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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Multimedia systems and equipment – Colour measurement and management – Part 2-2: Colour management – Extended RGB colour space – scRGB

Mesure et gestion de la couleur dans les systèmes et appareils multimédia – Partie 2-2: Gestion de la couleur – Espace chromatique RVB étendu – scRVB

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 2-2: Colour management – Extended RGB colour space – scRGB

FOREWORD

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International Standard IEC 61966 has been prepared by Technical Area 2: Colour measurement and management, of IEC technical committee 100: Audio, video and multimedia systems and equipment and ISO TC 42: Photography.

This bilingual version (2013-03) corresponds to the monolingual English version, published in 2003-01.

The text of this standard is based on the following documents:

FDIS	Report on voting
100/556A/FDIS	100/626/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.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 61966 consists of the following parts, under the general title *Multimedia systems and equipment – Colour measurement and management*:

Part 2-1: Colour management – Default RGB colour space – sRGB

Part 2-2: Colour management – Extended RGB colour space – scRGB

Part 3: Equipment using cathode ray tubes

Part 4: Equipment using liquid crystal display panels

Part 5: Equipment using plasma display panels

Part 7-1: Colour printers – Reflective prints – RGB inputs

Part 8: Multimedia colour scanners

Part 9: Digital cameras

It is published as a double logo standard.

In the ISO the Standard has been approved by 9 P-members out of 10 having cast the vote.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of August 2003 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

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.

The method of digitization in this part is designed to provide high bit precision, large colour gamut and extended dynamic range that is linear with respect to scene radiance. Based on IEC 61966-2-1 (sRGB), this colour space is well suited to meet the needs of the multimedia, gaming and computer graphics applications. This standard provides a robust solution to these needs. The white point and colour primaries of the scRGB solution are directly inherited from the IEC 61966-2-1 (sRGB) standard. The encoding transformations provide all of the necessary information to encode an image.

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 2-2: Colour management – Extended RGB colour space – scRGB

1 Scope

This part of IEC 61966 is applicable to the encoding, editing and communication of relative scene radiance, wide dynamic range, extended colour gamut, and extended bit precision RGB colours as a colour space used in computer systems and similar applications by defining encoding transformations. Primaries and white point values of the colour space defined in this standard are identical to CIE chromaticities for ITU-R BT.709-5 reference primaries and CIE standard illuminant D65 as its white point. The scRGB colour space is an extension of sRGB and it is considered compatible with sRGB.

Additional transformations, such as white point adaptation methods, are beyond the scope of this standard. The appropriate CIE recommendations should be referred to for guidelines in this area.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(845):1987, *International Electrotechnical Vocabulary (IEV) – Chapter 845: Lighting*

3 Definitions

For the purposes of this document, the following definitions apply. Definitions of illuminance, radiance, tristimulus, and other relating lighting terms are defined in IEC 60050(845).

3.1
output referred colour space
a colour space that represents the colorimetry of an output device with specified viewing conditions

3.2
wide dynamic range colour space
a colour space whose encoding encompasses values below black and above white

3.3
luma
luminance signal as defined by SMPTE/EG28: 1993

NOTE Video systems approximate the lightness response of vision by computing a luma component Y′ as a weighted sum of nonlinear R′G′B′ primary components: Each RGB signal is, comparable to the 1/3 power function with an offset defined by L*. Luma is often incorrectly referred to as luminance.

4 Encoding characteristics

4.1 General

The encoding transformations provide unambiguous methods to transform between CIE 1931 XYZ tristimulus values and 16-bit values for each channel of scRGB. The CIE 1931 XYZ values are scaled so that the sRGB black point to white point luminance is 0,0 to 1,0, not 0,0 to 100,0. Y-tristimulus values less than 0,0 in CIE 1931 XYZ space represent values below black. Y-tristimulus values greater than 1,0 represent values brighter than relative white.

