NATO STANDARDIZATION AGENCY
AGENCE OTAN DE NORMALISATION

16 September 2004 NSA/0313-AIR/7023

STANAG 7023 AIR (EDITION 3) – AIR RECONNAISSANCE PRIMARY IMAGERY DATA STANDARD

References:
a. MAS(AIR)0424-AR/7023 dated 12 April 2000 (Edition 2)
b. AC/224-D(2002)8 dated 28 March 2002 (Edition 3)(Ratification Draft)

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page iii is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page iii of the STANAG and, if they have not already done so, advise the Defence Investment Division, through their national delegation as appropriate of their intention regarding its ratification and implementation.

J. MAJ
Brigadier General, POL(A)
Director, NSA

Enclosure:
STANAG 7023 (Edition 3)

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STANAG 7023
(Edition 3)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: AIR RECONNAISSANCE PRIMARY IMAGERY DATA STANDARD

Promulgated on 16 September 2004

J. MAJ
Brigadier General, POL(A)
Director, NSA

0313E-04st7023ed3

RECORD OF AMENDMENTS

N°	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director NATO Standardization Agency under the authority vested in him by the NATO Standardization Organisation Charter.

2. No departure may be made from the agreement without informing the tasking authority in the form of a reservation. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

4. Ratification, implementation and reservation details are available on request or through the NSA websites (internet ***http://nsa.nato.int;*** NATO Secure WAN ***http://nsa.hq.nato.int***).

FEEDBACK

5. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III - 1110 Brussels - BE.

NATO STANDARDIZATION AGREEMENT
(STANAG)

AIR RECONNAISSANCE
PRIMARY IMAGERY DATA STANDARD

Annexes:

A. Auxiliary Data & Encoding Tables
B. Data Definitions
C. Abbreviations and Glossary

Related Documents:

DIAM 57-5	DOD EXPLOITATION OF MULTI-SENSOR IMAGERY
APP 8	ALLIED TACTICAL AIR MESSAGES (FORMATTED AND STRUCTURED)
ATP-47	HANDBOOK FOR AIR RECONNAISSANCE TASKING AND REPORTING
STANAG 3596 AR	AIR RECONNAISSANCE REQUEST AND REPORTING GUIDE
STANAG 3837 AA	AIRCRAFT STORES ELECTRICAL INTERCONNECTION SYSTEM
STANAG 4283 NAV	SPECIFICATIONS AND FORMATS FOR INTEROPERABILITY BETWEEN MARITIME PATROL AIRCRAFT AND MARITIME AIR OPERATIONS CENTERS
STANAG 4545	NATO SECONDARY IMAGERY FORMAT
STANAG 4559	NATO STANDARD IMAGE LIBRARY INTERFACE
STANAG 4575	NATO ADVANCED DATA STORAGE
STANAG 7024 AR	IMAGERY AIR RECONNAISSANCE TAPE RECORDER STANDARD
STANAG 7085 AR	INTEROPERABLE DATA LINKS FOR IMAGING SYSTEMS
ANSI X34-1977	AMERICAN NATIONAL STANDARDS INSTITUTE - AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII)

Table of Contents

1 Introduction

NATO STANAG 7023 establishes a standard data format and a standard transport architecture for the transfer of reconnaissance imagery and associated auxiliary data between reconnaissance Collection Systems and Exploitation Systems. NATO STANAG 7023 is not a communications protocol nor is it a document that will solve implementation issues concerning communications. The design of any system for communications robustness must be made in consideration with STANAGs 7024 and 7085.

Figure 1 illustrates where NATO STANAG 7023 fits into the overall reconnaissance architecture.

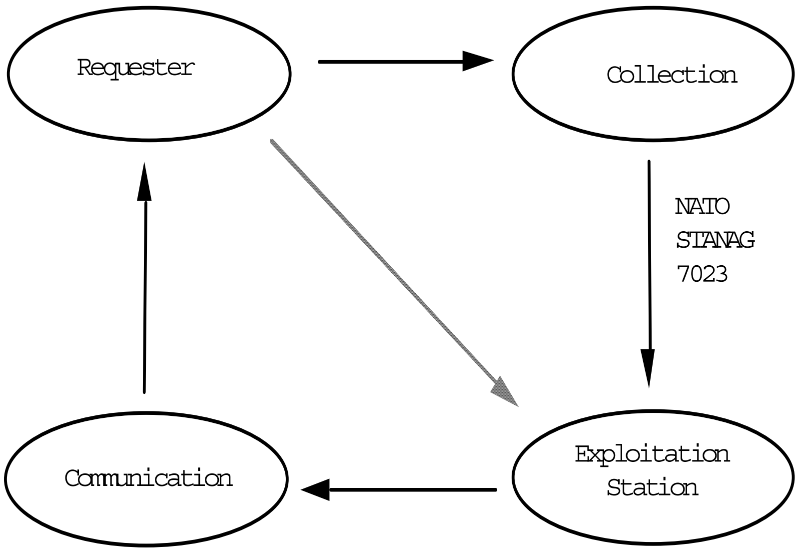


Figure 1 - The Reconnaissance Cycle

NATO STANAG 7023 works in conjunction with other NATO STANAGs 7085, 7024, 4575, 4545, 4559 and 3377 to complete the interface between the Collection System and the Exploitation System.

The flow of information begins in the Collection System. The information is formed into the STANAG 7023 format and then it flows to lower levels of the interface where it may be transmitted on a transport medium or saved on a storage medium. When the information arrives at the Exploitation System the reverse process occurs.

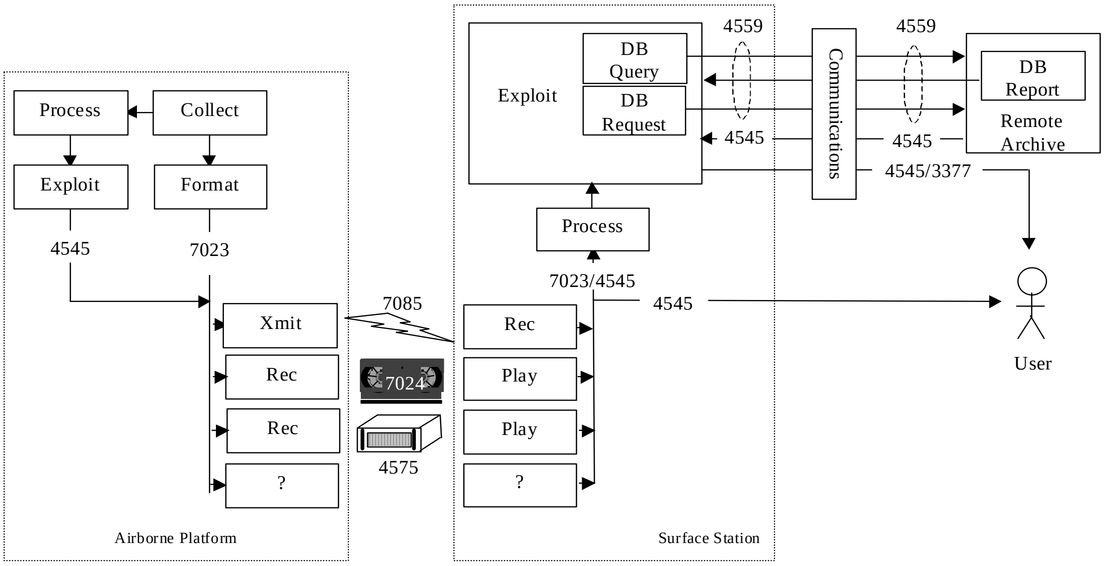


Figure 2 - The Interoperability STANAGs

The following list of top level design aims for NATO STANAG 7023 establish a basis for the design:

- promote interoperability
- handle primary imagery
- handle mission/intelligence data
- work in real time
- minimise platform processing
- assume exploitation of imagery has no prior knowledge of source
- image format does not handicap sensor performance
- digital and analogue versions
- layered/modular architecture
- end-to-end protocol
- self-describing sensor data format
- addressable data files
- multi-sensor/multispectral
- hardware independent
- expandable

NATO STANAG 7023 is a self-describing format. The auxiliary data defines the format of the image data. This enables NATO STANAG 7023 to handle any image from any type of sensor. Figure 3 illustrates this concept.

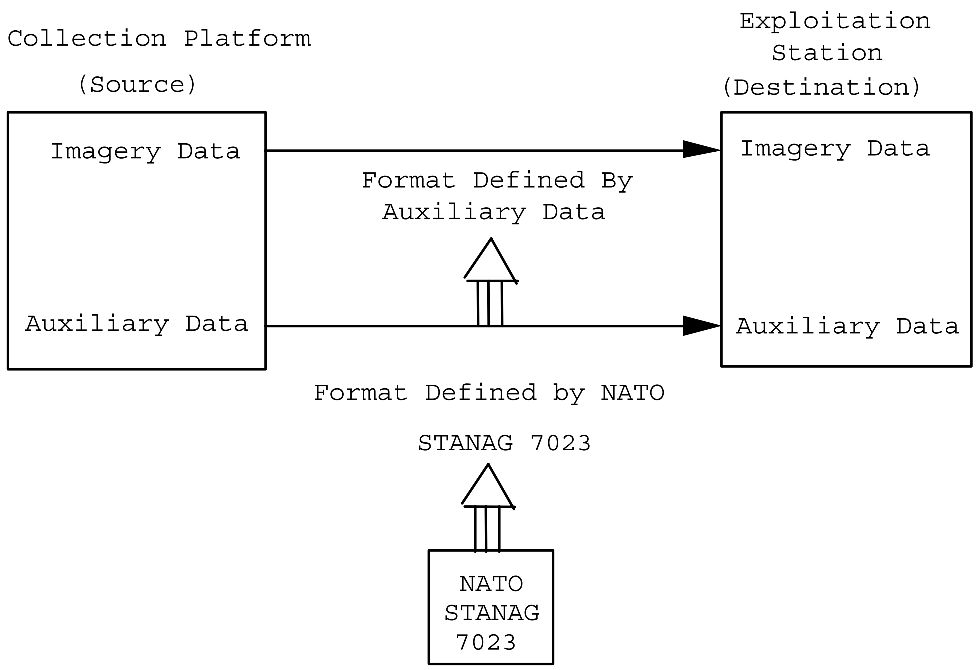


Figure 3 – Self-describing Format

The remainder of this document will focus on the following areas:

- Data Structure - section 2 describes the methodology with which the data is formatted.

- Data Content – section 3 identifies and categorises the reconnaissance data to be transported from a Collection System to an Exploitation System. In Annex A, reconnaissance data is divided into two functional categories:

- sensor data - actual imagery collected from a sensor,

- auxiliary data - information required by an image analyst to derive intelligence information from the imagery and the information required by the Exploitation System to process the raw imagery data into a form which is useable by the imagery analyst.

- Logical Data Format Encoding – section 4 defines the general encoding requirements for the data fields within the header and data files.

- Transport Architecture - section 5 defines the data structures required for the movement of imagery and auxiliary data across the transport media. This section of STANAG 7023 establishes a standard data format encoding for the transfer of reconnaissance imagery and associated auxiliary data between Collection Systems and Exploitation Systems.

- Data Packets – section 6 defines the structure of the data packet to be put on the transport medium.

2 Data Structure

This section defines how sensor and auxiliary data are organised at the source and destination.

2.1 Files

There are basically two general categories of data files: Sensor Output Data Files and Auxiliary Data Files. Associated with each file is a Header. The length of each file is defined in the Header.

Data File Summary

Each Data File is uniquely addressed
Each Data File has an associated Header
Header contains information about the Data File
  Source Address (1 Byte): (256 different Data Sources)
  Data File Address (4 Bytes): (4,294,967,296 different Data Files for each Data Source)
Equivalent to 2^{40} different file types
Data Files are variable in size
Auxiliary Data File format defined by NATO STANAG 7023
Sensor Data File format defined by Auxiliary Data Files

2.1.1 Sensor Output Data Files

Sensor Output Data Files may be of variable length up to a maximum of $FFFF FFFF (4 bytes). The format of the Sensor Data Files is defined in the Auxiliary Data Files. The system designer will determine the method by which sensor data is organised in the data files.

2.1.2 Auxiliary Data Files

Auxiliary Data Files support the processing and exploitation of imagery. The format of the Auxiliary Data Files are defined by this document. They are variable in length and defined by the Data File Size field in the Header. Examples of Auxiliary Data Files are: Mission Data Files, Platform Data Files, and Sensor Parametric Data Files.

2.2 Fields

The field structures for the Auxiliary Data Files are determined by this document. The field structure for Sensor Data Files are described by the Auxiliary Data Files. The fields making up a data file may be either mandatory, conditional, or optional. A value must exist in all mandatory fields. Conditional fields depend on values of other fields. Use of optional fields is left to the discretion of the system designer. If conditional or optional fields are not specified, they will contain a default value for their particular type (see 4.1.2).

2.3 Header

Field No.	Field name	No. of bytes
1	Edition number	1
2	Flags	1
3	Segment number	1
4	Source address	1
5	Data file address	4
6	Data file size	4
7	Data file number	4
8	Time tag	8
9	Sync type	1
10	Reserved	5
11	Cyclic Redundancy Check	2

The Header precedes every data file and contains significant information about the data file. The length of each Header is fixed at 32 bytes. The use of the Header is mandatory.

The Edition number has been included in the Header to ensure that ground replay facilities identify the edition of STANAG 7023 to be decoded. It is the first byte after the Sync to ensure it is decoded correctly, i.e. if in subsequent Editions the Header changed the edition number will still be able to be decoded.

The Source Address field identifies the source of data. This is an 8-bit field, making it possible to multiplex up to 256 simultaneous sources of information.

The next field is the Data File Address. This is a 4-byte field, making it possible to have up to 4,294,967,296 file types for each information source. Several gaps have been intentionally left to facilitate future growth.

2.4 Byte offset addressing

The addressing mechanism used is byte offset from the start of the record. Byte offset is measured from the first byte of the first sync, and includes only the 7023 data (not fill data). The first byte is offset "0" (zero).

3 Data Content

Sources of the data include the air data computer, the inertial navigation unit, the mission computer, and the sensor management system. The data can be divided into two generic categories of data, sensor data and auxiliary data.

7023 Information

Sensor Data	Auxiliary Data
Imagery	Format
	Mission
	Platform
	Sensor Parametric

7023 Data Sources

Sensor Data	Auxiliary Data
Imaging Sensors	Format Description Data - RMS
(64 Simultaneous)	Target Data - Mission Computer
	Platform Data - INS
	Segment/Event Data - RMS
	Sensor Parametric Data – RMS

3.1 Sensor Data

Sensor data is imagery collected from reconnaissance sensors classified by the type of data generated by the sensor system (IR, EO, SAR). This standard characterises sensors by how sensor data (at the interface to the transport/storage interface) is mapped in the image frame.

3.1.1 Sensor Image Data

The sensor image data can be in any form as long as the sensor modelling data can process it. The sensor data can be raw image data directly out of the sensor or it can be data that has been processed.

3.1.2 Sensor Modelling Data

There is a one-to-one correlation between the data in the Sensor Modelling Data Files (Sensor Sample Coordinate and Timing Data Tables) and the Image Data Files (Sensor Data Tables). They are not necessarily the same size in bytes although there is a one-to-one relationship between a pixel and a coordinate component. Softcopy imaging sensors used for mapping purposes shall be accompanied by two-dimensional (2-D) one-to-one sensor mapping data. The STANAG format may incorporate other modelling approaches in the future.

The sensor modelling defaults to a standard sensor model if no modelling data are used:

Modelling Method	**Sensor Type**	**Standard Sensor Model**
BASIC SEQUENTIAL	FRAMING, PAN/STEP FRAME	Planar image plane with equidistant spacing of adjacent samples in each dimension. Image plane is orthogonal to optical axis.
BASIC SEQUENTIAL	LINESCAN	Equiangular spacing of adjacent samples in the high frequency scanning direction. Lines that are grouped together in higher level image components (e.g. swath) are assumed to have been collected in parallel in the low frequency scanning direction.
BASIC SEQUENTIAL	PUSHBROOM	Equidistant spacing of adjacent samples in the high frequency scanning direction. Though lines may be

		grouped into higher level image components (e.g. swath), lines are assumed to have been collected sequentially in the low frequency scanning direction.
COLLECTION PLANE	RADAR, MTI	Depending on physical coordinate system, planar image plane with equidistant or equiangular spacing of adjacent samples in virtual and cross virtual look direction (vld, cvld).
RECTIFIED IMAGE		Planar image plane with equidistant spacing of adjacent samples in the primary and secondary dimension of the image coordinate system (X, Y).

