Adobe RGB Color Space Specification

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Specification of the Adobe RGB (1998) color space

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The Adobe RGB Color Space And Color Encoding

1 Scope

This document specifies a family of output-referred RGB color encodings named Adobe RGB to be used for digital exchange of Adobe RGB-encoded color data.

The Adobe RGB color space has a color gamut that is larger than sRGB (IEC61966–2.1) and closer to typical press gamuts. Adobe RGB is a monitor space, designed to be suited for print production with a broad range of colors.

The goal of publishing this specification is to enable vendors to construct equipment and products that will interoperate with similar products from other vendors.

2 Normative References

The following international standards are referenced in this text.

CIE Publication 15.2, Colorimetry

ICC.1:2001, File Format for Color Profiles

ISO 22028-1:2004, Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange

ISO 3664:2000, Viewing conditions – Graphic technology and photography

3 Requirements

3.1 Color space parameters

The full name of the Adobe RGB color space and color encoding is "Adobe RGB (1998)" with 1998 indicating the year of the version of the color specification. The shorter name "Adobe RGB" can be used, when not referencing a specific version.

"AdobeRGB" (without a space) shall be the reference name for Adobe RGB when used with PDF/X.

The Adobe RGB color space models an RGB display device. The color gamut of an Adobe RGB display device shall be the full Adobe RGB color space.

The image state of the Adobe RGB color space is output-referred as defined in ISO 22028-1:2004.

3.1.1 Chromaticity values

The chromaticity values for the Adobe RGB primaries shall be as follows:

Red	x=0.6400, y=0.3300
Green	x=0.2100, y=0.7100
Blue	x=0.1500, y=0.0600

Equal component values for the three primaries shall produce neutral colors with the following chromaticity values:

Neutral x=0.3127, y=0.3290

Note: The neutral chromaticity values correspond to CIE Illuminant D65.

3.1.2 White point and black point

Adobe RGB component values 1, 1, 1 shall produce the Adobe RGB white point. The luminance level of the Adobe RGB device white point shall be 200 cd/m^2. The corresponding XYZ_W tristimulus values shall be $X_W = 190.09$, $Y_W = 200.00$, $Z_W = 217.81$.

Adobe RGB component values 0, 0, 0 shall produce the Adobe RGB black point. The luminance level of the Adobe RGB device black point shall be 0.34731% of the white point luminance level. The corresponding XYZ_K tristimulus values shall be $X_K = 0.6602$, $Y_K = 0.6946$, $Z_K = 0.7565$.

3.1.3 Color component transfer function

The color component transfer function from device values to tristimulus values shall be:

- tristimulus value = Adobe RGB component value $^{2.199}$

where Adobe RGB component value shall be in the range [0, 1]

A linear section near 0 is permitted. If used, it shall be as follows:

- tristimulus value = max (component value $^{2.199}$, component value / K),

where K >= 32

Note: Decimal 2.199 = hexadecimal 02.33

3.1.4 Reference Viewing Conditions

Specifications for the reference viewing environments are based on ISO 3664:2000, standard and are defined as follows:

1. Reference Background — For the background as part of the monitor screen, the background is 20% of the reference monitor luminance level at the reference monitor white point. For the background beyond the monitor screen, the reference background is 20% reflectance of the reference ambient illuminance level
2. Reference Surround — 20% reflectance of the reference ambient illuminance level
3. Reference Ambient Illuminance Level — 64 lux
4. Reference Ambient White Point — x = 0.3457, y = 0.3585 (D50)
5. Reference Viewing Flare — 0%

   Note: ICC recommends that display measurement be made from the viewer position using a telescopic instrument, so viewer observed veiling glare in the reference viewing environment is included in the black point measurement.

3.1.5 Reference Observer Conditions

The reference observer is the CIE 1931 two-degree standard observer from the CIE 15.2 Colorimetry standard.

3.1.6 Encoding formats

Adobe RGB color component values can be encoded using integer or floating-point encodings.

