INTERNATIONAL ELECTROTECHNICAL COMMISSION

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT – Part 2-2: Colour management – EXTENDED RGB COLOUR SPACE – sRGB64

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International Standard IEC 61966 has been prepared by project team 61966: Colour measurement and management in multimedia systems and equipment, of IEC technical committee TC100: Audio, Video and Multimedia Systems and Equipment.

The text of this standard is based on

FDIS	Report on voting
XXX/FDIS	XXX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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1 GENERAL

1.1 Introduction

The method of digitisation in this part is designed to complement current colour management strategies, such as ICC, CMYK and sRGB, by enabling a method of handling colour in the operating systems, device drivers and the Internet that utilises a simple and robust device independent colour definition. This will provide good quality, large colour gamut, large bit precision and extended tonal range. Based on IEC 61966-2-1 (sRGB), this colour space is well suited for graphic arts RGB workflows, professional digital photography, computer gamuts and computer graphics.

Traditional graphic arts and prepress markets have successfully used CMYK colour management solutions for several decades now. For many very high end graphic arts markets, this solution still has significant advantages of all others. To take full advantage of CMYK workflow solutions, users must be well trained in this field. With the advent of distributed printing and proliferation of new capture and marking technologies, there arose a need for a more flexible solution for parts of these markets.

To address these needs, the International Colour Consortium proposed a colour device characterisation profile specification. This specification describes a profile format to help in communicating colour in graphic arts systems. Currently, the ICC has one means of tracking and ensuring that a colour is correctly mapped from the input to the output colour space. This is done by attaching a profile for the input colour space to the image or document in question. This solution is appropriate for some high end users.

However, there is still a broad range of users that do not require this level of flexibility and control in an embedded profile mechanism and have RGB, not CMYK based workflows. Instead it is possible to create a single, standard default colour space definition that can be processed as an implicit ICC sRGB profile. Additionally, most existing file formats do not, and may never, support colour profile embedding, and finally, there are a broad range of uses that actually discourage people from appending any extra data to their files. A common standard RGB colour space addresses these issues and is useful and necessary. This approach maintains the advantage of a clear relationship with ICC colour management systems while minimising software processes and support requirements.

To address issues, the IEC standardised sRGB (IEC 61966-2-1) as a standard colour space solution for office, home and web markets. The sRGB standard addresses these concerns, serves the needs of PC and Web based colour imaging systems and is based on the average performance of cathode ray tube displays. The sRGB solution is supported by the following observations:

- Most computer displays are similar in their key colour characteristics – the phosphor chromaticities (primaries) and transfer function
- RGB spaces are native to displays, scanners and digital cameras, which are the devices with the highest performance constraints

- RGB spaces can be made device independent in a straightforward way. They can also describe colour gamuts that are large enough for all but a small number of applications.

Yet, neither CMYK workflows, the ICC profile format nor the sRGB standard colour space provide a complete solution for all situations. In particular, the computer graphics and gaming industries desired a standard RGB colour space that was linear with respect to luminance. As a 64 bit encoding, sRGB64 allows for 16 bit per channel encoding, including an alpha channel for computer graphic operations. Many users in the prepress industries requested a larger colour gamut that was possible by cathode ray tube displays and thus sRGB. Finally, members of both the prepress and professional digital industry have expressed a desire additional tonal range beyond that of a typical cathode ray tube, which is the reference display for the sRGB standard. In addition, there was a strong request for compatibility with sRGB, ICC and current application workflow solutions. This extended colour standard space provides a robust solution to all of these needs and thus completes a complementary set of colour management solutions from consumer to professional markets. This complementary set of solutions includes sRGB, sRGB64, ICC and CMYK workflows.

This extended standard RGB colour space solution accomplishes these goals by extending the sRGB tonal range and bit precision and encoding the values linearly with respect to luminance. All other aspects of the sRGB64 solution are directly inherited from the IEC 61966-2-1 sRGB standard. This allows for robust compatibility with sRGB, ICC and CMYK workflow solutions.

