BS ISO/IEC 23001-8:2016

BSI Standards Publication

Information technology — MPEG systems technologies

Part 8: Coding-independent code points

bsi.

National foreword

This British Standard is the UK implementation of ISO/IEC 23001-8:2016. It supersedes BS ISO/IEC 23001-8:2013 which is withdrawn.

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Partie 8: Points de code indépendants du codage

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition (ISO/IEC 23001-8:2013), which has been technically revised.

It also incorporates the Amendment ISO/IEC 23001-8:2013/Amd 1:2015 and the Technical Corrigendum ISO/IEC 23001-8:2013/Cor 1:2015.

ISO/IEC 23001 consists of the following parts, under the general title *Information technology — MPEG systems technologies*:

— *Part 1: Binary MPEG format for XML*

— *Part 2: Fragment request units*

— *Part 3: XML IPMP messages*

— *Part 4: Codec configuration representation*

— *Part 5: Bitstream Syntax Description Language (BSDL)*

— *Part 7: Common encryption in ISO base media file format files*

— *Part 8: Coding-independent code points*

— *Part 9: Common encryption of MPEG-2 transport streams*

— *Part 10: Carriage of timed metadata metrics of media in ISO base media file format*

— *Part 11: Energy-efficient media consumption (green metadata)*

Information technology — MPEG systems technologies —

Part 8:
Coding-independent code points

1 Scope

This part of ISO/IEC 23001 defines various code points and fields that establish properties of a video or audio stream that are independent of the compression encoding and bit rate. These properties may describe the appropriate interpretation of decoded video or audio data or may, similarly, describe the characteristics of such signals before the signal is compressed by an encoder that is suitable for compressing such an input signal.

2 Normative references

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

ISO 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

Rec. ITU-R BS.1770, *Algorithms to measure audio programme loudness and true-peak audio level*

Rec. ITU-R BS.1771-1, *Requirements for loudness and true-peak indicating meters*

EBU R 128, *Loudness normalization and permitted maximum level of audio signals*

EBU Tech 3341, *Loudness Metering: EBU mode metering to supplement loudness normalization in accordance with EBU R128*

EBU Tech 3342, *Loudness Range: A measure to supplement loudness normalisation in accordance with EBU R 128*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
channel
Ch.
conceptual representation of an audio signal for coding or transmission as it may be used within the digital signal processing chain of an audio codec

Note 1 to entry: A channel may correspond directly to one specific loudspeaker or it may carry an audio signal that is meant to be further processed and played back on more than one loudspeaker by some means not further specified here.

3.1.2
DRC
dynamic range compressor process that modifies the amplitude of an audio signal

3.1.3
K-weighted
frequency weighting by means of a two-stage filter, as defined in Rec. ITU-R BS.1770

3.1.4
LKFS
loudness, K-weighted, relative to nominal full scale, as defined in Rec. ITU-R BS.1770

3.1.5
loudspeaker
LS
physical loudspeaker with a given geometric position relative to the listener and, if applicable, a label or name

Note 1 to entry: Even though the loudspeaker names used in this part of ISO/IEC 23001 each describe one discrete loudspeaker position, some loudspeaker signals may, in practice, be rendered on a loudspeaker array consisting of multiple loudspeakers which are all driven with the same audio signal, for example, in a theatrical setting.

3.1.6
loudspeaker index
association of a loudspeaker geometric position to a given index

3.1.7
loudspeaker layout
set of loudspeakers with a specific constellation of geometric positions meant for authoring or play-back of audio content

3.1.8
loudspeaker layout index
association of a loudspeaker layout to a given index

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

LSB least-significant bit

MSB most-significant bit

4 Conventions

NOTE The mathematical operators used in this part of ISO/IEC 23001 are similar to those used in the C programming language. However, integer division and arithmetic shift operations are specifically defined. Numbering and counting conventions generally begin from 0.

4.1 Arithmetic operators

The following arithmetic operators are defined as follows:

+	Addition.
−	Subtraction (as a two-argument operator) or negation (as a unary prefix operator).
*	Multiplication, including matrix multiplication.
x^y	Exponentiation. Specifies x to the power of y. In other contexts, such notation is used for superscripting not intended for interpretation as exponentiation.

/ Integer division with truncation of the result toward zero. For example, 7 / 4 and (−7) / (−4) are truncated to 1 and (−7) / 4 and 7 / (−4) are truncated to −1.

÷ Used to denote division in mathematical equations where no truncation or rounding is intended.

$\frac{x}{y}$ Used to denote division in mathematical equations where no truncation or rounding is intended.

$\sum_{i=x}^{y} f(i)$ The summation of f(i) with i taking all integer values from x up to and including y.

x % y Modulus. Remainder of x divided by y, defined only for integers x and y with x >= 0 and y > 0.

4.2 Relational operators

The following relational operators are defined as follows:

\> greater than

\>= greater than or equal to

< less than

<= less than or equal to

== equal to

!= not equal to

When a relational operator is applied to a syntax element or variable that has been assigned the value "na" (not applicable), the value "na" is treated as a distinct value for the syntax element or variable. The value "na" is considered not to be equal to any other value.

4.3 Bit-wise operators

The following bit-wise operators are defined as follows:

& Bit-wise "and". When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

| Bit-wise "or". When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

^ Bit-wise "exclusive or". When operating on integer arguments, operates on a two's complement representation of the integer value. When operating on a binary argument that contains fewer bits than another argument, the shorter argument is extended by adding more significant bits equal to 0.

x >> y Arithmetic right shift of a two's complement integer representation of x by y binary digits. This function is defined only for positive integer values of y. Bits shifted into the MSBs as a result of the right shift have a value equal to the MSB of x prior to the shift operation.

x << y Arithmetic left shift of a two's complement integer representation of x by y binary digits. This function is defined only for positive integer values of y. Bits shifted into the LSBs as a result of the left shift have a value equal to 0.

4.4 Mathematical functions

The following mathematical functions are defined as follows:

$$\text{Abs}(\ x\ ) = \begin{cases} x & ;\quad x >= 0 \\ -x & ;\quad x < 0 \end{cases} \tag{1}$$

$$\text{Clip1}_Y(\ x\ ) = \text{Clip3}(\ 0, (\ 1 << \text{BitDepth}_Y\ ) - 1, x\ ), \tag{2}$$

where BitDepth_Y is the representation bit depth of the corresponding luma colour component signal.

$$\text{Clip1}_C(\ x\ ) = \text{Clip3}(\ 0, (\ 1 << \text{BitDepth}_C\ ) - 1, x\ ), \tag{3}$$

where BitDepth_C is the representation bit depth of the corresponding chroma colour component signal C. In general, BitDepth_C may be distinct for different chroma colour components signals C, e.g. for C corresponding to Cb or Cr.

$$\text{Clip3}(\ x,y,z\ ) = \begin{cases} x & ;\quad z < x \\ y & ;\quad z > y \\ z & ;\quad \text{otherwise} \end{cases} \tag{4}$$

Floor(x) the largest integer less than or equal to x. (5)

Log10(x) returns the base-10 logarithm of x. (6)

$$\text{Round}(\ x\ ) = \text{Sign}(\ x\ ) * \text{Floor}(\ \text{Abs}(\ x\ ) + 0.5\ ). \tag{7}$$

$$\text{Sign}(\ x\ ) = \begin{cases} 1 & ;\quad x >= 0 \end{cases} \tag{8}$$

$$-1 \quad x < 0$$

$$\text{Sqrt}(x) = x \qquad (9)$$

5 Introduction

5.1 General

This Clause identifies the code points defined in this part of ISO/IEC 23001, as listed in Table 1 with cross-references to the subclause in which each is specified.

Table 1 — List of code point definitions

Name	**Abstract**	**Subclause**
ColourPrimaries	Video colour primaries	7.1
TransferCharacteristics	Video colour transfer characteristics	7.2
MatrixCoefficients and **VideoFullRangeFlag**	Video matrix colour coefficients	7.3
VideoFramePackingType and **QuincunxSamplingFlag**	Video frame packing	7.4
PackedContentInterpretationType	Interpretation of packed video frames	7.5
SampleAspectRatio, SarWidth, SarHeight	Sample aspect ratio of video	7.6
OutputChannelPosition	Audio channel assignment	8.1
ChannelConfiguration	Audio channel configuration	8.2
LoudspeakerGeometry	Audio loudspeaker geometry	8.3
LoudspeakerElevation	Audio loudspeaker elevation	8.3
LoudspeakerAzimuth	Audio loudspeaker azimuth	8.3
ProgramLoudness	Audio program loudness level	8.4
AnchorLoudness	Audio anchor content loudness level	8.5
LoudnessRange	Range of loudness	8.6
LoudnessRangeTop	Top value of loudness range	8.7
MomentaryLoudnessMax	Maximum Loudness (400 ms window)	8.8
ShortTermLoudnessMax	Maximum Loudness (3 s window)	8.9
ShortTermLoudness	Loudness (3 s window)	8.10
SamplePeakLevel	Level of sample peak magnitude	8.11
TruePeakLevel	Level of true peak	8.11
DrcCharacteristic	Index of DRC characteristic	8.12

5.2 Background

In a number of specifications, there is a need to identify some characteristics of media that are logically independent of the compression format (for example, aspects that relate to the sourcing or presentation or the role of the media component). These media characteristics have typically been documented by fields that take an encoded value or item selected from an enumerated list, herein called code points.

These code points are typically defined in the specification of compression formats to document these characteristics of the media. In past practices, the definition of these fields has been copied from standard to standard, sometimes with new values being added in later standards (and sometimes with later amendments specified to add new entries to existing standards).

This past practice has raised a number of issues, including the following:

a) A lack of a formal way to avoid conflicting assignments being made in different standards.

b) Having additional values defined in later specifications that may be practically used with older compression formats, but without clear formal applicability of these new values to older standards.

c) Any update or correction of code point semantics can incur significant effort to update all standards in which the code point is specified, instead of enabling a single central specification to apply across different referencing specifications.

d) The choice of reference for other specifications (such as container or delivery formats) not being obvious; wherein a formal reference to a compression format standard appears to favour that one format over others, and also appears to preclude definitions defined in other compression format specifications.

e) Burdensome maintenance needs to ensure that a reference to material defined in a compression format specification is maintained appropriately over different revisions of the referenced format specification, as the content of a compression format specification may change over time and is ordinarily not intended as a point of reference for defining such code points.

This part of ISO/IEC 23001 provides a central definition of such code points to address these issues.

5.3 Applicability

The usage of this part of ISO/IEC 23001 is illustrated in Figure 1. This part of ISO/IEC 23001 can be used to provide universal descriptions to assist interpretation of signals following decoding or to describe the properties of the signals before they are encoded.

This part of ISO/IEC 23001 provides code points for coding-independent description of multimedia signal characteristics.

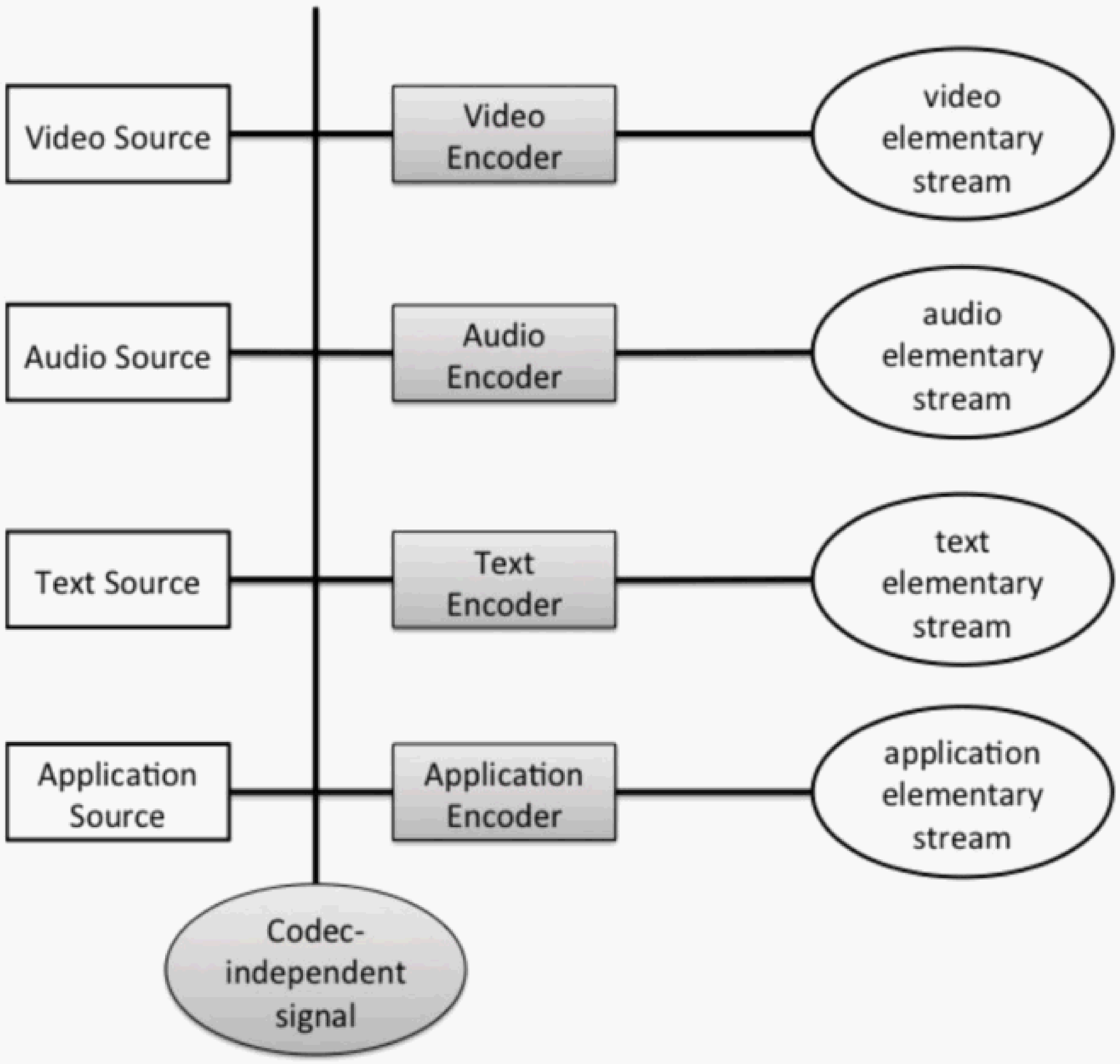


Figure 1 — Scope of this part of ISO/IEC 23001

6 Principles for definition and referencing of code points

6.1 Code point encoding and defaults

The code points defined herein may be specified as a value or a label of an enumerated list. The definition of their encoding and representation (e.g. as a binary number) is the responsibility of the specification using the code point, as is the identification of any applicable default value not specified herein. It is also possible for external specifications to use a mapping to values defined here, if they wish to preserve identical semantics but different code point assignments.

