The Compendium of Controlled Extensions (CE)
for the
National Imagery Transmission Format (NITF) Standard

Volume 1, Version 5.0
Tagged Record Extensions

Appendix AH

Generic Linear Array Scanner (GLAS) and Generic Frame-sequence Model (GFM) Support Data Extensions (SDEs)

Version 1.0

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FOREWORD

The National Imagery Transmission Format (NITF) Standard (NITFS) is the suite of standards documents for formatting digital imagery and imagery-related products and exchanging them among the Department of Defense (DoD), Intelligence Community (IC), and other United States (US) Government departments and agencies. Resulting from a collaborative US Government and industry effort, it is the common standard used to exchange and store files comprising images, symbols and graphics, text, and associated data.

This appendix to the controlled extension (CE) compendium provides a set of approved CE specifications to be used with the NITF version 2.1 (NITF 2.1). Tagged record extension (TRE) and data extension segment (DES) implementation criteria are defined in N0105-98, *NITFS Standards Compliance and Interoperability Test and Evaluation Program Plan*, *25 August 1998*.

The NITFS Technical Board (NTB) develops, coordinates, reviews, and plans for the NITFS. It is a consensus-based government/industry forum that responds to the Geospatial Intelligence Standards Working Group (GWG). The GWG manages geospatial and imagery standards for the DoD and IC encompassed by the National System for Geospatial Intelligence (NSG).

Changes to this appendix are controlled via the GWG, the NTB and the National Geospatial-Intelligence Agency (NGA). Comments, suggestions, or questions should be addressed to the NGA National Center for Geospatial Intelligence Standards (NCGIS), Mail Stop N32-TCAG, 7500 GEOINT Drive, Springfield, VA 22150, or emailed to ntbchair@nga.mil. Because contact information can change, the currency of this address information may be verified using the ASSIST Online database at https://assist.dla.mil.

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AH.1 INTRODUCTION

AH.1.1 Purpose

This document formally defines the Generic Linear Array Scanner (GLAS) and Generic Frame-sequence Model (GFM) support data extensions (SDEs) for geopositioning and mensuration as part of the National Imagery Transmission Format (NITF) standard (NITFS). By using the minimum required GLAS/GFM SDEs, geopositioning methods and functionality via the National Geospatial-Intelligence Agency (NGA) Mensuration Services Program (MSP) are supported. This document also defines the encoding requirements for the GLAS/GFM SDEs to support geopositioning and mensuration using the MSP.

GLAS and GFM are generic physical sensor models that apply to still imagery and motion imagery collected by electro-optical (EO) sensors, from the ultraviolet (UV) through infrared (IR) portions of the EO spectrum. The GLAS and GFM sensor models apply to a wide range of: 1) sensor designs, including frame, pushbroom, whiskbroom, and panoramic; 2) spectral sampling types, including panchromatic, multispectral imagery (MSI), and hyperspectral imagery (HSI); 3) collection platforms, such as airborne, spaceborne, and terrestrial; and 4) collection geometries, ranging from nadir to oblique at any ground sample distance (GSD).

AH.1.2 Background

The GLAS/GFM SDEs were originally developed as part of the National System for Geospatial Intelligence (NSG) Product Description Document (NSGPDD), which defines a wide variety of tagged record extensions (TREs) and data extension segments (DESs), including the "Common Sensor" (CS), i.e., the GLAS/GFM, SDEs that instantiate rigorous sensor models for still and motion imagery linear array scanners, still imagery framers, and frame sequence, i.e., motion imagery, sensors. In time the NSGPDD will simply point to this NITF standard for the GLAS/GFM specification, rather than attempting to maintain two documents.

Four of the GLAS/GFM SDEs are improvements to "Commercial Support" SDEs (STDI-0002, App. D) that provide sensor attitude (CSATTA), ephemeris (CSEPHA), exploitation reference data (CSEXRA), and sensor field alignment (CSSFAA) data. The GLAS/GFM versions retain all but the last character of the original SDE names, changing the last character to "B" to indicate new versions of these metadata containers. The CSEPHA and CSSFAA TREs were converted to DESs when the B versions were created.

Because of this history, the four commercial support SDEs CSATTA, CSEPHA, CSEXRA, and CSSFAA are often referred to as CS***A, while the seven GLAS/GFM SDEs are often referred to as CS***B (Table AH.1-1).

Table AH.1-1: Comparison of CS*A and CS***B SDEs**

CS***A Version		CS***B Version	
Name	**SDE Type**	**Name**	**SDE Type**
CSATTA	DES	CSATTB	DES
no CS***A parallel to CS***B		CSCSDB	DES
CSEPHA	TRE	CSEPHB	DES
CSEXRA	TRE	CSEXRB	TRE
CSSFAA	TRE	CSSFAB	DES
no CS***A parallel to CS***B		CSRLSB	TRE
no CS***A parallel to CS***B		CSWRPB	TRE

Although the CS***A SDEs were designed solely for commercial still imagery scanning sensors, the GLAS/GFM SDEs apply to both commercial and non-commercial sensors, to still imagery scanners and framers, and to still and motion imagery framers. The GFM supports motion imagery for framers, by instantiating a single model with a sequence of frames, as discussed further in Section AH.1.4. While GLAS does not explicitly support motion imagery for scanners, a data provider can still collect motion imagery from its scanning sensor and place the image products into separate NITF files so that they can be exploited using the GLAS sensor model via instantiation of one model per file.

In early drafts of the GLAS/GFM specification, the term "GFM" was defined as "Generic Frame Model". The word "sequence" was later added to the acronym definition, i.e., "Generic Frame-sequence Model", to emphasize that the generic frame model applies to both a sequence of frames and to a single frame.

AH.1.3 Applicable Imaging Sensors

The GLAS and GFM sensor models apply to frame, pushbroom, panoramic, and whiskbroom EO sensors and spectral types including panchromatic, MSI, and HSI; they do not apply to synthetic aperture radar (SAR) or light detection and ranging (LIDAR) sensors. The GLAS and GFM models work directly with non-rectified imagery providing the highest value geolocation accuracy and mensuration precision to the user.

The GLAS and GFM models, like any other physical sensor models, do not work for ortho-rectified imagery; however, it is possible for the models to work with geo-rectified imagery. The GFM can be made to work with geo-rectified imagery by either using field alignment values from CSSFAB that reflect the combined effect of camera geometry and rectification, or by using a combination of warping polynomials in the common sensor warping terms TRE version B (CSWRPB) and sensor field alignment values from CSSFAB.

The GLAS sensor model may or may not be able to correctly represent geo-rectified imagery; it depends upon whether or not the warping transformation via the CSWRPB TRE is capable of producing an intermediate virtual image in which for all rows in the image, all pixels along the selected row were imaged at the same time. It is this linkage between the row number within an image and its associated time stamp that allows the GLAS model to obtain precise sensor position and attitude data from the CSEPHB and CSATTB DESs, respectively, required for precise geopositioning.

AH.1.4 Improvements Compared to Earlier Version

The set of GLAS/GFM SDEs are improvements compared to the set of CS***A SDEs in four respects:

1. The GLAS/GFM SDEs support frame sequences in addition to linear array scanner images.
2. The GLAS/GFM SDEs model warping and rolling shutter collection with two new TREs, CSWRPB and common sensor rolling shutter terms (CSRLSB) respectively, for which A versions do not exist.
3. The GLAS/GFM SDEs model error terms by providing covariance support data via the common sensor covariance support (CSCSDB) DES, for which an A version does not exist.
4. Mensuration is possible when attitude and/or ephemeris vectors are provided in WGS 84 Earth-Centered Inertial (ECI) coordinates, rather than Earth-Centered Earth-Fixed (ECF) coordinates, using version 2 of the attitude and/or ephemeris DESs (CSATTB and CSEPHB respectively). If ECI values are provided, then additional required parameters in both DESs enable accurate ECI-to-ECF transformation.

Thus, the CS***B, i.e., GLAS/GFM, SDEs consist of:

1. CSEXRB TRE: Common Sensor Exploitation Reference data TRE
2. CSRLSB TRE: Common Sensor Rolling Shutter terms TRE (no "A" version exists)
3. CSWRPB TRE: Common Sensor Warping terms TRE (no "A" version exists)
4. CSATTB DES: Common Sensor Attitude data DES, versions 1 and 2
5. CSCSDB DES: Common Sensor Covariance Support Data DES (no "A" version exists)
6. CSEPHB DES: Common Sensor Ephemeris data DES, versions 1 and 2
7. CSSFAB DES: Common Sensor Sensor Field Alignment DES, versions 1 and 2

NGA's MSP has built generic Community Sensor Model (CSM)-conformant physical sensor models that can be applied to any image that includes the appropriate CSM geopositioning metadata; these physical sensor models have been named GLAS and GFM, and the MSP provides accurate geopositioning and mensuration results when the appropriate set of GLAS/GFM SDEs are present in the dataset.

Unlike the case for the CS***A SDEs, geometry model documentation exists for the GLAS and GFM sensor models, so that none of the metadata fields in this document are ambiguous. The geometry model document is called the "*Generic Linear Array Scanner (GLAS) and Generic Frame-sequence Model (GFM) Geometry Model Document*"; the CSMWG is coordinating to make it publicly available.

As mentioned above, a key improvement over the CS***A SDEs is that the CS***B SDEs support modeling of not only linear array scanners via the GLAS model but also frame sequences via the GFM. A data provider who delivers frame sequences as a NITF product would follow the Motion Imagery Extension for NITF 2.1 (MIE4NITF) standard (NGA.STND.0044) and populate the CS***B TREs [Ref. 1]. A data provider who delivers Full Motion Video (FMV) frame sequences in a format other than NITF, e.g., with key-length-value (KLV) metadata, would follow the Motion Imagery Standards Board (MISB) standards, particularly ST 1107.3 as provided in informative reference [17], to provide photogrammetric metadata analogous to the fields defined in the CS***B SDEs. The burden is on the motion imagery exploitation tool to map the metadata from KLV into CS***B in order for MSP's GFM to be able to exploit the frame sequence. Perhaps a future version of MSP's GFM will be enhanced to exploit a frame sequence directly from KLV metadata.

AH.1.5 GLAS/GFM SDE Descriptions

The following bullets summarize the seven GLAS/GFM SDEs. All date/time metadata are provided as Coordinated Universal Time (UTC) standard Zulu (Z) values unless otherwise stated.

- CSEXRB TRE: Common Sensor Exploitation Reference data TRE (Section AH.6.1) contains the date of image acquisition, time tags associated with exposure of a specific line of an image or frame, number of lines and samples in the collected image, and Universally Unique Identifiers (UUIDs) to associate image segments containing GLAS/GFM TREs with GLAS/GFM DESs in the same NITF file.
- CSRLSB TRE: Common Sensor Rolling Shutter terms TRE (Section AH.6.2) provides time as a function of pixel location across a frame. Time is then used by the model to interpolate ephemeris and attitude from the CSEPHB and CSATTB DESs, respectively. Time differences (i.e., delta-T or DT) with respect to the frame's reference time are modeled by blocks such that each corner of the block is assigned a DT value.
- CSWRPB TRE: Common Sensor Warping terms TRE (Section AH.6.3) consists of coefficients of terms that characterize any kind of warping that may have been applied to the imagery prior to building the image product.
- CSATTB DES: Common Sensor Attitude data DES (Section AH.6.4) consists of time-tagged attitude data via quaternions that rotate from sensor to either the WGS 84 ECF or ECI coordinate system, as specified by the data provider.
- CSCSDB DES: Common Sensor Covariance Support Data DES (Section AH.6.5) consists of:
  - ❖ Definition of correlated parameter groups (CPGs); e.g., one for ephemeris, one for attitude, and one for focal length; and may include imager calibration uncertainties and timing synchronization uncertainties.
  - ❖ Adjustable Parameter (AP) Uncertainties for each CPG
    - ➢ Full error covariance matrix, including cross terms (correlations)
    - ➢ Potential splitting into "basic" (bias within image) and "posts" (variations within an image, or frame sequence)

    - Values of parameters of Strictly Positive Definite Correlation Functions (SPDCFs) that describe how the AP decorrelates as a function of time. For example, the platform position error should be essentially equal to what it was one second ago, but after 30 minutes may be almost uncorrelated, or at least much less correlated, to its original position error.
  - Unmodeled error (UE) covariance and cross covariance
    - Values describing high frequency random error, sometimes called "jitter", that occurs within an image and that cannot be removed via a registration process. These unmodeled errors are applicable to a given line/sample location within an image.
    - SPDCF parameter values that describe the decorrelation of the unmodeled error as a function of the separation between a pair of points within an image in the line and sample dimensions.
  - *A posteriori* AP data
    - Vector of AP values
    - Error covariance matrix associated with the vector of AP values
- CSEPHB DES: Common Sensor Ephemeris data DES (Section AH.6.6) consists of time-tagged ephemeris data of the platform center of mass in either the WGS 84 ECF or ECI coordinate system, as specified by the data provider. Although the term ephemeris implies a spaceborne platform, the ephemeris data in the context of GLAS/GFM apply equally to airborne and ground platforms.
- CSSFAB DES: Common Sensor Sensor Field Alignment DES (Section AH.6.7) consists of:
  - Lever arm vector in the sensor coordinate system, from the platform center of mass to the imager perspective center
  - Time-tagged focal length value(s)
  - For linear array scanners, the association between image sample number (i.e., column) and (x,y) two-dimensional (2D) sensor locations in a virtual focal plane (fixed z value, one focal length distance away from the perspective center), provided as a one-dimensional (1D) grid laid out in the sample dimension, where each grid point is assigned (x,y) values. Note that the (x,y,z) coordinates are with respect to the sensor coordinate system.
  - For framers, association between image line and sample (i.e., row and column) numbers and 2D sensor locations in a virtual focal plane, provided via one of the following two options:
    - Option 1:
      - Traditional interior orientation (IO) camera calibration parameters in fiducial space, potentially for both "telescope optics" and "focal plane optics":
        - Principal point offset: x0, y0
        - Radial lens distortion: K0, K1, K2, K3
        - De-centering lens distortion: P1, P2, P3
        - Affine distortion: b1, b2
      - Eight (8) parameters of a Projective Transformation that map from image space (in pixels) to fiducial space (in mm), which is the space in which the above IO parameters are specified.
    - Option 2: 2D grid of (x,y) values analogous to those provided for a linear array scanner

AH.1.6 Document Overview

Section AH.2 provides the normative references with which this GLAS/GFM specification conforms, as well as informative references used to define terminology and other content of this document. Sections AH.3 and AH.4 respectively define technical terms and the acronyms and abbreviations. The next two sections, i.e., Sections AH.5 and AH.6, contain technical information about the GLAS and GFM SDEs and detailed specifications of each GLAS/GFM SDE, respectively. Implementation guidance, Section AH.7, includes an example of the metadata mechanism that links GLAS/GFM TREs and GLAS/GFM DESs to one another, plus the minimum required set of TREs and DESs needed for the dataset to be exploitable by the MSP models. Section **Error! Reference source not found.** describes maintenance and life cycle considerations, including activation of the reserved fields, while Section AH.9 provides conformance criteria.

AH.2 References

AH.2.1 Normative References

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[2] Community Sensor Model (CSM) Technical Requirements Document (TRD), Version 3.0.3, 2017-05-31, https://nsgreg.nga.mil/doc/view?i=4463.

[3] ISO 19105-2000, “Geographic Information – Conformance and Testing”.

[4] DoD Interface Standard National Imagery Transmission Format Version 2.1 for the National Imagery Transmission Format Standard, Revision C, Change Notice 2, document ID MIL-STD-2500C W/CHANGE 2, published 2 January 2019 by NGA, URL https://nsgreg.nga.mil/doc/view?i=4724.

[5] NITFS Tagged Record Extensions Registry, http://jitc.fhu.disa.mil/projects/nitf/registers/trereg.aspx.

[6] NITFS Data Extension Segment Registry, http://jitc.fhu.disa.mil/projects/nitf/registers/desreg.aspx.

[7] NITFS Field Value Registry, http://jitc.fhu.disa.mil/projects/nitf/registers/nitfcte/trereg.aspx.

[8] National System for Geospatial Intelligence Recommended Practice for Universally Unique Identifiers, NGA Recommended Practice, document ID NGA.RP.0001_1.0.0, published 3 January 2013 by NGA, URL https://nsgreg.nga.mil/doc/view?i=4034.

[9] National Imagery Transmission Format Standard (NITFS) Standards Compliance & Interoperability Test and Evaluation Program Plan, Version 1.0, document ID N-0105/98, 25 August 1998.

[10] The Compendium of Controlled Extensions (CE) for the National Imagery Transmission Format (NITF) Volume 1, Tagged Record Extensions Version 5.0, document ID STDI-0002-1_5.0, published 20 December 2019 by NGA, URL https://nsgreg.nga.mil/doc/view?i=4875.

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[13] "Unmanned Aircraft Design: A Review of Fundamentals" by Mohammed Sadraey. A publication in the Morgan & Claypool Publishers series "*Synthesis Lectures on Mechanical Engineering, #04*", ISBN 9781681731681, copyright 2017.

[14] United States Imagery and Geospatial Information Service (USIGS) Glossary, Revision B, 23 November 1999. Prepared by the National Imagery & Mapping Agency as the Functional Manager for Imagery, Imagery Intelligence and Geospatial Investment Activities for the Imagery and Geospatial Community.

[15] "Request for Comments (RFC) 4122: A Universally Unique IDentifier (UUID) URN Namespace", July 2005, published by the Internet Engineering Task Force (IETF), Document ID RFC 4122. URL https://www.ietf.org/rfc/rfc4122.txt.

[16] "Explanatory Supplement to the Astronomical Almanac" edited by P. Kenneth Seidelmann, U.S. Naval Observatory, University Science Books, Sausalito, California, copyright 2006.

[17] "Metric Geopositioning Metadata Set", Motion Imagery Standards Board (MISB) ST 1107.3, 22 Feb 2018. URL https://gwg.nga.mil/misb/docs/standards/ST1107.3.pdf.

AH.3 TERMS AND DEFINITIONS

Adjustable Parameter (AP): A parameter that can be refined, e.g. via a registration process, such that it impacts a sensor model's image-to-ground and ground-to-image transformation in order to make it more consistent with other data.

A posteriori: After an adjustment has occurred.

Chip: A portion of another image, be it from the original image as captured by a sensor, or from a sub-image cropped from an original image [Ref. 10].

Coordinated Universal Time (UTC): Coordinated Universal Time (*Universel Temps Coordonné*) is the time scale maintained by the International Earth Rotation Service (having previously been maintained by the *Bureau International de l'Heure*) that forms the basis of a coordinated dissemination of standard frequencies and time signals [Ref. 4].

Correlated Parameter Group (CPG): A set of adjustable parameters that: 1) are correlated, in general, with other parameters within the same group but uncorrelated with parameters in a different group; and 2) share the same strictly positive definite correlation function (SPDCF) which represents a temporal correlation model used to compute cross covariance matrices of adjustable parameters between images.

Digital Number (DN)**:** A unit of measure consisting of positive integers that vary from zero (0) to one less than a selected power of 2. This range corresponds to the number of bits used for coding numbers in binary format. For example, if a sensor used 8 bits to record the data, there are 2^8 = 256 digital values available, ranging from 0 to 255 [Ref. 12].

Field Alignment Block: A square area within the 2D frame array for which the virtual focal plane locations are provided at each of its four corners.

Frame: A 2D focal plane array (FPA) that collects a snapshot of the entire scene either at one time instant or over a relatively short and continuous time span, such as a rolling shutter collection.

Frame Sequence: A temporal sequence of frames, usually collected by a motion imagery sensor.

Frame Sequence Model: A model that applies to a sequence of frames that comprise a product; i.e., the vector of adjustable parameters in that model apply to the product as a whole.

Greenwich Mean Time (GMT): (1) In the United Kingdom, GMT means civil time of Coordinated Universal Time (UTC), which differs from International Atomic Time (TAI) by an integer number of seconds and maintained within +0.9 seconds of UT1 by the introduction of one-second steps (leap seconds) [Ref. 16]. (2) For navigation, GMT means Universal Time 1 (UT1), i.e., the time derived from the observed diurnal motion of stars or radio sources (Universal Time 0 or UT0) corrected for the shift in longitude of the observing station caused by polar motion. UT1 is independent of observing location but is influenced by the slightly variable rotation of the earth [Ref. 16].

Imager: Sensor or camera.

Imagery-Derived Product (IDP): Literal (image-like) or graphic representation of an original image or information extracted from the image. The purposes of an IDP are to create a value-added product that highlights specific types of information in the image, merges older imagery with data from other sources, creates an imagery product or data that can be declassified, or compresses imagery data for more efficient transmission. An IDP may be created using analog or digital techniques and stored in either a hardcopy or softcopy format. An IDP from satellite imagery is marked and handled at the same classification as the original image unless it is created and used according to NGA/CIO policy guidance and previously approved for particular applications by the director of NGA/CIO.

Linear Array Scanner: A broad class of time-dependent optical imaging sensors that includes pushbroom, whiskbroom, and panoramic sensors. Some platforms such as the WorldView commercial EO system share characteristics of pushbroom and panoramic sensors because they rely upon an angular rotation of the imager with respect to the platform during an imaging event (like a panoramic) but the scale of the collected imagery remains roughly equal throughout the image (like a pushbroom); these hybrid sensors can scan the ground in any direction with respect to the platform velocity vector and are typically called "linear array scanners" or "line scanners", but are sometimes called "pushbroom" even though it stretches the definition. See also "pushbroom", "whiskbroom", and "panoramic" sensor definitions.

Panoramic Sensor: A cross-track linear array scanner in which all pixels (samples or columns) along a line (row) are imaged at the same time, and subsequent lines (rows) of the image are built up consecutively using a rotating mirror; thus the direction of increasing lines (rows) is perpendicular to the flight direction. The rotating mirror changes the pointing direction of the instantaneous linear array across a wide change of look angles, sometimes from horizon to horizon, as it progresses from the first to the last row of the image; therefore, the scale of the collected imagery can vary drastically between nominally oblique geometry at the edges of the image and nominally nadir geometry in the vicinity of the center of the image.

Payload: [Remote Sensing] The sensors and equipment necessary to perform specific tasks, excluding the instrumentation necessary for the platform to operate. For example, the payload of an unmanned aerial vehicle (UAV) is the instrumentation that collects and processes the images; the equipment necessary to simply fly the UAV is not part of the payload. In some cases, "payload" has a much broader definition and covers all the equipment and sensors carried by the platform, e.g., including the avionics of a UAV [adapted from Ref. 13].

Pushbroom Sensor: An along-track linear array scanner in which all pixels (samples or columns) along a line (row) are imaged at the same time, and subsequent lines (rows) of the image are built up consecutively using the motion of the vehicle; thus the direction of increasing lines (rows) is parallel to the flight direction.

Platform: The object, structure, vehicle, or base upon which a remote sensor is mounted [Ref. 14].

Rolling Shutter: [Framing Sensors] A type of collection paradigm in which all pixels in the 2D array are not collected at the same time. Pixels will be imaged between the start of collection to the end of collection, typically involving a progression along consecutive rows or columns from top-to-bottom or left-to-right, respectively, across an image.

Support Data Extension (SDE): [NITFS] A TRE, a DES, or a reserved extension segment (RES). An allowed and approved SDE shall be either controlled by or registered with the NITFS Technical Board (NTB).

Universal Time 1 (UT1): (1) The time derived from the observed diurnal motion of stars or radio sources (Universal Time 0 or UT0) corrected for the shift in longitude of the observing station caused by polar motion. UT1 is independent of observing location but is influenced by the slightly variable rotation of the earth [Ref. 16]. (2) (DoD) A measure of time that conforms, within a close approximation, to the mean diurnal rotation of the Earth and serves as the basis of civil timekeeping. Universal Time (UT1) is determined from observations of the stars, radio sources, and also from ranging observations of the Moon and artificial Earth satellites. The scale determined directly from such observations is designated Universal Time Observed (UTO); it is slightly dependent on the place of observation. When UTO is corrected for the shift in longitude of the observing station caused by polar motion, the time scale UT1 is obtained. When an accuracy better than one second is not required, Universal Time can be used to mean Coordinated Universal Time (UTC). Also called ZULU time. Formerly called Greenwich Mean Time (GMT) [Ref. 14].

Universally Unique Identifier (UUID): A UUID is a type of Uniform Resource Name (URN) and is an identifier that is unique across both space and time, with respect to the space of all UUIDs. A UUID is a 128-bit sequence of integers that requires no central registration process. Since a UUID is a fixed size and contains a time field, it is possible for values to roll over (around A.D. 3400, depending on the specific algorithm used). A UUID can be used for multiple purposes, from tagging objects with an extremely short lifetime, to reliably identifying very persistent objects across a network [Ref. 15].

Unmodeled Error (UE): A type of sensor model error that, for practical reasons, is not treated as adjustable because its magnitude and direction vary considerably and in a non-systematic manner across the rows and columns of an image.

Whiskbroom Sensor: A linear array scanner in which a rotating mirror is used to quickly scan a pixel or small 1D array of pixels in the cross-track direction to obtain the samples (columns) that comprise a line (row), and the subsequent lines of the image are built up consecutively using the motion of the vehicle; thus the direction of increasing lines (rows) is parallel to the flight direction.

