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SMPTE REGISTERED DISCLOSURE DOCUMENT

Acquisition Metadata Sets for Video Camera Parameters

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Table of Contents

Introduction

This document defines metadata that is intended to capture camera acquisition parameters associated with each individual frame of the captured video. Such camera metadata can be used to provide user accessible information that enables optimization of various parameters during acquisition. The metadata can also be stored or carried with the picture signal to form a record of the shooting parameters used in the shoot. The metadata values are created individually for the shoot to provide a dynamic record for each camera parameter.

The metadata in this document is composed of three distinct groups – Lens Unit metadata, Camera Unit metadata and User Defined Acquisition metadata. The Lens Unit metadata provides a set of metadata items that define the lens parameter values during a shoot. Likewise, the Camera Unit metadata is a set of metadata items that define the camera parameter values during a shoot. The User Defined Acquisition metadata can be defined by users or camera makers.

These three groups are coded as KLV coded metadata sets with each set containing individual metadata items.

This document defines the KLV coded metadata sets and each KLV coded metadata item in full for the purpose of interoperability.

The final section provides guidance for the carriage of these KLV metadata sets through different transport mechanisms to allow the metadata sets to be successfully transported between applications using VANC packets on serial digital interfaces such as those complying with SMPTE ST 291-1 and in the essence containers of MXF files such as those complying with SMPTE ST 379-2.

1 Scope

This document describes metadata sets for the grouping of professional video camera acquisition parameters with frame granularity. The metadata sets are coded using the SMPTE KLV coding protocol as defined by SMPTE ST 336. Coding the metadata sets as KLV packets is intended to ensure maximum acceptability across a wide range of application areas.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this registered disclosure document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this registered disclosure document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

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

SMPTE ST 395:2014, Metadata Groups Registry Structure

SMPTE ST 400:2012, SMPTE Labels Structure

SMPTE ST 2115:2019, Free Scale Gamut and Free Scale Log Characteristics of Camera Signals

SMPTE Registration Authority: http://smpte-ra.org

CIE 15:2004, Colorimetry, 3rd Edition

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

3 Acronyms

Acronyms used in this document are listed below.

BER: Binary Encoding Rules

ID: Identifier

KLV: Key Length Value

MXF: Material Exchange Format

N/A: Not Applicable

UID: Unique Identifier

UL: Universal Label

UUID: Universally Unique Identifier

4 Definition of the Metadata Sets

The Acquisition Metadata Sets are KLV coded according to SMPTE ST 336. All metadata item values in the sets described in this document are associated with a given frame of video and values may change on a frame-by-frame basis.

There are three metadata sets; a Lens Unit Metadata Set, a Camera Unit Metadata Set and a User Defined Acquisition Metadata (UDAM) Set.

4.1 Set Keys

The Set Key is as per Table 1.

Table 1 – The Acquisition Metadata Set Key Value

Byte No.	Description	Value (hex)	Meaning
1–4	SMPTE UL Identifier	06.0E.2B.34	See SMPTE ST 336.
5	Category Designator	02h	SMPTE Groups
6	Registry Designator	53h	Local set with 2-byte Length field and 2-byte Local Tag field
7	Structure Designator	01h	Complies with register structure variant 1
8	Version Number	vvh (01h)	Version of the register at set registration
9	Compound class	0Ch	Identifies the Compound class in SMPTE ST 395
10	Production Metadata	02h	Identifies metadata sets created at point of creation or capture
11	Acquisition Metadata	01h	Identifies metadata sets associated with a video camera
12	Frame-based Acquisition Metadata	01h	Frame-based metadata set
13	Acquisition Set Kind	yyh	A non-zero value used to identify the specific camera acquisition set kind 01: Lens Unit Metadata Set (Local set) 02: Camera Unit Metadata Set (Local set) 03–7E: Reserved for future use 7F: User Defined Acquisition Metadata [1]
14	Acquisition Metadata Version 1	01h	Backwards compatible version number of this Acquisition Metadata Set
15	Null	00h	Zero value
16	Null	00h	Zero value

[1] The 'User Defined Acquisition Metadata' set kind may be used for private user defined ('dark') metadata. The local tags and values for this Set are assigned with tag value ranges from E0.00 to FF.FF. If this Set is inside MXF header metadata, local tags are allocated dynamically.
Note that the mapping of the Sets inside MXF header metadata is beyond the scope of this document.

4.2 Set Length

The Set Length field is BER encoded using long-form encoding as specified by SMPTE ST 336. The Length field is 4-byte in length.

4.3 Set Value

The contents of the Acquisition Metadata Sets are as defined in Tables in this section.

All items in each Set are encoded in the order shown in each Table.

The local tag values used in the metadata sets below are considered unique only within the confines of this specification.

Any new items added to either of the Sets described by the Tables in this section should increment the local tag value within that Set.

No new items should be added to these Sets without a revision of this document.

4.3.1 Lens Unit Metadata Set

The Lens Unit Metadata Set contents are as defined in Table 2. Byte 13 of the Set Key has the value of 01h.

Table 2 – Definition of the Lens Unit Metadata Set

Item Name	Type	Len	Local Tag [2]	Item UL	Req?	Meaning
Lens Unit Metadata	Set Key (UL)	16		See Table 1	Req	Lens Unit Metadata Set Key 06.0E.2B.34.02.53.01.01. 0C.02.01.01.01.01.00.00
Length	BER Length	4			Req	Set length
Instance UID	UUID	16	3C.0A	06.0E.2B.34 01.01.01.01 01.01.15.02 00.00.00.00	Opt	Unique ID of the instance of this data set [defined in SMPTE Elements Register]
Iris F-Number	UInt16	2	80.00	06.0E.2B.34 01.01.01.0D 04.20.02.02 01.00.00.00	Opt	Lens aperture setting "F-Number", i.e. = (focal length) / (effective diameter), in exposure value [EV] /1000h based on 8000h for F16
Iris T-Number	UInt16	2	80.08	06.0E.2B.34 01.01.01.0E 04.20.02.02 08.00.00.00	Opt	Lens aperture setting "T-Number", i.e. taking transmittance into consideration, in exposure value [EV] /1000h based on 8000h for T16
Iris Ring Position	UInt16	2	80.09	06.0E.2B.34 01.01.01.0E 04.20.02.02 09.00.00.00	Opt	Iris ring rotation angle in unsigned integer. 0 is for full open, and FFFFh for close.
Focus Position From Image Plane	LensSerial HalfFloat	2	80.01	06.0E.2B.34 01.01.01.0D 04.20.02.02 02.00.00.00	Opt	Distance in meters between the image plane and the object in focus
Focus Position From Front Lens Vertex	LensSerial HalfFloat	2	80.02	06.0E.2B.34 01.01.01.0D 04.20.02.02 03.00.00.00	Opt	Distance in meters between the front of the lens and the object in focus
Focus Ring Position	UInt16	2	80.0A	06.0E.2B.34 01.01.01.0E 04.20.02.02 0A.00.00.00	Opt	Focus ring rotation angle in unsigned integer. 0 is for near-end, FFFFh for infinity.
Macro Setting	Boolean	1	80.03	06.0E.2B.34 01.01.01.0D 04.20.02.02 04.00.00.00	Opt	Specifies by a flag, whether the macro photography mode is TRUE: on FALSE: off
Lens Zoom 35mm Still Camera Equivalent	LensSerial HalfFloat	2	80.04	06.0E.2B.34 01.01.01.0D 04.20.02.02 05.00.00.00	Opt	Normalized focal length in meters
Lens Zoom Actual Focal Length	LensSerial HalfFloat	2	80.05	06.0E.2B.34 01.01.01.0D 04.20.02.02 06.00.00.00	Opt	Actual focal length in meters
Zoom Ring Position	UInt16	2	80.0B	06.0E.2B.34 01.01.01.0E 04.20.02.02 0B.00.00.00	Opt	Zooming ring rotation angle in unsigned integer. 0 is for wide-end, and FFFFh is for tele-end.
Anamorphic Lens Squeeze Ratio	UInt8	1	80.0C	06.0E.2B.34 01.01.01.0E 04.20.02.02 0C.00.00.00	Opt	Optical image distortion with a special lens for widescreen movie. The unsigned value is in percent and is usually equivalent to the pixel aspect ratio of the captured picture.
Optical Inversion	Scanning Direction Type	1	80.0D	06.0E.2B.34 01.01.01.0D 04.20.02.02 0D.00.00.00	Opt	Optical image orientation. Value 0 is for ordinary lens systems.

Item Name	Type	Len	Local Tag [2]	Item UL	Req?	Meaning
Optical Extender Magnification	UInt16	2	80.06	06.0E.2B.34 01.01.01.0D 04.20.02.02 07.00.00.00	Opt	Magnification factor setup of an optical extender or conversion lens where present
Lens Attributes	UTF8String	var	80.07	06.0E.2B.34 01.01.01.0D 03.02.03.02 02.10.01.00	Opt	Informative description of additional attributes about the lens in use (as a text string). The string length is less than 64 bytes.

[2] If this Set is inside MXF header metadata, local tags are allocated dynamically.

4.3.2 Camera Unit Metadata Set

The Camera Unit Metadata Set contents are as defined in Table 3. Byte 13 of the Set Key has the value of 02h.

