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**Digital Video Systems Characteristics
Standard for Cable Television**

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MPEG-2 DIGITAL VIDEO SYSTEMS CHARACTERISTICS

STANDARD FOR CABLE TELEVISION

1. SCOPE

This standard contains the constraints and extensions for the use of MPEG-2 video coding in cable television systems.

2. REFERENCES

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.1 Normative references

All standards are subject to revision; and while parties to any agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents may not be compatible with the referenced version.

The following documents contain provisions that through reference in this text constitute provisions of this standard.

1. ISO/IEC 13818-1, Information technology — Generic coding of moving pictures and associated audio information: Systems (2013).
2. ISO/IEC 13818-2, Information technology — Generic coding of moving pictures and associated audio information: Video (2013).
3. CEA-608-E (2008), CEA Standard - Line 21 Data Services.
4. CEA-708-E (2013), CEA Standard - Digital Television (DTV) Closed Captioning.
5. CEA-708.1 (2012), CEA Standard - Digital Television (DTV) Closed Captioning: 3D Extensions.
6. SCTE 21 (2012), Standard for Carriage of NTSC VBI Data in Cable Digital Transport Streams.
7. SCTE 20 (2012), Method for Carriage of Closed Captions and Non-Real Time Sampled Video.
8. ATSC A/53 Part 4:2009, Digital Television Standard: Part 4 – MPEG-2 Video System Characteristics.
9. SMPTE ST 170:2004, Standard for Television – Composite Analog Video Signal, NTSC for Studio Applications.

2.2 Informative references

10. SMPTE RP 202, Video Alignment for Compression Coding.
11. SMPTE ST 274, Standard for television, 1920 x 1080 Scanning and Analog and Parallel Digital Interfaces for Multiple Picture Rates.
12. SMPTE ST 296, Standard for television, 1280 x 720 Progressive Image Sample Structure, Analog and Digital Representation and Analog Interface.
13. ITU-R BT.601, Encoding parameters of digital television for studios.
14. ITU-R BT.709, Parameter Values for the HDTV Standards for the Studio and for International Programme Exchange.
15. ANSI/SCTE 54, Digital Video Service Multiplex and Transport System Standard for Cable Television.
16. ANSI/SCTE 127, Carriage of Vertical Blanking Interval (VBI) Data in North American Digital Television Bitstreams.

3. COMPLIANCE NOTATION

As used in this document, “*shall*” or “*will*” denotes a mandatory provision of the standard. “*Should*” denotes a provision that is recommended but not mandatory. “*May*” denotes a feature whose presence does not preclude compliance that may or may not be present at the option of the implementer.

In the tables below conventional numbers denote decimal values, numbers preceded by **0x** are to be interpreted as hexadecimal values and numbers within single quotes (e.g., '10010100') are to be interpreted as a string of binary digits.

4. POSSIBLE VIDEO INPUTS

While not required by this standard, there are certain television production standards, shown in Table 1, that define video formats that relate to compression formats specified by this standard.

Table 1 Standardized Video Input Formats

Video standard	Active lines	Active samples/ line
SMPTE ST 274 [11]	1080	1920
SMPTE ST 296 [12]	720	1280
ITU-R BT.601 [13]	480 ¹	720

The compression formats may be derived from one or more appropriate video input formats. It may be anticipated that additional video production standards will be developed in the future that extend the number of possible input formats.

5. SOURCE CODING SPECIFICATION

The video compression algorithm shall conform to the Main Profile syntax of ISO/IEC 13818-2 [2]. The allowable parameters shall be bounded by the upper limits specified for the Main Profile at High Level. Additionally, bit streams shall meet the constraints and extensions described in Sections 5.1 and 5.2.

5.1 Constraints with respect to ISO/IEC 13818-2 Main Profile

The following tables list the allowed values for each of the ISO/IEC 13818-2 [2] syntactic elements that are restricted beyond the limits imposed by MP@HL.

5.1.1 Sequence header constraints

Table 2 identifies parameters in the sequence header of a bit stream that shall be constrained by the video subsystem and lists the allowed values for each.