Integer encodings shall be unsigned with 8, 10, 12, or 16 bits per component with the same number of bits for all three components. The component value range [0, 1] shall be encoded over the code value range [0, max integer value]. R', G', B' code values of 0, 0, 0 shall represent the Adobe RGB black point, and max integer code values shall represent the Adobe RGB white point. For integer encodings, all color values are within the Adobe RGB device gamut.

Floating-point encodings shall be 32 bit per component using the format specified in IEEE XXX. In floating-point encodings, a component value and its encoding value are the same. Code values 0.0, 0.0, 0.0 shall represent the Adobe RGB black point, and code values 1.0, 1.0, 1.0 shall represent the Adobe RGB white point. Component values outside the range [0, 1] are not allowed for floating-point encodings.

3.1.7 Precision

The difference between an original 24-bit Adobe RGB value, and the same value converted to XYZ, with the result converted back to 24-bit Adobe RGB, shall be 0, 0, 0, for any 24-bit RGB value.

The absolute difference between XYZ values provided by applying the specification and corresponding XYZ values provided by an implementation shall not exceed 0.000015, for any Adobe RGB value.

Note: 0.000015 is approx. 1/2 of 1/32768, which is the relative resolution of encoded XYZ values in ICC.1 version 2 PCS, where Y for white is encoded as 32768.

3.2 Conversion characteristics

3.2.1 Conversion from 24-bit Adobe RGB to XYZ (D65)

The three R'_8, G'_8, B'_8 8-bit channel values in 24-bit Adobe RGB shall be converted to R, G, B tristimulus values of range [0, 1] as follows:

$$R = \left(\frac{R'_8}{255}\right)^{2.199}$$

$$G = \left(\frac{G'_8}{255}\right)^{2.199}$$

$$B = \left(\frac{B'_8}{255}\right)^{2.199}$$

For Adobe RGB integer color encodings with a bit depth N other than eight, 255 in above formulas shall be replaced with (2^N-1).

The R, G, B tristimulus values shall be converted to XYZ tristimulus values as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.57667 & 0.18556 & 0.18823 \\ 0.29735 & 0.62736 & 0.07529 \\ 0.02703 & 0.07069 & 0.99133 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Absolute luminance $X_aY_aZ_a$ tristimulus values shall be obtained from XYZ tristimulus values as follows:

$$X_a = X(X_W - X_K)\frac{Y_W}{X_W} + X_K$$
$$Y_a = Y(Y_W - Y_K) + Y_K$$
$$Z_a = Z(Z_W - Z_K)\frac{Y_W}{Z_W} + Z_K$$

Notes:

The above conversion can be derived from the color space parameters.

The matrix is derived from the color space chromaticity values.

The range of Y is [0, 1], corresponding to the range from the Adobe RGB black point to the Adobe RGB white point.

3.2.2 Conversion from XYZ (D65) to 24-bit Adobe RGB

XYZ tristimulus values shall be obtained from absolute luminance $X_aY_aZ_a$ tristimulus values as follows

$$X = \frac{(X_a - X_K)}{(X_W - X_K)}\frac{X_W}{Y_W}$$
$$Y = \frac{(Y_a - Y_K)}{(Y_W - Y_K)}$$
$$Z = \frac{(Z_a - Z_K)}{(Z_W - Z_K)}\frac{Z_W}{Y_W}$$

The XYZ tristimulus values shall be converted to R, G, B tristimulus values as follows:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 2.04159 & -0.56501 & -0.34473 \\ -0.96924 & 1.87597 & 0.04156 \\ 0.01344 & -0.11836 & 1.01518 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

The R, G, B tristimulus values shall be clipped to the range [0, 1].

The R, G, B tristimulus values shall be converted to R'_8, G'_8, B'_8 8-bit channels in 24-bit Adobe RGB as follows:

$$R'_8 = 255(R^{\frac{1}{2.199}})$$
$$G'_8 = 255(G^{\frac{1}{2.199}})$$ followed by each R'_8, G'_8, B'_8 rounded to nearest integer.
$$B'_8 = 255(B^{\frac{1}{2.199}})$$

For Adobe RGB integer color encodings with a bit depth N other than eight, 255 in above formulas shall be replaced with (2^N-1).