Table 3 – Definition of the Camera Unit Metadata Set

Item Name	Type	Len	Local Tag [3]	Item UL	Req?	Meaning
Camera Unit Metadata	Set Key (UL)	16		See Table 1	Req	Camera Unit Metadata Set Key 06.0E.2B.34.02.53.01.01. 0C.02.01.01.02.01.00.00
Length	BER Length	4			Req	Set length
Instance UID	UUID	16	3C.0A	06.0E.2B.34 01.01.01.01 01.01.15.02 00.00.00.00	Opt	Unique ID of the instance of this data set [defined in SMPTE Elements Register]
Auto Exposure Mode	Label	16	81.00	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.01.00.00	Opt	Describes the setup mode the camera uses for automatic exposure. Each value is a SMPTE Label and registered in SMPTE Labels Register.
Exposure Index of Photo Meter	UInt16	2	81.15	06.0E.2B.34 01.01.01.0E 04.20.01.03 01.0C.00.00	Opt	Setting of the photo meter in ISO number up to 32000
Exposure Index of Photo Meter in Long Integer	UInt32	4	81.19	06.0E.2B.34 01.01.01.0E 04.20.01.03 01.0C.01.00	Opt	Setting of the photo meter in ISO number for high sensitivity camera
Auto Focus Sensing Area Setting	AutoFocus SensingArea SettingType	1	81.01	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.02.00.00	Opt	Describes the selected areas used for the auto focus. Each value is a registered code.
Color Correction Filter Wheel Setting	Color Correction FilterWheel SettingType	1	81.02	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.03.00.00	Opt	Specifies the setting of the built-in optical color compensation (CC) filter as an integer value where the value 1 means a clear filter. Each value is a registered code.
Neutral Density Filter Wheel Setting	UInt16	2	81.03	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.04.00.00	Opt	Specifies the setting of the attenuation ratio of the built-in optical neutral density (ND) filter.
Rotary Shutter	Boolean	1	81.1A	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.0E.00.00	Opt	Specifies that the mechanical shutter is TRUE: used FALSE: not used
Optical Anti-Aliasing Filter	UInt8	1	81.1B	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.0F.00.00	Opt	Roll off frequency of the optical filter placed before the image plane. 100: pixel Nyquist, 255: thru.

Item Name	Type	Len	Local Tag [3]	Item UL	Req?	Meaning
Image Sensor Dimension Effective Width	UInt16	2	81.04	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.05.00.00	Opt	Width of effective image area in micrometers
Image Sensor Dimension Effective Height	UInt16	2	81.05	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.06.00.00	Opt	Height of effective image area in micrometers
Capture Frame Rate	Rational	8	81.06	06.0E.2B.34 01.01.01.0D 04.01.03.01 03.01.00.00	Opt	Capture Frame Rate in fps (e.g. 50:1, 60000:1001). The rate at which the video is captured in frames per second.
Image Sensor Readout Mode	ImageSensor ReadoutMode Type	1	81.07	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.07.00.00	Opt	Image sensor Readout mode defined as a registered code.
Image Sensor Decimation Ratio	UInt8	1	81.1C	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.10.00.00	Opt	Vertical/horizontal decimation ratio of the reading out of pixels on the image sensor, mainly for high-speed capturing. 11h for normal scan, 22h for one-half skipping, and 00h for cropping.
Image Scan Direction	Scanning DirectionType	1	81.1D	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.11.00.00	Opt	Scanning in the opposite direction for mirror effect. The code values 0, 1, 2, and 3 are used for normal images, horizontal mirror images, vertical mirror images, and 180-degree rotated images, respectively.
Shutter Speed (Angle)	UInt32	4	81.08	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.08.00.00	Opt	Shutter speed as an angle defining the exposure time in minutes (angle) relative to a completely open shutter angle of 360 degrees
Shutter Speed (Time)	Rational	8	81.09	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.08.01.00	Opt	Shutter speed as a time defining the exposure time per one frame/field period in seconds
Camera Master Gain Adjustment	Int16	2	81.0A	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.09.00.00	Opt	Master Gain Control setting in 0.01 decibel units
ISO Sensitivity	UInt16	2	81.0B	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.0A.00.00	Opt	Sensitivity to light in ISO exposure index up to 32000
ISO Sensitivity in Long Integer	UInt32	4	81.1E	06.0E.2B.34 01.01.01.0E 04.20.01.03 01.0A.01.00	Opt	Sensitivity to light in ISO exposure index for high sensitivity camera
Color Matrix	RationalArray	8 + 9×8	81.18	06.0E.2B.34 01.01.01.0E 04.20.01.03 01.0D.00.00	Opt	Specifies the setting of the color balance of the camera with the ordered elements (R to R, G to R, B to R, R to G, G to G, B to G, R to B, G to B, B to B)
Electrical Extender Magnification	UInt16	2	81.0C	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.0B.00.00	Opt	Expresses the magnification setup of the picture size in percent where 100% (64h) represents the original picture size
Auto White Balance Mode	AutoWhite BalanceMode Type	1	81.0D	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.01.00.00	Opt	Auto White Balance Mode defined as a registered code

Item Name	Type	Len	Local Tag [3]	Item UL	Req?	Meaning
White Balance	UInt16	2	81.0E	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.02.00.00	Opt	White Balance value defined by the temperature in Kelvin
Tint Correction	Int16	2	81.1F	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.09.00.00	Opt	Color correction level along the line of Constant Correlated Color Temperature in 0.00001 of delta-uv unit
Camera Master Black Level	Int16	2	81.0F	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.03.00.00	Opt	Level of the master black of the camera expressed as a percentage in relation to the white value. Defined in 0.1 % units.
Camera Knee Point	UInt16	2	81.10	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.04.00.00	Opt	Level of the knee point in the camera transfer characteristic expressed as a percentage defined in 0.1 % units
Camera Knee Slope	Rational	8	81.11	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.05.00.00	Opt	Slope of the transfer characteristic above the knee point
Camera Luminance Dynamic Range	UInt16	2	81.12	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.06.00.00	Opt	Luminance dynamic range expressed as a percentage in reference to the nominal white level. Defined in 0.1 % units.
Capture Gamma Equation	Label	16	32.10	06.0E.2B.34 01.01.01.02 04.01.02.01 01.01.02.00 [4]	Opt	Specifies the gamma of the camera transfer function as a SMPTE Label value registered in SMPTE Labels Register
Capture Color Primaries	Label	16	32.19	06.0E.2B.34 01.01.01.09 04.01.02.01 01.06.01.00 [5]	Opt	Specifies the color primaries as a SMPTE Label value registered in SMPTE Labels Register
Coding Equations	Label	16	32.1A	06.0E.2B.34 01.01.01.02 04.01.02.01 01.03.01.00	Opt	Specifies the color difference conversion as a SMPTE Label value registered in SMPTE Labels Register
Luminance Code Range	Luminance CodeRange Type	1	81.20	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.12.00.00	Opt	Type of video level limitation and scaling. 0: unknown, 2: encoded data (0-1023), 5: normal viewing video (64-1023), 6: narrow data, 7: narrow video (64-940).
Gamma for CDL	UInt8	1	81.16	06.0E.2B.34 01.01.01.0E 04.20.01.03 02.07.00.00	Opt	Enumerated code that represents the gamma characteristic applied at the input to the ASC CDL
Color for CDL	UInt8	1	81.21	06.0E.2B.34 01.01.01.0D 04.20.01.03 02.0A.00.00	Opt	Enumerated code that represents the color primaries applied at the input to the ASC CDL
ASC CDL V1.2	HalfFloatArray	8 + 10×2	81.17	06.0E.2B.34 01.01.01.0E 04.20.01.03 02.08.00.00	Opt	10 parameters of ASC Color Decision List V1.2
Acquisition Setting Procedure	UTF8String	var	81.22	06.0E.2B.34 01.01.01.0D 04.20.01.03 01.13.00.00	Opt	Explanation of acquisition setting procedure for retaking the scene in the same condition or information to use in post production. The string length is less than 64 bytes.

Item Name	Type	Len	Local Tag [3]	Item UL	Req?	Meaning
Camera Setting File URI	UTF8String	var	81.13	06.0E.2B.34 01.01.01.0D 01.02.01.08 02.00.00.00	Opt	URI value of the file containing the camera setup parameters. The string length is less than 64 bytes.
Camera Attributes	UTF8String	var	81.14	06.0E.2B.34 01.01.01.0D 03.02.03.02 02.10.02.00	Opt	Informative description of additional attributes about the camera in use (as a text string). The string length is less than 64 bytes.

[3] If this Set is inside MXF header metadata, local tags are allocated dynamically.

[4] The UL is defined as Transfer Characteristic in SMPTE Metadata Elements Register.

[5] The UL is defined as Color Primaries in SMPTE Metadata Elements Register.

4.3.3 User Defined Acquisition Metadata Set

The User Defined Acquisition Metadata Set contents are as defined in Table 4. Byte 13 of the Set Key has the value 7Fh.

Table 4 – Definition of the User Defined Acquisition Metadata Set

Item Name	Type	Len	Local Tag	Item UL	Req?	Meaning
User Defined Acquisition Metadata	Set Key (UL)	16		See Table 1	Req	User Defined Acquisition Metadata Set Key 06.0E.2B.34.02.53.01.01. 0C.02.01.01.7F.01.00.00
Length	BER Length	4			Req	Set Length
Instance UID	UUID	16	3C.0A	06.0E.2B.34 01.01.01.01 01.01.15.02 00.00.00.00	Opt	Unique ID of the instance of this data set [defined in SMPTE Elements Register]
UDAM Set Identifier	AUID	16	E0.00	06.0E.2B.34 01.01.01.0D 04.06.08.05 00.00.00.00	Req	The immutable ID of the instance of this User Defined Acquisition Metadata Set
UDAM Set Version	Version Type	2	E0.10	06.0E.2B.34 01.01.01.0E 04.06.08.07 00.00.00.00	Opt	Two digits version number (major.minor) of this User Defined Acquisition Metadata Set. The value and also the numbering rule are defined in each User Defined Acquisition Metadata Set document.
All items can be defined by users or camera makers						

The UDAM Set Identifier that may identify the manufacturer and the product may be formatted as a UUID as per IETF RFC 4122 or it may be a private universal label. This can be generated for any manufacturer or product that needs access to this data extension structure.

