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**Recommendation ITU-R BT.1563-1**  
(03/2011)

**Data encoding protocol using  
key-length-value**

**BT Series**  
**Broadcasting service**  
**(television)**



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*Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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## RECOMMENDATION ITU-R BT.1563-1

**Data encoding protocol using key-length-value**

(Question ITU-R 130/6)

(2002-2011)

**Scope**

This Recommendation 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 Recommendation 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.

The ITU Radiocommunication Assembly,

*considering*

- a) that many countries have installed digital television production facilities based on the use of digital video components conforming to Recommendations ITU-R BT.601, ITU-R BT.656 and ITU-R BT.799;
- b) that high-definition television (HDTV) production systems have been installed based on digital HDTV interfaces conforming to Recommendation ITU-R BT.1120;
- c) that there exists the capacity within a signal conforming to Recommendation ITU-R BT.656 or ITU-R BT.799 for additional data signals to be multiplexed within the serial data stream;
- d) that there are operational and economic benefits to be achieved by the multiplexing of ancillary data signals with the serial data stream;
- e) that the operational benefits are increased if a minimum of different formats are used for ancillary data signals;
- f) that formatting of ancillary data packets is specified in Recommendation ITU-R BT.1364;
- g) that a generic formatting for a wide variety of data using ancillary data packets as one form of transmission will benefit broadcast transmission operations,

*recommends*

**1** that the key-length-value (KLV) data formatting – (Data Encoding Protocol Using Key-Length-Value), defined in Annex 1 be used as a method for a variety of data in the serial digital interface;

**2** that compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words “shall” or some other obligatory language such as “must” and the negative equivalents are used to express requirements. The use of such words shall in no way be construed to imply partial or total compliance with this Recommendation.

## Annex 1

### 1 KLV Protocol<sup>1</sup>

Table 1 and Fig. 1 present an introductory view of the KLV Protocol for encoding data. The data encoded may be a single data item, or a data group.

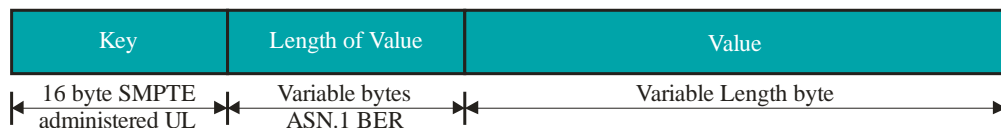
The KLV Coding Protocol is composed of a Universal Label (UL) identification “Key”, followed by a numeric “Length” (Value Length), followed by the data “Value”.

The length of the full Key shall be 16 bytes. The Value is a sequence of bytes of the data type as specified in a relevant Recommendation 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 Recommendation.

TABLE 1  
KLV Fields for Encoding of Data

Field	Description	Length	Contents/Format
<b>Key</b>	UL for identification of the Value	16 bytes	Section 1.1
<b>Length</b>	Length of the Value field	Defined in a relevant register, essence, application standard, but variable length	Section 1.2
<b>Value</b>	Value associated with the Key	Variable	Section 1.3

FIGURE 1  
KLV Encoding



BT.1563-01

#### 1.1 Universal Label Key

The KLV Coding Protocol shall use and only use a fixed 16-byte SMPTE-administered Universal Label, according to SMPTE 298M, as the Key to identify the data in the Value field. The term UL is used throughout this Recommendation to refer to a SMPTE-administered Universal Label (see Appendix 2).

The full Key shall consist of a 16-byte field including an Object ID (0x06) and the UL size (0x0E indicating a total Key size of 16 bytes) followed by a series of sub-identifiers starting with the UL Code (0x2B) and SMPTE Designator (0x34). The sub-identifiers define the UL Designator (bytes 3~8 inclusive) and Item Designator (bytes 9~16 inclusive) as specified in Table 2.

<sup>1</sup> SMPTE acts as the register of values for the universal label, Type Values, and entries in the Metadata dictionary. Readers of this Recommendation are urged to check registered values at <http://www.smpte-ra.org/> for the latest entries.

TABLE 2  
Field Descriptions for the Key for the KLV Encoding of Data

No.	Field	Description	Length	Content/Format
	UL Header			
1	OID	Object identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenated sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE sub-identifier	1 byte	Always 0x34
5	Category Designator	Category designator identifying the category of registry described (e.g., Dictionaries)	1 byte	See Table 3
6	Registry Designator	Registry Designator identifying the specific register in a category (e.g., Metadata Dictionaries)	1 byte	See Table 3
7	Structure Designator	Designator of the structure variant within the given registry designator	1 byte	Section 4.1.3
8	Version Number	Version of the given register which first defines the item specified by the Item Designator	1 byte	Incrementing number
9 to 16	Item Designator	Unique identification of the particular item within the context of the UL Designator	8 bytes	See relevant Recommendation and version

The first two sub-identifiers after the SMPTE Designator shall have reserved values for the KLV Coding Protocol according to this Recommendation.

Each word in the SMPTE 298M UL is coded using ASN.1 Basic Encoding Rules (BER) for Object Identifier coding specified in ISO/IEC 8825-1.

The values of each byte of the UL Designator shall be limited to the range 0x01 to 0x7F, which in BER Object Identifier coding are represented by a single byte.

The value of the Item Designator is coded using ASN.1 Basic Encoding Rules (BER) for Object Identifier coding and shall be 8 bytes in length.

The sub-identifiers in the UL Designator and Item Designator 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.

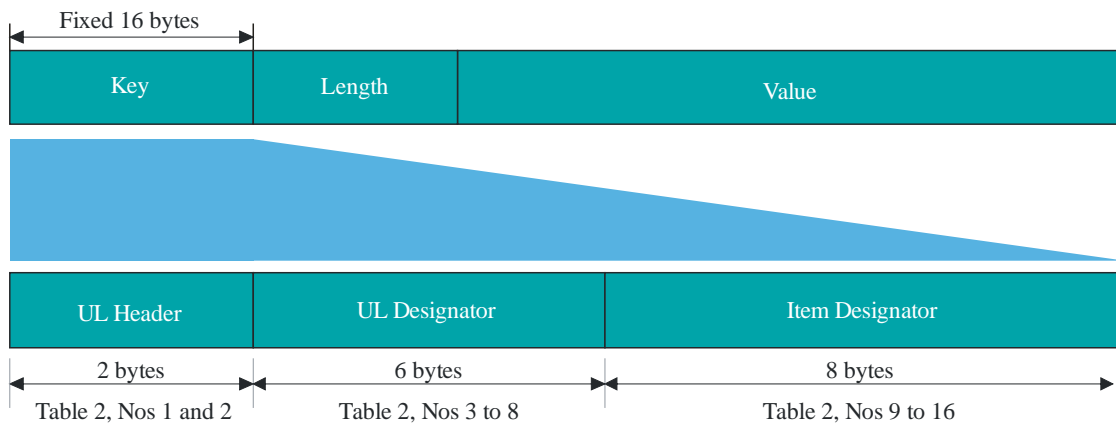
SMPTE 298M defines only the first four bytes of a UL: the Object ID, UL Size, UL Code and SMPTE Designator. This Recommendation specifies the application of SMPTE 298M ULs for the purpose of Key-Length-Value coding and defines the semantics of the remaining sub-identifiers of the UL Designator (bytes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

Decoders which recognize the Key but do not want to, or cannot, decode the associated Value may ignore the item and should 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 be used to 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 parser 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”.

