SMPTE STANDARD

Data Encoding Protocol Using Key-Length-Value

Table Of Contents

		Page
Foreword		2
Intellectual Property		2
1	Scope	2
2	Conformance Notation	3
2.1	Conforming Implementations	3
3	Normative References	4
4	Terms and Definitions	4
5	KLV Protocol	6
5.1	Overview	6
5.2	Encoding of the KLV Key Field	7
5.3	Encoding of the KLV Length Field	12
5.4	Encoding of Data Values	12
5.5	Empty Data Items	12
6	KLV Coding of Individual Data Items	13
6.1	General	13
6.2	Registers of Individual Data Items	13
6.3	Identification of Value Data Representations	14
7	KLV Group Coding	14
7.1	Introduction to Groups	14
7.2	Universal Sets	15
7.3	Global Sets	16
7.4	Local Sets	19
7.5	Variable-Length Packs	21
7.6	Defined-Length Packs	23

Copyright © 2017 by THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS
3 Barker Avenue, White Plains, NY 10601
(914) 761-1100

Approved
July 21, 2017

Documents
Document Sharing Hub
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

8 Wrappers and Containers 24
9 SMPTE Labels 24
10 Registered Private Information 25
Annex A Example Usage of the SMPTE UL (Informative) 26
Annex B Example of the KLV Encoding of a Single Metadata Item (Informative) 27
Annex C Example of a Universal Set (Informative) 28
Annex D Example of a Global Set (Informative) 29
Annex E Example of a Local Set (Informative) 30
Annex F Example of a Variable-Length Pack (Informative) 31
Annex G Example of a Defined-Length Pack (Informative) 32
Annex H Example of a Label (Informative) 33
Annex I ASN.1 BER Length Coding (Informative) 34
Annex J ASN.1 BER Encoding of an Object Identifier Value (Informative) 35
Bibliography (Informative) 36

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 - Metadata and Registers.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

1 Scope

This standard defines a byte-level data encoding protocol for representing data items and data groups. This protocol defines a data structure which is independent of the application or transportation method used.

The standard defines a Key-Length-Value (KLV) triplet as a data interchange protocol for data items or data groups where the Key identifies the data, the Length specifies the length of the data and the Value is the data itself. The KLV protocol provides a common interchange point for all compliant applications irrespective of the method of implementation or transport.

Documents
Document Sharing Hub
--`,,```,,,,````-`-`,,`,,`,`,,`---
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

The standard also provides methods for combining associated KLV triplets in data sets where the set of KLV triplets is itself coded with KLV data coding protocol. Such sets can be coded in either full form (Universal Sets) or in one of four increasingly bit-efficient forms (Global Sets, Local Sets, Variable Length Packs and Defined Length Packs). The standard provides a definition of each of these data constructs.

The standard also describes implications of KLV coding including the use of a SMPTE Universal Label as a value within a KLV coding triplet or whose meaning is entirely conveyed by the SMPTE UL itself. The two kinds of usage for such standalone SMPTE Universal Labels are a) as a value in a K L V construct and b) as a Key that has no Length and no Value. This standard defines where SMPTE ULs can be used for each kind of construct.

The standard also defines the use of KLV coding to provide a means to carry information that is registered with a non-SMPTE external agency.

The encoding byte range (length of the payload) specified in this document can accommodate unusually large volumes of data. Consequently, a specific application of KLV encoding might require only a limited operating data range and those details be defined in a relevant application document.

This revision is intended to yield identical encodings to previous revisions of ST 336 given identical dictionaries.

Section 4 provides a glossary of terms used in this standard.

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.

2.1 Conforming Implementations

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.

--`,,```,,,,````-`-`,,`,,`,`,,`---

Documents
Document Sharing Hub

Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

3 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 ST 298:2009 Universal Labels for Unique Identification of Digital Data.

ISO/IEC 8825-1:2008 |ITU-T X.690:2008, Information Technology – ASN.1 Encoding Rules – Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER), and Distinguished Encoding Rules (DER): BER Paragraphs 8.1.3.4 and 8.1.3.5 for Length, 8.19 for Object Identifier Coding.

4 Terms and Definitions

ASN
Abstract Syntax Notation (see ISO/IEC 8825-1 (ITU-T X.690)).

Basic Encoding Rules (BER)
ISO standard encoding for various constructs in ASN.1. Includes the encoding of Object Identifiers, and also of Length fields. The length bytes of the KLV packet conform to the Basic Encoding Rules (BER) for either the short form or long form encoding specified in ISO/IEC 8825-1, Pars. 8.1.3.4 and 8.1.3.5.

