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| Title: | High level syntax support for ARIB STD-B67 in Rec. H.264 / MPEG-4 AVC | | |
| Purpose: | Proposal | | |

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**Abstract**

This contribution proposes to extend the high level syntax of Rec. H.264 / MPEG-4 AVC to support the transfer characteristic curve for High Dynamic Range (HDR) content as specified in ARIB STD-B67. Two additions are proposed: a new entry code in the transfer\_characteristics table of the VUI and a new SEI message which allows to override the transfer\_characteristics entry in VUI for those receivers with HDR capabilities.

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# Introduction

High Dynamic Range (HDR) television will provide audiences with a more compelling quality of experience when watching TV programmes. To enable HDR broadcast services, proper transfer characteristic curves should be designed to convey the most realistic tonal reproduction of a scene, whilst minimising impairments. Besides this ambition, to facilitate the launch of HDR television services, HDR formats should be designed to have a minimal impact on the whole broadcast production and distribution chain. In production, having a transfer characteristic which requires metadata either to perform the conversion from HDR to Standard Dynamic Range (SDR) or intermixing of content items is impractical for at least two reasons:

* Synchronisation and reliability problems may arise with production metadata travelling through the complex production chains;
* Mixing of SDR and a variety of HDR content to produce digital video effects would require additional and complex processing.

On the distribution side, broadcasters may want to serve HDR and SDR (legacy) receivers using the same channel so that the designed transfer characteristics curve should be backward compatible. To address all these issues, ARIB STD-B67 [1] standardises a nonlinear Opto-Electronic Transfer Function (OETF) characteristic, which extends the SDR ITU-R BT.709 and BT.2020 OETFs in a compatible manner to support HDR production and distribution. The signal produced upon the application of the ARIB STD-B67 OETF to linear scene light provides both a high quality HDR image on a suitable HDR display, as well as a compatible picture on an SDR display of the same colour space. As the ARIB STD-B67 OETF is so similar in characteristic to a conventional SDR camera operating with a “knee”, and requires no production metadata, it is also compatible with existing production equipment, codecs and infrastructure without the need for modification.

Television production still makes large scale use of the H.264/AVC compression standard for both real-time and non-real time file based workflows, and that situation is not expected to change for very many years to come. Therefore, in order to enable the rapid adoption of HDR within television broadcasting, the H.264/AVC standard needs to be able to support ARIB STD-B67. Moreover, to allow material captured by HDR camcorders supporting the ARIB STD-B67 OETF and H.264/AVC compression to be used in both SDR and HDR productions, the backward compatibility feature of ARIB STD-B67 can be exploited.

This contribution presents the support required in H.264/AVC to include ARIB STD-B67 for the production of HDR television programmes, and to allow HDR camcorders to be used for both HDR and SDR production. The remainder of this document is structured as follows: Section 2 will provide an overview of the required support in the high level syntax of H.264/AVC while Section 3 will present the required changes to the syntax and semantics of the H.264/AVC specification text.

# Overview of the required support

This section describes how the required support for ARIB STD-B67 will be implemented in the H.264/AVC syntax. There are two aspects to be addressed: first how to signal in the bitstream that the non-linear coded pixel values refer to the scene light and second how to enable material captured by HDR camcorders to be used for both SDR and HDR productions, exploiting the backwards compatible nature of the ARIB STD-B67 signal.

For the first aspect it is proposed to add a new entry for the transfer\_characteristics syntax element in the Video Usability Information (VUI). This new entry (Number 18) will contain the equations associated with the OETF specified in [1]. This value has been chosen for consistency with HEVC [2] and to avoid confusion with equipment manufacturers. This will allow ARIB STD B-67 HDR content to be unambiguously identified as HDR, where in critical applications it is important that legacy SDR equipment does not attempt to process the signal.

