ICS：33.160.25
CCS：M74

UHD World Association
世界超高清视频产业联盟

High Dynamic Range Video Technology Part 3-5: Technical Requirements and Test Methods - Live Encoder Device

（Version NO. 1.0）

Release Time
2022-11-1

UHD World Association (UWA)
T/UWA 005.3-5-2022

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High Dynamic Range Video Technology Part 3-5:

Technical Requirements and Test Methods – Live Encoder Device

1 Scope

This document specifies the main technical requirements and measurement methods of HDR Vivid technology in ultra-high definition real-time encoder (hereinafter referred to as encoder).
This document is applicable to the R&D, production, application, testing, operation and maintenance of HDR Vivid supporting encoders in the radio, television and network audio-visual fields.

2 Normative references

The contents in the following documents, through normative references in the text, constitute indispensable provisions of this document. Among them, only the version of the dated reference document is applicable to this document; For undated references, the latest version (including all amendments) is applicable to this document.
GB/T 17975.1-2010 Information Technology - Generic Coding of Moving Images and Associated Audio Information - Part 1: Systems
GB/T 33475.2-2016 Information Technology Efficient Multimedia Coding Part 2: Video GY/T 299.1-2016 Efficient Audio Video Coding Part 1: Video (AVS2 for short)
GY/T 307-2017 Ultra High Definition Television System Decoding Production and Interactive Parameter Values
GY/T 315-2018 High Dynamic Range TV Program Production and Interactive Image Parameter Values
GY/T 323-2019 AVS2 4K Ultra HD Encoder Technical Requirements and Measurement Methods
T/UWA 005.1-2022 High Dynamic Range (HDR) Video Technology Part 1: Metadata and Adaptation
T/UWA 005.2-1-2022 High Dynamic Range (HDR) Video Technology Part 2:Application Guide System Integration
T/UWA 015-2022 High Dynamic Range Video Image Quality Part 1: Subjective Evaluation
ITU-T REC H.265 v4: High efficiency video coding
ISO/IEC 14496-12: Information technology Coding of audio visual objects Part 12: ISO base media file format
ISO/IEC 21122-1-2022 Information technology JPEG XS low latency lightweight image coding system Part 1: Core coding system
ISO/IEC23009-1: Information technology Dynamic adaptive streaming over HTTP (DASH) - Part 1: Media presentation description and segment formats

3 Terms and definitions

The following terms and definitions are applicable to this document.

3.1 HDR Vivid

HDR technical specification specified in T/UWA 005.1-2022, and the name of supporting derivative technology.

3.2 Metadata

Describe key information or features required in video or image processing.

3.3 **Static metadata**

Metadata associated with an image sequence, which remains unchanged within the image sequence.

3.4 **Dynamic metadata**

Metadata associated with each frame of image, which changes with different pictures.

4 **Abbreviations**

The following abbreviations are applicable to this document.
ASI Asynchronous Serial Interface
DVB Digital Video Broadcasting
DASH Dynamic Adaptive Streaming over HTTP
ES Elementary Stream
HLS HTTP Live Streaming
HDR High Dynamic Range
IDR Instantaneous Decoding Refresh
MPEG Moving Picture Experts Group
MP4 MPEG-4 Part 14
PSNR Peak Signal to Noise Ratio
PAT Program Association Table
PCR Program Clock Reference
PMT Program Map Table
SDR Standard Dynamic Range
TS Transport Stream
UDP User Datagram Protocol
VMAF Video Quality Multi Method Assessment Fusion

5 **Technical requirement**

5.1 **Media packaging requirements**

5.1.1 **Basic Requirements**

The encoder shall support TS or MP4 media packaging format.

5.1.2 **TS package**

The semantics of TS format media package format transport stream shall comply with the provisions of 2.4.3 in GB/T 17975.1-2010.
The syntax structure of PAT shall comply with 2.4.5.3 of GB/T 17975.1-2010.
The syntax structure of PMT shall comply with 2.4.5.8 of GB/T 17975.1-2010.
The setting of table_id shall comply with the provisions in Table 34 of GB/T 17975.1-2010.
If the transport stream contains the stream type in Table 1, it shall meet the requirements in Table 1.