NOTE 1 – Application writers should be aware that public and private registers of SMPTE UL number spaces exist and these registers will contain valid KLV keys which may be unknown to the parser. Provision of application level interpretation of unrecognized KLVs keys is important for interoperability.

FIGURE 2  
Key Structure



BT.1563-02

### 1.1.1 UL Designator

Table 3 defines byte values for the designators to be used in bytes 5 to 7 of the UL Designator. SMPTE Recommendations and Recommended Practices (RPs) which define a Key with the value of byte 5 (Registry Category Designator) in the range 0x01 to 0x04 shall register the full Key or Keys used with the SMPTE Registration Authority in the registry identified by bytes 6 and 7 (Registry Designator and Structure Designator).

#### 1.1.1.1 Dictionaries

SMPTE Standards and RPs which define the value of word 5 of the Key as 0x01 are Dictionary Recommendations and shall be used to define single data items with the KLV data construct.

#### 1.1.1.2 Groups (Sets and Packs)

SMPTE Standards and RPs which define the value of word 5 of the Key as 0x02 are Set and Pack Recommendations and shall be used to define groups of KLV coded data items.

TABLE 3  
UL Designator for Bytes 5 through 7

Category Designator	Registry Designator	Defined in:	Structure Designator	External References (informative)
Byte 5	Byte 6		Byte 7	
<b>0x01 – Dictionaries</b>		<b>Section 5</b>		
	01 – Metadata Dictionaries	Section 5.1.1	0x01~0x7F	0x01: SMPTE 335M
	02 – Essence Dictionaries	Section 5.1.2	0x01~0x7F	
	03 – Control Dictionaries	Section 5.1.3	0x01~0x7F	
	04 – Types Dictionaries	Section 5.1.4	0x01~0x7F	0x01: Types Draft, CD2003
<b>0x02 – Groups (Sets and Packs)</b>		<b>Section 6</b>		<b>SMPTE 395M</b>
	01 – Universal Sets	Section 6.1, Table 4	0x01~0x7F	
	02 (default) – Global Sets	Section 6.2, Table 6	Section 6.2, Table 5	
	03 (default) – Local Sets	Section 6.3, Table 8	0x01~0x7F	
	04 (default) – Variable Length Packs	Section 6.4, Table 10	0x01~0x7F	
	05 – Defined-Length Packs	Section 6.5, Table 11	0x01~0x7F	
	06 – Reserved	Section 6.6	0x01~0x7F	
<b>03 – Wrappers and Containers</b>		<b>Section 7</b>		
	01 – Simple Wrappers and Containers	Section 7.1	0x01~0x7F	
	02 – Complex Wrappers and Containers	Section 7.2	0x01~0x7F	
<b>04 – Labels</b>		<b>Section 8</b>		
	Labels Register	Section 8	0x01~0x7F	0x01: SMPTE 400M
<b>05 – Registered Private Information</b>		<b>Section 9</b>		<b>RP225</b>
<b>06 – 7E – Reserved</b>				

### 1.1.1.3 Wrappers and Containers

SMPTE Standards and RPs which define the value of word 5 of the Key as 0x03 are Wrapper and Container Recommendations and use the Key to identify the Wrapper or Container and its contents. The definition of the terms “Wrapper” and “Container” are defined in Appendix A.

### 1.1.1.4 Labels

The coding of Labels is defined in Section 5.

### 1.1.1.5 Registered Private Information

The coding of Registered Private Information is defined in Section 6.

### 1.1.1.6 Reserved

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

### 1.1.2 Registry Designator

As illustrated in Tables 2 and 3, byte 6 shall define the Registry Designator identifying the specific register in a category (e.g., Metadata Dictionary). 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.

Usage of the Registry Designator values is defined in Table 3.

### 1.1.3 Structure Designator

As illustrated in Tables 2 and 3, byte 7 shall define the Structure Designator for the given register.

Structure Designator values are allocated to distinguish between incompatible versions of the same register. They may be thought of as a major version number.

Usage of the Structure Designator values is defined in Table 3.

### 1.1.4 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.

For items not registered by SMPTE, the entity responsible for registration of items shall define its own version numbering policy.

NOTE 1 – 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, not by SMPTE.

New items may be added to registers after initial approval of the controlling Recommendation, 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. It is this number which is carried in byte 8.

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

### 1.1.5 Item Designator

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

The Item Designator field shall be a fixed 8 bytes in length. Item Designator values are from 1 to 8 bytes long, padded on the right with zero bytes to fill the 8 byte field, and coded using ASN.1 BER Object Identifier coding as described in Section 4.1.

The precise meaning and construction of the Item Designator depends upon the specific register and Structure Designator value, and is described further in the sections below.

## 1.2 Encoding of the KLV Length field

In the KLV coding protocol, the value of the Length field shall be encoded using the Basic Encoding Rules (BER) for either the short form or long form encoding of length bytes specified in ISO/IEC 8825-1, §§ 8.1.3, 8.1.3.3 through 8.1.3.5 (see Annex K). This method of encoding the Length field is self-contained and allows for efficient parsing of KLV encoded data. When the KLV



coding protocol is applied to groups of KLV coded units, the Length field for individual units may adopt a different method as defined by the Recommendation for the coding of that group (see Section 3).

Where appropriate, individual application Recommendations and RPs may define the maximum byte-length of the Length field or may place limitations on the value range of the Length field in order to simplify decoder requirements.

NOTE 1 – While there are no restrictions in this Recommendation on the maximum number of bytes in the Length field, the presence of large Length fields can be determined from the first byte of the ASN.1 BER Long Form Length Encoding.

NOTE 2 – It is suggested that the short form of ASN.1 BER be used for all Value fields smaller or equal to 127 (0x7F).

Implementations shall make every effort to apply a valid value to the Length field. However, in certain operations it may prove impractical to establish the length of the Value field. Such a case is an incoming data stream which is assigned a Key and a Length field at the start point. In this case, the value of the Length field cannot be established until the termination of the stream and at that point, it may prove impossible to return to the Length field to enter the value. In such cases, the Length field shall be set to (0x80) which shall indicate a non-deterministic length of the Value field. Any application document which allows the length of the Value field to be undefined must define an alternative method of locating the end of the Value field.

NOTE 3 – The length value (0x80) is used because it is normally meaningless as an ASN.1 BER long-form value as it indicates zero subsequent bytes.

### **1.3 Encoding of data values**

Data values may be either individual data items or data groups. In either case, the data is a byte string whose length is specified by the Length field value. The last byte of the Value field shall be the terminating byte of the data sequence.

### **1.4 Empty data items**

Specifications for contiguity of KLV packets including any gaps between KLV packets are outside the scope of this Recommendation and are addressed in the appropriate transport-layer documents.

However, should applications so require, breaks in the data sequence may be inserted by the use of a specific “Empty” data item. Use of “Empty” data items is not mandatory.

The “Empty” data item is a KLV coded packet which shall define a length value followed by an empty Value field. No attempt should be made to interpret the data in the Value field.

“Empty” data items may be coded as individual items, or within sets when allowed by the specific set definition.

Applications may delete or skip any or all “Empty” data items upon receipt. Applications may insert “Empty” data items, but shall not require other applications to preserve such items.

The “Empty” data item shall be defined in the metadata dictionary and may be defined in other dictionaries.

