HDR Signalling and Carriage of Dynamic Metadata for Colour Volume Transform; Application #1
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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ÉLÉCtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

Modal verbs terminology

In the present document "shall", "shall not", "should", "should not", "may", "need not", "will", "will not", "can" and "cannot" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"must" and "must not" are NOT allowed in ETSI deliverables except when used in direct citation.

Introduction

SMPTE ST 2094-10 [4] HDR dynamic metadata provides and describes dynamic information about the video signal. The usage of this information can be employed by the display to adapt the delivered HDR imagery to the capability of the display device. The information conveyed in the SEI message carrying SMPTE ST 2094-10 [4] HDR dynamic metadata is adequate for purposes corresponding to the use of Society of Motion Picture and Television Engineers SMPTE ST 2094-1 [3] "Dynamic Metadata for Color Volume Transform - Core Components" and SMPTE ST 2094-10 [4] "Dynamic Metadata for Color Volume Transform - Application #1".
1 Scope

The present document specifies the format of the HEVC SEI message for the carriage of SMPTE ST 2094-10 [4] HDR dynamic metadata.

The present document provides the guidelines for the carriage and signalling the presence of SMPTE ST 2094-10 [4] HDR dynamic metadata (carried in SEI messages defined in the present document) for DVB systems, using private data signalling methods compatible with those defined in ETSI TS 101 154 [8], ETSI TS 103 285 [9] and ETSI EN 300 468 [6].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[8] ETSI TS 101 154: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcast and Broadband Applications".
[9] ETSI TS 103 285: "Digital Video Broadcasting (DVB); MPEG-DASH Profile for Transport of ISO BMFF Based DVB Services over IP Based Networks".
2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Recommendation ITU-R BT.2246-2: "The present state of ultra-high definition television".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

display mapping: adapting the signal to the dynamic range and the colour gamut of the target display
dynamic range: ratio of the maximum light intensity to the minimum light intensity [i.1]

NOTE: In digital cameras the dynamic range is normally measured in terms of stops, which describe the total light range by power of 2.

extended display mapping metadata: subset of the ST2094_data() structure

high dynamic range: typically, a dynamic range of more than 10 stops is referred to as high dynamic range

standard dynamic range: typically, a dynamic range of up to 10 stops is referred to as standard dynamic range

3.2 Symbols

3.2.1 Arithmetic operators

For the purposes of the present document, the following arithmetic operators apply:

+ Addition
- Subtraction (as a two-argument operator) or negation (as a unary prefix operator)
x Multiplication, including matrix multiplication
÷ Used to denote division in mathematical equations where no truncation or rounding is intended
/ Integer division with truncation of the result toward zero

EXAMPLE: 7/4 and -7/-4 are truncated to 1 and -7/4 and 7/-4 are truncated to -1.

3.2.2 Relational operators

For the purposes of the present document, the following relational operators apply:

> Greater than
>= Greater than or equal to
< Less than
<= Less than or equal to
== Equal to
!= Not equal to
3.2.3 Assignment operators

For the purposes of the present document, the following assignment operators apply:

= Assignment operator
++ Increment, i.e. \( x \) is equivalent to \( x = x + 1 \); when used in an array index, evaluates to the value of the variable prior to the increment operation
-- Decrement, i.e. \( x \) - - is equivalent to \( x = x - 1 \); when used in an array index, evaluates to the value of the variable prior to the decrement operation
+= Increment by amount specified, i.e. \( x += 4 \) is equivalent to \( x = x + 4 \), and \( x += (-4) \) is equivalent to \( x = x + (-4) \)
-= Decrement by amount specified, i.e. \( x -= 4 \) is equivalent to \( x = x - 4 \), and \( x -= (-4) \) is equivalent to \( x = x - (-4) \)

3.2.4 Mathematical functions

For the purposes of the present document, the following mathematical functions apply:

\[
\text{Abs}(x) = \begin{cases} 
     x & ; \ x \geq 0 \\
    -x & ; \ x < 0 
\end{cases}
\]

\[
\text{Clip3}(x, y, z) = \begin{cases} 
     x & ; \ z < x \\
     y & ; \ z > y \\
     z & ; \text{otherwise}
\end{cases}
\]

