SMPTE STANDARD

SMPTE ST 2016-1:2009
Revision of SMPTE 2016-1-2007

Format for Active Format Description and Bar Data

Table of Contents

Approved
December 23, 2009

Figures

Tables

Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative Practices.

SMPTE ST 2016-1 was prepared by Technology Committee 22TV.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Standard. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

Image formatting information describes certain spatial characteristics of a high definition or standard definition video image. It may be generated and carried through all or some of the video production, distribution, and emission chain. The image formatting metadata types are Active Format Description (AFD), Bar Data, and Pan-Scan information.

AFD and Bar Data are intended to be broadcast with the video signal that they describe. AFD information is intended to guide DTV receivers and/or intermediate professional video equipment regarding the display of video of one aspect ratio on a display of another aspect ratio. Bar Data information is used to signal the precise unused areas of active video when the active image does not completely fill the picture area, in particular widescreen cinema material carried letterboxed in a frame with bars top and bottom.

Pan-Scan information is a set of data that is intended to guide professional video equipment in extracting an image to be presented in an aspect ratio that is different from that in which the material was produced or distributed. Independent parameters are provided for pan (horizontal offset), tilt (vertical offset), vertical size, horizontal size, and output aspect ratio. Pan-Scan information is not intended for use beyond the production and distribution environments.

The following suite of SMPTE standards defines the origination and carriage of AFD, Bar Data, and Pan-Scan information:

SMPTE ST 2016-1	Format for Active Format Description and Bar Data
SMPTE 2016-2	Format for Pan-Scan Information
SMPTE ST 2016-3	Vertical Ancillary Data Mapping of Active Format Description and Bar Data
SMPTE 2016-4	Vertical Ancillary Data Mapping of Pan-Scan Information
SMPTE 2016-5	KLV Data Coding for Active Format Description, Bar Data, and Pan-Scan Information

Other SMPTE standards may be used for alternative transport methods for this data. The relationship among these and related standards is shown in the Road Map in Annex C.

1 Scope

This Standard defines Active Format Description (AFD) and Bar Data for origination and conveyance through the production and distribution processes for standard definition or high definition television signals. AFD and Bar Data are intended to be ultimately broadcast with the video signals that they describe, therefore references to emission and DTV receivers are included to ensure compatibility between the origination of the AFD and Bar Data and its ultimate use.

Associated standards define how this information is placed into ancillary data packets and is KLV coded as SMPTE metadata. Annex C shows the relationship among the standards.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

3 Normative References

The following standards 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 agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ITU-R BT.656-4, Interfaces for Digital Component Video Signals in 525-Line and 625-Line Television Systems Operating at the 4:2:2 Level of Recommendation ITU-R BT.601 (Part A)

ITU-R BT.1358, Studio Parameters of 625 and 525 Line Progressive Scan Television Systems

SMPTE 274M-2008, Television — 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE 293M-2003, Television — 720 x 483 Active Line at 59.94-Hz Progressive Scan Production — Digital Representation

SMPTE 296M-2001, Television — 1280 x 720 Progressive Image Sample Structure — Analog and Digital Representation and Analog Interface

4 Definitions

active image: The portion of the video picture area that is being utilized for program content. Also referred to in CEA-CEB16 as the useful image inside the video frame. Active image excludes letterbox bars and pillarbox bars.

active video: The portion of the video signal that is used to carry picture information. For baseband digital systems, it has the specific meaning of the picture area where the V bits and H bits are both set to 0.

alternative center: A contraction of “alternative center cut” indicating an alternate aspect ratio subset of the active image, containing all of the critical action and centered on the active image.

bslbf : Bit string, left bit first, where “left” is the order in which bit strings are written. In this standard, bit strings are written as a string of 1's and 0's within single quote marks; e.g. ‘1000 0001’. Blanks within a bit string are for ease of reading and have no significance.

coded frame: The video frame as coded in a compressed bitstream for emission.

For consistency with ATSC, CEA, ETSI, and other standards, the Active Format Description and Bar Data specifications in this document refer to the term coded frame. For the purpose of this SMPTE standard, use of the words “coded frame” shall be taken to apply also to the active video area defined by the applicable production format standard for the video signal being described by the AFD and Bar Data.

letterbox: "Letterbox" describes a frame that the active image does not fill vertically, requiring bars without active image information at the top and/or the bottom of the image.

pillarbox: "Pillarbox" describes a frame that the active image does not fill horizontally, requiring bars without active image information at the left and/or right sides of the image. Some publications, including SMPTE RP 199, refer to pillarbox in a 16:9 display area by the term “sidebar”.

reconstructed frame: The video frame at the output of a compressed bitstream decoder.

For consistency with ATSC, ETSI, and other standards, the Active Format Description and Bar Data specifications in this document refer to the term reconstructed frame. For the purpose of this SMPTE standard, use of the words “reconstructed frame” shall be taken to apply also to the image area defined by the applicable production format standard for the video signal being described by the AFD and Bar Data.

uimsbf: Unsigned integer, most significant bit first. The byte order of multi-byte words is most significant byte first.

5 Active Format Description

The Active Format Description (AFD) is a 4-bit code describing a video picture in terms of the aspect ratio and other characteristics of the active image within the coded frame. The complete set of Active Format Description codes is shown in Table 1, where in every case the term image refers to the active image.

NOTE – A DTV receiver or intermediate processing equipment interprets the AFD in conjunction with the aspect ratio of the coded frame.

