



**ACADEMY**  
OF MOTION PICTURE  
ARTS AND SCIENCES

# Academy Color Predictor (ACP) User Guide

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# 1 Overview

The Academy Color Predictor (ACP) is a software application for the Apple® iPad® that compares the color rendering capabilities of digital cameras under different lighting setups. The spectral sensitivity of digital cameras varies from one camera to the next, and does not match that of film stock or the human eye. As a result, the colors in a scene are captured differently by different cameras – particularly when the scene is illuminated by multiple light sources or sources with a discontinuous spectrum.

The ACP features a database containing spectral sensitivities for various types of imaging devices, transmission characteristics for commonly used filters, and spectral power distributions for typical light sources. It allows users to specify various combinations of equipment and then compare the color reproduction results in two formats: color patches and graphical plots.

The color patches are similar to commonly used color test charts, with each patch divided into an upper and lower half. The upper halves of the patches represent colors illuminated by the reference light source, while the lower halves represent the same colors illuminated by the test light source. The differences that are discernible on the iPad are also likely to be captured by the camera.

Graphical plots show the distribution of various wavelengths of light and their relative saturation along an x and y axis, respectively. The curves are color-coded to represent the reference light source, the test light source, and the red, green and blue recording channels of the digital camera. The correlated color temperature (CCT), color rendering index (CRI) and color quality scale (CQS) values for the reference and test light sources are also provided.

As a preliminary evaluation tool, the ACP offers qualitative and quantitative information about color rendering differences from scene to scene, thereby alerting users to potential color correction difficulties in post-production.

## Background

An initial prototype of the ACP was created by the Solid State Lighting subcommittee of the Academy's Science and Technology Council. The prototype was constructed in MATLAB®, a scientific visualization toolkit licensed from The MathWorks, Inc. The prototype proved useful in demonstrations of the complex ways in which light sources with different spectral characteristics interact and affect color appearance. However, the MATLAB code was not conducive to distribution.

The ACP release version is now available for use on Apple iPad devices. As iPads typically have non-calibrated displays whose range of colors is more constrained than most motion picture palettes, the ACP assumes a typical or average display, with the understanding that small color variations may occur among devices. Experience has shown that if color differences between the reference and test light sources can be discerned on a given display, those differences are likely to be captured by the camera. However, appreciable differences may be present even when they are not evident on the display. For critical situations, additional testing is recommended using real luminaires and materials (e.g., costumes, props, makeup, etc.).

## Document Scope

This document is the User Guide for the ACP release version. It provides an overview of the application and describes its operation and use.

## Terminology

Descriptions of terms and acronyms used in this document may be found in Appendix A.

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## 2 Features

### 2.1 Default View

After launching the ACP, the graphical user interface appears in the default view, shown in Figure 1:

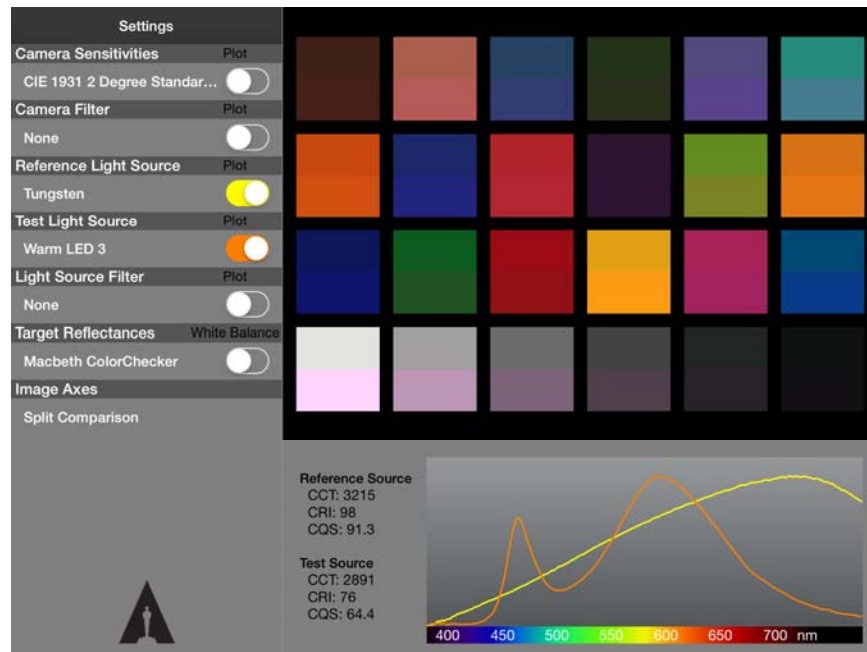


Figure 1.

