| MISB MOTION IMAGERY STANDARDS BOARD<br>**STANDARD**<br><br>**Inserting Time Stamps and Metadata in High Definition Uncompressed Video** | **MISB STD 0605.3**<br><br>**9 June 2011** |
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# 1 Scope

This Standard defines methods to carry frame-accurate time stamps and metadata in the Key Length Value (KLV) format within the Vertical Ancillary Data Space (VANC) of SMPTE 292M (High Definition) 720p, and SMPTE 424M (3Gbps) 1080p frame formats.

# 2 Introduction

Uncompressed High Definition (HD) formats have the capability to carry large amounts of data in the Vertical Ancillary Data Space (VANC). In capturing and mapping metadata to the VANC it becomes possible to align a motion imagery frame with metadata specific to that frame. This assures that time stamping of both the motion imagery and the metadata can be done in a frame accurate way assuring both a deterministic relationship between the motion imagery and the metadata and optimal alignment of the two for further post processing.

**NOTE:** For time stamps to be completely meaningful they must be specified with known accuracy in relation to both the imagery point of capture and the metadata point of capture. The qualification of time stamps accuracy is not well characterized presently in the MISB standards, but it is a future objective of the MISB to provide such qualifications.

# 3 References


[1] SMPTE ST 291:2010 *Ancillary Data Packet and Space Formatting*

[2] SMPTE ST 292:2008 *Bit-Serial Digital Interface for High-Definition Television Systems*

[3] SMPTE ST 424:2006 *Television – 3 Gb/s Signal/Data Serial Interface*

[4] SMPTE RP 214:2002 – *Packing KLV Encoded Metadata and Data Essence into SMPTE 291M Ancillary Data Packets*

[5] SMPTE ST 352:2010 Television – Video Payload Identification for Digital Interfaces

[6] SMPTE ST 12-2:2008 Television – Transmission of Time Code in the Ancillary Data Space

[7] MISB STANDARD 0603.1 – *Time Stamping Digital Motion Imagery using Coordinated Universal Time (UTC)*, Jun 2011

[8] SMPTE ST 425:2008 Television – *3 Gb/s Signal/Data Serial Interface – Source Image Format Mapping*

[9] SMPTE ST 296:2001 *1280 x 720 Progressive Image Sample Structure – Analog and Digital Representation and Analog Interface*

[10] SMPTE ST 274:2008 *1920 x 1080 Scanning and Analog and Parallel Digital Interfaces for Multiple Picture Rates*

# 4 VANC KLV Encoding (Normative)

Within the standards for uncompressed video, two reserved non-picture spaces—collectively termed the ancillary space or ANC— where data may be carried are the Horizontal Ancillary (HANC) and the Vertical Ancillary (VANC) data spaces. In this Standard use of the Vertical Ancillary data space is used. Procedures and mechanisms to encode KLV metadata into the Vertical Ancillary Data Space (VANC) of an uncompressed high definition video frame are further outlined in this section.

## *4.1 Encoding of KLV Metadata into the VANC*

SMPTE 291M [1] specifies the format of ancillary (ANC) data packets residing in the ancillary space defined by the physical interface document—SMPTE 292M [2] for HD-SDI and SMPTE 424M [3] for 720p and 1080p. An ANC data packet contains a User Data Word (UDW) space for 255 10-bit words. Ancillary data may be present within the horizontal ancillary data space (HANC) and the vertical ancillary data space (VANC); however, only VANC usage is allowed in this Standard.

SMPTE RP 214 [4] specifies a method for inserting KLV-formatted data into ANC packets. It also specifies: how to package 8-bit data within the 10-bit UDW space of an ANC packet; a Message ID (MID) field; and Packet Sequence Count (PSC) (described below).

