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SMPTE 407M-2006

SMPTE STANDARD

for Television — Material Exchange Format (MXF) — Operational Patterns 3a and 3b

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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 Administrative Practices.

This SMPTE document was prepared by the Technology Committee W25 on Metadata and Wrappers.

1 Scope

This standard defines operational patterns 3a and 3b as defined in SMPTE 377M section 7 for the exchange of MXF files that represent the following levels of file complexity:

OP3a: A material package that plays out an edit list from one or more file packages where only a single file package may be referenced at any given position on any material package timeline.

OP3b: A material package that plays out an edit list from two or more file packages each of which may be referenced and synchronized at any given position along the material package timeline.

In each case, a top-level file package is linked to an essence container where each essence container may comprise either a single essence element or an interleave of multiple essence elements. Furthermore, in each case, one or more of the essence containers may be internal or external to the file.

Approved
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This standard defines the operating restrictions, structural metadata objects, and individual attributes that shall be applied to the MXF file format specification to achieve interoperability when exchanging an MXF file with these operational patterns.

These operational patterns require the use of body partitions for internal essence containers. Subdivision of each essence container by using body partitions is optional.

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 edition of the standards indicated below.

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

SMPTE 378M-2004, Television — Material Exchange Format (MXF) — Operational Pattern 1a (Single Item, Single Package)

SMPTE 391M-2004, Television — Material Exchange Format (MXF) — Operational Pattern 1b (Single Item, Ganged Packages)

SMPTE 392M-2004, Television — Material Exchange Format (MXF) — Operational Pattern 2a (Play-List Items, Single Package)

SMPTE 393M-2004, Television — Material Exchange Format (MXF) — Operational Pattern 2b (Play-List Items, Ganged Packages)

3 Glossary of acronyms, terms and data types

The full glossary of acronyms, terms and data types used in the MXF specification is given in the MXF file format specification. It is not repeated here to avoid any divergence of meaning.

Essence element: An essence container may contain many essence elements interleaved together. An essence element in this standard corresponds to a separable part of the interleave which is described by an MXF track, such as a picture track, a sound track, or a data track.

4 Introduction

This standard defines MXF operational patterns 3a and 3b. SMPTE 377M defines the properties of the generalized operational patterns, and SMPTE EG 41 describes the concepts of operational patterns and the general conditions for audio-visual material exchange and interoperability. The introductory sections of these documents are not repeated here.

4.1 Operational pattern overview

Generalized MXF operational patterns are defined as a combination of the two dimensions as defined in the MXF file format specification.

These two dimensions are broadly illustrated in informative figure 1.

