

# Operational Guideline

- Draft -

May 2018

**Operational Guideline – Draft**

HDR signalisation in MXF for H.264

Version 0.1

**ARD** <sup>1</sup>

**ZDF**

**SRG SSR**

**arte**

© Publisher: 

**Ständiges ARD-Büro**

Bertramstraße 8

60320 Frankfurt/Main  
Germany

phone: +49 69 59 06 07

fax: +49 69 155 20 75

e-mail: ard-buero@ard.de

**Zweites Deutsches Fernsehen**

ZDF-Straße 1

55100 Mainz (Mayence)  
Germany

phone: +49 6131 70 0

fax: +49 6131 70 2157

e-mail: info@zdf.de

**Schweizerische Radio- und Fernsehgesellschaft**

Fernsehstrasse 1-4

8052 Zürich

Switzerland

**ARTE G.E.I.E**

Postfach 1980

77679 Kehl

Published on behalf of the above-named broadcast institutions by:

Institut für Rundfunktechnik GmbH (Broadcast Technology Institute)

Floriansmuehlstraße 60  
80939 München (Munich)  
Germany

phone: +49 89 32399 204

fax: +49 89 32399 205

e-mail: [presse@irt.de](mailto:presse@irt.de)

website: [www.irt.de](http://www.irt.de)

**Copyright Notice**

This document and all its contents are protected by copyright law. IRT reserves all its rights. You may not alter or remove any trademark, copyright, or other notice.

Institut für Rundfunktechnik has granted its client the right to distribute to third parties and to publish (also electronically solely in non-editable and non-copyable.pdf format) this complete and unchanged document.

Translation and modification of any parts of this document as well as the distribution of excerpts requires the prior written permission of Institut für Rundfunktechnik.

# Operational Guideline – Draft

---

HDR signalisation in MXF for H.264

May 2018

This document is a first draft for a future MXF Profile based on H.264. Currently, the focus of the document is the signalisation of HDR (High Dynamic Range) within the essence and accordingly in the wrapper. Further specification (audio, video, technical metadata, etc.) will be added as needed. This document reflects the requirements of ARD, ZDF, SRG and ARTE.

# Content

Operational Guideline – Draft .....	3
1 Introduction .....	5
2 Conformance Notation.....	5
3 H.264 based production codecs - normative (e.g. Panasonic AVCUltra, Sony XAVC) .....	6
• <i>Essence</i> :.....	6
• <i>Wrapper (MXF)</i> : .....	6
Background: H.264 essence signalisation parameters based on ITU-T H.264 Version 12 (April 2017) - informative .....	7
Video Usability Information VUI.....	7
Background: Parameters for H.264 based codecs in MXF - informative .....	7
Example File Specification by ZDF .....	8
HD/HDR (High Definition / High Dynamic Range) – Broadcast version .....	8
UHD/HDR (High Definition / High Dynamic Range) – Broadcast version.....	9

---

# 1 Introduction

---

UHDTV including HDR (High Dynamic Range) is specified in ITU-R BT.2100. HDR can only be used for Wider Colour Space specified in ITU-R BT.2020 (= ITU-R BT.2100). The following signalisation parameters are only based on this requirement. There is no ITU-R BT.709 colour space signalisation recommended for UHD video.

The following parameters shall be set within the H.264 essence (10 bit, 4:2:2 sub-sampling) and the MXF wrapper accordingly.

The parameters/specifications will be extended with respect to more detailed requirements for audio, video and technical metadata to support the interoperability for MXF-based file exchange.

---

# 2 Conformance Notation

---

This document contains both normative text and informative text.

All text is normative except for that in the Introduction, and any section explicitly labelled as 'Informative' or individual paragraphs which start with 'Note:'

Normative text describes indispensable or mandatory elements. It contains the conformance keywords 'shall', 'should' or 'may', defined as follows:

'Shall' and 'shall not':	Indicate requirements to be followed strictly and from which no deviation is permitted in order to conform to the document.
'Should' and 'should not':	Indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others. OR indicate that a certain course of action is preferred but not necessarily required. OR indicate that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.
'May' and 'need not':	Indicate a course of action permissible within the limits of the document.