Table 1 – Active Format Description codes

Active Format Description		AFD Code
In a 4:3 coded frame	**In a 16:9 coded frame**	**a3, a2, a1, a0**
Undefined (see below)	Undefined (see below)	'0000'
Reserved	Reserved	'0001'
Letterbox 16:9 image, at top of the coded frame (see note 1)	Full frame 16:9 image, the same as the coded frame (see notes 1 and 2)	'0010'
Letterbox 14:9 image, at top of the coded frame (see note 1)	Pillarbox 14:9 image, horizontally centered in the coded frame (see notes 1 and 3)	'0011'
Letterbox image with an aspect ratio greater than 16:9, vertically centered in the coded frame (see note 1)	Letterbox image with an aspect ratio greater than 16:9, vertically centered in the coded frame (see note 1)	'0100'
Reserved	Reserved	'0101'
Reserved	Reserved	'0110'
Reserved	Reserved	'0111'
Full frame 4:3 image, the same as the coded frame	Full frame 16:9 image, the same as the coded frame	'1000'
Full frame 4:3 image, the same as the coded frame (see note 4)	Pillarbox 4:3 image, horizontally centered in the coded frame	'1001'
Letterbox 16:9 image, vertically centered in the coded frame with all image areas protected (see note 5)	Full frame 16:9 image, with all image areas protected (see note 5)	'1010'
Letterbox 14:9 image, vertically centered in the coded frame	Pillarbox 14:9 image, horizontally centered in the coded frame	'1011'
Reserved	Reserved	'1100'
Full frame 4:3 image, with alternative 14:9 center (see note 6)	Pillarbox 4:3 image, with alternative 14:9 center (see note 6)	'1101'
Letterbox 16:9 image, with alternative 14:9 center (see note 6)	Full frame 16:9 image, with alternative 14:9 center (see note 6)	'1110'
Letterbox 16:9 image, with alternative 4:3 center (see note 6)	Full frame 16:9 image, with alternative 4:3 center (see note 6)	'1111'

If Bar Data is not present (see § 9.2.1), AFD '0000', indicates that exact information is not available and the active image should be assumed to be the same as the coded frame. AFD '0000', when accompanied by Bar Data, signals that the active image's aspect ratio is narrower than 16:9, but is not 4:3 or 14:9. As the exact aspect ratio cannot be conveyed by AFD alone, wherever possible, AFD '0000' should be accompanied by Bar Data to define the exact vertical or horizontal extent of the active image.

AFD code '0100' signals that the active image aspect ratio is wider than 16:9. As the exact aspect ratio cannot be conveyed by AFD alone, wherever possible, AFD '0100' should be accompanied by Bar Data to define the exact vertical extent of the active image.

AFD codes may be applicable to 4:3 coded frames, 16:9 coded frames, or both and may have different meanings for each. Example illustrations in Figures 2 and 3 show AFD representations for both 4:3 and 16:9 coded frames. The AFD codes may also be used with coded frames of other aspect ratios but such use is outside the scope of this standard.

NOTES

1 In determining AFD codes to originate, users are cautioned that emission systems in some areas of the world may not support some or all of AFD codes '0001' through '0111' .

2 In a 16:9 coded frame, AFD code '0010' represents the same image display as AFD code '1000'. AFD code '1000' is the preferred coding for a full frame 16:9 image. AFD code ‘0010’ is not used in North America.

3 In a 16:9 coded frame, AFD code '0011' represents the same image display as AFD code '1011'. AFD code '1011' is the preferred coding for a horizontally centered 14:9 pillarbox image. AFD code ‘0011’ is not used in North America.

4 In a 4:3 coded frame, AFD code '1001' represents the same image display as AFD code '1000'. AFD code '1000' is the preferred coding for a full frame 4:3 image.

5 AFD code '1010' is intended for use with images that may not fill the frame vertically but where all areas of the image should be displayed (e.g. an image where cropping is not permitted) and which therefore can only be adequately displayed in letterbox format.

6 The “alternative center” image refers to an area of essential picture information. The areas outside this area (shown gray in the illustrations in figures 1, 2, and 3) may optionally be cropped without significant loss to the viewer.

7 Aspect ratio information for the coded frame is not part of the AFD code and it is necessary to code this aspect ratio information separately – see § 5.2. The AFD and aspect ratio codes may be transported together as part of a larger data structure.

The AFD codes are illustrated using the diagrammatic representation shown in Figure 1, Figure 2, and Figure 3, where in every case the term image refers to the active image. The duplicate image displays for codes mentioned in Notes 3, 4 and 5 above are not illustrated.

For further guidance on how consumer devices handle AFD and Bar Data information, see the ETSI, Digital TV Group and CEA references in Annex A.

