SMPTE STANDARD

for Television — Material Exchange Format (MXF) — Mapping Type D-10 Essence Data to the MXF Generic Container

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1 Scope

This standard defines the mapping of compressed picture data according to the type D-10 data stream and up to 8 channels of AES3 data into the material exchange format generic container (MXF-GC). This mapping is given the acronym: MXF-GC(D-10).

The MXF specification is written in several parts. This is one of a set of documents that define the contents of the MXF file body.

The MXF file format specification includes operation pattern specifications that may define restrictions to be placed on the way in which this essence container type can be implemented. The reader is advised to carefully study the appropriate operational pattern document for compliance to the defined implementation.

2 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 editions of the standards indicated below.

SMPTE 331M-2004, Television — Element and Metadata Definitions for SDTI-CP

SMPTE 356M-2001, Television — Type D-10 Stream Specifications: MPEG-2 4:2:2P@ML for 525/60 and 625/50

SMPTE 377M-2004, Television — Material Exchange Format (MXF) File Format Specification

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SMPTE 379M-2004, Television — MXF Generic Container

SMPTE 385M-2004, Television — Mapping SDTI-CP Essence and Metadata into the MXF Generic Container

SMPTE RP 204-2000, SDTI-CP MPEG Decoder Templates

3 Glossary of acronyms, terms and data types

The general glossary of acronyms, terms and data types used in the MXF specification is given in SMPTE 377M. Supplementary glossaries of acronyms and terms are defined in SMPTE 379M and SMPTE 385M. They are not repeated here to avoid any divergence of meaning.

4 Introduction

The MXF generic container (MXF-GC) is a streamable essence container that encapsulates a sequence of one or more content packages (CP). SMPTE 379M defines the MXF generic container as the native essence container in MXF files. SMPTE 385M defines a system item that is compatible with SMPTE 326M (SDTI-CP) and also defines how SDTI-CP essence and metadata can be used in the MXF generic container.

This standard specifies the mapping of the type D-10 stream data and 8-channel AES3 data into the MXF generic container. This same data is directly compatible with SDTI-CP constrained by the template defined in SMPTE RP 204.

5 Type D-10 mapping

The MPEG-2 baseline decoder template specified by SMPTE RP204 provides for codecs operating with MPEG-2 4:2:2P@ML encoded pictures accompanied by an 8-channel AES3 data capability and a general data element. It specifies a codec capable of basic timing and transfer modes for SDTI operation. The specification is a baseline allowing receiver/decoders to be designed with higher capabilities if and when desired. Details of the element and metadata definitions plus the MPEG-2 baseline SDTI decoder template are given in SMPTE 331M and SMPTE RP 204.

This specification shall use frame-based mapping as defined by SMPTE 379M. The order of items in this mapping shall be system, picture, sound and data (if present).

NOTE – Auxiliary items and elements in SMPTE 326M are synonymous with data items and elements in the MXF generic container.

5.1 System item mapping

The mapping of system item data shall comply with that defined in SMPTE 385M. The system metadata pack and the package metadata set are required. The presence of the picture item, sound item, data item and control element depends on the setting of the system metadata bitmap as defined in SMPTE 385M.

The universal label (UL) used in the MXF GC(D-10) system item and in the MXF header metadata shall have the following value:

Table 1 – Specification of the MXF-GC(D-10) essence container UL

Byte No.	Description	Value (hex)	Meaning
1~13	See SMPTE 379M	--	Defined in Table 3 of SMPTE 379M
14	Type D-10 Mapping	01h	Mapping compliant to SMPTE 356M and SMPTE RP204
15	MPEG Constraints: SMPTE 356M	01h 02h 03h 04h 05h 06h	50 Mbps, 625/50 50 Mbps, 525/60 40 Mbps, 625/50 40 Mbps, 525/60 30 Mbps, 625/50 30 Mbps, 525/60
16	Type: Template Extension	01h or 02h	01h = template defined in this document 02h = extended template

This label value as described above shall be used as the essence container UL in the preface set and the appropriate file descriptor set of the header metadata and in the partition pack.

5.2 Picture item mapping

There shall be one essence element in the MXF-GC picture item which shall be a MPEG-2 4:2:2P@ML video elementary stream constrained according to SMPTE 356M.