4.3.4 Guide to the Use of the Acquisition Metadata Sets Definition Tables

Table 2, 3, and 4 use the following fields, which are defined as follows:

1. “Item Name” is a human readable name for easy reference.
2. “Type” identifies the data type of the item with the following type definitions:
   a. Set Key (UL): A 16-byte Universal Label used a Set Key as defined in SMPTE ST 336.
   b. BER Length: The Set Length type as defined in SMPTE ST 336.

c. UUID: Universal Unique Identifier as defined by IETF RFC 4122.

d. Label: SMPTE Label as defined in SMPTE ST 400 and registered in SMPTE Labels Register.

e. AUID: A 16-byte UID that contains a Label or a UUID. If the value is a UUID, it is stored such that the top and bottom 8 bytes of the UUID are swapped. For UUIDs, this makes the most significant bit of the first byte a '1' and thus creates a UID value that is always distinct from a Label.

f. Boolean: 1 byte value with the logical values FALSE and TRUE, these shall be encoded as binary values 00h and 01h, respectively. Binary value 00h shall be decoded as FALSE, and all other binary values shall be decoded as TRUE.

g. UInt8: Unsigned 8-bit integer.

h. Int16: Signed 16-bit integer.

i. UInt16: Unsigned 16-bit integer.

j. UInt32: Unsigned 32-bit integer.

k. Rational: A pair of 32-bit integer values where the first is the numerator and the second is the denominator (e.g., for an aspect ratio of 4:3, the number would appear as 00.00.00.04.00.00.00.03 in hexadecimal format).

l. HalfFloat: A 16-bit floating point number as defined in IEEE 754.

m. LensSerialHalfFloat: A 16-bit floating point number to describe distance (see Section 5.1.1).

n. UTF8String: A text string using variable length coding for each character according to the Unicode specification. UTF-8 coding is backwards compatible with single-byte coding of ISO/IEC 646 (ASCII) characters.

o. AutoFocusSensingAreaSettingType: 1-byte value to describe the automatic focusing (AF) sensing area (see Section 5.4.3).

p. ColorCorrectionFilterWheelSettingType: 1-byte value to describe the characteristics of the optical color compensation (CC) filter (see Section 5.4.4).

q. ImageSensorReadoutModeType: 1-byte value to describe the signal reading method from the image sensor (see Section 5.4.10).

r. AutoWhiteBalanceModeType: 1-byte value to describe the mode of the automatically adjusted white balance (see Section 5.4.19).

s. LuminanceCodeRangeType: 1-byte value to describe the luminance data code range (see Section 5.4.28).

3. “Len” is the length of the value field of the item.

4. “Local Tag” is the identifier for each item in the Set.

5. “Req?” is used to indicate whether the item in the Set is ‘required’ [Req] or ‘optional’ [Opt].

6. “Meaning” is used to give a human-readable description of the item.

4.4 Extending the Acquisition Metadata Sets

The Acquisition Metadata Sets may be extended with new Sets that share the characteristics of acquisition processing.

The Set version number described in byte 14 of the Set UL shall be incremented when the revision of an item results in incompatibility, e.g. changing the data type and/or increasing maximum string length.

4.5 Basic Set Rules

The following statements describe the common aspects for each data item in all Sets:

- The data is just a control function value corresponding to a setting or configuration in the acquisition device. For example, the Focus Position value is represented by the position of the focus ring and is not the measure of the actual focusing distance or the absolute distance to the object.
- Accuracy of the data value is not within the scope of this document.
- Synchronization with the video should be within a frame period.

5 Acquisition Metadata Definitions

This section defines the Acquisition Metadata items.

5.1 Lens Serial Data Format

The following formats are compatible with the industry practice known as the "Lens Serial" format which is supported by several major camera manufacturers, and based on SMPTE RP 215:2009 Section 5.5.

5.1.1 Common Distance Format

The Common Distance Format is used to describe a spatial length (in meters) using a 16-bit floating point value. The data type of this format is defined as LensSerialHalfFloat.

$$\text{distance} = \text{m} \times 10^{\text{e}} \text{ [meters], where:}$$

- “e” is the exponent in 2's complement form and is the upper 4 bits of the 16 bits. “e” represents −8 to 7.
- ”m” is the unsigned mantissa, and is the lower 12 bits of the 16 bits. “m” represents 0 to 4095.
- Using the above method of representation, multiple expressions could indicate a particular distance. The expression with the maximum value of mantissa should be used.

5.1.2 Common Lens Iris Format

The Common Lens Iris Format is used to describe an F-number (focal ratio) using a 16-bit unsigned integer.

$$\text{iris} = 2^{8\times\left(1-\frac{\text{Value}}{10000\text{h}}\right)}$$

Accordingly, the value in the file is calculated with the reverse function:

$$\text{Value} = 10000\text{h} \times \left(1 - \frac{\log_2 \text{iris}}{8}\right)$$

- This representation allows only F-numbers that are greater than (and not equal to) F1.0.
- The equation above implies that opening the iris by one stop (+1 EV [exposure value], e.g. 8 to 5.6) results in an increase in value of 1000h (i.e. 4096) such that, for example, A000h represents F8, B000h represents F5.6, E000h represents F2 and F000h represents F1.4. Values from 0000h to 6000h represent “Closed”.

5.2 Instance UID

The Instance UID value is a unique value that can be used to identify a given instance of the data set. All Instance UID of given instances of the Sets on the signal interface are different.

This item is used within MXF Header Metadata, and is not described in the essence container.

5.3 Items of Lens Unit Metadata Set

5.3.1 Iris F-Number

This item represents the iris position of the lens as a value calculated from the “F-number” according to the Common Lens Iris Format (per Section 5.1.2). The value is a 16-bit unsigned integer and is dimensionless.

The F-number (F) is a measure of the amount of light transmitted through the lens. It is the focal length divided by the "effective" aperture diameter and is given by

$F = \frac{f}{D}$, where *f* is the focal length of a lens, and *D* is the effective lens diameter.

Note: The iris position represents the setting of the iris ring on the lens without taking the optical limitation known as "F-drop" into consideration. This is commonly known as the "F-number".

5.3.2 Iris T-Number

This item represents the iris position of the lens as a value calculated from the “T-number” according to the Common Lens Iris Format (per Section 5.1.2). The value is a 16-bit unsigned integer and is dimensionless.

The T-number (T) is a measure of the amount of light transmitted through the lens in practice and is given by

$T = \frac{F}{\sqrt{t}}$, where *t* is the transmittance of the lens, and *F* is the F-number defined in Section 5.3.1.

5.3.3 Iris Ring Position

This item represents the rotational position of the lens iris ring.

This value is set by a lens controller and forms the "Iris Ring Position" metadata item.

This value has no units and is expressed as a 16-bit unsigned integer. 0000h represents a fully open iris, FFFFh a closed (or narrowest possible) iris. Intermediate values are proportional to the angle of rotation between the minimum and maximum angles, scaled between 0000h and FFFFh.

5.3.4 Focus Position items

These items, i.e. Focus Position From Image Plane item and Focus Position From Front Lens Vertex item, represent the values of the focus position of the lens, in meters, using the Common Distance Format (per Section 5.1.1). Each value is a 16-bit floating point number in LensSerialHalfFloat type.

The Focus Position From Image Plane item indicates the distance between the image plane (which is on the optical axis) and the object placed centrally in front of the lens when the center of the image is in focus.

The Focus Position From Front Lens Vertex item indicates the distance between the front of the lens and the object placed centrally in front of the lens when the center of the image is in focus.

Notes:

1. The focus position value can be, for example, derived from the setting of the focus ring on the lens.
2. If both of the Focus Position From Image Plane and the Focus Position From Front Lens Vertex items are recorded, priority is given to the Focus Position From Image Plane item.

5.3.5 Focus Ring Positions

This item represents the rotational position of the lens focus ring.

This value is set by a lens controller and forms the "Focus Ring Position" metadata item.

This value has no units and is expressed as a 16-bit unsigned integer. 0000h represents the minimum focus distance, FFFFh represents focusing at infinity. Intermediate values are proportional to the angle of rotation between the minimum and maximum angles, scaled between 0000h and FFFFh.

5.3.6 Macro Setting

This item is a Boolean item whose value is non-zero (TRUE) if the macro setting is ON, or zero (FALSE) if the macro setting is OFF.

This item indicates the capability of the lens macro function for close-up work with a limited focal range and can be generated by a macro on/off switch or by the zoom ring position. When the switch is ON, the value is true even if the focusing distance is long-range or infinity.

5.3.7 Lens Zoom items

These items, i.e. Lens Zoom Actual Focal Length item and Lens Zoom 35mm Still Camera Equivalent item, represent the focal length (zoom position) of the lens, in meters, using the Common Distance Format (see Section 5.1.1). Each value is a 16-bit floating point number in LensSerialHalfFloat type.

The Lens Zoom Actual Focal Length implies the "effective focal length" considering the focal point on the image plane side. The value may be calculated by the angle of the zoom ring on the lens.

The Lens Zoom 35mm Still Camera Equivalent is normalized to the 35-mm still camera equivalent value. The actual focal length multiplied by the crop factor is the 35-mm equivalent value, where the crop factor is calculated as follows:

$$\text{crop factor} = \frac{\text{effective diagonal of a 35-mm film image area}}{\text{effective diagonal of the image sensor}}$$

The diagonal of the 24 mm by 36 mm image area of a standard 35-mm film still camera is 43.267 mm.

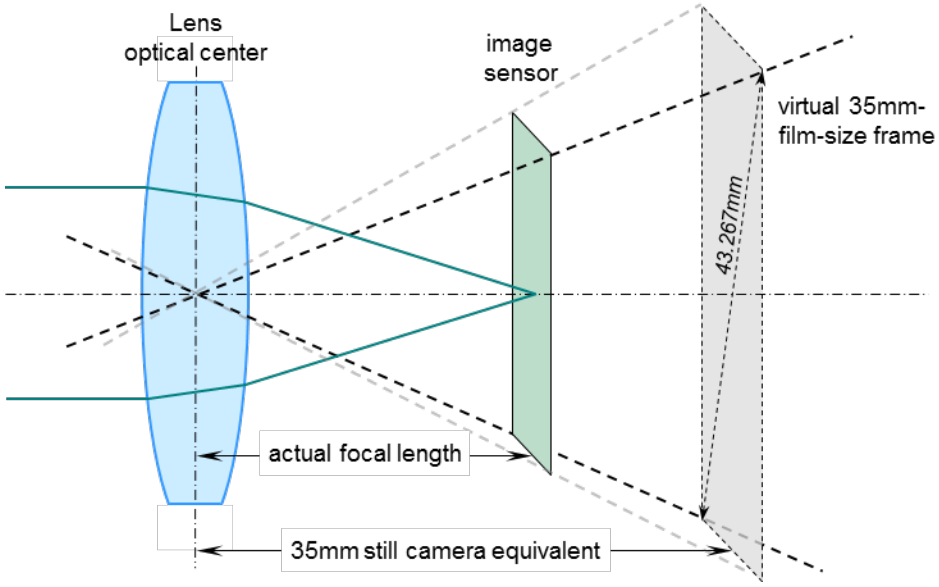

Figure 1 – Lens Zoom

The magnification ratio of any conversion lens or of any optical extender is ignored.

