| MISB Motion Imagery Standards Board<br><br>**STANDARD**<br><br>**Metric Geopositioning Metadata Set** | **MISB ST 1107.3**<br><br>**22 February 2018** |
|---|---|

## 1 Scope

This Standard (ST) defines threshold and objective metadata elements for photogrammetric applications. This ST defines a new Local Set (LS) with metadata elements selected from MISB ST 0801 [1], MISB ST 1010 [2], and MISB ST 1202 [3]. The metadata elements specific to metric sensing are a subset of ST 0801 photogrammetric metadata elements. This ST supersedes MISB EG 0810.

## 2 References


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

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

[3] MISB ST 1202.2 Generalized Transformation Parameters, Feb 2015.

[4] MISB ST 0807.21 MISB KLV Metadata Registry, Feb 2018.

[5] MISB ST 1201.3 Floating Point to Integer Mapping, Oct 2017.

[6] ISO/IEC 8825-1:2015 Information Technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).

[7] MISB ST 0603.5 MISP Time System and Timestamps, Oct 2017.

[8] MISB ST 0107.2 Bit and Byte Order for Metadata in Motion Imagery Files and Streams, Feb 2014.


## 3 Acronyms

| | |
|---|---|
| **CE** | Circular Error |
| **CE90** | Circular Error at 90% confidence |
| **CSM** | Community Sensor Model |
| **DGMS** | Direct Geopositioning Metric Sensor |
| **DMPI** | Designated Mean Point of Impact |
| **EG** | Engineering Guideline |
| **FFOV** | Full Field-of-View |
| **FLP** | Floating Length Pack |
| **GPS** | Global Positioning System |

| | |
|---|---|
| **IMU** | Inertial Measurement Unit |
| **ISR** | Intelligence, Surveillance and Reconnaissance |
| **KLV** | Key-Length-Value |
| **LE** | Linear Error |
| **LRF** | Laser Range Finder |
| **LS** | Local Set |
| **MISB** | Motion Imagery Standards Board |
| **PED** | Processing, Exploitation, and Dissemination |
| **RP** | Recommended Practice |
| **SACP** | Single Aimpoint Center Pixel |
| **SDCC** | Standard Deviation and Correlation Coefficient |
| **SMPTE** | Society of Motion Picture and Television Engineers |
| **ST** | Standard |
| **TLE** | Target Location Error |
| **UL** | Universal Label |

# 4 Revision History

| Revision | Date | Summary of Changes |
|---|---|---|
| ST 1107.3 | 02/22/2018 | • Update references [1], [2], [3], [4], [5], [6], [7] & removed [9], [10]<br>• Modified Tag 19 & Tag 20 Names to correspond to ST 0801<br>• Modified Tag 39 & Tag 40 Names to correspond to ST 0801<br>• Removed POSIX reference on Tag 43 Name<br>• Reordered Sections 4 & 5 |

# 5 Introduction

A metric sensor collects sufficient metadata to support the computation of a target coordinate (latitude, longitude, and height-above-ellipsoid), and its uncertainty known as Target Location Error (TLE) or Circular and Linear Error (CE/LE). A Direct Geopositioning Metric Sensor (DGMS) enables the computation of the target coordinate(s) and uncertainties from a single image. A DGMS integrates a Laser Range Finder (LRF) or a framing LIDAR sensor into the sensor system. The value of a DGMS is the ability to generate target coordinates (latitude, longitude, and height-above-ellipsoid), and an error estimate (TLE or CE/LE) for those coordinates with a known level of confidence as a result of direct calculation.

Two critical elements are required to exploit a metric sensor or a DGMS: (1) a rigorous sensor model; and (2) a complete set of metadata describing the sensor state and the measurement uncertainties of its state. These elements enable a myriad of down-stream Processing, Exploitation, and Dissemination (PED), such as allowing imagery to be combined with other imagery or data sources (i.e. data fusion). The sensor model is managed by the GWG/Community Sensor Model Working Group; however, the metadata elements to describe the sensor state and the measurement uncertainties, are defined in this standard.