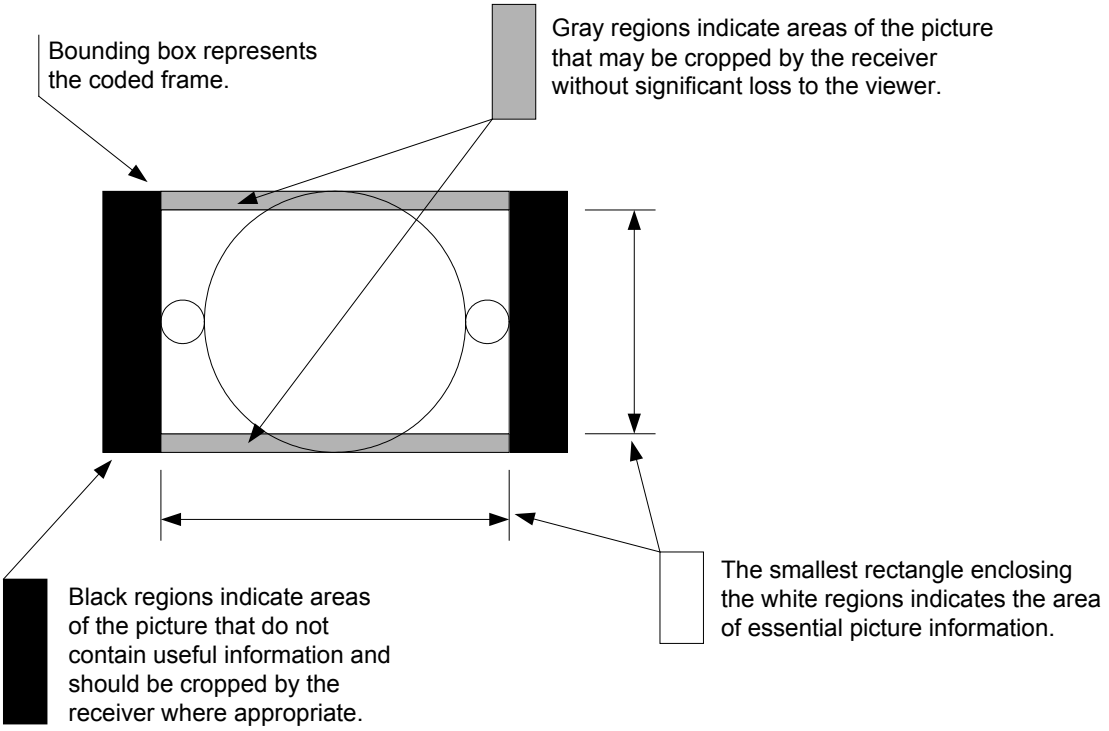


Figure 1 – Explanation of AFD diagrammatic representations (Informative)

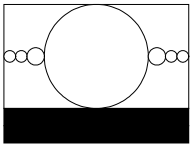
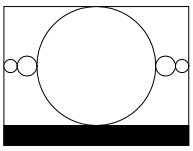
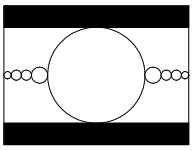
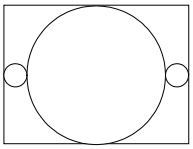
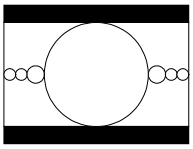
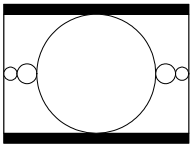
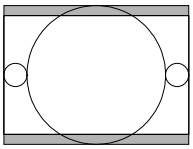
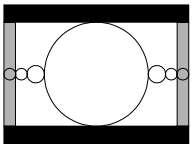
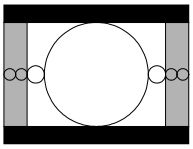
Active Format	Illustration in a 4:3 coded frame	Description
AFD = '0010' Box 16:9 (top)		Image with a 16:9 aspect ratio as letterbox at the top of a 4:3 coded frame.
AFD = '0011' Box 14:9 (top)		Image with a 14:9 aspect ratio as letterbox at the top of a 4:3 coded frame.
AFD = '0100' Box >16:9 (center)		Image with aspect ratio greater than 16:9 as a vertically centered letterbox in a 4:3 coded frame.
AFD = '1000' Full frame		Image is full frame, with an aspect ratio that is the same as the 4:3 coded frame.
AFD = '1010' 16:9 (center)		Image with a 16:9 aspect ratio as a vertically centered letterbox in a 4:3 coded frame.
AFD = '1011' 14:9 (center)		Image with 14:9 aspect ratio as a vertically centered letterbox in a 4:3 coded frame.
AFD = '1101' 4:3 (with alternative 14:9 center)		Image with a 4:3 aspect ratio and with an alternative 14:9 center in a 4:3 coded frame.
AFD = '1110' 16:9 (with alternative 14:9 center)		Image with a 16:9 aspect ratio and with an alternative 14:9 center as a vertically centered letterbox in a 4:3 coded frame.
AFD = '1111' 16:9 (with alternative 4:3 center)		Image with a 16:9 aspect ratio and with an alternative 4:3 center as a vertically centered letterbox in a 4:3 coded frame.

Figure 2 – AFD diagrammatic representations for images in a 4:3 coded frame (Informative)