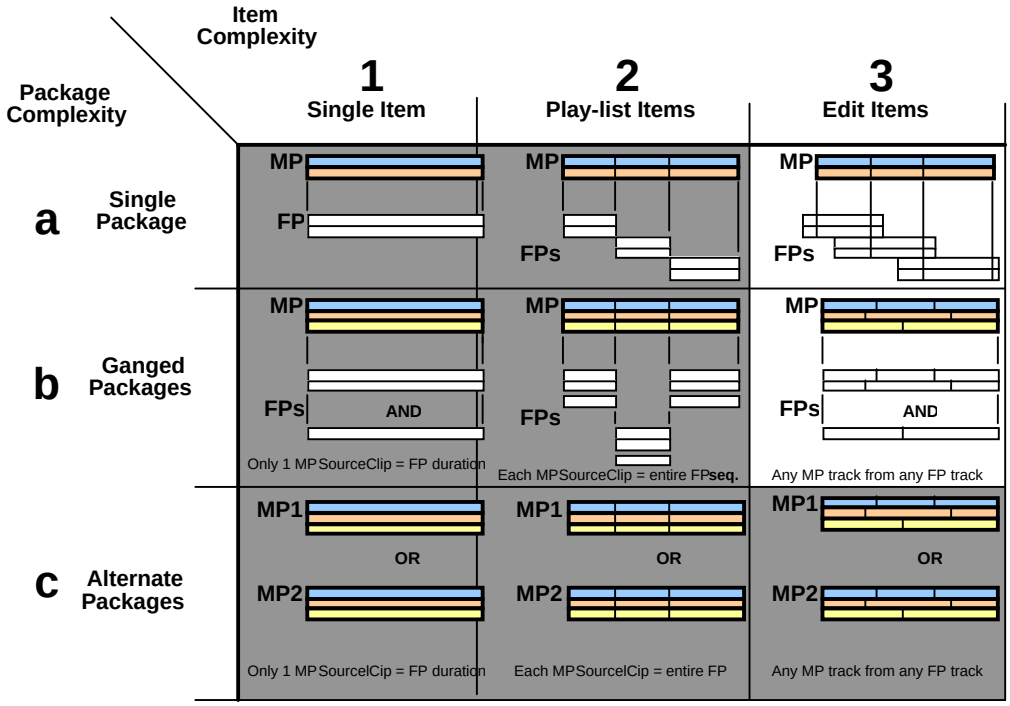

Figure 1 (informative) – Item and package complexity

This standard defines two generalized operational patterns as follows:

OP3a: A material package that plays out an edit list from one or more file packages where only a single file package may be referenced at any given position on any material package timeline.

This is illustrated in an informative manner in the rightmost column and top row.

Note that split editing is possible with this OP even though the figure suggests that all tracks must be aligned.

The detailed specifications of OP 3a are given in normative annex A.

OP3b: A material package that plays out an edit list from two or more file packages each of which may be referenced and synchronized at any given position along the material package timeline.

This is illustrated in an informative manner in the rightmost column and center row.

The detailed specifications of OP 3b are given in normative annex B.

None of these operational patterns apply constraints on the placement or use of descriptive metadata. General guidance on the use of descriptive metadata is given in SMPTE EG 42, SMPTE EG 41, and in SMPTE 380M. Implementers are encouraged to ensure descriptive metadata SourceClip references and descriptive metadata segments are kept consistent when essence references to file packages are modified.

Annex A (normative)
Specification of operational pattern 3a

A.1 MXF application

A.1.1 Material and top-level file package relationships

Other operational pattern specifications (e.g., SMPTE 378M, SMPTE 391M, SMPTE 392M, and SMPTE 393M) illustrate the relationship between the top-level file packages and lower-level source packages (as file or physical packages). This relationship is not repeated in figure A.1.

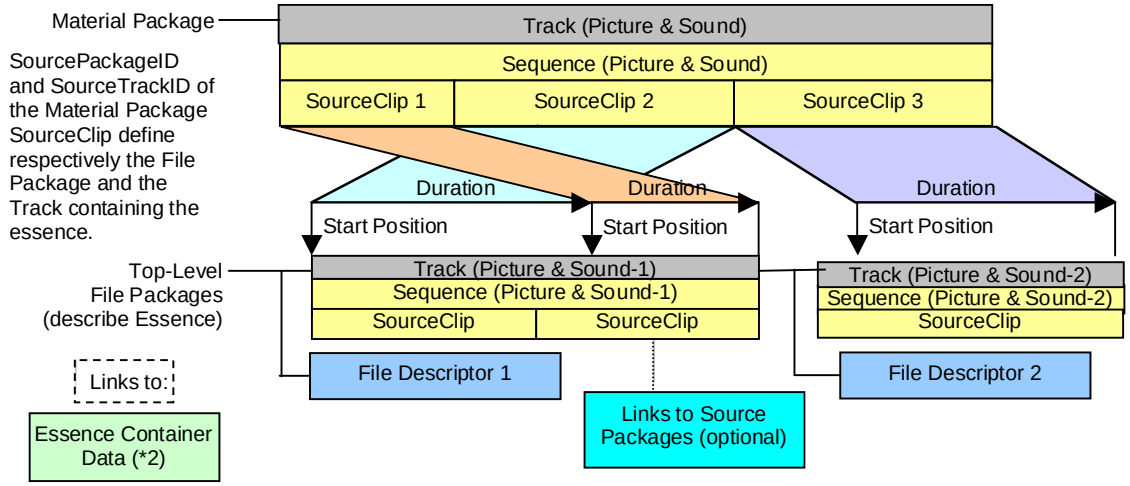

Figure A.1 (informative) – Outline of operational pattern 3a

A.1.2 General description

Operational pattern 3a is an extension of operational patterns 1a and 2a where the output comprises a non-linear edit list (a non-contiguous sequence) of essence containers containing the audio-visual items.

