MOTION IMAGERY STANDARDS BOARD	MISB ST 0601.17
STANDARD	
UAS Datalink Local Set	29 October 2020

1 Scope

MISB ST 0601 defines the Unmanned Air System (UAS) Datalink Local Set (LS) for UAS platforms. Typically produced on-board a UAS airborne platform, the UAS Datalink LS and compressed Motion Imagery travel together within an MPEG-2 Transport container for dissemination over a wireless Datalink.

The UAS Datalink LS is a bandwidth-efficient, extensible Key-Length-Value (KLV) metadata Local Set conforming to SMPTE ST 336 [1]. This standard defines the Local Set items with requirements for their use and provides additional details with examples.

Past versions of MISB ST 0601 provided a mapping to MISB EG 0104 *Predator UAV Basic Universal Metadata Set* metadata and Exploitation Support Data (ESD) metadata. MISB EG 0104 and ESD are both deprecated as of 18 September 2008. If mapping EG 0104 or ESD data to a ST 0601 Local Set, please refer to previous versions of ST 0601.

(Quick link to items comprising **UAS Datalink Local Set** in numeric order, see Table 1, or in alphabetical order, see Table 2).

2 References

MISB references cited here-in reflect versions current to the publication date of a document. In the event of a MISB document correction, the corrected document will have a single letter Minor Version appended to the Major Version number per the MISB Document Development Process [2]. For example, corrections to ST 0001.2, which has a Major Version of 2, becomes ST 0001.2a, which includes a Minor Version of "a". The MISB will not update the referring document (this document) with the Minor Version number change. When acquiring any MISB reference listed below from an NGA repository the latest version may be either a Major or Minor Version.

[1] SMPTE ST 336:2017 Data Encoding Protocol Using Key-Length-Value.
[2] MISB Document Development Process, May 2020.
[3] MISB ST 0807.25 MISB KLV Metadata Registry, Jun 2020.
[4] MISB ST 0603.5 MISP Time System and Timestamps, Oct 2017.
[5] MISB ST 0107.4 KLV Metadata in Motion Imagery, Feb 2019.
[6] MISB MISP-2021.1: Motion Imagery Handbook, Oct 2020.

[7] MISB ST 0806.4 Remote Video Terminal Metadata Set, Feb 2014.

[8] MISB ST 0604.6 Timestamps for Class 1/Class 2 Motion Imagery, Oct 2017.

[9] MISB ST 1010.3 Generalized Standard Deviation and Correlation Coefficient Metadata, Oct 2016.

[10] MIL-STD-2500C (CN2) National Imagery Transmission Format Version 2.1 for the National Imagery Transmission Format, Change Notice 2, 02 Jan 2019.

[11] MISB ST 1607 Constructs to Amend/Segment KLV Metadata, 2016.

[12] MISB ST 1201.4 Floating Point to Integer Mapping, Feb 2019.

[13] MISB ST 0801.6 Photogrammetry Metadata Set for Digital Motion Imagery, Feb 2018.

[14] MISB ST 0102.12 Security Metadata Universal and Local Sets for Motion Imagery Data, Jun 2017.

[15] MISB ST 0903.5 Video Moving Target Indicator and Track Metadata, Feb 2020.

[16] MISB ST 1204.3 Motion Imagery Identification System (MIIS) Core Identifier, Feb 2020.

[17] MISB ST 1206.1 SAR Motion Imagery Metadata, Jun 2017.

[18] MISB ST 1002.2 Range Motion Imagery, Jun 2016.

[19] MISB ST 1601.1 Geo-Registration Local Set, Nov 2018.

[20] MISB ST 1602.1 Composite Imaging Local Set, Nov 2018.

[21] MISB ST 0902.8 Motion Imagery Sensor Minimum Metadata Set, Nov 2018.

3 Acronyms and Definitions

BER	Basic Encoding Rules
DTED	Digital Terrain Elevation Data
KLV	Key Length Value
LS	Local Set
MPEG	Moving Picture Experts Group
MISB	Motion Imagery Standards Board
MISP	Motion Imagery Standards Profile
OID	Object IDentifier
RP	Recommended Practice
SDCC-FLP	Standard Deviation Correlation Coefficient Floating Length Pack
SMPTE	Society of Motion Picture Television Engineers
ST	Standard
UAS	Unmanned Air System
UL	Universal Label
US	Universal Set

4 Revision History

Revision	Date	Summary of Changes
ST 0601.17	10/29/2020	• Removed all unnecessary Universal labels (KLV Keys)

		• Fixed usage of the word "Tag" to indicate the numerical tag identifier and not the whole Tag-Length-Value item. The word "Item" represents the whole Tag-Length-Value item. • Section 8: corrected uint64 descriptions • Item 65: added indication version number is for major version only • Item 72: corrected example • Item 81: clarifications and illustration corrections. Added KLV example. • Item 121: added requirement ST 0601.17-37 and -38 • Item 137: corrected units in example • Item 139: added requirement ST 0601.17-39 • Item 140: added clarifications, illustration, and updated example • Item 141: added clarifications and requirement ST 0601.17-40 • Added new Item 142 – View Domain

5 Introduction

UAS platforms operate over a limited-bandwidth wireless communications channel (i.e., UAS Datalink). Because of the high overhead in using a Universal Set for KLV metadata (see SMPTE ST 336), the bit-efficient Local Set form for encoding metadata items is more appropriate for transmitting metadata.

This standard defines a UAS Datalink LS according to SMPTE encoding rules, plus MISB specific data types and methods for conserving bandwidth. This standard is extensible for future metadata. Registration of new metadata items in the proper metadata dictionary (public or private) is a pre-requisite for using the metadata items in the UAS Datalink LS.

5.1 UAS Datalink Local Set Changes and Updates

This document defines the UAS Datalink Local Set and is under configuration management. When updating MISB ST 0601 the MISB maintains the document version, revision history and date change.

6 UAS Datalink Local Set

6.1 Metadata Usage

Requirement(s)	
ST 0601.13-23	Excepting the requirements for Item 2, Precision Time Stamp, at the start and Item 1, Checksum, at the end of a UAS Datalink LS, any order of other items within the LS instance shall be valid.
ST 0601.13-24	Except for items noted with "Multiples Allowed," all items within an instance of a

	UAS Datalink LS shall be included only once.
ST 0601.14-35	Child-items within Item 100 (Segment Local Set) or Item 101 (Amend Local Set), shall be allowed to duplicate items of their parent.
ST 0601.8-14	The usage of all Tags within the UAS Datalink LS shall be consistent with the descriptions and clarifications contained within MISB ST 0601.
ST 0601.8-16	UAS Datalink LS decoding systems that understand the full-range representation of certain metadata items shall use the full-range representation and ignore the range-restricted representation when both exist in the same UAS Datalink LS packet.
ST 0601.8-17	UAS Datalink LS decoding systems that understand the Height Above Ellipsoid (HAE) representation of certain metadata items shall use the HAE representation and ignore the Mean Sea Level (MSL) representation when both exist in the same UAS Datalink LS packet.
ST 0601.9-20	When UAS Datalink LS decoding systems understand the extended representation of certain metadata items the decoder shall use the extended representation.
ST 0601.9-21	When UAS Datalink LS decoding systems understand the extended representation of certain metadata items the decoder shall ignore the restricted representation when both exist in the same UAS Datalink LS packet.

6.2 UAS Local Set Universal Label

The UAS Local Set 16-Byte UL "Key" is registered in MISB ST 0807 [3] as:

06.0E.2B.34.02.0B.01.01.0E.01.03.01.01.00.00.00 (CRC 56773)

Requirement	
ST 0601.8-19	Historical 16-byte Universal Label Keys shall be forbidden in future developments.

6.3 UAS Datalink LS Packet Structure

Figure 1 illustrates the general structure of a UAS Datalink LS packet. A packet is a combination of a UL Key, the Length of the Value, and the Value. UAS Datalink LS packets require the following items: Precision Time Stamp (Item 2), UAS Datalink LS Version Number (Item 65) and Checksum (Item 1).

The Precision Time Stamp (Item 2) is a sampled and quantized time value of the MISP Time System as defined in MISB ST 0603 [4]. The Precision Time Stamp represents the time of birth of the metadata within the packet. Section 6.4 provides details on timestamps. The UAS Datalink LS Version Number (Item 65) states the version of the MISB ST 0601 document used when constructing the packet. Section 6.6 provides details on version numbers. Each UAS Datalink LS packet includes a Checksum (Item 1) to validate the contents of the whole packet. Section 6.6 provides details on Checksums.

A packet can include any combination of metadata items from the UAS Datalink LS. Except for the Precision Time Stamp and Checksum, the order of items within a UAS Datalink LS packet is arbitrary, unless dictated by use of any Standard Deviation Correlation Coefficient Floating Length Pack (SDCC-FLP). In addition, some items have multiple instances within a single packet, so an item's use may not be unique in the LS (however the length and value will usually be different).

As ST 0601 is a Local Set, items within the set utilize a tag rather than a key identifier, thus represented as TLV (Tag Length Value) triplets.

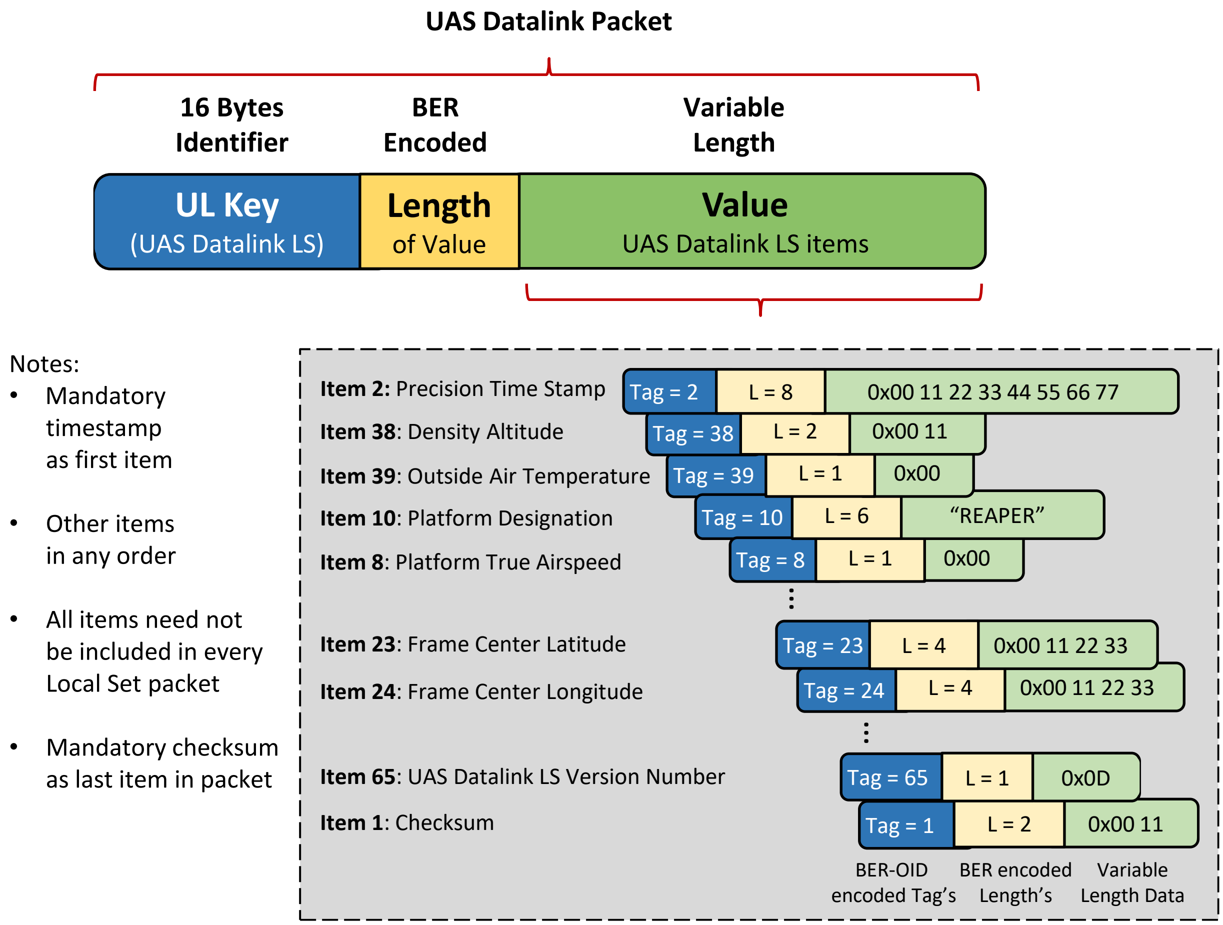

Figure 1: Example of a UAS Datalink LS Packet

6.3.1 KLV Metadata in Motion Imagery

MISB ST 0107 [5] provides a set of baseline requirements for applying KLV metadata in Motion Imagery.

Requirement	
ST 0601.8-03	All UAS Datalink LS metadata shall be expressed in accordance with MISB ST 0107.

6.3.2 Nested Packs within the UAS Datalink LS

To reduce bandwidth, KLV pack structures eliminate the tag and potentially the length when sending a group of related data items. Because packs do not include tags, they have a predefined order for items. There are two types of packs, a Variable Length Pack (VLP) and a Defined

Length Pack (DLP).

A VLP is a group of items represented as length-value pairs with each item's tag suppressed. Lengths in BER short or long form precede each item's value as illustrated in Figure 2. The VLP is a TLV triplet, where the Tag in Figure 2 is the tag for the VLP. The Length (Total) (in BER short or long form) represents the sum of all length-value pairs that follow. This length-value pair pattern continues for all represented items.

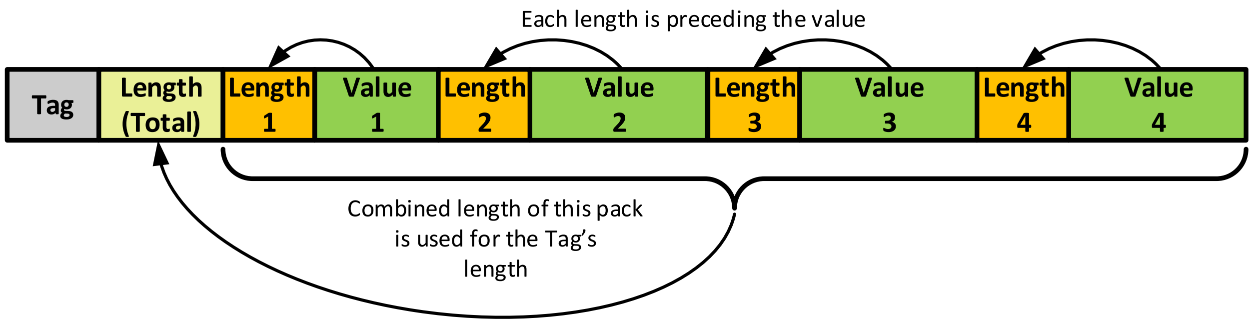

Figure 2: Illustration of Variable Length Pack

One exception to this pattern is where a length-value pair has an unknown value. In this case the length for the value is zero (0) with the value omitted. This preserves the defined order of the pack in cases where a value is unknown or omitted. For example, Figure 3 shows a VLP with a list of country codes. The VLP begins with its Local Set tag (Tag) and a total length of 9 bytes. The first length-value pair representing the first metadata item has a length of 3 bytes and a value of "CAN." The second item length-value pair has a length of 0 bytes, so the second value is undefined and omitted. The last item's length-value pair has a length of 3 bytes and a value of "FRA." This list of country codes maintains order even with the second item undefined.

Figure 3: Illustration of Variable Length Pack with a zero-ed item

A DLP is a group of items represented as values with each item's tag and length suppressed, where each item has a pre-defined or computable length. Figure 4 illustrates a DLP example showing the Local Set tag (Tag) for the DLP and a Length (Total) which is a sum of the lengths of three following values; that is, length of Value 1 + length of Value 2 + length of Value 3. Items (in Section 8) which utilize a DLP provide the pre-defined lengths or methods for computing the length of each item within the DLP. A DLP does not allow undefined values.

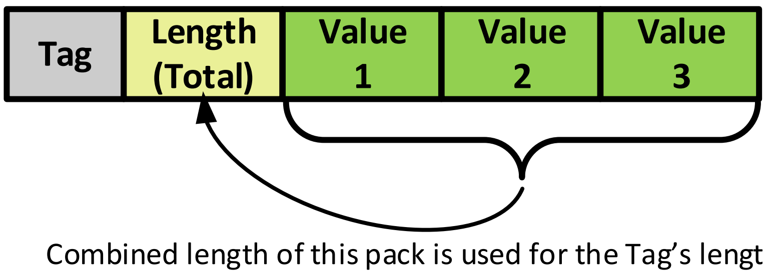

Figure 4: Illustration of Defined Length Pack

A DLP specification allows for the size of the final item to vary. When the final item's size varies the DLP is a Floating Length Pack (FLP). A FLP allows the final value to be a variable-length value such as a string. The length of the final value is the sum of all prior item lengths subtracted from the Length (Total).

Both VLP and DLP structures become truncation packs when removing one or more of their items at the end of the pack; that is, removing one or more length-pairs in a VLP or removing one or more values in a DLP. In both cases, the length (Total) of the VLP or DLP must reflect any truncation.

The Motion Imagery Handbook [6] provides additional details and references on pack structures and truncation packs.

6.3.3 Nesting Local Sets within the UAS Datalink LS

To allow re-use of metadata items in the UAS Datalink LS (e.g., platform location and sensor pointing angles), while providing greater flexibility to system implementers, other Local Sets with defined items in the UAS Datalink LS may nest within the UAS Datalink LS.

A nested Local Set is the same as any standalone metadata item defined within the UAS Datalink LS, where this document defines the Tag, and the Length is determined by the size of its Value. The Value then contains a set of TLV triplets defined by another standard or document. Figure 5 illustrates an example of a packet where the RVT LS (MISB ST 0806 [7]) nests within the UAS Datalink LS.

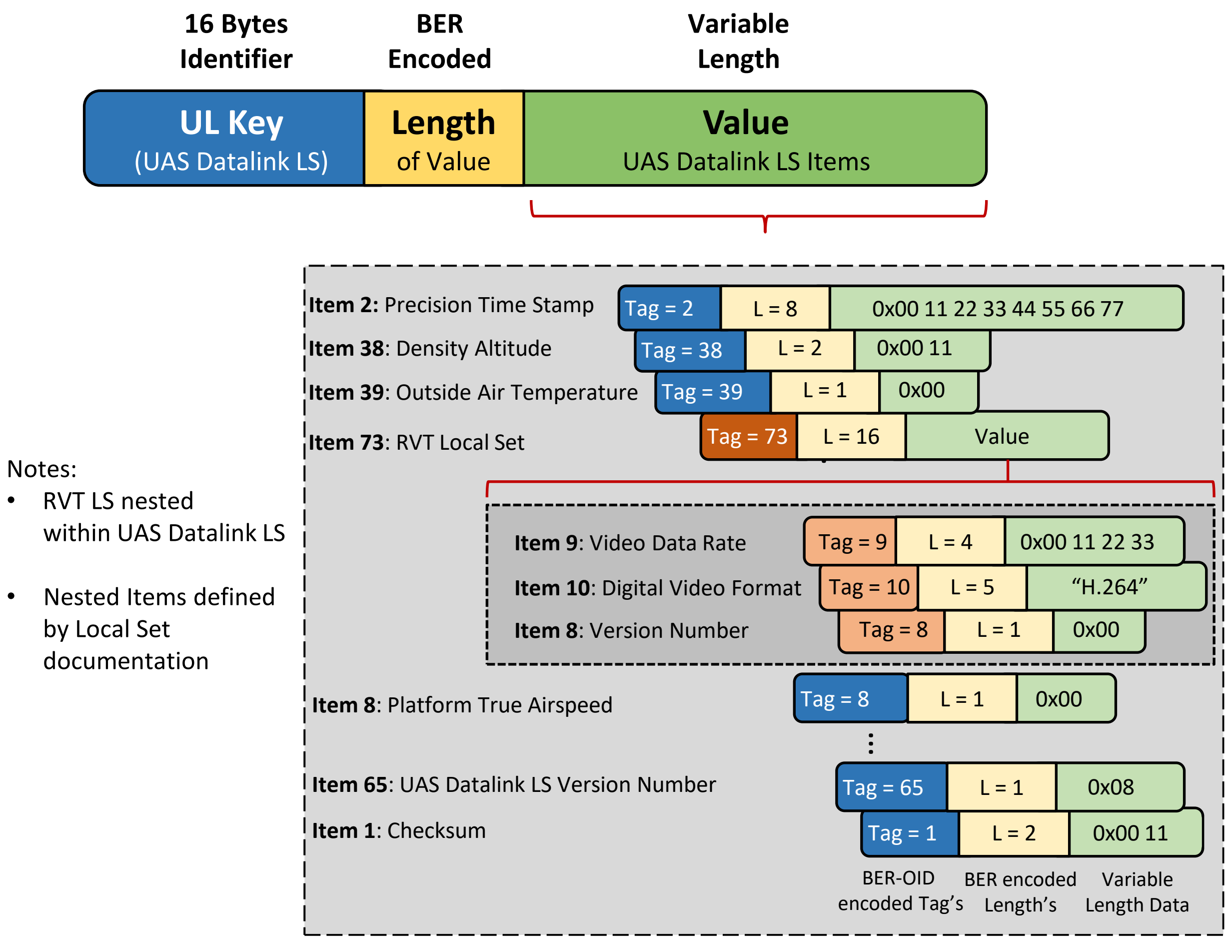

Figure 5: Nested Packet Example

In this example, the value of UAS Datalink LS Item 73, RVT Local Set, is the RVT LS with its own defined set of items. The items within the RVT LS are completely independent of the items in the UAS Datalink LS. For example, as shown in Figure 5, the RVT LS defines Item 8 as the Version Number while the UAS Datalink LS defines Item 8 as the Platform True Airspeed. UAS Datalink LS embeds the RVT LS within the value of Item 73 so Item 8, for RVT LS, parses within the scope of Item 73, while the Item 8 for UAS Datalink LS parses within the scope of the UAS Datalink LS.

6.3.4 Data Structures and Records

The nested Packs or Local Sets within the UAS Datalink LS are a collection of related values. From a software perspective, a collection of related values has various names such as a structure (C), or an object (java, C++). This document uses the general term, "record," for a collection of related values independent of the underlying KLV data format. Records are a collection of data fields with potentially different data types. Packs (VLP and DLP) and Local Sets are both instances of a record.

6.4 Packet Timestamp

Metadata sources and the flight computer (or equivalent) operate on the same time reference, which is typically GPS derived. The metadata source provides a timestamp included in a UAS Datalink LS packet (as well as the Motion Imagery) to facilitate synchronizing a Motion Imagery frame to its corresponding metadata. This packet timestamp represents the time of birth of all Local Set items contained within a UAS Datalink LS packet.

It is mandatory to include a Precision Time Stamp representing absolute time as defined in MISB ST 0603 [4] in every UAS Datalink LS packet. The Precision Time Stamp (Item 2) is an eight-byte unsigned integer counter of the number of SI Seconds (in microseconds) which have elapsed since midnight (00:00:00), January 1, 1970 (1970-01-01T00:00:00Z). Note: this time does not include leap seconds and therefore the Precision Time Stamp does not represent UTC. To convert the Precision Time Stamp to UTC, add or subtract leap seconds. The number of leap seconds may be represented by Item 136, Leap Seconds, or from a current leap second table. See the Motion Imagery Handbook [6] for details.

The first item of a UAS Datalink LS packet is the Precision Time Stamp as shown in Figure 6. It applies to all metadata in the packet and corresponds to the time of birth of all the data contained within the packet.

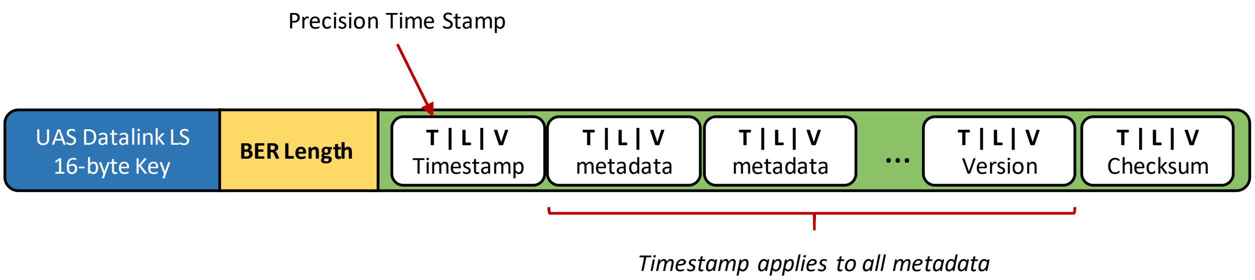

Figure 6: Packet Timestamp Example

Requirement(s)	
ST 0601.8-09	All instances of a UAS Datalink LS shall contain Item 2, Precision Time Stamp, as the first item of the LS.
ST 0601.8-10	The value assigned to Item 2, Precision Time Stamp, shall represent the time of birth of the metadata of all the items contained in that instance of the UAS Datalink LS.

In some cases, the time of birth timestamp may not directly correspond to the sample time of a metadata value. Thus, the maximum timestamp error encountered will be the difference in time between the current metadata packet, and the packet immediately preceding it. A recommendation is for systems to adjust metadata repetition rates to meet timing criteria.

The Precision Time Stamp provides two purposes: a baseline time for coordinating or synchronizing metadata with Motion Imagery and the actual real-world time. MISP conformant Motion Imagery will contain a Precision Time Stamp within the Motion Imagery frames (see MISB ST 0604 [8]) and a Precision Time Stamp within each metadata packet. These Precision Time Stamps enable the correlation of Motion Imagery frames and the metadata. Any modifications to the metadata Precision Time Stamp will break the synchronization of the metadata and Motion Imagery frames.

There are some cases where the Precision Time Stamp does not correctly represent real-world time; therefore, a Correction Offset (Item 137) provides a means to adjust the time presented to end users. The Correction Offset is typically a post-mission update and is usually a constant value over the whole mission or flight. The Correction Offset eliminates the need to do a post-mission change of the Precision Time Stamp value, which if changed can cause synchronization issues with the Motion Imagery frames. To compute the Corrected Time ($T_{Corrected}$) for display or other uses, add the Correction Offset ($T_{Correction}$) to the Precision Time Stamp ($T_{Precision}$), as shown in Equation 1.

$$T_{Corrected} = T_{Precision} + T_{Correction} \qquad \text{Equation 1}$$

To convert times to UTC, add the Leap Seconds ($L_{Seconds}$) offset as shown in Equation 2.

$$T_{Corrected} = T_{Precision} + T_{Correction} + (L_{Seconds} * 1{,}000{,}000) \qquad \text{Equation 2}$$

6.5 Report-on-Change

MISB ST 0601 assumes the Report-on-Change system described in the Motion Imagery Handbook. With exception of the three mandatory items (Item 1-Checksum, Item 2-Precision Time Stamp, and Item 65-UAS Datalink LS Version Number), additional items update when their value changes or if a Metadata Refresh Period (i.e., 30-second period) has elapsed since the last item update. Receivers treat an item as undefined when the item does **not** update within a Metadata Refresh Period.

MISB ST 0107 provides a set of baseline requirements when implementing Report-on-Change.

Requirement	
ST 0601.15-36	UAS Data-link LS items implemented using Report-on-Change shall adhere to the requirements for usage stated in MISB ST 0107.

Except for mandatory items and items marked “Yes” for “Multiples Allowed?” (or MUL in Table 1 set to “Y”), all items within the UAS Datalink Local Set may use Zero Length Items (ZLI).

6.5.1 Metadata Distribution

Within a constrained bandwidth channel shared by both Motion Imagery and metadata transmitting a large amount of metadata at one time can impact the received quality of the Motion Imagery. To prevent this, the MISB recommends distributing the Known-Static metadata items over a 30-second refresh period. For example, instead of sending item A, B and C every 30 seconds at time 00:00:00, send item A every 30 seconds starting at time 00:00:00; send item B every thirty seconds starting at time 00:00:05 (five seconds later); and send item C every thirty seconds starting at time 00:00:10 (10 seconds after the first item); etc. This distributes the metadata over time.

6.5.1.1 List Distribution

Certain items in the Local Set contain a list of elements, such as the Payload Record described in Item 138. These Local Set items may have their lists distributed over multiple packets instead of sending the full list in one packet. Metadata items which allow for this type of distribution have comments within their "Details" section. Transmission of a list over multiple packets requires the receiver to creates a full list from the individual parts. Unless noted by the item description, the list elements follow similar rules to the Report-on-Change updating, not including list elements in a 30 second time frame, means the list element is no longer part of the list.

Figure 7 illustrates the transmission of a six element Payload List to the Receiver within three packets (Packet 7, 23, and 39) spread over a period of 20 seconds. The Receiver fills in the list over time: within Packet 7's data, item 138 contains two elements of the list; Packets 8 through 22 (not shown) do not contain any Payload List data; Packet 23's data add two more items to the list; and so on. The result is all six items after 20 seconds. All elements in the lists have unique identifiers, so the Receiver continues to manage the list as items arrive.

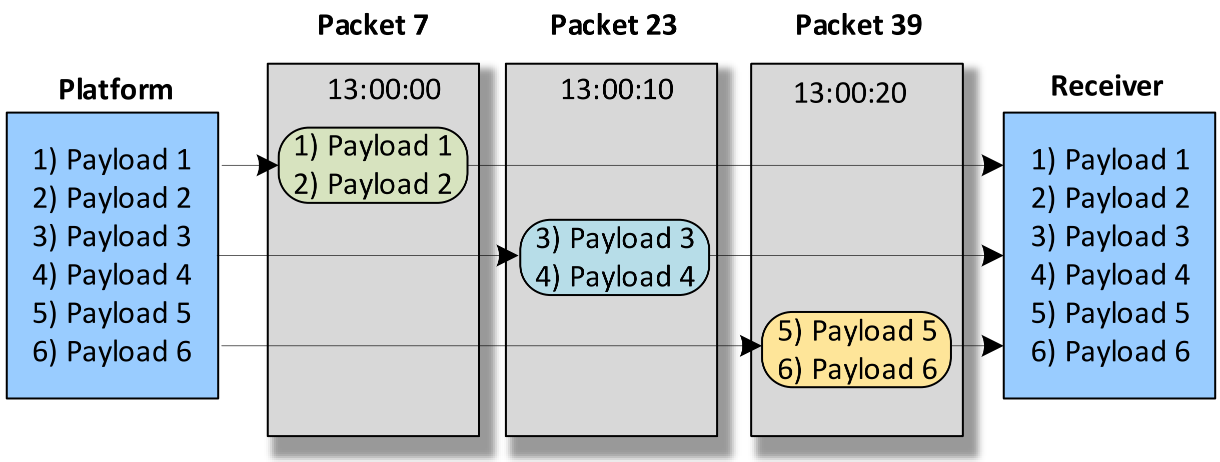

Figure 7: List Distribution

6.6 Packet Checksum and Version Number

A 16-bit checksum accompanies every UAS Datalink LS packet as the last item; this aids detecting erroneous metadata from being presented with the Motion Imagery. The checksum is a running 16-bit summation through the entire packet beginning with the 16-byte Local Set Key and ending with the length field of the checksum LS item (see Figure 8).

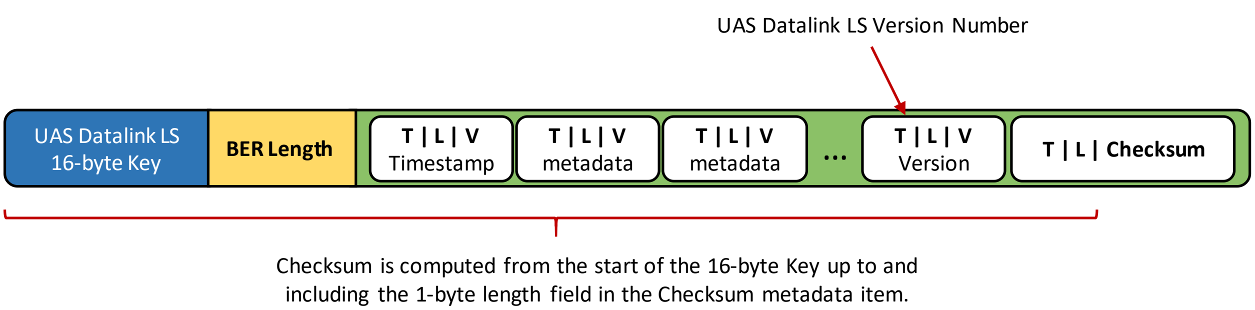

Figure 8: Checksum Computation Range

Note the presence of the three required items: Precision Time Stamp, UAS Datalink LS Version Number and Checksum.

Below is an example algorithm for calculating the checksum:

```
unsigned short bcc_16 (
  unsigned char * buff, // Pointer to the first byte in the 16-byte UAS Datalink LS key
  unsigned short len )  // Length from 16-byte UL key up to 1-byte checksum length
{
  // Initialize Checksum and counter variables
  unsigned short bcc = 0, i;

  // Sum each 16-bit chunk within the buffer into a checksum
  for ( i = 0 ; i < len; i++)
    bcc += buff[i] << (8 * ((i + 1) % 2));
  return bcc;
}  // end of bcc_16 ()
```

If the calculated checksum of the received packet does not match the checksum stored in the packet, the user is to discard the packet as being invalid. The lost packet is of little concern since another packet is available within reasonable proximity (in both data and time) to this lost packet.

New metadata items are added to the MISB ST 0601 LS frequently; for this reason, a version number (Item 65) of ST 0601, which updates at a minimum rate of once every 30 seconds, identifies the version used.

Requirement(s)	
ST 0601.8-08	All instances of a UAS Datalink LS where the computed checksum is not identical to the included checksum shall be discarded.
ST 0601.8-11	All instances of the UAS Datalink LS shall contain as the final item Item 1, Checksum.
ST 0601.8-12	All instances of the UAS Datalink LS shall contain Item 65, UAS Datalink LS Version Number.

6.7 Motion Imagery/Metadata Synchronization - Informative

The synchronization or time-alignment of a Motion Imagery frame with metadata within its container is the responsibility of the system designer who needs to consider: 1) enough bandwidth to accommodate the metadata without limiting the Motion Imagery; 2) required update rates of metadata; 3) presentation of Motion Imagery coincident with metadata at a receiver (i.e., receiver decoder buffer delay). Different applications will have differing requirements and metrics for the accuracy of synchronization. In general, it is best to ensure systems insert both the Precision Time Stamp into a Motion Imagery frame and the metadata into the transport stream as close as possible to the point of collection.

7 UAS Datalink Local Set Items

This section provides a summary of all the UAS Datalink LS items, with further details for each item in Section 8. Also provided is an overview of platform and sensor location/rotations, special values, and edits to metadata.

7.1 UAS Datalink Local Set Items Summary

Table 1 lists a summary of the metadata items within the UAS Datalink LS. Full details of each item are in Section 8. The column designations are as follows:

- The "Tag" column is the KLV Local Set tag number for the item. The tag is a BER-OID encoded integer value. Single-byte tags represent tag numbers from 1 through 127. Tag numbers greater than 127 use two-bytes (or more).
- The "Name" column is the label associated with the item.
- The "Units" column indicates the units of the data specified in the item's value field.
    - Units of "None" indicate the value is not a measurement and units do not apply
    - Units of "Set" or "Pack" indicate the value is a collection of information in the form of a Local Set or Pack
    - All other Units are SI enumerations (e.g., μs is microseconds, ° is degrees)
- The "Format" column indicates the item's KLV format for the Value.
- The "Length" column indicates the nominal length of the value. This may be a required length or variable length depending on the value.
- The "SDCC" column indicates whether the item is usable within a Standard Deviation Correlation Coefficient Floating Length Pack (SDCC-FLP) structure. The details of the SDCC-FLP construct are in MISB ST 1010 [9].
    - The item can be a part of the SDDCC-FLP when this column is "Y"
    - The item may not be a part of the SDCC-FLP when this column is "N"
- The "MUL" column indicates whether an item may have multiple instances within a single instance of the UAS Datalink Local set.
    - When this column's value is "Y" the item may have multiple instances
    - When this column's value is "N" the item is unique within the instance of the LS

Notes:

- See the Motion Imagery Handbook for further information on data types, such as IMAPB.