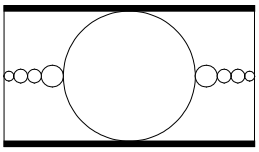
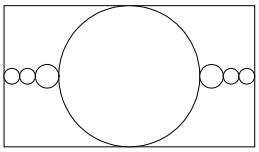
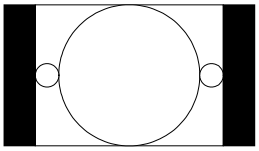
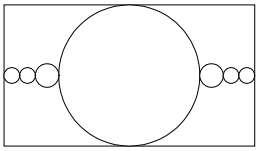
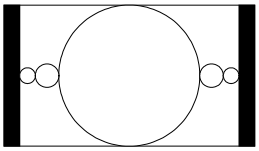
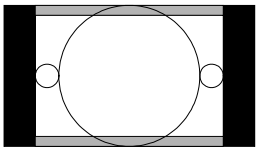
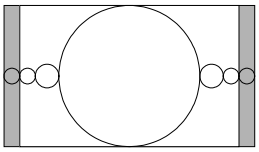
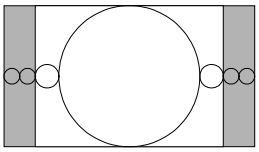
Active Format	Illustration in a 16:9 coded frame	Description
AFD = '0100' Box >16:9 (center)		Image with aspect ratio greater than 16:9 as a vertically centered letterbox in a 16:9 coded frame.
AFD = '1000' Full frame		Image is full frame, with an aspect ratio that is the same as the 16:9 coded frame.
AFD = '1001' 4:3 (center)		Image with a 4:3 aspect ratio as a horizontally centered pillarbox image in a 16:9 coded frame.
AFD = '1010' 16:9 (with complete 16:9 image protected)		Image is full frame, with a 16:9 aspect ratio and with all image areas protected.
AFD = '1011' 14:9 (center)		Image with a 14:9 aspect ratio as a horizontally centered pillarbox image in a 16:9 coded frame.
AFD = '1101' 4:3 (with alternative 14:9 center)		Image with a 4:3 aspect ratio and with an alternative 14:9 center as a horizontally centered pillarbox image in a 16:9 coded frame.
AFD = '1110' 16:9 (with alternative 14:9 center)		Image with a 16:9 aspect ratio and with an alternative 14:9 center in a 16:9 coded frame.
AFD = '1111' 16:9 (with alternative 4:3 center)		Image with a 16:9 aspect ratio and with an alternative 4:3 center in a 16:9 coded frame.

Figure 3 – AFD diagrammatic representations for images in a 16:9 coded frame (Informative)

5.1 Line and pixel numbers for AFD

Line and pixel numbers to be used for AFD calculations are video format-dependent and shall be based on the applicable production standard for the format, taking account of the spatial alignment of lines and pixels for compression encoding, all as shown in Table 2.

Table 2 – Video format information

Format	Applicable Production Standard	Pixels x Lines	Coded Pixels	Coded Lines		
				First Field	Second Field	Frame
480 Interlaced	SMPTE 125M	720 x 480	0 - 719	23 - 262	286 -525	–
480 Progressive	SMPTE 293M	720 x 480	0 - 719	–	–	45 - 524
576 Interlaced	ITU-R BT.656	720 x 576	0 - 719	23 - 310	336 - 623	–
576 Progressive	ITU-R BT.1358	720 x 576	0 - 719	–	–	45 - 620
720 Progressive	SMPTE 296M	1280 x 720	0 - 1279	–	–	26 - 745
1080 Interlaced	SMPTE 274M	1920 x 1080	0 - 1919	21 - 560	584 - 1123	–
1080 Progressive	SMPTE 274M	1920 x 1080	0 - 1919	–	–	42 - 1121

NOTE – Table 2 is based on a subset of the formats in SMPTE RP 202, Table 1.

In some compression systems, 704 pixels may be coded for the 480-line and 576-line formats; in this standard, 720 pixels shall be assumed for AFD and Bar Data calculations.

If AFD calculations result in non-integer values for lines or pixel numbers, the values used should be rounded to the nearest whole number.

5.2 Aspect ratio of coded frame

The aspect ratio of the coded frame shall be signaled with a single bit (see § 9.1). When the aspect ratio is 16:9, the bit shall be set to logical one. When the aspect ratio is 4:3, the bit shall be set to logical zero.

6 Bar Data

NOTE – The payload information defined in this clause is consistent with the Bar Data elements described in ATSC standard A/53. Other systems may use this scheme.

Bar Data should be present whenever the active image does not extend to the full height or width of the coded frame and AFD alone is insufficient to describe the extent of the image. Bar Data is constrained (below) to be signaled in pairs, either top and bottom bars or left and right bars, but not both pairs at once. Bars may be unequal in size. One bar of a pair may be zero width or height.

For signals destined for broadcast in regions where bar data may be used, AFD code ‘0100’ should, wherever possible, be accompanied by Top/Bottom Bar Data to define the height of the image.

For signals destined for broadcast in regions where bar data may be used, Bar Data may be used to define the width of the active image with aspect ratio less than 16:9 but not 4:3 or 14:9. This is signaled by using AFD code ‘0000’ in conjunction with the Bar Data.

See § 8 for the relationship among AFD, Bar Data and Pan-Scan information.

Bar Data consists of five elements: Bar Data flags, end of top bar line number, start of bottom bar line number, end of left bar pixel number, and start of right bar pixel number. In accordance with § 6.1, only three of these elements, the flags and one pair of bar numbers, will be signalled with any given frame where Bar Data is present. The line number or pixel number values define the innermost extent of the horizontal letterbox bars, and/or the vertical pillarbox bars. The syntax is shown in Table 3.

Table 3 – Bar Data element syntax

Syntax	No. of bits	Format
Bar Data flags() {		
top_bar_flag	1	Bslbf
bottom_bar_flag	1	Bslbf
left_bar_flag	1	Bslbf
right_bar_flag }	1	Bslbf
Top bar() {		
if (top_bar_flag == 1) {		
Marker_bits	2	'11'
line_number_end_of_top_bar }}	14	uimsbf
Bottom bar() {		
if (bottom_bar_flag == 1) {		
marker_bits	2	'11'
line_number_start_of_bottom_bar }}	14	uimsbf
Left bar() {		
if (left_bar_flag == 1) {		
marker_bits	2	'11'
Pixel_number_end_of_left_bar }}	14	uimsbf
Right bar() {		
if (right_bar_flag == 1) {		
marker_bits	2	'11'
Pixel_number_start_of_right_bar }}	14	uimsbf

6.1 Bar Data flags

The presence of bar data is signaled with a 4-bit field as shown in Table 3.

