SMPTE ST 2016-2:2014
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SMPTE STANDARD

Format for Pan-Scan Information

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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.

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SMPTE ST 2016-2 was prepared by Technology Committee 24TB.

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Introduction

Image formatting information describes certain spatial characteristics of a high definition or standard definition video image. It is 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 an image raster when the active video does not completely fill that raster, 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 ST 2016-2 Format for Pan-Scan Information
SMPTE ST 2016-3 Vertical Ancillary Data Mapping of Active Format Description and Bar Data
SMPTE ST 2016-4 Vertical Ancillary Data Mapping of Pan-Scan Information

Other SMPTE standards can be used for alternative transport methods for this data.

1 Scope

This Standard defines Pan-Scan information for origination and conveyance through the production and distribution processes for standard definition or high definition television signals.

Associated standards define how this information is placed into ancillary data packets and is KLV coded as SMPTE metadata (see Annex C).

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 document contains provisions which, through reference in this text, constitute provisions of this recommended practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

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

4 Definitions

4.1
output image
The rectangular area that represents the result of an image conversion process.

4.2
source image
The rectangular area represented by the production aperture of the source signal.

4.3
viewport
A selected rectangular area of a source image that will be used to create an output image.

5 Pan-Scan Information

5.1 Overview

Pan-Scan information describes a variable image viewport and output image aspect ratio that may be employed in professional applications to create a new output image from the source image. Pan-Scan information shall consist of six elements, comprising a Pan-Scan data set ID, Pan-Scan data flags and aspect ratio code, horizontal viewport offset, vertical viewport offset, vertical size coefficient, and horizontal size coefficient. These elements shall be coded as shown in table 1. One byte shall be used to label the data set with an ID code. One byte shall be used to represent the Pan-Scan flags and aspect ratio code. Eight bytes shall be used to represent two 16-bit numbers and two 14-bit numbers defining a viewport (target) aperture relative to the source image. Bits p0, t0, v0, and h0 shall be the least significant bits.

Center of picture shall be based on the source input format, and shall be as defined in SMPTE RP 187. For SMPTE ST 125 (525i) and SMPTE ST 293 (525P) formats, the center of picture should be based on 483 active lines. Although an 8-bit data structure is shown here, different transport mechanisms may specify a different structure and bit/byte order for transport.

Table 1 – Pan-Scan informational payload

Data Set Words		Data Set Word bits							
Word	**Function**	**b7**	**b6**	**b5**	**b4**	**b3**	**b2**	**b1**	**b0**
1	Data Set ID	id7	id6	id5	id4	id3	id2	id1	id0
2	P-S Flags & AR code	Pan	Tilt	Vert	Horiz	rsv	ar2	ar1	ar0
3	Pan Horizontal offset	p15	p14	p13	p12	p11	p10	p9	p8
4		p7	p6	p5	p4	p3	p2	p1	p0
5	Tilt Vertical offset	t15	t14	t13	t12	t11	t10	t9	t8
6		t7	t6	t5	t4	t3	t2	t1	t0
7	Vertical size	'0'	'0'	v13	v12	v11	v10	v9	v8
8		v7	v6	v5	v4	v3	v2	v1	v0
9	Horizontal size	'0'	'0'	h13	h12	h11	h10	h9	h8
10		h7	h6	h5	h4	h3	h2	h1	h0
11	Reserved	'0'	'0'	'0'	'0'	'0'	'0'	'0'	'0'
12	Reserved	'0'	'0'	'0'	'0'	'0'	'0'	'0'	'0'

where:

Pan, Tilt, Vert & Horiz are Pan-Scan parameter presence flags;
id7 – id0 is the Pan-Scan Data Set ID code;
ar2 – ar0 is the Output image aspect ratio code;
p15 – p0 is the Horizontal viewport offset (Pan);
t15 – t0 is the Vertical viewport offset (Tilt);
v13 – v0 is the Vertical size coefficient (Zoom vertical);
h13 – h0 is the Horizontal size coefficient (Zoom horizontal).
rsv is a reserved bit and shall be set to 0

5.2 Pan-Scan Data Sets

Applications may define more than one set of Pan-Scan Data Set parameters for an image sequence. Each data set shall be labeled by an 8-bit Data Set identification code. The intended use of the ID is to signal a unique pan-scan version. There may be multiple data sets per frame. Each data set shall have unique ID value. See Section 7.1.1 for assignments of the Data Set ID values.