5.2.1 Essence element key

The essence element key value shall be defined as follows:

Table 2 – Key value for the type D-10 picture element

Byte No.	Description	Value (hex)	Meaning
1~12	See SMPTE 379M	--	Defined in Table 2 of SMPTE 379M
13	Item Type Identifier	05h	SDTI-CP compatible picture item
14	Essence Element Count	01h	One essence element present
15	Essence Element Type	01h	MPEG2 422P@ML element as defined in SMPTE 331M
16	Essence Element Number	nnh	As defined by SMPTE 379M section 7.1.

5.2.2 Essence element length

The length field of the KLV coded element shall be 4 bytes BER long-form encoded (i.e., 83h.xx.yy.zz). The value of the length field shall correctly define the length of the element value.

5.2.3 Essence element value

The MPEG-2 4:2:2P@ML video elementary stream is as per the definition in SMPTE 331M. The encoded bitstream is constrained according to the type D-10 MPEG-2 data stream specification (SMPTE 356M).

NOTE – As per SMPTE 356M, the maximum bit-rate for this stream is 50 Mbps. When operating at 50 Mbps, the size (in bytes) is:

- For 525/60 operation: 208,541 bytes;
- For 625/50 operation: 250,000 bytes.

5.3 Sound item mapping

There shall be one sound element in the MXF GC sound item which shall be an 8-channel AES3 element defined according to SMPTE 331M.

5.3.1 Essence element key

The essence element key value shall be as follows:

Table 3 – Key value for the 8-channel AES3 sound element

Byte No.	Description	Value (hex)	Meaning
1~12	See SMPTE 379M	--	Defined in Table 2 of SMPTE 379M
13	Item Type Identifier	06h	SDTI-CP compatible sound Item
14	Essence Element Count	01h	One essence element present
15	Essence Element Type	10h	8-channel AES3 element as defined in SMPTE 331M
16	Essence Element Number	nnh	As defined by SMPTE 379M section 7.1.

5.3.2 Essence element length

The length field of the KLV coded element shall be 4 bytes BER long-form encoded (i.e., 83h.xx.yy.zz). The value of the length field shall correctly define the length of the element value.

5.3.3 Essence element value

The 8-channel AES3 element is as per the definition in SMPTE 331M. Active channels are filled with AES3 data according to the stream valid flag defined in SMPTE 331M. The active data length varies according to 625/50 or 525/60 operation (and in 525/60 operation varies over the frame sequence as it has a 5-frame sequence).

5.4 Data item mapping

The data item may contain zero or more data elements as defined in SMPTE 331M. If the data item has a variable length in each content package, then the end of the data item should be padded with the KLV fill item to ensure that the content package size is constant.

NOTE – The KLV fill item ensures that a simple index table can be used.

5.4.1 Essence element key

The essence element key value shall be as follows:

Table 4 – Key value for an auxiliary data element

Byte No.	Description	Value (hex)	Meaning
1~12	See SMPTE 379M	—	Defined in Table 2 of SMPTE 379M
13	Item Type Identifier	07h	SDTI-CP compatible data item
14	Essence Element Count	nnh	One or more essence elements present
15	Essence Element Type	Per SMPTE 331M	Data essence element as defined in SMPTE 331M
16	Essence Element Number	xxh	As defined by SMPTE 379M section 7.1.

5.4.2 Essence element length

The length field of the KLV coded element shall be 4 bytes BER long-form encoded (i.e., 83h.xx.yy.zz). The value of the length field shall correctly define the length of the element value.

5.4.3 Essence element value

As defined by SMPTE 331M.

6 Application Issues

6.1 Application of the KLV fill item

Within any MXF partition containing an essence container with this mapping specification, the KAG value defined in the partition pack shall have the value of 512 (02.00h) and the first byte of the key of the first element of each Item shall be aligned to the KLV alignment grid of that partition.

For each Item in a content package, the length of the KLV fill item should be the minimum required to align to a KAG boundary and be consistent with maintaining a constant content package size.

Where possible, any immediately preceding partition should align the start of each MXF partition containing an essence container with this mapping specification to a byte offset that is an integer multiple of the defined KLV alignment grid relative to the start of the header partition pack.

The length field of the KLV fill item shall be 4 bytes, BER long-form encoded (i.e., $83h.xx_h.yy_h.zz_h$).

NOTE – The application of the KAG shall comply with SMPTE 377M, section 5.4.1.

6.2 Application of index tables for constant GC item sizes

One index table segment should be present in the MXF header partition. Repetition of this index table segment in subsequent partitions is optional.