AH.4 ACRONYMS AND ABBREVIATIONS

Term	Definition
1D	one-dimensional
2D	two-dimensional
A	
A_S	Along Scan
AISDLVL	Associated Image Segment Display Level
AP	Adjustable Parameters
ASSIST	Acquisition Streamlining and Standardization Information System
ASSOC	Associated
ATT	attitude
B	
BCS	Basic Character Set
BCS-A	Basic Character Set – Alphanumeric
BCS-N	Basic Character Set – Numeric
C	
C	Conditional (“TYPE” column of metadata tables)

Term	Definition
C_S	Cross Scan
CC	Century represented as two digits
CE	Controlled Extension
CEL	Controlled Extension Length
CETAG	Controlled Extension Type identifier
CH	Control and Handling
CN	Change Notice
CPG	Correlated Parameter Group
Cr	Chrominance (red)
CS	CS***A SDEs: Commercial Support CS***B SDEs: Common Sensor
CS***A	"A" version of CS geopositioning TREs, i.e., CSATTA, CSEPHA, CSEXRA, CSSFAA
CS***B	"B" version of CS geopositioning SDEs, i.e., CSATTB, CSCSDB, CSEPHB, CSEXRB, CSRLSB, CSSFAB, CSWRPB
CSATTA	Commercial Support Attitude data DES, version A
CSATTB	Common Sensor Attitude data DES, version B
CSCSDB	Common Sensor Covariance Support Data DES, version B
CSEPHA	Commercial Support Ephemeris Data TRE, version A
CSEPHB	Common Sensor Ephemeris Data DES, version B
C-Set	Character Set
CSEXRA	Commercial Support Exploitation Reference data TRE, version A
CSEXRB	Common Sensor Exploitation Reference data TRE, version B
CSM	Community Sensor Model
CSMWG	Community Sensor Model Working Group
CSRLSB	Common Sensor Rolling Shutter terms TRE, version B
CSSFAA	Commercial Support Sensor Field Alignment TRE, version A
CSSFAB	Common Sensor Sensor Field Alignment DES, version B
CSWRPB	Common Sensor Warping terms TRE, version B
D	
DD	Day of the month, represented as 2 digits
DES	Data Extension Segment
DESID	DES Identifier
DESTAG	Data Extension Segment TAG
DESVER	Data Extension Segment VERsion
DGA	Direct Geopositioning Analysis
DoD	Department of Defense
DT	Delta Time
E	
ECF	Earth-Centered Earth-Fixed
ECI	Earth-Centered Inertial
ECS	Extended Character Set
ECS-A	Extended Character Set – Alphanumeric

Term	Definition
ERR	Error
ELEM	Element(s)
F	
F	Framer (versus a Scanner)
FMV	Full Motion Video
FSYNWA	Frame-Synchronous Metadata Wrapper TRE, version A
G	
GEOINT	Geospatial Intelligence
GFM	Generic Frame-sequence Model
GLAS	Generic Linear Array Scanner
GSD	Ground Sample Distance
GSET	Generic Sensor Exploitation Tool
GWG	Geospatial Intelligence Standards Working Group
H	
hh	Hour – represented as 2 digits
I	
IC	Intelligence Community
ID	Identifier
IDLVL	Image Display Level
IO	Interior Orientation
IS	Image Segment
ISH	Image Segment Subheader
ISO	International Organization for Standardization
ISO/IEC	ISO/International Electrotechnical Commission
ISO/TC	ISO/Technical Committee
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
J	
JITC	Joint Interoperability Test Command
K	
KLV	Key-Length-Value
L	
LEN	Length
LIDAR	Light Detection And Ranging
LOC	Location
M	
MIE4NITF	Motion Imagery Extension for NITF 2.1
m	meter(s)
MIL-STD	MILitary STandarD
MM	(1) Month of the year represented as 2 digits
mm	(1) minutes of the hour, represented as 2 digits (NITFS) (2) millimeter(s)
MSP	NGA Mensuration Services Program

Term	Definition
MTIMSA	MoTion Imagery Segment TRE, version A
N	
N/A	Not Applicable
NCGIS	National Center for Geospatial Intelligence Standards
NGA	National Geospatial-Intelligence Agency
NIIRS	National Imagery Interpretability Rating Scale
NITF	National Imagery Transmission Format
NITF 2.1	National Imagery Transmission Format Version 2.1
NITFS	National Imagery Transmission Format Standard
NSG	National System for Geospatial Intelligence
NSGPDD	National System for Geospatial Intelligence Product Definition Document
NSIF	NATO Secondary Image Format
NTB	NITFS Technical Board
NUM	NUMber
NUMAIS	Number of Associated Image Segments
P	
PF	Platform
PL	Payload
pix	Pixel
R	
R	Required
RADAR	Radio Detection And Ranging
REF	Reference
RFC	Request For Change
ROYGBIV	Red-Orange-Yellow-Green-Blue-Indigo-Violet
RP	Recommended Practice
S	
S	Scanner (versus a Framer)
SDE	Support Data Extension
SPDCF	Strictly Positive Definite Correlation Function
SR	Sensor
ss	Seconds of the minute, represented as 2 digits
STDI	Standard Identifier
STND	Standard
SUBH	Subheader
SV	Satellite Vehicle
T	
TBD	To Be Determined
TBR	To Be Resolved
TRD	Technical Requirements Document
TRE	Tagged Record Extension
TS	Telescope

Term	Definition
U	
UE	Unmodeled Error
UINT	Unsigned Integer
UINTn	Unsigned n-bit Integer
URL	Uniform Resource Locator
US	United States of America
UTC	Coordinated Universal Time, or in French, *Universel Temps Coordonné*
UT	Universal Time
UUID	Universally Unique Identifier
V	
VERT	Vertical
W	
WGS	World Geodetic System
Y	
YY	Calendar Year– represented as last 2 digits of 4-digit year
Z	
ZULU	Zero Meridian

AH.5 TECHNICAL NOTES

This section provides technical descriptions of specific aspects of the GLAS/GFM SDEs, such as the supported sensor types, rolling shutter considerations, and the differences between GLAS and GFM. This section also provides guidance for TRE placement in the NITF file, describes the mechanism by which GLAS/GFM TREs are linked to GLAS/GFM DESs, and a discussion of the GLAS/GFM reserved fields.

AH.5.1 Supported Sensor Designs

The GLAS/GFM model supports both still and motion imagery from EO sources; it is not applicable to SAR nor LIDAR sensors. For still imagery sensors, the GLAS model is applicable to pushbroom, whiskbroom, and panoramic sensors, while the GFM is applicable to a frame sensor. The term “frame” refers to a 2D focal plane array (FPA) that collects a snapshot of the entire scene either at one time instant or over a relatively short and continuous time span, such as a rolling shutter collection. Support for motion imagery, inherent to a single instantiation of the model, is provided by the GFM for framing sensors. If a data provider supplies pushbroom, whiskbroom, or panoramic motion imagery sequences, then the GLAS model shall be used to characterize the imagery.

For some whiskbroom collections, the time to sweep, i.e., collect, one row of an image is not negligible. In this case, the CSWRPB TRE shall be populated such that it mathematically re-samples the image pixels to a hypothetical intermediate image whereby all pixels along a given row were imaged at the same time.

AH.5.2 Rolling Shutter Support

The GFM specifies metadata and modeling to support rolling shutter collections by a framing sensor. The data provider shall populate the CSRLSB TRE if framing collection uses the rolling shutter collection paradigm, unless the timing effect is negligible. The GLAS model expects and properly accounts for the fact that the image exposure times vary as a function of location within the image; therefore, the CSRLSB TRE is not applicable to GLAS systems.

AH.5.3 GLAS/GFM SDE Associations with Image Segments

The NITF implementation of the GLAS/GFM data model requires that the GLAS/GFM SDEs be unambiguously associated with the image segments to which these SDEs apply. This association is trivial for the GLAS/GFM TREs, because TREs are always associated with the image segment in which they occur. The GLAS/GFM DESs are linked to the image segments via UUIDs assigned to the image segments via the CSEXRB TRE and the UUIDs assigned to the GLAS/GFM DESs.

A set of GLAS/GFM DESs may support a single image segment or multiple image segments in the same file. Also, a GLAS/GFM DES may support more than one image segment. Figure AH.5-1 depicts a NITF file that contains three image segments, each with its own set of GLAS/GFM SDEs. Each image segment contains one or more GLAS/GFM TREs in its subheader, and each set of GLAS/GFM DESs supports a different image segment and is linked to that image segment via UUIDS.

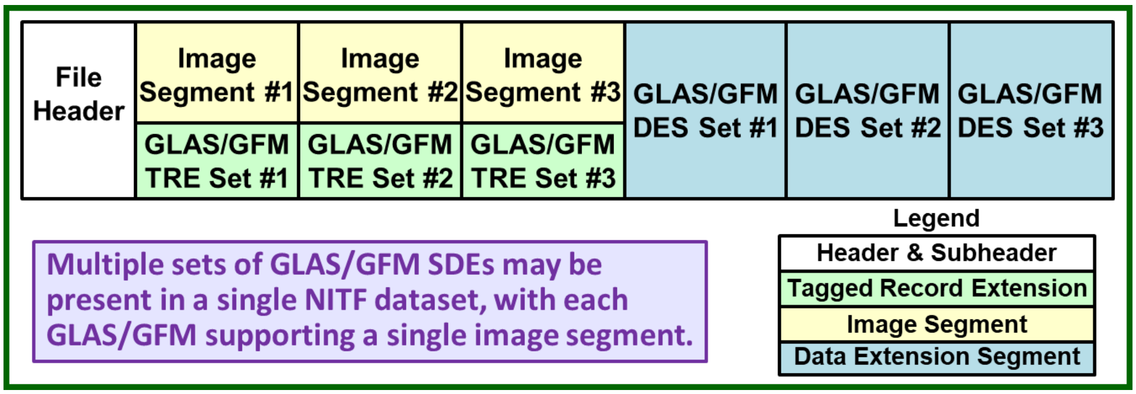

Figure AH.5-1: One GLAS/GFM Set for Each Image Segment

Another option is a set of GLAS/GFM DESs that support more than one image segment. Figure AH.5-2 shows two image segments supported by one set of GLAS/GFM DESs. Each image segment has its own GLAS/GFM TREs in its subheader, and the GLAS/GFM DESs are linked to the image segments via UUIDs.

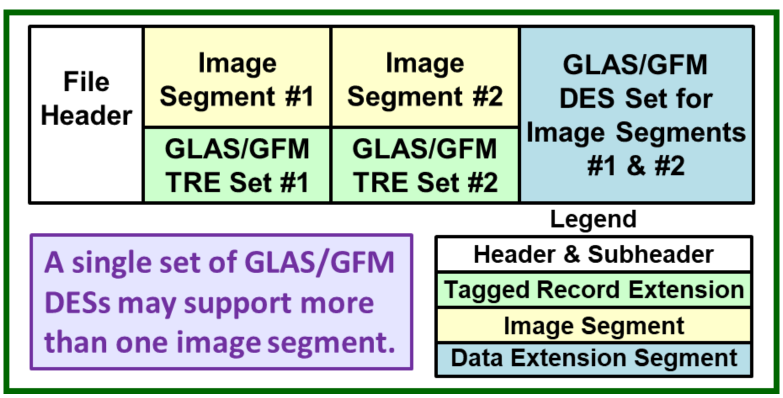

Figure AH.5-2: One Set of GLAS/GFM DESs Supports Multiple Image Segments

Yet another option involves GLAS/GFM DESs where some DESs support one image, some DESs support another image, and the remaining DESs support multiple images. For example, in Figure AH.5-3, two image segments, each containing image segment-specific GLAS/GFM TREs, are present in the dataset, along with three groups of GLAS/GFM DESs. The first group of GLAS/GFM DESs supports the first image segment. The second group supports both image segments, and the third group of GLAS/GFM DESs supports the second image segment. Once again, the GLAS/GFM DESs are linked to the image segments via UUIDs.

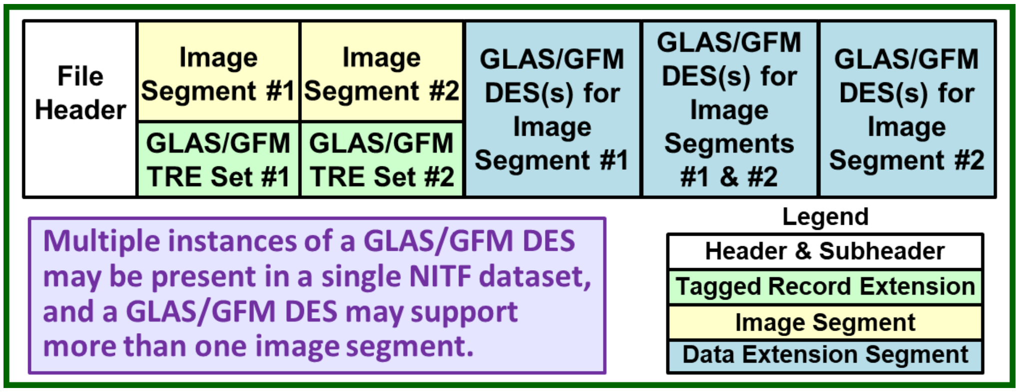

Figure AH.5-3: Some GLAS/GFM DESs Support Multiple Image Segments

AH.5.4 GLAS/GFM SDE Placement

In order for MSP to produce accurate results, the GLAS/GFM SDEs shall be in a single NITF dataset that also includes the image(s) to which the GLAS/GFM SDEs apply. The GLAS/GFM TREs shall be placed in the image segment subheader (ISH) of all image segments for which precise geolocation and mensuration using the GLAS/GFM model is to be performed, unless the ISH does not have sufficient space for all the TREs, in which case the TRE_OVERFLOW DES is implemented.

For an image contained in a single NITF file, all GLAS/GFM SDEs for that image shall be placed in the same file that contains the image itself. In the case of multi-segmented images, the GLAS/GFM DESs apply to the entire set of segments collectively.

AH.5.4.1 GLAS/GFM DES Placement

For an image contained in a single NITF file, all GLAS/GFM DESs for that image shall be placed in the DES portion of the same file that contains the image itself.

AH.5.4.2 GLAS/GFM TRE Placement

By default, all GLAS/GFM TREs for an image shall be placed in the extended subheader portion of the image segment that contains the image itself, unless the ISH does not have sufficient space for all the TREs in the image segment, in which case the data provider shall place the remaining TREs in the user-defined portion of the ISH. If the TREs exceed the size of the combined extended and user-defined portions of the ISH, then the data provider shall overflow the remaining TREs to the TRE_OVERFLOW DES.

Particular care should be taken as to whether the GLAS/GFM TREs are placed in the “user-defined” or “extended” section of the ISH, and whether any of these TREs should overflow to the TRE_OVERFLOW DES.

In NITF 2.0, the “user-defined” section of the (sub)header was restricted to proprietary, i.e., not published, TREs; only the names of these user-defined TREs were registered with the NTB. The extended section of the NITF file header and segment subheaders was only for TREs that the NTB fully managed and published.

With the advent of NITF 2.1 in 1997, these restrictions on the placement of user-defined and NTB-managed TREs disappeared. In other words, an NTB-managed TRE may be placed in the user-defined section of the NITF file header and segment subheader, and a user-defined TRE may be placed in the extended section of the file header and segment subheader.

Even so, some legacy and not-so-legacy NITF 2.1 readers do not look in the user-defined section of a (sub)header for NTB-managed TREs. Therefore, for interoperability purposes, the default location for TREs in a GLAS/GFM-conformant dataset shall be the extended section of the ISH.

Also, for interoperability with NATO systems, the NTB recommends that GLAS/GFM TREs be placed in the extended (sub)header because some NATO systems cannot find TREs in the user-defined portion of the (sub)header. In addition, the NTB recommends that TREs not overflow to the TRE_OVERFLOW DES unless absolutely necessary; i.e., only when the (sub)header size is not sufficient for all the TREs, because some NATO systems cannot read a TRE_OVERFLOW DES.

AH.5.5 Linking the GLAS/GFM SDEs: Universally Unique Identifiers

Splitting the GLAS/GFM metadata between the TREs in the ISH and DESs presents a challenge to the data consumer, particularly when a NITF file contains multiple images and/or frames, each with separate and distinct geometry data. Placing the CSEXRB TRE within the subheader of an image segment unambiguously associates that instance of the CSEXRB TRE to that image segment. However, NITF 2.1 provides no such native association for DESs. It is thus up to the metadata in each DES to provide the necessary linkage.

The GLAS/GFM TREs and DESs provide this linkage by assigning UUIDs to each instance of a GLAS/GFM TRE and DES. UUIDs are cryptographically generated 128-bit alphanumeric strings defined in ITU-T Rec X.667 | ISO/IEC 9384-8:2005 and generated according to the "NSG Recommended Practice for UUIDs" (NGA.RP.0001_1.0.0). UUIDs are stored in the GLAS/GFM TREs and DESs in canonical form as a 36-character hexadecimal string; e.g., "dbe26dc7-e03-4d29-8edb-41acc0e86b6e".

UUIDs are used to uniquely identify each data element itself and to identify the data elements associated with another element. A "data element" may be an entire image segment, a group of frames within a motion image segment, or an entire DES. The links are specified bidirectional to ensure that even if a NITF file is chipped or two NITF files are combined, the data consumer can still unambiguously match the correct DESs to the correct images. All UUIDs shall be generated using the methods specified in NGA.RP.0001_1.0.0.

To specify the UUID of each element, the CSEXRB TRE contains a field "IMAGE_UUID" and the CSATTB, CSEPHB, CSSFAB and CSCSDB DESs contain an associated element UUID field "ASSOC_ELEM_UUID" that is populated with the value of IMAGE_UUID from the CSEXRB TRE. These UUID fields uniquely specify the data in each image segment and DESs from both a syntactic (actual field values) and semantic (meaning or association of other field values) perspective.

To specify the linkage from the image segment to the specific DESs, the CSEXRB TRE contains a list of associated DES UUIDs via the "ASSOC_DES_UUID" fields that shall contain the UUID field values of each GLAS/GFM DES necessary to process that image from a geometric perspective.

To specify the reverse linkage from the DESs back to the image segment or segments to which those DESs contribute geometry data, each DES contains a list of ASSOC_ELEM_UUID fields. At a minimum, that list shall contain the value of the IMAGE_UUID field from the CSEXRB TRE contained in the ISH for each image for which the DES provides geometry data. In addition, the list of ASSOC_ELEM_UUID fields may contain other UUIDs as necessary for system specific data associates or additional processing or optimizations. For example, a system may choose to identify each correlation event not only by time of event but also by assigning a UUID to that event. That UUID for the correlation event could be added by the data provider to the ASSOC_ELEM_UUID list in the CSCSDB DES.

The DESs also contain a list of associated image segment display level (AISDLVL) fields, containing the display level of each image segment in that same NITF file for which that DES contains geometry data.

This convention is in use for other DESs and TREs and thus is also supported for the GLAS/GFM geometry data. However, because the display levels are not unique from NITF file to NITF file, if a NITF file is chipped or combined with another NITF file, and the tool producing that new file does not carefully update that list of associated display levels in each DES, a data consumer will not be able to process the image. Since the UUIDs are universally unique, a data consumer that uses the UUIDs to link the images with the DESs or extracted DES data can do so without concern as to whether the NITF file had been reorganized after original production.

AH.5.6 GLAS versus GFM Implementations

As mentioned in the previous section, the CSRLSB TRE applies to the GFM, when needed, but not to the GLAS model. All other CS***B SDEs are applicable to both GLAS and GFM but some of them are implemented differently for framers and scanners. Note that the field “SENSOR_TYPE” in the CSEXRB TRE has a value of either “S” (scanner) or “F” (framer) and indicates whether the GLAS and GFM model is provided by the CS***B SDEs.

AH.5.6.1 Sub-Array Blocks: GFM Only

The GFM uses the concept of blocks to identify rectangular sub-arrays within an image such that their corners are associated with specific metadata values. The block concept is applied to field alignment data supplied by the CSSFAB DES as discussed in Section AH.5.6.6, and to the rolling shutter data of the CSRLSB TRE which is defined in Table AH.6-2. The N_RS_ROW_BLOCKS and M_RS_COLUMN_BLOCKS fields provide the number of equally spaced blocks in the row and column dimensions, respectively, for which delta time (DT) values are provided at each of the four corners of the block.

The concept of blocks does not apply to GLAS sensors. The GLAS model expects and properly accounts for the fact that the image exposure times vary as a function of location within the image; therefore, use of the CSRLSB TRE is not applicable for GLAS. Similarly, the GLAS model provides field alignment data across a row without the need for 2D blocks.

AH.5.6.2 SDEs with No Implementation Differences

The CSATTB, CSCSDB, and CSEPHB DESs are implemented in the same way regardless of whether the sensor is a linear array scanner or a framing system.

AH.5.6.3 CSEXRB Differences

The CSEXRB TRE contains a field called “SENSOR_TYPE” that indicates whether the GLAS model (SENSOR_TYPE = S) or GFM (SENSOR_TYPE = F) is being provided. The CSEXRB TRE also contains the field “ROLLING_SHUTTER_FLAG” that indicates whether or not the CSRLSB TRE is provided and should be used. As discussed previously in Section AH.5.2, the CSRLSB TRE is not applicable regardless of linear scanner collection mode and so is not used for GLAS models, in which case ROLLING_SHUTTER_FLAG = 0.

The CSEXRB TRE provides timing information for the GLAS model via a time stamp field called “DAY_FIRST_LINE_IMAGE” for the first line of the synthetic array image. The CSEXRB TRE provides timing information for the GFM by either pointing to the MoTion Imagery Segment TRE, version A (MTIMSA) TRE (motion imagery sensors only) or within the CSEXRB TRE itself as indicated by the “TIME_STAMP_LOC” field. In any case, time stamps are provided in terms of an absolute time stamp for the first frame in the sequence and delta times for all subsequent frames.

AH.5.6.4 CSRLSB Differences

As discussed in Section AH.5.2, the CSRLSB TRE is never present in the dataset when the GLAS model is instantiated. The CSRLSB TRE may exist when the GFM is instantiated, but only if the framing senor operated in rolling shutter collection mode.

AH.5.6.5 CSWRPB Differences

The CSWRPB TRE contains a field called "SENSOR_TYPE" that indicates whether the GLAS model (SENSOR_TYPE = S) or GFM (SENSOR_TYPE = F) is being provided.

Additional fields are provided in the CSWRPB TRE to allow for association of specific focal length values with specific sets of warping data, and a flag to indicate what type of interpolation should be used to obtain the warping coefficient parameters for intermediate focal length values. The additional fields that apply to GFM, but not to GLAS, are WRP_INTERP and FL_WARPn. As mentioned in the description of NUM_SETS_WARP_DATA, the number of sets of warping data contained in the CSWRPB TRE is always 1 for GLAS but can be any number from 1 to 9 for GFM. The NUM_SETS_WARP_DATA value indicates how many sets of data are provided starting with the field FL_WARPn and ending with the field Bnji.

AH.5.6.6 CSSFAB Differences

The CSSFAB DES contains a field called "SENSOR_TYPE" that indicates whether the GLAS model (SENSOR_TYPE = S) or GFM (SENSOR_TYPE = F) is being provided. Conditional statements are provided within the DES definition to clearly distinguish fields that apply to GLAS versus GFM.

The main difference between GFM and GLAS with respect to the CSSFAB DES is that GLAS provides only one option for specifying field alignment data, i.e., a list of 2D coordinate pairs (X and Y values) associated with the endpoints of segments that comprise the full linear array of the sensor. The CSSFAB fields that instantiate the GLAS model are SMPL_NUM_FRST, DELTA_SMPL_PAIRS, NUM_FA_PAIRS, START_FALIGN_X, START_FALIGN_Y, END_FALIGN_X, and END_FALIGN_Y.

For the GFM, the CSSFAB DES offers two options for specifying field alignment data. The first option is analogous to GLAS and consists of a list of 2D coordinate pairs (X and Y values) associated with the corners of rectangular sub-arrays that comprise the full area array of the framer; these sub-arrays are called "blocks" as discussed in Section AH.5.6.1. This option is implemented when FIELD_ANGLE_TYPE = 0, indicating a direct field alignment grid provided by the CSSFAB DES.

The second option for the GFM to provide field alignment data is via the "Concatenated Approach" which involves using a well-known set of interior orientation calibration parameters to model the effects of focal length, principal point, lens distortion, and affine distortion such that separate sets of static values are provided for up to two sets of optics which correspond to the telescope and the focal plane; in addition, a set of 8 homography (2D to 2D projective transformation) parameter values are provided dynamically, on a frame-by-frame basis to relate the focal plane coordinate system to the telescope coordinate system.

AH.5.6.7 GLAS for Motion Imagery Scanners

As stated in Section AH.1.2, while GLAS does not explicitly support motion imagery for scanners, a data provider can still collect motion imagery from its scanning sensor and place the image products into separate NITF files so that they can be exploited using the GLAS sensor model via instantiation of one model per file. The errors in ephemeris and attitude data will likely be correlated between subsequent scanned images in a motion imagery collect. These error correlations can be conveniently represented using the CSCSDB DES.

AH.5.7 Leveraging Correlated Errors Across Multiple Images

In some cases, multiple images are collected by the same platform, payload, and/or sensor which have correlated errors, and these correlated errors can be leveraged to produce more reliable geolocation than would otherwise be possible if the error correlations were ignored. More reliable geolocation means that:

1) the achieved accuracy either stays the same or improves,

2) the reported uncertainty can become larger or smaller, and
3) the reported uncertainty, whether larger or smaller, is more consistent with the achieved accuracy.

The multiple images may be in a single NITF file and/or multiple NITF files and are inputs to the geolocation program, e.g., MSP and its underlying CSM algorithms.

An example of this scenario is determining the geolocation of a target imaged by four different collections, with two images collected by the same platform, payload, and sensor; a third image collected by the same platform and payload and a different sensor; and a fourth image collected by a different platform, payload, and sensor (Figure AH.5-4).

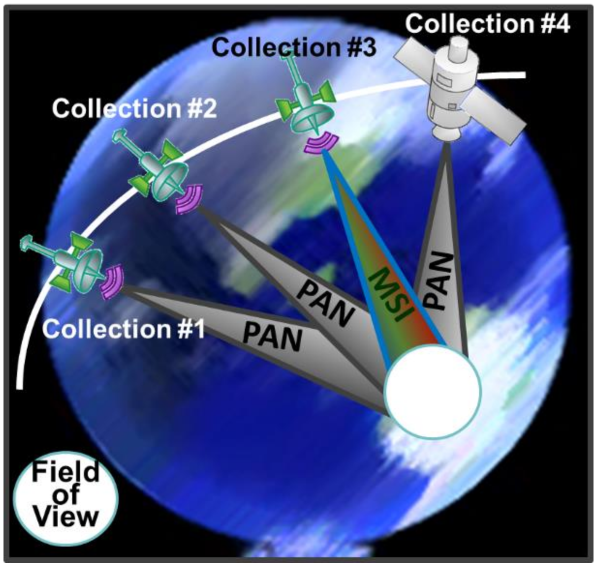

Figure AH.5-4: Multiple Image Collections of the Same Target

When the four images resulting from these four collections are input into a mensuration tool as a group, the GLAS/GFM SDEs provide the tool with information indicating whether errors are correlated across these four images (along with specific information about each individual image). As shown by Figure AH.5-5, the first three images have correlated errors, indicated by

1. Same last decorrelation event date and time (CSCSDB fields CORR_REF_DATEnj and CORR_REF_TIMEnj).
2. Images 1 and 2:
    a. Same platform, payload, and sensor IDs in CSEXRB
    b. BASIC_SR_FLAG = 1 → SPDCF type of "SR" (i.e., sensor) in CSCSDB
3. Image 3:
    a. Same platform and payload IDs in CSEXRB
    b. BASIC_PL_FLAG = 1 → SPDCF type of "PL" (i.e., payload) in CSCSDB

The fourth image, which was collected by a different platform, payload, and sensor than the other three images, has errors that are uncorrelated with the other three images, and thus the SPDCF section of the fourth image's CSCSDB DES is populated with data that correlate errors between this image and other images not included in this example. When evaluated per steps 1 through 3 above, there is no correlation of errors between image 4 and images 1, 2, and 3.

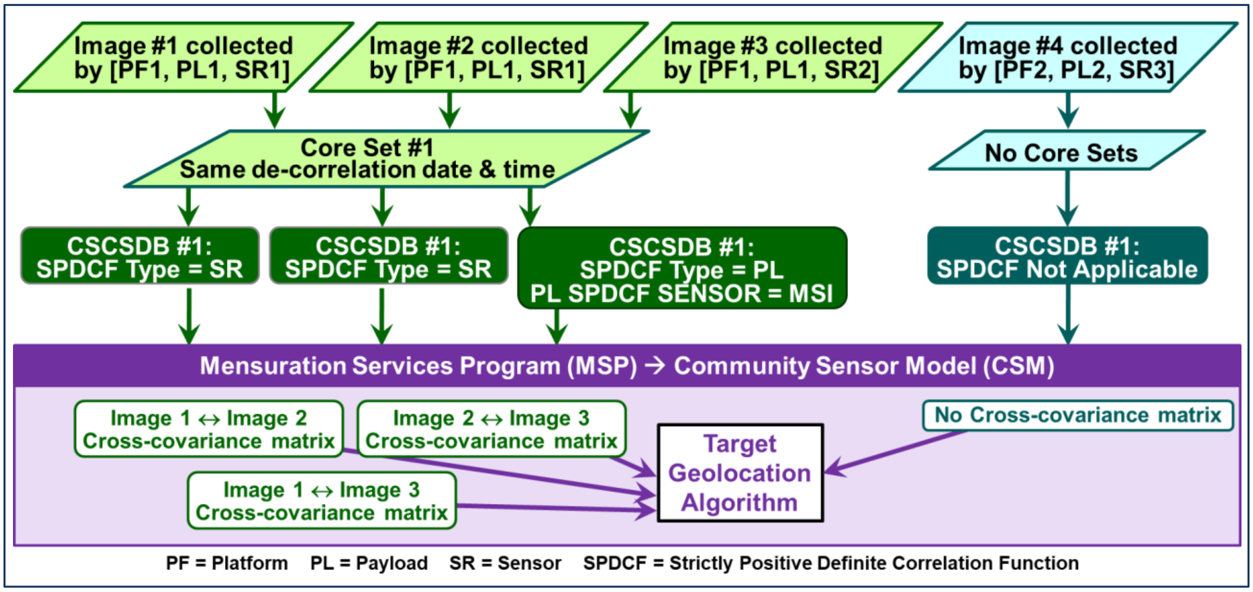

Figure AH.5-5: Mensuration Task Leveraging Correlated Errors Across Multiple Images

AH.5.7.1 Comparing Platform, Payload, and Sensor Identifiers in CSEXRB and CSCSDB

The following pseudo-code illustrates the logic involved in determining whether the adjustable parameters between pairs of images should be modeled as correlated:

```
If "dates and times of last de-correlation events" (i.e., CORR_REF_DATEnj and
CORR_REF_TIMEnj fields in the CSCSDB DES) of the two images are equal, then
    If platform, payload, and sensor IDs are identical for an image pair, then
        SPDCF type = "SR"
        Evaluate the SPDCF
    Else if platform and payload IDs are identical for an image pair, then
        SPDCF type = "PL"
        Evaluate the SPDCF
    Else if platform IDs are identical for an image pair, then
        SPDCF type = "PF"
        Evaluate the SPDCF
    Else
        Treat as uncorrelated → SPDCF is not applicable
    Endif
Else
    Treat as uncorrelated → SPDCF is not applicable
Endif
```

Comparing the platform, payload, and sensor IDs between a pair of images is accomplished using the PLATFORM_ID, PAYLOAD_ID, and SENSOR_ID field values in each image's instance of the CSEXRB TRE. The SPDCF in the CSCSDB DES is associated with the platform, payload, or sensor by the BASIC_PF_FLAGnj, BASIC_PL_FLAGnj, and BASIC_SR_FLAGnj fields respectively; values of 1 (yes), which may occur in at least one of these three fields, correspond to SPDCF types "platform", "payload", and "sensor", respectively.