The use of these elements shall be as illustrated in Figure 1. Horizontal offset (Pan) and vertical offset (Tilt) shall be 16-bit signed binary numbers, representing source image pixels or lines, with 4 bits subpixel resolution (i.e., "n"-bit fixed point binary number with "n-4" significant bits and four fractional bits). Vertical size (Zoom Vertical) shall be an unsigned binary number representing source image lines. Horizontal size (Zoom Horizontal) shall be an unsigned binary number representing source image pixels.

If the bounds of the viewport exceed the bounds of the source image these portions should be filled with a null signal (e.g. black or grey). If the bounds of the viewport are inside the source image, the pixels outside of the viewport should be discarded.

Pan-Scan parameters shall be interpreted based on the source image parameters (horizontal pixels and vertical lines). Image format up or down conversion (output image format resolution not the same as the input image format resolution) is outside the scope of this standard.

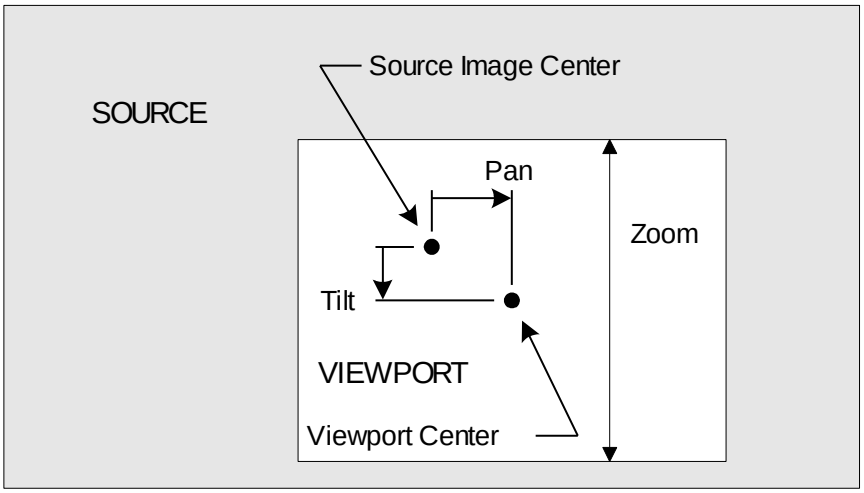

Figure 1 – Pan-Scan Parameters

5.3 Pan-Scan Data Flags and Aspect Ratio

The presence of Pan-Scan data shall be signaled with a 4-bit field for viewport data flags, carried in a one-byte field, as shown in Table 2. Setting all bits in the Pan, Tilt, V-Size and H-Size flags to logical zero shall turn Pan-Scan off. Individual flags shall be set on or off (1 or 0) to indicate to a receive device which Pan-Scan data is present as well as to activate the appropriate image processing (such as cropping and filtering). This field shall also code the aspect ratio of the output image using the codes shown in Table 3. The reserved bit shall be set to ‘0’.