Guidance is given for each code point as to a suitable type (e.g. unsigned integer) and a suitable value range (e.g. 0 to 63) for assistance in writing derived specifications. In some instances, default flag values are provided that are suggested to be inferred for code point parameters with associated flags that may not be explicitly signalled or specified in derived specifications.

6.2 Externally defined values

If the external specification permits values not defined by this part of ISO/IEC 23001 to be identified in the same field that carries values defined by this part of ISO/IEC 23001, then that other specification should identify how values defined herein can be distinguished from values not defined herein.

6.3 Reference format

References to code points in this part of ISO/IEC 23001 should use only the code point name (i.e. a "Name" from Table 1) and specification title, and not use section numbers or any other "fragile" reference such as a table number. Example: "**ChocolateDensity** as defined in ISO/IEC 23001-8 *Coding-independent code points*".

6.4 URN Format

The Uniform Resource Names (URN) prefix

urn:mpeg:mpegB:cicp:

is defined by this part of ISO/IEC 23001 to form URN labels for the names in Table 1, when followed by a name from that table. Systems may use these URNs to identify values defined herein.

EXAMPLE urn:mpeg:mpegB:cicp:ColourPrimaries

7 Video code points

7.1 Colour primaries

Type: Unsigned integer, enumeration

Range: 0 – 255

ColourPrimaries indicates the chromaticity coordinates of the source colour primaries as specified in Table 2 in terms of the CIE 1931 definition of x and y as specified by ISO 11664-1.

An 8-bit field should be adequate for representation of the ColourPrimaries code point.

Table 2 — Interpretation of colour primaries (ColourPrimaries) value

Value	Colour primaries			Informative remarks
0	Reserved			For future use by ISO/IEC
1	primary	x	y	Rec. ITU-R BT.709-5
	green	0.300	0.600	Rec. ITU-R BT.1361 conventional colour gamut system and extended colour gamut system
	blue	0.150	0.060	(historical)
	red	0.640	0.330	IEC 61966-2-1 sRGB or sYCC
	white D65	0.312 7	0.329 0	IEC 61966-2-4 Society of Motion Picture and Television Engineers RP 177 (1993) Annex B
2	Unspecified			Image characteristics are unknown or are determined by the application.
3	Reserved			For future use by ISO/IEC

Table 2 *(continued)*

Value	Colour primaries			Informative remarks
4	primary	x	y	Rec. ITU-R BT.470-6 System M (historical)
	green	0.21	0.71	United States National Television SystemCommittee 1953 Recommendation for transmission standards for colour television
	blue	0.14	0.08	
	red	0.67	0.33	
	white C	0.310	0.316	United States Federal Communications Commission Title 47 Code of Federal Regulations (2003) 73.682 (a) (20)
5	primary	x	y	Rec. ITU-R BT.470-6 System B, G (historical)
	green	0.29	0.60	Rec. ITU-R BT.601-6 625
	blue	0.15	0.06	Rec. ITU-R BT.1358 625 (historical)
	red	0.64	0.33	Rec. ITU-R BT.1700 625 PAL and 625 SECAM
	white D65	0.312 7	0.329 0	
6	primary	x	y	Rec. ITU-R BT.601-6 525
	green	0.310	0.595	Rec. ITU-R BT.1358 525 (historical)
	blue	0.155	0.070	Rec. ITU-R BT.1700 NTSC
	red	0.630	0.340	Society of Motion Picture and Television Engineers 170M (2004)
	white D65	0.312 7	0.329 0	(functionally the same as the value 7)
7	primary	x	y	Society of Motion Picture and Television Engineers 240M (1999)
	green	0.310	0.595	(functionally the same as the value 6)
	blue	0.155	0.070	
	red	0.630	0.340	
	white D65	0.312 7	0.329 0	
8	primary	x	y	Generic film (colour filters using Illuminant C)
	green	0.243	0.692 (Wratten 58)	
	blue	0.145	0.049 (Wratten 47)	
	red	0.681	0.319 (Wratten 25)	
	white C	0.310	0.316	
9	primary	x	y	Rec. ITU-R BT.2020
	green	0.170	0.797	
	blue	0.131	0.046	
	red	0.708	0.292	
	white D65	0.312 7	0.329 0	
10	primary	x	y	Society of Motion Picture and Television Engineers ST 428-1
	green (Y)	0.0	1.0	(CIE 1931 XYZ as in ISO 11664-1)
	blue (Z)	0.0	0.0	
	red (X)	1.0	0.0	
	centre white	1 ÷ 3	1 ÷ 3	

Table 2 *(continued)*

Value	Colour primaries			Informative remarks
11	primary	x	y	Society of Motion Picture and Television Engineers RP 431-2 (2011)
	green	0.265	0.690	
	blue	0.150	0.060	
	red	0.680	0.320	
	white	0.314	0.351	
12	primary	x	y	Society of Motion Picture and Television Engineers EG 432-1 (2010)
	green	0.265	0.690	
	blue	0.150	0.060	
	red	0.680	0.320	
	white D65	0.312 7	0.329 0	
13–21	Reserved			For future use by ISO/IEC
22	primary	x	y	EBU Tech. 3213-E (1975)
	green	0.295	0.605	
	blue	0.155	0.077	
	red	0.630	0.340	
	white D65	0.312 7	0.329 0	
23–255	Reserved			For future use by ISO/IEC

7.2 Transfer characteristics

Type: Unsigned integer, enumeration

Range: 0 – 255

TransferCharacteristics indicates the opto-electronic transfer characteristic of the source picture, as specified in Table 3, as a function of a linear optical intensity input L_c with a nominal real-valued range of 0 to 1. For interpretation of entries in Table 3 that are expressed in terms of multiple curve segments parameterized by the variable α over a region bounded by the variable β or by the variables β and γ, the values of α and β are defined to be the positive constants necessary for the curve segments that meet at the value β to have continuity of both value and slope at the value β. The value of γ, when applicable, is defined to be the positive constant necessary for the associated curve segments to meet at the value γ. For example, for TransferCharacteristics equal to 1, 6, 14, or 15, α has the value $1 + 5.5 * \beta$ = 1.099 296 826 809 442... and β has the value 0.018 053 968 510 807....

An 8-bit field should be adequate for representation of the **TransferCharacteristics** code point.

Table 3 — Interpretation of transfer characteristics (TransferCharacteristics) value

Value	Transfer characteristics		Informative remarks
0	Reserved		For future use by ISO/IEC
1	$V = \alpha * L_c^{0.45} - (\alpha - 1)$	for $1 >= L_c >= \beta$	Rec. ITU-R BT.709-5
	$V = 4.500 * L_c$	for $\beta > L_c >= 0$	Rec. ITU-R BT.1361 conventional colour gamut system (historical) (functionally the same as the values 6, 14 and 15; the value 1 is preferred)
2	Unspecified		Image characteristics are unknown or are determined by the application.

Table 3 *(continued)*

Value	Transfer characteristics	Informative remarks
3	Reserved	For future use by ISO/IEC
4	Assumed display gamma 2.2	Rec. ITU-R BT.470-6 System M (historical) United States National Television System Committee 1953 Recommendation for transmission standards for colour television United States Federal Communications Commission Title 47 Code of Federal Regulations (2003) 73.682 (a) (20) Rec. ITU-R BT.1700 (2007 revision) 625 PAL and 625 SECAM
5	Assumed display gamma 2.8	Rec. ITU-R BT.470-6 System B, G (historical)
6	$V = \alpha * L_C^{0.45} - (\alpha - 1)$ for $1 >= L_C >= \beta$ $V = 4.500 * L_C$ for $\beta > L_C >= 0$	Rec. ITU-R BT.601-6 525 or 625 Rec. ITU-R BT.1358 525 or 625 (historical) Rec. ITU-R BT.1700 NTSC Society of Motion Picture and Television Engineers 170M (2004) (functionally the same as the values 1, 14, and 15; the value 1 is preferred)
7	$V = \alpha * L_C^{0.45} - (\alpha - 1)$ for $1 >= L_C >= \beta$ $V = 4.0 * L_C$ for $\beta > L_C >= 0$	Society of Motion Picture and Television Engineers 240M (1999)
8	$V = L_C$ for $1 > L_C >= 0$	Linear transfer characteristics
9	$V = 1.0 + \mathrm{Log10}(L_C) \div 2$ for $1 >= L_C >= 0.01$ $V = 0.0$ for $0.01 > L_C >= 0$	Logarithmic transfer characteristic (100:1 range)
10	$V = 1.0 + \mathrm{Log10}(L_C) \div 2.5$ for $1 >= L_C >= \mathrm{Sqrt}(10) \div 1\,000$ $V = 0.0$ for $\mathrm{Sqrt}(10) \div 1\,000 > L_C >= 0$	Logarithmic transfer characteristic (100 * Sqrt(10) : 1 range)
11	$V = \alpha * L_C^{0.45} - (\alpha - 1)$ for $L_C >= \beta$ $V = 4.500 * L_C$ for $\beta > L_C > -\beta$ $V = -\alpha * (-L_C)^{0.45} + (\alpha - 1)$ for $-\beta >= L_C$	IEC 61966-2-4
12	$V = \alpha * L_C^{0.45} - (\alpha - 1)$ for $1.33 > L_C >= \beta$ $V = 4.500 * L_C$ for $\beta > L_C >= -\gamma$	Rec. ITU-R BT.1361 extended colour gamut system (historical)
13	$V = -(\alpha * (-4 * L_C)^{0,45} - (\alpha - 1)) \div 4$ for $-\gamma >= L_C >= -0.25$ $V = \alpha * L_C^{(1 \div 2.4)} - (\alpha - 1)$ for $1 > L_C >= \beta$	IEC 61966-2-1 sRGB or sYCC
14	$V = 12.92 * L_C$ for $\beta > L_C >= 0$ $V = \alpha * L_C^{0.45} - (\alpha - 1)$ for $1 >= L_C >= \beta$ $V = 4.500 * L_C$ for $\beta > L_C >= 0$	Rec. ITU-R BT.2020 (10-bit system) (functionally the same as the values 1, 6, and 15; the value 1 is preferred)

Table 3 *(continued)*

Value	Transfer characteristics	Informative remarks
15	$V = \alpha * L_c^{0.45} - (\alpha - 1)$ for $1 >= L_c >= \beta$ $V = 4.500 * L_c$ for $\beta > L_c >= 0$	Rec. ITU-R BT.2020 (12-bit system) (functionally the same as the values 1, 6, and 14; the value 1 is preferred)
16	$V = ((c_1 + c_2 * L_c^n) \div (1 + c_3 * L_c^n))^m$ for all values of L_c $c_1 = c_3 - c_2 + 1 = 107 \div 128 = 0.835\ 937\ 5$ $c_2 = 241\ 3 \div 128 = 18.851\ 562\ 5$ $c_3 = 239\ 2 \div 128 = 18.687\ 5$ $m = 252\ 3 \div 32 = 78.843\ 75$ $n = 653 \div 4\ 096 = 0.159\ 301\ 757\ 812\ 5$ for which L_c equal to 1 for peak white is ordinarily intended to correspond to a display luminance level of 10 000 candelas per square metre	Society of Motion Picture and Television Engineers ST 2084 for 10, 12, 14, and 16-bit systems
17	$V = (48 * L_c \div 52.37)^{(1 \div 2.6)}$ for all values of L_c for all values of L_c for which L_c equal to 1 for peak white is ordinarily intended to correspond to a display luminance level of 48 candelas per square metre	Society of Motion Picture and Television Engineers ST 428-1
18–255	Reserved	For future use by ISO/IEC

7.3 Matrix coefficients

Type: Unsigned integer, enumeration

Range: 0 – 255, plus associated flag

MatrixCoefficients describes the matrix coefficients used in deriving luma and chroma signals from the green, blue, and red, or X, Y, and Z primaries, as specified in Table 4 and the Formulae below.

A flag, VideoFullRangeFlag, may be supplied with this code point (see below).

VideoFullRangeFlag specifies the scaling and offset values applied in association with the MatrixCoefficients. When not present or not specified, the value 0 for VideoFullRangeFlag would ordinarily be inferred as the default value for video imagery.

An 8-bit field should be adequate for representation of the MatrixCoefficients code point.