Big-Endian
Multi-octet (multi-byte) data entity that has the most significant octet (byte) first in time or leftmost in diagrams.

Byte
Widely used alternative for the term ‘octet’ (see Octet, below).

CER
Canonical Encoding Rules (see ISO/IEC 8825-1 (ITU-T X.690)).

Container
Generic name for a data object which provides a framework to ‘contain’ different kinds of information. The term is commonly applied to multimedia where audio, video, data essence and metadata are formed into a single data object.

Control Data
Item of data that is used to provide a control function for essence data or metadata.

Data Group
Collection of data items.

Data Item
Data entity in this standard. The term ‘item’ is widely used in other documents and can have a different meaning. A data item is not a group in this standard.

Data Type
(see definition of Type below).

DER
Distinguished Encoding Rules (see ISO/IEC 8825-1 (ITU-T X.690)).

Documents
Document Sharing Hub
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

Dictionary
Register that provides for the semantic interpretation of the data items within the register.

Essence
Abstract term that describes any data or signal necessary to represent any single type of visual, aural or other sensory experience independent of the method of coding. Also identified by the SMPTE/EBU “Task Force for Harmonized Standards for the Exchange of Program Material as Bitstreams” (TFHS) as Video, Audio, and/or Data information. Essence can also be Graphics, Telemetry, Photographs, Haptic / Tactile or other information.

ISAN
International Standard Audiovisual Number.

Key
16-byte SMPTE administered Universal Label used for KLV coding of data.

KLV
Key-Length-Value; data format defined by this standard.

Metadata
Generally referred to as “data about data” or “data describing other data”. Metadata is information that is considered ancillary to or otherwise directly complementary to the essence. Also any information considered useful or of value when associated with the essence.

Metadata Dictionary
Standard database of approved Metadata Items including definitions and allowed formats.

Metadata Item
Broad term for a unit of metadata.

Object Identifier (OID)
First byte in the UL that identifies it as a UL — abbreviated OID. Always “06” in hexadecimal (hex) notation (0x06).

Octet
Data word comprising 8 binary digits.

Primitive Encoding
In ASN.1 notation, a definite-length encoding method that applies to simple encoding types and types derived from simple types by implicit tagging. It requires that the length of sub-identifiers be known in advance.

Register
Information store or database that is maintained by a registry.

Registry
Information system for registering data.

SMPTE Administered UL (abbreviated to UL in this standard)
UL that is administered by SMPTE in accordance with SMPTE ST 298. All SMPTE administered ULs are 16 bytes in length.

SMPTE Label
SMPTE UL that is self identifying. (See Section 9).

Documents
Document Sharing Hub

Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

SMPTE Registration Authority
Registration organization which keeps record of the use of SMPTE ST 298 UL Keys and other reference data.

ST / RP
Abbreviation for “SMPTE Standard or Recommended Practice”. In this document, it is used as a generic indication that other SMPTE documents (maybe not yet written) will be needed to fully define a particular usage of KLV. Those documents will be identified against each item in the appropriate register.

Type or Data Type
Information that defines how data is represented.

SMPTE UL
Abbreviation of the term ***SMPTE Administered UL.***

Tag
Special form of identification that is local to the coding format. In its fully expanded form, a Tag can be identical to the Item Designator.

UL
Universal Label; object identifier according to ISO/IEC 8824-1 (see also SMPTE ST 298). In this standard, this term is used to mean a SMPTE administered UL.

Wrapper
Identified by the SMPTE/EBU “Task Force for Harmonized Standards for the Exchange of Program Material as Bitstreams” (TFHS) as a means of wrapping video, audio, data essence and metadata information into a common framework. In this definition, it is identical to the definition of a container, but Wrappers can further be used to ‘wrap’ further metadata around an already defined container. In this sense, a container is a multi-purpose box which has audio-visual information and a wrapper is the packaging around the box including labeling and other supporting metadata.

5 KLV Protocol

5.1 Overview

Table 1 and Figure 1 present an overview of the KLV Protocol for encoding data. The data encoded can be a single data item, or a data group. The coding of data items is described in Section 6 while the coding of data groups is described in Section 7 of this standard.

The KLV Coding Protocol is composed of a Universal Label (UL) identification “Key”, followed by a numeric “Length” (Value Length), followed by the data “Value”.

