Color Soft Proofing Certification Program

Testing Protocol v9

1. Introduction

1.1 Background

This document describes evaluation procedures and measurement tolerances for the Idealliance Color Soft Proofing Certification program. The program is aimed at display-based proofing systems used for color preview and guidance in the graphics and printing industry. An **Applicant (**manufacturer, system vendor or user) may obtain certification for their display or soft proofing system upon validation by an **Evaluation Contractor**.

For the purpose of this new program, a **display** is an LCD flat panel device with fluorescent or LED backlight, a screen resolution of 90 pixels per inch or more, a screen size capable of previewing intended content at full scale, and a gamut that encases the intended reference print condition. A **soft proofing system** consists of such a display with software, measurement equipment and a host computer that adjusts incoming data such that a displayed image simulates the appearance of a hard copy proof calibrated to a reference print characterization and viewed under standard lighting. A **reference print characterization** is one for which CIELAB colorimetric values are specified for a standardized set of CMYK values, e.g. ISO 12642-2. **Standard lighting** refers to viewing environments that conform to ISO 3664.

Soft proofing systems are popular for color preview during prepress operations and for color verification during print manufacturing. An initial certification program was developed by

Idealliance and has been in use since 2006. The following factors have prompted the development of a new program to replace the existing one:

a) Improvements in display technology,
b) Improvements in measurement technology,
c) New standards defining requirements for soft proofing equipment and systems,
d) Requests by users for testing and validating new technologies,
e) Desire by vendors for unbiased assessment of their systems.

Note: The new program is not intended for, nor equipped to evaluate, tablet-based soft proofing systems. However, certification for such systems may be added in the future.

1.2 Certification categories

a) **Soft Proofing Display Certification**. This is a display-only category for LCD flat panel devices with fluorescent or LED backlight, with screen resolutions of 90 pixels per inch or more, and with screens sizes capable of previewing intended content at full scale. For certification the display must satisfy all requirements described in section 3.2. These requirements are derived from specifications in ISO 12646.
b) **Soft Proofing System Certification**. This refers to a system consisting of a display, software, measurement equipment and a host computer that adjusts incoming data such that a displayed image simulates the appearance of a hard copy proof that has been calibrated to a reference print characterization and viewed under standard lighting as described in section 3.1. For certification the system must satisfy all requirements described in sections 3.2 and 3.3. These requirements are derived from specifications in ISO 14861. Upon request, certification may include a qualification for the accurate handling of spot colors as described in section 3.4.

1.3 Overview of the Certification Program

The steps of the certification process are summarized below.

- An Application Form is completed online and submitted to Idealliance with fees based on the set of evaluations to be performed. The application form includes information about the Applicant and desired certification(s). The fee is payable irrespective of the outcome.
- The online form is copied internally to the Evaluation Contractor. Testing will be performed at a laboratory site specified by Contractor. Logistics for transporting hardware equipment to Contractor laboratory are arranged by Applicant and Contractor.
- For a system evaluation, Applicant must supply an Application Data Sheet (ADS) that provides information on hardware and software as well as detailed instructions on operation. Information provided in ADS must be sufficient for a skilled operator to achieve intended results. The ADS will be reviewed by the Evaluation Contractor and should include the following:
    1. Identification of manufacturer, system and components.
    2. Model of measurement device used to calibrate/profile system.
    3. Reference print characterization and ICC profile.
    4. Detailed instructions for setting up system.
    5. Any additional information necessary for device or system operation.

  Discrepancies or omissions will be reviewed with the Applicant. A sample ADS template may be downloaded from the Idealliance web site.

- Test procedures involving colorimetric measurements will be conducted as described in the Evaluation sections to assess the uniformity of the display and accuracy with which the system can simulate the intended reference print characterization and/or spot colors.
- Applicant may elect to use computer hardware furnished by the Evaluation Contractor if such equipment is available at the time of certification. It is strongly recommended that Applicant provide a technician to operate the system during testing at Evaluation Contractor site.
- Evaluation Contractor will provide a report to the Applicant by email. The report will include a compilation of results and status of pass or failure of each test. A sample evaluation report may be downloaded from the Idealliance web site.
- Applicants who have achieved successful certification will be provided with a logo and intellectual property rights for usage in their websites and marketing materials.
- Idealliance will maintain a list of certified soft proofing systems and displays on an official website and will update the site within 7 days of successful certification.
- A certification for a soft proofing system generally does not have an expiration date. However, a certified system that undergoes a significant change in hardware or software will require re-certification.

