SMPTE ST 436-1:2013
Revision of
SMPTE 436M-2006

SMPTE STANDARD

MXF Mappings for VI Lines and Ancillary Data Packets

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Approved
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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.

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

SMPTE ST 436-1 was prepared by Technology Committee 31FS.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. 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

This section is entirely informative and does not form an integral part of this Engineering Document.

Many of the established broadcast file formats transport opaque (without knowledge of the contents) Vertical Interval lines (VI lines or VI data) and Ancillary Packets (ANC packets). This standard is intended to allow the transport of opaque VI lines and ANC packets for compatibility with established formats and to facilitate the use of MXF for existing and new applications. Previous SMPTE documents used the nomenclature "Vertical Blanking Interval" which is being changed to "Vertical Interval" in new documents.

VI lines and ANC packets have many applications. In some cases this information can be encapsulated as standardized MXF essence or metadata items (e.g. embedded audio). In other cases this approach is not practical. For example, some applications documented by SMPTE may not have direct MXF mappings; in addition, some operators encode non-standardized data in VI lines. Attempting to document each of these applications is outside the scope of this standard. Adding a capability to MXF which supports opaque VI lines and opaque Ancillary packets is a better solution.

This standard provides a variety of VI data and ANC packet transport facilities which supports a broad range of MXF applications. In some applications the VI line or ANC packet mapping defined in SMPTE ST 385 / SMPTE ST 331 could be the best transport model (e.g. SMPTE ST 386 and SMPTE ST 387). Using SMPTE ST 382 to transport embedded audio (see SMPTE ST 299-1 and SMPTE ST 299-2) is current practice and is recommended for new implementations. It is recommended that new MXF standards use the VI line and ANC packet mapping that is most appropriate for the application.

If an MXF file's contents are converted from one video format to another, the VI data and ANC packets could require processing. In some cases, the conversions are simple and in others the conversions are complex. The specification of these conversions is beyond the scope of this standard. Additional information can be found in SMPTE RP 291-2.

This standard describes the transport of VI data and ANC packets in MXF files. This standard establishes a partial set of requirements and policies for the capture of video signals by encoders and for the regeneration of video signals by decoders. Specifications of some requirements (e.g. the processing of illegal input signals) are not part of the specification for MXF systems components. These specifications could be part of other standards and recommended practices.

Users of this standard must follow the recommendations and requirements established by video signal standards and recommended practices. This document does not describe the restrictions and capabilities of video interfaces; it offers features needed to transport VI lines and ANC packets in an MXF file.

This standard does not specify which VI lines or ANC packets will be captured by an encoder, or included in the MXF file or processed by a decoder. These provisions can be found in other documents or established by an application specification, a vendor or an end-user.

The original version of this standard encoded physical or logical Serial Digital Interface sample streams defined by SMPTE ST 259, SMPTE ST 292-1 and SMPTE ST 424 as MXF files. This standard can be used with Serial Digital Interface standards derived from the above standards given the limitations of this document's representation of VI Data, ANC Packets and the required MXF metadata.

1 Scope

This standard describes the carriage of Vertical Interval (VI) data and Ancillary (ANC) packets (HANC and VANC) in an MXF file. This standard defines the MXF wrapping of VI lines for 8-bit and 10-bit component digital signals for standard definition and high-definition television systems. This standard defines the MXF wrapping of ANC packets located on SMPTE Serial Digital Interfaces. This standard specifies information to be encoded in an MXF file so that a decoder can place decoded VI data and ANC packets at the desired locations in a reconstructed television signal. This standard does not describe the content of MXF VI data payloads and MXF ANC packet payloads or their conversion to and from physical or logical interfaces, networks, and systems other than MXF.

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.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3 Normative References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 259:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 259M-2008). Documents with the same root number (e.g. 259) and publication year (e.g. 2008) are functionally identical.

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

SMPTE ST 259:2008, Television — SDTV Digital Signal/Data — Serial Digital Interface

SMPTE ST 291-1:2011, Ancillary Data Packet and Space Formatting
(Note: Document previously numbered SMPTE ST 291:2011 – Content Unchanged)

SMPTE ST 292-1:2012, 1.5 Gb/s Signal/Data Serial Interface

SMPTE ST 377-1:2011, Material Exchange Format (MXF) — File Format Specification

Amendment 1:2012 to SMPTE ST 377-1:2011

Amendment 2:2012 to SMPTE ST 377-1:2011

SMPTE ST 379-1:2009, Material Exchange Format (MXF) — MXF Generic Container

SMPTE ST 379-2:2010, Material Exchange Format (MXF) — MXF Constrained Generic Container

SMPTE ST 424:2012, 3 Gb/s Signal/Data Serial Interface

SMPTE RP 168:2009, Definition of Vertical Interval Switching Point for Synchronous Video Switching

4 Definitions

The full glossary of acronyms, terms and data types used in the MXF specification is given in the MXF File Format Specification (SMPTE ST 377-1). They are not repeated here to avoid any divergence of meaning. The following additional definitions shall be used when interpreting this standard.

4.1
Active video
The lines in the television raster (and the samples within each of these lines) that are part of the visible image.

4.2
ANC packets
Ancillary packets contain up to 255 10-bit words of user data and most control and identifier words. These packets are transported in the vertical and horizontal intervals of a television signal. See SMPTE ST 291-1 and SMPTE RP 291-2.

Note: SMPTE ST 291-1 allows multiple type 1 ANC packets to be logically combined to transport ANC user data blocks with more than 255 user data words. This standard transports opaque ANC packets of all types.

4.3
ANC Element
The collection of ANC Structures for one field or frame of video.

4.4
ANC Payload Array
The ANC packet data for one ANC packet including the DID, data block number or SDID, data block count, ANC user data words, and possibly the check sum word.

Note: The use of ANC Payload Array might be confused with the ANC payload (ANC user data) used in some other SMPTE documents; caution is advised.

4.5
ANC Structure
The MXF properties for an ANC packet and the ANC Payload Array. This represents one ANC packet in an MXF file.

4.6
Data Element
KLV wrapped data essence within a Content Package. See SMPTE ST 379-1 and SMPTE ST 379-2 for additional information.

4.7
End active video (EAV)
A code word sequence in a stream that immediately follows the active video samples in a line. See SMPTE ST 125 and SMPTE RP 291-2.

4.8
Frame-wrapped
This standard uses the definitions of frame wrapping from the MXF family of standards.

Note: Frame wrapping in these documents means one of the following: 1) “frame wrapping” of a single frame (field 1 and field 2 of an interlaced image or both fields of a progressive segmented frame image); 2) “field wrapping” of a single field of an interlaced image; or 3) “progressive frame wrapping” of a progressive frame (ascending lines within the frame).

4.9
Line numbers
Line numbers in this standard shall follow the model defined in SMPTE ST 377-1 Annex “G.1.4 Video Interface” for component digital formats.

4.10
Picture Element
KLV wrapped picture essence data within a Content Package. See SMPTE ST 379-1, SMPTE ST 379-2, SMPTE ST 381-1, SMPTE ST 381-2 and SMPTE ST 381-3 for additional information.

4.11
Start active video (SAV)
A code word sequence in a stream that immediately precedes the active video samples in a line. See SMPTE ST 125 and SMPTE RP 291-2.

4.12
Switching line
The line in a video signal where switching between two synchronous video signals should occur. See SMPTE RP 168.

4.13
Vertical interval (VI)
The lines starting with the first line in a field or frame and ending with the line before the first active video line. “VI line” is used where the concept refers to the raster line containing VI data. The phrase “VI data” is used where the concept is the payload of the VI line. Vertical Interval is used in new SMPTE standards to refer to the vertical space in both analog and digital signals.