The composition of the Key is described in Section 5.2 of this standard. The length of the full Key is 16 bytes. The Length field is described in Section 5.3 of this standard. The byte-length of the Length field varies as defined in Section 5.3 of this standard. The Value is described in Section 5.4 of this standard. The Value is a sequence of bytes of the data type as specified in a relevant standard and is not further encoded by the KLV Protocol. The length of the Value field is variable and any limitations are defined in a relevant defining standard.

Documents
Document Sharing Hub
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

Table 1 - KLV Fields for Encoding of Data

Field	Description	Length	Contents/Format
Key	UL for identification of the Value	16 bytes	Section 5.2
Length	Length of the Value field	Variable, with constraints defined by an application document	Section 5.3
Value	Value associated with the Key	Variable	Section 5.4

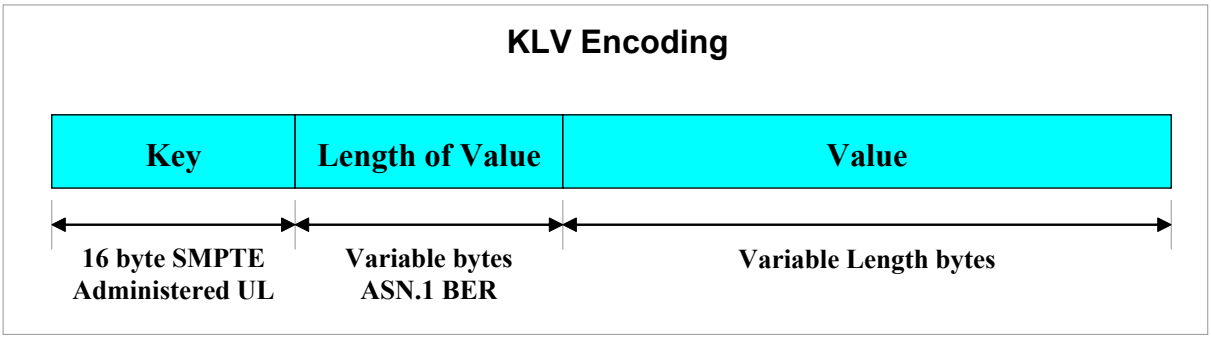


Figure 1 – KLV Encoding

5.2 Encoding of the KLV Key Field

5.2.1 Key Structure

The KLV Coding Protocol shall use a fixed 16-byte SMPTE-administered Universal Label, according to SMPTE ST 298, as the Key to identify the data in the Value field. The term UL is used throughout this standard to refer to a SMPTE-administered Universal Label.

The UL of the Key shall be as specified in Table 2.

The sub-identifiers in the Key shall have left-to-right significance with the first sub-identifier as the most significant. The leftmost sub-identifier of value 0x00 in the Key shall define the termination of the label and all sub-identifiers of lower significance shall also be set to 0x00. Sub-identifiers of value 0x00 shall have no significance to the meaning of the Key.

NOTE 1 - Each word in the UL is coded using ASN.1 Basic Encoding Rules (BER) for Object Identifier coding specified in ISO/IEC 8825-1, paragraph 8.19 as required by SMPTE ST 298 (For convenience, this is reproduced in Annex J). The BER Object Identifier coding constrains the value of all single-byte UL sub-identifiers to the range 0x01 to 0x7F.

NOTE 2 - SMPTE ST 298 defines only the first four bytes of a UL: the Object ID, UL Size, UL Code and SMPTE Designator. This standard specifies the application of SMPTE ST 298 ULs for the purpose of Key-Length-Value coding and defines the semantics of sub-identifier bytes 5 to 8. The semantics of the Item Designator (sub-identifier bytes 9-16) are defined by a number of separate documents, which are identified in the associated register and together cover all the defined values of the Key.

Documents
Document Sharing Hub
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

Table 2 (Normative) - Encoding of the KLV Key Field

No.	Field	Description	Length	Content/Format
UL bytes defined by ST 298				
1	**OID**	Object Identifier	1 byte	Always 0x06
2	**UL Size**	16-byte size of the UL	1 byte	Always 0x0E
3	**UL Code**	Concatenated sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	**SMPTE Designator**	SMPTE sub-identifier	1 byte	Always 0x34
UL sub-identifiers defined by ST 336				
5	**Category Designator**	Category designator identifying the category of registry described (e.g. Dictionaries)	1 byte	Defined in Table 3
6	**Registry Designator**	Registry Designator identifying the specific register in a category (e.g. Metadata Dictionaries)	1 byte	Defined in Table 3
7	**Structure Designator**	Designator of the structure variant within the given registry designator	1 byte	Defined in Table 3
8	**Version Number**	Version of the given register which first defines the item specified by the Item Designator	1 byte	Incrementing number
UL sub-identifiers defined by application standards listed in given register				
9 – 16	**Item Designator**	Unique identification of the particular item	8 bytes	Defined in relevant standard and version

Annex A shows an example of a Metadata Key from the SMPTE Metadata Dictionary in tabular and figure formats.