2. Conditions

This section describes items and conditions that are prerequisites and preparations for evaluation testing. The conditions include display and other system hardware, software, measurement device(s), printed patches, and viewing booths as appropriate.

2.1 Reference print characterization for soft proofing certification

The default reference print characterization for soft proofing system evaluation will be GRACoL 2013 for which characterization data and ICC profiles are available at the Idealliance web site. Certification for SWOP 2013 is also available. These references are identical to CRPC6 and CRPC5 respectively in ANSI-CGATS 21-2. Certification based on other reference print characterizations may be permissible subject to approval by the Evaluation Contractor and the possibility of additional fees.

2.2 RGB and CMYK test patches

Three sets of test patches will be used in the evaluation of soft proofing systems.

a) Display_RGB_Ref, a set of 318 RGB values identical to the test set in ISO 14861, will be used to test the colorimetric driving accuracy of the calibrated display.
b) CMYK_Gamut_Ref, a set of 226 CMYK values identical to the outer gamut set specified in ISO 12647-7, will be used to test the gamut reproduction of the calibrated display as specified in ISO 14861.
c) CMYK_Sim_Ref, a set of 84 CMYK values that are identical to the values in the Idealliance 2013 Control Wedge, will be used to evaluate overall colorimetric simulation accuracy of the soft proofing system.

Files containing the tone values of these test patches in CGATS.17 (ISO 28178) text format can be downloaded from the Idealliance web site.

2.3 Hard copy proofs of CMYK test patches

The soft proofing evaluation procedure includes colorimetric comparison between screen-displayed and booth-illuminated hard copy proofs of the CMYK_Sim_Ref test patches. Evaluation Contractor will maintain two sets of test patches printed on a high quality proofing system, one calibrated to GRACoL 2013 and one calibrated to SWOP 2013. The patches will be printed at a size of 12x12 cm. and will be verified by Evaluation Contractor to match GRACoL 2013 (or SWOP 2013) to a tolerance of $\Delta E_{00} <= 3$ using an Xrite i1Pro2 spectrophotometer. Applicant must supply hard copy proofs of the CMYK_Sim_Ref patches if the intended reference print characterization for certification is other than GRACoL2013 or SWOP 2013.

2.4 Measurement devices

Applicant should supply a measurement device for display calibration and profiling. The resulting display profile must be accessible to Contractor. If a measurement device is "built-in" to a display, Applicant should correlate this device to a trusted spectrophotometer in advance and incorporate appropriate compensations. Evaluation Contractor will maintain a contact spectrophotometer (Xrite i1Pro2) and tele-radiometer (Photo Research PR-655) for spectral measurement of displayed and printed test patches. Evaluation Contractor will periodically verify the calibration of these devices.

2.5 Patch display and measurement software

Applicant should supply software for displaying Display_RGB_Ref and CMYK_Gamut_Ref test patches on screen, recording measurements and saving colorimetric data in an ISO 28178 compatible file. This function may be a component in Applicant's system software, or a stand-alone utility application. Contractor can advise on commercially available software for this function. A contact spectrophotometer for taking the measurements should also be supplied by Applicant. Optionally, the Contractor will maintain an Xrite i1Pro2, which may be used instead.

Applicant must also provide a means for displaying the CMYK_Sim_Ref test patches in absolute colorimetric rendering for the intended reference print characterization. An option for this will be provided by Idealliance in the form of a PDF/X file, CMYK_Sim_Patches.pdf, which contains the patches as images on individual pages. This file can be properly displayed in Adobe Acrobat Pro, with Output Preview enabled and the simulation profile selected. The display of these patches does not need to be synchronized since measurement will be performed using the PR-655 with manual triggering.