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

\[
\text{Round}(x) = \text{Sign}(x) \times \text{Floor}(\text{Abs}(x) + 0.5)
\]

\[
\text{Sign}(x) = \begin{cases} 
     1 & ; \ x > 0 \\
     0 & ; \ x = 0 \\
    -1 & ; \ x < 0 
\end{cases}
\]

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CVS Coded Video Sequence
EN European Standard
HDR High Dynamic Range
HEVC High Efficiency Video Coding
ITU-R International Telecommunications Union - Radiocommunications standardization sector
ITU-T International Telecommunications Union - Telecommunications standardization sector
MPEG Moving Picture Expert Group
PQ Perceptual Quantizer

NOTE: As defined in SMPTE ST 2084 [1].

SEI Supplemental Enhancement Information
SI Service Information
SMPTE Society of Motion Pictures and Television Engineers
ST STandard
UHDTV Ultra High Definition TeleVision
4 ST2094-10_data() structure definition

4.1 Introduction

This clause specifies the syntax and semantics of ST2094-10_data() structure.

Clause 4.1 defines the syntax of the ST2094-10_data() structure.

Clause 4.2 defines the semantics of the ST2094-10_data() structure.

NOTE: The metadata elements of the ST2094-10_data() structure are defined according to the SMPTE ST 2086 [2], SMPTE ST 2094-1 [3] and SMPTE ST 2094-10 [4].

4.2 ST2094-10_data() structure syntax

The parsing process of each syntax element by the descriptor u(n) is described in Recommendation ITU-T H.265 [5].

<table>
<thead>
<tr>
<th>ST2094-10_data() { Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>app_identifier              ue(v)</td>
</tr>
<tr>
<td>app_version                 ue(v)</td>
</tr>
<tr>
<td>metadata_refresh_flag       u(1)</td>
</tr>
<tr>
<td>if( metadata_refresh_flag ) {</td>
</tr>
<tr>
<td>num_ext_blocks              ue(v)</td>
</tr>
<tr>
<td>if( num_ext_blocks ) {</td>
</tr>
<tr>
<td>while( !byte_aligned() )</td>
</tr>
<tr>
<td>dm_alignment_zero_bit       f(1)</td>
</tr>
<tr>
<td>for( i = 0; i &lt; num_ext_blocks; i ++ ) {</td>
</tr>
<tr>
<td>ext_dm_data_block(i)</td>
</tr>
<tr>
<td>}</td>
</tr>
<tr>
<td>}</td>
</tr>
<tr>
<td>while( !byte_aligned() )</td>
</tr>
<tr>
<td>dm_alignment_zero_bit       f(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ext_dm_data_block(i) { Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>ext_block_length[ i ]       ue(v)</td>
</tr>
<tr>
<td>ext_block_level[ i ]        u(8)</td>
</tr>
<tr>
<td>ext_dm_data_block_payload( ext_block_length[ i ], ext_block_level[ i ] )</td>
</tr>
</tbody>
</table>

Table 1: ST2094-data() syntax

Table 2: ext_dm_data_block() syntax
### Table 3: `ext_dm_data_block_payload()` syntax

