IEC 61966-12-2

Edition 2.0 2024-10

INTERNATIONAL STANDARD

Multimedia systems and equipment – Colour measurement and management –
Part 12-2: Simple metadata format for identification of colour gamut

IEC 61966-12-2:2024-10(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 17.180.20; 33.160.40

ISBN 978-2-8322-9821-3

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

Part 12-2: Simple metadata format for identification of colour gamut

FOREWORD

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IEC 61966-12-2 has been prepared by technical area 2: Colour measurement and management, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the number of bits of metadata format has been extended in Clause 4;
b) Annex C has been added for handling HDR content.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3847/CDV	100/4109/RVC

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 61966 series, published under the general title *Multimedia systems and equipment – Colour measurement and management*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

New technologies in capturing and displaying wide-gamut colour images enable a new market of wide-gamut video colour content creation. Recent video standards for wide gamut colour space encoding such as ITU-R BT.2100 (HDR), ITU-R BT.2020 (UHDTV) and IEC 61966-2-4 (xvYCC) were developed in order to be able to distribute content with a colour gamut that is extended with respect to classical colour gamuts such as those defined by standards ITU-R BT.601 (standard-definition television) and ITU-R BT.709 (high-definition television). With the increasing popularity of wide gamut and high dynamic range content and displays, the variety of colour gamuts of displays is expected to increase. This issue can be an obstacle to adoption of wide-gamut video colour content in professional content creation since the compatibility of the content to the employed displays, as well as the compatibility among different displays, is not ensured. The term "display" includes here any video colour reproduction equipment, such as direct view displays and projectors. Thanks to improvements in technology, the variety of colour gamuts and colour reproduction capacities of displays are increasing while the colour gamut and the colour encoding rules of existing colour space encoding standards are fixed.

To address this issue, IEC 61966-12-1 (*Metadata for identification of colour gamut (Gamut ID)*) specifies a colour gamut metadata scheme for video systems including information for colour reproduction. This metadata can apply to video content or displays. More specifically, improvements can be achieved if the wide-gamut colour content is created with the knowledge of the display colour gamut and if the colour reproduction in the display is done with the knowledge of the colour gamut of the pictorial content.

IEC 61966-12-1 has the capability to describe arbitrary 3D colour gamuts in a given colour space and include the full/medium profile for professional use and the simple profile for consumer use with easier product implementation. This approach is effective, but some ambiguities can occur in practical use, for example if typical CE devices are able to decode the simple profile only owing to CPU and software limitations.

In this case, even if a sender device and a receiver device are based on IEC 61966-12-1:

a) the receiver device cannot handle the Gamut ID of incoming content, if the sender device sends only a full or a medium profile;
b) the sender device should convert a full profile to a simple one for CE devices if the receiver can receive the simple profile only, but the conversion is not possible for all the cases.

Therefore, a simple Gamut ID profile standard based on this document has been developed to address this problem.

This second edition extends the number of bits of "back level ratio" in the metadata format to accommodate the wider dynamic range content and displays.

MULTIMEDIA SYSTEMS AND EQUIPMENT – COLOUR MEASUREMENT AND MANAGEMENT –

Part 12-2: Simple metadata format for identification of colour gamut

1 Scope

This part of IEC 61966-12 specifies the colour gamut metadata format for video systems intended for use in CE (consumer electronics) devices. The metadata specified in this part of IEC 61966-12 is limited to the gamut description for display types comprising the three primary additive colours, whose white and black points have the same chromaticity. It is fundamentally based on the conventional VESA-EDID format.

When associated with content, the simple metadata format defines the gamut for which the content was created. It can be used by the display for controlled colour reproduction even if the display's colour gamut is different from that of the content.

When associated with a display, the simple metadata format defines the display colour gamut. It can be used during content creation to enable improved colour reproduction.