3.1.2.1 Two-Dimensional One-to-One Sensor Mapping Data

Provides the parameters to mathematically map the sensor image to the projected object space. Describes sensor sample ordering, mapping, and modelling parameters. Sensor mapping data is tabular. The tables have the same dimensions as the sensor image frame.

3.1.2.1.1 X, Y and Z Sample Coordinate Data

Provides look angle coordinates for each sample in a frame. This enables processing equipment to map each sample to the projected object space. The format of this data is defined in the Sensor Sample Coordinate Description Data Table.

3.1.2.1.2 Sample Timing Data

Provides timing relationships between each sample in the frame. The time is either the time elapsed since the previous sample (differential) or the time at which the sample was sampled on a running clock (cumulative). The clock is reset periodically. The time at which the clock is reset and the timing techniques are defined with this data. The format of this data is defined in the Sensor Sample Timing Description Data Table.

3.2 Auxiliary Data

Auxiliary data is divided into categories associated with the source of the information. These categories are: format description data, mission data, platform data, event/index data, sensor parametric data.

4 Logical Data Format Encoding

This section defines general encoding requirements for data fields within the header and data files. Logical Data Format Encoding details the logical data organisation and encoding requirements of the reconnaissance data within the transport structures. This format is designed to handle the numerous sensor types and diverse sensor image formats currently in existence and has reserved data areas for future systems.

4.1 General Encoding Requirements

4.1.1 Types of Data File Fields

Headers and auxiliary data files are composed of two basic types of fields: encoded fields or immediate value fields. The encoded value fields contain a value which must be cross referenced to the appropriate lookup table or decoded (e.g. Date Time Group) to determine the information in that field. The immediate value fields contain a value that can be read directly. There are several methods of writing data into immediate value fields, including schemes such as ASCII, Real Number (RN) and Unsigned Binary.

4.1.2 Data Field Default Values

Data Type	**Default (Null) Value**
Real Number (RN) IEEE Double Format	NaN i.e. $FFFFFFFF FFFFFFFF
ASCII	All characters set to $00
Date Time Group	All bytes set to $00
Unsigned Binary (Immediate)	All bytes set to $FF

Data Type	**Default (Null) Value**
Unsigned Binary (Encoded)	A valid encoding unit according to the field

If there is no information to put in a field but it has to be sent as a Mandatory requirement then a default value shall be used in the field.

4.1.3 Time Fields

Throughout this format, time is assumed to be based on Universal Time Coordinated (UTC), also known as Zulu time.

4.1.4 Reserved Fields and Encoding Schemes

Fields and Encoding Schemes unused in the tables are to be considered as “Reserved” for future use.

4.2 Logical Data Format Tables

The logical format of reconnaissance data contained in the Header and Data Files is presented in Annex A in tabular form. Data Tables specify the parameters of each field contained in the Header or Data File.

4.2.1 Header Table

The logical data format of the data packet Header is specified through the use of the Header Data Table.

4.2.2 Auxiliary Data Tables

The logical data format of each Auxiliary Data File is presented via a data table. Located above the data table is the Header Data File Address, which identifies each data file. The tables contain descriptions of the fields and encoding information.

5 Transport Architecture

This section describes how sensor and auxiliary data will be transported from the collection source to the destination exploitation system.

5.1 Transport Scenario

Each data file in source memory is assembled with a Header and sync pattern into a data packet. The data packet is transported to the destination system. At the destination system, the data packet is disassembled.

To add to the robustness of the data transfer, packets can be re-sent. All re-sent packets shall have identical header details.

5.2 Transport Medium Data Structures

Figure 5 illustrates the logical structure of data as it resides on the transport medium.

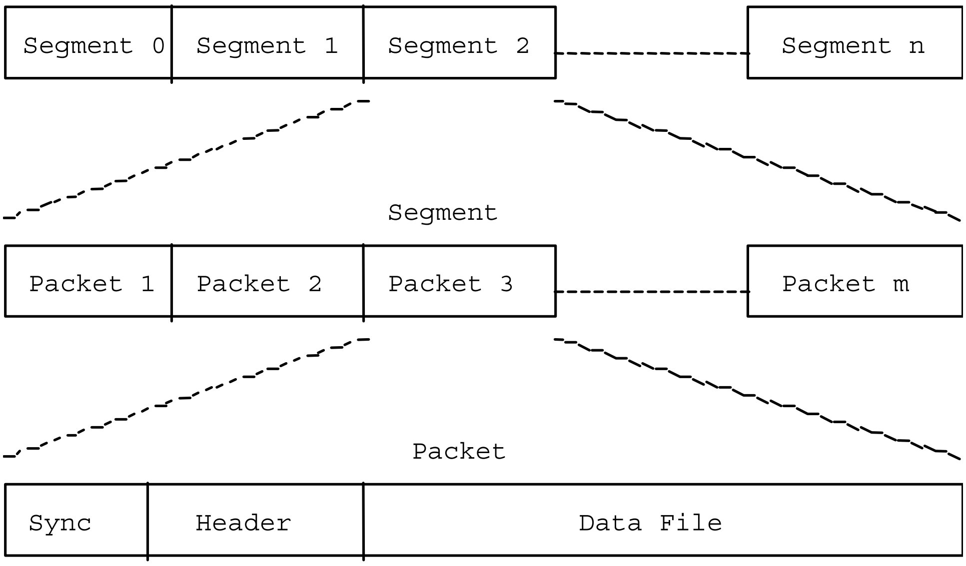


Figure 5 - Record / Segment / Packet Structure

5.2.1 A Record

A record is a collection of segments which in turn are collections of data packets, which are media and system architecture independent, and which may represent all or a portion of the data collected during the course of a mission. This STANAG is concerned with the contents and structure of a single record. Use of multi-records is to be addressed in a future Edition.

The size of a record is the number of bytes contained in the Sync, Header, and Data Files. It does not include any filler bytes outside of the above three types of data packets.

A record will contain a Preamble, one or more Data Segments and optionally Postambles. Figure 6 is a pictorial representation of a record (excluding the End of Segment and End of Record markers).

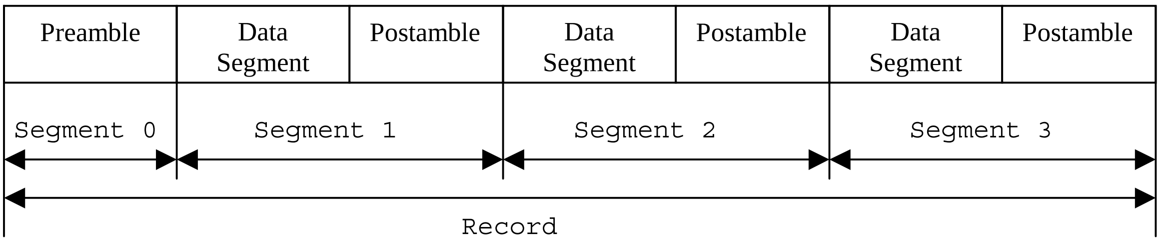


Figure 6 - A Record

5.2.2 Preamble/Postamble

5.2.2.1 Preamble

A 7023 preamble is a collection of 7023 packets received (data link), or read from some medium (tape/disc etc.) before the first data segment. The contents of the preamble shall contain enough information for the receiving ground station to interpret the contents of the following data files/packets (the only proviso being the hardware and software capability exists within the chosen ground station).

For example one would expect to find the following category of data files in the preamble:

Format Description Data	Time Tag.
Sensor Parametric Data	Information required to decode the following sensor data.
Target Data	Target description data.
Mission Data	Mission Details.

The preamble is usually produced prior to the reconnaissance sortie and in this case is not related in time to dynamic tables generated during the sortie. For this reason the Time Tag in the preamble is set to zero. It is possible to post-write data to the preamble within a sortie. In this case the Time Tag in the preamble is also set to zero.

The default settings for the sensors, gimbals, etc are defined in the tables in the preamble. During a data segment these values may change but at the start of each new segment they will take on the default values again.

Preamble data may be repeated in the postamble (with a change of segment number and time tag). Should the preamble be corrupted in any way, the repetition of preamble information would enable imagery data to be recovered. As the size of the preamble data is likely to be minimal compared to the size of the sensor data this repetition is considered to have minimal overhead for transmission or recording.

5.2.2.2 Postamble

A 7023 postamble, if included in a record, is a collection of 7023 packets received, or read from a transport medium after a data segment. The contents of the postamble shall contain enough information for the receiving ground station to interpret the contents of the preceding data files.

The use of the postamble is optional. It may be appended to the preamble (for use with solid state recording media) or it may be appended to the data segment(s). Whichever mechanism of including a postamble is used it should be maintained throughout the record. If a postamble is generated and appended to a data segment then it must be replicated and appended to each subsequent data segment. The postamble segment number will take on the value of the preceding data segment number (even if this requires renumbering of the postamble segment number).

A postamble shall contain enough indexing data files to define the position, type of targets, events and sensor operating periods contained within the preceding data segment.

For example:

Sensor Index Data	Used to interpret the operating periods of the sensors e.g. to calculate possible target coverage by the chosen sensor.
Segment Index Data	Used to define the position of the data segment within the record.
Event Index Data	Used to interpret the targets/events contained within the preceding segment of imagery data. e.g. target position within the preceding data segment (either on media or previously received via data link).

Due to the minimal size of the preamble/postamble in comparison to sensor data, it would be advisable to send/record certain tables even though they have not changed, e.g. Mission Data Tables.

A record containing postambles after the data segments may have the format as:

```
Segment 0
     Preamble files
     End of segment marker
Segment 1
     Data Files
     Preamble files
     Index tables for segment 1
     End of segment marker
Segment 2
     Data Files
     Preamble files
     Index tables for segment 1
     Index tables for segment 2
     End of segment marker
Segment 3
     Data Files
     Preamble files
     Index tables for segment 1
     Index tables for segment 2
     Index tables for segment 3
     End of segment marker
End of Record Marker
```

A record containing a postamble appended to the preamble may have the format as:

```
Segment 0
     Preamble files
     Index tables for segment 1
     Index tables for segment 2
     Index tables for segment 3
     End of segment marker
Segment 1
     Data Files
     End of segment marker
Segment 2
     Data Files
     End of segment marker
Segment 3
     Data Files
     End of segment marker
End of Record Marker
```

5.2.3 Segments

Information recorded over the course of a mission is divided into segments. There are no time gaps within a segment.

The first segment (segment 0) is the preamble.

Each subsequent segment may contain a mixture of sensor and auxiliary information from each operating source.

All packets in segment zero have a time tag = 0. The counter may be running before any packets are written to segment one. The first packet in segment one may have a time tag > 0.

A segment will have the structure of:

```
Segment (number = 0)
     Preamble (auxiliary data)
     Postamble (optional)
     End of Segment marker

Segment (number > 0)
     Data segment (a mix of sensor and auxiliary data)
     Postamble (optional)
     End of Segment marker
```

A data segment is a sub-set of a segment. A Postamble, if used, will follow the data segment.

5.2.3.1 Segment numbering scheme

The preamble is always segment number 0. Postamble files take on the same number as the previous data segment but are identified in the Header by setting a flag.

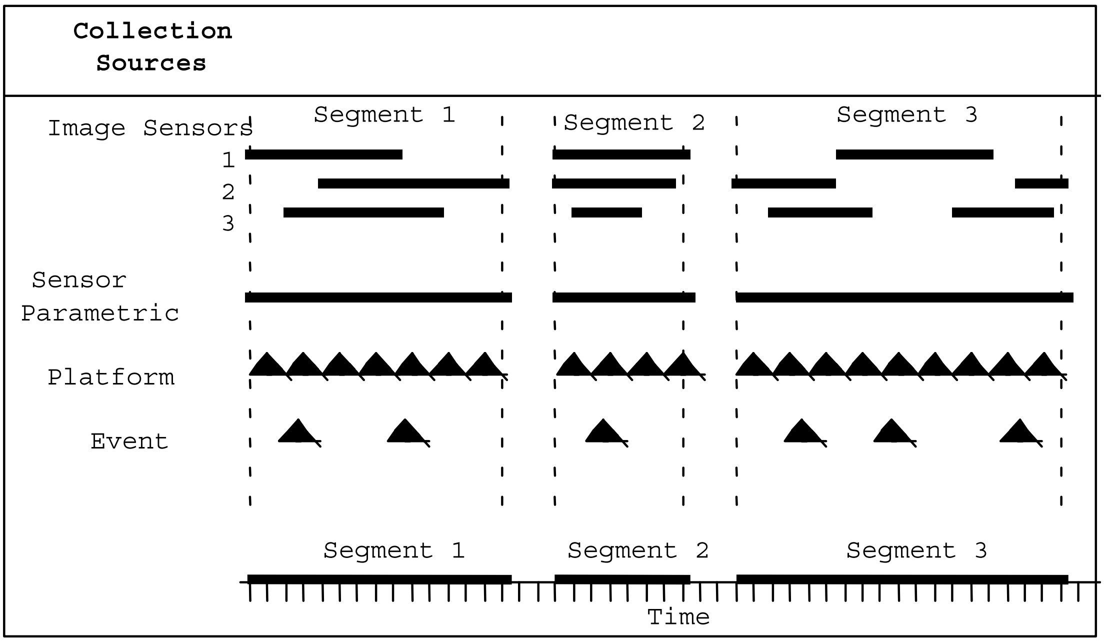


Figure 7 - Relationship of Segments to Events from collection data sources

5.2.3.2 Mandatory Tables

It is mandatory to generate certain tables at specific points of activity within a segment.

Activity	**Mandatory Table**
Change of sensor activation	Sensor Description Data Table (i.e. if Field 9 changes)
Target Event	Event Marker Data Table
End of Segment	End of Segment Marker Data Table
End of Record	End of Record Marker Data Table

Indexing tables can only occur in the preamble and postamble. Dynamic sensor related data tables can only occur in the data segment.

6 Data Packets

A data packet is composed of three fields: the synchronisation field, the header field, and the data field. Each unique packet can be identified by an address in its header field. The system designer must determine how each individual transport system handles the individual packets.

A Packet

Sync	Header	Data File

Sync - 10 Bytes
Header - 32 Bytes
Data File – 1 Byte to 4 GBytes

Figure 8 - Packet Composition

6.1 Synchronisation Field

The 10-byte synchronisation field contains the sync pattern that identifies the beginning of each packet. The serial synchronisation pattern shall be defined as the following bit sequence. The hexadecimal transmission is:

$0D $79 $AB $21 $6F $34 $1A $72 $B9 $1C

The first byte to be transmitted shall be $0D and the last byte shall be $1C in the above sequence.

6.2 Header Field

The Header describes the associated data file. The data source and data file address fields are used together to identify the type of data contained in the associated data file. The 32 byte Header is identically structured for each packet (sensor or auxiliary). The Header section follows the synchronisation field within each packet.

6.3 CRC checks

A Cyclic Redundancy Check (CRC) is a powerful but easily implemented technique to obtain data reliability.

The CRC is mandatory for the Header and optional for the Data File. A Flag in the Header will be set if the CRC is used on the Data File The mandated CRC is CRC-16, based on the CRC polynomial $X^{16} + X^{15} + X^{2} + 1$. Further information on CRC-16, including test code, is at Annex B-3.

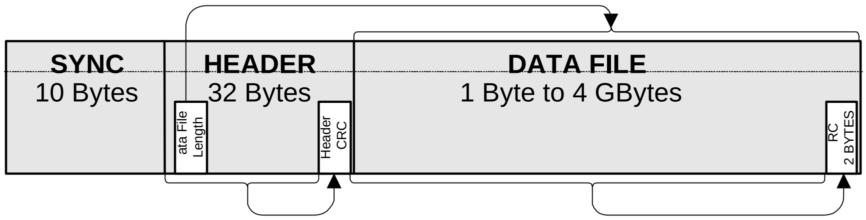


Figure 9 – CRC for Header and Data File

6.4 Data File

The data file contains the bulk of the information to be transferred. The length of the data file is defined in the header. The data file follows the header within each packet. The data file length is inclusive of the CRC bytes if used.