Table 1 **Assignment of Stream Type**

NO.	Stream Type	Stream_ Type assignment	Descriptor
1	GY/T 299.1-2016 video (AVS2 video)	0xD2	It shall be equipped with descriptors in Table 8 and Table 9 defined in Part 2-1 of T/UWA 005.2-2022.
2	AVS3 video	0xD4	
3	ITU-T H.265 video (HEVC video)	0x24	

5.1.3 MP4 package

MP4 packaging shall comply with the provisions of Chapter 7 in T/UWA 005.2-1-2022.

5.2 Code stream output protocol requirements

5.2.1 Basic Requirements

When outputting real-time code stream, HDR Vivid encoder shall support UDP protocol and can support ASI, HLS or DASH protocol.
HDR Vivid encoder shall support HLS or DASH protocol when recording and outputting on-demand files.

5.2.2 UDP protocol transmission

UDP transmission protocol shall comply with relevant provisions in 4.3 and 4.4 of GY/T 323-2019.

5.2.3 ASI protocol transmission

ASI output shall comply with 4.8 of GY/T 323-2019.

5.2.4 HLS protocol transmission

HLS playlist file shall comply with RFC8216, and HDR Vivid video description information shall be added.
HDR Vivid video description information embedding method shall meet the requirements of Chapter 8 in T/UWA 005.2-1-2022.
When HLS transmission is adopted, TS and MP4 packaging formats shall be supported at the same time.

5.2.5 DASH protocol transmission

The playlist file of DASH shall comply with the MPEG-DASH ISO/IEC 23009-1 standard, and the description information of HDR Vivid video in Representation shall be added.
HDR Vivid video description information embedding method shall meet the requirements of Chapter 9 in T/UWA 005.2-1-2022.
When DASH transmission is adopted, MP4 packaging format shall be supported.

5.3 Video encoding requirements

5.3.1 Basic Requirements

The encoder using HDR Vivid technology shall support one of AVS2, AVS3 and HEVC encoding formats.
The syntax and semantics of AVS2 video coding shall comply with the requirements of GY/T 299.1-2016.The syntax and semantics of AVS3 video coding shall meet the requirements of AVS3-P2 Phase 2 (WD 7.0) -20210208.
The syntax and semantics of HEVC video coding shall meet the requirements of ITU-T-REC-H.265-v4.

5.3.2 Encoded video parameters

5.3.2.1 **The video parameters of 4K encoder encoding code stream shall comply with the provisions in Table 2.**

Table 2 **4K Encoding Stream Video Parameters**

NO.	Parameter	Parameter value
1	Class and level	AVS2 and AVS3: 0x22, HEVC: Main10 AVS2 and AVS3, level: 6.0.60, HEVC, level: 5.1
2	Horizontal dimension	3840 pixels
3	Vertical dimension	2160 pixels
4	Aspect ratio	16: 9
5	Frame rate	50Hz (progressive)
6	Chroma format	HEVC: 4:2:2 Other: 4:2:0
7	Bit depth	10bit
8	Color range	AVS2 and AVS3 shall support the color gamut specified in GY/T 315-2018 and GY/T 307-2017, and the color gamut identification of coded code stream video shall comply with the provisions in Table 42 of GB/T 33475.2-2016 HEVC shall support the color gamut specified in GY/T 307-2017, and the encoded bitstream video shall conform to Rec Table E.3 of ITU-T H.265 v4
9	Dynamic range	AVS2 and AVS3 shall support the non-linear conversion function specified in GY/T 315-2018 and GY/T 307-2017, and the non-linear conversion function identification of encoded code stream video shall comply with the provisions in Table 43 of GB/T 33475.2-2016 HEVC shall support the non-linear conversion function specified in GY/T 315-2018 and GY/T 307-2017, and the non-linear conversion function identification of encoded code stream video shall comply with Table E.4 in Rec.ITU-T H.265 v4
10	GOP length	Support 24-100 continuous adjustable
11	Bitrate	The maximum supported code rate is not less than 36Mbps

5.3.2.2 **The video parameters of 8K encoder encoding code stream shall comply with the provisions in Table 3.**

Table 3 **Format Requirements of 8K Encoded Bitstream Video**

NO.	Parameter	Parameter value
1	Class and level	AVS2 and AVS3: 0x22, HEVC: Main10 AVS2 and AVS3, level: 8.0.60, HEVC, level: 6.1
2	Horizontal dimension	7680 pixels
3	Vertical dimension	4320 pixels
4	Aspect ratio	16: 9
5	Frame rate	50Hz (line by line)
6	Chroma format	4: 2:0
7	Sampling precision	10bit

