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**AVC Video Systems and Transport Constraints for Cable
Television**

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Errata

This version (2010-a) corrects editorial errors in the final approved document previously published as “ANSI/SCTE 128 2010”, namely:

- 1) The missing legends for tables 9A, 9B, 9C were restored
- 2) The numbering of the Tables from 9A forward was corrected

There were no normative content changes.

AVC Video Systems and Transport Constraints for Cable Television

1.0 SCOPE

This document defines the video coding and transport constraints on ITU-T Rec. H.264 | ISO/IEC 14496-10 [4] video compression (hereafter called "AVC") for Cable Television. In particular, this document describes the transmission of AVC coded video elementary streams in an MPEG-2 service multiplex (single or multi-program Transport Stream).

Note: The carriage of MPEG-2 video in the MPEG-2 service multiplex is described in SCTE 54 [1].

1.1 Background (Informative)

This document assists in creation of an AVC coded video elementary stream and its transport and is intended for broadcast purposes. There are other applications: time-shifting (e.g., PVR/DVR service), Video-on-Demand service, unicast, multicast, splicing (e.g., Ad-insertion) that could employ the specifications in this document. However, constraints specific to those applications are outside of the scope of this document.

2.0 NORMATIVE REFERENCES

The following documents contain provisions, which, 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.

2.1 SCTE References

- [1] ANSI/SCTE 54 (2006), Digital Video Service Multiplex and Transport System Standard for Cable Television.

2.2 Standards from other Organizations

- [2] ATSC A/65C, Program and System Information Protocol for Terrestrial Broadcast and Cable, Revision C, with Amendment No. 1, May 9, 2006; Section 6.9.2.
- [3] ISO/IEC 13818-1, (2007), "Information Technology – Generic coding of moving pictures and associated audio – Part 1: Systems."
- [4] ITU-T Rec. H.264 | ISO/IEC 14496-10, (2005), "Information Technology – Coding of audio visual objects – Part 10: Advanced Video Coding."
- [5] CEA-608-C (2005), Line 21 Data Services.
- [6] CEA-708-C (2006), Digital Television (DTV) Closed Captioning.
- [7] ATSC A/53 Part 4:2007, Digital Television Standard, MPEG-2 Video System Characteristics, 3 January 2007.
- [8] ETSI TS 101 154 V1.8.1 Digital Video Broadcasting (DVB): Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream, July, 2007.
- [9] SMPTE 2016-1: Standard for Television – Format for Active Format Description and Bar Data.
- [10] ISO/IEC 13818-2 (2000), Information Technology – Generic coding of moving pictures and associated audio - Part 2: Video

3.0 INFORMATIVE REFERENCES

The following documents may provide valuable information to the reader but are not required when complying with this standard.

3.1 SCTE References

- [11] ANSI/SCTE 43 (2005), Digital Video Systems Characteristics Standard for Cable Television.
- [12] ANSI/SCTE 21 (2001R2006), Standard For Carriage of NTSC VBI Data In Cable Digital Transport Streams.
- [13] ANSI/SCTE 07 (2006), Digital Transmission Standard for Cable Television.
- [14] DVS/714 [in preparation], Constraints on AVC Video Coding for Digital Program Insertion.