Table 1: UAS Datalink Local Set Items

Tag	Name	Units	Format	Len	SDCC	MUL	Description
1	Checksum	None	uint16	2	N	N	Checksum used to detect errors within a UAS Datalink LS packet

Tag	Name	Units	Format	Len	SDCC	MUL	Description
2	Precision Time Stamp	µs	uint64	8	N	N	Timestamp for all metadata in this Local Set; used to coordinate with Motion Imagery
3	Mission ID	None	utf8	V	N	N	Descriptive mission identifier to distinguish event or sortie
4	Platform Tail Number	None	utf8	V	N	N	Identifier of platform as posted
5	Platform Heading Angle	°	uint16	2	Y	N	Aircraft heading angle
6	Platform Pitch Angle	°	int16	2	Y	N	Aircraft pitch angle
7	Platform Roll Angle	°	int16	2	Y	N	Platform roll angle
8	Platform True Airspeed	m/s	uint8	1	Y	N	True airspeed (TAS) of platform
9	Platform Indicated Airspeed	m/s	uint8	1	Y	N	Indicated airspeed (IAS) of platform
10	Platform Designation	None	utf8	V	N	N	Model name for the platform
11	Image Source Sensor	None	utf8	V	N	N	Name of currently active sensor
12	Image Coordinate System	None	utf8	V	N	N	Name of the image coordinate system used
13	Sensor Latitude	°	int32	4	Y	N	Sensor latitude
14	Sensor Longitude	°	int32	4	Y	N	Sensor longitude
15	Sensor True Altitude	m	uint16	2	Y	N	Altitude of sensor as measured from Mean Sea Level (MSL)
16	Sensor Horizontal Field of View	°	uint16	2	Y	N	Horizontal field of view of selected imaging sensor
17	Sensor Vertical Field of View	°	uint16	2	Y	N	Vertical field of view of selected imaging sensor
18	Sensor Relative Azimuth Angle	°	uint32	4	Y	N	Relative rotation angle of sensor to platform longitudinal axis
19	Sensor Relative Elevation Angle	°	int32	4	Y	N	Relative elevation angle of sensor to platform longitudinal-transverse plane
20	Sensor Relative Roll Angle	°	uint32	4	Y	N	Relative roll angle of sensor to aircraft platform
21	Slant Range	m	uint32	4	Y	N	Slant range in meters
22	Target Width	m	uint16	2	Y	N	Target width within sensor field of view
23	Frame Center Latitude	°	int32	4	N	N	Terrain latitude of frame center
24	Frame Center Longitude	°	int32	4	N	N	Terrain longitude of frame center
25	Frame Center Elevation	m	uint16	2	N	N	Terrain elevation at frame center relative to Mean Sea Level (MSL)
26	Offset Corner Latitude Point 1	°	int16	2	N	N	Frame latitude offset for upper left corner
27	Offset Corner Longitude Point 1	°	int16	2	N	N	Frame longitude offset for upper left corner
28	Offset Corner Latitude Point 2	°	int16	2	N	N	Frame latitude offset for upper right corner
29	Offset Corner Longitude Point 2	°	int16	2	N	N	Frame longitude offset for upper right corner
30	Offset Corner Latitude Point 3	°	int16	2	N	N	Frame latitude offset for lower right corner
31	Offset Corner Longitude Point 3	°	int16	2	N	N	Frame longitude offset for lower right corner
32	Offset Corner Latitude Point 4	°	int16	2	N	N	Frame latitude offset for lower left corner
33	Offset Corner Longitude Point 4	°	int16	2	N	N	Frame longitude offset for lower left corner
34	Icing Detected	code	uint8	1	N	N	Flag for icing detected at aircraft location
35	Wind Direction	°	uint16	2	N	N	Wind direction at aircraft location
36	Wind Speed	m/s	uint8	1	N	N	Wind speed at aircraft location
37	Static Pressure	mbar	uint16	2	N	N	Static pressure at aircraft location
38	Density Altitude	m	uint16	2	N	N	Density altitude at aircraft location
39	Outside Air Temperature	°C	int8	1	N	N	Temperature outside of aircraft
40	Target Location Latitude	°	int32	4	N	N	Calculated target latitude
41	Target Location Longitude	°	int32	4	N	N	Calculated target longitude
42	Target Location Elevation	m	uint16	2	N	N	Calculated target elevation
43	Target Track Gate Width	Pixels	uint8	1	N	N	Tracking gate width (x value) of tracked target within field of view
44	Target Track Gate Height	Pixels	uint8	1	N	N	Tracking gate height (y value) of tracked target within field of view
45	Target Error Estimate - CE90	m	uint16	2	N	N	Circular error 90 (CE90) is the estimated error distance in the horizontal direction
46	Target Error Estimate - LE90	m	uint16	2	N	N	Lateral error 90 (LE90) is the estimated error distance in the vertical (or lateral) direction
47	Generic Flag Data	None	uint8	1	N	N	Generic metadata flags

Tag	Name	Units	Format	Len	SDCC	MUL	Description
48	Security Local Set	None	set	V	N	N	MISB ST 0102 local let Security Metadata items
49	Differential Pressure	mbar	uint16	2	N	N	Differential pressure at aircraft location
50	Platform Angle of Attack	°	int16	2	Y	N	Platform attack angle
51	Platform Vertical Speed	m/s	int16	2	Y	N	Vertical speed of the aircraft relative to zenith
52	Platform Sideslip Angle	°	int16	2	Y	N	Angle between the platform longitudinal axis and relative wind
53	Airfield Barometric Pressure	mbar	uint16	2	N	N	Local pressure at airfield of known height
54	Airfield Elevation	m	uint16	2	N	N	Elevation of airfield corresponding to Airfield Barometric Pressure
55	Relative Humidity	%	uint8	1	N	N	Relative humidity at aircraft location
56	Platform Ground Speed	m/s	uint8	1	N	N	Speed projected to the ground of an airborne platform passing overhead
57	Ground Range	m	uint32	4	N	N	Horizontal distance from ground position of aircraft relative to nadir, and target of interest
58	Platform Fuel Remaining	kg	uint16	2	N	N	Remaining fuel on airborne platform
59	Platform Call Sign	None	utf8	V	N	N	Call sign of platform or operating unit
60	Weapon Load	None	uint16	2	N	N	Current weapons stored on aircraft
61	Weapon Fired	None	uint8	1	N	N	Indication when a particular weapon is released
62	Laser PRF Code	None	uint16	2	N	N	A laser's Pulse Repetition Frequency (PRF) code used to mark a target
63	Sensor Field of View Name	None	uint8	1	N	N	Sensor field of view names
64	Platform Magnetic Heading	°	uint16	2	Y	N	Aircraft magnetic heading angle
65	UAS Datalink LS Version Number	None	uint8	1	N	N	Version number of the UAS Datalink LS document used to generate KLV metadata
66	Deprecated	N/A	N/A	N/A	N	N	This item has been deprecated.
67	Alternate Platform Latitude	°	int32	4	N	N	Alternate platform latitude
68	Alternate Platform Longitude	°	int32	4	N	N	Alternate platform longitude
69	Alternate Platform Altitude	m	uint16	2	N	N	Altitude of alternate platform as measured from Mean Sea Level (MSL)
70	Alternate Platform Name	None	utf8	V	N	N	Name of alternate platform connected to UAS
71	Alternate Platform Heading	°	uint16	2	N	N	Heading angle of alternate platform connected to UAS
72	Event Start Time – UTC	µs	uint64	8	N	N	Start time of scene, project, event, mission, editing event, license, publication, etc.
73	RVT Local Set	None	set	V	N	N	MISB ST 0806 RVT Local Set metadata items
74	VMTI Local Set	None	set	V	N	N	MISB ST 0903 VMTI Local Set metadata items
75	Sensor Ellipsoid Height	m	uint16	2	Y	N	Sensor ellipsoid height as measured from the reference WGS84 ellipsoid
76	Alternate Platform Ellipsoid Height	m	uint16	2	N	N	Alternate platform ellipsoid height as measured from the reference WGS84 Ellipsoid
77	Operational Mode	None	uint8	1	N	N	Indicates the mode of operations of the event portrayed in Motion Imagery
78	Frame Center Height Above Ellipsoid	m	uint16	2	N	N	Frame center ellipsoid height as measured from the reference WGS84 ellipsoid
79	Sensor North Velocity	m/s	int16	2	Y	N	Northing velocity of the sensor or platform
80	Sensor East Velocity	m/s	int16	2	Y	N	Easting velocity of the sensor or platform
81	Image Horizon Pixel Pack	None	dlp	V	N	N	Location of earth-sky horizon in the Imagery
82	Corner Latitude Point 1 (Full)	°	int32	4	N	N	Frame latitude for upper left corner
83	Corner Longitude Point 1 (Full)	°	int32	4	N	N	Frame longitude for upper left corner
84	Corner Latitude Point 2 (Full)	°	int32	4	N	N	Frame latitude for upper right corner
85	Corner Longitude Point 2 (Full)	°	int32	4	N	N	Frame longitude for upper right corner
86	Corner Latitude Point 3 (Full)	°	int32	4	N	N	Frame latitude for lower right corner
87	Corner Longitude Point 3 (Full)	°	int32	4	N	N	Frame longitude for lower right corner
88	Corner Latitude Point 4 (Full)	°	int32	4	N	N	Frame latitude for lower left corner
89	Corner Longitude Point 4 (Full)	°	int32	4	N	N	Frame longitude for lower left corner
90	Platform Pitch Angle (Full)	°	int32	4	Y	N	Aircraft pitch angle
91	Platform Roll Angle (Full)	°	int32	4	Y	N	Platform roll angle

Tag	Name	Units	Format	Len	SDCC	MUL	Description
92	Platform Angle of Attack (Full)	°	int32	4	Y	N	Platform attack angle
93	Platform Sideslip Angle (Full)	°	int32	4	Y	N	Angle between the platform longitudinal axis and relative wind
94	MIIS Core Identifier	None	byte	V	N	N	MISB ST 1204 MIIS Core Identifier binary value
95	SAR Motion Imagery Local Set	None	set	V	N	N	MISB ST 1206 SAR Motion Imagery Metadata Local Set metadata items
96	Target Width Extended	m	IMAPB	V	Y	N	Target width within sensor field of view
97	Range Image Local Set	None	set	V	N	N	MISB ST 1002 Range Imaging Local Set metadata items
98	Geo-Registration Local Set	None	set	V	N	N	MISB ST 1601 Geo-Registration Local Set metadata items
99	Composite Imaging Local Set	None	set	V	N	N	MISB ST 1602 Composite Imaging Local Set metadata items
100	Segment Local Set	None	set	V	N	Y	MISB ST 1607 Segment Local Set metadata items, used to enable metadata sharing
101	Amend Local Set	None	set	V	N	Y	MISB ST 1607 Amend Local Set metadata items, used to provide metadata corrections
102	SDCC-FLP	None	flp	V	N/A	Y	MISB ST 1010 Floating Length Pack (FLP) metadata item, providing Standard Deviation and Cross Correlation (SDCC) metadata
103	Density Altitude Extended	m	IMAPB	V	N	N	Density altitude above MSL at aircraft location
104	Sensor Ellipsoid Height Extended	m	IMAPB	V	Y	N	Sensor ellipsoid height extended as measured from the reference WGS84 ellipsoid
105	Alternate Platform Ellipsoid Height Extended	m	IMAPB	V	N	N	Alternate platform ellipsoid height extended as measured from the reference WGS84 ellipsoid
106	Stream Designator	None	utf8	V	N	N	A second designation given to a sortie
107	Operational Base	None	utf8	V	N	N	Name of the operational base hosting the platform
108	Broadcast Source	None	utf8	V	N	N	Name of the source, where the Motion Imagery is first broadcast
109	Range To Recovery Location	km	IMAPB	V	N	N	Distance from current position to airframe recovery position
110	Time Airborne	s	uint	V	N	N	Number of seconds aircraft has been airborne
111	Propulsion Unit Speed	RPM	uint	V	N	N	The speed the engine (or electric motor) is rotating at
112	Platform Course Angle	°	IMAPB	V	N	N	Direction the aircraft is moving relative to True North
113	Altitude AGL	m	IMAPB	V	Y	N	Above Ground Level (AGL) height above the ground/water
114	Radar Altimeter	m	IMAPB	V	Y	N	Height above the ground/water as reported by a RADAR altimeter
115	Control Command	None	dlp	V	N	Y	Record of command from GCS to Aircraft
116	Control Command Verification List	None	dlp	V	N	N	Acknowledgement of one or more control commands were received by the platform
117	Sensor Azimuth Rate	dps	IMAPB	V	Y	N	The rate the sensors azimuth angle is changing
118	Sensor Elevation Rate	dps	IMAPB	V	Y	N	The rate the sensors elevation angle is changing
119	Sensor Roll Rate	dps	IMAPB	V	Y	N	The rate the sensors roll angle is changing
120	On-board MI Storage Percent Full	%	IMAPB	V	N	N	Amount of on-board Motion Imagery storage used as a percentage of the total storage
121	Active Wavelength List	None	dlp	V	N	N	List of wavelengths in Motion Imagery
122	Country Codes	None	vlp	N/A	N	N	Country codes which are associated with the platform and its operation
123	Number of NAVSATs in View	count	uint	1	N	N	Count of navigation satellites in view of platform
124	Positioning Method Source	None	uint	1	N	N	Source of the navigation positioning information. (e.g., NAVSAT-GPS, NAVSAT-Galileo, INS)
125	Platform Status	None	uint	1	N	N	Enumeration of operational modes of the platform (e.g., in-route, RTB)
126	Sensor Control Mode	None	uint	1	N	N	Enumerated value for the current sensor control operational status
127	Sensor Frame Rate Pack	None	dlp	V	N	N	Values used to compute the frame rate of the Motion Imagery at the sensor
128	Wavelengths List	None	vlp	V	N	N	List of wavelength bands provided by sensor(s)

Tag	Name	Units	Format	Len	SDCC	MUL	Description
129	Target ID	None	utf8	V	N	N	Alpha-numeric identification of a target
130	Airbase Locations	None	vlp	V	N	N	Geographic location of the take-off site and recovery site
131	Take-off Time	μs	uint	V	N	N	Time when aircraft became airborne
132	Transmission Frequency	MHz	IMAPB	V	N	N	Radio frequency used to transmit the Motion Imagery
133	On-board MI Storage Capacity	GB	uint	V	N	N	The total capacity of on-board Motion Imagery storage
134	Zoom Percentage	%	IMAPB	V	N	N	For a variable zoom system, the percentage of zoom
135	Communications Method	None	utf8	V	N	N	Type of communications used with platform
136	Leap Seconds	s	int	V	N	N	Number of leap seconds to adjust Precision Time Stamp (Item 2) to UTC
137	Correction Offset	μs	int	V	N	N	Post-flight time adjustment to correct Precision Time Stamp (Item 2) as needed
138	Payload List	None	vlp	V	N	N	List of payloads available on the Platform
139	Active Payloads	None	byte	V	N	N	List of currently active payloads from the payload list (Item 138)
140	Weapons Stores	None	vlp	V	N	N	List of weapon stores and status
141	Waypoint List	None	vlp	V	N	N	List of waypoints and their status.
142	View Domain	None	vlp	V	N	N	Specifies the domain of values for Relative Sensor Azimuth, Elevation and Roll Angles

Table 2 provides a list of the UAS Datalink Local Set names with items in alphabetical order. Each name and tag provide a link to the details section for a Local Set item.

Table 2: Items Sorted by Name

Name	Tag	Name	Tag	Name	Tag
Active Payloads	139	Mission ID	3	Sensor Control Mode	126
Active Wavelength List	121	Number of NAVSATs in View	123	Sensor East Velocity	80
Airbase Locations	130	Offset Corner Latitude Point 1	26	Sensor Elevation Rate	118
Airfield Barometric Pressure	53	Offset Corner Latitude Point 2	28	Sensor Ellipsoid Height	75
Airfield Elevation	54	Offset Corner Latitude Point 3	30	Sensor Ellipsoid Height Extended	104
Alternate Platform Altitude	69	Offset Corner Latitude Point 4	32	Sensor Field of View Name	63
Alternate Platform Ellipsoid Height	76	Offset Corner Longitude Point 1	27	Sensor Frame Rate Pack	127
Alternate Platform Ellipsoid Height Extended	105	Offset Corner Longitude Point 2	29	Sensor Horizontal Field of View	16
Alternate Platform Heading	71	Offset Corner Longitude Point 3	31	Sensor Latitude	13
Alternate Platform Latitude	67	Offset Corner Longitude Point 4	33	Sensor Longitude	14
Alternate Platform Longitude	68	On-board MI Storage Capacity	133	Sensor North Velocity	79
Alternate Platform Name	70	On-board MI Storage Percent Full	120	Sensor Relative Azimuth Angle	18
Altitude AGL	113	Operational Base	107	Sensor Relative Elevation Angle	19
Amend Local Set	101	Operational Mode	77	Sensor Relative Roll Angle	20
Broadcast Source	108	Outside Air Temperature	39	Sensor Roll Rate	119
Checksum	1	Payload List	138	Sensor True Altitude	15
Communications Method	135	Platform Angle of Attack	50	Sensor Vertical Field of View	17
Composite Imaging Local Set	99	Platform Angle of Attack (Full)	92	Slant Range	21
Control Command	115	Platform Call Sign	59	Static Pressure	37
Control Command Verification List	116	Platform Course Angle	112	Stream Designator	106
Corner Latitude Point 1 (Full)	82	Platform Designation	10	Take-off Time	131
Corner Latitude Point 2 (Full)	84	Platform Fuel Remaining	58	Target Error Estimate - CE90	45
Corner Latitude Point 3 (Full)	86	Platform Ground Speed	56	Target Error Estimate - LE90	46
Corner Latitude Point 4 (Full)	88	Platform Heading Angle	5	Target ID	129
Corner Longitude Point 1 (Full)	83	Platform Indicated Airspeed	9	Target Location Elevation	42
Corner Longitude Point 2 (Full)	85	Platform Magnetic Heading	64	Target Location Latitude	40
Corner Longitude Point 3 (Full)	87	Platform Pitch Angle	6	Target Location Longitude	41

Name	Tag	Name	Tag	Name	Tag
Corner Longitude Point 4 (Full)	89	Platform Pitch Angle (Full)	90	Target Track Gate Height	44
Correction Offset	137	Platform Roll Angle	7	Target Track Gate Width	43
Country Codes	122	Platform Roll Angle (Full)	91	Target Width	22
Density Altitude	38	Platform Sideslip Angle	52	Target Width Extended	96
Density Altitude Extended	103	Platform Sideslip Angle (Full)	93	Time Airborne	110
Deprecated	66	Platform Status	125	Transmission Frequency	132
Differential Pressure	49	Platform Tail Number	4	UAS Datalink LS Version Number	65
Event Start Time – UTC	72	Platform True Airspeed	8	View Domain	142
Frame Center Elevation	25	Platform Vertical Speed	51	VMTI Local Set	74
Frame Center Height Above Ellipsoid	78	Positioning Method Source	124	Wavelengths List	128
Frame Center Latitude	23	Precision Time Stamp	2	Waypoint List	141
Frame Center Longitude	24	Propulsion Unit Speed	111	Weapon Fired	61
Generic Flag Data	47	Radar Altimeter	114	Weapon Load	60
Geo-Registration Local Set	98	Range Image Local Set	97	Weapons Stores	140
Ground Range	57	Range To Recovery Location	109	Wind Direction	35
Icing Detected	34	Relative Humidity	55	Wind Speed	36
Image Coordinate System	12	RVT Local Set	73	Zoom Percentage	134
Image Horizon Pixel Pack	81	SAR Motion Imagery Local Set	95		
Image Source Sensor	11	SDCC-FLP	102		
Laser PRF Code	62	Security Local Set	48		
Leap Seconds	136	Segment Local Set	100		
MIIS Core Identifier	94	Sensor Azimuth Rate	117		

7.2 Platform and Sensor Position and Rotation Metadata

To better assist the understanding and interoperability of the UAS Datalink LS, this section describes the collective relationship among the multiple platform, sensor position, and rotation metadata items available within the UAS Datalink LS.

Together the platform location and attitude, along with the sensor relative pointing angles define the location of an image or image sequence (i.e., Motion Imagery). Metadata items for sensor location (Items 13, 14, and 15/75), platform rotations (Items 5, 6, 7), and sensor rotations (Items 18, 19, 20), along with Euler Angle order-of-operation rules are discussed in more detail in the subsections that follow.

7.2.1 Sensor Location

The metadata items associated with sensor location are:

1. Latitude - Sensor Latitude (Item 13)
2. Longitude - Sensor Longitude (Item 14)
3. Height - Sensor Altitude (Item 15), or Sensor Ellipsoid Height (Item 75), or Sensor Ellipsoid Height Extended (Item 104). Note: a single instantiation is preferred, which is Item 75 | Item 104, for HAE-based photogrammetric purposes.

7.2.2 Platform Rotations

The metadata items associated with platform attitude and rotations are:

1. Platform Yaw - Platform Heading Angle (Item 5)

The platform heading angle is defined as the angle between the platform longitudinal axis (line made by the fuselage) and true north measured in the horizontal plane. Angles increase in a clockwise direction when looking from above the platform. North is 0 degrees, east is 90, south is 180, and west is 270 degrees from true north.

2. Platform Pitch - Platform Pitch Angle (Item 6), or full-range Platform Pitch (Item 90)

The pitch angle of the platform is the angle between the longitudinal axis (line made by the fuselage) and the horizontal plane. Angles are positive when the platform nose is above the horizontal plane. Take special care for Platform Pitch angles equal to +/- 90.

3. Platform Roll - Platform Roll Angle (Item 7), or full-range Platform Roll (Item 91)

The rotation operation performed about the longitudinal axis forms the roll angle between the previous aircraft transverse-longitudinal plane and the new transverse axis location (line from wing tip to wing tip). Positive angles correspond to the starboard (right) wing lowered below the previous aircraft transverse-longitudinal plane.

7.2.3 Sensor Rotations

The metadata items associated with sensor rotations are:

1. Sensor Relative Yaw - Sensor Relative Azimuth Angle (Item 18)

The sensor relative azimuth angle is defined as the angle between the platform longitudinal axis (line made by the fuselage) and the sensor pointing direction, measured in the plane formed by the platform longitudinal and transverse axes (line from wing tip to wing tip). Angles increase in a clockwise direction when looking from above the platform, with 0 degrees forward along the longitudinal axis.

2. Sensor Relative Pitch - Sensor Relative Elevation Angle (Item 19)

The relative elevation angle of the sensor to the aircraft is the downward (or upward) pointing angle of the sensor relative to the plane formed by the longitudinal axis (line made by the fuselage) and the transverse axis (line from wing tip to wing tip). Sensor pointing angles below the platform longitudinal-transverse plane are negative.

3. Sensor Relative Roll - Sensor Relative Roll Angle (Item 20)

Sensors that can rotate their camera about the lens axis make use of this sensor relative roll angle. A roll angle of zero degrees occurs when the top and bottom edges of the captured image lie perpendicular to the plane created by the sensor relative depression angle axis. Positive angles are clockwise when looking from behind the camera.

7.2.4 Euler Angle Order of Operations

To properly determine the orientation of a sensor on an airborne platform using the UAS Datalink LS metadata items outlined in Section 7.2, a specific order of position and rotation angles must be followed. The order of operations required to determine a sensor’s orientation is as follows:

1. Move a sensor to the geodetic Latitude, Longitude, and Altitude using
    a. Item 13, Sensor Latitude

   b. Item 14, Sensor Longitude
   c. Item 15, Sensor Altitude (or Item 75: Sensor Ellipsoid Height or Item 104: Sensor Ellipsoid Height Extended). Note: a single instantiation is preferred, which is Item 75 | Item 104, for HAE-based photogrammetric purposes.
2. Convert the geodetic coordinates to a geocentric system, then use a local-level North-East-Down (NED, right hand rule) sensor orientation
3. Perform a Platform Rotation. Start with Yaw, then Pitch, the Roll.
   a. Item 5, Platform Heading Angle
   b. Item 6, Platform Pitch Angle
   c. Item 7, Platform Roll Angle

Refer to Figure 9 for the different platform rotations outlined in steps 2 and 3 above.

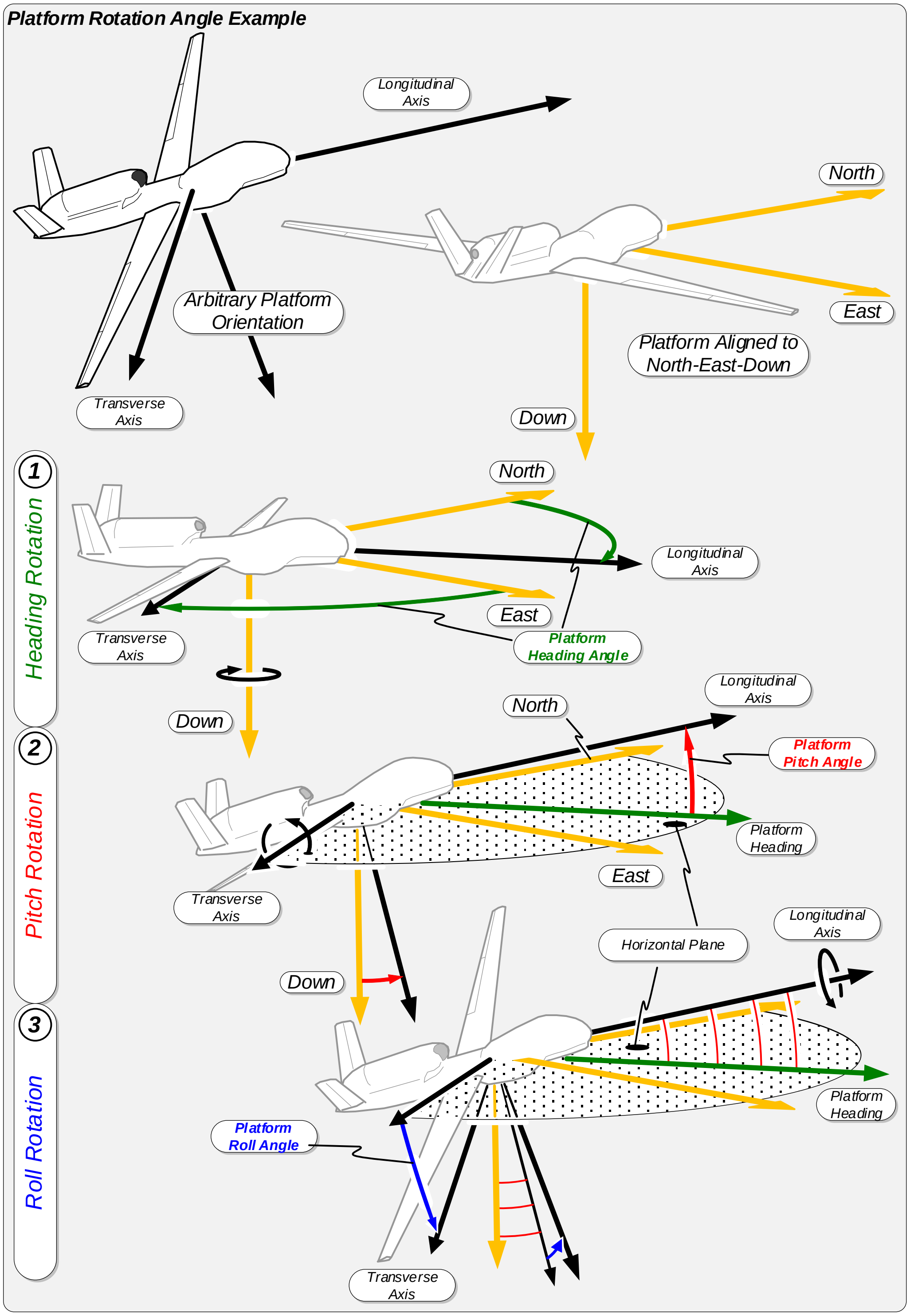

Figure 9 : Platform Rotation Angle Example

4. Perform a Sensor Rotation. Start with Yaw, then Pitch, then Roll
   a. Item 18, Sensor Relative Azimuth Angle
   b. Item 19, Sensor Relative Elevation Angle
   c. Item 20, Sensor Relative Roll Angle

Refer to Figure 10 for the different sensor rotations outlined in steps 4 above.

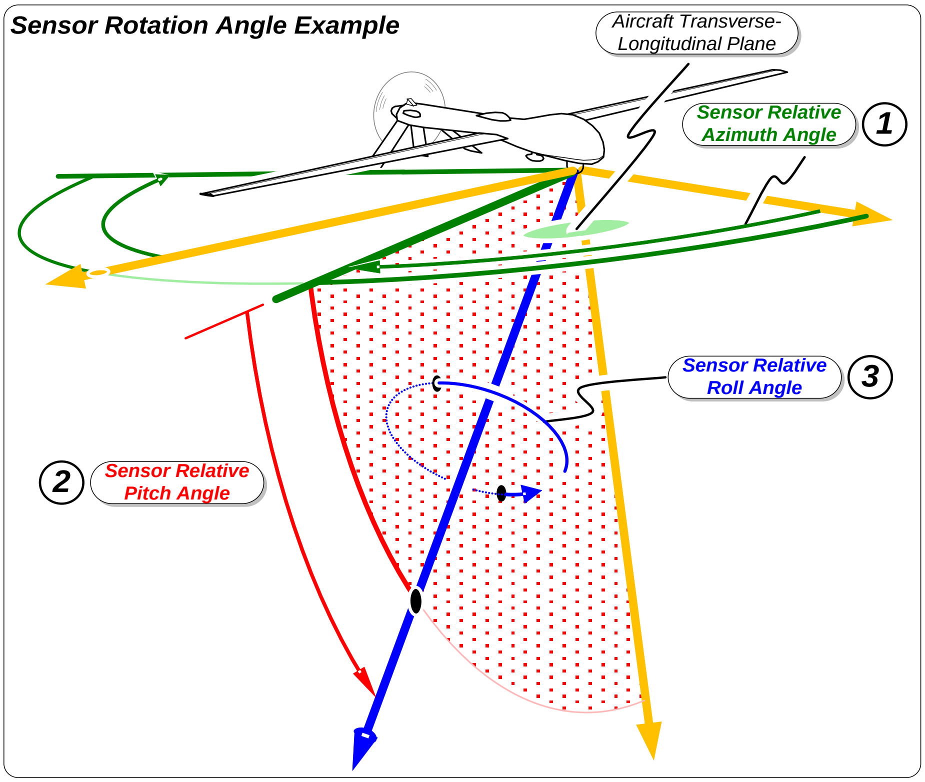

Figure 10 : Sensor Rotation Angle Example

Once the platform and sensor attitude are known, the user is free to use other metadata items like horizontal and vertical field of view to suit the purpose of an intended application.

7.3 Sensor Image Geographic Corner Metadata

Each pixel in a Motion Imagery frame represents a geographic point in the scene. Providing the coordinates for every pixel is difficult to compute and would require a large amount of bandwidth to transmit to receivers. Instead, the UAS Datalink LS includes a summary of the center and bounding area, or corner points, of the image. Figure 11 illustrates an example of corner-coordinate metadata as used in a Motion Imagery system.

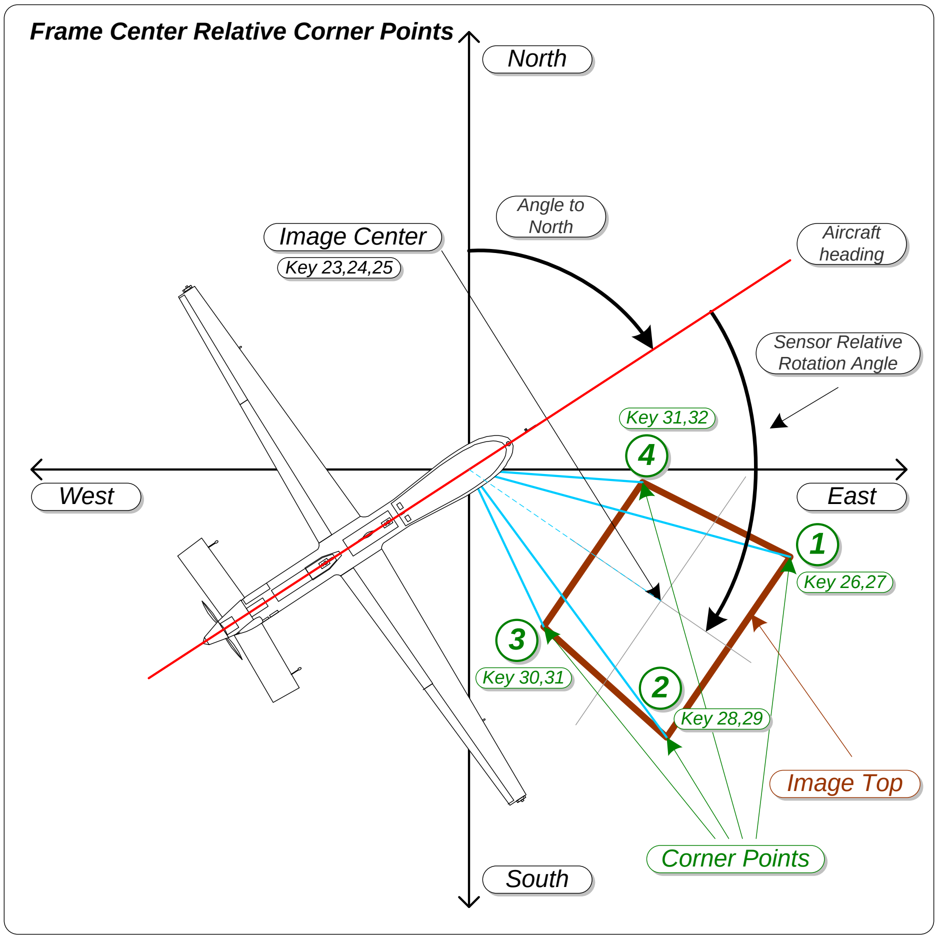

Figure 11: Corner Coordinate Metadata

The Sensor Image Corner Latitude/Longitude metadata consists of the items shown in Figure 12. The numbering of corner coordinates conforms to National Imagery Transmission Format (NITF) Standard numbering convention for single-image frame corner coordinates. See the NITF Standards document MIL-STD-2500 [10] for more information about corner coordinates. Corners not corresponding to geographic locations, i.e., above the horizon, are not included in the metadata since they are undefined.

The UAS Datalink LS provides two different methods for representing the corner coordinates which can provide either a savings in band width or provide an enhanced range. The two methods are absolute coordinates and relative to center point offsets.

Where absolute corner coordinates are known use Items 82-89. Figure 12 shows the mapping of absolute corner point coordinates to their respective items. Each Latitude and Longitude absolute corner point has one 8-byte floating point value corresponding to decimal degrees which covers the entire globe.

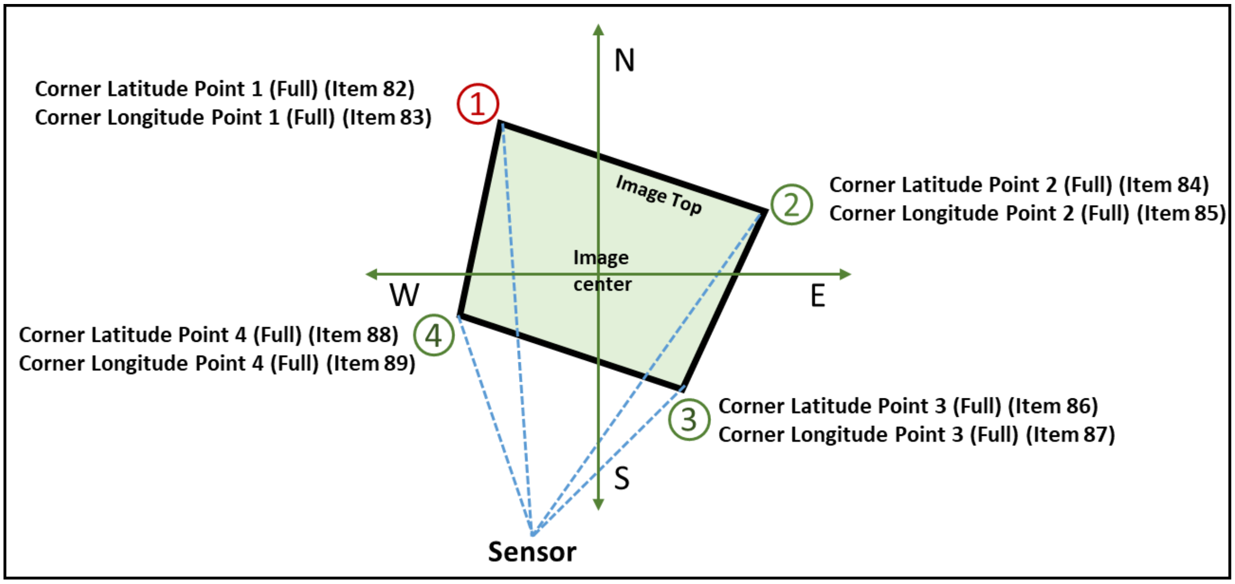

Figure 12: Corner Points Based on Absolute Positions

Where relative offsets from the Image center point are only available, compute the corner point coordinates using the Image center and its corner point offset information. Figure 13 shows this situation where the red interior lines indicate offsets from the Image center point to each respective corner point coordinate. The UAS Datalink LS Items 26-33 make use of Offset Corner Point metadata items and requires addition with the Frame Center coordinates to determine the actual corner points.

The UAS Datalink LS Offset Corner Points use a mapped 2-byte signed integer, which is converted to a decimal and added as an offset to the respective decimal representation of LS Frame Center Latitude or Longitude to determine the actual corner point. This offset method only covers a finite area about an image center point (16.6km x 16.6km square area at the Equator) yet still adequately represents a typical Motion Imagery sequence, while it conserves significant bandwidth over specification using absolute position information.

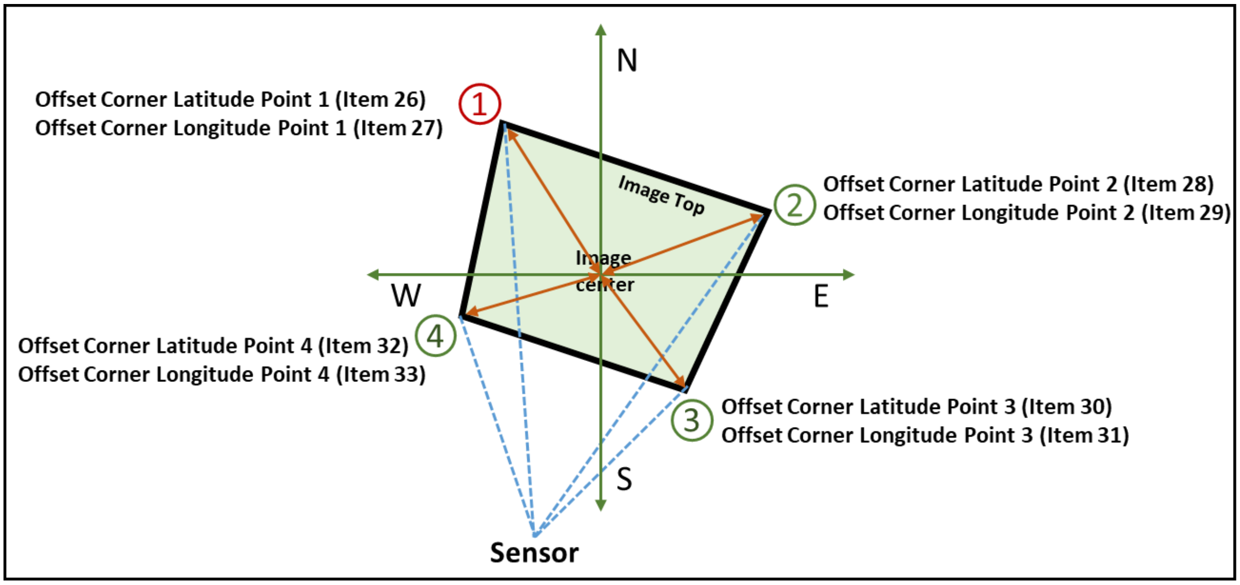

Figure 13: Corner Points Calculated Using Offsets from Image Center

SAR imagery uses the same UAS Datalink LS Items as described above, but the positions of the corner points is different for SAR imagery as is shown in Figure 14. Either the absolute or relative specification of the corner points can be used, but their interpretation of position is different.

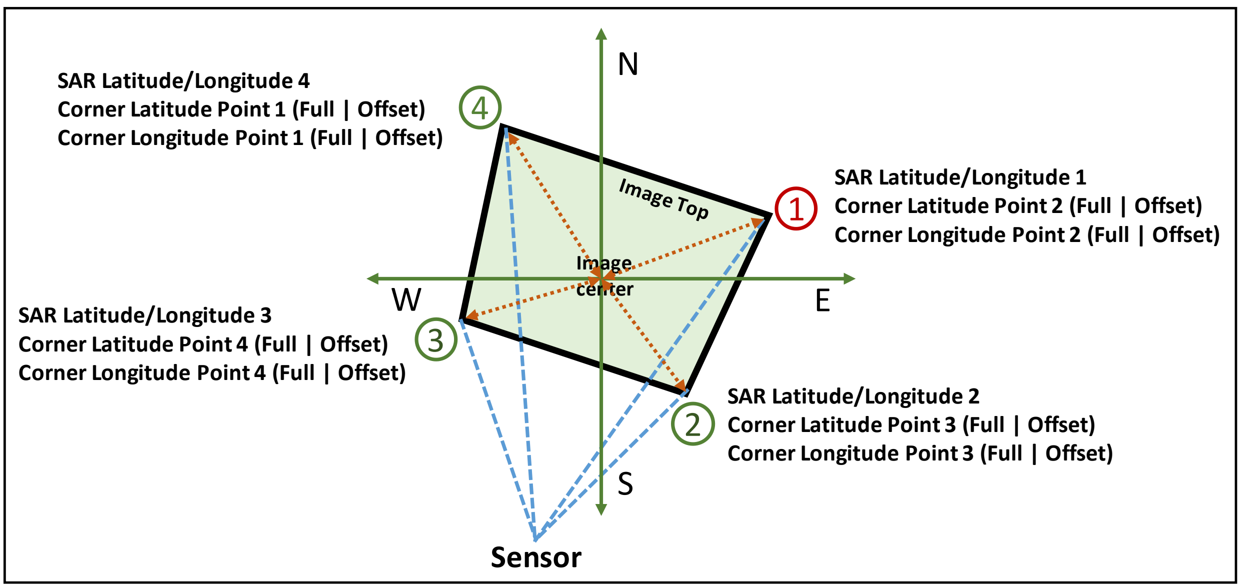

Figure 14: Corner Points Ordering for SAR

7.4 Alternate Platform Guideline

Within the UAS Datalink LS there are multiple metadata items which provide position and other relevant data about an “Alternate Platform.” These items differ from the “Platform” or “Sensor” metadata in that the “Alternate Platform” items provide no position or attitude information about an image sequence to which a UAS Datalink LS stream is tied.

Whenever a Motion Imagery stream is created (i.e., a binary sequence typically containing metadata (i.e., UAS Datalink LS) along with compressed Motion Imagery encapsulated in an MPEG-2 transport stream), the sensor and platform metadata items directly relate to the imagery acquired on the platform, whereas the “Alternate Platform” items describe an external platform.

For instance, suppose Platform B is receiving a Motion Imagery stream from Platform A. The metadata Platform B receives would describe where Platform A is, as well as its sensor’s pointing angles. If Platform A also includes “Alternate Platform” metadata, those metadata fields would represent position data for Platform C, or D, or even Platform B, but in any case, Platform A does not represent itself using “Alternate Platform” items.

“Alternate Platform” items do not directly describe Motion Imagery collected by an alternate platform, but rather aid situational awareness through metadata to Motion Imagery collected by a host platform.

7.5 Special Values

Various MISB ST 0601 metadata items allow special values or special bit-pattern representations to signal a condition. These include: “Out of Range” or “N/A (Off-Earth)” and “Reserved.”

The “Out of Range” special value signals an item’s value exceeds its defined range. As an example, some angles within this standard (such as platform pitch and roll) use mapped-integer values lying between a maximum and minimum angular value.

Requirement	
ST 0601.13-27	When a value recedes below its minimum or exceeds its maximum range and the item allows an ‘Out of Range’ special value, the ‘Out of Range’ special value shall be used.

The “N/A (Off-Earth)” special value signals a latitude or longitude value is not computable because the sensor is not pointing on the earth. For example, if a sensor performs a self-inspection of the platform (e.g., check for ice on the wings) the center point latitude and longitude are not valid points on the earth.

Requirement	
ST 0601.13-28	When a position consisting of a latitude/longitude moves beyond the surface of the earth and the item allows an ‘N/A (Off-Earth)’ special value, the ‘N/A (Off-Earth)’ special value shall be used.

Systems receiving MISB ST 0601 metadata will need to check for “Out of Range” or “N/A (Off-Earth)” values prior to using the data value in computation or for display.