Notes:

1. This 35-mm still camera equivalent value is usually used to calculate the angle of view.
2. If both of the Lens Zoom Actual Focal Length and the Lens Zoom 35mm Still Camera Equivalent items are recorded, priority is given to the Lens Zoom 35mm Still Camera Equivalent item.

5.3.8 Zoom Ring Positions

This item represents the rotational position of the lens zoom ring.

This value is set by a lens controller and forms the "Zoom Ring Position" metadata item.

This value has no units and is expressed as a 16-bit unsigned integer. 0000h represents the wide end of the zoom, FFFFh represents the tele end. Intermediate values are proportional to the angle of rotation between the minimum and maximum angles, scaled between 0000h and FFFFh.

5.3.9 Anamorphic Lens Squeeze Ratio

This item represents the optical-squeezing ratio with a special lens system, e.g. using cylindrical lens, for widescreen movies. The value is an 8-bit unsigned integer in percent. For example, the value 200 represents the “200%” Anamorphic Lens, i.e. also indicated “2x”, and 100 represents normal (using spherical lens).

Notes:

1. This value is equivalent to the pixel aspect ratio of the captured picture (where using square-pixel image sensor).
2. The screen aspect ratio is not decided by this item. Effective area of the image might be designated by other metadata or system settings.

5.3.10 Optical Inversion

This item represents upside-down and/or right-side-left imaging depending on the lens system.

The data type of this value is ScanningDirectionType (see 5.4.12), and the code value 0 (normal) is for ordinary lens systems.

Note: In the absence of other metadata describing the camera posture, this item can be used for inversions of other mirrors or prisms on the rig.

5.3.11 Optical Extender Magnification

This item represents the magnification ratio of the optical extender as a percentage value where 100% is a magnification ratio of 1.

The value is an unsigned 16-bit integer and the MSB is set to 0.

The item is expressed as a nominal value, which represents the magnification ratio at the central point of the image.

This function may be served by a lens built-in Extender, an optional Extender Lens unit, a Close-Up Lens unit or a Wide/Tele Conversion Lens unit. The data may be automatically or manually set. When two or more lenses are attached, the data should be the product of their magnification ratio. If all these functions are inactive or unavailable, the value is set to 100 (64h).

5.3.12 Lens Attributes

This item is a human-readable text description, e.g. model name, of the lens unit in use. The data type of the text is UTF8String, and the length is less than 64 bytes.

5.4 Items of Camera Unit Metadata Set

5.4.1 Auto Exposure Mode

This item identifies the automatic exposure (AE) function by a SMPTE Label value.

The SMPTE Label values are defined in Table 5.

When the exposure is controlled by a camera specific method (so called "program AE"), other SMPTE label values may be used, including class 14 label values.

The evaluation area of the captured image, the response and transition to a change of brightness, and the controlling algorithm are not included in the scope of this function.

When the automatic control is inactive, the SMPTE Label value is set to the manual exposure mode.

Table 5 – AE Mode Label Values

Name	UL	Description
Manual Exposure mode	06.0E.2B.34.04.01.01.0B. 05.10.01.01.01.01.00.00	Fully manual exposure control
Full Auto Exposure mode	06.0E.2B.34.04.01.01.0B. 05.10.01.01.01.02.00.00	All available camera facilities are used for exposure control
Gain Priority Auto Exposure mode	06.0E.2B.34.04.01.01.0B. 05.10.01.01.01.03.00.00	The gain control was set to manual exposure control
Iris Priority Auto Exposure mode	06.0E.2B.34.04.01.01.0B. 05.10.01.01.01.04.00.00	The iris control was set to manual exposure control. This is widely known as ‘aperture priority’.
Shutter Priority Auto Exposure mode	06.0E.2B.34.04.01.01.0B. 05.10.01.01.01.05.00.00	The shutter speed was set to manual exposure control. This is widely known as ‘shutter priority’.
Camera specific control mode	06.0E.2B.34.04.01.01.vv. 0E.xx.xx.xx.xx.xx.xx.xx	SMPTE class 14 Labels for manufacturer private

Notes:

1. Although several components (i.e. iris, shutter or gain of the amplifier) affect the exposure, the camera operator can manually fix each component in AE operation. For this reason, the AE mode label value identifies which component is manual.
2. SMPTE Label values are registered in SMPTE Labels Register. The values of the second 8-byte group for each entry in Table 5 are structured as follows:

   Byte 9: 05 (Process)
   Byte 10: 10 (Settings)
   Byte 11: 01 (Device Settings)
   Byte 12: 01 (Camera Settings)
   Byte 13: 01 (Exposure Settings)
   Byte 14: 01 to 05 (per Table 5)

5.4.2 Exposure Index of Photo Meter items

These items, i.e. Exposure Index of Photo Meter item and Exposure Index of Photo Meter in Long Integer item, represent the applied index of the light meter in terms of an ISO number (refer to Section 5.4.16).

The values are 16-bit and 32-bit integer for Exposure Index of Photo Meter and Exposure Index of Photo Meter in Long Integer items, respectively. The 32-bit item is used for a camera offering high sensitivity mode. When the 16-bit item is described, and the ISO number is greater than 32000, the value should be set to a number meaning overflow, i.e. 65535 or 32767.

Note: These items are referred to by a push/pull process in post production. If the value is different from the ISO Sensitivity of the camera, pull or push processing will be needed during post production.

5.4.3 Auto Focus Sensing Area Setting

This item is an AutoFocusSensingAreaSettingType code value to indicate the automatic focusing (AF) sensing area. The type is an enumeration of base type UInt8, and the permitted code values are listed in Table 6.

These values are used to evaluate the area of the image for distance measurement.

The response and transition to a moving object, including any wobbling rate and depth, assistance from other measurement methods or any controlling algorithm is not included in the scope of this definition.

When any automatic control is inactive, the value is set to the code for the Manual Focus mode.

Table 6 – Auto Focus Sensing Area Setting Code List

Name	Code (hex)	Description
Manual Focus mode	00h	The focus was manually set
Center Sensitive Auto Focus mode	01h	The focus was at the center of the frame
Full Screen Sensing Auto Focus mode	02h	The focus was set for the whole screen

Multi Spot Sensing Auto Focus mode	03h	The focus was set using multiple spot sensing
Single Spot Sensing Auto Focus mode	04h	The focus was set at a spot located adaptively or by the user
Reserved	05h–FEh	Reserved
Undefined	FFh	Undefined

5.4.4 Color Correction Filter Wheel Setting

This item represents the characteristics of the built-in optical color compensation (CC) filter as a ColorCorrectionFilterWheelSettingType code value. The type is an enumeration of base type UInt8, and the permitted code values are listed in Table 7.

Table 7 – Color Correction Filter Wheel Setting Code List

Name	Code (hex)	Description
Cross effect filter	00h	Transparent filter with meshed groove for cross effect
CC filter 3200K	01h	Transparent filter for 3200K lighting
CC filter 4300K	02h	Light yellow filter for 4300K lighting
CC filter 6300K	03h	Pale orange filter for 6300K lighting
CC filter 5600K	04h	Pale orange filter for 5600K lighting
Reserved	05h–FEh	Reserved
Undefined	FFh	Undefined

Notes:

1. This item should be omitted from the metadata set if the camera is not equipped with a built-in CC filter wheel.
2. This item does not represent any pseudo-CC-filter code which is not an optical effect (i.e. an electrical color compensation function). In such cases, the White Balance item (Section 5.4.20) can be used.

5.4.5 Neutral Density Filter Wheel Setting

This item describes the attenuation ratio of the built-in optical neutral density (ND) filter (i.e. flat gray filter). It represents the reciprocal number of the attenuation ratio (i.e. the denominator of the attenuation ratio of the filter where the numerator is 1). The value is an unsigned 16-bit integer as follows.

Attenuation ratio = 1 / Value

Notes:

1. For example, the ND Filter Value of 32 is identified as "ND32" whose attenuation ratio is 1/32. In general, the value is expressed as a power of two. The data can be set automatically by any built-in ND filter.
2. This item is not intended for any "ND filter" which uses gradation or color tone for artistic effect.

5.4.6 Rotary Shutter

This item is a Boolean item whose value is non-zero (TRUE) if the mechanical shutter is effective, or zero (FALSE) if the mechanical shutter is not used.

Note that the shutter time is described in "Shutter Time" items as actual exposure time with electrical shutter.

5.4.7 Optical Anti-Aliasing Filter

This item represents the roll-off frequency of the optical anti-aliasing filter placed before the image plane.

The percentage of pixel Nyquist frequency is described in an 8-bit unsigned integer. So the value less than 100 denotes sub-Nyquist, i.e. a blurring filter may be used in decimated sampling. The value 255 means thru filter, i.e. transparent.

5.4.8 Image Sensor Dimension items

These items (Image Sensor Dimension Effective Width and Image Sensor Dimension Effective Height) represent the width and height of the rectangular area of the image sensor in micrometers and are expressed as unsigned 16-bit integers.

The rectangular area on the image sensor corresponds to the displaying video frame. For MXF file, the frame is described as Display Width and Display Height of Picture Descriptor set in Header Metadata as a rule. However, for letterbox and/or pillar-box conversion, the dimensions are not recalculated, and do not correspond to Display Width and Height. In such cases, Active Width and Active Height, if present, show the rectangular area that corresponds to the Image Sensor Dimension items.

Note: Since values depend on the video output image, the dimensions vary according to the selected aspect ratio. For example, when an image sensor has the effective area of 10 mm × 5.6 mm (16:9) and the output image is edge cropped to 4:3, the Image Sensor Dimension values are 7467 for width and 5600 for height.

5.4.9 Capture Frame Rate

This item represents the rate at which video images are captured, expressed in frames per second.

