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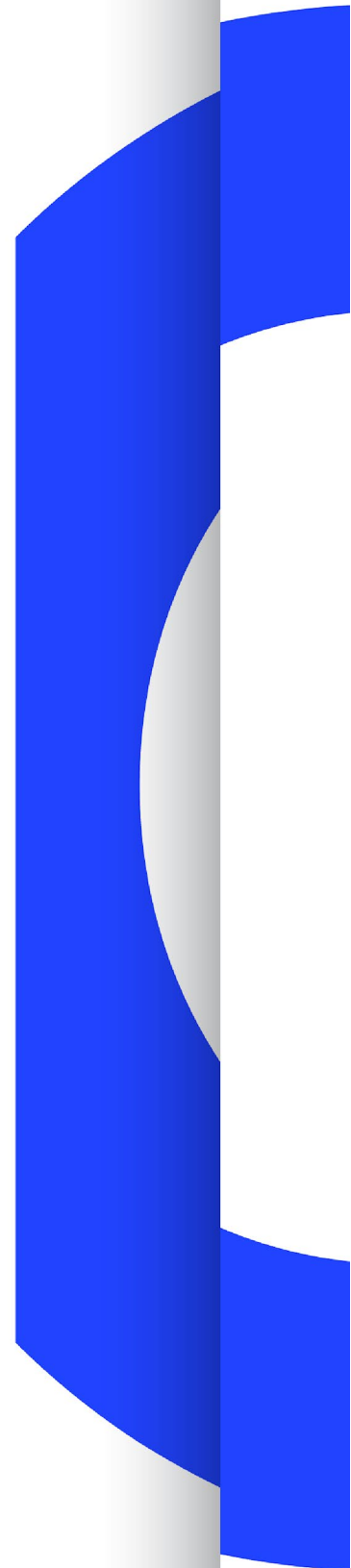
OPERATING EUROVISION AND EURORADIO

## Tech 3375

# SIGNALLING AND TRANSPORT OF HDR AND WIDE COLOUR GAMUT VIDEO OVER 3G-SDI INTERFACES

## BEST PRACTICE GUIDELINES

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## Abstract

High Dynamic Range (HDR) and Wider Colour Gamut (WCG) can be used to improve the video image quality enjoyed by viewers.

The use of HDR is not tied to the 2160p/50 image format. HDR can also be used with 1080p/50 or 1080p/25 (mainly used for documentary or film content).

Many EBU Members have 3G-SDI<sup>1</sup> based infrastructures in place and would like to use these for HDR productions. This document provides best practice for the use of existing 3G-SDI infrastructures for HDR productions, both in terms of signalling and interoperability.

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<sup>1</sup> Notwithstanding EBU Members' expectation that future production processing will continue to progress towards IP-based infrastructures.

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## Best Practice for Signalling and Transport of HDR and Wide Colour Gamut Video over 3G-SDI Interfaces

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### 1. Signalling of HDR/WCG 1080p/50 using single link 3G-SDI

The various flavours of 3G-SDI are specified in SMPTE ST 424 [1] and in the ST 425 set of standards. Single link 3G-SDI is specified in SMPTE ST 425-1 (2017) [2]. Within the SDI interfaces there is a signalling protocol, specified in SMPTE ST 352 [3], that identifies the payload sent through the interface (Video-Payload Identifier, V-PID). Signalling of the V-PID is mandatory for 3G interfaces.

Recommendation ITU-R BT.2100 [4] includes the 1080p/50 raster for HDR. It can be fully identified by using the V-PID.