The interpretation of MatrixCoefficients is specified by the following Formulae. E_R, E_G, and E_B are defined as "linear-domain" real-valued signals based on the indicated colour primaries (see 7.1) before applying the transfer characteristics (see 7.2).

NOTE 1 For purposes of the YZX representation when MatrixCoefficients is equal to 0, the symbols R, G, and B are substituted for X, Y, and Z, respectively, in the following descriptions of Formulae (10) to (12), Formulae (13) to (15), Formulae (19) to (21), and Formulae (28) to (30).

The application of the transfer characteristics function is denoted by $(x)'$ for an argument x. The signals E'_R, E'_G, and E'_B are determined by application of the transfer characteristics function as follows:

$$E'_R = (E_R)' \quad (10)$$

$$E'_G = (E_G)' \quad (11)$$

$$E'_B = (E_B)' \quad (12)$$

The range of E'_R, E'_G, and E'_B are specified as follows:

— If TransferCharacteristics is not equal to 11 or 12, E'_R, E'_G, and E'_B are real numbers with values in the range of 0 to 1.

— Otherwise [TransferCharacteristics is equal to 11 (IEC 61966-2-4) or 12 (Rec. ITU-R BT.1361 extended colour gamut system)], E'_R, E'_G and E'_B are real numbers with a larger range not specified in this part of ISO 23001.

Nominal white is specified as having E'_R equal to 1, E'_G equal to 1, and E'_B equal to 1.

Nominal black is specified as having E'_R equal to 0, E'_G equal to 0, and E'_B equal to 0.

The interpretation of MatrixCoefficients is specified as follows:

— If VideoFullRangeFlag is equal to 0, the following applies:

— If MatrixCoefficients is equal to 0 or 8, the following Formulae apply:

$$R = \text{Clip1}_Y((1 << (\text{BitDepth}_Y - 8)) * (219 * E'_R + 16)) \quad (13)$$

$$G = \text{Clip1}_Y((1 << (\text{BitDepth}_Y - 8)) * (219 * E'_G + 16)) \quad (14)$$

$$B = \text{Clip1}_Y((1 << (\text{BitDepth}_Y - 8)) * (219 * E'_B + 16)) \quad (15)$$

— Otherwise, if MatrixCoefficients is equal to 1, 4, 5, 6, 7, 9, 10, or 11, the following Formulae apply:

$$Y = \text{Clip1}_Y(\text{Round}((1 << (\text{BitDepth}_Y - 8)) * (219 * E'_Y + 16))) \quad (16)$$

$$Cb = \text{Clip1}_C(\text{Round}((1 << (\text{BitDepth}_C - 8)) * (224 * E'_{PB} + 128))) \quad (17)$$

$$Cr = \text{Clip1}_C(\text{Round}((1 << (\text{BitDepth}_C - 8)) * (224 * E'_{PR} + 128))) \quad (18)$$

— Otherwise, if MatrixCoefficients is equal to 2, the interpretation of the MatrixCoefficients syntax element is unknown or is determined by the application.

— Otherwise (MatrixCoefficients is not equal to 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, or 11), the interpretation of the MatrixCoefficients syntax element is reserved for future definition by ISO/IEC.

— Otherwise (VideoFullRangeFlag is equal to 1), the following Formulae apply:

— If MatrixCoefficients is equal to 0 or 8, the following Formulae apply:

$$R = \text{Clip1}_Y(((1 << \text{BitDepth}_Y) - 1) * E'_R) \quad (19)$$

$$G = \text{Clip1}_Y(((1 << \text{BitDepth}_Y) - 1) * E'_G) \quad (20)$$

$$B = \text{Clip1}_Y(((1 << \text{BitDepth}_Y) - 1) * E'_B) \quad (21)$$

— Otherwise, if MatrixCoefficients is equal to 1, 4, 5, 6, 7, 9, 10, or 11, the following Formulae apply:

$$Y = \text{Clip1}_Y(\text{Round}(((1 << \text{BitDepth}_Y) - 1) * E'_Y)) \quad (22)$$

$$Cb = Clip1_C(Round(((1 << BitDepth_C) - 1) * E'_{PB} + (1 << (BitDepth_C - 1)))) \quad (23)$$

$$Cr = Clip1_C(Round(((1 << BitDepth_C) - 1) * E'_{PR} + (1 << (BitDepth_C - 1)))) \quad (24)$$

— Otherwise, if MatrixCoefficients is equal to 2, the interpretation of the MatrixCoefficients syntax element is unknown or is determined by the application.

— Otherwise (MatrixCoefficients is not equal to 0, 1, 2, 4, 5, 6, 7, 8, 9, 10, or 11), the interpretation of the MatrixCoefficients syntax element is reserved for future definition by ISO/IEC.

The variables E'_Y, E'_{PB}, and E'_{PR} (for MatrixCoefficients not equal to 0 or 8) or Y, Cb, and Cr (for MatrixCoefficients equal to 0 or 8) are specified as follows.

— If MatrixCoefficients is not equal to 0, 8, 10, or 11, the following Formulae apply:

$$E'_Y = K_R * E'_R + (1 - K_R - K_B) * E'_G + K_B * E'_B \quad (25)$$

$$E'_{PB} = 0.5 * (E'_B - E'_Y) \div (1 - K_B) \quad (26)$$

$$E'_{PR} = 0.5 * (E'_R - E'_Y) \div (1 - K_R) \quad (27)$$

NOTE 2 E'_Y is a real number with the value 0 associated with nominal black and the value 1 associated with nominal white. E'_{PB} and E'_{PR} are real numbers with the value 0 associated with both nominal black and nominal white. When TransferCharacteristics is not equal to 11 or 12, E'_Y is a real number with values in the range of 0 to 1. When TransferCharacteristics is not equal to 11 or 12, E'_{PB} and E'_{PR} are real numbers with values in the range of −0.5 to 0.5. When TransferCharacteristics is equal to 11 (IEC 61966-2-4), or 12 (Rec. ITU-R BT.1361 extended colour gamut system), E'_Y, E'_{PB}, and E'_{PR} are real numbers with a larger range not specified in this part of ISO/IEC 23001.

— Otherwise, if MatrixCoefficients is equal to 0, the following Formulae apply:

$$Y = Round(G) \quad (28)$$

$$Cb = Round(B) \quad (29)$$

$$Cr = Round(R) \quad (30)$$

— Otherwise, if MatrixCoefficients is equal to 8, the following applies:

— If $BitDepth_C$ is equal to $BitDepth_Y$, the following Formulae apply:

$$Y = Round(0.5 * G + 0.25 * (R + B)) \quad (31)$$

$$Cb = Round(0.5 * G - 0.25 * (R + B)) + (1 << (BitDepth_C - 1)) \quad (32)$$

$$Cr = Round(0.5 * (R - B)) + (1 << (BitDepth_C - 1)) \quad (33)$$

NOTE 3 For the purposes of the YCgCo nomenclature used in Table 4, Cb and Cr of Formulae (32) and (33) can be referred to as Cg and Co, respectively. For Formulae (31) to (33) an appropriate inverse computation is as follows:

t = Y − (Cb − (1 << (BitDepthC − 1))) (34)

G = Clip1Y(Y + (Cb − (1 << (BitDepthC − 1)))) (35)

B = Clip1Y(t − (Cr − (1 << (BitDepthC − 1)))) (36)

R = Clip1Y(t + (Cr − (1 << (BitDepthC − 1)))) (37)

— Otherwise ($BitDepth_C$ is not equal to $BitDepth_Y$), the following Formulae apply:

$$Cr = Round(R) - Round(B) + (1 << (BitDepth_C - 1)) \quad (38)$$

$$t = Round(B) + ((Cr - (1 << (BitDepth_C - 1))) >> 1) \quad (39)$$

$$Cb = Round(G) - t + (1 << (BitDepth_C - 1)) \quad (40)$$

$$Y = t + ((Cb - (1 << (BitDepth_C - 1))) >> 1) \quad (41)$$

NOTE 4 For purposes of the YCgCo nomenclature used in Table 4, Cb and Cr of Formulae (40) and (38) can be referred to as Cg and Co, respectively. For Formulae (38) to (41) an appropriate inverse computation is as follows:

$$t = Y - ((Cb - (1 << (BitDepthC - 1))) >> 1) \quad (42)$$

$$G = Clip1_Y(t + (Cb - (1 << (BitDepth_C - 1)))) \quad (43)$$

$$B = Clip1_Y(t - ((Cr - (1 << (BitDepth_C - 1))) >> 1)) \quad (44)$$

$$R = Clip1_Y(B + (Cr - (1 << (BitDepth_C - 1)))) \quad (45)$$

— Otherwise, if MatrixCoefficients is equal to 10, the signal E'_Y is determined by application of the transfer characteristics function as follows, and Formulae (48) to (55) apply for specification of the signals E'_{PB} and E'_{PR}:

$$E_Y = K_R * E_R + (1 - K_R - K_B) * E_G + K_B * E_B \quad (46)$$

$$E'_Y = (E_Y)' \quad (47)$$

NOTE 5 In this case, E_Y is defined from the "linear-domain" signals for E_R, E_G, and E_B, prior to application of the transfer characteristics function, which is then applied to produce the signal E'_Y. E_Y and E'_Y are real values with the value 0 associated with nominal black and the value 1 associated with nominal white.

$$E'_{PB} = (E'_B - E'_Y) \div (2 * N_B) \quad \text{for } -N_B <= E'_B - E'_Y <= 0 \quad (48)$$

$$E'_{PB} = (E'_B - E'_Y) \div (2 * P_B) \quad \text{for } 0 < E'_B - E'_Y <= P_B \quad (49)$$

$$E'_{PR} = (E'_R - E'_Y) \div (2 * N_R) \quad \text{for } -N_R <= E'_R - E'_Y <= 0 \quad (50)$$

$$E'_{PR} = (E'_R - E'_Y) \div (2 * P_R) \quad \text{for } 0 < E'_R - E'_Y <= P_R \quad (51)$$

where the constants N_B, P_B, N_R, and P_R are determined by application of the transfer characteristics function to expressions involving the constants K_B and K_R as follows:

$$N_B = (1 - K_B)' \quad (52)$$

$$P_B = 1 - (K_B)' \quad (53)$$

$$N_R = (1 - K_R)' \quad (54)$$

$$P_R = 1 - (K_R)' \quad (55)$$

— Otherwise (MatrixCoefficients is equal to 11), the following Formulae apply:

$$E'_Y = E'_G \quad (56)$$

$$E'_{PB} = (0.986\,566 * E'_B - E'_Y) \div 2.0 \quad (57)$$

$$E'_{PR} = (E'_R - 0.991\,902 * E'_Y) \div 2.0 \quad (58)$$

NOTE 6 In this case, E'_{PB} can be referred to as D'_Z and E'_{PR} can be referred to as D'_X.

Table 4 — Interpretation of matrix coefficients (MatrixCoefficients) value

Value	Matrix coefficients	Informative remarks
0	Identity	The identity matrix. Typically used for GBR (often referred to as RGB); however, may also be used for YZX (often referred to as XYZ); see Formulae (28) to (30) IEC 61966-2-1 sRGB Society of Motion Picture and Television Engineers ST 428-1
1	K_R = 0.212 6; K_B = 0.072 2	Rec. ITU-R BT.709-5 Rec. ITU-R BT.1361 conventional colour gamut system and extended colour gamut system (historical) IEC 61966-2-1 sYCC IEC 61966-2-4 $xvYCC_{709}$ Society of Motion Picture and Television Engineers RP 177 (1993) Annex B See Formulae (25) to (27)
2	Unspecified	Image characteristics are unknown or are determined by the application
3	Reserved	For future use by ISO/IEC
4	K_R = 0.30; K_B = 0.11	United States Federal Communications Commission Title 47 Code of Federal Regulations (2003) 73.682 (a) (20) See Formulae (25) to (27)

Table 4 *(continued)*

Value	Matrix coefficients	Informative remarks
5	$K_R = 0.299$; $K_B = 0.114$	Rec. ITU-R BT.470-6 System B, G (historical) Rec. ITU-R BT.601-6 625 Rec. ITU-R BT.1358 625 (historical) Rec. ITU-R BT.1700 625 PAL and 625 SECAM IEC 61966-2-4 $xvYCC_{601}$ (functionally the same as the value 6) See Formulae (25) to (27)
6	$K_R = 0.299$; $K_B = 0.114$	Rec. ITU-R BT.601-6 525 Rec. ITU-R BT.1358 525 (historical) Rec. ITU-R BT.1700 NTSC Society of Motion Picture and Television Engineers 170M (2004) (functionally the same as the value 5) See Formulae (25) to (27)
7	$K_R = 0.212$; $K_B = 0.087$	Society of Motion Picture and Television Engineers 240M (1999) See Formulae (25) to (27)
8	YCgCo	See Formulae (31) to (45)
9	$K_R = 0.262\ 7$; $K_B = 0.059\ 3$	Rec. ITU-R BT.2020 (non-constant luminance) See Formulae (25) to (27)
10	$K_R = 0.262\ 7$; $K_B = 0.059\ 3$	Rec. ITU-R BT.2020 (constant luminance) See Formulae (46) to (55)
11	$Y'D'_ZD'_X$	Society of Motion Picture and Television Engineers ST 2085 (2015) See Formulae (56) to (58)
12–255	Reserved	For future use by ISO/IEC

7.4 Video frame packing type

Type: Unsigned integer, enumeration

Range: 0 – 15, plus associated flag

VideoFramePackingType indicates the type of packing arrangement used in video frames as specified in Table 5. A flag, QuincunxSamplingFlag, may be supplied with this code point (see below).