The Capture Frame Rate value is a 64-bit rational (ratio of two 32-bit signed integer, the first is the numerator and the second is the denominator).

The denominator value is a constant value throughout capture.

The numerator value should be less than 32768 and the value may vary during capture.

Both the denominator and numerator are positive.

Note: This item can be used to describe over/under-cranking to create slow/quick motion.

5.4.10 Image Sensor Readout Mode

This item is an ImageSensorReadoutModeType code which identifies the method of reading the sensor signals from the image sensor pixels.

The type is an enumeration of base type UInt8, and the permitted code values are assigned as defined in Table 8 (see also Figure 2).

Table 8 – Image Sensor Readout Mode Code List

Name	Code (hex)	Description
Interlaced field	00h	Interlaced scan (average of two lines)
Interlaced frame	01h	Interlaced scan (line alternation)
Progressive frame	02h	Progressive scan
Reserved	03h–FEh	Reserved
Undefined	FFh	Undefined method

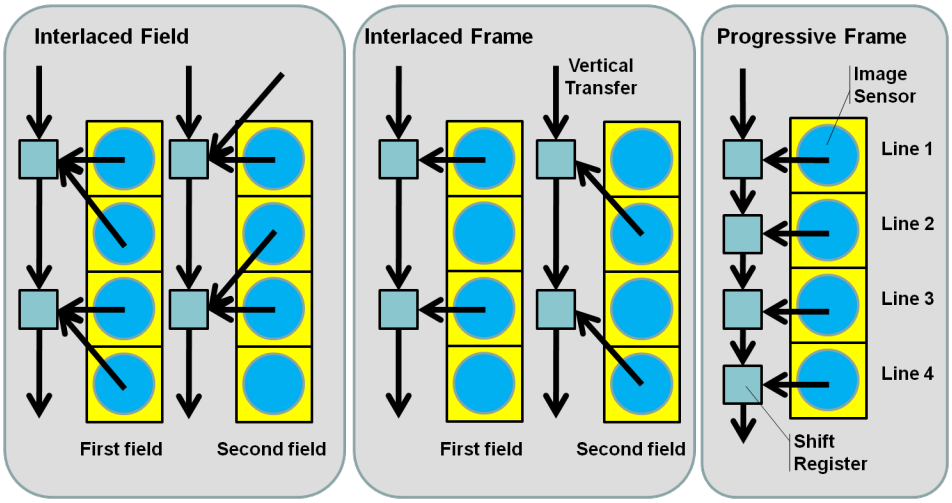

Figure 2 – Imager readout mode (e.g. CCD)

Note: This metadata identifies the effective exposure period of each line of pixels of the video signal output from the image sensor. If the video is scan-converted within the camera unit, the code value is determined according to the method of conversion.

5.4.11 Image Sensor Decimation Ratio

This item represents the vertical and horizontal decimation ratio of the reading out of pixels on the image sensor, mainly used for high-speed capturing.

The value is an 8-bit unsigned integer which consists of the vertical decimation pitch on upper nibble and the horizontal decimation pitch on lower nibble, and zero exceptionally indicates cropping. Thus each nibble denotes: 0 for partial-scan (cropping outer side), 1 for normal scan, 2 for interleaving, and 3 for one-out-of-three. So, 11h means normal (full-pixel scan), and 22h implies proportional half size (1/4 pixels).

5.4.12 Image Scan Direction

This item represents the direction of scanning for line/point-symmetric picture transformation.

The data type of this value is ScanningDirectionType defined for "Scanning Direction" in SMPTE ST 377-1. For example, the code values 0, 1, 2, and 3 are used for normal images, horizontal mirror images, vertical mirror images, and 180-degree rotated images, respectively.

5.4.13 Shutter Speed (Angle)

This item represents the exposure period, expressed as an angle [minutes] (i.e. 1/60 degree).

This value is a 32-bit unsigned integer where the value is the angle in minutes and is set to 21600 (360 × 60 = 5460h) where 21600 minutes represent a field/frame period.

Notes:

1. This function can also be used for slow shutter mode operation. For example, when the image sensor charges for 2 frame periods, the angle will be 43200 minutes (resulting in a value of 0000A8C0h).
   When the shutter effect is not used, this is the equivalent to 360 degrees resulting in a value of 21600 minutes. Otherwise, i.e. when an electrical and/or mechanical shutter is used, the actual exposure period is described.
2. If both of the Shutter Speed (Angle) and the Shutter Speed (Time) items are recorded, priority is given to the Shutter Speed (Angle) item.

5.4.14 Shutter Speed (Time)

This item represents the exposure period in seconds.

This value is a 64-bit rational (ratio of two 32-bit signed integer, the first is the numerator and the second is the denominator) that defines the shutter speed time expressed in seconds.

Both the denominator and numerator are positive.

Notes:

1. For example, 1/1000 would define a shutter speed of 1 msec.
2. This function can also be used for slow shutter mode operation. For example, when the image sensor charges for 2 frame periods in a 24-frame system, i.e. 2/24 seconds, the value is 0000000200000018h

5.4.15 Camera Master Gain Adjustment

This item represents the adjustment level of the master gain control, fed in increments of 0.01 decibel. The gain value implies a gain for each RGB signal.

This value is a 16-bit signed integer. When this function is inactive, the value is set to 0.

Note: For example, when a head-amplifier boosts the camera signal by +12 dB, the value is set to 1200 (4B0h).

5.4.16 ISO Sensitivity items

These items, i.e. ISO Sensitivity item and ISO Sensitivity in Long Integer item, represent the sensitivity of the camera unit to light in terms of an ISO number.

The values are 16-bit and 32-bit integer for ISO Sensitivity and ISO Sensitivity in Long Integer items, respectively. The 32-bit item is used for a camera offering high sensitivity mode. When the 16-bit item is described, and the ISO number is greater than 32000, the value should be set to a number meaning overflow, i.e. 65535 or 32767.

Each value (i.e. the ISO number) is calibrated in accordance with the exposure index defined in ISO 12232:2006 and is measured under the test conditions described in ISO 12232 except for "photosite integration time" which depends on the video rate. The range of possible values is continuous, unlike the discrete values (e.g., 100, 125, 160, 200, etc.) defined for still cameras in ISO 12232.

Note: These items do not specify the performance of the image sensor device, but it is a parameter to determine the exposure during acquisition. Therefore, although the ISO number is initially adjusted to an appropriate setting as made available by the camera manufacturer, the actual value will in practice fluctuate depending on the Master Gain or other settings.

5.4.17 Color Matrix

This item represents the matrix applied between the R, G, B channels.

Compensation of a color filter of an image sensor according to the color matrix should be applied prior to gamma encoding.

The Color Matrix item is a 9 elements ordered Array of 64-bit rational (ratio of two 32-bit signed integer, the first is the numerator and the second is the denominator) containing the following values (see Table 9):

Table 9 – Structure of Color Matrix

Name	Type	Len	Description
Number of elements	UInt32	4	9
Length of each element	UInt32	4	8
R to R	Rational	8	Amount of Red channel into Red Channel
G to R	Rational	8	Amount of Green channel into Red Channel

B to R	Rational	8	Amount of Blue channel into Red Channel
R to G	Rational	8	Amount of Red channel into Green Channel
G to G	Rational	8	Amount of Green channel into Green Channel
B to G	Rational	8	Amount of Blue channel into Green Channel
R to B	Rational	8	Amount of Red channel into Blue Channel
G to B	Rational	8	Amount of Green channel into Blue Channel
B to B	Rational	8	Amount of Blue channel into Blue Channel

5.4.18 Electrical Extender Magnification

This item represents the ratio of the electrical extender magnification, expressed as a percentage value where 100% is a magnification ratio of 1.

The percentage value is an unsigned 16-bit integer and the MSB is set to 0.

Since this item is for simple picture magnification, it does not separately specify the position of the close up. The center of the resized picture should be considered the same as the captured picture. This item is not intended for any special effects such as partial screen zooming, i.e. distorting picture or superimposing sub screen, but for full screen zooming.

When this function is inactive, the value is set to 100 (64h).

5.4.19 Auto White Balance Mode

This item represents the mode of the automatically adjusted white balance as an AutoWhiteBalanceModeType code value.

The type is an enumeration of base type UInt8, and the permitted code values are as enumerated in Table 10.

Table 10 – Auto White Balance Mode Code List

Name	Code (hex)	Description
Preset White Balance Setup	00h	The WB is set to a fixed value
Automatic White Balance Setup	01h	The WB value is continuously adjusted automatically
Hold White Balance Setup	02h	The current WB value is held. This mode is usually triggered manually during the automatic WB mode.
One Push White Balance Setup	03h	Rapid adjustment to an automatically determined WB value. This mode is usually triggered manually during the preset WB mode or the automatic WB mode.
Reserved	04h–FEh	Reserved values
Undefined	FFh	Undefined

Notes:

1. This function is not used to define a target color tone. The evaluation area of the image, the response and transition against the change of light and the controlling algorithm are considered out of scope for this definition.
2. When the automatic white balance mode control is inactive, the value is set to the ‘Preset White Balance’ code.

5.4.20 White Balance

This item represents the white balance, expressed as a color temperature [Kelvin].

The value is an unsigned 16-bit integer and the MSB is set to 0.

This function is implemented by electrical or optical filters inside the camera unit.

Notes:

1. This value does not imply the actual color temperature of the light source.
2. The WB color temperature has a spectral power distribution curve that is a close approximation to that of black body radiation calculated by Planck's law.

5.4.21 Tint Correction

This item represents the level of color correction along a Constant CCT (correlated color temperature) line, i.e. orthogonal to Planckian locus on CIE 1960 UCS (uniform chromaticity space), in other words, deviation from the color-temperature point along the isotemperature line on a ***uv*** chromaticity diagram (Figure 3).

The value is a signed 16-bit integer, and the unit is 0.00001 (10ppm) of Δ***uv***.