#### Settings window

The settings window in the upper left corner of the screen is the control panel for selecting the camera, filters and light sources for the reference and test setups. Spectral sensitivity and spectral power distribution data for a variety of cameras and light sources are included in the ACP software.

#### Main display window

To the right of the settings window is the main display window. It presents the color reproduction results of the reference and test setups as a color reference chart with an array of color patches. Each patch is divided into an upper and lower half. The upper halves of the patches represent colors illuminated by the reference light source, while the lower halves represent the same colors illuminated by the test light source.

#### Graphical readout window

Below the main display window is the graphical readout window. It presents spectral power distribution data as graphical plots of relative luminance (y axis) versus wavelength in nanometers (x axis). As a visual aid, the colors in the rainbow-colored band along the x axis approximate the corresponding wavelengths. The

correlated color temperature (CCT), color rendering index (CRI) and color quality scale (CQS) values for the reference and the test light sources are also provided.

## 2.2 Settings

There are several menus in the settings window, each corresponding to a different equipment variable.

### Camera Sensitivities

The **Camera Sensitivities** menu (Figure 2) allows the selection of the imaging device – the type of camera intended for use. It also includes CIE 1931 2 Degree Standard Observer, which corresponds to human vision as defined in the CIE 1931 specification. This sensitivity approximates what is seen directly by the human eye.

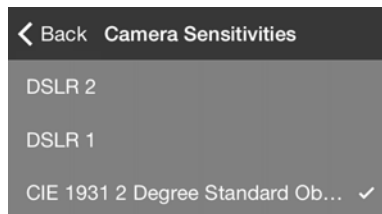


Figure 2.

The adjacent **Plot** switch enables the red, green and blue sensitivity curves of the selected camera (or CIE 1931) to be displayed in the graphical readout window.

### Camera Filter

The **Camera Filter** menu (Figure 3) operates much the same as the Camera Sensitivities menu.

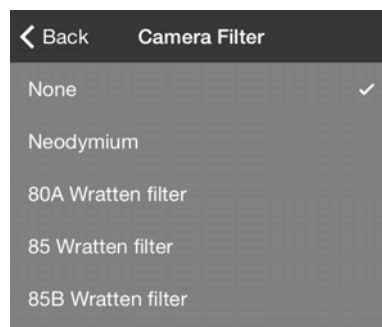


Figure 3.

It contains a list of commonly used camera filters whose properties can be overlaid onto the camera sensitivity setting. Once a filter is selected, its color rendering effect will be instantly shown in the main display window. If the adjacent Plot switch is selected, the spectral curve for the filter will be added to the graphical readout window.

## Reference Light Source

The **Reference Light Source** identifies the lighting that will serve as a “control” component – the predictable, known technology to which the test light source will be compared. The menu choices for this setting are shown in Figure 4. Once the reference light source is selected, the color reproduction results will be instantly shown in the main display window. If the adjacent Plot switch is selected, the spectral curve for the reference light source will be added to the graphical readout window.

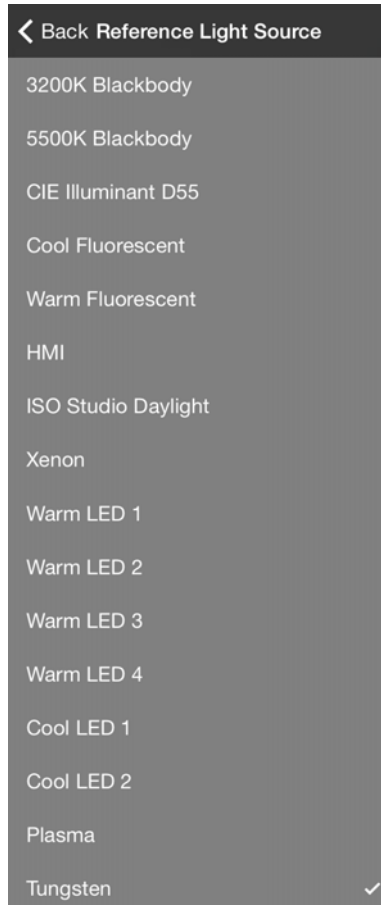


Figure 4.

## Test Light Source

The **Test Light Source** identifies the lighting technology to be evaluated. The menu choices for this setting are shown in Figure 5. Once the test light source is selected, the color reproduction results will be instantly shown in the main display window. If the adjacent Plot switch is selected, the spectral curve for the test light source will be added to the graphical readout window.