The definition of the index table format is given in the MXF file format specification (SMPTE 377M). This section describes the application of index tables to an MXF-GC(D-10) essence container.

Any KLV fill items are treated as a part of the element that they follow and are not indexed in their own right. Note that the index entry array is not used for GC(D-10) types with fixed item lengths. Note also that an “edit unit” is the duration of one content package (i.e., video frame).

The index table segment is constructed as follows:

Table 5 – Index table segment set

Item Name	Meaning	Value
Index Table Segment	A segment of an Index Table	
Length	Set Length	
Instance ID	Unique ID of this instance	
Index Edit Rate	Frame rate of the Type D-10 video	{25,1} or {30000, 1001}
Index Start Position	Byte address of first edit unit indexed by this table segment	0
Index Duration	Number of edit units indexed by this table segment (NSA)	0
Edit Unit Byte Count	Defines the length of a fixed size edit unit	>0
IndexSID	Identifier of the index table segment	
BodySID	Identifier of the essence container	
Slice Count	Number of slices minus 1 (NSL)	0
Delta Entry Array	Map of elements in each content package (optional) (see table 6)	
IndexEntry Array	Index from sample number to stream offset	Not encoded

This mapping specification may use the optional delta entry array table as defined in SMPTE 377M. An example delta entry array table for system, picture, sound and data elements is given below:

Table 6 – Structure of example delta entry array

Field Name	Meaning	Typical Values	Comment
NDE	Number of delta entries	4	
Length	Length of each delta entry	6	
PosTableIndex	No temporal reordering	0	Element 0 e.g. System Data Pack Element
Slice	Slice number in index entry	0	
Element Delta	(Fixed) Delta from start of slice to this element	0	
PosTableIndex	No temporal reordering	0	Element 1 e.g. picture item
Slice	Slice number in index entry	0	
Element Delta	(Fixed) Delta from start of slice to this element	Len(system item + fill))	
PosTableIndex	No temporal reordering	0	Element 2 e.g. sound item
Slice	Slice number in index entry	0	
Element Delta	(Fixed) Delta from start of slice to this element	Len(system item + fill + element 1 + fill)	
PosTableIndex	No temporal reordering	0	Element 3 e.g. data item
Slice	Slice number in index entry	0	
Element Delta	(Fixed) Delta from start of slice to this element	Len(system item + fill + element 1 + element 2 + fill)	

6.3 File descriptor sets

The file descriptor sets are those structural metadata sets in the header metadata that describe the essence and metadata elements defined in this standard. The structure of these sets is defined in the MXF file format specification (SMPTE 377M).

The definition of the property values in the file descriptor sets appropriate to this specification are given in annex A of this standard.

File descriptor sets should be present in the header metadata for each essence element and for the system metadata pack element.

6.4 Mapping track numbers to generic container elements

The number of essence tracks in the associated header metadata package shall be the same as the number of essence elements used in this mapping application. The track number value shall be derived as described in the MXF generic container specification (SMPTE 379M).

The associated header metadata package should define one metadata track to describe the contents of the system metadata pack of the CP-compatible system item. The track number value shall be derived as described in SMPTE 385M. This track can be used to describe the date/time components in the CP-compatible system item.

6.5 Essence container partitions

The type D-10 mapping maintains each content package of the generic container as a separate editable unit with the contents of the system, picture, sound and data items in synchronism. As a consequence, if the essence container using this mapping is partitioned, then each partition shall contain an integer number of content packages where each content package contains all the Items required.

Annex A (informative)
Descriptor set values for the essence elements defined in this standard

The file descriptors in this annex are defined in SMPTE 377M. These descriptors are replicated here with the aim to indicate property values, where appropriate. Where more than one file descriptor is referenced by a package, it will need to first reference the multiple descriptor as described in SMPTE 377M.

In all tables describing sets in this annex, the columns are defined as follows:

- Item name: the name of the property;
- Type: the defined type of the property;
- Len: the length of the value in bytes where known;
- Meaning: a description of the property;
- 525/60: default values for 525-line source video;
- 625/50: default values for 625-line source video.

Note that the key, length, instance UID and generation UID rows are not included in these tables.

NOTE – For the case of properties in this annex that are SMPTE labels (ULs), a list of appropriate values is provided in the SMPTE Labels Registry, SMPTE RP 224.