Integrating metric capability with Motion Imagery is increasingly important as Motion Imagery plays a more significant role in fulfilling ISR mission needs. The photogrammetric metadata defined in MISB ST 0801 provides the required elements to describe a sensor with sufficient content to compute precision geolocations. The variance-covariance information about the parameters in ST 0801 may be conveyed through MISB ST 1010. The first 31 elements of the Local Set (LS) defined in this standard are the elements in ST 0801 having uncertainty information (consistent with the order required in ST 1010). The Standard Deviation and Correlation Coefficient Floating Length Pack (FLP) per ST 1010 for these elements immediately follows. The remaining elements of the LS are elements in ST 0801 which do not have an uncertainty model.

# 6 Accuracy and Metricity

The terms "accuracy" and "metricity" have two different, but related definitions. Accuracy is a measure of how well a system is able to calculate the location of a point of interest compared to its actual location in the real world. A more accurate sensor can produce target coordinates closer to the true location of a coordinate (i.e. the missed distance is small) than a less accurate sensor. Accuracy is usually stated as a system requirement and is dependent on how well a system measures its state when an image is collected. A system may improve its accuracy by using higher quality system components (e.g. improved Inertial Measurement Unit (IMU) or Global Positioning System (GPS) solution). Understanding the accuracy of a sensor's metadata requires the measurement of uncertainties (errors); this refers to the metricity.

Metricity provides confidence in the calculated location of a point of interest. This confidence is expressed in terms of predicted uncertainties for various components of the geopositioning result, and therefore, depends on how well the system knows the uncertainties (errors) associated with the measured system parameters for each image. A metric sensor reports the metadata elements as dynamic information available about the system at the time the imagery is captured by the system. Even when values have large uncertainties and inaccurate data, the sensor is metric. A system which does not provide current error estimates for dynamic system values may not be considered metric.

Figure 1 illustrates this relationship between accuracy and metricity. The lower left quadrant represents a less accurate, non-metric system. The calculated target location shows a large displacement when compared to the actual geolocation of the target. By improving the system components, the system may become more accurate and move into the lower right quadrant. For both of these non-metric cases, the confidence in the calculated target location is unknown.

If, however, the less accurate, non-metric system of the lower left quadrant provided error estimates for the dynamic system parameters, it becomes a metric sensor and moves to the upper left quadrant. While such a system may not improve in accuracy, the confidence in the calculated target location is known and may be used for engagement, collateral damage assessment, weapons effect calculations or other precision-based tasks. The ideal case is where the system components are of sufficient high quality for accuracy and produce error estimates (metric) for the dynamic system parameters. This is the case shown in the upper right quadrant, and such a system is able to provide actionable target information.

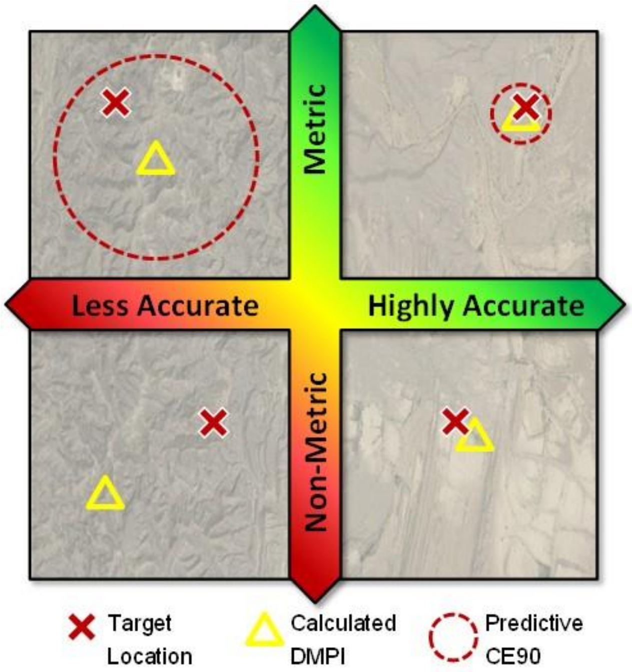


**Figure 1: Relationship between Accuracy and Metricity**

## 7 Metadata Timing

The design and understanding of system timing is extremely important in a metric sensor system. The Metric Geopositioning LS includes a metadata element to record the time for when a set of metadata elements are valid. Uncertainties and misalignments in timing can introduce additional error in the uncertainty of calculated target coordinates. Systems which implement this standard should have the capability to capture and timestamp both the Motion Imagery and the metadata at the same instant in time a corresponding image is captured. Any timing differences between the metadata elements themselves, or between the metadata elements and the captured image needs to be understood and accounted for in the uncertainty (error) estimates.