NOTE 1 – Section 4.1.1 provides guidance on the use of the version number byte. In the particular case of the empty data item, implementations have been deployed with different version values so it is recommended that decoders ignore the version number value.

NOTE 2 – The empty data item is widely known as the Fill Item.

## 2 KLV Coding of individual data items

The KLV coding of individual data items is a simple application of the Key, Length and Value as defined in Section 4.

The Key of individual data items is defined in a register together with the ranges of Length and the specification of the Value itself. For individual data items the value of byte 5 of the Key shall be 0x01.

### 2.1 Registers of individual data items

Individual data items that are KLV coded are collected into registers for the purpose of data management.

This Recommendation defines four different registers as identified in Table 3. These registers are “dictionaries” and they are identified by the value of byte 6 of the Key as follows:

#### 2.1.1 Metadata dictionaries

Metadata dictionaries shall be identified by byte 6 having the value of 0x01. Metadata dictionaries shall be registers of metadata items.

Metadata is information other than Essence, that has no inherent stand-alone value, but is related to Essence (i.e., it is contextual and has no meaning outside its relationship to the associated Essence). Examples of Metadata include: URL, URI, timecode, MPEG-2 PCR, filename, program labels, copyright information, version control, watermarking, conditional-access keys, etc.

#### 2.1.2 Essence dictionaries

Essence dictionaries shall be identified by byte 6 having the value of 0x02. Essence dictionaries shall be registers of essence items.

Essence is the data that represents pictures, sound and text. Types of Essence include Video, Audio and Data of various kinds, including captions, graphics, still images, text, enhancements and other data as needed by each application.

#### 2.1.3 Control dictionaries

Control dictionaries shall be identified by byte 6 having the value of 0x03. Control dictionaries shall be registers of control data items.

#### 2.1.4 Types dictionaries

Types dictionaries shall be identified by byte 6 having the value of 0x04. Types dictionaries shall be registers of data types.

Many register values share a common set of definitions for multiple data representations. To simplify the register definitions, the “Types” dictionary shall be used to define these data representations. The Types dictionary shall be used as a shared resource for all other dictionaries.

## 2.2 Identification of Value data representations

The Value of many data items can be represented in more than one way. For example, a start time in the metadata dictionary can be represented as a character string of the timecode or as an efficient bit-packed form. The first offers direct mapping to a display whereas the second offers high transmission efficiency for use in narrow-band data channels. There are many such metadata dictionary items that have multiple data representations for the same descriptor.

Where a data item has more than one data representation for the value, one representation shall be designated as the default representation and shall be assigned a Key with at least one trailing zero byte. Alternate representations shall be assigned Keys by replacing the leftmost trailing zero byte with non-zero values, which shall be assigned sequentially. Each representation shall be documented as a separate entry in the register.

Informative example:

- 01.02.03.04.00.00.00.00 is “Name” (default data representation in 16-bit Unicode characters).
- 01.02.03.04.01.00.00.00 is “Name” (different data representation in ISO 7-bit characters).
- 01.02.03.04.02.00.00.00 is “Name” (another data representation in UTF-8 Unicode characters).

The parser treats all representations as the same data item, i.e., it recognizes 01.02.03.04.00, then looks for xx in place of the “00” to identify different encodings. Since the default representation is defined, the extra non-zero term in the 5th position is known to be a new data representation of the default register item. It should be noted that different representations may constrain the values that a data item may use.

### 3 KLV group coding

Group coding of data items can be used to reduce the overhead of repeating redundant information that appears in the Key of each unit as in Universal Sets. Group coding also allows logical groups of individual data items, or groups of items, to be encoded together and provides options for increased bit-efficiency. In order of increasing coding efficiency, the K-L-V Coding Protocol can be used to support Universal Sets, Global Sets, Local Sets, Variable-length Packs and Defined-Length Packs described as follows:

- Universal Sets shall be used to construct a logical grouping of data items and other KLV encoded items. Universal Sets use the full KLV Coding Construct throughout.
- Global Sets are defined as per Universal Sets, but offer coding efficiency by sharing a common Key header. This coding gain is lossless and every Key can be fully recovered from the data in the Global Set alone.
- Local Sets are defined as per Universal Sets, but offer coding efficiency through the use of short Local Tags whose meaning is defined within the context of the Local Set. Local Sets retain the KLV data construct but require a separate Recommendation or RP to define the meaning of the Local Tags and to provide a map from the Local Tag value to the Key value.
- Variable-length Packs are defined as a further grouping of data items that eliminates the use of Keys and Local Tags for all individual items within the group. Variable-length Packs therefore rely on a Recommendation or RP which defines the order of data items within the pack and the UL of each item in the pack.
- Defined-Length Packs are the most efficient (and least flexible) grouping of data items that eliminates the use of both Keys and Local Tags and removes the length for all individual items within the group. Thus Defined-Length packs rely on a Recommendation or RP which defines both the order of data items, the length of each data item within the pack and the UL of each item in the pack.

Group coding shall only be used for the encoding of sets and packs described in this Recommendation.

Sets and Packs shall consist of a number of individual data items which are coded as a group by the KLV Set or Pack data construct. The Set or Pack shall be defined by a full Key whose value shall be registered with the SMPTE Registration Authority.

Sets and Packs may encode data which are themselves Sets or Packs as well as individual register items. This is called KLV recursive coding and this Recommendation provides no limit on the number of levels of recursion which may be used by any particular application.

The presence of Sets or Packs shall be indicated by 0x02 in the Registry Category Designator field (byte 5) of the Set or Pack Key. The Registry Designator field (byte 6) shall be used to identify the type of Set or Pack. The Set or Pack register shall be identified by the Structure Designator field (byte 7) and the version of the register shall be identified by the Version Number field (byte 8).

The Set or Pack Value shall be comprised of a number of individual data items with coding as defined by the Set or Pack type. In a Pack, the order and presence of items is defined. By default, the order and presence of items in a Set are not defined. Specific Recommend Practices or Recommendations may define constraints for the order and presence of data items within any specific Set or group of Sets.

The following sections define how the data items are encoded for Universal Sets, Global Sets, Local Sets, Variable-length Packs and Defined-Length Packs.

### 3.1 Universal Sets

A Universal Set is defined as a number of data items that are grouped for application or management reasons. Data items may be in any order within the Universal Set and may be present or absent.

The use of Keys for Universal Set coding shall be defined by an accompanying Recommendation or RP including a Structure Designator and an accompanying Universal Set Register including a version number.

The Key of a Universal Set shall be 16 bytes in length.

The Length of a Universal Set shall be coded as per ASN.1 notation; long or short form as required.

The Value of a Universal Set shall be a sequence of KLV-encoded items whose total length is given by the Length field. Each and every data item in a Universal Set shall apply KLV Data Coding protocol including the full Key value.

Relevant Application Recommendations or RPs may specify constraints upon the Value of a Universal Set such as the number and size of items, the allowed sequence of items and whether any items are mandatory or optional.

The Key for Universal Sets is described by Table 4. The Universal Set Designator is defined within the last 8 bytes in the Universal Set Key. Universal Set Keys shall be defined in an associated Recommendation or RP and the Key value shall be registered with the SMPTE Registration Authority in accordance with the provisions of the accompanying Recommendation or RP to guarantee a unique Key value.

Figure 3 illustrates the data structure for the encoding of Universal Sets.