NO.	Parameter	Parameter value
8	Gamut	AVS2 and AVS3 shall support the color gamut specified in GY/T 315-2018 and GY/T 307-2017, and the color gamut identification of coded code stream video shall comply with the provisions in Table 42 of GB/T 33475.2-2016 HEVC shall support the color gamut specified in GY/T 307-2017, and the encoded bitstream video shall conform to Rec Table E.3 of ITU-T H.265 v4
9	dynamic range	AVS2 and AVS3 shall support the non-linear conversion function specified in GY/T 315-2018 and GY/T 307-2017, and the non-linear conversion function identification of encoded code stream video shall comply with the provisions in Table 43 of GB/T 33475.2-2016 HEVC shall support the non-linear conversion function specified in GY/T 315-2018 and GY/T 307-2017, and the non-linear conversion function identification of encoded code stream video shall comply with Table E.4 in Rec.ITU-T H.265 v4
10	GOP length	Support 24-100 continuous adjustable
11	code rate	The maximum supported code rate is not less than 120Mbps

5.3.2.3 AVS2 and HEVC shall support 4K video parameters, and AVS3 shall support 4K and 8K video parameters.

5.3.3 HDR Vivid stream metadata

5.3.3.1 Metadata syntax

HDR metadata information in the bitstream mainly includes static metadata information and dynamic metadata information.

When the curve is PQ, the code stream shall include static metadata and dynamic metadata information.

When the curve is HLG, the code stream shall contain dynamic metadata information.

See Table 4 for static metadata syntax.

Table 4 **Static Metadata Syntax**

Target device display and content metadata extension definition	Descriptor
Hdr_ Static_ Metadata (){	
For (c=0; c<3; c++){	
Display_ Primaries_ X [c]	U (16)
Display_ Primaries_ Y [c]	U (16)
}	
White_ Point_ X	U (16)
White_ Point_ Y	U (16)
Max_ Display_ Mastering_ Luminance	U (16)
Min_ Display_ Mastering_ Luminance	U (16)
Max_ Content_ Light_ Level	U (16)
Max_ Picture_ Average_ Light_ Level	U (16)
}	

See Table 5 for dynamic metadata syntax.

Table 5 **Dynamic Metadata Syntax**

Vivid Dynamic Metadata Definition	Descriptor
Hdr_ Dynamic_ Metadata (){	
System_ Start_ Code	U (8)
If (system_start_code==0x01 | | system_start_code==0x02 | | system_start_code==0x03 | | system_start_code==0x04 | | system_start_code==0x05 | | system_start_code==0x06 | | system_start_code==0x07){	
Num_ Windows=1	
For (w=0; w<num_windows; w++){	
Minimum_ Maxrgb_ Pq [w]	U (12)
Average_ Maxrgb_ Pq [w]	U (12)
Variance_ Maxrgb_ Pq [w]	U (12)
Maximum_ Maxrgb_ Pq [w]	U (12)
}	
For (w=0; w<num_windows; w++){	
Tone_ Mapping_ Enable_ Mode_ Flag [w]	U (1)
If (tone_mapping_enable_mode_flag [w]==1){	
Tone_ Mapping_ Param_ Enable_ Num [w]	U (1)
Tone_ Mapping_ Param_ Num [w]++	
For (i=0; i<tone_mapping _param_num [w]; i++){	
Targeted_ System_ Display_ Maximum_ Luminance_ Pq [i] [w]	U (12)
Base_ Enable_ Flag [i] [w]	U (1)
If (base _enable_flag [i] [w]){	
Base_ Param_ M_ P [i] [w]	U (14)
Base_ Param_ M_ M [i] [w]	U (6)
Base_ Param_ M_ A [i] [w]	U (10)
Base_ Param_ M_ B [i] [w]	U (10)
Base_ Param_ M_ N [i] [w]	U (6)
Base_ Param_ K1 [i] [w]	U (2)
Base_ Param_ K2 [i] [w]	U (2)
Base_ Param_ K3 [i] [w]	U (4)
Base_ Param_ Delta_ Enable_ Mode [i] [w]	U (3)
Base_ Param_ Enable_ Delta [i] [w]	U (7)
}	
3Spline_ Enable_ Flag [i] [w]	U (1)
If (3Splin_enable_flag [i] [w]){	
3Spline_ Enable_ Num [i] [w]	U (1)
3Spline_ Num++;	
For (j=0; j<3Spline_num; j++){	
3Spline_ TH_ Enable_ Mode [j] [i] [w]	U (2)
If ((3Spline_TH_mode [j] [i] [w]==0) | | (3Spline_TH_mode [j] [i]	