Table 2 – Pan-Scan presence flags and aspect ratio code

Bit	Description	Comments
b7	Pan data present	'1' = present
b6	Tilt data present	'1' = present
b5	Vertical Size data present	'1' = present
b4	Horizontal Size data present	'1' = present
b3	Reserved	set to '0'
b2	Output image aspect ratio	ar-2
b1		ar-1
b0		ar-0

5.4 Horizontal Viewport Offset – Pan

The Pan value shall be a 16-bit signed binary number, using two's complement, with 4 bits of sub-pixel resolution. It shall specify the location of the center of the viewport with respect to the center of the source image, in source pixels. Positive numbers shall represent a pan to the right. The illustration in figure 1 shows a viewport with a positive pan. A zero value shall represent "no pan". The range of values of horizontal viewport offset (pan) shall be from $7FF.F_h$ ($2047^{15}/_{16}$) to 800.0_h (-2048).). If the Pan flag is set to 0, then the Horizontal viewport offset shall be equal to zero and the Horizontal viewport offset data shall be disregarded.

5.5 Vertical Viewport Offset – Tilt

The Tilt value shall be a 16-bit signed binary number, using two's complement, with 4 bits of sub-pixel resolution. It shall specify the location of the center of the viewport with respect to center of the source image, in source lines. Positive numbers shall represent a tilt down. The illustration in figure 1 shows a viewport with a positive tilt. A zero value shall represent "no tilt". The range of values of vertical viewport offset (tilt) shall be from $7FF.F_h$ ($2047^{15}/_{16}$) to 800.0_h (-2048). If the Tilt flag is set to 0, then the Vertical viewport offset shall be equal to zero and the Vertical viewport data shall be disregarded.

5.6 Vertical Size Coefficient – Zoom Vertical

The vertical size coefficient value shall be a 14-bit unsigned binary number. It shall specify the height of the viewport, in lines of the source image. Values greater than the number of lines in the source image shall represent a zoom-out or shrinkage of the image. Values less than the number of lines in the source image shall represent a zoom-in or expansion of the image. The maximum value of the vertical size coefficient shall be $1FFF_h$ (8191). If the Vertical Size flag is set to 0, then the Vertical Size shall be equal to the source image format's vertical line count and the Vertical Size coefficient data shall be disregarded.

5.7 Horizontal Size Coefficient – Zoom Horizontal

The horizontal size coefficient value shall be a 14-bit unsigned binary number. It shall specify the width of the viewport, in pixels of the source image. Values greater than the number of pixels in the source image line shall represent a zoom-out or shrinkage of the image. Values less than the number of pixels in the source image line shall represent a zoom-in or expansion of the image. The maximum value of the horizontal size coefficient shall be $1FFF_h$ (8191). If the Horiz Size flag is set to 0, then the Horizontal Size coefficient shall be equal to the source image format's horizontal pixel count and the Horizontal Size coefficient shall be disregarded.

5.8 Output Image Aspect Ratio Coding

Code values defining the output image aspect ratio shall be as shown in Table 3.

Table 3 – Output image aspect ratio codes

Code ar-2, ar-1, ar-0	Aspect ratio	Description and application
'000'	Undefined	
'001'	1.33	Video (4:3)
'010'	1.56	Video (14:9)
'011'	1.78	Video (16:9) widescreen
'100'	1.85	Film format widescreen
'101'	2.40	Film format (’Scope) (See note 3)
'110'	Reserved	Reserved for future definition
'111'	Reserved	Reserved for future definition

Notes:

1 The aspect ratio in Table 3 applies to the Output Image and does not specify the aspect ratio of the viewport.

2 An example of Pan-Scan information for a simple image extraction is shown in Annex B.

3 Also known as Anamorphic format as defined in the American Cinematographer Manual

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

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.

7 Coding of Pan-Scan information

7.1 Pan-Scan Information Coding

Pan-Scan information shall be as defined in Section 5 of this standard and shown in Table 1. When coded for transport as ancillary data, Pan-Scan information shall be coded in a total of 12 bytes: one byte for data set id, one byte for Pan-Scan presence flags and the aspect ratio code, eight bytes for four Pan-Scan parameter values and two reserved bytes.