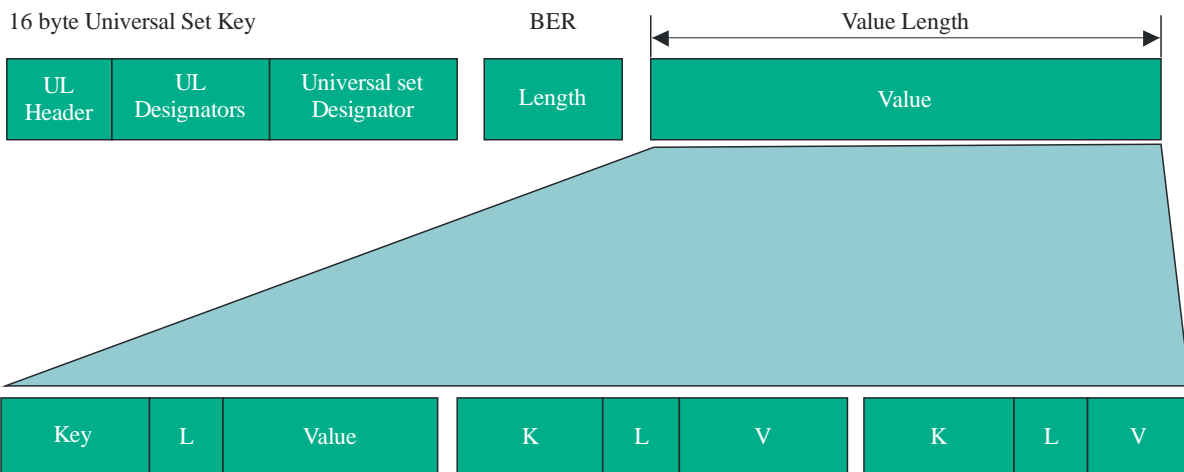
TABLE 4

Field Descriptions for the Key for the KLV Encoding of Universal Sets

No.	Field	Description	Length	Content/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	byte	Always 0x2B
4	SMPTE Designator	SMPTE sub-identifier	1 byte	Always 0x34
5	Registry Category Designator	Sets and Packs	1 byte	Always 0x02
6	Registry Designator	Universal Sets	1 byte	Always 0x01
7	Structure Designator	Designator of the structure variant within the Universal Set Register	1 byte	Defined by the Universal Set Register and Recommendation or RP
8	Version Number	Version of the given Register which first defines the item specified by the Item Designator	1 byte	Incrementing number
9 to 16	Universal Set Designator	Unique identification of the particular Universal Set	8 bytes	See Universal Set Register

FIGURE 3

KLV Coded Universal Set Data Structure



Value is composed of individually- encoded KLV items with 16 byte Key and BER Length

### 3.2 Global Sets

A Global Set is defined as a number of data items that are grouped to losslessly reduce the length of the Keys for each item within the Set. Data items may be in any order within the Global Set and may be present or absent.

The use of Keys for Global Set coding shall be defined by an accompanying Recommendation or RP including a Structure Designator and an accompanying Global Set Register including a version number.

The Key of a Global Set shall be 16 bytes in length.

The Length of a Global Set shall be coded by default as per ASN.1 notation; long or short form as required.

The Value of a Global Set shall be a sequence of KLV-encoded items whose total length is given by the Length field. Each and every data item of a Global Set shall apply KLV Data Coding protocol but with a shortened Global Tag value replacing the Key as described next.

The Global Set UL shall be defined in two parts:

The first group of 8 bytes (UL Header and UL Designator) shall be registered with the SMPTE Registration Authority and shall be used to identify the Global Set Recommendation or RP including the structure designator. Each entry in the Global Set Register shall record the version number in which it was first defined.

The second group of 8 bytes is called the Global Set Designator and shall be used to define the common UL Header and UL Designator for all the Keys within the Global Set. This second group of 8 bytes shall include the UL Header fields together with as much of the UL Designator as is common to all items in the Global Set and indicated by the Structure Designator (byte 7). The Global Set Designator may be terminated by a zero-value byte to indicate termination of the common UL Designator root. The significant length of the second group to the zero value terminator shall be 2 to 8 bytes. If the length of the second group is 8 bytes, then the zero-value terminator byte is not required.

Each Global Tag is from 2 to 12 words in length. Global Tags of length less than 12 words shall be terminated by a single zero value thus removing redundant UL data.

The full 16-byte Key of each data item in the Global Set can be losslessly re-created by concatenating the non-zero bytes of the Global Set Designator and the Global Tag of the item. If the resulting concatenation is less than 16 bytes in length, the remaining bytes in the 16-byte space shall be zero filled.

Relevant Application Recommendations or RPs may specify constraints upon the Value of a Global Set such as the number and size of items, the allowed sequence of items and whether any items are mandatory or optional.

The Key for Global Sets is described by Table 5. The Global Set Designator is defined within the last 8 bytes in the Global Set Key. Global Set Keys shall be defined in an associated Recommendation or RP and the Key value shall be registered with the SMPTE Registration Authority in accordance with the provisions of the accompanying Recommendation or RP to guarantee a unique Key value.

TABLE 5  
Field Descriptions for the Key for Global Set Encoding

No.	Field	Description	Length	Contents/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE designator	1 byte	Always 0x34
5	Registry Category Designator	Sets and Packs	1 byte	Always 0x02
6	Registry Designator	Global Sets	1 byte	See Table 6
7	Structure Designator	Designator of the structure variant within the Global Set Register	1 byte	See note at the end of this table
8	Version Number	Version of the Global Set Register which first defines the item specified by the Global Set Designator	1 byte	Incrementing number
9 to 16	Global Set Designator	The common portion of the Key shared by all Global Tags	8 bytes	Active number defines the bytes needed to establish the common root for all Global Tags (2 to 8 bytes)

NOTE 1 – The Value is equal to 1 plus the number of initial bytes of the Key which are copied from this table before the start of the common portion. Values of 1 (0 bytes copied) through 9 (8 bytes copied) are allowable. A Value of 5 (4 bytes copied) is most reasonable.

Figure 4 illustrates the structure for the encoding of Global Data Sets.

The 16-byte Global Set Key is followed by the Global Set Length (encoded using ASN.1 BER length encoding) which is followed by a number of data items which shall each be triplets of Global Tag, Length and Value.

The default specification of the Length fields of individual data items is ASN.1 BER short or long-form encoding. When non-ASN.1 BER encoding is used it shall be big-endian byte ordered. The full range of allowed Length field lengths is defined by the Registry Designator, according to Table 6. All Length fields in the Global Set shall follow the same syntax.

Global Sets can accommodate recursion, so that the Key linked to a Global Tag may identify either a single data item from a register or a data set or pack from a Set or Pack Recommendation or RP and the corresponding Register.