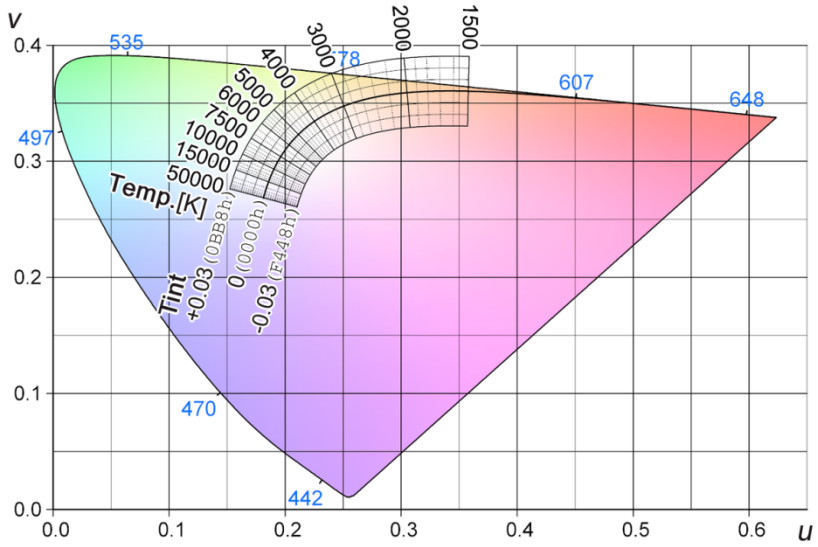

Figure 3 – Color Temperature and Tint Correction

Note that the value could be beyond the boundaries of CCT, i.e. Δ***uv***=±0.02 (some say ±0.05).

5.4.22 Camera Master Black Level

This item represents the master black level setting of the camera.

The value is a signed 16-bit integer.

The value is the difference between the camera output black level and the input black level in units of 0.1 percent where 100 percent means white.

When this function is inactive, the value is set to 0.

Note: A positive value means that the black level is shifted upwards to brighten the picture. The contrast of picture will be modified by this control in order to maintain a stable white level.

5.4.23 Knee Function

Video cameras typically ameliorate their sensor's harsh clipping with a knee function which allows compression of the upper portion of the dynamic range. The compression characteristic of the knee function is described

with two parameters: Knee Point and Knee Slope. When this function is inactive, the Knee Slope value is set to 1/1.

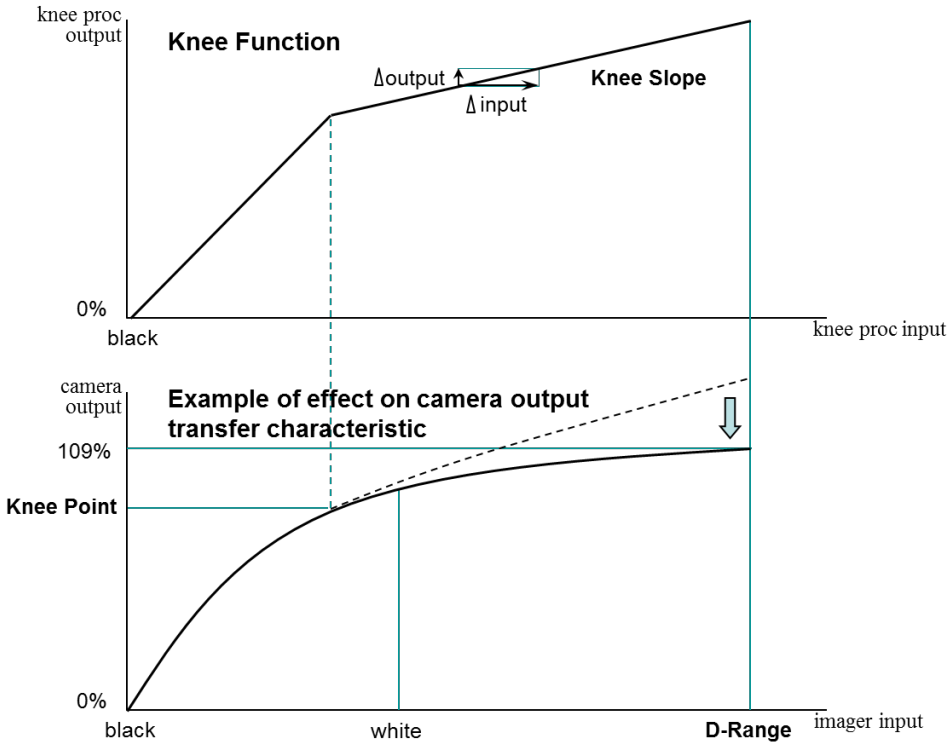

Figure 4 – Knee and Dynamic Range

5.4.23.1 Camera Knee Point

This item represents the knee point of the camera knee characteristic (see Figure 4) expressed as the luminance level at which dynamic range compression starts to flatten the contrast curve.

The Knee Point value increment is in units of 0.1 percent and the value is an unsigned 16-bit integer.

5.4.23.2 Camera Knee Slope

This item represents the degree of dynamic range compression applied to the signal from the camera imager, expressed as the slope of the line shown in Figure 4 (a) starting at the Knee Point.

$$\text{KneeSlope} = \frac{\Delta\text{output}}{\Delta\text{input}}$$

The value is a 64-bit rational (ratio of two 32-bit signed integer, the first is the numerator and the second is the denominator).

Both the denominator and numerator are positive.

The slope of the bottom line (between black level and the Knee Point) is one, i.e. no transformation.

5.4.24 Camera Luminance Dynamic Range

This item represents the peak signal level that the camera image sensor would deliver in the absence of any signal compression that may be applied through the knee characteristics described above. The value is expressed in units of 0.1 percent and is represented as a 16-bit unsigned integer to allow large headroom for peak signal levels at the camera sensor (see Figure 4).

5.4.25 Capture Gamma Equation

This item represents the camera capture gamma value as a 16-byte SMPTE Label. The Label values of representative gamma types are listed in Table 11.

When a camera-specific gamma curve is required, a private label registered by an organization (i.e. Class 14) may be used. The label also defines the base format, e.g. ITU-R BT.709, to indicate the display specifications.

Note: The signal processor compensates for the distortion of the image sensor. Since this item indicates the basic gamma curve, the value is not affected by the other non-linear level conversion functions (i.e. knee control, black gamma, solarization reduction, etc.).

Table 11 – Representative Gamma Type Label list (informative)

Transfer Characteristics Name	UL	Description
ITU-R BT.709	06.0E.2B.34.04.01.01.01.04.01.01.01.01.02.00.00	
SMPTE ST 240	06.0E.2B.34.04.01.01.01.04.01.01.01.01.03.00.00	
Scene Linear	06.0E.2B.34.04.01.01.06.04.01.01.01.01.06.00.00	
IEC 61966-2-4 xvYCC	06.0E.2B.34.04.01.01.0D.04.01.01.01.01.08.00.00	
ITU-R BT.2020	06.0E.2B.34.04.01.01.0E.04.01.01.01.01.09.00.00	
ITU-R BT.2100 Hybrid Log-Gamma	06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0B.00.00	
Camera Log S3	06.0E.2B.34.04.01.01.0D.04.01.01.01.01.0E.00.00	Refer to SMPTE ST 2115.
Sony S-Log	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.01.05.01	Sony private
Sony S-Log2	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.01.05.08	Sony private
Sony S-Log3	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.01.06.04	Sony private. Equivalent to Camera Log S3.
Sony S-Log3.Cine	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.01.06.05	Sony private. See below.
Preset specific gamma curve	06.0E.2B.34.04.01.01.vv.0E.xx.xx.xx.xx.xx.xx.xx	Class 14 labels for manufacturer private use

"Sony S-Log3.Cine" is used instead of "Sony S-Log3", only in the case of combining with S-Gamut3.Cine as the color primaries.

5.4.26 Capture Color Primaries

This item represents the camera-capture color-specification type as a 16-byte SMPTE Label. The Label values of representative color primaries type are listed in Table 12.

Since this type is normally determined by transfer characteristics type (gamma label), this item should be described when an irregular or special color primaries type is applied, or explicit description is needed.

When a camera-specific color type is required, a private label registered by an organization (i.e. Class 14) may be used. The label also defines the base format, e.g. ITU-R BT.709, to indicate the display specifications.

Table 12 – Representative Color Primaries Type Label list (informative)

Color Primaries Name	UL	Description
Default	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.03.7F.00	determind by the Gamma
ITU-R BT.709	06.0E.2B.34.04.01.01.06.04.01.01.01.03.03.00.00	
ITU-R BT.2020	06.0E.2B.34.04.01.01.0D.04.01.01.01.03.04.00.00	
Sony S-Gamut	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.03.01.03	Sony private
Camera Gamut S3	06.0E.2B.34.04.01.01.0D.04.01.01.01.03.0B.00.00	Refer to SMPTE ST 2115.
Camera Gamut SC	06.0E.2B.34.04.01.01.0D.04.01.01.01.03.0C.00.00	Refer to SMPTE ST 2115.
IMF P3D65	06.0E.2B.34.04.01.01.0D.04.01.01.01.03.06.00.00	SMPTE ST 2067-21
Sony S-Gamut	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.03.01.03	Sony private

Sony S-Gamut3	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.03.01.04	Sony private. Equivalent to Camera Gamut S3.
Sony S-Gamut3.Cine	06.0E.2B.34.04.01.01.06.0E.06.04.01.01.03.01.05	Sony private. Equivalent to Camera Gamut SC.
Preset specific color primaries	06.0E.2B.34.04.01.01.vv.0E.xx.xx.xx.xx.xx.xx.xx	Class 14 labels for manufacturer private use

5.4.27 Coding Equations

This item represents the coding equations type, i.e. color-difference matrix, as a 16-byte SMPTE Label. Since this type is normally determined by the video-scanning format and the transfer characteristics type (gamma label), this item should be described when an irregular matrix is applied, or explicit description is needed.

5.4.28 Luminance Code Range

This item represents the available data range and the preservation of the video data code as a LuminanceCodeRangeType code value.

The type is an enumeration of base type UInt8, and the permitted code values and meaning of this item are shown in Table 13.

Each value is defined such that it consists of the preservation type (bit 0), the code range type (bit 1 and 2), and higher reserved five bits filled by 0. When the bit 0 is set to zero, the code, e.g. logarithm encoded stream, shall be preserved until decoding, in other words, scale conversion and color correction are prohibited.