For the second aspect a new SEI message is proposed to override the transfer\_characteristics value in the VUI. This may be used for less critical applications where the flexibility to use HDR material captured using the ARIB STD-67 transfer curve in both HDR and SDR productions would be advantageous. More precisely the backward compatibility designed for the OETF specified in ARIB STD-B67 allows the display of pictures on legacy SDR screens without the need for additional metadata or processing, and SDR production tools (e.g. non-linear editors) should treat the signal as if it were a SDR signal. This is achievable by setting the transfer\_characteristics property in the VUI equal to 1, 14 or 15 (depending on whether the signal is BT.709 or BT.2020 colour space and 10 or 12 bits) and inserting the proposed SEI message. When the bitstream is delivered to SDR and HDR production systems, the following will happen:

* **SDR (legacy) production tools**: Will process and display the decoded video using the transfer\_characteristics value read in the VUI and ignore the SEI message as they do not understand its syntax and semantics.
* **HDR production tools**: Will process and display the decoded video using the transfer\_characteristics value conveyed by the proposed SEI message and ignore the corresponding value in the VUI. The SEI message will convey the value for transfer\_characteristics entry number 18 which corresponds to ARIB STD-B67. It should be noted that this SEI message is not limited to ARIB STD-B67 but any future OETF which guarantees some degree of backward compatibility can be accommodated.

The proposed SEI message contains only one syntax element and will be introduced in the following section.

# Required syntax changes to support ARIB STD-B67 in Rec. H.264

This section presents the required syntax changes to the H.264/AVC syntax to include the additional entry for the transfer\_characteristics and the SEI message. All changes refer to the latest published version of the specification text [3] and are highlighted in yellow.

**E.2.1 VUI parameters semantics**

| Value | Transfer Characteristic | Informative Remark |
| --- | --- | --- |
| 0 | Reserved | For future use by ITU‑T | ISO/IEC |
| 1 | V = 1.099 \* Lc0.45 – 0.099 for 1 >= Lc >= 0.018  V = 4.500 \* Lc for 0.018 > Lc >= 0 | Rec. ITU‑R BT.709-5  Rec. ITU‑R BT.1361 conventional colour gamut system  (functionally the same as the value 6) |
| 2 | Unspecified | Image characteristics are unknown or are determined by the application. |
| 3 | Reserved | For future use by ITU‑T | 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 = 1.099 \* Lc0.45 – 0.099 for 1 >= Lc >= 0.018  V = 4.500 \* Lc for 0.018 > Lc >= 0 | Rec. ITU‑R BT.601‑6 525 or 625  Rec. ITU‑R BT.1358 525 or 625  Rec. ITU‑R BT.1700 NTSC  Society of Motion Picture and Television Engineers 170M (2004)  (functionally the same as the value 1) |
| 7 | V = 1.1115 \* Lc0.45 – 0.1115 for 1 >= Lc >= 0.0228  V = 4.0 \* Lc for 0.0228 > Lc >= 0 | Society of Motion Picture and Television Engineers 240M (1999) |
| 8 | V = Lc for 1 > Lc >= 0 | Linear transfer characteristics |
| 9 | V = 1.0 + Log10( Lc ) ÷ 2 for 1 >= Lc >= 0.01  V = 0.0 for 0.01 > Lc >= 0 | Logarithmic transfer characteristic (100:1 range) |
| 10 | V = 1.0 + Log10( Lc ) ÷ 2.5 for 1 >= Lc >= Sqrt( 10 ) / 1000  V = 0.0 for Sqrt( 10 ) / 1000 > Lc >= 0 | Logarithmic transfer characteristic (100 \* Sqrt( 10 ) : 1 range) |
| 11 | V = 1.099 \* Lc0.45 – 0.099 for Lc >= 0.018  V = 4.500 \* Lc for 0.018 > Lc > −0.018  V = −1.099 \* ( −Lc )0.45 + 0.099 for −0.018 >= Lc | IEC 61966-2-4 |
| 12 | V = 1.099 \* Lc0.45 – 0.099 for 1.33 > Lc >= 0.018  V = 4.500 \* Lc for 0.018 > Lc >= −0.0045  V = −( 1.099 \* ( −4 \* Lc )0.45 – 0.099 ) ÷ 4 for −0.0045 > Lc >= −0.25 | Rec. ITU‑R  BT.1361 extended colour gamut system |
| 13 | V = 1.055 \* Lc(1÷2.4) − 0.055 for 1 > Lc >= 0.0031308  V = 12.92 \* Lc for 0.0031308 > Lc >= 0 | IEC 61966-2-1 (sRGB or sYCC) |
| 14 | V =1.099\* Lc0.45 − 0.099 for 1 >= Lc >= 0.018  V = 4.500 \* Lc for 0.018 > Lc >= 0 | Rec. ITU-R BT.2020 for 10 bit system |
| 15 | V =1.0993\* Lc0.45 − 0.0993 for 1 >= Lc >= 0.0181  V = 4.500 \* Lc for 0.0181 > Lc >= 0 | Rec. ITU-R BT.2020 for 12 bit system |
| 16 | Reserved | For future use by ITU‑T | ISO/IEC |
| 17 | Reserved | For future use by ITU‑T | ISO/IEC |
| 18 | V = 0.5 \* Lc0.5 for 1 >= Lc >= 0  V = a \* ln (Lc – b) + c for Lc > 1  a = 0.17883277, b = 0.28466892, c = 0.55991073 | Association of Radio Industries and Businesses (ARIB) STD-B67 |
| 19..255 | Reserved | For future use by ITU‑T | ISO/IEC |