<table>
<thead>
<tr>
<th>Description</th>
<th>Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ext_dm_data_block_payload()</code></td>
<td><code>ext_dm_data_block_payload(ext_block_length, ext_block_level) {</code></td>
</tr>
<tr>
<td><code>ext_block_len_bits = 8 * ext_block_length</code></td>
<td><code>ext_block_use_bits = 0</code></td>
</tr>
<tr>
<td><code>if( ext_block_level == 1 ) {</code></td>
<td><code>min_PQ u(12)</code></td>
</tr>
<tr>
<td><code>max_PQ u(12)</code></td>
<td><code>avg_PQ u(12)</code></td>
</tr>
<tr>
<td><code>ext_block_use_bits += 36</code></td>
<td><code>}</code></td>
</tr>
<tr>
<td><code>if( ext_block_level == 2 ) {</code></td>
<td><code>target_max_PQ u(12)</code></td>
</tr>
<tr>
<td><code>trim_slope u(12)</code></td>
<td><code>trim_offset u(12)</code></td>
</tr>
<tr>
<td><code>trim_power u(12)</code></td>
<td><code>trim_chroma_weight u(12)</code></td>
</tr>
<tr>
<td><code>trim_saturation_gain u(12)</code></td>
<td><code>ms_weight i(13)</code></td>
</tr>
<tr>
<td><code>ext_block_use_bits += 85</code></td>
<td><code>}</code></td>
</tr>
<tr>
<td><code>if( ext_block_level == 3 ) {</code></td>
<td><code>min_PQ_offset u(12)</code></td>
</tr>
<tr>
<td><code>max_PQ_offset u(12)</code></td>
<td><code>avg_PQ_offset u(12)</code></td>
</tr>
<tr>
<td><code>ext_block_use_bits += 36</code></td>
<td><code>}</code></td>
</tr>
<tr>
<td><code>if( ext_block_level == 4 ) {</code></td>
<td><code>TF_PQ_mean u(12)</code></td>
</tr>
<tr>
<td><code>TF_PQ_stdev u(12)</code></td>
<td><code>ext_block_use_bits += 24</code></td>
</tr>
<tr>
<td><code>}</code></td>
<td><code>}</code></td>
</tr>
<tr>
<td><code>if( ext_block_level == 5 ) {</code></td>
<td><code>active_area_left_offset u(13)</code></td>
</tr>
<tr>
<td><code>active_area_right_offset u(13)</code></td>
<td><code>active_area_top_offset u(13)</code></td>
</tr>
<tr>
<td><code>active_area_bottom_offset u(13)</code></td>
<td><code>ext_block_use_bits += 52</code></td>
</tr>
<tr>
<td><code>}</code></td>
<td><code>while( ext_block_use_bits++ &lt; ext_block_len_bits )</code></td>
</tr>
<tr>
<td><code>ext_dm_alignment_zero_bit f(1)</code></td>
<td><code>}</code></td>
</tr>
</tbody>
</table>

### 4.3 ST2094-10_data() structure semantics

**app_identifier** identifies an application and shall be set equal to 1 according to constraints of the section 5 of SMPTE ST 2094-10 [4].

**app_version** specifies the application version in the application and shall be set equal to 0 according to constraints of the section 5 of SMPTE ST 2094-10 [4].

**metadata_refresh_flag** when set equal to 1 cancels the persistence of any previous extended display mapping metadata in output order and indicates that extended display mapping metadata follows. The extended display mapping metadata persists from the coded picture to which the SEI message containing ST2094-10_data() is associated (inclusive) to the coded picture to which the next SEI message containing ST2094-10_data() and with metadata_refresh_flag set equal to 1 in output order is associated (exclusive) or (otherwise) to the last picture in the CVS (inclusive). When set equal to 0 this flag indicates that the extended display mapping metadata does not follow.

**num_ext_blocks** specifies the number of extended display mapping metadata blocks. The value shall be in the range of 1 to 254, inclusive.

**dm_alignment_zero_bit** shall be equal to 0.
**ext_block_length[i]** is used to derive the size of the i-th extended display mapping metadata block payload in bytes. The value shall be in the range of 0 to 1 023, inclusive.

**ext_block_level[i]** specifies the level of payload contained in the i-th extended display mapping metadata block. The value shall be in the range of 0 to 255, inclusive. The corresponding extended display mapping metadata block types are defined in Table 4. Values of **ext_block_level[i]** that are reserved shall not be present in the bitstreams conforming to this version of the present document. Blocks using reserved values shall be ignored:

- When the value of **ext_block_level[i]** is set equal to 1, the value of **ext_block_length[i]** shall be set equal to 5.
- When the value of **ext_block_level[i]** is set equal to 2, the value of **ext_block_length[i]** shall be set equal to 11.
- When the value of **ext_block_level[i]** is set equal to 3, the value of **ext_block_length[i]** shall be set equal to 5.
- When the value of **ext_block_level[i]** is set equal to 4, the value of **ext_block_length[i]** shall be set equal to 3.
- When the value of **ext_block_level[i]** is set equal to 5, the value of **ext_block_length[i]** shall be set equal to 7.

