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

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DIGITAL VIDEO SYSTEMS CHARACTERISTICS

STANDARD FOR CABLE TELEVISION

1. SCOPE

This document describes the characteristics and normative specifications for the Video Subsystem Standard for Cable Television.

2. REFERENCES

2.1 Normative references

The following documents contain provisions that through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

1. ISO/IEC IS 13818-1, International Standard (2000), MPEG-2 Systems.
2. ISO/IEC IS 13818-2, International Standard (2000), MPEG-2 Video.
3. ISO/IEC 13818-2: 1996/Cor. 1: 2000 (E) MPEG 2 Video Technical Corrigendum 1.
4. CEA-608-B (2000), Line 21 Data Services
5. CEA-708-B (1999), Digital Television (DTV) Closed Captioning.
6. ANSI/SCTE 21(2001) (Formerly DVS 053), Standard for Carriage of NTSC VBI Data in Cable Digital Transport Streams.
7. ANSI/SCTE 20 (2004) (Formerly DVS 157), SCTE Proposed Standard Methods for Carriage of Closed Captions and Non-Real Time Sampled Video.
8. ATSC Standard: Digital Television Standard (A/53), Revision C with Amendment 1, 13 July 2004.
9. SMPTE 170M (1999), Television – Composite Analog Video Signal – NTSC for Studio Applications.

2.2 Informative references

11. SMPTE 274M (2003), Standard for television, 1920 x 1080 Scanning and Interface.
12. SMPTE 296M (2001), Standard for television, 1280 x 720 Scanning, Analog and Digital Representation, and Analog Interface.
13. ITU-R BT.601-5 (1995), Encoding parameters of digital television for studios.
14. ITU-R BT.709-4 (2000), Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange.
15. ITU-T J.83B Digital Video Transmission Standard for Cable Television.
16. ANSI/SCTE 07 (2000) (Formerly DVS 031), Digital Video Transmission System for Cable Television.
17. ANSI/SCTE 54 (2004), Digital Video Service Multiplex and Transport System Standard for Cable Television.
18. CEA-CEB10-A (2002), EIA-708-B Implementation Guidance.

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.

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 274M	1080	1920
SMPTE 296M	720	1280
ITU-R BT.601-5	483 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 including Technical Corrigendum 1 and Technical Corrigendum 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 syntactic elements that are restricted beyond the limits imposed by MP@HL.

In these tables 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.

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.

¹Footnote: The number of active lines is not specified in ITU-R.601-5. "483" is the original number of lines specified in the NTSC standard. However current accepted practice in North America allows the line count to be anywhere from 480 to 486.

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.

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 are black, per MPEG rules.

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 Note
chroma_format	'01'
horizontal_size_extension	'00'
vertical_size_extension	'00'
bit_rate_extension	'0000 0000 0000'
vbv_buffer_size_extension	'0000 0000'
frame_rate_extension_n	'00'
frame_rate_extension_d	'0000 0'

Note: The profile_and_level_indication field shall indicate the lowest profile and level defined in ISO/IEC 13818-2, 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 are allowed in the transmitted bit stream, it is noted that ITU-R BT.709 and SMPTE 170M 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 (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 170M.

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.

5.1.5 Picture header constraints

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

Informative note: In conformance with [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`).

5.1.6 Picture coding constraints

Use of `progressive_frame` in [2] is constrained as follows: If `progressive_frame` is set to '1', `frame_pred_frame_dct` shall be '1'.

5.2 Bit stream specifications beyond MPEG-2

This section covers the extension and user data part of the video syntax. These data are inserted at the sequence, GOP, and picture level and are used to carry advanced DTV closed captions, as well as NTSC closed captions and other data that might be present in the VBI of an NTSC signal.

5.2.1 Encoding and transport of advanced DTV captions

Advanced DTV closed captions, when present, shall be encoded in accordance with EIA-708-B and shall be transported in accordance with ATSC A/53-B as modified by Amendment 1 to ATSC A/53-B (note that advanced DTV captions are signaled in A/53B by setting the `cc_type` field to '10' or '11').

5.2.2 Encoding and transport of NTSC closed captions

Line 21 caption data, encoded in accordance with CEA-608-B, when present shall be transported in accordance with ANSI/SCTE 20 or ATSC A/53B as modified by Amendment 1 to ATSC A/53B or both. (Note that such Line 21 caption data is signaled in A/53B by setting the `cc_type` field to '00' or '01'). In addition, the interleaving of the sequence SHALL be as follows: After the first `user_data_start_code` for SCTE 20 user data is sent (followed by the line 21 caption data per SCTE 20), then the second `user_data_start_code` is sent (followed by the ATSC A/53B user data which may include both CEA-608-B and CEA-708-B formats). Note that other data may be present in Line 21.

5.2.3 Encoding of other NTSC VBI data

For transport of other NTSC VBI data please see references [6] and [7].

5.2.4 Encoding and transport of bar data

Bar data, when present, shall be encoded and transported in accordance with ATSC A/53-B as modified by Amendment 1 to ATSC A/53-B.

5.2.5 Encoding and transport of active format description data

Active format description data, when present, shall be encoded and transported in accordance with ATSC A/53-B as modified by Amendment 1 to ATSC A/53-B.