This document provides the simplest, but unambiguous solution for typical CE devices that are based on colour gamut information communication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *International Electrotechnical Vocabulary – Part 845: Lighting*

IEC 61966-12-1, *Multimedia systems and equipment – Colour measurement and management – Part 12-1: Metadata for identification of colour gamut (Gamut ID)*

ISO 15076-1, *Image technology colour management – Architecture, profile format and data structure – Part 1: Based on ICC.2010*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-845 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
content
set of video signals in production, post-production or consumption

3.2
colour gamut
range of colours achievable on a given colour reproduction medium (or present in an image of that medium) under a given set of viewing conditions

Note 1 to entry: It is a volume in colour space.

3.3
gamut mapping
mapping of the colour-space coordinates of the elements of a source image to colour-space coordinates of the elements of a reproduction to compensate for differences in the source and output medium colour gamut capability

4 Simple description of gamut

The three primary additive colours gamut can be specified by four combinations of CIE-xy chromaticity values of red, green, blue and white. The gamut is assumed to have the characteristic that combining equal amounts of the three primaries (red, green, blue) produces the chromaticity of white. These values can be encoded according to the gamut CIE-xy chromaticity values used in Vesa Enhanced Extended Display Identification Data Standard (Defines EDID Structure Version 1, Revision 4). The description includes eight values (CIE-xy chromaticity values for each red, green, blue and white) with 10-bit fixed point form in the range of 0,0 to 1,0. These display primary and the white point CIE-xy chromaticity values should be measured in such a way as to minimize the contribution from the display black. In addition to VESA-EDID format, the information of White Absolute Luminance (WAL) and Black Level Ratio (BLR) are included. WAL value is defined in cd/m^2 and denoted as Y_W, and encoded into 16-bit unsigned integer form. BLR is defined as Equation (1), and encoded into 32-bit fixed point form in the range of 0,0 to 1,0.

$$\mathrm{BLR} = \left(Y_K \;/\; Y_W\right) \qquad (1)$$

where

Y_K is the luminance of black shown in Figure 1;

Y_W is the luminance of white shown in Figure 1.

Table 1 shows the total metadata which includes the VESA–EDID compatible CIE-xy chromaticity values of red, green, blue and white and BLR and WAL value. The total size of this format is 16 B.

Refer to Annex C for information about handling HDR content.

Table 1 – Simple metadata format for identification of colour gamut

Byte# hex	Size B	Colour characteristic	Description							
			7	6	5	4	3	2	1	0
00	1	Red_x, Red_y, Green_x, Green_y Bits1 & bits0	Rx1	Rx0	Ry1	Ry0	Gx1	Gx0	Gy1	Gy0
01	1	Blue_x, Blue_y, White_x, White_y bits1 & bits0	Bx1	Bx0	By1	By0	Wx1	Wx0	Wy1	Wy1
02	1	Red_x bit9 – bit2	Rx9	Rx8	Rx7	Rx6	Rx5	Rx4	Rx3	Rx2
03	1	Red_y bit9 – bit2	Ry9	Ry8	Ry7	Ry6	Ry5	Ry4	Ry3	Ry2
04	1	Green_x bit9 – bit2	Gx9	Gx8	Gx7	Gx6	Gx5	Gx4	Gx3	Gx2
05	1	Green_y bit9 – bit2	Gy9	Gy8	Gy7	Gy6	Gy5	Gy4	Gy3	Gy2
06	1	Blue_x bit9 – bit2	Bx9	Bx8	Bx7	Bx6	Bx5	Bx4	Bx3	Bx2
07	1	Blue_y bit9 – bit2	By9	By8	By7	By6	By5	By4	By3	By2
08	1	White_x bit9 – bit2	Wx9	Wx8	Wx7	Wx6	Wx5	Wx4	Wx3	Wx2
09	1	White_y bit9 – bit2	Wy9	Wy8	Wy7	Wy6	Wy5	Wy4	Wy3	Wy2
0A	1	White absolute luminance Bit15 – bit8 (16 bit unsigned Integer)	WAL15	WAL14	WAL13	WAL12	WAL11	WAL10	WAL9	WAL8
0B	1	White absolute luminance Bit7 – bit0 (16 bit unsigned Integer)	WAL7	WAL6	WAL5	WAL4	WAL3	WAL2	WAL1	WAL0
0C	1	Black level ratio Bit31 – bit24 (32-bit fixed point)	BLR31	BLR30	BLR29	BLR28	BLR27	BLR26	BLR25	BLR24
0D	1	Black level ratio Bit23 – bit16 (32-bit fixed point)	BLR23	BLR22	BLR21	BLR20	BLR19	BLR18	BLR17	BLR16
0E	1	Black level ratio Bit15 – bit8 (32-bit fixed point)	BLR15	BLR14	BLR13	BLR12	BLR11	BLR10	BLR9	BLR8
0F	1	Black level ratio Bit7 – bit0 (32-bit fixed point)	BLR7	BLR6	BLR5	BLR4	BLR3	BLR2	BLR1	BLR0