7.1.1 Data Set ID byte

The data set ID byte shall be coded as a full byte within the range from 00_h to FF_h. The data set ID code with all bits set to logical 0 (0_h) shall indicate that there is no Pan-Scan present and the remaining 11 bytes of Pan-Scan information should be ignored. The ID value of 01_h shall be used to indicate a generic Pan-Scan data set. The ID values from 02_h to $3F_h$ shall be reserved. The ID values from 40_h to FE_h shall be user defined. The ID value of FF_h shall be reserved. Within a frame, there shall not be duplicate data set ID’s.

Note: The reader is cautioned that user defined value assignments need to be pre-arranged between parties that use these data set values and that other parties might interpret them differently.

7.1.2 Pan-Scan flags byte

The four Pan-Scan presence flags shall be coded, together with the aspect ratio from Table 3, in the Pan-Scan flags byte as shown in Table 2. The remaining bit (b3) shall be reserved, shall be set to logical zero, and should be ignored by receiving equipment.

A Pan-Scan flags byte with all bits set to logical zero shall indicate that the remaining 10 bytes of Pan-Scan information should be ignored.

7.1.3 Pan-Scan information fields

The Pan-Scan pan (horizontal offset), tilt (vertical offset), vertical size, and horizontal size parameter values from Table 1 that are to be transported shall be coded in four 16-bit fields, each filling 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.

Vertical Size and Horizontal Size shall be 14-bit numbers, and the most significant bits b7 and b6 of their high order bytes shall be set to ‘0’.

7.2 Data Repetition Rate

Pan-Scan information, when coded as ancillary data, shall be signaled such that:

1. for natively generated interlaced video system signals, the Pan-Scan information for the first and second fields of the same frame shall be identical;

2. for interlaced video signals derived from 24p image sequences, the Pan-Scan information for each field shall be identical to the Pan-Scan information for the image from which it was derived;

   Note: For example, when transporting 24 frame/sec(fps) image sequences within 60 fields per second(fld/sec) video formats, there will be video frames where the Pan-Scan information located in the VANC of the first field is different than the Pan-Scan information located in the VANC of the second field. For example, if the 24fps source images, ABCDE are converted to a 60 fld/sec video sequence, A/A, B/B, B/C, C/D, D/D, E/E, the mixed video frames (B/C and C/D) consist of fields that are derived from different 24fps images and can have different Pan-Scan information. Further, in the case of video frame B/C, the second field derived from the C image occurs prior to the first field derived from the C image in the 60 field per second sequence.

3. for progressive segmented frame systems, the Pan-Scan information signaled for the first and second segments of the same frame shall be identical.

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 274:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 274M-2008). Documents with the same root number (e.g. 274) and publication year (e.g. 2008) are functionally identical.

SMPTE ST 125:2013, SDTV Component Video Signal Coding 4:4:4 and 4:2:2, for 13.5 MHz and 18 MHz Systems

SMPTE ST 274:2008, Television – 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE ST 293:2003, Television – 720 x 483 Active Line at 59.94-Hz Progressive Scan Production – Digital Representation

SMPTE ST 296:2012, 1280 × 720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

SMPTE ST 2036-1:2013, Ultra High Definition Television — Image Parameter Values for Program Production

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

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

ITU-R BT.1358-1 (09/07), Studio Parameters of 625 and 525 Line Progressive Television Systems

American Cinematographer Manual, Tenth Edition, ASC Press, 2013

Annex B Example Pan-Scan Information (Informative)