QuincunxSamplingFlag indicates whether a quincunx sampling structure is used in the frame packed video representation. When not present or not specified, the value 0 for QuincunxSamplingFlag would ordinarily be inferred as the default value for packed video imagery.

Table 5 — Definition of VideoFramePackingType

Value	Interpretation
0	Each component plane of the decoded frames contains a "checkerboard" based interleaving of corresponding planes of two constituent frames as illustrated in Figure 2.
1	Each component plane of the decoded frames contains a column based interleaving of corresponding planes of two constituent frames as illustrated in Figure 3.
2	Each component plane of the decoded frames contains a row based interleaving of corresponding planes of two constituent frames as illustrated in Figure 4.

Table 5 *(continued)*

Value	Interpretation
3	Each component plane of the decoded frames contains a side-by-side packing arrangement of corresponding planes of two constituent frames as illustrated in Figure 5 and Figure 7.
4	Each component plane of the decoded frames contains top-bottom packing arrangement of corresponding planes of two constituent frames as illustrated in Figure 6.
5	The component planes of the decoded frames in output order form a temporal interleaving of alternating first and second constituent frames as illustrated in Figure 8.
6	The decoded frame constitutes a complete 2D frame without any frame packing (see NOTE 4).

NOTE 1 Figure 2 to Figure 7 provide typical examples of rearrangement and upconversion processing for various packing arrangement schemes. In Figure 2 to Figure 7, an upconversion processing is performed on each constituent frame to produce frames having the same resolution as that of the decoded frame. An example of the upsampling method to be applied to a quincunx sampled frame as shown in Figure 2 or Figure 7 is to fill in missing positions with an average of the available spatially neighbouring samples (the average of the values of the available samples above, below, to the left and to the right of each sample to be generated). The actual upconversion process to be performed, if any, is outside the scope of this part of ISO/IEC 23001.

NOTE 2 The sample aspect ratio (SAR) may be signalled appropriately (see SampleAspectRation in 7.3) to describe the intended horizontal distance between the columns and the intended vertical distance between the rows of the luma sample array in the decoded frame. For the typical examples in Figure 2 to Figure 4 with an SAR of 1:1 for the upconverted colour plane, signalling SAR of 1:1 is appropriate. For the typical examples in Figure 5 and Figure 7 with an SAR of 1:1 for the upconverted colour plane, signalling an SAR of 2:1 is appropriate. For the typical example in Figure 6 with an SAR of 1:1 for the upconverted colour plane, signalling an SAR of 1:2 is appropriate.

NOTE 3 VideoFramePackingType equal to 5 describes a temporal interleaving process of different frames.

NOTE 4 VideoFramePackingType equal to 6 is used to signal the presence of 2D content (that is not frame packed) in 3D services that use a mix of 2D and 3D content.

All other values of VideoFramePackingType are reserved for future use by ISO/IEC.

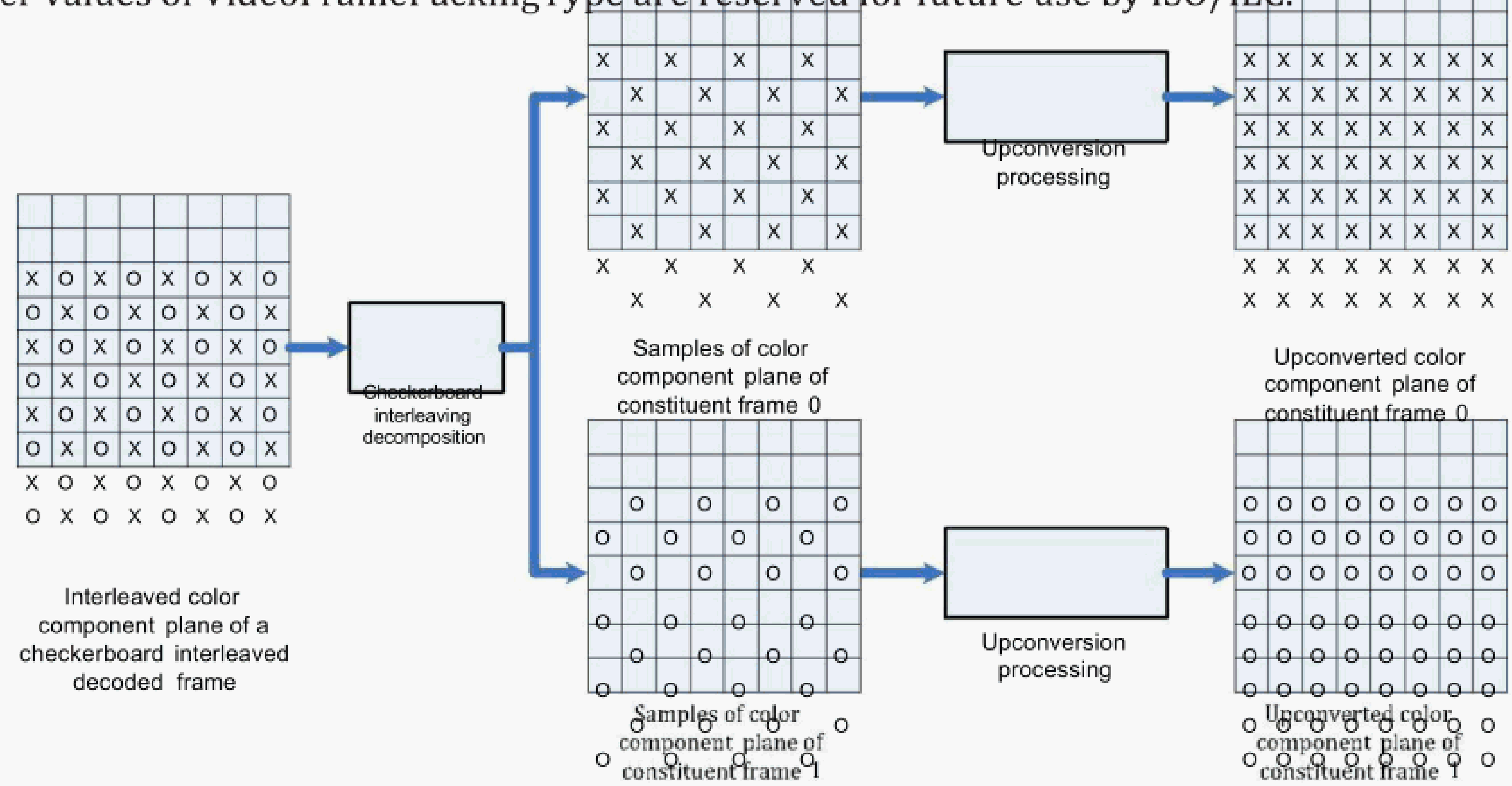


Figure 2 — Rearrangement and upconversion of checkerboard interleaving (VideoFramePackingType equal to 0)

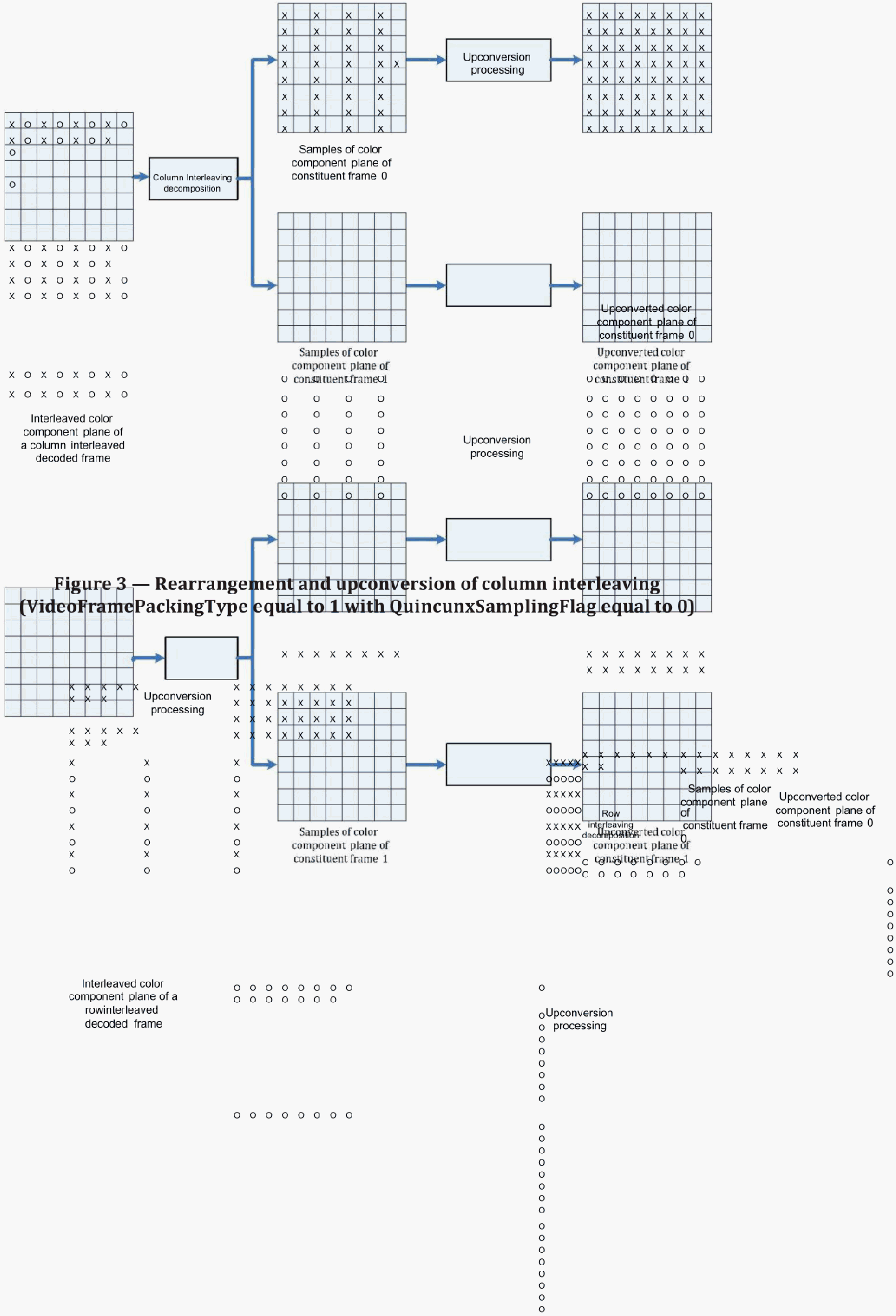


Figure 3 — Rearrangement and upconversion of column interleaving (VideoFramePackingType equal to 1 with QuincunxSamplingFlag equal to 0)

Figure 4 — Rearrangement and upconversion of row interleaving (VideoFramePackingType equal to 2 with QuincunxSamplingFlag equal to 0)