Decoders that recognize the Key but do not want to, or cannot, decode the associated Value may ignore the item and continue the decoding process of subsequent items using the Length value to ‘skip’ the Value of the un-decoded item. If decoders store and forward the item, they shall forward the item unaltered.

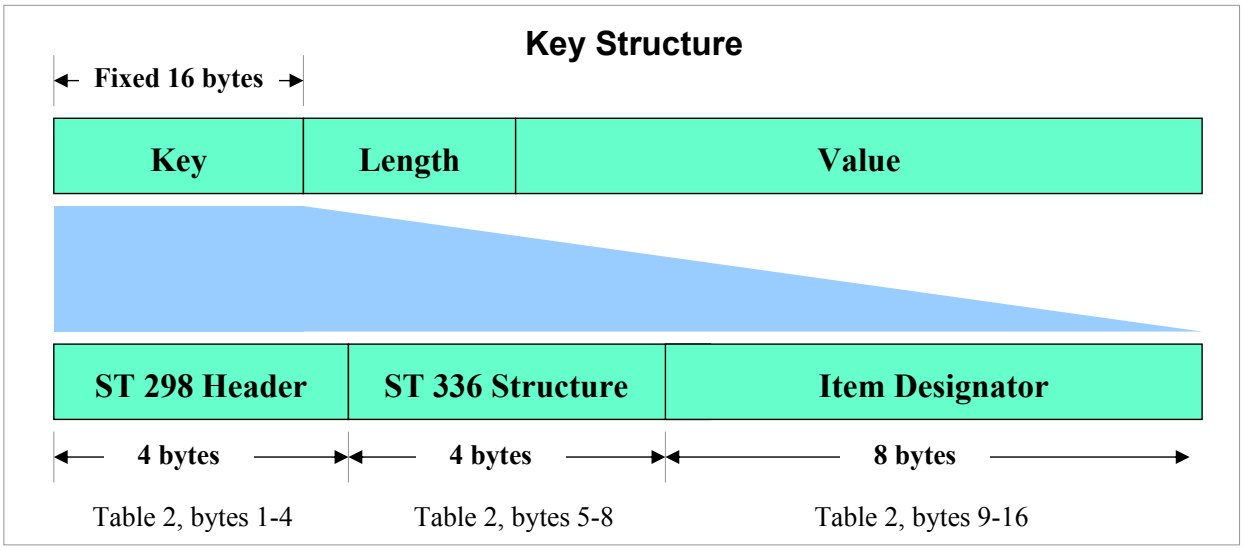
Bytes 5 and 6 of the Key shall identify the contents of, and define the interpretation of the Value for all values of the Item Designator within a given category and registry designator. Table 3 defines the use of bytes 5 and 6. When bytes 5 and 6 do not match any of the values in Table 3, the decoder shall not interpret the contents of the "V" bytes, shall make the K L and V available to application processing, and shall continue parsing with the byte immediately following the end of the "V".

Documents
Document Sharing Hub

Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

NOTE - Public and private registers of SMPTE UL number spaces exist and these registers will contain valid KLV keys which can be unknown to the decoder. Provision of application level interpretation of unrecognized KLV keys is important for interoperability.

Figure 2 – Key Structure



5.2.2 Key Bytes 5 – 7

5.2.2.1 Definitions for Key Bytes 5-7

The values for bytes 5 to 7 of Keys shall conform to Table 3.
SMPTE Standards (STs) and Recommended Practices (RPs) that define a Key with the value of byte 5 (Registry Category Designator) in the range 0x01 to 0x04 shall register the Key or Keys used with the SMPTE Registration Authority in the register identified by bytes 6 and 7 (Registry Designator and Structure Designator).
Structure Designator values are allocated to distinguish between incompatible versions of the same register. They can be thought of as a major version number.

