SMPTE ST 330:2022
Revision of SMPTE ST 330:2011

SMPTE STANDARD

Unique Material Identifier (UMID)

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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 its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 30MR.

Intellectual Property

SMPTE draws attention to the fact that it is claimed that compliance with this Standard may involve the use of one or more patents or other intellectual property rights (collectively, "IPR"). The Society takes no position concerning the evidence, validity, or scope of this IPR.

Each holder of claimed IPR has assured the Society that it is willing to License all IPR it owns, and any third party IPR it has the right to sublicense, that is essential to the implementation of this Standard to those (Members and non-Members alike) desiring to implement this Standard under reasonable terms and conditions, demonstrably free of discrimination. Each holder of claimed IPR has filed a statement to such effect with SMPTE. Information may be obtained from the Director, Standards & Engineering at SMPTE Headquarters.

Attention is also drawn to the possibility that elements of this Standard may be subject to IPR other than those identified above. The Society shall not be responsible for identifying any or all such IPR.

Introduction

UMID (Unique Material IDentifier) is a unique identifier for audiovisual material that is locally created and globally unique, and thus enables the Material to be linked with its associated Metadata. The UMID itself is neither intended for the identification of copyright nor the ownership of rights. Nor, for example, does it identify program content or works.

The UMID differs from many unique identifiers in that the number does not depend wholly upon a pre-registration process but can be generated automatically at the point of Material origination without reference to a central resource. The UMID consists of an ordered group of components each providing a key aspect to the identification of the audiovisual material, be it picture, sound or data. A key property of a UMID generated in accordance with this Standard is that it is possible to use the resulting UMID simply as a globally unique Dumb Number.

The UMID can exist in one of two forms:

- A Basic UMID, which contains the minimum components necessary for unique identification; and
- An Extended UMID, which attaches a packed metadata set (Source Pack) to the Basic UMID.

This Standard specifies the formats of each component in both the Basic UMID and the Extended UMID. It also identifies and specifies methods by which the components of the identifier can be created.

1 Scope

This Standard defines the format of the Unique Material Identifier (UMID).

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; then formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this standard. Dated references require that the specific edition cited shall be used as the reference. Undated citations refer to the edition of the referenced document (including any amendments) current at the date of publication of this document. All standards are subject to revision, and users of this engineering document are encouraged to investigate the possibility of applying the most recent edition of any undated reference.

SMPTE ST 298:2009, SMPTE Standard — Universal Labels for Unique Identification of Digital Data

SMPTE ST 309:2012, SMPTE Standard — Transmission of Date and Time Zone Information in Binary Groups of Time and Control Code

SMPTE ST 335:2012, SMPTE Standard — Metadata Element Dictionary Structure

SMPTE ST 335:2012, SMPTE Standard Amendment 1:2019 — Metadata Element Dictionary Structure – Amendment 1

SMPTE ST 336:2017, SMPTE Standard — Data Encoding Protocol Using Key-Length-Value

SMPTE ST 2029:2009, SMPTE Standard — Uniform Resource Names for SMPTE Resources

SMPTE RP 205:2014, SMPTE Recommended Practice — Application of Unique Material Identifiers in Production and Broadcast Environments

AES3-2009 (r2019): AES standard for digital audio engineering — Serial transmission format for two-channel linearly represented digital audio data

IEEE 802-2014, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture

IEEE 1394-2008, IEEE Standard for a High-Performance Serial Bus

ISO 3166-1:2013, Codes for the representation of names of countries and their subdivisions — Part 1: Country codes

ISO/IEC 8859-1:1998, Information Technology — 8-Bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1

IETF RFC 1321, The MD5 Message-Digest Algorithm

IETF RFC 4122, A Universally Unique Identifier (UUID) URN Namespace

ICAO T_Documents, Doc 9674 - World Geodetic System - 1984 (WGS-84) Manual

NOTE: In accordance with SMPTE Standard Operation Manual ver. 3.1, Section 10.e, this ICAO document has been exceptionally allowed as the SMPTE normative reference by the SMPTE ST committee.

4 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

4.1 Basic UMID

32-byte value composed of a 12-byte UL, a 1-byte length field, a 3-byte Instance Number field, and a 16-byte Material Number field, specified in this Standard

NOTE: Conventionally, the term “Basic UMID” is also used to represent the first 32-bytes of an Extended UMID. The phrase “the Basic part of an Extended UMID” is used where clarification is required.

4.2 Coordinated Universal Time

UTC

time scale used to compensate the representation of date and time for the difference between TAI atomic time and the observed rotational position of the Earth with respect to the Sun

NOTE: The reference point between TAI and UTC is established as 1972-01-01T00:00:00Z (UTC) = 1972-01-01 00:00:10 (TAI) at the reference meridian. Calendar-time after this reference point is expressed as UTC = TAI – all the Leap Seconds inserted since then.

4.3 Daylight Saving Time

DST

civil time observed when daylight saving is adopted in a country or region

4.4 Essence

data or signal necessary to represent any single type of visual, aural or other sensory experience, independent of the method of coding

4.5 Extended UMID

64-byte value composed of a 32-byte Basic UMID followed by a 32-byte Source Pack, specified in this Standard, wherein the 32-byte Source Pack is used to identify a finer granularity than is identified by the Basic part of the Extended UMID

4.6 Geoid

equipotential surface in the gravity field of the Earth which coincides with the undisturbed mean sea level extended continuously through the continents. When the Geoid is determined by utilizing gravity data collected on the Earth's surface of local areas or regions only, it is called a local Geoid

4.7 Instance

specific item of stored Material(s) that shares the same Material Number regardless of its Instance Number value

4.8 Instance Number

24-bits value in a UMID, which shall take either a value of zero for an original Material or a non-zero value for any copy or derivation of the original Material

4.9 International Atomic Time

TAI

time scale established and maintained by the BIPM (Bureau international des poids et mesures) to standardize an absolute time reference scale. The TAI is measured as a continuous uninterrupted count of seconds from the origin 1958-01-01 00:00:00 (TAI)

4.10 Julian Date

JD

count of days that have elapsed since Greenwich noon on 1 January 4713 B.C., Julian proleptic calendar

NOTE: At midnight, the JD ends in ".5". See also Modified Julian Date

4.11 Leap Second

one second unit count inserted into the UTC counting method to compensate for the difference between TAI atomic time and the observed rotational position of the Earth

4.12 Material

persistent and deterministic form of a unique set of audio and/or visual Essence(s) playable on a single timeline

NOTE 1: A Material can be a single item or a set of synchronized items, but will always be continuous along the timeline.

NOTE 2: A Material, often preceded with a term “original”, will always be globally uniquely identified by a UMID with a newly created Material Number together with a zero Instance Number, whose global uniqueness is algorithmically guaranteed according to this Standard.

NOTE 3: A Material can either be a playable bit stream, or an abstract source from which a playable bit stream is to be created.

4.13 Material Number

16-byte non-zero globally unique identifier corresponding to an original Material

4.14 Material Type

indicator of the kind of Essence or Essences of a Material a UMID is associated with

4.15 Material Unit

entity that represents a quantum of a Material defined by its cyclic sampling structure

NOTE 1: A duration of a Material Unit depends on a type of Material; examples are an AES3 block and a video frame.

NOTE 2: The duration of the Material Unit is determined by requirements of the type of Material and its application. The duration is not specified in the Basic UMID but can be specified in the Source Pack.

4.16 Metadata

data which conveys information about the Material

4.17 Modified Julian Date

MJD

abbreviated version of the Julian date (JD) dating method, defined as MJD = JD - 2,400,000.5

NOTE: The origin of MJD equals 00:00 hours UTC time, 17 November 1858.

4.18 Source Pack

last 32 bytes of an Extended UMID, which contains information of “when”, “where” and “who” created a Material, as specified in this Standard

4.19 Universal Label

UL

SMPTE Universal Label specified in SMPTE ST 298

NOTE: A UL is truncated to 12 bytes length when used in the UMID format. When the UMID UL is extracted for external use, it will always be increased to 16 bytes by appending 4 bytes of zero value and change the value of the label size in 2nd byte of the UL from 0Ah to 0Eh.

4.20 Unique Material Identifier

UMID

Unique Material Identifier whose format and value creation methods are specified in this Standard

NOTE: A UMID can take a form of either a 32-byte Basic UMID or a 64-byte Extended UMID, where the Extended UMID is still a valid UMID but the one extended with additional 32-bytes of geo-location and other information to form a Source Pack. See also Basic UMID, Extended UMID and Source Pack.

5 General Specification

A Unique Material Identifier (UMID) provides for the globally unique identification of any audiovisual Material.

This Standard defines a dual approach through the specification of a Basic UMID and an Extended UMID.

The Basic UMID shall provide a globally unique identification for a Material that comprises an integer number of one or more contiguous Material Units. The Basic UMID has no embedded mechanism to distinguish between individual Material Units within a single instance of Material. The data in the Basic UMID can be created through automatic generation.

The Extended UMID shall comprise the Basic UMID followed immediately by a Source Pack that provides a signature for Material Units. The Source Pack shall comprise a fixed length metadata pack of 32 bytes that provides sufficient Metadata by which source “when, where and who (or what)” information can be identified regardless of current ownership or status. The Extended UMID shall also provide a mechanism to distinguish between individual Material Units within a single instance of Material.