2.6 Visual test images

An informative visual assessment of soft proofing performance will be performed using selected ISO 12640 (SCID) CMYK test images. Files of these test images are available for download from the Idealliance web site for use in this certification process only. Applicant should supply high quality hard copy proofs of these images calibrated to the intended reference print characterization, i.e GRACoL2013 or SWOP 2013 or other alternative.

2.7 Spot color soft proofing

At Applicants request, a system may be tested for accurate simulation of spot colors. A spot color PDF/X test file containing a selection of spot colors from the Pantone Solid Coated library is available from Idealliance. The test will verify the capability to process spot color information

and accurately display the in-gamut colors. The system should provide a gamut warning for spot colors that lie outside the display gamut.

2.8 Colorimetric calculations and the use of Delta E (2000)

CIE XYZ tristimulus values and other colorimetric quantities are calculated according to ISO 13655:2009. Colorimetric tolerances, unless otherwise stated, are based on the CIEDE2000 color difference formula, abbreviated as ΔE_{00}. This weighted color difference equation provides good correlation to perceived color differences and is specified in ISO 13655:2009.

2.9 Related ISO standards

Testing procedures and evaluation protocols will be derived from specifications, either wholly or in part, found in the following standards.

CGATS 21:2013 Graphic Technology – Printing digital data across multiple technologies

ISO 3664:2009 Graphic technology and photography – Viewing conditions

ISO 12640-1:1995 Graphic Technology – Prepress digital data exchange – Standard colour image data (SCID)

ISO 12642:2006 Graphic Technology – Input data for characterization of 4-colour printing

ISO/DIS 12646:2014 Graphic Technology – Displays for colour proofing - characteristics

ISO 12647-7 Graphic Technology -- Process control for the production of halftone color separations, proof and production prints, Part 7: Proofing processes working from digital data

ISO 13655:2009 Graphic Technology – Spectral measurement and colorimetric computation for graphic arts images

ISO/DIS 14861:2014 Graphic Technology – Requirements for colour soft proofing systems

ISO 28178:2008 Graphic technology – Exchange format for colour and process control data using XML or ASCII text

3. Evaluation procedures

The following sections describe the measurement procedures, tolerances and visual assessments that are used to evaluate a display or system.

3.1 Hard copy viewing environment

A viewing booth at Evaluation Contractor site that conforms to the requirements in ISO 3664 will be used in the evaluation of soft proofing systems. Nominal viewing illuminant parameters are listed in Table 1. The P2 illuminance level of 500 lux, which aligns with a nominal luminance level (160 cd/m^2) for display evaluation, will typically be used. However it will be adjusted if the soft proofing system normally operates at higher display luminance levels. The

hard copy viewing environment will also comply with the recommendations on extraneous light and reflections described in ISO 3664.

Table 1. Tolerances for hard copy viewing booth taken from ISO 3664.

Viewing Illuminant Parameters	Tolerance
Illuminance (P2)	500 lux, +/- 125 lux
Chromaticity (D50, 1964 observer)	$u'_{10} = 0.2102$, $v'_{10} = 0.4889$, +/- 0.005
General CRI - Color Rendering Index	> 90
MI_v – Visual Metamerism Index	< 1.0 (C or better)
MI_u – UV Metamerism Index	< 1.5
Illuminance Uniformity (2 page area)	I_{min}/I_{max} >= 0.75

3.2 Display characteristics evaluation

In order for electronic displays to be effective for color soft proofing they must meet certain requirements of color stability, tone uniformity and angular viewing consistency. These requirements are evaluated using procedures and metrics taken from ISO 12646.

3.2.1 Calibration and stability

The display will be tested in a controlled environment (18-28°C) that shall not vary more than 0.5°C. Default calibration conditions will be 160 cd/m^2 luminance, 2.2 gamma, and CIE chromaticity (x=0.3478, y=0.3595) of D50/2 degree observer. However, applicant may request alternative calibration conditions for preferred system operation. After a 30-minute warm up followed by calibration, stability will be assessed every 15 minutes for a period of 90 minutes and must achieve a tolerance of +/- 2% in luminance and +/- 0.005 in xy chromaticity.