Operational pattern 3a is intended to meet the requirements of non-linear editing applications where the playout is sourced from one or more essence containers in a single file or in multiple files.

In order to support this operational pattern, devices will require random access to the contents of the essence containers.

A.1.2.1 Example uses (informative)

This operational pattern closely resembles the structure of an off-line edit system. However, this operational pattern generally requires the use of non-linear storage devices so that the playout of the material package tracks appears to be continuous.

An application of this operational pattern is to provide a time-lined output of a single picture (so that the single picture appears for a defined duration) and to provide ‘stuttering’, ‘flashback’ and other picture repeat effects.

A.2 Operational pattern constraints

A list of general constraints for this operational pattern is given in table A.1.

Table A.1 – General constraints for operational pattern 3a

File Kind	MXF
"Operational Pattern"	3a: (Edit-list of items with one or more Essence Containers).
Role	Interchange of edit lists using workgroup shared Essence Containers and exchange of edited files where the receiver of the file is permitted to define new edit points.
Essence	One or more Essence Containers, Operational Pattern Qualifiers apply (see Table A.2).
Material Packages	1
Number of Material Package SourceClips for each Essence Track	>1
Top-level File Packages	>=1 (up to number of Material Package SourceClips). Zero or more Top-level File Packages may be external to the file.
Number of Essence Container Types	1
Lower-level Source Packages	0 or more. Essence described by Lower-level File Packages must be external to the file.
Partition limits	None
Body Partitions	Required when >1 Top-level File Packages. Note: when there are >1 Top-level File Packages, it is recommended that each Top-level File Package is contained in at least one Body Partition.
Index Tables	Optional, but recommended.
Editing Support	Full edit list capability constrained to cut edits.
Streaming Support	This Operational Pattern requires non-linear access between the junctions of SourceClips.

Note that the "Number of Material Package SourceClips" in table A.1 above refers only to essence tracks. Operational patterns are intended to constrain the essence handling of an MXF application, so in the case where the essence is continuous and only the Metadata in a file has multiple SourceClips, it is likely that the file is an operational pattern lower than 3a.

A.3 Header metadata specification

A.3.1 General

The structural metadata sets and the normative universal label used to identify this operational pattern are defined in SMPTE 377M with specific constraints and additions detailed below.

A.3.2 Constraints on the MXF packages

All provisions from SMPTE 392M section 6.2 apply except for the following difference:

1. The material package SourceClips may start and end at different positions along each material package track to provide for split edit capability.

NOTE – At least one track must implement this non-linear provision in order for the file to be identified as OP3a and not OP2a.

A.3.3 Universal label for operational pattern 3a

The universal label value to define this operational pattern shall be as defined in table A.2.

Table A.2 – Value of the MXF operational pattern identification universal label

Byte No.	Description	Value (hex)
1-12	Defined in the MXF File Format Specification Operational Patterns Section	—
13	Operational Pattern: Item Complexity	03h
14	Operational Pattern: Package Complexity	01h
15	Operational Pattern :Qualifiers (application dependent)	(see SMPTE 377M)
16	Operational Pattern: OP3a qualifiers	(see SMPTE 392M, table 3)

The meanings of the bytes in this label are specified in the operational pattern section of SMPTE 377M. Bytes 13 and 14 uniquely identify this operational pattern specification and byte 15 contains generic qualifier bits which are defined in the MXF file format specification. Byte 16 contains qualifier bits which are defined in SMPTE 392M, table 3.

A.3.4 Operational pattern qualifiers (Bytes 15 and 16)

This operational pattern shall support the qualifiers as specified in byte 15 of the operational pattern universal label. Each bit of byte 15 shall be correctly set, as defined by SMPTE 377M, to reflect the status of the essence container.

A.3.4.1 Essence container location (Byte 15, bit 1)

Refer to SMPTE 392M section 6.4.1 for details.