The Basic UMID shall be 32 bytes long and the Extended UMID shall be 64 bytes long.

Both UMID types shall use the Key-Length-Value (KLV) construct defined by SMPTE ST 336. The Key is originally a 16-byte Universal Label (UL) which shall be truncated to 12 bytes for the UMIDs specified in this Standard.

In the case of the Basic UMID, the Length field shall have a value of 13_h and the value shall be formed by the combination of a Material Number and an Instance Number.

In the case of the Extended UMID, the Length field shall have a value of 33_h and the value shall be formed by the combination of the Material and the Instance Numbers followed by the Source Pack.

All components of the UMID shall have a defined byte order for consistent application in storage and streaming environments.

Figure 1 illustrates the layout of the both the Basic UMID and the Extended UMID.

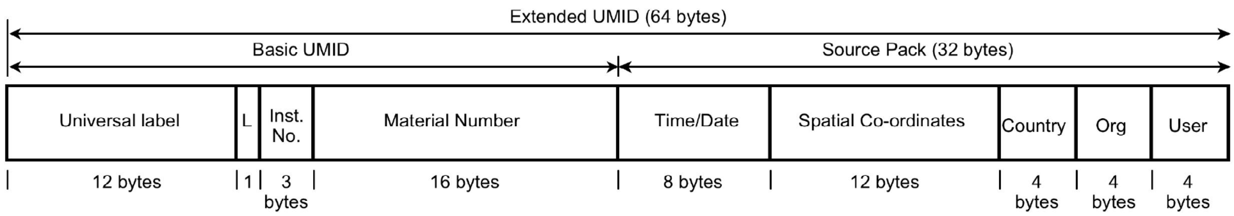


Figure 1 – Basic and Extended UMID Structures

The components of the Basic UMID shall be:

1. A 12-byte Universal Label,
2. A 1-byte Length (L) value,
3. A 3-byte Instance Number (Inst. No.), and
4. A 16-byte Material Number.

The combination of the Instance and Material Numbers shall be treated as a Dumb Number.

NOTE: The Material Number does not indicate the status of the Material (such as copy number) or its representation (such as the compression kind). The Material Number can be identical in copies and in different representations of the Material. The purpose of the Instance Number is to separately identify different representations or Instances of a Material. Thus, for example, a high-resolution picture and a thumbnail can both have the same Material Number because they both represent the same picture but, because they are different Instances, they will always have different Instance Numbers for the different representations. Guidance for the consistent application of new Material Numbers and Instance Numbers is given in SMPTE RP 205.

The Extended UMID shall comprise a Basic UMID, followed by a Source Pack. The components of the Source Pack shall be:

1. An 8-byte date stamp and unit count component,
2. A 12-byte geospatial coordinate,
3. A 4-byte country code,
4. A 4-byte organization code, and
5. A 4-byte originator code.

NOTE 1: The Source Pack only represents information available at a time when the Extended UMID is first applied. The Source Pack values therefore refer to the “when, where and who (or what)” at the point of application of the Source Pack and this can differ from the originating device.

NOTE 2: All metadata fields in the Source Pack can be automatically generated for each Material Unit using a timer, a global position calculator and pre-registered identification data. Where automatic generation of any value is not possible, it can be manually entered.

NOTE 3: The terms origination and originator above refer to physical origination and have no meaning in terms of intellectual property right.

6 UMID Format Specification

6.1 Byte Order

Number formats including the Material and Instance Numbers together with the date/time and geospatial coordinate fields shall be presented with the least significant byte first (also known as little-endian byte order) unless otherwise defined.

6.2 Basic UMID

6.2.1 Structure of Basic UMID

The Basic UMID shall be 32 bytes long, and shall contain a 12-byte Universal Label, a Length, an Instance Number, and a Material Number in this order with each item as defined below.

6.2.2 UMID Universal Label

6.2.2.1 12-Byte Universal Label

The 12-byte Universal Label defines the type of Material which the UMID identifies, and the methods by which the Material Number and the Instance Number are created.

The first 12 bytes of the UMID shall identify the UMID with a SMPTE Universal Label as defined by SMPTE ST 298 having the registered string value defined in Table 1.

Table 1 – UMID Universal Label

Byte No.	Description	Value (hex)	Meaning
1	Object identifier	06h	Universal Label start
2	Label size	0Ah	12-byte Universal Label
3	Designation: ISO	2Bh	ISO Registered
4	Designation: SMPTE	34h	SMPTE Registered
5	Registry category	01h	Dictionaries
6	Specific category	01h	Metadata Dictionaries
7	Structure	01h	Dictionary Standard (SMPTE ST 335)
8	Version number	05h	Version of the Metadata Dictionary
9	Class	01h	Identifiers and Locators
10	Subclass	01h	Globally Unique Identifiers

11	Material type	XXh	See Section 6.2.2.2
12	Number generation method	YYh	See Section 6.2.2.3

NOTE: SMPTE ST 298 defines SMPTE Universal Labels as having a length of 16 bytes. The 12-byte UMID Universal Label is still a valid and unique ISO object identifier as defined in SMPTE ST 298. When the UMID Universal Label is used in isolation, the 12-byte UMID Universal Label can be converted to a SMPTE Universal Label by padding with 4 bytes of null fill and changing the value of the label size in byte 2 from ‘0Ah’ to ‘0Eh’.

6.2.2.2 Material type identification

Byte 11 of the UL defines the Material Type being identified using one of the values defined in

Table 2.

The use of Material Types ‘01h’, ‘02h’, ‘03h’ and ‘04h’ shall be deprecated for use in implementations using this revised Standard. These values are preserved only for compatibility with systems implemented using SMPTE ST 330:2000.

Table 2 – Material Type Identification

Byte value	Meaning	Examples and notes
01h	Picture material	Deprecated and cannot be used
02h	Audio material	Deprecated and cannot be used
03h	Data material	Deprecated and cannot be used
04h	Other material	Deprecated and cannot be used
05h	Single picture component	e.g. Y component
06h	Two or more picture components in a single container	e.g. interleaved Y, Cb and Cr components
08h	Single audio component	e.g mono audio
09h	Two or more audio components in a single container	e.g. AES3 audio pair
0Bh	Single auxiliary (or data) component	e.g. sub-titles only
0Ch	Two or more auxiliary (or data) components in a single container	e.g. multiple sub-titles streams in different languages
0Dh	Mixed group of components in a single container	e.g. video & stereo audio pair
0Fh	Material Type is not identified	

6.2.2.3 Number generation method identification

Byte 12 of the UL defines the methods by which the Material and Instance Numbers are created. This byte is divided into top and bottom nibbles for the purpose of this definition.

The top nibble shall occupy the 4 most significant bits (MSBs) of the byte and the value shall be used to define the method of Material Number generation. The values used by this nibble shall be limited to the range 0 to 7_h so that byte 12 conforms to the ASN.1 BER short form coding rules used by SMPTE ST 298.

The methods of Material Number generation shall be as defined in Table 3 and the specification of each method shall be as defined in Annex A.

Table 3 – Identification of Material Number Generation Method

Value (hex)	Method
0	No defined method
1	SMPTE Method
2	UUID/UL Method
3	Masked Method
4	IEEE 1394 Network Method
5	Hashed Method
6	Reserved but not defined
7	Fixed Material Number

The bottom nibble shall occupy the 4 least significant bits (LSBs) of the byte and the value shall be used to define the method of Instance Number generation. The values used by this nibble is unlimited and thus occupy the range 0_h to F_h.

The methods of Instance Number generation shall be as defined in Table 4 and the specifications of each method shall be as defined in Annex B.

Table 4 – Identification of Instance Number Generation Method

Value (hex)	Method
0	No defined method
1	Local Registration
2	24-Bit PRS Generator
3	Copy Number and 16-Bit PRS Generator
4	Copy Number and Local Registration
5 ~ E	Reserved but not defined
F	Live Stream

6.2.3 Length

The Length field defines the length of the remaining parts of the UMID.

The Length shall be a 1-byte number with the value 13_h for the Basic UMID and 33_h for the Extended UMID.

6.2.4 Instance Number

The 3-byte Instance Number shall identify different Instances of Material where each Instance shares a common Material Number. An Instance Number allows each Instance to be linked to all Metadata associated with a particular Instance of the Material.

The Instance Number shall be created by one of the methods identified in Table 4 and defined in Annex B.

At the origination of a new Material, a new Material Number shall be created together with an Instance Number initialized to zero to globally uniquely identify the original Material.

6.2.5 Material Number

The 16-byte Material Number shall be globally unique for every item of Material and may have the same value for related Instances of the same Material, where the Instance Number is used to uniquely identify these related Instances within a predefined closed domain.

A common Material Number may be used to identify all Instances of the same Material in a predefined closed domain.

The 16-byte Material Number shall be created by one of several means identified in Table 3 and defined in Annex A. Annex A defines methods by which the Material Number may be generated and which are known to provide a high likelihood of being unique.

NOTE: A common Material Number allows a given Instance of a Material to be linked to other Instances of the same Material.