3.2.2 Normal tone and contrast uniformity

After calibration and stabilization, display uniformity is evaluated in a direction perpendicular (normal) to the screen at 25 equally spaced regions on the display as depicted in Figure 1 and described in ISO 12646.

Figure 1: Regions to be measured for assessing display uniformity

A contact spectrophotometer (i1Pro2) will be used to measure CIEXYZ values at three driving levels (White, Gray, Dark) in each region. Using the central region as reference, ΔE_{00} deviations will be calculated for each of the 24 surrounding regions for each driving level. Deviations of contrast, defined as Gray/White luminance ratio, will also be calculated for each region with reference to the central region. Tolerances are listed in Table 2.

Table 2. Tolerances for perpendicular (normal) tone uniformity.

Tone Uniformity	Requirements
Tone deviation (24 regions vs center)	
White (R=G=B=255)	ΔE_{00} <= 4
Gray (R=G=B=128)	ΔE_{00} <= 4
Dark (R=G=B=64)	ΔE_{00} <= 4
Contrast deviation (24 regions vs center)	
$CIEY_{Gray}/CIEY_{White}$	< 10%

Note: Measurements of some edge patches may require re-orientation of the i1Pro2. Any measurement deviation due to such device orientation will not cause failure of the test.

3.2.3 Angular tone and contrast uniformity

After calibration and stabilization, angular display uniformity is evaluated using the same 25 equally spaced regions across the screen, but in a direction angled from the central observer point as shown in Figure 3.

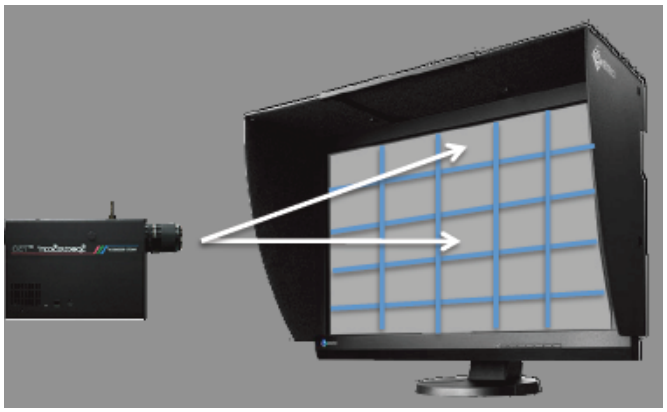

Figure 2: Assessing angular tone variation using a spectroradiometer.

CIEXYZ tone values will be measured at the various angles with a PR655 spectroradiometer. The device will be placed such that the sensor is a minimum of 50 centimeters from the screen center on the viewing axis normal to the screen surface and such that the maximum angle of will be 30 degrees or less. Measurements of the center will be used as reference in calculating the deviation at each of the 24 surrounding regions. Angular contrast uniformity is evaluated by calculating the Gray/White luminance ratio from these measurements. Tolerances are listed in Table 3.

Table 3. Tolerances for angular tone and contrast uniformity.

Angular Tone Uniformity	Requirements
Angular Tone deviation (24 regions vs center)	
White (R=G=B=255)	ΔE_{00} <= 10
Gray (R=G=B=128)	ΔE_{00} <= 10
Dark (R=G=B=64)	ΔE_{00} <= 10
Angular Contrast deviation (24 regions vs center)	
Y_{Gray}/Y_{White}	< 10%

Note: The procedure above deviates from the methodology in ISO 12646, which specifies angular measurements toward the center region from viewing locations perpendicular to the corners and edges of the display screen. The method of evaluation described above more directly replicates the angular geometry for an actual observer positioned at the central viewing point.

3.3 System colorimetric evaluation

Requirements for system colorimetric performance are taken from specifications in ISO 14861. In preparation for evaluation testing, the system is to be calibrated and profiled according to system instructions.