<table>
<thead>
<tr>
<th><strong>ext_block_level</strong></th>
<th><strong>extended display mapping metadata block type</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reserved</td>
</tr>
<tr>
<td>1</td>
<td>Level 1 Metadata - Content Range</td>
</tr>
<tr>
<td>2</td>
<td>Level 2 Metadata - Trim Pass</td>
</tr>
<tr>
<td>3</td>
<td>Level 3 Metadata - Content Range Offsets</td>
</tr>
<tr>
<td>4</td>
<td>Level 4 Metadata - Temporally Filtered Image Level</td>
</tr>
<tr>
<td>5</td>
<td>Level 5 Metadata - Active Area</td>
</tr>
<tr>
<td>6…255</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

When an extended display mapping metadata block with **ext_block_level** equal to 5 is present, the following constraints shall apply:

- An extended display mapping metadata block with **ext_block_level** equal to 5 shall be preceded by at least one extended display mapping metadata block with **ext_block_level** equal to 1, 2, 3 or 4.
- Between any two extended display mapping metadata blocks with **ext_block_level** equal to 5, there shall be at least one extended display mapping metadata block with **ext_block_level** equal to 1, 2, 3 or 4.
- No extended display mapping metadata block with **ext_block_level** equal to 1, 2, 3 or 4 shall be present after the last extended display mapping metadata block with **ext_block_level** equal to 5.
- The metadata of an extended display mapping metadata block with **ext_block_level** equal to 1, 2, 3 or 4 shall be applied to the active area specified by the first extended display mapping metadata block with **ext_block_level** equal to 5 following this block.
- When the active area defined by the current extended display mapping metadata block with **ext_block_level** equal to 5 overlaps with the active area defined by preceding extended display mapping metadata blocks with **ext_block_level** equal to 5, all metadata of the extended display mapping metadata blocks with **ext_block_level** equal to 1, 2, 3 or 4 associated with the current extended display mapping metadata block with **ext_block_level** equal to 5 shall be applied to the pixel values of the overlapping area.

**min_PQ** specifies the minimum luminance value of the current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4 095, inclusive. Note that the 12-bit **min_PQ** value with full range is calculated as follows:

\[
\text{min}_PQ = \text{Clip3}(0, 4 095, \text{Round}(\text{Min} \times 4 095)) \tag{1}
\]

where Min is **MinimumPqencodedMaxrgb** as defined in clause 6.1.3 of SMPTE ST 2094-10 [4].
max_PQ specifies the maximum luminance value of current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit max_PQ value with full range is calculated as follows:

\[
\text{max}_\text{PQ} = \text{Clip3}(0, 4095, \text{Round}(\text{Max} \times 4095))
\]  

(2)

where Max is MaximumPqencodedMaxrgb as defined in clause 6.1.5 of SMPTE ST 2094-10 [4].

avg_PQ specifies the midpoint luminance value of current picture in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit avg_PQ value with full range is calculated as follows:

\[
\text{avg}_\text{PQ} = \text{Clip3}(0, 4095, \text{Round}(\text{Avg} \times 4095))
\]  

(3)

where Avg is AveragePqencodedMaxrgb as defined in section 6.1.4 of SMPTE ST 2094-10 [4].

target_max_PQ specifies the maximum luminance value of a target display in 12-bit PQ encoding. The value shall be in the range of 0 to 4095, inclusive. The target_max_PQ is the PQ encoded value of TargetedSystemDisplayMaximumLuminance as defined in clause 10.4 of SMPTE ST 2094-1 [3]. If there is more than one extended display mapping metadata block with ext_block_level equal to 2, those blocks shall have no duplicated target_max_PQ.

trim_slope specifies the slope metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_slope is not present, it shall be inferred to be 2048. Note that the 12-bit slope value is calculated as follows:

\[
\text{trim}_\text{slope} = \text{Clip3}(0, 4095, \text{Round}((S - 0.5) \times 4096))
\]  

(4)

where \(S\) is the ToneMappingGain as defined in clause 6.2.3 of SMPTE ST 2094-10 [4].

trim_offset specifies the offset metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_offset is not present, it shall be inferred to be 2048. Note that the 12-bit offset value is calculated as follows:

\[
\text{trim}_\text{offset} = \text{Clip3}(0, 4095, \text{Round}((O + 0.5) \times 4096))
\]  

(5)

where \(O\) is the ToneMappingOffset as defined in clause 6.2.2 of SMPTE ST 2094-10 [4].