4.14
VI Element
The collection of VI Structures for one field or frame of video in an MXF file.

4.15
VI Payload Array
The data for one VI line.

4.16
VI Structure
The MXF properties for a VI data and the VI Payload Array. This represents one VI line in an MXF file.

5 Common Provisions for MXF Wrapping of VI Lines and ANC Packets

The VI data and ANC packets are carried in this standard as frame-wrapped Data Elements in the Generic Container. This allows the VI lines and ANC packets to be synchronized and co-located with the associated audio and video

VI lines and ANC packets encoded using this standard shall be frame wrapped as defined in SMPTE ST 379-1 and SMPTE ST 379-2.

A single VI Element shall contain all of the VI Structures for a given frame or field. A single ANC Element shall contain all of the ANC Structures for a given frame or field.

Note: Clip and custom wrapping is not permitted because long-form material encoding will have high latencies and require large buffers in decoders. The encoder latency is a result of capturing all of the VI lines and ANC packets before the encoder can start writing the MXF file.

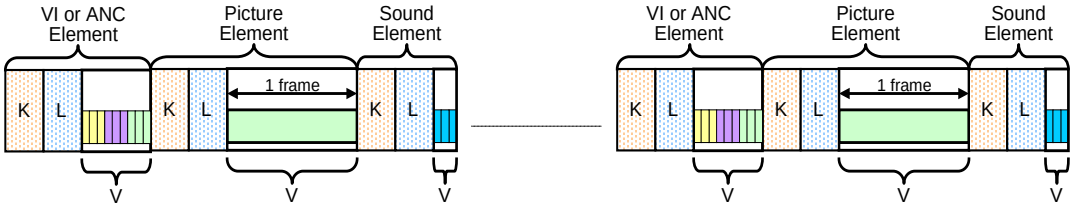

Figure 1 – Frame-wrapped VI Elements or ANC Elements

KAG usage shall comply with SMPTE ST 377-1 and there are no additional KAG provisions in this document.

Index table usage shall comply with SMPTE ST 377-1.

5.1 The Sequence of VI Lines and ANC Packets in a Frame

ANC packets and VI lines shall be placed at the specified location in the reconstructed video signal. The sequence of ANC packets within a line shall not be changed by the MXF file encoder or decoder.

Note: Devices such as ANC packet inserters, extractors, format converters, and other video signal processors could reorder ANC packets, VI lines, or make other changes as required.

Within a given line, the ANC Structures shall be in the sequence the ANC packets are intended to be in the reconstructed video signal.

For progressive images — The VI Structures and ANC Structures shall be in line number sequence.

For interlaced images represented as frames — The VI Structures and ANC Structures for field 1 shall precede the VI Structures and ANC Structures for field 2 in a single VI element and/or a single ANC Element. The VI Structures and ANC Structures for each field shall be in line number sequence within the field.

For interlaced images represented as fields — The VI Structures and ANC Structures for each field shall be in line number sequence.

For progressive segmented frame images — The VI Structures and ANC Structures shall be in the same sequence as the interlaced images represented as frames. See the definition above.

5.2 The Synchronization of VI Elements, ANC Elements and Video

The optional VI Element for frame N and the optional ANC Element for frame N shall be in the Content Package for frame N. The order of Systems, VI, ANC, Date, Picture, Sound and Compound Elements and Items in a file shall be constant. The number of Elements and Items of any particular type shall be constant in each Content Package.

If the Content Package for frame N includes a System Item, the System Item shall be the first Item in the Content Package. The order of Elements and Items in a Content Package may be in an order specified by other SMPTE Standards, Recommended Practices or application specifications. If no other specification is used, the order of Items and Elements should be zero or one System Item, zero or one VI Element, zero or one ANC Element, zero or more additional Data Items, zero or one Picture Item, and any other optional Sound Items or Compound Items.

New MXF file decoders should accept files with the Items and Elements in a variety of sequences. This rule will enhance interoperability.

Note: These rules allow OP-Atom compliant VI data and ANC packet files to be created when the only Elements contained in the MXF file are VI Elements, ANC Elements, and other Data Elements. Additional information on “Atom” files can be found in SMPTE ST 390.

The VI Elements or ANC Elements shall be in the same order as their corresponding playout Picture Elements. If the Picture Elements are reordered by a compression technology, the VI Elements and ANC Elements shall not be reordered.

Notes:

(1) VI Elements or ANC Elements are stored in the same order as their corresponding playout Picture Elements to minimize hardware buffers and latency for capture and insertion of MXF VI Lines and ANC packets.

(2) For essence types such as long GoP MPEG-2 where the displayed order and stored order are different, the VI Elements and ANC Elements will be stored in display order. For example:

an MPEG Display order of	B0 B1 I2 B3 B4 P5 B6 B7 P8
has an MPEG stored order of	I2 B0 B1 P5 B3 B4 P8 B6 B7
has ANC and VI packets	A0 A1 A2 A3 A4 A5 A6 A7 A8
and the elements are stored	(A0 I2) (A1 B0) (A2 B1) (A3 P5) (A4 B3) (A5 B4) (A6 P8) (A7 B6) (A8 B7)

(3) It is recommended that an MXF file processor or decoder only start processing the file at a location where the video transmission sequence and the playout sequence match. This is a location where no re-ordering has occurred. This synchronization is required for proper decoding of the video as well as proper reconstruction of the VI lines and ANC packets information in the reconstructed video signal.

(4) Keeping the VI lines and ANC packets in playout sequence and synchronizing them with the MXF encoded audio and MXF encoded video using established MXF mechanisms offers the best solution for many applications. In certain applications this is not true. For example; merging playout order ANC packets into MPEG user data space in a long GoP transmission order MPEG stream adds latency and complexity. One solution is to add the ANC packets to the MPEG user data space before encapsulating the MPEG stream in an MXF file. In this case the reordering and synchronization is supported by MPEG mechanisms, not this standard.

(5) There are additional considerations required for processing or decoding MPEG-4 AVC essence. Those are beyond the scope of this document.

5.3 Essence Container ULs

The Essence Container UL is defined in SMPTE ST 379-1 and SMPTE ST 379-2. If an MXF file contains VI Elements, then the VI Data Essence Container Label shall appear in the Essence Container UL batches in the file as defined in SMPTE ST 377-1. If an MXF file contains ANC Elements, then the ANC Packet Essence Container Label shall appear in the Essence Container UL batches in the file.

Note: The Essence Container UL, VI Element Key, and ANC Element Key are not used to define the coding of individual VI lines or ANC packets since there could be multiple VI line types or ANC packet types in a frame or an MXF file.

Table1 – Specification of the VI Data and ANC Packet Essence Container Label

Byte No.	Description	Value (hex)	Meaning
1-12	Defined by Generic Container	06.0E.2B.34. 04.01.01.01. 0D.01.03.01.	
13	Essence Container Kind	02h	MXF Generic Container
14	Mapping Kind	0Dh 0Eh	VI Data ANC Packet
15	Reserved	00h	Not used
16	Reserved	00h	Not used

Note: This standard provides for optional properties that can be used to describe the contents of VI lines and ANC packets. See Section 8.

5.4 Sample Coding

MXF files are a collection of 8-bit bytes. VI data may be represented by 1, 8, or 10 bits per sample and ANC packets can be represented by 8 or 10 bits per sample.