The transmission of data fields in a file is from left to right or top to bottom as they are written in this document.

7 Sensor Data

All Sensor Data Tables are defined on a per sensor basis. A collection platform may define up to 64 sensors. Each sensor is allocated a sensor number in the range $00 to $3F. The source address for a given sensor is generated from a base address plus the sensors ID. The base address for all parametric data is $40. When combined with the sensor number this forms a source address in the range $40 to $7F.

7.1 Sensor Characterisation Models

This type of data is descriptive of a specific sensor type. Specific types of sensors (IR, EO) generate imagery in different forms. As a result, different parameters are required to describe the various forms of data generated by these sensors (thermal IR responses, etc.).

7.2 Coordinate Systems

7.2.1 Overview

There will be a logical progression of position and attitude vectors, which will define the position, and attitude of the collection platform sensor mounting and the sensor itself.

All Position vectors are measured as x, y and z offsets in metres from the origin of the preceding coordinate system.

All Attitude vectors are measured in radians as rotations about the z, y and x axis of the preceding coordinate system.

This "chain" of vectors is defined as follows:

1.	Aircraft Position Vector	A_p
2.	Aircraft Attitude Vector	A_A
3.	Gimbals[0] Position Vector	G_{P0}
4.	Gimbals[0] Attitude Vector	G_{A0}
5.	Gimbals[1] Position Vector	G_{P1}
6.	Gimbals[1] Attitude Vector	G_{A1}
7.	....	....
8.	Gimbals[n] Position Vector	G_{Pn}
9.	Gimbals[n] Attitude Vector	G_{an}
10.	Sensor Position Vector	S_{Pn}
11.	Sensor Attitude Vector	S_{an}
12.	Sensor Sample coordinates *	SSC_{xy}

*The Sensor Sample Coordinates are given for a particular (x, y) sample. These should be given as unit vectors. If these are not given directly they should be calculated when required from the Sensor Description Data. A typical example of the above vectors for a single set of Gimbals is shown below:

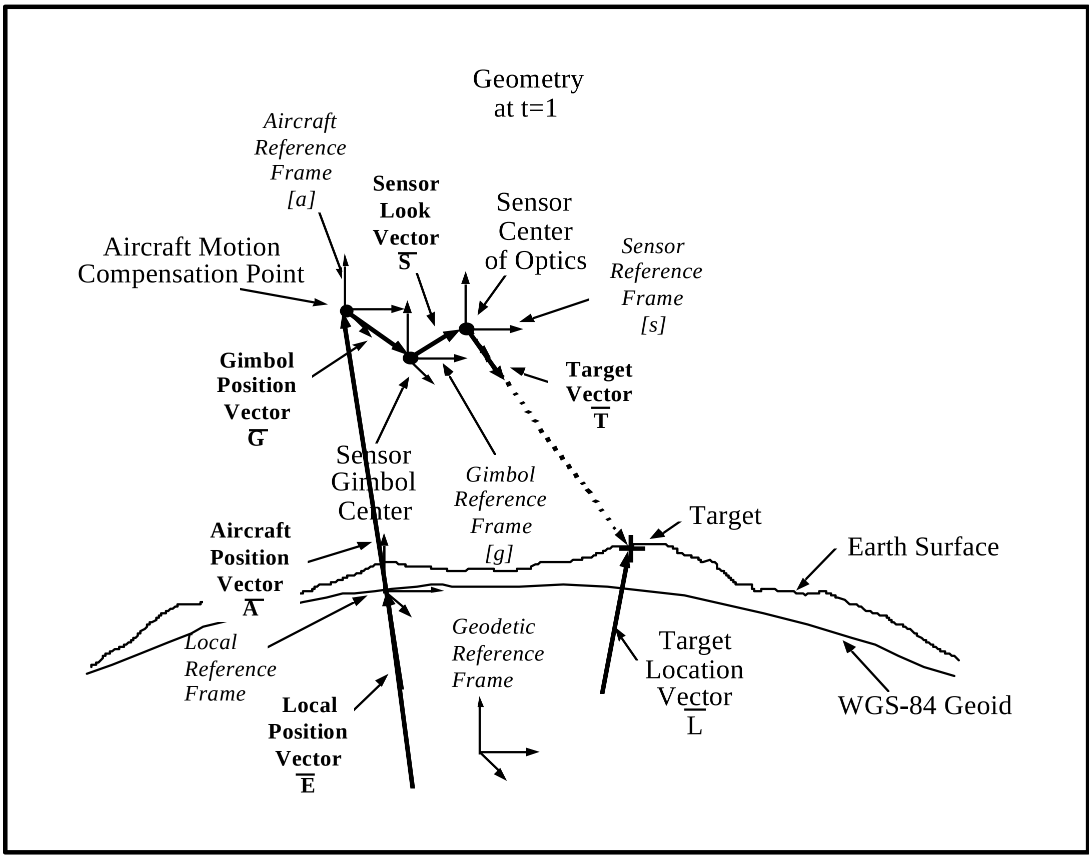


Figure 10 - Vector diagram for Platform, Gimbals and Sensor

7.2.2 Collection Platform Global Position

The global position of the collection Platform is given by its latitude, longitude and height. The STANAG assumes that this position is given for the platform motion compensation point. In practice this may not be true. Where the position is given for some other part of the platform this will introduce small errors.

The accuracy of the position information will be dependent on the navigation system employed. The majority of navigation systems will be Inertial Navigation Systems (INS). It is probable that the collection platform INS will have some error associated with it, due to INS drift. These systems may or may not be periodically corrected using GPS. Dependent upon the GPS system employed it may also have errors associated with it.

The platform height will normally be given by RADALT or barometric pressure. The platform may also be capable of determining its GPS height above the WGS-84 geodetic datum. It is the responsibility of the collection platform to supply the most accurate position and height information that is available.

If the source of the height information is known the relevant field should be used and the other fields set to NaN. If the source is unknown all three fields should be filled with the same data. If it is known that the source is definitely not a particular source, the relevant field should be filled with NaN.

The exploitation platform can make use of the type of height field used within the table to improve its target marking capabilities. GPS height will be assumed to be referenced to the WGS-84 geodetic datum at the given latitude and longitude. RADALT and barometric heights can be assumed to be referenced to the terrain surface and mean sea level at the given latitude and longitude. Using maps that contain terrain information will allow the calculation of the platform above the WGS-84 geodetic datum.

Within STANAG 7023 there is no way to quantify any errors within the INS, although the navigational confidence may be indicated. The Dynamic Platform Data tables allow for latitude, longitude, height above sea level, height above the ground and GPS height. The exploitation platform will have to take the values from the Dynamic Platform Data Tables as accurate and valid for the motion compensation point of the collection platform, while taking into account the navigational confidence. It is possible for the exploitation platform to determine error vectors for latitude and longitude, via correlation of the targets with appropriate map data.

In order to perform tasks such as target marking the position and height of the aircraft may have to be transformed from the global world coordinate system to a local coordinate system.

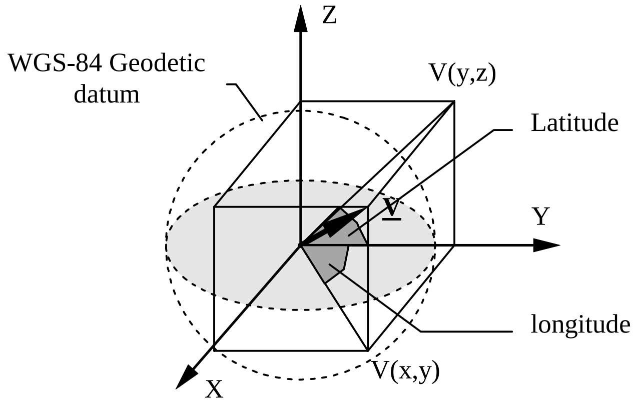


Figure 11 - Global Coordinate System

The collection platform position vector A_p is described in terms of the angle its $A_p(x,y)$ projection it makes with the Y-axis (longitude), the angle its $A_p(y,z)$ projection makes with the Y-axis (latitude) and the magnitude of the vector. The magnitude of the vector gives the distance from the centre of the geodetic datum. This can be directly used to give height above the geodetic datum. Local transforms can then be used to supply a local coordinate system.

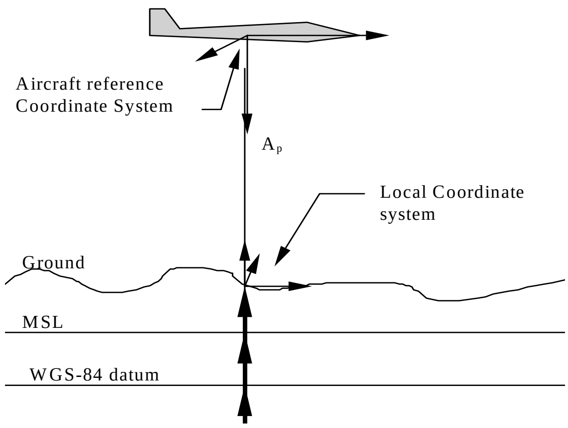


Figure 12 - Local Coordinate System

The height of the platform will usually be given as the height above sea level or the height above ground. GPS can give the height above the WGS-84 geodetic datum.

The position of the aircraft will be defined for the point at which its latitude and longitude vector crosses the height datum. The method used to obtain the platform height will determine the origin of the local coordinate system.

Dependent upon the sophistication of the exploitation platform height may be referenced to a local terrain datum which can be used to determine a more accurate target location or the terrain may be considered flat.

7.2.3 Aircraft Reference

The Roll, Pitch, and Yaw of the aircraft is referenced to the aircraft reference coordinate system. The aircraft reference coordinate system is defined with its positive x-axis along the track of the aircraft. The positive y-axis along the starboard wing and the positive z-axis vertically downwards along the line from the motion compensation point of the aircraft to the NADIR. Such that the artificial horizon defines a plane parallel to the xy plane.

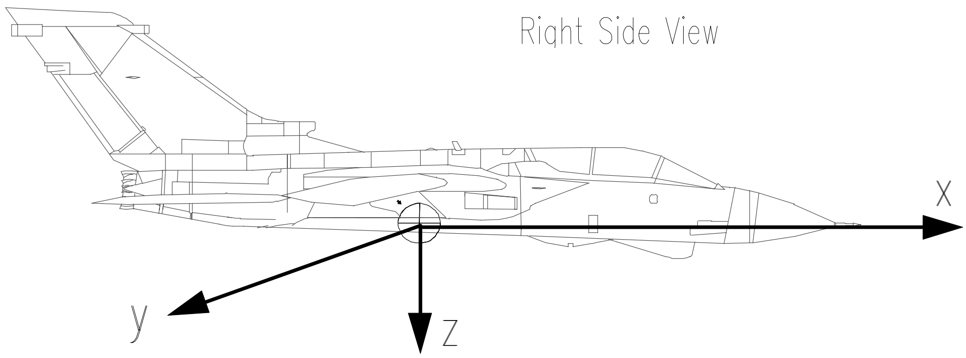


Figure 13 - Aircraft Coordinate System

The parameters for Roll, Pitch, and Yaw are recorded in the Dynamic platform data tables. The senses for Roll Pitch and Yaw are defined below.

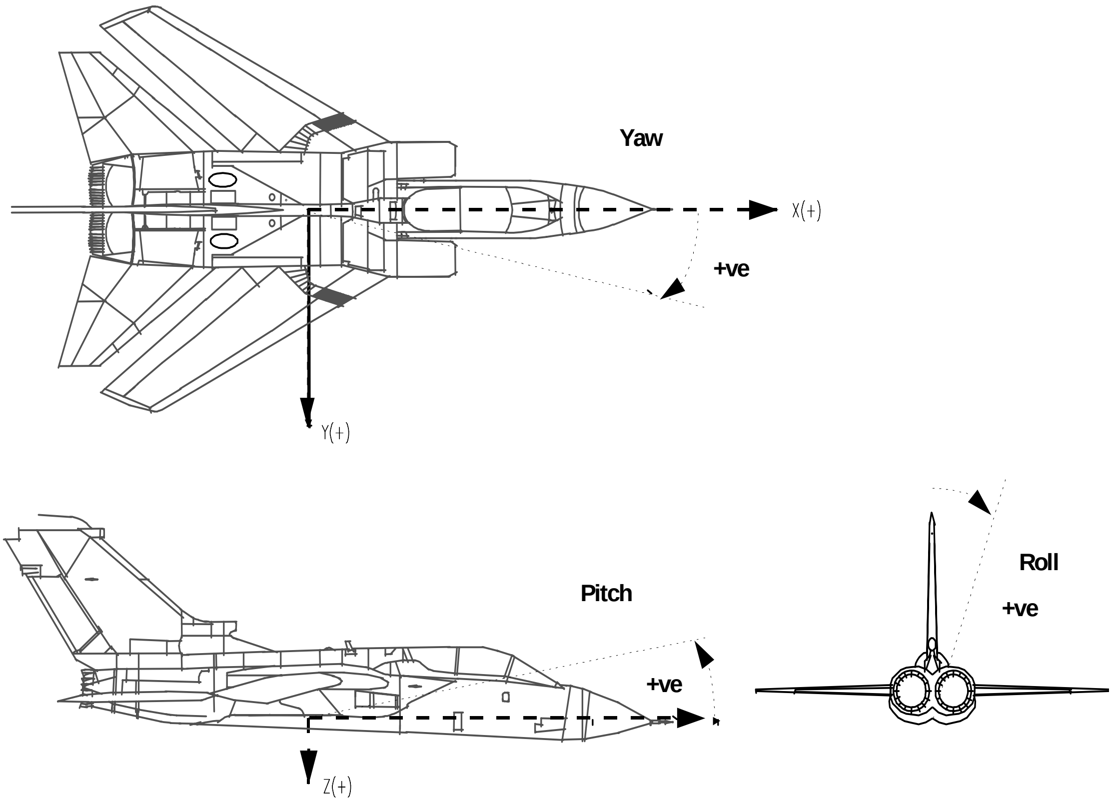


Figure 14 - Sense for Roll, Pitch, and Yaw

7.2.4 Gimbals

The collection platform may or may not have gimbals.

Although platform models may model gimbals for a sensor it is not mandatory to transmit gimbals tables for non existent gimbals. If no gimbals position or attitude tables are sent then the exploitation platform model should assume a position vector of (0,0,0) and an attitude vector of (0,0,0).

Because gimbals may not have coaxial axial centres of rotation it may be necessary to define a single physical gimbals with multiple gimbals tables. The STANAG allows for up to 16 gimbals stages per sensor.

Each gimbals stage will consist of position vector and an attitude vector.

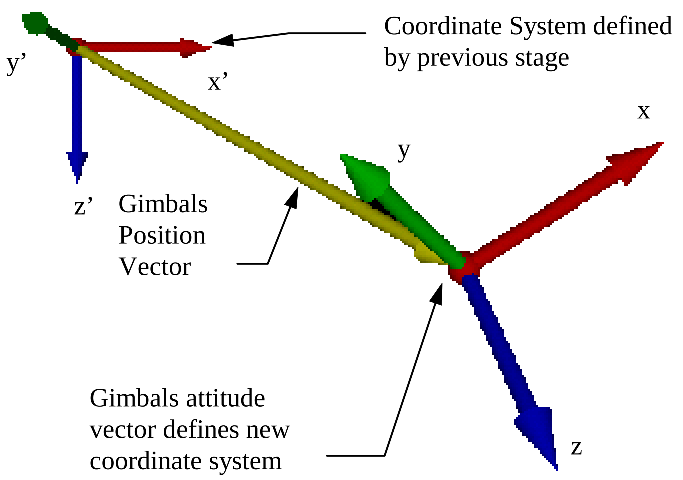


Figure 15 - Gimbals Position and Attitude

The gimbals stages will form a chain of position and attitude vectors. The first stage will have its origin at the platform centre of motion, and be referenced to the platform coordinate system. The last stage will describe the position and attitude for the sensor mounting plate.