If the SPDCF type is "sensor" (SR), then the SPDCF applies only if the respective values of the PLATFORM_IDs, PAYLOAD_IDs, and SENSOR_IDs all match in the CSEXRB TREs of both images. If the SPDCF type is "payload" (PL), then the SPDCF applies only if the respective PLATFORM_IDs and PAYLOAD_IDs of both images match. If the SPDCF type is "platform" (PF), then the SPDCF applies only if the PLATFORM_ID values of both images match. For SPDCFs of type "platform" and "payload", the sensor pairings for which the SPDCF applies are also specified in the CSCSDB DES in the form of sensor IDs in the BASIC_PF_SPDCF_SENSORnkjp or BASIC_PL_SPDCF_SENSORnkjp fields, respectively. If the BASIC_PF_SPDCF_SENSORnkjp or BASIC_PL_SPDCF_SENSORnkjp field value is "ALL", the SPDCF applies to any sensor pairing; otherwise, these fields shall include the SENSOR_ID of the other image in each image product's respective CSCSDB DES for the ID comparison to be true.

AH.5.7.2 Choosing Platform, Payload, and Sensor Identifier Values

The CSEXRB TRE may be the only element of the NITF dataset with platform, payload, and/or sensor IDs, and so these fields must serve the dual purpose of mensuration and search and discovery. Although the MSP does not require the actual values in human-readable/interpretable form, these fields may be the only identifiers available and thus must be the actual, human-readable values.

For example, an analyst may search the data library for images from a particular sensor system, which requires a human-readable sensor name with which to search. Alternatively, an analyst may receive a dataset with the sensor ID value "PAN" and non-human-readable platform and payload ID values, in which case the analyst will not be able to find the sensor description document to find out more about the sensor, such as the wavelength range sampled by the panchromatic sensor.

To fulfill all their functions, the PLATFORM_ID, PAYLOAD_ID, and SENSOR_ID fields shall be populated with actual, human-readable values. Each combination [PLATFORM_ID, PAYLOAD_ID, SENSOR_ID] values shall be registered with the NTB, and each combination shall be unique. Field value requests for only one or two of these three fields shall be rejected; all three values must be requested as a set. Multiple variants of the same PLATFORM_ID, PAYLOAD_ID, or SENSOR_ID are not allowed. For example, for a given sensor only one SENSOR_ID value shall be registered with the NTB in order to ensure that the values will be the same as found in other TREs/DESs when that same data is found in other places.

AH.5.8 Formatting and Time Standard Guidance for Date and Times Metadata Fields

Combined date and time stamps are encoded up to nanosecond precision using the format "CCYYMMDDhhmmss.nnnnnnnnn", where "CC" is the two-digit century (00 to 99), "YY" the last two digits of the year (00 to 99), "MM" the two-digit month (01 to 12), "DD" the two-digit day of the month (01 to 31), "hh" the two-digit hour of the day (00 to 23), "mm" the two-digit minute (00 to 59), and "ss.nnnnnnnnn" the number of seconds to the nearest nanosecond (00.000000000 to 59.999999999).

Universal Time (UT) is a time standard based on the Earth's rotation, and there are several versions of the UT standard that differ by up to a few seconds. The GLAS/GFM SDEs uses two common versions of the UT standard: UT1 and Coordinated Universal Time (UTC). UT1 is the mean solar time at 0° longitude and is used for Julian dates in the GLAS/GFM SDEs. UTC is the civil international atomic clock time standard which approximates UT1; leap seconds are periodically added to (or subtracted from) UTC to keep it within 0.9 seconds of UT1. The UTC standard is used for all non-Julian date timestamps in the GLAS/GFM SDEs.

Julian dates are a continuous count of days and fractions of days since Julian day number 0, which corresponds to 12h UT1 (Greenwich Mean Noon) on January 1, 4713 B.C.; 0h UT1 corresponds to a Julian date fraction of 0.5. Almost 2.5 million days have transpired since Julian day 0. A double precision floating point number can represent an epoch (e.g., a timestamp associated with metadata, such as ephemeris, attitude, and focal length) expressed as a Julian date to about 1 millisecond of precision. The U.S. Naval

Observatory publishes the "American Ephemeris and Nautical Almanac", which lists the Julian dates for every day of the current year.

AH.5.9 ECI-to-ECF Transformation Overview

GLAS/GFM allow attitude and ephemeris to be provided in either ECF or ECI coordinates. However, when ECI is used, additional information about the coordinate system itself must also be provided in order to mensurate or georeference objects in the scene with the same accuracy as if ECF had been used. At a high level, the following phenomena are modeled:

1. Precession, i.e., the slow, continuous change in orientation of the Earth's axis of rotation (equations based upon static parameter values)
2. Nutation, i.e., a small oscillation superimposed on the precession of the Earth, mostly caused by the Moon (equations based upon static parameter values)
3. Polar wander, i.e., the shift in the geographical poles relative to the Earth's surface after accounting for the motion of the tectonic plates (equations based upon parameter values that shall be provided on a per dataset basis)
4. UT1-to-UTC offset (equations based upon parameter values that shall be provided on a per dataset basis)
5. Earth tides (equations based upon static parameter values)

The Polar wander and UT1-to-UTC offset parameter values (Items 3 and 4, respectively) are included in each individual instance of the CSATTB or CSEPHB DES when version 2 of that DES is used and when the attitude or ephemeris data in that DES is specified using ECI. The algorithm to convert the ECI data to ECF as a function of these five phenomena is found in the "*Generic Linear Array Scanner (GLAS) and Generic Frame-sequence Model (GFM) Geometry Model Document*". Data consumers must not assume that the ECI-to-ECF parameters are identical between two instances of the CSATTB and/or CSEPHB DESs, even if those DESs are in the same NITF dataset and/or apply to the same image segment.

Precession, nutation, and Earth tides are corrected using equations populated with parameter values that characterize precession, nutation, and Earth tides. Polar wander and UT1-to-UTC offset are determined using a set of equations with parameter values supplied by the data provider. These equations are extrapolations about the "operating points" – the TA_POLE and TB_UT fields – for polar wander and UT1-to-UTC offset, respectively, in units of "Julian date". Ideally, the parameter values for these extrapolation equations are updated on the order of once a week, or more often if desired. The extrapolation results are insensitive to small changes in the values of TA_POLE and TB_UT; i.e., the impact is negligible whether they had been defined at UT1 times versus UTC times, and therefore possibly off by a second or so.

It may appear as though the parameter that expresses the time difference between UTC and UT1 is missing. The "UT1-to-UTC offset" extrapolation equation computes this time difference; thus, the constant term of the polynomial, which is the I_UT field in units of seconds, is one of the key terms in determining this time difference.

AH.5.10 Reserved Fields in the GLAS/GFM SDEs

Each of the GLAS/GFM SDEs, with the exception of the CSRLSB TRE, contain data fields designed to allow new data to be added to the SDEs without requiring a change in the SDE versions. For example, the CSEXRB and CSWRPB TREs each contain a field called "RESERVED". The number of bytes in the RESERVED field value is provided by the "RESERVED_LEN" field, which occurs just before the RESERVED field.

Similarly, the user-defined portion of each GLAS/GFM DES subheader contains a pair of metadata fields, RESERVEDSUBH_LEN and RESERVEDSUBH, where the RESERVEDSUBH_LEN field provides the number of bytes in the RESERVEDSUBH field. Also, the DESDATA portion of each GLAS/GFM DES contains a pair of metadata fields, RESERVED_LEN and RESERVED, where the RESERVED_LEN field provides the number of bytes in the RESERVED field.

The RESERVED and RESERVEDSUBH are placeholders for new data fields. Therefore, the allowed value of the RESERVED_LEN and RESERVEDSUBH_LEN fields is zero (0). As a result, the RESERVED and RESERVEDSUBH fields are not present when these SDEs are populated.

For instructions on activating the reserved fields in the GLAS/GFM SDEs, see Section AH.8.

AH.6 EXTENSION SPECIFICATIONS

The three GLAS/GFM TREs are described first (Sections AH.6.1 through AH.6.3), followed by the four GLAS/GFM DESs (Sections AH.6.4 through AH.6.7), including a data specification table for each SDE's field values. Additional information specific to each GLAS/GFM SDE is also provided. Technical details of projection equations supported by these SDEs can be found in the "GLAS/GFM Geometry Model".

Each SDE data specification table includes a mnemonic identifier for the FIELD name, field DESCRIPTION, field SIZE in bytes, character set (C-Set), field VALUE RANGE, UNITs of measure, field ACCURACY, and TYPE, i.e., obligation, criteria, where "R" = required and "C" = conditional. Brackets around a TYPE value, e.g., "<R>", indicate that the field may be populated with BCS spaces, which is only allowed for fields formatted using the ECS-A or BCS-A character set. Italicized text in the VALUE RANGE column indicates instructions rather than an actual value range. An accuracy value of "varies" indicates that the accuracy required for a metadata field will depend on the system implementing the GLAS/GFM SDEs.

AH.6.1 Common Sensor Exploitation Reference Data (CSEXRB) TRE

The Common Sensor Exploitation Reference data (CSEXRB) TRE provides exploitation support data, including image acquisition date and time, detailed temporal metadata for rows, columns, and frames, target information, the UUID of the image segment, and the UUIDs of the GLAS/GFM DESs that provide additional geopositioning information. The format, description and implementation of the user-defined fields of the CSEXRB TRE are defined in Table AH.6-1.

The CSEXRB TRE is an integral part of both the GLAS and GFM models; it can provide the geolocation and mensuration capability, or it can be used by itself to provide generic, high-level exploitation support data. Data consumers must consult the data contained in the image segment's CSEXRB TRE in addition to checking for the existence of other SDEs to determine whether the minimum set of GLAS or GFM data are provided for mensuration of the image segment.

Fields in CSEXRB Table AH.6-1 marked with a dagger "†" symbol are not necessary for the application of the GLAS or GFM models; they are provided solely for compatibility with the CS***A version of the TRE and to support data providers that are using CSEXRB solely to communicate high-level exploitation metadata but are not using the GLAS or GFM georeferencing models. Systems that cannot populate those fields, either because the data are not available, or the values are outside the legal value range, should not be dissuaded from using GLAS or GFM because those fields cannot be populated.

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: "R" = Required, "C" = Conditional, "< >" = BCS spaces allowed for the entire field. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CETAG	**Unique Extension Identifier**. Unique TRE identifier.	6	BCS-A	CSEXRB	N/A	exact	R
CEL	**Length of User-Defined Data**. Length in bytes of data in subsequent fields. TRE length is 11 plus the CEL field value.	5	BCS-N	00260 *to* 99985	bytes	exact	R
IMAGE_UUID	**UUID Assigned to the Current Image Plane**. This field shall contain the UUID assigned to the current image plane; the current image plane may consist of multiple image segments based on NITF file size restrictions. In the multi-segment case, each instance of CSEXRB contained in an image segment which is part of the multi-segment image plane shall report the same UUID value in this field.	36	BCS-A	*a valid UUID string in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	R
NUM_ASSOC_DES	**Number of GLAS/GFM DESs Associated with this Image**. This field shall contain the number of GLAS/GFM DESs associated with the current image. If CSEXRB provides high level exploitation metadata and does not support a GLAS/GFM data model, then NUM_ASSOC_DES = 0.	3	BCS-N	000 *to* 999	N/A	exact	R
***Start of number of associated* GLAS/GFM DES *loop. Loop runs from* n = 1 *to* NUM_ASSOC_DES*. Loop is omitted if* NUM_ASSOC_DES = 000.**							
ASSOC_DES_UUIDi	**UUID of the i^{th} GLAS/GFM DES Associated with this Image**. This field shall contain a UUID identifying the i^{th} GLAS/GFM DES associated with the current image.	36	BCS-A	*a valid UUID string in canonical format, e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e*	N/A	exact	C
End of associated DES loop.							
PLATFORM_ID	**Platform Identifier**. This field shall contain the platform identifier of the system that collected the current image.	6	BCS-A	*see the NITF Field Value Registry; and see Section AH.5.7*	N/A	exact	R
PAYLOAD_ID	**Payload Identifier**. This field shall contain the payload identifier of the system that collected the current image.	6	BCS-A	*see the NITF Field Value Registry; and see Section AH.5.7*	N/A	exact	R
SENSOR_ID	**Sensor Identifier**. This field shall contain the sensor identifier of the system that collected the current image.	6	BCS-A	*see the NITF Field Value Registry; and see Section AH.5.7*	N/A	exact	R
SENSOR_TYPE	**Sensor Type**. This field shall contain a code identifying the type of sensor that collected the image, with "S" indicating a line scanner and "F" a framing sensor. If the CSEXRB TRE is not part of a GLAS/GFM data model, then this field does not apply and shall be populated with a BCS space.	1	BCS-A	S *(line scanner),* F *(framing sensor), or* BCS space *if field is N/A*	N/A	exact	<R>

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: "R" = Required, "C" = Conditional, "< >" = BCS spaces allowed for the entire field. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
GROUND_REF_ POINT_X GROUND_REF_ POINT_Y GROUND_REF_ POINT_Z	**X, Y, and Z Coordinates of the Ground Reference Point**. The ground reference points are in ECF coordinates. These fields shall be populated with BCS spaces when they are not applicable.	12	BCS-A	-99999999.99 *to* +99999999.99 *or* BCS spaces	meters	varies	<R>
If **(SENSOR_TYPE = S),** ***then the following fields are contained in this instance of the*** **CSEXRB TRE.**							
DAY_FIRST_LINE_ IMAGE	**Day of First Line of the Synthetic Array Image**. This field contains the date associated with the collection of the first line of the synthetic array image.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
TIME_FIRST_LINE_ IMAGE	**Time of First Line of the Image**. This field contains the number of seconds from midnight to the start of collection of the first line of the image and applies to the entire image even if the pixels span multiple image segments. If the TIME_IMAGE_DURATION is negative (see below), then TIME_FIRST_LINE_IMAGE is the time associated with the chronological end of the top/first line in the image (still the top edge of the top line).	15	BCS-N	00000.000000000 *to* 86399.999999999	seconds (UTC Zulu)	varies	C
TIME_IMAGE_ DURATION	**Image Duration Time**. This field contains the signed time difference between the start collection times for the top and bottom lines of the image, i.e., time of bottom line minus time of top line. If the value is negative, then the image lines were chronologically collected from bottom to top, and this field represents the signed time difference between the chronological end of the top and bottom line collection. This field applies to the entire image even if the pixels span multiple image segments.	16	BCS-N	-86399.999999999 *to* +86399.999999999	seconds	varies	C
End of the **(SENSOR_TYPE = S)** ***conditional.***							

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: “R” = Required, “C” = Conditional, “< >” = BCS spaces allowed for the entire field. “†” Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***If* (SENSOR_TYPE = F), *then the following fields are contained in this instance of the* CSEXRB TRE.**							
TIME_STAMP_LOC	**Location of Frame Time Stamps**. This field identifies the TRE containing the frame time stamps, with “0” indicating that the values are in this instance of the CSEXRB TRE and “1” indicating they are in the MTIMSA TRE.	1	BCS-N	0 *or* 1	N/A	exact	C
***If* (TIME_STAMP_LOC = 0), *then the following fields are contained in this instance of the* CSEXRB TRE.**							
REFERENCE_FRAME_NUM	**Reference Frame Number**. This field contains the absolute frame number of the first frame of this temporal block as determined by the collection system. If the collection system does not assign absolute frame numbers across multiple collections, this field value is BCS spaces.	9	BCS-A	000000001 *to* 999999999 *or* BCS spaces	N/A	exact	<C>
BASE_TIMESTAMP	**Base Time Stamp**. This field contains the base time stamp from which the time stamps for the frames in this temporal block are derived.	24	BCS-N	*CCYYMMDDhhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
DT_MULTIPLIER	**Delta Time Duration**. This field contains the number of nanoseconds equal to one “time unit”, or the minimum “delta time” that can be expressed between frames.	8	UINT64	1 *to* $(2^{64} – 1)$	nano-seconds	varies	C
DT_SIZE	**Byte Size of the Delta Time Values**. This field reports the size in bytes of the DTn values.	1	UINT8	1 *to* 8	bytes	exact	C
NUMBER_FRAMES	**Number of Frames in the Current Temporal Block**. This field reports the number of frames in this image segment for this camera and temporal block, i.e., the number of frames in the current frame sequence.	4	UINT32	0 *to* $(2^{32} – 1)$	N/A	exact	C
NUMBER_DT	**Number of Delta Time Values**.	4	UNIT32	0 *to* $(2^{32} – 1)$	N/A	exact	C
Start of delta time loop, which runs from n = 0001 to NUMBER_DT. Loop is omitted if NUMBER_DT = "0000.							
DTn	**n^{th} Delta Time Value**. This field records the n^{th} delta time value. This value is formatted as an unsigned k-bit integer, with k = (8*DT_SIZE).	DT_SIZE	UINTk	0 *to* $(2^{(8*DT\_SIZE)} – 1)$	N/A	exact	C
End of delta time loop.							
End of the* (TIME_STAMP_LOC = 0) *conditional.							
End of the* (SENSOR_TYPE = F) *conditional.							

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: “R” = Required, “C” = Conditional, “< >” = BCS spaces allowed for the entire field. “†” Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
MAX_GSD†	**Maximum Mean Ground Sample Distance**. This field contains the predicted maximum mean GSD for the Primary Target (point targets) or center of image (area targets). If not applicable, the field value is BCS spaces.	12	BCS-A	0000000000.0 *to* 9999999999.9 *or* BCS spaces	inches	varies	<R>
ALONG_SCAN_ GSD†	**Measured Along-Scan and Cross-Scan GSD**. These fields contain the measured along-scan and cross-scan GSD for the Primary Target (point targets) or center of image (area targets). This field is populated with BCS spaces when not applicable.	12	BCS-A	0000000000.0 *to* 9999999999.9 *or* BCS spaces	inches	varies	<R>
CROSS_SCAN_ GSD†							
GEO_MEAN_GSD†	**Measured Geometric Mean GSD**. This field contains the measured geometric mean GSD for the Primary Target for the Primary Target (point targets) or center of image (area targets). If not applicable, the field value is BCS spaces.	12	BCS-A	0000000000.0 *to* 9999999999.9 *or* BCS spaces	inches	varies	<R>
A_S_VERT_GSD†	**Measured Along-Scan Vertical GSD**. This field contains the measured along-scan vertical GSD for the Primary Target (point targets) or center of image (area targets). If not applicable, the field value is BCS spaces.	12	BCS-A	0000000000.0 *to* 9999999999.9 *or* BCS spaces	inches	varies	<R>
C_S_VERT_GSD†							
GEO_MEAN_VERT_ GSD†	**Measured Geometric Mean Vertical GSD**. This field contains the measured geometric mean vertical GSD for the Primary Target (point targets) or center of image (area targets). If not applicable, the field value is BCS spaces.	12	BCS-A	0000000000.0 *to* 9999999999.9 *or* BCS spaces	inches	varies	<R>
GSD_BETA_ANGLE†	**Angle Between Along-Scan and Cross-Scan Directions**. This field provides the angle on the Earth-tangent plane between the along-scan and cross-scan directions at the Primary Target (point targets) or center of image (area targets). If not applicable, the field value is BCS spaces.	5	BCS-A	000.0 *to* 180.0 *or* BCS spaces	degrees	varies	<R>
DYNAMIC_RANGE†	**Dynamic Range of Pixels in Image Across All Bands**. This field reports the dynamic range of the pixels in the image across all the bands collected by the sensor. If not applicable, the field value is BCS spaces.	5	BCS-A	00000 *to* 99999 *or* BCS spaces	digital numbers	varies	<R>

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: "R" = Required, "C" = Conditional, "< >" = BCS spaces allowed for the entire field. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
NUM_LINES	**Number of Lines in the Entire Image**. This field reports the number of lines in the entire image before image segmentation, if necessary.	7	BCS-N	0000000 *to* 9999999	lines	exact	R
NUM_SAMPLES	**Number of Samples Per Line in the Entire Image**. This field reports the number of samples in the entire image before image segmentation, if necessary.	5	BCS-N	00000 *to* 99999	samples	exact	R
ANGLE_TO_ NORTH†	**Angle to True North**. This field contains the angle of the image segment with respect to True North, measured clockwise from the first row vector, i.e., a vector pointing from row, column [0,0] to [0, NCOLS – 1] in the NITF CCS, to True North (Figure AH.6-1). If not applicable, the field value is BCS spaces.	7	BCS-A	000.000 *to* 359.999 *or* BCS spaces	degrees	varies	<R>
OBLIQUITY_ANGLE†	**Obliquity Angle**. This field contains the angle between the satellite vehicle (SV) nadir pointing vector and SV-to-target line-of-sight vector at TIME_FIRST_LINE_IMAGE. If not applicable, the field value is BCS spaces.	6	BCS-A	00.000 *to* 90.000 *or* BCS spaces	degrees	varies	<R>
AZ_OF_OBLIQUITY†	**Azimuth of Obliquity**. This field contains the azimuthal angle of the SV-to-target line-of-sight vector projected in the target local horizontal plane, measured clockwise from True North computed at TIME_FIRST_LINE_IMAGE. The velocity control point of the focal plane is projected to the target local horizontal plane. If not applicable, the field value is BCS spaces.	7	BCS-A	000.000 *to* 359.999 *or* BCS spaces	degrees	varies	<R>
ATM_REFR_FLAG	**Atmospheric Refraction Flag**. This field indicates whether a correction should be applied to the line-of-sight calculation to account for atmospheric refraction effects.	1	BCS-N	0 = *Do not apply correction* 1 = *Apply correction*	N/A	exact	R
VEL_ABER_FLAG	**Velocity Aberration Flag**. This field indicates whether a correction should be applied to the line-of-sight calculation to account for velocity aberration effects.	1	BCS-N	0 = *Do not apply correction* 1 = *Apply correction*	N/A	exact	R
Environmental Metadata							
GRD_COVER†	**Ground Cover Flag**. This field indicates whether the scene contains snow, or that the information is not available.	1	BCS-N	1 = *Snow* 0 = *No Snow*	N/A	exact	R

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: "R" = Required, "C" = Conditional, "< >" = BCS spaces allowed for the entire field. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
				9 = *Not Available*			
SNOW_DEPTH_ CATEGORY†	**Snow Depth Category**. This field provides the weighted average of the snow depths for all of the grids that overlap the tasked image area.	1	BCS-N	0 = *0 inches* 1 = 1 to 8 *inches of ice and/or snow* 2 = *9 to 17 inches* 3 = *greater than 17 inches* 9 = *Not Available*	N/A	exact	R
SUN_AZIMUTH†	**Sun Azimuth Angle**. This field contains the sun azimuth angle at the predicted image collection start time, measured clockwise from True North in a plane tangent to the Earth's surface at the target location (as viewed from above the Earth's surface), of the line-of-sight vector from the target to the center of the Sun.	7	BCS-A	000.000 *to* 359.999 *or* BCS spaces	degrees	varies	<R>
SUN_ELEVATION†	**Sun Elevation Angle**. This field contains the sun elevation angle in degrees from the local target plane to the sun, calculated at the predicted image collection start time where the local target plane is defined as a plane tangent to the Earth's surface at the target location. If not applicable, the field value is BCS spaces.	7	BCS-A	-90.000 *to* +90.000 *or* BCS spaces	degrees	varies	<R>
Performance Metadata							
PREDICTED_NIIRS†	**NIIRS for the Mono Collection at Principal Target**. This field contains the predicted NIIRS associated with the image. If the sensor is tasked by GSD, if NIIRS is not predicted, or if NIIRS is not applicable, then this field shall be BCS spaces (0x20).	3	BCS-A	0.0 *to* 9.0 *or* BCS spaces	NIIRS	varies	<R>
CIRCL_ERR†	**Circular Error**. This field contains the calculated mono CE90 value of the geolocation in the horizontal ground plane of the image based on the LE90 value. This value is specifically tied to the image product represented by this instance of the CSEXRB TRE. If not applicable, the field value is BCS spaces.	5	BCS-A	000.0 *to* 999.9 *or* BCS spaces	feet	varies	<R>

Table AH.6-1: Common Sensor Exploitation Reference Data (CSEXRB) TRE

(TYPE: "R" = Required, "C" = Conditional, "< >" = BCS spaces allowed for the entire field. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
LINEAR_ERR†	**Linear Error**. This field contains the assumed mono LE90 value in feet perpendicular to the horizontal ground plane of the image. This value is specifically tied to the image product represented by this instance of the CSEXRB TRE.	5	BCS-A	000.0 *to* 999.9 *or* BCS spaces	feet	varies	<R>
CLOUD_COVER†	**Cloud Cover**. This field reports the percentage of the image plane obscured by cloud. A value of 999 indicates cloud cover is unknown. This field is populated with BCS spaces when not applicable. If a cloud cover image segment is in the same dataset as the CSEXRB TRE, then CLOUD_COVER shall be populated with a value consistent with the cloud cover grid.	3	BCS-A	000 *to* 100, 999, *or* BCS spaces *Must be consistent with cloud cover image segment, if present*	percent	varies	<R>
***If* (SENSOR_TYPE = F)*, then the following fields are contained in this instance of the* CSEXRB TRE.**							
ROLLING_SHUTTER_FLAG	**Rolling Shutter Flag**. This field indicates the type of integration across the image frame, with"0" indicating the same integration time is used across the image frame, and "1" indicating that the integration time changes across the image frame. The value is BCS spaces if not applicable.	1	BCS-A	0 = *same integration time across the frame,* 1 = *changing time during integration across the frame,* *or* BCS space	N/A	exact	<C>
End of the* (SENSOR_TYPE = F) *conditional.							
UE_TIME_FLAG	**Time Unmodeled Error Flag**. This field identifies whether time un-modeled error parameters are included, with "0" indicating "no" and "1" indicating "yes". This field is populated with a BCS space when not applicable.	1	BCS-A	0 = *no* 1 = *yes* *or* BCS space	N/A	exact	<R>
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "00000".	5	BCS-N	00000	bytes	exact	R
RESERVED	**Reserved Field**. Reserved for future use.	††	†††	*omit*	N/A	N/A	C

† The field is not necessary for the GLAS/GFM sensor model.

†† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

††† The RESERVED field does not necessarily have a single data type, since the RESERVED field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

ANGLE_TO_NORTH – Angle of the image segment, in degrees, with respect to the image projection of True North, measured clockwise from the first row vector (pointing from the first column of the image segment to the last column along the first row of the image segment) to the image projection of the vector pointing to True North (Figure AH.6-1). If the value is all hyphen-minus characters, then this field is not provided and may not be applicable.

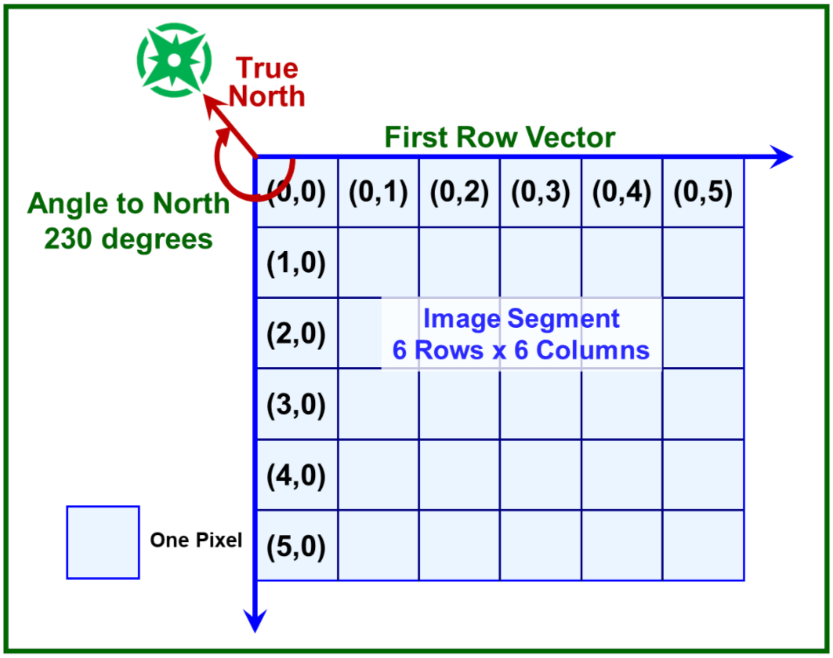

Figure AH.6-1: Angle-to-North Definition

AH.6.2 Common Sensor Rolling Shutter Terms (CSRLSB) TRE

The Common Sensor Rolling Shutter terms (CSRLSB) TRE provides a varying time for each pixel represented in the NITF image (Table AH.6-2). The delta times indicated in the CSRLSB TRE are with respect to the frame time indicated by the CSEXRB or MTIMSA TRE. Regardless of the TRE (CSEXRB or MTIMSA), the fields that are used to compute the frame time are REFERENCE_FRAME_NUM, BASE_TIMESTAMP, DT_MULTIPLIER, DT_SIZE, NUMBER_FRAMES, NUMBER_DT, and DTn. The timestamp of a specific frame is computed as a function of these fields using Equation (1) from Reference [12]. In the CSRLSB TRE, the delta times are provided for blocks, where the delta time is given for each of the four corners of the block.

Table AH.6-2: Common Sensor Rolling Shutter Terms (CSRLSB) TRE

(TYPE: “R” = Required, “C” = Conditional)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CETAG	**Unique Extension Identifier**. Unique TRE identifier.	6	BCS-A	CSRLSB	N/A	exact	R
CEL	**Length of User-Defined Data**. Length in bytes of data in subsequent fields. TRE length is 11 plus the CEL field value.	5	BCS-N	00052 *to* 99940	bytes	exact	R
N_RS_ROW_BLOCKS	**Blocks in Row Dimension**. This field contains the number of equally spaced blocks in the row dimension of the image.	2	BCS-N	01 *to* 99	N/A	exact	R
M_RS_COLUMN_BLOCKS	**Blocks in Column Dimension**. This field contains the number of equally spaced blocks in the column dimension of the image.	2	BCS-N	01 *to* 99	N/A	exact	R
***Start of number of blocks in row dimension loop. Loop runs from* n = 01 *to* N_RS_ROW_BLOCKS.**							
***Start of number of blocks in column dimension loop. Loop runs from* m = 01 *to* M_RS_COLUMN_BLOCKS.**							
RS_DT_1nm RS_DT_2nm RS_DT_3nm RS_DT_4nm	**Rolling Shutter Delta Time**. These fields provide the rolling shutter delta time with respect to the image reference time associated with the frame of interest for the 4 corners of block nm, with RS_DT_1: Upper-left corner RS_DT_2: Upper-right corner RS_DT_3: Lower-right corner RS_DT_4: Lower-left corner. The number of digits before and after the decimal point may change, i.e., the decimal point may float, as long as all 12 bytes are specified. For example, if the value is 15.4, then the formatted field value may be “+15.40000000”, “+000000015.4”, “+00015.40000”, or some other variant. However, the data provider should place the radix so that the number of digits after the decimal point represents the precision of the provided value. Therefore, if the precision of the measurement is to the second decimal place, then the appropriate value is “+00000015.40”.	12	BCS-N	-9999999999. *to* +9999999999. *floating decimal point permitted*	milli-seconds	varies	R
End of number of blocks in column dimension loop.							
End of number of blocks in row dimension loop.							

AH.6.3 Common Sensor Warping Terms (CSWRPB) TRE

The Common Sensor Warping terms (CSWRPB) TRE accommodates the general case of a scanner when samples along a line of an image were not all imaged at the same time (Table AH.6-3). For a framer, the CSWRPB TRE can model the effects of optical distortion in the image, pair-wise rectifying it to aid in stereo viewing, or image stabilization. This TRE provides the de-warping information needed to handle these situations.

For products where time increases with increasing or decreasing column (sample) coordinate, contrasted with the usual case where time increases with row (line) coordinate, the CSWRPB TRE shall be populated with values that induce a 90 degree rotation so that the resultant first row (line) is associated with TIME_FIRST_LINE_IMAGE.

Table AH.6-3: Common Sensor Warping Terms (CSWRPB) TRE

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CETAG	**Unique Extension Identifier**. Unique TRE identifier.	6	BCS-A	CSWRPB	N/A	exact	R
CEL	**Length of User-Defined Data**. Length in bytes of data in subsequent fields. TRE length is 11 plus the CEL field value.	5	BCS-N	0069 *to* 99985	bytes	exact	R
NUM_SETS_WARP_DATA	**Number of Sets of Warping Data**. This field contains the number of sets of warping data in this instance of the CSWRPB TRE. If the sensor is a scanner, there shall be one set of warping data.	1	BCS-N	1 *to* 9	N/A	exact	R
SENSOR_TYPE	**Sensor Type**. This field shall identify the type of sensor that collected the image.	1	BCS-A	S *(for line scanner)* F *(for framing array)*	N/A	exact	R
If (SENSOR_TYPE = F), *then include the WRP_INTERP field; otherwise this field is omitted*.							
WRP_INTERP	**Warping Interpolation Type**. This field shall identify the type of warping interpolation between sets of corrections calculated by evaluating the warping polynomials, with a value of 0 for nearest neighbor and a value of 1 for linear.	1	BCS-N	0 *(for nearest neighbor)* 1 *(for linear)*	N/A	exact	C
***Start of number of sets of warping data loop. Loop runs from* n = 1 *to* NUM_SETS_WARP_DATA.**							
***If* (SENSOR_TYPE = F), *then the following fields are contained in this instance of the* CSWRPB TRE.**							
FL_WARPn	**Focal Length Associated with the n^th^ Set of Warping Data**.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	C
End of the* (SENSOR_TYPE = F) *conditional.							
OFFSET_LINEn	**Line Coordinate Normalization Offset**. This field contains the offset for normalization of the line coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	rows	exact	C

Table AH.6-3: Common Sensor Warping Terms (CSWRPB) TRE

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
OFFSET_SAMPn	**Sample Coordinate Normalization Offset**. This field contains the offset for normalization of the sample coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	columns	exact	C
SCALE_LINEn	**Line Coordinate Normalization Scale**. This field contains the scale for normalization of the line coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	rows	exact	C
SCALE_SAMPn	**Sample Coordinate Normalization Scale**. This field contains the scale for normalization of the sample coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	columns	exact	C
OFFSET_LINE_ UNWRPn	**Unwarped Line Coordinate Normalization Offset**. This field contains the offset for normalization of the line coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	rows	exact	C
OFFSET_SAMP_ UNWRPn	**Unwarped Sample Coordinate Normalization Offset**. This field contains the offset for normalization of the sample coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	columns	exact	C
SCALE_LINE_ UNWRPn	**Unwarped Line Coordinate Normalization Scale**. This field contains the scale for normalization of the line coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	rows	exact	C
SCALE_SAMP_ UNWRPn	**Unwarped Sample Coordinate Normalization Scale**. This field contains the scale for normalization of the sample coordinate for the n^{th} set of warping data.	7	BCS-N	0000001 *to* 9999999	columns	exact	C
LINE_POLY_ ORDER_M1n	**Order of the Line De-Warping Polynomial Term Associated with Line Dependency** for the n^{th} set of warping data.	1	BCS-N	0 *to* 9	N/A	exact	C
LINE_POLY_ ORDER_M2n	**Order of the Line De-Warping Polynomial Term Associated with Sample Dependency** for the n^{th} set of warping data.	1	BCS-N	0 *to* 9	N/A	exact	C
SAMP_POLY_ ORDER_N1n	**Order of the Sample De-Warping Polynomial Term Associated with Line Dependency** for the n^{th} set of warping data.	1	BCS-N	0 *to* 9	N/A	exact	C
SAMP_POLY_ ORDER_N2n	**Order of the Sample De-Warping Polynomial Term Associated with Sample Dependency** for the n^{th} set of warping data.	1	BCS-N	0 *to* 9	N/A	exact	C
***Start of Number of Line Polynomial* M2 *Values loop. Loop runs from* j = 0 *to* LINE_POLY_ORDER_M2n.**							
***Start of Number of Line Polynomial* M1 *Values loop. Loop runs from* i = 0 *to* LINE_POLY_ORDER_M1n.**							

Table AH.6-3: Common Sensor Warping Terms (CSWRPB) TRE

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
Anji	**Line De-Warping Polynomial Coefficient of Order (i,j)**. This field contains the coefficient of (i,j) order for the line de-warping polynomial associated with the n^{th} set of warping data.	21	BCS-A	-9.99999999999999E±99 *to* +9.99999999999999E±99	N/A	varies	C
End of number of line polynomial* M1 *values loop.							
End of number of line polynomial* M2 *values loop.							
***Start of number of sample polynomial* N2 *values loop. Loop runs from* j = 0 *to* SAMP_POLY_ORDER_N2n.**							
***Start of number of sample polynomial* N1 *values loop. Loop runs from* i = 0 *to* SAMP_POLY_ORDER_N1n.**							
Bnji	**Sample De-Warping Polynomial Coefficient of Order (i,j)**. This field contains the coefficient of (i,j) order for the sample de-warping polynomial associated with the n^{th} set of warping data.	21	BCS-A	-9.99999999999999E±99 *to* +9.99999999999999E±99	N/A	varies	C
End of number of sample polynomial* N1 *values loop.							
End of number of sample polynomial* N2 *values loop.							
End of number of sets of warping data loop.							
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "00000".	5	BCS-N	00000	bytes	exact	R
RESERVED	**Reserved Field.** Reserved for future use.	†	††	*omit*	N/A	N/A	C

† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

†† The RESERVED field does not necessarily have a single data type, since the RESERVED field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

AH.6.4 Common Sensor Attitude Data (CSATTB) DES

The Common Sensor Attitude data (CSATTB) DES (Table AH.6-4) provides chronologically-ordered sensor attitude information needed to run the rigorous sensor model that performs geolocation and mensuration. Quaternion data provided in this DES are used to construct an orthogonal rotation matrix that transforms a line-of-sight vector from the sensor frame to the object (ECF or ECI) frame. This DES is used in conjunction with the other GLAS/GFM SDEs.

There are two versions of the CSATTB DES. In both versions, the ECI_ECF_ATT field designates whether attitude vectors are in ECI (value = 0) or ECF (value = 1) coordinates. In version 1, if ECI is designated, then no ECI-to-ECF transformation information is provided, the DT_ATT field immediately follows the ECI_ECF_ATT field, and MSP cannot mensurate the dataset. In version 2, however, if the ECI_ECF_ATT field value = 0 (i.e., ECI vectors), then a set of 32 required ECI-to-ECF transformation parameters immediately follows the ECI_ECF_ATT field. The reference "*Generic Linear Array Scanner (GLAS) and Generic Frame-sequence Model (GFM) Geometry Model Document*" provides the equations as a function of these parameters. Although both DES versions are valid, version 2 is strongly recommended when the ECI_ECF_ATT = 0 (ECI). If ECI_ECF_ATT = 1 (i.e., ECF vectors), then the logic is the same for both versions 1 and 2 because ECI-to-ECF transformation parameters are not needed and thus not present in the DES.

Note that MSP's GLAS/GFM model disables error propagation by setting the number of adjustable parameters to zero if QUAL_FLAG_ATT = 0 (suspect data). Values of (1) ECI_ECF_ATT = 0 (ECI) in CSATTB DES version 1, or (2) INTERP_TYPE_ATT = 3 (spherical) in either DES version are not supported by all MSP versions that claim GLAS/GFM conformance. Data providers who use these options, and whose consumers rely on MSP for georeferencing and mensuration functions, must ensure that those consumers have access to a suitable version of MSP within their toolset.

Table AH.6-4: Common Sensor Attitude Data (CSATTB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DE	**File Part Type**. This field shall contain the characters "DE".	2	BCS-A	DE	N/A	exact	R
DESID	**Unique DES Type Identifier**. This field shall contain a valid identifier properly registered with the GWG NTB.	25	BCS-A	CSATTB	N/A	exact	R
DESVER	**Version of the Data Definition**. This field shall contain the version number of the use of the DES.	2	BCS-N	01, 02	N/A	exact	R
DESCLAS to DESCTLN	**DES Security Metadata.** Security classification metadata.	167	ECS-A	*populate in accordance with MIL-STD-2500C*	N/A	exact	R
DESSHL	**DES User-Defined Subheader Length**. This field contains the number of bytes in the user-defined subheader.	4	BCS-N	0046 *to* 9999	bytes	exact	R
UUID	**Assigned UUID for the DES**. This UUID refers to the entire DES, i.e., both the subheader and the data portions of the DES.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	R

Table AH.6-4: Common Sensor Attitude Data (CSATTB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
NUMAIS	**Number of Associated Image Segments**. This field provides the number of image segments associated with this DES. If NUMAIS = ALL, the DES is associated with all image segments in the NITF dataset, and field AISDLVLn is omitted. Otherwise, NUMAIS is between 1 and 998 (999 is covered by "ALL") and is no more than the number of image segments in the dataset.	3	BCS-A	001 *to* 998, *or* ALL	N/A	exact	R
Start of number of associated image segments loop. Loop runs from **n = 1** ***to*** **NUMAIS.** ***Loop is omitted if*** **NUMAIS = ALL.**							
AISDLVLn	**nth Associated Image Segment Display Level**. This field provides the Image Display Level (IDLVL) of each image segment associated with this DES. AISDLVLn shall correspond to IDLVL values of image segments in the same dataset. If NUMAIS = ALL, this field is omitted.	3	BCS-N	001 *to* 999	N/A	exact	C
End of number of associated image segments loop.							
NUM_ASSOC_ELEM	**Number of Associated Elements**. This field contains the number of elements associated with this DES. For Level 1 and 2 conformance, this list shall include the IMAGE_UUID from the CSEXRB TRE for all images associated with this DES, as well as the UUIDs of any other elements that are authoritatively associated with this DES.	3	BCS-N	000 *to* 276	N/A	exact	R
If **NUM_ASSOC_ELEM > 0*****, start of number of associated elements loop. Loop runs from*** **n = 1** ***to*** **NUM_ASSOC_ELEM*****. Otherwise omit.***							
ASSOC_ELEM_UUIDn	**UUID of the nth Associated Element**. This field contains the UUID of the nth element associated with this DES. The type of associated element is unrestricted.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	C
End of number of associated elements loop.							
RESERVEDSUBH_LEN	**Length of Reserved Subheader Field**. This field value shall be "0000".	4	BCS-N	0000	bytes	exact	R
RESERVEDSUBH	**Reserved Subheader Field**. Reserved for future use.	†	††	*omit*	N/A	N/A	C
Beginning of the **DESDATA** ***portion of the*** **CSATTB DES.**							
QUAL_FLAG_ATT	**Attitude Data Quality Flag**. This field indicates the quality of the provided attitude data.	1	BCS-N	0 *(suspect data)* 1 *(good data)*	N/A	exact	R
INTERP_TYPE_ATT	**Interpolation Type**. This field identifies the type of interpolation recommended for the end user.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)* 2 *(Lagrangian)* 3 *(spherical)*	N/A	exact	R

Table AH.6-4: Common Sensor Attitude Data (CSATTB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
If **(INTERP_TYPE_ATT = 2 *or* 3), *then the following field is provided; otherwise the field is omitted*.**							
INTERP_ORDER_ATT	**Order of Interpolation Polynomial**. This field indicates the order of the interpolation polynomials recommended for the end user. If INTERP_TYPE_ATT = 2, then INTERP_ORDER_ATT may be 3, 5, or 7 and is the Lagrangian polynomial order. If INTERP_TYPE_ATT =3, then INTERP_ORDER_ATT may be 1 or 3, with 1 indicating spherical linear interpolation, and 3 indicating spherical spline interpolation.	1	BCS-N	3, 5, 7 (INTERP_TYPE_ATT=2) 1, 3 (INTERP_TYPE_ATT=3)	N/A	exact	C
End of the **(INTERP_TYPE_ATT = 2 *or* 3) *conditional.***							
ATT_TYPE	**Attitude Type**. This field identifies the type of attitude data supplied in the DES. Refined attitude data (ATT_TYPE = 2) indicates smoothed attitude data resulting from data processing.	1	BCS-N	0 *(predicted)* 1 *(actual; time of collection)* 2 *(refined)*	N/A	exact	R
ECI_ECF_ATT	**Coordinate Reference Frame Flag**. This field identifies whether attitude data are with respect to Earth-Centered Fixed (ECF) or Earth-Centered Inertial (ECI) reference frames.	1	BCS-N	0 *(ECI)* 1 *(ECF)*	N/A	exact	R
If **[(ECI_ECF_ATT = 0) & (DESVER ≥ 02)], *then the following fields are provided; otherwise the fields are omitted*.**							
TA_POLE	**TA Pole**. This field provides the time (Julian date) associated with the polar wander parameters. *see Section AH.5.8 for formatting guidance*	19	BCS-N	2000000.00000000000 *to* 3000000.00000000000 *see Section AH.5.8 for formatting guidance*	Julian date	exact	C
A_POLE	**A Pole**. This field provides the polar wander parameter A in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
B_POLE	**B Pole**. This field provides the polar wander parameter B in arc-seconds/day.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec/day	exact	C
CJ1_POLE CJ2_POLE	**C Pole**. These fields provide the polar wander parameters CJ1 and CJ2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
DJ1_POLE DJ2_POLE	**D Pole**. These fields provide the polar wander parameters DJ1 and DJ2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
PJ1_POLE PJ2_POLE	**PJ Pole**. These fields provide the periods PJ1 and PJ2 (Julian days) associated with the polar wander parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
E_POLE	**E Pole**. This field provides the polar wander parameter E in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C

Table AH.6-4: Common Sensor Attitude Data (CSATTB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
F_POLE	**F Pole**. This field provides the polar wander parameter F in arc-seconds/day.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec/day	exact	C
GK1_POLE GK2_POLE	**GK Pole**. These fields provide the polar wander parameters GK1 and GK2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
HK1_POLE HK2_POLE	**HK Pole**. These fields provide the polar wander parameters HK1 and HK2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
PK1_POLE PK2_POLE	**PK Pole**. These fields provide the periods PK1 and PK2 (Julian days) associated with the polar wander parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
TB_UT	**TB UT**. This field provides the time (Julian date) associated with the universal time (UT) parameters.	19	BCS-N	2000000.00000000000 *to* 3000000.00000000000 *see Section AH.5.8 for formatting guidance*	Julian date	exact	C
I_UT	**I UT**. This field provides the UT parameter I in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	C
J_UT	**J UT**. This field provides the UT parameter J in seconds/day.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds /day	exact	C
KN1_UT KN2_UT KN3_UT KN4_UT	**K UT**. These fields provide the UT parameters KN1, KN2, KN3, and KN4 in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	C
LN1_UT LN2_UT LN3_UT LN4_UT	**L UT**. These fields provide the UT parameters LN1, LN2, LN3, and LN4 in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	C
PN1_UT PN2_UT PN3_UT PN4_UT	**P UT**. These fields provide the periods PN1, PN2, PN3, and PN4 in (Julian days) associated with the UT parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
End of the* [(ECI_ECF_ATT = 0) & (DESVER ≥ 02)] *conditional.							

Table AH.6-4: Common Sensor Attitude Data (CSATTB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DT_ATT	**Time Between Attitude Reference Points**. This field contains the time interval between chronologically ordered consecutive attitude reference points. The time of any attitude reference point, *k*, is: $t_k = TO\_ATT + (k-1) \times DT\_ATT$ for *k* = 1, …, NUM_ATT quaternions.	13	BCS-N	000.000000001 *to* 999.999999999	seconds	varies	R
DATE_ATT	**Date of First Attitude Reference Point**. This field contains the date of the first attitude reference point formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	R
T0_ATT	**Time Stamp of First Attitude Reference Point**. This field contains the time stamp of the first attitude reference point formatted as hhmmss.nnnnnnnnn.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	R
NUM_ATT	**Number of Attitude Reference Points**. This field contains the number of attitude reference points throughout the scan interval.	5	BCS-N	00001 *to* 99999	N/A	exact	R
***Start of number of attitude reference points loop. Loop runs from* n = 1 *to* NUM_ATT.**							
Q1n Q2n Q3n Q4n	**Quaternions 1, 2, 3, and 4 of the n^th^ Attitude Reference Point**. These fields contain the attitude quaternion components Q1 through Q4, in either the ECI or ECF reference frame, depending upon the value of ECI_ECF_ATT, for the n^th^ attitude reference point, listed in chronological order. Angular offsets from the CSSFAB DES need to be applied to the Q*n* values to generate sensor frame attitude. If angular offsets are zero, then these quaternions define the sensor frame attitude.	18	BCS-N	-1.000000000000000 *to* +1.000000000000000	N/A	varies	C
End of number of attitude reference points loop.							
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "000000000".	9	BCS-N	000000000	bytes	exact	R
RESERVED	**Reserved Field**. Reserved for future use.	†††	††	*omit*	N/A	N/A	C

† The size in bytes of the RESERVEDSUBH field equals the value of the preceding RESERVEDSUBH_LEN field.

†† The RESERVEDSUBH and RESERVED fields do not necessarily have a single data type, since each field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

††† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

AH.6.5 Common Sensor Covariance Support Data (CSCSDB) DES

The Common Sensor Covariance Support Data (CSCSDB) DES (Table AH.6-5) provides the stochastic modeled sensor errors and the unmodeled sensor errors for the optical dataset.

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DE	**File Part Type**. This field shall contain the characters "DE".	2	BCS-A	DE	N/A	exact	R
DESID	**Unique DES Type Identifier**. This field shall contain a valid identifier properly registered with the GWG NTB.	25	BCS-A	CSCSDB	N/A	exact	R
DESVER	**Version of the Data Definition**. This field shall contain the version number of the use of the DES.	2	BCS-N	01	N/A	exact	R
DESCLAS to DESCTLN	**DES Security Metadata.** Security classification metadata.	167	ECS-A	*populate in accordance with MIL-STD-2500C*	N/A	exact	R
DESSHL	**DES User-Defined Subheader Length**. This field contains the number of bytes in the user-defined subheader.	4	BCS-N	0046 *to* 9999	bytes	exact	R
UUID	**Assigned UUID for the DES**. This UUID refers to the entire DES, i.e., both the subheader and the data portions of the DES.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	R
NUMAIS	**Number of Associated Image Segments**. This field provides the number of image segments associated with this DES. If NUMAIS = ALL, the DES is associated with all image segments in the NITF dataset, and field AISDLVLn is omitted. Otherwise, NUMAIS is between 1 and 998 (999 is covered by "ALL") and is no more than the number of image segments in the dataset.	3	BCS-A	001 *to* 998, *or* ALL	N/A	exact	R
***Start of number of associated image segments loop. Loop runs from* n = 1 *to* NUMAIS. *Loop is omitted if* NUMAIS = ALL.**							
AISDLVLn	**n^th Associated Image Segment Display Level**. This field provides the Image Display Level (IDLVL) of each image segment associated with this DES. AISDLVLn shall correspond to IDLVL values of image segments in the same dataset. If NUMAIS = ALL, this field is omitted.	3	BCS-N	001 *to* 999	N/A	exact	C
End of number of associated image segments loop.							
NUM_ASSOC_ELEM	**Number of Associated Elements**. This field contains the number of elements associated with this DES. For Level 1 and 2 conformance, this list shall include the IMAGE_UUID from the CSEXRB TRE for all	3	BCS-N	000 *to* 276	N/A	exact	R

