

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Multimedia systems and equipment – Colour measurement and management –  
Part 2-4: Colour management – Extended-gamut YCC colour space for video  
applications – xvYCC**

**Systèmes et appareils multimédia – Mesure et gestion de la couleur –  
Partie 2-4: Gestion de la couleur – Extension de gamme de l'espace chromatique  
YCC pour applications vidéo – xvYCC**

<https://standards.iteh.ai/catalog/standards/iec/f71bc9d0-c77d-4304-92de-badea6718d64/iec-61966-2-4-2006>



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



IEC 61966-2-4

Edition 1.1 2016-04  
CONSOLIDATED VERSION

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Multimedia systems and equipment – Colour measurement and management –  
Part 2-4: Colour management – Extended-gamut YCC colour space for video  
applications – xvYCC**

**Systèmes et appareils multimédia – Mesure et gestion de la couleur –  
Partie 2-4: Gestion de la couleur – Extension de gamme de l'espace  
chromatique YCC pour applications vidéo – xvYCC**

<https://standards.iteh.ai/catalog/standards/iec/f71bc9d0-c77d-4304-92de-badea6718d64/iec-61966-2-4-2006>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.160.40

ISBN 978-2-8322-3369-6

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**



## REDLINE VERSION

## VERSION REDLINE



**Multimedia systems and equipment – Colour measurement and management –  
Part 2-4: Colour management – Extended-gamut YCC colour space for video  
applications – xvYCC**

**Systèmes et appareils multimédia – Mesure et gestion de la couleur –  
Partie 2-4: Gestion de la couleur – Extension de gamme de l'espace chromatique  
YCC pour applications vidéo – xvYCC**

<https://standards.iteh.ai/catalog/standards/iec/f71bc9d0-c77d-4304-92de-badea6718d64/iec-61966-2-4-2006>



## CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope .....	6
2 Normative references .....	6
3 Terms and definitions .....	6
4 Colorimetric parameters and related characteristics .....	7
4.1 Primary colours and reference white .....	7
4.2 Opto-electronic transfer characteristics .....	7
4.3 YCC (luma-chroma-chroma) encoding methods.....	8
4.4 Digital quantization methods .....	8
5 Encoding transformations .....	9
5.1 Introduction .....	9
5.2 Transformation from xvYCC values to CIE 1931 XYZ values.....	9
5.3 Transformation from CIE 1931 XYZ values to xvYCC values.....	10
Annex A (informative) Compression of specular components of Y' signals.....	13
Annex B (informative) Default transformation from 16-bit scRGB values to xvYCC values .....	14
Annex C (informative) xvYCC/ITU-R BT.709 and sYCC/sRGB compatibility.....	16
Annex D (informative) Recommended usage of IEC 61966-12-2 for this standard.....	18
Bibliography .....	19
Figure A.1 – Example of the specular compression method .....	13
Figure C.1 – Relationship between ITU-R BT.709 and sRGB .....	16
Figure C.2 – Relationship between xvYCC and sYCC .....	17
Table 1 – CIE chromaticities for reference primary colours and reference white.....	7

INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**MULTIMEDIA SYSTEMS AND EQUIPMENT –  
COLOUR MEASUREMENT AND MANAGEMENT –**

**Part 2-4: Colour management –  
Extended-gamut YCC colour space  
for video applications – xvYCC**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

**This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.**

**IEC 61966-2-4 edition 1.1 contains the first edition (2006-01) [documents 100/967/CDV and 100/1026/RVC], its corrigendum 1 (November 2006) and its amendment 1 (2016-04) [documents 100/2457A/CDV and 100/2601/RVC].**

**In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.**

International Standard IEC 61966-2-4 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

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 2-4: Colour management – Extended-gamut YCC colour space for video applications – xvYCC
- Part 2-5: Colour management – Optional RGB colour space – opRGB (~~under consideration~~)
- Part 3: Equipment using cathode ray tubes
- Part 4: Equipment using liquid crystal display panels
- Part 5: Equipment using plasma display panels
- Part 6: Front projection displays
- Part 7-1: Colour printers – Reflective prints – RGB inputs
- ~~Part 7-2: Colour printers – Reflective prints – CMYK inputs (proposed work item)~~
- Part 8: Multimedia colour scanners
- Part 9: Digital cameras
- ~~Part 10: Quality assessment (proposed work item)~~
- ~~Part 11: Quality assessment – Impaired video in network systems (proposed work item)~~
- Part 12-1: Metadata for identification of colour gamut (Gamut ID)
- Part 12-2: Simple Metadata format for identification of colour gamut

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

**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

After the publication of IEC 61966-2-1, Amendment 1, the sYCC colour encoding was used to capture, store and print extended colour gamut for still image applications. Users received pleasant benefit by exchanging and reproducing wide-gamut colour images.