### 4.1.1 VANC KLV Packet Formatting

**Under the rules identified in §4.1 above, a VANC KLV Packet is formatted as shown in**

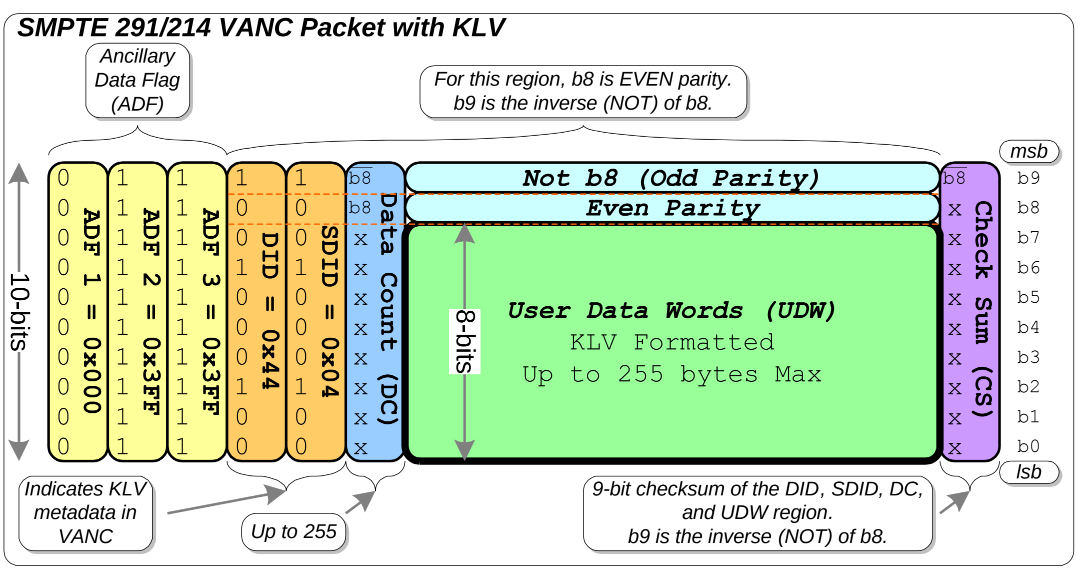


**Figure 4-1: VANC Packet with KLV**

Note that the Data ID (DID) = 0x44, and Secondary Data ID (SDID) = 0x04 for SMPTE 291M packets formatted under SMPTE RP214 practices for KLV VANC metadata. DID, SDID, Data Count (DC), and UDW space of the ANC packet for VANC KLV packets use bit 8 for even parity, and non-parity (logical NOT of bit 8) for bit 9. The maximum UDW space is 255 bytes with the size specified by the Data Count word.

### 4.1.2 User Data Words (UDW) Formatting for KLV data

For KLV applications, the User Data Words (UDW) section of an ANC data packet is formatted as shown in

Figure 4-2:

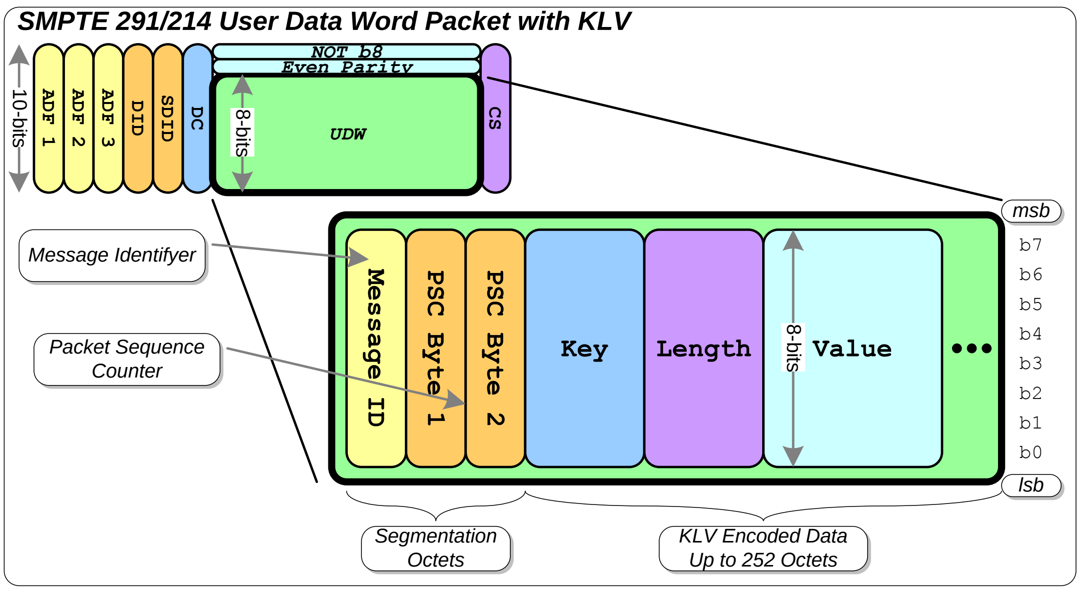


**Figure 4-2: User Data Word Packet with KLV**

The first three words within the UDW space are **mandatory**. This leaves 255-3=252 bytes for a KLV payload within each VANC packet.

- The first word of the UDW space is a Message ID (MID) field which identifies the ANC KLV packets belonging to the same KLV packet.
- The next two words represent a Packet Sequence Counter (PSC) which links long KLV packets to one another.
- The remainder of the UDW space is used to carry KLV metadata (up to 252 bytes). Over a digital interface, bit 8 of the KLV UDWs is the even parity of bits 0 through 7, and bit 9 is the logical NOT of bit 9.