There are two parts to the proposed standard described in this standard: the encoding transformations and the reference conditions. The encoding transformations, along with sRGB transformations provided in Annex A, provide all of the necessary information to encode an image for display in the reference conditions. If actual conditions differ from reference conditions, additional processing may be required.

1.2 Scope

The IEC 61966 standards are a series of methods and parameters for colour measurements and management for use in multimedia systems and equipment applicable to the assessment of colour reproduction.

This part of IEC 61966 is applicable to the encoding and communication of extended colour gamut, dynamic range and bit precision RGB colours used in computer systems and similar applications by defining encoding transformations for use in defined reference conditions.

If actual conditions differ from the reference conditions, additional processing could be required. Such additional rendering transformations, such as white point adaptation methods, are beyond the scope of this standard. Please refer to the appropriate CIE recommendations for guidelines in this area.

1.3 Normative References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards

IEC 61966-2-1: 199x, MULTIMEDIA SYSTEMS AND EQUIPMENT - *COLOUR MEASUREMENT AND MANAGEMENT- Part 2-2: Colour Management - DEFAULT RGB COLOUR SPACE – sRGB*

ITU-R BT.709-2: 1995, *Parameter Values for the HDTV Standards for Production and International Programme Exchange*

1.4 Definitions

For the purpose of this International Standard, the following definitions apply. Definitions of illuminance, luminance, tristimulus, and other relating lighting terms are defined in reference IEC 60050(845).

2 REFERENCE CONDITIONS

The reference image display characteristics, reference viewing conditions and reference observer are identical to those described in IEC 61966-2-1 (sRGB).

3 ENCODING CHARACTERISTICS

3.1 Introduction

The encoding transformations between 1931 CIEXYZ values and 16-bit sRGB64 values provide unambiguous methods to represent optimum image colorimetry when viewed on the reference display in the reference viewing conditions by the reference observer. The 1931 CIEXYZ values are scaled such as the sRGB black point to white point luminance is 0.0 to 1.0, not 0.0 to 100.0. When transformed to sRGB values by methods such as described in Annex A, these values represent the appearance of the image as displayed on the reference display in the reference viewing condition. Y-tristimulus values less than 0.0 in CIEXYZ space represent colours darker than black in the reference conditions. Y-tristimulus values greater than 1.0 represent values brighter than white in the reference conditions.

3.2 Transformation from signed 16-bit RGB values to 1931 CIE XYZ values

The relationship is defined as follows:

$$\begin{aligned} R'_{sRGB64} &= R_{sRGB64} \div 8192{,}0 \\ G'_{sRGB64} &= G_{sRGB64} \div 8192{,}0 \\ B'_{sRGB64} &= B_{sRGB64} \div 8192{,}0 \end{aligned} \qquad (1)$$

and

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0{,}4124 & 0{,}3576 & 0{,}1805 \\ 0{,}2126 & 0{,}7152 & 0{,}0722 \\ 0{,}0193 & 0{,}1192 & 0{,}9505 \end{bmatrix} \begin{bmatrix} R'_{sRGB64} \\ G'_{sRGB64} \\ B'_{sRGB64} \end{bmatrix} \qquad (2).$$

3.3 Transformation from 1931 CIE XYZ values to signed 16-bit RGB values

The relationship is defined as follows:

$$\begin{bmatrix} R'_{sRGB64} \\ G'_{sRGB64} \\ B'_{sRGB64} \end{bmatrix} = \begin{bmatrix} 3{,}2406 & -1{,}5372 & -0{,}4986 \\ -0{,}9689 & 1{,}8758 & 0{,}0415 \\ 0{,}0557 & -0{,}2040 & 1{,}0570 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \qquad (3)$$

and:

$$
\begin{aligned}
R_{sRGB64} &= R'_{sRGB64} \times 8192{,}0 \\
G_{sRGB64} &= G'_{sRGB64} \times 8192{,}0 \\
B_{sRGB64} &= B'_{sRGB64} \times 8192{,}0
\end{aligned} \qquad (4).
$$