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: “R” = Required, “C” = Conditional. “†” Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	images associated with this DES, as well as the UUIDs of any other elements that are authoritatively associated with this DES.						
***Start of number of associated elements loop. Loop runs from* n = 1 *to* NUM_ASSOC_ELEM.**							
ASSOC_ELEM_ UUIDn	**UUID of the n^{th} Associated Element**. This field contains the UUID of the n^{th} element associated with this DES. The type of associated element is unrestricted.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	C
End of number of associated elements loop.							
RESERVEDSUBH_ LEN	**Length of Reserved Subheader Field**. This field value shall be “0000”.	4	BCS-N	0000	bytes	exact	R
RESERVEDSUBH	**Reserved Subheader Field**. Reserved for future use.	†	††	*omit*	N/A	N/A	C
***Beginning of the* DESDATA *portion of the* CSCSDB DES.**							
COV_VERSION_ DATE	**Covariance Version Date**. This field contains the date of the version of the covariance implementation. For a given covariance version date, the fields CORE_SETS, REF_FRAME_I, NUM_GROUPS, and NUM_ADJ_PARAM are constant, i.e., if two images have the same COV_VERSION_DATE, these fields will be the same in both images.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	R
CORE_SETS	**Number of Core Sets** reported in this DES.	1	BCS-N	0 *to* 6	N/A	exact	R
***Start of number of core sets loop. Loop runs from* n = 1 *to* CORE_SETS.**							
REF_FRAME_ POSITIONn REF_FRAME_ ATTITUDEn	**Reference Frame for the Position Coordinate System and the Attitude Coordinate System of n^{th} Core Set**. These fields indicate the reference frame used for the position coordinate system and the reference frame attitude for the n^{th} Core Set.	1	BCS-N	1 *(ECF)* 2 *(Sensor Frame)* 3 *(Orbital Frame)* 4 *(TCEF – Target-Centered Earth Fixed)* 5 *(ECI)* 6 *(SCEF – Sensor-Centered Earth Fixed)*	N/A	exact	C
NUM_GROUPSn	**Number of Independent Sensor Error Parameter Groups for the n^{th} Core Set**. This field provides the number of independent sensor error parameters groups associated with the n^{th} Core Set.	1	BCS-N	1 *to* 7	N/A	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***Start of number of groups loop. Loop runs from* j = 1 *to* NUM_GROUPSn.**							
CORR_REF_ DATEnj	**Date of Last De-Correlation Event for jth CPG of nth Core Set**. This field reports the date of the last de-correlation event for this CPG. The date is formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIMEnj	**Time Stamp of Last De-Correlation Event for jth CPG of nth Core Set**. This field contains the time stamp of the last de-correlation event for this CPG formatted as hhmmss.nnnnnnnnn.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
NUM_ADJ_ PARMnj	**Number of Adjustable Parameters in jth CPG of nth Core Set**. This field contains the number of adjustable sensor parameters in the jth CPG of the nth core set. This value represents the number of sensor parameters for which the covariance data in this group applies.	1	BCS-N	1 *to* 7	N/A	exact	C
***Start of number of adjustable sensor parameters loop. Loop runs from* k = 1 *to* NUM_ADJ_PARMnj.**							
ADJ_PARM_IDnjk	**Identity of the kth Fundamental Adjustable Parameter**. This field identifies the kth fundamental adjustable parameter for which the covariance data in this CPG apply. Sensor position x, y, and z parameters are in units of meters-squared. Sensor attitude parameters are in units of radians-squared, with ω defined as the rotation about x, ϕ as the rotation about y, and κ as the rotation about z. Focal length parameters are in units of meters-squared.	1	BCS-N	1 = *sensor position* x 2 = *sensor position* y 3 = *sensor position* z 4 = *sensor attitude* ω 5 = *sensor attitude* ϕ 6 = *sensor attitude* κ 7 = *focal length*	m^2 m^2 m^2 rad^2 rad^2 rad^2 m^2	exact	C
End of number of adjustable sensor parameters loop.							
BASIC_SUB_ ALLOCnj	**Sub-Allocation Flag of Fundamental Adjustable Parameters in jth CPG to Basic Adjustable Parameters**. This field indicates whether the Fundamental Adjustable Parameters of the jth CPG are sub-allocated to Basic Adjustable Parameters.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (BASIC_SUB_ALLOCnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
***Start of error covariance elements loop. Loop runs from* k = 1 *to* (0.5·NUM_ADJ_PARM) × (NUM_ADJ_PARM + 1).**							
ERRCOV_C1njk	**Individual Error Covariance Terms Within jth CPG**. This field contains the kth individual error covariance terms within the jth CPG. ERRCOV_C1 terms represent the upper triangular portion of the error covariance (cross-covariance at τ = 0) for the current image's jth CPG. E.g., if NUM_ADJ_PARM = 3, then ERRCOV_C1 is a 3 ×3	21	BCS-A	-9.99999999999999E±99 *to* +9.99999999999999E±99	N/A	varies	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	matrix and the elements supplied, in order, are: C1(1,1), C1(1,2), C1(1,3), C1(2,2), C1(2,3), and C1(3,3). Units vary. If ADJ_PARM_ID = 1, 2, 3, or 7, units are meters-squared. If ADJ_PARM_ID = 4, 5, or 6, units are radians-squared. Given dimension n_3 = NUM_ADJ_PARM, there are $0.5 \cdot n_3 \cdot (n_3 + 1)$ elements supplied.						
End of error covariance elements loop.							
BASIC_PF_FLAGnj	**Flag Indicating if SPDCF of Type "PF" is Provided for j^th^ CPG**. This field indicates whether a platform type SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (BASIC_PF_FLAGnj = 1), *then the following fields are provided in this instance of the* CSCSDB DES.**							
NUM_BASIC_PFnj	**Number of Platform Type SPDCFs Provided for j^th^ Group**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of platform type* SPDCF *loop. Loop runs from* k = 1 *to* NUM_BASIC_PFnj.**							
BASIC_PF_ SPDCFnjk	**Identifier of the k^th^ Basic SPDCF of Platform Type for j^th^ CPG**. This field identifies the k^th^ SPDCF to use for the j^th^ CPG and other image products collected by the same platform, different payload, and different sensor as defined by fields in a related CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
NUM_PAIRINGS_ BASIC_PFnjk	**Number of Sensor Pairings to Which the k^th^ SPDCF Applies**. This field provides the number of sensor pairings (sensor associated with this image and other sensor on this platform) to which this SPDCF applies.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of sensor pairings loop. Loop runs from* p = 1 *to* NUM_PAIRINGS_BASIC_PFnjk.**							
BASIC_PF_SPDCF _SENSORnkjp	**Identifier of Other Sensor to Which This SPDCF Applies**. This field contains the p^th^ sensor identifier from a related CSEXRB TRE SENSOR_ID field to which this SPDCF applies (i.e., defines a correlation). A value of "ALL" means that this SPDCF applies to all sensor pairings.	6	BCS-A	*a valid sensor ID from a related* CSEXRB *TRE* SENSOR_ID *field, or* ALL	N/A	exact	C
End of number of sensor pairings loop.							
End of number of platform type* SPDCF *loop.							
End of the* (BASIC_PF_FLAGnj = 1) *conditional.							
BASIC_PL_FLAGnj	**Flag Indicating if SPDCF of Type "PL" is Provided for j^th^ CPG**. This field indicates whether a payload type SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
IF (BASIC_PL_FLAGnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.							
NUM_BASIC_PLnj	**Number of Payload Type SPDCFs Provided for j^th^ CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***Start of number of payload type* SPDCF *loop. Loop runs from* k = 1 *to* NUM_BASIC_PLnj.**							
BASIC_PL_ SPDCFnjk	**Identifier of the k^th Basic SPDCF of Payload Type for j^th CPG**. This field identifies the k^th SPDCF to use for the j^th CPG and other image products collected by the same platform, same payload, and different sensor as defined by fields in a relating CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
NUM_PAIRINGS_ BASIC_PLnjk	**Number of Sensor Pairings to Which the k^th SPDCF of Payload Type Applies**. This field provides the number of sensor pairings (sensor associated with this image and other sensor on this payload) to which this SPDCF applies.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of sensor pairings loop. Loop runs from* p = 1 *to* NUM_PAIRINGS_BASIC_PLnjk.**							
BASIC_PL_SPDCF _SENSORnkjp	**Identifier of Other Sensor to Which This SPDCF Applies**. This field contains the p^th sensor identifier from a related CSEXRB TRE SENSOR_ID field which identifies another sensor to which this SPDCF applies (i.e., defines a correlation). A value of "ALL" here means that this SPDCF applies to all sensor pairings.	6	BCS-A	*a valid sensor ID from a related* CSEXRB *TRE* SENSOR_ID *field, or* ALL	N/A	exact	C
End of number of sensor pairings loop.							
End of number of payload type* SPDCF *loop.							
End of the* (BASIC_PL_FLAGnj = 1) *conditional.							
BASIC_SR_FLAGnj	**Flag Indicating if SPDCF of Type "SR" is Provided for j^th CPG**. This field indicates whether a sensor type SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (BASIC_SR_FLAGnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
BASIC_SR_ SPDCFnj	**Identifier of the Basic SPDCF of Sensor Type for j^th CPG**. This field identifies the SPDCF to use for the j^th CPG and other image products collected by the same platform, payload, and sensor as defined by fields in a related CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
End of the* (BASIC_SR_FLAGnj = 1) *conditional.							
***End of the* (BASIC_SUB_ALLOCnj = 1) *conditional*.**							
POST_SUB_ ALLOCnj	**Flag Indicating Sub-Allocation to Correction Posts for j^th CPG**. This field indicates if fundamental adjustable parameters in the j^th group are sub-allocated to correction posts.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (POST_SUB_ALLOCnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
POST_START_ DATEnj	**Date of the First Post** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
POST_START_ TIMEnj	**Time of the First Post**. This field contains the time of the first post, on the POST_START_DATEnj date, reported as the number of seconds elapsed from midnight. Note that this field does not support leap seconds.	15	BCS-N	00000.000000000 *to* 86399.999999999	seconds	varies	C
POST_DTnj	**Time Between Consecutive Posts**.	13	BCS-N	000.000000000 *to* 999.999999999	seconds	varies	C
NUM_POSTSnj	**Number of Posts**.	3	BCS-N	002 *to* 999	N/A	exact	C
COMMON_ POSTS_COVnj	**Common Correction Posts Error Covariance Flag**. This field indicates if the same covariance is to be applied at all posts.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (COMMON_POSTS_COVnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
***Start of error covariance elements loop. Loop runs from* k = 1 *to* (0.5*NUM_ADJ_PARM)*(NUM_ADJ_PARM + 1).**							
ERRCOV_C2njk	**Individual Error Covariance Terms Within j^{th} CPG**. This field contains the k^{th} individual error covariance term within the j^{th} CPG. ERRCOV_C2 terms represent the upper triangular portion of the error covariance (cross-covariance at $\tau = 0$) for the current image's j^{th} CPG. E.g., if NUM_ADJ_PARM = 3, then ERRCOV_C2 is a 3 ×3 matrix and the elements supplied, in order, are: C2(1,1), C2(1,2), C2(1,3), C2(2,2), C2(2,3), and C2(3,3). Units vary. If ADJ_PARM_ID = 1, 2, 3, or 7, units are meters-squared. If ADJ_PARM_ID = 4, 5, or 6, units are radians-squared. Given dimension n_3 = NUM_ADJ_PARM, there are $0.5 \cdot n_3 \cdot (n_3 + 1)$ elements supplied.	21	BCS-A	-9.99999999999999E±99 *to* +9.99999999999999E±99	N/A	depends on ADJ_PARM _ID value	C
End of error covariance elements loop.							
***End of the* (COMMON_POSTS_COVnj = 1) *conditional*.**							
***If* (COMMON_POSTS_COVnj = 0), *then the following fields are contained in this instance of the* CSCSDB DES.**							
***Start of number of posts loop. Loop runs from* k = 1 *to* NUM_POSTSnj.**							
***Start of error covariance elements loop. Loop runs from* p = 1 *to* (0.5·NUM_ADJ_PARM) × (NUM_ADJ_PARM + 1).**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
ERRCOV_C2njkp	**Individual Error Covariance Terms for the kth Post Within jth CPG**. This field contains the pth individual error covariance term associated with the kth post within the jth CPG. ERRCOV_C2 terms represent the upper triangular portion of the error covariance (cross-covariance at $\tau = 0$) for the current image's jth CPG. E.g., if NUM_ADJ_PARM = 3, then ERRCOV_C2 is a 3 ×3 matrix and the elements supplied, in order, are: C2(1,1), C2(1,2), C2(1,3), C2(2,2), C2(2,3), and C2(3,3). Units vary. If ADJ_PARM_ID = 1, 2, 3, or 7, units are meters-squared. If ADJ_PARM_ID = 4, 5, or 6, units are radians-squared. Given dimension n_3 = NUM_ADJ_PARM, there are $0.5 \cdot n_3 \cdot (n_3 + 1)$ elements supplied.	21	BCS-A	-9.99999999999999E±99 *to* +9.99999999999999E±99	N/A	varies	C
End of error covariance elements loop.							
End of number of posts loop.							
***End of the* (COMMON_POSTS_COVnj = 0) *conditional*.**							
POST_INTERPnj	**Post Interpolation Method**. This field identifies the method used to interpolate between posts. Future values shall be registered with the GWG NTB.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)* *or see the NTB Registry*	N/A	exact	C
POST_PF_FLAGnj	**Flag Indicating if a Post SPDCF of Type "PF" is Provided for jth CPG**. This field indicates whether a platform type post SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (POST_PF_FLAGnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_POST_PFnj	**Number of Platform Type Post SPDCFs Provided for jth CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of platform type post SPDCF loop. Loop runs from* k = 1 *to* NUM_POST_PFnj.**							
POST_PF_SPDCFnjk	**Identifier of the kth Post SPDCF of Platform Type for jth CPG**. This field identifies the kth post SPDCF to use for the jth CPG and other image products collected by the same platform, different payload, and different sensor as defined by fields in a related CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
NUM_PAIRINGS_POST_PFnjk	**Number of Sensor Pairings to Which the kth Post SPDCF of Platform Type Applies**. This field identifies the number of sensor pairings (sensor associated with this image and other sensor on this platform) to which this post SPDCF applies.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of post-related sensor pairings loop. Loop runs from* p = 1 *to* NUM_PAIRINGS_POST_PFnjk.**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
POST_PF_SPDCF_ SENSORnjkp	**Identifier of Other Sensor to Which This Post SPDCF Applies**. This field contains the pth sensor identifier from a related CSEXRB TRE SENSOR_ID field which identifies another sensor to which this post SPDCF applies (i.e., defines a correlation). A value of "ALL" means that this post SPDCF applies to all sensor pairings.	6	BCS-A	*a valid sensor ID from a related* CSEXRB *TRE* SENSOR_ID *field, or* ALL	N/A	exact	C
End of number of post-related sensor pairings loop.							
End of number of platform type Post* SPDCF *loop.							
***End of the* (POST_PF_FLAGnj = 1) *conditional*.**							
POST_PL_FLAGnj	**Flag Indicating if a Post SPDCF of Type "PL" is Provided for jth CPG**. This field indicates whether a payload type post SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***If* (POST_PL_FLAGnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_POST_PLnj	**Number of Payload Type Post SPDCF Provided for jth CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of payload type Post* SPDCF *loop. Loop runs from* k = 1 *to* NUM_POST_PLnj.**							
POST_PL_ SPDCFnjk	**Identifier of the kth Post SPDCF of Payload Type for jth CPG**. This field identifies the kth post SPDCF to use for the jth CPG and other image products collected by the same platform, same payload, and different sensor as defined by fields in a related CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
NUM_PAIRINGS_ POST_PLnjk	**Number of Sensor Pairings to Which the kth Post SPDCF of Payload Type Applies**. This field identifies the number of sensor pairings (sensor associated with this image and other sensor on this payload) to which this post SPDCF applies.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of post-related sensor pairings loop. Loop runs from* p = 1 *to* NUM_PAIRINGS_POST_PLnjk.**							
POST_PL_SPDCF_ SENSORnjkp	**Identifier of Other Sensor to Which This Post SPDCF Applies**. This field contains the pth sensor identifier from a related CSEXRB TRE SENSOR_ID field which identifies another sensor to which this post SPDCF applies (i.e., defines a correlation). A value of "ALL" means this post SPDCF applies to all sensor pairings.	6	BCS-A	*a valid sensor ID from a related* CSEXRB *TRE* SENSOR_ID *field, or* ALL	N/A	exact	C
End of number of post-related sensor pairings loop.							
End of number of payload type post* SPDCF *loop.							
***End of the* (POST_PL_FLAGnj = 1) *conditional*.**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
POST_SR_FLAGnj	**Flag Indicating if Post SPDCF of Type "SR" is Provided for jth CPG**. This field indicates whether a sensor type post SPDCF is provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
IF (POST_SR_FLAGnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.							
POST_SR_ SPDCFnj	**Identifier of the Post SPDCF of Sensor Type for jth CPG**. This field identifies the post SPDCF to use for the jth CPG and other image products collected by the same platform, same payload, and same sensor as identified by fields in a related CSEXRB TRE.	2	BCS-N	01 *to* 99	N/A	exact	C
POST_CORRnj	**Intra-Image Correlation Only Flag**. This field indicates if the post correlation SPDCF applies only within an image. This flag only applies to Sensor type post SPDCFs as Platform and Payload type post SPDCFs are assumed to apply both within an image and image-to-image.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	C
***End of the* (POST_SR_FLAGnj = 1) *conditional*.**							
***End of the* (POST_SUB_ALLOCnj = 1) *conditional*.**							
End of number of groups loop.							
End of number of core sets loop.							
IO_CAL_AP	**IO Calibration Adjustable Parameters Flag**. This field indicates whether IO calibration adjustable parameters are included.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	R
***If* (IO_CAL_AP = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_SETS_ CAL_AP	**Number of Sets of Calibration Adjustable Parameters**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of calibration adjustable parameter sets loop. Loop runs from* n = 1 *to* NUM_SETS_CAL_AP.**							
FOCAL_LENGTH_ CALn	**Focal Length Associated with nth Set of Calibration Adjustable Parameters**.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	C
End of number of calibration adjustable parameter sets loop.							
NCAL_CPG	**Number of CPGs**. This field contains the number of CPGs for the calibration adjustable parameters.	2	BCS-N	01 *to* 11	N/A	exact	C
***Start of number of CPGs loop. Loop runs from* n = 1 *to* NCAL_CPG.**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CORR_REF_ DATE_IOn	**Date of Last De-Correlation Event for nth CPG**. The date is formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_IOn	**Time of Last De-Correlation Event for nth CPG**. The time is formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
N1CALn	**Number of Calibration Adjustable Parameters in the nth CPG**.	2	BCS-N	01 *to* 11	N/A	exact	C
***Start of number of calibration adjustable parameters loop. Loop runs from* j = 01 *to* N1CALn.**							
CAL_AP_IDnj	**Calibration Adjustable Parameter Identities**. This field identifies the jth calibration adjustable parameter in the nth CPG. The parameters have a set numbering, 01 to 11, which corresponds to the ordered set {X0, Y0, K0, K1, K2, K3, P1, P2, P3, A1, A2}. Note: Units of error covariance data are millimeters squared for CAL_AP_ID values 01 to 08, 10, and 11. Error covariance data for ID 09 is unitless.	2	BCS-N	01 *(for X0)* 02 *(for Y0)* 03 *(for K0)* 04 *(for K1)* 05 *(for K2)* 06 *(for K3)* 07 *(for P1)* 08 *(for P2)* 09 *(for P3)* 10 *(for A1)* 11 *(for A2)*	mm^2 mm^2 mm^2 mm^2 mm^2 mm^2 mm^2 mm^2 N/A mm^2 mm^2	exact	C
End of the number of calibration adjustable parameters loop.							
***Start of number of calibration adjustable parameter sets loop. Loop runs from* j = 1 *to* NUM_SETS_CAL_AP.**							
***Start of error covariance elements loop. Loop runs from* k = 1 *to* (0.5*N1CALn)*(N1CALn + 1).**							
ERRCOV_C3njk	**kth Individual Calibration Adjustable Parameter Error Covariance Term Within jth Set of nth CPG**. This field contains the kth individual calibration adjustable parameter error covariance term within the jth calibration adjustable parameter set of the nth CPG. ERRCOV_C3 terms represent the upper triangular portion of the error covariance E.g., if NUM_ADJ_PARM = 3, then ERRCOV_C3 is a 3 × 3 matrix and the elements supplied, in order, are: C3(1,1), C3(1,2), C3(1,3), C3(2,2), C3(2,3), and C3(3,3).	21	BCS-A	±9.99999999999999E±99	varies	varies	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	Note 1: Given dimension n_3 = N1CALn, there are $0.5{\cdot}n_3{\cdot}(n_3+1)$ elements supplied. Units for error covariance are provided in the description of the CAL_AP_IDnj field. The order in which the sets of error data for each group is provided should be consistent with the order of FOCAL_LENGTH_CALn values provided above.						
End of error covariance elements loop.							
End of number of calibration adjustable parameter sets loop.							
CAL_INTERPn	**Interpolation Type for nth CPG**. This field contains the calibration adjustable parameter interpolation type for the nth CPG. A value of "0" indicates nearest neighbor interpolation and a value of "1" indicates linear interpolation.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)*	N/A	exact	C
SPDCF_ID_TIMEn	**SPDCF Identifier for nth CPG in the Time Dimension**.	2	BCS-N	01 *to* 99	N/A	exact	C
SPDCF_ID_FLn	**SPDCF Identifier for nth CPG in the Focal Length Dimension**.	2	BCS-N	01 *to* 99	N/A	exact	C
End of number of CPGs loop.							
End of the* (IO_CAL_AP = 1) *conditional.							
TS_CAL_AP	**Time Synch Calibration Adjustable Parameters Flag**. This field flags whether time synch calibration adjustable parameters are included.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	R
If (TS_CAL_AP = 1), *then the following fields are contained in this instance of the* CSCSDB DES.							
NUM_TS_GRP	**Time Synch Parameter Type Flag**. This field identifies the type of time synch parameters used in this CSCSDB DES. The types are: 1: One group of both position and attitude delta time adjustable parameters. There is no focal length time adjustable parameter. 2: Two groups, one for each position and attitude. There is no focal length time adjustable parameter. 3: One group of position, attitude, and focal length delta time adjustable parameters. 4: Two groups: one containing position and attitude, and one containing focal length delta time adjustable parameters. 5: Three groups: one for position, one for attitude, and one for focal length delta time adjustable parameters.	1	BCS-N	1 *(one group; pos. & att.)* 2 *(two groups; one for pos., one for att.)* 3 *(one group; pos., att., & focal length)* 4 *(two groups; one for pos. & att., and one for focal length)* 5 *(three groups; pos., att., focal length)*	N/A	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***If* (NUM_TS_GRP = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
CORR_REF_ DATE_TS	**<u>Date of Last De-Correlation Event for this Type 1 Time Synch CPG</u>** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TS	**<u>Time of Last De-Correlation Event for this Type 1 Time Synch CPG</u>** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TSRR TSRC TSCC	**<u>Time Sync Covariance Elements</u>**. These fields contain the three elements of the upper triangular portion of the 2 × 2 Time Synch Calibration Error Covariance matrix, where TSRR: Element (1,1), i.e., the first element TSRC: Element (1,2), i.e., the second element TSCC: Element (2,2), i.e., the third element	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_SPDCF	**<u>SPDCF Identifier for this Type 1 Time Synch CPG</u>**.	2	BCS-N	01 *to* 99	N/A	exact	C
***End of the* (NUM_TS_GRP = 1) *conditional*.**							
***If* (NUM_TS_GRP = 2), *then the following fields are contained in this instance of the* CSCSDB DES.**							
CORR_REF_ DATE_TSP	**<u>Date of Last De-Correlation Event for this Type 2 Time Synch Position CPG</u>** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSP	**<u>Time of Last De-Correlation Event for this Type 2 Time Synch Position CPG</u>** formatted as hhmmss.nnnnnnnnn.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_POS_COV	**<u>Type 2 Time Sync Position Adjustable Parameter Covariance</u>**. This field contains the time synch position calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_POS_SPDCF	**<u>SPDCF Identifier for this Type 2 Time Synch Position CPG</u>**.	2	BCS-N	01 *to* 99	N/A	exact	C
CORR_REF_ DATE_TSA	**<u>Date of Last De-Correlation Event for this Type 2 Time Synch Attitude CPG</u>** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CORR_REF_ TIME_TSA	**Time of Last De-Correlation Event for this Type 2 Time Synch Attitude CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_ATT_COV	**Type 2 Time Sync Attitude Adjustable Parameter Covariance**. This field contains the time synch attitude calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_ATT_SPDCF	**SPDCF Identifier for this Type 2 Time Synch Attitude CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
***End of the* (NUM_TS_GRP = 2) *conditional*.**							
***If* (NUM_TS_GRP = 3), *then the following fields are contained in this instance of the* CSCSDB DES.**							
CORR_REF_ DATE_TS	**Date of Last De-Correlation Event for this Type 3 Time Synch CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TS	**Time of Last De-Correlation Event for this Type 3 Time Synch CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_POS_COV	**Type 3 Time Sync Position Adjustable Parameter Covariance**. This field contains the time synch position calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_POS_ATT_ COV	**Type 3 Time Sync Covariance Parameter Between Position and Attitude Adjustable Parameter**. This field contains the time synch covariance parameter between position and attitude adjustable parameter value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_POS_FL_COV	**Type 3 Time Sync Covariance Parameter Between Position and Focal Length Adjustable Parameter**. This field contains the time synch covariance parameter between position and focal length adjustable parameter value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_ATT_COV	**Type 3 Time Sync Attitude Adjustable Parameter Covariance**. This field contains the time synch attitude calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_ATT_FL_COV	**Type 3 Time Sync Covariance Parameter Between Attitude and Focal Length Adjustable Parameter**. This field contains the time	21	BCS-A	±9.99999999999999E±99	s^2	varies	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	synch covariance parameter between attitude and focal length adjustable parameter value.						
TS_FL_COV	**Type 3 Time Sync Focal Length Adjustable Parameter Covariance**. This field contains the time synch focal length calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_SPDCF	**SPDCF Identifier for this Type 3 Time Synch CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
End of the **(NUM_TS_GRP = 3)** ***conditional.***							
If **(NUM_TS_GRP = 4),** ***then the following fields are contained in this instance of the*** **CSCSDB DES.**							
CORR_REF_ DATE_TSPA	**Date of Last De-Correlation Event for this Type 4 Time Synch Position and Attitude CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSPA	**Time of Last De-Correlation Event for this Type 4 Time Synch Position and Attitude CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_POS_COV	**Type 4 Time Sync Position Adjustable Parameter Covariance**. This field contains the time synch position calibration error covariance value. This value represents the first element, (1,1), of the upper triangular portion of the 2 × 2 Time Synch Calibration Error Covariance matrix.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_POS_ATT_ COV	**Type 4 Time Sync Covariance Parameter Between Position and Attitude Adjustable Parameter**. This field contains the time synch covariance parameter between position and attitude adjustable parameter value. This value represents the second element, (1,2), of the upper triangular portion of the 2 × 2 Time Synch Calibration Error Covariance matrix.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_ATT_COV	**Type 4 Time Sync Attitude Adjustable Parameter Covariance**. This field contains the time synch attitude calibration error covariance value. This value represents the third and final element, (2,2), of the upper triangular portion of the 2 × 2 Time Synch Calibration Error Covariance matrix.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_PA_SPDCF	**SPDCF Identifier for this Type 4 Time Synch Position and Attitude CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CORR_REF_ DATE_TSFL	**Date of Last De-Correlation Event for this Type 4 Time Synch Focal Length CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSFL	**Time of Last De-Correlation Event for this Type 4 Time Synch Focal Length CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_FL_COV	**Type 4 Time Sync Focal Length Adjustable Parameter Covariance**. This field contains the time synch focal length calibration error covariance value.	21	BCS-A	±9.9999999999999E±99	s^2	varies	C
TS_FL_SPDCF	**SPDCF Identifier for this Type 4 Time Synch Focal Length CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
***End of the* (NUM_TS_GRP = 4) *conditional*.**							
***If* (NUM_TS_GRP = 5), *then the following fields are contained in this instance of the* CSCSDB DES.**							
CORR_REF_ DATE_TSP	**Date of Last De-Correlation Event for this Type 5 Time Synch Position CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSP	**Time of Last De-Correlation Event for this Type 5 Time Synch Position CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_POS_COV	**Type 5 Time Sync Position Adjustable Parameter Covariance**. This field contains the time synch position calibration error covariance value.	21	BCS-A	±9.9999999999999E±99	s^2	varies	C
TS_POS_SPDCF	**SPDCF Identifier for this Type 5 Time Synch Position CPG**.	2	BCS-N	01 *to* 99	N/A	varies	C
CORR_REF_ DATE_TSA	**Date of Last De-Correlation Event for this Type 5 Time Synch Attitude CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSA	**Time of Last De-Correlation Event for this Type 5 Time Synch Attitude CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_ATT_COV	**Type 5 Time Sync Attitude Adjustable Parameter Covariance**. This field contains the time synch attitude calibration error covariance.	21	BCS-A	±9.9999999999999E±99	s^2	varies	C
TS_ATT_SPDCF	**SPDCF Identifier for this Type 5 Time Synch Attitude CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
CORR_REF_ DATE_TSFL	**Date of Last De-Correlation Event for this Type 5 Time Synch Focal Length CPG** formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
CORR_REF_ TIME_TSFL	**Time of Last De-Correlation Event for this Type 5 Time Synch Focal Length CPG** formatted as hhmmss.nnnnnnnnn. Note that this field does not support the recording of leap seconds.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	C
TS_FL_COV	**Type 5 Time Sync Focal Length Adjustable Parameter Covariance**. This field is the time synch focal length calibration error covariance value.	21	BCS-A	±9.99999999999999E±99	s^2	varies	C
TS_FL_SPDCF	**SPDCF Identifier for this Type 5 Time Synch Focal Length CPG**.	2	BCS-N	01 *to* 99	N/A	exact	C
End of the* (NUM_TS_GRP = 5) *conditional.							
End of the* (TS_CAL_AP = 1) *conditional.							
UE_FLAG	**Unmodeled Error Flag**. This field indicates the presence of unmodeled error data in this instance of the CSCSDB DES. Note: Unmodeled error data are tied to unwarped image space if a CSWRPB TRE is populated.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	R
***If* (UE_FLAG = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
LINE_DIMENSION	**Number of Grid Points in the Line Dimension**. This field reports the number of grid points in the line dimension where unmodeled error data is provided.	3	BCS-N	001 *to* 999	N/A	exact	C
SAMPLE_ DIMENSION	**Number of Grid Points in the Sample Dimension**. This field reports the number of grid points in the sample dimension where unmodeled error data is provided.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of line-dimension grid points loop. Loop runs from* n = 1 *to* LINE_DIMENSION.**							
***Start of number of sample-dimension grid points loop. Loop runs from* j = 1 *to* SAMPLE_DIMENSION.**							
URRnj	**Unmodeled Error Covariance Element (1,1)**. This field contains the first element of the upper triangular portion of the 2 × 2 unmodeled error covariance matrix associated with the j^{th} sample of the n^{th} line of the unmodeled error grid.	21	BCS-A	±9.99999999999999E±99	$pixels^2$	varies	C
URCnj	**Unmodeled Error Covariance Element (1,2)**. This field contains the second element of the upper triangular portion of the 2 × 2	21	BCS-A	±9.99999999999999E±99	$pixels^2$	varies	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	unmodeled error covariance matrix associated with the j^{th} sample of the n^{th} line of the unmodeled error grid.						
UCCnj	**Unmodeled Error Covariance Element (2,2)**. This field contains the third and final element of the upper triangular portion of the 2 × 2 unmodeled error covariance matrix associated with the j^{th} sample of the n^{th} line of the unmodeled error grid.	21	BCS-A	±9.99999999999999E±99	$pixels^2$	varies	C
End of number of sample-dimension grid points loop.							
End of number of line-dimension grid points loop.							
LINE_SPDCF	**SPDCF Identifier for Unmodeled Error in the Line Dimension**.	2	BCS-N	01 *to* 99	N/A	exact	C
SAMPLE_SPDCF	**SPDCF Identifier for Unmodeled Error in the Sample Dimension**.	2	BCS-N	01 *to* 99	N/A	exact	C
***End of the* (UE_FLAG = 1) *conditional*.**							
SPDCF_FLAG	**SPDCF Flag**. This field is a flag indicating if SPDCF data is provided in this instance of the CSCSDB DES.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	R
***If* (SPDCF_FLAG = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_SPDCF	**Number of SPDCFs**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of* SPDCFs *loop. Loop runs from* n = 1 *to* NUM_SPDCF.**							
SPDCF_IDn	**n^{th} SPDCF Identification Number**. This field contains the SPDCF ID for the n^{th} SPDCF stored in this instance of the CSCSDB DES.	2	BCS-N	01 *to* 99	N/A	exact	C
SPDCF_Pn	**Number of Constituent SPDCFs Associated with the n^{th} SPDCF ID**.	2	BCS-N	01 *to* 99	N/A	exact	C
***Start of number of constituent* SPDCFs *loop. Loop runs from* j = 1 *to* SPDCF_Pn.**							
SPDCF_FAMnj	**SPDCF Family Identification**. This field identifies the family of the j^{th} constituent SPDCF.	1	BCS-N	0 *(CSM four parameter),* 1 *(piece-wise linear), or* 2 *(damped cosine)*	N/A	exact	C
SPDCF_WEIGHTnj	**Weighting of the j^{th} Constituent SPDCF**. This field provides the weighting value associated with the j^{th} constituent SPDCF; all weights associated with a given SPDCF_IDn shall sum to 1.	5	BCS-N	0.000 *to* 1.000	N/A	varies	C
***If* (SPDCF_FAMnj = 0), *then the following fields are contained in this instance of the* CSCSDB DES.**							
FP_Anj	**CSM Four Parameter Correlation Function Parameter A**. This field provides the value for parameter "A" of a CSM four parameter correlation function.	8	BCS-N	0.000001 *to* 1.000000	N/A	varies	C