For historical reasons, the "Reserved" value maintains backward compatibility with older versions of MISB ST 0601.

7.6 Segment LS and Amend LS within the UAS Datalink LS

New use cases require changing, adding, and sharing of one or more items within a metadata set. The Segment LS-Tag 100 enables defining shared common metadata items, while reusing metadata items in describing multiple unique image areas within an image (see for example, the Composite Imaging LS). The Amend LS-Tag 101 enables editing, adding, and deleting metadata, while preserving existing metadata (see for example, the Geo-Registration LS). The Motion Imagery Handbook discusses the theory underlying these Local Set constructs, while MISB ST 1607 [11] provides guidance in their use.

8 UAS Datalink LS Item Details

This section provides detailed information on each metadata item including information about their use along with a software and a KLV format mapping. The software format is the format of the value within a computer program (e.g., float, double, int), while the KLV format (e.g., mapped floating point, IMAP) is the bit-efficient representation when transmitting the metadata.

The left side of Figure 15 illustrates metadata items (Time, Position, etc.) represented in common software formats (int, float, etc.). A metadata encoder (e.g., computer, sensor, or Motion Imagery encoder) encodes the Software Format values into their binary KLV Format (Item 1, Item 2, etc.). The KLV Format metadata along with the Motion Imagery are transmitted to one or more receivers which decode the KLV Format metadata back into Software Format values for display, computation, or other uses as shown in the right side of the figure.

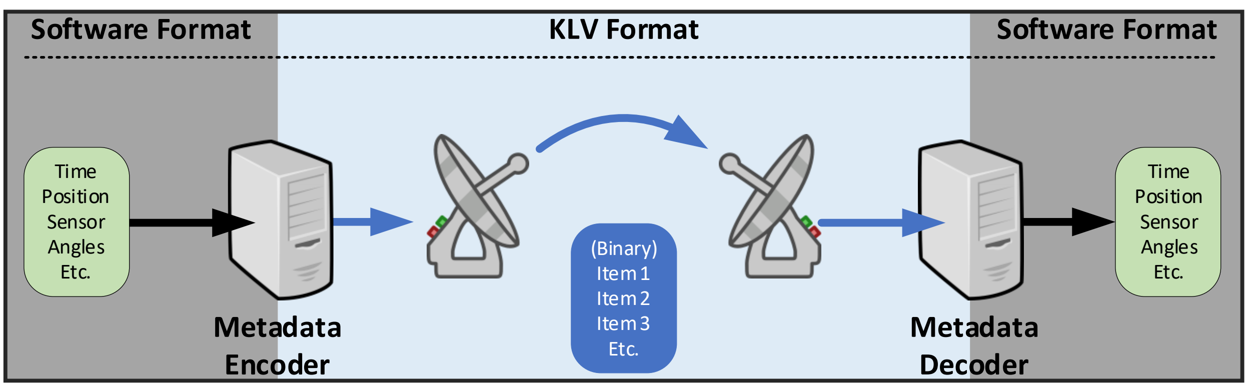

Figure 15: Illustration of Software Format and KLV Format usage

In each metadata item's subsection below, an item "summary table" presents the item's information followed by examples or further detail as needed. Each summary table contains the following information:

- **Description** – A brief description of the item's meaning.
- **Units** – The units used for measured items. "None" indicates the item is not a measured quantity.

- **Format (Software)** – The data format used within a software application to represent the value of an item. Formats are:
  - byte – One or more bytes which represent a binary value
  - int8 – 8-bit, 2's complement signed integer
  - int16 – 16-bit, 2's complement signed integer
  - int32 – 32-bit, 2's complement signed integer
  - int64 – 64-bit, 2's complement signed integer
  - uint8 – 8-bit, unsigned integer – i.e., single byte
  - uint16 – 16-bit unsigned short
  - uint32 – 32-bit unsigned integer
  - uint64 – 64-bit unsigned long
  - float32 – 32-bit IEEE 754 floating point value
  - float64 – 64-bit IEEE 754 floating point value
  - string – A list of characters
  - record – A data structure of related values
  - list – A list of values
  - N/A – Not Applicable
- **Min (Software)** – Specifies the minimum value allowed for the value
- **Max (Software)** – Specifies the maximum value allowed for the value
- **Format (KLV)** – The data format used within the KLV Local Set. Formats are:
  - int – Variable length, 2's complement signed integer
  - int8 – 8-bit, 2's complement signed integer
  - int16 – 16-bit, 2's complement signed integer
  - int32 – 32-bit, 2's complement signed integer
  - uint – Variable length unsigned integer
  - uint8 – 8-bit, unsigned integer – i.e., single byte
  - uint16 – 16-bit unsigned short
  - uint32 – 32-bit unsigned integer
  - uint64 – 64-bit unsigned long
  - IMAPB – Mapping using the IMAPB method (see MISB ST 1201 [12])
  - byte – One or more bytes which represent a binary value
  - dlp – Defined length pack
  - vlp – Variable length pack
  - flp – Floating length pack
  - set – Local Set
  - utf8 – String of characters following the utf8 standard
- **Min (KLV)** – Specifies the minimum value allowed for the value. When mapping values the Min(KLV) can be very different than the Min(Software).
- **Max (KLV)** – Specifies the maximum value allowed for the value. When mapping values the Max(KLV) can be very different than the Max(Software).
- **Offset (KLV)** – specifies the offset used when mapping between software and KLV formats
- **Length** – specifies the nominal length to use. If Required Length has a value other than "N/A" then the length will equal the Required Length. A length of "Variable" means the length is determined at run-time for the Tag-Length-Value item.
- **Max Length** – specifies the recommended maximum length. With some items the

underlying standard or data structure does not have a limit. If the Max Length is not determinable it will have a value of "Not Limited." Network guards may use this value as a check to prevent data leaks.

- **Required Length** – specifies a required length if one exists. With a required length the value portion of the Tag-Length-Value is not to exceed the number of required length bytes nor the value be less than the required length. See requirement below.
- **Resolution** – specifies the smallest representative values in the KLV format. With variable length values a list of resolutions based on the length is provided.
- **Special Values** – specifies signaling values for numeric values, such as "Out of Range" or "N/A (Off-Earth)," if they exist for the item. A Special Value listed as "None" indicates there are no special values, currently, for the item. A Special Value listed as "N/A" indicates special values do not apply to the item because it is not a numeric value (e.g., a string or set are not numeric items).
- **Allowed in SDCC Pack** – a Yes or No indication if the item is allowed in a Standard Deviation Cross Correlation (SDCC) Pack. Yes, indicates the item is allowed in the SDDC Pack.
- **Multiples Allowed –** a Yes or No indication if multiple instances of the item are allowable in a single instantiation of a UAS Datalink LS. Yes, indicates multiple instances of the item may be in the LS.
- **Software Value to KLV Value** – Defines the method (i.e., an equation) of converting from a Software Value to its KLV Value.
    - IMAPB represents the forward mapping of a Software Value to a KLV Value using the min, max, length and [soft] value.
- **KLV Value to Software Value** – Defines the method (i.e., an equation) of converting from a KLV Value to its Software Value. The KLV Value bit pattern in each equation is interpretable in diverse ways. KLV_{uint} means to interpret the value as an unsigned integer. KLV_{int} means to interpret the value as a two's complement integer. KLV_{val} means to interpret as a byte (or utf8 character).
    - RIMAPB represents the reverse mapping of a KLV Value to its Software Value using the min, max, length and [KLV] value.
- **Example Software Value** – Example value in the native format of the value.
- **Example KLV Value** – Example of the Tag-Length-Value after encoding the Software value. The tag and length are in base 10 and prefixed with "0d," while the value is in base 16 (i.e., hex) and prefixed with "0x."
- The bottom section of the summary table provides notes, clarification, purpose, or other information about the metadata item.

Requirement	
ST 0601.13-29	When a metadata item has a *Required Length* numerically specified in this standard, the KLV encoded value for the item shall use exactly the number of bytes specified by the Required Length.

Programmer's Notes: the "Example Value" for an item is shown in full precision, beyond an items' resolution, so programmers can verify they are using the right formulas. The number of significant digits expressed is determined as follows:

1) The dynamic range and the precision needed determines the number of bits in an integer.
2) The precision and the maximum value determines the type of value to use (single precision float vice double).
3) The type of value determines the number of digits (7 to 9 for single, 15 to 17 for double) needed. Nine- and 17-digits account for any rounding issues in the final digits. The final one or two digits may be different for different complier optimization/hardware.

8.1 Item 1: Checksum

Description						
Checksum used to detect errors within a UAS Datalink LS packet						
Units		**Format**	**Min**	**Max**	**Offset**	
None	**Software**	uint16	0	(2^16)-1		
	KLV	uint16	0	(2^16)-1	N/A	
Length		**Max Length**		**Required Length**		
2		2		2		
Resolution		**Special Values**				
N/A		None				
Required in LS?	Mandatory	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No	

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
0x8C ED	01	02	8CED

- Lower 16-bits of summation
- Performed on entire LS packet, including 16-byte US key and 1-byte checksum length
- Checksum is mandatory in every UAS Datalink LS packet

8.1.1 Details

8.1.1.1 Example 16-bit Checksum Code

```
unsigned short bcc_16 (
  unsigned char * buff, //Pointer to the first byte in the 16-byte UAS Datalink LS key.
  unsigned short len )  //Length from 16-byte US key up to 1-byte checksum length.
{
  unsigned short bcc = 0, i;  // Initialize Checksum and counter variables.
  for ( i = 0 ; i < len; i++)
    bcc += buff[i] << (8 * ((i + 1) % 2));
  return bcc;
}  // end of bcc_16 ()
```

8.1.1.2 Sample Checksum Data

```
64 bits to checksum: 060E 2B34 0200 81BB

         060E
       + 2B34
         3142
       + 0200
         3342
       + 81BB
         B4FD <-- Final Checksum
```

8.2 *Item 2: Precision Time Stamp*

Description					
Timestamp for all metadata in this Local Set; used to coordinate with Motion Imagery					
Units		**Format**	**Min**	**Max**	**Offset**
Microseconds (µs)	**Software**	uint64	0	(2^64)-1	
	KLV	uint64	0	(2^64)-1	N/A

Length	Max Length	Required Length
8	8	8

Resolution	Special Values
1 microsecond	None

Required in LS?	Allowed in SDCC Pack?	Multiples Allowed?
Mandatory	No	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
Oct. 24, 2008. 00:13:29.913	02	08	0004 59F4 A6AA 4AA8

- Represented in the number of microseconds elapsed since midnight (00:00:00), January 1,1970 not including leap seconds. See MISB ST 0603
- Precision Time Stamp is mandatory in every UAS Datalink LS packet

8.2.1 Details

This metadata item is an implementation of the MISP Time System. This item represents time as the number of microseconds elapsed since January 1, 1970 (1970-01-01T00:00:00Z) using an unsigned eight (8) byte integer. A Precision Time Stamp discretely labels a scale of time. <u>The Precision Time Stamp does not include leap seconds and therefore the Precision Time Stamp does not represent UTC.</u>

The Precision Time Stamp is critical for synchronizing metadata to the Motion Imagery by correlating it to a Precision Time Stamp embedded in the Motion Imagery. See Section 6.4 for further information about the usage and importance of the Precision Time Stamp in UAS Datalink Local Set.

8.3 Item 3: Mission ID

Description					
Descriptive mission identifier to distinguish event or sortie					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	127	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
MISSION01	03	09	4D49 5353 494F 4E30 31

- Value field is Free Text
- Suggested maximum: 127 characters
- Format and contents of a Mission ID are mission dependent

8.4 Item 4: Platform Tail Number

Description					
Identifier of platform as posted					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	127	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
AF-101	04	06	4146 2D31 3031

- E.g.: "AF008," "BP101," etc.
- Value field is Free Text
- Suggested maximum: 127 characters
- Format and contents of a Platform Tail Number are mission dependent

8.5 Item 5: Platform Heading Angle

Description					
Aircraft heading angle					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	0	360	
	KLV	uint16	0	(2^16)-1	None

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~5.5 millidegrees	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{65535}\right) * \mathrm{KLV_{int}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
159.974365 Degrees	05	02	71C2

- Relative between longitudinal axis and True North measured in the horizontal plane
- Map 0..(2^16)-1 to 0..360

8.5.1 Details

The platform heading angle is defined as the angle between longitudinal axis (line made by the fuselage) and true north measured in the horizontal plane. Angles increase in a clockwise direction when looking from above the platform. North is 0 degrees, east is 90, south is 180, and west is 270 degrees from true north. Refer to Figure 16:

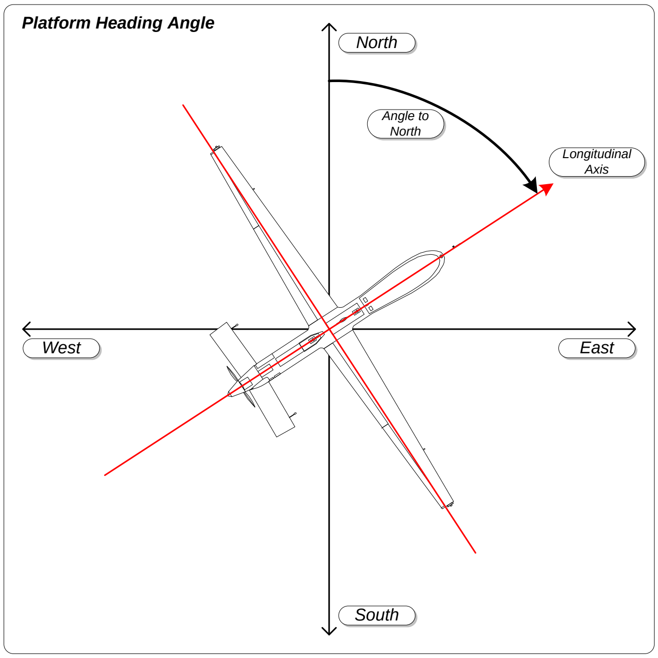

Figure 16: Platform True Heading Angle

8.6 Item 6: Platform Pitch Angle

Description					
Aircraft pitch angle					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float32	-20	20	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~610 microdegrees	0x8000 = "Out of Range" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{40}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{40}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-0.431531724 Degrees	06	02	FD3D

- Angle between longitudinal axis and horizontal plane
- Positive angles above horizontal plane
- Map -((2^15)-1)..(2^15)-1 to +/-20
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.6.1 Details

For legacy purposes, both range-restricted (Item 6) and full-range (Item 90) representations of Platform Pitch Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the full-range version (Item 90) as per Section 6.1.

The pitch angle of the platform is the angle between the longitudinal axis (line made by the fuselage) and the horizontal plane. Angles are positive when the platform nose is above the horizontal plane (see Figure 17). Pitch angles are limited to +/- 20 degrees to increase metadata resolution within this range.

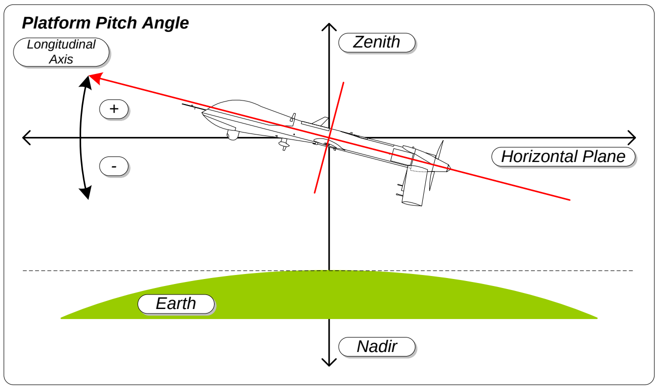

Figure 17: Platform Pitch Angle

8.7 Item 7: Platform Roll Angle

Description					
Platform roll angle					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float32	-50	50	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1525 microdegrees	0x8000 = "Out of Range" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{100}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{100}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
3.40586566 Degrees	07	02	08B8

- Angle between transverse axis and transverse-longitudinal plane
- Positive angles for lowered right wing
- Map -((2^15)-1)..(2^15)-1 to +/-50
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.7.1 Details

For legacy purposes, both range-restricted (Item 7) and full-range (Item 91) representations of Platform Roll Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the full-range version (Item 91) as per Section 6.1.

The rotation operation performed about the longitudinal axis forms the roll angle between the previous aircraft transverse-longitudinal plane and the new transverse axis location (line from wing tip to wing tip). Positive angles correspond to the starboard (right) wing lowered below the previous aircraft transverse-longitudinal plane (see Figure 18). Roll angles are limited to +/- 50 degrees to increase metadata resolution within this range.

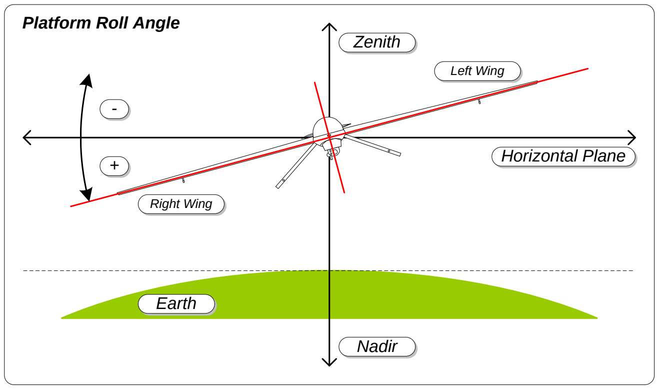

Figure 18: Platform Roll Angle

8.8 Item 8: Platform True Airspeed

Description					
True airspeed (TAS) of platform					
Units		**Format**	**Min**	**Max**	**Offset**
Meters/Second (m/s)	**Software**	uint8	0	255	
	KLV	uint8	0	255	None
Length	**Max Length**	**Required Length**			
1	1	1			
Resolution	**Special Values**				
1 meter/second	None				
Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = Soft_{Val}$
KLV Value To Software Value	$Soft_{val} = KLV_{int}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
147 Meters/Second	08	01	93

- Indicated Airspeed adjusted for temperature and altitude
- 1 m/s = 1.94384449 knots

8.8.1 Details

True airspeed is the actual speed an aircraft is traveling relative to the air mass in which it travels. Without a relative wind condition, the true airspeed is equal to the speed over the ground. The calculation of an aircraft's true airspeed uses the outside temperature, impact pressure (pitot tube), and static pressure.

8.9 *Item 9: Platform Indicated Airspeed*

Description					
Indicated airspeed (IAS) of platform					
Units		**Format**	**Min**	**Max**	**Offset**
Meters/Second (m/s)	**Software**	uint8	0	255	
	KLV	uint8	0	255	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
1 meter/second	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
159 Meters/Second	09	01	9F

- Derived from Pitot tube and static pressure sensors
- 1 m/s = 1.94384449 knots

8.9.1 Details

The indicated airspeed of an aircraft is calculated from the difference between static pressure, and impact pressure. Static pressure is measured by a sensor not directly in the air stream and impact pressure is measured by a Pitot tube positioned strategically within the air stream. The difference in pressure while moving provides a way to calculate the indicated platform airspeed.

8.10 *Item 10: Platform Designation*

Description					
Model name for the platform					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	127	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
MQ1-B	0A	05	4D51 312D 42

- e.g.: 'Predator', 'Reaper', 'Outrider', 'Pioneer', 'IgnatER', 'Warrior', 'Shadow', 'Hunter II', 'Global Hawk', 'Scan Eagle', etc
- Value field is Free Text
- Suggested maximum: 127 characters

8.10.1 Details

The platform designation metadata item distinguishes which platform is carrying the Motion Imagery generating payload equipment. Figure 19 shows example platforms.

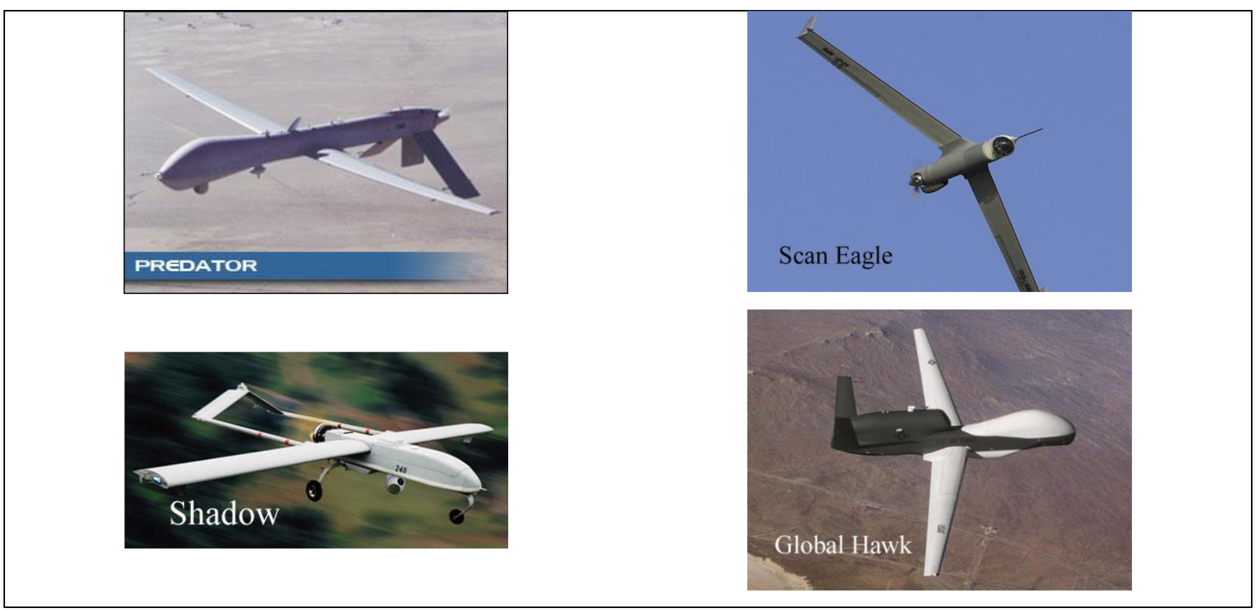

Figure 19: Example Platforms

8.11 Item 11: Image Source Sensor

Description					
Name of currently active sensor					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	127	N/A

Resolution	**Special Values**
N/A	N/A

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
EO	0B	02	454F

- E.g.: 'EO Nose', 'EO Zoom (DLTV)', 'EO Spotter', 'IR Mitsubishi PtSi Model 500', 'IR InSb Amber Model TBT', 'LYNX SAR Imagery', 'TESAR Imagery', etc.
- Value field is Free Text
- Suggested maximum: 127 characters

8.11.1 Details

Figure 20 shows a sample imaging source sensor configuration. In this example there are three image sensors: EO Narrow, EO Wide, and IR Sensor. One of these sensors is active at a time and the Image Source Sensor would indicate which one is active.

Figure 20: Sample Imaging Sensor

8.12 Item 12: Image Coordinate System

Description					
Name of the image coordinate system used					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A
Length	**Max Length**		**Required Length**		
Variable	127		N/A		
Resolution	**Special Values**				
N/A	N/A				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
WGS-84	0C	06	5747 532D 3834

- E.g.: 'Geodetic WGS84', 'Geocentric WGS84', 'None'
- Suggested maximum 127 characters

8.12.1 Details

8.12.1.1 World Geodetic System – 1984 (WGS 84)

The World Geodetic System of 1984 (WGS 84) is a 3-D, Earth-centered reference system developed originally by the U.S. Defense Mapping Agency. This system is the official GPS reference system.

8.12.1.2 Notes and Clarification

As of MISB ST 0601.4, a reference to "DIGEST V2.1 Part 3 Sec 6.4" within the UAS LS section has been removed because of the reference's inapplicability to the Image Coordinate System metadata item. "Geodetic WGS84" is the preferred Image Coordinate System. Other values are provided for sake of completeness to map items between legacy metadata sets.

8.13 Item 13: Sensor Latitude

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Sensor latitude</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td>-90</td><td>90</td><td></td></tr>
<tr><th>KLV</th><td>int32</td><td>-((2^31)-1)</td><td>(2^31)-1</td><td>None</td></tr>
<tr><th>Length</th><th colspan="3">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td>4</td><td colspan="3">4</td><td colspan="2">4</td></tr>
<tr><th>Resolution</th><th colspan="5">Special Values</th></tr>
<tr><td>~42 nanodegrees</td><td colspan="5">0x80000000 = "Reserved"</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>Yes</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th>Software Value To KLV Value</th><td colspan="5">$\mathrm{KLV}_{\mathrm{val}} = \left(\frac{4294967294}{180}\right) * \mathrm{Soft}_{\mathrm{val}}$</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="5">$\mathrm{Soft}_{\mathrm{val}} = \left(\frac{\mathrm{LS}_{\mathrm{range}}}{\mathrm{int}_{\mathrm{range}}}\right) * \mathrm{KLV}_{\mathrm{int}} = \left(\frac{180}{4294967294}\right) * \mathrm{KLV}_{\mathrm{int}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">60.176822966978335 Degrees</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>0D</td><td>04</td><td>5595 B66D</td></tr>
<tr><td colspan="6">

- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90

</td></tr>
</table>

8.13.1 Details

Latitude is the angular distance north or south of the earth's equator, measured in degrees along a meridian. Generated from GPS/INS information and based on the WGS84 coordinate system.

In a realized system, this item accounts for the lever arm distance between a platform's GPS antenna (or known central platform position) to a sensor's general location (like the center of a gimbaled sensor).

While accounting for a lever arm in this way is sufficient in many Motion Imagery systems, the MISB recommends exploring the use of Photogrammetric metadata sets (i.e., MISB ST 0801 [13]) for improved representations of system accuracies.

8.14 Item 14: Sensor Longitude

<table>
<tr><th colspan="8">Description</th></tr>
<tr><td colspan="8">Sensor longitude</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th colspan="2">Min</th><th colspan="2">Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td colspan="2">-180</td><td colspan="2">180</td><td></td></tr>
<tr><th>KLV</th><td>int32</td><td colspan="2">-((2^31)-1)</td><td colspan="2">(2^31)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="3">Max Length</th><th colspan="3">Required Length</th></tr>
<tr><td colspan="2">4</td><td colspan="3">4</td><td colspan="3">4</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="6">Special Values</th></tr>
<tr><td colspan="2">~84 nanodegrees</td><td colspan="6">0x80000000 = "Reserved"</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th colspan="2">Allowed in SDCC Pack?</th><td>Yes</td><th colspan="2">Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="6">$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="6">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$</td></tr>
<tr><th colspan="4" rowspan="2">Example Software Value</th><th colspan="4">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th colspan="2">Value</th></tr>
<tr><td colspan="4">128.42675904204452 Degrees</td><td>0E</td><td>04</td><td colspan="2">5B53 60C4</td></tr>
<tr><td colspan="8">• Based on WGS84 ellipsoid
• Map -((2^31)-1)..(2^31)-1 to +/-180</td></tr>
</table>

8.14.1 Details

Longitude is the angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England, to the meridian passing through a position of interest. Generated from GPS/INS information and based on the WGS84 coordinate system.

In a realized system, this item accounts for the lever arm distance between a platform's GPS antenna (or known central platform position) to a sensor's general location (like the center of a gimbaled sensor).

While accounting for a lever arm in this way is sufficient in many Motion Imagery systems, the MISB recommends exploring the use of Photogrammetric metadata sets (i.e., MISB ST 0801) for improved representations of system accuracies.

8.15 *Item 15: Sensor True Altitude*

Description					
Altitude of sensor as measured from Mean Sea Level (MSL)					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900
Length		**Max Length**		**Required Length**	
2		2		2	
Resolution		**Special Values**			
~0.3 meters		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{19900}\right) * (\mathrm{Soft_{val}} + 900)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} - \mathrm{Offset} = \left(\frac{19900}{65535}\right) * \mathrm{KLV_{uint}} - 900$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
14190.7195 Meters	0F	02	C221

- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.15.1 Details

For legacy systems, Item 15 and Item 75 | Item 104 are allowed with preference for Item 75 | Item 104.

True altitude is the true vertical distance above mean sea level.

For improved modeling accuracy use Sensor Ellipsoid Height (Item 75) or Sensor Ellipsoid Height Extended (Item 104).

In a realized system, this LS item accounts for the lever arm distance between a platform's GPS antenna (or known central platform position) to a sensor's general location (like the center of a gimbaled sensor).

While accounting for a lever arm in this way is sufficient in many Motion Imagery systems, the MISB recommends exploring the use of Photogrammetric metadata sets (i.e., MISB ST 0801) for improved representations of system accuracies.

8.16 Item 16: Sensor Horizontal Field of View

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Horizontal field of view of selected imaging sensor</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float32</td><td>0</td><td>180</td><td></td></tr>
<tr><th>KLV</th><td>uint16</td><td>0</td><td>(2^16)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">2</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~2.7 millidegrees</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>Yes</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV_{val}} = \left(\frac{65535}{180}\right) * \mathrm{Soft_{val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{180}{65535}\right) * \mathrm{KLV_{uint}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">144.571298 Degrees</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>10</td><td>02</td><td>CD9C</td></tr>
<tr><td colspan="6">• Map 0..(2^16)-1 to 0..180</td></tr>
</table>

8.16.1 Details

The field of view of a lens is defined as the angle over the focal plane where objects are recorded on a film or electro-optical sensor. Field of view is dependent upon the focal length of the lens, and the physical size of the sensor. Typical imaging devices have a square or rectangular imaging sensor. The image (or sequence of images) is typically captured as a square or rectangle and displayed to a user with image edges perpendicular to level sight.

The distance between left edge and right edge is represented as an angle in the horizontal field of view metadata item. Refer to Figure 21.

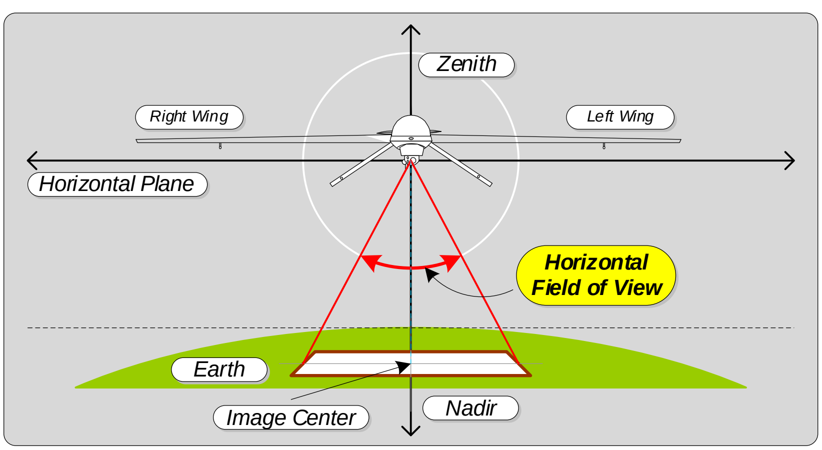

Figure 21: Horizontal Field of View

8.17 Item 17: Sensor Vertical Field of View

Description					
Vertical field of view of selected imaging sensor					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	0	180	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~2.7 millidegrees	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{180}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{180}{65535}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
152.643626 Degrees	11	02	D917

- Map 0..(2^16)-1 to 0..180

8.17.1 Details

The field of view of a lens is defined as the angle over the focal plane where objects are recorded on a film or electro-optical sensor. Field of view is dependent upon the focal length of the lens, and the physical size of the sensor. Typical imaging devices have a square or rectangular imaging sensor. The image (or sequence of images) is typically captured as a square or rectangle and displayed to a user with image edges perpendicular to level sight.

The distance between top edge and bottom edge is represented as an angle in the vertical field of view metadata item. Refer to Figure 22.

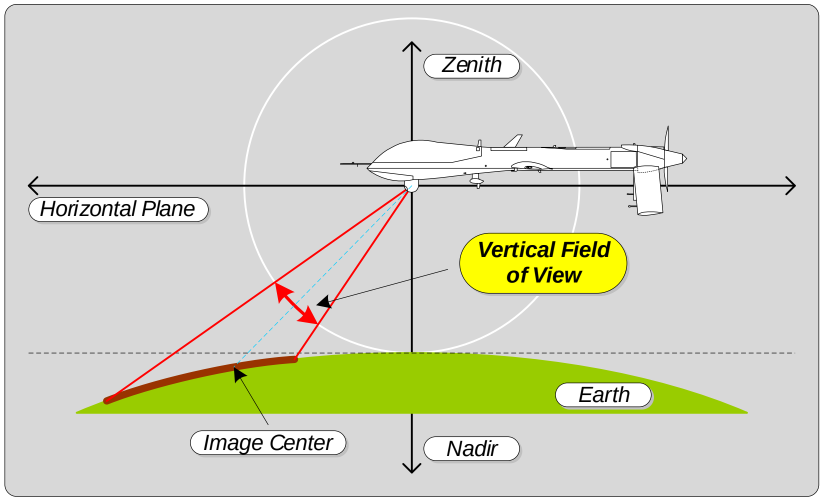

Figure 22: Vertical Field of View

8.18 *Item 18: Sensor Relative Azimuth Angle*

Description
Relative rotation angle of sensor to platform longitudinal axis

Units		Format	Min	Max	Offset
Degrees (°)	**Software**	float64	0	360	
	KLV	uint32	0	(2^32)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967295}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{360}{4294967295}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
160.71921143697557 Degrees	12	04	724A 0A20

- Rotation angle between platform longitudinal axis and camera pointing direction as seen from above the platform
- Map 0..(2^32)-1 to 0..360

8.18.1 Details

The relative azimuth angle of a sensor is the angle formed between the platform longitudinal axis (line made by the fuselage) and the sensor pointing direction as measured in the plane formed by the platform longitudinal and transverse axis (line from wing tip to wing tip). Refer to Figure 23.

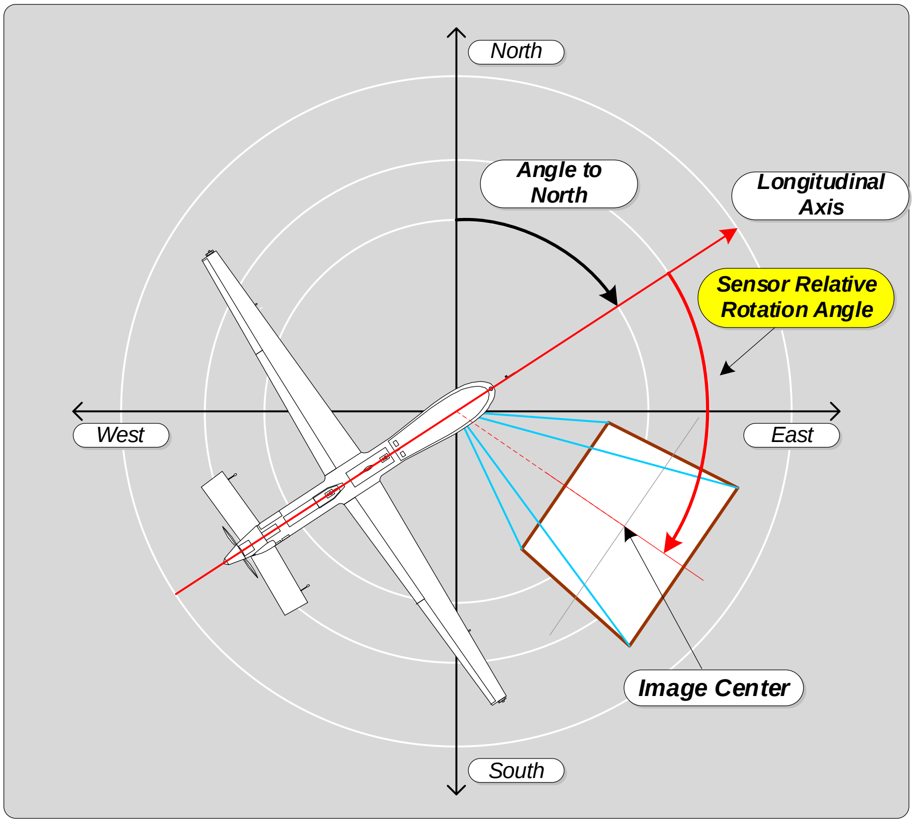

Figure 23: Relative Rotation Angle

8.19 Item 19: Sensor Relative Elevation Angle

Description					
Relative elevation angle of sensor to platform longitudinal-transverse plane					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	0x80000000 = "Reserved"

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{360}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{360}{4294967294}\right) * KLV_{int}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-168.79232483394085 Degrees	13	04	87F8 4B86

- Negative angles down
- Map -((2^31)-1)..(2^31)-1 to +/-180

8.19.1 Details

The relative elevation angle of a sensor to the aircraft is the downward (or upward) pointing angle of the sensor relative to the plane formed by the longitudinal axis (line made by the fuselage) and the transverse axis (line from wing tip to wing tip). Sensor pointing angles below the platform longitudinal-transverse plane are negative. Refer to Figure 24:

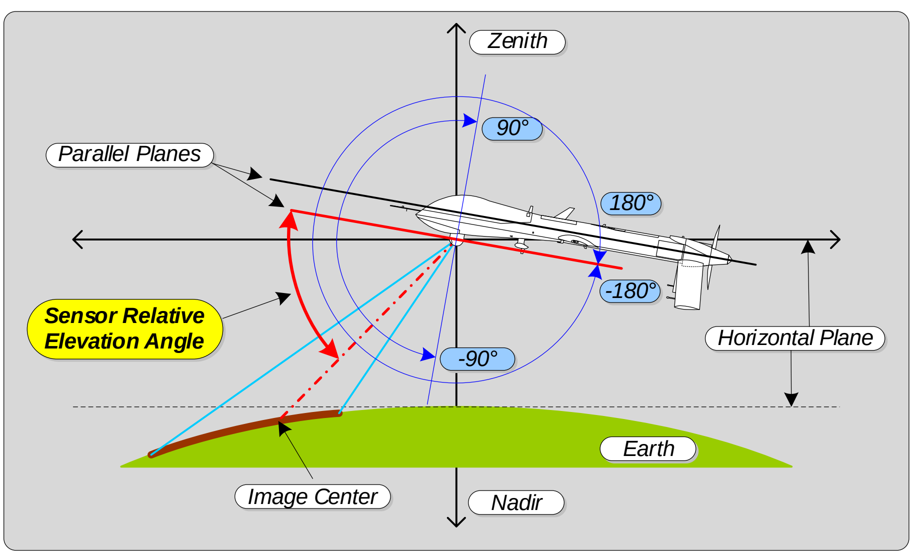

Figure 24: Sensor Relative Elevation Angle

8.20 Item 20: Sensor Relative Roll Angle

Description					
Relative roll angle of sensor to aircraft platform					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	0	360	
	KLV	uint32	0	(2^32)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967295}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{360}{4294967295}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
176.86543764939194 Degrees	14	04	7DC5 5ECE

- Twisting angle of camera about lens axis. Top of image is zero degrees. Positive angles are clockwise when looking from behind camera
- Map 0..(2^32)-1 to 0..360

8.20.1 Details

Sensors able to rotate their camera about the lens axis, make use of this Sensor Relative Roll Angle item. A roll angle of zero degrees occurs when the top and bottom edges of the captured image lie perpendicular to the plane created by the sensor relative depression angle axis. Positive angles are clockwise when looking from behind the camera.

8.21 Item 21: Slant Range

Description						
Slant range in meters						
Units		**Format**	**Min**	**Max**	**Offset**	
Meters (m)	**Software**	float64	0	5,000,000		
	KLV	uint32	0	(2^32)-1	None	
Length		**Max Length**		**Required Length**		
4		4		4		
Resolution		**Special Values**				
~1.2 millimeters		None				
Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No	

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967295}{5000000}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{5000000}{4294967295}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
68590.983298744770 Meters	15	04	0383 0926

- Distance to target
- Map 0..(2^32)-1 to 0..5000000 meters
- 1 nautical mile (knot) = 1852 meters

8.21.1 Details

The slant range is the distance between the sensor and image center. Refer to Figure 25.

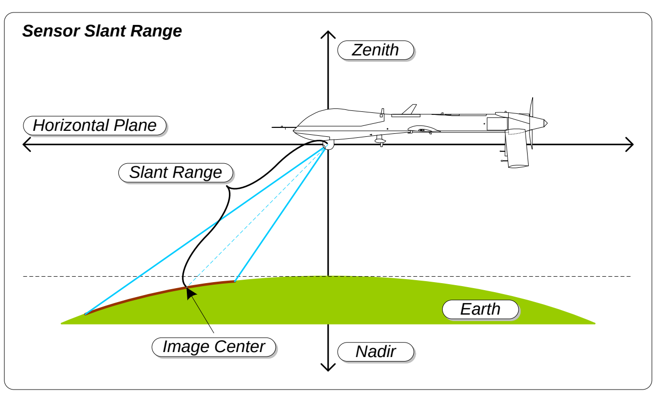

Figure 25: Sensor Slant Range

As of MISB ST 0601.3 Generic Flag Data 01 (Item 47) contains a flag which indicates whether Slant Range is "Computed" or "Measured." By default, the Slant Range is set to "Computed." "Measured" is to be used when a ranging device (radar, or laser) is providing Slant Range estimates.