6.3 Extended UMID

The Extended UMID shall be 64 bytes long and shall comprise a Basic UMID (with a Length value of 33_h), followed by a Source Pack.

6.4 Source Pack

6.4.1 General Specification

The Source Pack is a metadata pack that identifies the source of a Material Unit by defining the “when, where and who (or what)” of the Material Unit with which the Source Pack is associated.

The Source Pack shall only be present in the Extended UMID.

Once a non-zero Source Pack field value has been included in an Extended UMID, it shall not be changed and shall always relate to its associated Material Unit.

The Source Pack shall be 32 bytes long, and should contain a date and time stamp, geospatial coordinates, a country code, an organization code, and a user code in this order with each item as defined below.

Any component of the Source Pack may be zero-filled where no meaningful value can be entered. Any zero-filled component shall be wholly zero-filled to clearly indicate to a downstream decoder that the component does not contain a meaningful value.

6.4.2 Date Stamp and Unit Count Component

6.4.2.1 General Specification

The date stamp and unit count component of the Source Pack provides the temporal information (the “when”).

The date stamp and unit count component shall identify the time and date of origination of the Material Unit with which the Source Pack is associated.

6.4.2.2 Date stamp and unit count for all material types (single and in combination)

6.4.2.2.1 Overview

In the case where the Material Unit has a Material Type identifier (byte 11 of the UL) with any value of '05_h' or higher, the data format for the 8-byte date stamp and unit count shall be as described in Figure 2.

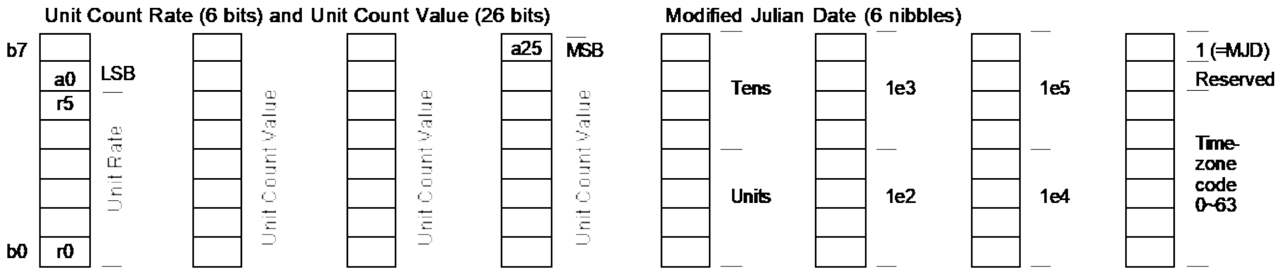


Figure 2 – Date Stamp and Unit Count Data Format

6.4.2.2.2 Unit count rate and unit count value

Bits 0 to 5 of the first byte (bits r0 to r5 in Figure 2) shall be used to identify the unit count rate. The remaining 26 bits in the first four bytes (bits a0 to a25 in Figure 2) shall be used as the unit count value within a 24-hour period starting at midnight in UTC.

The unit count rate values shall be as defined in Table 5.

The unit count value shall be a maximum unsigned integer whose multiplication with the unit count rate is less than a measured time point in UTC. For example, the unit count value of zero ('0') represents the measured time point equal to or greater than 00:00 min 00 sec (midnight) in UTC and less than 00:00 min 0.04 sec in UTC for the unit count rate of 25 Hz ('4' for bits r5~r0).

NOTE: The starting point of the unit count value as the midnight in UTC comes from its alignment with the rollover point of date in MJD, which is defined at the midnight in UTC.

Table 5 – Identification of Unit Count Rate

Decimal Value of bits r5~r0	Unit Count Rate (Hz)	Intended Application
0 (default)	48000/64 (750)	Indicate the Material Unit rate for AES3 block rates for an audio frame rate of 48 kHz, and an increment shall be made in steps of 3 for each duration of an AES3 block (of 192 samples). This Material Unit rate is also used for a default count method for all other Material Types and may be used as a method of calculating time within a 24 hour period.
1	32000/64 (500)	Indicates the Material Unit rate for AES3 block rates for an audio frame rate of 32 kHz, and an increment shall be made in steps of 3 for each duration of an AES3 block (of 192 samples).
2	24	Indicates the Material Unit rate for film rates at 24 fps (frames per second).
3	24/1.001	Indicates the Material Unit rate for film-for-television rates at 24/1.001 fps.
4	25	Indicates the Material Unit rate for film and television rates at 25 fps.
6	30	Indicates the Material Unit rate for film and television rates at 30 fps.

7	30/1.001	Indicates the Material Unit rate for film-for-television and television rates at 30/1.001 fps.
8	48	Indicates the Material Unit rate for film rates at 48 fps.
9	48/1.001	Indicates the Material Unit rate for film-for-television rates at 48/1.001 fps.
10	50	Indicates the Material Unit rate for film and television rates at 50 fps.
12	60	Indicates the Material Unit rate for film and television rates at 60 fps.
13	60/1.001	Indicates the Material Unit rate for film-for-television and television rates at 60/1.001 fps.
14	72	Indicates the Material Unit rate for film and television rates at 72 fps.
16	75	Indicates the Material Unit rate for film and television rates at 75 fps.
18	90	Indicates the Material Unit rate for film and television rates at 90 fps.
20	96	Indicates the Material Unit rate for film and television rates at 96 fps.
22	100	Indicates the Material Unit rate for film and television rates at 100 fps.
24	120	Indicates the Material Unit rate for film and television rates at 120 fps.
25	120/1.001	Indicates the Material Unit rate for film and television rates at 120/1.001 fps.
26	144	Indicates the Material Unit rate for film and television rates at 144 fps.
28	160	Indicates the Material Unit rate for film and television rates at 160 fps.
30	165	Indicates the Material Unit rate for film and television rates at 165 fps.
32	180	Indicates the Material Unit rate for film and television rates at 180 fps.
34	200	Indicates the Material Unit rate for film and television rates at 200 fps.
36	240	Indicates the Material Unit rate for film and television rates at 240 fps.
37	240/1.001	Indicates the Material Unit rate for film and television rates at 240/1.001 fps.
38	300	Indicates the Material Unit rate for film and television rates at 300 fps.
49	1	Indicates the Material Unit rate for film and television rates at 1 fps.
60	44100/64 (~689)	Indicates the Material Unit rate for AES3 block rates for an audio frame rate of 44.1 kHz (CD rate), and an increment shall be made in steps of 3 for each duration of an AES3 block (of 192 samples).
61	44100/64.064 (~688)	Indicates the Material Unit rate for AES3 block rates for an audio frame rate of 44.1/1.001 kHz, and an increment shall be made in steps of 3 for each duration of an AES3 block (of 192 samples).
63	Unspecified	Indicates that the Material Unit rate is not specified and the increments could be irregular. Its value can be determined by other means. The time of day is incalculable using this value.
All other values	Reserved	All values not defined in the rows above are reserved for future use and cannot be used.

NOTE: The 26 bits for the unit count value allow a maximum count range of 67,108,864 over a 24-hour period. This allows for a minimum unit duration of approximately 1.29 msec, which is equivalent to a maximum unit rate of 775 units per second.

6.4.2.2.3 Modified Julian date and time-zone code

The last four bytes of the date stamp and unit count component shall be based on the Modified Julian Date (MJD). While the allocation of the MJD data fields used to be defined according to SMPTE ST 309, the following is a reproduction of the SMPTE ST 309:2012 specifications with the latest information being reflected. If there is any discrepancy between the following and the latest SMPTE ST 309, the former shall take precedence.

Time-zone, date format, daylight saving time

The last byte of the date stamp encodes the time-zone and defines the format for the encoding of the date in the remaining six nibbles as detailed in Table 6.

Table 6 – Date Format and Time-Zone Offset Coding

Bits	Assignation	Description
1's bit 2's bit 4's bit 8's bit 16's bit 32's bit	Time-zone code 0-63 (00h-3Fh)	See Table 7
64's bit	Reserved	Always '0'
128's bit	MJD flag	Always '1' for (6-digit) MJD format

The MJD flag bit (128's bit) shall be always logical one for the date to represent the MJD encoded date information as six BCD digits in ascending order of magnitude in the remaining six nibbles as depicted in Figure 2.

The 64's bit, which is allocated for the DST (Daylight saving time) flag in SMPTE ST 309, is reserved for the Source Pack, and thus shall be always logical zero.

Six bits in the last byte (32's bit – 1's bit) code the time-zone as defined in Table 7.

