The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

ATSC was formed in 1982 by the member organizations of the Joint Committee on InterSociety Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable Telecommunications Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). Currently, there are approximately 120 members representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

ATSC Digital TV Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

Note: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith. One or more patent holders have, however, filed a statement regarding the terms on which such patent holder(s) may be willing to grant a license under these rights to individuals or entities desiring to obtain such a license. Details may be obtained from the ATSC Secretary and the patent holder.

Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
</tr>
</thead>
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ATSC Standard A/72 Part 1 –
Video System Characteristics of AVC in the ATSC Digital Television System

1. SCOPE

2. REFERENCES
All referenced documents are subject to revision. Users of this Standard are cautioned that newer editions might or might not be compatible.

2.1 Normative References
The following documents, in whole or in part, as referenced in this document, contain specific provisions that are to be followed strictly in order to implement a provision of this Standard.


1 Also published by ITU as ITU-T Recommendation H.264. A/72 Part 1 does not implement Annexes G and H of [4].
2.2 Informative References
The following documents contain information that may be helpful in applying this Standard.


3. COMPLIANCE NOTATION
This section defines compliance terms for use by this document:

shall – This word indicates specific provisions that are to be followed strictly (no deviation is permitted).

shall not – This phrase indicates specific provisions that are absolutely prohibited.

should – This word indicates that a certain course of action is preferred but not necessarily required.

should not – This phrase means a certain possibility or course of action is undesirable but not prohibited.

3.1 Treatment of Syntactic Elements
This document contains symbolic references to syntactic elements used in the audio, video, and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code) and may consist of character strings that are not English words (e.g., dynrng).

3.1.1 Reserved Elements
One or more reserved bits, symbols, fields, or ranges of values (i.e., elements) may be present in this document. These are used primarily to enable adding new values to a syntactical structure.
without altering its syntax or causing a problem with backwards compatibility, but they also can be used for other reasons.

The ATSC default value for reserved bits is ‘1.’ There is no default value for other reserved elements. Use of reserved elements except as defined in ATSC Standards or by an industry standards setting body is not permitted. See individual element semantics for mandatory settings and any additional use constraints. As currently-reserved elements may be assigned values and meanings in future versions of this Standard, receiving devices built to this version are expected to ignore all values appearing in currently-reserved elements to avoid possible future failure to function as intended.

3.2 Symbols, Abbreviations, and Mathematical Operators
The symbols, abbreviations, and mathematical operators used herein are as found in Section 3.4 of ATSC A/53 Part 1 [1] and as herein specified.

one_bits – Each bit in fields marked, one_bits, shall be set to ‘1’.

3.3 Terms
The following terms are used within this document.

Digital Program Insertion – A term (sometimes called “DPI”) that refers to the splicing of MPEG-2 transport streams for the purpose of insertion of advertisements and other content types using an in-stream messaging mechanism. See ANSI/SCTE 35 [19].

HDTV – High Definition Television.

reserved – Set aside for future use by a Standard.

SDTV – Standard Definition Television.

4. SYSTEM OVERVIEW (INFORMATIVE)
Please see the A/53 Part 4 Section titled “System Overview” [2].

5. POSSIBLE VIDEO INPUTS
Please see the A/53 Part 4 Section titled “Possible Video Inputs” [2] for information regarding television production standards. Television production standards supported by this standard include 25 and 50 Hz inputs as well as 29.97 and 59.94 Hz inputs.

6. VIDEO PROCESSING BEFORE AVC COMPRESSION
The image formats for AVC compression may be derived from the production video formats as follows:

6.1 16:9 Aspect Ratio Source Images
In order to maintain square pixels and simple-ratio scaling factors, identical cropping from both left and right sides of the image should be done. If uneven cropping is required for some reason, the output image should be left justified in the result. Cropping should be performed prior to de-interlacing when required.

6.2 4:3 Aspect Ratio Source Images
In order to maintain square pixels and simple-ratio scaling factors, identical cropping from both left and right sides of the image should be done. If uneven cropping is required for some reason,
the output image should be left justified in the result. Cropping should be performed prior to de-interlacing.

6.3 Active Format Description

When the active image area in a 16:9 video signal does not fill the full 16:9 frame, Active Format Description (AFD) and (optionally) Bar Data information in accordance with SMPTE ST 2016-1 [10] should be present in the source video signal. It is expected that such AFD information, and (optional) Bar Data, will be included in the compressed bit stream and used by a receiver to optimize the display of images that do not fill the coded frame.

Bar Data values are specific to a given video format and, if used, will have to be recalculated when an incoming video signal is decimated (as above) and compressed to the AVC compression format. Formats without controlling source documents, as specified for compression in this standard, shall use the compressed domain line and pixel numbering.