trim_power specifies the power metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_power is not present, it shall be inferred to be 2048. Note that the 12-bit power value is calculated as follows:

\[
\text{trim}_\text{power} = \text{Clip3}(0, 4095, \text{Round}((P - 0.5) \times 4096))
\]  

(6)

where \(P\) is the ToneMappingGamma as defined in clause 6.2.4 of SMPTE ST 2094-10 [4].

trim_chroma_weight specifies the chroma weight metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_chroma_weight is not present, it shall be inferred to be 2048. Note that the 12-bit chroma weight value is calculated as follows:

\[
\text{trim}_\text{chroma}_\text{weight} = \text{Clip3}(0, 4095, \text{Round}((CW + 0.5) \times 4096))
\]  

(7)

where \(CW\) is the ChromaCompensationWeight as defined in clause 6.3.1 of SMPTE ST 2094-10 [4].

trim_saturation_gain specifies the saturation gain metadata. The value shall be in the range of 0 to 4095, inclusive. If trim_saturation_gain is not present, it shall be inferred to be 2048. Note that the 12-bit saturation gain value is calculated as follows:

\[
\text{trim}_\text{saturation}_\text{gain} = \text{Clip3}(0, 4095, \text{Round}((SG + 0.5) \times 4096))
\]  

(8)

where \(SG\) is the SaturationGain as defined in clause 6.3.2 of SMPTE ST 2094-10 [4].

ms_weight this field is reserved for future specification. This 13-bit signed integer shall be 0x1fff (-1).

min_PQ_offset specifies a creative adjustment to min_PQ. The value shall be in the range of 0 to 4095, inclusive. This integer range encodes the normalised PQ value range [-1.0, 1.0] inclusive, as specified in section 6.1.6 of SMPTE ST 2094-10 [4]. If min_PQ_offset is not present, it shall be inferred to be 2048. This default value corresponds to the encoded normalized PQ value of 0.0 as specified in section 6.1.6 of SMPTE ST 2094-10 [4].
The 12-bit min\_PQ\_offset value is calculated as follows:

$$\text{min}_PQ\_\text{offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Min}_PQ\_\text{offset} + 1) * 2048))$$

(9)

where Min\_offset is MinimumPqencodedMaxrgbOffset as defined in section 6.1.6 of ST 2094-10 [4].

\textbf{max\_PQ\_offset} specifies a creative adjustment to max\_PQ. The value shall be in the range of 0 to 4095, inclusive. This integer range encodes the normalised PQ value range [-1.0, 1.0] inclusive, as specified in section 6.1.8 of SMPTE ST 2094-10 [4].

If max\_PQ\_offset is not present, it shall be inferred to be 2048. This default value corresponds to the encoded normalized PQ value of 0.0 as specified in section 6.1.8 of SMPTE ST 2094-10 [4].

The 12-bit max\_PQ\_offset value is calculated as follows:

$$\text{max}_PQ\_\text{offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Max}_PQ\_\text{offset} + 1) * 2048))$$

(10)

where Max\_offset is MaximumPqencodedMaxrgbOffset as defined in section 6.1.8 of ST 2094-10 [4].

\textbf{avg\_PQ\_offset} specifies a creative adjustment to avg\_PQ. The value shall be in the range of 0 to 4095, inclusive. This integer range encodes the normalised PQ value range [-1.0, 1.0] inclusive, as specified in section 6.1.7 of SMPTE ST 2094-10 [4].

If avg\_PQ\_offset is not present, it shall be inferred to be 2048. This default value corresponds to the encoded normalized PQ value of 0.0 as specified in section 6.1.7 of SMPTE ST 2094-10 [4].

The 12-bit avg\_PQ\_offset value is calculated as follows:

$$\text{avg}_PQ\_\text{offset} = \text{Clip3}(0, 4095, \text{Round}((\text{Avg}_PQ\_\text{offset} + 1) * 2048))$$

(11)

where Avg\_offset is AveragePqencodedMaxrgbOffset as defined in section 6.1.7 of ST 2094-10 [4].