Table 7 – Time-Zone Offset and Time Precision Coding

Offset		Standard Time (Informative)	Daylight Saving (Informative)		Offset		Standard Time (Informative)	Daylight Saving (Informative)
Code	Hours				Code	Hours		
00	UTC	Greenwich			0A	UTC-00:30		
01	UTC-01:00	Azores			0B	UTC-01:30		
02	UTC-02:00	Mid-Atlantic			0C	UTC-02:30		Newfoundland
03	UTC-03:00	Buenos Aires	Halifax		0D	UTC-03:30	Newfoundland	
04	UTC-04:00	Halifax	New York		0E	UTC-04:30		
05	UTC-05:00	New York	Chicago		0F	UTC-05:30		
06	UTC-06:00	Chicago	Denver		1A	UTC-06:30		
07	UTC-07:00	Denver	Los Angeles		1B	UTC-07:30		
08	UTC-08:00	Los Angeles			1C	UTC-08:30		
09	UTC-09:00	Alaska			1D	UTC-09:30	Marquesa Island	
10	UTC-10:00	Hawaii			1E	UTC-10:30		
11	UTC-11:00	Midway Island			1F	UTC-11:30		

12	UTC-12:00	Kwajalein	
13	UTC+13:00		New Zealand
14	UTC+12:00	New Zealand	
15	UTC+11:00	Solomon Islands	
16	UTC+10:00	Guam	
17	UTC+09:00	Tokyo	
18	UTC+08:00	Beijing	
19	UTC+07:00	Bangkok	
20	UTC+06:00	Dhaka	
21	UTC+05:00	Islamabad	
22	UTC+04:00	Abu Dhabi	
23	UTC+03:00	Moscow	
24	UTC+02:00	Eastern Europe	Central Europe
25	UTC+01:00	Central Europe	United Kingdom
26 27	Undefined	Reserved; do not use	
28 29 30 31	Undefined	Depreciated	

2A	UTC+11:30		
2B	UTC+10:30		
2C	UTC+09:30		
2D	UTC+08:30		
2E	UTC+07:30		
2F	UTC+06:30		
3A	UTC+05:30		
3B	UTC+04:30		
3C	UTC+03:30		
3D	UTC+02:30		
3E	UTC+01:30		
3F	UTC+00:30		
32	UTC+12:45	Chatham Island	
33 34 35 36 37	Undefined	Reserved; do not use	
38	User defined time offset		
39	Undefined	Unknown	Unknown

NOTE: The use of codes 28 to 31 to signal time precision information is depreciated since SMPTE ST 309:2012

NOTE: Because the starting point of the unit count value is defined as the midnight in UTC regardless of the time-zone, the code specified according to Table 7 is for a descriptive purpose only. In case when a local time clock is used for the Source Pack by a material source device, the starting point of the unit count value is calculated from the midnight in the local time with the time-zone offset being considered, though.

6.4.2.2.4 Date/Time accuracy considerations (informative)

Date/Time accuracy

According to a definition of the unit count value, an inaccuracy of a reciprocal of a specified unit count rate cannot be avoided. To reduce the inaccuracy of a time point of the Material Unit occurrence, the unit count rate higher than a frequency of the Material Unit occurrence can be used. In this case, however, care ought to be taken for an initial unit count value after the midnight in UTC, which would have been always zero if the specified unit count rate is equal to the frequency of the Material Unit occurrence.

For example, when the unit count rate of 120/1.001 Hz (‘25’ for bits r5-r0) is specified for the Material Units that occur at a frequency of 30/1.001 Hz, wherein the unit count value is incremented by four and thus the inaccuracy is reduced to one fourth, if the last unit count value immediately before the midnight in UTC takes a value of 10,357,642 or, the maximum unit count value that can be taken for the unit count rate of 120/1.001 Hz, the initial unit count value immediately after the midnight in UTC will always be three (instead of zero).

Leap second

By definition, the Leap Second is inserted at the last time point of a predefined day in UTC as “23:59:60”. Because of unpredictable nature of the predefined day, it is hard to expect that a UTC time clock of a material source device always correctly inserts the Leap Second. Therefore, time inaccuracy in one second is taken into consideration after the predefined day for the Leap Second.

NOTE: While the common practice is to introduce the Leap Second in local YMDhms representation simultaneous with its occurrence at the midnight in UTC, there are existing practices to defer an insertion of the Leap Second until the end of the broadcast day, which is generally not the midnight in local time but the time at which the daily jam sync occurs.

Time-zone offset

It ought to be noted that the accuracy of the time-zone offset is out of scope of this standard because of its descriptive purpose only (though the best effort is still desired to specify a correct value for it).

6.4.3 Geospatial Coordinate Component

6.4.3.1 Structure of Geospatial Coordinate Component

The geospatial coordinate component of the Source Pack provides the location information (the “where”).

The geospatial coordinate component shall define the geospatial coordinates at the time of origination of the Material Unit with which the Source Pack is associated.

The geospatial coordinate component shall define the location in latitude, longitude and altitude for the recording device, sensor device or the target object. The geospatial coordinate value shall consist of three parts, each of 4 bytes, defined as follows:

1. Altitude: 8 decimal numbers specifying the altitude in meters;

2. Longitude: 8 decimal numbers specifying east/west 180.00000 degrees (5 decimal places active);

3. Latitude: 8 decimal numbers specifying north/south 90.00000 degrees (5 decimal places active).

The reference World Geodetic System for the geospatial coordinate component shall be WGS-84 (as defined by ICAO Doc 9674) which is the datum used by the Navigation System with Time And Ranging (NAVSTAR) Global Positioning System (GPS).

NOTE: Although geospatial coordinates can be static for many kinds of material, this is not true for all cases. Material captured from a moving source such as a camera mounted on a vehicle can show changing geospatial coordinate values.

Figure 3 illustrates the format of the geospatial coordinate component.

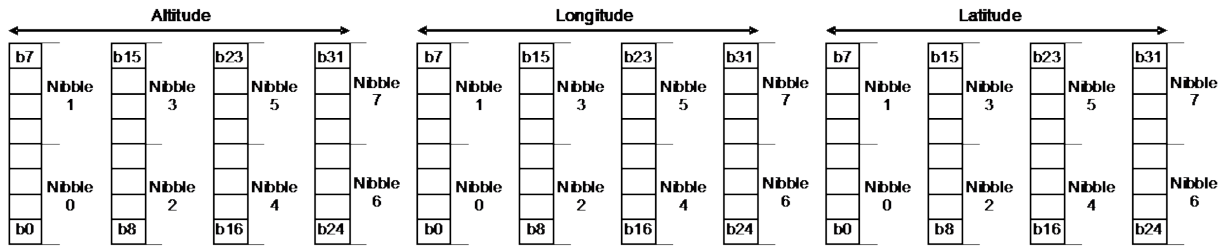


Figure 3 – 12-byte Geospatial Coordinate Format

Except where otherwise specified, each nibble shall have a decimal number value in the range 0~9. Values in the range A_h~F_h shall be reserved for special purposes as defined in the following sub-sections.

The format of each 4-byte part shall be little-endian which means that the least significant decimal number occupies the least significant 4 bits of the first byte (nibble 0) and the most significant decimal number occupies the most significant 4 bits of the fourth byte (nibble 7).

6.4.3.2 Altitude part

6.4.3.2.1 General Specification

The altitude value shall be expressed either as a value from the center of the earth or as a signed value relative to the sea level of the local Geoid.

If nibbles 0 to 7 all lie in the range 0 to 9, the altitude value shall be measured from earth center using the full range of nibbles 0 to 7.

NOTE: This allows an altitude of 99,999,999 meters from earth center.

If nibble 7 lies in the range A_h to F_h, the altitude shall be measured relative to the sea level of the local Geoid and these values of nibble 7 shall be interpreted as defined in Table 8.

Table 8 – Values and Definitions for Nibble 7

Nibble 7 Value	Definition
Ah	Defines a positive altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the sensor device location
Bh	Defines a positive altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the recording device location
Ch	Defines a positive altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the target object location
Dh	Defines a negative altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the sensor device location
Eh	Defines a negative altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the recording device location
Fh	Defines a negative altitude relative to the sea level of the local Geoid and that the geospatial coordinates are those of the target object location

in which,

Sensor device location: where the geospatial coordinates are the location of the sensor device, typically that of the camera or microphone. This location would be used in the case of an integrated camcorder device where the geospatial coordinate sensor is located in the camcorder.

Recording device location: where the geospatial coordinates are the location of the recording device, typically that of a video or audio recorder which is remotely located from the camera or microphone. This location would be used in the case where geospatial coordinates of the target object or the sensor device are not available at the time of recording.

Target object location: where the geospatial coordinates are the location of the target object, typically that of the image or sound source. This location would be used in the case where, for example, a sensor device was capturing images at long range, but where the location of the image object was known by some means.

In nibble 6, semantics are primarily defined for each bit as:

- b27 and b26 shall indicate “the number of satellites – 1” used for the measurement.

- b25 shall indicate if the geospatial measurements have been aided with any supportive apparatus such as a gyroscope.

- b24 shall indicate whether the value in nibble 5 is used for altitude measurement or for PDOP (Position Dilution of Precision) value (including the horizontal DOP or the vertical DOP). If this bit is ‘0’, then nibble 5 provides for an altitude range of +/-999,999 meters. If this bit is ‘1’, then nibble 5 shall be interpreted as the PDOP value and the altitude is limited to the range +/- 99,999 meters. Note that this bit is useful only if the measurement has been calculated using more than two satellites.

NOTE: PDOP is the value obtained from more than three satellites. If only three satellites are available, it would be called either Horizontal DOP or Vertical DOP. The relationship between these values is: $PDOP^2 = HDOP^2 + VDOP^2$.

The nibble 6 shall specify one of the values defined in Table 9.