7.2.4.1 Gimbals Position Vectors

The gimbals position vector defines the offset of its axis of rotation from the gimbals mounting point. Dependent upon the type of gimbals being described it is possible that this vector may vary during the STANAG 7023 record. Typically however this vector will be used to describe the static or stationary offset of the centre of the rotation of this gimbals stage with respect to the previous stage's coordinate system.

7.2.4.2 Gimbals Attitude

The gimbals attitude vector defines the rotation of gimbals with respect to the previous stage's coordinate system. If the physical gimbals axes of rotation all cross at a single point then a single gimbals attitude vector can be used to describe the rotations possible with the gimbals, as in case 1 below. If the gimbals are not coaxial then multiple gimbals stages will be needed, as in case 2 below.

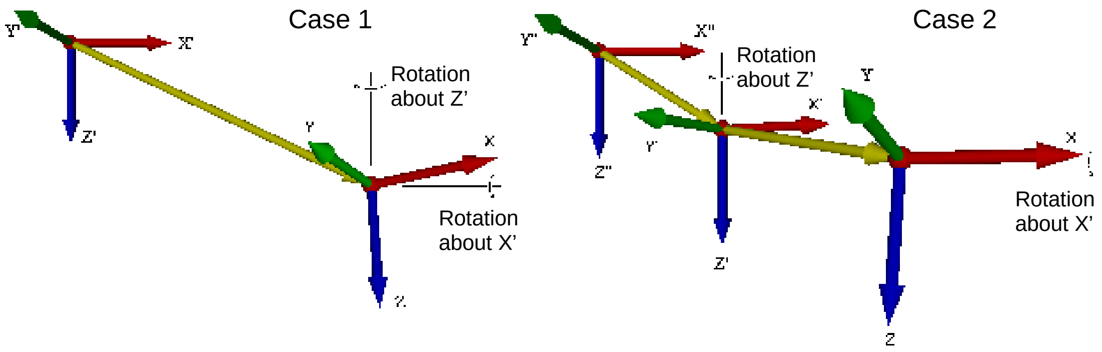


Figure 16 - Single and multiple stage gimbals

Multiple gimbal stages can also be used to simplify gimbals rotation at some arbitrary orientation. The first gimbal stage is used to define an offset and rotation to the arbitrary orientation. The second stage then defines an offset of zero and a rotation about a single axis. The first stage position, attitude and the second stage position tables need only be written during the preamble. The second stage attitude is then only written when it changes. This will simplify the collection platform as no calculations are required to report changes to the gimbals attitude and the change can be written directly as a single field in the second stage attitude table.

7.2.5 Sensor

It is possible for a collection platform to not transmit any gimbals tables but to directly show the position and attitude of the sensor with respect to the platform centre of motion. If no gimbals positions or attitudes are transmitted then these should be modelled as zero. The sensor position and attitude are then effectively referenced from the platform's centre of motion.

The sensor has its own coordinate system. All sensors are assumed to have the look vector along the x-axis.

Linescan sensors scan lines in the xy plane. Unless otherwise stated by sensor modelling the scan is assumed to be the (Line FOV/2) either side of the x-axis. Frame scan sensors are assumed to scan lines as per linescan sensors and frames in the z direction. Unless otherwise stated by sensor modelling the scan is assumed to be the (Frame FOV/2) either side of the x-axis.

The actual scan direction +/- y and +/- z is defined in the sensor description data table. Where y is in the high frequency scanning direction and z is in the low frequency scanning direction.

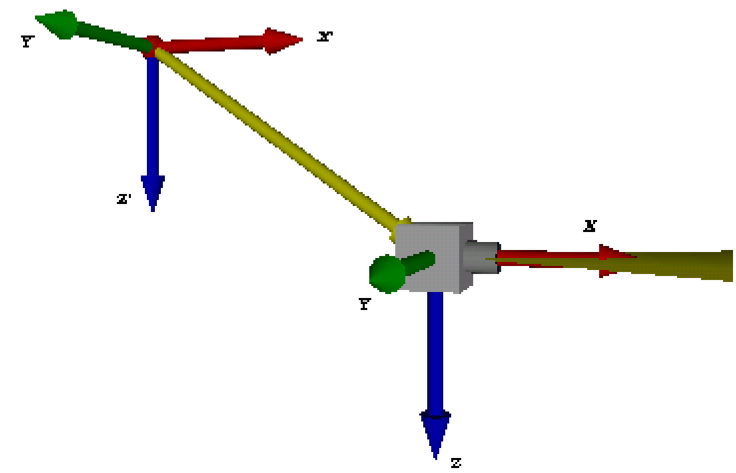


Figure 17 - Sensor Look vector

Where x', y' and z' are the coordinate system defined by a previous stage.

7.2.5.1 Sensor Position Vector

The sensor position vector describes the position of the sensor's centre of optics with respect to its mounting origin.

7.2.5.2 Sensor Attitude

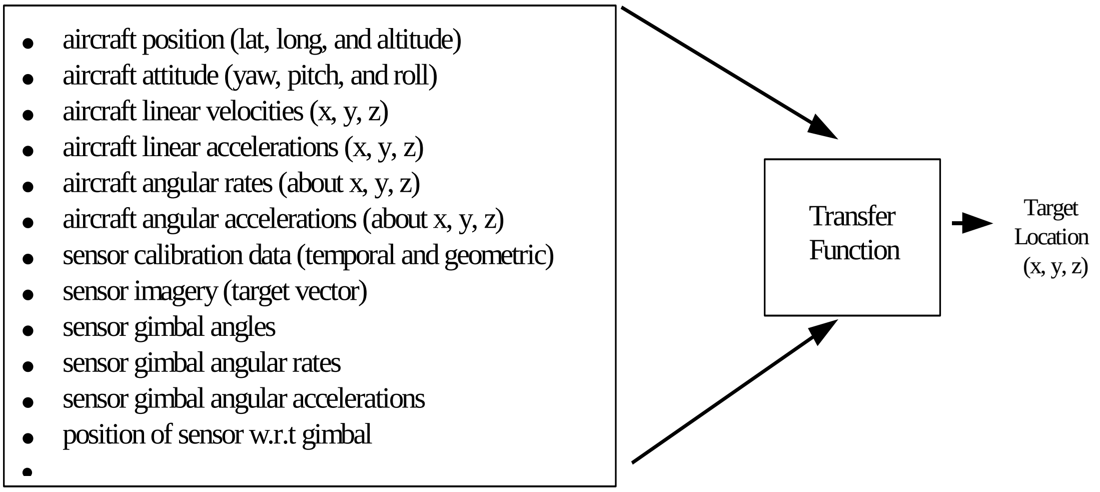
The sensor attitude vector describes the look vector of the sensors optics. The rotation vector can be used to apply a rotational offset to the sensor for scanning directions other than +/- y for lines and +/- z for frames.

7.2.6 Sample Look vectors

The Sample Look vector for a given sample can be obtained either directly from sensor modelling data or indirectly from the field of view and the number of pixels.

7.3 Target Marking and Mensuration

One of the requirements of reconnaissance imagery is to be able to derive target coordinates from the imagery and to make distance measurements on or from the imagery. This is sometimes difficult because imagery has several types of distortions. NATO STANAG 7023 contains the required information to characterise the distortions of the imagery so the imagery interpreter can perform mensuration and target locating from the reconnaissance imagery.



The model presented below is a first order model and does not take first order and second order derivatives into account.

In order to perform target marking and mensuration it is necessary to calculate the sample position vector (or base vector) and look vector for a given sample. This basically gives the position of the centre of optics and a unit vector in the look direction of the sample. If the image samples are transformed for display an inverse transform will have to be applied to the display pixel before performing the following calculation.

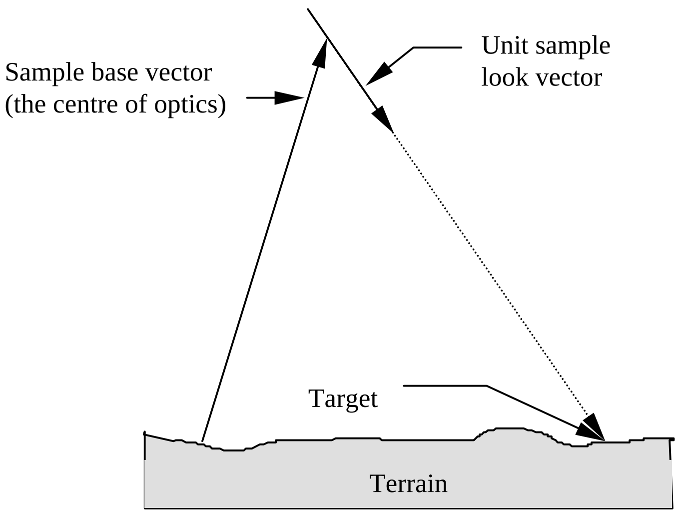


Figure 18 - Base Vector and Sample Look Vector

Conceptually it is relatively simple to calculate the position of the sensor centre of optics and its look vector, from the platform, gimbals and sensor vectors described above.

$$[R] = [P_p] * [P_A] * [G_{P0}] * [G_{A0}] * \ldots\ldots [G_{Pn}] * [G_{An}] * [S_p] * [S_A]$$

where:

R is the resultant transformation matrix.
P_p is the translation matrix for the platforms position.
P_A is the rotational matrix for the platform. (Roll, Pitch, Yaw).
G_{P0} is the translation matrix for the first stage gimbals position.
G_{A0} is the rotational matrix for the first stage gimbals.
G_{Pn} is the translation matrix for the nth stage gimbals position.
G_{An} is the rotational matrix for the nth stage gimbals.
S_p is the translation matrix for the Sensor’s position.
S_A is the rotational matrix for the Sensor.

This can then be used to determine the position of the centre of optics by evaluating the resultant transformation matrix for the Sensors centre of optics (0, 0, 0). This will result in a position vector Rp.

We then take the unit look vector for the sample in which we are interested.

The unit vector for the sensor’s centre sample will be (1, 0, 0).

The transformation matrix is then re-evaluated for the unit look vector Rl, of the appropriate sample. The required Resultant unit look vector is then given by (Rl - Rp).

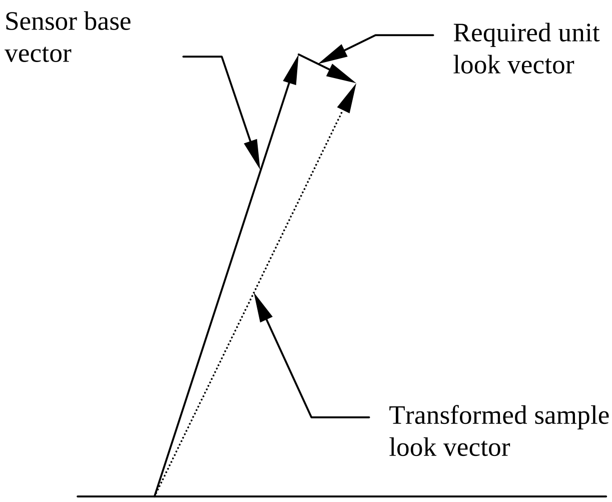


Figure 19 - Calculation of Base and Sample Look Vectors

In practice the position of the platform is given in latitude, longitude and height. This does not lend itself to the above approach without some modification. Two possible approaches are available:

1. Define a local coordinate system at ground level for the aircraft's lat and long. Then assume a flat coordinate system referencing the platform at (0, 0, height) relative to this coordinate system. Any calculated target position would then be at the aircraft latitude and longitude plus an offset to the target.

2. Reference the aircraft location to the centre of the earth. The aircraft height and the target height can be calculated from the WGS-84 ellipsoid and local terrain data. For this it is necessary to define a world coordinate system and its relationship to latitude, longitude and WGS-84.

Annex A – Auxiliary Data and Encoding Tables

The Tables in Annex A allow a collection system to transmit sufficient sensor data and auxiliary data to enable an exploitation system to display and exploit imagery.

It is not necessary for collection systems to use the full set of STANAG 7023 Tables. The set of Tables used by a collection system will be dependent upon the requirements of the platform and sensor suite. The collection system must make no assumptions about the capability of the exploitation system to receive and decode its data stream. If the data is required by the exploitation system and it is available then the collection system should transmit it.

An exploitation system must have the capability to receive the full set of STANAG 7023 Tables.

A-1 Source / Data File Address Structure

Source File	Source Address (Hex)	Data File	Data File Address (Hex)	Annex No.
Format Description Data	$00	Format Time Tag Data Table	$0000 0001	A-3.1
Mission Data	$10	General Administrative Reference Data Table	$0000 0000	A-4.1
	$10	Mission Security Data Table	$0000 0010	A-4.2
	$10	Air Tasking Order Data Table	$0000 0020	A-4.3
	$10	Collection Platform Identification Data Table	$0000 0030	A-4.4
	$10	Requester Data Table	$0000 0040 to $0000 005F	A-4.5
	$10	Requester Remarks Data Table	$0000 0060 to	A-4.6

Source File	**Source Address (Hex)**	**Data File**	**Data File Address (Hex)**	**Annex No.**
			$0000 007F	
Target Data	$11	General Target Information Data Table	$0000 0000 to $0000 0FE0	A-5.1
	$11	General Target Location Data Table	$0000 1000 to $0000 1FEF	A-5.2
	$11	General Target EEI Data Table	$0000 2000 to $0000 2FEF	A-5.3
	$11	General Target Remarks Data Table	$0000 3000 to $0000 3FEF	A-5.4
Platform Data	$20	Minimum Dynamic Platform Data Table	$0000 0000 to $0040 0000	A-6.1
	$20	Comprehensive Dynamic Platform Data Table	$0000 0001 to $0040 0001	A-6.2
	$20	Sensor Grouping Data Table	$0041 0000 to $0041 00FF	A-6.3
Segment/Event Index Data	$30	End of Record Marker Data Table	$0000 0000	A-7.1
	$30	End of Segment Marker Data Table	$0000 0001	A-7.2
	$30	Event Marker Data Table	$0000 0002	A-7.3
	$30	Segment Index Data Table	$0000 0100 to $0000 FF00	A-7.4
	$30	Event Index Data Table	$0000 0101 to $0000 FFFF	A-7.5

Source File	**Source Address (Hex)**	**Data File**	**Data File Address (Hex)**	**Annex No.**
User Defined Data	$3F	User Defined Data Table	$0000 0000 to $0000 FFFF	A-8
Sensor Parametric Data	$40 to $7F	Sensor Identification Data Table	$0000 0000 to $0040 0000	A-9.1
	$40 to $7F	PASSIVE Sensor Description Data Table	$0000 0001	A-11.1
	$40 to $7F	Sensor Calibration Data Table	$0000 0002	A-9.2
	$40 to $7F	Sync Hierarchy and Image Build Data Table	$0000 0003	A-9.3
	$40 to $7F	Sensor Data Timing Data Table	$0000 0004	A-9.14
	$40 to $7F	Sensor Operating Status Data Table	$0000 0006	A-9.4
	$40 to $7F	Sensor Position Data Table	$0000 0010	A-9.5
	$40 to $7F	Minimum Sensor Attitude Data Table	$0000 0020	A-9.6
	$40 to $7F	Comprehensive Sensor Attitude Data Table	$0000 0030	A-9.7
	$40 to $7F	Gimbals Position Data Table	$0000 0050 to $0000 005F	A-9.8
	$40 to $7F	Minimum Gimbals Attitude Data Table	$0000 0060 to $0000 006F	A-9.9
	$40 to $7F	Comprehensive Gimbals Attitude Data Table	$0000 0070 to $0000 007F	A-9.10
	$40 to $7F	Sensor Index Data Table	$0000 0200 to $0000 02FF	A-9.11
	$40 to $7F	PASSIVE Sensor Element Data Table	$0000 1000	A-11.2
	$40 to $7F	Sensor Sample Coordinate Description Data Table	$0000 1010	A-9.12