3.2 Standards from other Organizations

- [15] SMPTE 170M (1999), Television – Composite Analog Video Signal – NTSC for Studio Applications.
- [16] SMPTE 274M (2003), Standard for television, 1920 x 1080 Scanning and Interface.
- [17] SMPTE 296M (2001), Standard for television, 1280 x 720 Scanning, Analog and Digital Representation, and Analog Interface.
- [18] ITU-R BT.601-5 (1995), Encoding parameters of digital television for studios.
- [19] ITU-R BT.709-4 (2000), Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange.
- [20] ITU-T J.83B Digital (1997) and ERRATUM 1(1998), Digital Video Transmission Standard for Cable Television.
- [21] CEA-CEB16: Active Format Description (AFD) & Bar Data Recommended Practice.
- [22] SMPTE 125M (1995), Standard for television, Component Video Signal 4:2:2, Bit Parallel Digital Interface.
- [23] SMPTE 293M (2003), Standard for television, 720x483 Active Line at 59.95 Hz Progressive Scan Production, Digital Representation.
- [24] SMPTE 267M (1995), Standard for television, Bit Parallel Digital Interface- Component Video Signal 4:2:2 16x9 Aspect Ratio.
- [25] ITU-T Rec. T.35, (2000), “Procedure for the allocation of ITU-T defined codes for non-standard facilities.”
- [26] ATSC A/53, Part 3:2007, “Service Multiplex and Transport Subsystem Characteristics”, 3 January 2007.
- [27] CEA-861-D “A DTV Profile for Uncompressed High Speed Digital Interfaces”, Publication Date: July 1, 2006.

4.0 COMPLIANCE NOTATION

Throughout this document, there are words that are used to define the significance of particular requirements. These words are:

“shall”	This word or the adjective “REQUIRED” means that the item is an absolute requirement of this specification.
“shall not”	This phrase means that the item is an absolute prohibition of this specification.
“should”	This word or the adjective “RECOMMENDED” means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be

	understood and the case carefully weighted before choosing a different course.
“should not”	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
“may”	This word or the adjective “OPTIONAL” means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
“forbidden”	The value specified shall never be used.

This document contains symbolic references to syntactic elements used in the video and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., reserved), may contain the underscore character (e.g., constraint_set0_flag) and may consist of character strings that are not English words (e.g., pic_width_in_mbs_minus1).

5.0 DEFINITIONS AND ACRONYMS

5.1 Acronyms

The following definitions and acronyms are used in this document:

ATSC	Advanced Television Systems Committee
AU	Access Unit
CPB	Coded Picture Buffer
DPB	Decoded Picture Buffer
DTS	Decoding Time Stamp
DTV	Digital Television
DVB	Digital Video Broadcasting
DVS	Digital Video Subcommittee
ESPI	Elementary_Stream_Priority_Indicator
FPP	Forward Predicted Picture
GOP	Group of Pictures
HDTV	High Definition Television
HRD	Hypothetical Reference Decoder
IDR	Instantaneous Decoding Refresh
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MPEG	Moving Picture Experts Group
NAL	Network Abstraction Layer
PPS	Picture Parameter Set
PTS	Presentation Time Stamp

QAM	Quadrature Amplitude Modulation
RAI	Random_Access_Indicator
SDTV	Standard Definition Television
SEI	Supplemental Enhancement Information
SPS	Sequence Parameter Set
SRAP	SCTE Random Access Point
T-STD	Transport Stream System Target Decoder
TS	Transport Stream
VBI	Vertical Blanking Interval
VUI	Video Usability Information

5.2 Definitions

AVC ITU-T Rec. H. 264 | ISO/IEC 14496-10 Advanced Video Coding standard

AVC Receiver The term "AVC Receiver" in this standard means a receiver having at least the attributes listed below:

1. Able to parse and decode the normative elements from AVC [4] that are specified with constraints in this standard;
2. Not adversely affected by the presence or absence of optional and informative elements from AVC [4];
3. Not adversely affected by the presence or absence of optional and informative elements in this standard;
4. Able to parse and process all elements from AVC [4] Annex D (SEI messages) and Annex E (VUI syntax elements) that are specified as normative in this standard and conveyed in-band; Note : These are optional elements in the AVC specification;
5. Able to parse and decode all the normative elements from ISO/IEC 13818-1 [3] that are normatively included and/or constrained by this standard;
6. Not adversely affected by the presence or absence of optional elements from ISO/IEC 13818-1 [3] (such as data in adaptation fields) that are specified with constraints in this standard;
7. Supports the processing of end_of_stream_rbsp() syntax element required by applications where another bitstream follows the end_of_stream NAL unit. The bitstream that follows will start with an IDR picture and may be accompanied by a time base discontinuity.