8.22 Item 22: Target Width

Description					
Target width within sensor field of view					
Units		Format	Min	Max	Offset
Meters (m)	Software	float32	0	10,000	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.16 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{10000}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} = \left(\frac{10000}{65535}\right) * KLV_{uint}$

Example Software Value	Example KLV Item (All Hex) Tag	Len	Value
722.819867 Meters	16	02	1281

- Map 0..(2^16)-1 to 0..10000 meters
- 1 meter = 3.2808399 feet

8.22.1 Details

For legacy purposes, both restricted (Item 22) and extended (Item 96) representations of Target Width MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the extended version (Item 96) being favored as per Section 6.1.

The target width is the linear ground distance between the center of both sides of the captured image. Refer to Figure 26.

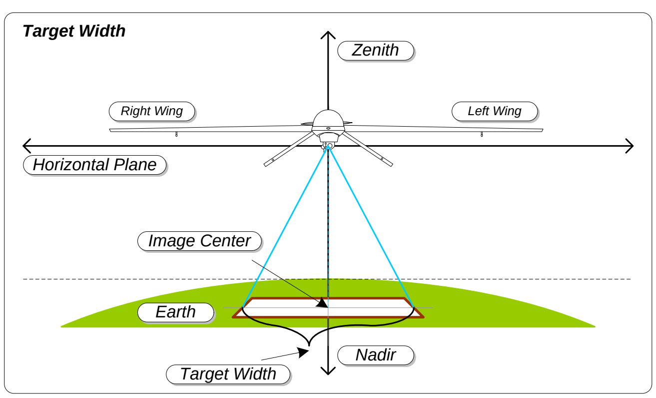

Figure 26: Target Width

8.23 Item 23: Frame Center Latitude

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Terrain latitude of frame center</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td>-90</td><td>90</td><td></td></tr>
<tr><th>KLV</th><td>int32</td><td>-((2^31)-1)</td><td>(2^31)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">4</td><td colspan="2">4</td><td colspan="2">4</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~42 nanodegrees</td><td colspan="4">0x80000000 = "N/A (Off-Earth)" indicator</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV_{val}} = \left(\frac{4294967294}{180}\right) * \mathrm{Soft_{Val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{180}{4294967294}\right) * \mathrm{KLV_{int}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">-10.542388633146132 Degrees</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>17</td><td>04</td><td>F101 A229</td></tr>
<tr><td colspan="6">• Based on WGS84 ellipsoid
• Map -((2^31)-1)..(2^31)-1 to +/-90
• See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.</td></tr>
</table>

8.23.1 Details

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. Frame centers which lie above the horizon typically do not correspond to a point on the earth (an example being the tracking of an airborne object) and are reported using the special value for "N/A (Off-Earth)."

8.24 Item 24: Frame Center Longitude

Description					
Terrain longitude of frame center					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
29.157890122923014 Degrees	18	04	14BC 082B

- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.24.1 Details

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. Frame centers which lie above the horizon typically do not correspond to a point on the earth (an example being the tracking of an airborne object) and are reported using the special value for "N/A (Off-Earth)."

8.25 Item 25: Frame Center Elevation

Description					
Terrain elevation at frame center relative to Mean Sea Level (MSL)					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.3 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{19900}\right) * (Soft_{val} + 900)$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} - Offset = \left(\frac{19900}{65535}\right) * KLV_{uint} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
3216.03723 Meters	19	02	34F3

- Map 0..(2^16)-1 to -900..19000 meters

8.25.1 Details

For legacy purposes, both MSL (Item 25) and HAE (Item 78) representations of Frame Center Elevation MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the HAE version (Item 78).

The center of the captured image or image sequence has a real earth coordinate represented by a latitude-longitude-altitude triplet. When a frame center lies above the horizon and does not correspond to a point on the earth, the MISB recommends not reporting the Frame Center Elevation.

The altitude is represented as height above mean sea level (MSL).

8.26 *Item 26: Offset Corner Latitude Point 1*

Description					
Frame latitude offset for upper left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_23_Value

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?		Allowed in SDCC Pack?		Multiples Allowed?	
Optional		No		No	

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{23_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{val}}}$

Example Software Value	Example KLV Item (All Hex): Tag	Len	Value
0.0136602540 Degrees	1A	02	1750

- Based on WGS84 ellipsoid
- Use with Frame Center Latitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.26.1 Details

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 27). Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

The Offset Corner Latitude Point 1 is added to the Frame Center Latitude metadata item to determine the latitude of the first corner point of an image. Convert both KLV items to decimal values prior to the addition.

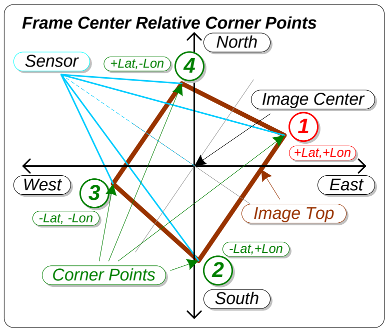

Figure 27: Offset Corner Point 1 (Corner Point 1 highlighted in red)

8.27 Item 27: Offset Corner Longitude Point 1

Description					
Frame longitude offset for upper left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_24_Value

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{24_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{val}}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
0.0036602540 Degrees	1B	02	063F

- Based on WGS84 ellipsoid
- Use with Frame Center Longitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.27.1 Details

The corner points of a captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value for “N/A (Off-Earth).” When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

Corner Point 1 is the upper left corner of the captured image. See Figure for Item 26 above.

The Offset Corner Longitude Point 1 is added to the Frame Center Longitude metadata item to determine the longitude of the first corner point of an image. Convert both KLV items to decimal values prior to the addition.

8.28 Item 28: Offset Corner Latitude Point 2

Description					
Frame latitude offset for upper right corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_23_Value
Length	**Max Length**	**Required Length**			
2	2	2			
Resolution	**Special Values**				
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{23_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{val}}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
-0.0036602540 Degrees	1C	02	F9C1

- Based on WGS84 ellipsoid
- Use with Frame Center Latitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.28.1 Details

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 28). Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

The Offset Corner Latitude Point 2 is added to the Frame Center Latitude metadata item to determine the latitude of the second corner point of an image. Convert both KLV items to decimal values prior to the addition.

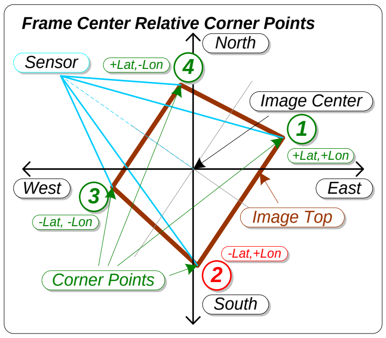

Figure 28: Offset Corner Point 2 (Corner Point 2 highlighted in red)

8.29 Item 29: Offset Corner Longitude Point 2

Description					
Frame longitude offset for upper right corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_24_Value

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{24_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{val}}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
0.0136602540 Degrees	1D	02	1750

- Based on WGS84 ellipsoid
- Use with Frame Center Longitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.29.1 Details

The corner points of a captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value for "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

Corner Point 2 is the upper right corner of the captured image. See Figure for Item 28 above.

The Offset Corner Longitude Point 2 is added to the Frame Center Longitude metadata item to determine the longitude of the corner point of an image. Convert both KLV items to decimal values prior to the addition.

8.30 Item 30: Offset Corner Latitude Point 3

Description					
Frame latitude offset for lower right corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_23_Value

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?	Allowed in SDCC Pack?	Multiples Allowed?
Optional	No	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{23_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{23_{val}}}$

Example Software Value	Example KLV Item (All Hex) Tag	Len	Value
-0.0110621778 Degrees	1E	02	ED1F

- Based on WGS84 ellipsoid
- Use with Frame Center Latitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.30.1 Details

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 29). Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

The Offset Corner Latitude Point 3 is added to the Frame Center Latitude metadata item to determine the latitude of the first corner point of an image. Convert both KLV items to decimal values prior to the addition.

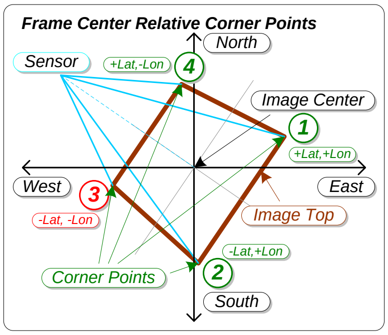

Figure 29: Offset Corner Point 3 (Corner Point 3 highlighted in red)

8.31 Item 31: Offset Corner Longitude Point 3

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Frame longitude offset for lower right corner</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float32</td><td>-0.075</td><td>0.075</td><td></td></tr>
<tr><th>KLV</th><td>int16</td><td>-((2^15)-1)</td><td>(2^15)-1</td><td>Tag_24_Value</td></tr>
</table>

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{0.15}\right) * \left(\mathrm{Soft_{val}} - \mathrm{LS_{24_{val}}}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{dec}}} = \left(\frac{0.15}{65534}\right) * \mathrm{KLV_{int}} + \mathrm{LS_{24_{val}}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>-0.0051602540 Degrees</td><td>1F</td><td>02</td><td>F732</td></tr>
</table>

- Based on WGS84 ellipsoid
- Use with Frame Center Longitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.31.1 Details

The corner points of a captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value for “N/A (Off-Earth).” When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

Corner Point 3 is the lower right corner of the captured image. See Figure for Item 30 above.

The Offset Corner Longitude Point 3 is added to the Frame Center Longitude metadata item to determine the longitude of the corner point of an image. Convert both KLV items to decimal values prior to the addition.

8.32 *Item 32: Offset Corner Latitude Point 4*

Description					
Frame latitude offset for lower left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_23_Value

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65534}{0.15}\right) * \left(Soft_{val} - LS_{23_{val}}\right)$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} + LS_{23_{dec}} = \left(\frac{0.15}{65534}\right) * KLV_{int} + LS_{23_{val}}$

Example Software Value	**Example KLV Item (All Hex)** Tag	Len	Value
0.0010621778 Degrees	20	02	01D0

- Based on WGS84 ellipsoid
- Use with Frame Center Latitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.32.1 Details

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 30). Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

The Offset Corner Latitude Point 4 is added to the Frame Center Latitude metadata item to determine the latitude of the first corner point of an image. Convert both KLV items to decimal values prior to the addition.

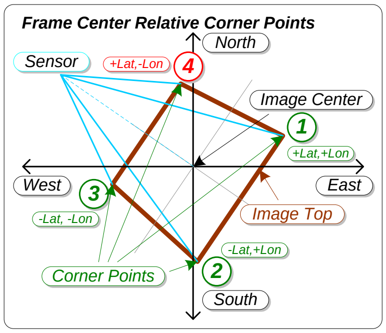

Figure 30: Offset Corner Point 4 (Corner Point 4 highlighted in red)

8.33 Item 33: Offset Corner Longitude Point 4

Description					
Frame longitude offset for lower left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-0.075	0.075	
	KLV	int16	-((2^15)-1)	(2^15)-1	Tag_24_Value
Length	**Max Length**	**Required Length**			
2	2	2			
Resolution	**Special Values**				
~1.2 microdegrees	0x8000 = "N/A (Off-Earth)" indicator				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65534}{0.15}\right) * \left(Soft_{val} - LS_{24_{val}}\right)$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} + LS_{24_{dec}} = \left(\frac{0.15}{65534}\right) * KLV_{int} + LS_{24_{val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-0.0121602540 Degrees	21	02	EB3F

- Based on WGS84 ellipsoid
- Use with Frame Center Longitude
- Map -((2^15)-1)..(2^15)-1 to +/-0.075
- 1.2 micro degrees is ~0.25 meters at equator
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.33.1 Details

The corner points of a captured image or image sequence have a real earth coordinate represented by a latitude-longitude pair. Corner points which lie above the horizon typically do not correspond to a point on the earth and are reported using the special value for "N/A (Off-Earth)." When any corner point offsets are outside of the mapped range, the MISB recommends not reporting corner point offsets and instead using the full precision corner points (Items 82 through 89).

Corner Point 4 is the lower left corner of the captured image. See Figure for Item 32 above.

The Offset Corner Longitude Point 4 is added to the Frame Center Longitude metadata item to determine the longitude of the corner point of an image. Convert both KLV items to decimal values prior to the addition.

8.34 Item 34: Icing Detected

Description					
Flag for icing detected at aircraft location					
Units		**Format**	**Min**	**Max**	**Offset**
Icing Code (code)	**Software**	uint8	0	2	
	KLV	uint8	0	2	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
N/A	None

Required in LS?	Allowed in SDCC Pack?	Multiples Allowed?
Optional	No	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{Val}}$

Example Software Value	Example KLV Item (All Hex) Tag	Len	Value
Icing Detected	22	01	02

- 0: Detector off
- 1: No icing Detected
- 2: Icing Detected

8.34.1 Details

This metadata item signals when the icing sensor detects water forming on its vibrating probe.

8.35 Item 35: Wind Direction

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Wind direction at aircraft location</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float32</td><td>0</td><td>360</td><td></td></tr>
<tr><th>KLV</th><td>uint16</td><td>0</td><td>(2^16)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">2</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~5.5 millidegrees</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
</table>

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{360}{65535}\right) * \mathrm{KLV_{uint}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>235.924010 Degrees</td><td>23</td><td>02</td><td>A7C4</td></tr>
</table>

- The direction the air body (around the aircraft) is coming from relative to true north
- Map 0..(2^16)-1 to 0..360

8.36 Item 36: Wind Speed

Description					
Wind speed at aircraft location					
Units		Format	Min	Max	Offset
Meters/Second (m/s)	Software	float32	0	100	
	KLV	uint8	0	255	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
~0.4 meters/second	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{255}{100}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{100}{255}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
69.8039216 Meters/Second	24	01	B2

- The speed of the body of air that surrounds the aircraft relative to the ground
- Map 0..255 to 0..100 meters/second
- 1 m/s = 1.94384449 knots

8.37 Item 37: Static Pressure

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Static pressure at aircraft location</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Millibar (mbar)</td><th>Software</th><td>float32</td><td>0</td><td>5000</td><td></td></tr>
<tr><th>KLV</th><td>uint16</td><td>0</td><td>(2^16)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">2</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~0.08 millibar</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV_{val}} = \left(\frac{65535}{5000}\right) * \mathrm{Soft_{val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{5000}{65535}\right) * \mathrm{KLV_{uint}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">3725.18502 Millibar</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>25</td><td>02</td><td>BEBA</td></tr>
<tr><td colspan="6">• Map 0..(2^16)-1 to 0..5000 mbar
• 1 mbar = 0.0145037738 PSI</td></tr>
</table>

8.37.1 Details

The static pressure is the pressure of the air that surrounds the aircraft. Static pressure is measured by a sensor mounted out of the air stream on the side of the fuselage. This is used with impact pressure to compute indicated airspeed, true airspeed, and density altitude.

8.38 Item 38: Density Altitude

Description					
Density altitude at aircraft location					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900
Length		**Max Length**		**Required Length**	
2		2		2	
Resolution		**Special Values**			
~0.3 meters		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{19900}\right) * (Soft_{val} + 900)$				
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} - Offset = \left(\frac{19900}{65535}\right) * KLV_{uint} - 900$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
14818.6770 Meters		26	02	CA35	

- Relative aircraft performance metric based on outside air temperature, static pressure, and humidity
- Map 0..(2^16)-1 to -900..19000 meters
- Offset = -900
- 1 meter = 3.2808399 feet

8.38.1 Details

Density altitude is the pressure altitude corrected for non-standard temperature variation. Density altitude is a relative metric of the takeoff, climb, and other performance related parameters of an aircraft.

8.39 Item 39: Outside Air Temperature

Description					
Temperature outside of aircraft					
Units		Format	Min	Max	Offset
Celsius (°C)	Software	int8	-128	+127	
	KLV	int8	-128	127	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
1 degree Celsius	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
84 Celsius	27	01	54

- The measured temperature outside of the platform

8.40 Item 40: Target Location Latitude

Description					
Calculated target latitude					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None
Length		**Max Length**		**Required Length**	
4		4		4	
Resolution		**Special Values**			
~42 nanodegrees		0x80000000 = "N/A (Off-Earth)" indicator			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{180}\right) * \mathrm{Soft_{Val}}$				
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{180}{4294967294}\right) * \mathrm{KLV_{int}}$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
-79.163850051892850 Degrees		28	04	8F69 5262	

- This is the crosshair location if different from frame center
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.40.1 Details

The crosshair or target location of a captured image or image sequence has real earth coordinates represented by a latitude-longitude-elevation triplet and may differ from the center of the captured image. Target locations which lie above the horizon do not correspond to a point on the earth and are reported using the special value “N/A (Off-Earth).”

8.41 Item 41: Target Location Longitude

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Calculated target longitude</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td>-180</td><td>180</td><td></td></tr>
<tr><th>KLV</th><td>int32</td><td>-((2^31)-1)</td><td>(2^31)-1</td><td>None</td></tr>
</table>

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?		Allowed in SDCC Pack?		Multiples Allowed?	
	Optional		No		No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>166.40081296041646 Degrees</td><td>29</td><td>04</td><td>7654 57F2</td></tr>
</table>

- This is the crosshair location if different from frame center
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.41.1 Details

The crosshair or target location of a captured image or image sequence has real earth coordinates represented by a latitude-longitude-elevation triplet and may differ from the center of the captured image. Target locations that lie above the horizon do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

8.42 Item 42: Target Location Elevation

Description					
Calculated target elevation					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.3 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{19900}\right) * (\mathrm{Soft_{val}} + 900)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} - \mathrm{Offset} = \left(\frac{19900}{65535}\right) * \mathrm{KLV_{uint}} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
18389.0471 Meters	2A	02	F823

- This is the crosshair location if different from frame center
- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.42.1 Details

The crosshair or target location of a captured image or image sequence has real earth coordinates represented by a latitude-longitude-elevation triplet and may differ from the center of the captured image. When target locations lie above the horizon and do not correspond to a point on the earth, the MISB recommends not reporting the Target Locations Elevation.

8.43 Item 43: Target Track Gate Width

Description					
Tracking gate width (x value) of tracked target within field of view					
Units		**Format**	**Min**	**Max**	**Offset**
Pixels	**Software**	uint16	0	510	
	KLV	uint8	0	255	None

Length	**Max Length**	**Required Length**
1	1	1

Resolution	**Special Values**
2 pixels	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{round}\left(\frac{\mathrm{Soft_{Val}}}{2}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = 2 * \mathrm{KLV_{uint}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
6 Pixels	2B	01	03

- Closely tied to source Motion Imagery

8.43.1 Details

For Target Tracking Sensors which display a box or gate around the target location, the Target Track Gate Width specifies the width in pixels for the displayed tracking gate.

8.44 Item 44: Target Track Gate Height

Description					
Tracking gate height (y value) of tracked target within field of view					
Units		**Format**	**Min**	**Max**	**Offset**
Pixels	**Software**	uint16	0	510	
	KLV	uint8	0	255	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
2 pixels	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{round}\left(\frac{\mathrm{Soft_{Val}}}{2}\right)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = 2 * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
30 Pixels	2C	01	0F

- Closely tied to source Motion Imagery

8.44.1 Details

For Target Tracking Sensors which display a box or gate around the target location, the Target Track Gate Height specifies the height in pixels for the displayed tracking gate.

8.45 Item 45: Target Error Estimate - CE90

Description					
Circular error 90 (CE90) is the estimated error distance in the horizontal direction					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	0	4095	
	KLV	uint16	0	(2^16)-1	None
Length		**Max Length**		**Required Length**	
2		2		2	
Resolution		**Special Values**			
~0.0624 meters		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{4095}\right) * \mathrm{Soft_{val}}$				
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{4095}{65535}\right) * \mathrm{KLV_{uint}}$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
425.215152 Meters		2D	02	1A95	
• Specifies the radius of 90% probability on a plane tangent to the earth's surface					

8.45.1 Details

Target covariance values are represented in an easting-northing-up coordinate system centered about the target point as illustrated in Figure 31:

Covariance Matrix:

$$Q = \begin{bmatrix} \sigma_e^2 & \sigma_{en} & \sigma_{eu} \\ \sigma_{ne} & \sigma_n^2 & \sigma_{nu} \\ \sigma_{ue} & \sigma_{un} & \sigma_u^2 \end{bmatrix}$$

Min and Max Sigma Values:

$$\sigma_{max}^2 = \frac{\left(\sigma_e^2 + \sigma_n^2\right) + \sqrt{\left(\sigma_e^2 + \sigma_n^2\right)^2 - 4\left(\sigma_e^2 \sigma_n^2 - \sigma_{en}^2\right)}}{2}$$

$$\sigma_{min}^2 = \frac{\left(\sigma_e^2 + \sigma_n^2\right) - \sqrt{\left(\sigma_e^2 + \sigma_n^2\right)^2 - 4\left(\sigma_e^2 \sigma_n^2 - \sigma_{en}^2\right)}}{2}$$

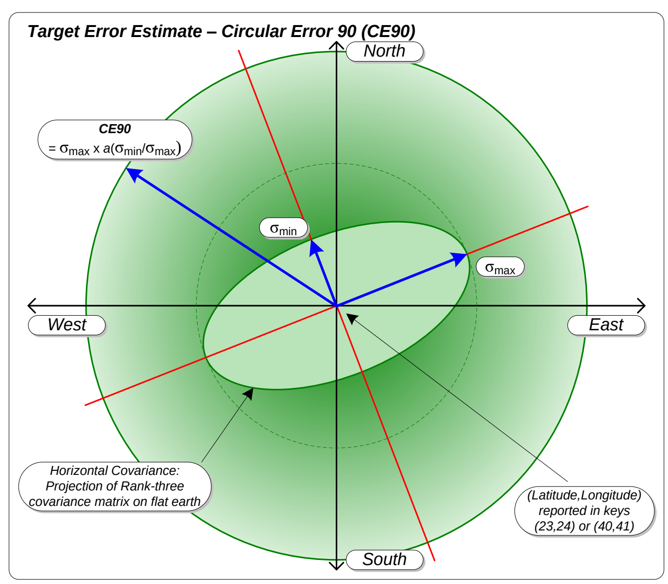

Figure 31: Target Error Estimate - Circular Error 90%

CE90 represents the 90 percent probability circular error radius of absolute horizontal accuracy. With $\sigma_{\max}$ and $\sigma_{\min}$ known, the Circular Error for 90% confidence can be calculated as: $CE90 = \sigma_{\max} \cdot a\left(\frac{\sigma_{\min}}{\sigma_{\max}}\right)$ where $a(x) = 0.4194\,x^2 + 0.0774\,x + 1.648$. This is one means for determining CE90 from statistical data in the easting-northing-up coordinate system, yet similar calculations are allowed.

8.46 Item 46: Target Error Estimate - LE90

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Lateral error 90 (LE90) is the estimated error distance in the vertical (or lateral) direction</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Meters (m)</td><th>Software</th><td>float32</td><td>0</td><td>4095</td><td></td></tr>
<tr><th>KLV</th><td>uint16</td><td>0</td><td>(2^16)-1</td><td>None</td></tr>
<tr><th>Length</th><th colspan="3">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td>2</td><td colspan="3">2</td><td colspan="2">2</td></tr>
<tr><th>Resolution</th><th colspan="5">Special Values</th></tr>
<tr><td>0.0625 meters</td><td colspan="5">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th>Software Value To KLV Value</th><td colspan="5">$\mathrm{KLV_{val}} = \left(\frac{65535}{4095}\right) * \mathrm{Soft_{Val}}$</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="5">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{4095}{65535}\right) * \mathrm{KLV_{uint}}$</td></tr>
<tr><th colspan="2">Example Software Value</th><th colspan="4">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="2" rowspan="2">608.9231 Meters</td><th>Tag</th><th>Len</th><th colspan="2">Value</th></tr>
<tr><td>2E</td><td>02</td><td colspan="2">2611</td></tr>
<tr><td colspan="6">• Specifies the interval of 90% probability in the local vertical direction</td></tr>
</table>

8.46.1 Details

Target covariance values are represented in an easting-northing-up coordinate system centered about the target point. This is shown below:

Covariance Matrix:

$$Q = \begin{bmatrix} \sigma_e^2 & \sigma_{en} & \sigma_{eu} \\ \sigma_{ne} & \sigma_n^2 & \sigma_{nu} \\ \sigma_{ue} & \sigma_{un} & \sigma_u^2 \end{bmatrix}$$

Min and Max Sigma Values:

$$\sigma_{max}^2 = \frac{\left(\sigma_e^2 + \sigma_n^2\right) + \sqrt{\left(\sigma_e^2 + \sigma_n^2\right)^2 - 4\left(\sigma_e^2\sigma_n^2 - \sigma_{en}^2\right)}}{2}$$

$$\sigma_{min}^2 = \frac{\left(\sigma_e^2 + \sigma_n^2\right) - \sqrt{\left(\sigma_e^2 + \sigma_n^2\right)^2 - 4\left(\sigma_e^2\sigma_n^2 - \sigma_{en}^2\right)}}{2}$$

LE90 represents the 90 percent probability linear error of absolute vertical accuracy.
With the vertical (or "up") variance known (σ_u), the 90 percent linear error can be calculated as $LE90 = 1.645 \cdot \sigma_u$. This is one means for determining LE90 from statistical data in the easting-northing-up coordinate system, yet similar calculations are allowed.

8.47 Item 47: Generic Flag Data

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Generic metadata flags</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>uint8</td><td>0</td><td>63</td><td></td></tr>
<tr><th>KLV</th><td>uint8</td><td>0</td><td>63</td><td>N/A</td></tr>
<tr><th>Length</th><th colspan="3">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td>1</td><td colspan="3">1</td><td colspan="2">1</td></tr>
<tr><th>Resolution</th><th colspan="5">Special Values</th></tr>
<tr><td>N/A</td><td colspan="5">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th>Software Value To KLV Value</th><td colspan="5">$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="5">$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$</td></tr>
<tr><th colspan="2">Example Software Value</th><th colspan="4">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="2" rowspan="2">49</td><th>Tag</th><th>Len</th><th colspan="2">Value</th></tr>
<tr><td>2F</td><td>01</td><td colspan="2">31</td></tr>
<tr><td colspan="6">• See Details</td></tr>
</table>

8.47.1 Details

The Generic Data Flags are miscellaneous boolean (yes / no) aircraft and image related data settings which are individual bits in a single byte value. Table 3 lists six settable bit-flags along with two reserved values for potential future use.

Table 3: Generic Flag Data

Bit	Setting Name	One[a] Indicates	Zero[a] Indicates	Comments
0	Laser Range	Laser on	Laser off	Laser Range Finder can be used to aid in geo-positioning
1	Auto-Track	Auto-Track on	Auto-Track off	Sensor steering is automatically controlled by on-board tracking system
2	IR Polarity	Black Hot	White Hot	IR sensor images use either black values indicating hot or white values indicating hot
3	Icing Status	Icing Detected	No Icing Detected	Icing status on the aircraft (i.e., the wings). Icing on wings can affect the continuation of the mission
4	Slant Range	Measured	Calculated	Slant range is measured (i.e., using Laser Range Finder) or calculated using gimbal/aircraft position and angles
5	Image Invalid	Image Invalid	Image Valid	An invalid image may result from a lens change, bad focus or other camera issues which significantly degrades the image
6	Reserved	Not Used	Always Zero	Always Zero
7	Reserved	Not Used	Always Zero	Always Zero

[a] Versions 13 through 16 of ST 0601 unintentionally inverted the column definitions; Versions 13a - 16a uses the correct column definitions.

Figure 32 illustrates the bit-flags within the byte value along with an example value of 0x03 which indicates the Auto-Tracker is on and the Laser Range Finder is on. The least significant bit (LSBit) is the Laser Range setting and the most significant bit (MSBit) is a reserved value. If more flags are added in the future, which require additionally bytes, the new flags will be added as “Most Significant Bytes.” The current byte value shown in Figure 32 will then be the Least Significant Byte.

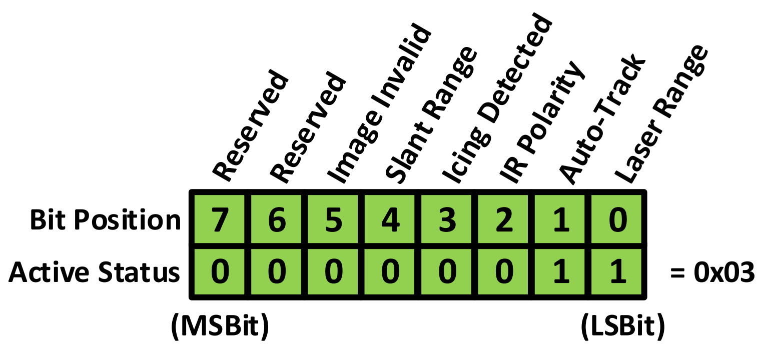

Figure 32: Generic Flag Data Byte

8.48 *Item 48: Security Local Set*

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">MISB ST 0102 local let Security Metadata items</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>record</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>set</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">Not Limited</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">See MISB ST 0102</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">See MISB ST 0102</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">N/A</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>30</td><td>-</td><td>N/A</td></tr>
<tr><td colspan="6">• Use the MISB ST 0102 Local Set items within the MISB ST 0601 item 48
• The length field is the size of all MISB ST 0102 metadata items to be packaged within item 48</td></tr>
</table>

8.48.1 Details

MISB ST 0102 [14] allows for the use of either Universal Set or Local Set methods. However, to minimize bandwidth when incorporating MISB ST 0102 into an instance of the UAS Datalink LS, the Local Set method is required.

Requirement	
ST 0601.14-31	When incorporating the ST 0102 Security Metadata set into an instance of the UAS Datalink Local Set, the ST 0102 format shall use the Local Set format.

8.49 Item 49: Differential Pressure

Description					
Differential pressure at aircraft location					
Units		Format	Min	Max	Offset
Millibar (mbar)	Software	float32	0	5000	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.08 millibar	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{5000}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{5000}{65535}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
1191.95850 Millibar	31	02	3D07

- Measured as the Stagnation/impact/total pressure minus static pressure
- Map 0..(2^16)-1 to 0..5000 mbar
- 1 mbar = 0.0145037738 PSI

8.49.1 Details

Differential pressure provides a method of calculating relative velocity of an item as it passes through a fluid, or conversely the velocity of a fluid as it passes by an item. Velocity can be determined by differential pressure by the following:

$$v_1 = \sqrt{\frac{2p_d}{\rho}}$$

where p_d is the measured differential pressure (p_d = impact pressure minus static pressure = $p_i - p_s$), and ρ is the density of the fluid outside the item.

8.50 *Item 50: Platform Angle of Attack*

Description					
Platform attack angle					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-20	20	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~610 microdegrees	0x8000 = "Out of Range" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{40}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{40}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
-8.67030854 Degrees	32	02	C883

- Angle between platform longitudinal axis and relative wind
- Positive angles for upward relative wind
- Map -((2^15)-1)..(2^15)-1 to +/-20
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.50.1 Details

For legacy purposes, both range-restricted (Item 50) and full-range (Item 92) representations of Platform Angle of Attack MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the full-range version (Item 92).

The angle of attack of an airborne platform is the angle formed between the relative wind and platform longitudinal axis (line made by the fuselage). Positive angles for wind with a relative upward component. Refer to Figure 33.

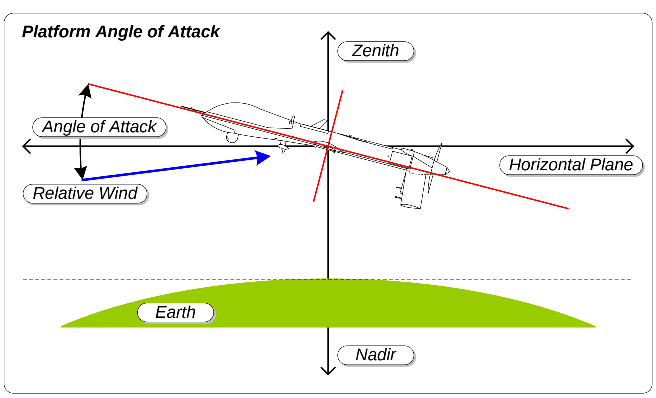

Figure 33: Platform Angle of Attack

8.51 *Item 51: Platform Vertical Speed*

Description					
Vertical speed of the aircraft relative to zenith					
Units		**Format**	**Min**	**Max**	**Offset**
Meters/Second (m/s)	**Software**	float32	-180	180	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~0.0055 meters/second	0x8000 = "Out of Range" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
-61.8878750 Meters/Second	33	02	D3FE

- Positive ascending, negative descending
- Map -((2^15)-1)..(2^15)-1 to +/-180
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.51.1 Details

Platform Vertical Speed is the climb or decent rate in meters per second of an airborne platform in the zenith direction. Positive values indicate an ascending platform, while negative values indicate descending.

8.52 Item 52: Platform Sideslip Angle

Description					
Angle between the platform longitudinal axis and relative wind					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	-20	20	
	KLV	int16	-((2^15)-1)	(2^15)-1	None
Length	**Max Length**	**Required Length**			
2	2	2			
Resolution	**Special Values**				
~610 microdegrees	0x8000 = "Out of Range" indicator				
Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No
Software Value To KLV Value	$KLV_{val} = \left(\frac{65534}{40}\right) * Soft_{Val}$				
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{40}{65534}\right) * KLV_{int}$				
Example Software Value	**Example KLV Item (All Hex)**				
	Tag	**Len**	**Value**		
-5.08255257 Degrees	34	02	DF79		

- Positive angles to right wing, negative to left
- Map -((2^15)-1)..(2^15)-1 to +/-20
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.52.1 Details

For legacy purposes, both range-restricted (Item 52) and full-range (Item 93) representations of Platform Sideslip Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the full-range version (Item 93).

The angle formed between the platform longitudinal axis (line made by the fuselage) and the relative wind is the sideslip angle. Figure 34 illustrates a negative sideslip angle.

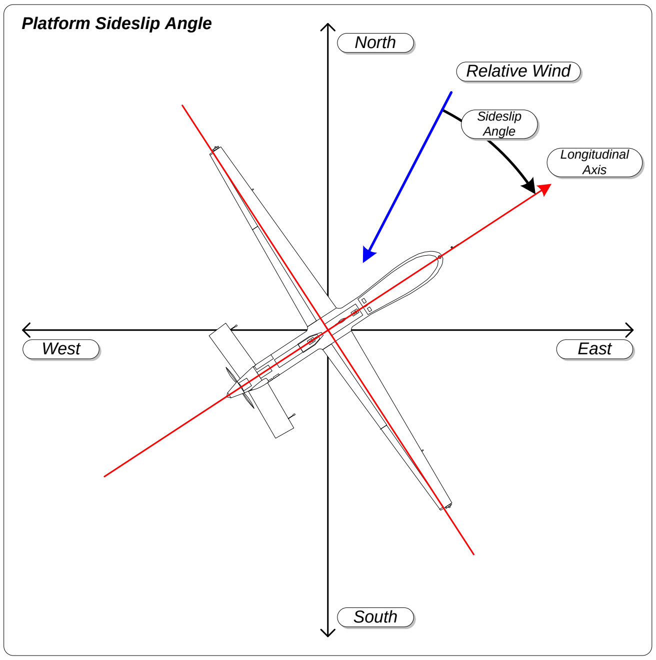

Figure 34: Platform Sideslip Angle

8.53 Item 53: Airfield Barometric Pressure

Description					
Local pressure at airfield of known height					
Units		Format	Min	Max	Offset
Millibar (mbar)	Software	float32	0	5000	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.08 millibar	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{5000}\right) * Soft_{Val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} = \left(\frac{5000}{65535}\right) * KLV_{uint}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
2088.96010 Millibar	35	02	6AF4

- Pilot's responsibility to update
- Map 0..(2^16)-1 to 0..5000 mbar
- 1013.25mbar = 29.92inHg
- Min/max recorded values of 870/1086 mbar

8.53.1 Details

Altimeters use the Airfield Barometric Pressure to calibrate their values and display airfield elevation.

8.54 Item 54: Airfield Elevation

Description					
Elevation of airfield corresponding to Airfield Barometric Pressure					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.3 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{19900}\right) * (\mathrm{Soft_{val}} + 900)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{int}} - \mathrm{Offset} = \left(\frac{19900}{65535}\right) * \mathrm{KLV_{uint}} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
8306.80552 Meters	36	02	7670

- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.54.1 Details

Airfield Elevation is measured at the airfield location. This relates to the Airfield Barometric Pressure metadata item.

8.55 Item 55: Relative Humidity

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Relative humidity at aircraft location</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Percent (%)</td><th>Software</th><td>float32</td><td>0</td><td>100</td><td></td></tr>
<tr><th>KLV</th><td>uint8</td><td>0</td><td>(2^8)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">1</td><td colspan="2">1</td><td colspan="2">1</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~0.4%</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV_{val}} = \left(\frac{255}{100}\right) * \mathrm{Soft_{Val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{100}{255}\right) * \mathrm{KLV_{int}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">50.5882353 Percent</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>37</td><td>01</td><td>81</td></tr>
<tr><td colspan="6">• Map 0..(2^8)-1 to 0..100</td></tr>
</table>

8.55.1 Details

Relative Humidity is the ratio between the water vapor density and the saturation point of water vapor density expressed as a percentage.

8.56 Item 56: Platform Ground Speed

Description					
Speed projected to the ground of an airborne platform passing overhead					
Units		**Format**	**Min**	**Max**	**Offset**
Meters/Second (m/s)	**Software**	uint8	0	255	
	KLV	uint8	0	255	None

Length	**Max Length**	**Required Length**
1	1	1

Resolution	**Special Values**
1 meter/second	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\text{KLV}_{\text{val}} = \text{Soft}_{\text{Val}}$
KLV Value To Software Value	$\text{Soft}_{\text{val}} = \text{KLV}_{\text{uint}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
140 Meters/Second	38	01	8C

- 0..255 meters/sec
- 1 m/s = 1.94384449 knots

8.56.1 Details

Platform Ground Speed is the aircraft's speed as projected onto the ground.

8.57 Item 57: Ground Range

Description					
Horizontal distance from ground position of aircraft relative to nadir, and target of interest					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float64	0	5,000,000	
	KLV	uint32	0	(2^32)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~1.2 millimeters	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967295}{5000000}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{5000000}{4294967295}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
3506979.0316063400 Meters	39	04	B38E ACF1

- Dependent upon Slant Range and Depression Angle
- Map 0..(2^32)-1 to 0..5000000 meters
- 1 nautical mile (knot) = 1852 meters

8.57.1 Details

Ground Range is the horizontal distance between the aircraft/sensor location and the target of interest and does not account for terrain undulations.

8.58 Item 58: Platform Fuel Remaining

Description					
Remaining fuel on airborne platform					
Units		**Format**	**Min**	**Max**	**Offset**
Kilogram (kg)	**Software**	float32	0	10,000	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.16 kilograms	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{10000}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{10000}{65535}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
6420.53864 Kilograms	3A	02	A45D

- Metered as fuel weight remaining
- Map 0..(2^16)-1 to 0..10000 Kilograms
- 1 kilogram = 2.20462262 pounds

8.58.1 Details

Platform Fuel Remaining indicates the current weight of fuel present on the platform.

8.59 Item 59: Platform Call Sign

Description					
Call sign of platform or operating unit					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	127	N/A

Resolution	**Special Values**
N/A	N/A

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
TOP GUN	3B	07	544F 5020 4755 4E

- Value field is Free Text

8.59.1 Details

The Platform Call Sign distinguishes groups or squadrons of platforms within different operating units from one another. Call sign is often related to the aircraft tail number.

8.60 *Item 60: Weapon Load*

Description					
Current weapons stored on aircraft					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint16	0	2^16-1	
	KLV	uint16	0	(2^16)-1	N/A

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
N/A	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = Soft_{Val}$
KLV Value To Software Value	$Soft_{val} = KLV_{uint}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
45016	3C	02	AFD8

- Broken into two bytes: [T][L][V] = [0x41][0x02][[byte1][byte2]]
- [byteN] = [[nib1][nib2]], nib1= msn
- byte1-nib1 = Station Number
- byte1-nib2 = Substation Number
- byte2-nib1 = Weapon Type
- byte2-nib2 = Weapon Variant

8.60.1 Details

Note: the Weapon Stores (Item 140) replaces the Weapon Load (Item 60) and Weapon Fired (Item 61) for providing information about Weapons and their status.

The Weapon Load item is composed of two bytes: the first byte indicates the aircraft store location, and the second byte indicates the store type. Each byte is composed of two nibbles with [nib1] being the most significant nibble with bit order [3210] where 3=msb.