The Payload Array is an MXF array including an array element count. Since the array elements are bytes, the array length is also the number of bytes stored. The Payload Array includes the MXF VI data or MXF ANC packets data and any padding bytes. The Payload Array Element Length shall be 1. This is the Array element length field defined in SMPTE ST 377-1 for the Array compound data type. See SMPTE ST 377-1 section “Compound Data Types”.

Future SMPTE ST 436-1 encoders shall produce MXF files that comply with one or more of the padding/alignment schemes defined in Annex B Annex B.5 defines files with “No padding”. Future SMPTE ST 436-1 decoders should accept files that comply with one or more of the padding/alignment schemes described in Annex B Future SMPTE ST 436-1 decoders may accept files with other padding/alignment schemes to improve interoperability. Any padding bytes should have a value of zero.

Note: This standard does not recommend the use of a specific alignment/padding scheme.

The sample words in the video stream and the bytes in the MXF stream shall be in big-endian sequence. This is in keeping with the established MXF big-endian bit and byte sequencing policy.

A separate property describes the number of samples stored in the Payload Array. This property’s value is defined later in this document.

5.4.1 1-bit sample coding for VI data

For a 1-bit coding, a single bit represents the most-significant-bit of the source samples. An encoder’s source sample processing and/or filtering is not specified in this standard. The decoder output sample should be

black (not 0) for a zero-bit and white (not all ones) for a one-bit. The bits representing the samples shall be packed eight bits to the byte. The first bit is the high-order bit as shown in Figure 2.

Note: This coding can be used for low-bandwidth VI signals (e.g. a digitized representation of traditional analog Time and Control Codes; see SMPTE ST 12-1 LTC.) An encoder needs to use appropriate filtering to prevent artifacts. Likewise, the decoder needs to reconstruct legal signals. See SMPTE ST 125 for signal requirements.

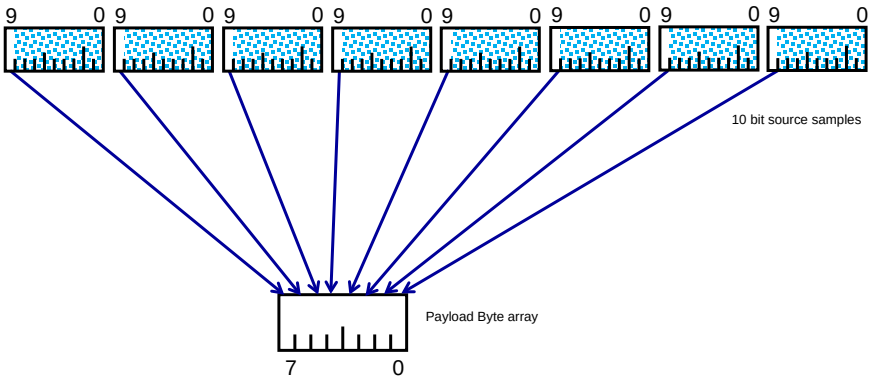

Figure 2 – 1-bit samples mapped to Payload Array

5.4.2 8-bit sample coding for VI data

For an 8-bit VI data coding, each byte in the MXF file represents the high-order 8 bits of the 10-bit source samples as shown in Figure 3. When encoding the low-order 2 bits from the 10-bit source samples are lost. A decoder should set the two low-order bits to zero.

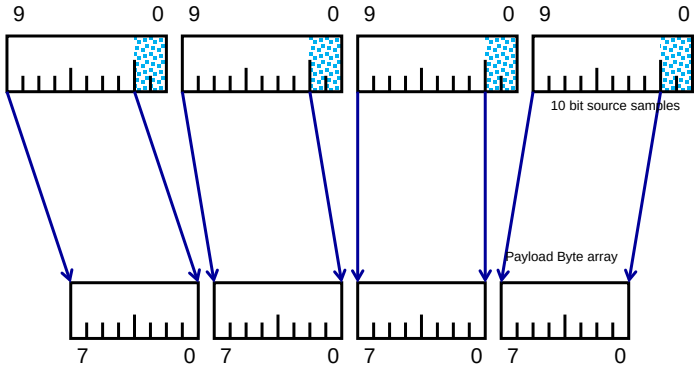

Figure 3 – 8-bit samples mapped to VIPayload Array

5.4.3 8-bit sample coding for ANC packet data

For an 8-bit ANC packet coding, each byte in the stream represents the low-order 8 bits of the 10-bit source samples as shown in Figure 4. When encoding the high-order 2 bits (parity and inverted parity) from the 10-bit source samples are lost. A decoder shall set the two high-order bits to parity and inverted parity as required by SMPTE ST 291-1.

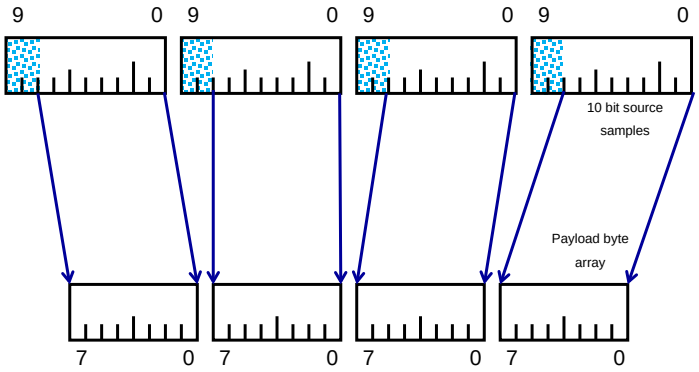

Figure 4 – 8-bit samples mapped to ANC Payload Array

5.4.4 10-bit sample coding

For a 10-bit coding, 4 bytes representing 3 source samples shall be coded using the high-order 30-bits (bits 2 to 31) of a 32-bit (4 byte) Payload Array data word. The 2 low-order bits of the payload data 32-bit word (bits 0 and 1) should be set to zero. See Figure 5.

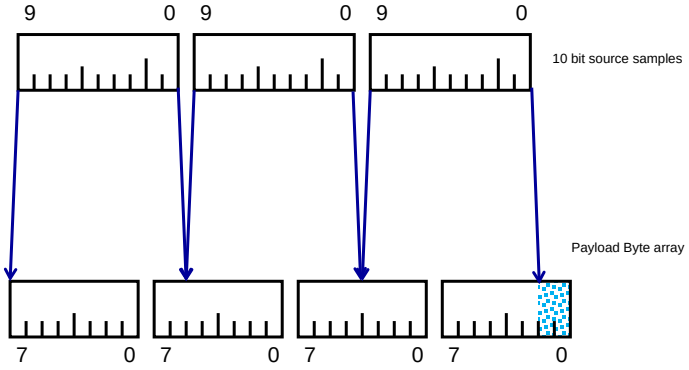

Figure 5 – 10-bit samples mapped to Payload Array

5.5 The Number of VI Lines or ANC Packets Property (Informative)

One of the properties in the VI Element is the “Number of Lines” which is the number of the VI lines contained in this VI Element. This number can be zero if the current VI Element does not have any VI lines in the payload space. This capability can be used so every Content Package in a file can have a VI Element even if the video stream does not have VI lines with every frame (or field.)

The same scheme can be used for ANC packets.

5.6 Line Numbers for Video Fields and Frames (Informative)

The video image standards specify line number for a given format. SMPTE ST 377-1 includes references to these formats and it also describes a line number scheme to be used in MXF related standards. These values are used in the Line Number Properties that are included in the VI Element Value and the ANC Element Value.

These structures include enumerated values for progressive segmented frames, field 1, field 2 and full frames which are redundant with line numbers. The line numbers were intended to be coded for the complete frame and the field enumerated values were intended as additional information or hints.