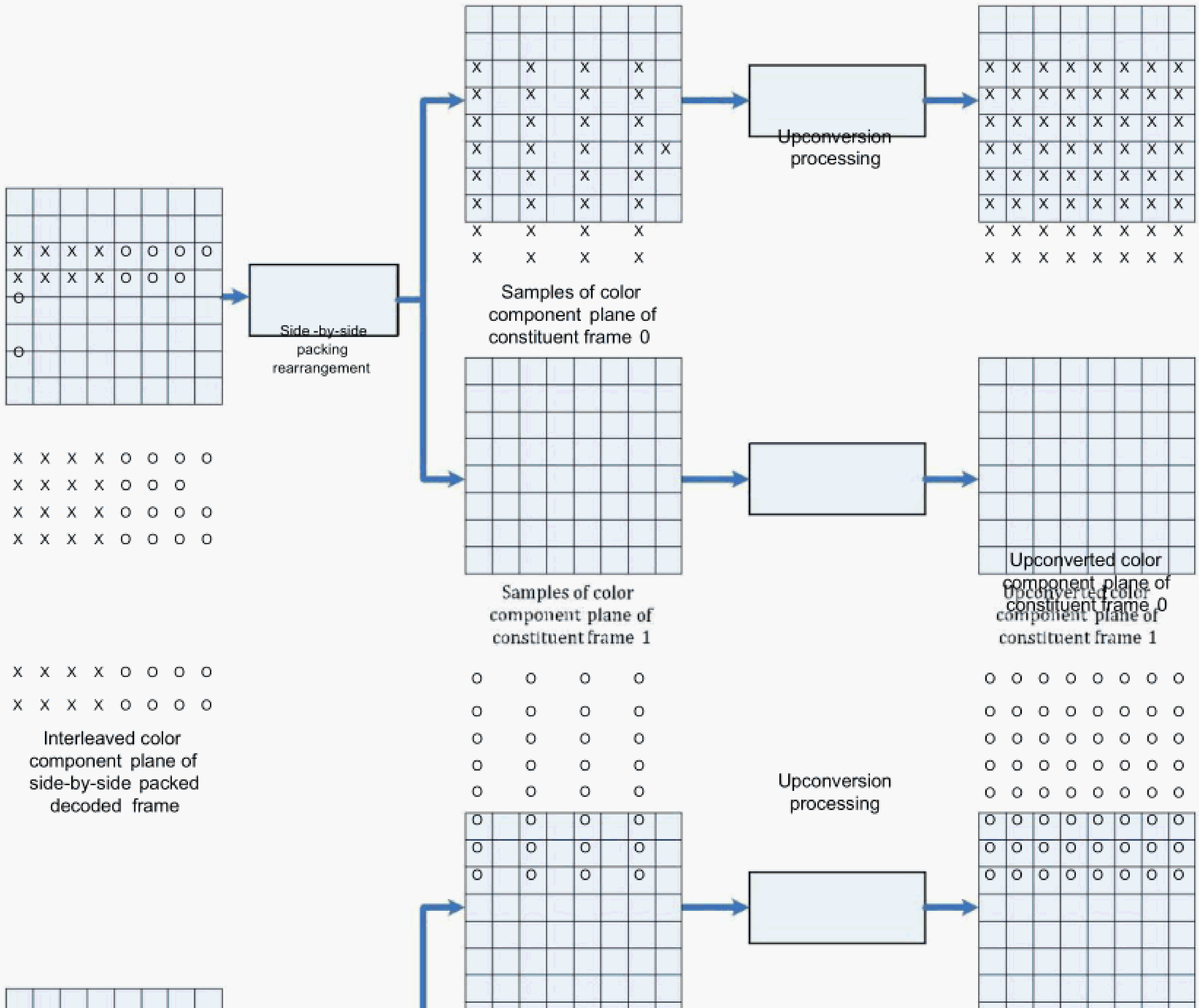
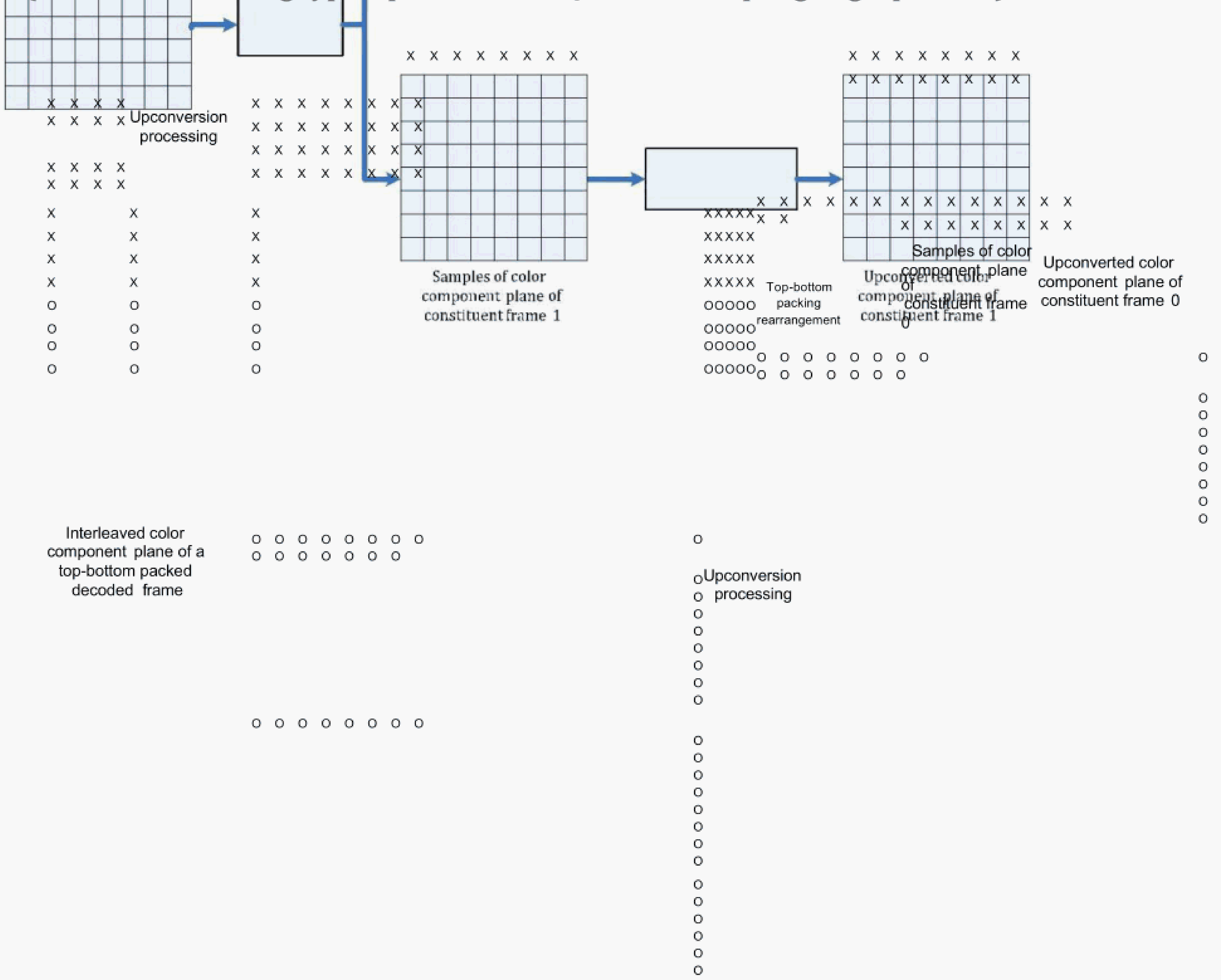


Figure 5 — Rearrangement and upconversion of side-by-side packing arrangement (VideoFramePackingType equal to 3 with QuincunxSamplingFlag equal to 0)



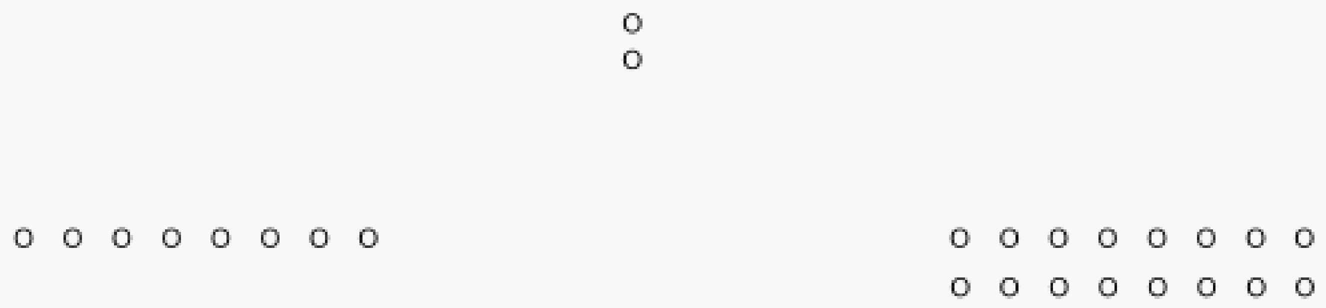


Figure 6 — Rearrangement and upconversion of top-bottom packing arrangement (VideoFramePackingType equal to 4 with QuincunxSamplingFlag equal to 0)

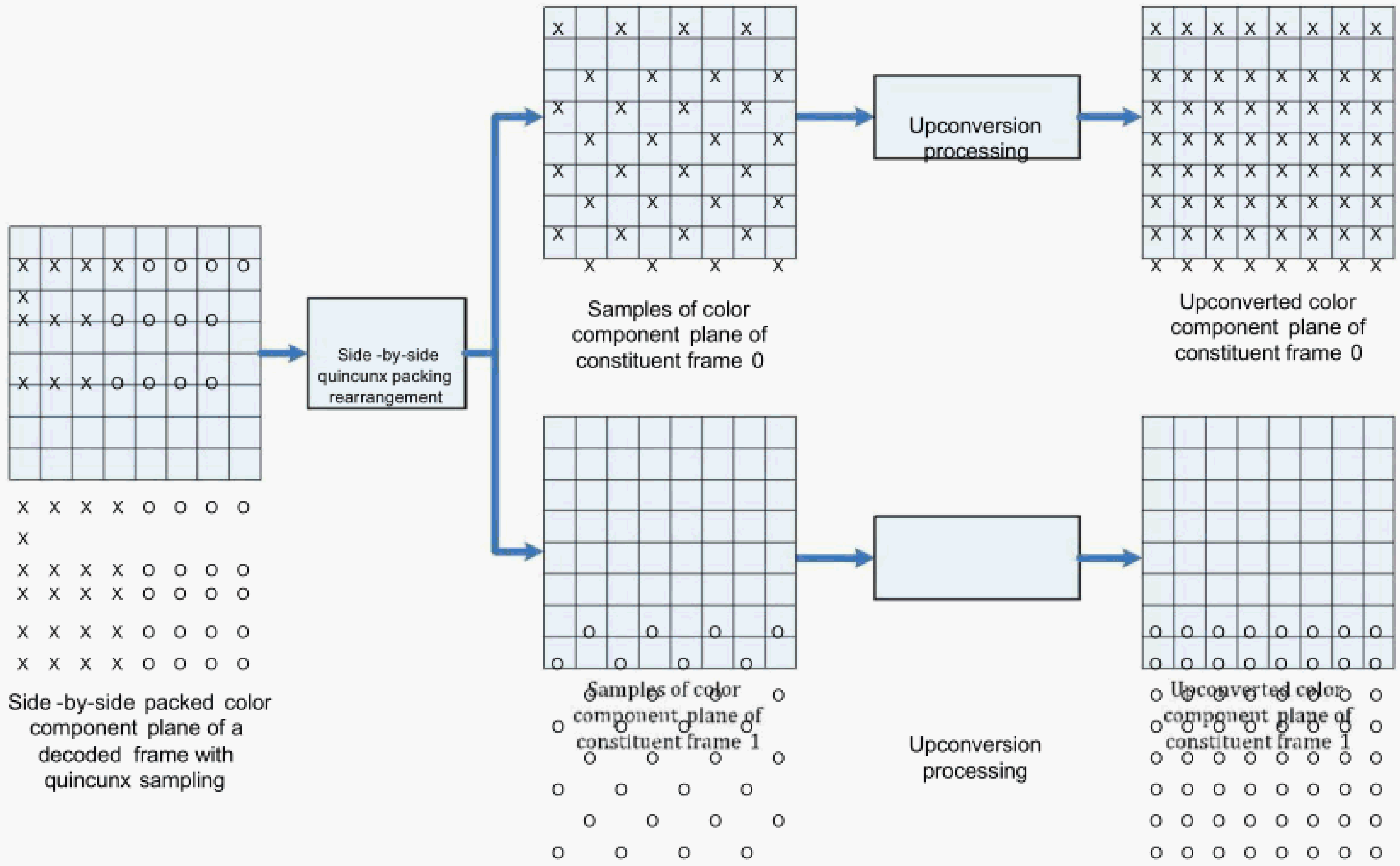


Figure 7 — Rearrangement and upconversion of side-by-side packing arrangement with quincunx sampling (VideoFramePackingType equal to 3 with QuincunxSamplingFlag equal to 1)

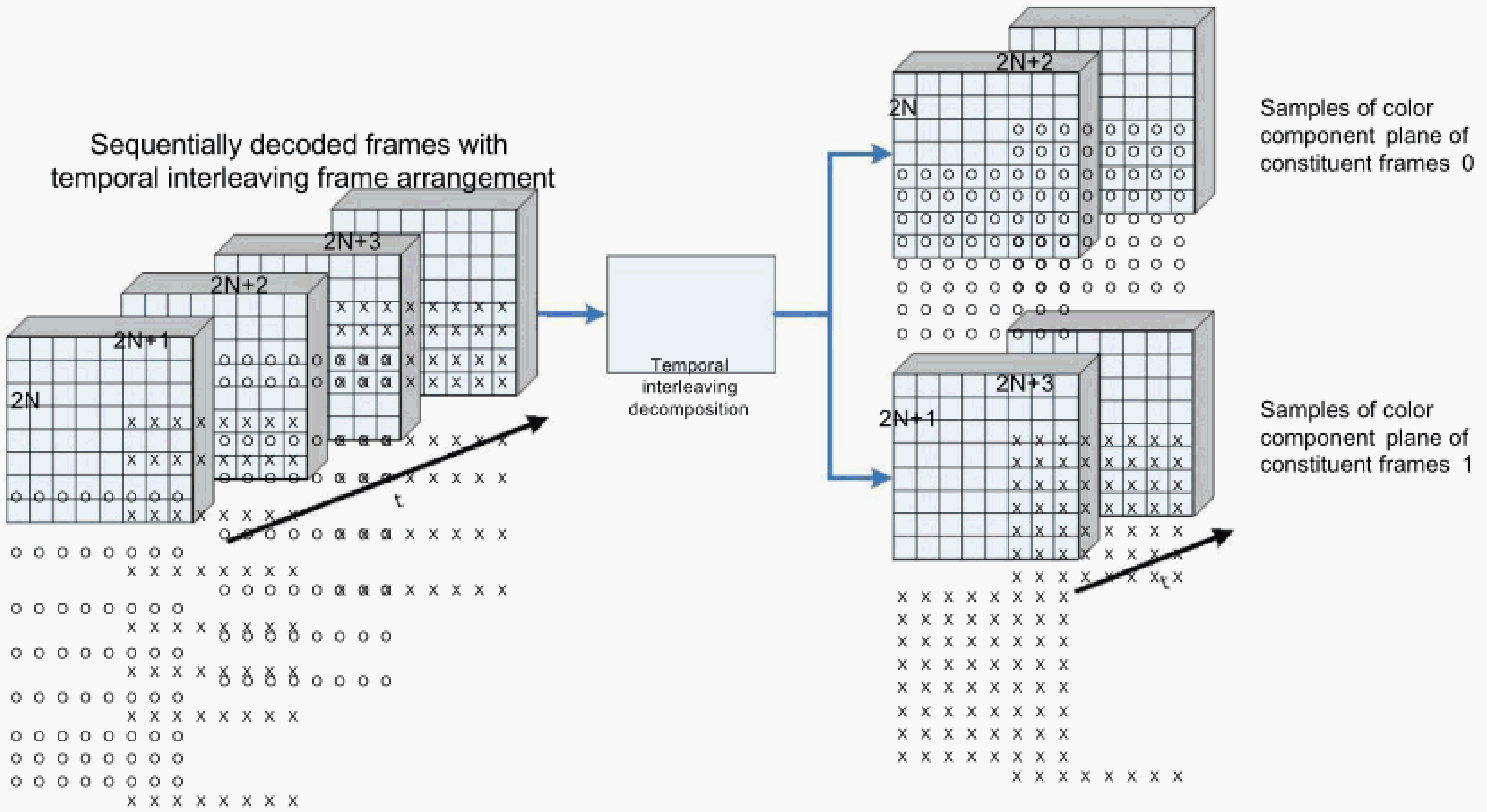


Figure 8 — Rearrangement of a temporal interleaving frame arrangement (VideoFramePackingType equal to 5)

7.5 Packed video content interpretation

Type: Unsigned integer, enumeration

Range: 0 – 15

PackedContentInterpretationType indicates the intended interpretation of the constituent frames as specified in Table 6. Values of PackedContentInterpretationType that do not appear in Table 6 are reserved for future specification by ISO/IEC.