A.3.4.2 Interleaving of multiple essence tracks (Byte 15, bit 2)

Refer to SMPTE 392M section 6.4.2 for details.

A.3.4.3 Number of essence tracks (Byte 15, bit 3)

Refer to SMPTE 392M section 6.4.3 for details.

A.3.4.4 Qualifiers specific to this operational pattern (Byte 16)

Refer to SMPTE 392M section 6.4.4 for details.

Note that these bits provide additional qualification of the matching bit of the generic qualifiers contained in byte 15. The generic qualifiers shall be used if they apply and the specific qualifier may be used in any combination with the generic qualifiers.

A.3.5 Minimum implementation (informative)

All constraints given in the MXF file format specification apply unless specifically overridden or extended in this standard.

The minimum implementation of operational pattern 3a is recommended to have the following sets in reference to the MXF file format specification. This section is a recommendation because the exact number of sets depends on the number of top-level file packages and the number of tracks in each top-level file package.

1 preface set, 1 or more identification sets, 1 content storage set, and 2 or more essence container data sets.

One material package including sets for:

- the time code track
- each picture track as required by the essence container
- each sound track as required by the essence container
- each data track as required by the essence container.

One or more top-level file packages each including sets for:

- each picture track as required by the essence container
- each sound track as required by the essence container
- each data track as required by the essence container
- each essence descriptor required to describe each essence track.

The annexes of the MXF format specification give the properties of the sets which should be implemented. All required set properties should be supported by MXF encoders that comply with this operational pattern.

A.4 MXF file interchange: Essence container issues

A.4.1 Essence container identification

Refer to SMPTE 392M section 7.1 for details.

A.4.2 Essence container requirements in operational pattern 3a

Refer to SMPTE 392M section 7.2 for details. Note that where the text in SMPTE 392M mentions “operational pattern 2a” it refers to “operational pattern 3a” in this standard.

Annex B (normative)
Specification of operational pattern 3b

B.1 MXF application

B.1.1 Material and top-level file package relationships

Other operational pattern specifications (e.g., SMPTE 378M, SMPTE 391M, SMPTE 392M, and SMPTE 393M) illustrate the relationship between the top-level file packages and lower-level source packages (as file or physical packages). This relationship is not repeated in figure B.1.