Table 13 – Luminance Code Range Code List

Value (hex)	Description	Available Code Range			Preservation	Examples
		8-bit	10-bit	12-bit		
00h	Unknown Code	unknown/undefined distribution			required	–
01h	Unknown Picture				no need	–
02h	Full-Scaled Code	0–255	0–1023	0–4095	required	S-Log series
03h	Full-Scaled Picture				no need	computer, still picture
04h	Reserved	–			–	–
05h	Normal Video	16–255	64–1023	256–4095	no need	R709 for broadcast
06h	Video Ranged Code	16–235	64–940	256–3760	required	some cinema log
07h	Limited Range Video				no need	HyperGamma 100%
08h–FFh	Reserved	–			–	–

For ordinary legal video, the default value is 05h (101b), because the brighter level beyond the reference white level is permitted. For S-Log series, 02h (010b) is used. For some types of log video that have been scaled to occupy the legal video range, 06h (110b) is used.

Note: Serial digital interfaces (SDI) reserve digital values for timing reference such that the permitted video range of the interface is narrower than the video range of the full-range signal.

5.4.29 Gamma for CDL

This item represents the gamma characteristics at the input of the CDL, i.e. called ICT (Input Conversion Transform). The value is described in an 8-bit code. Available code values are as enumerated in Table 14.

Table 14 – ASC CDL ICT Code List

Name	Code (hex)	Description
Content Video	00h	gamma not defined below, specified as Capture Gamma
Scene Linear	01h	proportional to the light level
S-Log	02h	Sony S-Log 800% D-Range (see Section 5.4.25)
Cine-Log	03h	generic logarithm gamma in cinema system
S-Log2	04h	Sony S-Log2 1300% D-Range (see Section 5.4.25)
R709 Video	05h	ITU-R Rec BT.709 (irrespective of high light range)
ACES Proxy	06h	An ACES Log approximation
S-Log3/S-Gamut3	07h	Sony S-Log3 with S-Gamut3 (see Section 5.4.25)
S-Log3/S-Gamut3.Cine	08h	Sony S-Log3 with S-Gamut3.Cine (see Section 5.4.25)
BT2020	09h	ITU-R Rec BT.2020
ST2084	0Ah	SMPTE ST 2084 Inverse EOTF
HybridLogGamma	0Bh	ITU-R Rec BT.2100 Hybrid Log-Gamma
Reserved	0Ch–FEh	Reserved
Undefined	FFh	Undefined

In some cases, Undefined (code FFh) implies that an alternative to "Gamma for CDL" is described as another metadata defined in other specifications.

5.4.30 Color for CDL

This item represents the color primaries part of ICT, Available code values are as enumerated in Table 15.

Table 15 – Color for CDL Code List

Name	Code (hex)	Description
Default	00h	Specified on "Gamma for CDL"
R709	01h	ITU-R Rec BT.709 Color Primaries
BT2020	02h	ITU-R Rec BT.2020 Color Primaries
S-Gamut	03h	Conventional Sony Gamut for S-Log
S-Gamut3	04h	Master-Grading Sony Gamut for S-Log3
S-Gamut3.Cine	05h	Monitoring-Use Sony Gamut for S-Log3
Reserved	06h	Reserved
ACES-AP0	07h	ACES RGB Color Primaries per SMPTE ST 2065-1
ACES-AP1	08h	ACESproxy Color Primaries
P3D65	09h	SMPTE ST 2067-21 COLOR.6
Reserved	0Ah–FEh	Reserved
Undefined	FFh	Undefined

In some cases, Undefined (code FFh) implies that an alternative to "Color for CDL" is described as another metadata defined in other specifications.

5.4.31 ASC CDL V1.2

This item represents ASC CDL V1.2. The V1.2 includes 10 items: Slope R, Slope G, Slope B, Offset R, Offset G, Offset B, Power R, Power G, Power B and Saturation. Each item is described in “ASC Color Decision List (ASC CDL) Transfer Functions and Interchange Syntax” instituted by American Society of Cinematographers.

The item type is HalfFloatArray, where HalfFloat is identical with the half precision binary floating-point (binary16) format defined in IEEE 754.

Table 16 – Structure of ASC CDL V1.2

Name	Type	Len	Description
Number of elements	UInt32	4	10
Length of each element	UInt32	4	2
Slope R	HalfFloat	2	ASC Slope Red Value
Slope G	HalfFloat	2	ASC Slope Green Value
Slope B	HalfFloat	2	ASC Slope Blue Value
Offset R	HalfFloat	2	ASC Offset Red Value
Offset G	HalfFloat	2	ASC Offset Green Value
Offset B	HalfFloat	2	ASC Offset Blue Value
Power R	HalfFloat	2	ASC Power Red Value
Power G	HalfFloat	2	ASC Power Green Value
Power B	HalfFloat	2	ASC Power Blue Value
Saturation	HalfFloat	2	ASC Saturation Value

5.4.32 Acquisition Setting Procedure

This item is a human-readable text description to retain a record of special and/or complex camera settings, i.e. difficult to represent by normalized values, codes or labels as for other items. For example, "adjust to the man in the shade, and close Iris 1 stop”, “use slightly SkinToneDetail to cover pores” or some set phrase. This explanation might be used when retaking the scene in the same condition, or for setting parameters in post-production process. The data type of the text is UTF8String, and the length is less than 64 bytes.

5.4.33 Camera Setting File URI

This item is used to identify the URI (Uniform Resource Identifier) of a file that defines the camera setting values as human-readable text in UTF8String type. The URI complies with IETF RFC 3986, except that the length is less than 64 bytes.

Note: UTF-8 may be used within a URI to represent characters outside the range of the US-ASCII coded character set. IETF RFC 3987 defines this method as a complement to the URI.

5.4.34 Camera Attributes

This item is a human-readable text description, e.g. model name, of the camera unit in use. The data type of the text is UTF8String, and the length is less than 64 bytes.

6 Carriage of the Acquisition Metadata Sets

Since each metadata set can be considered simply as a KLV coded set, there are several methods available to transport and store the data. Since the metadata sets carry time-sensitive metadata, the Acquisition Metadata Sets should be carried in frame synchronism with the associated video essence data. Unless otherwise specified, it is assumed that all Acquisition Metadata Sets are carried.

This section explains how the Acquisition Metadata Sets can be used in two different application areas — the ancillary data packets (ANC) on serial digital interfaces (SDI) and the MXF Generic Container (GC). Other methods of transport and storage can also be used where there is a provision for carrying KLV coded data.

6.1 Carriage in Vertical Ancillary Data Packets

SMPTE ST 291-1 defines an ancillary data packet. The Acquisition Metadata Sets can be carried in vertical ancillary space as type 2 data packets.

The type 2 data packet consists of the ancillary data flag (ADF), the data ID (DID), the secondary data ID (SDID), the data count (DC), the user data words (UDW), and the checksum (CS). The DID is set to the value 43h. The SDID is set to the value 05h. The ADF and CS are defined in SMPTE ST 291-1.

The first user word of the ancillary packet payload that follows the DC field defines a packet sequence count (PSC). This word forms a 8-bit PSC number that defines the number of ancillary packets with the same DID/SDID value necessary to carry the KLV encoded message (bit 7 of the word represents the MSB and bit 0 of the word represents the LSB of the PSC value).The PSC number is incremented by 1 with the value 1 assigned to the first ancillary packet containing the first part of consecutive Metadata sets of a frame.

The ancillary space packet UDW is a sequence of 10-bit words. The Acquisition Metadata Sets are transmitted in bits b7 through b0 of the 10-bit data word. Bit b8 is even parity for bits b7 through b0 of the 10-bit data word, and bit b9 equals not bit b8 (see Figure 5).

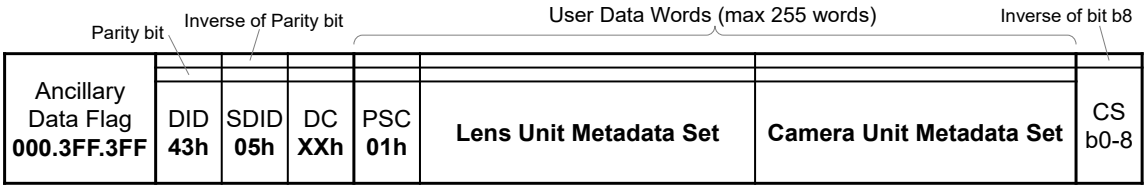

Figure 5 – Structure of an ANC Packet carrying the Acquisition Metadata Sets

The Acquisition Metadata Sets carried in the vertical ancillary space are typically encoded in the order described in this document. For example, the Lens Unit Metadata Set is encoded first in the data packet, followed by the Camera Unit Metadata Set and any User Defined Acquisition Metadata Set.

Figure 6 is an example of carriage of Acquisition Metadata Sets in multiple ancillary packets.