Aircraft store location is indicated by station number which starts its numbering at the outboard left wing as store location 1 and increases towards the outboard right wing (see Figure 35). Each station can have a different weapon installed, or multiple weapons on the same station. For multiple weapons per station, the substation number begins at 1. A substation number of 0 indicates a single store located at the station. The aircraft store location byte has two nibbles: the first most significant nibble indicates Station Number; the second nibble the Substation Number.

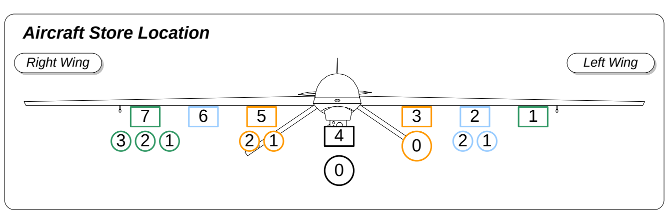

Figure 35: Aircraft Store Location

The weapon type byte is also composed of two nibbles: the first most significant nibble indicates Weapon Type; the second nibble indicates Weapon Variant. A list of available weapons is undefined.

8.61 Item 61: Weapon Fired

Description					
Indication when a particular weapon is released					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint8	0	255	
	KLV	uint8	0	255	N/A
Length		**Max Length**		**Required Length**	
1		1		1	
Resolution		**Special Values**			
N/A		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$KLV_{val} = Soft_{Val}$				
KLV Value To Software Value	$Soft_{val} = KLV_{Val}$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
186		3D	01	BA	

- Correlate with Precision Time Stamp
- Identical format to Weapon Load byte 2:
- [byteN] = [[nib1][nib2]]
- nib1 = Station Number
- nib2 = Substation Number

8.61.1 Details

Note: the Weapon Stores (Item 140) replaces the Weapon Load (Item 60) and Weapon Fired (Item 61) for providing information about Weapons and their status.

The Weapon Fired metadata item has the same format as the first byte of the Weapon Load metadata item indicating station and substation location of a store. Byte 1 is composed of two nibbles with [nib1] being the most significant nibble with bit order [3210] where 3=msb.

When included in a KLV packet, correlate the Weapon Fired item with the mandatory timestamp to determine the release time of a weapon.

8.62 Item 62: Laser PRF Code

Description					
A laser's Pulse Repetition Frequency (PRF) code used to mark a target					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint16	0	65535	
	KLV	uint16	0	65535	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
N/A	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
1743	3E	02	06CF

- The Laser PRF code is a three or four digit number consisting of the values 1..8
- Only the values 111..8888 can be used without 0's or 9's

8.62.1 Details

When enabled, laser designators can generate a pulsed signal according to a Pulse Repetition Frequency (PRF) code which distinguishes one laser beam from another.

8.63 Item 63: Sensor Field of View Name

Description					
Sensor field of view names					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint8	0	7	
	KLV	uint8	0	7	None
Length		**Max Length**		**Required Length**	
1		1		1	
Resolution		**Special Values**			
N/A		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$				
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{uint}}$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
2		3F	01	02	

- Enumerated list of names to indicate the lens type in use

8.63.1 Details

The Sensor Field of View Name indicates the Motion Imagery sensor’s current lens type. Table 4 lists the allowed Field of View Names.

Table 4: Field of View Names

Value	Meaning
0	Ultranarrow
1	Narrow
2	Medium
3	Wide
4	Ultrawide
5	Narrow Medium
6	2x Ultranarrow
7	4x Ultranarrow
8	Continuous Zoom
9-255	Reserved – Do not use

This item is for generic guidance and does not correspond to a specific field of view value. Refer to Sensor Horizontal Field of View Conversion (Item 16) and Sensor Vertical Field of View Conversion (Item 17) metadata items for specific aperture angles.

8.64 *Item 64: Platform Magnetic Heading*

Description					
Aircraft magnetic heading angle					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float32	0	360	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~5.5 millidegrees	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{360}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} = \left(\frac{360}{65535}\right) * \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
311.868162 Degrees	40	02	DDC5

- Relative between longitudinal axis and Magnetic North measured in the horizontal plane
- Map 0..(2^16)-1 to 0..360

8.64.1 Details

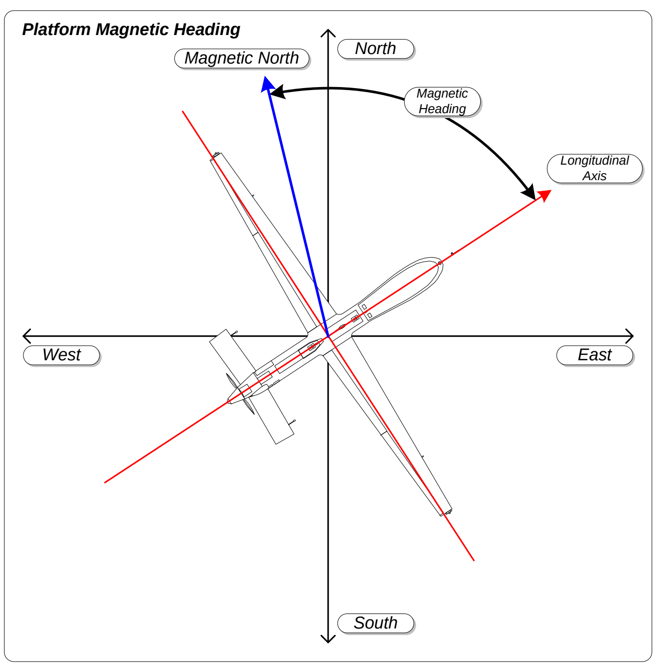

Figure 36: Magnetic Heading

8.65 Item 65: UAS Datalink LS Version Number

Description					
Version number of the UAS Datalink LS document used to generate KLV metadata					
Units		Format	Min	Max	Offset
Number (None)	Software	uint8	0	255	
	KLV	uint8	0	255	None

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
N/A	None

Required in LS?	Mandatory	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
13	41	01	0D

- Indicates the major version of MISB ST 0601 used as the source standard when encoding the metadata into KLV
- 0 is pre-release, initial release (0601.0), or test data
- 1..255 corresponds to document revisions MISB ST 0601.1 thru MISB ST 0601.255
- UAS Datalink LS Version Number is mandatory in every UAS Datalink LS packet

8.66 Item 66: Deprecated

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">This item has been deprecated.</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">N/A</td><th>Software</th><td>N/A</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Length	Max Length	Required Length
N/A	N/A	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	N/A
KLV Value To Software Value	N/A

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>N/A</td><td>42</td><td>-</td><td>N/A</td></tr>
</table>

- The Target Location Covariance Matrix is supported using the Standard Deviation and Cross Correlation Floating Length Pack (SDCC-FLP) pack - see Item 102.

8.67 Item 67: Alternate Platform Latitude

Description					
Alternate platform latitude					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~42 nanodegrees	0x80000000 = "Reserved"

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{180}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{180}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
-86.041207348947040 Degrees	43	04	85A1 5A39

- Represents latitude of an airborne or ground based platform connected via direct datalink with UAS
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90

8.68 Item 68: Alternate Platform Longitude

Description					
Alternate platform longitude					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	**Max Length**	**Required Length**
4	4	4

Resolution	**Special Values**
~84 nanodegrees	0x80000000 = "Reserved"

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{360}\right) * Soft_{Val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{360}{4294967294}\right) * KLV_{int}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
0.15552755452484243 Degrees	44	04	001C 501C

- Represents longitude of an airborne or ground based platform connected via direct datalink with UAS
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180

8.69 Item 69: Alternate Platform Altitude

Description					
Altitude of alternate platform as measured from Mean Sea Level (MSL)					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900
Length		**Max Length**		**Required Length**	
2		2		2	
Resolution		**Special Values**			
~0.3 meters		None			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{19900}\right) * (Soft_{val} + 900)$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} - Offset = \left(\frac{19900}{65535}\right) * KLV_{uint} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
9.44533455 Meters	45	02	0BB3

- Represents altitude of platform connected with UAS
- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.69.1 Details

For Legacy systems, Item 69 and Item 76 | Item 105 are allowed with preference for Item 76 | Item 105.

The Alternate Platform Altitude is the altitude of an airborne or ground based platform connected via direct datalink to a UAS generating Motion Imagery and metadata. The Alternate Platform Altitude is a true altitude or true vertical distance above mean sea level.

8.70 Item 70: Alternate Platform Name

Description					
Name of alternate platform connected to UAS					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	127	N/A

Resolution	**Special Values**
N/A	N/A

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
APACHE	46	06	4150 4143 4845

- E.g.: 'Apache', 'Rover', 'Predator', 'Reaper', 'Outrider', 'Pioneer', 'Warrior', 'Shadow', 'Hunter II', 'Global Hawk', 'Scan Eagle', etc.
- Value field is Free Text
- Suggested maximum: 127 characters

8.70.1 Details

The Alternate Platform Name metadata item distinguishes a platform which is generating Motion Imagery and metadata products and relates to the referring UAS. The alternate platform can be airborne, or ground based and is to be described sufficiently (yet with brevity) in text using this metadata item.

An alternate platform is an airborne or ground based platform connected via direct datalink to a UAS generating Motion Imagery and metadata.

8.71 Item 71: Alternate Platform Heading

Description					
Heading angle of alternate platform connected to UAS					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float32	0	360	
	KLV	uint16	0	(2^16)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~5.5 millidegrees	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{65535}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
32.6024262 Degrees	47	02	172F

- Relative between longitudinal axis and True North measured in the horizontal plane
- Map 0..(2^16)-1 to 0..360

8.71.1 Details

Heading angle is defined as the angle between the alternate platform longitudinal axis (line made by the fuselage) and true north measured in the horizontal plane. Angles increase in a clockwise direction when looking from above the platform. North is 0 degrees, east is 90, south is 180, and west is 270 degrees from true north.

The alternate platform is an airborne or ground based platform connected via direct datalink to a UAS generating Motion Imagery and metadata.

8.72 Item 72: Event Start Time - UTC

Description					
Start time of scene, project, event, mission, editing event, license, publication, etc.					
Units		**Format**	**Min**	**Max**	**Offset**
Microseconds (µs)	**Software**	uint64	0	(2^64)-1	
	KLV	uint64	0	(2^64)-1	N/A
Length	**Max Length**	**Required Length**			
8	8	8			
Resolution	**Special Values**				
1 microsecond	None				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$KLV_{val} = Soft_{Val}$				
KLV Value To Software Value	$Soft_{val} = KLV_{uint}$				
Example Software Value	**Example KLV Item (All Hex)**				
	Tag	**Len**	**Value**		
April 16, 1995 13:44:54 (798039894000000)	48	08	0x0002 D5D0 2466 0180		

- Represented as the microseconds elapsed since midnight (00:00:00), January 1, 1970

8.72.1 Details

A Precision Time Stamp discretely labels a scale of time and is widely used within systems of differing underlying architectures. The Precision Time Stamp, which does not include leap seconds, is specified in MISB ST 0603. In converting the Precision Time Stamp to UTC, leap seconds are added (or subtracted). See the Motion Imagery Handbook for appropriate conversions.

The Event Start Time - UTC metadata item is used to represent the start time of a mission, or other event related to the Motion Imagery collection.

Event Start Time – UTC is to be interpreted as an arbitrary time hack indicating the start of some event.

8.73 Item 73: RVT Local Set

Description					
MISB ST 0806 RVT Local Set metadata items					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 0806
KLV Value To Software Value	See MISB ST 0806

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
N/A	49	-	N/A

- Use the MISB ST 0806 Local Set within the MISB ST 0601 Item 73.
- The length field is the size of all RVT LS metadata items to be packaged within Item 73

8.73.1 Details

The RVT Local Set item allows users to include, or nest, RVT LS (MISB ST 0806 [7]) metadata items within MISB ST 0601.

This provides users who are required to use the RVT LS metadata items (Points of Interest, Areas of Interest, etc.) a method to leverage the data field contained within MISB ST 0601 (i.e., platform location, and sensor pointing angles).

8.74 Item 74: VMTI Local Set

Description					
MISB ST 0903 VMTI Local Set metadata items					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 0903
KLV Value To Software Value	See MISB ST 0903

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
N/A	4A	-	N/A

- Use the MISB ST 0903 Local Set within the MISB ST 0601 Item 74.
- The length field is the size of all VMTI LS metadata items to be packaged within Item 74

8.74.1 Details

The VMTI Local Set allows users to include, or nest, VMTI LS (MISB ST 0903 [15]) metadata items within MISB ST 0601.

This provides users who are required to use the VMTI LS a method to leverage the items within MISB ST 0601 (like platform location, and sensor pointing angles, or frame center).

8.75 Item 75: Sensor Ellipsoid Height

Description					
Sensor ellipsoid height as measured from the reference WGS84 ellipsoid					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.3 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{19900}\right) * (\mathrm{Soft_{val}} + 900)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} - \mathrm{Offset} = \left(\frac{19900}{65535}\right) * \mathrm{KLV_{uint}} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
14190.7195 Meters	4B	02	C221

- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.75.1 Details

For legacy systems, Item 15 and Item 75 | Item 104 are allowed with preference for Item 75 | Item 104.

Sensor Ellipsoid Height is the vertical distance between the sensor and the WGS84 Reference Ellipsoid. Measurement is GPS derived.

8.76 Item 76: Alternate Platform Ellipsoid Height

Description					
Alternate platform ellipsoid height as measured from the reference WGS84 Ellipsoid					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	**Max Length**	**Required Length**
2	2	2

Resolution	**Special Values**
~0.3 meters	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65535}{19900}\right) * (\mathrm{Soft_{val}} + 900)$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{uint_{range}}}\right) * \mathrm{KLV_{uint}} - \mathrm{Offset} = \left(\frac{19900}{65535}\right) * \mathrm{KLV_{uint}} - 900$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
9.44533455 Meters	4C	02	0BB3

- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.76.1 Details

For Legacy systems, Item 69 and Item 76 | Item 105 are allowed with preference for Item 76 | Item 105.

The Alternate Platform Ellipsoid Height is the vertical distance between the sensor and the WGS84 Reference Ellipsoid. Measurement is GPS derived.

An alternate platform is an airborne or ground based platform that is connected via direct datalink to a UAS generating Motion Imagery and metadata.

8.77 Item 77: Operational Mode

Description					
Indicates the mode of operations of the event portrayed in Motion Imagery					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint8	0	5	
	KLV	uint8	0	5	N/A
Length	**Max Length**	**Required Length**			
1	1	1			
Resolution	**Special Values**				
N/A	None				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$				
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$				
Example Software Value	**Example KLV Item (All Hex)**				
	Tag	**Len**	**Value**		
1 (Operational)	4D	01	01		

- Enumerated list of values, see details

8.77.1 Details

Operational Modes in Table 5 provide an indication of the event portrayed in the metadata. This allows for categorization of Motion Imagery streams and is often useful for archival systems.

Table 5: Operation Modes

Value	Meaning
0	Other
1	Operational
2	Training
3	Exercise
4	Maintenance
5	Test
6-255	Reserved - Do Not Use

8.78 Item 78: Frame Center Height Above Ellipsoid

Description					
Frame center ellipsoid height as measured from the reference WGS84 ellipsoid					
Units		Format	Min	Max	Offset
Meters (m)	Software	float32	-900	19000	
	KLV	uint16	0	(2^16)-1	-900

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~0.3 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{65535}{19900}\right) * (Soft_{val} + 900)$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{uint_{range}}\right) * KLV_{uint} - Offset = \left(\frac{19900}{65535}\right) * KLV_{uint} - 900$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
9.44533455 Meters	4E	02	0BB3

- Map 0..(2^16)-1 to -900..19000 meters
- 1 meter = 3.2808399 feet

8.78.1 Details

For legacy purposes, both MSL (Item 25) and HAE (Item 78) representations of Frame Center Elevation MAY appear in the same MISB ST 0601 packet. A single representation is preferred favoring the HAE version (Item 78).

Frame Center Ellipsoid Height Above Ellipsoid is the vertical distance of the image's center point on the ground and the WGS84 Reference Ellipsoid. Measurement is GPS derived.

8.79 Item 79: Sensor North Velocity

Description					
Northing velocity of the sensor or platform					
Units		Format	Min	Max	Offset
Meters/Second (m/s)	Software	float32	-327	327	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1 cm/sec	0x8000 = "Out of Range" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{654}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{654}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
25.4977569 Meters/Second	4F	02	09FB

- Sensor movement rate in the north direction
- Positive towards True North
- Map -((2^15)-1)..(2^15)-1 to +/-327
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.80 Item 80: Sensor East Velocity

Description					
Easting velocity of the sensor or platform					
Units		**Format**	**Min**	**Max**	**Offset**
Meters/Second (m/s)	**Software**	float32	-327	327	
	KLV	int16	-((2^15)-1)	(2^15)-1	None

Length	Max Length	Required Length
2	2	2

Resolution	Special Values
~1 cm/sec	0x8000 = "Out of Range" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{65534}{654}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{654}{65534}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
12.1 Meters/Second	50	02	04BC

- Sensor movement rate in the east direction
- Positive towards East
- Map -((2^15)-1)..(2^15)-1 to +/-327
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.81 Item 81: Image Horizon Pixel Pack

Description					
Location of earth-sky horizon in the Imagery					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	dlp	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	20	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See Details
KLV Value To Software Value	See Details

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
(x0,y0)=(0,36) (x1,y1)=(56,0)	51	04	0038 2400

- Floating Length Pack
- Start x0, Start y0, End x1, and End y1 are all mandatory
- Lat/Lon pairs are optional

8.81.1 Details

The Image Horizon Pixel Pack allows a user to separate sky and ground portions of an image by defining a line representing the horizon. The method for detecting where the horizon is within the image is left to the system implementer.

The line representing the horizon transects the image, meaning the line intersects with two of the four edges of the image. Using a vector to define the horizon provides an orientation of which side represents air and which side represents ground. The Horizon Vector's start and end points lie on the extents of the image. From the vectors start point "looking" at the end point, the pixels to the right of the Horizon Vector designates the ground region, while pixels to the left represent sky. Figure 37 illustrates the Horizon Vector's end points and the sky/ground (GND) orientation.

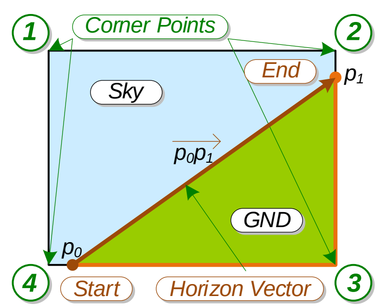

Figure 37: Horizon Vector

With the Horizon Vector defined, only the image corner points to the right are considered valid ground coordinates and points to the left are set to "N/A" (see Items 23-33, 40, 41, 42, and 82-89). No invalid corner coordinates are allowed when the Image Horizon Pixel Pack is included in the same MISB ST 0601 packet.

The Horizon Vector and valid corner coordinates define the Pixel Frame (PF) (i.e., a polygon) which represents ground pixels.

In the example shown in in Figure 37, corner point number 3 is the only valid corner point and is used with the start and end points to define a 3-point Pixel Frame.

Figure 38 illustrates examples for a 3-point, 4-point, and 5-point Pixel Frame.

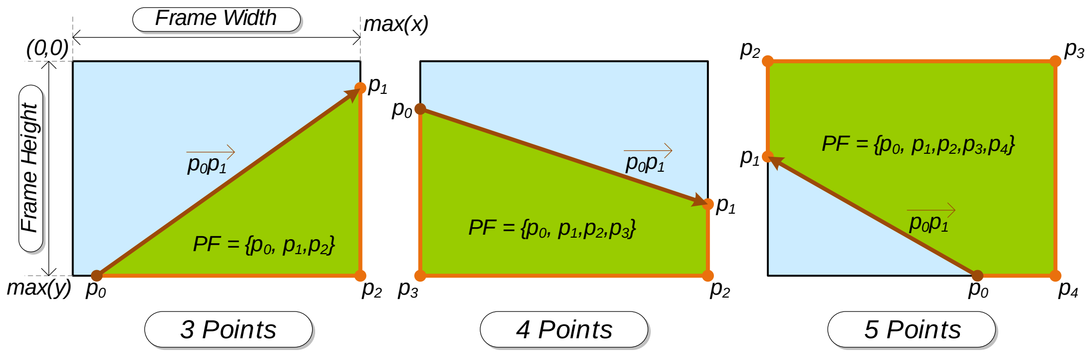

Figure 38: Pixel Frame Examples

Note that the pixel points p_0 through p_4 do not always directly correspond with the offset (Items 26-33) or absolute (Items 82-89) corner coordinates defined within this document.

By its definition, the intent of the Horizon Vector is as an estimate of the horizon location since it does not include the curvature of the earth and with most airborne systems the horizon is far away and difficult to precisely pinpoint using pixel accurate values.

Therefore, instead of pixel locations, integer percentages of image width and height provide the Horizon Vector starting and ending coordinates. Integer resolution is sufficient as an estimate for the horizon. For example, the resolution for 1% of an image with a width of 1280 pixels is 1280x0.01 = 12.8 pixels. The upper left corner of the image has coordinates (x, y) equal to (0%,0%); the upper right has image coordinates of (100%, 0%), etc. Percentages also have the advantage that they are scale invariant – if the image size is scaled the percentages still represent the horizon line.

1.1.1 Example

The illustration in Figure 39 shows an image with a horizon (barely visible through haze) and an example of the Image Horizon Pixel Pack values for 720p airborne imagery. The points p_0 and p_1 define the Horizon Vector's starting and ending points respectively; with $p_0 = (\frac{0}{1280}, \frac{260}{720}) = (0\%, 36.\overline{11}\%)$, and $p_1 = (\frac{720}{1280}, \frac{0}{1280}) = (56.25\%, 0\%)$. The resulting percentages are rounded to the nearest unit percentage; therefore, $p_0 = (0\%, 36\%)$, and $p_1 = (56\%, 0\%)$.

The orange line shows the Pixel Frame polygon, representing the area of the image which contains points on the earth's surface.

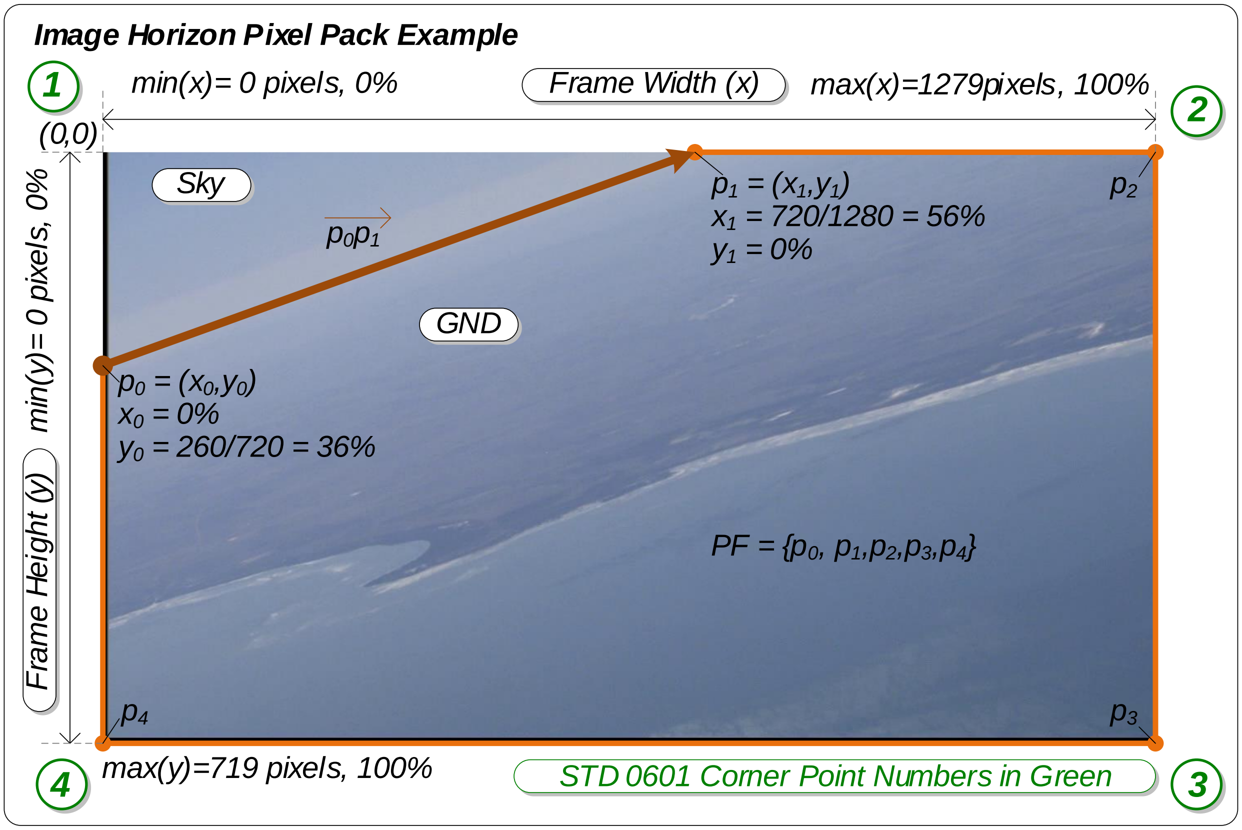

Figure 39: Image Horizon Pixel Pack Example

1.1.2 Decoding the Image Horizon Pixel Pack

When an Image Horizon Pixel Pack only includes the x and y coordinates of the Horizon Vector and not the geo-locations, the Horizon Vector is used to determine the image pixel coordinates (derived from the relative values) which construct the Pixel Frame.

When the latitudes and longitudes of the Horizon Vector are included, these geo-locations along with the valid offset or absolute corner coordinates in the same MISB ST 0601 packet are then matched with the appropriate points defined by the Pixel Frame.

1.1.3 Floating Length Pack Definition for the Image Horizon Pixel Pack

The Image Horizon Pixel Pack makes use of a Floating Length Pack (see Motion Imagery Handbook) which allows a user to include or exclude data items as necessary. The first items defined within this pack are the mandatory Start x_0, Start y_0 and End x_1, End y_1 coordinates representing the start and end of the Horizon Vector. These four values are each a single byte unsigned integer ranging from 0 to 100 percent. The optional real earth latitude-longitude geo-coordinate pairs follow the start and end points of the Horizon Vector.

The minimum required components are the Start x0, Start y0 and End x1, End y1 points defining the Horizon Vector in image space. The latitudes/longitudes of these points are optional, but the MISB recommends providing them. Table 6 defines the order and bytes sizes of the values in the Image Horizon Pixel Pack.

The “Name” column is the corresponding name of the metadata item. The “Units/Range” column provides the units of measurement for the item’s value, and the range of allowed values. The “Type” column indicates the data type used for the value of the item. This is directly related to the “Length” column, which indicates the number of bytes allotted to the item value. Finally, the “M/O” column indicates whether the corresponding metadata item is mandatory (i.e., “M”), or optional (i.e. “O”). However, the MISB recommends providing the optional values.

Table 6: Image Horizon Pixel Pack

Name	Notes	Units/Range	Type	Len	M/O
Start x0	The X coordinate (in percent) of an X-Y pair representing the start point of a vector crossing an image. Top left of image is 0,0 with positive X increasing to the right. To be used with Start y0. Mandatory in the Image Horizon Pixel Pack.	Percent [0..100]	uint8	1	M
Start y0	The Y coordinate (in percent) of an X-Y pair representing the start point of a vector crossing an image. Top left of image is 0.0 with positive Y increasing down. To be used with Start x0. Mandatory in the Image Horizon Pixel Pack.	Percent [0..100]	uint8	1	M
End x1	The X coordinate (in percent) of an X-Y pair representing the end point of a vector crossing an image. Top left of image is 0,0 with positive X increasing to the right. To be used with End y1. Mandatory in the Image Horizon Pixel Pack.	Percent [0..100]	uint8	1	M
End y1	The Y coordinate (in percent) of an X-Y pair representing the end point of a vector crossing an image. Top left of image is 0.0 with positive Y increasing down. To be used with End x1. Mandatory in the Image Horizon Pixel Pack.	Percent [0..100]	uint8	1	M
Start Latitude	The Latitude of the Start point (x0,y0) on the image border. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-90. Use (-2^31) as an "error" indicator. Optional (but recommended).	Degrees [-90..+90]	int32	4	O
Start Longitude	The Longitude of the Start point (x0,y0) on the image border. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-180. Use (-2^31) as an "error" indicator. Optional (but recommended).	Degrees [-180..+180]	int32	4	O
End Latitude	The Latitude of the End point (x1,y1) on the image border. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-90. Use (-2^31) as an "error" indicator. Optional (but recommended).	Degrees [-90..+90]	int32	4	O
End Longitude	The Longitude of the End point (x1,y1) on the image border. Based on WGS84 ellipsoid. Map -(2^31-1)..(2^31-1) to +/-180. Use (-2^31) as an "error" indicator. Optional (but recommended).	Degrees [-180..+180]	int32	4	O

8.82 *Item 82: Corner Latitude Point 1 (Full)*

Description					
Frame latitude for upper left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~42 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{180}{4294967294}\right) * KLV_{int}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
-10.528728379108287 Degrees	52	04	F106 9B63

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.82.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Item 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 40). Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value “N/A (Off-Earth).”

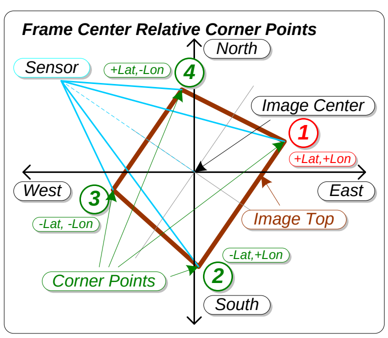

Figure 40: Offset Corner Point 1 (Corner Point 1 highlighted in red)

8.83 Item 83: Corner Longitude Point 1 (Full)

Description					
Frame longitude for upper left corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	**Max Length**	**Required Length**
4	4	4

Resolution	**Special Values**
~84 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
29.161550376960857 Degrees	53	04	14BC B2C0

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.83.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Item 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair. Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

Corner Point 1 is the upper left corner of the captured image. See Figure for Item 82 above.

8.84 *Item 84: Corner Latitude Point 2 (Full)*

Description					
Frame latitude for upper right corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~42 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Allowed in SDCC Pack?	Multiples Allowed?
Optional	No	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{180}{4294967294}\right) * KLV_{int}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-10.546048887183977 Degrees	54	04	F100 4D00

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.84.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Item 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 41). Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

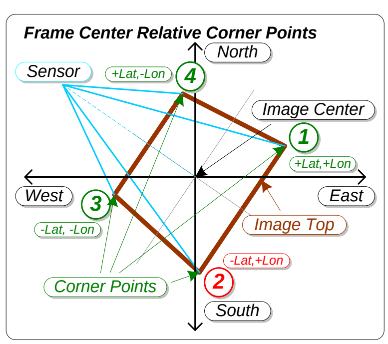

Figure 41: Offset Corner Point 2 (Corner Point 2 highlighted in red)

8.85 Item 85: Corner Longitude Point 2 (Full)

Description					
Frame longitude for upper right corner					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None
Length		**Max Length**		**Required Length**	
4		4		4	
Resolution		**Special Values**			
~84 nanodegrees		0x80000000 = "N/A (Off-Earth)" indicator			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
29.171550376960860 Degrees	55	04	14BE 84C8

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.85.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Item 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair. Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

Corner Point 2 is the upper right corner of the captured image. See Figure for Item 84 above.

8.86 Item 86: Corner Latitude Point 3 (Full)

Description					
Frame latitude for lower right corner					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~42 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{180}{4294967294}\right) * KLV_{int}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-10.553450810972622 Degrees	56	04	F0FD 9B17

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.86.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Items 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 42). Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

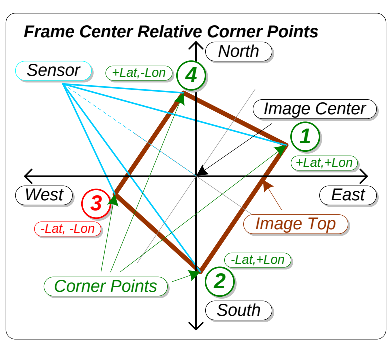

Figure 42: Offset Corner Point 3 (Corner Point 3 highlighted in red)

8.87 Item 87: Corner Longitude Point 3 (Full)

Description					
Frame longitude for lower right corner					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
29.152729868885170 Degrees	57	04	14BB 17AF

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.87.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Items 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair. Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value “N/A (Off-Earth).”

Corner Point 3 is the lower right corner of the captured image. See Figure for Item 86 above.

8.88 Item 88: Corner Latitude Point 4 (Full)

Description					
Frame latitude for lower left corner					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~42 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{180}\right) * \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{180}{\mathrm{0xFFFFFFFE}} * \mathrm{LS}\right) = \left(\frac{180}{4294967294}\right) * \mathrm{KLV_{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
-10.541326455319641 Degrees	58	04	F102 052A

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.88.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Items 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair (see Figure 43). Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

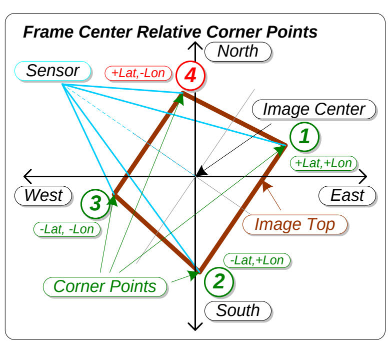

Figure 43: Offset Corner Point 4 (Corner Point 4 highlighted in Red)

8.89 Item 89: Corner Longitude Point 4 (Full)

Description					
Frame longitude for lower left corner					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	-180	180	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	Max Length	Required Length
4	4	4

Resolution	Special Values
~84 nanodegrees	0x80000000 = "N/A (Off-Earth)" indicator

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \left(\frac{\mathrm{LS}_{\mathrm{range}}}{\mathrm{int}_{\mathrm{range}}}\right) * \mathrm{KLV}_{\mathrm{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV}_{\mathrm{int}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
29.145729868885170 Degrees	59	04	14B9 D176

- Full Range
- Based on WGS84 ellipsoid
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-28 when the location moves beyond the surface of the earth.

8.89.1 Details

For legacy purposes, both range-restricted (Items 26-33) and full-range (Items 82-89) representations of Image Corner Coordinates MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Items 82-89) being favored as per Section 6.1.

The corner points of a captured image or image sequence have real earth coordinates represented by a latitude-longitude pair. Corner points that lie above the horizon typically do not correspond to a point on the earth and are reported using the special value "N/A (Off-Earth)."

Corner Point 4 is the lower left corner of the captured image. See Figure for Item 88 above.

8.90 *Item 90: Platform Pitch Angle (Full)*

Description					
Aircraft pitch angle					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None
Length		**Max Length**		**Required Length**	
4		4		4	
Resolution		**Special Values**			
~42 nanodegrees		0x80000000 = "Out of Range" indicator			
Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No
Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{val}$				
KLV Value To Software Value	$Soft_{val} = \left(\frac{180}{0xFFFFFFFE} * LS\right) = \left(\frac{180}{4294967294}\right) * KLV_{int}$				
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
-0.43152510208614414 Degrees		5A	04	FF62 E2F2	

- Angle between longitudinal axis and horizontal plane. Positive angles above horizontal plane
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.90.1 Details

For legacy purposes, both range-restricted (Item 6) and full-range (Items 90) representations of Platform Pitch Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Item 90) being favored as per Section 6.1.

The pitch angle of the platform is the angle between the longitudinal axis (line made by the fuselage) and the horizontal plane. Angles are positive when the platform nose is above the horizontal plane. This item allows unrestricted pitch angle values (see Figure 44).

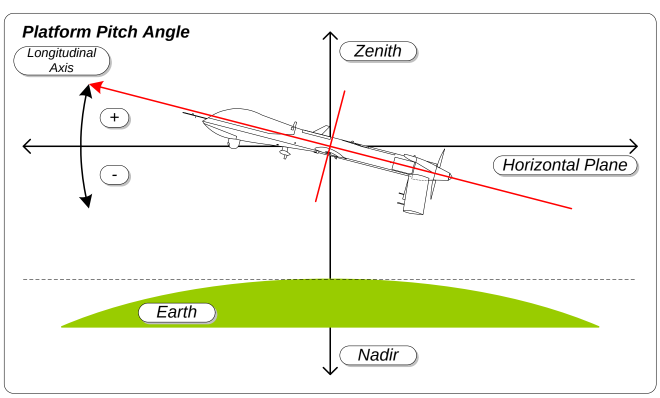

Figure 44: Platform Pitch Angle

8.91 Item 91: Platform Roll Angle (Full)

Description					
Platform roll angle					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees (°)	**Software**	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None

Length	**Max Length**	**Required Length**
4	4	4

Resolution	**Special Values**
~42 nanodegrees	0x80000000 = "Out of Range" indicator

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{Val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{180}{4294967294}\right) * KLV_{int}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
3.4058139815022304 Degrees	5B	04	04D8 04DF

- Angle between transverse axis and transverse-longitudinal plane.
- Positive angles for lowered right wing
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.91.1 Details

For legacy purposes, both range-restricted (Item 7) and full-range (Items 91) representations of Platform Roll Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Item 91) being favored as per Section 6.1.

The rotation operation performed about the longitudinal axis forms the roll angle between the previous aircraft transverse-longitudinal plane and the new transverse axis location (line from wing tip to wing tip). Positive angles correspond to the starboard (right) wing lowered below the previous aircraft transverse-longitudinal plane. This item allows unrestricted roll angles (see Figure 45).

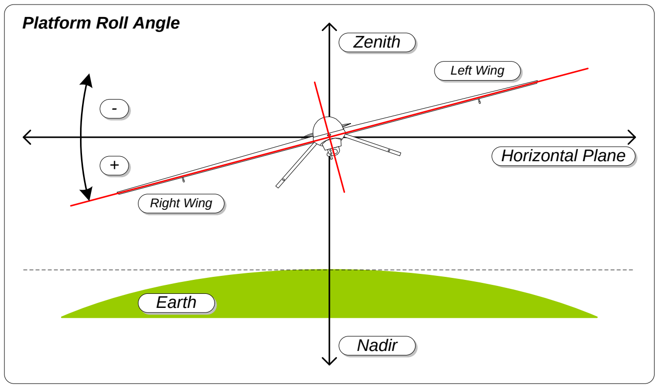

Figure 45: Platform Roll Angle

8.92 Item 92: Platform Angle of Attack (Full)

Description					
Platform attack angle					
Units		Format	Min	Max	Offset
Degrees (°)	Software	float64	-90	90	
	KLV	int32	-((2^31)-1)	(2^31)-1	None
Length	Max Length	Required Length			
4	4	4			
Resolution	Special Values				
~42 nanodegrees	0x80000000 = "Out of Range" indicator				
Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = \left(\frac{4294967294}{180}\right) * Soft_{val}$
KLV Value To Software Value	$Soft_{val} = \left(\frac{LS_{range}}{int_{range}}\right) * KLV_{int} = \left(\frac{180}{4294967294}\right) * KLV_{int}$

Example Software Value	Tag	Len	Value
-8.6701769841230370 Degrees	5C	04	F3AB 48EF

- Angle between platform longitudinal axis and relative wind
- Positive angles for upward relative wind
- Map -((2^31)-1)..(2^31)-1 to +/-90
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.92.1 Details

For legacy purposes, both range-restricted (Item 50) and full-range (Items 92) representations of Platform Angle of Attack MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Item 92) being favored as per Section 6.1.

The angle of attack of an airborne platform is the angle formed between the relative wind and platform longitudinal axis (line made by the fuselage). Positive angles for wind with a relative upward component. Refer to Figure 46.

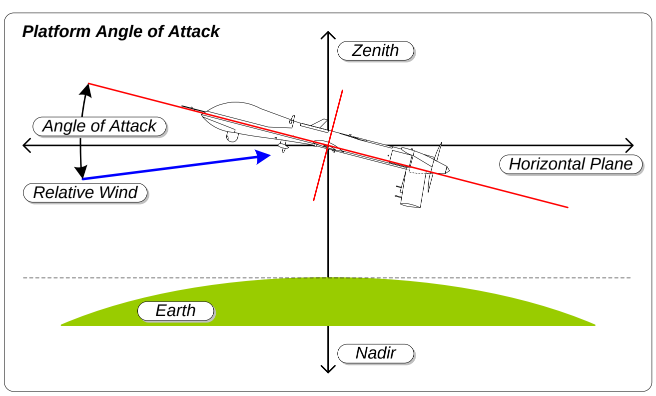

Figure 46: Platform Angle of Attack

8.93 Item 93: Platform Sideslip Angle (Full)

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Angle between the platform longitudinal axis and relative wind</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td>-180</td><td>180</td><td></td></tr>
<tr><th>KLV</th><td>int32</td><td>-((2^31)-1)</td><td>(2^31)-1</td><td>None</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">4</td><td colspan="2">4</td><td colspan="2">4</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">~84 nanodegrees</td><td colspan="4">0x80000000 = "Out of Range" indicator</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>Yes</td><th>Multiples Allowed?</th><td>No</td></tr>
</table>

Software Value To KLV Value	$\mathrm{KLV_{val}} = \left(\frac{4294967294}{360}\right) * \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \left(\frac{\mathrm{LS_{range}}}{\mathrm{int_{range}}}\right) * \mathrm{KLV_{int}} = \left(\frac{360}{4294967294}\right) * \mathrm{KLV_{int}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>-47.683 Degrees</td><td>5D</td><td>04</td><td>DE17 9323</td></tr>
</table>

- Full Range
- Positive angles to right wing, neg to left
- Map -((2^31)-1)..(2^31)-1 to +/-180
- See Requirement ST 0601.13-27 when the value is not within the specified KLV min/max range.