The following is a reproduction of Table 5 from SMPTE ST 425-1:

**Table 1: Payload Identifier Definitions, Bytes 2 to 4 (Table 5 from SMPTE ST 425-1)**

Bits	Byte 2	Byte 3	Byte 4
Bit 7	Interlaced (0) or Progressive (1) transport	Aspect ratio 16:9 (1), unknown (0)	Reserved
Bit 6	Interlaced (0) or Progressive (1) picture	Horizontal Pixel Array Size 1920 (0) or 2048 (1)	Reserved
Bit 5	Transfer characteristics	Colorimetry	Reserved
Bit 4	SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)	Rec 709*1 (0h) Reserved (1h) UHDTV*2 (2h) Unknown (3h)	Luminance and color difference signal  Y'C'B'C'R (0) I <sub>TCp</sub> (1)
Bit 3	Picture Rate (Refer to SMPTE ST 352 Table 2)	Sampling structure (Refer to Table 5a)	Reserved
Bit 2			Reserved
Bit 1			Bit depth 10-bit Full Range (0), 10-bit (1h), 12-bit (2h), 12-bit Full Range (3h)
Bit 0			
*1 Rec709 indicates Conventional System Colorimetry as defined in Recommendation ITU-R BT.709 and referenced in SMPTE ST 274			
*2 UHDTV indicates Recommendation ITU-R BT.2020 Reference Primaries and reference white as referenced in Recommendation ITU-R BT.2100.			

From this table, the typical signalling for 1080p/50 video in its YCbCr, 10-bit narrow range<sup>2</sup>, 4:2:2 form is:

**Table 2: Signalling of 1080p/50 variants in single link 3G-SDI (SMPTE ST425-1)**

	Byte 1	Byte 2	Byte 3	Byte 4
1080p/50 SDR BT.709	89h	C9h	80h	01h
1080p/50 HDR BT.2100 HLG	89h	D9h	A0h	01h
1080p/50 HDR BT.2100 PQ	89h	E9h	A0h	01h

## 2. Signalling of HDR/WCG 1080p/25 using single link HD-SDI

HD-SDI is specified in SMPTE ST 292-1 [6] (first published in 1998, last updated in 2018). This is a nominally 1.5 Gbit/s serial digital interface that can transport high definition video signals up to 1080i/25 (30) and 1080p/25 (30).

Recommendation ITU-R BT.2100 includes the 1080p/25 raster for HDR. It can be fully identified by using the SMPTE ST 352 V-PID.

It must be noted that although the SMPTE states that the payload identifier is optional for SMPTE ST 292-based serial digital interfaces, it is nevertheless strongly recommended.

The EBU considers the use of the V-PID mandatory for this application.

The following is a reproduction of Table 5 from SMPTE ST 292-1:

**Table 3: Payload Identifier definitions for 1080-line interlaced and progressive payloads on a 1.485 Gbit/s serial digital interface (Table 5 from SMPTE ST 292-1)**

Bits	Byte 1	Byte 2	Byte 3	Byte 4
Bit 7	1	Interlaced (0) or Progressive (1) transport	Colorimetry	Reserved
Bit 6	0	Interlaced (0) or Progressive (1) picture	Horizontal pixel count 1920 (0) or 2048 (1)	Reserved
Bit 5	0	Transfer characteristics  SDR-TV (0h) HLG (1h) PQ (2h) Unspecified (3h)	Aspect ratio 16:9 (1), unknown (0)	Reserved
Bit 4	0		Colorimetry	Luminance and color difference signal  Y'C'B'C'R (0) I'C'T'P (1)
Bit 3	0	Picture Rate (see Table 2 SMPTE ST 352)	Sampling structure (see Table 6)	Reserved
Bit 2	1			Reserved
Bit 1	0			Bit Depth 8-Bit (0), 10-Bit (1), Reserved (2h), 10-Bit Full Range (3h)
Bit 0	1			

From this table, the typical signalling for 1080p/25 video in its YCbCr, 10-bit narrow range, 4:2:2 form is:

<sup>2</sup> For an explanation of video signal ranges, see EBU R 103 [5].