ANNEX A
(informative)
Default Transformation between 8-bit sRGB and 16-bit sRGB64 Values

This annex describes the recommended default transformation between sRGB and sRGB64. This transformation is targeted to real-time display transformations. Other transformations that focus on other requirements are possible. If such other transformations are intended to exchange with other devices or applications, these transformations should be described within the application documentation or file format as appropriate.

A.1 Transformation from 16-bit sRGB64 values to 8-bit sRGB

The relationship is defined as follows:

$$\begin{aligned} R_0 &= R_{sRGB64} \div 8192 \\ G_0 &= G_{sRGB64} \div 8192 \\ B_0 &= B_{sRGB64} \div 8192 \end{aligned} \qquad \text{(A1)}$$

If $R_0, G_0, B_0 < 0$

$$\begin{aligned} R_{sRGB} &= 0 \\ G_{sRGB} &= 0 \\ B_{sRGB} &= 0 \end{aligned} \qquad \text{(A2)}$$

else if $0 \le R_0, G_0, B_0 < 0{,}00304 \quad (0 \le R_{sRGB64}, G_{sRGB64}, B_{sRGB64} \le 24)$

$$\begin{aligned} R_{sRGB} &= 12{,}92 \times R_0 \times 255 \\ G_{sRGB} &= 12{,}92 \times G_0 \times 255 \\ B_{sRGB} &= 12{,}92 \times B_0 \times 255 \end{aligned} \qquad \text{(A3)}$$

else if $0{,}003304 \le R_0, G_0, B_0 \le 1{,}0 \quad (25 \le R_{sRGB64}, G_{sRGB64}, B_{sRGB64} \le 8192)$

$$\begin{aligned} R_{sRGB} &= \left[1{,}055 \times R_0^{(1{,}0/2{,}4)}\right] - 0{,}055 \\ G_{sRGB} &= \left[1{,}055 \times G_0^{(1{,}0/2{,}4)}\right] - 0{,}055 \\ B_{sRGB} &= \left[1{,}055 \times B_0^{(1{,}0/2{,}4)}\right] - 0{,}055 \end{aligned} \qquad \text{(A4)}$$

else

$$\begin{aligned} R_{sRGB} &= 255 \\ G_{sRGB} &= 255 \\ B_{sRGB} &= 255 \end{aligned} \qquad \text{(A5)}$$

A.2 Transformation from 8-bit sRGB to 16-bit sRGB64 values

The relationship is defined as follows:

If $0 \leq R_{sRGB}, G_{sRGB}, B_{sRGB} < 10$

$$\begin{aligned} R_{sRGB-X} &= 2{,}4865 \times R_{sRGB} \\ G_{sRGB-X} &= 2{,}4865 \times G_{sRGB} \\ B_{sRGB-X} &= 2{,}4865 \times B_{sRGB} \end{aligned} \tag{A6}$$

else

$$\begin{aligned} R_{sRGB-X} &= \left[\left(R_{sRGB} + 14{,}025 \right) / 269{,}025 \right]^{2{,}4} \times 8192 \\ G_{sRGB-X} &= \left[\left(G_{sRGB} + 14{,}025 \right) / 269{,}025 \right]^{2{,}4} \times 8192 \\ B_{sRGB-X} &= \left[\left(B_{sRGB} + 14{,}025 \right) / 269{,}025 \right]^{2{,}4} \times 8192 \end{aligned} \tag{A7}$$

Bibliography

"A Standard Default Colour Space for the Internet: sRGB" Michael Stokes, Matthew Anderson, Srinivasan Chandrasekar, and Ricardo Motta, http://www.w3.org/Graphics/Color/sRGB.html