Recently, various kinds of displays that are capable of producing a wider gamut of colour than the conventional CRT-based displays are emerging. However, most of the current video contents that are displayed on conventional displays, are rendered for the sRGB-gamut. Users of wide-gamut displays could benefit from wide-gamut colour images by video colour encoding that supports a larger colour gamut.

This standard defines the “extended-gamut YCC colour space for video applications”. It is based on the current implementation of YCC colour encoding that is used in the video industry (namely ITU-R BT.709-5) and extends its definition to the wider gamut of colour range.

**iTeh Standards**  
**(<https://standards.iteh.ai>)**  
**Document Preview**

[IEC 61966-2-4:2006](https://standards.iteh.ai/catalog/standards/iec/f71bc9d0-c77d-4304-92de-badea6718d64/iec-61966-2-4-2006)

<https://standards.iteh.ai/catalog/standards/iec/f71bc9d0-c77d-4304-92de-badea6718d64/iec-61966-2-4-2006>

# MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

## Part 2-4: Colour management – Extended-gamut YCC colour space for video applications – xvYCC

### 1 Scope

This part of IEC 61966 is applicable to the encoding and communication of YCC colours used in video systems and similar applications by defining encoding transformations for use in defined reference capturing conditions. If actual conditions differ from the reference conditions, additional rendering transformations may be required. Such additional rendering transformations are beyond the scope of this standard.

### 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) – Part 845: Lighting*

ITU-R Recommendation BT.601-5:1995, *Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios*

ITU-R Recommendation BT.709-5:2002, *Parameter values for the HDTV standards for production and international programme exchange*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those concerning illuminance, luminance, tristimulus, and other related lighting terms given in IEC 60050-845, apply.

#### 3.1 scene-referred colour encoding

representation of estimated colour-space coordinates of the elements of an original scene, where a scene is defined to be the relative spectral radiance

#### 3.2 output-referred colour encoding

representation of estimated colour-space coordinates of image data that are appropriate for specified output device and viewing conditions

#### 3.3 extended gamut

colour gamut extending outside that of the standard sRGB CRT display defined in IEC 61966-2-1

### 3.4

#### **luma**

luminance signal as defined by SMPTE/EG28:1993

NOTE 1 To avoid interdisciplinary confusion resulting from the two distinct definitions of luminance, it has been proposed that the video documents use “luma” for “luminance, television” (i.e., the luminance signal).

NOTE 2 Video systems approximate the lightness response of vision by computing a luma component  $Y'$  as a weighted sum of non-linear (or gamma-corrected) R'G'B' primary components. Luma is often carelessly referred to as luminance.

## 4 Colorimetric parameters and related characteristics

This clause defines colorimetric parameters and the related characteristics of reference capturing devices.

### 4.1 Primary colours and reference white

The CIE chromaticities for the reference red, green, and blue primary colours, and for reference white CIE standard illuminant D65, are given in Table 1. These primaries and white point values are identical to those of ITU-R BT.709-5.

**Table 1 – CIE chromaticities for reference primary colours and reference white**

	<b>Red</b>	<b>Green</b>	<b>Blue</b>	<b>White/D65</b>
$x$	0,640 0	0,300 0	0,150 0	0,312 7
$y$	0,330 0	0,600 0	0,060 0	0,329 0
$z$	0,030 0	0,100 0	0,790 0	0,358 3

### 4.2 Opto-electronic transfer characteristics

Opto-electronic transfer characteristics are defined as follows.

If  $R, G, B \leq -0,018$ ,

$$\begin{aligned}
 R' &= -1,099 \times (-R)^{0,45} + 0,099 \\
 G' &= -1,099 \times (-G)^{0,45} + 0,099 \\
 B' &= -1,099 \times (-B)^{0,45} + 0,099
 \end{aligned} \tag{1}$$

If  $-0,018 < R, G, B < 0,018$ ,

$$\begin{aligned}
 R' &= 4,50 \times R \\
 G' &= 4,50 \times G \\
 B' &= 4,50 \times B
 \end{aligned} \tag{2}$$

If  $R, G, B \geq 0,018$ ,

$$\begin{aligned}
 R' &= 1,099 \times (R)^{0,45} - 0,099 \\
 G' &= 1,099 \times (G)^{0,45} - 0,099 \\
 B' &= 1,099 \times (B)^{0,45} - 0,099
 \end{aligned} \tag{3}$$

where  $R, G, B$  is a voltage normalized by reference white level and proportional to the implicit light intensity that would be detected with a reference camera colour channel;  $R', G', B'$  is the resulting non-linear primary signal.