## 8 Bandwidth Considerations

The Metric Geopositioning LS offers a significant reduction in the amount of information transmitted as compared to the Truncation Packs endorsed by version 3 and earlier versions of ST 0801. This efficiency is realized for several reasons: (1) combining metadata elements from various ST/RP's into a single Local Set replaces the 16-byte Universal Label (UL) key required for each element with a one-byte tag; (2) the variance-covariance information is contained in one location (the ST 1010 tag), eliminating the need for such information in the ST 0801 Truncation Packs; and (3) a single time tag is recorded in the LS for all data elements, eliminating the need for time tags in the ST 0801 Truncation Packs.

# 9 Metric Geopositioning Local Set (LS)

The elements in the Metric Geopositioning LS are listed in Table 1. The documents that define these metadata elements contain additional details regarding the data type, size, and the mappings for integers, if applicable. Metadata elements originating from other standards referenced by ST 1107 are encoded according to the definition, rules, and requirements within those documented standards.

The elements in the Metric Geopositioning LS are listed in Table 1, which has six columns: Tag, Name, Key, Element Data, Type and Uncertainty Data.

The *Tag* column is the Local Set Tag that must be used when encoding the value into the Local Set.

The *Name* and *Key* columns describe the semantic meaning of the value and are direct references into the MISB KLV Dictionary [4].

The *Element Data* column describes the method of encoding the value in binary; the allowed values in this column are:

- IMAPB - Indicates the use of MISB ST 1201 [5] to encode the floating-point value
- FLOAT - Indicates the use of either 16 or 32-bit IEEE Floating Point values
- UINT - Indicates an unsigned integer
- LS - Indicates the item value contains a KLV Local Set
- FLP - Indicates the item value contains a Floating Length Pack
- BER-OID - Indicates the item is encoded as a BER OID value (ISO 8825-1 [6])

The *Type* column indicates a particular element as a Threshold element or an Objective element. A “Threshold” element represents a core element required for data exploitation. The additional “Objective” elements complete an ideal set of elements for a DGMS, which may yield results with the highest fidelity. The Objective elements are required for Single Aim-point Center Pixel (SACP) or Full Field of View (FFOV) exploitation. It is the responsibility of a program office to select the Objective elements to produce a data population plan that enables the full capabilities for their system.

The *Uncertainty Data* column defines the ST 1010 Source List for the SDCC-FLP in Tag 32 along with the type of value. The allowed values are:

- N/A - Not Applicable (i.e. not included in the Source List)
- IMAPB - Indicates the use of MISB ST 1201 to encode the floating-point value using the given minimum and maximum values
- FLOAT - Indicates the use of either 16 or 32-bit IEEE floating point values

The order of the elements in the LS is important when building the value for Tag 32. The length of each value in the Local Set is defined at run-time based on the accuracy requirements and bandwidth availability.