[w]==2)){	
3Spline_ TH_ Enable_ MB [j] [i] [w]	F (8)
}	
3Spline_ TH_ Enable [j] [i] [w]	F (12)
3Spline_ TH_ Enable_ Delta1 [j] [i] [w]	F (10)
3Spline_ TH_ Enable_ Delta2 [j] [i] [w]	F (10)
3Spline_ Enable_ Strength [j] [i] [w]	F (8)
}	
}	
}	
}	
Color_ Saturation_ Mapping_ Enable_ Flag [w]	U (1)
If (color_saturation_mapping_flag [w]){	
Color_ Saturation_ Enable_ Num [w]	U (3)
For (i=0; i<color_saturation_num [w]; i++){	
Color_ Saturation_ Enable_ Gain [i] [w]	U (8)
}	
}	
}	
}	
}	

5. 3. 3. 2 **Metadata requirements**

Each frame of the video stream shall contain the corresponding dynamic metadata of the frame.
When the video stream contains only one version of dynamic metadata, each frame of video shall contain one dynamic metadata;
When the video stream contains multiple versions of dynamic metadata, each frame of video should contain multiple dynamic metadata, and the number of metadata should correspond to the number of versions.

5. 3. 3. 3 **AVS2/AVS3 coding requirements**

Metadata embedding and encapsulation of AVS2 video and AVS3 video shall comply with 6.3 of T/UWA 005.2-1-2022.

5. 3. 3. 4 **HEVC coding requirements**

The ES stream of each frame of the video code stream shall contain one or more dynamic metadata, and the embedding and encapsulation requirements of dynamic metadata shall comply with the provisions of 6.2 in T/UWA 005.2-1-2022.

5. 3. 3. 5 **Dynamic metadata parameter range**

See Table 6 for the requirements for dynamic metadata fields included in the video stream.
The parameters of the basic curve and cubic spline curve in the video code stream shall meet the requirements of the tone mapping curve generation method described in T/UWA 005.1-2022 9.1 to generate a complete tone mapping curve, and the generated curve shall meet the requirements of monotonic increasing characteristics.

Table 6 **Dynamic Metadata Parameter Range**

Metadata Type	Parameter name	Parameter definition	Standard scope	Encoder output requirements
Basic statistical parameters	Minimum_ Maxrgb_ Pq	Minimum of RGB component maximum	0-4095	The deviation ratio of statistical parameters and their corresponding video frames calculated by the method in Appendix A of T/UWA 005.1-2022 is<=10% or the absolute difference is<=50, and meets the minimum_ Maxrgb_ Pq<=average_ Maxrgb_ Pq<=maximum_ Maxrgb_ Pq
	Average_ Maxrgb_ Pq	Average of RGB component maximum values	0-4095	
	Maximum_ Maxrgb_ Pq	Maximum of RGB component maximum	0-4095	
	Variance_ Maxrgb_ Pq	Range of variation in the maximum value of RGB components	0-4095	
Tone mapping	Tone_ Mapping_ Enable_ Mode_ Flag	Tone mapping identification	0-1	Fixed value 1, HDR Vivid encoder needs to output its own tone mapping parameters
	Tone_ Mapping_ Param_ Enable_ Num	Number of tone mapping parameters minus one	0-1	0-1, HDR Vivid encoder contains at least one set of tone mapping parameters
Reference target display The indicator is the most highlighted degree	Targeted_ System_ Display_ Maximum_ Luminance_ Pq	Represents the maximum brightness of the reference target display corresponding to the metadata, 2080 represents that the corresponding reference display is SDR, and others represent HDR	0-4095	The mandatory support reference target display is HDR, and the optional support target reference display is SDR
Basic curve parameters	Base_ Enable_ Flag	Basic curve parameter identification, 0 means not including basic curve parameters, 1 means including basic curve parameters	0-1	Within the standard range
	Base_ Param_ M_ P	Foundation curve coefficient parameters	0-16383	
	Base_ Param_ M_ M		0-63	
	Base_ Param_ M_ A		0-1023	
	Base_ Param_ M_ B		0-1023	
	Base_ Param_ M_ N		0-63	
	Base_ Param_ M_ K1		0-3	<=1, greater than 1 is the reserved value