### 4.3 YCC (luma-chroma-chroma) encoding methods

The encoding equations from the primary RGB (red-green-blue) signal:  $R', G', B'$  to the YCC (luma-chroma-chroma) signal:  $Y', Cb', Cr'$  is defined by the following two methods. It is important to follow one of the encodings in the specified application.

$xvYCC_{601}$ , which is implemented mainly in the SDTV (standard-definition television) applications as defined in ITU-R BT. 601-5, is defined as follows:

$$\begin{bmatrix} Y'_{601} \\ Cb'_{601} \\ Cr'_{601} \end{bmatrix} = \begin{bmatrix} 0,299\ 0 & 0,587\ 0 & 0,114\ 0 \\ -0,168\ 7 & -0,331\ 3 & 0,500\ 0 \\ 0,500\ 0 & -0,418\ 7 & -0,081\ 3 \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad (4)$$

NOTE The coefficients in equation (4) are from ITU-R BT.601-5 which defines  $Y'$  of YCC to the three decimal place accuracy. An additional decimal place is defined above to be consistent with the other matrix coefficients defined in this standard.

$xvYCC_{709}$ , which is implemented mainly in the HDTV (high-definition television) applications as defined in ITU-R BT. 709-5, is defined as follows:

$$\begin{bmatrix} Y'_{709} \\ Cb'_{709} \\ Cr'_{709} \end{bmatrix} = \begin{bmatrix} 0,212\ 6 & 0,715\ 2 & 0,072\ 2 \\ -0,114\ 6 & -0,385\ 4 & 0,500\ 0 \\ 0,500\ 0 & -0,454\ 2 & -0,045\ 8 \end{bmatrix} \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} \quad (5)$$

### 4.4 Digital quantization methods

Quantization of YCC (luma-chroma-chroma) signal:  $Y', Cb', Cr'$  is defined as follows.

For 8-bit representation:

$$\begin{aligned} Y_{xvYCC(8)} &= \text{round}[219 \times Y' + 16] \\ Cb_{xvYCC(8)} &= \text{round}[224 \times Cb' + 128] \\ Cr_{xvYCC(8)} &= \text{round}[224 \times Cr' + 128] \end{aligned} \quad (6)$$

For  $n$ -bit ( $n > 8$ ) representation:

$$\begin{aligned} Y_{xvYCC(N)} &= \text{round}\left[\left(219 \times Y' + 16\right) \times 2^{n-8}\right] \\ Cb_{xvYCC(N)} &= \text{round}\left[\left(224 \times Cb' + 128\right) \times 2^{n-8}\right] \\ Cr_{xvYCC(N)} &= \text{round}\left[\left(224 \times Cr' + 128\right) \times 2^{n-8}\right] \end{aligned} \quad (7)$$

NOTE Bit levels "from 0 to  $2^{N-8}-1$ " and "from  $255 \times 2^{N-8}$  to  $2^N-1$ " (0 and 255, for the case of 8-bit encoding) are used exclusively for synchronization and are not allowed for storing colour values. Levels from " $2^{N-8}$  to  $255 \times 2^{N-8}-1$ " (from 1 to 254, for the case of 8-bit encoding) are available.

## 5 Encoding transformations

### 5.1 Introduction

The encoding transformations between xvYCC values and CIE 1931 XYZ values provide unambiguous methods to represent optimum image colorimetry of the captured scene. Scene colorimetry is defined as relative to the white objects, assuming that the exposure is properly controlled. It should be noted that dynamic range compression is needed when storing the wide dynamic range images (see Annex A for descriptions). Additionally, if the condition of the capturing device deviates from the ideal condition defined in Clause 4, operations such as colour compensation, colour correction and a certain degree of colour rendering can be performed. However, the methods for these operations are beyond the scope of this standard.