**Table 1: Metric Geopositioning Local Set (LS)**

| Local Set Key | | | | Local Set Name | |
|---|---|---|---|---|---|
| **06.0E.2B.34.02.0B.01.01.0E.01.03.03.22.00.00.00** (CRC 13780) | | | | **Metric Geopositioning LS** | |
| **Tag** | **Name** | **Key** | **Element Data** | **Type** | **Uncertainty Data IMAPB(Min, Max) or FLOAT** |
| 1 | Sensor ECEF Position Component X | 06.0E.2B.34.01.01.01.01.0E.01.02.01.25.00.00.00 (CRC 25208) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,650) |
| 2 | Sensor ECEF Position Component Y | 06.0E.2B.34.01.01.01.01.0E.01.02.01.26.00.00.00 (CRC 63908) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,650) |
| 3 | Sensor ECEF Position Component Z | 06.0E.2B.34.01.01.01.01.0E.01.02.01.27.00.00.00 (CRC 36624) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,650) |
| 4 | Sensor ECEF Velocity Component X | 06.0E.2B.34.01.01.01.01.0E.01.02.01.2E.00.00.00 (CRC 31847) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,70) |
| 5 | Sensor ECEF Velocity Component Y | 06.0E.2B.34.01.01.01.01.0E.01.02.01.2F.00.00.00 (CRC 2771) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,70) |
| 6 | Sensor ECEF Velocity Component Z | 06.0E.2B.34.01.01.01.01.0E.01.02.01.30.00.00.00 (CRC 50586) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,70) |
| 7 | Sensor Absolute Heading | 06.0E.2B.34.01.01.01.01.0E.01.02.01.37.00.00.00 (CRC 38071) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,0.2) |
| 8 | Sensor Absolute Pitch | 06.0E.2B.34.01.01.01.01.0E.01.02.01.38.00.00.00 (CRC 16473) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,0.2) |
| 9 | Sensor Absolute Roll | 06.0E.2B.34.01.01.01.01.0E.01.02.01.39.00.00.00 (CRC 14061) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,0.2) |
| 10 | Sensor Absolute Heading Rate | 06.0E.2B.34.01.01.01.01.0E.01.02.01.40.00.00.00 (CRC 34799) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,1) |
| 11 | Sensor Absolute Pitch Rate | 06.0E.2B.34.01.01.01.01.0E.01.02.01.41.00.00.00 (CRC 61787) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,1) |
| 12 | Sensor Absolute Roll Rate | 06.0E.2B.34.01.01.01.01.0E.01.02.01.42.00.00.00 (CRC 27271) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,1) |
| 13 | Boresight Offset Delta X | 06.0E.2B.34.01.01.01.01.0E.01.02.02.18.00.00.00 (CRC 39365) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,650) |

| **Local Set Key** | | | | **Local Set Name** | |
|---|---|---|---|---|---|
| **06.0E.2B.34.02.0B.01.01.0E.01.03.03.22.00.00.00** (CRC 13780) | | | | **Metric Geopositioning LS** | |
| **Tag** | **Name** | **Key** | **Element Data** | **Type** | **Uncertainty Data IMAPB(Min, Max) or FLOAT** |
| 14 | Boresight Offset Delta Y | 06.0E.2B.34.01.01.01.01.0E.01.02.02.19.00.00.00 (CRC 61297) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,650) |
| 15 | Boresight Offset Delta Z | 06.0E.2B.34.01.01.01.01.0E.01.02.02.1A.00.00.00 (CRC 29869) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,650) |
| 16 | Boresight Delta Angle 1 | 06.0E.2B.34.01.01.01.01.0E.01.02.02.1B.00.00.00 (CRC 00537) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,2) |
| 17 | Boresight Delta Angle 2 | 06.0E.2B.34.01.01.01.01.0E.01.02.02.1C.00.00.00 (CRC 21300) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,2) |
| 18 | Boresight Delta Angle 3 | 06.0E.2B.34.01.01.01.01.0E.01.02.02.1D.00.00.00 (CRC 09600) | **IMAPB** (see ST 0801 [1]) | OBJECTIVE | **IMAPB**(0,2) |
| 19 | Focal Plane Principal Point Offset Y | 06.0E.2B.34.01.01.01.01.0E.01.02.02.03.00.00.00 (CRC 40061) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,1) |
| 20 | Focal Plane Principal Point Offset X | 06.0E.2B.34.01.01.01.01.0E.01.02.02.04.00.00.00 (CRC 52560) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,1) |
| 21 | Sensor Calibrated / Effective Focal Length | 06.0E.2B.34.01.01.01.01.0E.01.02.02.05.00.00.00 (CRC 48100) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | **IMAPB**(0,350) |
| 22 | Radial Distortion Constant Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.6A.00.00.00 (CRC 14040) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 23 | First Radial Distortion Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0A.00.00.00 (CRC 28426) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 24 | Second Radial Distortion Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0B.00.00.00 (CRC 06590) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 25 | Third Radial Distortion Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0C.00.00.00 (CRC 18579) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 26 | First Tangential / Decentering Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0D.00.00.00 (CRC 15911) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 27 | Second Tangential / Decentering Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0E.00.00.00 (CRC 42491) | **FLOAT** | OBJECTIVE | **FLOAT** |