Figure 5.

### Light Source Filter

The **Light Source Filter** menu (Figure 6) contains a list of commonly used lighting filters whose properties can be overlaid onto those of the test light source. Once a filter is selected, its color rendering effect will be instantly shown in the main display window. If the adjacent Plot switch is selected, the spectral curve for the light source filter will be added to the graphical readout window.



Figure 6.

## Target Reflectances

The **Target Reflectances** menu (Figure 7) lists several commonly used color reference charts that can be shown in the main display window. The color patches in each chart will instantly change as the camera, filters and light sources are selected.

The adjacent **White Balance** switch (shown in Figure 1) allows the reference light source and the test light source to be balanced together (when the switch is “off”) or separately (when the switch is “on”). If the color patches achieve noticeably better matches with the “on” setting, the light sources may have disparate color rendering capabilities. From a production standpoint, it means that color correction would be simplified if both light sources were not used in the same scene.

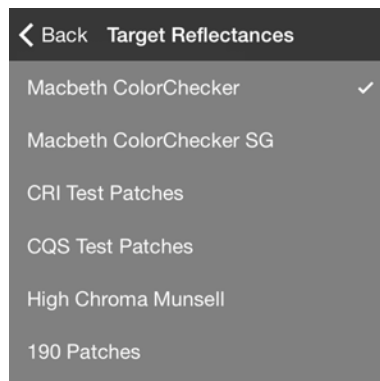


Figure 7.

## Image Axes

The **Image Axes** menu offers useful formats for comparing color reproduction results in the main display window. Although only Split Comparison is included with this release, other formats may be added in future versions.

Split Comparison is a virtual representation of an empirical test in which an oversized Macbeth ColorChecker® chart is illuminated by the reference light source, and in front of it, a proportionately smaller version of the chart is illuminated by the test light source. The smaller chart has the top half of each color sample cut away. When an image is captured with these two illuminated charts in alignment, it provides an immediate comparison of the color rendering capabilities of the two lighting technologies.

## 2.3 Additional Targets

The Macbeth ColorChecker chart that appears in the ACP’s default view is one of several color reference charts available in the Target Reflectances menu. The Macbeth ColorChecker SG target (Figure 8) presents the color reproduction results for the reference and test setups using a wider array of color samples:

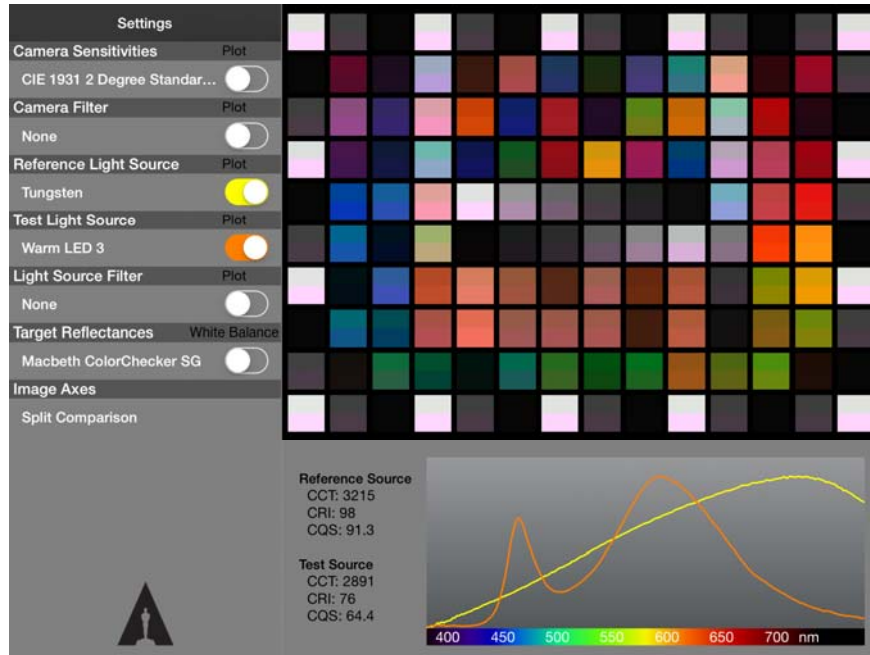


Figure 8.