Table 2 Sequence Header Constraints

Sequence Header Syntactic Element	Allowed Value
horizontal_size_value	See Table 3
vertical_size_value	See Table 3
aspect_ratio_information	See Table 3
frame_rate_code	See Table 3
bit_rate_value (64 QAM)	≤ 67500
bit_rate_value (256 QAM)	≤ 97000
vbv_buffer_size_value	≤ 488

The allowable values for the field bit_rate_value are application dependent. In the application of 64 QAM transmission, this field shall correspond to a bit rate which is less than or equal to 27.0 Mbps. In the higher data rate application of 256 QAM transmission, the corresponding bit rate is less than or equal to 38.8 Mbps.

¹The number of active lines is not specified in ITU-R BT.601. Please refer to SMPTE RP 202 [10] for full specifics.

5.1.2 Compression format constraints

Table 3 lists the allowed compression formats.

Table 3 Compression Format Constraints

vertical_size_ value	horizontal_size_ value	aspect_ratio_ information	frame_rate_ code	progressive_ sequence
1080 ¹	1920	1, 3	1, 2, 4, 5	1
1080 ¹	1920	1, 3	4, 5	0
1080 ¹	1440	3	1, 2, 4, 5	1
1080 ¹	1440	3	4, 5	0
720	1280	1, 3	1, 2, 4, 5, 7, 8	1
480	720	2, 3	1, 2, 4, 5, 7, 8	1
480	720	2, 3	4, 5	0
480	704	2, 3	1, 2, 4, 5, 7, 8	1
480	704	2, 3	4, 5	0
480	640	1, 2	1, 2, 4, 5, 7, 8	1
480	640	1, 2	4, 5	0
480	544	2	1	1
480	544	2	4	0
480	528	2	1	1
480	528	2	4	0
480	352	2	1	1
480	352	2	4	0

¹ Note that 1088 lines are actually coded in order to satisfy the MPEG-2 requirement that the coded vertical size be a multiple of 16 (progressive scan) or 32 (interlaced scan). The bottom 8 lines should be disregarded by decoders.

Legend for MPEG-2 coded values in Table 3					
aspect_ratio_information	1 = square samples	2 = 4:3 display aspect ratio	3 = 16:9 display aspect ratio		
frame_rate_code	1 = 23.976 Hz	2 = 24 Hz	4 = 29.97 Hz	5 = 30 Hz	7 = 59.94 Hz 8 = 60 Hz
progressive_sequence	0 = interlaced scan 1 = progressive scan				

5.1.3 Sequence extension constraints

A sequence_extension structure is required to be present after every sequence_header structure. This means that video shall be encoded in accordance with MPEG-2. Table 4 identifies parameters in the sequence extension part of a bit stream that shall be constrained by the video subsystem and lists the allowed values for each.

Table 4 Sequence Extension Constraints

Sequence extension syntactic element	Allowed values
progressive_sequence	See Table 3
profile_and_level_indication	See 5.1.3.1
chroma_format	'01'
horizontal_size_extension	'00'
vertical_size_extension	'00'
bit_rate_extension	'0000 0000 0000'
vbv_buffer_size_extension	'0000 0000'

Sequence extension syntactic element	Allowed values
frame_rate_extension_n	'00'
frame_rate_extension_d	'0000 0'

5.1.3.1 Profile and Level indication

The profile_and_level_indication field shall indicate the lowest profile and level as defined in ISO/IEC 13818-2 [2], Section 8 that is consistent with the parameters of the video elementary stream.

5.1.4 Sequence display extension constraints

Table 5 identifies parameters in the sequence display extension part of a bit stream that shall be constrained by the video subsystem and lists the allowed values for each.

Table 5 Sequence Display Extension Constraints

Sequence display extension syntactic element	Allowed values
video_format	'000'

While all values for color primaries, transfer characteristics and matrix coefficients defined in Tables 6-7, 6-8 and 6-9 of ISO/IEC 13818-2 [2] are allowed in the transmitted bit stream, it is noted that ITU-R BT.709 [14] and SMPTE ST 170 [9] are the most likely to be in common use. The preferred values for color primaries, transfer characteristics and matrix coefficients are defined to be ITU-R BT.709 [14] (value 0x01 in all three cases) for all compression formats in Table 3. Except for those Table 3 formats having vertical_size value = 480, frame_rate_code = 4 and progressive_sequence = 0 (the so-called "NTSC formats"), the colorimetry shall be explicitly indicated in the sequence_display_extension. If the so-called "NTSC formats" do not have the colorimetry explicitly indicated in the sequence_display_extension, they shall be encoded in accordance with SMPTE ST 170 [9].