NOTE The metadata format in this document has backward compatibility with IEC 61966-12-2:2014 because addresses "0C" and "0D" indicate same bits.

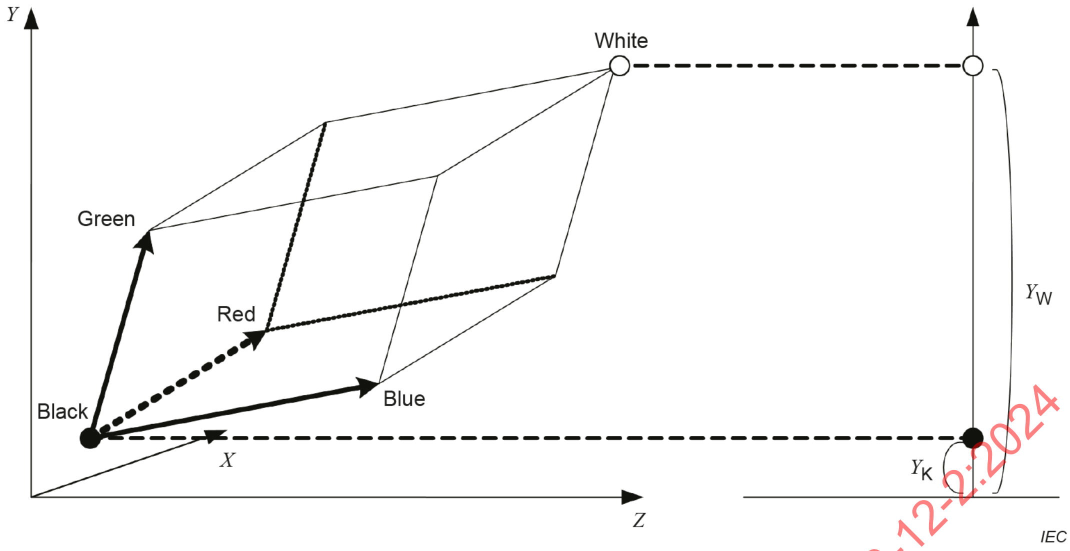

Figure 1 – The colour gamut for display types comprising three primary additive colours

5 Relationship with IEC 61966-12-1

A content gamut is usually smaller than a colour encoding gamut of today's extended-gamut colour space, such as IEC 61966-2-4 xvYCC. If there is no description of an actual colour gamut for some content, it is possible that gamut mapping will use the colour encoding gamut as the content gamut, which can cause some problems. IEC 61966-12-1 solves this problem by associating an explicit description of an actual content gamut to content. IEC 61966-12-1 has a full, medium and simple profile.

The full profile and the medium profile have high flexibility for describing 3D-shapes of complicated content gamuts in a colour space as shown in Figure 2. Consequently, IEC 61966-12-1 full and medium profiles are well suited for some professional applications, such as content production. In addition, IEC 61966-12-1 provides simple profile formats that are limited to three primary type colour gamuts, as shown in Figure 3.