Source File	**Source Address (Hex)**	**Data File**	**Data File Address (Hex)**	**Annex No.**
	$40 to $7F	Sensor Sample Timing Description Data Table	$0000 1020	A-9.13
	$40 to $7F	Sensor Compression Data Table	$0000 0100	A-10.1
	$40 to $7F	JPEG Sensor Quantisation Data Table	$0000 0101	A-10.3
	$40 to $7F	JPEG Sensor Huffman Data Table	$0000 0102	A-10.4
	$40 to $7F	RADAR Sensor Description Data Table	$0001 0001	A-12.1
	$40 to $7F	RADAR Collection Plane Image Geometry Data Table	$0001 0300	A-12.2
	$40 to $7F	Reference Track Data Table	$0001 0301	A-12.3
	$40 to $7F	Rectified Image Geometry Data Table	$0001 0302	A-12.4
	$40 to $7F	Virtual Sensor Definition Data Table	$0001 0303	A-12.5
	$40 to $7F	RADAR Parameters Data Table	$0001 0304	A-12.6
	$40 to $7F	ISAR Track Data Table	$0001 0305	A-12.7
	$40 to $7F	RADAR Element Data Table	$0001 1000	A-12.8
Sensor Data	$80 to $BF	Sensor Data Table	$0000 0000	A-13.1
	$80 to $BF	Sensor Sample “x” Coordinate Data Table	$0000 0010	A-13.2
	$80 to $BF	Sensor Sample “y” Coordinate Data Table	$0000 0020	A-13.3
	$80 to $BF	Sensor Sample “z” Coordinate Data Table	$0000 0030	A-13.4
	$80 to $BF	Sensor Sample Timing Data Table	$0000 0050	A-13.5
Reserved	$C1 to $FF	Reserved for future source addressing		

A-2 Header Table

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Edition Number	Mand	1	Immed	Unsigned Binary	For example: $02 = Edition 2.
2	Flags	Mand	1	Encode	Unsigned Binary	Bit 0 = Unused. Bit 1 = Compression indicator. Set to “1” when data is compressed. Bit 2 = CRC indicator. Set to “1” when the last two bytes of the data file are used as a CRC error correction code. Bit 3 = Preamble and Postamble table indicator. Set to “1” for preamble and postamble tables.
3	Segment Number	Mand	1	Immed	Unsigned Binary	For example: $03 = Segment number 3.
4	Source Address	Mand	1	Encode	Unsigned Binary	$00 = FORMAT DESCRIPTION DATA $10 = MISSION DATA $11 = TARGET DATA $20 = PLATFORM DATA $30 = SEGMENT/EVENT INDEX DATA $3F = USER DEFINED DATA $40 to $7F = SENSOR PARAMETRIC DATA $80 to $BF = SENSOR DATA
5	Data File Address	Mand	4	Encode	Unsigned Binary	See section A-1.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
6	Data File Size	Mand	4	Immed	Unsigned Binary	The size of the Data File in bytes. Maximum value = $FFFF FFFF.
7	Data File Number	Mand	4	Immed	Unsigned Binary	This is a generation sequence number (not necessarily a transmission sequence number) and acts as a counter per source address within a segment. The initial value for each counter will be zero. The counter values will be reset to zero at segment boundaries. Counter values will be allowed to wrap around within segments.
8	Time Tag	Mand	8	Immed	Unsigned Binary	This is an incrementing counter that increases at a rate defined in the Format Time Tag Data File. The purpose of the Time Tag is to preserve the relative time between events that happen at the source. The value of the Time Tag in the Header is equal to the condition of the Time Tag counter in the source equipment at the time of the first sample in the Data File. For Data Files in segment zero the Time Tag is set to zero. For postambles, the Time Tag has no meaning.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
9	Sync Type	Mand	1	Encode	Unsigned Binary	$00 = INACTIVE $01 = SUPER FRAME SYNC $02 = FRAME SYNC $04 = FIELD SYNC $08 = SWATH SYNC $0A = LINE SYNC $0C = TILE SYNC
10	Reserved	Mand	5			
11	Cyclic Redundancy Check	Mand	2	Encode	Unsigned Binary	CRC-16 Polynomial: $X^{16} + X^{15} + X^{2} + 1$

A-2.1 Use of Data File Number and Time Tag Header Fields

The Data File Number and Time Tag fields are combined to describe specific related data packets. Their use and interpretation is described below.

Packet No.	**Source Address**	**Data File Number**	**Time Tag**	**Remarks**
1	X	0	1	New Packet Type X
2	X	1	2	New Packet Type X
3	X	2	3	New Packet Type X
4	Y	0	3	New Packet Type Y
5	X	3	4	New Packet Type X
6	X	3	5	Invalid Packet Different Time Tags and identical Data File Numbers are not allowed.
7	X	4	6	New Packet Type X
8	X	4	6	Redundant Packet (must contain an exact copy of Packet No 7)

Relationship between Data File Number and Time Tag

A-3 Auxiliary Data Tables

A-3.1 Format Time Tag Data Table

Source Type : Format Description Data
Source Address : $00
File Address : $0000 0001

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Time Tag Increments	Mand	8	Immed	RN	Value of "Tick" in fractions of a second or whole seconds; e.g. the RN value could indicate microseconds or milliseconds. The SI unit of time is the second.

A-4 Mission Data Tables

Mission data is provided for the imagery interpreter and can be transported with imagery data to describe the tasking of the particular sortie being flown. It includes information normally contained in a fragmentary order (FRAG), an abbreviated form of an "Operations (OPS) Order" which is generally more specific and time sensitive.

A-4.1 General Administrative Reference Data Table

Source Type : Mission Data
Source Address : $10
File Address : $0000 0000

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Mission Number	Mand	8	Immed	ASCII	Number assigned to the recce mission.
2	Mission Start Time	Mand	8	Encode	DTG	Mission date and time.
3	Project Identifier Code (PIC)	Opt	2	Encode	ASCII	Project identifier code assigned to the platform. Encoding defined in DIAM 57-5.
4	Number of Targets	Mand	1	Immed	Unsigned Binary	Number of preplanned targets. Range of values: 0-255
5	Number of Requesters	Mand	1	Immed	Unsigned Binary	Number of units requesting reports. Range of values: 0-32 There can be no Requesters or up to 32 Requesters.

A-4.2 Mission Security Data Table

Source Type : Mission Data
Source Address : $10
File Address : $0000 0010

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Mission Security Classification	Mand	64	Immed	ASCII	Security classification of the overall mission.
2	Date	Opt	8	Encode	DTG	Effective date of security classification guide.
3	Authority	Opt	60	Immed	ASCII	Authority issuing the downgrade. The security Classification Guide.
4	Downgrading Instructions	Opt	1024	Immed	ASCII	Downgrading instructions.

A-4.3 Air Tasking Order Data Table

Source Type : Mission Data
Source Address : $10
File Address : $0000 0020

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Air Tasking Order Title	Mand	7	Immed	ASCII	Reference number - identifies the ATO.
2	Air Tasking Order Originator	Mand	20	Immed	ASCII	Unit designator of ATO point of origin.
3	Air Tasking Order Serial Number	Opt	10	Immed	ASCII	Unique number which identifies the specific mission.
4	Date Time Group	Opt	8	Encode	DTG	Date and Time the ATO originated.
5	Qualifier	Opt	3	Immed	ASCII	Denotes a version of the basic ATO.
6	Qualifier Serial Number	Opt	2	Immed	Unsigned Binary	Starts at 1 for first qualifying message sent for basic ATO.

A-4.4 Collection Platform Identification Data Table

Source Type : Mission Data
Source Address : $10
File Address : $0000 0030

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Squadron	Opt	6	Immed	ASCII	Identifies squadron performing reconnaissance mission.
2	Wing	Opt	4	Immed	ASCII	Identifies the wing with which the squadron is associated.
3	Aircraft Type	Opt	16	Immed	ASCII	Type of aircraft used in the mission.
4	Aircraft Tail Number	Opt	6	Immed	ASCII	Tail number of aircraft used in the mission.
5	Sortie Number	Mand	2	Immed	Unsigned Binary	A reference used to identify the images taken by all the sensors during one air reconnaissance sortie.
6	Pilot ID	Opt	3	Immed	ASCII	Used to identify the pilot.

A-4.5 Requester Data Table

Each requester is assigned a unique requester index number. STANAG 7023 can handle both Information Requesters and Mission Requesters simultaneously. This table describes the Requester and the required Report type, it also identifies the communications channels to be used.

Source Type : Mission Data
Source Address : $10
File Address Range : $0000 0040 to $0000 005F

File Addressing scheme is $0000 00xx where bits 0-4 represents the Requester Index Number as an offset from $0000 0040.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Report Message Type	Mand	1	Encode	Unsigned Binary	Identifies type of report requested. $01 INFLIGHTREP $02 RECCEXREP $03 IPIR/SUPIR $04 IPIR/SUPIR (ADP) $05 RADARXREP $06 RECCEXREP (ADP)
2	Message Communications Channel	Mand	16	Immed	ASCII	Communications channel used for the transmission of alphanumeric messages.
3	Secondary Imagery Dissemination Channel	Mand	16	Immed	ASCII	Communications channel used for the transmission of processed (annotated) imagery and imagery derived products.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
4	LTOIV (Latest Time of Intelligence Value)	Mand	8	Encode	DTG	The latest time that the information is of value. The time by which the intelligence is to be received by the Requester.
5	Requester Serial Number	Mand	6	Immed	ASCII	Reference number used to identify the requesting agency or unit.
6	Mission Priority	Mand	1	Encode	Unsigned Binary	The priority of the mission to the individual requester. $01 PRIORITY 1 (TOP PRIORITY) $02 PRIORITY 2 $03 PRIORITY 3
7	Requester Address	Mand	512	Immed	ASCII	Address of requester.
8	Requester Type	Mand	1	Encode	Unsigned Binary	Used to identify the type of Requester. $01 MISSION REQUESTER $02 INFORMATION REQUESTER
9	Operation Codeword	Opt	48	Immed	ASCII	Codeword name.
10	Operation Plan Originator & Number	Opt	48	Immed	ASCII	Operation plan details.
11	Operation Option Name - Primary	Opt	48	Immed	ASCII	Primary operation option name.
12	Operation Option Name - Secondary	Opt	48	Immed	ASCII	Secondary operation option name.
13	Exercise Nickname	Opt	48	Immed	ASCII	Nickname of exercise.
14	Message Additional Identifier	Opt	48	Immed	ASCII	Additional information.

A-4.6 Requester Remarks Data Table

The least significant bits of the file address are used to associate the requester remarks with the appropriate requester.

Source Type : Mission Data
Source Address : $10
File Address Range : $0000 0060 to $0000 007F

File Addressing scheme is $0000 00xx where bits 0-4 represents the Requester Index Number as an offset from $0000 0060.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Remarks	Mand	1024	Immed	ASCII	Additional information provided by the requester.

A-5 Target Data Tables

A-5.1 General Target Information Data Table

Targets can be collected on any particular mission, or for any number of operations and for any number of requesters. If the requester or the targets must be associated with a particular operation then target and requester IDs will be used.

The Fields to be completed within the table will depend on the target type; line, area or point.

Source Type : Target Data
Source Address : $11
File Address Range : $0000 0000 to $0000 0FE0

File Addressing scheme is $0000 0xx0 where xx represents the target number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Target Type	Mand	1	Encode	Unsigned Binary	Used to define the target type. $00 POINT $01 LINE $02 AREA $04 STRIP See definitions following this table.
2	Target Priority	Mand	1	Encode	Unsigned Binary	The targets rank of importance or necessity. $01 PRIORITY 1 (TOP PRIORITY) $02 PRIORITY 2 $03 PRIORITY 3

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
3	Basic Encyclopaedia (BE) Number	Opt	16	Immed	ASCII	Pre-established reference number assigned to target.
4	Target Security Classification	Opt	64	Immed	ASCII	Security classification of the individual target.
5	Required Time on Target	Opt	8	Encode	DTG	Time at which the reconnaissance platform is located at the target position.
6	Requested Sensor Type	Opt	1	Encode	Unsigned Binary	Indicates the requested type of imagery collected at this target. $01 FRAMING $02 LINESCAN $03 PUSHBROOM $04 PAN FRAME $05 STEP FRAME $10 SAR $11 MTI
7	Requested Sensor Response Band	Opt	1	Encode	Unsigned Binary	Requested sensor response band. $01 VISUAL $02 NEAR IR $03 IR $04 DUAL BAND $10 MICROWAVE $11 mm WAVE
8	Requested Collection Technique	Opt	1	Encode	Unsigned Binary	Collection technique for this target. $01 VERTICAL $02 FORWARD OBLIQUE

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						$03 RIGHT OBLIQUE $04 LEFT OBLIQUE $05 BEST POSSIBLE
9	Number of Locations	Mand	1	Immed	Unsigned Binary	Number of locations in the target type search.
10	Requester Address Index	Mand	4	Encode	Unsigned Binary	Used to identify Requester(s). LSB = Requester 0 MSB = Requester 31 The 32 bits have a one-to-one mapping with the Requester Index Number. If the bit is set then the Requester(s) require Target Information. Bit 0 maps to $0000 0040 Bit 1 maps to $0000 0041 Bit 2 maps to $0000 0042 .... Bit 31 maps to $0000 005F
11	Target Name	Opt	32	Immed	ASCII	Target reference name.

Definition of target types [ATP-47(A)]:

Point: A point target is a precisely defined point location and should be expressed to an accuracy of 100 metres. The planned sensor coverage should be not less than 100 metres radius around the defined location.

Line: A line search is a section of a Line of Communication (LOC) and is identified by precisely defined point locations for the start and end points, and by a description of the LOC.

Area: Area searches are tasked by identifying the corners of the required area coverage.

Strip: A strip point is a straight line between 2 defined point locations.

A-5.2 General Target Location Data Table

This file is used to determine the target location.

Source Type : Target Data
Source Address : $11
File Address Range : $0000 1000 to $0000 1FEF

File Addressing scheme is $0000 1xxy where xx represents the target number, and y the location number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Start, Target or Corner Location	Mand	8+8	Immed	RN+RN	Latitude and longitude of start location of the target.
2	Start, Target or Corner Elevation	Opt	8	Immed	RN	Elevation of start location of the target in metres.
3	Target Diameter or Width	Opt	8	Immed	RN	Target diameter or width in metres.
4	Map Series	Opt	8	Immed	ASCII	Map series.
5	Sheet Number of Target Location	Opt	14	Immed	ASCII	Map sheet number.
6	Inverse Map Scale	Opt	8	Immed	RN	eg.1:50,000 is RN = 50,000.
7	Map Edition Number	Opt	1	Immed	Unsigned Binary	Edition number of map.
8	Map Edition Date	Opt	8	Encode	DTG	Date of map.

A-5.3 General Target EEI Data Table

Source Type : Target Data
Source Address : $11
File Address Range : $0000 2000 to $0000 2FEF

File Addressing scheme is $0000 2xxy where xx represents the target number, and y the location number.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Target Category/ Essential Elements of Information	Mand	32	Immed	ASCII	Critical items of information that are to be answered regarding the specific target.
2	EEI/Target Category Designation Scheme	Mand	1	Encode	Unsigned Binary	Standard NATO Target definitions. $01 NATO STANAG 3596
3	Weather Over the Target Reporting Code	Opt	7	Encode	ASCII	Standard NATO Codes (TARWI). See document ATP-47 for codes. Forecast weather over the target is the default value. Actual weather over the target can be used if available for input.

A-5.4 General Target Remarks Data Table

Source Type : Target Data
Source Address : $11
File Address Range : $0000 3000 to $0000 3FEF

File Addressing scheme is $0000 3xxy where xx represents the target number, and y the location number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Remarks	Mand	1024	Immed	ASCII	A free text remarks field referring to the mission.

A-6 Platform Data Tables

Platform data is provided for both the interpreter and exploitation processing equipment. This data describes information about the collection platform on which the sensor suite is located.

Any sensor can be associated with any of the dynamic data tables by the Platform ID and by the File Address of the Sensor Identification Data Table.

Note:

- Only one Dynamic Data Table is required per Platform ID, i.e. Minimum or Comprehensive.

A-6.1 Minimum Dynamic Platform Data Table

Source Type : Platform Data
Source Address : $20
File Address : $0000 0000 to $0040 0000

File Addressing scheme is $00xx 0000 where xx represents the Platform ID, and Platform ID = $00 is reserved for the aircraft platform data.

