinates. A cct temperature value is calculated and displayed for any set of x,y values on or near the black body locus (figure 5).

MEASUREMENTS

The USL Projection Color Analyzer has been designed to make the measurements required in installation and maintenance of movie theaters. The PCA is a spot meter that measures luminance, chromaticity and correlated color temperature. When used with the Reflectance Standard it can also make the following theater related measurements;
Projector Output in lumens
Screen Gain
Projection Stray Light
Contrast Ratio
Diffuse Reflectance (of walls, ceiling etc.)

MAKING THE MEASUREMENTS

When the Color Analyzer is pointed at the screen, the laptop display indicates the screen luminance, (brightness), as seen within the 1 degree circle in the viewfinder. The correlated color temperature of that area is also displayed.

The Reflectance Standard is a specially prepared white disc made of barium sulfate or white plastic that reflects more than 98% of all the light falling on it throughout the visible spectrum. The surface is nearly Lambertion, which means that the light reflected from a source perpendicular to the surface will vary according to the cosine of the angle with the perpendicular. It gives the ability to measure light impinging on a surface, as indicated in the paragraph on illuminance, above and it also acts as a known standard of reflectance, as the name implies.
For example, in measuring screen gain, one can hold the Reflectance Standard against the screen and measure the reflected light with the Color Analyzer, then take the Standard away and measure the reflected light from the screen. The ratio of the light reflected by the screen to the light reflected from the Standard is the screen gain.

Screen Gain= Light from the screen
Light from the Reflectance Standard

Projector light output in Lumens
The projector light output in lumens is simply the illuminance in footcandles times the usefull projected light area in square feet.

Light output, (lumens)= illuminance (footcandles) times light area (square feet).

Projection Stray Light

The stray light of concern includes all ambient light from sources within the auditorium as well as lens flare from the projection lens. Measurement of the stray light is done by projection a special test film, which has a black spot in the center and measuring the light on the screen within the projected black spot. The ratio of light within the black spot to light from the screen with no film in the gate times one hundred gives the percentage of stray light. The measurement can also be made by inserting a small, flat metal disk within the gate in place of the test film.

Contrast Ratio

Contrast ratio is the ratio of light measurement of the lightest area of a film scene to the measurement of the darkest area of the scene.

Diffuse Reflectance

The diffuse reflectance of the wall surfaces of an auditorium can be measured with the aid of the reflectance standard. The reflectance standard can be held against the wall surface and a measurement of the reflected light made. The standard is then removed and the light reflected from the wall is made. The ratio of the wall-reflected light to the light from the standard is the diffuse reflectance of the surface.

PCA Export

It is recommended but not required that you stop the scanning before exporting any data.The PCA export function is designed to allow a recording of PCA data displayed into either Microsoft Word or Microsoft Excel compatible documents. At this time, only the MS Word export will contain a specified company logo and the actual spectral readout of the current scanned sample. The MS Excel compatible file will only contain the Luminance CIE x, CIE y and Color Temperature readings.
To export, click the “Export” button on the PCA main screen. When the “Export” dialog is displayed (Figure 6), select the type of document you wish to export to. Then, you must specify a filename in the “Export To” section by clicking the “Browse....” button and specifying a valid filename. If you are exporting to a Microsoft Word document, you can also specify a company logo that will appear in the header of the exported document by clicking the “Logo....” button and selecting a valid image file.
An email feature is also included so that the PCA software can attach your exported document to an email. To do this, simply check the “Send to e-mail recipient” checkbox. When you have specified the documents type, filename, logo and email option, click the “Export” button to export the scan data. You may be prompted with additional screens if you elected to email the document.

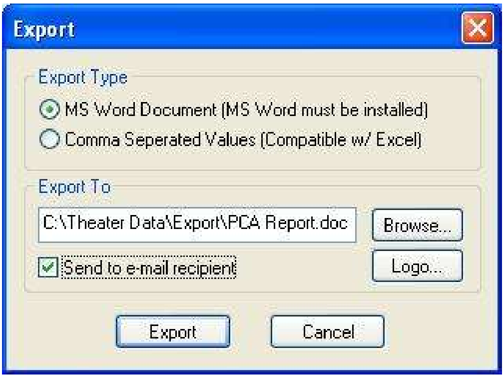

Figure 6

SPECIFICATIONS

Viewfinder angle of view:
Angle of sensitive area:
Luminance range:
Luminance accuracy:
Chromaticity accuracy:

NOTES

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