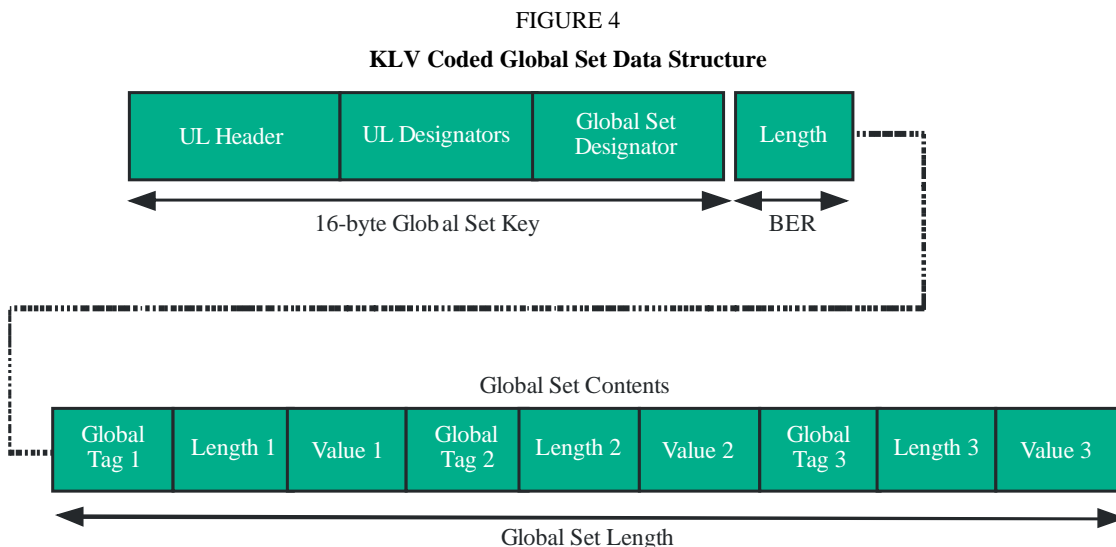


TABLE 6

### Coding of Registry Designator (Byte 6) for Global Set Syntax

Byte 6 Value	Length field	Description
0x02	ASN.1 BER short or long	Any length (default)
0x22	1 byte	Length up to 255
0x42	2 bytes	Length up to 65535
0x62	4 bytes	Length up to $2^{32}-1$

### 3.3 Local Sets

A Local Set is defined as a number of data items that are grouped to reduce the length of the Keys for each item within the Set. Data items may be in any order within the Local Set and may be present or absent.

The use of Keys for Local Set coding shall be defined by an accompanying Recommendation or RP including a Structure Designator and an accompanying Local Set Register including a version number.

The Key of a Local Set shall be 16 bytes in length.

The Length of a Local Set shall be coded by default as per ASN.1 BER length notation; long or short form as required.

The Value of a Local Set shall be a sequence of KLV-encoded items whose total length is given by the Length field.

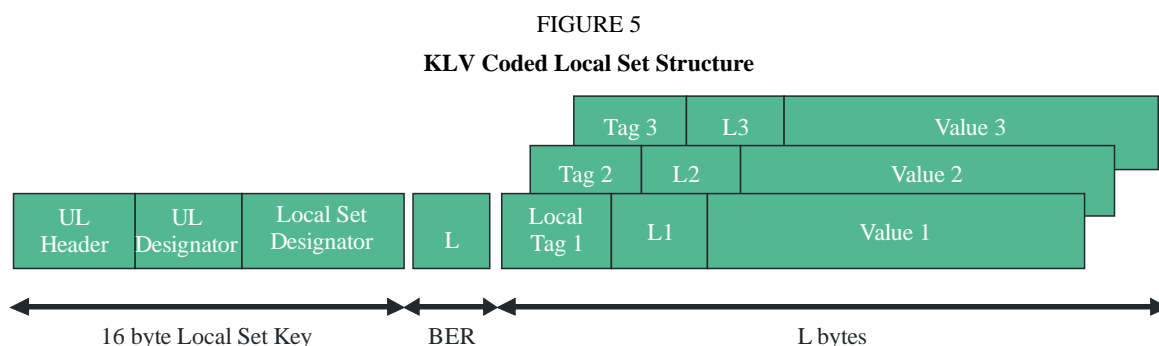
The Key for Local Sets is described by Table 7. The Local Set Designator is defined within the last 8 bytes in the Local Set Key. Local Set Keys shall be defined in an associated Recommendation, Standard or RP and the Key value shall be registered with the SMPTE Registration Authority in accordance with the provisions of the accompanying Recommendation or RP to guarantee a unique Key value.



TABLE 7  
Field Descriptions for the Key for Local Set Encoding

No.	Field	Description	Length	Contents/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE designator	1 byte	Always 0x34
5	Registry Category Designator	Sets and Packs	1 byte	Always 0x02
6	Registry Designator	Local Sets	1 byte	See Table 8
7	Structure Designator	Designator of the structure variant within the Local Set Register	1 byte	Defined by the Local Set Register and Recommendation or RP
8	Version Number	Version of the Local Set Register which first defines the item specified by the Local Set Designator	1 byte	Incrementing number
	Local Set Designator			
9 to 16	Local Set Designator	Defines the Local set placement in a hierarchical structure	8 bytes	Defined by the Local Set Register and Recommendation or RP

The data structure for the encoding of Local Sets is illustrated by Fig. 5.



BT.1563-05

The 16-byte Local Set Key is followed by the Set Length, which is followed by a number of data items, which shall each be triplets of Local Tag, Length and Value.

The preferred size of Local Tag fields is 1 byte. The default specification of Length fields is ASN.1 BER short or long-form encoding. When non-ASN.1 BER encoding is used it shall be big-endian byte ordered. The full range of allowed combinations of Local Tag and Length field lengths is defined by the Registry Designator, according to Table 8.

TABLE 8  
Coding of Registry Designator (Byte 6) for Local Set Syntax

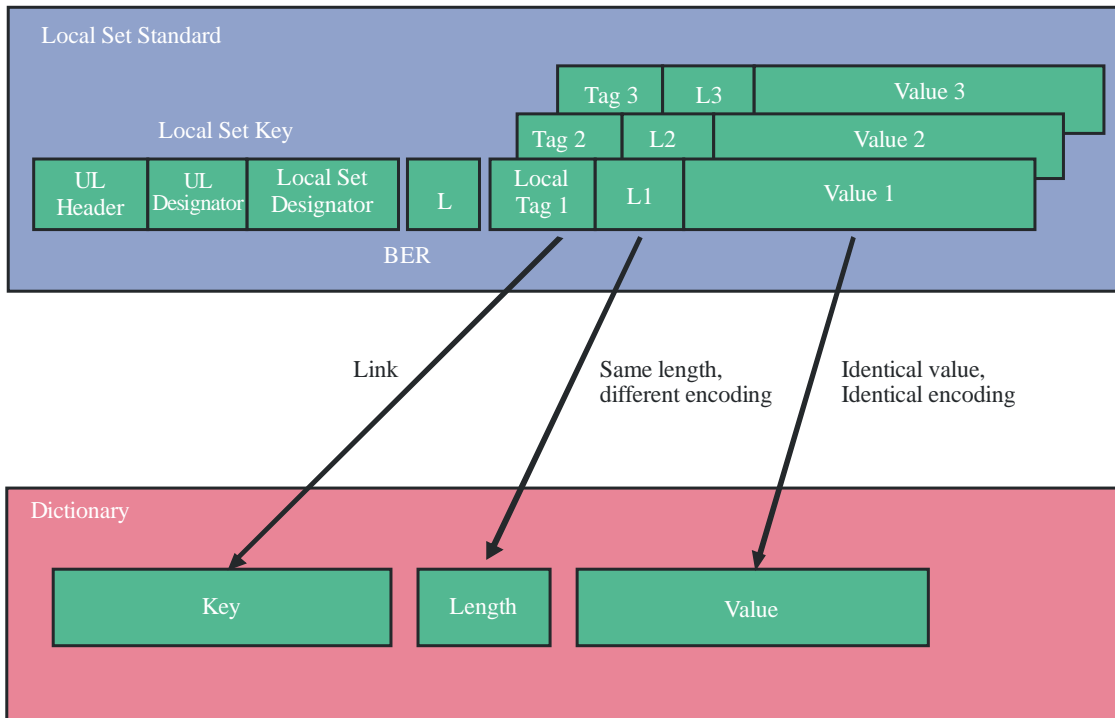
Byte 6 Value	Length field	Local Tag field	Description
0x03	ASN.1 BER short or long	1 byte	Any length (default)
0x0B	ASN.1 BER short or long	ASN.1 OID BER	
0x13	ASN.1 BER short or long	2 bytes	
0x1B	ASN.1 BER short or long	4 bytes	
0x23	1 byte	1 byte	Length up to 255
0x2B	1 byte	ASN.1 OID BER	
0x33	1 byte	2 bytes	
0x3B	1 byte	4 bytes	
0x43	2 bytes	1 byte	Length up to 65535
0x4B	2 bytes	ASN.1 OID BER	
0x53	2 bytes	2 bytes	
0x5B	2 bytes	4 bytes	
0x63	4 bytes	1 byte	Length up to 232-1
0x6B	4 bytes	ASN.1 OID BER	
0x73	4 bytes	2 bytes	
0x7B	4 bytes	4 bytes	