Table Requirement : Conditional on the Comprehensive Dynamic Platform Data Table not sent

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Platform Time	Mand	8	Encode	DTG	Time at which data was collected.
2	Platform Geo-Location	Mand	8+8	Immed	RN+RN	The position of the platform given as latitude and longitude in

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						radians.
3	MSL Altitude	Cond	8	Immed	RN	Altitude above mean sea level. A value for height must appear in 1 or more of fields 3, 4 or 5.
4	AGL Altitude	Cond	8	Immed	RN	Altitude above ground level. A value for height must appear in 1 or more of fields 3, 4 or 5.
5	GPS Altitude	Cond	8	Immed	RN	Altitude above the WGS-84 geodetic datum. A value for height must appear in 1 or more of fields 3, 4 or 5.
6	Platform true airspeed	Cond	8	Immed	RN	Airspeed. This field is conditional on field 7. One or other or both must be sent.
7	Platform ground speed	Cond	8	Immed	RN	Velocity over the ground. This field is conditional on field 6. One or other or both must be sent.
8	Platform true Course	Cond	8	Immed	RN	Platform ground track angle relative to true north . Platform heading corrected for drift. Either field 12 or field 8 must be sent.
9	Platform true Heading	Mand	8	Immed	RN	Platform heading relative to true north.
10	Platform Pitch	Mand	8	Immed	RN	Rotation about the y-axis

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						Nose up = +ve. 0.0 = Platform z-axis aligned to Nadir.
11	Platform Roll	Mand	8	Immed	RN	Rotation about x-axis Port wing up = +ve.
12	Platform Yaw	Cond	8	Immed	RN	Angle of heading from track over ground. Rotation about z-axis in the xy plane Nose starboard to track = +ve. Either field 12 or field 8 must be sent.
13	Navigational Confidence	Opt	3	Encode	Unsigned Binary	The following 2-bit codes exist for all fields above 12 * 2 = 24bits = 3bytes. $0 FAIL $1 POSSIBLE FAILURE $2 DE-RATED $3 FULL SPECIFICATION

Order of Navigational Confidence 2-bit codes:

MSByte								LSByte			
F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1

Where Fn is a 2-bit code for field number n, as defined above. E.g. F1 is a 2-bit code that gives the navigational confidence of the field 1 the Platform Time, F2 is a 2-bit code which gives the navigational confidence of the field 2 the Platform Geo-Location.

A-6.2 Comprehensive Dynamic Platform Data Table

Source Type : Platform Data
Source Address : $20
File Address : $0000 0001 to $0040 0001

File Addressing scheme is $00xx 0001 where xx represents the Platform ID, and Platform ID = $00 is reserved for the aircraft platform data.

Table Requirement : Conditional on the Minimum Dynamic Platform Data Table not sent.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Platform Time	Mand	8	Encode	DTG	Time at which platform data was collected.
2	Platform Geo-Location	Mand	8+8	Immed	RN+RN	The position of the platform given as latitude and longitude in radians.
3	MSL Altitude	Cond	8	Immed	RN	Altitude above mean sea level. A value for height must appear in 1 or more of fields 3, 4 or 5.
4	AGL Altitude	Cond	8	Immed	RN	Altitude above ground level. A value for height must appear in 1 or more of fields 3, 4 or 5.
5	GPS Altitude	Cond	8	Immed	RN	Altitude above the WGS-84 geodetic datum. A value for height must appear in 1 or more of fields 3, 4 or 5.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
6	Platform true airspeed	Cond	8	Immed	RN	Airspeed. This field is conditional on field 7. One or other or both must be sent.
7	Platform ground speed	Cond	8	Immed	RN	Velocity over the ground. This field is conditional on field 6. One or other or both must be sent.
8	Platform true Course	Cond	8	Immed	RN	Platform ground track angle relative to true north. Platform heading corrected for drift. Either field 12 or field 8 must be sent.
9	Platform true Heading	Mand	8	Immed	RN	Platform heading relative to true north.
10	Platform Pitch	Mand	8	Immed	RN	Rotation about the y-axis Nose up = +ve. 0.0 = Platform z-axis aligned to Nadir.
11	Platform Roll	Mand	8	Immed	RN	Rotation about x-axis Port wing up = +ve.
12	Platform Yaw	Cond	8	Immed	RN	Angle of heading from track over ground. Rotation about z-axis in the xy plane Nose starboard to track = +ve. Either field 12 or field 8 must be sent.
13	Platform Velocity North	Opt	8	Immed	RN	The projection of the velocity vector on an earth stabilised North

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						vector. North is (+).
14	Platform Velocity East	Opt	8	Immed	RN	The projection of the velocity vector on an earth stabilised East vector. East is (+).
15	Platform Velocity Down	Opt	8	Immed	RN	The projection of the velocity vector on a gravity vector. Rate of change of platform altitude. Down is (+).
16	Platform Acceleration North	Opt	8	Immed	RN	The projection of the Acceleration of platform on an earth stabilised North vector.
17	Platform Acceleration East	Opt	8	Immed	RN	The projection of the Acceleration of platform on an earth stabilised East vector.
18	Platform Acceleration Down	Opt	8	Immed	RN	The projection of the Acceleration of platform on an earth stabilised gravity vector.
19	Platform Heading Rate	Opt	8	Immed	RN	Rate of change of platform true heading.
20	Platform Pitch Rate	Opt	8	Immed	RN	Rate of change of platform true Pitch angle.
21	Platform Roll Rate	Opt	8	Immed	RN	Rate of change of platform true Roll angle.
22	Platform Yaw Rate	Opt	8	Immed	RN	Rate of change of platform true yaw

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						angle.
23	Platform Heading angular Acceleration	Opt	8	Immed	RN	Angular acceleration of platform heading.
24	Platform Pitch angular Acceleration	Opt	8	Immed	RN	Angular acceleration of platform Pitch.
25	Platform Roll angular Acceleration	Opt	8	Immed	RN	Angular acceleration of platform Roll.
26	Platform Yaw angular Acceleration	Opt	8	Immed	RN	Angular acceleration of platform Yaw.
27	V/H	Opt	8	Immed	RN	The ratio of velocity to height. Used to correct sensor geometry.
28	Navigational Confidence	Opt	7	Encode	Unsigned Binary	The following 2 bit codes exist for all fields above 27 * 2 = 54bits = 7bytes. $0 FAIL $1 POSSIBLE FAILURE $2 DE-RATED $3 FULL SPECIFICATION

Order of Navigational Confidence 2-bit codes:

MSByte				-------				LSByte			
NU	F27	F26	F25	F24	-------	-------	F5	F4	F3	F2	F1

Where Fn is a 2-bit code for field number n, as defined above. E.g. F1 is a 2-bit code that gives the navigational confidence of the field 1 the Platform Time, F2 is a 2-bit code which gives the navigational confidence of the field 2 the Platform Geo-Location.

A-6.3 Sensor Grouping Data Table

Source Type : Platform Data
Source Address : $20
File Address : $0041 0000 to $0041 00FF

The Group ID number is encoded into the last Byte of the File Address.
This table is of variable length dependent upon the number of sensors in the group.
Table size = (n + 4) bytes.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Group type	Mand	1	Encode	Unsigned Binary	$00 = Coverage $01 = Spectral
2	Number of sensor numbers within the Group	Mand	1	Immed	Unsigned Binary	Number of sensor source IDs that are grouped together, e.g. #n.
3	Coverage relationship	Mand	1	Encode	Unsigned Binary	$00 = None $01 = 100% Overlapped (nominally identical coverage) $02 = less than 100% Overlapped $03 = Abutted
4	Timing relationship	Mand	1	Encode	Unsigned Binary	$00 = Simultaneous $01 = Sequential $FF = No timing relationship
5	Sensor number	Mand	1	Immed	Unsigned Binary	Sensor number #1

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
6	Sensor number	Cond	1	Immed	Unsigned Binary	Sensor number #2
						Repeat until all #n sensor numbers are recorded.
n+4	Sensor number	Cond	1	Immed	Unsigned Binary	Sensor number #n

A-7 Segment/Event Data Tables

A-7.1 End of Record Marker Data Table

This table is to mark the end of a record. Its Header segment value will increment by one from the previous End of Segment Marker (EOS) value. The exception to this rule is when the last EOS Header segment number = $FF (the maximum permitted value) then the EOR Header segment value will also take on the value $FF. In all situations this table will be considered independent of the previous segment.

Segment	EOS	Segment	EOS		Segment	EOS	EOR
0	0	1	1	Repeat for segment 2 onwards	N or $FF	N or $FF	N+1 or $FF

Where EOS = End of Segment Marker Data Table, EOR = End of Record Marker Data Table.

Source Type : Segment/Event Data
Source Address : $30
File Address : $0000 0000
Table Requirement : MANDATORY

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Size of record	Mand	8	Immed	Unsigned Binary	The total number of bytes in the whole of the record including this table.

A-7.2 End of Segment Marker Data Table

This table is to mark the end of a segment. It is the last segment table to be generated for the segment. The Time Tag value in the Header must be equal to or exceed the value for all previous Time Tags generated for other segment data files.

Source Type : Segment/Event Data
Source Address : $30
File Address : $0000 0001
Table Requirement : MANDATORY

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Size of segment	Mand	8	Immed	Unsigned Binary	The total number of bytes in the whole of the segment including this table.

The EOS Marker Data Table shall follow the postamble (if used). The EOS Marker Data Table shall count the number of bytes in the whole of the segment including the EOS Marker Data Table itself. The EOS Marker Data Table shall not be regarded as part of the preamble or postamble and shall not be repeated in the postambles of subsequent segments.

A-7.3 Event Marker Data Table

This table is used to mark the position of an event in the data segment.

Source Type : Segment/Event Data
Source Address : $30
File Address : $0000 0002
Table Requirement : CONDITIONAL on an event occurring.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Event Number	Mand	1	Immed	Unsigned Binary	Event number. ($00 - $FF)
2	Event Type	Mand	1	Encode	Unsigned Binary	$00 Pre-programmed Point Event/Target $01 Pre-programmed Duration START $02 Pre-programmed Duration END $03 Manual Point Event/Target $04 Manual Duration START $05 Manual Duration END $06 Recce Waypoint $07 Automatically Generated Event
3	Primary Sensor Number	Mand	1	Immed	Unsigned Binary	If there is only one sensor: Set fields 3, 4 and 5 to the primary sensor number.
4	Secondary Sensor Number	Opt	1	Immed	Unsigned Binary	If there are two sensors: Set field 3 to the primary sensor number, and Set fields 4 and 5 to the secondary sensor number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
5	Third Sensor Number	Opt	1	Immed	Unsigned Binary	If there are three sensors: Set field 3 to the primary sensor number, and Set field 4 to the secondary sensor number, and Set field 5 to the tertiary sensor number.
6	Target number	Opt	1	Immed	Unsigned Binary	Target number ID. If no target then value = $FF

A-7.4 Segment Index Data Table

Functions as a directory used to identify segments that occurred during a record on the transport media. The indexing scheme utilising this data is based on the fact that the structure consists of chronologically ordered data.

Source Type : Segment/Event Data
Source Address : $30
File Address Range : $0000 0100 to $0000 FF00

File Addressing scheme is $0000 xx00 where xx represents the segment number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Start of data segment	Mand	8	Immed	Unsigned Binary	Number of bytes offset from start of record to start of data segment.
2	End of data segment	Mand	8	Immed	Unsigned Binary	Number of bytes offset from start of record to end of data segment.
3	Start time of recording	Mand	8	Encode	DTG	Time imaging started in the data segment defined by this segment index.
4	Stop time of recording	Mand	8	Encode	DTG	Time imaging ended in the data segment defined by this segment index.
5	Start of Header Time Tag	Mand	8	Immed	Unsigned Binary	Value of the time tag in the first header of the segment.
6	End of Header Time Tag	Mand	8	Immed	Unsigned Binary	Value of the time tag in the last header of the segment.
7	Aircraft location	Mand	8+8	Immed	RN+RN	Aircraft latitude and longitude

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
	at the start of recording of the segment					location at segment start.
8	Aircraft location at the end of recording of the segment	Mand	8+8	Immed	RN+RN	Aircraft latitude and longitude location at segment end.

A-7.5 Event Index Data Table

The Event Index data structure keeps a chronological record of each event. The Event Index data structure can be thought of as a table of contents for the entire record.

Source Type : Segment/Event Data
Source Address : $30
File Address Range : $0000 0101 to $0000 FFFF

File Addressing scheme is $0000 xxyy where xx represents the segment number, and yy the event number. xx and yy have the range $01 to $FF.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Event Type	Mand	1	Encode	Unsigned Binary	$00 Pre-programmed Point Event/Target $01 Pre-programmed Duration START $02 Pre-programmed Duration END $03 Manual Point Event/Target $04 Manual Duration START $05 Manual Duration END $06 Recce Waypoint $07 Automatically Generated Event
2	Target Number	Cond	1	Immed	Unsigned Binary	If event is imaging over a target then value = Target Number If no target then value = $FF
3	Target Sub-section	Cond	1	Immed	Unsigned Binary	If the event is not a Point Event then this is the associated leg or corner number. If the event is a Point Event the field value = $00.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
4	Time Tag	Mand	8	Immed	Unsigned Binary	Time Tag in Header.
5	Event Time	Opt	8	Encode	DTG	The time of the event in DTG format.
6	Aircraft Geo-Location	Opt	8+8	Immed	RN+RN	Latitude and Longitude. Platform location in radians.
7	Primary Sensor Number	Mand	1	Immed	Unsigned Binary	If there is only one sensor: Set fields 7, 8 and 9 to the primary sensor number.
8	Secondary Sensor Number	Opt	1	Immed	Unsigned Binary	If there are two sensors: Set field 7 to the primary number, and Set fields 8 and 9 to the secondary sensor number.
9	Third Sensor Number	Opt	1	Immed	Unsigned Binary	If there are three sensors: Set field 7 to the primary sensor number, and Set field 8 to the secondary sensor number, and Set field 9 to the tertiary sensor number.
10	Event position in the record	Mand	8	Immed	Unsigned Binary	Number of bytes offset from start of record to start of event.
11	Event Name	Opt	32	Immed	ASCII	Reference name of the event.

A-8 User Defined Data Tables

A section of the address space has been reserved for user defined tables. The format and contents of the tables are to be determined by the user. The User Defined Tables must not contain any information necessary for the interpretation or exploitation of the data.

Non host exploitation systems should be aware that data in these tables will be irrelevant to their system and should not be acted upon.

The use of these tables must follow all of the protocols of other STANAG 7023 tables, e.g. a STANAG 7023 Sync and Header must precede the table.

Source Type : User Defined Data
Source Address : $3F
File Address Range : $0000 0000 to $0000 FFFF

File Addressing scheme is $0000 xxxx where xxxx is determined by the user.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**

A-9 Sensor Parametric Data Tables

Auxiliary parameters are used to describe the sensor data thereby allowing destination equipment to decipher the sensor data and to produce a literal image. Sensor Parametric data is divided into two general categories:

1) General sensor description data used to describe any sensor system regardless of the type of sensor. General descriptive data such as sensor identification parameters and sensor data compression information is included in this category.

2) Sensor specific description data.

A-9.1 Sensor Identification Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type	:	Sensor Parametric Data
Source Address	:	$40 to $7F
File Address:	:	$0000 0000 to $0040 0000

The Platform ID (to be associated with the sensor number) is encoded in the upper bytes of the File Address, i.e. $00xx 0000.

File Address $0000 0000 is by default associated with the Aircraft Platform ID. Values $0001 0000 to $0040 0000 are available for 64 Platform IDs. Each sensor can associate itself with any Platform ID.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Sensor Type	Mand	1	Encode	Unsigned Binary	Classification indicative of the characteristics of the collection device. $00 Reserved $01 FRAMING $02 LINESCAN $03 PUSHBROOM $04 PAN FRAME $05 STEP FRAME $10 RADAR real (single mode) $11 MTI $12 RADAR virtual $13 RADAR multi-mode
2	Sensor Serial Number	Opt	16	Immed	ASCII	Serial number of the sensor.
3	Sensor Model Number	Opt	16	Immed	ASCII	Model number of the sensor.
4	Sensor Modelling Method	Mand	1	Encode	Unsigned Binary	Defines the interpretation of the sensor data. $00 BASIC SEQUENTIAL MODELLING $01 VECTOR MODELLING $02 COLLECTION PLANE $03 RECTIFIED IMAGE $04 - $FE RESERVED $FF NOT APPLICABLE
5	Number of Gimbals	Mand	1	Immed	Unsigned Binary	The number of gimbals defined for the sensor. Range of values: 0 to 16.