Table 4: Signalling of 1080p/25 variants in single link HD-SDI (SMPTE ST292-1)

	Byte 1	Byte 2	Byte 3	Byte 4
1080p/25 SDR BT.709	85h	C5h	80h	01h
1080psf/25 SDR BT.709	85h	45h	20h	01h
1080p/25 HDR BT.2100 HLG	85h	D5h	A0h	01h
1080psf/25 HDR BT.2100 HLG	85h	55h	A0h	01h
1080p/25 HDR BT.2100 PQ	85h	E5h	A0h	01h
1080psf/25 HDR BT.2100 PQ	85h	65h	A0h	01h

### 3. 10-bit transparent infrastructures

It is highly recommended that implementers/broadcasters shall ensure that ancillary data and the signalling (see Table 1) is not altered throughout the production chain. In addition, equipment within the production chain shall process the signalling appropriately. Otherwise, each production step must be verified manually (correct setting of colour space, colour matrix, transfer function).

### 4. Additional signalling in the VANC, based on SMPTE ST 2108

Beside the default/legacy signalling dealt with above, SMPTE ST 2108:2016 [7] defines an ANC data packet for the transport of both static and dynamic HDR/WCG mastering metadata over professional interfaces.

For HDR systems which require metadata relating to mastering screen brightness, colour volume etc. (i.e. those based on the Perceptual Quantiser EOTF), SMPTE ST 2108 is compatible with:

- ITU-T H.265 [8] Mastering display colour volume SEI messages
- Content light level information SEI message
- ATSC A/341 [9] ST 2094-10 [10] data SEI message
- ETSI TS 103 433-1 SL-HDR1 [11], and
- further dynamic HDR metadata such as SMPTE ST 2094-20 [12], -30 [13] and -40 [14]

This data format is also compatible with CTA 861-G [15], so ultimately the HDR metadata used in the production workflow should be capable of reaching the home and the HDMI interface, if so desired, without the need for too many conversions (so hopefully it is not too error prone).

No HDR/WCG mastering metadata is required for systems based on ITU-R BT.2100 HLG.

### 5. General recommendations for the transport of 1080p/50 HDR signals over 3G SDI

The SMPTE ST 425-1 V-PID/SMPTE ST 292-1 V-PID containing HDR/WCG signalling correctly identifies the colorimetry, transfer function and colour difference format in use for a signal present on a professional interface.

For ITU-R BT.2100 HLG signals this data allows adaptation of an HDR/WCG image to the capabilities of a particular display in professional and domestic environments and conversion of the HDR/WCG image to or from an SDR image.

For ITU-R BT.2100 PQ signals this data, in association with ST 2086:2018 [16] and ST 2094:2016-4 data (Static and Dynamic Colour Volume metadata) encapsulated in a SMPTE ST 2108 ANC data



packet provides all of the information required to aid adaptation of an HDR/WCG image to the capabilities of a particular display in professional environments, or to facilitate conversion of the HDR/WCG image to or from an SDR image.

**Considering the above, the EBU recommends that:**

- 1) Users shall specify equipment that is compliant with SMPTE ST 425-x:2016 (or later) that includes HDR/WCG signalling in the payload ID.
- 2) Users shall specify equipment that is compliant with SMPTE ST 292-x:2018 (or later) that includes HDR/WCG signalling in the payload ID.
- 3) Users shall check their equipment regularly, also after performing a firmware upgrade.
- 4) Test and measurement equipment is used to verify and check signalling parameters. During recording/playback of MXF files, users should pay attention that the correct format is signalled/interpreted from the file metadata.
- 5) If needed, users shall look for encoders/decoders that support ST 2086 and/or ST 2094 Dynamic Metadata for Colour Volume Transforms.
- 6) If needed, users shall ensure that equipment in the production chain supports ST 2108:2016 (or later) HDR/WCG Metadata Packing and Signalling

*Note: if HLG is employed items 5) and 6) are optional, unless specific tone re-mapping is required on the target display*

## 6. Proprietary HDR formats

Members using proprietary HDR formats should be aware that, at present there is limited or no support for correct signalling of these formats within SDI infrastructure and what support there is may be limited to certain manufacturers.

Additionally, some formats may have multiple operating points available, e.g. multiple options for luma level of diffuse white, so care is needed to ensure that, if proprietary formats are in use, all equipment is configured and tested correctly.

The EBU recommends that EBU Members use standardised HDR formats in production and programme exchange.

## 7. References

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