Table A.1 – CDCI (picture) essence descriptor

Item Name	Type	Len	525/60	625/50
Linked Track ID	UInt32	4		
Sample Rate	Rational	8	30000, 1001	25,1
Container Duration	Length	8		
Codec	UL	16	See SMPTE RP 224	See SMPTE RP 224
Essence Container	UL	16	See SMPTE RP 224	See SMPTE RP 224
Picture Essence Coding	UL	16	See SMPTE RP 224	See SMPTE RP 224
Signal Standard	Enum	1	1	1
Frame layout	UInt8	1	1 (= I)	1 (= I)
Stored Width	UInt32	4	720	720
Stored Height	UInt32	4	256	304
StoredF2Offset	Int32	4	0	0
Sampled Width	UInt32	4	720	720
Sampled Height	UInt32	4	256	304
Sampled X-Offset	Int32	4	0	0
Sampled Y-Offset	Int32	4	0	0
Display Height	UInt32	4	243	288
Display Width	UInt32	4	720	720
Display X-Offset	Int32	4	0	0
Display Y-Offset	Int32	4	13	16
DisplayF2Offset	Int32	4	0	0
Aspect Ratio	Rational	8	{4,3} or {16,9}	{4,3} or {16,9}
Active Format Descriptor (AFD)	UInt8	1	0	0

Item Name	Type	Len	525/60	625/50
Video Line Map	Array of Int32	8+(2*4)	{7,270}	{7,320}
Alpha Transparency	UInt8	1	0 (False)	0 (False)
Gamma	UL	16	See SMPTE RP 224	See SMPTE RP 224
Image Alignment Offset	UInt32	4	0	0
Field Dominance	UInt8	1	1	1
Image Start Offset	UInt32	4	0	0
Image End Offset	UInt32	4	0	0
Component Depth	UInt32	4	8	8
Horizontal Sub-sampling	UInt32	4	2	2
Vertical Sub-sampling	UInt32	4	1	1
Color Siting	UInt8	1	4	4
Reversed Byte Order	Boolean	1	False (0)	False (0)
Padding Bits	UInt16	2	0	0
Alpha Sample Depth	UInt32	4	0	0
Black Ref Level	UInt32	4	16	16
White Ref level	UInt32	4	235	235
Colour Range	UInt32	4	225	225
Locators	StrongRefArray (Locators)	8+16n	Present only if essence container is external to the file	Present only if essence container is external to the file

Table A.2 – Generic sound essence descriptor

Item Name	Type	Len	525/60-I	625/50-I
Linked Track ID	UInt32	4		
Sample Rate	Rational	8	{30000, 1001}	{25,1}
Container Duration	Length	8		
Codec	UL	16	See SMPTE RP 224	See SMPTE RP 224
Essence Container	UL	16	See SMPTE RP 224	See SMPTE RP 224
Sound Essence Coding	UL	16	See SMPTE RP 224	See SMPTE RP 224
Audio sampling rate	Rational	8	{48000,1}	{48000,1}
Locked/Unlocked	Boolean	4	01h (locked)	01h (locked)
Audio Ref Level	Int8	1	0 (default)	0 (default)
Electro-Spatial Formulation	UInt8 (Enum)	1	Not encoded	Not encoded
Channel Count	UInt32	4	4 or 8	4 or 8
Quantization bits	UInt32	4	16 or 24	16 or 24
Dial Norm	Int8	1	Not encoded	Not encoded
Locators	StrongRefArray (Locators)	8+16n	Present only if essence container is external to the file	Present only if essence container is external to the file

Table A3 – Generic data essence descriptor

Item Name	Type	Len	525/60-I	625/50-I
Linked Track ID	UInt32	4		
Sample Rate	Rational	8	{30000, 1001}	{25,1}
Container Duration	Length	8		
Codec	UL	16	See SMPTE RP 224	See SMPTE RP 224
Essence Container	UL	16	See SMPTE RP 224	See SMPTE RP 224
Data Essence Coding	UL	16	See SMPTE RP 224	See SMPTE RP 224
Locators	StrongRefArray (Locators)	8+16n	Present only if essence container is external to the file	Present only if essence container is external to the file

Annex B (informative)
Bibliography

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SMPTE 326M-2000, Television — SDTI Content Package Format (SDTI-CP)

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ISO/IEC 13818-2:2000, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information: Video (MPEG-2)

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