	Base_ Param_ M_ K2		0-3	<=1, greater than 1 is the reserved value
	Base_ Param_ M_ K3		0-15	1 or 2, the remaining values are reserved
	Base_ Param_ Delta_ Mode	Base curve parameter adjustment mode	0-7	Within the standard range
	Base_ Param_ Delta	Adjustment coefficient of foundation curve	0-127	
Cubic spline parameters	3Spline_ Enable_ Flag	Identification of cubic spline curve, 1 means including cubic spline parameters, 0 means not including cubic spline parameters	0-1	
	3Spline_ Enable_ Num	Number of cubic spline interval groups, number of cubic spline interval groups=3Spline_ Enable_ Num+1	0-1	
	3Spline_ TH_ Enable_ Mode	Cubic spline interval pattern identification	0-3	
	3Spline_ TH_ Enable_ MB	Incl. cubic spline interval skew 3Spline_ TH_ MB and dark area offset base_ Offset	0-255	
	3Spline_ TH_ Enable	3Spline_ TH, initial offset of cubic spline interval	0-4095	
	3Spline_ TH_ Enable_ Delta1	Cubic spline interval 1 offset	0-1023	
	3Spline_ TH_ Enable_ Delta2	Cubic spline interval 2 offset	0-1023	
	3Spline_ Enable_ Strength	Cubic spline interval adjustment strength	0-255	
Color correction parameters	Color_ Saturation_ Mapping_ Enable_ Flag	Color correction mark	0-1	
	Color_ Saturation_ Enable_ Num	Number of color corrections	0-7	
	Color_ Saturation_ Enable_ Gain	Color correction intensity	0-255	

5.3.3.6 **Metadata compatibility**

The stream containing metadata should be able to play on devices that do not support HDR Vivid.
When the code stream containing metadata is a PQ curve, the IDR frame of the coded output code stream shall contain the static metadata information defined in Table 4 of 5.3.3.1, and the color gamut and dynamic range

of the coded output code stream shall meet the requirements of 5.3.2. Terminals that do not support Vivid dynamic metadata processing should be able to display the original PQ effect normally.
When the code stream containing metadata is HLG curve, the color gamut and dynamic range in the coded output code stream shall meet the requirements specified in 5.3.2. Terminals that do not support HDR Vivid dynamic metadata processing should be able to display the original HLG effect normally.

5.3.4 Encoder function requirements

See Table 7 for encoder function requirements.

Table 7 **Encoder function requirements**

NO.	Project	Technical Requirement	Mandatory /Optional
1	TS transport stream packet length	The output format of the transport stream should support 188 byte packet length	necessary
2	Dynamic metadata generation	Support statistical analysis of input video content and automatic generation of dynamic metadata	necessary
3	SDI input interface	4K encoder: support 4-link 3G-SDI or 12G-SDI 8K encoder: support 4-link 12G-SDI	necessary
4	ST 2110 input	Support audio and video stream input defined by ST 2110-10, ST 2110-20, ST 2110-22, ST 2110-30, ST 2110-22 should support JPEG XS encoded stream	Optional
5	PQ curve output	It supports the output of HDR Vivid standard bitstream, and the video content transmission curve is the PQ curve format described in GY/T 315. It supports the conversion of PQ, SDR curve format to HLG curve format	necessary
6	HLG curve output	It supports the output of HDR Vivid standard bitstream, and the video content transmission curve is the HLG curve format described in GY/T 315. It supports the conversion of HLG, SDR curve format to PQ curve format	necessary
7	BT.2020 Color gamut output	It supports the output of code stream conforming to HDR Vivid standard and the color gamut is BT.2020. If the source color gamut is not BT.2020, it should support the color gamut conversion to BT.2020	necessary
8	Parameter configuration import/export	The parameter configuration can be imported and exported. The parameter configuration will be retained after shutdown and restart	necessary
9	Parameter setting	The coding parameters such as video coding rate, GOP length, GOP structure and audio coding rate can be effectively set	Optional

Note:
JPEG XS encoding code stream: the encoding output code stream defined in ISO/IEC 21122.
ST 2110: A set of standards specified by SMPTE to regulate the carrying, synchronization and description of different IP entity streams in the field production process

5.4 Total encoder/decoder delay

The total encoding and decoding delay of 4K encoder shall not exceed 3 seconds.

The total encoding and decoding delay of 8K encoder shall not exceed 5 seconds.