If the Sensor Modelling Method is VECTOR MODELLING then the following tables are to be used:

Sensor sample “x” coordinate data table
Sensor sample “y” coordinate data table
Sensor sample “z” coordinate data table

A-9.2 Sensor Calibration Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0002

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Calibration date	Mand	8	Encode	DTG	The date the sensor was calibrated.
2	Calibration Agency	Mand	91	Immed	ASCII	The Agency which performed the calibration. Agency name, address and phone number.

A-9.3 Sync Hierarchy and Image Build Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type	:	Sensor Parametric Data
Source Address	:	$40 to $7F
File Address	:	$0000 0003

This table can be used to supplement the Sensor Description Data Table (PASSIVE and RADAR) and is CONDITIONAL on the Sensor Description Data Table being used correctly.

It describes the data structure hierarchy used to sequence samples.
The accumulation strategy of the image components at each hierarchical level is referenced to the X and Y axes of the image:

- X is the first dimension of image coordinate system - sample PDA defines the X axis.
- Y is the second dimension of image coordinate system - sample SDA defines the Y axis.

Build directions are used to indicate the direction of accumulation of image components of a given hierarchical level within the superordinated hierarchical level. A sample is always understood to be an image component subordinate to the lowest hierarchical level defined through this table.

Notation:
PDA : Primary direction of accumulation within a given hierarchical level
SDA : Secondary direction of accumulation within a given hierarchical level

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	SUPER FRAME hierarchy	Mand	1	Immed	Unsigned binary	Hierarchy level of image component SUPER FRAME. If used, SUPER FRAME shall be at the highest hierarchy level (value = $01). If not used default value = $00.
2	FRAME hierarchy	Mand	1	Immed	Unsigned Binary	Hierarchy level of image component FRAME. If not used default value = $00.
3	FIELD hierarchy	Mand	1	Immed	Unsigned binary	Hierarchy level of image component FIELD. If not used default value = $00.
4	SWATH hierarchy	Mand	1	Immed	Unsigned binary	Hierarchy level of image component SWATH. If not used default value = $00.
5	TILE hierarchy	Mand	1	Immed	Unsigned binary	Hierarchy level of image component TILE. If not used default value = $00.
6	LINE hierarchy	Mand	1	Immed	Unsigned binary	Hierarchy level of image component LINE. If not used default value = $00.
7	Build direction of TILE image components.	Opt	1	Encode	Unsigned binary	Direction of accumulation of TILE image components within the superordinated hierarchical level. $00 = not used. $01 = PDA is X positive, SDA is Y positive.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						\$02 = PDA is X positive, SDA is Y negative. \$03 = PDA is X negative, SDA is Y positive. \$04 = PDA is X negative, SDA is Y negative. \$05 = PDA is Y positive, SDA is X positive. \$06 = PDA is Y positive, SDA is X negative. \$07 = PDA is Y negative, SDA is X positive. \$08 = PDA is Y negative, SDA is X negative.
8	Frame Coverage Relationship	Opt	1	Encode	Unsigned Binary	\$00 = None \$01 = 100% Overlapped (nominally identical coverage) \$02 = less than 100% Overlapped \$03 = Abutted

Historically the use of terms such as FRAME, SWATH, TILE, LINE, etc. was understood to be well defined within the reconnaissance community. Now such terms are defined differently by different users and FRAME and SWATH are often interchanged. The above use of the phrase “image component” is an attempt to provide a system that is independent of the possible misleading terms.

Fields 1 to 6

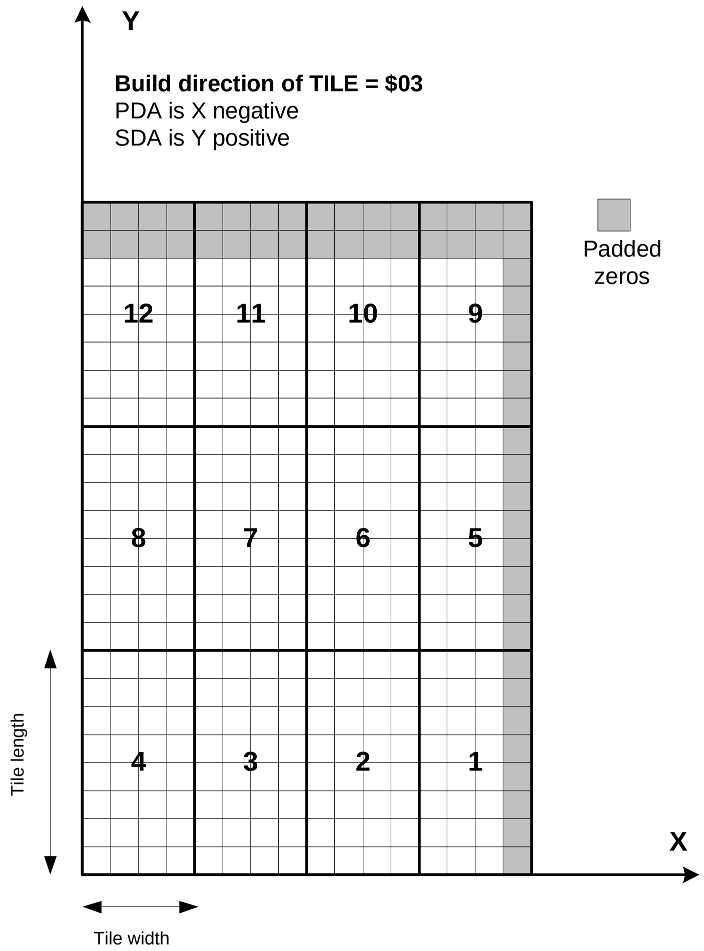
Fields 1 to 6 describe the hierarchy level of image components. These immediate unsigned binary fields can take on 7 values: 0, 1, 2, 3, 4, 5, 6:

Hierarchy value = 0: Image component is not used in the image structure.
Hierarchy value = 1: Highest order image component.
Hierarchy value = 2: Second highest order image component.
Etc.
Hierarchy value = 6: Sixth highest order image component.

Except for zero ($00), no two of these fields can have the same hierarchy value.

Example: Considering the image structure to be a FRAME built up from TILES, Fields 1 to 6 take on the following values:

Field no.	Value	Comment
1	0	SUPER FRAME not used = 0
2	1	FRAME has hierarchy = 1
3	0	FIELD not used = 0
4	0	SWATH not used = 0
5	2	TILE has hierarchy = 2
6	0	LINE not used = 0


Y
Build direction of TILE = $03
PDA is X negative
SDA is Y positive
12
11
10
9
8
7
6
5
4
3
2
1
Padded zeros
X
Tile length
Tile width

A-9.4 Sensor Operating Status Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0006

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Status	Mand	256	Immed	ASCII	Sensor error description.

A-9.5 Sensor Position Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0010

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	X vector component	Mand	8	Immed	RN	X component of the offset vector.
2	Y vector component	Mand	8	Immed	RN	Y component of the offset vector.
3	Z vector component	Mand	8	Immed	RN	Z component of the offset vector.

This table describes the position of the centre of the sensor relative to the last gimbal position. If gimbals are not used then this table gives the position of the centre of the sensor relative to the aircraft coordinate system.

A-9.6 Minimum Sensor Attitude Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0020

Table Requirement : Conditional on the Comprehensive Sensor Attitude Data Table not sent.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Rotation about Z-axis	Mand	8	Immed	RN	Rotation of the sensor in the xy plane in radians.
2	Rotation about Y-axis	Mand	8	Immed	RN	Rotation of the sensor in the xz plane in radians.
3	Rotation about X-axis	Mand	8	Immed	RN	Rotation of the sensor in the yz plane in radians.

The order of rotation of the sensor is in the order of the fields, i.e. Z-axis, Y-axis, X-axis.

A-9.7 Comprehensive Sensor Attitude Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0030

Table Requirement : Conditional on the Minimum Sensor Attitude Data Table not sent

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Rotation about Z-axis	Mand	8	Immed	RN	Rotation of the sensor in the xy plane in radians.
2	Rotation about Y-axis	Mand	8	Immed	RN	Rotation of the sensor in the xz plane in radians.
3	Rotation about X-axis	Mand	8	Immed	RN	Rotation of the sensor in the yz plane in radians.
4	Rotation rate about Z-axis	Mand	8	Immed	RN	Rate of rotation of the sensor in the xy plane in radians/sec.
5	Rotation rate about Y-axis	Mand	8	Immed	RN	Rate of rotation of the sensor in the xz plane in radians/sec.
6	Rotation rate about X-axis	Mand	8	Immed	RN	Rate of rotation of the sensor in the yz plane in radians/sec.
7	Rotation acceleration about Z-axis	Mand	8	Immed	RN	Acceleration of rotation of the sensor in the xy plane in radians/sec^2.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
8	Rotation acceleration about Y-axis	Mand	8	Immed	RN	Acceleration of rotation of the sensor in the xz plane in radians/sec^2.
9	Rotation acceleration about X-axis	Mand	8	Immed	RN	Acceleration of rotation of the sensor in the yz plane in radians/sec^2.

The order of rotation of the sensor is in the order of the fields, i.e. Z-axis, Y-axis, X-axis.

A-9.8 Gimbals Position Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address Range : $0000 0050 to $0000 005F

File Addressing scheme is $0000 005x where x represents the gimbal ID.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	X vector component	Mand	8	Immed	RN	X component of the offset vector.
2	Y vector component	Mand	8	Immed	RN	Y component of the offset vector.
3	Z vector component	Mand	8	Immed	RN	Z component of the offset vector.

The sensor is attached to the last gimbal (if gimbals are used) and will have its own position data in the Sensor Position Data Table.

A-9.9 Minimum Gimbals Attitude Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address Range : $0000 0060 to $0000 006F

File Addressing scheme is $0000 006x where x represents the gimbal ID.

Table Requirement : Conditional that the Comprehensive Gimbals Attitude Data Table is not sent

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Rotation about Z-axis	Mand	8	Immed	RN	Rotation of the gimbals in the xy plane in radians.
2	Rotation about Y-axis	Mand	8	Immed	RN	Rotation of the gimbals in the xz plane in radians.
3	Rotation about X-axis	Mand	8	Immed	RN	Rotation of the gimbals in the yz plane in radians.

The order of rotation of the gimbals is in the order of the fields, i.e. Z-axis, Y-axis, X-axis.

The sensor is attached to the last gimbal (if gimbals are used) and will have its own attitude data in the Sensor Attitude Data Tables.

A-9.10 Comprehensive Gimbals Attitude Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address Range : $0000 0070 to $0000 007F

File Addressing scheme is $0000 007x where x represents the gimbal ID.

Table Requirement : Conditional that the Minimum Gimbals Attitude Data Table is not sent

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Rotation about Z-axis	Mand	8	Immed	RN	Rotation of the gimbals in the xy plane in radians.
2	Rotation about Y-axis	Mand	8	Immed	RN	Rotation of the gimbals in the xz plane in radians.
3	Rotation about X-axis	Mand	8	Immed	RN	Rotation of the gimbals in the yz plane in radians.
4	Rotation rate about Z-axis	Mand	8	Immed	RN	Rate of rotation of the gimbals in the xy plane in radians/sec.
5	Rotation rate about Y-axis	Mand	8	Immed	RN	Rate of rotation of the gimbals in the xz plane in radians/sec.
6	Rotation rate about X-axis	Mand	8	Immed	RN	Rate of rotation of the gimbals in the yz plane in radians/sec.
7	Rotation	Mand	8	Immed	RN	Acceleration of rotation of the

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
	acceleration about Z-axis					gimbals in the xy plane in radians/sec^2.
8	Rotation acceleration about Y-axis	Mand	8	Immed	RN	Acceleration of rotation of the gimbals in the xz plane in radians/sec^2.
9	Rotation acceleration about X-axis	Mand	8	Immed	RN	Acceleration of rotation of the gimbals in the yz plane in radians/sec^2.

The order of rotation of the gimbals is in the order of the fields, i.e. Z-axis, Y-axis, X-axis.

The sensor is attached to the last gimbal (if gimbals are used) and will have its own attitude data in the Sensor Attitude Data Tables.

A-9.11 Sensor Index Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address Range : $0000 0200 to $0000 02FF

File Addressing scheme is $0000 02xx where xx represents the segment number.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Collection Start Time	Mand	8	Encode	DTG	The date and time at the start of the sensor activation.
2	Collection Stop Time	Mand	8	Encode	DTG	The date and time at the end of the sensor activation.
3	Start Header Time Tag	Mand	8	Immed	Unsigned Binary	The time tag of the first header for the sensor activation.
4	End Header Time Tag	Mand	8	Immed	Unsigned Binary	The time tag of the last header for the sensor activation.
5	Aircraft location at Collection Start Time	Mand	8+8	Immed	RN+RN	Latitude and Longitude.
6	Aircraft location at Collection End Time	Mand	8+8	Immed	RN+RN	Latitude and Longitude.
7	Sensor Start	Mand	8	Immed	Unsigned	Number of bytes offset from start of

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
	Position				Binary	record to start of sensor activation.
8	Sensor End Position	Mand	8	Immed	Unsigned Binary	Number of bytes offset from start of record to end of sensor activation.
9	(*)					Repeat fields 1-8 for each sensor activation.

A-9.12 Sensor Sample Coordinate Description Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 1010

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Vector model	Mand	1	Encode	Unsigned Binary	$00=Sample by sample $01=Pixel by pixel
2	Size of “x” vector component	Mand	1	Immed	Unsigned Binary	The number of bits used for the “x” vector component. Range $00 to $FF.
3	Type of “x” vector component	Mand	1	Encode	Unsigned Binary	$00=Unsigned Binary $01=Signed Binary $02=Real Number $03=Short Float (IEEE 32-bit definition)
4	Size of “y” vector component	Mand	1	Immed	Unsigned Binary	The number of bits used for the “y” vector component. Range $00 to $FF.
5	Type of “y” vector component	Mand	1	Encode	Unsigned Binary	$00=Unsigned Binary $01=Signed Binary $02=Real Number $03=Short Float (IEEE 32-bit definition)

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
6	Size of “z” vector component	Mand	1	Immed	Unsigned Binary	The number of bits used for the “z” vector component. Range $00 to $FF.
7	Type of “z” vector component	Mand	1	Encode	Unsigned Binary	$00=Unsigned Binary $01=Signed Binary $02=Real Number $03=Short Float (IEEE 32-bit definition)
8	(*)					Repeat Fields 2 to 7 for each element, if Vector model is equal to $00=Sample by sample. Maximum number of elements = 64k. Order of elements is according to sensor element ID.

This table is used in conjunction with the Sensor Element Data Table and the Sensor Sample “x”, “y” and “z” Coordinate Data Tables.

Vector modelling may be accomplished on a sample by sample or on a pixel by pixel basis, as indicated by the field “Vector Model”.

In general there is a one-to-one relationship between a sample and its coordinate components, i.e. Sensor Sample “x”, “y” and “z” Coordinate Data Tables and corresponding Sensor Data Table are identically structured (Image size, Tile Size, Data ordering), though they may be different in overall number of bytes.

If vector modelling is on a pixel by pixel basis:

- the look vectors of each sample of the same pixel are assumed to be identical and shall not be repeated for each sample, i.e. the “x”, “y” and “z” Sensor Sample Coordinate Data Tables are treated alike to single element sensor data;
- a size of zero for a particular coordinate component (x, y, or z) shall indicate that for all pixels of the image this coordinate component is to be set to zero. In this case, the Sensor Sample Coordinate Data Table of that component shall not occur in the data stream.

The coordinate system for vector modelling is the sensor coordinate system. Its origin (0, 0, 0) is the optical centre of the sensor. The x-axis is the pointing direction of the sensor, which, in general falls together with the optical axis of the sensor.

A-9.13 Sensor Sample Timing Description Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 1020

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Timing model	Mand	1	Encode	Unsigned Binary	$00 = Sample by sample $01 = Pixel by pixel
2	Timing accuracy	Mand	1	Encode	Unsigned Binary	$00 = Real Number $01 = Short Float (IEEE 32-bit definition)
3	Timing method	Mand	1	Encode	Unsigned Binary	Describes the type of time interval represented by the timing data. CUMULATIVE represents the time relative to the Header Time Tag. DIFFERENTIAL represents the change in time from one sampling to the next. $FF = UNUSED $00 = CUMULATIVE $01 = DIFFERENTIAL
4	(*)					If Timing model is equal to $00 =

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						Sample by sample, repeat Field 3 for each element. Maximum number of elements = 64k. Order of elements is according to sensor element ID.

