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Graphic technology — Graphic arts transmission densitometry — Terminology, equations, image elements and procedures

Supplement 1

SECRETARIAT
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CGATS

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Foreword

This Supplement to CGATS.5-2005 corrects errors in Annex F (Table F.1) and Annex G of that standard, and adds a new Informative Annex I that defines a method for correcting measured colorimetric data for differences in backing material.

The Committee for Graphic Arts Technologies Standards (CGATS) was accredited by the American National Standards Institute in 1989 to serve as the coordinator of graphic arts standards activities. CGATS identifies areas in which standards are needed and desired, respecting the established activities of existing accredited standards committees and industry standards developers. CGATS writes standards only where need exists and no other committee is undertaking the writing.

This edition of CGATS.9 updates and replaces the 1994 version of this document. It includes no substantial technical changes but has been reorganized to make the information more readily accessible and to bring some nomenclature into closer agreement with that used in ISO. CGATS recommends the voluntary implementation and use of this standard by all segments of the graphic arts industry.

Requests for interpretation must be sent in writing to the CGATS Secretariat. This request will be forwarded to the appropriate committee, which will respond in writing. A statement, written or oral, that is not processed in accordance with the procedures noted above will not be considered the official position of CGATS, and should not be relied upon as a Formal Interpretation.

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Annex F
(informative)

Aperture size in reflectance measurements

Target elements on print control strips are seldom larger than 5 mm square and small spot 45/0 and 0/45 geometry spectrophotometers are available to read them. The small size of the targets and the small aperture required to read them requires special consideration of variations due to translucent blurring (lateral scattering) error.

When a sample is translucent, some of the illuminating light penetrates the sample and scatters laterally to points outside of the area viewed by the instrument detector, causing the reported reflectance values to be lower than they would be if all the reflected light were collected. The interaction between the translucency of the sample and optical configuration of the instrument is called translucent blurring, and the difference in the reflectance factor measured on the translucent sample compared to the corrected reflectance factor is called translucent blurring error [17,23].

White glass reflectance standards and pressed powder pellets often used to calibrate large aperture spectrophotometers are generally translucent. Graphic arts proofing and printing substrates are translucent to some degree.

To minimize translucent blurring error, large uniform samples are measured by illuminating a spot larger than the measurement aperture (over-illumination). ISO 5-4 requires that the "irradiated area of the specimen shall be greater than the sampling aperture, and its boundary shall lie at least 2 mm beyond the boundary of the sampling aperture." Based on the principle of optical reciprocity, equivalent measurements can be made with the viewing area larger than the irradiated area (over-collection).

For targets 5 mm and smaller it is not practical to over-illuminate (or over-collect) with a 2 mm annular ring since the measurement aperture would be 1 mm or less. For graphic arts applications it is recommended that the boundary of the irradiated area should be at least 0.5 mm outside the boundary of the sampling aperture.

To minimize errors due to translucent blurring (light laterally spreading within the specimen beyond the limits of the aperture), it is important to use opaque calibration reference materials with low internal light scattering properties. This eliminates one source of translucent blurring error.

Compared to white glass reference materials, targets on paper are relatively opaque and the use of black backing further reduces the scattering that causes translucent blurring error. Where the material being measured is translucent, it is desirable to have the illuminating beam significantly smaller or larger than the viewing beam. ASTM E 1164 [15] specifies an annular ring approximately equal to the depth of penetration of the light into the specimen. This spreading within the specimen may occur as the result of coarse texture, translucency, or creped construction.

Another factor that must be considered in the selection of instrument aperture when measuring halftone images is the relationship to screen ruling. Table F.1 shows the minimum recommended aperture size as a function of common screen rulings.

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Table F.1 — Minimum and recommended aperture size and sampling area

Nominal screen frequency		Round sampling aperture (mm)		Non-round sampling area [1] (mm^2)	
lines/inch	**lines/cm**	**Minimum**	**Recommended**	**Minimum**	**Recommended**
65	26	3.8	5.7	11.3	25.5
85	33	3.0	4.5	7.1	15.9
100	39	2.6	3.9	5.3	11.9
120	47	2.1	3.2	3.5	7.8
133	52	1.9	2.9	2.8	6.4
150	59	1.7	2.6	2.3	5.1
175	69	1.4	2.1	1.5	3.5
200	79	1.3	2.0	1.3	3.0

NOTE These sampling aperture sizes are valid for instruments that are not moving relative to the target and have a round aperture. For scanning instruments or instruments with apertures that are not round, the equivalent measurement area should be covered.

[1] Area can be achieved using either a single measurement, or by averaging multiple measurements in random or adjacent locations on the sample. This includes the use of scanning type instruments that make continuous measurements from a sample.