However, the IEC 61966-12-1 simple profile is 77 B and still large for CE devices. This document is therefore limited to the CIE-xy chromaticity values of the three primary additive colour gamuts and has a reduced size of 16 B.

Refer to Annex A for more details about the conversion from IEC 61966-12-2 to the IEC 61966-12-1 simple profile. Refer to Annex B for an example of simple metadata format and conversion to the IEC 61966-12-1 simple profile.

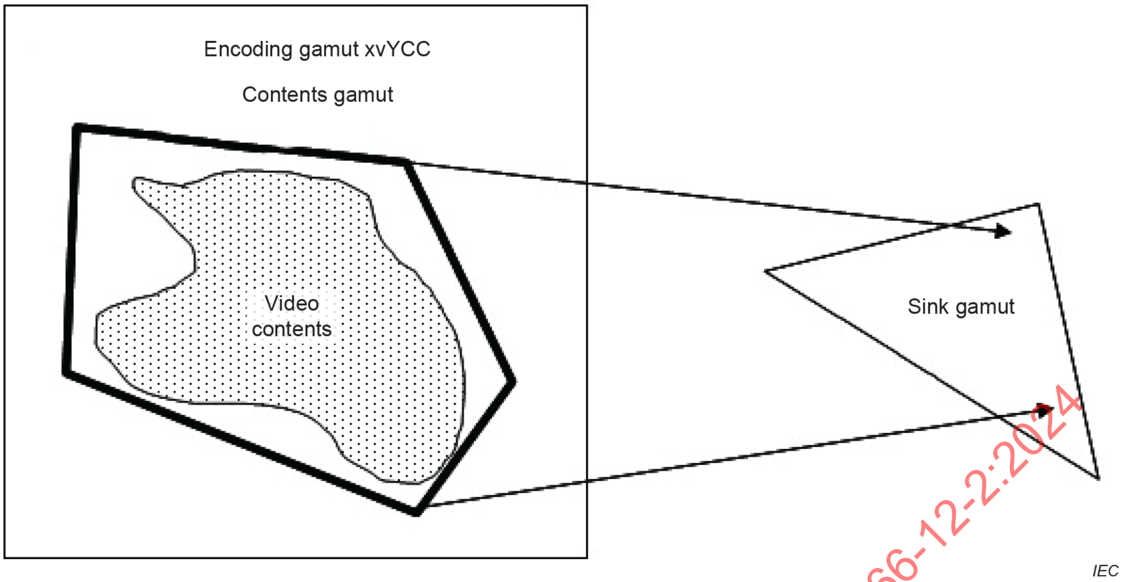

Figure 2 – IEC 61966-12-1 full and medium profiles

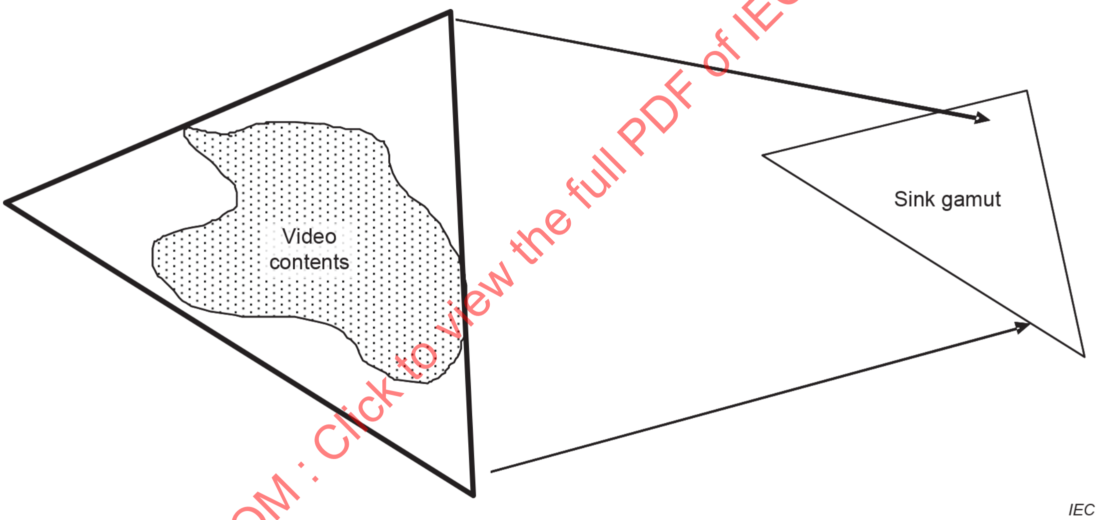

Figure 3 – IEC 61966-12-1 simple profile and IEC 61966-12-2

Table 2 – Differences of IEC 61966-12-1 simple profile and IEC 61966-12-2

	IEC 61966-12-1 simple profile	**IEC 61966-12-2**
Size	77 B (Header: 17 B + Gamut description: 60 B)	16 B (Gamut description only)
Coordinate's format	– CIE-XYZ tristimulus values of 5 colours (red, green, blue, white, black) – s15Fixed16Number (see ICC profiles in ISO 15076-1)	– CIE-xy chromaticity values of four colours (red, green, blue, white) – VESA–EDID compatible – 16-bit unsigned integer form – 32-bit fixed point form in the range of 0,0 to 1,0

Annex A
(informative)

Conversion from IEC 61966-12-2 to IEC 61966-12-1 simple profile

IEC 61966-12-2 can be converted to the IEC 61966-12-1 simple profile. This annex shows an example of the conversion method. The conversion equations calculate five CIE-XYZ tristimulus values of red, green, blue, white and black colour vertices from four CIE-xy chromaticity values of the red, green, blue and white colour vertices, WAL and BLR values. The inverse conversion cannot be uniquely defined when the additivity rule of the three primary colours mixture is not guaranteed.