Both the MID and PSC fields are discussed more in the sections that follow.

#### 4.1.2.1 Message ID (MID) Information

SMPTE RP214 states that the MID field is used to identify packets that carry information belonging to the same message. This MID value increments from 0x01 to 0xFF with each KLV packet sent within the VANC space. Over a digital interface, bit 9 ("b8") of the MID UDW is the even parity of bits 0 through 7, and bit 9 is the logical NOT of bit 8.

Note: Previous versions of this document recommended using the MID field to convey additional information about the type of KLV data contained in the VANC packet. This old method allowed the same MID to be for multiple different KLV packets each falling into a common group (i.e. "Geospatial / Security Data" had a MID of 0x01). When a second KLV packet is identified with the same MID value as a previous packet, the PSC is then repeated. Downstream systems then ignore the second set of VANC KLV packets as they have identical MID and PSC values as previous packets.

This document **requires** using the practices specified in SMPTE RP214 for identifying MID values.

#### 4.1.2.2 Packet Sequence Counter (PSC) Information

The PSC consumes the two user data words following the MID field. The two words form a two-byte value that represents the number of ancillary packets with the same MID value of the same KLV packet. The first data word of the PSC number represents the upper 8 bits and the second word of the PSC number represents the lower 8 bits of the 16-bit PSC number (bit 7 of the first word represents the MSB and bit 0 of the second word represents the LSB of the PSC value).

The first ANC packet for each different MID has a PSC value starting at 1, and increases for each successive VANC KLV packet required to carry the KLV packet.

As with the MID value, bit 8 of the two PSC UDWs is the even parity of bits 0 through 7, and bit 9 is the logical NOT of bit 8.

## *4.2 VANC KLV Packet Encoding*

For HD motion imagery systems, this document **requires** the following:

1. **Shall** only use the vertical (VANC) space for ANC packets containing KLV data in accordance with SMPTE RP214.
2. **Shall** use the available VANC luminance data space prior to using the chrominance data space for KLV data.
3. The *first* VANC KLV data on Line 9 **shall** contain a Coordinated Universal Time (UTC) time stamp in KLV Pack format as described in §4.2.1 below, with VANC packets inserted on this line until full, continuing onto line 10.
4. If available, or required by the interface, the *second* VANC KLV data packet **shall** contain a KLV representation of the Video Payload Identifier as specified by SMPTE 352M [5]. The 4-byte value of the KLV **shall** match the 4-byte value in the HANC representation of the SMPTE 352M payload identifier.
5. The SMPTE 12M-2 [6] time stamp as defined in §4.2.2 **shall** be inserted on Line 14. No other KLV data **shall** be on this line. Additional KLV packets **shall** continue on Line 15. Other non-KLV data packets are allowed on line 14 after the SMPTE 12M-2 time stamp.
6. The final line for VANC KLV for 720p imagery **shall** be Line 25.

7. The final line for VANC KLV for 1080p imagery **shall** be Line 41.
8. If required by the system, additional VANC data packets containing non-KLV data **shall** follow all VANC packets containing KLV data.

### 4.2.1 Encoding Precision Time Stamp into the VANC

A Precision Time Stamp representing Coordinated Universal Time (UTC) **shall** be used to time stamp each uncompressed video frame [7]. The time stamp **shall** be encoded into a fixed length KLV Pack shown in Figure 4-3.

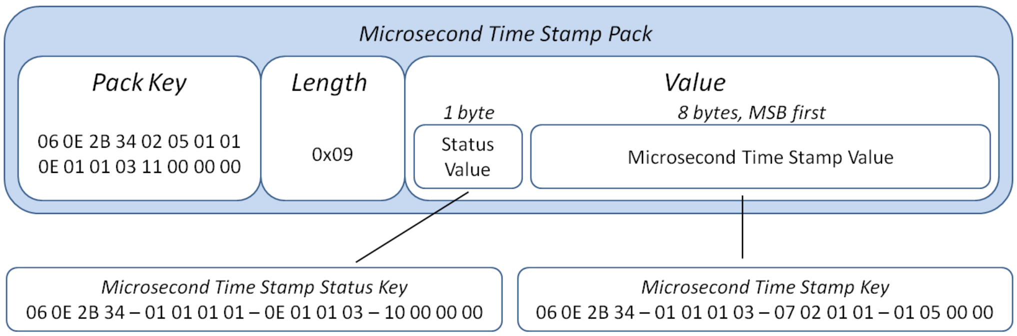


**Figure 4-3: Microsecond Time Stamp Pack Description**

The Pack **shall** have the Key (in hex): 06.0E.2B.34 02.05.01.01 0E.01.01.03 11.00.00.00