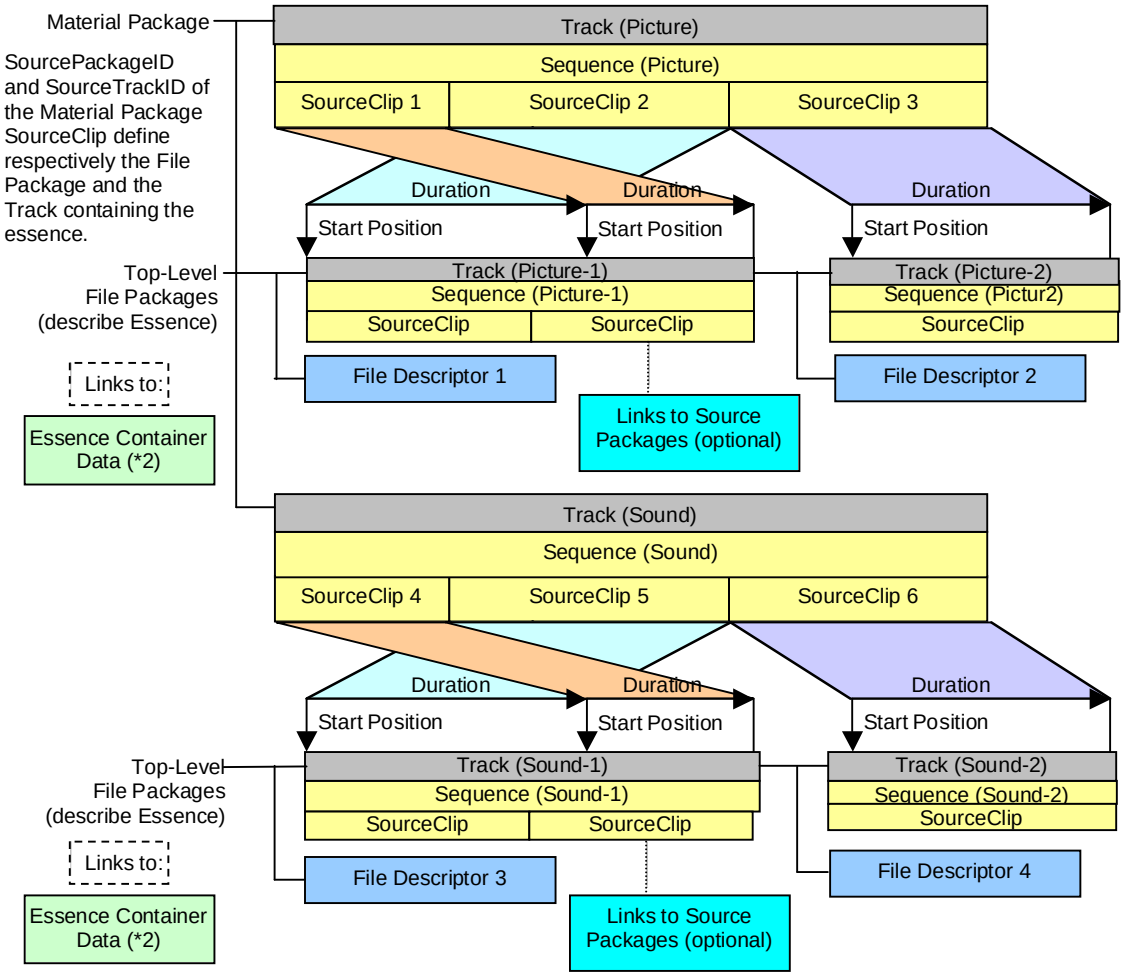

Figure B.1 (informative) – Outline of operational pattern 3b

B.1.2 General description

Operational pattern 3b is an extension of operational patterns 3a where the output comprises a non-linear edit list (a non-contiguous sequence) of synchronized essence containers containing the audio-visual items. The synchronized essence containers provide for the carriage of multiple essence types that are designed to be accessed along the same timeline for synchonised playout. Unlike OP2b (SMPTE 393M), the start points and durations of the ganged essence containers do not have to be identical.

Operational Pattern 3b is intended to meet the requirements of non-linear editing applications where the playout is sourced from one or more synchronized essence containers in multiple files.

In order to support this operational pattern, devices will require random access to the contents of the essence containers.

B.1.2.1 Example uses (informative)

This operational pattern closely resembles the structure of an off-line edit system. However, this operational pattern generally requires the use of non-linear storage devices so that the playout of the material package tracks appears to be continuous. In this operational pattern, it is most likely that each essence container will contain only a single essence track although multiple essence tracks are permitted. An analogy would be a EDL that accesses a video recorder and an audio recorder as separate physical devices.

As with operational pattern 3a, this operational pattern can be used to provide a time-lined output of a single picture (so that the single picture appears for a defined duration) and to provide 'stuttering', 'flashback' and other picture and/or sound repeat effects.

B.2 Operational pattern constraints

A list of general constraints for this operational pattern is given in table B.1.

Table B.1 – General constraints for operational pattern 3b

File Kind	MXF
"Operational Pattern"	3b: (Edit-list of items with one or more ganged Essence Containers)
Role	Interchange of edit lists using workgroup shared Essence Containers with ganged audio visual content and exchange of edited files where the receiver of the file is permitted to define new edit points.
Essence	Two or more Essence Containers, Operational Pattern Qualifiers apply (see Table B.2)
Material Packages	1
Number of Material Package SourceClips for each Essence Track	>1
Top-level File Packages	>1 (up to number of Material Package SourceClips). Zero or more Top-level File Packages may be external to the file.
Number of Essence Container Types	1
Lower-level Source Packages	0 or more. Essence described by Lower-level File Packages must be external to the file.
Partition limits	None.
Body Partitions	Required when >1 Top-level File Packages. Note: when there are >1 Top-level File Packages, it is recommended that each Top-level File Package is contained in at least one Body Partition.
Index Tables	Optional, but recommended.
Editing Support	Full edit list capability constrained to cut edits. Essence along the same output timeline may be contained in ganged Essence Containers.
Streaming Support	This Operational Pattern does not provide for streaming support.