NOTE 1 All currently-specified packed content interpretation types are for purposes relating to stereoscopic video imagery.

For each specified frame packing arrangement scheme, there are two constituent frames that are referred to as frame 0 and frame 1.

Table 6 — Definition of PackedContentInterpretationType

Value	Interpretation
0	Unspecified relationship between the frame packed constituent frames
1	Indicates that the two constituent frames form the left and right views of a stereo view scene, with frame 0 being associated with the left view and frame 1 being associated with the right view
2	Indicates that the two constituent frames form the right and left views of a stereo view scene, with frame 0 being associated with the right view and frame 1 being associated with the left view

NOTE 2 The value 2 for PackedContentInterpretationType is not expected to be prevalent in industry use. However, the value was specified herein for purposes of completeness.

7.6 Sample aspect ratio indicator

Type: Unsigned integer, enumeration

Range: 0 – 255

SampleAspectRatio, when present and not equal to 255, indicates the value of the sample aspect ratio of the luma samples. Table 7 shows the meaning of the code. When SampleAspectRatio is not present or is equal to 255, the sample aspect ratio is indicated by SarWidth : SarHeight.

Table 7 — Meaning of sample aspect ratio indicator (SampleAspectRatio)

Value	Sample aspect ratio	(Informative) Examples of use
0	Unspecified	
1	1:1 ("square")	7680×4320 16:9 frame without horizontal overscan 3840×2160 16:9 frame without horizontal overscan 1280×720 16:9 frame without horizontal overscan 1920×1080 16:9 frame without horizontal overscan (cropped from 1920×1088) 640×480 4:3 frame without horizontal overscan
2	12:11	720×576 4:3 frame with horizontal overscan 352×288 4:3 frame without horizontal overscan
3	10:11	720×480 4:3 frame with horizontal overscan 352×240 4:3 frame without horizontal overscan
4	16:11	720×576 16:9 frame with horizontal overscan 528×576 4:3 frame without horizontal overscan
5	40:33	720×480 16:9 frame with horizontal overscan 528×480 4:3 frame without horizontal overscan
6	24:11	352×576 4:3 frame without horizontal overscan 480×576 16:9 frame with horizontal overscan
7	20:11	352×480 4:3 frame without horizontal overscan 480×480 16:9 frame with horizontal overscan
8	32:11	352×576 16:9 frame without horizontal overscan
9	80:33	352×480 16:9 frame without horizontal overscan
10	18:11	480×576 4:3 frame with horizontal overscan
11	15:11	480×480 4:3 frame with horizontal overscan
12	64:33	528×576 16:9 frame without horizontal overscan
13	160:99	528×480 16:9 frame without horizontal overscan
14	4:3	1440×1080 16:9 frame without horizontal overscan
15	3:2	1280×1080 16:9 frame without horizontal overscan

Table 7 *(continued)*

Value	Sample aspect ratio	(Informative) Examples of use
16	2:1	960×1080 16:9 frame without horizontal overscan
17–254	Reserved	
255	SarWidth : SarHeight	

NOTE For the examples in Table 7, the term "without horizontal overscan" refers to display processes in which the display area matches the area of the cropped decoded pictures and the term "with horizontal overscan" refers to display processes in which some parts near the left and/or right border of the cropped decoded pictures are not visible in the display area. As an example, the entry "720×576 4:3 frame with horizontal overscan" for SampleAspectRatio equal to 2 refers to having an area of 704×576 luma samples (which has an aspect ratio of 4:3) of the cropped decoded frame (720×576 luma samples) that is visible in the display area.

When SampleAspectRatio is not present or is equal to 255, the following applies:

— If SarWidth and SarHeight are present and are not equal to 0, the values of SarWidth and SarHeight shall be relatively prime, and the following applies:

  — **SarWidth** indicates the horizontal size of the sample aspect ratio (in arbitrary units).

  — **SarHeight** indicates the vertical size of the sample aspect ratio (in the same arbitrary units as SarWidth).

— Otherwise, the sample aspect ratio shall be considered unspecified by this Recommendation | International Standard.

When SampleAspectRatio is present and is not equal to 255, if SarWidth and SarHeight are present, their values shall be equal to the values specified in Table 7.

8 Audio code points

8.1 Loudspeaker index and speaker channel position

Type: Unsigned integer, enumeration

Range: 0 – 127

OutputChannelPosition indicates the descriptive loudspeaker position in the 3D environment relative to the listener.

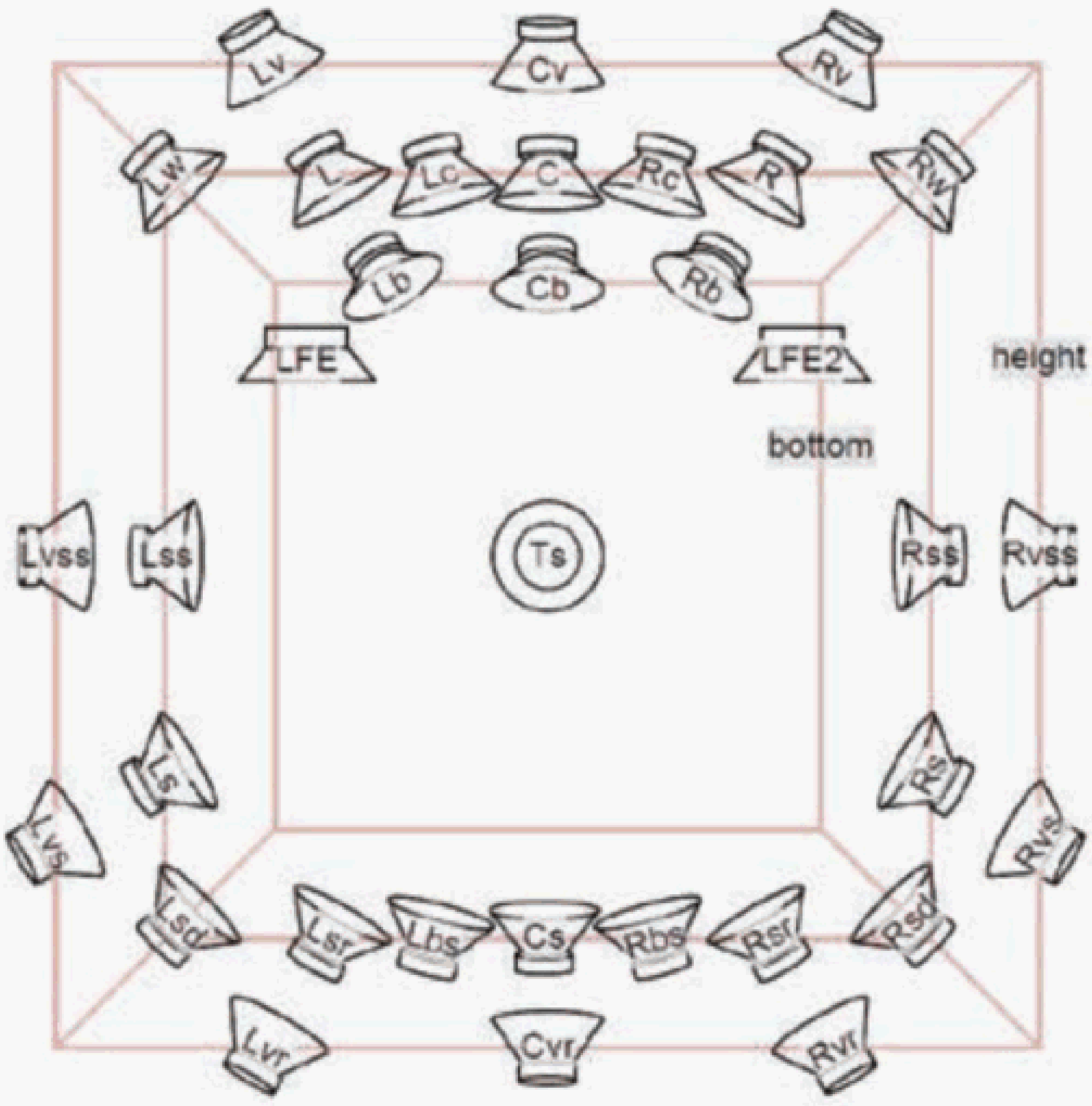
For the purpose of this part of ISO/IEC 23001, the terms "loudspeaker" and "loudspeaker layout" are preferred over the terms "channel" and "channel configuration" because the latter appear to be potentially codec-dependent. Previous editions of this part of ISO/IEC 23001 and certain standards use these terms (channel, channel configuration) and in their respective contexts should be understood synonymously to the terms "loudspeaker" and "loudspeaker layout".

When a speaker is indicated as being at an explicit position, the position is provided by some means outside the scope of this International Standard. That might include signalling by azimuth, elevation, distance, or by some other suitable means.

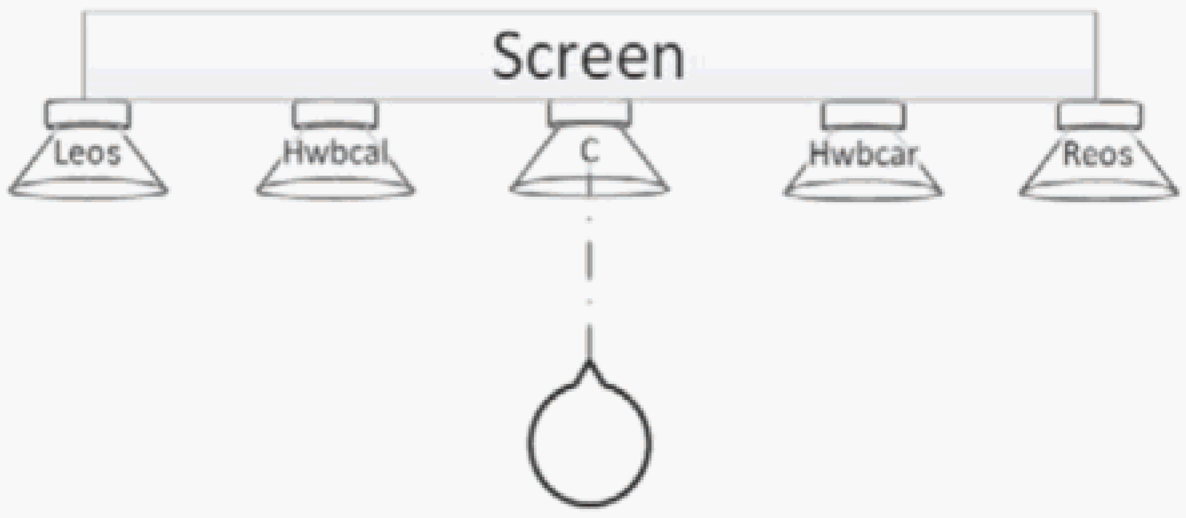
Table 8 *(continued)*

Value	Loudspeaker position		Loudspeaker position according to IEC 62574	
	Abbr.	**Name**	**Abbr.**	**Name**
41	Lbs	Left back surround		
42	Rbs	Right back surround		
43–125		Reserved		Reserved
126	Expl	Explicit position (see text)		
127		Unknown / undefined		

Figure 9 shows a subset of the loudspeaker positions in the 3D environment relative to the listener, with each loudspeaker labelled with an abbreviation from Table 8. Loudspeakers lying on the innermost box are in the bottom level, those on the middle box are in the middle level, and those on the outermost box are in the top level. The circles labelled Ts represent the top centre loudspeaker directly above the listener's position.



a) General loudspeaker positions



b) Positions of screen-related loudspeakers

Figure 9 — Loudspeaker positions

8.2 Loudspeaker layout index and channel configuration

Type: Unsigned integer, enumeration

Range: 0 – 31

The **ChannelConfiguration** specifies the loudspeaker layout. This defines the number of loudspeakers and their associated positions. The name, abbreviation, and general position of each loudspeaker are informative and can be deduced from Table 9. Due to historical reasons, loudspeaker names may correspond to different geometrical positions or coordinates depending on the loudspeaker layouts in which they have been defined.

Unless otherwise noted, the list of loudspeaker names in Table 9 does not imply any particular order in which corresponding channel signals are stored or transmitted in a certain coding scheme. If such an order is required by a coding scheme, then the corresponding standard should mandate an order of channels within the scope of its own specification.