Note: The additional information from items 6 and 7 is optionally provided for the benefit of AVC receivers that include support for applications such as PVR, DPI and VOD.

Forward Predicted Picture A predicted picture that does not use any later-displayed picture as a reference.

Program An ISO-IEC 13818-1 MPEG-2 Program

SGOP A SCTE Group Of Pictures (SGOP) is the group of pictures spanning two consecutive SRAPs including the prior SRAP AU but not including the subsequent SRAP AU.

SRAP Picture An I- or IDR-picture that is part of an SRAP Access Unit.

Numerical formats are defined in the following table:

Table 1: Numerical Format Definitions

Example Values	Description
12345	Example of a decimal value format
0x2A	Example of a hexadecimal value format
'10010100'	Example of a string of binary digits

6.0 MPEG-2 MULTIPLEX AND TRANSPORT CONSTRAINTS FOR AVC

This section and its subsections describe MPEG-2 System details pertaining to AVC that extends the specifications of SCTE 54 [1].

6.1 Services and Features

Note: As described in SCTE 54 [1] and other SCTE standards, the MPEG-2 Transport provides services and features enabled by information carried at the MPEG-2 Transport multiplex level and not at the video elementary stream component level. Some of these services are System Information and Program Guide, Emergency Alerts, and Specification of Private Data Services.

Note: The bitrate value for the AVC Bitstream is application dependent and limited by the contiguous bandwidth of the transmission channel. In the application of AVC transmission over a 64-QAM channel, bitrate value in combination with other bitstreams in the MPEG-2 Transport multiplex, conforms to a channel bitrate of less than or equal to 27.0 Mbps; in transmissions over 256-QAM channels to less than or equal to 38.8 Mbps.

This section describes additional services and features details pertaining to AVC.

6.2 MPEG-2 Systems Standard

6.2.1 Video T-STD

Video T-STD for AVC shall be based on Section 2.14.3.1 of ISO/IEC 13818-1 [3] and shall follow the constraints for the profile and level encoded in the video elementary stream in Appendix A of AVC [4].

6.3 Assignment of identifiers

This section describes additional identifiers relevant to AVC video elementary stream components.

6.3.1 AVC Stream Type Codes

The AVC stream type value shall be 0x1B.

6.3.2 Descriptors

6.3.2.1 Video descriptor

AVC video is signaled by the `AVC_video_descriptor()` when required by ISO/IEC 13818-1[3] or as otherwise appropriate. This descriptor, when carried, shall be placed in the descriptor loop for the video program element of the PMT with a descriptor tag value of 0x28.

Certain services may include video elementary streams that contain one or more AVC still pictures that conform to the still picture model of ISO/IEC 13818-1 [3]. Any elementary stream containing still pictures shall include a `AVC_video_descriptor()` with `AVC_still_present_flag` set to “1” in accordance with section 2.6.64 of 13818-1[3]. Constraints for transmitting AVC still pictures are defined in section 9.0 of this document.

6.3.2.2 Caption service descriptor

When caption services are delivered within the AVC video elementary stream (as specified in Section 8.0), the `caption_service_descriptor()`, as defined in Sec. 6.9.2 of ATSC A/65C [2], shall be present as described in SCTE 54 [1] section 5.8.3.6.

6.3.2.3 SCTE Adaptation field data descriptor

When private data bytes of the adaptation field of the TS packets are in use, with tag, length, and data structures as defined in Section 6.4.3, the `SCTE_adaptation_field_data_descriptor` shall be placed in the descriptor loop for the video program element of the PMT. In the absence of such adaptation field private data, the descriptor shall not be included in the corresponding `ES_info_loop` of the PMT. The presence of the `SCTE_adaptation_field_descriptor()` shall mean that `private_data_byte(s)` carried in adaptation field data in this stream are in tag-length-data format, where the tag values are as defined in SCTE standards. The absence of this descriptor does not preclude private data in the adaptation header that could conform to MPEG or other standards. The SCTE adaptation field data descriptor shall be formatted per Table 2.