Informative text is potentially helpful to the user, but it is not indispensable and it does not affect the normative text. Informative text does not contain any conformance keywords.

---

### 3 H.264 based production codecs - normative (e.g. Panasonic AVCUltra, Sony XAVC)

- Essence:

Parameter	ITU-R T.H264, 04/2017 [VUI Video Usability Information]	ITU-R BT.2020 (=SDR)	ITU-R BT.2100 HLG	ITU-R BT.2100 PQ
Video Range	<i>video_full_range_flag</i>	0		
Colour Space	<i>colour_primaries</i>	9		
Transfer function	<i>transfer_characteristics</i>	14	18	16
Colour Matrix	<i>matrix_coefficients</i>	9		

- Wrapper (MXF):

Parameter	SMPTE ST377-1:2011	ITU-R BT.2020 (=SDR)	ITU-R BT.2100 HLG	ITU-R BT.2100 PQ
Video Range	BlackRefLevel	64		
	WhiteRefLevel	940		
	ColorRange	897		
Colour Space	Color Primaries	060e2b34.0401010d.04010101.03040000 Identifies ITU-R BT.2020 color primaries and white point		
Transfer function	Transfer Characteristic	060e2b34.0401010e.04010101.01090000 TransferCharacteristic_ITU2020	060e2b34.0401010d.04010101.010b0000 TransferCharacteristic_HLG_OETF	060e2b34.0401010d.04010101.010a0000 TransferCharacteristic_SMPTEST2084
Colour Matrix	Coding Equations	060e2b34.0401010d.04010101.02060000 Identifies ITU-R BT.2020 coding equations for non-constant luminance		

## Background: H.264 essence signalisation parameters based on ITU-T H.264 Version 12 (April 2017) - informative

The following section currently focuses only to the signalisation of UHD-content with/without HDR. HDR-based signalling is only valid for progressive scanning and with the following spatial resolutions (refer to ITU-R BT.2100):

- 1080 x 1920 (HD-based)
- 2160 x 3840 (UHD-1)
- 4320 x 7680 (UHD-2)

### Video Usability Information VUI

All new UHD and/or HDR related parameters are specified in the Video Usability Information VUI of [H.264](#) (Annex E). The VUI is located in the sequence parameter set (sps).

If the *video\_signal\_type\_present\_flag* is present in the bit stream at least the following information shall be included:

- *video\_format*
- *video\_full\_range\_flag*
- *colour\_description\_present\_flag*
  - o *colour\_primaries*
  - o *transfer\_characteristics*
  - o *matrix\_coefficients*

For H.264-based production codecs (Panasonic AVCUltra, Sony XAVC) the following information shall be set within the essence stream for HDR-based content:

- *video\_format* → 0 (Component)
- ***video\_full\_range\_flag*** → 0 or not set = 0 (legal range 64-940 in 10 bit)
- *colour\_description\_present\_flag*
  - o ***colour\_primaries*** → 9 (= ITU-R BT.2020/2100)
  - o ***transfer\_characteristics*** → 14 (=SDR = BT.2020); 16 (= PQ = SMPTE ST 2084); 18 (= HLG = ARIB STD-B67)
  - o ***matrix\_coefficients*** → 9 (= ITU-R BT.2020 non-constant-luminance)

*transfer\_characteristics*: both HDR transfer characteristics are specified in ITU-R BT.2100. SDR transfer characteristics is specified in ITU-R BT.2020.

*matrix\_coefficients*: defined in ITU-R BT.2020 and BT.2100 but in BT.2100 it is only valid for YCbCr colour\_space.