7. SOURCE CODING SPECIFICATION

This section establishes a specific subset of the AVC video compression standard [4]. The AVC video compression algorithm shall conform to either the Constrained Baseline Profile, the Main Profile, or the High Profile syntax of AVC video (ISO/IEC 14496-10) [4].

The constraints and specifications applicable to bit streams are listed in Section 7.1 (including subsections 7.1.1 through 7.1.6), 7.3 and 7.4. Bounds on allowed picture sizes and other compression format constraints are shown in Table 7.3.

Main and High Profile bit streams meet the constraints and specifications specified in ANSI/SCTE 128-1 [3] Sections 7.2 (“Source coding specification”) and 8.0 (“Carriage of Captioning, AFD, and Bar Data”).

Constrained Baseline Profile AVC bit streams shall meet the constraints and specifications specified in Table 7.3 and as further described in Sections 7.1, 7.2, and 7.4 of this document.

AVC bit streams shall utilize both the “Supplemental enhancement information (SEI)” and the “Video usability information (VUI)” syntactic elements defined in ISO/IEC 14496-10 Annexes D and E [4]. Decoder design should be made under the assumption that any legal structure as permitted by ISO/IEC 14496-10 [4] may occur in the broadcast stream even if presently reserved or unused.

7.1 Constraints with Respect to AVC (ISO/IEC 14496-10)

The tables in section 7.2.1 (“Constraints with respect to AVC”) of ANSI/SCTE 128-1 [3] list the allowed values for each of the ISO/IEC 14496-10 [4] syntactic elements which are constrained.

7.1.1 Constraints with Respect to AVC Main and High Profiles

Picture coding shall not use the High Profile tools unless required by the picture format. See Section 7.2.1.5 (“Compression format constraints”) of ANSI/SCTE 128-1 [3].

7.1.2 Constraints with Respect to AVC Baseline Profile

When used for image formats where Baseline profile is permitted, the picture coding shall use the Constrained Baseline profile, which means that only the subset of Baseline tools that are also present in the Main profile are used.
7.1.3 AVC Access Point
An Access Point is defined as an access unit in an AVC bit stream at which a decoder can begin decoding video successfully. The access unit must contain one Sequence Parameter Set NAL unit and one Picture Parameter Set NAL unit that are active or being activated when decoding the primary coded picture in this access unit. The access unit must contain an IDR picture or an I picture.

7.1.4 Sequence Parameter Set Constraints
The Sequence Parameter Set constraints shall be the same as those in Section 7.2.1.1 (“Sequence Parameter Set (SPS) constraints”) of ANSI/SCTE 128-1 [3].

7.1.5 Picture Parameter Set Constraints
The Picture Parameter Set constraints shall be the same as those in Section 7.2.1.3 (“Picture Parameter Constraints and Level Limits”) of ANSI/SCTE 128-1 [3].

7.1.6 Video Usability Information (VUI) Parameter Constraints
The Video Usability Information (VUI) constraints shall be the same as those in Section 7.2.1.2 (“Video Usability Information (VUI) Constraints”) of ANSI/SCTE 128-1 [3].

7.2 Compression Format Constraints
Section 7.2.1.5 (“Compression format constraints”) of ANSI/SCTE 128-1 [3] includes detailed constraints on picture sizes and related parameters. Those constraints are relaxed in this standard to allow other coded image sizes to be used for broadcast stream optimization. The fixed image size rows are intended as format interoperation points and their use is encouraged. For images subsampled from 1920x1080 source image formats (HDTV per SMPTE ST 274 [5]), the maximum number of horizontal and vertical macroblocks is 120 and 68, respectively, with an image aspect ratio as close to 16:9 as possible. For images subsampled from 1280x720 source image formats (HDTV per SMPTE ST 296 [7]), the maximum number of horizontal and vertical macroblocks is 80 and 45, respectively, with an image aspect ratio as close to 16:9 as possible. For images subsampled from 720x480 or 720x576 source image formats (SDTV per either SMPTE ST 125 [6] or ITU-R BT.601 [8]), the maximum number of horizontal and vertical macroblocks is 45 and 30, respectively, with an image aspect ratio as close to 4:3 or 16:9 as possible.