Table 9 – Definition for Nibble 6 of the Altitude Part

Nibble 6 Value	Definition
0h	All geospatial coordinates have been manually input (+/-999,999m)
1h	The measurement has been obtained by the GPS system, but that the result is not valid and could at best be that held over from the last successful capture (+/- 999,999m)
2h	The measurement has been obtained by only the supportive apparatus because no or only one satellite has been captured (+/-999,999m)
3h	The altitude part describes measurements of not only the altitude but also the shooting direction of a camera as a sensor device (both the azimuth and the elevation angle of a camera shooting). See Section 6.4.3.2.2 (+/-19,999m)
4h	The measurement has been captured from two satellites only, without any supportive apparatus, and the nibble 5 for the altitude measurement (+/-999,999m)
5h	The altitude part describes measurements of not only the altitude but also the shooting direction of a camera as a sensor device (the azimuth only). See Section 6.4.3.2.2 (+/-19,999m)
6h	The measurement has been captured from two satellites with supportive apparatus, and the nibble 5 for the altitude measurement (+/-999,999m)
7h	The altitude part not only describes the altitude measurement of a camera as a sensor device but also indicates the camera to be omnidirectional (360-degree shooting) one. See Section 6.4.3.2.2 (+/-19,999m)
8h	The measurement has been captured from three satellites, without any supportive apparatus, and the nibble 5 for the altitude measurement (+/-999,999m)
9h	The measurement has been captured from three satellites, without any supportive apparatus, and the nibble 5 for the PDOP (+/-99,999m)
Ah	The measurement has been captured from three satellites with supportive apparatus, and the nibble 5 for the altitude measurement (+/-999,999m)
Bh	The measurement has been captured from three satellites with supportive apparatus, and the nibble 5 for the PDOP (+/-99,999m)
Ch	The measurement has been captured from more than or equal to four satellites, without any supportive apparatus, and the nibble 5 for the altitude measurement (+/-999,999m)
Dh	The measurement has been captured from more than or equal to four satellites, without any supportive apparatus, and the nibble 5 for the PDOP (+/-99,999m)
Eh	The measurement has been captured from more than or equal to four satellites with supportive apparatus, and the nibble 5 for the altitude measurement. (+/-999,999m)
Fh	The measurement has been captured from more than or equal to four satellites with supportive apparatus, and the nibble 5 for the PDOP. (+/-99,999m)

The interpretation of nibble 5 shall depend on the value of bit b24 in nibble 6 (see above).

If the value of nibble 6 is 9_h, B_h, D_h or F_h, then the altitude value shall be limited to +/-99,999m and the value of nibble 5 shall be the PDOP (Position Dilution of Precision) value. The PDOP value shall define a rounded integer number from ‘0’ upward where a higher value indicates lower positional accuracy.

If the value of nibble 6 is 0_h, 1_h, 2_h, 4_h, 6_h, 8_h, A_h, C_h or E_h, then the altitude value shall have the range +/-999,999m and the value of nibble 5 shall be the most significant decimal value of the altitude.

If the value of nibble 6 is 3_h, 5_h or 7_h, then the altitude value shall have the range +/-19,999m and the value of nibble 5 shall be used for a camera shooting direction. See Section 6.4.3.2.2 for more information.

Figure 4 schematically demonstrates how the altitude part is to be described when nibble 7 lies in the range Ah to Fh, i.e., when the altitude is measured relative to the sea level of the local Geoid (except for a case when nibble 6 is one of 0h, 1h, 3h, 5h or 7h).

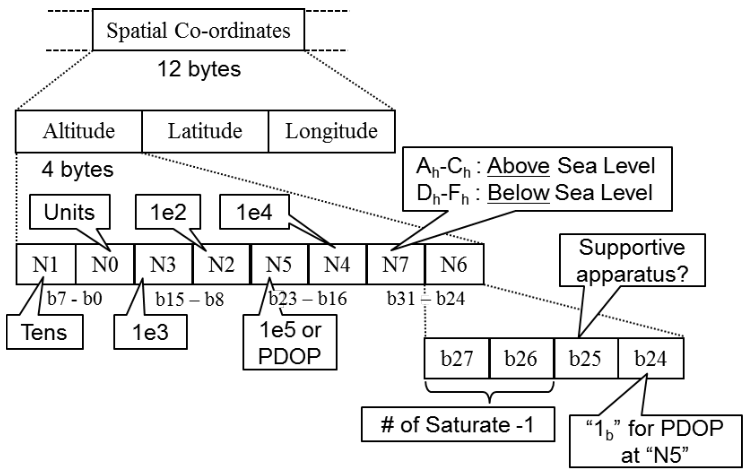


Figure 4 – Description of Altitude Measured Relative to the Sea Level of the Local Geoid

6.4.3.2.2 Camera shooting direction

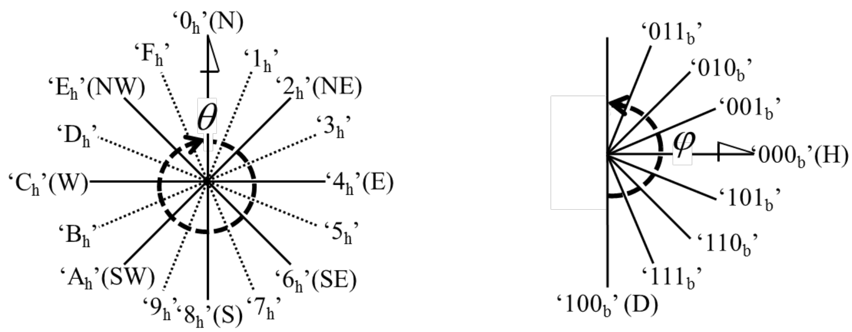
Since the PDOP value is meaningful only when the measurement is conducted by using at least three satellites, the nibble 6 can never take a value such as 3_h, 5_h and 7_h, which indicates a use of the PDOP value for nibble 5 in spite of the number of satellites being less than three, according to Figure 4.

Those values are therefore used for the altitude part to describe not only the altitude but also a shooting direction of a camera as a sensor device, instead of the number of satellites, a use of the supportive apparatus or the PDOP value.

When Bh/Eh or Ch/Fh is specified in nibble 7, the altitude described by the altitude part shall not be interpreted as that of the sensor device such as a camera but as the recording device or the target object, respectively, according to Table 8, irrespective of the camera shooting direction. To avoid confusion of a target entity described by the altitude part, a value of 3h, 5h or 7h should not be used for nibble 6 when one of those values is specified in nibble 7.

Camera shooting direction (both the azimuth and the elevation angle) ('3_h' for nibble 6)

When the value of nibble 6 is 3_h, the values of nibble 5 and the most significant 3 bits (3 MSBs) of nibble 4 shall be interpreted as the azimuth and the elevation angle of a camera shooting based on the value assignment specified in Figure 5 (a) and (b), respectively.



(a) Shooting Azimuth (Nibble5) **(b) Shooting Elevation Angle (3 MSBs in Nibble4)**

Figure 5 – Value Assignment for a Camera Shooting Direction

More specifically, each value in Figure 5 is assigned to a representative value of a respective range in the shooting azimuth (θ) and the shooting elevation angle (φ) of a camera, which shall be as defined in Table 10 and

Table 11, respectively.

Table 10 – Value Assignment for Shooting Azimuth in Nibble 5 of the Altitude Part

Shooting Azimuth	Assigned Value	Representative Value (in degree)	Range (in degree)
North (N)	0h	0.0	$-11.25 \le \theta < 11.25$
North-northeast	1h	22.5	$11.25 \le \theta < 33.75$
Northeast (NE)	2h	45.0	$33.75 \le \theta < 56.25$
East-northeast	3h	67.5	$56.25 \le \theta < 78.75$
East (E)	4h	90.0	$78.75 \le \theta < 101.25$
East-southeast	5h	112.5	$101.25 \le \theta < 123.75$
Southeast (SE)	6h	135.0	$123.75 \le \theta < 146.25$
South-southeast	7h	157.5	$146.25 \le \theta < 168.75$
South (S)	8h	180.0	$168.75 \le \theta < 191.25$
South-southwest	9h	202.5	$191.25 \le \theta < 213.75$
Southwest (SW)	Ah	225.0	$213.75 \le \theta < 236.25$
West-southwest	Bh	247,5	$236.25 \le \theta < 258.75$
West (W)	Ch	270.0	$258.75 \le \theta < 281.25$
West-northwest	Dh	292.5	$281.25 \le \theta < 303.75$
Northwest (NW)	Eh	315.0	$303.75 \le \theta < 326.25$
North-northwest	Fh	337.5	$326.25 \le \theta < 348.75$

Table 11 – Value Assignment for Shooting Elevation Angle for 3 MSBs in Nibble 4 of the Altitude Part

Shooting Elevation Angle	Assigned Value	Representative Value (in degree)	Range (in degree)
	011b	67.5	$56.25 \leq \varphi \leq 90.00$
	010b	45.0	$33.75 \leq \varphi < 56.25$
	001b	22.5	$11.25 \leq \varphi < 33.75$
Horizontal (H)	000b	0.0	$-11.25 \leq \varphi < 11.25$
	101b	-22.5	$-33.75 \leq \varphi < -11.25$
	110b	-45.0	$-56.25 \leq \varphi < -33.75$
	111b	-67.5	$-78.75 \leq \varphi < -56.25$
Downward (D)	100b	-90.0	$-90.00 \leq \varphi < -78.75$

The LSB of nibble 4 shall be used to represent the most significant altitude number, which may be a 0 or a 1. The nibble 3 to 0 shall be used to represent the 4 decimal numbers which immediately follow the most significant altitude number. Consequently, the altitude value shall have the range +/-19,999m.