5.7 Multiple Video Streams with VI Elements and/or ANC Elements (Informative)

When MXF files are constructed with two or more video streams each of these streams may have associated VI Elements or ANC Elements. In this situation an MXF Standard or Recommended Practice ought to describe the scheme used to associate the VI Elements or ANC Elements with the appropriate video stream.

6 MXF Vertical Interval Line Wrapping Specifications

This standard provides an MXF encoding of VI lines for 8-bit and 10-bit digital component source samples as defined by SMPTE ST 259, SMPTE ST 292-1 and SMPTE ST 424.

A device shall be capable of encoding or decoding VI lines after the switching line and up to and including the first line of active video. A device may encode or decode other lines.

When a decoder is assembling the reconstructed video signal, there may be a conflict between VI lines decoded using this standard and lines from the reconstructed video image. In this case, the VI data from this standard should take precedence in the reconstructed video signal.

Note: If an encoder encounters an incorrectly formed or missing VI line, the encoder can represent the missing VI line by generating an empty VI Element for that line.

6.1 VI Elements

Each VI Element shall be KLV-coded according to Table 2 and Table 4. The properties in the VI Element shall be stored in the order presented in Table 2 and Table 4. All properties shall be provided (“required” in MXF terminology.)

As specified in Table 4 and illustrated in Figure 6, the VI Element Value shall start with the number of VI lines for the associated Picture Element. This shall be followed by the VI Structure consisting of a line number, wrapping type, sample coding, and sample count for the VI Payload Array, and the VI Payload Array. This data shall be repeated for each VI Structure in the VI Element.

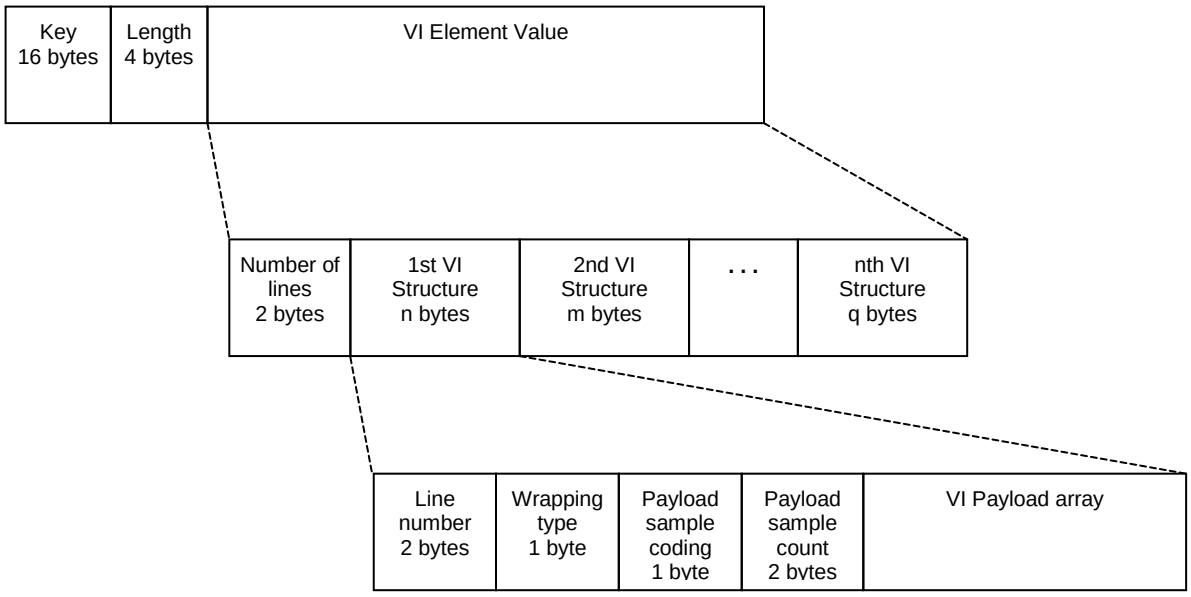

Figure 6 – VI Element

Table 2 – VI Element

Item Name	Type	Len	UL Designator	Meaning	Default
VI Element Key	Element Key	16	Given in Table 3	Identifies a Frame Element	
Length	BER Length	4	83.xx.xx.xxh	Overall Length of VI Element Value	
VI Element Value	Element Value	See Table 4	Given in Table 4	VI element value	

Table 3 – VI Element Key

Byte No.	Description	Value (hex)	Meaning
1-12	See MXF Generic Container Specification	06.0E.2B.34. 01.02.01.01. 0D.01.03.01.	
13	Item Type Identifier	17h	Data Item
14	Essence Element Count	01h	Count of VI Elements in this Data Item
15	Essence Element Type	01h	Frame-Wrapped VI Element
16	Essence Element Number	01h	The Number (used as an Index) of this VI Element in this Data Item

Table 4 – VI Element Value

Item Name	Type	Len	UL Designator	Meaning	Default
Number of Lines	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 03.00.00.00	Number of VI Lines in this element (N)	
The following group of properties is the VI Structure and it is repeated N times (each Line Number follows the Payload Array of the previous VI line)					
Line Number	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 04.00.00.00	The line number of this stored line according to SMPTE ST 377-1 Annex G.1.4 “Video Interface”	
Wrapping Type	UInt8	1	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 05.00.00.00	Wrapping type of the VI payload: 1 - Frame (Interlaced or progressive segmented frame) 2 - Field 1 3 - Field 2 4 - Progressive frame	
Payload Sample Coding	UInt8	1	06.0E.2B.34. 01.01.01.0A. 04.01.05.03. 0F.00.00.00	An enumerated Sample Coding: 1 - 1-bit component luma samples 2 - 1-bit component color difference samples 3 - 1-bit component luma and color difference samples 4 - 8-bit component luma samples 5 - 8-bit component color difference samples 6 - 8-bit component luma and color difference samples 7 - 10-bit component luma samples 8 - 10-bit component color difference samples 9 - 10-bit component luma and color difference samples 10 - Reserved 11 - Reserved 12 - Reserved	
Payload Sample Count	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 06.00.00.00	A count of the number of samples stored in the VI Payload Array	
VI Payload Array	Array of UInt8	Var (8+n)	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 07.00.00.00	An array of UInt8 samples containing the coded data. The array count (n) is the number of payload data bytes in the array including any padding bytes.The Payload Array Element Length shall be 1.	

The length field of the KLV coded VI Element shall be 4 bytes using BER long-form encoded. The value of the length property shall be the length of the VI Element Value.

6.2 VI Payload Byte Array and Sample Coding

The information representing the samples shall be in first sample to last sample sequence. The first sample shall be the sample following SAV. The final sample shall be the last sample before EAV. The MXF file's VI Payload Array shall include only the luma samples, only the color difference samples, or both, as required by the defining standard for the payload type.

The payload sample count property shall be the number of samples placed in the VI Payload Array.

An implementation shall support 8-bit sample words. In addition an implementation may also support 1-bit and/or 10-bit sample coding. See Section 5.4

7 MXF Ancillary Data Packet Wrapping Specifications

This standard provides an MXF encoding of ANC packets (HANC and VANC) as defined in SMPTE ST 291-1 for 8-bit and 10-bit digital component source samples as defined by SMPTE ST 259, SMPTE ST 292-1 and SMPTE ST 424.

When a decoder is assembling the reconstructed video signal, there may be a conflict between VANC packets decoded using this standard and the lines for the reconstructed video image. In this case, the VANC packets decoded from this standard should take precedence in the reconstructed video signal.