| Local Set Key | | | | Local Set Name | |
|---|---|---|---|---|---|
| **06.0E.2B.34.02.0B.01.01.0E.01.03.03.22.00.00.00** (CRC 13780) | | | | **Metric Geopositioning LS** | |
| **Tag** | **Name** | **Key** | **Element Data** | **Type** | **Uncertainty Data IMAPB(Min, Max) or FLOAT** |
| 28 | Third Tangential / Decentering Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.83.00.00.00 (CRC 16709) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 29 | Differential Scale Affine Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.0F.00.00.00 (CRC 54095) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 30 | Skewness Affine Parameter | 06.0E.2B.34.01.01.01.01.0E.01.02.02.10.00.00.00 (CRC 07174) | **FLOAT** | OBJECTIVE | **FLOAT** |
| 31 | Slant Range | 06.0E.2B.34.01.01.01.01.07.01.08.01.01.00.00.00 (CRC 16588) | **FLOAT** | OBJECTIVE | **IMAPB**(0,650) |
| 32 | Standard Deviation and Correlation Coefficient FLP | 06.0E.2B.34.02.05.01.01.0E.01.03.03.21.00.00.00 (CRC 64882) | **FLP** | **THRESHOLD** | N/A |
| 33 | Generalized Transformation LS | 06.0E.2B.34.02.0B.01.01.0E.01.03.05.05.00.00.00 (CRC 40498) | **LS** | OBJECTIVE | N/A |
| 34 | Image Rows | 06.0E.2B.34.01.01.01.01.0E.01.02.02.06.00.00.00 (CRC 08248) | **UINT** | **THRESHOLD** | N/A |
| 35 | Image Columns | 06.0E.2B.34.01.01.01.01.0E.01.02.02.07.00.00.00 (CRC 22156) | **UINT** | **THRESHOLD** | N/A |
| 36 | Pixel Size X | 06.0E.2B.34.01.01.01.01.0E.01.02.02.82.00.00.00 (CRC 14321) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | N/A |
| 37 | Pixel Size Y | 06.0E.2B.34.01.01.01.01.0E.01.02.02.82.01.00.00 (CRC 00193) | **IMAPB** (see ST 0801 [1]) | **THRESHOLD** | N/A |
| 38 | Slant Range Pedigree | 06.0E.2B.34.01.01.01.01.0E.01.02.02.87.00.00.00 (CRC 35764) | **UINT** | OBJECTIVE | N/A |
| 39 | SPRM Row Coordinate | 06.0E.2B.34.01.01.01.01.0E.01.02.05.07.00.00.00 (CRC 12632) | **FLOAT** | OBJECTIVE | N/A |
| 40 | SPRM Column Coordinate | 06.0E.2B.34.01.01.01.01.0E.01.02.05.08.00.00.00 (CRC 58806) | **FLOAT** | OBJECTIVE | N/A |
| 41 | LRF Divergence | 06.0E.2B.34.01.01.01.01.0E.01.02.05.09.00.00.00 (CRC 37634) | **FLOAT** | OBJECTIVE | N/A |

| Local Set Key | | | | Local Set Name | |
|---|---|---|---|---|---|
| **06.0E.2B.34.02.0B.01.01.0E.01.03.03.22.00.00.00** (CRC 13780) | | | | **Metric Geopositioning LS** | |
| **Tag** | **Name** | **Key** | **Element Data** | **Type** | **Uncertainty Data IMAPB(Min, Max) or FLOAT** |
| 42 | Valid Range of Radial Distortion | 06.0E.2B.34.01.01.01.01.0E.01.02.02.69.00.00.00 (CRC 44292) | **FLOAT** | OBJECTIVE | N/A |
| 43 | Precision Time Stamp | 06.0E.2B.34.01.01.01.03.07.02.01.01.01.05.00.00 (CRC 64827) | **UINT**(8) | **THRESHOLD** | N/A |
| 44 | Document Version | 06.0E.2B.34.01.01.01.01 0E.01.02.05.05.00.00.00 (CRC 56368) | **BER-OID** | **THRESHOLD** | N/A |
| 45 | CRC-16-CCITT | 06.0E.2B.34.01.01.01.01.0E.01 02.03.5E.00.00 00 (CRC 31377) | **UINT**(2) | **THRESHOLD** | N/A |

# 10 Metric Geopositioning Local Set Element Details

| Requirement(s) | |
|---|---|
| ST 1107.1-01 | All metadata shall be expressed in accordance with MISB ST 0107 [8]. |
| ST 1107.1-02 | All metadata elements indicated as THRESHOLD in MISB ST 1107 Table 1 shall be populated and transmitted in the Metric Geopositioning LS. |

## *10.1 Tags 1 through Tags 31 - ST 0801 Defined*

Refer to MISB ST 0801 for a complete description of the parameters listed for Tags 1 through 31.