Table 9 — ChannelConfiguration, loudspeaker layout index, corresponding number of loudspeakers and their associated positions

Value	"Front/ Surr. LFE" notation	Loudspeaker names in loudspeaker layout	Loudspeaker abbrev.	Informative geometric position Azim.,	Elev. See NOTE	Ch. is LFE
0	—	any setup	—	—		—
1	1/0.0	centre front	C	0,	0	0
2	2/0.0	left front,	L	30,	0	0
		right front	R	−30,	0	0
3	3/0.0	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front	R	−30,	0	0
4	3/1.0	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		rear centre	Cs	180,	0	0
5	3/2.0	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		left surround,	Ls	110,	0	0
		right surround	Rs	−110,	0	0
6	3/2.1	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		left surround,	Ls	110,	0	0
		right surround,	Rs	−110,	0	0
		LFE	LFE	0,	−15	1

NOTE "Nominal" positions as found in typical layout definitions. Tolerances for the angular positions are omitted by intention as the values vary between various definitions that can be found in relevant industry standard documents. The azimuth angle is expressed in degrees, positive values rotate to the left when facing the front, i.e. counter clockwise when looking from above. The elevation angle is expressed in degrees where positive values indicate angles above the horizontal plane.

Table 9 *(continued)*

Value	"Front/ Surr. LFE" notation	Loudspeaker names in loudspeaker layout	Loudspeaker abbrev.	Informative geometric position Azim.,	Elev. See NOTE	Ch. is LFE
18	6/7.1	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		left surround,	Ls	110,	0	0
		right surround,	Rs	−110,	0	0
		left back surround,	Lbs	150,	0	0
		right back surround	Rbs	−150,	0	0
		LFE,	LFE	0,	−15	1
		left front vertical height,	Lv	30,	30	0
		right front vertical height,	Rv	−30,	30	0
		centre front vertical height,	Cv	0,	30	0
		left vertical height surround,	Lvs	110,	30	0
		right vertical height surround,	Rvs	−110,	30	0
		top centre surround	Ts	0,	90	0
19	5/6.1	centre front,	C	0,	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		left side surround,	Lss	90,	0	0
		right side surround,	Rss	−90,	0	0
		rear surround left,	Lsr	135,	0	0
		rear surround right,	Rsr	−135,	0	0
		LFE,	LFE	0,	−15	1
		left front vertical height,	Lv	30,	30	0
		right front vertical height,	Rv	−30,	30	0
		left surround vertical height rear,	Lvr	135,	30	0
		right surround vertical height rear	Rvr	−135,	30	0

NOTE "Nominal" positions as found in typical layout definitions. Tolerances for the angular positions are omitted by intention as the values vary between various definitions that can be found in relevant industry standard documents. The azimuth angle is expressed in degrees; positive values rotate to the left when facing the front, i.e. counter clockwise when looking from above. The elevation angle is expressed in degrees where positive values indicate angles above the horizontal plane.

Table 9 *(continued)*

Value	"Front/ Surr. LFE" nota-tion	Loudspeaker names in loudspeaker layout	Loudspeaker abbrev.	Informative geometric position Azim., Elev. See NOTE		Ch. is LFE
20	7/6.1	centre front,	C	0,	0	0
		left edge of screen,	Leos	"left eos",	0	0
		right edge of screen,	Reos	"right eos",	0	0
		left front,	L	30,	0	0
		right front,	R	−30,	0	0
		left side surround,	Lss	90,	0	0
		right side surround,	Rss	−90,	0	0
		rear surround left,	Lsr	135,	0	0
		rear surround right,	Rsr	−135,	0	0
		LFE,	LFE	0,	−15	1
		left front vertical height,	Lv	45,	30	0
		right front vertical height,	Rv	−45,	30	0
		left vertical height surround,	Lvs	110,	30	0
		right vertical height surround	Rvs	−110,	30	0
21–63	Reserved					

NOTE "Nominal" positions as found in typical layout definitions. Tolerances for the angular positions are omitted by intention as the values vary between various definitions that can be found in relevant industry standard documents. The azimuth angle is expressed in degrees; positive values rotate to the left when facing the front, i.e. counter clockwise when looking from above. The elevation angle is expressed in degrees where positive values indicate angles above the horizontal plane.

Where the geometric position of a loudspeaker is described by means of a semantic position relative to a video screen (e.g. "left edge of screen"), the reader is advised to consult appropriate screen size definitions to obtain additional information about typical angles as they will appear in real world loudspeaker arrangements.

8.3 Loudspeaker positioning

LoudspeakerGeometry

Type: Unsigned integer, enumeration

Range: 0 – 127

LoudspeakerAzimuth

Type: Signed integer

Range: from −180 to 180

LoudspeakerElevation

Type: Signed integer

Range: from −90 to 90

LoudspeakerGeometry specifies the nominal geometric position of a loudspeaker or audio channel according to Table 10, with azimuth and elevation angles in polar coordinates. The **LoudspeakerAzimuth** angle is expressed in degrees; positive values rotate to the left when facing the front, i.e. counter clockwise when looking from above. The **LoudspeakerElevation** angle is expressed

Table 10 *(continued)*

Value	Ch. is LFE	Nominal geometric position in polar coordinates (radius omitted)	
		Azimuth[°]	Elevation[°]
36 See NOTE	1	−45	−15
37	0	left edge of screen	0
38	0	right edge of screen	0
39	0	half-way between centre of screen and left edge of screen	0
40	0	half-way between centre of screen and right edge of screen	0
41	0	150	0
42	0	−150	0
43–127	Reserved		
NOTE In addition to the geometrical position, these entries also indicate an "LFE" channel, which typically has a strongly reduced frequency content.			

Figure 10 through Figure 13 indicate the loudspeaker position in the 3D environment relative to the listener, each labelled with the LoudspeakerGeometry (circled with arrow) and the nominal azimuth angle in degrees).

Figure 10 — Loudspeaker positions, upper layer [index 25 indicates the loudspeaker directly above the listener, sometimes referred to as the "voice of god (VoG)" loudspeaker]

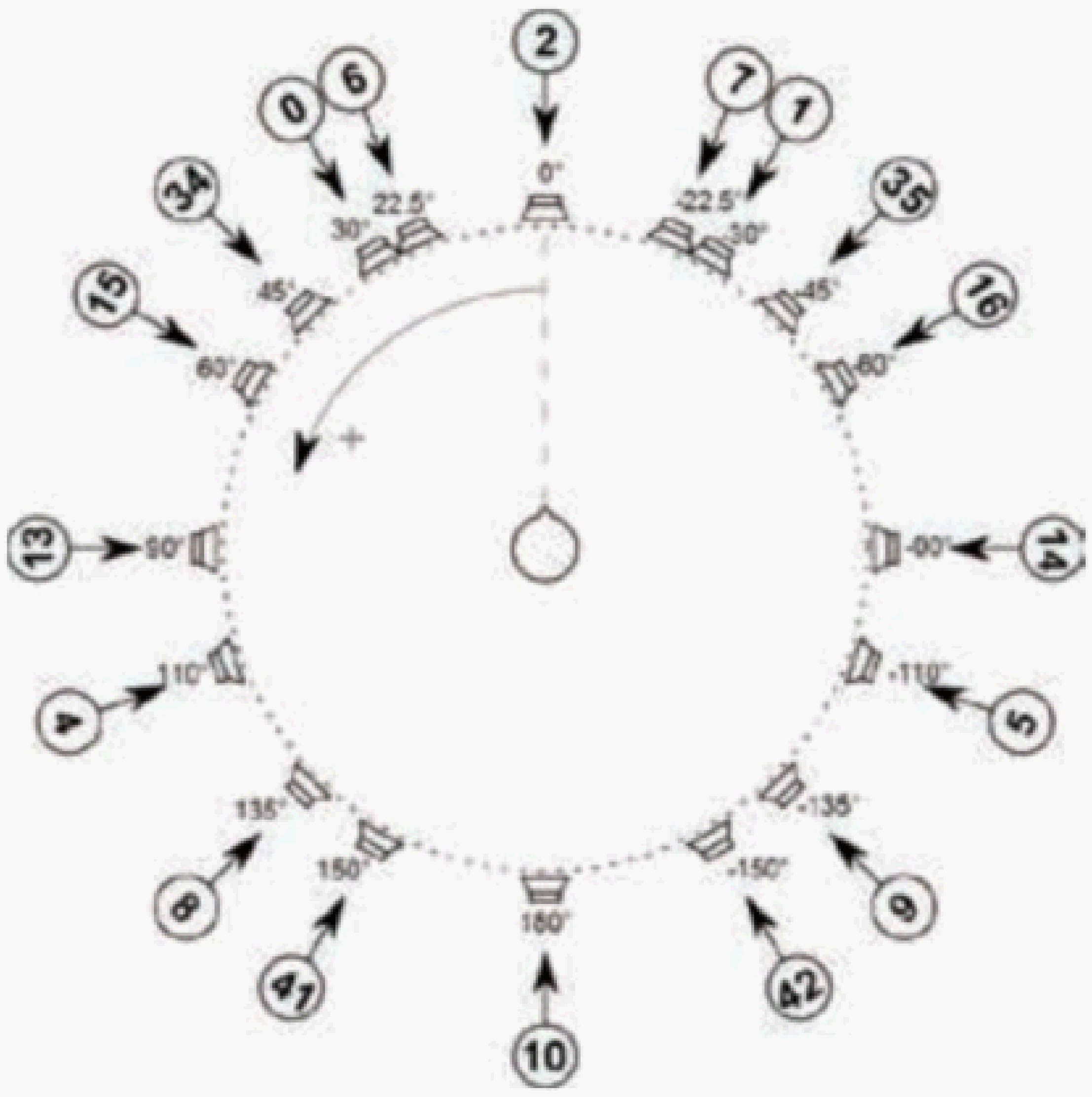


Figure 11 — Loudspeaker positions, mid layer

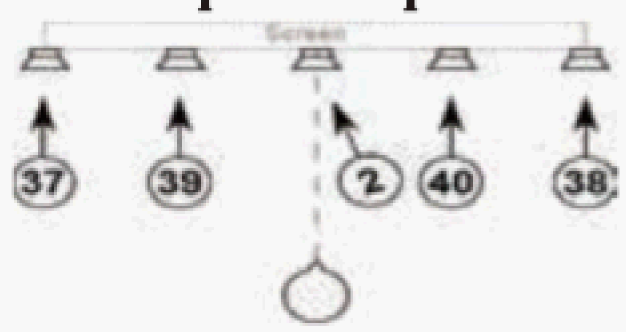


Figure 12 — Loudspeaker positions, screen relative

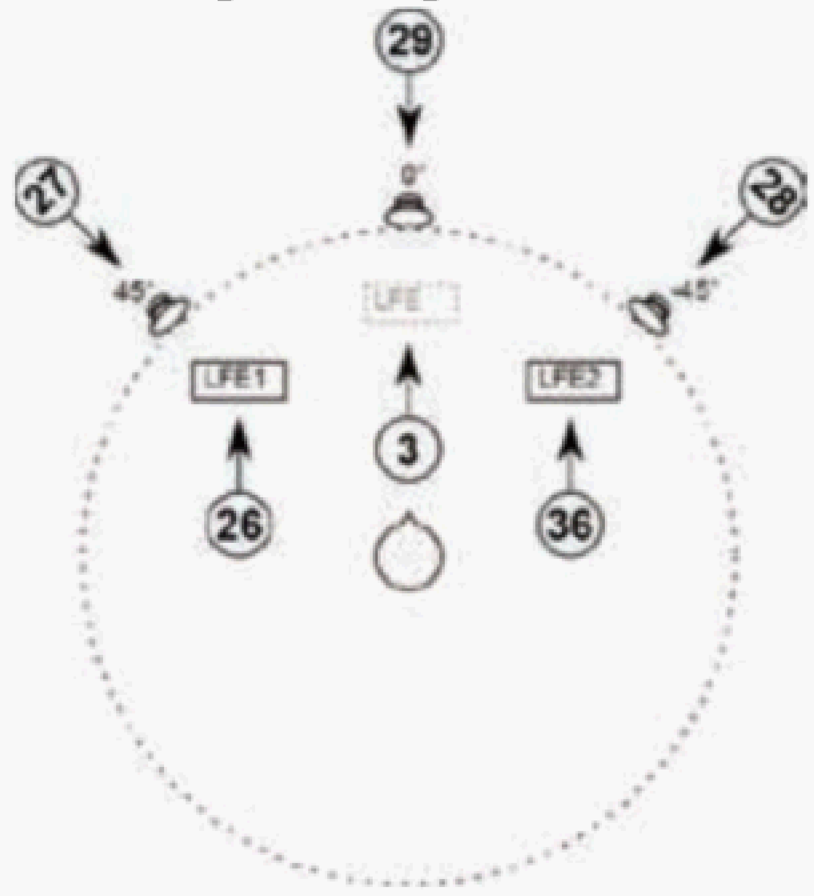


Figure 13 — Loudspeaker positions, bottom layer

8.4 Program loudness level

Type: fixed-point or integer value

Range: −41 to 0 dB, with a precision of at least 1 dB

ProgramLoudness indicates the overall loudness of the corresponding audio program. It should be measured in such a way that if two pieces of content have their loudness normalized using the value of ProgramLoudness, the resulting audio will have consistent loudness. Decoders evaluate this value and apply an appropriate level shift to audio to maintain a consistent loudness of output audio, matched with a user-given target loudness. The ProgramLoudness should be the overall loudness measured in LKFS according to Rec. ITU-R BS.1770.

NOTE Application standards refer to different versions of Rec. ITU-R BS.1770. Accordingly, it is out of the scope of this part of ISO/IEC 23001 to recommend a particular loudness measurement method.