x_i and y_i are x,y coordinates of colours described in IEC 61966-12-2. X_i, Y_i and Z_i are X,Y,Z coordinates of IEC 61966-12-1 simple profile. In both coordinate systems, i = R,G,B,W, or K, which denotes red, green, blue, white or black colour vertices.

The conversion process has the following four steps:

a) In the first step, X,Y,Z values for white colour are calculated. Here, absolute Y_W value information from IEC 61966-12-2 should be used. We can calculate X,Y,Z values using Y_W value and x,y chromaticity coordinates for white colour as Equation (A.1).

$$\begin{bmatrix} X_W \\ Y_W \\ Z_W \end{bmatrix} = Y_W \begin{bmatrix} \frac{x_W}{y_W} \\ 1 \\ \frac{1 - x_W - y_W}{y_W} \end{bmatrix} \tag{A.1}$$

b) In the second step, X,Y,Z values for black colour are calculated. First, Y_K can be obtained from Y_W and BLR values in Equation (A.2).

$$Y_K = BLR \times Y_W \tag{A.2}$$

Then, X,Y,Z values for black can be Y_K and x,y chromaticity coordinates can be calculated as Equation (A.3) for we assume black has the same chromaticity as white.

$$\begin{bmatrix} X_K \\ Y_K \\ Z_K \end{bmatrix} = Y_K \begin{bmatrix} \frac{x_W}{y_W} \\ 1 \\ \frac{1 - x_W - y_W}{y_W} \end{bmatrix} \tag{A.3}$$

c) Then in the third step, assuming three primary additive colours, Y values for red, green and blue colours without the offset value by black are estimated using the calculated value of white and black colours as Equation (A.4). Here, −1 denotes the inverse of the 3 × 3 matrix.