8.93.1 Details

For legacy purposes, both range-restricted (Item 52) and full-range (Items 93) representations of Platform Sideslip Angle MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the full-range version (Item 93) being favored as per Section 6.1.

The angle formed between the platform longitudinal axis (line made by the fuselage) and the relative wind is the sideslip angle. Figure 47 illustrates a negative sideslip angle.

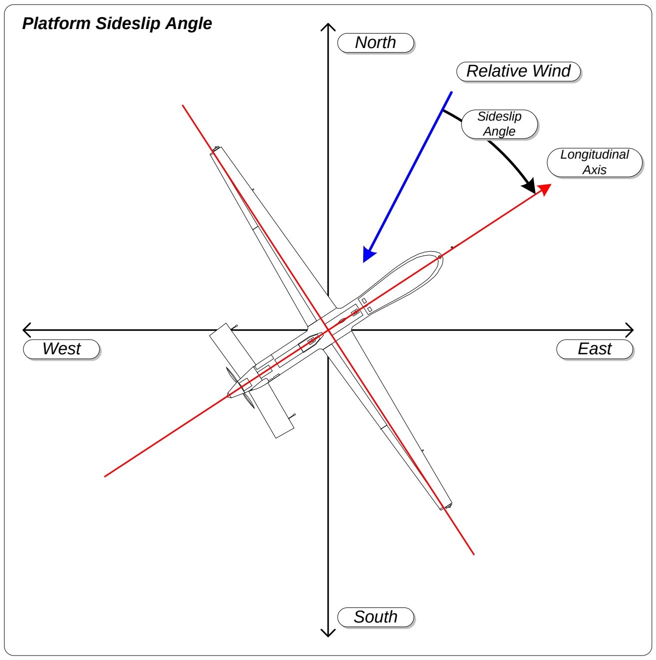

Figure 47: Platform Sideslip Angle

8.94 Item 94: MIIS Core Identifier

Description					
MISB ST 1204 MIIS Core Identifier binary value					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	byte	N/A	N/A	
	KLV	byte	N/A	N/A	None

Length	Max Length	Required Length
Variable	50	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 1204
KLV Value To Software Value	See MISB ST 1204

Example Software Value	Tag	Len	Value
0170:F592-F023-7336-4AF8-AA91-62C0-0F2E-B2DA/ 16B7-4341-0008-41A0-BE36-5B5A-B96A-3645:D3 (Text version of a Core ID with Physical Sensor ID and Virtual Platform ID - see MISB ST 1204 for explanation)	5E	22	0170 F592 F023 7336 4AF8 AA91 62C0 0F2E B2DA 16B7 4341 0008 41A0 BE36 5B5A B96A 3645

- Use according to the rules and requirements defined in ST 1204

8.94.1 Details

The MIIS Core Identifier allows users to include the MIIS Core Identifier (MISB ST 1204 [16]) Binary Value (opposed to the text-based representation) within MISB ST 0601. Item 94's value does not include MISB ST 1204's 16-byte Key or length, only the value portion.

See MISB ST 1204 [16] for generation and usage requirements.

8.95 Item 95: SAR Motion Imagery Local Set

Description					
MISB ST 1206 SAR Motion Imagery Metadata Local Set metadata items					
Units		Format	Min	Max	Offset
None	Software	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A
Length	Max Length	Required Length			
Variable	Not Limited	N/A			
Resolution	Special Values				
N/A	N/A				
Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No
Software Value To KLV Value	See MISB ST 1206				
KLV Value To Software Value	See MISB ST 1206				
Example Software Value	Example KLV Item (All Hex)				
	Tag	Len	Value		
N/A	5F	-	N/A		

- Use according to the rules and requirements defined in MISB ST 1206

8.95.1 Details

The SAR Motion Imagery Local Set item allows users to include the SAR Motion Imagery Metadata (MISB ST 1206) within MISB ST 0601. The SARMI metadata set allows users to exploit both sequential synthetic aperture radar (SAR) imagery and sequential SAR coherent change products as Motion Imagery.

See MISB ST 1206 [17] for generation and usage requirements.

8.96 Item 96: Target Width Extended

Description					
Target width within sensor field of view					
Units		Format	Min	Max	Offset
Meters (m)	Software	float64	0	1,500,000	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	8	N/A

Resolution	Special Values
2 bytes = 64 meters 3 bytes = 0.25 meters	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(0, 1500000, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(0, 1500000, \mathrm{Length}, \mathrm{KLV_{val}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
13,898.5463 Meters	60	03	00D9 2A

- Range of 0 to 1,500,000 m established as maximum distance visible from an altitude of 40,000 m
- To be consistent with Item 22 Target Width, recommend a length of 3 bytes which provides ~0.25 meters of resolution

8.96.1 Details

For legacy purposes, both distance-restricted (Item 22) and extended (Item 96) representations of Target Width MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the extended version (Item 96) being favored as per Section 6.1.

The target width is the linear ground distance between the center of both sides of the captured image. Refer to Figure 48. As Target Width (Item 22) limits the distance to 10,000 meters, this limit is no longer sufficient to support current capabilities. Target Width Extended is intended to allow for the maximum viewable distance from an altitude of 40,000 meters which is sufficient for all airborne UAS systems.

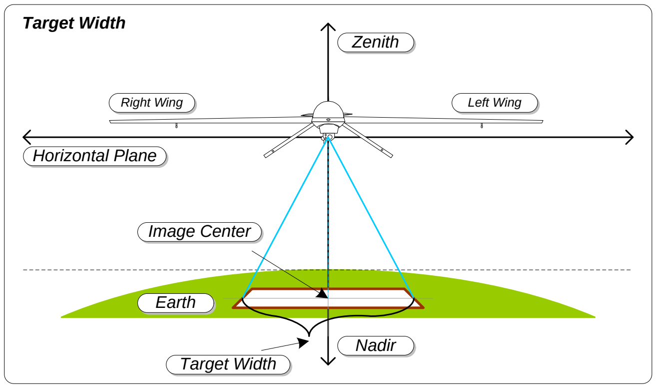

Figure 48: Target Width

8.97 Item 97: Range Image Local Set

Description					
MISB ST 1002 Range Imaging Local Set metadata items					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 1002
KLV Value To Software Value	See MISB ST 1002

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
N/A	61	-	N/A

- See Details

8.97.1 Details

The Range Image Local Set item allows users to include the Range Image LS (MISB ST 1002 [18]) within MISB ST 0601. Range Motion Imagery is a temporal sequence of range images. Each range image is a collection of range measurements from a sensor to target scene. A range measurement is the distance (e.g., meters) from an object (or area) in the scene to the sensor. The KLV structures of this standard are intended to allow for flexibility, efficient packing, and future extensions. Range Motion Imagery can be used standalone, or in collaboration with other Motion Imagery.

See MISB ST 1002 for generation and usage requirements.

8.98 Item 98: Geo-Registration Local Set

Description					
MISB ST 1601 Geo-Registration Local Set metadata items					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 1601
KLV Value To Software Value	See MISB ST 1601

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
N/A	62	-	N/A

- See Details

8.98.1 Details

The Geo-Registration Local Set item allows users to include the Geo-Registration Local Set (MISB ST 1601 [19]) within the UAS Datalink LS. MISB ST 1601 supports the identification of a geo-registration algorithm and standard deviations and correlation coefficients output from a geo-registration process.

See MISB ST 1601 for generation and usage requirements.

8.99 Item 99: Composite Imaging Local Set

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">MISB ST 1602 Composite Imaging Local Set metadata items</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>record</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>set</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See MISB ST 1602
KLV Value To Software Value	See MISB ST 1602

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>N/A</td><td>63</td><td>-</td><td>N/A</td></tr>
</table>

- See Details

8.99.1 Details

The Composite Imaging Local Set item supports the composition of several Motion Imagery source images into one composite Motion Imagery image. Such use cases include: tiled images, picture-in-picture, stacked images, and blended images. The composition is destructive, where background image information replaces foreground image information.

See MISB ST 1602 [20] for generation and usage requirements.

8.100 Item 100: Segment Local Set

Description					
MISB ST 1607 Segment Local Set metadata items, used to enable metadata sharing					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	set	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	Yes

Software Value To KLV Value	See MISB ST 1607
KLV Value To Software Value	See MISB ST 1607

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
N/A	64	-	N/A

- See Details

8.100.1 Details

The principles underlying the Segment LS construct are found in the Motion Imagery Handbook; MISB ST 1607 [11] defines its rules of usage. At a high level, consider a UAS Datalink LS as consisting of a parent set of items, and one or more child sets of items. Segment LS enables use of MISB ST 0601 items at the parent level, and reuse of the same items – possibly and likely with different item values – or other items not specified at the parent level or at the child level, effectively adding items with new values. A use of a item at the parent level is applicable across the MISB ST 0601 set, whereas use of the same item within the Segment LS signals its use as restricted to the purpose indicated by other items present within the Segment LS. For example, a Item 94 MIIS Core Identifier at the parent level applies to the entire Motion Imagery frame; a Item 94 within a Segment LS may apply to a second senor image overlay and its specific sensor MIIS Core Identifier.

In cases where the MISB ST 0902 [21] mandatory set of items (which are a subset of MISB ST 0601) are distributed between a parent/child set, the MISP requirement for the MISB ST 0902 set is still satisfied.

It is incumbent on the system implementer to meet all required metadata items for conformance, such as MISB ST 0902 metadata, regardless of whether the items are present in a parent or a child set.

8.101 Item 101: Amend Local Set

Description						
MISB ST 1607 Amend Local Set metadata items, used to provide metadata corrections						
Units		Format	Min	Max	Offset	
None	Software	record	N/A	N/A		
	KLV	set	N/A	N/A	N/A	
Length	Variable	Max Length	Not Limited	Required Length	N/A	
Resolution	N/A	Special Values	N/A			
Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	Yes	
Software Value To KLV Value	See MISB ST 1607					
KLV Value To Software Value	See MISB ST 1607					
Example Software Value	Example KLV Item (All Hex)					
	Tag	Len	Value			
N/A	65	-	N/A			

- See Details

8.101.1 Details

In applying the Amend Local Set, it is best to take the perspective of the receiver of the data. Described in Section 6.3.3 is the concept of nesting a Local Set within a MISB ST 0601 Local Set.

The principles underlying the Amend LS construct are found in the Motion Imagery Handbook; MISB ST 1607 [11] defines it rules for usage; an application of its use is found in MISB ST 1601 [19]. At a high level, consider a UAS Datalink LS as consisting of a parent set of items, and one or more child sets of items. Amend LS enables use of MISB ST 0601 items at the parent level, and reuse of the same items – possibly and likely with different item values – or other items not specified at the parent level at the child level, effectively adding items with new values. A use of an item at the parent level is applicable across the MISB ST 0601 LS, whereas use of the same item within the Amend LS signals its use as restricted to the purpose indicated by other items present within the Amend LS. For example, an Item 13 Sensor Latitude at the parent level may also be at a child level, but with a different value. A receiver can choose either value to complete a MISB ST 0601 set. In effect, the value of an item can be changed for the same item.

Metadata originating at its source is always maintained and never discarded. Values which “replace” existing values are basically “added” to the overall MISB ST 0601 metadata stream.

8.102 Item 102: SDCC-FLP

Description					
MISB ST 1010 Floating Length Pack (FLP) metadata item, providing Standard Deviation and Cross Correlation (SDCC) metadata					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	flp	N/A	N/A	N/A
Length	**Max Length**		**Required Length**		
Variable	Not Limited		N/A		
Resolution	**Special Values**				
N/A	N/A				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	Yes
Software Value To KLV Value	See MISB ST 1010				
KLV Value To Software Value	See MISB ST 1010				
Example Software Value	**Example KLV Item (All Hex)**				
	Tag	**Len**	**Value**		
N/A	66	-	N/A		

- See Details

8.102.1 Details

In applying the SDCC-FLP item, it is advised to review the usage of the SDCC-FLP (Standard Deviation Correlation Coefficient Floating Length Pack) construct presented in MISB ST 1010 [9]. The allowed metadata items from MISB ST 0601 for use in the SDCC-FLP are denoted with a “Y” in the MISB ST 0601 Table 1 column labeled SDCC FLP.

The SDCC defines a compact structure for two data lists: Standard Deviation and Cross Correlation values. The data type and size for each list must be self-consistent; all Standard Deviation values must be the same type and size; all Cross Correlation values must be the same type and size. The type and size of each list can be determined at runtime.

Important: In version 10 of MISB ST 0601 the Standard Deviation values are restricted to IEEE floating point values. Future versions of MISB ST 0601 may allow for the use IMAP values after appropriate limits are defined for each Standard Deviation.

Cross Correlation values may use either IEEE or IMAP types as needed by the system producing the SDCC pack. Each value indicated with a “Y” in the SDCC FLP column of Table 1 can have uncertainty (i.e., standard deviation or sigma, σ) computed or measured information. Additionally, each value can be correlated to any of the other value resulting in a potential correlation coefficient value for that pair of values. Values with no correlation result in a correlation coefficient value of zero for that pair of values.

MISB ST 1010 defines how to package the standard deviation and correlation coefficient values. Per MISB ST 1010, at runtime the list of values with standard deviation values defined constitutes the Refined Source List. The Refined Source List values are written into the UAS Datalink Local Set immediately followed by the SDCC-FLP, where each row of the SDCC-FLP upper triangular matrix is in the same order as the values just written in the Local Set.

The SDCC-FLP has five defining parameters: Matrix Size, Parse Control, Bit Vector, Standard Deviation Elements (values), and the Correlation Coefficient Elements (values).

1.1.3.1 Matrix Size

The Matrix Size is set to the value of the Refined Source List. This value will be less than or equal to the size of the Source List.

1.1.3.2 Parse Control

UAS Datalink LS only uses the Mode 2 Parse Control mode. Consult MISB ST 1010 for further description of Mode 1 and 2 of the Parse Control.

Requirement	
ST 0601.10-22	The UAS Datalink Local Set shall only include SDCC-FLPs using Mode 2 Parse Control, as defined in MISB ST 1010.

Five values in the Mode 2 Parse Control are computed at runtime: C_s, S_f, S_{len}, C_f, and C_{len}.

- The C_s value indicates the SDCC-FLP uses a sparse representation of the correlation coefficient values.
- The S_f value defines the data format type of the standard deviation values, either IMAP (see MISB ST 1201 [12]) or IEEE Floating Point values. MISB ST 1010 does not allow the mixing of types; therefore, convert all standard deviation values to one type.
- The MISB recommends using four-byte IEEE Floating Point values for standard deviation values.
- The S_{len} value defines the number of bytes each standard deviation value uses. Add more bytes if a system requires greater precision.
- The C_f value defines the data format type of the correlation coefficient values (i.e., either IEEE Floating Point or MISB ST 1201 mapped values).
- The C_{len} value defines the number of bytes for each correlation coefficient value. Systems requiring greater precision can use more bytes.

1.1.3.3 Bit Vector

As discussed in MISB ST 1010 correlation coefficient data can be a sparse matrix. The Bit Vector indicates where to eliminate the zeros in the SDCC-FLP. See MISB ST 1010 Appendix A to determine when to use the Bit Vector. The decision to use the Bit Vector can be made at run time.

1.1.3.4 Standard Deviation Values

The standard deviation values in IEEE Floating Point and included in the SDCC-FLP in the same order of the Refined Source List.

1.1.3.5 Correlation Coefficient Values

The correlation coefficient values converted to the desired data format, either IEEE Floating Point or MISB ST 1201 mapped values, and included in the SDCC-FLP. The rows and columns of the correlation coefficient matrix are in the same order as the Refined Source List.

8.103 Item 103: Density Altitude Extended

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Density altitude above MSL at aircraft location</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Meters
(m)</td><th>Software</th><td>float64</td><td>-900</td><td>40000</td><td></td></tr>
<tr><th>KLV</th><td>IMAPB</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">8</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-900, 40000, \mathrm{Length}, \mathrm{Soft_{val}})$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-900, 40000, \mathrm{Length}, \mathrm{KLV_{uint}})$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">23,456.24 Meters</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>67</td><td>03</td><td>2F92 1E</td></tr>
<tr><td colspan="6">

- Relative aircraft performance metric based on outside air temperature, static pressure, and humidity
- Max Altitude: 40,000m for airborne systems
- For resolution < 1.0m, a length of >= 3 bytes is required

</td></tr>
</table>

8.103.1 Details

For legacy purposes, both range restricted (Item 38) and range extended (Item 103) representations of Density Altitude MAY appear in the same MISB ST 0601 packet. A single representation is preferred, with the range extended version (Item 103) being favored as per Section 6.1.

The purpose of Density Altitude Extended is to increase the range of altitude values currently defined in Item 38 Density Altitude to support all CONOPs for airborne systems.

8.104 Item 104: Sensor Ellipsoid Height Extended

Description					
Sensor ellipsoid height extended as measured from the reference WGS84 ellipsoid					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float64	-900	40000	
	KLV	IMAPB	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	8	N/A

Resolution	**Special Values**
2 bytes = 2 meters 3 bytes = 78.125 mm	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-900, 40000, \mathrm{Length}, \mathrm{Soft_{Val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-900, 40000, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
23,456.24 Meters	68	03	2F92 1E

- Max Altitude of 40,000m for airborne systems
- For resolution < 1.0m, a length of >= 3 bytes is required

8.104.1 Details

For legacy systems, Item 15 and Item 75 | Item 104 are allowed with preference for Item 75 | Item 104.

The purpose of Sensor Ellipsoid Height Extended is to increase the range of altitude values currently defined in Item 75 Sensor Ellipsoid Height to support all CONOPs for airborne systems.

8.105 Item 105: Alternate Platform Ellipsoid Height Extended

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Alternate platform ellipsoid height extended as measured from the reference WGS84 ellipsoid</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Meters
(m)</td><th>Software</th><td>float64</td><td>-900</td><td>40000</td><td></td></tr>
<tr><th>KLV</th><td>IMAPB</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Length	Max Length	Required Length
Variable	8	N/A

Resolution	Special Values
2 bytes = 2 meters 3 bytes = 78.125 mm	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$KLV_{val} = IMAPB(-900, 40000, Length, Soft_{Val})$
KLV Value To Software Value	$Soft_{val} = RIMAPB(-900, 40000, Length, KLV_{uint})$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>23,456.24 Meters</td><td>69</td><td>03</td><td>2F92 1E</td></tr>
</table>

- Max Altitude of 40,000m set for airborne systems
- For resolution < 1.0m, a length of >= 3 bytes is required

8.105.1 Details

For Legacy systems, Item 69 and Item 76 | Item 105 are allowed with preference for Item 76 | Item 105.

The purpose of Alternate Platform Ellipsoid Height Extended is to increase the range of altitude values currently defined in Item 76 Alternate Platform Ellipsoid Height to support all CONOPs for airborne systems.

8.106 Item 106: Stream Designator

Description					
A second designation given to a sortie					
Units		Format	Min	Max	Offset
None	Software	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	127	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{Val}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
BLUE	6A	04	424C 5545

- Stream Designator represents a shorthand descriptor for a particular Motion Imagery data stream, typically delivered over IP (Internet Protocol)
- Stream designator is typically tied to the IP of a particular GCS. This is primarily a USAF designator. (example – feed color of Blue)

8.107 Item 107: Operational Base

Description					
Name of the operational base hosting the platform					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	127	N/A

Resolution	**Special Values**
N/A	N/A

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{Val}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
BASE01	6B	06	4241 5345 3031

- Operational Base indicates the location for the Launch Recovery Equipment (LRE)

8.108 Item 108: Broadcast Source

Description					
Name of the source, where the Motion Imagery is first broadcast					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	string	N/A	N/A	
	KLV	utf8	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	127	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{utf8}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
HOME	6C	04	484F 4D45

- Broadcast Source is the location (i.e., airbase) for where the Motion Imagery originates or is first broadcast
- Example - Creech, Cannon, etc.

8.109 Item 109: Range To Recovery Location

Description					
Distance from current position to airframe recovery position					
Units		**Format**	**Min**	**Max**	**Offset**
KM	**Software**	float32	0	21000	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
2 bytes = 1 KM 3 bytes = 3.9 meters 4 bytes = 1.525 cm	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(0{,}21000, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(0{,}21000, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
1.625 KM	6D	03	0001 A0

- None

8.109.1 Details

The Range To Recovery Location is the minimum distance from the current aircraft position to the aircraft recovery position. The distance is computed over the surface of the earth at the given altitude of the aircraft (i.e., not a straight-line distance potentially through the earth). The furtherst distance is a point on the opposite side of the earth, at the given altitude.

The maximum value for the IMAPB computation results from the recovery location on the opposite side of the earth from the aircraft flying at the maximum altitude of 40,000 m. The largest radius of the ellipsoid earth is at the equator, with the WGS84 radius equal to 6,378,137.0 m. This radius plus the maximum altitude is 6,418,137 meters, which equals r. Half the circumference, C, of a circle with this radius is the maximum value.

$$C = 2\pi r = 2 * 6{,}418{,}137 * \pi = 40{,}326{,}344$$

$$\frac{1}{2}C = 20{,}163{,}172$$

This value is rounded up to 21 million meters or 21,000 Km.

8.110 Item 110: Time Airborne

Description					
Number of seconds aircraft has been airborne					
Units		**Format**	**Min**	**Max**	**Offset**
Seconds (s)	**Software**	uint32	0	2^32-1	
	KLV	uint	0	2^32-1	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
1 second	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\text{KLV}_{\text{val}} = \text{Soft}_{\text{Val}}$
KLV Value To Software Value	$\text{Soft}_{\text{val}} = \text{KLV}_{\text{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
19887 seconds (05:31:27)	6E	02	4DAF

- This item is related to the "Take-Off Time" (Item 131)
- Suggest using "Time airborne" (Item 110) or "Take-Off Time" (Item 131) but not both in the same MISB ST 0601 Local Set

8.110.1 Details

Time Airborne is a continual count of the number of seconds since the aircraft took off from the ground (or ship). The Take-Off time (Item 131) is the timestamp indicating when the aircraft became airborne. The Time Airborne and Take-Off Time are related mathematically using the Precision Time Stamp (Item 2), so the Local Set needs only one of these items to compute the other.

To compute the Time Airborne (T_{Air}) from the Take-Off Time ($T_{Takeoff}$) and the current Precision Time Stamp ($T_{Precision}$) use Equation 3.

$$T_{Air} = Round\left[\frac{T_{Precision} - T_{Takeoff}}{1000000}\right] \qquad \text{Equation 3}$$

To compute the Take-Off Time ($T_{Takeoff}$) from the Time Airborne (T_{Air}) and the Precision Time Stamp ($T_{Precision}$) use Equation 4.

$$T_{Takeoff} = T_{Precision} - (T_{Air} * 1000000) \qquad \text{Equation 4}$$

The Time Airborne value supports flight times up to 2^{32}-1 seconds or 136 years.

8.111 Item 111: Propulsion Unit Speed

Description					
The speed the engine (or electric motor) is rotating at					
Units		**Format**	**Min**	**Max**	**Offset**
Revolutions Per Minute (RPM)	**Software**	uint32	0	(2^32)-1	
	KLV	uint	0	(2^32)-1	N/A

Length	**Max Length**	**Required Length**
Variable	4	N/A

Resolution	**Special Values**
1 revolution/minute	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{uint}}$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
3000 revolutions per minute	6F	02	0BB8

- RPMs can apply to combustion engine or electric motor propelling the aircraft
- With multi-rotor aircraft, use an average or other representative value

8.112 Item 112: Platform Course Angle

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Direction the aircraft is moving relative to True North</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Degrees (°)</td><th>Software</th><td>float64</td><td>0</td><td>360</td><td></td></tr>
<tr><th>KLV</th><td>IMAPB</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">8</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">2 bytes = 16.625 millidegrees</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
</table>

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(0{,}360, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(0, 360, \mathrm{Length}, \mathrm{KLV_{uint}})$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>125 degrees</td><td>70</td><td>02</td><td>1F40</td></tr>
</table>

- Length is variable based on users desired accuracy
- 0 (or 360) is true north, east is 90, south is 180, west is 270

8.112.1 Details

The Platform Course is the direction the platform is moving (not necessarily the direction the platform is pointing). The "course" is illustrated in Figure 49 in red; the UAS is pointed southwest (Item 5 – Platform Heading Angle), the wind is from the west-northwest (to the east southeast) (Item 35 – Wind Direction) – the platform's "course" is moving to the south east. Other directional items are the Platform Magnetic Heading (Item 64) and Platform Side Slip Angle (Full) (Item 52). Platform Course is directly measurable by on-board navigation or estimated computationally by comparing the last known position to current position.

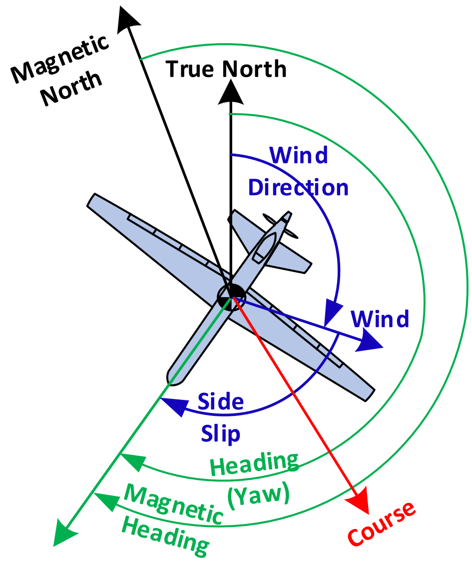

Figure 49: Platform Course compared to other directional data.

8.113 Item 113: Altitude AGL

Description					
Above Ground Level (AGL) height above the ground/water					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float64	-900	40000	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
2 bytes = 2.0 meters 3 bytes = 0.7 cm	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-900{,}40000, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-900{,}40000, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
2150 meters	71	03	05F5 00

- Max Altitude of 40,000m for airborne systems

8.113.1 Details

Altitude - AGL (Above Ground Level) is the distance measured from the ground (or terrain) to the aircraft. Different devices and techniques measure altitude using different reference points, as illustrated in Figure 50.

Height Above Ellipsoid altitude is the distance from the WGS84 Ellipsoid and the aircraft. Mean Sea Level (MSL) altitude is the distance from the WGS84 Geoid and the aircraft. Density altitude is a computational value using air pressure and temperature.

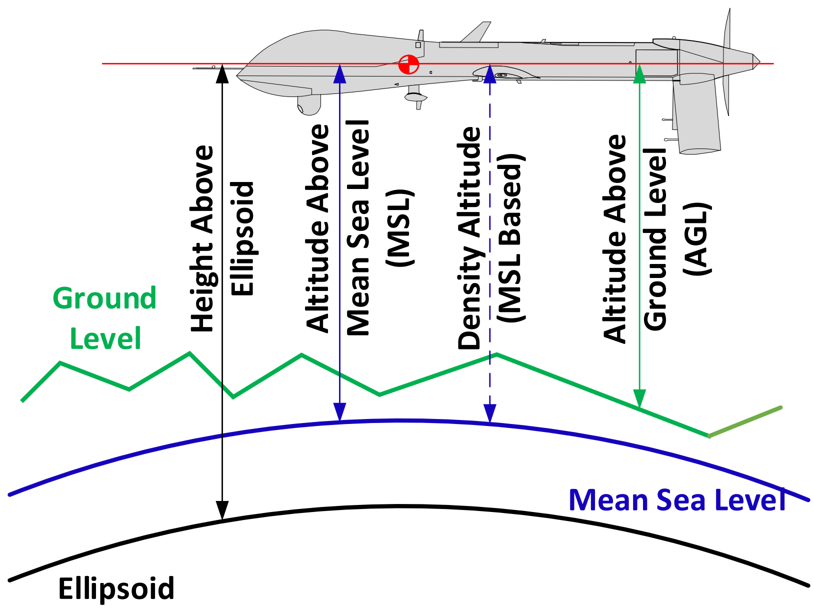

Figure 50: Comparison of HAE, Altitude MSL, Density Altitude and Altitude AGL

8.114 Item 114: Radar Altimeter

Description					
Height above the ground/water as reported by a RADAR altimeter					
Units		**Format**	**Min**	**Max**	**Offset**
Meters (m)	**Software**	float64	-900	40000	
	KLV	IMAPB	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	4	N/A

Resolution	**Special Values**
2 bytes = 2.0 meters 3 bytes = 0.7 cm	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-900{,}40000, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-900{,}40000, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
2154.50 meters	72	03	05F7 40

- Max Altitude of 40,000m for airborne systems
- Radar Altimeter height is AGL, see Item 113 for AGL definition

8.115 Item 115: Control Command

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Record of command from GCS to Aircraft</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>record</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>dlp</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>Yes</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">See Details</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">See Details</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">5, "Fly to Waypoint 1"</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>73</td><td>13</td><td>0511 466C 7920 746F 2057 6179 706F 696E 7420 31</td></tr>
<tr><td colspan="6">

A copy of the command and control values used to request platform/sensor to perform an action
Item 116 uses the Command ID to signal validation
Command is a "string" format defined by platform vendor
Control Command Verification (Item 116) shows acknowledgement of the command

</td></tr>
</table>

8.115.1 Details

The purpose of the Control Command (Item 115) and Command Acknowledgement (Item 116) items are to report the commands issued to the platform/sensor and the acknowledgement of those commands. The Control Command defines a command ID and the command string which describes the command or action to perform. At some later time, the command is acknowledged by the platform and Item 116 records the acknowledgement, by just restating the Command ID.

Figure 51 provides an illustration of the data flow where the GCS issues a command (A) to the platform and at the same time records the command with a Command ID (#5) in the metadata stream. The platform receives and acknowledges the command (B) by sending some form of acknowledgement to the GCS. The GCS matches the Command ID with the original command and records the acknowledgement of the command in the KLV.

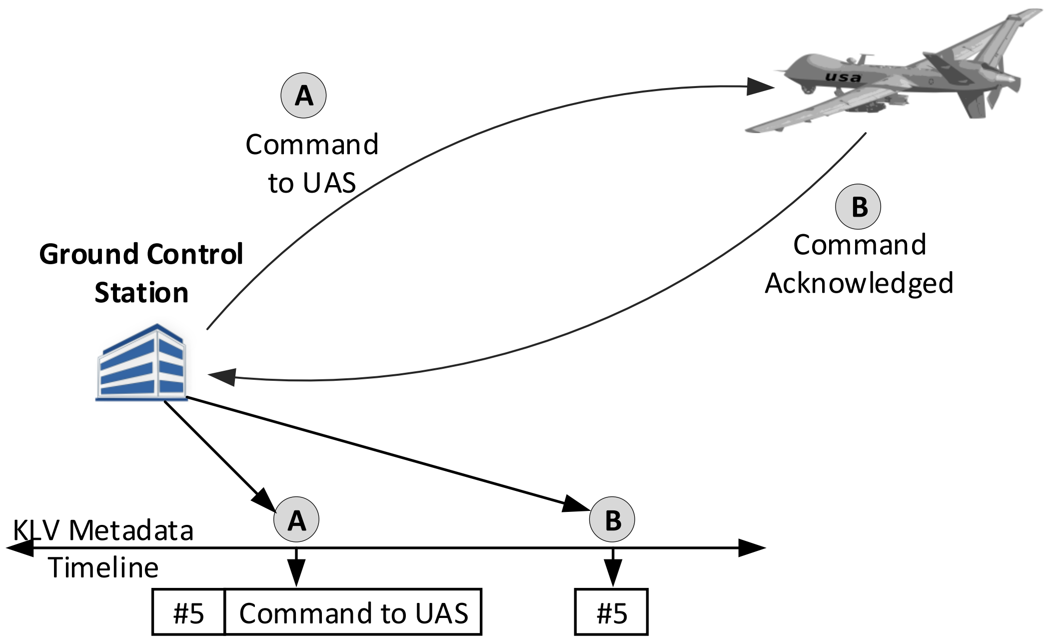

Figure 51: Control Command Usage

This Control Command value has four components combined into a KLV Pack: Command ID, Command String Length, Command String and Command Time.

The Command ID is a BER-OID integer value to track the command. This is an increasing and unique number assigned to each command as it is issued. Item 116 uses the command ID to show the command acknowledgement.

The Command String Length encodes the length of the Command String in BER short or long form.

The Command String is a utf8 value which describes the command. This string has a maximum length of 127 characters. The format and content of the string is vendor defined.

The Command Time is the Precision Time Stamp when first issuing the command to the platform. Item 115 is repeatable to meet Report-on-Change requirements (i.e., updates every 30 seconds) before item 116 acknowledges the Command. On the first use of item 115, for a specific Command ID, the Command Time defaults to the Precision Time Stamp of the packet. On subsequent repeats of the item, systems can optionally include the Command Time from the first use of the Command Pack for the specific Command ID. The Control Command, with a given Command ID, may be repeated (e.g., every thirty seconds) for as many packets as desired but when a Command Acknowledgement is used for the Command ID, the Control Command associated with the Command ID is no longer repeated.

Combining the Command ID, Command String, and the optional Command Time forms the pack structure, as shown in Figure 52.

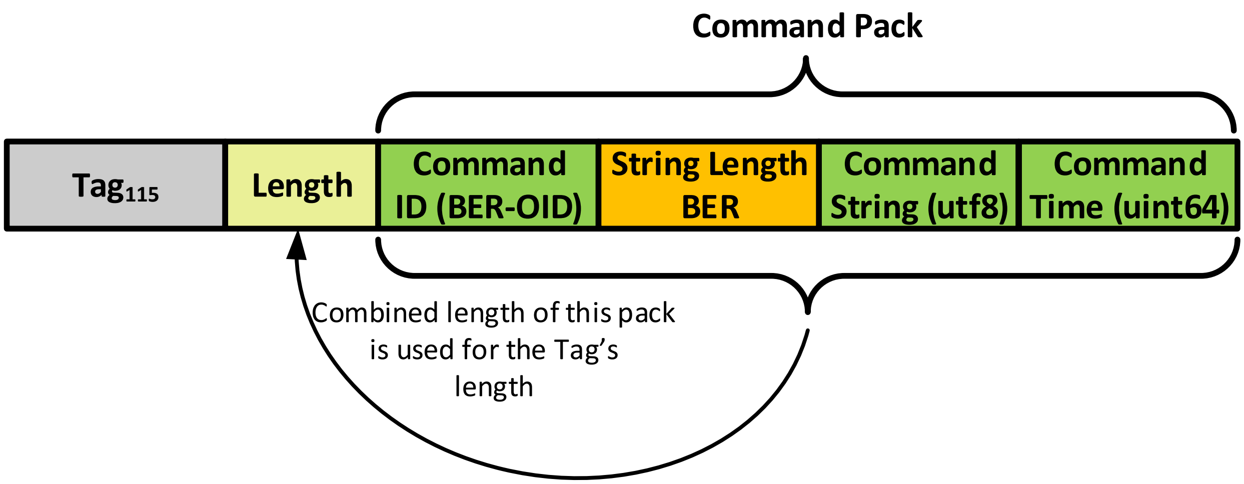

Figure 52: Command Pack

Table 7 summarizes the values and their order in the Command Pack.

Table 7: Command Pack values

Name	Type	Len	M/O
Command ID	uint (BER-OID)	v	M
Command String	utf8	v	M
Command Time	uint64	8	O

8.116 Item 116: Control Command Verification List

Description					
Acknowledgement of one or more control commands were received by the platform					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	list	N/A	N/A	
	KLV	dlp	N/A	N/A	N/A
Length		**Max Length**		**Required Length**	
Variable		N/A		N/A	
Resolution		**Special Values**			
N/A		N/A			
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value		See Details			
KLV Value To Software Value		See Details			
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
Verification of command 3 and 7		74	02	0307	

- Records validation of control commands recorded in Item 115
- See Item 115 details for description of how this item is used

8.116.1 Details

The Control Command Verification List is a variable length pack of one or more BER-OID values. Each value is a verification or acknowledgement of a Control Command sent to the platform – see Item 115 for more details.

As illustrated in Figure 53, the Local Set item consists of the item, followed by the Length and then one or more BER-OID Control Command Verification Identifiers from Item 115.

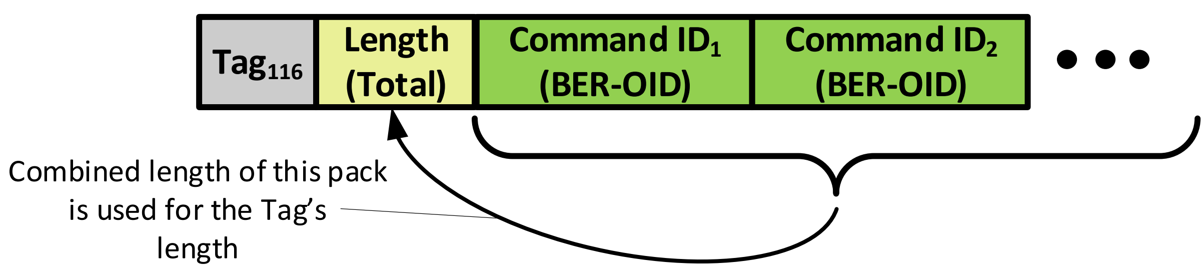

Figure 53: Control Command Verification List VLP

8.117 Item 117: Sensor Azimuth Rate

Description					
The rate the sensors azimuth angle is changing					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees Per Second (dps)	**Software**	float32	-1000.0	1000.0	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
2 bytes = 0.0625 degrees/second 3 bytes = 0.000244 degrees/second	None

Required in LS?	Optional	Allowed in SDCC Pack?	Yes	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-1000, 1000, \mathrm{Length}, \mathrm{Soft_{Val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-1000.0, 1000.0, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
1 degree/second	75	02	3E90

- Uses the same orientation as Sensor Relative Azimuth Angle (Item 18)
- Refer to Item 18's diagram: From above the aircraft looking down, when the sensor is moving clockwise the rate is positive and negative when its moving counterclockwise

8.118 Item 118: Sensor Elevation Rate

Description					
The rate the sensors elevation angle is changing					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees Per Second (dps)	**Software**	float32	-1000.0	1000.0	
	KLV	IMAPB	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	4	N/A

Resolution	**Special Values**
2 bytes = 0.0625 degrees/second 3 bytes = 0.000244 degrees/second	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-1000, 1000, \mathrm{Length}, \mathrm{Soft_{Val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-1000.0, 1000.0, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
0.004176 degrees/second	76	03	3E80 11

- Uses the same orientation as Sensor Relative Elevation Angle (Item 19)
- Refer to Item 19's diagram: From the side view of the aircraft shown, when the sensor is moving clockwise the rate is positive and negative when its moving counterclockwise

8.119 Item 119: Sensor Roll Rate

Description					
The rate the sensors roll angle is changing					
Units		**Format**	**Min**	**Max**	**Offset**
Degrees Per Second (dps)	**Software**	float32	-1000.0	1000.0	
	KLV	IMAPB	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	4	N/A

Resolution	**Special Values**
2 bytes = 0.0625 degrees/second 3 bytes = 0.000244 degrees/second	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	Yes	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(-1000, 1000, \mathrm{Length}, \mathrm{Soft_{Val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(-1000.0, 1000.0, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	**Example KLV Item (All Hex)**		
	Tag	**Len**	**Value**
-50 degrees/second	77	02	3B60

- Uses the same orientation as Sensor Relative Roll Angle (Item 20)
- Refer to Item 20's description: From behind the sensor, when the sensor is moving clockwise the rate is positive and negative when its moving counterclockwise

8.120 Item 120: On-board MI Storage Percent Full

Description					
Amount of on-board Motion Imagery storage used as a percentage of the total storage					
Units		**Format**	**Min**	**Max**	**Offset**
Percentage (%)	**Software**	float32	0	100.0	
	KLV	IMAPB	N/A	N/A	N/A

Length	**Max Length**	**Required Length**
Variable	3	N/A

Resolution	**Special Values**
2 bytes = 0.004 percent 3 bytes = 1.5E-5 percent	None

Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(0{,}100, \mathrm{Length}, \mathrm{Soft_{Val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(0{,}100, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	**Tag**	**Len**	**Value**
72 % Full	78	02	4800

(Example KLV Item (All Hex))

- Used with "On-board MI Storage Capacity" (Item 133), if available, to determine remaining recording storage space

8.121 Item 121: Active Wavelength List

Description					
List of wavelengths in Motion Imagery					
Units		Format	Min	Max	Offset
None	Software	list	N/A	N/A	
	KLV	dlp	N/A	N/A	N/A
Length	Max Length		Required Length		
Variable	Not Limited		N/A		
Resolution	Special Values				
N/A	N/A				
Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No
Software Value To KLV Value	See Details				
KLV Value To Software Value	See Details				
Example Software Value	Example KLV Item (All Hex)				
	Tag	Len	Value		
1,3 (Visible and NIR)	79	02	0103		
• Used with Wavelengths List (Item 128)					

8.121.1 Details

The Active Wavelength List provides a list of wavelengths used by the sensor to generate the Motion Imagery. This value updates when the sensor changes and the new sensor has a different wavelength than the last sensor used. For example, the sensor changes from a visible light to an infrared sensor. Multiple wavelengths identifiers support multi-band sensors or sensors which fuse multiple wavelength bands.