6.1.1 top_bar_flag

This flag bit shall indicate, when set to logical one, that the top Bar Data is present. If **left_bar_flag** is '1', this flag shall be set to '0'.

6.1.2 bottom_bar_flag

This flag bit shall indicate, when set to logical one, that the bottom Bar Data is present. This flag shall have the same value as **top_bar_flag**.

6.1.3 left_bar_flag

This flag bit shall indicate, when set to logical one, that the left Bar Data is present. If **top_bar_flag** is '1', this flag shall be set to '0'.

6.1.4 right_bar_flag

This flag bit shall indicate, when set to logical one, that the right Bar Data is present. This flag shall have the same value as **left_bar_flag**.

6.2 Line number end of top bar

The **line_number_end_of_top_bar** value is a 14-bit unsigned integer representing the last line of a horizontal letterbox bar area at the top of the reconstructed frame. Designation of line numbers shall be based on the video standards and information shown in Table 2.

6.3 Line number start of bottom bar

The **line_number_start_of_bottom_bar** value is a 14-bit unsigned integer value representing the first line of a horizontal letterbox bar area at the bottom of the reconstructed frame. Designation of line numbers shall be based on the video standards and information shown in Table 2.

6.4 Pixel number end of left bar

The **pixel_number_end_of_left_bar** value is a 14-bit unsigned integer representing the last horizontal luminance sample of a vertical pillarbox bar area at the left side of the reconstructed frame. Pixels shall be numbered from zero, starting with the leftmost pixel, based on the video standards and information shown in Table 2.

6.5 Pixel number start of right bar

The **pixel_number_start_of_right_bar** value is a 14-bit unsigned integer representing the first horizontal luma sample of a vertical pillarbox bar area at the right side of the reconstructed frame. Pixels shall be numbered from zero, starting with the leftmost pixel, based on the video standards and information shown in Table 2.

6.6 Line and pixel numbering

Designation of line and pixel numbers for Bar Data is video format-dependent and shall be based on the applicable standard for the format, taking account of the spatial alignment of lines and pixels for compression, all as shown in Table 2.

If Bar Data calculations result in non-integer values for lines or pixel numbers, the values used should be rounded to the nearest whole number.

For equipment generating Bar Data, when the Bar Data is present, line or pixel numbers shall be signaled on a frame by frame basis, with one set of Bar Data numbers per frame. For interlaced video frames, the line number for each bar may correspond to a line from either the first or the second field.

For progressive segmented frame systems, the Bar Data line numbers shall correspond to the numbers for interlaced video with the same raster structure.

NOTES

1 SMPTE RP 199 provides guidance in calculating the line and pixel numbers for images of different aspect ratios.

2 Examples showing derivation of Bar Data line numbers for progressive and interlaced systems are illustrated in Annex B.

7 Conversion to Other Video Formats

This section relates to any image-processing equipment that modifies a video signal such that a change in AFD and/or Bar Data is required.

The production formats listed in Table 2 do not restrict the applicability of AFD and Bar Data for use with any other formats for distribution or emission. When a video signal is converted from one format to another format, the device carrying out such conversion or encoding shall, if necessary, process the associated AFD and Bar Data so that it is correct for the output video format, replacing the original AFD and Bar Data.

NOTE – DTV receivers expect Bar Data to be expressed in terms of the source (production) image format as defined in the applicable SMPTE standard and assume that the image has been encoded in accordance with SMPTE RP 202. Therefore, changes to AFD and Bar Data will only be required if the conversion or encoding process changes the aspect ratio of the coded frame or changes the underlying associated production format. In particular, this means that Bar Data does not need to be changed for a video compression format that uses horizontal sub-sampling.

It is expected that equipment simply passing, switching, or recording the video signal, without format conversion, will leave the AFD and Bar Data unchanged.

8 Relationship Among AFD, Bar Data and Pan-Scan Information

Any combination of AFD and Bar Data may be present in a video signal. When AFD and Bar Data are present together, AFD is used by DTV receivers in preference to Bar Data, except in the case of AFD ‘0000’ and ‘0100’ where Bar Data is used in concert with AFD as described in § 6. In the absence of Bar Data or AFD information, DTV receivers interpret the active format as being the same as the coded frame. Video processing equipment using AFD and Bar Data should follow the same rules as DTV receivers. If Pan-Scan information is present in a video signal that also contains Bar Data and/or AFD, then video processing equipment should respond to either the Pan-Scan information or to Bar Data and/or the AFD, but not to both sets of information simultaneously.

9 Coding of AFD and Bar Data

9.1 Active Format Description coding

Active Format Description (AFD) information is a 4-bit code with values as defined in § 5 of this standard. When coded for transport as ancillary data, or KLV coded as SMPTE metadata, the AFD code shall be carried within a one-byte field, as shown in Table 4. One additional bit (b2) shall be used to signal the aspect ratio (AR) of the coded frame with values as defined in § 5.2. The remaining bits (b7, b1, and b0) of the AFD information byte are reserved and shall be set to logical zero.