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
FP_ALPHAnj	**CSM Four Parameter Correlation Function Parameter alpha**. This field provides the value for parameter "alpha" of a CSM four parameter correlation function.	8	BCS-N	0.000000 *to* 1.000000	N/A	varies	C
FP_BETAnj	**CSM Four Parameter Correlation Function Parameter beta**. This field provides the value for parameter "beta" of a CSM four parameter correlation function.	9	BCS-N	00.000000 *to* 10.000000	N/A	varies	C
FP_Tnj	**CSM Four Parameter Correlation Function Parameter T**. This field provides the value for parameter "T" of a CSM four parameter correlation function.	21	BCS-A	+1.00000000000000E-06 *to* +9.99999999999999E+99	N/A	varies	C
***End of the* (SPDCF_FAMnj = 0) *conditional*.**							
***If* (SPDCF_FAMnj = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_SEGSnj	**Number of Segments in the Piece-Wise Linear Correlation Model**. This field contains the number of piece-wise linear correlation model segments which are associated with the j^{th} constituent SPDCF.	2	BCS-N	02 *to* 10	N/A	exact	C
***Start of number of piece-wise linear correlation segments loop. Loop runs from* k = 1 *to* NUM_SEGSnj.**							
PL_MAX_CORnjk	**Piece-Wise Linear Function Segment Maximum Correlation Value**. This field contains the maximum correlation value over the k^{th} segment. Note that the first PL_MAX_CORnjk value must be greater than zero and all successive values must be less than the preceding value. Note also that the correlation value of the last segment is constant in value and has unbounded length.	8	BCS-N	0.000000 *to* 1.000000	N/A	varies	C
PL_TAU_ MAX_CORnjk	**Piece-Wise Linear Function Difference (Tau Segment Value)**. This field contains the starting difference value for the k^{th} segment. Note that the first PL_TAU_MAX_CORnjk value must be equal to zero and that all successive values must be greater than the preceding value.	21	BCS-A	+0.00000000000000E+00 *to* +9.99999999999999E+99	N/A	varies	C
End of number of piece-wise linear correlation segments loop.							
***End of the* (SPDCF_FAMnj = 1) *conditional*.**							
***If* (SPDCF_FAMnj = 2), *then the following fields are contained in this instance of the* CSCSDB DES.**							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DC_Anj	**Damped Cosine Correlation Function Parameter A**. This field provides the value for parameter "A" of a damped cosine correlation function.	8	BCS-N	0.000001 to 1.000000	N/A	varies	C
DC_Tnj	**Damped Cosine Correlation Function Parameter T**. This field provides the value for parameter "T" of a damped cosine correlation function.	21	BCS-A	+1.00000000000000E-06 *to* +9.99999999999999E+99	N/A	varies	C
DC_Pnj	**Damped Cosine Correlation Function Parameter P**. This field provides the value for parameter "P" of a damped cosine correlation function.	21	BCS-A	+1.00000000000000E-06 *to* +9.99999999999999E+99	N/A	varies	C
***End of the* (SPDCF_FAMnj = 2) *conditional*.**							
End of number of constituent SPDCFs loop.							
End of number of* SPDCFs *loop.							
***End of the* (SPDCF_FLAG = 1) *conditional*.**							
DIRECT_ COVARIANCE_ FLAG	**Direct Covariance Flag**. This field indicates if *a posteriori* adjustable parameters and variance-covariance matrix data are provided.	1	BCS-N	0 *(no)* 1 *(yes)*	N/A	exact	R
***If* (DIRECT_COVARIANCE_FLAG = 1), *then the following fields are contained in this instance of the* CSCSDB DES.**							
DC_TYPE	**Direct Covariance Type Flag**. This field indicates the type of direct covariance. This field has been designed to support the future expansion of this set; the current value shall be set to 0 and future values coordinated with NTB.	1	BCS-A	0 (*a posteriori adjustments and covariance as outlined in the above sections of the* CSCSDB *DES),* 1 *to* 9 *(reserved),* *or see NTB Registry*	N/A	exact	C
***If* (DC_TYPE = 0), *then the following fields are contained in this instance of the* CSCSDB DES.**							
NUM_PARA	**Total Number of Adjustable Parameters Described in the Covariance Support Data**.	4	BCS-N	0001 *to* 9999	N/A	exact	C
***Start of number of adjustable parameter corrections loop. Loop runs from* n = 1 *to* NUM_PARA.**							
ADJn	**n^{th} Adjustable Parameter Value Obtained from an External Adjustment**.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
End of number of adjustable parameter corrections loop.							

Table AH.6-5: Common Sensor Covariance Support Data (CSCSDB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***Start of direct covariance error covariance elements loop. Loop runs from* n = 1 *to* (0.5·NUM_PARA) × (NUM_PARA + 1).**							
ERRCOV_C4n	**Individual Adjustable Parameter Error Covariance Terms**. This field contains the n[th] individual adjustable parameter error covariance term from the upper triangular portion of the error covariance matrix generated in support of the *a posteriori* adjustment.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
End of direct covariance error covariance elements loop.							
***End of the* (DC_TYPE = 0) *conditional*.**							
***End of the* (DIRECT_COVARIANCE_FLAG = 1) *conditional*.**							
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "000000000".	9	BCS-N	000000000	bytes	exact	R
RESERVED	**Reserved Field**. Reserved for future use.	†††	††	*omit*	N/A	N/A	C

† The size in bytes of the RESERVEDSUBH field equals the value of the preceding RESERVEDSUBH_LEN field.

†† The RESERVEDSUBH and RESERVED fields do not necessarily have a single data type, since each field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

††† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

AH.6.6 Common Sensor Ephemeris Data (CSEPHB) DES

The Common Sensor Ephemeris data (CSEPHB) DES (Table AH.6-6) provides chronologically-ordered platform ephemeris information needed to run the rigorous sensor model that performs geolocation and mensuration.

There are two versions of the CSEPHB DES. In both versions, the ECI_ECF_EPHEM field designates whether ephemeris vectors are in ECI (value = 0) or ECF (value = 1) coordinates. In version 1, if ECI is designated, then no ECI-to-ECF transformation information is provided, the DT_EPHEM field immediately follows the ECI_ECF_EPHEM field, and MSP cannot mensurate the dataset. In version 2, however, if the ECI_ECF_EPHEM field value = 0 (i.e., ECI vectors), then a set of 32 required ECI-to-ECF transformation parameters immediately follows the ECI_ECF_EPHEM field. Reference [1] provides the equations as a function of these parameters. Although both DES versions are valid, version 2 is strongly recommended when ECI_ECF_EPHEM = 0 (ECI). If ECI_ECF_EPHEM = 1 (ECF), then the logic is the same for both DES versions 1 and 2 because ECI-to-ECF transformation parameters are not needed and thus not present in the DES.

Note that MSP's GLAS/GFM model disables error propagation by setting the number of adjustable parameters to zero if QUAL_FLAG_EPH = 0 (suspect data). A value of ECI_ECF_EPHEM = 0 (ECI) in CSEPHB DES version 1 is not supported by all MSP versions that claim GLAS/GFM conformance. Data providers who use this option, and whose consumers rely on MSP for georeferencing and mensuration functions, must ensure that those consumers have access to a suitable version of MSP within their toolset.

Table AH.6-6: Common Sensor Ephemeris Data (CSEPHB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DE	**File Part Type**. This field shall contain the characters "DE".	2	BCS-A	DE	N/A	exact	R
DESID	**Unique DES Type Identifier**. This field shall contain a valid identifier properly registered with the GWG NTB.	25	BCS-A	CSEPHB	N/A	exact	R
DESVER	**Version of the Data Definition**. This field shall contain the version number of the use of the DES.	2	BCS-N	01, 02	N/A	exact	R
DESCLAS to DESCTLN	**DES Security Metadata.** Security classification metadata.	167	ECS-A	*populate in accordance with MIL-STD-2500C*	N/A	exact	R
DESSHL	**DES User-Defined Subheader Length**. This field contains the number of bytes in the user-defined subheader.	4	BCS-N	0046 *to* 9999	bytes	exact	R
UUID	**Assigned UUID for the DES**. This UUID refers to the entire DES, i.e., both the subheader and the data portions of the DES.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	R
NUMAIS	**Number of Associated Image Segments**. This field provides the number of image segments associated with this DES. If NUMAIS = ALL, the DES is associated with all image segments in the NITF dataset, and field AISDLVLn is omitted. Otherwise, NUMAIS is between 1 and 998	3	BCS-A	001 *to* 998, *or* ALL	N/A	exact	R

Table AH.6-6: Common Sensor Ephemeris Data (CSEPHB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	(999 is covered by "ALL") and is no more than the number of image segments in the dataset.						
***Start of number of associated image segments loop. Loop runs from* n = 1 *to* NUMAIS. *Loop is omitted if* NUMAIS = ALL.**							
AISDLVLn	**n^th Associated Image Segment Display Level**. This field provides the Image Display Level (IDLVL) of each image segment associated with this DES. AISDLVLn shall correspond to IDLVL values of image segments in the same dataset. If NUMAIS = ALL, this field is omitted.	3	BCS-N	001 *to* 999	N/A	exact	C
End of number of associated image segments loop.							
NUM_ASSOC_ ELEM	**Number of Associated Elements**. This field contains the number of elements associated with this DES. For Level 1 and 2 conformance, this list shall include the IMAGE_UUID from the CSEXRB TRE for all images associated with this DES, as well as the UUIDs of any other elements that are authoritatively associated with this DES.	3	BCS-N	000 *to* 276	N/A	exact	R
***Start of number of associated elements loop. Loop runs from* n = 1 *to* NUM_ASSOC_ELEM.**							
ASSOC_ELEM_ UUIDn	**UUID of the n^th Associated Element**. This field contains the UUID of the n^th element associated with this DES. The type of associated element is unrestricted.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	C
End of number of associated elements loop.							
RESERVEDSUBH _LEN	**Length of Reserved Subheader Field**. This field value shall be "0000".	4	BCS-N	0000	bytes	exact	R
RESERVEDSUBH	**Reserved Subheader Field**. Reserved for future use.	†	††	*omit*	N/A	N/A	C
Beginning of the DESDATA *portion of the* CSEPHB DES.							
QUAL_FLAG_ EPH	**Ephemeris Data Quality Flag**. This field indicates the quality of the provided ephemeris data.	1	BCS-N	0 *(suspect data)* 1 *(good data)*	N/A	exact	R
INTERP_TYPE_ EPH	**Interpolation Type**. This field identifies the type of interpolation recommended for the end user.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)* 2 *(Lagrangian)*	N/A	exact	R
***If* (INTERP_TYPE_EPH = 2)*, then the following fields are contained in this instance of the* CSEPHB DES.**							
INTERP_ORDER _EPH	**Order of Interpolation Polynomial**. This field indicates the order of the interpolation polynomials recommended for the end user.	1	BCS-N	3, 5, *or* 7	N/A	exact	C

Table AH.6-6: Common Sensor Ephemeris Data (CSEPHB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
End of the* (INTERP_TYPE_EPH = 2) *conditional.							
EPHEM_FLAG	**Ephemeris Source Type**. This field identifies the source of orbit determination ephemeris data. Refined ephemeris data (ATT_TYPE = 2) indicates smoothed ephemeris data resulting from data processing.	1	BCS-N	0 *(predicted)* 1 *(actual; collection time)* 2 *(refined)*	N/A	exact	R
ECI_ECF_EPHEM	**Coordinate Reference Frame Flag**. This field identifies whether ephemeris data are with respect to Earth-Centered Fixed (ECF) or Earth-Centered Inertial (ECI) reference frames.	1	BCS-N	0 *(ECI)* 1 *(ECF)*	N/A	exact	R
***If* [(ECI_ECF_EPHEM = 0) & (DESVER ≥ 02)], *then the following fields are provided; otherwise the fields are omitted*.**							
TA_POLE	**TA Pole**. This field provides the time (Julian date) associated with the polar wander parameters. *see Section AH.5.8 for formatting guidance*.	19	BCS-N	2000000.00000000000 *to* 3000000.00000000000 *see Section AH.5.8 for formatting guidance*	Julian date	exact	C
A_POLE	**A Pole**. This field provides the polar wander parameter A in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
B_POLE	**B Pole**. This field provides the polar wander parameter B in arc-seconds/day.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec/day	exact	C
CJ1_POLE CJ2_POLE	**C Pole**. These fields provide the polar wander parameters CJ1 and CJ2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
DJ1_POLE DJ2_POLE	**D Pole**. These fields provide the polar wander parameters DJ1 and DJ2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
PJ1_POLE PJ2_POLE	**PJ Pole**. These fields provide the periods PJ1 and PJ2 (Julian days) associated with the polar wander parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
E_POLE	**E Pole**. This field provides the polar wander parameter E in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
F_POLE	**F Pole**. This field provides the polar wander parameter F in arc-seconds/day.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec/day	exact	C
GK1_POLE GK2_POLE	**GK Pole**. These fields provide the polar wander parameters GK1 and GK2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C
HK1_POLE HK2_POLE	**HK Pole**. These fields provide the polar wander parameters HK1 and HK2 in arc-seconds.	11	BCS-N	-1.00000000 *to* +1.00000000	arc-sec	exact	C

Table AH.6-6: Common Sensor Ephemeris Data (CSEPHB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
PK1_POLE PK2_POLE	**PK Pole**. These fields provide the periods PK1 and PK2 (Julian days) associated with the polar wander parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
TB_UT	**TB UT**. This field provides the time (Julian date) associated with the universal time (UT) parameters.	19	BCS-N	2000000.00000000000 *to* 3000000.00000000000 *see Section AH.5.8 for formatting guidance*	Julian date	exact	C
I_UT	**I UT**. This field provides the UT parameter I in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	c
J_UT	**J UT**. This field provides the UT parameter J in seconds/day.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds/ day	exact	C
KN1_UT KN2_UT KN3_UT KN4_UT	**K UT**. These fields provide the UT parameters KN1, KN2, KN3, and KN4 in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	C
LN1_UT LN2_UT LN3_UT LN4_UT	**L UT**. These fields provide the UT parameters LN1, LN2, LN3, and LN4 in seconds.	12	BCS-N	-1.000000000 *to* +1.000000000	seconds	exact	C
PN1_UT PN2_UT PN3_UT PN4_UT	**P UT**. These fields provide the periods PN1, PN2, PN3, and PN4 in (Julian days) associated with the UT parameters.	10	BCS-N	000.000000 *to* 500.000000	Julian days	exact	C
End of the* [(ECI_ECF_EPHEM = 0) & (DESVER ≥ 02)] *conditional.							
DT_EPHEM	**Time Between Ephemeris Vectors**. This field contains the time interval between chronologically ordered consecutive ephemeris vectors in seconds. Time for any ephemeris vector, *k*, is: $$t_k = TO\_EPHEM + (k-1) \times DT\_EPHEM$$ for *k* = 1, …, NUM_EPHEM vectors.	13	BCS-N	000.000000001 *to* 999.999999999	Second s	varies	R

Table AH.6-6: Common Sensor Ephemeris Data (CSEPHB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DATE_EPHEM	**Date of First Ephemeris Vector**. This field contains the date of the first ephemeris vector formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	R
T0_EPHEM	**UTC Time Stamp of First Ephemeris Vector**. This field shall contain the time stamp of the first ephemeris formatted as hhmmss.nnnnnnnnn.	16	BCS-N	*hhmmss.nnnnnnnnn* *see Section AH.5.8 for formatting guidance*	UTC Zulu	varies	R
NUM_EPHEM	**Number of Ephemeris Vectors**.	5	BCS-N	00001 *to* 99999	N/A	exact	R
***Start of number of ephemeris vectors loop. Loop runs from* n = 1 *to* NUM_EPHEM.**							
EPHEM_Xn EPHEM_Yn EPHEM_Zn	**X, Y, and Z Coordinates of the nth Ephemeris Vector**. This field contains the X, Y, and Z coordinates in meters, in either the ECI or ECF reference frame, depending upon the value of ECI_ECF_EPHEM, for the nth ephemeris vector. Ephemeris vectors are listed in chronological order.	12	BCS-N	-99999999.99 *to* +99999999.99	meters	varies	R
End of number of ephemeris vectors loop.							
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "000000000".	9	BCS-N	000000000	bytes	exact	R
RESERVED	**Reserved Field**. Reserved for future use.	†††	††	*omit*	N/A	N/A	C

† The size in bytes of the RESERVEDSUBH field equals the value of the preceding RESERVEDSUBH_LEN field.

†† The RESERVEDSUBH and RESERVED fields do not necessarily have a single data type, since each field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

††† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

AH.6.7 Common Sensor Sensor Field Alignment (CSSFAB) DES

The Common Sensor Sensor Field Alignment (CSSFAB) DES (Table AH.6-7) provides information about the detectors, sensor type, and sensor field alignment including the focal length and principal point offset components. For GLAS, CSSFAB uses "field alignment pairs" to define the virtual focal plane locations of the endpoints of segments of the linear array. For GFM, CSSFAB uses either "field alignment blocks" to define the virtual focal plane locations of the corner points of square areas of the 2D frame array or interior orientation parameters in a "Concatenated Approach" (Section AH.5.6.6).

The CSSFAB DES is an integral part of the GLAS and GFM models and provides the band wavelength metadata for the stored image(s) to estimate the effect of wavelength on geopositioning and mensuration. The band wavelength metadata are included in the CSSFAB DES so that the GLAS/GFM SDEs contain all the necessary information without the need to leverage other SDEs, which may not be present, or the ISH, which may not contain the band wavelength. These metadata are applied in the GLAS and GFM projection models. For single band imagery, the application of the CSSFAB DES is straightforward. However, for multi-band imagery, it is more complicated and involves one of the following two cases: (1) band-to-band registered, i.e., co-registered, multi-band image segment; and (2) non-co-registered multi-band image segment. Section AH.7.5 provides implementation guidance for an image segment without band-to-band registration.

The CSSFAB DES contains two valid versions for use. Version 1 (DESVER = "01") is the original version where the only valid TELESCOPE_OPTICS_FLAG value is "0". Version 2 (DESVER = "02") allows for the TELESCOPE_OPTICS_FLAG values "0", "1", and "2" as valid options. While both versions are acceptable, version 2 is preferred, and data providers may simply set the TELESCOPE_OPTICS_FLAG to zero (0) when it is not applicable.

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
DE	**File Part Type**. This field shall contain the characters "DE".	2	BCS-A	DE	exact	N/A	R
DESID	**Unique DES Type Identifier**. This field shall contain a valid identifier properly registered with the GWG NTB.	25	BCS-A	CSSFAB	exact	N/A	R
DESVER	**Version of the Data Definition**. This field shall contain the version number of the use of the DES.	2	BCS-N	01, 02	exact	exact	R
DESCLAS to DESCTLN	**DES Security Metadata.** Security classification metadata.	167	ECS-A	*populate in accordance with MIL-STD-2500C*	N/A	exact	R
DESSHL	**DES User-Defined Subheader Length**. This field contains the number of bytes in the user-defined subheader.	4	BCS-N	0046 *to* 9999	bytes	exact	R
UUID	**Assigned UUID for the DES**. This UUID refers to the entire DES, i.e., both the subheader and the data portions of the DES.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	R

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
NUMAIS	**Number of Associated Image Segments**. This field provides the number of image segments associated with this DES. If NUMAIS = ALL, the DES is associated with all image segments in the NITF dataset, and field AISDLVLn is omitted. Otherwise, NUMAIS is between 1 and 998 (999 is covered by "ALL") and is no more than the number of image segments in the dataset.	3	BCS-A	001 *to* 998, *or* ALL	N/A	exact	R
***Start of number of associated image segments loop. Loop runs from* n = 1 *to* NUMAIS. *Loop is omitted if* NUMAIS = ALL.**							
AISDLVLn	**n^th^ Associated Image Segment Display Level**. This field provides the Image Display Level (IDLVL) of each image segment associated with this DES. AISDLVLn shall correspond to IDLVL values of image segments in the same dataset. If NUMAIS = ALL, this field is omitted.	3	BCS-N	001 *to* 999	N/A	exact	C
End of number of associated image segments loop.							
NUM_ASSOC_ELEM	**Number of Associated Elements**. This field contains the number of elements associated with this DES. For Level 1 and 2 conformance, this list shall include the IMAGE_UUID from the CSEXRB TRE for all images associated with this DES, as well as the UUIDs of any other elements that are authoritatively associated with this DES.	3	BCS-N	000 *to* 276	N/A	N/A	R
***Start of number of associated elements loop. Loop runs from* n = 1 *to* NUM_ASSOC_ELEM.**							
ASSOC_ELEM_UUIDn	**UUID of the n^th^ Associated Element**. This field contains the UUID of the n^th^ element associated with this DES. The type of associated element is unrestricted.	36	BCS-A	*a valid UUID in canonical format (e.g., dbe26dc7-e003-4d29-8edb-41acc0e86b6e)*	N/A	exact	C
End of number of associated elements loop.							
RESERVEDSUBH_LEN	**Length of Reserved Subheader Field**. This field value shall be "0000".	4	BCS-N	0000	bytes	exact	R
RESERVEDSUBH	**Reserved Subheader Field**. Reserved for future use.	†	††	*omit*	N/A	N/A	C
***Beginning of the* DESDATA *portion of the* CSSFAB DES.**							
SENSOR_TYPE	**Sensor Type**. This field identifies the type of sensor, with "S" for a scanner or "F" for a framing camera.	1	BCS-A	S *(line scanner)* F *(framing camera)*	N/A	N/A	R

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
BAND_TYPE	**Spectral Band Category**. This field identifies the category of spectral band for which data are supplied. For multiple co-registered bands, the reference (base) band is provided. For multiple bands that are not co-registered, each band shall be provided in a separate image segment with its own instance of the CSSFAB DES.	1	BCS-A	M *(for Panchromatic)* R *(for Red)* G *(for Green)* B *(for Blue)* N *(for Near Infrared)* BCS space (0x20)	N/A	N/A	<R>
BAND_WAVELENGTH	**Reference Wavelength**. This field contains a weighted average reference wavelength for the data in this instance of the CSSFAB DES.	11	BCS-N	00.00000000 *to* 99.99999999	µm	N/A	R
N_BANDS	**Number of Bands from the Associated Image Segments**. This field provides the number of spectral bands from the associated image segment(s) associated with this DES. If this DES is associated with all the bands in the associated image segment(s), N_BANDS = 0, and fields BAND_INDEXi, IREPBANDi, and ISUBCATi shall be omitted.	5	BCS-N	00000 *(all bands of AIS), or* 00001 *to* 99999	N/A	N/A	R
Start of number of band indices loop. Loop runs from* i = 00001 *to* N_BANDS. *If* N_BANDS = 0*, then this loop is omitted.							
BAND_INDEXi	**Band Order Index of the ith Spectral Band of the Associated Image Segment(s)**. This field provides the index of the ith spectral band in the associated mage segment(s). Indexing is 1-based and is unique only within the context of a given image segment. For ex., if a 3-band image plane is spread over two image segments, band index = "00001" refers to the first band of both image segments, not the first band of the first image segment. Index values are set at initial dataset production. If bands are chipped or re-ordered, BAND_INDEXi values may no longer be valid, and the data consumer relies on the IREPBANDi and ISUBCATi fields when matching this instance of CSSFAB DES with a band from an associated image segment(s).	5	BCS-N	00001 *to* 99999	rank	N/A	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
IREPBANDi	**Band-Specific Representation and Sub-Category of the i^{th} Band of the Associated Image Segment(s)**. These fields provide the IREPBANDn and ISUBCATn fields of the band from the associated ISH. If the corresponding IREPBANDn or ISUBCATn field is BCS spaces (0x20), then IREPBANDi or ISUBCATi is BCS spaces. Because ISUBCATi is in µm, ISUBCATi = ISUBCATn/1000. Note: IREPBANDn and ISUBCATn, even in combination, are not required to be unique and should not be the primary mechanism to identify a specific spectral band. However, they provide supplemental information to assist a data consumer to correctly identify the associated band when the file has been updated or chipped without correctly updating the CSSFAB DES.	2	BCS-A	*the value stored in the ISH* IREPBANDn *field of the associated image segment(s)*	N/A	exact	<C>
ISUBCATi		6	BCS-A	*the value stored in the ISH* ISUBCATn *field divided by 1000, of the associated image segment(s)*	µm	exact	<C>
End of number of band indices loop.							
End of the* (N_BANDS ≠ 00000) *conditional.							
NUM_FL_PTS	**Number of Focal Length Points**.	3	BCS-N	001 *to* 999	N/A	N/A	R
FL_INTERP	**Focal Length Interpolation Type**. This field identifies the recommended interpolation to be used with focal length point data.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)*	N/A	N/A	R
FOC_LENGTH_DATE	**Focal Length Date**. This field records the date of the first focal length point formatted as CCYYMMDD.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	R
***Start of number of focal length points loop. Loop runs from* n = 001 *to* NUM_FL_PTS.**							
FOC_LENGTH_TIMEn	**n^{th} Focal Length Time**. This field contains the time associated with the n^{th} focal length, in seconds from midnight at the start of the day specified in the FOC_LENGTH_DATE field.	15	BCS-N	00000.000000000 *to* 99999.999999999	seconds	varies	R
FOC_LENGTHn	**n^{th} Focal Length**. This field contains the n^{th} focal length, i.e., the effective distance between the primary mirror and focal plane.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	R
End of number of focal length points loop.							
PPOFF_X	**X-, Y-, and Z-Components of the Primary Mirror Vertex Offset**. These fields contain the X-, Y-, and Z-components of the offset from vehicle center of mass to primary mirror vertex, in meters.	10	BCS-N	-99.999999 *to* +99.999999	meters	varies	R
PPOFF_Y							
PPOFF_Z							