## Background: Parameters for H.264 based codecs in MXF - informative

The relevant parameters for HDR signalisation within MXF shall be written according to chapter F.4.1 (Generic Picture Essence Descriptor) and F.4.2 (CDCI Picture Essence Descriptor) of SMPTE ST377-1.

Additional Information: Currently only SMPTE RDD 32:2017 exists (written by Sony) which describes the XAVC MXF Mapping and Operation Points including HDR signalisation in MXF.

## Example File Specification by ZDF

ZDF as a public service broadcaster in Germany has already started to specify technical parameters for a file-based exchange of video material. All ZDF-specifications are based on the “Technical Guidelines for the Production of Television Programs for ARD, ZDF and ORF” (TPRF-HDTV).

The following two tables are just an excerpt of the ZDF-specification

### HD/HDR (High Definition / High Dynamic Range) – Broadcast version

<b>Identifier: ZDF-S01-HD-HDR</b>	
Container	*.MXF - MXF OP1a according to SMPTE 377 (SingleItem SinglePackage)
Codec	XAVC HD Intra Class 100
Resolution	1920x1080
Frame Rate	50
Chroma Subsampling	4:2:2
Bit Depth	10 bit
Scan Type	Progressive (1080p/50)
HDR-Standard	Hybrid Log Gamma (HLG) according to ITU-R BT.2100
EOTF	HLG System Gamma: 1.2
Peak Luminance	1000 cd/m <sup>2</sup>
Colour Space	ITU-R BT.2020
Audio	8-Channels 24 Bit 48KHz PCM (CHCOUNT=1) - Little Endian
Note: The file shall always contain 8 audio channels (channels which are not used shall be filled with silence or muted (24 bit 48 kHz PCM)).	
Multi-channel audio	Dolby E
Audio track allocation	Audio 1: Broadcast audio left
	Audio 2: Broadcast audio right
	Audio 3: International sound left / 2. Audio program left
	Audio 4: International sound right / 2. Audio program right
	Audio 5: Audio description left
	Audio 6: Audio description right
	Audio 7: Dolby E
	Audio 8: Dolby E
Timecode	Start-Timecode (first Frame) is 10:00:00:00



## UHD/HDR (High Definition / High Dynamic Range) – Broadcast version

<b>Identifier: ZDF-S01-UHD-HDR</b>	
Container	*.MXF - MXF OP1a according to SMPTE 377 (SingleItem SinglePackage)
Codec	XAVC QFHD Intra Class 480 VBR
Resolution	3840x2160
Frame Rate	50
Chroma Subsampling	4:2:2
Bit Depth	10 bit
Scan Type	Progressive (2160p/50)
HDR-Standard	Hybrid Log Gamma (HLG) according to ITU-R BT.2100
EOTF	HLG System Gamma: 1.2
Peak Luminance	1000 cd/m <sup>2</sup>
Colour Space	ITU-R BT.2020
Audio	8-Channels 24 Bit 48KHz PCM (CHCOUNT=1) - Little Endian
Note: The file shall always contain 8 audio channels (channels which are not used shall be filled with silence or muted (24 bit 48 kHz PCM)).	
Multi-channel audio	Dolby E
Audio track allocation	Audio 1: Broadcast audio left
	Audio 2: Broadcast audio right
	Audio 3: International sound left / 2. Audio program left
	Audio 4: International sound right / 2. Audio program right
	Audio 5: Audio description left
	Audio 6: Audio description right
	Audio 7: Dolby E
	Audio 8: Dolby E
Timecode	Start-Timecode (first Frame) is 10:00:00:00



**Institut für Rundfunktechnik**

Floriensmühlstraße 60

80939 München

[www.irt.de](http://www.irt.de)

Tel. +49 (0) 89 | 323 99 - 204

Fax +49 (0) 89 | 323 99 - 205

[presse@irt.de](mailto:presse@irt.de)

Registergericht München Eintrag Abteilung

B Band 65 Nr. 5191