Note: The use of ANC packets from the first lines of the uncompressed field or frame up to and including the switching line is discouraged; however, it is not prohibited by this standard. See SMPTE RP 291-2 for additional information and recommendations.

ANC packets shall be coded using an 8-bit or a 10-bit coding format. The details of the 8-bit and 10-bit coding formats are defined in Section 7.2.

For the 8-bit sample format, two Essence Container ULs shall be defined. One is used to signal ANC packets without parity or check-sum errors and the other is used to signal ANC packets which may have corrupt data. The appropriate Essence Container UL shall be placed in the Essence Container UL batch property as defined in SMPTE ST 377-1.

Note: The 10-bit format is intended to be used as a "pass-through" when it is necessary to transport the parity-bits, inverted parity-bits and check-sum word. This can be used when the integrity of the complete source sample stream is unknown or its exact transport is critical.

7.1 ANC Element

Each ANC Element shall be KLV-coded according to Table 5 and Table 7. The properties in the ANC Element shall be stored in the order presented in Table 5 and Table 7. All properties shall be provided.

As specified in Table 5 and Table 7 and illustrated in Figure 7, the ANC Element shall start with the number of ANC Structures for the associated Picture Element. This shall be followed by the line number, wrapping type, sample coding, sample count for the ANC Payload Array, and the ANC Payload Array. This data shall be repeated for each ANC Structure in the ANC Element.

ANC packets that are in the vertical interval before SAV shall be marked as HANC packets.

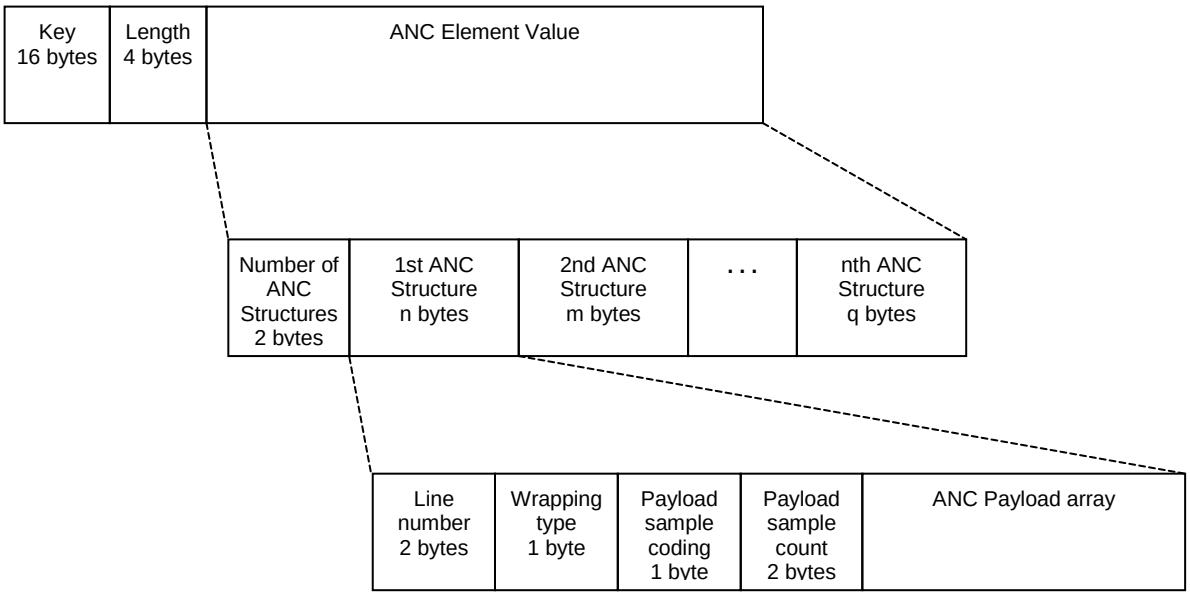

Figure 7 – ANC Element

Table 5 – ANC Element

Item Name	Type	Len	UL Designator	Meaning	Default
ANC Element Key	Element Key	16	Given in Table 6	Identifies an ANC Element	
Length	BER Length	4	83.xx.xx.xxh	Overall Length of Element	
ANC Element Value	Element Value	Refer to Table 7	Given in Table 7	ANC Packet element value	

Table 6 – Key Value for the ANC Element

Byte No.	Description	Value (hex)	Meaning
1-12	See the MXF Generic Container Specification	06.0E.2B.34. 01.02.01.01. 0D.01.03.01.	
13	Item Type Identifier	17h	Data Item
14	Essence Element Count	01h	Count of ANC Elements in this Data Item
15	Essence Element Type	02h	Frame-Wrapped ANC Element
16	Essence Element Number	01h	The Number (used as an Index) of this ANC Element in this Data Item

Table 7 – ANC Element Value

Item Name	Type	Len	UL Designator	Meaning	Default
Number of ANC packets	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 08.00.00.00	Number of ANC packets in this element (N)	
The following group of properties isthe ANC Structure and it is repeated N times (each Line Number follows the Payload Array of the previous ANC packet)					
Line Number	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 09.00.00.00	The line number of this ANC packet according to SMPTE ST 377-1 Annex G.1.4 “Video Interface”	
Wrapping Type	UInt8	1	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 0A.00.00.00	Wrapping type of the ANC Packet payload: 001h VANC Frame (Interlaced or segmented progressive frame) 002h VANC Field 1 003h VANC Field 2 004h VANC Progressive frame 011h HANC Frame (Interlaced or progressive segmented frame) 012h HANC Field 1 013h HANC Field 2 014h HANC Progressive frame	
Payload Sample Coding	UInt8	1	06.0E.2B.34. 01.01.01.0A. 04.01.05.03. 10.00.00.00	An enumerated Sample Coding: 1 reserved 2 reserved 3 reserved 4 8-bit luma samples 5 8-bit color difference samples 6 8-bit luma and color difference samples 7 10-bit luma samples 8 10-bit color difference samples 9 10-bit luma and color difference samples 10 8-bit luma samples – with parity error 11 8-bit color difference samples – with parity error 12 8-bit luma and color difference samples – with parity error	
Payload Sample Count	UInt16	2	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 0B.00.00.00	A count of the number of samples stored in the ANC Payload Array	
ANC Payload Array	Array of UInt8	Var (8 + n)	06.0E.2B.34. 01.01.01.0A. 04.01.05.02. 0C.00.00.00	An array of UInt8 containing the coded data. The array count (n) is the number of payload data bytes in the array including any padding bytes. The Payload Array Element Length shall be 1.	

The length field of the KLV coded ANC Element shall be 4 bytes using BER long-form encoded. The value of the length property shall be the length of the ANC Element Value.

The value of the ANC Element Key shall be constant throughout the entire Generic Container. This is to ensure proper linking to the header metadata as required by SMPTE ST 379-1 and SMPTE ST 379-2.

Payload Sample Coding that indicates parity errors may be used by an encoder to represent ANC packets that are known or found to be in error but are still valuable in a specific application.

Note: The luma and color difference samples coding are included in this standard to support some legacy devices. SMPTE RP 291-2 has recommendations with respect to the concurrent use of luma and color difference space for ANC packet transport.

This standard does not specify when these enumerated values for parity errors should be used by an encoder nor does it specify how a decoder should process these packets.

7.2 ANC Payload Array and Sample Coding

8-bit encoding: This ANC Payload Array shall include words from the source ANC packets starting with the ANC DID word and ending with the last word of ANC user data. The low-order 8-bits from the source ANC packet shall be placed in this standard's ANC Payload Array. The two bits representing the parity, the inverted parity, and the complete check sum from the source ANC packet's words are lost. See Sections 5.4 and 5.4.3.

