



**ATSC**

ADVANCED TELEVISION  
SYSTEMS COMMITTEE

# **ATSC Candidate Standard: A/341 Amendment – 2094-40**

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Doc. S34-301r2  
20 February 2018

**Advanced Television Systems Committee**  
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202-872-9160

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This specification is being put forth as a Candidate Standard by the TG3/S34 Specialist Group. This document is an editorial revision of the Working Draft (S34-301r1) dated 23 January 2018. All ATSC members and non-members are encouraged to review and implement this specification and return comments to [cs-editor@atsc.org](mailto:cs-editor@atsc.org). ATSC Members can also send comments directly to the TG3/S34 Specialist Group. This specification is expected to progress to Proposed Standard after its Candidate Standard period.

### Revision History

Version	Date
Candidate Standard approved	20 February 2018
Standard approved	Insert date here

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## **ATSC Candidate Standard: A/341 Amendment – 2094-40**

### **1. OVERVIEW**

This document describes technology documented in ST 2094-40 “Dynamic Metadata for Color Volume Transform — Application #4” which is a technology for the use of dynamic metadata for HDR content. If approved by the ATSC, A/341:2018, “Video – HEVC,” (“A/341”) would be amended according to the edits described herein.

### **2. REFERENCES**

The following references would be added to A/341.

#### 2.1 Normative References

- [1] SMPTE: “Dynamic Metadata for Color Volume Transformation – Application #4,” Doc. ST 2094-40 (2016), Society of Motion Picture and Television Engineer, White Plains, NY.

#### 2.2 Informative References

- [2] SMPTE: “Dynamic Metadata for Color Volume Transformation – Core Components,” Doc. ST 2094-1 (2016), Society of Motion Picture and Television Engineers, White Plains, NY.
- [3] Delta: “Manufacturers Codes for H.32X Terminal” (2017), Delta Information Systems, [http://www.delta-info.com/DeltaWeb/Manufacturer\\_codes/Manucode.pdf](http://www.delta-info.com/DeltaWeb/Manufacturer_codes/Manucode.pdf).

### **3. DEFINITION OF TERMS.**

No new acronyms, abbreviations or terms would be added to A/341.

### **4. CHANGES TO A/341**

In this section of this document, “[ref]” indicates that a cross reference to a cited referenced document that is listed in A/341 would be inserted (or as otherwise described within the square brackets). An actual cross reference to a referenced document listed in this document would be updated with the reference number of the newly added references that would be incorporated into A/341.

#### 4.1 Add a Bullet to Section 6.3.2.2

- The bitstream may contain SEI messages with payloadType value equal to 4. This allows for the optional transmission of the ST 2094-40 metadata message described in [ref to new subsection described below].

#### 4.2 Add a New Subsection Under Section 6.3.2.2

The text below would be added to A/341 as a new subsection under Section 6.3.2.2 “PQ Transfer Characteristics.” The new subsection would be entitled Section 6.3.2.2.x “Encoding and Transport of SMPTE ST 2094-40 Metadata Message.”

The HEVC video bitstream may contain the 2094-40 metadata message in order to provide dynamic information about the video signal. 2094-40 metadata messages, when present, can provide statistical information about the scene as well as basis OOTF (optical-optical transfer function) data that can guide the tone mapping of displays with lower peak luminance capabilities

than the peaks present in the video signal. The information conveyed in the 2094-40 metadata message defined in [ref to new Annex described below] provides carriage for metadata elements defined in ST 2094-1 [2] and ST 2094-40 [1].

2094-40 metadata, when present, shall be encoded and transported as User data registered by a Recommendation ITU-T T.35 Supplemental Enhancement Information (SEI) message per registration authority codes [3].

The syntax and semantics for payload `user_data_registered_itu_t_t35()` shall be as specified in [ref to new Annex described below] section [ref to new Annex, Section 1 described below]. Where present the corresponding NAL unit type shall be set equal to `PREFIX_SEI_NUT`.

If a 2094-40 metadata message is present, the following constraints shall apply:

- The 2094-40 metadata message shall be associated with every access unit of the bitstream. If this message is present, it shall only be present once per access unit.
- Mastering Display Color Volume SEI messages (containing SMPTE ST 2086 [23] static metadata) shall be present in the bitstream.

#### 4.3 Add a New Annex to A/341

The below text comprises a new Annex that would be added to A/341. The Annex would be entitled “Metadata Based on SMPTE ST 2094-40\_Data.”