As illustrated in Figure 54, the Local Set item consists of the item, followed by the Length and then one or more BER-OID identifiers from the Wavelength List (see Item 128).

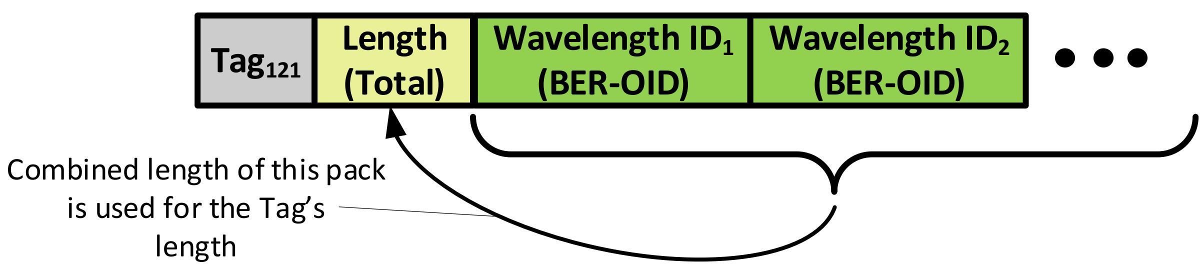

Figure 54: Illustration of Active Sensor Wavelength List VLP

The Wavelength ID's reference the sensors wavelength information from the Wavelength table defined in Item 128. The Wavelength ID's must be within the bounds of the current contents of Wavelength table. The current contents are the values in the table defined within the last 30 seconds.

Requirement	
ST 0601.17-37	A Wavelength ID in Item 121 shall be one of the current values (i.e., specified

	within the last 30 seconds) from the Wavelength Table defined in Item 128.

Figure 55 illustrates three examples of different Active Sensors. The first two are nominal Visible light and IR sensors. The third example shows a blended sensor which uses both Visible light and NIR to form the image.

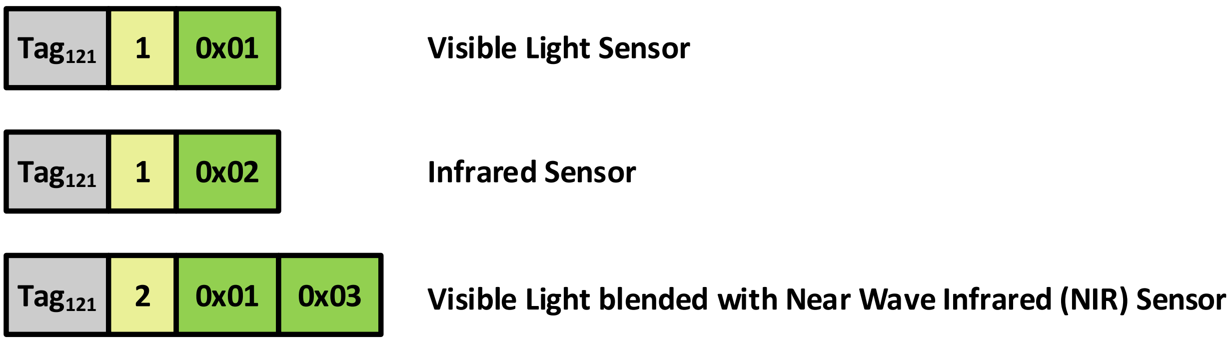

Figure 55: Examples of Active Sensor Wavelength List

The Wavelength list includes a zero (0) value to indicate there are no Active Wavelengths. When the Active Wavelength List uses ID set to zero (0) there are no active wavelengths; therefore, when the Active Wavelength List uses wavelength ID 0, it is a contraction to include any other ID in the Active Wavelength list.

Requirement	
ST 0601.17-38	Where the Active Wavelength List includes Wavelength ID zero (0), the Active Wavelength List shall not contain any other Wavelength IDs.

8.122 Item 122: Country Codes

<table>
<tr><th colspan="8">Description</th></tr>
<tr><td colspan="8">Country codes which are associated with the platform and its operation</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th colspan="2">Max</th><th colspan="2">Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>record</td><td>N/A</td><td colspan="2">N/A</td><td colspan="2"></td></tr>
<tr><th>KLV</th><td>vlp</td><td>N/A</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="3">Max Length</th><th colspan="3">Required Length</th></tr>
<tr><td colspan="2">N/A</td><td colspan="3">Not Limited</td><td colspan="3">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="6">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="6">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th colspan="2">Allowed in SDCC Pack?</th><td>No</td><th colspan="2">Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="6">See Details</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="6">See Details</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="5">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">Canada, (Unknown Country), France</td><th>Tag</th><th>Len</th><th colspan="3">Value</th></tr>
<tr><td>7A</td><td>0B</td><td colspan="3">010E 0343 414E 0003 4652 41</td></tr>
<tr><td colspan="8">• None</td></tr>
</table>

8.122.1 Details

The Country Codes item provides country related information about the platform and its operation. The country which own and fly aircraft, along with where the platform is flying, and the country observed in the Motion Imagery scene are all needed information. For example, Country A is flying Country B's UAV over Country C while imaging Country D and Country E performs analysis and classification of the Motion Imagery. There are five country codes of interest: Operator Country, Manufacture Country, Overflight Country, Object Country (Motion Imagery Scene) and Classifying Country. For the example above:

- Operator = Country A
- Manufacture = Country B
- Overflight Country = Country C
- Object Country = Country D
- Classifying country = Country E

Table 8 lists the definitions for each of the different Country Code types.

Table 8: Country Definitions

Function	Description
Overflight Country	The country the platform is operating or flying over. This may be different than the country within the scene of the Motion Imagery.
Operator Country	Country where the operator is located. For example, a GCS operator.
Country of Manufacture	The Country where the platform was manufactured.
Object Country	The country within the Motion Imagery scene or the "Object" of the Motion Imagery. **Note: This value is an item in MISB ST 0102 and is not included in this item's country codes list.**
Classifying Country	The country which initially analyzes or classified the Motion Imagery. **Note: This value is an item in MISB ST 0102 and is not included in this item's country codes list.**

The Country Codes item is a four item Variable Length Pack (VLP), which contains: Country Coding Method, Overflight Country Code, Operator Country Code, and Country Code of Manufacture. The first VLP item is the Country Coding Method, an enumeration integer from the list of methods in MISB ST 0102 – Table 2: Security Metadata Local Set Elements, Item 12. The value indicates how to interpret the country codes specified in the VLP. Each country code is a string (utf8) encoded according to the coding method specified in the first item of the VLP.

Figure 56 illustrates the VLP structure for the item. Construct the Local Set item by first encoding Item 122 then include the Length (Total) using the BER short or long form method. Next, each of the four length-value pairs follows the Length (Total) in the exact order indicated. Each length-value pair length is encoded using BER short or long form encoding.

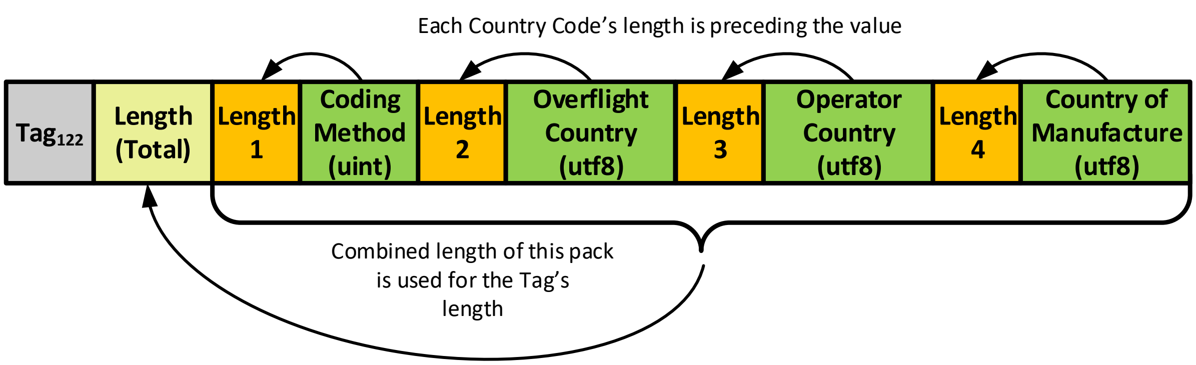

Figure 56: Illustration of Country Code List VLP

If one of the country values is unknown, set the length for the country code to zero (0) and do not include the country code string. For example, Figure 57 illustrates the case where the operator country is unknown. Assuming the Coding Method is *GENC three letter*, the Overflight Country is Canada, the Operating Country is unknown (thus the length is set to zero (0)), and the Country Code of Manufacture for the platform is France.

Tag_{122}	11	1	0x0E	3	CAN	0	3	FRA

Figure 57: Illustration of Unknown Country in VLP

There are two truncation cases for the VLP: if the Country Code of Manufacture is unknown (since it is the last item in the list), or if both the Operator Country and Country Code of Manufacture are unknown (the last two items in the VLP). When truncating a value, the length-value pair are both removed.

Table 9 summarizes the values and their order in the Country Codes VLP.

Table 9: Country Code VLP values

Name	Type	Len	M/O
Coding Method	uint	v	M
Overflight Country	utf8	v	M
Operator Country	utf8	v	O
Country of Manufacture	utf8	v	O

8.123 Item 123: Number of NAVSATs in View

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Count of navigation satellites in view of platform</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">count</td><th>Software</th><td>uint</td><td>0</td><td>255</td><td></td></tr>
<tr><th>KLV</th><td>uint</td><td>0</td><td>255</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">1</td><td colspan="2">1</td><td colspan="2">1</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">1</td><td colspan="4">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="4">$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="4">$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{uint}}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">7 (Satellites)</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>7B</td><td>01</td><td>07</td></tr>
</table>

- Number of satellites used to determine position
- Used with Positioning Method Source (Item 124) for NAVSAT Types

8.124 Item 124: Positioning Method Source

Description					
Source of the navigation positioning information. (e.g., NAVSAT-GPS, NAVSAT-Galileo, INS)					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint	1	255	
	KLV	uint	1	255	N/A

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
N/A	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
3 (INS and GPS Positioning)	7C	01	03

- A set of flags specifying the source(s) of positioning information
- A value with all bits set to zero does not have meaning and is not allowed

8.124.1 Details

The Positioning Method Source is an integer interpreted as a set of bit flags as indicated in Table 10. Bit zero is the Least Significant Bit (LSB).

Table 10: Position Methods by Bit Location

Bit	Type	Name	Country
0	INS	On-board Inertial Navigation System	N/A
1	NAVSAT	GPS	United States
2	NAVSAT	Galileo	E.U.
3	NAVSAT	QZSS	Japan
4	NAVSAT	NAVIC	India
5	NAVSAT	GLONASS	Russia
6	NAVSAT	BeiDou-1	China
7	NAVSAT	BeiDou-2	China

For example, a value of three (or binary 0000 0011) indicates “On-board Inertial Navigation System” and “GPS” provide the positioning information for the platform.

To support potential future growth of this item, any additional Positioning Methods will be added in more significant bytes. The bit positions stated above are in the least significant byte of the value.

8.125 Item 125: Platform Status

<table>
<tr><th colspan="8">Description</th></tr>
<tr><td colspan="8">Enumeration of operational modes of the platform (e.g., in-route, RTB)</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th colspan="2">Max</th><th colspan="2">Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>uint</td><td>0</td><td colspan="2">12</td><td colspan="2"></td></tr>
<tr><th>KLV</th><td>uint</td><td>0</td><td colspan="2">12</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="3">Max Length</th><th colspan="3">Required Length</th></tr>
<tr><td colspan="2">1</td><td colspan="3">1</td><td colspan="3">1</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="6">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="6">None</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th colspan="2">Allowed in SDCC Pack?</th><td>No</td><th colspan="2">Multiples Allowed?</th><td>No</td></tr>
<tr><th colspan="2">Software Value To KLV Value</th><td colspan="6">$KLV_{val} = Soft_{val}$</td></tr>
<tr><th colspan="2">KLV Value To Software Value</th><td colspan="6">$Soft_{val} = KLV_{uint}$</td></tr>
<tr><th colspan="3">Example Software Value</th><th colspan="5">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="3" rowspan="2">9 (Egress)</td><th>Tag</th><th>Len</th><th colspan="3">Value</th></tr>
<tr><td>7D</td><td>01</td><td colspan="3">09</td></tr>
<tr><td colspan="8">• Use table in Details to resolve enumeration name</td></tr>
</table>

8.125.1 Details

The Platform Status is an enumeration of modes for the platform throughout the life-cycle of a single flight. Table 11 lists the modes:

Table 11: Platform Status Modes

Value	Name	Description
0	Active	Platform active but with unknown status
1	Pre-flight	Platform is performing pre-flight tasks
2	Pre-flight-taxiing	Platform is taxiing before take-off
3	Run-up	Engine run-up before take-off
4	Take-off	Platform is taking off
5	Ingress	Platform is flying to first target
6	Manual operation	Human is piloting the platform
7	Automated-orbit	Automated system is piloting platform
8	Transitioning	Platform is transitioning to new target
9	Egress	Platform if flying to recovery location (i.e., Return to Base (RTB)
10	Landing	Platform is landing – wheels down
11	Landed-taxiing	Platform has landed and is taxiing
12	Landed-Parked	Platform is parked after mission, awaiting power down
13-255	Reserved	Reserved for future expansion - Do not use

Some modes may be appropriate to use at the same time, for example “Manual Operation” and “Take-off” could be occurring at the same time. Use the mode which describes the situation with the most detail.

8.126 Item 126: Sensor Control Mode

Description					
Enumerated value for the current sensor control operational status					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	uint	0	6	
	KLV	uint	0	6	N/A

Length	Max Length	Required Length
1	1	1

Resolution	Special Values
N/A	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
5 (Auto-Holding Position)	7E	01	05

- Use table in Details to resolve enumeration name

8.126.1 Details

The Sensor Control Mode provides an enumeration of the operational status of a sensor. Table 12 lists the possible modes.

Table 12: Sensor Control Modes

Value	Name	Description
0	Off	The sensor is powered off
1	Home Position	The sensor is in its “home” or “lock” position (e.g., locked for landing)
2	Uncontrolled	No person or system is controlling the sensor
3	Manual Control	A person is directing the sensor
4	Calibrating	The sensor is calibrating (e.g., IR NUC)
5	Auto - Holding Position	An autonomous system is controlling the sensor positioning which is in a holding mode pointing at a specific stationary ground position
6	Auto - Tracking	An autonomous system is controlling the sensor positioning which is tracking an object
7-255	Reserved	Reserved for future expansion - Do not use

8.127 Item 127: Sensor Frame Rate Pack

Description					
Values used to compute the frame rate of the Motion Imagery at the sensor					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	dlp	N/A	N/A	N/A
Length	**Max Length**		**Required Length**		
Variable	16		N/A		
Resolution	**Special Values**				
N/A	None				
Required in LS?	Optional	**Allowed in SDCC Pack?**	No	**Multiples Allowed?**	No
Software Value To KLV Value	See Details				
KLV Value To Software Value	See Details				
Example Software Value	**Example KLV Item (All Hex)**				
	Tag	**Len**	**Value**		
60000/1001 = 59.94 fps	7F	05	83D4 6087 69		
• The sensor frame rate may be different than the encoded frame rate					

8.127.1 Details

The Sensor Frame Rate Pack consists of two unsigned integers used to compute the frame rate. The ratio of the two integers provides the capability to compute both integer and drop-frame frame rates. For example, typical integer frame rates of 30, 60 are the ratio of 30/1 and 60/1, respectively. While drop-frame rates of 29.97 and 59.94 are the ratio of 30000/1001 and 60000/1001, respectively.

The Sensor Frame Rate Pack is a two-element truncation pack where the first element is the numerator in BER-OID format, and the second element is the denominator in BER-OID format, as shown in Figure 58.

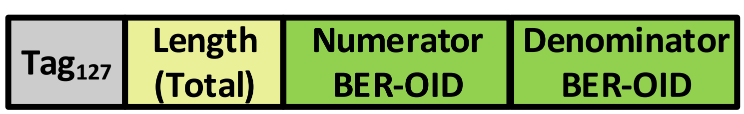

Figure 58: Sensor Frame Rate Pack

If the pack does not include the second value, the denominator defaults to a value of one (1).

Table 13 summarizes the order and values for the Sensor Frame Rate Pack.

Table 13: Sensor Frame Rate Pack

Name	Type	Len	M/O
Numerator	Uint (ber-oid)	v	M
Denominator	Uint (ber-oid)	v	O

8.128 Item 128: Wavelengths List

Description					
List of wavelength bands provided by sensor(s)					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	list	N/A	N/A	
	KLV	vlp	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See Details
KLV Value To Software Value	See Details

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
21,1000, 2000, NNIR (Narrow NIR)	8100	0E	0D15 0000 07D0 0000 0FA0 4E4E 4952

- Used with Active Wavelength List (Item 121)

8.128.1 Details

The Wavelengths List is a list of information used by the on-board sensors which collect Motion Imagery. This item is a companion to Active Wavelength List (Item 121).

A sensor wavelength record contains a numeric identifier (ID), min/max wavelengths, and a unique name for display on remote terminals, etc. The ID is a unique number for the wavelength record. Custom wavelength records begin at ID 21 and increment as needed. A custom wavelength record persists only for a given flight. The “Min” and “Max” wavelengths define the range of the band. The “Name” is a unique string describing the band. The sensor wavelength record does not include the “Description,” it is only in the table for informational purposes.

See the Motion Imagery Handbook Section 3.1 for information on these wavelengths and descriptions.
Table 14 shows predefined sensor records which support a set of common wavelengths used by sensors. The Active Wavelength List (Item 121) can use these predefined wavelength bands if they are sufficient for the given platform’s sensors. If a platform/sensor requires more specific or customized wavelength records, this item enables their definition. Any custom Wavelengths List records are sent at a minimum of once every 30 seconds. If the predefined wavelengths are sufficient for the platforms sensors there is no need to send a Wavelengths List item. Table 14 includes ID 0 to indicate there are no active wavelengths.

A sensor wavelength record contains a numeric identifier (ID), min/max wavelengths, and a unique name for display on remote terminals, etc. The ID is a unique number for the wavelength record. Custom wavelength records begin at ID 21 and increment as needed. A custom wavelength record persists only for a given flight. The “Min” and “Max” wavelengths define the

range of the band. The “Name” is a unique string describing the band. The sensor wavelength record does not include the “Description,” it is only in the table for informational purposes.

See the Motion Imagery Handbook Section 3.1 for information on these wavelengths and descriptions.

Table 14: Predefined Wavelength Information Records

ID	Min (nm)	Max (nm)	Name	Description
0	N/A	N/A	N/A	Empty List
1	380	750	VIS	Visible light
2	750	100,000	IR	Infrared
3	750	3000	NIR	Near/Short Wave Infrared
4	3000	8000	MIR	Mid-wave Infrared
5	8000	14000	LIR	Long-wave Infrared
6	14000	100,000	FIR	Far-Infrared
7-20	Reserved	Reserved		Reserved for future use

The Wavelengths List item is a list of wavelength records formatted as a Variable Length Pack (VLP). Each value of the VLP is a separate wavelength record formatted as a Floating Length Pack (FLP). The FLP consists of four fields, in order: Wavelength ID, Min Wavelength, Max Wavelength and Wavelength Name. The Wavelength ID is a BER-OID encoded integer. The Wavelength Min and Wavelength Max values are IMAPB(0,1e9,4) which provides a precision of ~½ a nanometer, and covers the spectrum range from X-Rays to VHF. The Wavelength Name is a utf8 string of characters with varying length. Figure 59 illustrates the FLP.

Wavelength ID (BER-OID)	Min Wavelength (IMAPB)	Max Wavelength (IMAPB)	Wavelength Name (utf8)

Figure 59: Wavelength Record in FLP

Combining one or more FLP’s, along with each of their lengths, forms the Wavelengths List Local Set item’s VLP as illustrated in Figure 60.

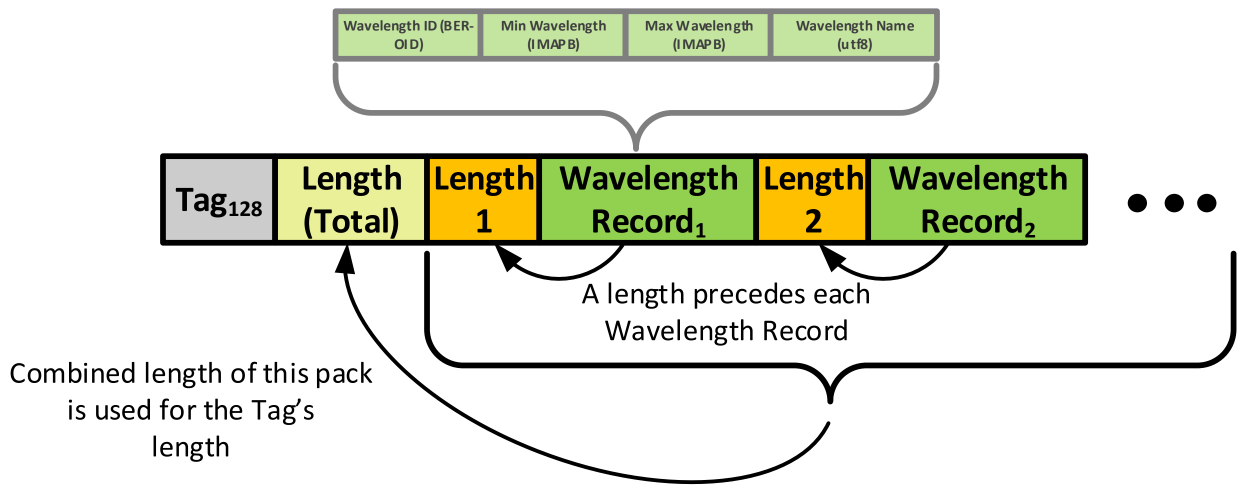

Figure 60: Wavelengths List VLP

Each Wavelength Record's length provides the information to parse all the Wavelength Records items properly. Given a Wavelength Record FLP, the Wavelength ID in BER-OID format can be one or more bytes. The BER-OID format is self-describing providing the rules for obtaining the number of bytes for the value. The Wavelength Min and Wavelength Max values are both four (4) bytes each. Subtracting the sum of the Wavelength ID BER-OID bytes, and the eight bytes from the Wavelength Min / Wavelength Max from the VLP length determines the length of the Wavelength Name string: $Name_{len} = Length_1 - (BEROID_{len} + 8)$

Sending all Wavelength Records in one UAS Datalink LS is unnecessary and could contribute to bandwidth compromises. Sending Wavelength Records using multiple UAS Datalink LS's distributes the metadata and reduces these issues. See the List Distribution Section for more information.

Table 15 summarizes the order and values for the Wavelengths Record FLP.

Table 15: Wavelength Record Values

Name	Type	Len	M/O
Wavelength ID	uint (ber-oid)	v	M
Minimum Wavelength	float (IMAPB)	4	M
Maximum Wavelength	float (IMAPB)	4	M
Wavelength Name	utf8	v	M

8.129 Item 129: Target ID

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Alpha-numeric identification of a target</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>string</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>utf8</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

Length	Max Length	Required Length
Variable	32	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{val}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>A123</td><td>8101</td><td>04</td><td>4131 3233</td></tr>
</table>

- Platform/Mission specific identifier for a target.
- Format is application specific

8.130 Item 130: Airbase Locations

<table>
<tr><th colspan="7">Description</th></tr>
<tr><td colspan="7">Geographic location of the take-off site and recovery site</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th colspan="2">Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>record</td><td>N/A</td><td>N/A</td><td colspan="2"></td></tr>
<tr><th>KLV</th><td>vlp</td><td>N/A</td><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="3">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="3">24</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="5">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="5">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td colspan="2">No</td></tr>
</table>

Software Value To KLV Value	See Details
KLV Value To Software Value	See Details

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>(38.841859, -77.036784, 3),
(38.939353, -77.459811, 95)

[See Bullet Note Below]</td><td>8102</td><td>18</td><td>0B40 6BC2 0919 BDA5 5407 0E00 0B40 783C B819 A292 7407 C600</td></tr>
</table>

- Truncation Pack which includes the Latitude, Longitude and HAE for both sites
- If Take-off and Recovery sites are the same only provide the Take-off site
- Example Software Value shows two triplets, where each triplet is a location (latitude, longitude, elevation)

8.130.1 Details

The Airbase Locations item is a Variable Length Pack (VLP) describing either the take-off location, the recovery location or both within a Location Defined Length Pack (DLP).

Both the take-off and recovery locations are coordinates with WGS84 Latitude, Longitude and Height Above Ellipsod (HAE). Each location is described in a DLP containing IMAPB values for latitude, longitude and HAE. The latitude and longitude are each four (4) bytes and the HAE is three (3) bytes, as illustrated in Figure 61.

Latitude IMAPB(-90,90,4)	Longitude IMAPB(-180,180,4)	HAE IMAPB(-900, 9000,3)

Figure 61: Location DLP

The lengths have been choosen to provide a 1 meter or better precision. The WGS84 earth radius, R, of 6378137 meters at the equator, is used to compute the circumference of $2\pi R = 40{,}075{,}017$ meters. Using this circumference as the worst case (i.e., spherical model), the latitude and longitude precision values are computed. One meter of precision is 1/40,075,017$^{\text{th}}$ of the earth circumference.

For latitude values, one meter of precision is $180 * \frac{1}{40075017} = 4.49$ microdegrees. With the maxium magnitude of +/- 90 degrees and 4.49 microdegrees the Software value requires an IEEE double precision floating point value. IMAPB requires 4 bytes to provide the same precision. Using IMAP(-90,90,4) provides 11.9 microdegrees or 1.19 cm of precision.

For longitude values, one meter of precision is $360 * \frac{1}{40075017} = 8.98$ microdegrees. With a maxium magnitude of +/- 180 degrees and 8.89 microdegrees the software value requires an IEEE double precision floating point value. IMAPB requires 4 bytes to provide the same preicsion. Using IMAPB(-180,180,4) provides 23.8 microdegrees of 2.65 cm of precision.

For HAE with a range from -900 to 9000 meters and similar precisions (1 meter or better) requires using three bytes. Using IMAPB(-900, 9000, 3) provides 0.19 cm of precision.

The Airbase Locations VLP contains the take-off location, followed by the recovery location, and with each preceded by the length of the location as shown in Figure 62.

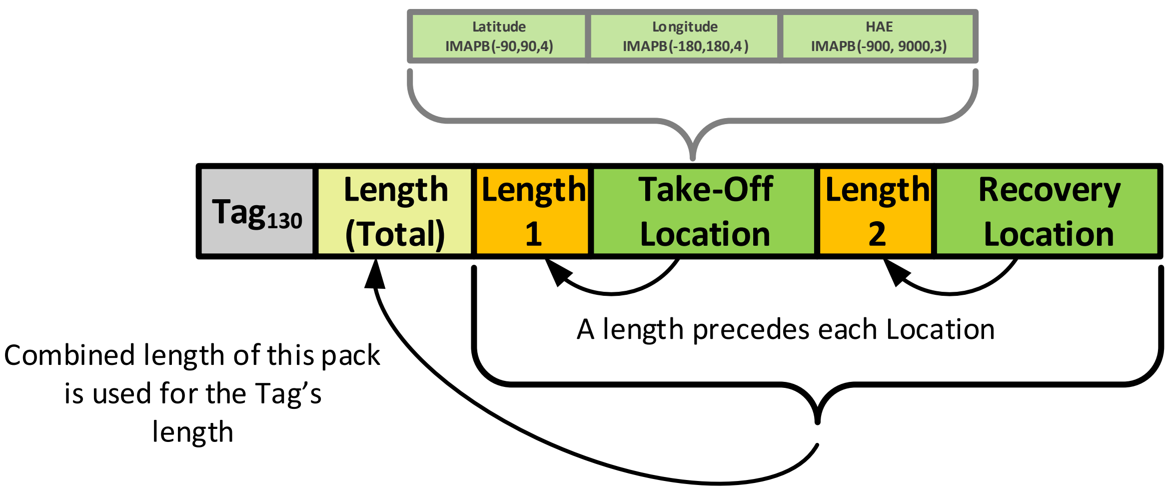

Figure 62: Airbase Locations VLP

The Airbase Locations item has several bandwidth optimizations:

1) Do not include the Recovery Location (i.e., truncate it), if the Take-Off Location and the Recovery Location are the same. When a receiver parses the location, if the Recovery Location is absent then the Recovery Location is set equal to the Take-Off location, i.e., the aircraft is doing a round trip back to the take-off location.
2) If either the Take-Off Location or Recovery Location is unknown, the length for the respective location's value is set to zero (0). Therefore, when a receiver parses the item and either the Take-Off Location or Recovery Location length is zero, the Software Values for the location are set to an "unknown."
3) If both the Take-Off Location and Recover Locations are unknown, Item 130 does not appear in the Local Set.
4) Do not include the HAE value (i.e., truncate it) in either location if it is unknown.

Table 16 lists the order and values for the Locations Pack.

Table 16: Locations Pack values

Name	Type	Len	M/O
Latitude	float (IMAPB)	4	M
Longitude	float (IMAPB)	4	M
HAE	float (IMAPB)	3	O

8.131 Item 131: Take-off Time

Description					
Time when aircraft became airborne					
Units		**Format**	**Min**	**Max**	**Offset**
Microseconds (µs)	**Software**	uint64	0	(2^64)-1	
	KLV	uint	0	(2^64)-1	N/A

Length	Max Length	Required Length
Variable	8	N/A

Resolution	Special Values
1 microsecond	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
2018-06-21T13:43:57.122999	8103	08	0005 6F27 1B5E 41B7

- Represented in the number of microseconds elapsed since midnight (00:00:00), January 1, 1970 not including leap seconds
- See MISB ST 0603
- See details for Time Airborne (Item 110) for description and usage

8.132 Item 132: Transmission Frequency

Description
Radio frequency used to transmit the Motion Imagery

Units		Format	Min	Max	Offset
MHz	Software	float64	1	99999	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
2 bytes = 4 MHz 3 bytes = 15.625 KHz	None

Required in LS?		Allowed in SDCC Pack?		Multiples Allowed?	
Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(1\ ,99999, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(1, 99999, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	Len	Value
2.4 GHz	8104	03	0257 C0

- The Radio Frequency used to transmit the UAS Motion Imagery from the platform to the ground station or satellite uplink

8.133 Item 133: On-board MI Storage Capacity

Description					
The total capacity of on-board Motion Imagery storage					
Units		**Format**	**Min**	**Max**	**Offset**
Gigabytes (GB)	**Software**	uint32	0	(2^32)-1	
	KLV	uint	0	(2^32)-1	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
1 Gigabyte	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
10,000 GB (10 TB) Hard Drive	8105	02	2710

- Used with "On-Board Storage Percent Full" (Item 120) to determine remaining storage/time available for recording

8.134 Item 134: Zoom Percentage

Description					
For a variable zoom system, the percentage of zoom					
Units		**Format**	**Min**	**Max**	**Offset**
Percent (%)	**Software**	float32	0	100.0	
	KLV	IMAPB	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
1 byte = 1% 2 bytes = .0039%	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{IMAPB}(0, 100.0, \mathrm{Length}, \mathrm{Soft_{val}})$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{RIMAPB}(0, 100.0, \mathrm{Length}, \mathrm{KLV_{uint}})$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
55.0 %	8106	02	3700

- Percentage of Zoom of the sensor system
- Includes both digital and optical zoom
- 0% means no zoom, 100% means fully zoomed

8.135 Item 135: Communications Method

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Type of communications used with platform</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>string</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>utf8</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">127</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
</table>

<table>
<tr><th>Software Value To KLV Value</th><td colspan="3">$\mathrm{KLV_{val}} = \mathrm{Soft_{val}}$</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="3">$\mathrm{Soft_{val}} = \mathrm{KLV_{val}}$</td></tr>
<tr><th>Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td rowspan="2">Frequency Modulation</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>8107</td><td>14</td><td>4672 6571 7565 6E63 7920 4D6F 6475 6C61 7469 6F6E</td></tr>
</table>

- Type of signal used to communicate with platform

8.136 Item 136: Leap Seconds

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">Number of leap seconds to adjust Precision Time Stamp (Item 2) to UTC</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">Seconds (s)</td><th>Software</th><td>int32</td><td>-(2^31)</td><td>(2^31)-1</td><td></td></tr>
<tr><th>KLV</th><td>int</td><td>-(2^31)</td><td>(2^31)-1</td><td>N/A</td></tr>
</table>

Length	Max Length	Required Length
Variable	4	N/A

Resolution	Special Values
1 Second	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV}_{\mathrm{val}} = \mathrm{Soft}_{\mathrm{Val}}$
KLV Value To Software Value	$\mathrm{Soft}_{\mathrm{val}} = \mathrm{KLV}_{\mathrm{int}}$

<table>
<tr><th rowspan="2">Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>30 seconds</td><td>8108</td><td>01</td><td>1E</td></tr>
</table>

- Add this value to Precision Time Stamp (Item 2) to convert to UTC
- When adjusting Precision Time Stamp to UTC multiply this leap second value by 1,000,000 to convert it to microseconds
- See handbook for more details on Leap Seconds and the MISP Time System
- See "Packet Timestamp" section for more information on the use of this item

8.137 Item 137: Correction Offset

Description					
Post-flight time adjustment to correct Precision Time Stamp (Item 2) as needed					
Units		**Format**	**Min**	**Max**	**Offset**
microseconds (µs)	**Software**	int64	-(2^63)	(2^63)-1	
	KLV	int	-(2^63)	(2^63)-1	N/A

Length	Max Length	Required Length
Variable	8	N/A

Resolution	Special Values
1 microsecond	None

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	$\mathrm{KLV_{val}} = \mathrm{Soft_{Val}}$
KLV Value To Software Value	$\mathrm{Soft_{val}} = \mathrm{KLV_{uint}}$

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
1:23:45.678901 (5025678901 µs)	8109	05	012B 8DC6 35

- Add value to Precision Time Stamp (Item 2) to correct time
- This value DOES NOT INCLUDE leap seconds offset. See Leap Seconds (Item 136) to add leap second offset
- See "Packet Timestamp" section for more information on the use of this item

8.138 Item 138: Payload List

<table>
<tr><th colspan="6">Description</th></tr>
<tr><td colspan="6">List of payloads available on the Platform</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>list</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>vlp</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">Not Limited</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
</table>

<table>
<tr><th>Software Value To KLV Value</th><td colspan="3">See Details</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="3">See Details</td></tr>
<tr><th>Example Software Value</th><th colspan="3">Example KLV Item (All Hex)</th></tr>
<tr><td rowspan="2">(0, 0, "VIS Nose Camera")
(1, 0, "ACME VIS Model 123")
(2, 0, "ACME IR Model 456")

[See Bullet Note Below]</td><th>Tag</th><th>Len</th><th>Value</th></tr>
<tr><td>810A</td><td>3F</td><td>0312 0000 0F56 4953 204E 6F73 6520 4361
6D65 7261 1501 0012 4143 4D45 2056 4953
204D 6F64 656C 2031 3233 1402 0011 4143
4D45 2049 5220 4D6F 6465 6C20 3435 36</td></tr>
</table>

- List of Payloads on-board platform. Payloads include non-Motion Imagery sensors
- Used with Active Payloads (Item 139)
- Example Software Value shows three triplets, where each triplet is a Payload Record (Identifier, Type, Name)

8.138.1 Details

The Payload List provides type and name of all relevant payloads on the platform. The Payload List may contain optical sensors and non-optical payload packages such as SIGINT, LIDAR, or RADAR systems. Some of the items in the Payload List will have further wavelength information provided in the Wavelengths List when they become active. This list does not contain any weapons, see Item 140 for listing platform weapons.

The Payload List is a Floating Length Pack (FLP) which contains a Payload Record. A Payload Record consists of four elements: Payload Identifier, Payload Type, Name Length and Payload Name. The Payload Identifier is a unique BER-OID integer sequentially assigned starting with the number zero (0). The Active Payload (Item 139) uses the Payload Identifier to specify which payloads are active. The Payload Type is a BER-OID enumeration from Table 17. The Name Length encodes the length of the Payload Name in BER short or long form. The Payload Name is a descriptive name of the payload defined by the metadata encoder.

Table 17: Payload Type Enumeration

Payload Type	Enumeration Meaning
0	Electro Optical MI Sensor
1	LIDAR
2	RADAR
3	SIGINT

4	SAR

Note: With a FLP, the final element's length can be determined automatically; however, by including the Name Length the Payload Record enables future expansion.

Requirement	
ST 0601.13-30	When including a Payload List (Item 138) in the UAS Datalink LS, the Payload Identifier value shall start at zero (0) and increment by one (1) for each additional payload.

Figure 63 illustrates the four items in a Payload Record.

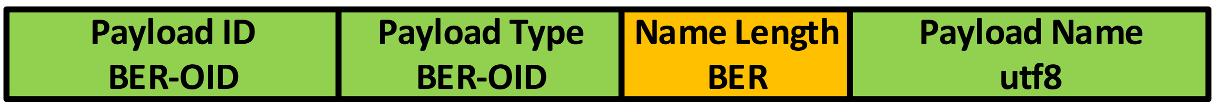

Figure 63: Payload Record FLP

The Payload List starts with a Payload Count in BER-OID format. The Payload Count is the total number of payloads on the platform. Following the Payload Count, a series of Payload Records within a VLP as shown in Figure 64. Preceding each Payload Record in the list is the BER (short or long form) value of the Payload Record's length. The Length (Total) of all Payload Records and their lengths follows Item 138.

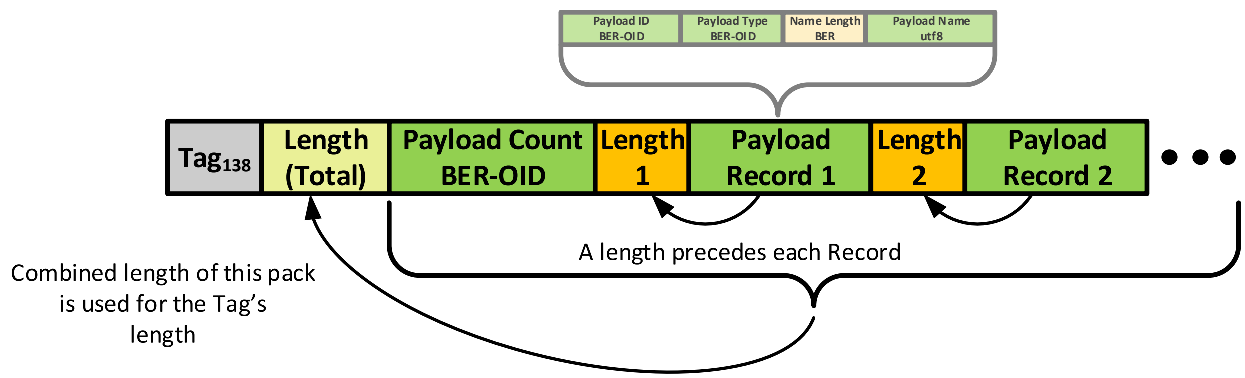

Figure 64: Payload List VLP

Table 18 shows an example Payload List.

Table 18: Example Payload List

Payload Identifier	Payload Type	Payload Name
0	0	VIS Nose Camera
1	0	ACME VIS Model 123
2	0	ACME IR Model 456
3	1	NO COMP - LIDAR
4	4	SAR Model X

Figure 65 shows the KLV value for the Example Payload List in Table 18.