Note: If the original signal source is an ATSC stream and the colorimetry is not explicitly indicated in the sequence_display_extension, the signal may have been encoded in accordance with ITU-R BT.709 [14].

5.1.5 Picture header constraints

In all cases other than when vbv_delay has been set to the value 0xFFFF (see ISO/IEC 13818-1 [1]), the value of vbv_delay shall be vbv_delay <= 45000.

Informative note: In conformance with ISO/IEC 13818-1 [1] decoders are expected to use vbv_delay for buffer management only when the STD descriptor is present in the Transport Stream for the program being decoded and the leak_valid flag in the descriptor is set to '0'. The majority of the broadcast systems currently deployed do not include the STD descriptor and, therefore, decoders are expected to manage the buffer using the time stamps (i.e., PCR and PTS) in the Transport Stream applicable to the program being decoded. If vbv_delay is used for buffer size management, the video ES bit rate is limited to 16 Mbps because of the constraint on the size of receiver buffer, which 8 MB (see Table 2 where vbv_buffer_size <=488). Please refer to clause 2.4.3.2 of ISO/IEC 13818-1 [1] for more information.

5.1.6 Picture coding constraints

Use of progressive_frame in ISO/IEC 13818-2 [2] is constrained as follows: If progressive_frame is set to '1', frame_pred_frame_dct shall be '1'.

5.2 Constraints on MPEG-2 user_data

This section covers the user_data part of the video syntax. These data are inserted as ISO/IEC 13818-2 [2], extension_and_userdata(2) structures as defined in ISO/IEC 13818-2, Section 6.2.2 [2], following the

picture_header() and picture_coding_extension() structures. These data are used to carry advanced DTV closed captions, as well as 525 Line closed captions and other data that might be present in the VBI of a 525 Line signal.

5.2.1 Encoding and carriage of DTV captions

DTV closed caption data shall consist of content specified in CEA-708 [4] (including CEA-608 data carried in accordance with Section 4.3.2 of CEA-708, if present) and CEA-708.1 [5] and shall be transported as picture user data as specified in ATSC A/53 Part 4 Section 6.2 [8]. Other standards define methods to carry non-caption data in the closed caption data stream. The data rate of the DTVCC Transport Channel defined in CEA-708 [4] Section 4 is 9600 bits per second.

5.2.2 Encoding and carriage of 525 Line closed captions

Legacy line 21 caption data, encoded in accordance with CEA-608 [3], when present shall be carried in accordance with ATSC A/53 Part 4 [8] and may additionally be carried with ANSI/SCTE 20 [7]. ANSI/SCTE 20 caption data, when present, shall only be used with standard definition interlaced video formats listed in Table 3.

5.2.3 Encoding and carriage of Active Format Description and Bar Data

Active Format Description data, when present, shall be encoded and carried in accordance with ATSC A/53 Part 4 [8].

Bar Data, when present, shall be encoded and carried in accordance with ATSC A/53 Part 4 [8].

5.2.4 Encoding of other NTSC VBI data

For transport of other NTSC VBI data see SCTE 20[7] or SCTE 21[6] or SCTE 127 [15].

5.3 Ordering of information carried in MPEG-2 picture level user_data

When multiple usages of user_data are present, each instance shall be carried in a discrete ISO/IEC 13818-2 [2], extension_and_userdata(2) structure as defined in ISO/IEC 13818-2, Section 6.2.2 [2]. When any are present these structures shall be placed in the bitstream in the following order:

1. SCTE 20 [7] 525 Line closed caption and legacy data
2. ATSC A/53 Part 4 [8] DTV Closed Captions
3. ATSC A/53 Part 4 [8] Active Format Description
4. ATSC A/53 Part 4 [8] Bar Data

Ordering of other usages of extension_and_userdata(2) such as SCTE 21 [6] non-caption data or any private data is not specified in this standard.