NOTE 1 – A relevant Local Set Recommendation or RP shall define the link between the Local Tag of each data item and the corresponding Key value. This link shall be defined in a relevant Local Set Recommendation or RP that provides, for each Local Tag, the Key of the defining item. This linking definition is a mechanism that gives users of this Recommendation the flexibility to define their own aliases for highly efficient coding. The relevant Local Set Recommendation or RP shall also define the intended scope of applicability of the local tag or alias within the specification. Developers of Local Sets shall provide the mapping between each Tag in a Local Set and the defining Key. Unlike Universal Sets and Global Sets where the Key of each data item in the set can be losslessly recreated, the Key of each Local Set Tag cannot be reconstructed without recourse to the defining Recommendation or RP and the corresponding Register.

Local Sets can accommodate recursion, so that the Key linked to a Local Tag may identify either a single data item from a register or a data set or pack from a Set or Pack Recommendation or RP and the corresponding Register.

Figure 6 is an informative illustration of the linking between a Local Tag and a full Key.

FIGURE 6  
**Informative Illustration of Local Set Label-to-Global Key Linking**



BT.1563-06

### 3.4 Variable-Length Packs

A Variable-Length Pack is similar to a Local Set but does not have Local Tags. Thus each item of a Variable-length Pack comprises only a Length field and a Value field. Items in a Variable-Length Pack must appear in the defined order.

The use of Keys for Variable-Length Pack coding shall be defined by an accompanying Recommendation or RP including a Structure Designator and an accompanying Variable-Length Pack Register including a version number.

The Key of a Variable-Length Pack shall be 16 bytes in length.

The Length of a Variable-Length Pack shall be coded by default as per ASN.1 BER length notation; long or short form as required.

The Value of a Variable-Length Pack shall be a sequence of KLV-encoded items whose total length is given by the Length field.

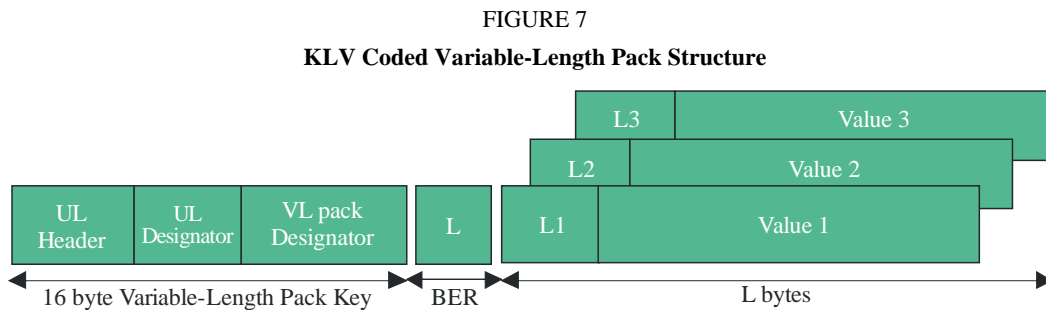
The Key for Variable-Length Pack is described by Table 9. The Variable-Length Pack Designator is defined within the last 8 bytes in the Local Set Key. Variable-Length Pack Keys shall be defined in an associated Recommendation or RP and the Key value shall be registered with the SMPTE Registration Authority in accordance with the provisions of the accompanying Recommendation or RP to guarantee a unique Key value.

TABLE 9

## Field Descriptions for the Key for Variable-Length Pack Encoding

No.	Field	Description	Length	Contents/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE designator	1 byte	Always 0x34
5	Registry Category Designator	Sets and Packs	1 byte	Always 0x02
6	Registry Designator	Variable Length Packs	1 byte	See Table 10
7	Structure Designator	Designator of the structure variant within the Variable Length Pack Register	1 byte	Defined by the Variable Length Pack Register and Recommendation or RP
8	Version Number	Version of the Variable Length Pack Register which first defines the item specified by the Variable Length Pack Designator	1 byte	Incrementing number
	Variable Length Pack Designator			
9 to 16	Variable Length Pack Designator	Defines the variable length pack placement in a hierarchical structure	8 bytes	Defined by the Variable Length Pack Register and Recommendation or RP

The data structure for the encoding of Variable-Length Packs is illustrated by Fig. 7.



BT.1563-07

The 16-byte Variable-Length Pack Key is followed by the Variable-Length Pack Length (encoded using ASN.1 BER length encoding) which is followed by a number of items which shall each be doublets of Length and Value.

The default specification of the Length fields of individual items is ASN.1 BER short or long-form encoding. When non-BER encoding is used it shall be big-endian byte ordered. The full range of allowed Length field lengths is defined by the Registry Designator, according to Table 10.

TABLE 10

**Coding of Registry Designator (Byte 6) for Variable Length Pack Syntax**

Byte 6 Value	Length fields	Description
0x04	ASN.1 BER short or long	Any length (default)
0x24	1 byte	Length up to 255
0x44	2 bytes	Length up to 65535
0x64	4 bytes	Length up to $2^{32}-1$

Because the items within a pack do not have a local Tag, the order of the items shall be specified by the defining Recommendation, Standard or RP.

A relevant Variable-Length Pack Recommendation or RP shall define the link between each data item and the corresponding Key value by providing the Key of each item in the Variable-Length Pack. This linking definition is a mechanism that gives users of this Recommendation the flexibility to define their own aliases for highly efficient coding. Developers of Variable-Length Packs shall register the mapping between each item in a Variable-Length Pack and the defining Key. Unlike Universal Sets and Global Sets where the Key of each item in the set can be losslessly recreated, the Key of each item in a Variable-Length Pack cannot be reconstructed without recourse to the defining Recommendation or RP and the corresponding Register.

Variable-Length Packs can accommodate recursion, so that the Key linked to an item may identify either a single data item from a register or a data group from a Set or Pack Recommendation or RP and the corresponding Register.