### 5.2 Transformation from xvYCC values to CIE 1931 XYZ values

For 24-bit encoding (8-bit/channel), the relationship between 8-bit values and  $Y', Cb', Cr'$  is defined as:

$$\begin{aligned} Y' &= (Y_{xvYCC(8)} - 16)/219 \\ Cb' &= (Cb_{xvYCC(8)} - 128)/224 \\ Cr' &= (Cr_{xvYCC(8)} - 128)/224 \end{aligned} \quad (8)$$

For  $N$ -bit/channel ( $N > 8$ ) encoding, the relationship between  $N$ -bit values and  $Y', Cb', Cr'$  is defined as:

$$\begin{aligned} Y' &= \left( \frac{Y_{xvYCC(N)}}{2^{N-8}} - 16 \right) / 219 \\ Cb' &= \left( \frac{Cb_{xvYCC(N)}}{2^{N-8}} - 128 \right) / 224 \\ Cr' &= \left( \frac{Cr_{xvYCC(N)}}{2^{N-8}} - 128 \right) / 224 \end{aligned} \quad (9)$$

For xvYCC<sub>601</sub> encoding, the non-linear  $Y', Cb', Cr'$  values are transformed to the non-linear  $R', G', B'$  values as follows:

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} 1,000 & 0 & 0,000 & 0 & 1,402 & 0 \\ 1,000 & 0 & -0,344 & 1 & -0,714 & 1 \\ 1,000 & 0 & 1,772 & 0 & 0,000 & 0 \end{bmatrix} \begin{bmatrix} Y'_{601} \\ Cb'_{601} \\ Cr'_{601} \end{bmatrix} \quad (10)$$

NOTE The possible range for non-linear  $R'G'B'_{(601)}$  calculated from, for example, equation (10) will be between -1,0732 and 2,0835.

For xvYCC<sub>709</sub> encoding, the non-linear  $Y', Cb', Cr'$  values are transformed to the non-linear  $R', G', B'$  values as follows:

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} 1,000 & 0 & 0,000 & 0 & 1,574 & 8 \\ 1,000 & 0 & -0,187 & 3 & -0,468 & 1 \\ 1,000 & 0 & 1,855 & 6 & 0,000 & 0 \end{bmatrix} \begin{bmatrix} Y'_{709} \\ Cb'_{709} \\ Cr'_{709} \end{bmatrix} \quad (11)$$

NOTE The possible range for non-linear  $R'G'B'_{(709)}$  calculated from, for example, equation (11) will be between -1,1206 and 2,1305.

The non-linear  $R', G', B'$  values are then transformed to linear  $R, G, B$  values as follows.

If  $R', G', B' \leq -0,081$

$$\begin{aligned} R &= -\left(\frac{R' - 0,099}{-1,099}\right)^{\frac{1}{0,45}} \\ G &= -\left(\frac{G' - 0,099}{-1,099}\right)^{\frac{1}{0,45}} \\ B &= -\left(\frac{B' - 0,099}{-1,099}\right)^{\frac{1}{0,45}} \end{aligned} \quad (12)$$

If  $-0,081 < R', G', B' < 0,081$

$$\begin{aligned} R &= R'/4,50 \\ G &= G'/4,50 \\ B &= B'/4,50 \end{aligned} \quad (13)$$

If  $R', G', B' \geq 0,081$

$$\begin{aligned} R &= \left(\frac{R' + 0,099}{1,099}\right)^{\frac{1}{0,45}} \\ G &= \left(\frac{G' + 0,099}{1,099}\right)^{\frac{1}{0,45}} \\ B &= \left(\frac{B' + 0,099}{1,099}\right)^{\frac{1}{0,45}} \end{aligned} \quad (14)$$

The linear  $R, G, B$  values are transformed to CIE 1931 XYZ values as follows:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0,412 4 & 0,357 6 & 0,180 5 \\ 0,212 6 & 0,715 2 & 0,072 2 \\ 0,019 3 & 0,119 2 & 0,950 5 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (15)$$

NOTE When the capturing device performs dynamic range compression of the brighter-than-white (for example, specular) components, the compressed colours will be displayed at the top-end range of the "reference" display as described in Annex C. In this case, the XYZ tristimulus values of the compressed components represent the colorimetry of the rendered scene, not the colorimetry of the original scene.

### 5.3 Transformation from CIE 1931 XYZ values to xvYCC values

The CIE 1931 XYZ values can be transformed to linear  $R, G, B$  values as follows:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 3,241 0 & -1,537 4 & -0,498 6 \\ -0,969 2 & 1,876 0 & 0,041 6 \\ 0,055 6 & -0,204 0 & 1,057 0 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix} \quad (16)$$