IDEAlliance Guide to M1 Workflow

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This document is intended as brief guide to using M1 measurement devices to color manage optically brightened papers. The document begins with terminology and introductory information about M1. To go right to the procedures to be used for color managing optically brightened papers using M1 measurement go to the section titled The M1 Workflow that begins on page 4.

Note: This document is a working draft, and will be revised as new information becomes available. Please check back at www.gracol.org for updated versions.

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Introduction

Before 2009, industry standards for D50 color-viewing and D50 color-measurement did not set requirements for the UV portion of the illuminating source. As a result, industry-standard color-viewing lamps contained little or no UV output and did not produce the level of whiteness and the color gamut of natural daylight. Similarly, industry standard measurement devices did not consistently characterize the influence of optical brightening agents (OBAs) on the apparent reflectance of print graphics.

The limited UV output of the typical viewing lamps before 2009 resulted in limited limited OBA excitement by the UV energy. Commercial printing papers historically did not contain OBA unless they were intended for high jobs. As a result, color matching could be achieved more easily by using a proof that, like the commercial papers, contained little or no OBAs, eliminating the UV variable. Therefore, it became common for proofing substrate manufacturers to offer a product with “no OBAs” for better proof-to-press sheet matching. But paper makers are now adding significant amounts of OBA into all print substrates.

In 2009, ISO 3664 Graphic Technology (lighting) and photography - Viewing conditions was updated to tighten the tolerances for the UV portion of the D50 spectrum. Under ISO 3664:2009, viewing lamps must contain an amount of UV that is similar to D50, so that a press sheet (or proof) with optical brighteners would be “appropriately excited” with the correct amount of UV, making for a more consistent appearance in the viewing cabinet.

Also in 2009, ISO 13655 Graphic Technology – Spectral measurement and colorimetric computation for graphic arts images, new classifications of measurements were introduced to differentiate legacy unfiltered measurements (M0) and new D50 full spectrum measurements (M1). Using ISO 13655:2009 M1 measurement and ISO 3664:2009 lighting, UV contents of the viewing light and UV contents of the measurement light are in better alignment. There was just one problem: in many cases, the disparate OBA content of the press sheet and of proofing substrate meant that the two no longer matched visually or instrumentally.

With the enhanced correlation to D50 in measurement and viewing, the quantity of OBA in the press sheet and the proofing substrate returned to the spotlight. In cases where press sheets had significant OBAs, they would look blue in comparison to the OBA-free proofing stocks in conforming to ISO 3663:2009 lighting. Press sheets and proofing substrates that appeared to match in a legacy viewing cabinet before no longer matched due to OBA excitement.

In order to overcome these new challenges in proof-to-print matching, a small group of printing experts from the IDEAlliance Print Properties and Colorimetric Council began working on the solution, code-named the “M1 Workflow.”
**What are M0, M1, M2, and M3?**

ISO 13655:2009 provides us with a series of “measurement conditions” that can be used to differentiate whether or not a measurement was captured “the old way with UV included”, “the new way with UV included”, and whether or not the measurement was filtered with a UV-cut filter or a polarizing filter. It also, for the first time, standardized the illuminant used for instrumentation so that two devices using the M1 condition report the effect of OBA in the same way. Graphic reproduction was finally able to take spectral readings with the same level of standardization.

**The old way with UV included: M0**

Prior to ISO 13655:2009, instrument manufacturers had the liberty to characterize the UV portion of the spectrum in accordance with their own technical expertise. Accordingly, different instruments, made by different manufacturers had varying amounts of UV in their instrument light sources. The result: different characterization of OBA effects resulting in slightly different measurements. M0 is fully consistent with instruments used in specification laboratories. However, when used with ISO 3664:2009 lighting, M0 does not excite OBAs in the same way that the viewing light source excites them.

**The new way with UV included: M1**

M1 uses a calibrated amount of UV in the instrument source to more accurately capture the effect of OBAs on appearance under simulated D50 lighting. If you are not using controlled lighting (ISO 3664:2009) to simulate D50, there are limited benefits to buying new measurement devices that support M1 measurement. However, if you are working with optically brightened press sheets, using ISO complaint D50 lighting, then instruments that support M1 is essential.

**Using a UV-cut filter: M2.**

In addition to “unfiltered” measurement, ISO provides measurement conditions for “filtered” measurements as well. For UV-cut measurement, the ISO measurement condition is M2. The intention is to remove all excitation energy below 400 nm. While this does not completely eliminate the OBA emission, it reduces the emission to a level where it is no longer a significant contributor to spectral radiance factor.