The Pack **shall** have the Length (in hex): 0x09

The Pack **shall** consist of two elements:

1. A 1-byte Microsecond Time stamp Status word as defined in Table 4-1
   Key (in hex) = 06.0E.2B.34.01.01.01.01.0E.01.01.03.10.00.00.00
2. An 8-byte 64-bit user defined time stamp – "microseconds since 1970"
   Key (in hex) = 06.0E.2B.34.01.01.01.03.07.02.01.01.01.05.00.00
   The 64-bit time stamp is inserted as 8 bytes, most significant byte first.

**Table 4-1: Microsecond Time stamp Status Byte Definition**

| MICROSECOND TIME STAMP STATUS BYTE DEFINITION Key = {06.0E.2B.34 01.01.01.01 0E.01.01.03 10.00.00.00} | | |
|---|---|---|
| **Bit Position** | **Value** | **Definition** |
| 7 (MSB) | 0 | GPS Locked: time stamp clock locked to GPS |
| | 1 | GPS Flywheel: time stamp clock not locked to GPS, so it is running on an internal oscillator |
| 6 | 0 | Normal: time stamp incremented normally since last message |
| | 1 | Discontinuity: time stamp has not incremented normally since last message |
| 5 | 0 | Forward - If Bit 6=1, this indicates that the time stamp jumped forward |
| | 1 | Reverse - If Bit 6=1, this indicates that the time stamp jumped backwards |
| 4-0 (LSB) | 1 | Reserved Bits = '11111' |

There **shall** be no additional KLV data in this VANC packet; however, additional VANC packets can exist on this same line in the VANC.

Methods for creating the microsecond time stamp are outlined in [7].

### 4.2.2 Encoding Commercial Time Stamp into the VANC

To ensure interoperability with commercial video equipment, a SMPTE 12M-2 time stamp is inserted for each uncompressed video frame. The time code **shall** be inserted into VANC line 14 in accordance with SMPTE 12M-2.

### 4.2.3 Video Payload Identification

SMPTE 424M [3] relies on SMPTE 425M [8] for identifying the source image format conveyed over the physical interface. SMPTE 425M mandates that a Payload Identifier (specified by SMPTE 352M [5]) be included in the horizontal space of the digital stream.

When required by the interconnecting interface, or included by the imaging system on slower interfaces, the KLV version of the SMPTE 352M packet **shall** also be included as the second VANC KLV packet.

See SMPTE 352M and 425M for more details.

# Annex A - Uncompressed HD Motion Imagery (Informative)

Uncompressed HD motion imagery consists of uncompressed HD video and KLV metadata and appropriate time stamps embedded in the VANC. The MISB has approved the HD progressive mode standards outlined in SMPTE 296M [9] and SMPTE 274M [10]. This Annex further describes the data carrying capabilities of the VANC data space for 720p and 1080p high definition systems.

# 1 HD Standards Overview

## *1.2 SMPTE 296M (720p)*

SMPTE 296M 1280x720 HD format (Figure A1) consists of 750 data lines, where 720 lines represent the active image area of the uncompressed video frame. The 30 remaining lines represent the Vertical Ancillary Data Space (VANC) of which 20 lines can be used to store data. Lines 1-5 and 746-750 are reserved for buffer/sync space between the usable data lines.