#### **ANNEX (n): METADATA BASED ON ST 2094-40\_DATA (NORMATIVE)**

This annex specifies the syntax and semantics of `user_data_registered_itu_t_t35()`. The syntax for `user_data_registered_itu_t_t35()` is shown in Table 1.

Note: The metadata elements are defined according to the SMPTE standards ST 2094-1[2], or ST 2094-40 [1].

**Table 1** `user_data_registered_itu_t_t35()`

<code>user_data_registered_itu_t_t35() {</code>	Descriptor
<code>itu_t_t35_country_code</code>	u(8)
<code>itu_t_t35_terminal_provider_code</code>	u(16)
<code>itu_t_t35_terminal_provider_oriented_code</code>	u(16)
<code>application_identifier</code>	u(8)
<code>application_version</code>	u(8)
<code>num_windows</code>	u(2)
<code>for( w = 1; w &lt; num_windows; w++) {</code>	
<code>    window_upper_left_corner_x[ w ]</code>	u(16)
<code>    window_upper_left_corner_y[ w ]</code>	u(16)
<code>    window_lower_right_corner_x[ w ]</code>	u(16)
<code>    window_lower_right_corner_y[ w ]</code>	u(16)
<code>        center_of_ellipse_x[ w ]</code>	u(16)
<code>        center_of_ellipse_y[ w ]</code>	u(16)
<code>        rotation_angle[ w ]</code>	u(8)
<code>        semimajor_axis_internal_ellipse[ w ]</code>	u(16)
<code>        semimajor_axis_external_ellipse[ w ]</code>	u(16)
<code>        semiminor_axis_external_ellipse[ w ]</code>	u(16)
<code>        overlap_process_option[ w ]</code>	u(1)
<code>}</code>	

<b>targeted_system_display_maximum_luminance</b>	u(27)
<b>targeted_system_display_actual_peak_luminance_flag</b>	u(1)
if( targeted_system_display_actual_peak_luminance_flag ) {	
<b>num_rows_targeted_system_display_actual_peak_luminance</b>	u(5)
<b>num_cols_targeted_system_display_actual_peak_luminance</b>	u(5)
for( i = 0; i < num_rows_targeted_system_display_actual_peak_luminance; i++ )	
for( j = 0; j < num_cols_targeted_system_display_actual_peak_luminance; j++ )	
<b>targeted_system_display_actual_peak_luminance[ i ][ j ]</b>	u(4)
}	
for( w = 0; w < num_windows; w++ ) {	
for( i = 0; i < 3; i++ )	
<b>maxscl[ w ][ i ]</b>	u(17)
<b>average_maxrgb[ w ]</b>	u(17)
<b>num_distribution_maxrgb_percentiles[ w ]</b>	u(4)
for( i = 0; i < num_distribution_maxrgb_percentiles[ w ]; i++ ) {	
<b>distribution_maxrgb_percentages[ w ][ i ]</b>	u(7)
<b>distribution_maxrgb_percentiles[ w ][ i ]</b>	u(17)
}	
<b>fraction_bright_pixels[ w ]</b>	u(10)
}	
<b>mastering_display_actual_peak_luminance_flag</b>	u(1)
if( mastering_display_actual_peak_luminance_flag ) {	
<b>num_rows_mastering_display_actual_peak_luminance</b>	u(5)
<b>num_cols_mastering_display_actual_peak_luminance</b>	u(5)
for( i = 0; i < num_rows_mastering_display_actual_peak_luminance; i++ )	
for( i = 0; i < num_cols_mastering_display_actual_peak_luminance; i++ )	
<b>mastering_display_actual_peak_luminance[ i ][ j ]</b>	u(4)
}	
for( w = 0; w < num_windows; w++ ) {	
<b>tone_mapping_flag[ w ]</b>	u(1)
if( tone_mapping_flag[ w ] ) {	
<b>knee_point_x[ w ]</b>	u(12)
<b>knee_point_y[ w ]</b>	u(12)
<b>num_bezier_curve_anchors[ w ]</b>	u(4)
for( i = 0; i < num_bezier_curve_anchors[ w ]; i++ )	
<b>bezier_curve_anchors[ w ][ i ]</b>	u(10)
}	
<b>color_saturation_mapping_flag[ w ]</b>	u(1)
if( color_saturation_mapping_flag[ w ] ) {	
<b>color_saturation_weight[ w ]</b>	u(6)
}	
}	
}	

This SEI message provides information to enable color volume transformation of the reconstructed color samples of the output pictures. The input to the indicated color volume transform process is the linearized RGB color components of the source content.