**Using a polarizing filter: M3**

Some specialty measurement applications benefit from using crossed polarization filters. ISO 13655:2009 accommodates this measurement also. The measurement condition for polarized measurement is M3 which also requires the same UV cut condition as M2.
Quantifying OBA Effect

ISO/FDIS 15397 (2013) describes two methods to quantify OBA effect in paper. One of the methods is based on the CIELAB-b* value of the paper under two measurement conditions. As detailed in clause 5.12 of ISO/FDIS 15397, the difference of the CIE-b*-values indicates the degree of fluorescence that can be expected in graphic arts viewing and measurements. In other words, S is used to notate substrate as follows: the metric, OBA_S, quantifies the OBA amount in a substrate as follows:

\[ OBA_S = b^*_M2 - b^*_M1 \]  
Eq. (1)

Note the quantity, \( b^*_M1 \), is the CIE-b* value of the paper when the instrument source has the full UV content of D50, and the quantity, \( b^*_M2 \), is the CIE-b* value of the paper when UV is excluded from the source. Thus, OBA_S is the difference between two measurements, M1 and M2, from the same substrate.

While the paper industry is interested in quantifying the degree of fluorescence, i.e., the OBA amount, the graphic arts industry is interested in color match between a printing substrate and a proofing substrate. For this reason, the metric, \( \Delta OBA_S \), is defined as the difference in OBA amounts between proof and print.

\[ \Delta OBA_S = OBA_{Proof} - OBA_{Print} \]  
Eq. (2)

In color proofing, it is the OBA difference between the two substrates (\( \Delta OBA_S \)), not the OBA amount of the substrate that influences their visual difference. In other words, the larger the \( \Delta OBA_S \) is, the more critical is the viewing illumination and the color management task in achieving color match in the M1 color-managed workflow.

GRACoL® 2013, ISO 15339, and the CGATS.21 datasets all are based on M1 measurements. For calibration and color matching when using stocks containing OBA all measurements should be M1. Press side process control measurements may be M0, referencing the calibration state achieved with M1 measurements.

The M1 Workflow

The M1 measurement standards open the door to a new way of measuring. Previously, color management did not work well with optically brightened substrates. M1 changes all that and gives us the promise of proofing and press matching with brightened stocks. M1 is about to change the way we do everything in the world of color management.

In 2013 and 2014, ISO and ANSI/CGATS introduced a new set of standards and characterization data based on M1. The famous ISO 12647-2 standard was updated using M1 measurements, and the new G7 based CGATS.21 and ISO 15339 are all based on M1 measurement. These new standards give us more realistic paper colors and aims, as well as the ability to customize based on actual substrate colors.
The path to implementing the M1 Workflow involves new lighting, new measuring instruments, and procedures to assure good results. This document describes one way to put the pieces of this workflow together. The following is the procedure for use with an M1 workflow:

1. Verify lighting conditions are in compliance with ISO 3664:2009. Lighting conditions can be verified in the following manner:
   a. Having the viewing cabinet manufacturer verify the viewing condition and provide a certificate of compliance.
   b. Installing only new or within specification ISO 3664:2009 certified lamps in the viewing booth.

2. Use M1 measurements to characterize and generate ICC profiles of printing and proofing devices with substrates containing OBA.

Note: If you do not have the above two requirements, i.e., ISO 3664:2009 compliant lighting and the M1 measurement instrument, you do not have the M1 workflow.

3. Identify the Characterized Reference Print Condition (CRPC).
   a. M1 workflow changes how we print to color conformance. M1 workflow is printing to standard datasets, e.g., CRPC-6.
   b. The reference printing condition should be based on M1. Examples of reference printing conditions based on M1 are datasets from CGATS.21-2 and ISO 15339-2. (SWOP3, SWOP5 and GRACoL_2013.icc are ICC profiles generated from the CGATS21-2-CRPC6 dataset.)

4. Identify the substrate to be used for printing.
   a. The substrate should have similar print characteristics to the selected dataset. For example, a coated dataset should be matched to a coated sheet, and an uncoated dataset to an uncoated sheet.
   b. Print characteristics and surface type should be taken into consideration. For example, for work on an uncoated paper a dataset for a coated paper would not be appropriate.
   c. Record the OBA amount of the printing substrate using Eq. (1).

5. Determine the Target Printing Condition.
   a. The substrate should fall within the usable colorimetric range of the specified CRPC as outlined in CGATSCGATS.21-11.
   b. Record the CIELAB and OBA of the substrate.
   c. If the substrate white point is in compliance ($\Delta E_{00} \leq 2$), this is the target print condition.
   d. If the substrate is not within compliance, then calculate the target printing condition using the substrate relativity calculator.
   e. Because of the substrate difference between the white point of the CRPC and the OBA brightened printing paper, printing to substrate-corrected colorimetric aims (SCCA) using M1 metrology is mandatory.
   f. Use the substrate-corrected dataset to specify new process control aims and to generate a custom ICC profile for color proofing.
   g. If the substrate-corrected dataset is used, it must be communicated to all parties in the workflow (proofing, press, print buyer, etc.).