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
ANGOFF_X ANGOFF_Y ANGOFF_Z	**X-, Y-, and Z-Components of the Angular Sensor Frame Offset**. These fields contain the X-, Y-, and Z-components of the angular offset from attitude reference frame to sensor frame. Order of rotation is assumed to be z, y, and x for positive counterclockwise rotations in going from attitude reference frame CSATTB DES quaternion representations to the sensor frame. If angular offsets are zero, the data in the accompanying CSATTB DES is sensor frame attitude.	10	BCS-N	-3.1415927 *to* +3.1415927	radians	varies	R
***If* (SENSOR_TYPE = S), *then the following fields are contained in this instance of the* CSSFAB DES.**							
SMPL_NUM_FIRST	**Sample Number of the First Field Alignment of the First Pair**. This field identifies the sample position of the first field alignment pair.	12	BCS-N	-99999.99999 *to* +99999.99999	column	varies	C
DELTA_SMPL_PAIRS	**Delta Samples to the Corresponding Sample of Successive Pairs**. This field provides the increment of the sample number to each successive field alignment pair, which is a fixed value representing the grid spacing in the sample (cross-scan) dimension.	11	BCS-N	00000.00000 *to* 99999.99999	column	varies	C
NUM_FA_PAIRS	**Number of Field Alignment Pairs**. This field contains the number of field alignment pairs in this instance of the CSSFAB DES.	3	BCS-N	001 *to* 999	N/A	exact	C
***Start of number of field alignment pairs loop. Loop runs from* n = 001 *to* NUM_FA_PAIRS.**							
START_FALIGN_Xn START_FALIGN_Yn	**X- and Y-Positions of the Start of the nth Field Alignment Pair**. These fields contain the x- and y-coordinates of the position, in meters, of the first sample of the nth field alignment pair.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
END_FALIGN_Xn END_FALIGN_Yn	**X- and Y-Positions of the End of the nth Field Alignment Pair**. These fields contain the x- and y-coordinates of the position, in meters, of the last sample of the nth field alignment pair.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
End of number of field alignment pairs loop.							
End of the* (SENSOR_TYPE = S) *conditional.							
***If* (SENSOR_TYPE = F), *then the following fields are contained in this instance of the* CSSFAB DES.**							
NUM_SETS_FA_DATA	**Number of Sets of Field Angle Data**. This field contains the number of field angle (FA) sets for the FRAME image.	1	BCS-N	1 *to* 9	N/A	exact	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
FIELD_ANGLE_TYPE	**Field Angle Type**. This field identifies the field angle type, with 0 for a direct field alignment grid and 1 for calibration parameters. A value of "0" is not allowed when the CSWRPB TRE is in the dataset.	1	BCS-N	0 *(direct field alignment grid)* 1 *(calibration parameters)*	N/A	N/A	C
FA_INTERP	**Field Angle Interpolation Type**. This field identifies the interpolation to use when interpolating between sets of field angle data.	1	BCS-N	0 *(nearest neighbor)* 1 *(linear)*	N/A	exact	C
***If* (FIELD_ANGLE_TYPE = 0), *then the following fields are contained in this instance of the* CSSFAB DES.**							
***Start of number of frame field angle sets loop. Loop runs from* n = 1 *to* NUM_SETS_FA_DATA.**							
FL_CALn	**Focal Length Associated with the n^th^ Set of Field Angle Data**.	11	BCS-N	00.00000000 *to* 99.99999999	meters	N/A	C
NUM_FIR_LINEn	**First Line Number of the First Block of Field Alignment Data**.	12	BCS-N	-99999.99999 *to* +99999.99999	row	N/A	C
DELTA_LINEn	**Delta Lines to the Corresponding Line of Successive Blocks**. This field contains the difference in lines between successive blocks of field alignment data for the n^th^ field angle set. This value represents the number of unique lines per block; a fixed value representing the grid spacing in the line dimension.	11	BCS-N	00000.00000 *to* 99999.99999	row	N/A	C
NUM_FA_BLOCKS_LINEn	**Number of Field Alignment Blocks in the Line Dimension**. This field contains the number of field alignment blocks occurring in the line dimension for the n^th^ field angle set.	3	BCS-N	001 *to* 999	N/A	exact	C
NUM_FIR_SAMPn	**First Sample Number of the First Block of Field Alignment Data**. This field contains the first sample number of the first block of field alignment data in the n^th^ field angle set.	12	BCS-N	-99999.99999 *to* +99999.99999	column	varies	C
DELTA_SAMPn	**Delta Samples to the Corresponding Sample of Successive Blocks**. This field contains the difference in samples between successive blocks of field alignment data for the n^th^ field angle set. This value represents the number of unique samples per block; a fixed value representing the grid spacing in the sample dimension.	11	BCS-N	00000.00000 *to* 99999.99999	column	varies	C
NUM_FA_BLOCKS_SAMPn	**Number of Field Alignment Blocks in the Sample Dimension**. This field contains the number of field alignment blocks occurring in the sample dimension for the n^th^ field angle set.	3	BCS-N	001 *to* 999	N/A	exact	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
***Start of number of field alignment blocks in line dimension loop. Loop runs from* j = 001 *to* NUM_FA_BLOCKS_LINEn.**							
***Start of number of field alignment blocks in sample dimension loop. Loop runs from* k = 001 *to* NUM_FA_BLOCKS_SAMPn.**							
Note: The field alignment coordinates for each block are numbered clockwise from top left.							
FA_X1njk FA_Y1njk	**X- and Y-Coordinates of the First of Four Field Alignment Coordinates for Block$_{j,k}$ of the nth Frame Field Angle Set**. These fields contain the x- and y-coordinates, in meters, of the first (upper/top left) coordinate point for Block$_{j,k}$ of the nth frame camera field angle set.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
FA_X2njk FA_Y2njk	**X- and Y-Coordinates of the Second of Four Field Alignment Coordinates for Block$_{j,k}$ of the nth Frame Field Angle Set**. These fields contain the x- and y-coordinates of the second (upper/top right) coordinate point for Block$_{j,k}$ of the nth frame camera field angle set.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
FA_X3njk FA_Y3njk	**X- and Y-Coordinates of the Third of Four Field Alignment Coordinates for Block$_{j,k}$ of the nth Frame Field Angle Set**. These fields contain the x- and y-coordinates of the third (lower/bottom right) coordinate point for Block$_{j,k}$ of the nth frame camera field angle set.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
FA_X4njk FA_Y4njk	**X- and Y-Coordinates of the Fourth of Four Field Alignment Coordinates for Block$_{j,k}$ of the nth Frame Field Angle Set**. These fields contain the x- and y-coordinates of the fourth and last (lower/bottom left) coordinate point for Block$_{j,k}$ of the nth frame camera field angle set.	11	BCS-N	-99.9999999 *to* +99.9999999	meters	varies	C
End of number of field alignment blocks in sample dimension loop.							
End of number of field alignment blocks in line dimension loop.							
End of number of frame field angle sets loop.							
End of the* (FIELD_ANGLE_TYPE = 0) *conditional.							
***If* (FIELD_ANGLE_TYPE = 1), *then the following fields are contained in this instance of the* CSSFAB DES.**							
NUM_FP_ARRAYS_ LINE	**Number of Focal Plane Arrays in the Line Dimension**. This field provides the number of focal plane arrays in the line dimension; the value is "001" if CSWRPB is associated with this DES.	3	BCS-N	001 *to* 999	N/A	exact	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
NUM_FP_ARRAYS_ SAMP	**Number of Focal Plane Arrays in the Sample Dimension**. This field identifies the number of focal plane arrays in the sample dimension; the value is "001" if CSWRPB is associated with this DES.	3	BCS-N	001 *to* 999	N/A	exact	C
***Start of number of focal plane arrays in line dimension loop. Loop runs from* n = 001 *to* NUM_FP_ARRAYS_LINE.**							
***Start of number of focal plane arrays in sample dimension loop. Loop runs from* j = 001 *to* NUM_FP_ARRAYS_SAMP.**							
LS_FID_TRANS_T0nj	**Image to Fiducial Transform Parameters t0, t1, t2, t3, t4, t5, t6, and t7**. This field contains the frame image coordinates to fiducial coordinates transformation parameters t0, t1, t2, t3, t4, t5, t6, and t7. Note that the units of t*n* vary.	21	BCS-A	±9.99999999999999E±99	mm	varies	C
LS_FID_TRANS_T1nj					mm/pix		
LS_FID_TRANS_T2nj					mm/pix		
LS_FID_TRANS_T3nj					1/pix		
LS_FID_TRANS_T4nj					1/pix		
LS_FID_TRANS_T5nj					mm		
LS_FID_TRANS_T6nj					mm/pix		
LS_FID_TRANS_T7nj					mm/pix		
End of number of focal plane arrays in sample dimension loop.							
End of number of focal plane arrays in line dimension loop.							
***Start of number of frame field angle sets loop. Loop runs from* n = 1 *to* (NUM_SETS_FA_DATA).**							
FL_CAL_IOPn	**Focal Length Associated with the nth Set of Frame Camera Field Angle Data**. This field contains the focal length, in meters, associated with the nth frame camera field angle set.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	C
PPO_X0n	**Principal Point Offsets X_0 and Y_0**. These fields contain the x- and y-components of the principal point offset, in units of millimeters, associated with the nth frame camera field angle set.	21	BCS-A	±9.99999999999999E±99	mm	varies	C
PPO_Y0n							
RLD_K0n	**Radial Lens Distortion, K_0**. This field contains the radial lens distortion parameter, K_0, (which is a dimensionless value) associated with the nth frame camera field angle set.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RLD_K1n	**Radial Lens Distortion, K_1**. This field contains the radial lens distortion parameter, K_1, which has units of inverse square millimeters, associated with the nth frame camera field angle set.	21	BCS-A	±9.99999999999999E±99	$1/mm^2$	varies	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
RLD_K2n	**Radial Lens Distortion, K_2**. This field contains the radial lens distortion parameter, K_2, which has units of inverse millimeters to the fourth power, associated with the n^{th} frame camera field angle set.	21	BCS-A	±9.99999999999999E±99	$1/mm^4$	varies	C
RLD_K3n	**Radial Lens Distortion, K_3**. This field contains the radial lens distortion parameter, K_3, which has units of inverse millimeters to the sixth power, associated with the n^{th} frame camera field angle set.	21	BCS-A	±9.99999999999999E±99	$1/mm^6$	varies	C
DCD_P1n DCD_P2n DCD_P3n	**Decentering Distortion Parameters P_1, P_2, and P_3**. These fields contain the decentering distortion parameters, P_1, P_2, and P_3.	21	BCS-A	±9.99999999999999E±99	1/mm 1/mm $1/mm^2$	varies	C
AD_A1n AD_A2n	**Affine Distortion Parameters A_1 and A_2**. These fields contain the affine distortion parameters, A_1 and A_2, associated with the n^{th} frame camera field angle set, which are dimensionless quantities.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RADIUS_OF_ VALIDITYn	**Radius from the Principal Point to the Outermost Region where Radial Distortion Coefficients are Valid**. This field contains the radius of validity associated with the n^{th} frame camera field angle set measured from the principal point to the outermost/furthest region where the radial distortion coefficients are still valid.	21	BCS-A	+0.00000000000000E+00 *to* +9.99999999999999E±99	mm	varies	C
End of number of frame field angle sets loop.							
End of the* (FIELD_ANGLE_TYPE = 1) *conditional.							
TELESCOPE_ OPTICS_FLAG	**Flag Variable Indicating if Additional IO Parameter Set Present Due to Telescope Optics Corrections**. This field indicates if an IO parameter set of telescope optics corrections is present. Values are 0: Telescope optics corrections not included (DESVER = 01 and 02) 1: Frame-based telescope optics corrections included (DESVER=02) 2: Time-based telescope optics corrections included (DESVER = 02)	1	BCS-N	0 *(DESVER = 01)* 0, 1, 2 *(DESVER = 02)*	N/A	exact	R
***If* (TELESCOPE_OPTICS_FLAG = 1)*, then the following fields are contained in this instance of the* CSSFAB DES.**							
NUM_TELE_ SETS_FA_DATA	**Number of Sets of Telescope Optics Field Angle Data**. This field reports the number of sets of telescope optics related field angle data.	1	BCS-N	0 *to* 1	N/A	exact	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
N_FRAMES	**Total Number of Frames in the Sequence**. This field contains the total number of frames in the sequence. This value shall be identically equal to the NUMBER_FRAMES field value in the accompanying CSEXRB TRE.	4	UINT32	0 *to* (2^{32} – 1)	frames	exact	C
***Start of number of frames loop. Loop runs from* n = 1 *to* N_FRAMES.**							
TELE_TRANS_T0n	**Frame to Telescope-Optics Transform Parameters t0, t1, t2, t3, t4, t5, t6, and t7**. These fields contain the frame coordinates to telescope-optics coordinates transformation parameters t0, t1, t2, t3, t4, t5, t6, and t7. Note that the units of t*n* vary.	21	BCS-A	±9.99999999999999E±99	mm	varies	C
TELE_TRANS_T1n					mm/mm		
TELE_TRANS_T2n					mm/mm		
TELE_TRANS_T3n					1/mm		
TELE_TRANS_T4n					1/mm		
TELE_TRANS_T5n					mm		
TELE_TRANS_T6n					mm/mm		
TELE_TRANS_T7n					mm/mm		
End of number of frames loop.							
***Start of number of telescope optics field angle datasets loop. Loop runs from* n = 1 *to* NUM_TELE_SETS_FA_DATA.**							
FL_CAL_IOP_ TELEn	**Focal Length Associated with the n^th^ Set of Telescope-Optics Field Angle Data**. This field contains the focal length, in meters, associated with the n^{th} telescope-optics field angle dataset.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	C
PPO_X0_TELEn	**Telescope-Optics Principal Point Offsets X_0 and Y_0**. These fields contain the x- and y-components of the telescope-optics principal point offset associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	mm	varies	C
PPO_Y0_TELEn							
RLD_K0_TELEn	**Telescope-Optics Radial Lens Distortion, K_0**. This field contains the telescope-optics radial lens distortion parameter, K_0, a dimensionless value, associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RLD_K1_TELEn	**Telescope-Optics Radial Lens Distortion, K_1**. This field contains the telescope-optics radial lens distortion parameter, K_1, which has	21	BCS-A	±9.99999999999999E±99	$1/mm^2$	varies	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
	units of inverse square millimeters, associated with the n^th telescope-optics field angle dataset.						
RLD_K2_TELEn	**Telescope-Optics Radial Lens Distortion, K_2**. This field contains the telescope-optics radial lens distortion parameter, K_2, which has units of inverse millimeters to the fourth power, associated with the n^th telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	$1/mm^4$	varies	C
RLD_K3_TELEn	**Telescope-Optics Radial Lens Distortion, K_3**. This field contains the telescope-optics radial lens distortion parameter, K_3, which has units of inverse millimeters to the sixth power, associated with the n^th telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	$1/mm^6$	varies	C
DCD_P1_TELEn DCD_P2_TELEn DCD_P3_TELEn	**Telescope-Optics Decentering Distortion Parameters P_1, P_2, and P_3**. These fields contain the telescope-optics decentering distortion parameters, P_1, P_2, and P_3, associated with the n^th telescope-optics field angle dataset. P_1 and P_2 are in units of inverse millimeters; P_3 is in units of inverse square millimeters.	21	BCS-A	±9.99999999999999E±99	1/mm 1/mm $1/mm^2$	varies	C
AD_A1_TELEn AD_A2_TELEn	**Telescope-Optics Affine Distortion Parameters A_1 and A_2**. These fields contain the telescope-optics affine distortion parameters, A_1 and A_2, associated with the n^th telescope-optics field angle dataset, which are dimensionless quantities.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RADIUS_OF_ VALIDITY_TELEn	**Radius from the Principal Point to the Outermost Region where Radial Distortion Coefficients are Valid for Telescope-Optics**. This field contains the radius of validity associated with the n^th telescope-optics field angle dataset measured from the principal point to the outermost/furthest region where the radial distortion coefficients are still valid for the telescope-optics.	21	BCS-A	+0.00000000000000E+00 *to* +9.99999999999999E±99	mm	varies	C
End of number of telescope optics field angle datasets loop.							
End of the* (TELESCOPE_OPTICS_FLAG = 1) *conditional.							
***If* (TELESCOPE_OPTICS_FLAG = 2), *then the following fields are contained in this instance of the* CSSFAB DES.**							
NUM_TELE_ SETS_FA_DATA	**Number of Sets of Telescope Optics Field Angle Data**. This field contains the number of sets of telescope optics related field angle data.	1	BCS-N	0 *to* 1	N/A	exact	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
N_FRAME_TIMES	**Total Number of Frame Times in the Sequence**. This field contains the total number of frame times in the sequence.	4	UINT32	0 *to* (2^{32} – 1)	frames	exact	C
N_VARYING_IO	**Total Number of Time Varying IO Parameters**. This field contains the total number of time-varying IO parameters.	2	BCS-N	00 *to* 11	N/A	exact	C
***Start of number of time varying parameters loop. Loop runs from* n = 1 *to* N_VARYING_IO. *Loop is omitted if* N_VARYING_IO = 0.**							
TIME_VARYING _IO_PARM_ID	**Time Varying IO Parameter Identities**. This field contains a number from 1 to 11 corresponding to the ordered set {X0, Y0, K0, K1, K2, K3, P1, P2, P3, A1, A2}.	2	BCS-N	01 *to* 11	N/A	exact	C
End of number of time varying IO parameters loop.							
TELE_DATE	**Telescope Date of Applicability**. This field contains the date associated with the first set of telescope parameters.	8	BCS-N	*CCYYMMDD* *see Section AH.5.8 for formatting guidance*	UTC Zulu	exact	C
***Start of number of frame times loop. Loop runs from* n = 1 *to* N_FRAME_TIMES. *Loop is omitted if* N_FRAME_TIMES = 0.**							
TELE_TIME	**Telescope Time of Applicability**. This field contains the number of seconds from midnight, at the start of day specified by the field TELE_DATE, associated with this set of telescope parameters.	8	BCS-N	00000.000000000 *to* 86399.999999999	seconds (UTC Zulu)	varies	C
TELE_TRANS_T0n	**Frame to Telescope-Optics Transform Parameters t0, t1, t2, t3, t4, t5, t6, and t7**. These fields contain the frame coordinates to telescope-optics coordinates transformation parameters t0, t1, t2, t3, t4, t5, t6, and t7. Note that the units of t*n* vary.	21	BCS-A	±9.9999999999999E±99	mm	varies	C
TELE_TRANS_T1n					mm/mm		
TELE_TRANS_T2n					mm/mm		
TELE_TRANS_T3n					1/mm		
TELE_TRANS_T4n					1/mm		
TELE_TRANS_T5n					mm		
TELE_TRANS_T6n					mm/mm		
TELE_TRANS_T7n					mm/mm		
***Start of number of time varying IO parameters loop. Loop runs from* n = 1 *to* N_VARYING_IO. *Loop is omitted if* N_VARYING_IO = 0.**							
TIME_VARYING _IO_M	**Time Varying IO Parameter M**. This field contains the value of the time varying IO parameter in the order associated with the values in the TIME_VARYING_IO_PARM_ID field.	21	BCS-A	±9.9999999999999E±99	varies	varies	C

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
End of number of time varying IO parameters loop.							
End of number of frame times loop.							
Start of number of telescope optics field angle datasets loop. Loop runs from **n = 1** ***to*** **NUM_TELE_SETS_FA_DATA.** ***Loop is omitted if*** **NUM_TELE_SETS_FA_DATA = 0.**							
FL_CAL_IOP_ TELEn	**Focal Length Associated with the n^th^ Set of Telescope-Optics Field Angle Data**. This field contains the focal length, in meters, associated with the n^{th} telescope-optics field angle dataset.	11	BCS-N	00.00000000 *to* 99.99999999	meters	varies	C
PPO_X0_TELEn	**Telescope-Optics Principal Point Offsets X_0 and Y_0**. These fields contain the x- and y-components of the telescope-optics principal point offset associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	mm	varies	C
PPO_Y0_TELEn							
RLD_K0_TELEn	**Telescope-Optics Radial Lens Distortion, K_0**. This field contains the telescope-optics radial lens distortion parameter, K_0, a dimensionless value, associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RLD_K1_TELEn	**Telescope-Optics Radial Lens Distortion, K_1**. This field contains the telescope-optics radial lens distortion parameter, K_1, which has units of inverse square millimeters, associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	$1/mm^2$	varies	C
RLD_K2_TELEn	**Telescope-Optics Radial Lens Distortion, K_2**. This field contains the telescope-optics radial lens distortion parameter, K_2, which has units of inverse millimeters to the fourth power, associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	$1/mm^4$	varies	C
RLD_K3_TELEn	**Telescope-Optics Radial Lens Distortion, K_3**. This field contains the telescope-optics radial lens distortion parameter, K_3, which has units of inverse millimeters to the sixth power, associated with the n^{th} telescope-optics field angle dataset.	21	BCS-A	±9.99999999999999E±99	$1/mm^6$	varies	C
DCD_P1_TELEn	**Telescope-Optics Decentering Distortion Parameters P_1, P_2, and P_3**. These fields contain the telescope-optics decentering distortion parameters, P_1, P_2, and P_3, associated with the n^{th} telescope-optics field angle dataset. P_1 and P_2 are in units of inverse millimeters; P_3 is in units of inverse square millimeters.	21	BCS-A	±9.99999999999999E±99	1/mm	varies	C
DCD_P2_TELEn					1/mm		
DCD_P3_TELEn					$1/mm^2$		

Table AH.6-7: Common Sensor Sensor Field Alignment (CSSFAB) DES

(TYPE: "R" = Required, "C" = Conditional. "†" Annotations are explained at the end of this table.)

Field	Description	Size	C-Set	Value Range	Units	Accuracy	Type
AD_A1_TELEn AD_A2_TELEn	**Telescope-Optics Affine Distortion Parameters A_1 and A_2**. These fields contain the telescope-optics affine distortion parameters, A_1 and A_2, associated with the n^{th} telescope-optics field angle dataset, which are dimensionless quantities.	21	BCS-A	±9.99999999999999E±99	N/A	varies	C
RADIUS_OF_ VALIDITY_TELEn	**Radius from the Principal Point to the Outermost Region where Radial Distortion Coefficients are Valid for Telescope-Optics**. This field contains the radius of validity associated with the n^{th} telescope-optics field angle dataset measured from the principal point to the outermost/furthest region where the radial distortion coefficients are still valid for the telescope-optics.	21	BCS-A	+0.00000000000000E+00 *to* +9.99999999999999E±99	mm	varies	C
End of number of telescope optics field angle datasets loop.							
End of the **(TELESCOPE_OPTICS_FLAG = 2)** ***conditional.***							
End of the **(SENSOR_TYPE = F)** ***conditional.***							
RESERVED_LEN	**Length of Reserved Field**. This field value shall be "000000000".	9	BCS-N	000000000	bytes	exact	R
RESERVED	**Reserved Field**. Reserved for future use.	†††	††	*omit*	N/A	N/A	C

† The size in bytes of the RESERVEDSUBH field equals the value of the preceding RESERVEDSUBH_LEN field.

†† The RESERVEDSUBH and RESERVED fields do not necessarily have a single data type, since each field represents possible expansion of the TRE, which may include multiple new fields each with its own data type.

††† The size in bytes of the RESERVED field equals the value of the preceding RESERVED_LEN field.

AH.7 IMPLEMENTATION GUIDANCE

This section provides implementation guidance for a number of aspects of the GLAS/GFM sensor model. The relevant NITF version, minimum required GLAS/GFM SDEs for MSP functionality, image segmentation considerations, NITF size limits, wavelength-dependent effects, and chipping guidance are all provided below. Section AH.7.7 provides examples of linking GLAS/GFM TREs and DESs via UUIDS.

AH.7.1 NITF Version 2.1 Only

The GLAS/GFM SDES are limited to NITF version 2.1 datasets only.

AH.7.2 Minimum Required GLAS/GFM SDEs

Although some programs may include a few GLAS/GFM SDEs for purposes other than geopositioning, when accurate geopositioning and mensuration are required, then the dataset shall contain a minimum set of GLAS/GFM SDEs that allow MSP's CSM plugins to exploit that dataset.

For non-rectified, non-warped imagery, five of the GLAS/GFM SDEs shall be present, with the TREs in the ISH and the DESs linked to that image segment via their assigned UUID values (Table AH.7-1). The five (5) required SDEs are CSATTB, CSCSDB, CSEPHB, CSEXRB, and CSSFAB. The CSWRPB TRE is required if the data provider performed any geometric manipulation of pixel data that cannot be modeled by the CSSFAB DES; and the CSRLSB TRE is required if a framing sensor has a rolling shutter effect that causes a noticeable impact on geolocation and mensuration results.

Table AH.7-1: Minimum SDE Set for GLAS/GFM MSP Functionality

R = Required, C = Conditional, N/A = Not Applicable

SDE	Non-Rectified, Non-Warped		Non-Rectified, Warped		Rolling Shutter Collection	
	Scanner	Framer	Scanner	Framer	Scanner	Framer
CSATTB	R	R	R	R	R	R
CSCSDB	R	R	R	R	R	R
CSEPHB	R	R	R	R	R	R
CSEXRB	R	R	R	R	R	R
CSSFAB[3]	R	R	R	R	R	R
CSRLSB	N/A	N/A	N/A	N/A	N/A	R[1]
CSWRPB	C[4]	N/A	R	R	C[2]	C[2]

Note 1: The CSRLSB TRE is only required for framing sensors operating in rolling shutter mode resulting in a noticeable impact to geolocation and mensuration results. For scanning sensors in rolling shutter mode, the GLAS/GFM SDEs natively provide timing information per pixel and the CSRLSB TRE is not needed.
Note 2: The presence of CSWRPB TRE is conditional on whether the image has been geometrically manipulated, i.e., warped, in a way that cannot be modeled by the CSSFAB DES. If so, then the CSWRPB TRE is required.
Note 3: New data products implementing the GLAS/GFM SDEs shall only implement CSSFAB DES version 2.
Note 4: CSWRPB is present for a whiskbroom sensor if the time to acquire an entire row is significant.

The CSWRPB TRE shall be populated in all ISHs for which warping must be accounted for to meet mensuration/geopositioning accuracy requirements. The warping terms are applied after multiple image segments are attached together using the NITF Attachment and Display Level fields in the ISH.