The information conveyed in this SEI message is intended to be adequate for purposes corresponding to the use of SMPTE ST 2094-40 [1].

**itu\_t\_t35\_country\_code** shall be a byte having a value specified as a country code by Rec. ITU-T T.35 Annex A [ref]. The value shall be 0xB5.

**itu\_t\_t35\_terminal\_provider\_code** shall be a fixed 16-bit field. The value shall be 0x003C.

**itu\_t\_t35\_terminal\_provider\_oriented\_code** shall be a 16-bit code. The value shall be as specified in Table 2.

**Table 2** itu\_t\_t35\_terminal\_provider\_oriented\_code

itu_t_t35_terminal_provider_oriented_code	Indicated value
0x0000	Unspecified
0x0001	ST 2094-40 [1]
0x0002 – 0x00FF	Reserved

**application\_identifier** – identifies an application and is set equal to 4 according to the constraints of Section 5 of ST 2094-40 [1].

**application\_version** – identifies the version and is set equal to 0 according to the constraints of Section 5 of ST 2094-40 [1].

**num\_windows** – indicates the number of processing windows. The first processing window shall be for the entire picture. The value of num\_windows shall be 1.

**window\_upper\_left\_corner\_x[ w ]** – specifies the x coordinate of the top left pixel of the w-th processing window. The value of window\_upper\_left\_corner\_x[ w ] shall not exceed 65535. window\_upper\_left\_corner\_x[ w ] shall not be used in this version of this Standard.

**window\_upper\_left\_corner\_y[ w ]** – specifies the y coordinate of the top left pixel of the w-th processing window. The value of window\_upper\_left\_corner\_y[ w ] shall not exceed 65535. window\_upper\_left\_corner\_y[ w ] shall not be used in this version of this Standard.

**window\_lower\_right\_corner\_x[ w ]** – specifies the x coordinate of the bottom right pixel of the w-th processing window. The value of window\_lower\_right\_corner\_x[ w ] shall not exceed 65535. window\_lower\_right\_corner\_x[ w ] shall not be used in this version of this Standard.

**window\_lower\_right\_corner\_y[ w ]** – specifies the y coordinate of the bottom pixel of the w-th processing window. The value of window\_lower\_right\_corner\_y[ w ] shall not exceed 65535. window\_lower\_right\_corner\_y[ w ] shall not be used in this version of this Standard.

**center\_of\_ellipse\_x[ w ]** – specifies the x coordinate of the center position of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of center\_of\_ellipse\_x[ w ] shall be in the range of 0 to (width of Picture – 1), inclusive, and in multiples of 1 pixel. center\_of\_ellipse\_x[ w ] shall not be used in this version of this Standard.

**center\_of\_ellipse\_y[ w ]** – specifies the y coordinate of the center position of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of center\_of\_ellipse\_y[ w ] shall be in the range of 0 to (height of Picture – 1), inclusive, and in multiples of 1 pixel. center\_of\_ellipse\_y[ w ] shall not be used in this version of this Standard.

**rotation\_angle[ w ]** – specifies the clockwise rotation angle in degree of arc with respect to the positive direction of the x-axis of the concentric internal and external ellipses of the elliptical pixel selector in the w-th processing window. The value of rotation\_angle[ w ] shall be in the range of 0 to 180, inclusive, and in multiples of 1. rotation\_angle[ w ] shall not be used in this version of this Standard.