$$\begin{bmatrix} Y_R - Y_K \\ Y_G - Y_K \\ Y_B - Y_K \end{bmatrix} = \begin{bmatrix} \frac{x_R}{y_R} & \frac{x_G}{y_G} & \frac{x_B}{y_B} \\ 1 & 1 & 1 \\ \frac{1 - x_R - y_R}{y_R} & \frac{1 - x_G - y_G}{y_G} & \frac{1 - x_B - y_B}{y_B} \end{bmatrix}^{-1} \begin{bmatrix} X_W - X_K \\ Y_W - Y_K \\ Z_W - Z_K \end{bmatrix} \tag{A.4}$$

d) In the last step, X,Y,Z values of red, green and blue colours are calculated using the estimated luminance of each colour in step two, and then black offset values are added as shown in Equations (A.5), (A.6) and (A.7).

$$\begin{bmatrix} X_R \\ Y_R \\ Z_R \end{bmatrix} = \begin{bmatrix} \frac{x_R}{y_R} \\ 1 \\ \frac{1 - x_R - y_R}{y_R} \end{bmatrix} (Y_R - Y_K) + \begin{bmatrix} X_K \\ Y_K \\ Z_K \end{bmatrix} \tag{A.5}$$

$$\begin{bmatrix} X_G \\ Y_G \\ Z_G \end{bmatrix} = \begin{bmatrix} \frac{x_G}{y_G} \\ 1 \\ \frac{1 - x_G - y_G}{y_G} \end{bmatrix} (Y_G - Y_K) + \begin{bmatrix} X_K \\ Y_K \\ Z_K \end{bmatrix} \tag{A.6}$$

$$\begin{bmatrix} X_B \\ Y_B \\ Z_B \end{bmatrix} = \begin{bmatrix} \frac{x_B}{y_B} \\ 1 \\ \frac{1 - x_B - y_B}{y_B} \end{bmatrix} (Y_B - Y_K) + \begin{bmatrix} X_K \\ Y_K \\ Z_K \end{bmatrix} \tag{A.7}$$

At this step, all five CIE-XYZ tristimulus values of red, green, blue, white and black colour vertices which are needed in the IEC 61966-12-1 simple profile are defined. Each X,Y,Z value should be encoded in the s15Fixed16Number format.

Annex B
(informative)

Example of simple metadata format and conversion to IEC 61966-12-1 simple profile

This annex provides an example of the simple metadata format. This example describes the theoretical gamut of IEC 61966-2-5 opRGB and the encoded data. Table B.1 shows the CIE-xy chromaticity coordinates for four colour vertices: white, red, green, blue of opRGB colour space.

Table B.1 – Colour gamut for IEC 61966-2-5 opRGB

	CIE-x	CIE-y
White	0,312 7	0,329 0
Red	0,640 0	0,330 0
Green	0,210 0	0,710 0
Blue	0,150 0	0,060 0

White absolute luminance values of white and black level are160 cd/m^2 and 0,4 cd/m^2.

The simple metadata format calculated from the chromaticity values CIE-xy coordinates for the above four colour vertices is shown in Table B.2. The x,y chromaticity values for red, green, blue and white colour vertices are encoded into fixed 10-bit values. The white absolute luminance is encoded into a 16-bit unsigned integer form and the black level ratio is encoded into a 32-bit fixed point form in the range of 0,0 to 1,0.

Table B.2 – Encoded simple metadata format

Byte# hex	Size B	Colour characteristic	Description							
			7	6	5	4	3	2	1	0
00	1	Red/Green bits1 and bits0	1	1	1	0	1	1	1	1
01	1	Blue/White bits1 and bits0	1	0	0	1	0	0	0	1
02	1	Red_x bit9 to bit2	1	0	1	0	0	0	1	1
03	1	Red_y bit9 to bit2	0	1	0	1	0	1	0	0
04	1	Green_x bit9 to bit2	0	0	1	1	0	1	0	1
05	1	Green_y bit9 to bit2	1	0	1	1	0	1	0	1
06	1	Blue_x bit9 to bit2	0	0	1	0	0	1	1	0
07	1	Blue_y bit9 to bit2	0	0	0	0	1	1	1	1
08	1	White_x bit9 to bit2	0	1	0	1	0	0	0	0
09	1	White_y bit9 to bit2	0	1	0	1	0	1	0	0
0A	1	White absolute luminance bit15 – bit8 (16-bit unsigned integer)	0	0	0	0	0	0	0	0
0B	1	White absolute luminance bit7 – bit0 (16-bit unsigned integer)	1	0	1	0	0	0	0	0
0C	1	Black level ratio bit31 – bit24 (32-bit fixed point)	0	0	0	0	0	0	0	0
0D	1	Black level ratio bit23 – bit16 (32-bit fixed point)	1	0	1	0	0	0	1	1
0E	1	Black level ratio bit15 – bit8 (32-bit fixed point)	1	1	0	1	0	1	1	1
0F	1	Black level ratio bit7 – bit0 (32-bit fixed point)	0	0	0	0	1	0	1	0