Note: It is understood that the two measurement devices, i1Pro2 and PR655, have significantly different measurement geometry. Thus measurements from the two devices are not compared to each other in any of the evaluations below.

3.3.1 Display driving evaluation

Display driving is evaluated by how well the display is characterized by its ICC display profile and its ability to achieve the gamut of the intended reference characterization. It consists of two tests.

First, the 318 Display_RGB_Ref test patches will be directly displayed (i.e. display profile is source profile for patches) at screen center as depicted in Figure 3 and measured sequentially with the same device that was used to calibrate and profile the display.

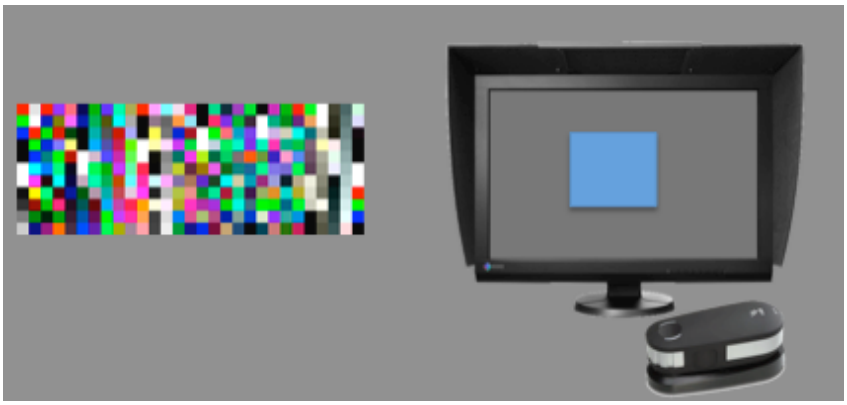

Figure 3. Display RGB patch set and measurement.

Color differences between recorded measurements and values predicted by the display profile (absolute rendering intent) should conform to tolerances in Table 4.

Table 4. Display calibration tolerances for RGB test patches

Display Characterization	Requirements
318 RGB_Display_Ref patches	Average ΔE_{00} <= 2.5 95% ΔE_{00} <= 4.0

Second, the 226 outer gamut CMYK patches identified in Section 2.2 will be similarly displayed and measured sequentially as depicted in Figure 4.

Figure 4. CMYK outer gamut patch set and measurement.

Color differences calculated with respect to the intended CMYK reference profile (absolute rendering intent) should conform to the tolerances in Table 5. This test verifies that the display gamut is sufficient to simulate intended reference print characterization.

Table 5. Tolerance for CMYK outer gamut patches

Test	Requirement
226 CMYK_Gamut_Ref patches	Maximum ΔE_{00} <= 3

3.3.2 CMYK simulation

To test the reproduction (simulation) quality, measurements will be made with the PR655 tele-spectroradiometer. Displayed patches, representing the 84 CMYK_Sim_Ref values, shall be sequentially displayed and measured at the center of the display. These measurements will be compared to measurements of the printed patches taken at the intended viewing plane of a view booth as depicted in Figure 5. The view booth shall comply with the conditions in section 3.1.