- semimajor\_axis\_internal\_ellipse[ w ]** – specifies the semi-major axis value of the internal ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of `semimajor_axis_internal_ellipse[ w ]` shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. `semimajor_axis_internal_ellipse[ w ]` shall not be used in this version of this Standard.
- semimajor\_axis\_external\_ellipse[ w ]** – specifies the semi-major axis value of the external ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of `semimajor_axis_external_ellipse[ w ]` shall not be less than `semimajor_axis_internal_ellipse[ w ]`. The value of `semimajor_axis_external_ellipse[ w ]` shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. `semimajor_axis_external_ellipse[ w ]` shall not be used in this version of this Standard.
- semiminor\_axis\_external\_ellipse[ w ]** – specifies the semi-minor axis value of the external ellipse of the elliptical pixel selector in amount of pixels in the w-th processing window. The value of `semiminor_axis_external_ellipse[ w ]` shall be in the range of 1 to 65535, inclusive, and in multiples of 1 pixel. `semiminor_axis_external_ellipse[ w ]` shall not be used in this version of this Standard.
- overlap\_process\_option[ w ]** – an enumerator that indicates one of the two methods of combining rendered pixels in the w-th processing window in an image with at least one elliptical pixel selector. For overlapping elliptical pixel selectors in an image, `overlap_process_option[ w ]` shall have the same value. `overlap_process_option[ w ] = 0` shall indicate the Weighted Averaging method and `overlap_process_option[ w ] = 1` shall indicate the Layering method as described in Annex B of reference [1]. `overlap_process_option[ w ]` shall not be used in this version of this Standard.
- targeted\_system\_display\_maximum\_luminance** – specifies the nominal maximum display luminance of the targeted system display in units of 0.0001 candelas per square meter. The value of `targeted_system_display_maximum_luminance` shall be in the range of 0 to 10000, inclusive.
- targeted\_system\_display\_actual\_peak\_luminance\_flag** – when present, shall be equal to 0 for this version of this Standard. The value 1 for `targeted_system_display_actual_peak_luminance_flag` is reserved for future use.
- num\_rows\_targeted\_system\_display\_actual\_peak\_luminance** – specifies the number of rows in the `targeted_system_display_actual_peak_luminance` array. The value of `num_rows_targeted_system_display_actual_peak_luminance` shall be in the range of 2 to 25, inclusive. `num_rows_targeted_system_display_actual_peak_luminance` shall not be used in this version of this Standard.
- num\_cols\_targeted\_system\_display\_actual\_peak\_luminance** – specifies the number of columns in the `targeted_system_display_actual_peak_luminance` array. The value of `num_cols_targeted_system_display_actual_peak_luminance` shall be in the range of 2 to 25, inclusive. `num_cols_targeted_system_display_actual_peak_luminance` shall not be used in this version of this Standard.
- targeted\_system\_display\_actual\_peak\_luminance[ i ][ j ]** – specifies the normalized actual peak luminance of the targeted system display. The value of `targeted_system_display_actual_peak_luminance[ i ][ j ]` shall be in the range of 0 to 1, inclusive, and in multiples of 1/15. `targeted_system_display_actual_peak_luminance[ i ][ j ]` shall not be used in this version of this Standard.
- maxscl[ w ][ i ]** – specifies the maximum of the i-th color component of linearized RGB values in the w-th processing window in the scene. The value of `maxscl[ w ][ i ]` shall be in the range of 0 to 1, inclusive, and in multiples of 0.00001. `maxscl[ w ][ 0 ]`, `maxscl[ w ][ 1 ]`, and `maxscl[ w ][ 2 ]` correspond to the R, G, B color components, respectively.



**average\_maxrgb[ w ]** – specifies the average of linearized maxRGB values in the w-th processing window in the scene. The value of average\_maxrgb[ w ] shall be in the range of 0 to 1, inclusive, and in multiples of 0.00001.

**num\_distribution\_maxrgb\_percentiles[ w ]** – indicates the number of linearized maxRGB values at given percentiles in the w-th processing window in the scene. The value of num\_distribution\_maxrgb\_percentiles [ w ] shall be 9.

**distribution\_maxrgb\_percentages[ w ][ i ]** – specifies an integer percentage value corresponding to the i-th percentile linearized RGB value in the w-th processing window in the scene. The value of distribution\_maxrgb\_percentages[ w ][ i ] shall be in the range of 0 to 100, inclusive.

The value of distribution\_maxrgb\_percentages[ 0 ][ i ] shall be fixed as shown in Table 3:

**Table 3** distribution\_maxrgb\_percentages[ 0 ][ i ]

Index	Value
distribution_maxrgb_percentages[ 0 ][ 0 ]	1
distribution_maxrgb_percentages[ 0 ][ 1 ]	5
distribution_maxrgb_percentages[ 0 ][ 2 ]	10
distribution_maxrgb_percentages[ 0 ][ 3 ]	25
distribution_maxrgb_percentages[ 0 ][ 4 ]	50
distribution_maxrgb_percentages[ 0 ][ 5 ]	75
distribution_maxrgb_percentages[ 0 ][ 6 ]	90
distribution_maxrgb_percentages[ 0 ][ 7 ]	95
distribution_maxrgb_percentages[ 0 ][ 8 ]	99

**distribution\_maxrgb\_percentiles[ w ][ i ]** – specifies the linearized maxRGB value at the i-th percentile in the w-th processing window in the scene. The value of distribution\_maxrgb\_percentiles[ w ][ i ] shall be in the range of 0 to 1, inclusive, and in multiples of 0.00001.