The scRGB components that range from 0 to 16 384 encompass all visible surface colours (from –0,5 to 1,5). The range from 12 288 to 65 535 is used to encode an extended specular range of colours (from larger than 1,0 to 7,4999).

4.2 Transformation from CIE 1931 XYZ values to 16-bit scRGB values ($R_{\text{scRGB}(16)}$, $G_{\text{scRGB}(16)}$, $B_{\text{scRGB}(16)}$)

The relationship is defined as follows:

$$\begin{bmatrix} R_{\text{scRGB}} \\ G_{\text{scRGB}} \\ B_{\text{scRGB}} \end{bmatrix} = \begin{bmatrix} 3{,}240\,625 & -1{,}537\,208 & -0{,}498\,629 \\ -0{,}968\,931 & 1{,}875\,756 & 0{,}041\,518 \\ 0{,}055\,710 & -0{,}204\,021 & 1{,}056\,996 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad (1)$$

and:

$$\begin{aligned} R_{\text{scRGB}(16)} &= \text{round}\left[\left(R_{\text{scRGB}} \times 8192{,}0\right) + 4\,096\right] \\ G_{\text{scRGB}(16)} &= \text{round}\left[\left(G_{\text{scRGB}} \times 8192{,}0\right) + 4\,096\right] \\ B_{\text{scRGB}(16)} &= \text{round}\left[\left(B_{\text{scRGB}} \times 8192{,}0\right) + 4\,096\right] \end{aligned} \quad (2)$$

4.3 Transformation from 16-bit scRGB values ($R_{\text{scRGB}(16)}$, $G_{\text{scRGB}(16)}$, $B_{\text{scRGB}(16)}$) to CIE 1931 XYZ values

The relationship is defined as follows:

$$\begin{aligned} R_{\text{scRGB}} &= \left(R_{\text{scRGB}(16)} \div 8192{,}0\right) - 0{,}5 \\ G_{\text{scRGB}} &= \left(G_{\text{scRGB}(16)} \div 8192{,}0\right) - 0{,}5 \\ B_{\text{scRGB}} &= \left(B_{\text{scRGB}(16)} \div 8192{,}0\right) - 0{,}5 \end{aligned} \quad (3)$$

and

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0{,}412\,4 & 0{,}357\,6 & 0{,}180\,5 \\ 0{,}212\,6 & 0{,}715\,2 & 0{,}072\,2 \\ 0{,}019\,3 & 0{,}119\,2 & 0{,}950\,5 \end{bmatrix} \begin{bmatrix} R_{\text{scRGB}} \\ G_{\text{scRGB}} \\ B_{\text{scRGB}} \end{bmatrix} \quad (4)$$

Annex A
(informative)

Simple transformation between 8-bit sRGB and 16-bit scRGB values

A.1 General

This annex describes a simple transformation between 8-bit sRGB and 16-bit scRGB. While more complicated and intelligent tonal rendering should be applied for the scRGB images to obtain the most preferred images, this transformation is targeted to real-time display transformations for quick and easy previewing. 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.2 Transformation from 16-bit scRGB values ($R_{\text{scRGB}_{(16)}}$, $G_{\text{scRGB}_{(16)}}$, $B_{\text{scRGB}_{(16)}}$) to 8-bit sRGB values ($R_{\text{sRGB}_{(8)}}$, $G_{\text{sRGB}_{(8)}}$, $B_{\text{sRGB}_{(8)}}$)

The relationship is defined as follows:

$$\begin{aligned} R_{\text{scRGB}} &= \left(R_{\text{scRGB}_{(16)}} \div 8192\right) - 0{,}5 \\ G_{\text{scRGB}} &= \left(G_{\text{scRGB}_{(16)}} \div 8192\right) - 0{,}5 \\ B_{\text{scRGB}} &= \left(B_{\text{scRGB}_{(16)}} \div 8192\right) - 0{,}5 \end{aligned} \qquad \text{(A.1)}$$