**D.1 SEI payload syntax**

|  |  |  |
| --- | --- | --- |
| sei\_payload( payloadType, payloadSize ) { | C | Descriptor |
| … |  |  |
| else if( payloadType = = 55 ) |  |  |
| alternative\_transfer\_characteristics( payloadSize ) | 5 |  |
| … |  |  |
| } |  |  |

**D.1.27 Alternative transfer characteristics information SEI message syntax**

|  |  |  |
| --- | --- | --- |
| alternative\_transfer\_characteristics( payloadSize ) { | C | Descriptor |
| **preferred\_transfer\_characteristics** | 5 | u(8) |
| } |  |  |

**D.1.28 Reserved SEI message syntax**

**D.2 SEI payload semantics**

**D.2.27 Alternative transfer characteristics SEI message semantics**

The alternative transfer characteristics SEI message provides a preferred alternative value for the transfer\_characteristics syntax element that is indicated by the colour description syntax of VUI parameters of the SPS. This SEI message is intended to be used in cases when some value of transfer\_characteristics is preferred for interpretation of the pictures of the coded video sequence although some other value of transfer\_characteristics may also be acceptable for interpretation of the pictures of the coded video sequence and that other value is provided in the colour description syntax of VUI parameters of the SPS for interpretation by decoders that do not support interpretation of the preferred value (e.g., because the preferred value had not yet been defined in a previous version of this Recommendation | International Standard).

**preferred\_transfer\_characteristics** specifies a preferred alternative value for the transfer\_characteristics syntax element of the colour description syntax of VUI parameters of the SPS. The semantics for preferred\_transfer\_characteristics are otherwise the same as for the transfer\_characteristics syntax element specified in the VUI parameters of the SPS (see clause E.2.1 and Table E.4). When preferred\_transfer\_characteristics is not equal to the value of transfer\_characteristics indicated in the VUI parameters of the SPS, decoders should ignore the value of transfer\_characteristics indicated in the VUI parameters of the SPS and instead use the value indicated by preferred\_transfer\_characteristics.

**D.2.28 Reserved SEI message semantics**

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# References

1. Association of Radio Industries and Businesses ARIB STD-B67 Ver. 1.0, “*Essential parameter values for the extended image dynamic television system (EIDRTV)*”, July 2015.
2. R. Joshi, S. Liu, G. Sullivan, G. Tech, Y.-K. Wang, J. Xu and Y. Ye, “High Efficiency Video Coding (HEVC) Screen Content Coding: Draft 5”, JCTVC-V1005, 22nd meeting, Geneva, CH, October 2015.
3. ITU-T, Recommendation H.264, “Advanced video coding for generic audiovisual services”, February 2014.