The DESs are all placed into the NITF file containing the image segment(s) with GLAS/GFM TREs in its subheader. The internal UUID of each DES shall be referenced by the ISH's CSEXRB TRE so that MSP recognizes the GLAS/GFM DESs that apply to that image segment.

A NITF file may contain multiple image segments, some or all of which include GLAS/GFM TREs. Multiple separate image segments may reference the same instance of all or some of the GLAS DESs as required for the specific collection or collections. If multiple instances of any GLAS DES are provided in the same NITF file, the data provider must take care to assign unique UUIDs to each DES and to link each image segment to the correct set of DESs through each ISH instance of the CSEXRB TRE.

AH.7.3 GLAS/GFM Image Dimensions

The GLAS/GFM SDEs are designed to work with segmented images, i.e., images that are too large to fit in a single image segment and thus span more than one image segment. In this case, the CSEXRB fields NUM_LINES and NUM_SAMPLES provide the image size before it is segmented, and the NUM_LINES and NUM_SAMPLES fields apply to each image segment created to contain the entire image. Of course, if the image fits into a single image segment, then NUM_LINES is the same as NROWS in the ISH, and NUM_SAMPLES is the same as NCOLS in the ISH.

AH.7.4 GLAS/GFM DESs That Exceed NITF File Size Limit

The GLAS/GFM DESs carry the potential to contain a substantial amount of metadata. In some situations, it is feasible that the amount of metadata could exceed the maximum size that is currently allowable in NITF 2.1 datasets, i.e., (10^{12} – 2) bytes or 931.32 GB. In these situations, it is recommended to split or chip the image product into multiple products. The two most important factors in doing this is correctly populating the system timing metadata and UUID metadata. Correctly applying the timing and UUID metadata will link the sensor systems together in GLAS/GFM. However, by doing this exploitation would need to be done on multiple products, if the exploitation of the "full" product is required.

AH.7.5 Wavelength-Dependent Effects

Band wavelength metadata in the CSSFAB DES enable estimation of wavelength-dependent atmospheric refraction correction on geolocation. Implementation of the CSSFAB DES is simple for single-band image segments and needs no further explanation. Multi-band imagery, i.e., MSI and HSI, is more complicated.

Note that the ISUBCAT values in the CSSFAB DES are in microns, while ISUBCAT values from the ISH are in nanometers. Therefore, the CSSFAB ISUBCAT values are created by dividing ISH ISUBCAT values by 1000.

AH.7.5.1 Band-to-Band Registered Spectral Image Segment

If the spectral image segment has undergone band-to-band registration, and the bands are co-registered to one of the bands in the spectral image segment, then only one instance of the CSSFAB DES is required. For example, consider a seven-band image segment containing red, orange, yellow, green, blue, indigo and violet (ROYGBIV), with bands ordered by increasing wavelength. Bands 2 through 7 are co-registered to the first, i.e., red, band. The band-dependent fields in the CSSFAB DES are:

CSSFAB DES
BAND_WAVELENGTH = red wavelength in microns
N_BANDS = 7
BAND_INDEX = {1, 2, 3, 4, 5, 6, 7}
IREPBAND = {R, "", "", G, B, "", ""}
ISUBCAT = {red, orange, yellow, green, blue, indigo, violet} wavelengths in microns

The models will compute the atmospheric refraction correction as a function of the BAND_WAVELENGTH field value that corresponds to the reference band in the co-registered case.

AH.7.5.2 Non-Co-Registered Bands in a Spectral Image Segment

Creating a spectral image segment without co-registering the bands is generally not recommended because the geopositioning metadata vary from band to band, and because the same [row, column] location is not the same ground coordinate from band to band. As a result, one cannot extract a spectral profile for a single ground location by using the same [row, column] position for all bands, which makes spectral exploitation extremely complicated. However, the GLAS and GFM projection models do support including non-co-registered bands within a single image segment by allowing multiple instances of the CSSFAB DES to be associated with that segment, where each instance of the DES provides data for only a single band or group of co-registered bands.

For example, consider a seven-band ROYGBIV image with bands ordered by increasing wavelength and:

- The red, orange and yellow bands are co-registered to the orange band.
- The green band is not co-registered to any other band.
- The blue, indigo, and violet bands are co-registered to the indigo band.

In order to provide projection data for all seven bands, three instances of the CSSFAB DES must be associated with this spectral image segment. The BAND_INDEXi, IREPBANDi and ISUBCATi field arrays in each instance of the CSSFAB DES specify which bands are associated with that instance of the CSSFAB DES, and the BAND_WAVELENGTH field is set to the wavelength of the reference band to which the other bands are co-registered.

Given that seven ROYGBIV bands are ordered by increasing wavelength, the band-dependent parameters in the three instances of the CSSFAB DES are:

CSSFAB #1
BAND_WAVELENGTH = orange wavelength
N_BANDS = 3
BAND_INDEX = {1, 2, 3}
IREPBAND = {R, “”, “”}
ISUBCAT = {red, orange, yellow} wavelengths in microns

CSSFAB #2
BAND_WAVELENGTH = green wavelength
N_BANDS = 1
BAND_INDEX = {4}
IREPBAND = {G}
ISUBCAT = {green} wavelength in microns

CSSFAB #3
BAND_WAVELENGTH = indigo wavelength
N_BANDS = 3
BAND_INDEX = {5, 6, 7}
IREPBAND = {B, “”, “”}
ISUBCAT = {blue, indigo, violet} wavelengths in microns

The models will then compute the atmospheric refraction correction as a function of the BAND_WAVELENGTH field value that corresponds to the reference band where some bands have been co-registered (i.e., CSSFAB #1 and #3), and for each individual band separately when the band is not co-registered to another band (CSSFAB #2).

AH.7.6 Imagery-Derived Products and Chipping Guidance

When a NITF file containing GLAS/GFM SDEs is chipped spatially or temporally, the GLAS/GFM SDEs are not altered when the chipped product is created. i.e., the metadata field values are not altered. However, the ICHIPB TRE shall be placed in the subheader of the chipped image segment to record the chipping parameters. The GLAS/GFM SDEs are also not altered when an imagery-derived product is created.

Since the GLAS/GFM SDEs are unaltered during chipping, including the UUID values, elimination of all or a portion of an image segment may eliminate one or more GLAS/GFM TREs, including CSEXRB. Since the GLAS/GFM DESs contain the UUID in the CSEXRB TRE of the associated image segment, it is therefore possible for GLAS/GFM SDEs to list a UUID of a CSEXRB TRE that is no longer in the dataset.

For example, consider the case where a single set of GLAS/GFM DESs support multiple image segments, as shown in Figure AH.5-2. If a derived image is created that includes image segment #1 but not image segment #2, the GLAS/GFM DESs are the same in the derived image, while the GLAS/GFM TREs in image segment #2 are no longer in the dataset. The GLAS/GFM DESs in the derived image will still list the UUID value of the CSEXRB TRE from image segment #2, even though this linkage is no longer relevant.

The data provider determines whether GLAS/GFM data should be split into multiple DESs and whether multiple image segments reference the same instance of a DES. Regardless, because the UUIDs uniquely identify each GLAS/GFM DES and the CSEXRB TRE, downstream processing can unambiguously identify each GLAS/GFM element without performing byte-by-byte comparisons and can thus make simple, intelligent choices when chipping or consolidating NITF files.

AH.7.7 Example of GLAS/GFM SDE Linkage via UUIDs

Figure AH.7-1 depicts a NITF file containing a motion image and a single-band still image, with three instances of the CSEXRB TRE. In this example, for clarity the UUID fields are populated by the simple string "U*n*", with "*n*" providing the unique identifier, (e.g., U4), instead of full length 36-character strings.

AH.7.7.1 Image Segment #1: Motion Image

The first image segment contains five single-band frames of a motion image and uses the MIE4NITF standard to encode the frames within a single image segment [Ref. 1]. Ephemeris data are split across two instances of the CSEPHB DES; CSEPHB:UUID=U8 supports the first 3 frames and CSEPHB:UUID=U7 the last two frames. As a result, two instances of the CSEXRB TRE are in the motion ISH and are associated with the appropriate frames using the MIE4NITF Frame-Synchronous Metadata Wrapper (FSYNWA) TRE. The first three frames are associated with CSEXRB TRE with IMAGE_UUID = U1, and the last two frames are associated with the CSEXRB TRE with IMAGE_UUID = U2.

The ASSOC_DES_UUID list in each of the two CSEXRB TREs provides the complete set of GLAS/GFM DESs associated with each group of frames. The same CSATTB DES (UUID = U4), CSCSDB DESs (UUIDs = U5 and U6, and CSSFAB DES (UUID = U12) support all five frames of image segment #1. However, the CSEPHB DES with UUID = U8 supports the first 3 frames of the motion image, as specified by the ASSOC_DES_UUID value of U8 appearing in the first instance of the CSEXRB TRE. The ephemeris data for the last 2 frames of image segment #1 are supplied by the CSEPHB DES with UUID = U7, indicated in the second instance of the CSEXRB TRE, ASSOC_DES_UUID = U7.

All five frames of the motion image segment require two instances of the CSCSDB DES, illustrating a use case where multiple CSCSDB DESs are required to support the same portion of the image segment.

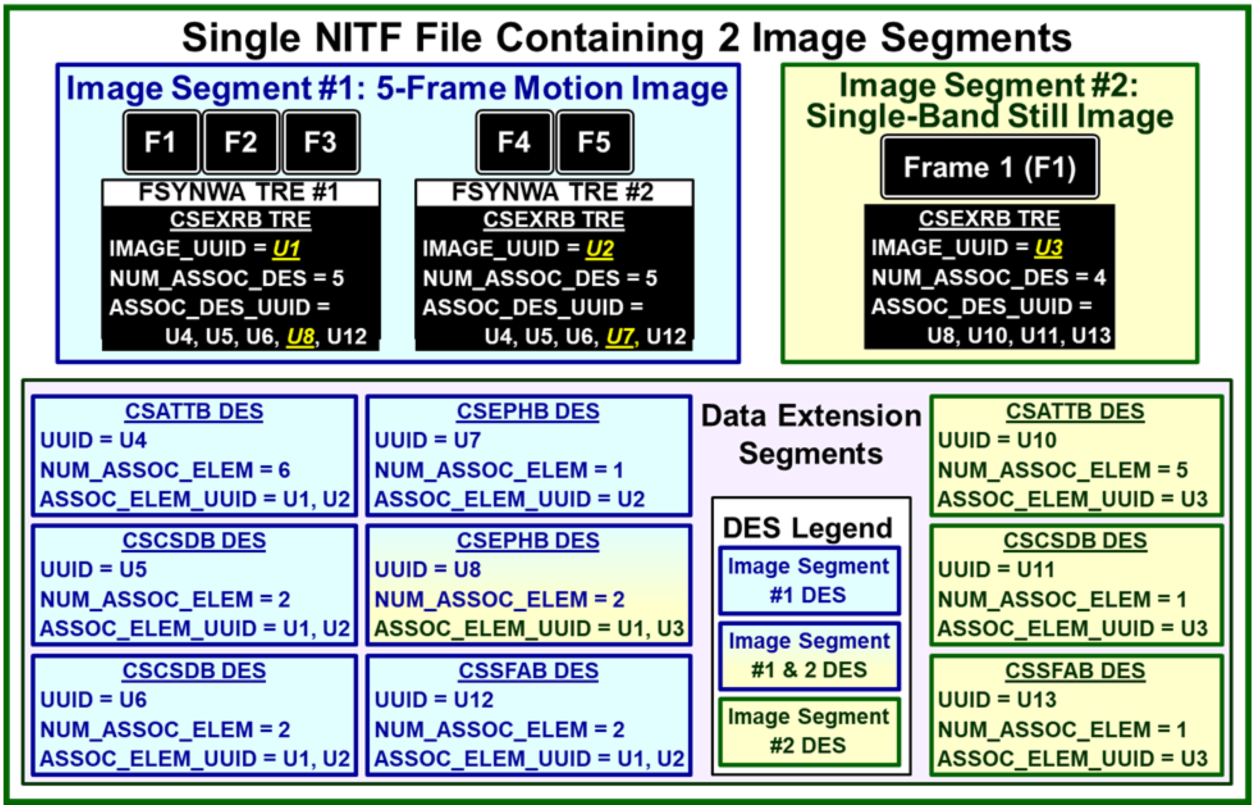

Figure AH.7-1: Example of NITF segment linkage using UUID values

AH.7.7.2 Image Segment #1: Motion Image

The first image segment contains five single-band frames of a motion image and uses the MIE4NITF standard to encode the frames within a single image segment [Ref. 1]. Ephemeris data are split across two instances of the CSEPHB DES; CSEPHB:UUID=U8 supports the first 3 frames and CSEPHB:UUID=U7 the last two frames. As a result, two instances of the CSEXRB TRE are in the motion ISH and are associated with the appropriate frames using the MIE4NITF Frame-Synchronous Metadata Wrapper (FSYNWA) TRE. The first three frames are associated with CSEXRB TRE with IMAGE_UUID = U1, and the last two frames are associated with the CSEXRB TRE with IMAGE_UUID = U2.

The ASSOC_DES_UUID list in each of the two CSEXRB TREs provides the complete set of GLAS/GFM DESs associated with each group of frames. The same CSATTB DES (UUID = U4), CSCSDB DESs (UUIDs = U5 and U6, and CSSFAB DES (UUID = U12) support all five frames of image segment #1. However, the CSEPHB DES with UUID = U8 supports the first 3 frames of the motion image, as specified by the ASSOC_DES_UUID value of U8 appearing in the first instance of the CSEXRB TRE. The ephemeris data for the last 2 frames of image segment #1 are supplied by the CSEPHB DES with UUID = U7, indicated in the second instance of the CSEXRB TRE, ASSOC_DES_UUID = U7.

All five frames of the motion image segment require two instances of the CSCSDB DES, illustrating a use case where multiple CSCSDB DESs are required to support the same portion of the image segment.

AH.7.7.3 Image Segment #2: Single-Band Still Image

This example also contains a single-band still image in a second image segment, with a third instance of the CSEXRB TRE that assigns a UUID value of U3 to this second image segment. The CSEXRB TRE in image segment #2 links this image segment to the GLAS/GFM DESs with UUID values of U8, U10, U11, and U13.

The CSATTB, CSCSDB, and CSSFAB DESs only support image segment #2. However, image segment #2 uses the same CSEPHB DES, i.e., CSEPHB:UUID=8, as the first 3 frames of image segment #1.

AH.7.8 Example of a Chipped GLAS/GFM NITF File

In this example, the NITF file in Figure AH.7-1 is temporally chipped, eliminating the last two bands of the motion image, while the single-band still image is not altered in the chipped dataset (Figure AH.7-2). Thus, image segment #1 contains only three bands and one instance of the CSEXRB TRE, which is wrapped in the FSYNWA TRE. The GLAS/GFM DESs that supported all five frames, i.e., CSATTB:UUID=4, CSCSDB:UUID=U5, CSCSDB:UUID=U6, and CSSFAB:UUID=U12, still list the UUID value "U2" of the no-longer-present CSEXRB TRE associated with the last two frames of the original motion image segment. Also, the dataset still contains ephemeris data for the two deleted frames via CSEPHB:UUID=U7.

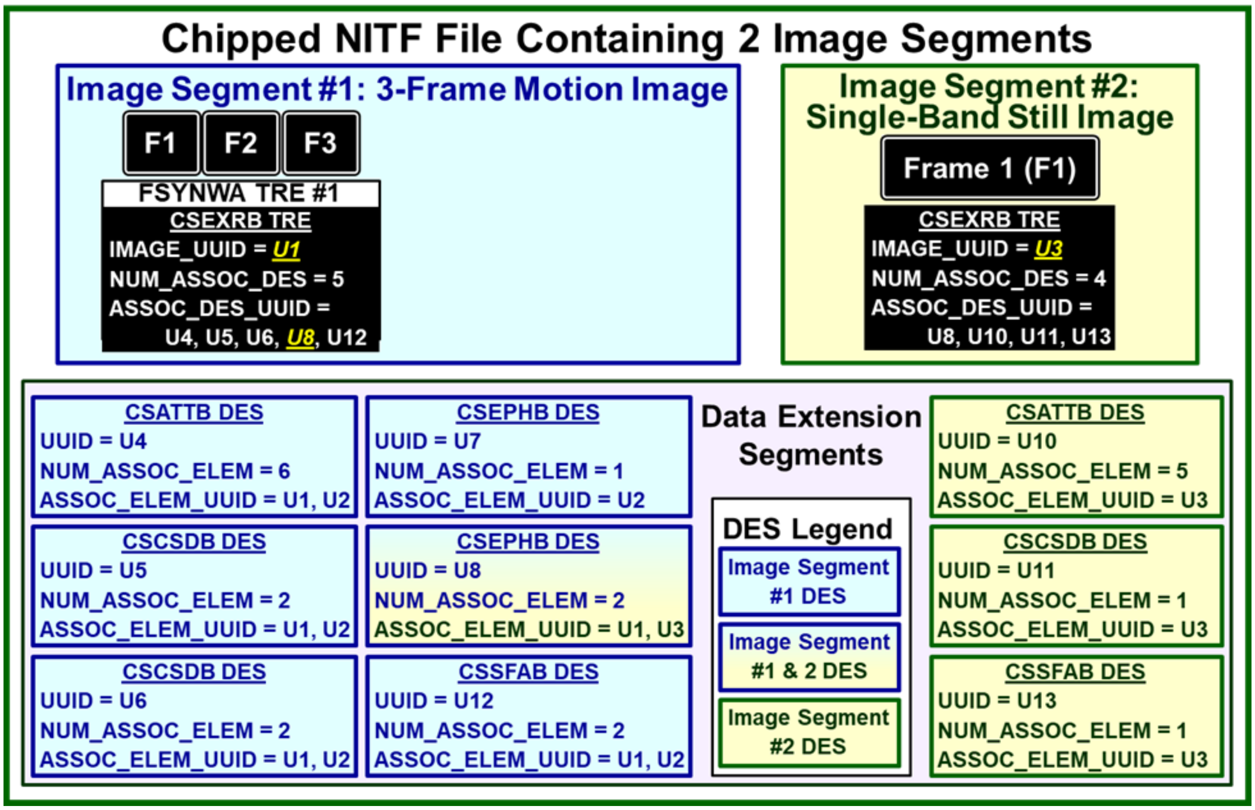

Figure AH.7-2: Example of a Chipped NITF File

AH.8 MAINTENANCE AND LIFE CYCLE

AH.8.1 Downstream Processing

With one exception, downstream users/applications shall not make any alterations to the GLAS and GFM SDEs as emphasized in the descriptions of each TRE and DES.

The one case where an alteration to the CSCSDB DES is warranted is after triangulation or registration of the image has been performed, and the application wants to store the results of this procedure in the NITF file. In this case, the application shall change the value of the field "DIRECT_COVARIANCE_FLAG" from "0" to "1" and populate the fields in the section of the CSCSDB DES that apply when DIRECT_COVARIANCE_FLAG = 1.

AH.8.2 Activating GLAS/GFM Reserved Fields

The specifications of the GLAS/GFM SDEs allow additional fields to be added without creating new versions of these SDEs, provided that the following conditions are met:

1. The additional fields do not invalidate or contradict fields defined in a previous version of the SDE.
2. The default value for all added fields is
   a. ECS-A and BCS-A fields: all BCS spaces.
   b. ECS-N and BCS-N fields: all hyphen-minus characters
3. The consumer is guaranteed that any processing performed without the benefit of the additional fields will at worst be less precise or accurate than if those additional fields were understood.
   a. Correctly implemented processing will never result in outright incorrect results if the additional fields are ignored.

Each GLAS/GFM TRE, as well as the DESDATA section of each GLAS/GFM DES, ends with two fields: RESERVED_LEN, in bytes, and RESERVED, where the number of bytes in the RESERVED field equals RESERVED_LEN. In addition, each GLAS/GFM DES subheader ends with two fields, RESERVEDSUBH_LEN, in bytes, and RESERVEDSUBH, where the number of bytes in the RESERVEDSUBH field equals RESERVEDSUBH_LEN. These fields are designed to allow new metadata and data to be added to the GLAS/GFM SDEs without requiring the creation of a new version of the SDE.

When additional metadata and data are defined, the definition of the relevant RESERVED(SUBH) field(s) shall be rewritten to indicate the normative structure of the additional data. The existence of additional data is signaled by a non-zero length of the RESERVED(SUBH)_LEN field. *Metadata and data shall only be defined for the reserved fields via Requests For Change (RFCs) submitted to and approved by the NTB; individual programs shall not add program-specific fields.*

AH.9 CONFORMANCE CRITERIA

AH.9.1 Definition of Conformance

As stated in ISO 19105-2000 (r2006) *Geographic Information – Conformance and Testing* [Ref. 3], conformance is the fulfilment of specified requirements. An item conforms to a Geospatial Intelligence (GEOINT) standard when it fulfills:

- The mandatory requirements of the standard, and
- The conditional requirements of the standard (when the stated conditions apply), and
- Those optional requirements of the standard needed to enable the purpose of the item.

The mandatory, conditional, and optional fields are clearly identified in the “Type” column of the GLAS/GFM metadata tables in Section AH.6. For the NITFS, the “Type” column labels a mandatory field as “required”, using the abbreviation “R”. The GLAS/GFM data and metadata fields are either required or conditional (Type = “C”); there are no optional fields.

AH.9.2 Conformance Levels

Data providers who populate the GLAS and GFM SDEs are subject to three levels of conformance:

1. Level 0: Incomplete sensor model
2. Level 1 Conformance: Necessary conformance
   a. Necessary GLAS/GFM SDEs and metadata fields completely describe the sensor model, but they may not correctly describe the sensor model
3. Level 2 Conformance: Sufficient conformance

a. GLAS/GFM SDEs correctly and completely describe the sensor model

These three conformance levels are described in Sections AH.9.2.1, AH.9.2.2, and AH.9.2.3 respectively.

AH.9.2.1 Level 0 Conformance: Incomplete Sensor Model

Level 0 conformance is defined as a dataset that does not contain a complete sensor model. Level 0 conformance occurs when the dataset does not contain a sufficient set of GLAS/GFM SDEs, and/or the GLAS/GFM SDEs are not sufficiently populated, to completely describe the sensor model. As a result, the dataset does not contain sufficient information to support geopositioning and/or mensuration, and therefore the dataset does not support MSP functionality.

Level 0 conformance is permissible only when geopositioning and mensuration are not required of the image product. This is often the case for a (near)-raw dataset. The data provider may still use the GLAS/GFM SDEs to provide information necessary to the dataset, such as sensor attitude and ephemeris data using the CSATTB and CSEPHB DESs.

AH.9.2.2 Level 1 Conformance: Necessary Conformance

Level 1 conformance is defined as

1. Minimum set GLAS/GFM SDEs shall be present in the dataset for MSP functionality
2. Correct conditional fields shall be populated
3. Field values shall have the correct data type, size, and value range
4. Data consumers shall be able to accept data when the value of RESERVED_LEN and RESERVEDSUBH_LEN are non-zero

Level 1 conformance is necessary but not sufficient for accurate geopositioning and mensuration. Thus MSP may provide geopositioning and mensuration results, but the MSP results are not necessarily correct.

AH.9.2.3 Level 2 Conformance: Sufficient Conformance

Level 2 conformance is defined as a dataset that meets level 1 conformance criteria, and the GLAS/GFM SDEs correctly describe the sensor model. Therefore, the MSP will provide correct geopositioning and mensuration results.

While Level 1 conformance is a necessary condition, it is not sufficient for accurate mensuration and geopositioning. For example, a data provider may provide field values with the correct byte size and value range, but the field values may be an unreasonable numerical description of reality.

Therefore, Level 2 conformance goes one step further than Level 1 conformance and requires that when the GLAS/GFM SDEs are used to instantiate MSP's GLAS or GFM sensor model, the sensor model shall pass Generic Sensor Exploitation Tool (GSET) external tests as documented in the *CSM Technical Requirements Document (TRD)* and associated appendices that address testing [Ref. 2]. The required test information is available on the CSM Working Group's (CSMWG) portion of the GWG website (http://www.gwg.nga.mil/csmwg.php). GSET external tests consist of:

1. Direct Geopositioning Analysis (DGA), which is aimed at ensuring sensor model absolute accuracy and associated error propagation; and
2. Precision Modeling Analysis (PMA), which is aimed at ensuring that the sensor model internal relative accuracy within an image is modeled adequately.

AH.9.3 GLAS/GFM Pack and Unpack Criteria

AH.9.3.1 GLAS/GFM Pack Criteria

Requirements for implementing, i.e., packing, the GLAS/GFM SDEs are provided in Table AH.9-1.

Table AH.9-1: GLAS/GFM Pack Criteria

Number	Requirement
1	The GLAS SDEs shall all be in the same NITF file as the image(s) that they support.
2	The default TRE location shall be the extended portion of the ISH.
3	If the combined size of the TREs exceed the storage capacity of the extended portion of the ISH, then some of the TREs may be placed in the user-defined portion of ISH.
4	If the combined size of TREs exceeds the size of the combined extended and user-defined portions of the ISH, then the data provider shall place as many TREs as possible in first the extended portion of the ISH, then the user-defined portion of the ISH, and then overflow the remaining TREs to the TRE_OVERFLOW DES.
5	If the CSATTB DES version 2 is implemented and ECI_ECF_ATT = 0, i.e., ECI vectors, then the 32 ECI-to-ECF transformation parameters shall be populated with valid values.
6	If the CSEPHB DES version 2 is implemented and ECI_ECF_EPH = 0, i.e., ECI vectors, then the 32 ECI-to-ECF transformation parameters shall be populated with valid values.
7	Data providers shall only implement CSSFAB DES version 2.
8	The number of image segments associated with a particular DES via the NUMAIS and AISDLVL fields shall be no more than the total n umber of image segments in the NITF file itself.
9	RESERVED_LEN field in GLAS/GFM TREs and data portion of GLAS/GFM DESs: This field shall be set to 0 by data providers.
10	RESERVED field in GLAS/GFM TREs and data portion of GLAS/GFM DESs: Data providers shall omit the reserved field.
11	RESERVEDSUBH_LEN field in subheader portion of GLAS/GFM DESs: This field shall be set to 0 by data providers.
12	RESERVEDSUBH field in subheader portion of GLAS/GFM DESs: Data providers shall omit the reserved field.
13	Data providers shall populate the combination of fields [PLATFORM_ID, PAYLOAD_ID, and SENSOR_ID] in the CSEXRB TRE with a unique set of three values approved by the NTB.

AH.9.3.2 GLAS/GFM Unpack Criteria

Requirements for ingesting, i.e., unpacking, the GLAS/GFM SDEs are provided in Table AH.9-2.

Table AH.9-2: GLAS/GFM Unpack Criteria

Number	Requirement
1	RESERVED_LEN field in GLAS/GFM TREs and data portion of GLAS/GFM DESs: Data consumers shall be able to accept data when the value of RESERVED_LEN is non-zero.
2	RESERVED field in GLAS/GFM TREs and data portion of GLAS/GFM DESs: Data consumers shall ignore the data contained in this field unless the implementation is aware of a future approved revision to the field definition that provides syntax and semantics to the data contained within.

Table AH.9-2: GLAS/GFM Unpack Criteria

Number	Requirement
3	RESERVED field in GLAS/GFM TREs and data portion of GLAS/GFM DESs: Data consumers shall persist all data in a non-zero length RESERVED field when chipping or modifying the NITF file.
4	RESERVEDSUBH_LEN field in subheader of GLAS/GFM DESs: Data consumers shall be able to accept data when the value of RESERVEDSUBH_LEN is non-zero.
5	RESERVEDSUBH field in subheader of GLAS/GFM DESs: Data consumers shall ignore the data contained in this field unless the implementation is aware of a future approved revision to the field definition that provides syntax and semantics to the data contained within.
6	RESERVEDSUBH field in subheader of GLAS/GFM DESs: Data consumers shall persist all data in a non-zero length RESERVEDSUBH field when chipping or modifying the NITF file.