Table 4 – AFD information byte

Bits	Description
b7	'0' (reserved)
b6-b3	AFD code data bits: a3, a2, a1, a0
b2	Aspect ratio (AR) of the coded frame: '1' = 16:9, '0' = 4:3
b1-b0	'00' (reserved)

NOTE – The bit positions for the AFD Information byte are consistent with practice in the U.K..

9.2 Bar Data coding

Bar Data information has status flags and line/pixel number values as defined in § 6 of this standard and shown in table 3. When coded for transport as ancillary data, or KLV coded as SMPTE metadata, Bar Data information shall be coded in a total of five bytes: one byte for Bar Data flags and four bytes for two Bar Data values.

9.2.1 Bar Data flags

The four Bar Data flags shall be coded in the Bar Data flags byte, as shown in Table 5. The remaining bits (b3, b2, b1, b0) are reserved and shall be set to logical zero.

Table 5 – Bar Data flags byte

Bits	Description	
B7	Top bar flag	'1' = Top Bar Data present
B6	Bottom bar flag	'1' = Bottom Bar Data present
B5	Left bar flag	'1' = Left Bar Data present
B4	Right bar flag	'1' = Right Bar Data present
B3-b0	Reserved	'0000'

NOTE – In ATSC standard A/53, the four lsb's of the byte coding the Bar Data flags are set to logical one in accordance with MPEG practice.

The bits in the Bar Data flags byte shall indicate to which bars the Bar Data values apply. In accordance with § 6, only one pair of Top and Bottom bars or one pair of Left and Right bars shall be signaled as present simultaneously.

When the Bar Data flag bits are all set to logical zero, there is no Bar Data present and the remaining 4 bytes of Bar Data should be ignored by receiving equipment.

9.2.2 Bar Data values

The Bar Data values from table 3 that are to be transported shall be coded in two 16-bit fields: Bar Data Value 1 and Bar Data Value 2. Each Bar Data value shall be carried in two bytes, with the most significant bit in bit 'b7' of the first byte and the least significant bit in bit 'b0' of the second byte.

Each 16-bit field shall consist of fixed marker bits '11' in the two most significant positions followed by the line number / pixel number information as shown in Table 3. If no valid Bar Data values for line number or pixel number are to be carried, then all bits of this field, including the marker bits, shall be set to logical zero.

Bar Data Value 1 shall correspond to the first (most significant) Bar Data flag bit that is set to logical one and Bar Data Value 2 shall correspond to the next Bar Data flag bit that is set to logical one.

9.3 Data repetition rate

AFD and Bar Data, when coded as ancillary data, shall be signaled on a frame by frame basis.

For equipment generating AFD and Bar Data with interlaced video systems, the AFD and Bar Data signaled for the first and second fields of the same frame shall be identical. For progressive segmented frame systems, the AFD and Bar Data signaled for the first and second segments of the same frame shall be identical.

NOTES

1 It is possible that a single interlaced video frame may comprise fields derived from different source images; e.g., when material originated as film, 24p, 50p, or 60p has been converted to 50i or 60i format. Users should take this into account when planning for the signalling of AFD and Bar Data changes, and are strongly encouraged to make the transition when it will be least disruptive, such as when the program dips to black.

2 It is possible that an interlaced video stream that has been derived by conversion from 50p or 60p material already carrying AFD/Bar Data, may, at points where AFD or Bar Data changes, contain a video frame for which the AFD and Bar Data data is not identical in each field. The same situation may occur when interlaced video carrying AFD/Bar Data has been processed in video equipment that switches on field rather than frame boundaries. This may be due to a variety of “real-world” circumstances downstream of the generating equipment. Users should take this into account when considering the design and operation of equipment that receives or processes AFD and Bar Data on an incoming video signal. It is expected that the new AFD or Bar Data value on the second field will typically be ignored by processing equipment.

3 Program producers planning to signal picture format changes should note that some receiving devices may have difficulty reacting to frequent changes in AFD and Bar Data and that rapid changes in picture formatting may be subjectively objectionable to the viewer.

Annex A (Informative)
Bibliography

ATSC A/53, Part 4:2009, Digital Television Standard — MPEG-2 Video System Characteristics

CEA-CEB16 (2006), Active Format Description (AFD) & Bar Data Recommended Practice

Digital TV Group v1.2.1 (2001), DTG Implementation and User Group Digital Receiver Implementation Guidelines and Recommended Receiver Reaction to Aspect Ratio Signalling in Digital Video Broadcasting

ETSI EN300294 V1.4.1 (2003-04), Television Systems; 625-Line Television Wide Screen Signalling (WSS)

ETSI TS101154 V1.9.1 (2009-09), Digital Video Broadcasting (DVB); Implementation Guidelines for the Use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream

ISO/IEC IS 13818-2:2000 (E), International Standard, Information Technology – Generic Coding of Moving Pictures and Associated Audio Information, Video

SMPTE RP 186-2008, Video Index Information Coding for 525- and 625-Line Television Systems

SMPTE RP 187-1995, Center, Aspect Ratio and Blanking of Video

SMPTE RP 199-2004, Mapping of Pictures in Wide-Screen (16:9) Scanning Structure to Retain Original Aspect Ratio of the Work

SMPTE RP 202-2008, Video Alignment for Compression Coding

SMPTE RP 221-2008, Specifications for Extraction of 4 x 3 Areas from Digital 16 x 9 Images for Television Systems

Annex B (Informative)
Example of Bar Data

B.1 Example of Bar Data for progressive scan active image with aspect ratio >16:9