NOTE: The value range +/-19,999m is sufficient in most practical applications by taking into account that the height of the world's highest mountain Everest is 8,848 meters and the depth of the world's deepest sea Mariana Trench is 10,911 meters.

Figure 6 schematically demonstrates how the altitude part is to be described when ‘3h’ is specified in nibble 6, where not only the altitude but also the shooting direction (both the azimuth and the elevation angle) of a camera as a sensor device is described.

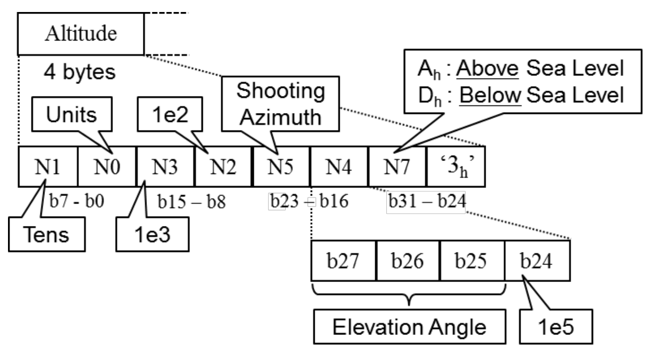


Figure 6 – Description of Altitude and Shooting Direction of Camera (‘3_h’ for N6)

Camera shooting direction (the azimuth only) (‘5_h’ for nibble 6)

When the value of nibble 6 is 5_h, the values of nibble 5 shall be interpreted as the azimuth of a camera shooting based on the value assignment specified in Figure 5 (a) or Table 10.

The LSB of nibble 4 shall be used to represent the most significant altitude number, which may be a 0 or a 1. The nibble 3 to 0 shall be used to represent the 4 decimal numbers which immediately follow the most significant altitude number. Consequently, the altitude value shall have the range +/-19,999m.

The 3 MSBs of nibble 4 are reserved and shall be ‘0’.

NOTE: The 3 MSBs indicate “Horizontal (H)” if they are inadvertently interpreted as the shooting elevation angle according to Figure 5 (b).

Figure 7 schematically demonstrates how the altitude part is to be described when ‘5_h’ is specified in nibble 6, where not only the altitude but also the shooting direction (the azimuth only) of a camera as a sensor device is described.

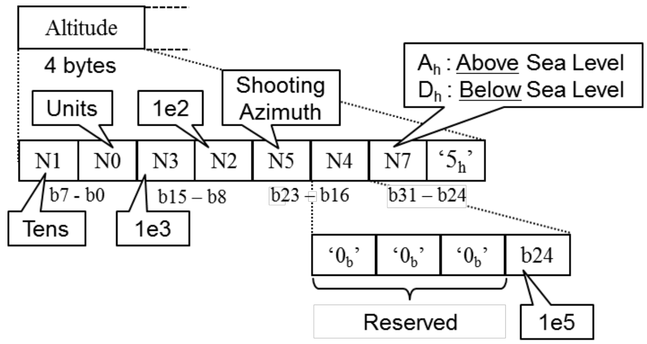


Figure 7 – Description of Altitude and Shooting Direction of Camera (‘5_h’ for N6)

Shooting by omnidirectional (360-degree) camera (‘7_h’ for nibble 6)

When the value of nibble 6 is 7_h, it shall indicate that a camera used for the shooting is omnidirectional (360-degree) one.

The LSB of nibble 4 shall be used to represent the most significant altitude number, which may be a 0 or a 1. The nibble 3 to 0 shall be used to represent the 4 decimal numbers which immediately follow the most significant altitude number. Consequently, the altitude value shall have the range +/-19,999m.

Nibble 5 and the 3 MSBs of nibble 4 are reserved and shall be ‘0’.

NOTE: The nibble 5 and the 3 MSBs indicate “North (N)” and “Horizontal (H)”, respectively, if they are inadvertently interpreted as the shooting azimuth and elevation angle according to Figure 5 (a) and (b), respectively,

Figure 8 schematically demonstrates how the altitude part is to be described when ‘7_h’ is specified in nibble 6, where the altitude of an omnidirectional (360 degree) camera as a sensor device is described.

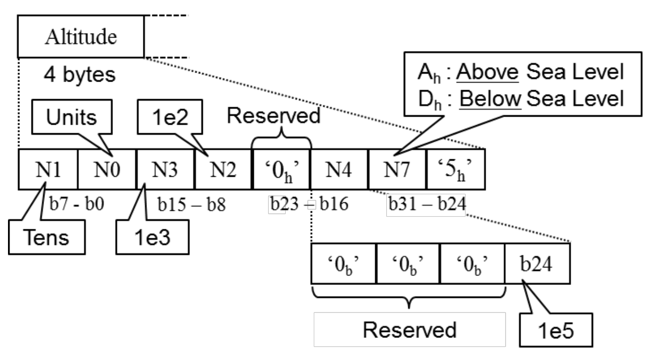


Figure 8 – Description of Altitude and Shooting by Omnidirectional (360-deg) Camera (‘7_h’ for N6)

6.4.3.3 Longitude part

Nibble 7 of the longitude part shall be used to represent the combination of the east/west parameter and the most significant longitude number, which may be a 0 or a 1. The LSB of nibble 7 shall be used to represent the longitude number and the remaining bits shall represent the east/west parameter. This results in the following values defined in Table 12.

Table 12 – Definitions for Nibble 7 of the Longitude Part

Value	Definition
0h	Longitude West 0
1h	Longitude West 1
Eh	Longitude East 0
Fh	Longitude East 1

6.4.3.4 Latitude part

Nibble 7 of the latitude part shall specify the north/south parameter as follows in Table 13.

Table 13 – Definitions for Nibble 7 of the Latitude Part

Value	Definition
0h	Latitude North
Fh	Latitude South

Where the geospatial coordinate metadata field is not used, all the 12 bytes shall be zero. In this case, the first 4 bytes indicate that the altitude is at the center of the earth (which is clearly not a valid value).

6.4.4 Country, Organization and User Components

6.4.4.1 Introduction

The country, organization and user components of the Source Pack provide the originator information (the “who” or “what”).

6.4.4.2 Country code component

The country code component shall identify the registered country name of the originator of the Material Unit with which the Source Pack is associated;

The country code component shall be either the country code of the legal organization or person owning or operating the device, or zero (See Section 6.4).

The 4-byte country code shall be an abbreviated alphanumeric string according to the values defined in ISO 3166-1. Where the country code is less than 4 bytes, the active part of the code shall occupy the first part of the 4 bytes and the remainder shall be the space character (20_h).

ISO 3166-1 3-byte alpha codes should be used, but 2-byte alpha codes or numeric codes may be used where other policies prescribe.

For non-zero values, each byte shall be an alphanumeric character from the Latin set 1 as defined by ISO/IEC 8859-1. Alphanumeric character values shall be in the range 20_h to $7E_h$ inclusive.

NOTE: The value 7Fh is a non-printable character.

6.4.4.3 Organization code component

The organization code component shall identify the organization name of the originator of the Material Unit with which the Source Pack is associated.

The organization code is local to the country code, so organizations may use the same organization code provided the country code is different.

The organization code shall be either a 4-byte alphanumeric string which uniquely represents the organization under a given country code in a very high probability, or zero (See Section 6.4).

Organization codes shall not use the "~" symbol (ISO/IEC 8859-1 character number: $7E_h$) as the first character. This character shall be reserved for freelance operator registration.

Where the organization code is less than 4 bytes, the active part of the code shall occupy the first part of the 4 bytes and the remainder shall be the space character (20_h).

For non-zero values, each byte shall be an alphanumeric character from the Latin set 1 as defined by ISO/IEC 8859-1. Alphanumeric character values shall be in the range 20_h to $7E_h$ inclusive.

6.4.4.4 User code component

The user code component shall identify the user name of the originator of the Material Unit with which the Source Pack is associated.

This user code is local to the organization code for a given country code, so the same user code may be used provided the country and organization codes are different. The user code may be a device name or person name as determined by the organization.

The user codes shall be assigned locally by each organization and used in conjunction with the organization code.

If the organization code is zero per Section 6.4, then the user code also shall be zero.

If the organization code is the 4-byte alphanumeric string that uniquely represents the organization, then the user code shall be either a 4-byte alphanumeric string which is determined by the organization (and may, for example, relate to a department, person or to the device itself), or zero (See Section 6.4).

Where the user code is less than 4 bytes, the active part of the code shall occupy the first part of the 4 bytes and the remainder shall be the space character (20_h).

For non-zero values, each byte shall be an alphanumeric character from the Latin set 1 as defined by ISO/IEC 8859-1. Alphanumeric character values shall be in the range 20_h to $7E_h$ inclusive.

6.4.4.5 Freelance operator component

A freelance operator is an individual who is not, or does not wish to be, associated with an organization, but still wishes to be identified as an operator with a predetermined code called a freelance operator code.