8.5 Anchor loudness level

Type: fixed-point or integer value

Range: −41 to 0 dB, with a precision of at least 1 dB

AnchorLoudness indicates the loudness of the anchor elements of the corresponding audio signal (usually the dialog). The method of identifying the anchor elements is chosen by the content author and is out of scope for this part of ISO/IEC 23001. It should be chosen in such a way that, if two pieces of content have their loudness normalized using the values of AnchorLoudness, the anchor elements of the resulting audio will have consistent loudness. The AnchorLoudness should be the loudness of the anchor content of the program, measured in LKFS according to Rec. ITU-R BS.1770.

NOTE 1 Application standards refer to different versions of Rec. ITU-R BS.1770. Accordingly, it is out of the scope of this part of ISO/IEC 23001 to recommend a particular loudness measurement method.

NOTE 2 The anchor content of a program may be the dialog, whereupon this code-point measures the dialog level.

8.6 Range of loudness

Type: fixed-point or integer value

Range: 0 to 90 dB, with a precision of at least 1 dB

LoudnessRange indicates the loudness range of the corresponding audio program. It is the loudness difference between the loudest and softest part of that audio program. The loudness of the loudest part is described by LoudnessRangeTop. LoudnessRange is measured in dB according to EBU R 128-2014, EBU – Tech 3342.

8.7 Top of loudness range

Type: fixed-point or integer value

Range: −41 to 6 dB, with a precision of at least 1 dB

LoudnessRangeTop indicates the loudness value of the top of the loudness range described by LoudnessRange of the corresponding audio program. LoudnessRangeTop is measured in LKFS according to EBU R 128-2014, EBU – Tech 3342.

8.8 Maximum of momentary loudness level

Type: fixed-point or integer value

Range: −41 to 6 dB, with a precision of at least 1 dB

MomentaryLoudnessMax indicates the maximum value of the loudness values obtained from measurements of the corresponding audio program using a 400 ms window. MomentaryLoudnessMax is measured in LKFS as specified in EBU R 128-2014, EBU – Tech 3341, Rec. ITU-R BS.1771-1.

8.9 Maximum of short-term loudness level

Type: fixed-point or integer value

Range: −41 to 6 dB, with a precision of at least 1 dB

ShortTermLoudnessMax indicates the maximum value of the loudness values in LKFS obtained from measurements of the corresponding audio program using a 3 s window. Measurements are specified in EBU R 128-2014, EBU – Tech 3341, Rec. ITU-R BS.1771-1.

8.10 Short-term loudness level

Type: fixed-point or integer value

Range: −70 to 6 dB, with a precision of at least 1 dB

ShortTermLoudness indicates the value of the loudness values in LKFS obtained from measurements of the corresponding audio program using a 3 s window. Measurements are specified in EBU R 128-2014, EBU – Tech 3341, Rec. ITU-R BS.1771-1. The 3 s window shall include the current frame.

8.11 Peak level

Type: fixed-point or integer value

Range: −41 to 40 dB, with a precision of at least 1 dB

SamplePeakLevel indicates the level of the largest magnitude of the corresponding audio program samples. SamplePeakLevel is measured in dB relative to full scale.

TruePeakLevel indicates the level of the largest magnitude of the corresponding audio program samples after oversampling. TruePeakLevel is measured in dBTP as specified in Rec. ITU-R BS.1770.

8.12 Compressor characteristic

Type: Unsigned integer, enumeration

Range: 0 – 127

DrcCharacteristic indicates the index of a steady-state compressor input-output characteristic. The characteristic describes the compressor gain in dB depending on the compressor input level in dB measured using a 1 kHz sinusoid.

The definition of all DRC characteristics is based on a loudness normalized DRC input level of −31 LKFS.

A DRC characteristic index value of 0 indicates that the characteristic is undefined or unknown.

The DRC characteristic index values 1–6 are defined by the pseudo code in Table 11 and parameters in Table 12. For a steady state input level inLevelDb in dB, the function returns a DRC gain level outGainDb in dB as shown in Figure 14. The loudness normalized DRC input level is called drcInputLoudnessTarget.

Table 11 — Pseudo-code for DRC characteristic generation

```
compressorIO(inLevelDb) {
   drcInputLoudnessTarget = −31;
   gainDbMin = −32.0;
   gainDbMax = 32.0;
   tmp = (drcInputLoudnessTarget − inLevelDb) * ioRatio;
   if (tmp >= 0.0)
         outGainDb = tmp / pow(1 + pow(tmp / gainDbMax, expLo), 1 / expLo);
   else
         outGainDb = tmp / pow(1 + pow(tmp / gainDbMin, expHi), 1 / expHi);
   return outGainDb;
}
```

Table 12 — Parameters of DRC characteristic index values 1 to 6

Parameter	DrcCharacteristic					
	1	2	3	4	5	6
ioRatio	0.0	0.2	0.4	0.6	0.8	1.0
expLo	9.0	9.0	9.0	9.0	6.0	5.0
expHi	12.0	12.0	12.0	12.0	8.0	6.0

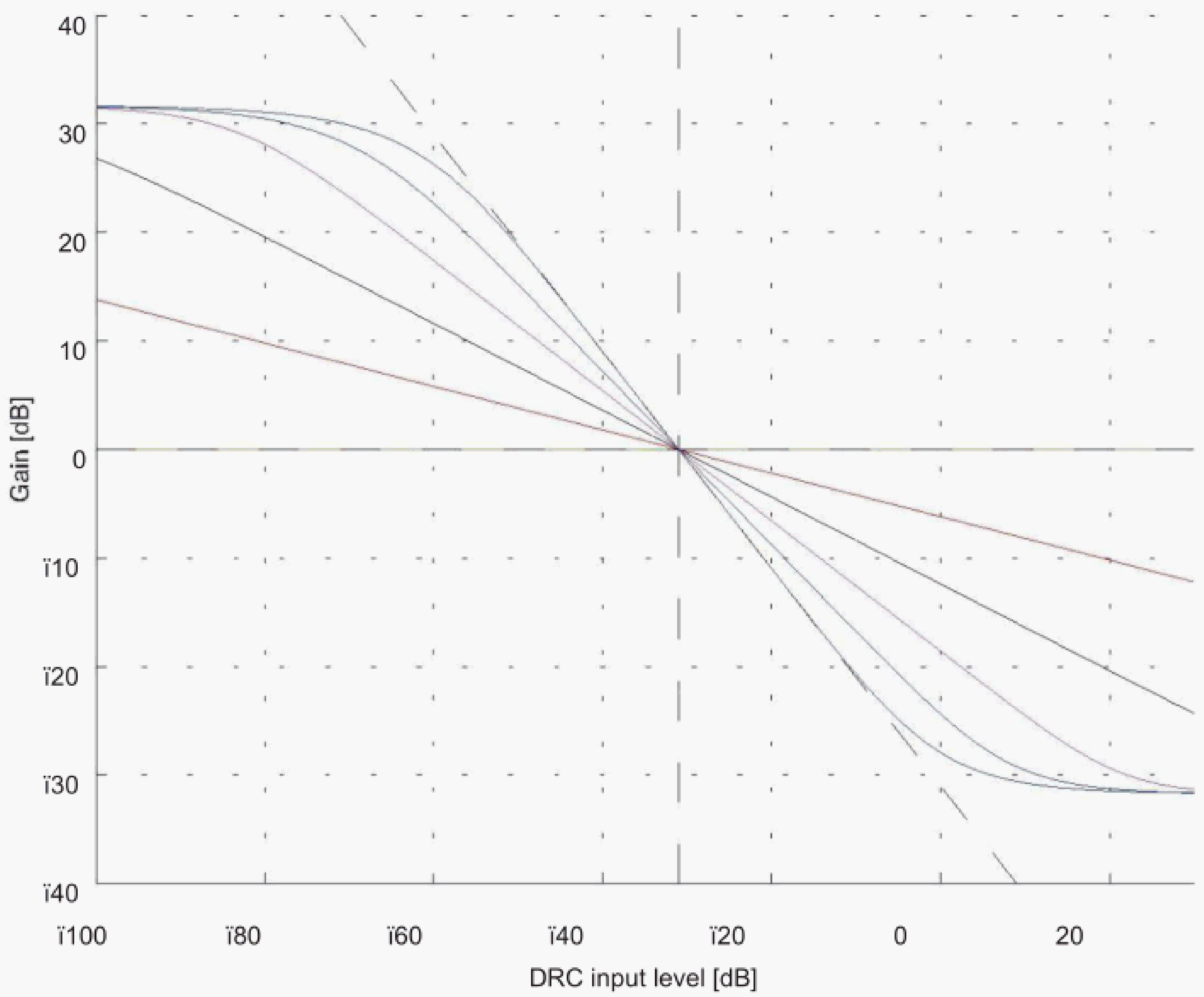


Figure 14 — Illustration of static DRC characteristic index values 1 to 6

The DRC characteristic index values 7–11 are defined by Figure 15 and Table 13. These characteristics can be generated by piece-wise linear interpolation between the nodes A to E. The node coordinates in dB are given in Table 13. These characteristics are also known as DRC profiles “Film Light” (7), “Film Standard” (8), “Music Light” (9), “Music Standard” (10), and “Speech” (11). The profiles were introduced in Reference [23].

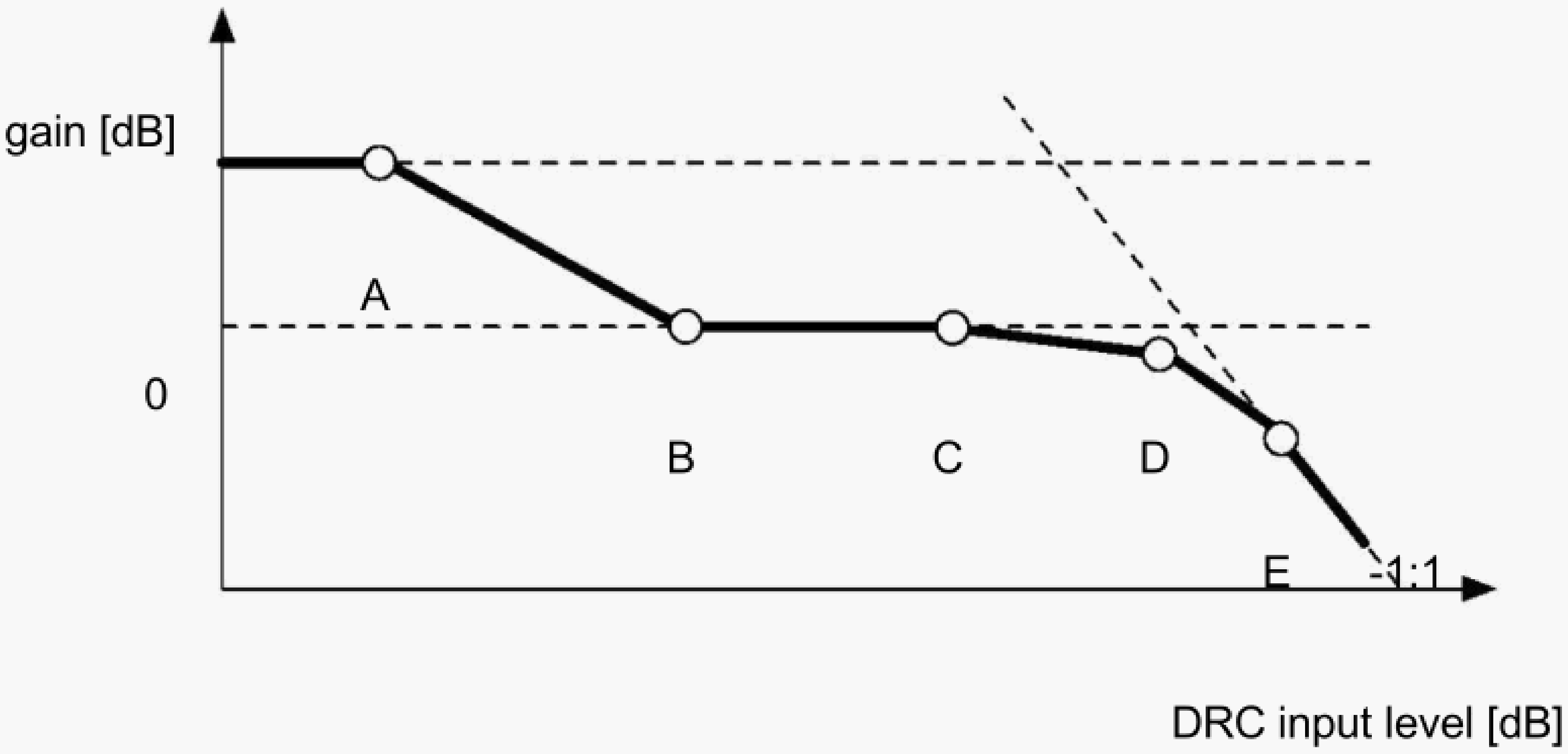


Figure 15 — Illustration of DRC characteristic index values 7 to 11

Table 13 — Node coordinates in dB of DRC characteristic index values 7 to 11

Node	DrcCharacteristic									
	7		8		9		10		11	
A	−53	6	−43	6	−65	12	−55	12	−50	15
B	−41	0	−31	0	−41	0	−31	0	−31	0
C	−21	0	−26	0	−21	0	−26	0	−26	0
D	−11	−5	−16	−5	na	na	−16	−5	−16	−5
E	9	−24	4	−24	9	−15	4	−24	4	−24

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