### 3.5 Defined-Length Packs

NOTE 1 – The term Fixed-Length Pack has been replaced by Defined-Length Pack with this version of the Recommendation.

A Defined-Length Pack is similar to a Variable-Length Pack but does not have Length fields. Thus each item of a Defined-Length Pack comprises only a Value field. Items in a Defined-Length Pack shall appear in the defined order.

The use of Keys for Defined-Length Pack coding shall be defined by an accompanying Recommendation or RP including a Structure Designator and an accompanying Defined-Length Pack Register including a Version number.

The Key of a Defined-Length Pack shall be 16 bytes in length.

The Length of a Defined-Length Pack shall be coded as per ASN.1 BER length notation; long or short form as required.

The Value of a Defined-Length Pack shall be a sequence of items whose total length is given by the Length field.

Individual items in a Defined-Length Pack occur in a defined order, and each item has a defined length. Individual items within the pack may have length values which need to be determined by parsing the item, thus resulting in a pack with a defined yet variable overall length. There is no requirement in this Recommendation for Defined-Length Packs to have fixed, constant length values.

The Key for a Defined-Length Pack is described by Table 11. The Defined-Length Pack Designator is defined within the last 8 bytes in the Local Set Key. Defined-Length Pack Keys shall be defined in an associated Recommendation or RP and the Key value shall be registered with the SMPTE Registration Authority in accordance with the provisions of the accompanying Recommendation or RP to guarantee a unique Key value.

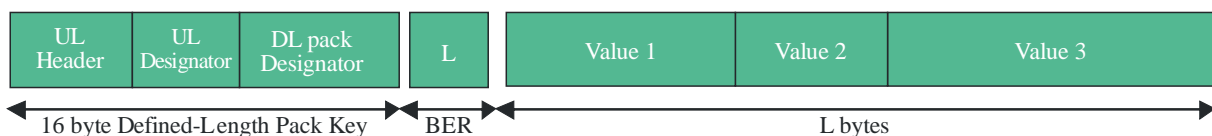
The data structure for the encoding of Defined-Length Packs is illustrated by Fig. 8.

TABLE 11  
Field Descriptions for the Key for Defined-Length Pack Encoding

No.	Field	Description	Length	Contents/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE designator	1 byte	Always 0x34
5	Registry Category Designator	Sets and Packs	1 byte	Always 0x02
6	Registry Designator	Defined-Length Packs	1 byte	Always 0x05
7	Structure Designator	Designator of the structure variant within the Defined-Length Pack Register	1 byte	Incrementing number
8	Version Number	Version of the Defined-Length Pack Register which first defines the item specified by the Defined-Length Pack Designator	1 byte	Incrementing number
	Defined-Length Pack Designator			
9 to 16	Defined-Length Pack Designator	Defines the Defined-Length pack placement in a hierarchical structure	8 bytes	Defined by the Defined-Length Pack Register and Recommendation or RP

FIGURE 8

KL V coded Defined-Length Pack Structure



Because the items within a Defined-Length Pack do not have a Local Tag, the order of the items shall be specified by the defining Recommendation or RP.

A relevant Defined-Length Pack Recommendation or RP shall define the link between each data item and the corresponding Key value by providing the Key of the defining item. This linking definition is a mechanism that gives users of this Recommendation the flexibility to define their own aliases for highly efficient coding. Developers of Defined-Length Packs shall register the mapping between each item in a Defined-Length Pack and the defining Key. Unlike Universal Sets and Global Sets where the Key of each item in the set can be losslessly recreated, the Key of each item in a Defined-Length Pack cannot be reconstructed without recourse to the defining Recommendation or RP and the corresponding Register.

Defined-Length Packs can accommodate recursion, so that the Key linked to an item may identify either a single data item from a register or a data group from a Set or Pack Recommendation or RP and the corresponding Register.

NOTE 2 – In many cases, groups can be coded as Universal Sets, Local Sets, Variable Length Packs and Defined-Length Packs without changing the values of the individual metadata items within the group. In each case, for a given group, only byte 6 of the group key will change and bytes 9 to 16 would remain the same.

### **3.6 Forbidden Use**

The value of byte 6 having the value of 0x06 shall not be used for KLV coding.

## **4 Wrappers and Containers**

Wrappers and Containers shall be identified by byte 5 having the value of 0x03.

Wrappers and Containers differ from Sets and Packs in that they do not necessarily employ an overall KLV data construct for the entire contents of the Wrapper or Container. It is recommended that individual parts of a Wrapper or Container encode data using the KLV coding protocol, but these parts may be bound together by other techniques. In some cases, a Wrapper or Container may employ an overall KLV construct in certain applications (such as a streaming interface) but employ another technique in other applications (such as a storage container). In these cases, the Wrapper or Container is not redefined as a Set or a Pack but retains the definition as a Container or Wrapper for consistency of identification.

Simple Wrappers and Containers are defined as embedding all the data into a single framework with no external references. Simple Wrappers and Containers shall be identified by byte 6 having the value 0x01.

Complex Wrappers and Containers are defined by frameworks where individual data items may be included in a file by reference rather than embedding. Complex Containers and Wrappers can be more efficient and are suited to local environments where references can be easily resolved. Complex Wrappers and Containers shall be identified by byte 6 having the value 0x02.

The definition of individual Wrapper and Container specifications is outside the scope of this Recommendation and will be found in other documents.

## **5 SMPTE Labels**

SMPTE Labels shall be identified by byte 5 having the value of 0x04. SMPTE Labels shall not be used as the Key in KLV coding. SMPTE Labels may be used as a value within a KLV coding triplet or within any other coding construct.

SMPTE Labels shall be used to identify any object whose meaning is entirely conveyed by the SMPTE Administered UL itself. SMPTE Labels may be used to identify essence coding schemes, provide unique identification of parametric values, identify metadata constructs and more.

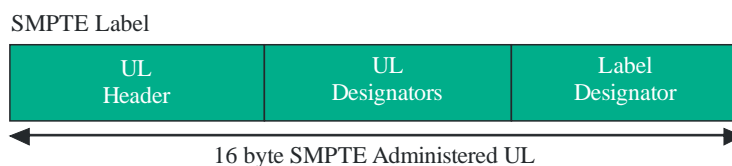
Within Wrappers and Containers and sometimes even in Sets, there is sometimes the need to identify aspects of the data contents which are not identified by the Set, Wrapper or Container Key. Such an aspect can be identified by including a SMPTE Label in the Set, Wrapper or Container as a data item. It is necessary to define the presence of a SMPTE Label at a high level in the SMPTE UL structure so that decoders are aware that the item is a SMPTE Label and not the Key of a KLV coded triple. The Field descriptions of the SMPTE UL for SMPTE Labels are described in Table 12. A SMPTE Label is illustrated in Fig. 9.