The organization code and user code components may be combined to form a freelance operator component for the freelance operator code as follows. When the first byte of the combined components is $7E_h$ (“~”), the combined components shall specify the freelance operator code.

The operator code shall be either an 8-byte alphanumeric string which uniquely represents the freelance operator under a given country code in a very high probability, or zero (See Section 6.4).

When non-zero freelance operator code is used, freelance operators shall specify the country code according to their country of domicile to the country code component that precedes the freelance operator code component.

All freelance operator codes shall start with the “~” symbol (ISO/IEC 8859-1 character number, $7E_h$). The remaining 7 alphanumeric characters shall all be filled with characters from the Latin set 1 as defined by ISO/IEC 8859-1. Alphanumeric character values shall be in the range 20_h to $7E_h$ inclusive.

Where the freelance operator code is less than 8 bytes (including the “~” character), the active part of the code shall occupy the first part of the 8 bytes and the remainder shall be the space character (20_h).

NOTE: If the freelance operator code is zero, it will be interpreted as setting the organization and user codes zero.

Annex A (Normative) Generation of UMID Material Numbers

A.1 SMPTE Method (‘1h’)

A.1.1 Structure

In this method, the Material Number to be generated shall be divided into 3 parts as shown in Figure A.1.

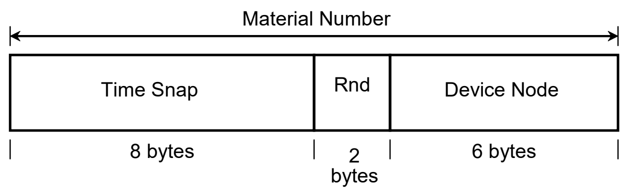


Figure A.1 – Format of the SMPTE Material Number

The three sub-components shall be:

- An 8-byte time snap value. This time snap value shall be referenced to the first associated unit of the material. Note that the time snap is neither a time-code nor a time-stamp. It is simply a method of creating a globally unique Material Number in combination with the subsequent two parts. The time snap value shall be treated as a dumb number.
- A 2-byte random number. This is included to prevent possible conflicts which might occur if the time snap value happens to be a duplicate time, creating the possibility of duplicate Material Numbers from the same device.
- A 6-byte node identifier that is a uniquely registered number for each device used for material creation.

Each of these three parts is now defined in detail.

A.1.2 Time Snap

The 8-byte time snap format shall be divided up into a first 4-byte section used to enter a count, which marks a point of time in one day and a second 4-byte section used to enter the Modified Julian Date (MJD). The allocation of the time snap into individual bytes is shown in Figure A.2.

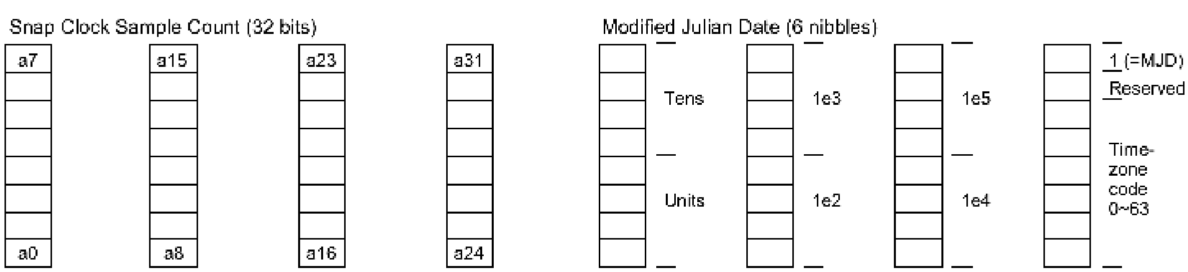


Figure A.2 – Format of the 8-byte time snap

The first 4 bytes, which define the time in a day period, shall represent the value of the snap clock sample count starting from midnight. The 32 bits for the time-of-day allow a maximum count range of 4,294,967,296.

The snap clock may be any suitable clock that preferably has an integer number of clock cycles in a day. The minimum clock value shall be the Material Unit rate and the maximum value shall be 49.7 kHz. The minimum value is determined by the need to ensure that each Material Unit has a unique number and the maximum value is determined by the need to avoid overflow of the 32-bit counter in any day.

The 4-byte date format shall use the Modified Julian Date (MJD). The allocation of the MJD data fields shall be as defined in SMPTE ST 309.

A.1.3 Random Number

This 16-bit number is provided to help avoid duplicate numbers that can occur through incorrect setting of the clock or through a change in node identification.

The number shall be created by a 16-bit random number generator, whose creation method shall be linked neither to the time snap value nor to the network node value.

A.1.4 Node Identifier

The node identification shall be an IEEE 6-byte address, normally defined by the IEEE 802 network host address. For systems with multiple network node addresses, only one address shall be used as the node identifier. Where a particular port is being used to output the defined material, the network node address of that port shall be used.

NOTE: The node identifier bytes are placed left to right in Figure A.1 according to network byte order.

A.2 UUID/UL Method (‘2_h’)

This method permits either a Universally Unique IDentifier (UUID) according to IETF RFC 4122 or a SMPTE Universal Label (UL) according to SMPTE ST 298 to be accommodated in the same space with a guarantee that the values are always different.

According to IETF RFC 4122, the UUID “variant” bits (see below) ensure that the MSB of the 9th byte of every UUID is always ‘1’. A UUID shall be mapped into the Material Number in its defined byte order.

Per SMPTE ST 298, the MSB of 1st byte of every UL is always ‘0’. A UL shall be mapped into the Material Number with the last 8 bytes swapped with the first 8 bytes. Thus the 1st byte of the UL will be placed in 9th byte of the Material Number and vice-versa.

These two mappings ensure that the MSB of 9th byte in the Material Number is always a ‘0’ for a UL and a ‘1’ for a UUID. Thus, the value of a UL and a UUID in the Material Number will always be different.

The defining Standard for creating a UUID shall be IET RFC 4122.

NOTE: The node identification of a UUID is an IEEE 6-byte address, normally defined by the IEEE 802 network host address. For systems with multiple network node addresses, only one address can be used.

A.3 Masked Method (‘3_h’)

A.3.1 General Specification

In certain applications, the uniqueness of the Material Number is the only desired function. The material originator does not wish to reveal any information about the time, location, or equipment on which the Material originated, for privacy or other security reasons (*e.g.*, investigative journalism). The masked method shall create a Material Number that is statistically unique to very high probability.

Masked Material Numbers are effectively random and do not support sorting or any other meaning-based processing.

A.3.2 Reference Masking Method (Informative)

The reference masking method post-processes a Material Number, which has been created by either of the methods defined in Annex A.1 or Annex A.2 using additional pseudorandom data and the MD5 hash function (IETF RFC 1321).

The 128-bit “clear” Material Number ought to be computed in accordance with Annex A.1 or Annex A2. An additional 128 bits of local data is appended to the clear Material Number. The 256-bit string is then processed using the MD5 algorithm resulting in a 128-bit result. This result is the masked Material Number.

The local data can be a fixed string of 128 “0” bits. Additional security implications are discussed below.

A.3.3 Alternative Masking Methods

The masked Material Number is an unpredictable number uniformly distributed over the range 0 through 2^{128}-1. Its effectiveness as a unique identifier relies on this uniform random distribution, and the exact method of its generation is not important. Therefore, the use of the reference masking method is not normative, and any method providing an equivalent level of unpredictability and uniformity of distribution can be used when the “masked method” value (‘3_h') is specified in the “Number generation method” field (byte 12) of the UMID Universal Label (see Table 3 in Section 6.2.2.3).

A.3.4 Security Implications (Informative)

The MD5 function is designed as a “secure hash function”, for which it is computationally infeasible to derive the input value from the output value. Therefore, a single blinded Material Number does not reveal the IEEE 802 Node ID of the originator, nor does it reveal the time snap. However, as in many hash applications, a brute-force attack is possible in which an opponent tries all possible values of clear Material Number, computes the corresponding MD5 hash, and compares this result to the blinded Material Number he wishes to identify. If the opponent can independently guess likely values for the time snap and node ID, it could then be practical to use a brute-force attack to expose the blinded Material Number. This attack is especially powerful if another application, producing clear Material Numbers, also runs (concurrently or sequentially) on the same hardware as the sensitive application.

For this reason, particularly sensitive editorial content originators might want to employ additional unpredictable data (sometimes called salt) to resist brute-force attacks. In the reference masking method, 128 bits of salt are suggested, but alternative masking methods can use more. Methods of deriving unpredictable data are discussed in IETF RFC-2518 and in standard cryptography texts.

A.4 IEEE 1394 Network Method (‘4_h’)

In this method, the Material Number to be generated shall be composed of 3 parts as shown in Figure A.3.