\textbf{TF\_PQ\_mean} specifies the temporally filtered mean of the maximum RGB value of the current frame. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit TF\_PQ\_mean value for i\textsuperscript{th} frame TF\_PQ\_mean\textsubscript{i} is calculated as follows:

$$\text{TF}_{\text{PQ}}\_\text{norm}\_\text{mean}\_i = \text{TF}_{\text{PQ}}\_\text{norm}\_\text{mean}_{i-1} \times (1 - \alpha) + \text{mean}(\text{PQ(maxRGB)}_i) \times \alpha$$

(12)

where maxRGB is defined in section 4.1.1 of SMPTE ST 2094-1 [3] and in the range [0, 1], and:

$$\alpha = \min(1, \min(1, (SC \times |\text{mean}(\text{PQ(maxRGB)}_i) - \text{mean}(\text{PQ(maxRGB)}_{i-1})| \times 8 + 0.1) \times 24/\text{ framerate}))$$

(13)

The value of SC is set to 1 at a scene boundary; otherwise the value of SC is set to 0:

$$\text{TF}_{\text{PQ}}\_\text{mean}\_i = \text{Clip3}(0, 4095, \text{Round}(\text{TF}_{\text{PQ}}\_\text{norm}\_\text{mean}\_i * 4095))$$

(14)

**NOTE 1:** For an initial frame where there is no i-1 frame, a default value for TF\_PQ\_mean of 1474 (0.36) may be used.

\textbf{TF\_PQ\_stddev} specifies the temporally filtered standard deviation of the maximum RGB value of the current frame. The value shall be in the range of 0 to 4095, inclusive. Note that the 12-bit value for i\textsuperscript{th} frame TF\_PQ\_stddev\textsubscript{i} is calculated as follows:

$$\text{TF}_{\text{PQ}}\_\text{norm}\_\text{stddev}\_i = \text{TF}_{\text{PQ}}\_\text{norm}\_\text{stddev}_{i-1} \times (1 - \alpha) + \text{stddev}(\text{PQ(maxRGB)}_i) \times \alpha$$

(15)

where maxRGB is defined in section 4.1.1 of SMPTE ST 2094-1 [3] and in the range [0, 1], and:

$$\alpha = \min(1, \min(1, (SC \times |\text{mean}(\text{PQ(maxRGB)}_i) - \text{mean}(\text{PQ(maxRGB)}_{i-1})| \times 8 + 0.1) \times 24/\text{ framerate}))$$

(16)

The value of SC is set to 1 at a scene boundary; otherwise the value of SC is set to 0:

$$\text{TF}_{\text{PQ}}\_\text{stddev}\_i = \text{Clip3}(0, 4095, \text{Round}(\text{TF}_{\text{PQ}}\_\text{norm}\_\text{stddev}\_i * 4095))$$

(17)

**NOTE 2:** For an initial frame where there is no i-1 frame, a default value for TF\_PQ\_stddev of 0 may be used.
NOTE 3: The alpha value is calculated to ensure a smooth transition between scenes. The scene boundary can be determined by an appropriate mechanism, such as in the encoder.

`active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset` specify the selected pixels of the current picture, in terms of a rectangular region specified in picture coordinates for active area. The values shall be in the range of 0 to 8 191, inclusive. See also ProcessingWindow definitions in SMPTE ST 2094-10 [4].

`active_area_left_offset, active_area_right_offset, active_area_top_offset, active_area_bottom_offset` represent the coordinates of UpperLeftCorner and LowerRightCorner constrained in clause 7.1 of SMPTE ST 2094-10 [4] as follows:

\[
\text{UpperLeftCorner} = (\text{active\_area\_left\_offset}, \text{active\_area\_top\_offset}) \\
\text{LowerRightCorner} = (X\text{Size} - 1 - \text{active\_area\_right\_offset}, Y\text{Size} - 1 - \text{active\_area\_bottom\_offset})
\]

where Xsize is the horizontal resolution of the current picture and Ysize is the vertical resolution of the current picture.

`ext_dm_alignment_zero_bit` shall be equal to 0.
Annex A (informative):
SMPTE ST 2094-10 HDR Dynamic Metadata in MPEG-2 TS for DVB Systems

A.1 Introduction

This annex was removed as the carriage and signalling of SMPTE ST 2094-10 HDR dynamic metadata in DVB systems compliant MPEG-2 transport streams has now been defined in ETSI TS 101 154 [8] and ETSI EN 300 468 [6].
## History

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