B.1 Example of Pan-Scan to Extract a 4:3 Image from a 16:9 Image

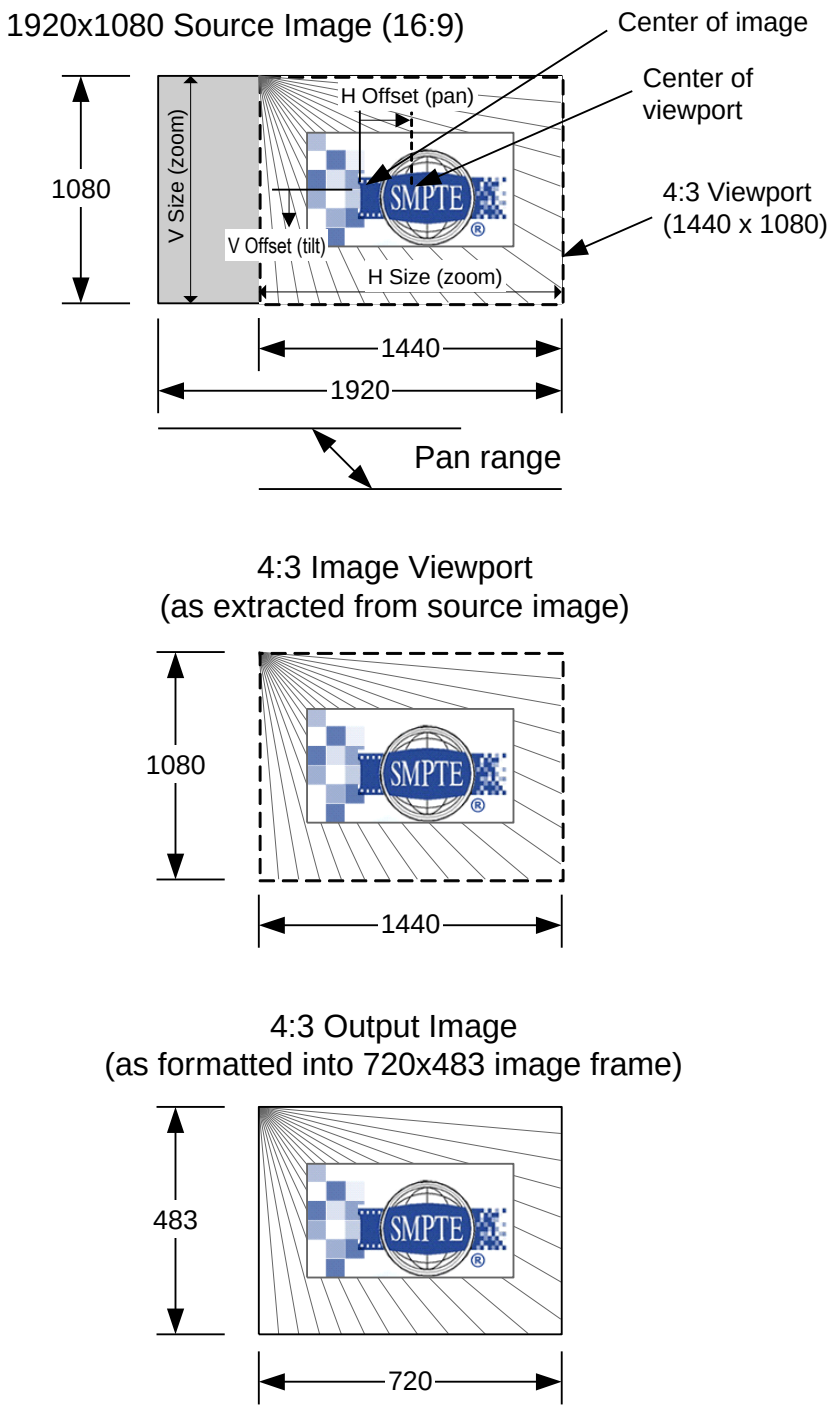

Figure B.1 – Extraction of a 4:3 viewport from a 1920 x 1080 16:9 source image

This example illustrates the process of extracting a 4:3 viewport image from a 1920x1080 16:9 source image. In this simple example the viewport is the full height of the source image (no zoom) and with no tilt. The figure shows the viewport panned to the right edge in the 16:9 frame. For completeness, the figure illustrates the process of format conversion to the output image. In this example, the output image format is 720x483. The format conversion process is not covered by this standard.

Pan-scan parameters for this example are derived as follows:

1. In this example, the data set ID values are set to the first user space value, 64 (40_h). Each successive data set ID is incremented by 1 (65, 66).