6. Print to substrate-corrected process control aims using M1 measurement.
7. Select a proofing substrate that has adequate “head room” to avoid gamut clipping. Experiences have shown that a proofing substrate should have a slightly larger L* value (no higher than 2 L*) and a larger OBA value (no higher than 5 OBA) than the printing paper (Figure 1).

![Proofing substrate selection criteria](image)

**Figure 1.** Proofing substrate selection criteria

8. Produce color-managed proofs using the device link between substrate-corrected CRPC6 ICC profile and proofer ICC profile in Absolute colorimetric rendering intent.


**Tips, Hints, and Trouble-Shooting**

The paper industry is mainly interested in quantifying the fluorescence of paper. The graphic arts industry is interested in achieving proof and print visual match. M1 workflow addresses proof-to-print color match under the influence of OBA. This guideline offers the following tips and hints for trouble-shooting the M1 workflow.

**Q:** I’m a graphic arts designer. What do I need to know about the M1 workflow?

**A:** You will continue to select a standard CMYK color space, e.g., GRACoL, as the Working Space in the Adobe CS (Creative Suite) When the paper stock
has not been specified for the job, the color proof should match the standard dataset. When the paper stock has been specified for the job, the color proof should match the substrate-corrected dataset. This is the beginning of the M1 workflow.

Q: Currently, there is no OBA-loaded paper used in my printing workflow. What do you recommend?

A: This is the legacy workflow we used to have. Namely, the OBA of the printing paper is less than 3. Thus, you can continue printing to the standard process control aims, and proofing to the published CRPC using a standard printer ICC profile. The proof-to-print visual match does not require the new viewing condition.

Q: When should I care about the M1 technology in printing and proofing workflow?

A: When print buyers complain about the poor color match between what you print and the contract proof you use.

Q: I routinely print on moderate to high OBA stock and my proofing substrate has no OBA. What do you recommend?

A: Many printers are in the same boat. Proof-to-print color mismatch is the problem. Implementing M1 technology and the workflow is in order. Follow the M1 workflow guidelines, discussed in this publication.

Q: Why are color management and $\Delta$OBA important in achieving proof-to-print color match?

A: ICC color management promises “What You See is What You Get” by transforming color, pixel by pixel, using multi-dimensional look-up tables via a device link or between device spaces and PCS. If the bluish highlights of the OBA brightened print is out of the gamut of the proofer color space, poor color match between proof and print will result. If we keep the $\Delta$OBA small in the color management settings, we can avoid the gamut clipping in the highlights, thus, ensure the WYSIWYG color between proof and print.

Q: Why are certified color measurement devices and certified viewing cabinets important in the M1 workflow?

A: In order to obtain color match between printed color on brightened stock and proof on non-brightened stock, the characteristics of OBA print, as detected by the measurement light source and as visually examined in the viewing light source, must be taken into consideration. If the viewing light source has more UV energy than the measurement light source, the brightened print will look bluer than the non-brightened proof. If the viewing light source has less UV energy than the measurement light source, the brightened print will look
yellower than the non-brightened proof. This is why we need certified instruments and viewing cabinets to ensure the benefits of the M1 workflow.

Q: I’ve implemented M1 workflow by printing and proofing to substrate-corrected dataset (SCCA). I recognized the improvement in color match between the brightened print and the non-brightened proof. How can I improve the color match further?

A: SCCA is substrate-adjusted numerical values. When print and proof conform to SCCA, it does not necessarily mean that print and proof will match visually. This is because conformity is based on acceptability (tolerances), not perceptibility. The probability of visual match will be high if tighter tolerances (95%tile is less than 2ΔE00) are met between print and SCCA and between proof and SCCA.

Q: ISO/FDIS 15397 (2013) describes two metrics, ΔB and OBA_S, to quantify the fluorescence effect in paper. Why is ΔB metric not preferred?

A: The ΔB metric is based on the brightness value of the paper under D65 illumination, i.e., the fluorescence effect is the difference of D65/10-degree brightness measurement performed with UV and with a UV-cut filter. The graphic art industry uses D50/2-degree as the primary illuminant/observer combination, not D65/10-degree, to measure color. Therefore, we can use the same color measurement conditions (D50) to assess the fluorescence effect in paper using the OBA_S metric.