Note: For 8-bit coding, the above provisions require the encoding of the complete ANC packet including the Data Identification Word (DID), Secondary Data Identification Word (SDID), Data Block Number (DBN), Data Count (DC) and User Data Words (UDW). The "Data Identification Word for Deletion of an Ancillary Data Packet" is a distinguished DID value. It is not an additional ANC word.

8-bit decoding: A decoder regenerating a video signal using this standard shall generate the required ANC packet flag words, the checksum word, parity and inverted parity-bits for all ANC packet words according to SMPTE ST 291-1.

10-bit coding: For 10-bit samples, the first source sample word captured shall be the ANC packets DID and the last source sample word captured shall be the check-sum. The 10-bit coding mode is designed to allow "pass through" of ANC packets without correcting the parity or check sum. This allows faithful bit-accurate reproduction of the source sample words as seen by the MXF encoder. Mapping of 10-bit words into the 8-bit Payload Array shall be performed according to Section 5.4.4

The payload sample count property shall be the number of 8-bit or 10-bit samples stored in the ANC Payload Array. This count includes the DID, SDID or DBN, DC, user data words, and possibly the check-sum. See the 8 and 10-bit coding rules for the exact list of sample words stored.

8 Descriptors

Data Essence Descriptors are provided for files containing VI Elements and ANC Elements. Although no additional properties are defined here, optional properties defined in other documents may be stored in this descriptor.

When VI lines or ANC packets exist in an MXF file, the appropriate descriptor from Section 8.1 or 8.3 shall be present in the file. The descriptor shall be associated with a Data Track using the mechanisms defined in SMPTE ST 377-1.

Note: This specification details an opaque transport mechanism for VI data and ANC packets in MXF files. MXF descriptors are provided for the identification of the VI data and ANC packet essence contained within the file. If an application needs to signal additional properties, this can be done by inserting optional properties within these descriptors. The definition of these optional properties could be public or private and is outside the scope of this document.

8.1 VI Data Descriptor

The VI Data Descriptor may contain optional properties that describe the VI lines content.

Table 8 – VI Data Descriptor

Item Name	Type	Len	UL Designator	Req ?	Meaning	Default
VI Data Descriptor	Set UL	16	See Table 9	Req	Defines the VI Data Descriptor Set	
Length	BER Length	4		Req	Set length	
All items (properties) are from the MXF Generic Data Descriptor – no additional properties are defined here.						

8.2 Key for the VI Data Descriptor

The Key (UL) for this universal set is defined below:

Table 9 – Key for VI Data Descriptor

Byte No.	Description	Value (hex)	Meaning
1-13	Defined in Section "9.6 Structural Header Metadata Implementation" of SMPTE ST 377-1 (File Format Specification)	06.0E.2B.34. 02.53.01.01. 0D.01.01.01. 01.	
14	Set Kind (1)	01h	VI Data Descriptor
15	Set Kind (2)	5Bh	
16	Reserved	00h	Reserved

8.3 ANC Data Descriptor

The ANC packets data descriptor may contain optional properties that describe the ANC packet contents.

Table 10 – ANC Packets Descriptor

Item Name	Type	Len	UL Designator	Req ?	Meaning	Default
ANC Data Descriptor	Set UL	16	See Table 11	Req	Defines the ANC Data Descriptor Set	
Length	BER Length	4		Req	Set length	
All items (properties) arefrom the MXF Generic Data Descriptor – no additional properties are defined here.						

8.4 Key for the ANC Data Descriptor

The Key (UL) for this universal set is defined below:

Table 11 – Key for ANC Packets Descriptor

Byte No.	Description	Value (hex)	Meaning
1-13	Defined in Section "9.6 Structural Header Metadata Implementation" of SMPTE ST 377-1 (File Format Specification)	6.0E.2B.34. 02.53.01.01. 0D.01.01.01. 01.	
14	Set Kind (1)	01h	ANC Data Descriptor
15	Set Kind (2)	5Ch	
16	Reserved	00h	Reserved

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 272:2004) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 272M-2004). Documents with the same root number (e.g. 272) and publication year (e.g. 2004) 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 272:2004, Television — Formatting AES Audio and Auxiliary Data into Digital Video Ancillary Data Space

SMPTE ST 299-1:2009, 24-Bit Digital Audio Format for SMPTE 292 Bit-Serial Interface
(Note: Document previously numbered SMPTE 299-2009 – Content Unchanged)

SMPTE ST 299-2:2010, Extension of the 24-Bit Digital Audio Format to 32 Channels for 3 Gb/s Bit-Serial Interfaces

SMPTE ST 331:2011, Element and Metadata Definitions for the SDTI-CP

SMPTE ST 381-1:2005, Television — Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Generic Container

SMPTE ST 381-2:2011, Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Constrained Generic Container

SMPTE ST 381-3:2013, Material Exchange Format — Mapping AVC Streams into the MXF Generic Container

SMPTE ST 382:2007, Material Exchange Format — Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container

Amendment 1:2012 to SMPTE ST 382:2007

Amendment 2:2013 to SMPTE ST 382:2007

SMPTE ST 385:2012, Material Exchange Format (MXF) — Mapping SDTI-CP Essence and Metadata into the MXF Generic Container

SMPTE ST 386:2004, Television — Material Exchange Format (MXF) — Mapping Type D-10 Essence Data to the MXF Generic Container

SMPTE ST 387:2004, Television — Material Exchange Format (MXF) — Mapping Type D-11 Essence Data to the MXF Generic Container

SMPTE ST 390:2011, Material Exchange Format (MXF) – Specialized Operational Pattern “OP-Atom” (Simplified Representation of a Single Item)

SMPTE RP 208:2002, Transport of VBI Packet Data in Ancillary Data Packets

SMPTE RP 218:2009, Specifications for Safe Action and Safe Title Areas for Television Systems

SMPTE RP 291-2:2013, Ancillary Data Space Use — 4:2:2 SDTV and HDTV Component Systems and 4:2:2 2048 × 1080 Production Image Formats

ISO/IEC 13818-2:2013, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information — Part 2: Video

ISO/IEC 14496-10:2012, Information Technology — Coding of Audio-Visual Objects — Part 10: Advanced Video Coding

Annex B Known Padding and Alignment Rules (Normative)

The original version of this standard included normative provisions to facilitate alignment at certain boundaries. In some cases the provision could be interpreted in multiple ways which has resulted in some differences in established MXF file encoders.

Note: The original version of this standard did not specify a maximum number of padding bytes. Some implementations have used this space when the number of ANC packets or VI lines to be transported is not constant or unknown. Future implementations of MXF file decoders for this standard are encouraged to process files which have not followed the four-byte padding recommendation or which can include large padding space.

The following padding and alignment schemes are known to be in use. This standard does not recommend the use of any one of the following padding/alignment provisions over the others. The Payload Array padding should have a value of zero.

B.1 Structure Padding To Achieve Four-Byte Alignment

All Payload Arrays shall include zero, one, two or three padding bytes so that the first byte following each Payload Array is at a byte offset which is a multiple of four bytes relative to the first byte of an ANC or VI Element (the Element Key.)