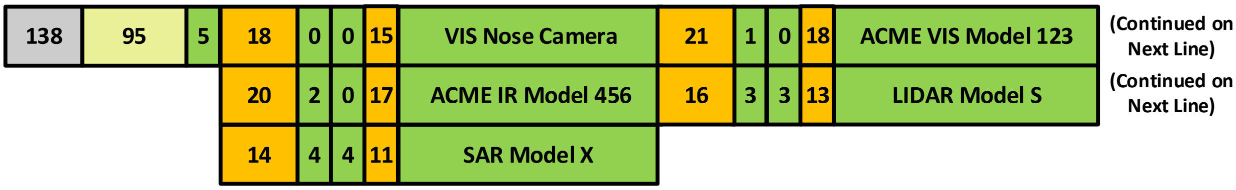

Figure 65: Example Payload List KLV

Sending all Payload Records in one UAS Datalink LS is unnecessary and could contribute to bandwidth compromises. Sending Payload Records using multiple UAS Datalink LS's distributes the metadata and reduces these issues. In each Payload List, the Payload Count is constant and contains the total number of payloads on-board the platform. See the List Distribution Section for more information.

Table 19 defines the Payload Count. Table 20 summarizes the order and values of the Payload Record Pack.

Table 19: Payload Count

Name	Type	Len	M/O
Payload Count	uint (ber-oid)	v	M

Table 20: Payload Record Pack values

Name	Type	Len	M/O
Payload ID	uint (ber-oid)	v	M
Payload Type	uint (ber-oid)	v	M
Payload Name	utf8	v	M

8.139 Item 139: Active Payloads

<table>
<tr><th colspan="8">Description</th></tr>
<tr><td colspan="8">List of currently active payloads from the payload list (Item 138)</td></tr>
<tr><th>Units</th><th></th><th>Format</th><th>Min</th><th>Max</th><th>Offset</th></tr>
<tr><td rowspan="2">None</td><th>Software</th><td>list</td><td>N/A</td><td>N/A</td><td></td></tr>
<tr><th>KLV</th><td>byte</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><th colspan="2">Length</th><th colspan="2">Max Length</th><th colspan="2">Required Length</th></tr>
<tr><td colspan="2">Variable</td><td colspan="2">Not Limited</td><td colspan="2">N/A</td></tr>
<tr><th colspan="2">Resolution</th><th colspan="4">Special Values</th></tr>
<tr><td colspan="2">N/A</td><td colspan="4">N/A</td></tr>
<tr><th>Required in LS?</th><td>Optional</td><th>Allowed in SDCC Pack?</th><td>No</td><th>Multiples Allowed?</th><td>No</td></tr>
<tr><th>Software Value To KLV Value</th><td colspan="5">See Details</td></tr>
<tr><th>KLV Value To Software Value</th><td colspan="5">See Details</td></tr>
<tr><th colspan="2">Example Software Value</th><th colspan="4">Example KLV Item (All Hex)</th></tr>
<tr><td colspan="2" rowspan="2">Payload ID's 0,1, and 3 are Active</td><th>Tag</th><th>Len</th><th colspan="2">Value</th></tr>
<tr><td>810B</td><td>01</td><td colspan="2">0B</td></tr>
<tr><td colspan="6">• Denotes which payloads from the Payload List (Item 138) are currently active</td></tr>
</table>

8.139.1 Details

The Active Payloads item is a list of the subset of payloads from the Payload List which are currently in use. The list is a series of Payload Identifiers which map into the Payload List allowing receivers to determine the Active Payload Names.

The list is a series of bits which represent which payloads are active. A bit value of one (1) means the payload is active, a bit value of zero (0) means the payload is not active. Using the example from the Payload List (Item 138), if payloads 0, 1, and 3 are active, bits 0, 1, and 3 will be set in the Active Payloads Value, as shown in Figure 66. The result for this example is a single byte with the value of 0x0B.

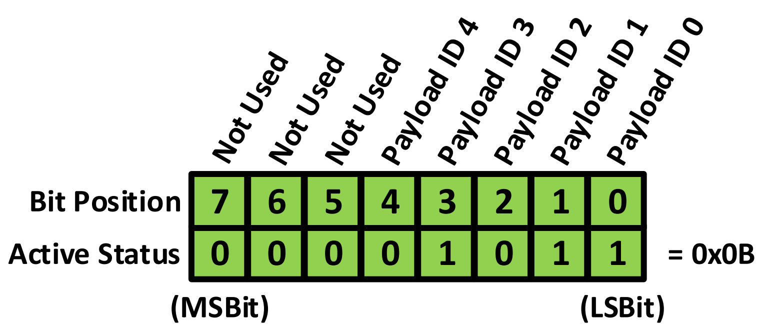

Figure 66: Active Payloads Example

Use additional bytes when the Payload List (Item 138) has more than eight payloads.

The bit position set to one (1) must be within the bounds of the current contents of Payload List. The current contents are the values in the table defined within the last 30 seconds.

Requirement	
ST 0601.17-39	A bit position value set to one (1) in Item 139 shall be one of the current Payload ID values (i.e., specified within the last 30 seconds) from the Payload List defined in Item 138.

8.140 Item 140: Weapons Stores

Description					
List of weapon stores and status					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	list	N/A	N/A	
	KLV	vlp	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See Details
KLV Value To Software Value	See Details

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
(1, 1, 1, 3,([0,0, 0, 1], 3), "Harpoon") (1, 1, 2, 2,([1,1, 1, 1], 4), "Hellfire") (1, 2, 1, 1,([0,0, 0, 0], 3), "GBU-15") [See Bullet Note Below]	810C	2D	0E01 0101 0382 0307 4861 7270 6F6F 6E0F 0101 0202 9E04 0848 656C 6C66 6972 650C 0102 0101 0306 4742 552D 3135

- Example Software Value shows three value groups, where each group is a Weapons Record (Station Id, Hardpoint ID, Carriage ID, Store ID, ([engagement status bits], general status), Weapon Type)

8.140.1 Details

The Weapons Stores is a list of Weapons Records. Each record contains **Weapon Location**, **Weapons Status**, and **Weapons Type** encoded as a Variable Length Pack (VLP).

The **Weapon Location** is a physical address on the platform using Station Number, Hardpoint ID, Carriage ID and Store ID. Figure 67 illustrates an aircraft with attached weapons and the physical address of each weapon. In this example, there is one Station ID which is the fuselage itself. On the wing there are two hard points for attaching weapons (Hard Point ID 1 and Hard Point ID 2). The aircraft's Hard Point ID 1 configuration uses two weapons carriage systems (Carriage ID 1 and Carriage ID 2), each with four weapon stores (Store ID 1 through 4). The aircraft's Hard Point ID 2 configuration only includes a single weapon, so the Carriage ID and Store ID are both 1. Four values provide the means to address any weapon on the aircraft. For example the three weapons, highlighted in red, have the following addresses (from left to right): (1, 1, 1, 3), (1, 1, 2, 2), and (1,2,1,1).

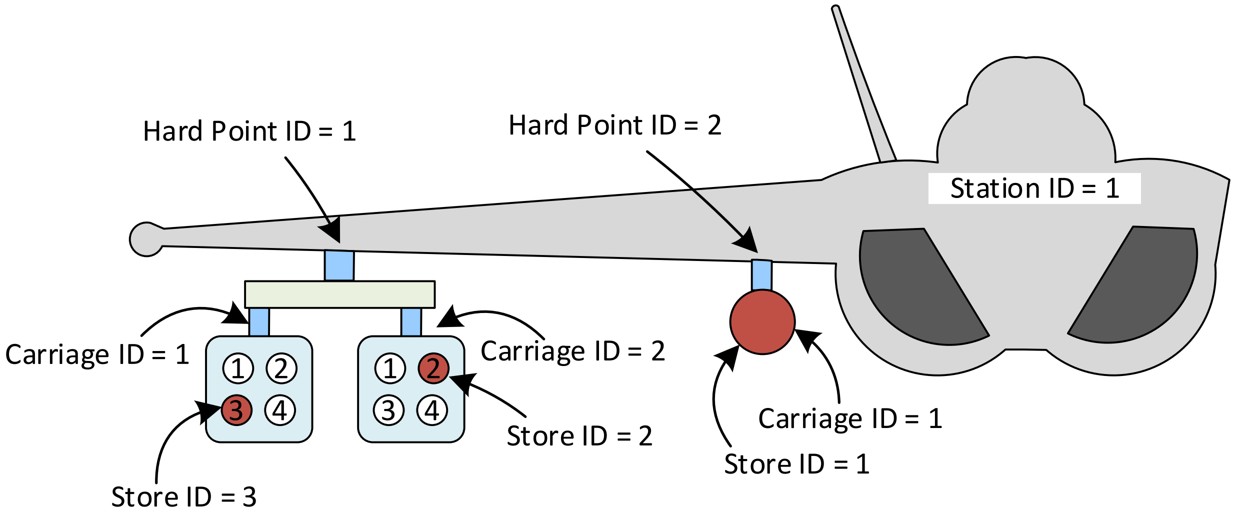

Figure 67: Weapon Stores Illustration

The **Weapon Status** contains two parts: General Status and Engagement Status of the weapon. The General Status is an enumeration with the values in Table 21.

Table 21: Weapon/Store State (General Status)

Status	Meaning	Description
0	Off	No power operating power is available to the Store
1	Initialization	Operating Power is on and the Store is initializing
2	Ready/Degraded	Store initialization completed – full capability not available
3	Ready/All Up Round	Store initialization completed – full capability is available
4	Launch	Dedicated release processes started including activation of irreversible functions
5	Free Flight	Store has successfully separated from the platform
6	Abort	Either commanded into or safety critical anomaly detected.
7	Miss Fire	Weapon miss-fired
8	Hang Fire	Weapon which does not separate from aircraft when activated for employment or jettison.
9	Jettisoned	Intentional or emergency separation of weapon from aircraft with the weapon in the unarmed state (fuze-safe).
10	Stepped Over	Weapon is bypassed due to failure. Weapon can still be jettisoned.
11	No Status Available	Unknown status
12 – 127	Reserved	Future status

The Engagement Status is a set of bit values to report the status of a weapon before it's launched. Table 22 lists the Engagement Status bit position, name, and meanings when the bit is zero and one. The Bit Position is the location of the bit in the MSB of the Weapon Status, see Figure 69.

Table 22: Engagement Status

Bit Position	Name	Value is 0	Value is 1
1	Fuze Enabled	Fuze functions are **not** set	Fuze functions are set
2	Laser Enabled	Laser functions are **not** set	Laser functions are set
3	Target Enabled	Target functions are **not** set	Target functions are set
4	Weapon Armed	Master Arm is **not** set	Master Arm is set

The **Storage (or Weapon) Type** is a string which names the type of weapon.

A Weapons Record's items encode into a VLP with seven values as shown in Figure 68.

Figure 68: Weapons Record

The first four values define the Weapons Location in BER-OID format. These are Station ID, Hardpoint ID, Carriage ID and Store ID. The next value is the Weapon Status (labeled "Status" in the figure) also in BER-OID format using two bytes. The Weapon Status encodes both the General Status and Engagement Status into the two bytes as shown in Figure 69.

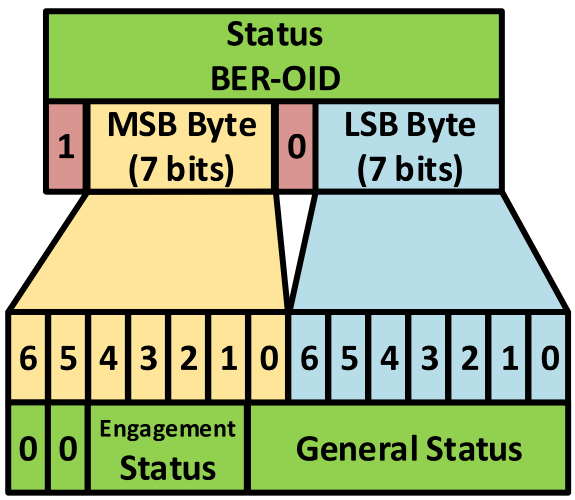

Figure 69: Status BER-OID bit pattern

After decoding the Weapons Status BER-OID value, a 14-bit value remains. The least significant eight (8) bits are the General Status, the next four (4) bits are the Engagement Status, and the remaining bits are set to zero for future use. If the Engagement Status bits are all zero (0) and the high-order bit of the General Status is zero (0), the 7 low order bits of the first byte of the BER-OID status value will be zero. Per BER-OID requirements (see ST 0107), when the low order 7 bits of the MSB are zero, the MSB is eliminated, making the status value one byte. A minimum of one byte of status value is always included in the Weapons Record. Future additions to the status value will add more significant bytes if needed; the bits for Engagement and General status will not change.

Following status information, a BER short or long form value defines the length of the Weapon Type string which follows the length.

A VLP structure encodes a list of Weapons Records, where the Weapons Record's length precedes each record, as shown in Figure 70.

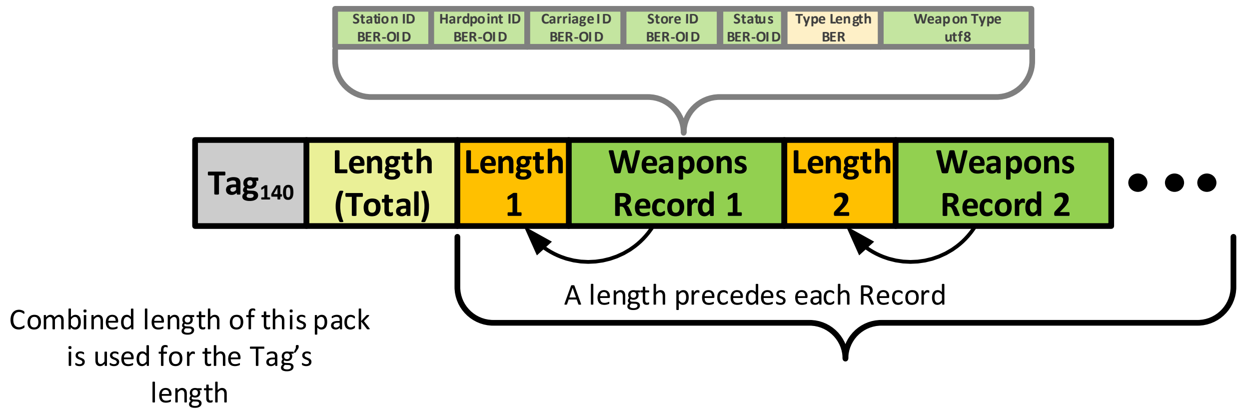

Figure 70: Weapons Stores List VLP

Sending all Weapons Records in one UAS Datalink LS is unnecessary and could contribute to bandwidth spikes. Sending Weapons Records over multiple UAS Datalink LS's, smooths out the metadata bandwidth and reduces the possibility of bandwidth spikes. See the List Distribution Section for more information.

Table 23 summarizes the order and values for the Weapons Record Pack.

Table 23: Weapons Record Pack values

Name	Type	Len	M/O
Station ID	uint (ber-oid)	v	M
Hardpoint ID	uint (ber-oid)	v	M
Carriage ID	uint (ber-oid)	v	M
Store ID	uint (ber-oid)	v	M
Status	uint (ber-oid)	v	M
Weapon Type	utf8	v	M

8.141 Item 141: Waypoint List

Description					
List of waypoints and their status.					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	list	N/A	N/A	
	KLV	vlp	N/A	N/A	N/A

Length	Max Length	Required Length
Variable	Not Limited	N/A

Resolution	Special Values
N/A	N/A

Required in LS?	Optional	Allowed in SDCC Pack?	No	Multiples Allowed?	No

Software Value To KLV Value	See Details
KLV Value To Software Value	See Details

Example Software Value	Example KLV Item (All Hex)		
	Tag	**Len**	**Value**
(0, 1, (1, 1), (38.889422, -77.035162, 200)) (1, 2, (1, 0), (38.889268, -77.049918, 250)) (2, 32767, (0, 1), (38.889741, -77.012933, 100)) (3, -2, (0, 0), (38.889822, -77.010092, 300)) [See Bullet Note Below]	810D	40	0F00 0001 0340 71D8 9419 BDBF E708 9800 0F01 0002 0240 71D3 8819 BCCE 2408 FC00 0F02 7FFF 0140 71E3 0819 BF2C 1B07 D000 0F03 FFFE 0040 71E5 AF19 BF5A A709 6000

- Example Software Value shows four value groups, where each group is a Waypoint Record (Waypoint Id, Prosecution Order, Info Value, and geo location (latitude, longitude, elevation))

8.141.1 Details

Waypoints are a series of aircraft destinations used to navigate the aircraft to certain locations. A flight plan typically includes waypoints which are known at the beginning of a mission; however, depending on real-time events and information, the plan may change. Several types of changes are possible throughout the lifecycle of a mission: the waypoint order changes; cancellation of a waypoint; and adding ad hoc waypoints.

Figure 71 illustrates a set of waypoints (WP_1, WP_2, WP_3, and WP_7) along with their order of operation (called Prosecution Order) indicated in the parenthesis below the WP number. In this example the aircraft is proceeding to waypoint 3 (WP_3), so its Prosecution Order is set to zero (0), which signifies the waypoint is the "current" waypoint. Waypoint 2 (WP_2) is the next waypoint, so its prosecution order is set to one (1), followed by waypoint 7 (WP_7) with Prosecution Order of two (2). The aircraft has already visited waypoint 1 (WP_1) so waypoint 1's Prosecution Order is set to negative one (-1). Waypoints with negative values are *historical waypoints*; these may be important for users. Producers may or may not track historical waypoints.

Figure 72 shows a change in the example waypoint plan. In this illustration, waypoint two (WP_2) has been removed from the plan, so its Prosecution Order is un-set. Additionally, an ad hoc waypoint (WP_9) has been added and inserted as the next waypoint to visit after the current waypoint, therefore waypoint 9's Prosecution Order has been set to (1).

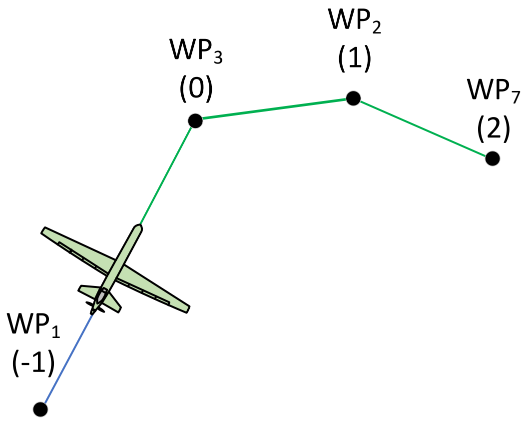

Figure 71: Waypoint list example

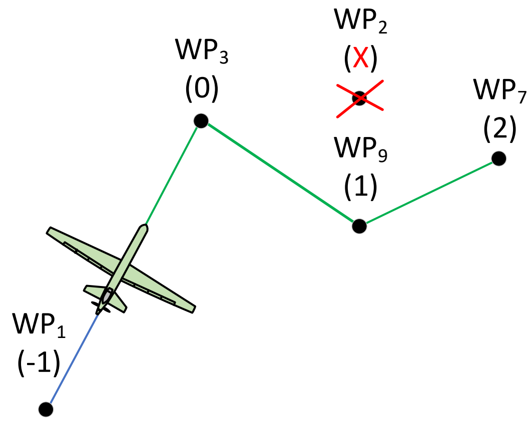

Figure 72: Waypoint list changed

The Waypoint List is a list of Waypoint Records encoded as a Variable Length Pack (VLP) to support waypoint management. A Waypoint Record contains: Waypoint ID, Prosecution Order, Info Value, and Location.

- The Waypoint ID is a unique integer identifier for the Waypoint; the value is positive and with each new waypoint the value increments by one. The Waypoint ID uses BER-OID encoding to encode its value.
- The Prosecution Order value is the position in the order of operation list. In the producer at any given moment, the Prosecution Order values are unique in the waypoint list but do not need to be sequential (i.e., the Prosecution Order list values may have “holes”). Planned waypoints are positive (i.e., >0) values. The current waypoint has a value of zero. A waypoint list which does not have an element with a Prosecution Order of zero means the platform is currently not following a waypoint plan. Optional historical waypoints have negative values (i.e., <0). When canceling a way point (i.e., clearing a waypoint from the list) a waypoint set its Prosecution Order to the maximum positive value to indicate cancellation; this is the only value where multiple Waypoint Records can use the same Prosecution Order. The Prosecution Order uses a 2-byte signed integer, which allows for 32766 planned and 32768 historical waypoints. The cancelled waypoint value is 32767 (0x7FFF). Producers may cancel all types of waypoints (active, planned, or historical).
- The Info Value contains two values: Mode and Source. The Mode states the method of control to fly to the waypoint, either automated or manual. The Source is the creation method for the Waypoint, either it was pre-planned, or it was ad hoc. Both Mode and Source are single bits in the Info Value. The least significant bit (lsb) stores the Mode bit. When the Mode bit is zero (0), the Mode is automated; when the Mode bit is one (1) the Mode is manual. The next lsb is the Source bit. When the Source bit is zero (0), the Source is pre-planned; when the Source bit is one (1) the Source is ad hoc. The Info Value is a single byte value stored as a BER-OID value for future values if needed. The remaining bits of the Info Value are set to zero. Figure 73 illustrates the bit values for the Info Value.

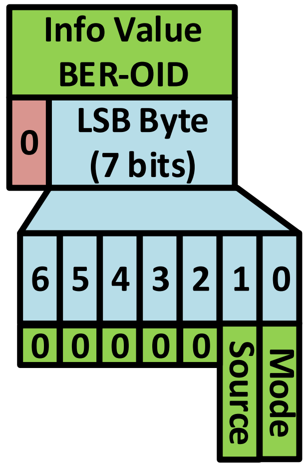

Figure 73: Info Value bit-values

- The Location is the geographic point for the Waypoint in latitude, longitude and HAE. The Location value uses the same DLP as the Location value from Item 130.

Figure 74 shows the four items ordered within a defined length pack.

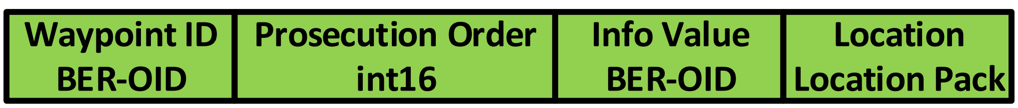

Figure 74: Waypoint Record DLP

Combining a group of Waypoint Records into a VLP, forms the Waypoint List as shown in Figure 75.

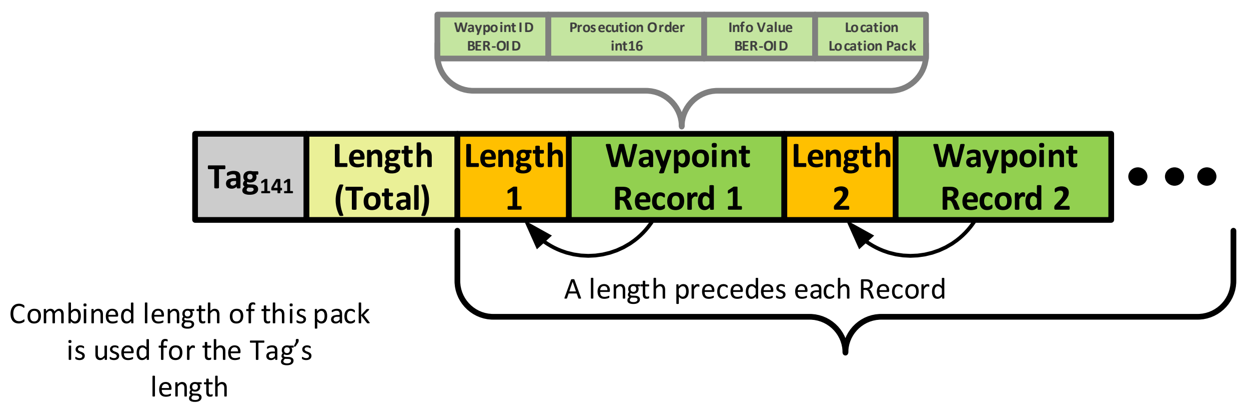

Figure 75: Waypoint List VLP

Table 24 summarizes the order and values for the Waypoint Record Pack.

Table 24: Waypoint Record Pack values

Name	Type	Len	M/O
Waypoint ID	Uint (ber-oid)	v	M

Prosecution Order	Int16	2	M
Info Value	Uint (ber-oid)	v	O
Location DLP(1)	vlp	v	O

(1) See Item 130 for definition of Location DLP.

8.141.1.1 Historical Waypoints

When a platform has made it to a waypoint destination, the producer may change it into a historical waypoint by setting its Prosecution Order to the “next” negative number less than the smallest Prosecution Order in the list; the values do not have to be sequential. This enables receivers to determine the last waypoint by taking the min value of all Prosecution Orders. The producer chooses the next historical waypoint Prosecution Order value to aid in its list management. For example, if a waypoint list contains three historical waypoints with Prosecution Orders -5, -2, -1 and the producer add a new historical waypoint, the producer would assign a value of -6. Alternatively, the producer could cancel all the historical waypoints (via setting the Prosecution Orders to 0x7FFF) and set the new historical waypoint Prosecution Order to -1. Producers may not report historical waypoints, so receivers may receive lists with “holes” in the Prosecution Orders.

Historical waypoints change infrequently, requiring updates only once every 30 seconds if retained. Producers may optionally reactivate a historical waypoint by updating the Prosecution Order to a positive value.

Requirement	
ST 0601.17-40	When creating a new historical waypoint, the waypoint’s Prosecution Order shall be less than the largest magnitude negative Prosecution Order of all waypoints in the waypoint list.

8.141.1.2 List Management

Sending all Waypoint Records in one UAS Datalink LS is not necessary and could contribute to bandwidth spikes. Sending Waypoint Records using multiple UAS Datalink LS’s, distributes the metadata and reduces these issues. See the List Distribution Section for more information.

When producers change the Prosecution Order of one or more records in the list, the producer should update the records with the lowest (non-negative) Prosecution Order first. This method sends the most relevant data to the receiver first, i.e., the current way point (if updated), then the next planned waypoint (if updated), etc. Due to Report-on-Change, while a List Distribution update is made to the waypoint list, the receiver may see Waypoint Records with the same Prosecution Order value for a period of time until all list updates are complete.

8.142 Item 142: View Domain

Description					
Specifies the domain of values for Relative Sensor Azimuth, Elevation and Roll Angles					
Units		**Format**	**Min**	**Max**	**Offset**
None	**Software**	record	N/A	N/A	
	KLV	vlp	N/A	N/A	N/A
Length		**Max Length**		**Required Length**	
Variable		N/A		N/A	
Resolution		**Special Values**			
N/A		N/A			
Required in LS? Optional		**Allowed in SDCC Pack?** No		**Multiples Allowed?** No	
Software Value To KLV Value		See Details			
KLV Value To Software Value		See Details			
Example Software Value		**Example KLV Item (All Hex)**			
		Tag	**Len**	**Value**	
(210.0, 300.0, -75.0, 50.0)		810E	0E	0634 8000 4B00 0006 1A40 000C 8000	

- Example Software Value shows azimuth domain pair and elevation domain pair

8.142.1 Details

The primary purpose of the View Domain is to aid in determining what area around the UAS is viewable by the sensor. View Domain defines the sensor's bounds for the Sensor Relative Azimuth Angle (Item 18), Sensor Relative Elevation Angle (Item 19), and the Sensor Relative Roll Angle (Item 20). These bounds plus the Field of View items provide the needed information for defining the sensor's possible viewing area. Other factors for deciding what may be "viewable", such as the maximum distance away from the sensor needed to resolve an object, depend on the sensor and optical characteristics and are beyond the scope of this item.

The angles described by the View Domain may intersect a ground model to show the potential ground coverage of the sensor. The quality of the ground model (e.g., flat earth estimate, DTED, 3-D model) determines the quality of the ground coverage computation. The View Domain's angles are the logical or physical limits of the sensing system and all measures are relative to the platform; therefore, the View Domain should be a Known-Static (see MISB ST 0107) item. The rotation of the platform on any of its axes will change the intersection of the View Domain's angles and the ground model, thus changing the ground coverage.

The View Domain item includes azimuth, elevation, and roll. The azimuth and elevation values primarily define the View Domain. For example, the azimuth and elevation angles may define the viewing area in the form of a partial cone extending from the sensor. Figure 76 illustrates two partial cone examples extending from a UAS in straight and level flight. The azimuth and elevation limits project as partial cones (yellow) from the sensor to a flat earth region (green) and the redish area illustrates an example image footprint within the cones. The example on the left shows the partial cone covering about 300 degrees of azimuth and about 50 degrees of elevation. The example on the right shows a partial cone covering about 135 degrees of azimuth on the right side of the aircraft and 50 degrees of elevation.

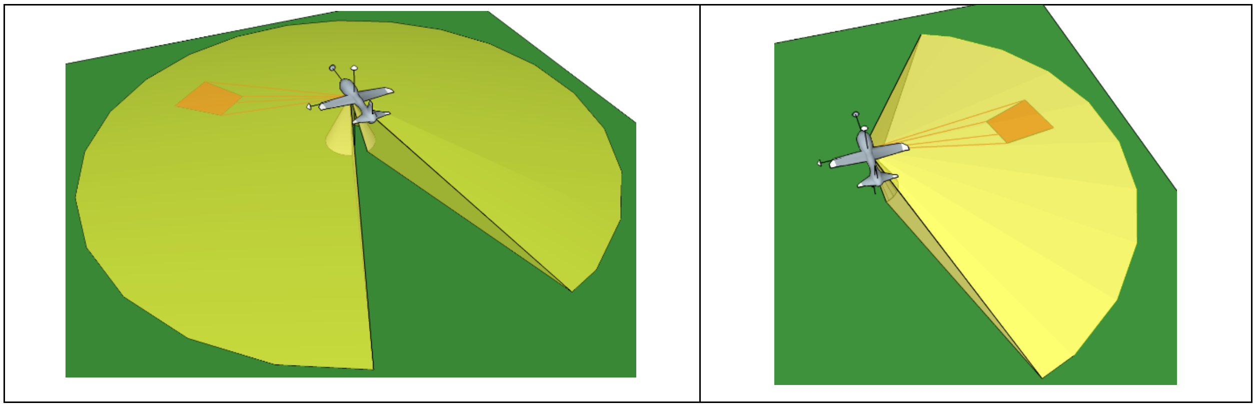

Figure 76: View Domain Partial Cone Examples

The definition of the bounds includes three pairs of values with each pair including a **starting point** and **angular range**. The **starting points** are the minimum relative: azimuth, elevation, and roll angles. Each of these angles have the same definition as Items 18, 19, and 20, respectively; however, the encoding of the values uses IMAPB to enable more flexibility. The **angular range** specifies the limit from the starting point to the sensor's maximum value; numerically the angular range is always a positive value. Adding the angular range to their respective starting point defines the domain for that angle.

Figure 77 illustrates two examples each showing the starting point for the Sensor Relative Azimuth Minimum Angle (green) and the Azimuth Angular Range (red), both of which define the Azimuth Domain (blue). The example on the right shows the resulting domain spans through the "360 back to zero" angular measure; applications will need to adjust the values when exceeding the circles upper bounds value (i.e., modulus 360 degrees).

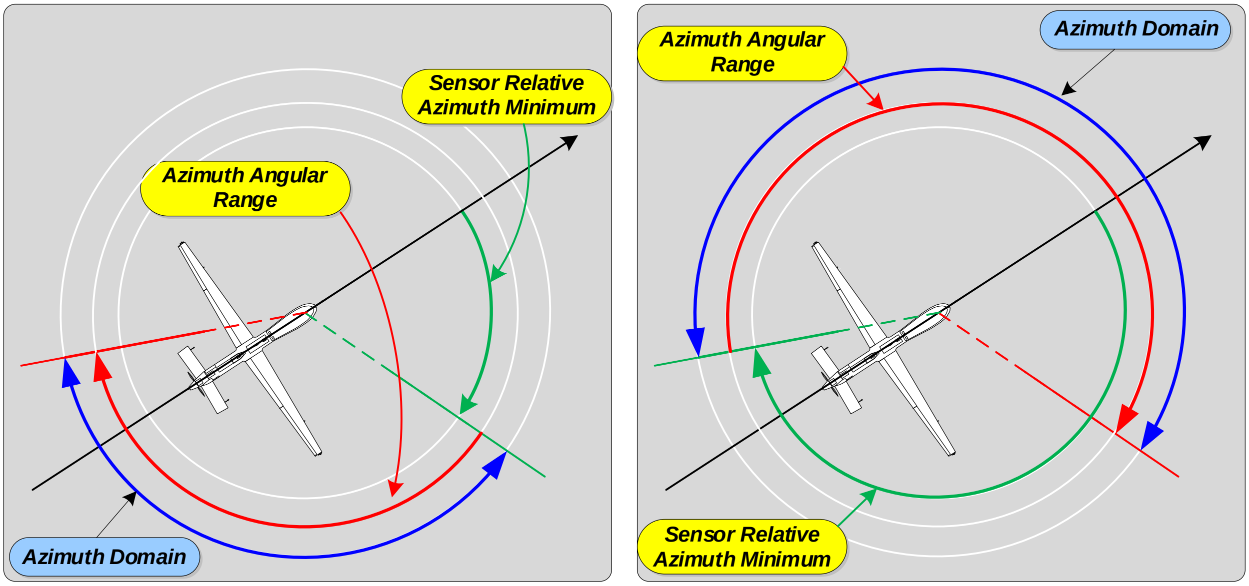

Figure 77: Sensor Relative Azimuth Minimum and Maximum

The value of the View Domain Item is a variable length truncation pack (vlp) consisting of three pairs of elements, with each pair preceded with a pair length. Figure 78 illustrates the View

Domain Item with its Tag (142), Length (Total), and vlp Value. The Value consists of: an azimuth Pair Length, a pair of azimuth domain values (i.e., Azimuth Start and Azimuth Range), an elevation Pair Length, a pair of elevation domain values (i.e., Elevation Start and Elevation Range), a roll Pair Length, and a pair of roll domain values (i.e., Roll Start and Roll Range). Producers must include the pairs in the order shown in Figure 78.

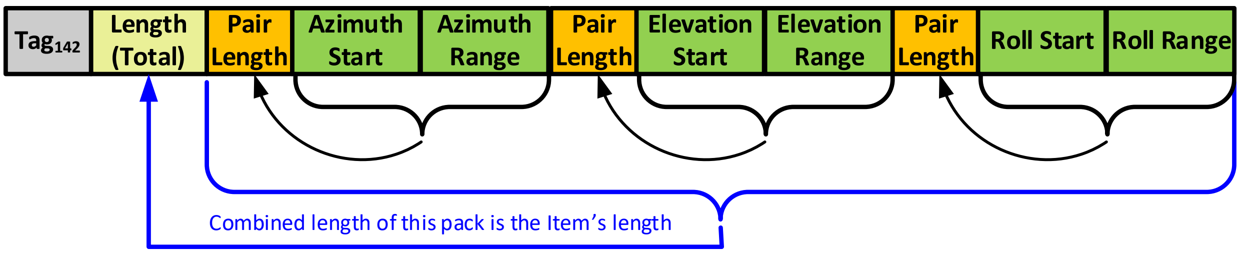

Figure 78: View Domain Variable Length Pack

Each pair length is the byte count for the pair of values, encoded as a BER length. The length of each value in the pair is the same (i.e., exactly half the pair's preceding pair length). Each starting point value of a pair uses IMAPB(min, max) to encode its value. Table 25 lists the min and max ranges (from Items 18, 19, and 20) for each starting point; the IMAPB length is determined at runtime to adjust to the data producers desired precision.

Table 25: Starting Point IMAPB Values

Starting Point	Min	Max
Sensor Relative Azimuth	0.0	360.0
Sensor Relative Elevation	-180.0	180.0
Sensor Relative Roll	0.0	360.0

The angular range in each pair uses IMAPB(0.0, 360.0) with the same length of the starting point.

As the View Domain Item is a truncation pack, producers may eliminate one or more domain pairs and their pair length from the end of the View Domain Item's value (per truncation pack rules, see MISB Motion Imagery Handbook). Figure 79 illustrates a View Domain Item with the roll domain truncated. This example shows the azimuth domain from 210.0 to 150.0 degrees (i.e., 210 + 300 = 510 modulus 360 = 150) and the elevation domain from -75.0 to -25.0 degrees (i.e. -75 + 50 = -25); the visual representation of this View Domain example is the figure on the left in Figure 76.

Tag_{142}	14	6	210.0	300.0	6	-75.0	50.0

Figure 79: Truncation Example

When a pair of values is unknown, the Pair Length may be set to zero indicating the item is missing the value pair. Figure 80 illustrates a View Domain where the azimuth limit is unknown, so its Pair Length is set to zero indicating the azimuth starting point and angular range are missing; the remaining values define the elevation and roll domains.

Tag_{142}	14	0	6	-75.0	50.0	4	350.0	20.0

Figure 80: Unknown Azimuth Example

The View Domain is a raw measure of potential sensor movement and does not include obstructions such as landing gear or weapons on wings.

Appendix A – Deprecated Requirements

REQ-2.08 (ST 0601 decoders shall accept Universal Keys with any version number represented within byte 8.) as this is difficult to enforce from a conformance perspective and is in with another requirement specifying the exact 16-byte KLV key to use (REQ-1.02) [REQ-1.02 is now REQ. ST 0601.8-18].

Requirement ST 0601.8-18 was removed per recent MISB practices where Universal Keys are defined within a dictionary and thus not considered requirements.

Requirement ST 0601.8-01 was removed because it is not an implementation requirement nor is it testable.

Requirement ST 0601.8-13 was replaced with two requirements, one specifying the allowed order and a second requirement specifying the required uniqueness.

Requirements ST 0601.8-02, -04, -05, -06, and -07 were moved to ST 0107.3 because they apply to all MISB KLV based metadata.

Requirement ST 0601.8-15 is deprecated because all “TBDs” have been removed from this standard.

Requirements ST 0601.13-25, -26 and ST 0601.14-32, -33, -34 were moved to ST 0107.4 because they apply to all MISB KLV based metadata.

Requirement(s)	
ST 0601.8-18 (Deprecated)	The UAS Datalink Local Set 16-byte Universal Key shall be 06 0E 2B 34 - 02 0B 01 01 – 0E 01 03 01 - 01 00 00 00 (CRC 56773)
ST 0601.8-01 (Deprecated)	Any changes to MISB ST 0601 shall be accompanied by a document revision and date change and coordinated with the managing organization.
ST 0601.8-13 (Deprecated)	Excepting the requirements for Tag 2 at the start and Tag 1 at the end of a UAS Datalink LS any instance of the UAS Datalink LS, an instance of an UAS Datalink LS containing any number of properly formatted unique Tags in any order shall be valid.
ST 0601.8-02 (Deprecated)	Applications that implement MISB ST 0601 shall allow for metadata elements in the UAS Datalink Local Set that are unknown so that they are forward compatible with future versions of the interface.
ST 0601.8-04 (Deprecated)	All UAS Datalink LS metadata shall be formatted in compliance with SMPTE ST 336 [1].
ST 0601.8-05 (Deprecated)	Implementations of MISB ST 0601 shall parse unknown, but properly formatted metadata UAS Datalink Local Set packets, so as to not impact the reading of known Tags within the same instance.
ST 0601.8-06 (Deprecated)	All instances of item Tags within a UAS Datalink LS packet shall be BER-OID encoded using the fewest possible bytes in accordance with SMPTE ST 336.
ST 0601.8-07 (Deprecated)	All instances of item length fields within a UAS Datalink LS packet shall be BER Short form or BER Long form encoded using the fewest possible bytes in accordance with SMPTE ST 336 [1].
ST 0601.8-15 (Deprecated)	UAS Datalink LS items that have incomplete descriptions (i.e., “TBD”) shall be informative rather than normative.
ST 0601.13-25	All reportable UAS Data-link LS items which are Known-Changing or Known-Static

(Deprecated)	shall be reported no less than once every thirty (30) seconds.
ST 0601.13-26 (Deprecated)	Metadata items which have not been updated within a thirty (30) second period shall be considered Unknown.
ST 0601.14-32 (Deprecated)	Required items of a UAS Datalink LS (Tag 1-Checksum, Tag 2-Precision Time Stamp, and Tag 65-UAS Datalink LS Version Number) instance shall always be reported with positive lengths (i.e. Zero-Length Items (ZLI) are not allowed for these items).
ST 0601.14-33 (Deprecated)	Where a UAS Data-link LS item has a length of zero, consumers shall interpret the value of the item as "unknown.”
ST 0601.14-34 (Deprecated)	A Zero-Length Item (ZLI) shall only be used in packets after a non-ZLI is reported.