If $R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} < 0 \quad \left(R_{\text{scRGB}_{(16)}}, G_{\text{scRGB}_{(16)}}, B_{\text{scRGB}_{(16)}} \leq 4095\right)$

$$\begin{aligned} R_{\text{sRGB}_{(8)}} &= 0 \\ G_{\text{sRGB}_{(8)}} &= 0 \\ B_{\text{sRGB}_{(8)}} &= 0 \end{aligned} \qquad \text{(A.2)}$$

else if

$$0 \leq R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} < 0{,}018 \quad \left(4096 \leq R_{\text{scRGB}_{(16)}}, G_{\text{scRGB}_{(16)}}, B_{\text{scRGB}_{(16)}} \leq 4243\right)$$

$$\begin{aligned} R_{\text{sRGB}_{(8)}} &= \text{round}\left[\left(4{,}500 \times R_{\text{scRGB}}\right) \times 255\right] \\ G_{\text{sRGB}_{(8)}} &= \text{round}\left[\left(4{,}500 \times G_{\text{scRGB}}\right) \times 255\right] \\ B_{\text{sRGB}_{(8)}} &= \text{round}\left[\left(4{,}500 \times B_{\text{scRGB}}\right) \times 255\right] \end{aligned} \qquad \text{(A.3)}$$

else if

$$0{,}018 \leq R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} \leq 1{,}0 \quad \left(4244 \leq R_{\text{scRGB}_{(16)}}, G_{\text{scRGB}_{(16)}}, B_{\text{scRGB}_{(16)}} \leq 12288\right)$$

$$
\begin{aligned}
R_{\mathrm{sRGB}(8)} &= \mathrm{round}\left[\left(\left(1{,}099 \times R_{\mathrm{scRGB}}{}^{(0{,}45)}\right) - 0{,}099\right) \times 255\right] \\
G_{\mathrm{sRGB}(8)} &= \mathrm{round}\left[\left(\left(1{,}099 \times G_{\mathrm{scRGB}}{}^{(0{,}45)}\right) - 0{,}099\right) \times 255\right] \\
B_{\mathrm{sRGB}(8)} &= \mathrm{round}\left[\left(\left(1{,}099 \times B_{\mathrm{scRGB}}{}^{(0{,}45)}\right) - 0{,}099\right) \times 255\right]
\end{aligned} \qquad \text{(A.4)}
$$

else

$$
\begin{aligned}
R_{\mathrm{sRGB}(8)} &= 255 \\
G_{\mathrm{sRGB}(8)} &= 255 \\
B_{\mathrm{sRGB}(8)} &= 255
\end{aligned} \qquad \text{(A.5)}
$$

A.3 Transformation from 8-bit sRGB values ($R_{\mathrm{sRGB}(8)}, G_{\mathrm{sRGB}(8)}, B_{\mathrm{sRGB}(8)}$) to 16-bit scRGB values ($R_{\mathrm{scRGB}(16)}, G_{\mathrm{scRGB}(16)}, B_{\mathrm{scRGB}(16)}$)

The relationship is defined as follows:

$$
\text{If} \quad 0 \le R_{\mathrm{sRGB}(8)}, G_{\mathrm{sRGB}(8)}, B_{\mathrm{sRGB}(8)} < 21
$$

$$
\begin{aligned}
R_{\mathrm{scRGB}(16)} &= \mathrm{round}\left(7{,}139 \times R_{\mathrm{sRGB}(8)} + 4096\right) \\
G_{\mathrm{scRGB}(16)} &= \mathrm{round}\left(7{,}139 \times G_{\mathrm{sRGB}(8)} + 4096\right) \\
B_{\mathrm{scRGB}(16)} &= \mathrm{round}\left(7{,}139 \times B_{\mathrm{sRGB}(8)} + 4096\right)
\end{aligned} \qquad \text{(A.6)}
$$