The XYZ tristimulus values for five colour vertices: white, black, red, green, blue of the opRGB colour space can be decoded in accordance with Annex A (see Table B.3).

Table B.3 – Conversion result to CIE-XYZ values for five colour vertices

	CIE-X	CIE-Y	CIE-Z
White	151,928 783	160,000 000	174,243 323
Black	0,380 193	0,400 391	0,436 034
Red	92,156 976	47,760 013	4,779 668
Green	30,047 025	100,715 680	11,750 826
Blue	30,485 168	12,325 089	158,584 898

The resultant converted Gamut ID metadata in the simple profile of IEC 61966-12-1 format is shown below. This format includes three headers described in Table B.4, Table B.5, and Table B.6 and CIE XYZ tristimulus values of five colours in Table B.7. These XYZ values are basically the same values as in Table B.3, and encoded in the s15Fixed 16Number format.

Table B.4 – Example for the header

Byte # hex	Size B	Symbols	Description								Values
			7	6	5	4	3	2	1	0	
00	1	N, P	0	1	0	0	0	0	1	1	
			R	ID_PROFILE		ID_PRECISION		ID_GBD SPACE			
01	1	ID_G	Byte # of start of the description of gamut geometry								0h00
02	1										0h09
03	1	ID_E	Byte # of start of the description of colour reproduction								0h00
04	1										0h00
05	1		Reserved. Shall be zero.								0h00
06	1										0h00
07	1		Reserved. Shall be zero.								0h00
08	1										0h00

Table B.5 – Example for the header of description of gamut geometry

Byte # hex	Size B	Symbol	Description	Values
09	1	ID_V	Byte # of start of vertices	0h00
0A	1			0h0D
0B	1		Reserved	0h00
0C	1		Reserved	0h00

Table B.6 – Example of definition of vertices

Byte # hex	Size B	Symbol	Description	Values
0D	1	V	Total number of vertices	0h00
0E	1			0h05
0F	1	R	Shall be zero	0h00
10	1			0h00
11	[3VN / 8] = 60		3V encoded colour space coordinates defining V vertices	See Table D.5 of IEC 61966-1:2020

Table B.7 – Example of encoded colour space coordinates for vertices

Byte # hex	Value hex	Description
11	00	White X
12	97	
13	ED	
14	C4	
15	00	White Y
16	A0	
17	00	
18	00	
19	00	White Z
1A	AE	
1B	3E	
1C	4A	
1D	00	Black X
1E	00	
1F	61	
20	54	
21	00	Black Y
22	00	
23	66	
24	80	
25	00	Black Z
26	00	
27	6F	
28	9F	
29	00	Red X
2A	5C	
2B	28	
2C	2F	
2D	00	Red Y
2E	2F	
2F	C2	
30	90	
31	00	Red Z
32	04	
33	C7	
34	98	
35	00	Green X
36	1E	
37	0C	
38	09	
39	00	Green Y
3A	64	
3B	B7	
3C	36	
3D	00	Green Z
3E	0B	
3F	C0	
40	36	

Byte # hex	Value hex	Description
41	00	Blue X
42	1E	
43	7C	
44	33	
45	00	Blue Y
46	0C	
47	53	
48	39	
49	00	Blue Z
4A	9E	
4B	95	
4C	BB	