Note that the “Number of Material Package SourceClips” in table B.1 above refers only to essence tracks. Operational patterns are intended to constrain the essence handling of an MXF application, so in the case where the essence is continuous and only the metadata in a file has multiple SourceClips, it is likely that the file is an operational pattern lower than 3b.

B.3 Header metadata specification

B.3.1 General

The structural metadata sets and the normative universal label used to identify this operational pattern are defined in SMPTE 377M with specific constraints and additions detailed below.

B.3.2 Constraints on the MXF packages

All provisions from SMPTE 393M section 6.2 apply, except for the following difference:

1. The material package SourceClips may start and end at different positions along each material package track to provide for split edit capability.

NOTE – At least one track must implement this non-linear provision in order for the file to be identified as OP3b and not OP2b.

B.3.3 Universal label for operational pattern 3b

The universal label value to define this operational pattern shall be as defined in table B.2.

Table B.2 – Value of the MXF operational pattern identification universal label

Byte No.	Description	Value (hex)
1-12	Defined in the MXF File Format Specification Operational Patterns Section	—
13	Operational Pattern: Item Complexity	03h
14	Operational Pattern: Package Complexity	02h
15	Operational Pattern :Qualifiers (application dependent)	(see SMPTE 377M)
16	Operational Pattern: OP3b qualifiers	(see SMPTE 393M, table 3)

The meanings of the bytes in this label are specified in the operational pattern section of SMPTE 377M. Bytes 13 and 14 uniquely identify this operational pattern specification and byte 15 contains generic qualifier bits which are defined in the MXF file format specification. Byte 16 contains qualifier bits which are defined in SMPTE 393M, table 3.

B.3.4 Operational pattern qualifiers (Bytes 15 and 16)

This operational pattern shall support the qualifiers as specified in byte 15 of the operational pattern universal label. Each bit of byte 15 shall be correctly set, as defined by SMPTE 377M, to reflect the status of the essence container.

B.3.4.1 Essence container location (Byte 15, bit 1)

Refer to SMPTE 393M section 6.4.1 for details.

B.3.4.2 Interleaving of multiple essence tracks (Byte 15, bit 2)

Refer to SMPTE 393M section 6.4.2 for details.

B.3.4.3 Number of essence tracks (Byte 15, bit 3)

Refer to SMPTE 393M section 6.4.3 for details.

B.3.4.4 Qualifiers specific to this operational pattern (Byte 16)

Refer to SMPTE 393M section 6.4.4 for details.

Note that these bits provide additional qualification of the matching bit of the generic qualifiers contained in byte 15. The generic qualifiers shall be used if they apply, and the specific qualifier may be used in any combination with the generic qualifiers.

B.3.5 Minimum implementation (informative)

All constraints given in the MXF file format specification apply unless specifically overridden or extended in this standard. The minimum implementation of operational pattern 3b is recommended to have the following sets in reference to the MXF file format specification. This section is a recommendation because the exact number of sets depends on the number of top-level file packages and the number of tracks in each top-level file package.

1 preface set, 1 or more Identification sets, 1 content storage set, and 2 or more essence container data sets.

One material package including sets for:

- the time code track
- each picture track as required by the essence container
- each sound track as required by the essence container
- each data track as required by the essence container.

Two or more top-level file packages each including sets for:

- each picture track as required by the essence container
- each sound track as required by the essence container
- each data track as required by the essence container
- each essence descriptor required to describe each essence track.

The annexes of the MXF format specification give the properties of the sets which should be implemented. All required set properties should be supported by MXF encoders that comply with this operational pattern.

B.4 MXF file interchange: Essence container issues

B.4.1 Essence container identification

Refer to SMPTE 393M section 7.1 for details.

B.4.2 Essence container requirements in operational pattern 3b

Refer to SMPTE 393M section 7.2 for details. Note that where the text in SMPTE 393M mentions “operational pattern 2b” it refers to “operational pattern 3b” in this standard.

Annx C (informative)
Bibliography

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