5.5 Encoder image quality requirements

5.5.1 Objective quality requirements

Without HDR Vivid dynamic metadata, the average PSNR component value should not be less than 36dB; The VMAF value shall not be lower than 85 points.

5.5.2 Subjective quality requirements

When HDR Vivid metadata is applied to complete post-processing, the subjective quality of encoder coding damage should meet one of the following three requirements:

1) When using the double stimulus continuous quality scaling method specified in ITU-R Rec BT.500, the average image quality reduction percentage is not more than 20%;
2) When the stimulation comparison method specified in T/UWA 015-2022 is used, the quality rating is ≥ -1;
3) When using the single stimulus comparison method specified in T/UWA 015-2022, the score is ≥ 80.

6 measuring method

6.1 Measurement conditions

Ambient temperature: 15 ℃~35 ℃;
Relative humidity: 20%~80%;
Atmospheric pressure: 86kPa~106kPa;
Voltage amplitude: 220V ± 11V AC;
Voltage frequency: 50Hz ± 1Hz.

6.2 Encoder configuration

The total output bit rate of 4K encoder is configured as 38Mbps, and the video bit rate is configured as 36Mbps.
The total output bit rate of 8K encoder is configured as 120Mbps, and the video bit rate is configured as 115Mbps.
Note: The audio sampling frequency is configured as 48kHz, and the audio code rate is configured as: 256kbps for dual channel and 2.0 stereo, 448kbps for 5.1 surround sound.

6.3 Test link

The measurement method specified in this document adopts TS transmission link, and other transmission links can be used for reference.

6.4 Reference decoder and reference display device

6.4.1 Reference decoder

4K/8K decoder with HDR Vivid certification.

6.4.2 Reference display device

4K/8K display device with HDR Vivid certification.

6.5 Media packaging measurement

6.5.1 Test System Connection Diagram

See Figure 1 for the connection diagram of the test system.

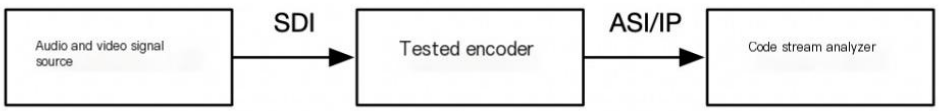

Figure 1 **Media packaging test**

6.5.2 Testing procedure

The test steps are as follows:
Precondition: Open the code stream analyzer, connect the IP output interface of the encoder to the code stream analyzer, and the code stream analyzer works normally.

1) The tested encoder outputs HDR Vivid code stream and enters the code stream analyzer tool for package layer detection;
2) Check whether TS output code stream meets the requirements of 5.1.2.
3) Check whether the MP4 output code stream meets the requirements of 5.1.3.

6.6 Bit stream output protocol measurement

HLS protocol: check whether the M3U8 file corresponding to the playlist output by the tested encoder and HDR Vivid description information meet the requirements of 5.2.4.
DASH protocol: check whether the MPD file and HDR Vivid description information corresponding to the playlist output by the encoder meet the requirements of 5.2.5.

6.7 Video coding measurement

6.7.1 Coding method class and level

Use video format analysis tools to view class and level information.
The video format analysis tool shall support HEVC, AVS2, AVS3 coding format class and level analysis and result display.

6.7.2 Encoded stream video format

Refer to 6.7.1 test item to check the encoded code stream format.

6.8 HDR Vivid metadata measurement

6.8.1 HDR Vivid Metadata Compliance Test

HDR Vivid metadata detection tool is used to test metadata, verify whether the encoding stream metadata encapsulation meets the requirements of 5.3.3.1~5.3.3.4, and verify whether the parsed metadata meets the requirements of 5.3.3.5.

6.8.2 HDR Vivid Frame Alignment Test

Use the reference HDR Vivid metadata detection tool to analyze the encoded output stream and detect whether the HDR Vivid metadata in the output stream meets the requirements specified in 5.3.3.2.

6.8.3 Compatibility test

Play at the terminal that does not support HDR Vivid, and verify whether the playback compatibility of encoded code stream meets the requirements of 5.3.3.6.