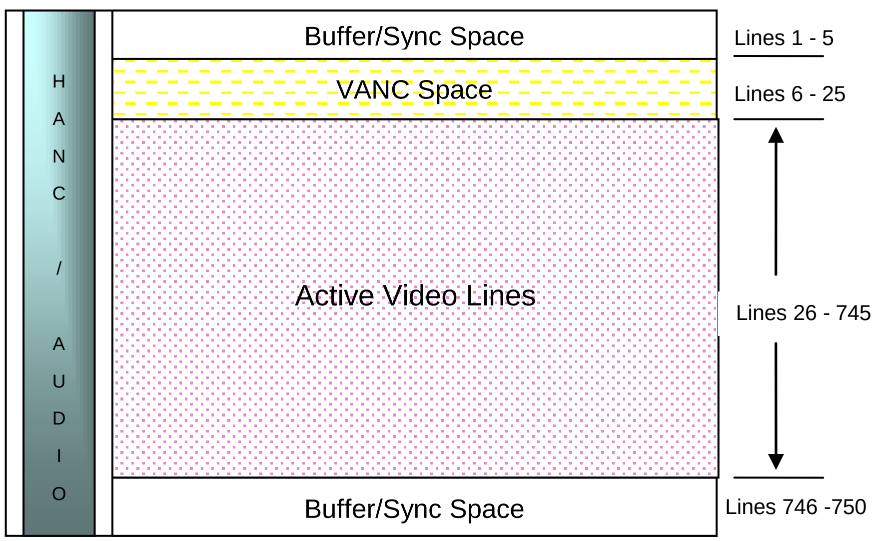


**Figure A1: SMPTE 296M 720p Video Frame**

## *1.3 SMPTE 274M (1080p)*

SMPTE 274M 1920x1080 HD format (Figure A1) consists of 1125 data lines, where 1080 lines represent the active image area of the uncompressed video frame. The 45 remaining lines represent the Vertical Ancillary Data Space (VANC) of which 36 lines can be used to store data. Lines 1-5 and 1122-1125 are reserved for buffer space between the usable data lines.

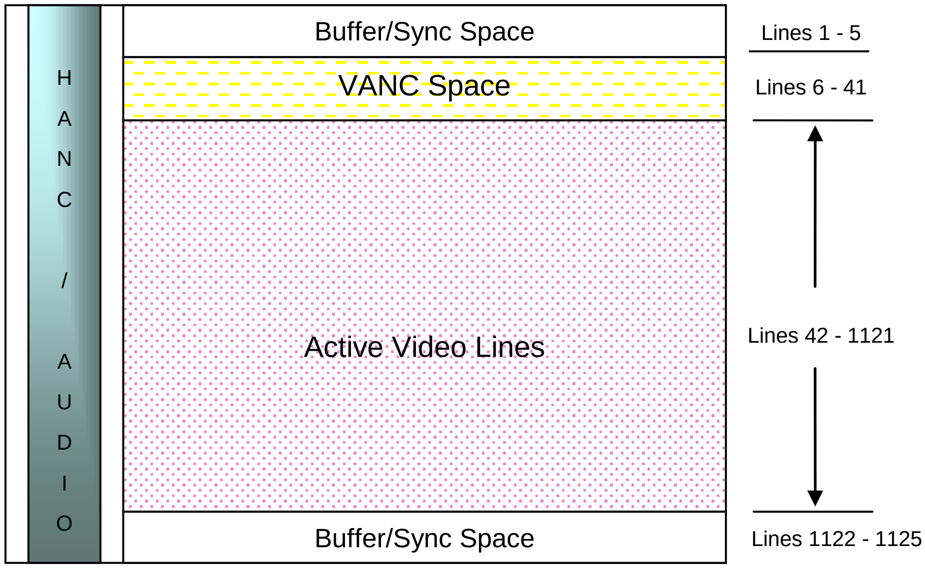


**Figure A1: SMPTE 274M 1080p Video Frame**

# 2 VANC Capacity for KLV metadata

SMPTE 291M [1] outlines the procedures for creating and inserting VANC data packets into the VANC space. Each data packet has 10-bytes of overhead (3-bytes for ADF, 1-byte DID, 1-byte SDID, 1-byte DC, 1-byte MID, 2-byte PSC, 1-byte CS), and a maximum of 252 bytes available for KLV data. The following sections elaborate on the metadata capacity available for both 720p, and 1080p systems.

## 2.1 SMPTE 296M (720p) Metadata Capacity

A 720p motion imagery frame has a capacity of 1280 words (bytes) per line, and can accommodate a minimum of five completely filled VANC packets. Since each packet contains 10 bytes of overhead each line can support a maximum of 1280 – (5 packets x 10 bytes/packet) = 1230 bytes. VANC packets can exist on lines 9-13, and 15-25 comprising the 16 lines of available luminance space. VANC packets can also exist in the chrominance space of the motion imagery for a total of 32 lines for metadata. Thus, 1230 KLV bytes/line x 32 lines = 39,360 bytes per 720p frame. At 60 Hz, this equates to a data rate of 18.89 Mbps.

## 2.2 SMPTE 274M (1080p) Metadata Capacity

A 1080p motion imagery frame has a capacity of 1920 words (bytes) per line, and can accommodate a minimum of 8 completely filled VANC packets. Since each packet contains 10 bytes of overhead, each line can support a maximum of 1920 – (8 packets x 10 bytes/packet) = 1840 bytes. VANC packets can exist on lines 9-13, and 15-41 comprising the 32 lines of available luminance space. VANC packets can also exist in the chrominance space of the motion imagery for a total of 64 lines for metadata. Thus, 1840 KLV bytes/line x 64 lines = 117,760 bytes per 1080p frame. At 60 Hz, this equates to a data rate of 56.52 Mbps.