Table 2: SCTE adaptation field data descriptor

Syntax	Number of bits	Identifier
<code>SCTE_adaptation_field_data_descriptor(){</code>		
<code>descriptor_tag</code>	8	<code>uimsbf</code>
<code>descriptor_length</code>	8	<code>uimsbf</code>
<code>}</code>		

Where:

descriptor_tag: This value shall be set to 0x97

descriptor_length: This value is 0x00

Note: This descriptor varies from the signaling mechanism used by DVB[8] to indicate the presence of `AU_Information`. The descriptor establishes announcement for general and consistent syntax and semantics for the private data of the TS packet’s adaptation field.

6.4 AVC Program Constraints

MPEG-2 Programs shall be constrained to carry at most one AVC video elementary stream component with a stream_type value of 0x1B.

6.4.1 SCTE Random Access Point (SRAP) Access Unit Composition

An **SCTE Random Access Point (SRAP)** access unit, or SRAP, demarcates a location within an AVC Bitstream where an AVC Receiver is able to begin decoding video. The spacing of successive random access points is an important contributor to channel change time, but is not the only factor contributing to channel change time. Other factors that contribute to channel change time include physical device tuning constraints, RF tuning, or conditional access operations.

An SRAP access unit is an AVC access unit shown pictorially in Figure 1. An SRAP access unit shall include exactly one Sequence Parameter Set (SPS) (that is active) with VUI and the Picture Parameter Set (PPS) that is required for decoding the associated picture. The SPS shall precede any SEI NAL units that may be present in an SRAP access unit.

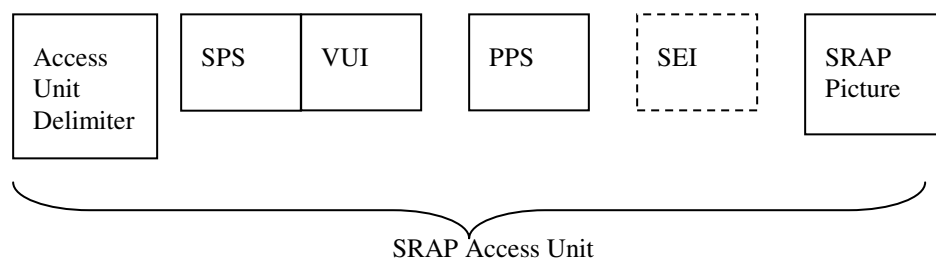


Figure 1: NAL Unit Order for a Typical SRAP Access Unit

The picture encoded within the SRAP access unit, the SRAP Picture, shall be either an I- or IDR-picture. In broadcast applications, this picture is typically a reference picture.

6.4.2 SRAP Transport Constraints

An SRAP shall meet the following transport constraints.

6.4.2.1 TS Packet Header and Adaptation Field Constraints

A TS packet containing the PES packet header of an SRAP shall have an adaptation field. The payload_unit_start_indicator bit shall be set to '1' in the TS packet header and the adaptation_field_control bits shall be set to '11' (as per ISO/IEC 13818-1 [3]). In addition, the random_access_indicator bit in the Adaptation field of the TS packet that contains the PES packet header of the SRAP shall be set to '1' and follow the constraints as specified in ISO/IEC 13818-1 [3] in Subclause 2.4.3.5.

Per ISO/IEC 13818-1 [3], the elementary_stream_priority_indicator bit shall be set to '1' in the adaptation field of a TS packet containing the first slice start code of the SRAP Picture (which is an I or IDR picture with slice_type = 2 or slice_type = 7).