The AVC video compression standard [4] requires that coded vertical size be a multiple of 16 (progressive scan) or 32 (interlaced scan). While many possible compression formats use square pixels and complete macroblocks, should the compression format require “padding out” of the coded frame (such as 1080 lines requires 1088 to be actually coded), those extra macroblocks shall be placed at the bottom and/or right edge of the coded frame.
### Table 7.1 Recommended Compression Formats

<table>
<thead>
<tr>
<th>Vertical Size</th>
<th>Horizontal Size</th>
<th>PicWidth InMbs</th>
<th>PicHeight InMbs</th>
<th>Prod Format</th>
<th>aspect_ratio_idc</th>
<th>profile_idc¹</th>
<th>level_idc</th>
<th>Display Aspect Ratio</th>
<th>Allowed Frame Rates</th>
<th>Progressive/Interlaced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1080</td>
<td>1920</td>
<td>120</td>
<td>68</td>
<td>HDTV</td>
<td>1</td>
<td>100</td>
<td>40</td>
<td>16:9</td>
<td>1,2,3,4,5,6,7,8</td>
<td>I or P</td>
</tr>
<tr>
<td>720</td>
<td>1280</td>
<td>80</td>
<td>45</td>
<td>HDTV</td>
<td>1</td>
<td>100</td>
<td>40</td>
<td>16:9</td>
<td>1, 2, 5, 6, 8</td>
<td>P</td>
</tr>
<tr>
<td>480</td>
<td>720</td>
<td>45</td>
<td>30</td>
<td>SDTV</td>
<td>3 or 5</td>
<td>77 or 100</td>
<td>31, 40</td>
<td>4:3 or 16:9</td>
<td>1,2,3,4,5,6,7,8</td>
<td>I</td>
</tr>
<tr>
<td>480</td>
<td>640</td>
<td>40</td>
<td>30</td>
<td>SDTV</td>
<td>1</td>
<td>100</td>
<td>31, 40</td>
<td>4:3</td>
<td>1,2,3,4,5,6,7,8</td>
<td>I</td>
</tr>
<tr>
<td>576</td>
<td>720</td>
<td>45</td>
<td>30</td>
<td>SDTV</td>
<td>2 or 4</td>
<td>77 or 100</td>
<td>31, 40</td>
<td>4:3 or 16:9</td>
<td>7 or 8</td>
<td>I</td>
</tr>
</tbody>
</table>

**Legend:**
- Frame rate: 1 = 23.976 Hz, 2 = 24 Hz, 3 = 29.97 Hz, 4 = 30 Hz, 5 = 59.94 Hz, 6 = 60 Hz, 7 = 25 Hz, 8 = 50 Hz
- aspect_ratio_idc: 1 = 1:1 [square samples], 2 = 12:11, 3 = 10:11, 4 = 16:11, 5 = 40:33, 7 = 20:11, 14 = 4:3

**Footnotes:**
1. A compliant bitstream may have a profile_idc value of either 66, 77, or 100.
2. The use of aspect_ratio_idc = 4 in this case is intended for 16:9 display aspect ratio images.

Note: aspect_ratio_idc, profile_idc, level_idc are parameters in the Sequence Parameter Set (SPS) of the AVC bit stream.

#### 7.3 Low Delay Mode and Still Picture Mode

The Low Delay Mode and Still Picture Mode constraints shall be the same as Section 7.2.1.6 (“Low Delay Mode”) and Section 9.0 (“Support For AVC Still Pictures”) of ANSI/SCTE 128-1 [3].

#### 7.4 Bit Stream Specifications Beyond AVC (ISO/IEC 14496-10)

This section covers the specific data carried in the SEI RBSP and VUI sections of the video syntax. The syntax used for the insertion of closed captioning, AFD, and bar data in the SEI payload shall be as specified in the following sections.

##### 7.4.1 Transport of Caption, Active Format Description (AFD) and Bar Data

Captions, AFD and bar data, when present, shall be carried according to A/53, Part 4 [2], Section 6.2 as further constrained and described in 7.4.2 of this document.

Note: CEA-708 [10] requires a fixed bandwidth of 9600 bits per second for the closed caption payload data when AVC is used for Terrestrial Fixed Broadcast applications. Bandwidth calculations should anticipate this requirement. CEA-708 [10] also provides carriage for CEA-608 [11] Line 21 caption data.

Note: Additional background on AFD and bar data may be found in ETSI TS 101 154 V1.11.1 [12], the Digital Receiver Implementation Guidelines [13], and CEA CEB16 [17].

##### 7.4.2 Caption, AFD and Bar Data

Closed Captions, AFD and Bar Data shall be as specified by Section 8.1 (“Caption, AFD and Bar Data Syntax”) of ANSI/SCTE 128-1 [3].

##### 7.4.3 Constraints for Digital Program Insertion

Where Digital Program Insertion is to be used, the video syntax shall follow the constraints of ANSI/SCTE 172 [9].
Note: See also Section 7.2.1.7 ("Program Splicing Constraint") of ANSI/SCTE 128-1 [3] and ANSI/SCTE 35 [19].

-- End of document --