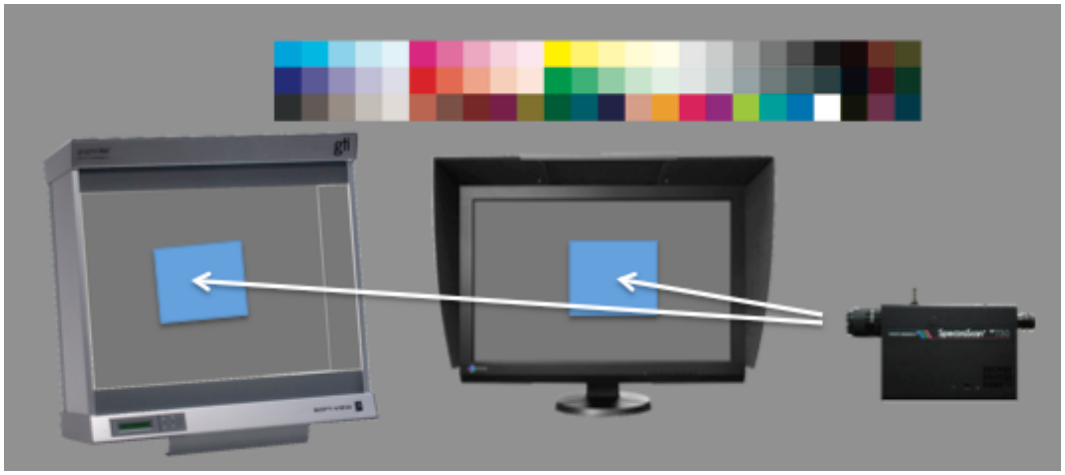

Figure 5. CMYK test set and measurement of printed and displayed patches.

An imperfect colorimetric match between the printed and displayed white patches may unduly impact the colorimetric comparison between other colors. Therefore a linear CIEXYZ scaling will be applied to the display and/or print measurements such that the displayed white patch XYZ values will match those of the printed white patch. In addition, dark end normalization between display and print measurements may be incorporated into the scaling if necessary to compensate for differences in flare between print and display setups. Table 6 shows the colorimetric requirements that should be attained in terms of computed ΔE_{00} color differences for the set of patches. In addition, the CIEY contrast between the paper white patch and the black patch (CMYK=0,0,0,100) will be calculated and shall attain a value between 0.5 and 2.0.

Table 6. Colorimetric tolerances for evaluating display-to-print match

Display / Print Comparison	Requirements
84 CMYK_Sim_Ref patches	Mean ΔE_{00} <= 4 Max. ΔE_{00} <= 6.5 Primaries – Max. ΔE_{00} <= 5 Composed Grays – Max. ΔE_{00} <= 3
Ratio of W/B contrast	$0.5 <= (Y_w/Y_b)_{print} / (Y_w/Y_b)_{display} <= 2.0$

3.3.3 Visual assessment of color match (informative)

Selected CMYK test images from ISO 12640 will be used to check the visual quality of simulation. A visual inspection will examine smoothness, white point, dark end, uniformity, contrast and overall color match to hardcopy proofs as depicted in Figure 6. Individuals experienced in critical color reproduction for printing and premedia will perform the visual assessment. These observations will serve as an informative complement to measurement results obtained in sections 3.2 and 3.3, and are intended to identify artifacts or unexpected performance. Results will be reported as qualitative descriptions of the match between display and print. (Note: Applicant should supply high quality inkjet proof prints of the visual test images

calibrated to the intended reference print condition, i.e. GRACoL2013 or SWOP2013 or other)

Figure 6. Visual comparison between print and soft proof

3.3.4 Spot color simulation (optional)

A spot color test file in PDF/X format described in section 2.7 and depicted in Figure 7 will be displayed and the individual patches measured with an i1Pro2. The required tolerance for spot colors that lie within the display gamut is ΔE_{00} <= 3. An out-of-gamut warning should indicate if a spot color lies outside the display gamut.

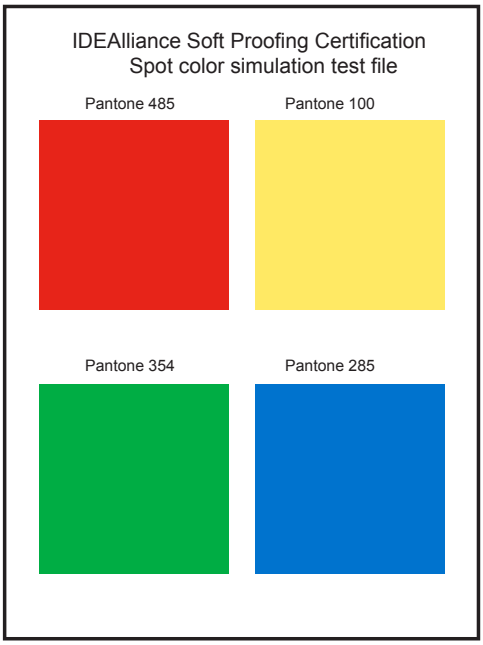

Figure 7. Spot color PDF test file.