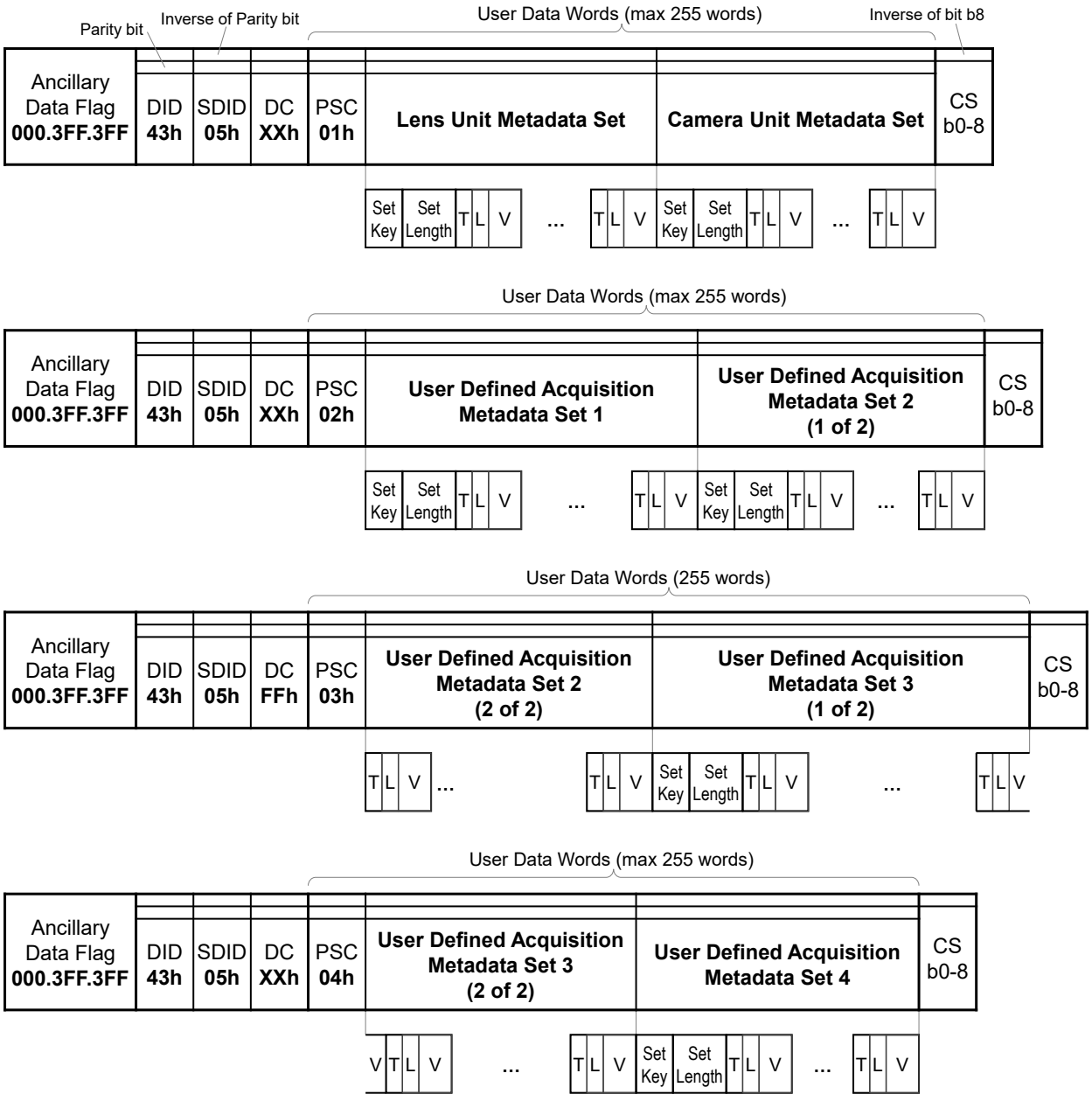

Figure 6 – Structure of multiple ANC Packets carrying the Acquisition Metadata Sets

This example illustrates the actual form of multiple packets:

- There are three ways of spanning packets as shown in the figure:
  - The end of first packet, the packet is terminated at the end of a Set (Camera Unit Metadata Set in here).
  - The end of second packet, a Set (User Defined Metadata Set 2 in here) is split at a boundary of Tag-Length-Value units.
  - The end of third packet, a Set (User Defined Metadata Set 3 in here) is split by the limitation of UDW size. Note that this method is not recommended because some decoders cannot accept this.

- The number of packets in a line shall not exceed seven, and the number of lines shall not exceed three. Therefore, the maximum number of packets in a frame is 21. However, the number of packets should be as few as possible. Note that some devices cannot handle more than four packets per line.
- When the ancillary packets on SDI are recorded into an MXF file as a Data Item as per SMPTE ST 436-1, the packets may be restructured.

6.2 Carriage in the MXF Generic Container

The MXF Generic Container (MXF GC) is defined in SMPTE ST 379-1 and ST 379-2. The KLV Acquisition Metadata Sets defined in this document can be carried in the MXF GC by application of the mapping specifications that allow System Item and/or Data Item to be mapped into the MXF GC. Note that the mapping of the metadata sets to an associated picture element is beyond the scope of this document.

6.2.1 Carriage in the MXF System Item

SMPTE ST 385 defines how the SDTI-CP System Item can be mapped to the MXF GC (CP-System Item). SMPTE ST 394 defines a superset of the System Item defined in SMPTE ST 385 (GC-System Item).

SMPTE ST 331 defines metadata packets that are intended for use in the System Item including a packet for the carriage of KLV metadata (SMPTE ST 331, Section 8.9 KLV metadata). The Acquisition Metadata Sets can be carried as metadata blocks in the Picture Metadata Set of the CP-System Item or the Picture Item Descriptor of the GC-System Item. Figure 7 shows how to convey two Acquisition Metadata Sets in the CP-System Item or the GC-System Item.

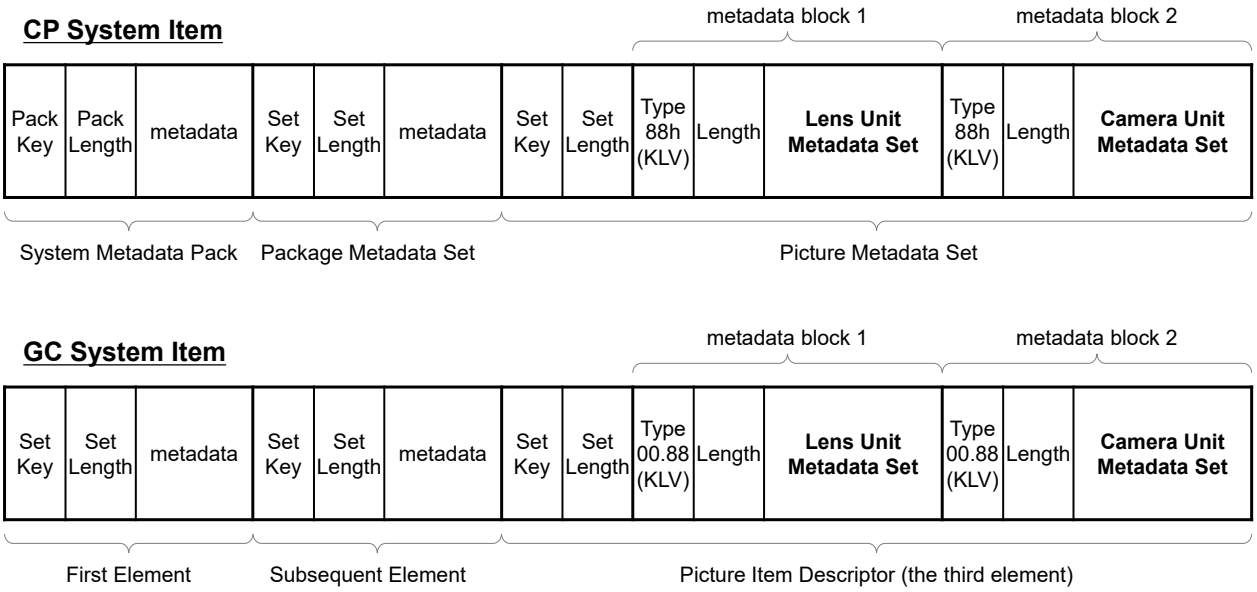

Figure 7 – Structure of System Items carrying the Acquisition Metadata Sets

CP-System Item Picture Metadata Set Key: 06.0E.2B.34.02.43.01.01.0D.01.03.01.04.01.03.xx

The 16th byte of the Picture Metadata Set Key represents the number of metadata blocks in this Set.

GC-System Item Picture Item Descriptor Key: 06.0E.2B.34.02.53.01.01.0D.01.03.01.14.02.03.yy

The 16th byte of the Picture Item Descriptor Key represents the element number (e.g. ‘02’ represents the number of the third element).

6.2.2 Carriage in the MXF Data Item

SMPTE ST 436-1 defines how the ANC Packet can be mapped to the MXF GC (Data Item).

The Acquisition Metadata Sets are carried as ANC packet payloads, and the MXF wrapped ANC packets defined in the standard are carried in a GC Data Item. As shown in Figure 8, an MXF wrapped ANC packet consists of parameters of the ANC packet on an SDI line, Array header, the ANC packet, and padding.

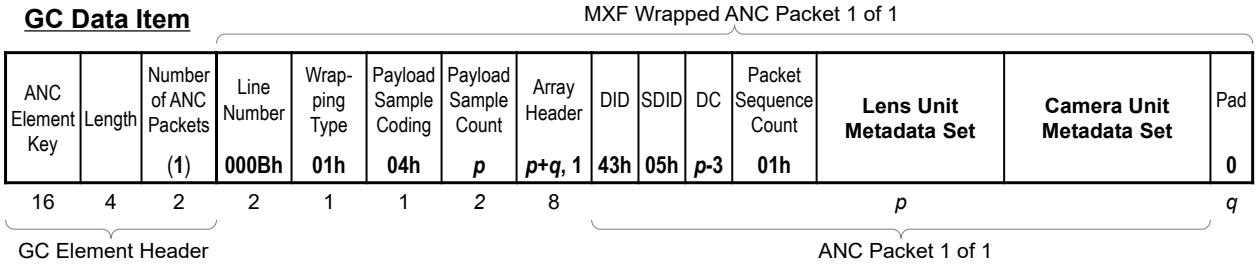

Figure 8 – Structure of a Data Item containing one ANC Packet

ANC Element Key: 06.0E.2B.34.01.02.01.01.0D.01.03.01.17.01.02.01

When metadata sets are distributed on multiple ANC packets, set the number of packets to Number of ANC Packets field, and describe the Line number of the second MXF wrapped ANC packet after the padding of the first packet. For example, the four ANC packets illustrated in Figure 6 are conveyed in sequence, set the Number of ANC Packets field to 4, and put four MXF wrapped ANC packets in that order.

The following are additional rules.

- The Data Item as per SMPTE ST 436-1 shall be placed after the audio-visual essences.
- Payload Sample Coding item shall be set to 04h, i.e. 8-bit luma component, and Line Number is 11 typically. In addition, the Line Number 9 is also used for the MPEG-4 SStP video stream.
- CS (Checksum word) should be omitted.
- Four-Byte Alignment type B.3 in SMPTE ST 436-1 Annex B should be used but also B.1 is permitted.
- When the System Item carries an Acquisition Metadata Set, the Data Item should not contain the Set in order to avoid duplication.

Annex A Bibliography (Informative)

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