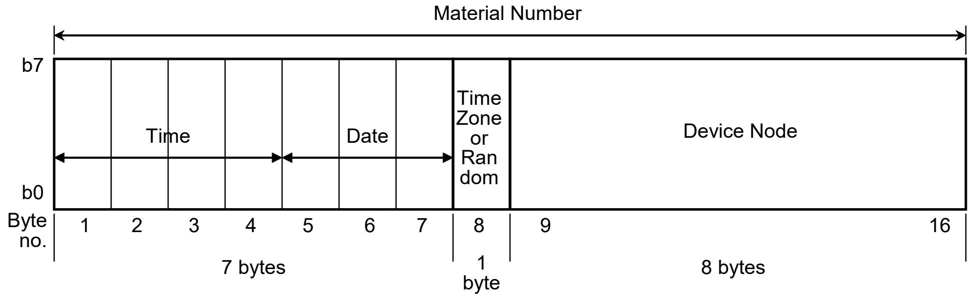


Figure A.3 – Format of the IEEE 1394 Network Material Number

The byte values of the 3 parts shall be defined as follows:

1) A 7-byte time and date format as follows:

    a) Bytes 1 to 4 define the time in a day period represented by the snap clock sample count. The 32 bits for the time-of-day allow a maximum count range of 4,294,967,296. The snap clock may be any suitable clock that preferably has an integer number of clock cycles in a day. The minimum clock value shall be the Material Unit rate and the maximum value shall be 49.7 kHz. The time value shall be treated as a dumb number.

        NOTE: The minimum value is determined by the need to ensure that each material unit has a unique number and the maximum value is determined by the need to avoid overflow of the 32-bit counter in any day.

    b) Bytes 5 to 7 provide the Modified Julian Date (MJD) information as a 3-byte date value per Annex A.1.1.

2) Byte 8 may take one of two forms based on the value of bit 6 of the byte. Bit 7 of byte 8 shall be '1' to identify that the date is the MJD (and not the DDMMYY) format. When bit 6 of byte 8 is '0' the remaining bits, b5 to b0, are assigned as per SMPTE ST 309 to give the time-zone information. When bit 6 of byte 8 is '1' bits b5 to b0 form a 6-bit random number serving to reduce the likelihood of the same number being created more than once when a device's clock is incorrectly set. In accordance with SMPTE ST 309, the time shall be UTC.

3) The 6-byte device node ID shall use the EUI-64 network node ID value defined by IEEE 1394 to fill the available 8-byte space. If the network node number is EUI-48 rather than EUI-64, then the convention is to set the 4^{th} and 5^{th} bytes of the address (bytes 12 & 13 of the Material Number) to the fixed values of 'FF_h' and 'FE_h", respectively, for easy detection. The first 3 bytes of the EUI-48 address are then mapped to bytes 9 to 11 of the Material Number and the last 3 bytes of the EUI-48 address are mapped to bytes 14 to 16 of it.

A.5 Hashed Method ('5_h')

In this method, a 128-bit (16-byte) hash value shall be generated for the Material Number by using the RFC 1321 based MD5 message-digest algorithm.

Input data for the hash value generation is not specified in this standard but shall be sufficiently unique for the resulting hash value to be globally unique. Examples for the input data include, but not limited to, an essence bit-stream or the SHA-512 based 64-byte C4 Digest data (SMPTE ST 2114).

NOTE: It has been proven that the MD5 is vulnerable and thus unsuitable to be used for the cryptographic purposes. A use of the MD5 for the Material Number generation, however, relies on its uniformity, or every hash value is to be generated with roughly the same probability within the 128-bit value space, which meets the requirement of a globally unique value.

A.6 Fixed Material Number (‘7_h’)

This method generates a time-independent Material Number which is demanded such as when a UMID is used to globally uniquely identify a material source device rather than an individual Material it generates.

In this method, the Material Number shall be generated according to the IEEE 1394 Network Method (See Annex A.4) with the UTC Epoch being specified to the 7-byte time and date format part.

NOTE: The UTC Epoch is 63072010 seconds after the SMPTE Epoch (1970-01-01T00:00:00TAI) according to SMPTE ST 2059.

The UTC Epoch is defined as 1972-01-01T00:00:00Z and thus the Bytes 1 to 4 assigned for the time in a day shall be zero-filled. According to Section 6.4.2.2.3, because January 1st, 1972, is represented by the Modified Julian Date (MJD) as 41,317, the Bytes 5 to 7 shall be fixed to 17h, 13h and 04h, respectively, followed by the Byte 8 which shall be 80h according to Table 6 (128’s bit and 64’s bit to be ‘1’ and ‘0’, respectively, to indicate the MJD and the reserved bit, and 32’s bit to 1’s bit to be ‘0’ to indicate UTC).

Consequently, the Bytes 1 to 8 shall be fixed to 00_h 00_h 00_h 00_h 17_h 13_h 04_h 80_h.

The 8-byte device node part shall be filled with a device node ID based on the EUI-64 or the modified EUI-48 as per Annex A.4, which uniquely identifies the device as a material source.

Annex B (Normative) Generation of UMID Instance Numbers

B.1 Local Registration (‘1_h’)

In this method, the Instance Number for every instance of a given Material Number shall be obtained from a local register, which records all registered Instance Numbers for the Material Number in question.

This method requires a carefully managed local environment - for instance, Material can be taken off-site and copies made with duplicate Instance Numbers. Thus, this method should only be used where full managerial control of the local environment can be guaranteed.

B.2 24-Bit PRS Generator (‘2_h’)

In this method, any suitable Pseudo-Random Sequence (PRS) generator polynomial may be used provided it has a maximal length of 16,777,215 clock cycles. At the point of creating a new instance of the Material, the 24-bits from the PRS generator shall be sampled to gain a new Instance Number.

PRS generators shall not permit a zero value.

The following conditions shall apply:

1. Any suitable seed may be used to start the PRS 24-bit generator.

2. The PRS generator should use a free-running clock having no time relationship with the clock used to generate the sampling strobe.

3. The PRS generator clock frequency should be greater than 10 kHz.

4. The number of feedback taps resulting from the PRS generator polynomial should be between 8 and 16 to ensure the random nature of the sequence.

B.3 Copy Number and 16-Bit PRS Generator (‘3_h’)

In this method, the first (leftmost) byte of the Instance Number shall be incremented by one for each new processing such as a copy operation.

The remaining two bytes shall be created from a 16-bit Pseudo-Random Sequence (PRS) generator. The constraints on the 16-bit PRS generation shall be the same as that defined in Annex B.2 with the exception that the PRS generator shall have a maximal length of 65,535 clock cycles and that the recommended number of feedback taps shall be between 4 and 12 to ensure the random nature of the sequence.

This Instance Number generation method shall be selected only either when a previous UMID, whose Material Number is to be inherited, is a newly created one or when the Instance Number contained in the previous UMID is generated according to also this method or the copy number and local registration method (See Annex B.4).

B.4 Copy Number and Local Registration (‘4_h’)

In this method, the first (leftmost) byte of the Instance Number shall be incremented by one for each new processing such as a copy operation.

A value for the remaining two bytes shall be obtained from a local register, which records all the values it has provided for the Material Number in question in order to avoid their duplication.

This Instance Number generation method shall be selected only either when a previous UMID, whose Material Number is to be inherited, is a newly created one or when the Instance Number contained in the previous UMID is generated according to also this method or the copy number and 16-bit PRS generator method (See Annex B.3).

B.5 Live Stream (‘F_h’)

This Instance Number method shall be used only to identify that the Material is a direct live signal source from a material creation device.

NOTE 1: This Instance Number method differentiates original Material on a wire that comes directly from a camera, microphone or any other source devices (and thus before recording) from already recorded Material (and thus has a UMID with a new Material Number and a zero Instance Number) being reproduced on the wire.

NOTE 2: Care ought to be taken for the treatment of multiple sources of the same live stream via parallel feeds. See SMPTE RP 205 for more information.

Annex C (Normative) Text Representation of the UMID

C.1 General Specification

Some applications do not support the use of byte-coded data such as used by the UMID. In these applications, failure can occur due to false interpretation of the byte values, either individually or in particular sequences.

This Annex provides for the representation of the UMID as a ISO 7-bit character text string both to aid human readability and to ensure that byte values are not falsely decoded in a textual format. This Annex provides for two textual formats, a URN representation and a simple text string.

The URN representation of a UMID shall be as defined in SMPTE ST 2029.

C.2 Legacy Text Format Definition

The simple text string representation defined in SMPTE ST 330:2004 shall be deprecated for further use, but is defined here for legacy. This format provided for the UMID, whether as a basic UMID or as an extended UMID, to be represented as a simple string of the hexadecimal representation of each byte of a UMID.

The hexadecimal representation was preceded by the identifier ‘0x’. This default method of identification resulted in 66 hexadecimal characters to represent a basic UMID as follows:

0x060A2B340101010501010D13 … etc.

The hexadecimal letters could be encoded as upper case (A…F) with the proviso that decoders accept hexadecimal letter representations in both upper and lower case (A…F and a…f).

Bibliography (Informative)

SMPTE ST 2059, SMPTE Standard — Generation and Alignment of Interface Signals to the SMPTE Epoch

SMPTE ST 2114, SMPTE Standard — Unique Digital Media Identifier (C4 ID)

EBU/SMPTE Task Force for Harmonized Standards for the Exchange of Programme Material as Bit Streams, Final Report: Analyses and Results, July 1998, SMPTE J. 107(9):603-815; 1998 September

IETF RFC 2518, HTTP Extensions for Distributed Authoring