TABLE 12

**Field Descriptions of the SMPTE Administered UL for SMPTE Labels**

No.	Field	Description	Length	Contents/Format
	UL Header			
1	OID	Object Identifier	1 byte	Always 0x06
2	UL Size	16-byte size of the UL	1 byte	Always 0x0E
	UL Designator			
3	UL Code	Concatenation of sub-identifiers ISO, ORG	1 byte	Always 0x2B
4	SMPTE Designator	SMPTE designator	1 byte	Always 0x34
5	Registry Category Designator	Labels	1 byte	Always 0x04
6	Registry Designator	Specific labels register	1 byte	Incrementing number
7	Structure Designator	Designator of the structure variant within the labels register	1 byte	Incrementing number
8	Version Number	Version of the labels register which first defines the item specified by the label designator	1 byte	Incrementing number
	Labels Designator			
9 to 16	Labels Designator	Defines the labels placement in a hierarchical structure	8 bytes	Defined by the labels register and Recommendation or practice

FIGURE 9

**SMPTE Administered UL for SMPTE Labels**



## 6 Registered private information

Registered private information shall be identified with the Registry Category field of the SMPTE administered UL set to 0x05. The purpose of this category is to provide a Recommendation, unambiguous means to carry information that is registered with an external agency, and where that information is not desired to be publicly registered in a SMPTE register, or not desired to be qualified as either metadata or essence.

This registered private information does not define a SMPTE administered UL as either a Key or a SMPTE Label.

Refer to SMPTE RP 225 for the authoritative definition of the remainder of the UL fields when the Registry Category Designator is set to 0x05.

## Appendix A

### Glossary of Terms and Acronyms

For the purpose of this Recommendation, the following terms and definitions are used.

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

**Basic Encoding Rules (BER)** – An ISO Recommendation 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 shall conform to the Basic Encoding Rules (BER) for either the short form or long form encoding specified in ISO/IEC 8825-1, §§ 8.1.3.4 and 8.1.3.5.

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

**Byte** – A widely used alternative for the term “octet”.

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

**Container** – A 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** – An item of data that is used to provide a control function for essence data or metadata.

**Data Group** – A collection of data items.

**Data Item** – A data entity in this Recommendation. Note that the term “item” is widely used in other documents and may have a different meaning. Note also that a data item is not a group in this Recommendation.

**Data Type** – (See definition of Type below.)

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

**Dictionary** – A register that provides for the semantic interpretation of the data items within the register.

**Essence** – An 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 Recommendations for the Exchange of Program Material as Bitstreams” (TFHS) as Video, Audio, and/or Data information. Essence can also be Graphics, Telemetry, Photographs, or other information.

**ISAN** – International Recommendation Audiovisual Number.

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

**KLV** – Key-Length-Value.

**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** – The Recommendation database of approved Metadata Items including definitions and allowed formats.

**Metadata Item** – A broad term for a unit of metadata.

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

**Octet** – A 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** – An information store or database that is maintained by a registry.

**Registry** – An information system for registering data.

**SMPTE Administered UL** – A UL that is administered by SMPTE in accordance with ANSI/SMPTE 298M. All SMPTE administered ULs are 16 bytes in length.

**SMPTE Label** – A SMPTE UL that is self identifying (see Section 7).

**SMPTE Registration Authority** – A registration organization which keeps record of the use of ANSI/SMPTE 298M UL Keys and other reference data.

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

**SMPTE UL** – An abbreviation of the term **SMPTE Administered UL**.

**Tag** – A special form of identification that is local to the coding format. In its fully expanded form, a Tag may be identical to the Item Designator.

**UL** – Universal Label; an object identifier according to ISO/IEC 8824-1 (see also ANSI/SMPTE 298M). In this Recommendation, this term is used to mean a SMPTE administered UL.

**Wrapper** – Identified by the SMPTE/EBU “Task Force for Harmonized Recommendations 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 may 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 labelling and other supporting metadata.

## Appendix B (Informative)

### ASN.1 BER Length Coding

NOTE 1 – The term “byte” used in this Recommendation is synonymous with the term “octet” used in ISO/IEC 8825-1.

The following section is quoted from ISO/IEC 8825-1:

“8.1.3.3 For the definite form, the length octets shall consist of one or more octets, and shall represent the number of octets in the contents octets using either the short form (see § 8.1.3.4) or the long form (see § 8.1.3.5) as a sender’s option.

NOTE 2 – The short form can only be used if the number of octets in the contents octets is less than or equal to 127.”

“8.1.3.4 In the short form, the length octets shall consist of a single octet in which bit 8 is zero and bits 7 to 1 encode the number of octets in the contents (Value) octets (which may be zero), as an unsigned binary integer with bit 7 as the most significant bit.

#### Example:

L = 38 can be encoded as 00100110<sub>2</sub>”.

“8.1.3.5 In the long form, the length octets shall consist of an initial octet and one or more subsequent octets. The initial octet shall be encoded as follows:

- a) bit 8 shall be one;
- b) bits 7 to 1 shall encode the number of subsequent octets in the length octets, as an unsigned binary integer with bit 7 as the most significant bit;
- c) the value 1111111<sub>2</sub> shall not be used.

NOTE 3 – This restriction is introduced for possible future extensions.

Bits 8 to 1 of the first subsequent byte, followed by bits 8 to 1 of the second subsequent byte, followed in turn by bits 8 to 1 of each further byte up to and including the last subsequent byte, shall be the encoding of an unsigned binary integer equal to the number of bytes in the Value field, with bit 8 of the first subsequent byte as the most significant bit.

NOTE 4 – This is sometimes known as “big-endian byte order”.

#### Example:

L = 201 can be encoded as:

Byte 1 = 10000001<sub>2</sub>, Byte 2 = 11001001<sub>2</sub> [b7 .....b0].

## Appendix C (Informative)

### ASN.1 BER Encoding of an object identifier value

NOTE 1 – The term “byte” used in this Recommendation is synonymous with the term “octet” used in ISO/IEC 8825-1.

The following section is quoted from ISO/IEC 8825-1:

#### 8.19 Encoding of an object identifier value

**8.19.1** The encoding of an object identifier value shall be primitive.

**8.19.2** The contents octets shall be an (ordered) list of encodings of subidentifiers (see 8.19.3 and 8.19.4) concatenated together.

Each subidentifier is represented as a series of (one or more) octets. Bit 8 of each octet indicates whether it is the last in the series: bit 8 of the last octet is zero; bit 8 of each preceding octet is one. Bits 7 to 1 of the octets in the series collectively encode the subidentifier. Conceptually, these groups of bits are concatenated to form an unsigned binary number whose most significant bit is bit 7 of the first octet and whose least significant bit is bit 1 of the last octet. The subidentifier shall be encoded in the fewest possible octets, that is, the leading octet of the subidentifier shall not have the value  $80_{16}$ .

**8.19.3** The number of subidentifiers (N) shall be one less than the number of object identifier components in the object identifier value being encoded.

**8.19.4** The numerical value of the first subidentifier is derived from the values of the first **two** object identifier components in the object identifier value being encoded, using the formula:

$$(X*40) + Y$$

where X is the value of the first object identifier component and Y is the value of the second object identifier component.

NOTE – This packing of the first two object identifier components recognizes that only three values are allocated from the root node, and at most 39 subsequent values from nodes reached by  $X = 0$  and  $X = 1$ .

**8.19.5** The numerical value of the *i*th subidentifier, ( $2 \leq i \leq N$ ) is that of the  $(i + 1)$ th object identifier component.

#### Example

An OBJECT IDENTIFIER value of:

{joint-iso-itu-t 100 3}

which is the same as:

{2 100 3}

has a first subidentifier of 180 and a second subidentifier of 3. The resulting encoding is:

OBJECT IDENTIFIER	Length	Contents
06 <sub>16</sub>	03 <sub>16</sub>	813403 <sub>16</sub>

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