## *10.2 Tag 32 - Standard Deviation and Correlation Coefficient FLP (SDCC-FLP)*

Each of the values listed for Tags 1 through 31 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 30 values resulting in a potential correlation coefficient value for that particular 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 for the measurements made in Tags 1 through 31 into the SDCC-FLP. Tags 1 through 31 define the Source List (see ST 1010) for ST 1107. Per ST 1010, a Refined Source List is defined at run-time based on which standard deviation and correlation coefficient values are available.

At runtime the list of values with standard deviation values defined is the Refined Source List. Per ST 1010, the Refined Source List values are written into the Metric Geopositioning Local Set (in any order) 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).

### 10.2.1 Matrix Size

The Matrix Size is set to the value of the Refined Source List. This value will be less than or equal to 31, the size of the Source List.

### 10.2.2 Parse Control

ST 1107 requires the use of Mode 2 Parse Control. Consult MISB ST 1010 for further description of Mode 1 and 2 of the Parse Control.

| Requirement | |
|---|---|
| ST 1107.2-12 | The Metric Geopositioning Local Set shall only include SDCC-FLPs using Mode 2 Parse Control, as defined in MISB ST 1010 [2]. |

Five values in the Mode 2 Parse Control are computed at runtime: Cs, $S_f$, $S_{len}$, $C_f$, and $C_{len}$.

- The $C_s$ value indicates if the correlation coefficient values are sparsely represented in the SDCC-FLP (see Section 10.2.3).
- The $S_f$ value defines the data format type of the standard deviation values, either IMAP (see MISB ST 1201) or IEEE Floating Point values. ST 1010 does not allow the mixing of types; therefore, all standard deviation values need to be converted to one type. Systems need to determine how to balance the desired precision and bandwidth requirements. If exterior orientation parameters (Tags 1 through 18 and 31) or Threshold parameters are the only Refined Source List elements, the recommended data type and size are two-byte integers specified using IMAPB. The IMAPB upper and lower bounds are described for each respective parameter in Table 1. If interior orientation parameters (Tags 19 through 30), or exterior and interior orientation parameters are included in the Refined Source List, the recommended data type for all standard deviation values is four-byte IEEE Floating Point. ST 1010 does not support mixed data types for standard deviation values, and the most conservative value is used if two different data types are present.
- The $S_{len}$ value defines the number of bytes used by each standard deviation value. If a system requires greater precision, more bytes can be added.
- The $C_f$ value defines the data format type of the correlation coefficient values, either IMAP (see MISB ST 1201) or IEEE Floating Point values. IMAP is recommended to save bandwidth. The mapping is IMAP (-1.0, 1.0, $C_{len}$) for all correlation coefficient values with a recommended value for $C_{len}$ equal to two (2) bytes. This does not limit the use of additional bytes if a system requires greater precision.

- The $C_{len}$ value defines the number of bytes for each correlation coefficient value. Systems requiring greater precision can use more bytes.

### 10.2.3 Bit Vector

As discussed in ST 1010 correlation coefficient data can be a sparse matrix. The Bit Vector indicates where to eliminate the zeros in the SDCC-FLP. See Appendix A in ST 1010 to determine when the Bit Vector should be used. The decision to use the Bit Vector can be made at run time.

### 10.2.4 Standard Deviation Values

The standard deviation values converted to the desired data format (if necessary), either IMAP or IEEE Floating Point, and included in the SDCC-FLP in the same order of the Refined Source List.

### 10.2.5 Correlation Coefficient Values

The correlation coefficient values are converted to the desired data format (if necessary), either IMAP or IEEE Floating Point, 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.

## *10.3 Tag 33 - Generalized Transformation*

The Generalized Transformation Local Set is an optional set of data captured in Tag 33, which relates the virtual image coordinate system to the distorted image coordinate system. In the case of a single sensor within a turret, the Generalized Transformation LS may appear up to four times in the Metric Geopositioning LS to account for all enumerations defined in MISB ST 1202.