Documents
Document Sharing Hub
Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017

Table 3 (Normative) - Definitions for Key Bytes 5 - 7

Category Designator	Registry Designator	Defined In:	Structure Designator	Defining Documents (informative)
Byte 5	**Byte 6**		**Byte 7**	
0x01 – Dictionaries		**Section 6**		
	0x01 – Metadata Dictionaries	Section 6.2.2	0x01~0x7F	Byte 7 = 0x01: SMPTE ST 335
	0x02 – Essence Dictionaries	Section 6.2.3	0x01~0x7F	Byte 7 =0x01: SMPTE ST 2088
	0x03 – Control Dictionaries	Section 6.2.4	0x01~0x7F	
	0x04 – Types Dictionaries	Section 6.2.5	0x01~0x7F	Byte 7 = 0x01: SMPTE ST 2003
0x02 – Groups (Sets and Packs)		**Section 7**		**SMPTE ST 395**
	0x01 – Universal Sets	Section 7.2	0x01~0x7F	
	0x02 (default) – Global Sets	Section 7.3, Table 4	Section 7.3	
	0x03 (default) – Local Sets	Section 7.4, Table 5	0x01~0x7F	
	0x04 (default) – Variable Length Packs	Section 7.5, Table 6	0x01~0x7F	
	0x05 – Defined-Length Packs	Section 7.6	0x01~0x7F	
	0x06 – Reserved		0x01~0x7F	
0x03 – Wrappers and Containers		**Section 8**		
	0x01 – Simple Wrappers and Containers		0x01~0x7F	
	0x02 – Complex Wrappers and Containers		0x01~0x7F	
0x04 – Labels		**Section 9**		
	Labels Registers	Specific Labels Register - Section 9	0x01~0x7F	Byte 7 = 0x01: SMPTE ST 400
0x05 – Registered Private Information		**Section 10**		**SMPTE RP 225**
0x06 – 0x7E - Reserved				

5.2.2.2 Dictionaries

SMPTE STs and RPs that define Keys with the value of byte 5 set to 0x01 shall define Dictionary Keys that shall define single data items.

The coding of individual data items is defined in Section 6.

-`,,```,,,,````-`-`,,`,,`,`,,`---

Documents
Document Sharing Hub

Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Full document details: SMPTE ST 336 2017

Licensee=/, User=,
Not for Resale,

5.2.2.3 Groups (Sets and Packs)

SMPTE STs and RPs that define Keys with the value of byte 5 set to 0x02 shall define Set Keys or Pack Keys that shall be used to define groups of KLV coded data items.

The coding of data groups is defined in Section 7. Global Sets, Local Sets and Variable Length Packs use more than one value to identify the lengths of the Length field and, in the case of Local Sets, the Local Tag field.

5.2.2.4 Wrappers and Containers

SMPTE STs and RPs that define Keys with the value of byte 5 set to 0x03 shall define Wrapper Keys or Container Keys that shall identify the Wrapper or Container and its contents. The terms 'Wrapper' and 'Container' are defined in Section 4 Terms and Definitions.
The use of Wrappers and Containers is defined in Section 8.

5.2.2.5 Labels

The coding of Labels is defined in Section 9.

5.2.2.6 Registered Private Information

The coding of Registered Private Information is defined in Section 10.

5.2.2.7 Reserved

Reserved Registry Categories are reserved for future extension to this standard or for provisions defined by other SMPTE standards. No other specifications shall use these reserved values.

5.2.3 Version Number

For items registered by SMPTE, byte 8 shall define the version number of the given register, which first defines the item specified by the Item Designator (defined in Section 5.2.4).
For items not registered by SMPTE, the entity responsible for registration of items shall define its own version numbering policy.

NOTE - In any register, SMPTE can assign parts of the register to another organization whether as a public or private organization, or for other reasons make a part of the register an open space for undefined use. The policy of assigning these parts of the registry is not specified by this standard but by the individual registry standards. Typically, SMPTE will assign the first node that identifies the non-SMPTE organization and this node will be given a SMPTE version number. The values of the version number that lie under the SMPTE assigned node will then be assigned by the appropriate non-SMPTE organization.

New items will be added to registers after initial approval of the controlling Standard or RP. Each time a set of item definitions is added, the current Version Number of the particular register is incremented. Each entry in a register includes the version number in which the item was first defined. This Version Number is carried in byte 8.

Decoders may ignore the version number or use the version number as an additional guide and consistency check in the process of parsing a Key.

5.2.4 Item Designator

Bytes 9 through 16 of the Key comprise the Item Designator.

Documents
Document Sharing Hub

Copyright Society of Motion Picture and Television Engineers
Provided by IHS Markit under license with SMPTE
No reproduction or networking permitted without license from IHS
Licensee=/, User=,
Not for Resale,
Full document details: SMPTE ST 336 2017