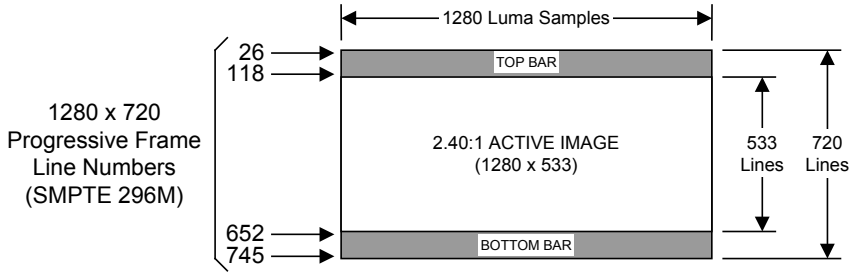


Figure B.1 – 2.4:1 letterbox image displayed in a 1280 x 720 16:9 frame

This example shows a 2.4:1 aspect ratio widescreen image as a vertically centered letterbox in a 1280 x 720 progressive 16:9 coded frame. The AFD code to be signaled for this arrangement is '0100', with an aspect ratio code of '1'. Bar Data to complete the description is derived as follows:

1 SMPTE RP 199 describes how picture height or width is calculated for a given aspect ratio. In this case, the height of a 2.4:1 aspect ratio image in a 1280 x 720 frame is 1280/2.4 = 533 lines, when rounded to the nearest whole number.

2 The total height of the two bars is 720 – 533 = 187 lines. It is normal practice, though not required, to approximately center the image vertically in the frame, therefore one bar is 93 lines high and the other is 94 lines high.

3 The line numbers are referenced to the production standard for the source image, which in this case is SMPTE 296M, taking account of the spatial alignment of lines and pixels recommended in table 2 of this standard. As shown in table 2, the first line of the 720 coded frame (in SMPTE terms the active video), is line 26 and the last line is line 745. Therefore, the bottom of the top bar is 26 + 93 –1 = 118, and the top of the bottom bar is 745 – 94 +1 = 652.

4 The line numbers are coded as unsigned 14 bits, carried in two bytes of data. The Bar Data flags are set to indicate which bars are present, in this case top and bottom.

Table B.1 shows the Bar Data information parameter values for the above example.

Table B.1 – Bar Data for a 2.4:1 letterbox image in 16:9 coded frame

Parameter	Value for 1280 x 720p frame
Bar Data flags	'1100'
line_number_end_of_top_bar (Bar Data Value 1)	'00 0000 0111 0110' (0076_h) (118)
line_number_start of_bottom_bar (Bar Data Value 2)	'00 0010 1000 1100' ($028C_h$) (652)

B.2 Example of Bar Data for interlaced scan active image with aspect ratio >16:9

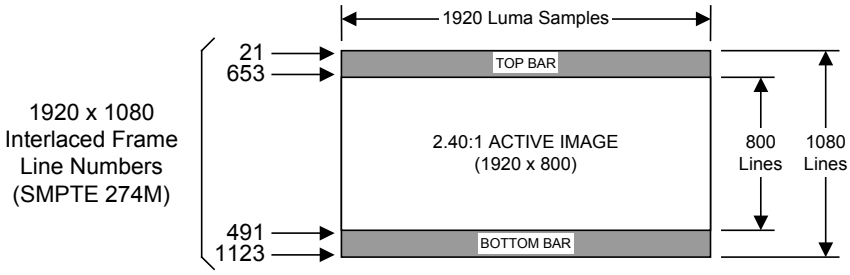


Figure B.2 – 2.4:1 letterbox image displayed in a 1920 x 1080 16:9 frame

Table B.2 – Example of Bar Data line numbering for 1920x1080i

Top bar height in lines	Bar ends on line number	
	from first field	from second field
0		583
1	21	
2		584
3	22	
4		585
5	23	
6		586
continues in sequence		
137	89	
138		652
139	90	
140		653
141	91	
142		654
143	92	

Bottom bar height in lines	Bar begins on line number	
	from first field	from second field
143		1052
142	490	
141		1053
140	491	
139		1054
138	492	
137		1055
continues in sequence		
6	558	
5		1121
4	559	
3		1122
2	560	
1		1123
0	561	

This example shows a 2.4:1 aspect ratio widescreen image as a vertically centered letterbox in a 1920 x 1080 interlaced 16:9 coded frame. The AFD code to be signaled for this arrangement is '0100', with an aspect ratio code of '1'. Bar Data to complete the description is derived as follows:

1 SMPTE RP 199 describes how picture height or width is calculated for a given aspect ratio. In this case, the height of a 2.4:1 aspect ratio image in a 1920 x 1080 frame is 1920/2.4 = 800 lines.

2 The total height of the two bars is 1080 – 800 = 280 lines. It is normal practice, though not required, to approximately center the image vertically in the frame, therefore both bars are 140 lines high.

3 The line numbers are referenced to the production standard for the source image, which in this case is SMPTE 274M, taking account of the spatial alignment of lines and pixels recommended in Table 2 of this standard. The first line of the 1080 coded frame (in SMPTE terms the active video), is line 21 (from the first field) and the last line is line 1123 (from the second field). As highlighted in gray in Table B.2, the 140th

line from the top of the image is line 653 (a line from the second field). Similarly the 140th line from the bottom of the image is line 491 (a line from the first field).