Notes:

The conversion from XYZ to Adobe RGB is the inverse of the conversion from Adobe RGB to XYZ, with the addition of clipping R, G, B, to the range [0, 1].

The matrix is derived from the color space chromaticity values.

The range of Y is [0, 1], corresponding to the range from the Adobe RGB black point to the Adobe RGB white point.

3.2.3 Conversion from 24-bit Adobe RGB to ICC CIEXYZ PCS Version 2

The R'_8, G'_8, B'_8 8-bit channels in 24-bit Adobe RGB shall be converted to R, G, B tristimulus values of range [0, 1] as follows:

$$R = (\frac{R'_8}{255})^{2.199}$$

$$G = (\frac{G'_8}{255})^{2.199}$$

$$B = (\frac{B'_8}{255})^{2.199}$$

For Adobe RGB integer color encodings with a bit depth N other than eight, 255 in above formulas shall be replaced with $(2^N–1)$.

The R, G, B tristimulus values shall be converted to $XYZ_{PCS\ v2}$ tristimulus values as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.60974 & 0.20528 & 0.14919 \\ 0.31111 & 0.62567 & 0.06322 \\ 0.01947 & 0.06087 & 0.74457 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Notes:

The ICC CIEXYZ PCS has a D50 white point.

The matrix is derived from the color space chromaticity values, and a chromatic adaptation to D50, using the Bradford matrix as specified in the ICC.1 specification, rounded off to the s15.16 binary format used in ICC profiles.

The range of Y is [0, 1], corresponding to the range from the Adobe RGB black point to the Adobe RGB white point. This is a common PCS value range for ICC Version 2 profiles.

3.2.4 Conversion from ICC CIEXYZ PCS Version 2 to 24-bit Adobe RGB

The $XYZ_{PCS\ v2}$ tristimulus values shall be converted to R, G, B tristimulus values as follows:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.96253 & -0.61068 & -0.34137 \\ -0.97876 & 1.91615 & 0.03342 \\ 0.02869 & -0.14067 & 1.34926 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

The R, G, B tristimulus values shall be clipped to the range [0, 1].

The R, G, B tristimulus values shall be converted to R'_8, G'_8, B'_8 8-bit channels in 24-bit Adobe RGB as follows:

$$R'_8 = 255(R^{\frac{1}{2.199}})$$

$$G'_8 = 255(G^{\frac{1}{2.199}})$$ followed by each R'_8, G'_8, B'_8 rounded to nearest integer.

$$B'_8 = 255(B^{\frac{1}{2.199}})$$

For Adobe RGB integer color encodings with a bit depth N other than eight, 255 in above formulas shall be replaced with (2^N-1).

Notes:

The conversion from $XYZ_{PCS\ v2}$ to Adobe RGB is the inverse of the conversion from Adobe RGB to $XYZ_{PCS\ v2}$, with the addition of clipping R, G, B, to the range [0, 1].

The ICC CIEXYZ PCS has a D50 white point.

The matrix is derived from the color space chromaticity values, and a chromatic adaptation to D50, using the Bradford matrix as specified in the ICC.1 specification, rounded off to the s15.16 binary format used in ICC profiles, then inverted.

The range of Y is [0, 1], corresponding to the range from the Adobe RGB black point to the Adobe RGB white point. This is a common PCS value range for ICC Version 2 profiles.

4 The origins of Adobe RGB

The Adobe RGB color space and color encodings are defined by Adobe Systems. The Adobe RGB (1998) color space and color encodings were first introduced with Adobe Photoshop 5.0.2 in November 1998 to meet the demands for an RGB working space suited for print production. Adobe RGB (1998) was incorrectly named SMPTE-240M in Photoshop 5.0.

An Adobe RGB ICC profile can be downloaded from
http://www.adobe.com/support/downloads/main.html

An Adobe RGB ICC profile software product can be licensed from Adobe Systems. For more information contact adobergbinformation@adobe.com