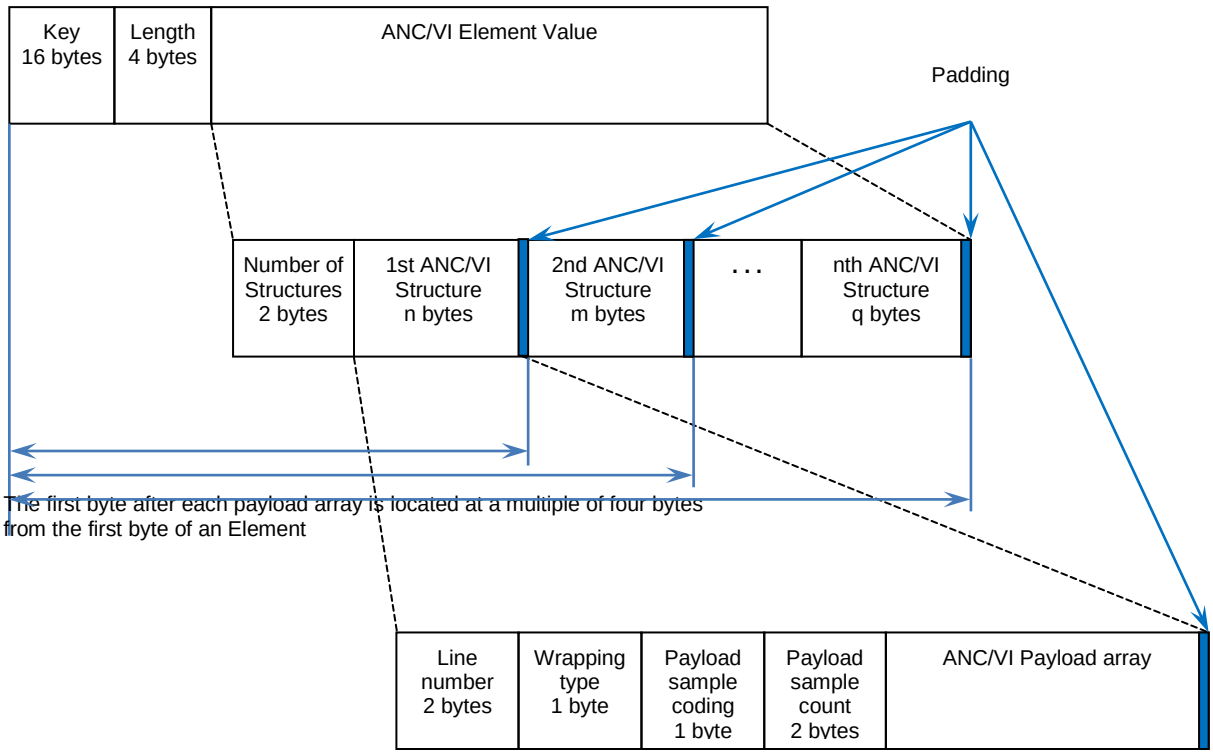

Figure B.1 – Element Padding

B.2 Structure Padding to a Multiple Of Four-Bytes

All Payload Arrays shall include zero, one, two or three padding bytes so that each ANC or VI Structure (starting with the ANC/VI Structure Line Number) is a multiple of four bytes in length.

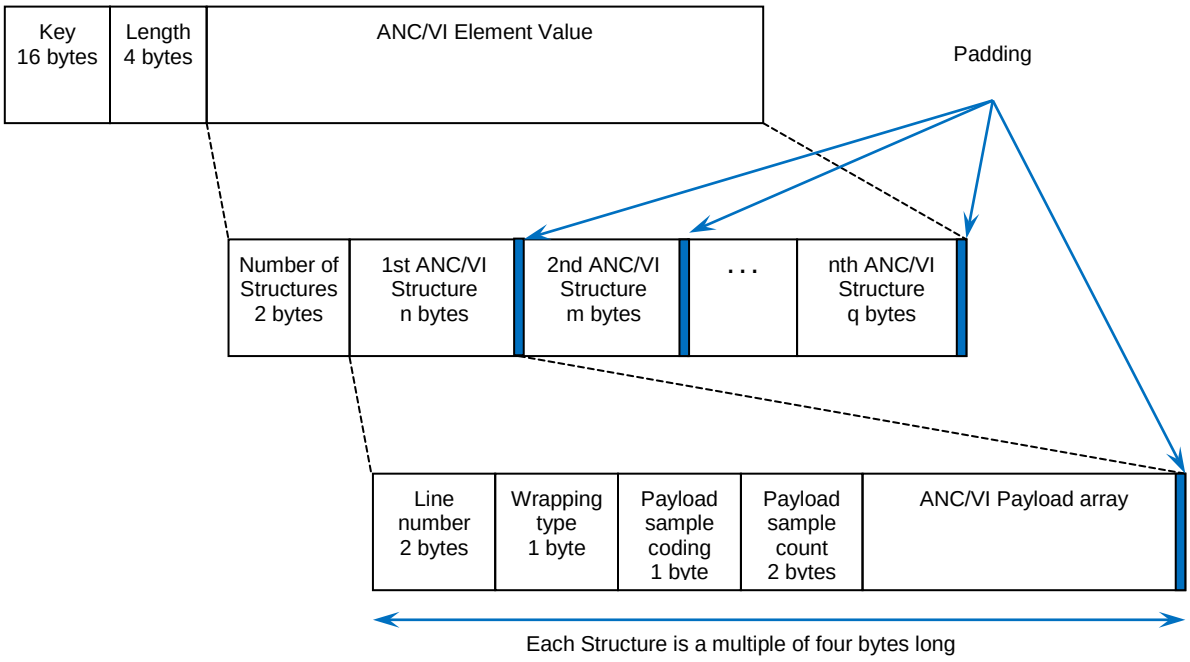

Figure B.2 – Structure Padding

B.3 Payload Padding to a Multiple Of Four-Bytes

All Payload Arrays shall include zero, one, two or three padding bytes so that each Payload Array is a multiple of four bytes long.