The CRI Test Patches target (Figure 9) displays the color patches prescribed for color rendering index evaluation:

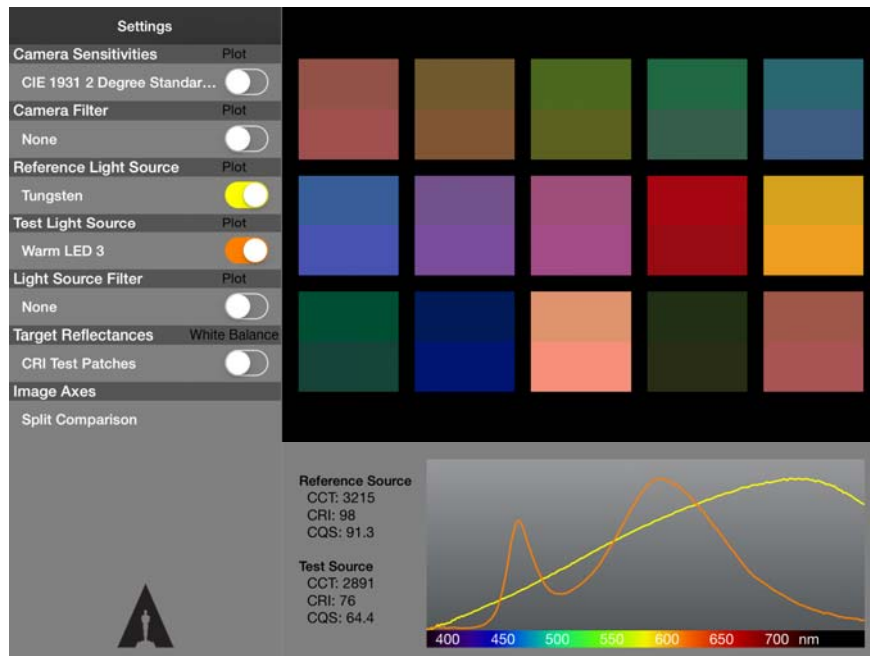


Figure 9.

The CQS Test Patches target (Figure 10) displays the color patches prescribed for the NIST color quality scale evaluation:

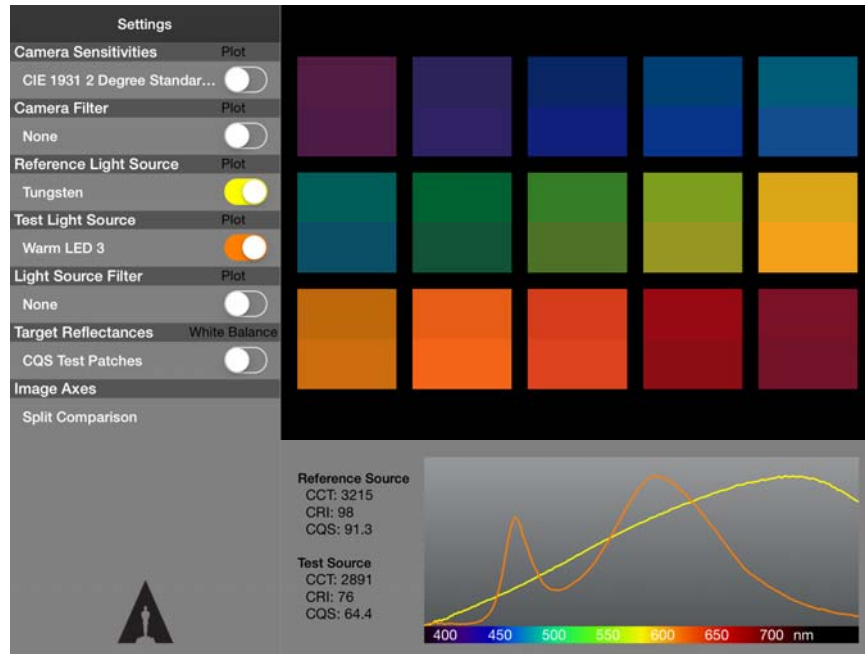


Figure 10.

The High Chroma Munsell target (Figure 11) is a special set of color patches representing high chroma colors:

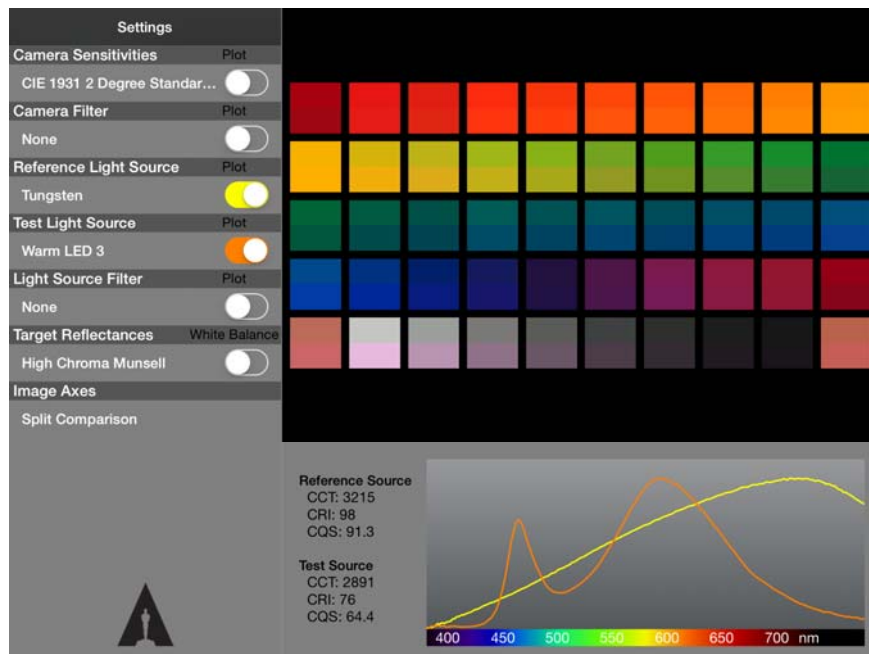


Figure 11.

The 190 Patches target (Figure 12) provides 190 color samples for comparison:

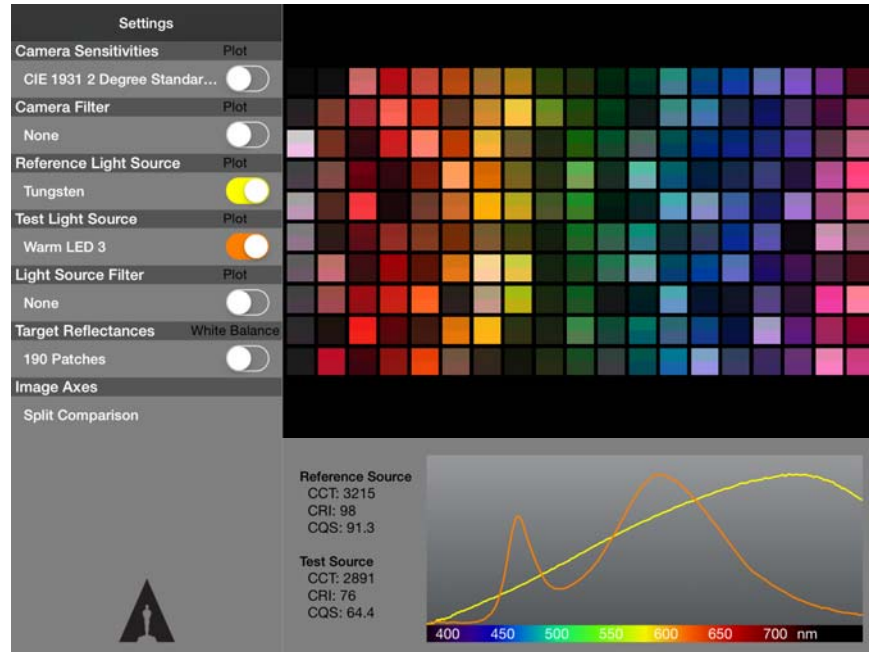


Figure 12.

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## 3 Appendix A: Terminology

The following terms and acronyms are used throughout this document:

**ACP**

Academy Color Predictor

**Academy**

Academy of Motion Picture Arts and Sciences

**CCT**

correlated color temperature

**CIE**

Commission Internationale de l'Éclairage (International Commission on Illumination)

**CQS**

color quality scale

**CRI**

color rendering index

**DSLR**

digital single-lens reflex

**HMI**

hydrargyrum medium-arc iodide

**ISO**

International Organization for Standardization

**LED**

light-emitting diode

**Macbeth ColorChecker® chart**

An array of common colors used to verify color rendering during photography, documented in SMPTE ST 303

**NIST**

National Institute of Standards and Technology

**SMPTE**

Society of Motion Picture and Television Engineers

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## 4 Related Documents and Resources

ISO 7589, *Photography – Illuminants for sensitometry – Specifications for daylight, incandescent tungsten and printer*

SMPTE ST 303, *For Television – Color Reference Pattern*

C. McCamy, H. Marcus, and J.G. Davidson, "A Color-Rendition Chart," *Journal of Applied Photographic Engineering* 2, no. 3 (Summer 1976): 95–99

Y. Ohno and W. Davis, "NIST CQS version 7.5," Excel Software (Sept. 10, 2009)