## *10.4 Tag 34 through Tag 42 - ST 0801 Defined*

Refer to MISB ST 0801 for a complete description of the parameters listed for Tags 34 through 42.

## *10.5 Tag 43 - Precision Time Stamp*

The Precision Time Stamp is the time when the metadata in this Local Set has been measured. As the Precision Time Stamp is required to be inserted into every frame of Motion Imagery, the Precision Time Stamp provides a deterministic relationship between a specific image within a sensor's imagery and the values in the Local Set. For the majority of imaging systems, a Precision Time Stamp will denote a time between the start and end of the image integration time period. It is important that metadata be registered to the image it relates.  Synchronization of an image with its metadata is critical for photogrammetric exploitation of the data. Unknown misalignments between an image and metadata can be detrimental to precise geopositioning exploitation. Please refer to MISB ST 0603 [7] for information about time stamps.

### 10.6 Tag 44 - Document Version

The Document Version identifies which version of this document the metadata set was constructed from. For example, if ST 1107.2 is used, the value for this Tag will be "2".

### 10.7 Tag 45 - CRC-16-CCITT

To help detect erroneous metadata post transmission, a two-byte CRC is included in every LS as the last item. The CRC is computed across the entire LS starting with the 16-byte LS key and ending with the length field of the CRC data element. Figure 2 illustrates the data range the checksum is performed over. If the calculated CRC of the received LS packet does not match the CRC stored in the packet, the packet is discarded as being invalid.

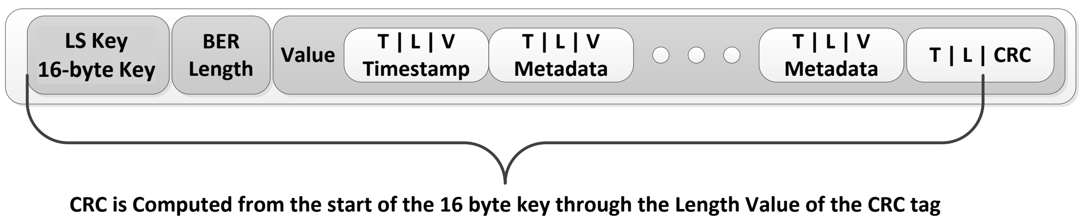


**Figure 2: CRC Representation**

## 11 Future Considerations

### 11.1 Standard Deviation for Timing

Currently this Local Set does not include a standard deviation for time because of on-going discussions within various community organizations. In future editions temporal standard deviation may be included.

### 11.2 Invoking MISB ST 1107 for the Multi-Sensor Array Case

Systems exist with complex sensor arrays containing multiple sensors within a single turret. The intent of ST 1107 is to be generic, and support use cases for systems with one or multiple sensors on board a turret; however, the metadata for systems with multiple sensors has not been described in the current version of this document. This will be defined in a later version of this document.

# 12 Deprecated Requirements

| Requirement(s) | |
|---|---|
| ST 1107.1-03 (Deprecated) | The program office shall select from the "Objective" elements in MISB ST 1107 Table 1 to produce a data population plan that enables the full capability for their system. |
| ST 1107.1-04 (Deprecated) | When transmitting a Metric Geopositioning LS either the airborne platform elements or the spaceborne platform elements shall be used, but not both. |
| ST 1107.1-05 (Deprecated) | When the Metric Geopositioning LS is used for airborne DGMS application, real-time position ECEF values as represented by LS Tags 1, 2 and 3 shall be present. |
| ST 1107.1-06 (Deprecated) | When the Metric Geopositioning LS is used for spaceborne DGMS application, real-time ECEF values as represented by LS Tags 7, 8 and 9 shall be present. |
| ST 1107.1-07 (Deprecated) | Only one value of position information shall be transmitted in the stream. |
| ST 1107.1-08 (Deprecated) | Position information shall be transmitted only once per stream. |
| ST 1107.1-09 (Deprecated) | Only one value of velocity information shall be transmitted in the stream. |
| ST 1107.1-10 (Deprecated) | Velocity information shall be transmitted only once per stream. |
| ST 1107.1-11 (Deprecated) | Standard Deviation and Correlation Coefficient metricity information of a data element shall be conveyed in accordance with MISB ST 1010[2]. |