else

$$
\begin{aligned}
R_{\mathrm{scRGB}(16)} &= \mathrm{round}\left\{\left[\left(R_{\mathrm{sRGB}(8)} + 25{,}245\right) / 280{,}245\right]^{\left(1{,}0/0{,}45\right)} \times 8192 + 4096\right\} \\
G_{\mathrm{scRGB}(16)} &= \mathrm{round}\left\{\left[\left(G_{\mathrm{sRGB}(8)} + 25{,}245\right) / 280{,}245\right]^{\left(1{,}0/0{,}45\right)} \times 8192 + 4096\right\} \\
B_{\mathrm{scRGB}(16)} &= \mathrm{round}\left\{\left[\left(B_{\mathrm{sRGB}(8)} + 25{,}245\right) / 280{,}245\right]^{\left(1{,}0/0{,}45\right)} \times 8192 + 4096\right\}
\end{aligned} \qquad \text{(A.7)}
$$

Annex B
(informative)

Non-linear encoding for scRGB: scRGB-nl and its YCC Transformation: scYCC-nl

B.1 General

This annex describes non-linear encoding for scRGB: scRGB-nl and its YCC transformation: scYCC-nl. Applications and hardware developers who want to support various colour compression schemes based on luma-chroma-chroma spaces can utilise this standard. This transformation is targeted for compression and storage, and is not targeted for displaying images.

B.2 Non-linear encoding in 12-bit

The relationship is defined as follows:

If $R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} \geq 0{,}003\ 130\ 8$

$$
\begin{aligned}
R'_{\text{scRGB}} &= 1{,}055 \times R_{\text{scRGB}}^{(1{,}0/2{,}4)} - 0{,}055 \\
G'_{\text{scRGB}} &= 1{,}055 \times G_{\text{scRGB}}^{(1{,}0/2{,}4)} - 0{,}055 \\
B'_{\text{scRGB}} &= 1{,}055 \times B_{\text{scRGB}}^{(1{,}0/2{,}4)} - 0{,}055
\end{aligned}
\qquad \text{(B.1)}
$$

If $0{,}003\ 130\ 8 > R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} > -0{,}003\ 130\ 8$

$$
\begin{aligned}
R'_{\text{scRGB}} &= 12{,}92 \times R_{\text{scRGB}} \\
G'_{\text{scRGB}} &= 12{,}92 \times G_{\text{scRGB}} \\
B'_{\text{scRGB}} &= 12{,}92 \times B_{\text{scRGB}}
\end{aligned}
\qquad \text{(B.2)}
$$

If $R_{\text{scRGB}}, G_{\text{scRGB}}, B_{\text{scRGB}} \leq -0{,}003\ 130\ 8$

$$
\begin{aligned}
R'_{scRGB} &= -1{,}055 \times \left(-R_{scRGB}\right)^{(1{,}0/2{,}4)} + 0{,}055 \\
G'_{scRGB} &= -1{,}055 \times \left(-G_{scRGB}\right)^{(1{,}0/2{,}4)} + 0{,}055 \\
B'_{scRGB} &= -1{,}055 \times \left(-B_{scRGB}\right)^{(1{,}0/2{,}4)} + 0{,}055
\end{aligned}
\qquad \text{(B.3)}
$$

12 bit non-linear version of scRGB-nl: $R_{\text{scRGB-nl}}, G_{\text{scRGB-nl}}, B_{\text{scRGB-nl}}$ is defined as:

$$
\begin{aligned}
R_{\text{scRGB-nl}} &= \text{round}\left(1\ 280 \times R'_{\text{scRGB}} + 1\ 024\right) \\
G_{\text{scRGB-nl}} &= \text{round}\left(1\ 280 \times G'_{\text{scRGB}} + 1\ 024\right) \\
B_{\text{scRGB-nl}} &= \text{round}\left(1\ 280 \times B'_{\text{scRGB}} + 1\ 024\right)
\end{aligned}
\qquad \text{(B.4)}
$$