2. Pan data present flag is 1 (in this example horizontal offset is used to derive three extractions, center of picture, left justified and right justified).

3. Tilt data present flag is 0 (no vertical offset used).

4. Vertical size data present flag is 1 (turns on vertical processing).

5. Horizontal size data present flag is 1 (turns on horizontal processing).

6. Output image aspect ratio is 4:3, aspect ratio code is set to 001, as defined in Table 6 (indicates how the output pixels are to be mapped).

7. Pan H-Offset = 0 for centered viewport. For full pan right, offset = (1920 – 1440)/2 = plus 240 pixels. For full pan left offset = minus 240.

8. Tilt V-Offset = 0 (no vertical offset used).

9. Vertical Size coefficient is full height = 1080 lines (vertical zoom =1).

10. In this case (non-anamorphic source and output images), the viewport and output image aspect ratios are the same (4:3). RP 199 describes how picture height or width is calculated for a given aspect ratio and the width of a 4:3 aspect ratio image in a 1920 x 1080 frame is 3/4 * 1920 x = 1440 pixels.

11. Horizontal Size coefficient = 1440 pixels (horizontal crop because the horizontal size is less than the source image horizontal size).

12. The numerical values for H Size and V Size are coded in 14 bits unsigned to be carried in two bytes of data. The numerical values for H-Offset and V-Offset are coded in 16 bits signed, 2’s complement (12 bits integer, 4 bit fractions). The four Pan-Scan flags, reserved bit b3 (set to 0), and Aspect Ratio code are combined in one byte.

Table B.1 shows the Pan-Scan information parameter values for the above example with full right pan viewport.

Table B.1 – Pan-Scan parameters for a 4:3 viewport from 1920x1080 16:9 source image – right pan

Parameter	Value
Data Set ID	'1000 0000' {40_h}
Pan-Scan Flags and AR	'1011 0001' {$B1_h$}
Pan H - Offset	'0000 1111 0000.0000' {0F0.0 $_h$ } (+240.0)
Tilt V - Offset	'0000 0000 0000.0000' {000.0 $_h$ } (0.0)
Zoom vertical - Vertical Size	'00 0100 0011 1000' {0438 $_h$ } (1080)
Zoom Horizontal - Horizontal Size	'00 0101 1010 0000' {05A0 $_h$ } (1440)

Table B.2 shows the Pan-Scan information parameter values for the above example with full left pan viewport.

Table B.2 – Pan-Scan parameters for a 4:3 viewport from 1920x1080 16:9 source image – left pan

Parameter	Value
Data Set ID	'1000 0001'{41_h}
Pan-Scan Flags and AR	'1011 0001' {$B1_h$}
Pan H - Offset	'1111 1111 10001.0000' {F10.0 $_h$ } (-240.0)
Tilt V - Offset	'0000 0000 0000.0000' {000.0 $_h$ } (0.0)
Zoom vertical - Vertical Size	'00 0100 0011 1000' {0438 $_h$ } (1080)
Zoom Horizontal - Horizontal Size	'00 0101 1010 0000' {05A0 $_h$ } (1440)

Table B.3 shows the Pan-Scan information parameter values for the above example with viewport centered.

Table B.3 – Pan-Scan parameters for a 4:3 viewport from 1920x1080 16:9 source image – centered

Parameter	Value
Data Set ID	'1000 0010' {42_h}
Pan-Scan Flags and AR	'0011 0001' {31_h}
Pan H - Offset	'0000 0000 0000.0000' {000.0_h} (0.0)
Tilt V - Offset	'0000 0000 0000.0000' {000.0 $_h$ } (0.0)
Zoom vertical - Vertical Size	'00 0100 0011 1000' {0438 $_h$ } (1080)
Zoom Horizontal - Horizontal Size	'00 0101 1010 0000' {05A0 $_h$ } (1440)