4 Table B.2 shows the sequence of Bar Data line numbers for a given bar height and the particular line numbers in a 1920 x 1080 interlace frame. Bar heights greater than 143 lines are possible but not shown in the table.

5 The line numbers are coded as 14 bits unsigned, to be carried in two bytes of data. The Bar Data flags are set to indicate which bars are present, in this case top and bottom.

Table B.3 shows the Bar Data information parameter values for the above example.

Table B.3 – Bar Data for a 2.4:1 letterbox image in 16:9 coded frame

Parameter	Value for 1920 x 1080i frame
Bar Data flags	'1100'
line_number_end_of_top_bar (Bar Data Value 1)	'00 0010 1000 1101' ($028D_{h)}$) (653)
line_number_start of_bottom_bar (Bar Data Value 2)	'00 0001 1110 1011' ($01EB_{h}$) (491)

NOTE – The values in Table B.3 relate to the frame; equipment generating Bar Data with interlaced video systems uses this value for both the first and second fields.

Annex C (Informative)
Road Map to Related Standards for AFD, Bar Data and Pan-Scan (informative)

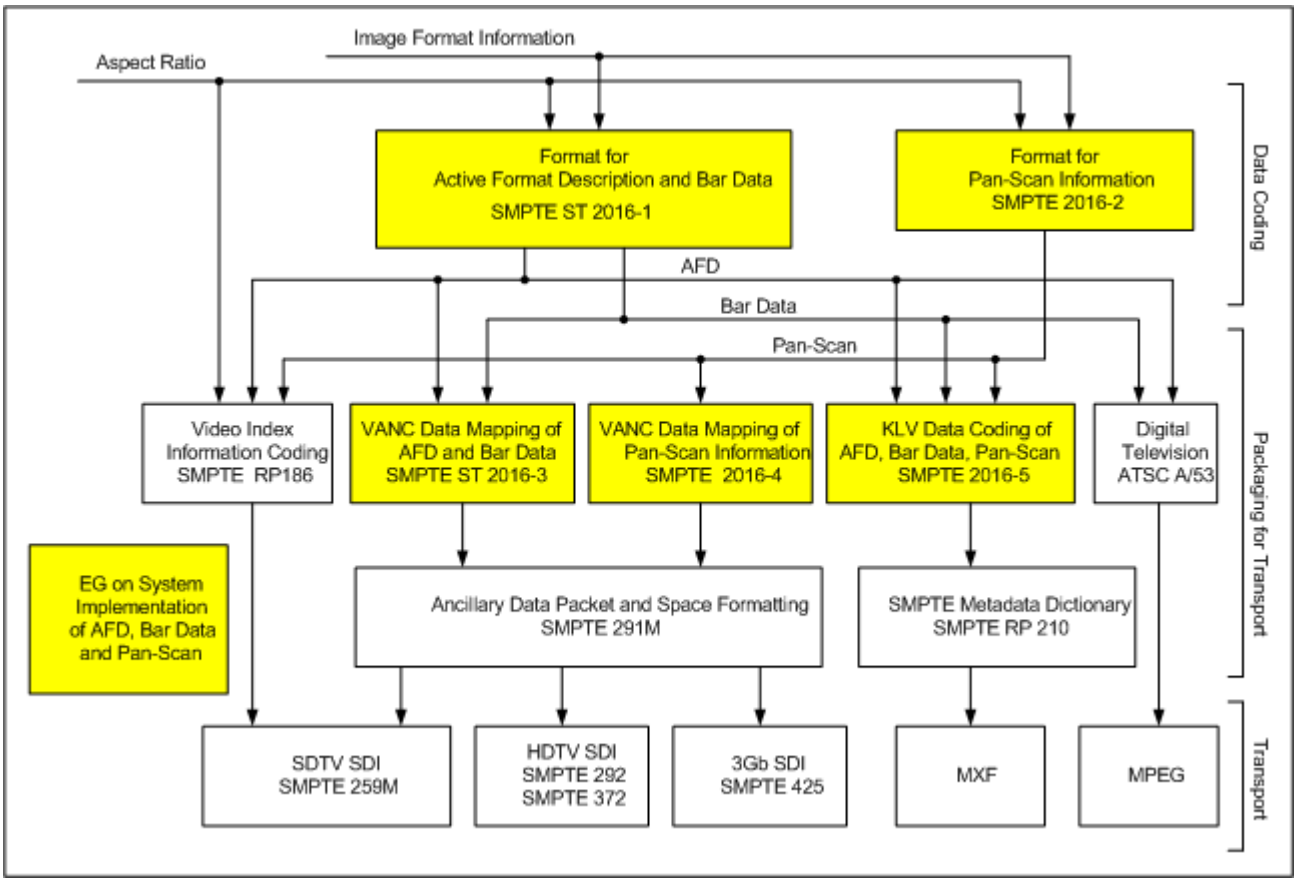


Figure C.1 – Road Map – AFD, Bar Data, and Pan-Scan information

Revision Notes

This revision incorporates Amendment #1 to SMPTE ST 2016-1 approved December 14, 2009.

The changes are summarized below:

1. The Table of Contents and the Foreword section have been revised.
2. An Intellectual Property section has been added to be in conformance with other SMPTE documents.
3. Normative References in Section 3 have been updated.
4. The following sections have been revised: Note 1 in Section 5, Section 7, and Section 9.3.
5. Informative References in the Annex A Bibliography have been updated.
6. In Annex C, Figure C.1 (Road Map) has been revised to show updated document reference numbers.