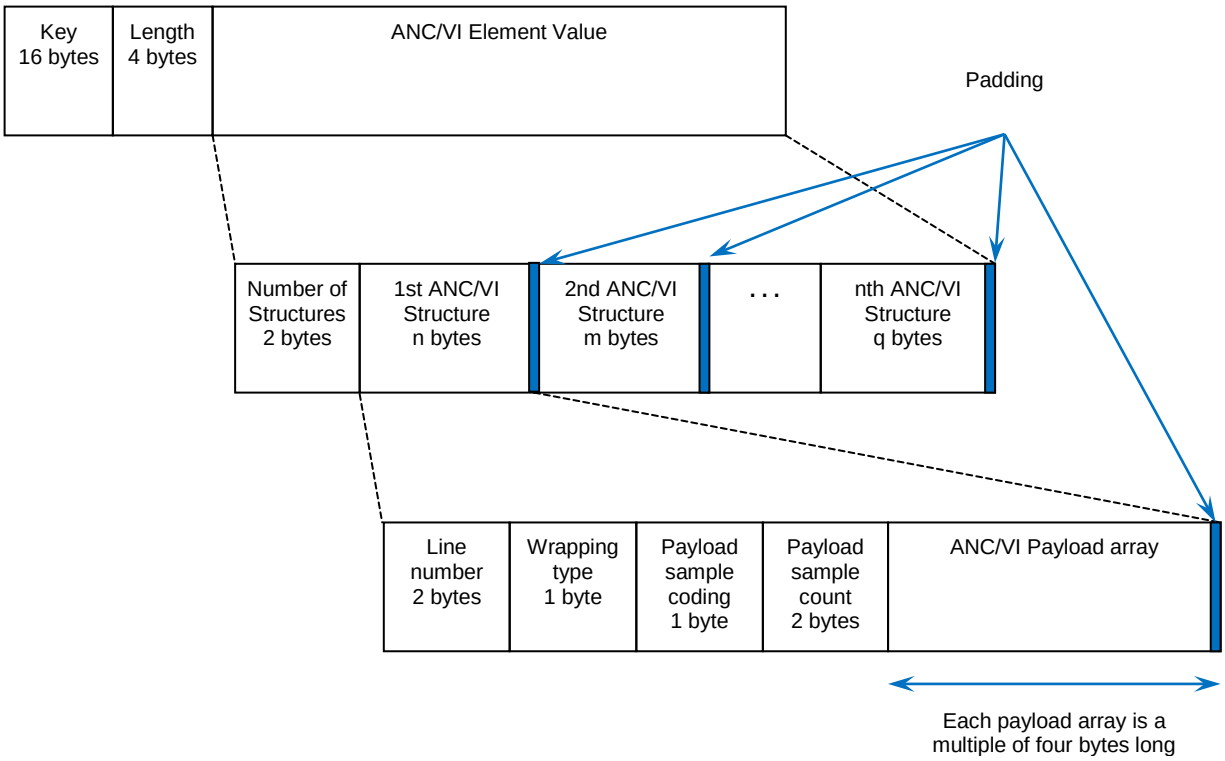

Figure B.3 – Payload Padding

B.4 Final Structure Padding to Achieve Four-Byte Element Alignment

The last Payload Array in an ANC or VI Element shall include zero or more padding bytes so that the Element (starting with the Element Key) is a multiple of four bytes in length.

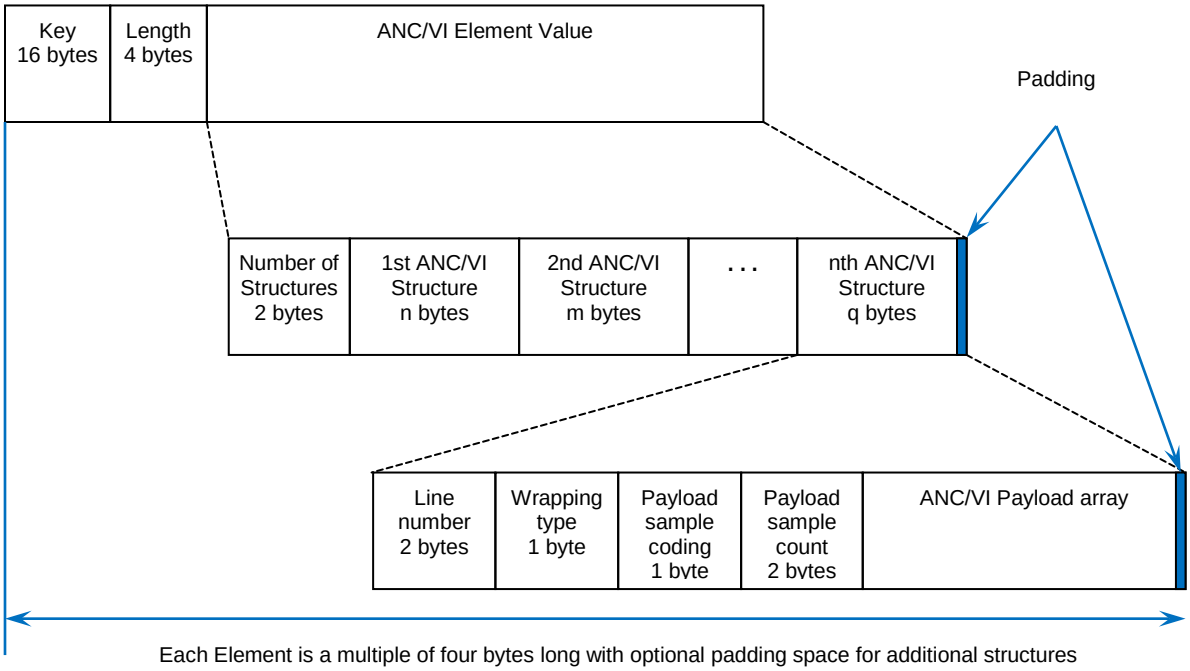

Figure B.4 – Final Structure Padding

B.5 No Padding

The Payload Array(s) in all ANC or VI Elements shall have no padding bytes.

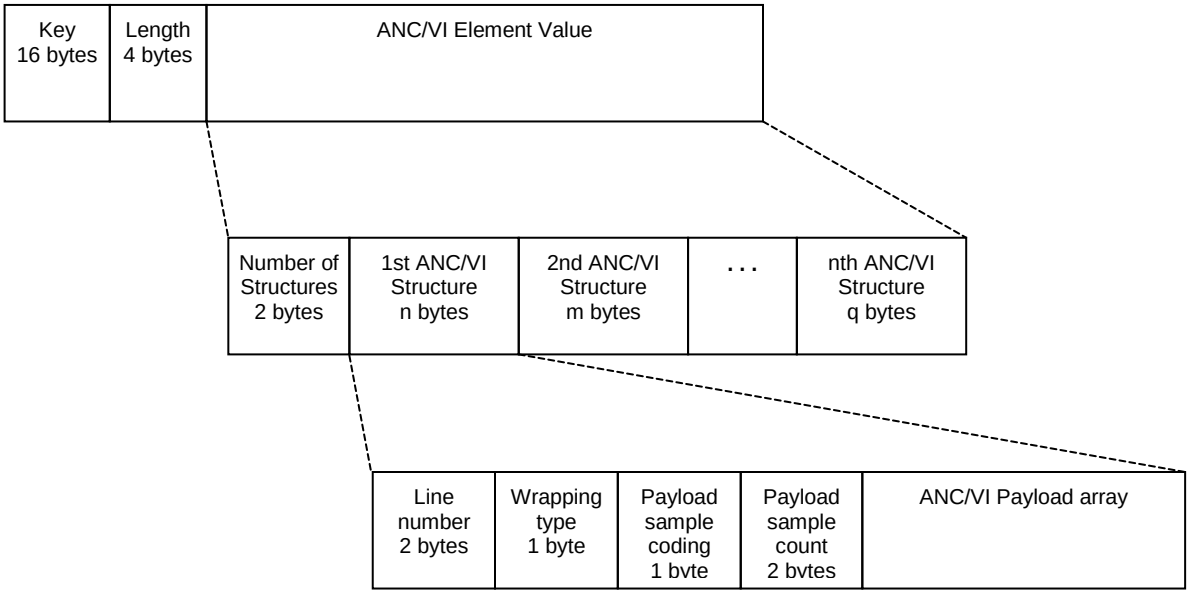

Figure B.5 – No Padding

Annex C Changes From SMPTE 436M-2006 (Informative)

This document is a revision of SMPTE 436M-2006. The primary goal of this revision was to provide a better document for future implementations of the original standard. Two technical changes were made:

1) The padding and alignment provisions were relaxed and clarified to improve interoperability with established implementations of the original standard. An Annex describing the known implementations has also been added.

2) The provisions for Element ordering were relaxed to resolve conflicts with other SMPTE standards.

In addition several editorial changes were made. These include:

1) The document complies with current SMPTE document styles and conformance terminology.

2) The Normative References and Bibliography document references were updated.

3) SMPTE ST 379-2 was added to the Normative References.

4) SMPTE ST 381-3 was added to the bibliography and is referenced in the definition of Picture Element.

5) Terminology differences between this standard, SMPTE ST 377-1, SMPTE ST 379-1 and SMPTE ST 379-2 were resolved. The terminology use by this standard was also improved.

6) Other editorial changes were made to improve readability and resolve language differences between this document and other standards.