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Annex G
(informative)

Procedures for widening the bandwidth of narrow bandpass instruments

This standard describes procedures for tristimulus integration of spectral measurements taken with either 10 nm or 20 nm bandwidth instruments. The ASTM method for tristimulus integration assumes that the instrument bandwidth and sampling interval are approximately equal (20 nm bandwidth implies a 20 nm sampling interval). A triangular response function with the half-power point equal to the bandwidth is also assumed. Some laboratory instruments make measurements with bandwidths that are smaller than this. To make use of the 10 or 20 nm spectral weights in the standard such data, collected at narrower intervals, it must be integrated to either 10 or 20 nm effective bandwidth.

The technique that is used to create the desired data is to successively apply a triangular weighting function, which is based on the desired (new) sampling intervals and bandwidth, to the existing data. This weighted data is then summed over the appropriate interval and normalized by the sum of the weights used. This process is repeated for each new data point required. The triangular weighting function is a linear function that is 1 at the wavelength of interest and 0 at a point that is equal to one desired bandwidth greater and less than the wavelength of interest.

As an example, assume that data is available at 2 nm intervals and that data is desired at 10 nm intervals (and 10 nm bandwidth).

1. The calculation of the estimated value at 450 nm uses data from 440 to 460 nm (plus and minus one bandwidth). The data points for the available 2 nm data are at … 440, 442, 444 …. 458, 460, 462, etc … nm.

2. A proper triangular function for these conditions would then be 11 points, the wavelength of interest (because it occurs in both the 2 nm and the desired 10 nm data) and 5 points (10 nm) on either side of the wavelength of interest. Since the slope of the triangle is linear, the weights will be 0.0, 0.2, 0.4, 0.6, 0.8, 1.0, 0.8, 0.6, 0.4, 0.2, 0.0.

3. Because the sum of the weights must be normalized to unity (1.0), and the sum of the weights is 5, the resultant summation must be divided by 5.

The calculation of the estimated reflectance (Rf) at 450 nm for a 10 nm bandwidth is therefore:

$$Rf_{10}(450) = [1/5] \times [0.0 \times Rf_2(440) + 0.2 \times Rf_2(442) + 0.4 \times Rf_2(444) + 0.6 \times Rf_2(446) + 0.8 \times Rf_2(448) + 1.0 \times Rf_2(450) + 0.8 \times Rf_2(452) + 0.6 \times Rf_2(454) + 0.4 \times Rf_2(456) + 0.2 \times Rf_2(458) + 0.0 \times Rf_2(460)]$$

This process would be repeated at 10 nm intervals over the wavelength range of 360 nm to 780 nm. Similar procedures would be used for other bandwidth and sampling intervals.

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ANNEX I
(informative)

Correcting measured colorimetric data for differences in backing material

I.1 Introduction

The question of which backing to use when making spectral reflectance measurements has many answers depending on the application and perspective of those using the data. The densitometry standards all call for a black backing to minimize the impact of back printing and to minimize variability due to translucency effects and local variations in opacity and backing uniformity. The color management world finds more consistent results between visual comparisons of proof and print when using profiles based on white or self backing.

The following methodology, referred to as the tristimulus correction method, is provided to convert colorimetric data of halftone samples measured over one backing to approximate that measured over another backing. The only input used is the tristimulus values of the substrate alone over the second backing.

The tristimulus correction method is based on the observation that when the deltas in X, Y, and Z between measurements made over two backing materials (i.e. black and white) are plotted vs. the X, Y, and Z values for measurements made over either material the best fit result is approximately a straight line. At the lowest value of each tristimulus value, the delta between measurements made over the two backings is at or near zero. The maximum difference in measurement due to backing material characteristics is always at the maximum tristimulus value that equates to a measurement of the substrate (usually paper) alone; i.e., in an area containing no printing.

I.2 Calculation procedure

Measurements over one backing can be used to estimate the measurements that would be made over another backing by simply adding (or subtracting) a correction factor in X, Y, and Z. This correction factor is simply a proportional amount of the difference between measurements of the substrate alone over the two backings where the proportion added is defined by the value of X (or Y, or Z) on the first substrate compared to the minimum value of X and the value of X for the substrate alone.

This leads to a correction equation for X as follows:

$$X(n)_2 = X(n)_1 + (X(s)_2 - X(s)_1) * \frac{(X(n)_1 - X_{MIN})}{(X(s)_1 - X_{MIN})}$$

where

$X(n)_1$ = Measured value of X for sample n over backing 1

$X(n)_2$ = Predicted value of X for sample n over backing 2

$X(s)_1$ = Measured value of X of the substrate over backing 1

$X(s)_2$ = Measured value of X of the substrate over backing 2

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X_{MIN} = Minimum value of X which generally corresponds to a 4-color solid, which is patch ID 24 of the IT8.7/3 data set or patch ID 1286 of the IT8.7/4 data set.

For computation this equation can be rearranged as follows:

$$X(n)_2 = (X(n)_1 * (1 + C_1)) - C_2$$

where:

$$C_1 = \frac{X(s)_2 - X(s)_1}{X(s)_1 - X_{MIN}}$$

and

$$C_2 = C_1 * X_{min}$$

Corrections for Y and Z of the individual samples are accomplished in a similar manner and CIE L*, a* and b* values are computed from the new tristimulus values.

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