6.9 Function measurement

6.9.1 Measurement of transport stream standard compliance

See Figure 2 for the connection diagram of the test system

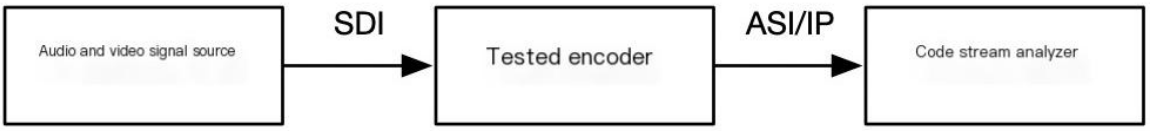

Figure 2 Transport Stream Standard Compliance Test

The test steps are as follows:

Connect the ASI output interface (or IP interface) of the encoder under test to the stream analyzer, output TS Over UDP protocol, observe for 15min, and check whether the output stream of the encoder under test complies with the TS transport stream packet length of 188 bytes specified in 5.4.

6.9.2 HDR curve format output measurement

See Figure 3 for the connection diagram of the test system

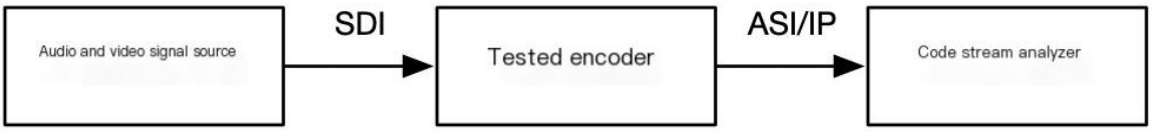

Figure 3 HDR curve format output test

The test steps are as follows:

1) Input HLG BT.2020, PQ BT.2020 and SDR BT.709 signal sources to the encoder under test through SDI mode.
2) The measured encoder ASI output interface (or IP interface) is connected to the code stream analyzer for HDR Vivid inspection;
3) The output of the tested encoder is specified as HLG HDR Vivid, and the output code stream conforms to the specified parameters.
4) The measured encoder output is specified as PQ HDR Vivid, and the output code stream conforms to the specified parameters.

6.9.3 ST 2110 input test

See Figure 4 for the connection diagram of the test system

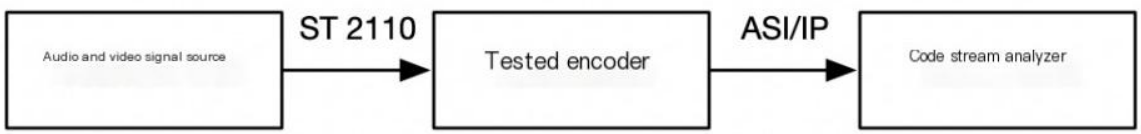

Figure 4 ST 2110 input test

The test steps are as follows:

1) Set the ST 2110 input signal video to be in uncompressed format, configure the tested encoder to output HDR Vivid, verify whether the output stream of the tested encoder plays correctly through the stream analyzer, and confirm that the tested encoder supports the ST 2110 format input.
2) Set the JPEG XS encoding format of ST 2110 input signal video, configure the tested encoder to output HDR Vivid, verify whether the output stream of the tested encoder plays correctly through the stream analyzer, and determine that the tested encoder supports ST 2110 format input and JPEG XS input.

6.10 Measurement of total codec delay

Refer to the requirements specified in Section 5.8 of GY/T 323-2019 for the measurement method of total encoding and decoding delay.

6.11 Encoder image quality measurement

6.11.1 **Objective test method**

PSNR or VMAF standard quality evaluation tools are selected for objective evaluation of signal source and coding output image quality, and the calibration test sequence is streamed in real time. The encoder input and output signals are compared frame by frame through standard tools to obtain objective data analysis results.

6.11.2 **Subjective evaluation method I**

According to ITU-R Rec BT.500.

6.11.3 **Subjective evaluation method II**

According to 5.5.1 in T/UWA 015-2022.

6.11.4 **Subjective evaluation method III**

According to 5.5.2 in T/UWA 015-2022.

References

[1] T/AVS 105-2018 AVS2 4K Ultra HD Encoder Technical Requirements and Measurement Methods
[2] SMPTE ST 2086: Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images
[3] SMPTE ST 2110-10:2017 Professional Media over Managed IP Networks: System Timing and Definitions
[4] SMPTE ST 2110-20:2017 Professional Media Over Managed IP Networks: Uncompressed Active Video
[5] SMPTE ST 2110-30:2017 Professional Media over Managed IP Networks -- PCM Digital Audio
[6] SMPTE ST 2110-22:2019 Professional Media Over Managed IP Networks: Constant Bit Rate Compressed Video