The value of distribution\_maxrgb\_percentiles[ 0 ][ i ] shall be as shown in Table 4:

**Table 4** distribution\_maxrgb\_percentiles[ 0 ][ i ]

Index	Value
distribution_maxrgb_percentiles[ 0 ][ 0 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 1 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 2 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 3 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 4 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 5 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 6 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 7 ]	as measured
distribution_maxrgb_percentiles[ 0 ][ 8 ]	99.98% percentile by default, but can be redefined with a number between 99.90% percentile and 99.99% percentile.

**fraction\_bright\_pixels[ w ]** – specifies the fraction of selected pixels in the image that contains the brightest pixel in the scene. The value of fraction\_bright\_pixels[ w ] shall be in the range of 0 to 1, inclusive, and in multiples of 0.001.

**mastering\_display\_actual\_peak\_luminance\_flag** – shall be equal to 0 for this version of this Standard. A value of 1 for mastering\_display\_actual\_peak\_luminance\_flag is reserved for future use.

- num\_rows\_mastering\_display\_actual\_peak\_luminance** – specifies the number of rows in the `mastering_display_actual_peak_luminance` array. The value of `num_rows_mastering_display_actual_peak_luminance` shall be in the range of 2 to 25, inclusive. `num_rows_mastering_display_actual_peak_luminance` shall not be used in this version of this Standard.
- num\_cols\_mastering\_display\_actual\_peak\_luminance** – specifies the number of columns in the `mastering_display_actual_peak_luminance` array. The value of `num_cols_mastering_display_actual_peak_luminance` shall be in the range of 2 to 25, inclusive. `num_cols_mastering_display_actual_peak_luminance` shall not be used in this version of this Standard.
- mastering\_display\_actual\_peak\_luminance[ i ][ j ]** – specifies the normalized actual peak luminance of the mastering display used for mastering the image essence. The value of `mastering_display_actual_peak_luminance[ i ][ j ]` shall be in the range of 0 to 1, inclusive, and in multiples of 1/15. `mastering_display_actual_peak_luminance[ i ][ j ]` shall not be used in this version of this Standard.
- tone\_mapping\_flag[ w ]** – indicates that the metadata for the tone mapping function in the *w*-th processing window is present. `tone_mapping_flag[ 0 ]` shall be equal to 1.
- knee\_point\_x[ w ]** – specifies the *x* coordinate of the separation point between the linear part and the curved part of the tone mapping function. The value of `knee_point_x[ w ]` shall be in the range of 0 to 1, excluding 0, and in multiples of 1/4095.
- knee\_point\_y[ w ]** – specifies the *y* coordinate of the separation point between the linear part and the curved part of the tone mapping function. The value of `knee_point_y[ w ]` shall be in the range of 0 to 1, excluding 0, and in multiples of 1/4095.
- num\_bezier\_curve\_anchors[ w ]** – indicates the number of the intermediate anchor parameters of the tone mapping function in the *w*-th processing window. The maximum value of `num_bezier_curve_anchors[ w ]` shall be 9.
- bezier\_curve\_anchors[ w ][ i ]** – specifies the *i*-th intermediate anchor parameter of the tone mapping function in the *w*-th processing window in the scene. The value of `bezier_curve_anchors[ w ][ i ]` shall be in the range of 0 to 1, inclusive, and in multiples of 1/1023.
- color\_saturation\_mapping\_flag[ w ]** – shall be equal to 0 for this version of this Standard. A value of 1 for `color_saturation_mapping_flag[ w ]` is reserved for future use.
- color\_saturation\_weight[ w ]** – specifies a number that shall adjust the color saturation gain in the *w*-th processing window in the scene. The value of `color_saturation_weight[ w ]` shall be in the range of 0 to 63/8, inclusive, and in multiples of 1/8. The default value shall be 1. `color_saturation_weight[ w ]` shall not be used in this version of this Standard.

Note: Definitions of the metadata items and terms used in this section of the document are provided in ST 2094-1 [2] and ST 2094-40 [1]. A color volume transform method using this message is described in Annex B of ST 2094-40 [1].

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