This table is used in conjunction with the Sensor Element Data Table and the Sensor Sample Timing Data Table.

Timing may be accomplished on a sample by sample or on a pixel by pixel basis, as indicated by the field “Timing Model”.

In general there is a one-to-one relationship between a sample and its timing, i.e. Sensor Sample Timing Data Table and corresponding Sensor Data Table are identically structured (Image size, Tile Size, Data ordering), though they may be different in overall number of bytes.

If timing is on a pixel by pixel basis:

- the timing of each sample of the same pixel is assumed to be identical and shall not be repeated for each sample, i.e. the Sensor Sample Timing Data Table is treated alike to single element sensor data.

A-9.14 Sensor Data Timing Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0004

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Frame period	Opt	8	Immed	RN	The duration Between the commencement of one frame, and the commencement of the next frame in seconds.
2	Intra Frame Time	Opt	8	Immed	RN	The duration Between the completion of the active part of one frame, and the commencement of the next frame in seconds.
3	Line period	Opt	8	Immed	RN	The duration between commencement of one line and the commencement of the next line in seconds.
4	Intra Line time	Opt	8	Immed	RN	The duration between completion of the active part of one line and the commencement of the next line in seconds.

A-10 Sensor Compression Tables

A-10.1 Sensor Compression Data Table

Identifies the algorithms and parameters of the imagery compression scheme used. This file defines the compression scheme used on the image data. If the sensor data is not compressed then this file is not used.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0100

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Compression algorithm	Mand	1	Encode	Unsigned Binary	Algorithm used to compress sensor data. $02 JPEG (ISO/IEC 10918-1:1994)

A-10.2 JPEG Compression Data Tables

If Image Compression is by the JPEG method, then the tables described in this section may be required.

The JPEG compression method complies with the international standard for image compression, ISO/IEC 10918-1:1994.

The JPEG compression format specified within STANAG 7023 ensures that each Image Data Packet contains only complete fully ISO/IEC JPEG compliant interchange format data stream.

An important table to be used in conjunction with JPEG compression format is the Sensor Description Data Table and the figure that appears with it – The STANAG 7023 Sensor Frame Description to accommodate Tiles (e.g. JPEG files).

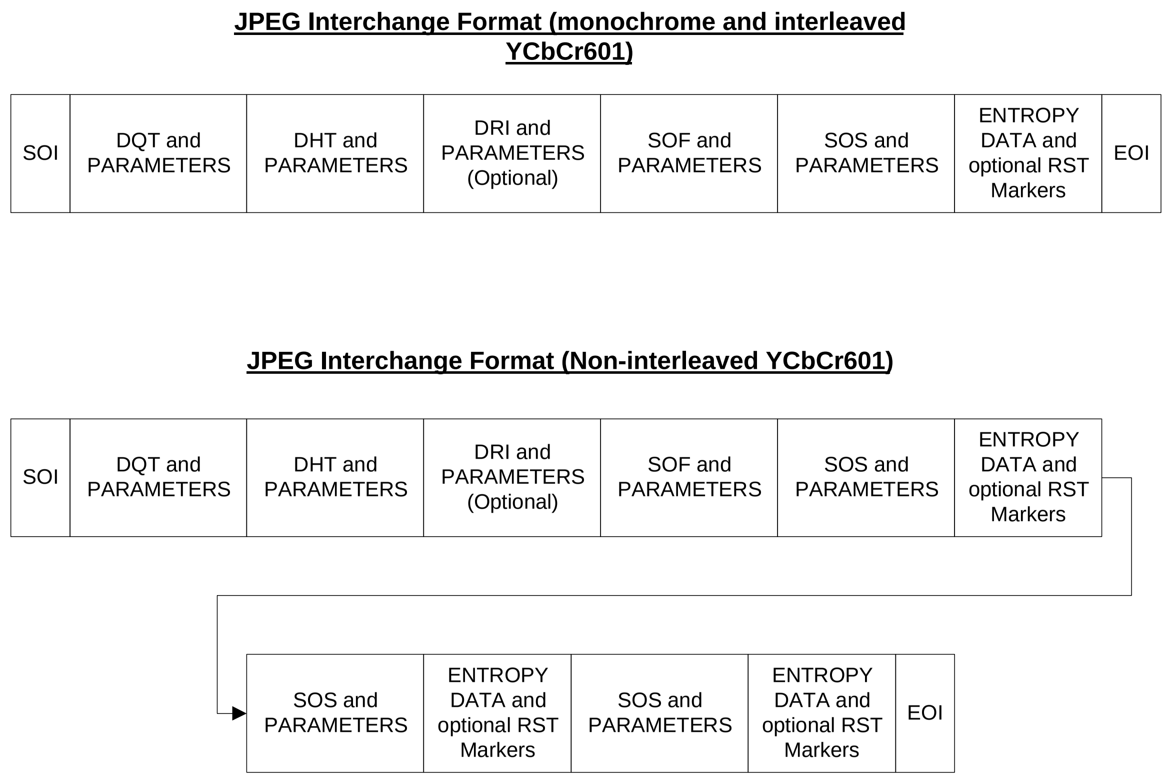


Figure A-2 - The JPEG Interchange Format

For low bandwidth systems the JPEG abbreviated image format can be used, in which case the JPEG Sensor Quantisation Data Table and the JPEG Sensor Huffman Data Table can be omitted from the Image Data Packets. These two tables must occur elsewhere in the record prior to the relevant Image Data Packets.

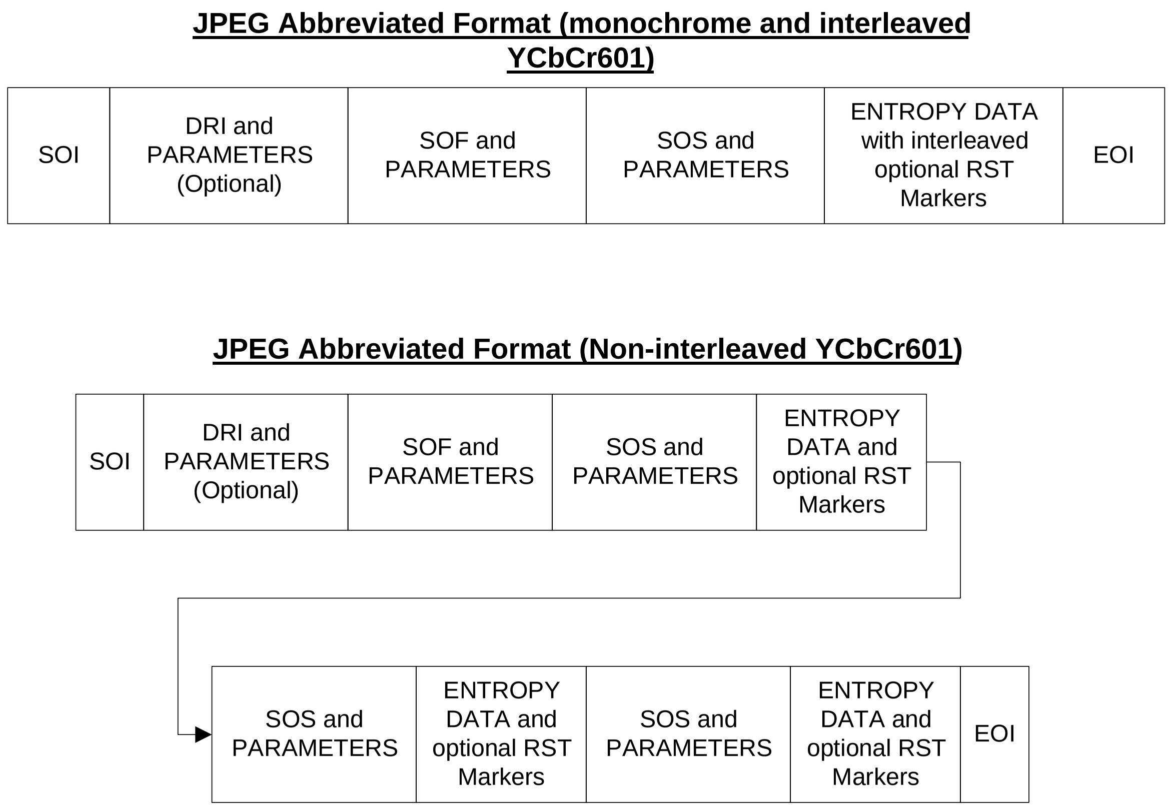


Figure A-3 - The JPEG Abbreviated Image Format

The JPEG processes supported by STANAG 7023 are the 8-bit precision baseline JPEG process and the 12-bit precision extended sequential JPEG process for both monochrome and colour images.

Arithmetic entropy coding, and progressive/hierarchical representations are not supported by STANAG 7023.

It is mandatory to convert RGB colour source data to YCbCr601 in accordance with CCIR601 before JPEG compression.

Each Image Data Packet shall contain one single JPEG image. The required JPEG markers within this JPEG image are as follows. (The order that the markers appear in the Image Data Packet is as listed):

SOI	Start of Image Marker
SOF_0 or SOF_1	Start of Frame Marker and Parameters
SOS	Start of Scan Marker and Parameters
EOI	End of Image Marker

The JPEG interchange format requires that the following markers appear between SOI and SOS and before each subsequent SOS if subsequent SOS markers exist:

DQT	Define Quantisation Table Marker and Parameters
DHT	Define Huffman Table Marker and Parameters

One or both of these two markers (DQT and DHT) may be omitted if the abbreviated image format is used.

If scan restarts are used then the Define Restart Interval Marker (DRI) and Parameters shall appear between SOI and SOS and before each subsequent SOS if there is more than one scan.

No other JPEG markers are allowed by STANAG 7023.

Compressed image data shall follow each SOS. RSTn markers may be interleaved within the compressed image data if specified by the Define Restart Interval Marker.

A-10.3 JPEG Sensor Quantisation Data Table

This JPEG Sensor Quantisation Data Table is used whenever one or more of the current quantisation tables 0 to 3 are to be updated with new custom quantisation values. Tq (See field 3) is used to specify which table is to be replaced.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0101

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	DQT Define Quantisation Table Marker	Mand	2	Encode	Unsigned Binary	Ensures that a JPEG decoder can identify this table type and understand its contents. This field is included here to conform with ISO/IEC 10918-1:1994 Value = $FFDB
2	L_q Length of parameters	Mand	2	Immed	Unsigned Binary	Describes the length in bytes of this table. The Length excludes Field 1. This field is included here to conform with ISO/IEC 10918-1:1994
3	P_qT_q Quantisation table element precision	Mand	1	Encode	Unsigned Binary	Binary Pq specifies the precision of the quantisation table values Qk in quantisation table number Tq

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						Encoded as binary XY where; X (4 Bits) is the precision, with: $0 is 8-bit precision $1 is 16-bit precision. Y (4 Bits) is the quantisation table number $0 to $3.
4	Q_k Quantisation table elements (64) in zigzag order	Mand	64 or 128	Immed	Unsigned Binary	Specifies the 64 custom quantisation table elements for the table referred to in field 3. Zigzag is defined in ISO/IEC 10918-1:1994.
5	(*)	(*)	(*)	(*)	(*)	(*)

(*) Fields 3 and 4 repeat for each additional Quantisation Table up to a maximum of four tables in total.

This table shall be used for the JPEG Abbreviated Image Format.

There are four possible Quantisation Tables that are numbered 0 to 3. It is mandatory for STANAG 7023 collection platforms and exploitation systems that support JPEG compression to have Quantisation Tables 0 and 1 pre-entered with the following default Quantisation Tables. These default tables are permanently stored in both the collection platforms and exploitation platforms.

Quantisation Table 0 shall be the table that appears in section K.1 Table K.1 Luminance Quantisation Table of ISO/IEC 10918-1:1994.

Quantisation Table 1 shall be the table that appears in section K.1 Table K.2 Chrominance Quantisation Table of ISO/IEC 10918-1:1994.

The Default Quantisation Table 0 shall be used as the default table for monochrome imagery.

The Quantisation Tables 2 and 3 have no values until written by this JPEG Sensor Quantisation Data Table. The default tables are permanently valid unless overwritten by a custom table during the mission. Once any of the four Quantisation Tables are overwritten by a custom table that table shall be permanently valid unless it is overwritten by a new custom table later in the mission.

A-10.4 JPEG Sensor Huffman Data Table

This JPEG Sensor Huffman Data Table is used whenever one or more of the current DC or AC Huffman tables 0 to 3 are to be updated with new custom DC or AC Huffman values. T_cT_h is used to specify which table is to be replaced.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0102

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	DHT Define Huffman Table marker	Mand	2	Encode	Unsigned Binary	Ensures that a JPEG decoder can identify this table type and understand its contents. This field is included here to conform to ISO/IEC 10918-1:1994. Value = $FFC4
2	L_h Length of parameters	Mand	2	Immed	Unsigned Binary	Describes the length in bytes of this table. The Length excludes Field 1. This field is included here to conform to ISO/IEC 10918-1:1994.
3	T_cT_h Huffman Table Class and Table	Mand	1	Encode	Unsigned Binary	Binary specifies whether the following table is a DC or an AC table and also specifies the table

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
	Identifier					identification number. Encoded as binary byte XY where; X (4 Bits) is the table type, with: $0 = DC $1 = AC. Y (4 Bits) is the huffman table number from $0 to $3.
4	L_1 Number of codes in each length	Mand	16	Immed	Unsigned Binary	Details the number of huffman codes that exist for each of the 16 lengths. The lengths are from 1 to 16.
5	$V_{i,j}$ Huffman Code Values	Mand	12, 16, 162, or 226	Immed	Unsigned Binary	Details the values of the huffman codes for each of the 16 lengths. No of bytes = 12 for 8-bit greyscale DC table or YCbCr601 colour DC table. No of bytes = 16 for 12-bit greyscale DC table. No of bytes = 162 for 8-bit greyscale AC table or YCbCr601 colour AC table. No of bytes = 226 for 12-bit greyscale AC table.
6	(*)	(*)	(*)	(*)	(*)	(*)

(*) Fields 3, 4 and 5 repeat for each additional Huffman Table up to a maximum of eight tables in total (four DC and four AC tables).

This table shall be used for the JPEG Abbreviated Image Format.

There are four possible DC Huffman Tables and four possible AC Huffman Tables that are each numbered 0 to 3. It is mandatory for STANAG 7023 collection platforms and exploitation systems that support JPEG compression to have DC and AC Huffman Tables 0 and 1 pre-entered with the following default Huffman Tables. These default tables are permanently stored in both the collection platforms and exploitation platforms.

DC Huffman Table 0 shall be the table that appears in section K.3.1 Table K.3 Luminance DC Difference Table of ISO/IEC 10918-1:1994.

DC Huffman Table 1 shall be the table that appears in section K.3.1 Table K.4 Chrominance DC Difference Table of ISO/IEC 10918-1:1994.

AC Huffman Table 0 shall be the table that appears in section K.3.2 Table K.5 Table for Luminance AC Coefficients of ISO/IEC 10918-1:1994.

AC Huffman Table 1 shall be the table that appears in section K.3.2 Table K.6 Table for Chrominance AC Coefficients of ISO/IEC 10918-1:1994.

The Default DC and AC Huffman Table 0 shall be used as the default table for monochrome imagery.

The Huffman Tables 2 and 3 have no values until written by this JPEG Sensor Huffman Data Table. The default tables are permanently valid unless overwritten by a custom table during the mission. Once any of the four DC or AC Huffman Tables are overwritten by a custom table that table shall be permanently valid unless it is overwritten by a new custom table later in the mission.

A-11 PASSIVE SENSOR Data Tables

A-11.1 Passive Sensor Description Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 0001

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Frame or Swath size	Mand	4	Immed	Unsigned Binary	The number of lines per frame or swath.
2	Active Line time	Mand	8	Immed	RN	The duration of an active part of the line in seconds.
3	Line size of active data	Mand	4	Immed	Unsigned Binary	The number of samples per line of significant data.
4	Packets per Frame or Swath	Mand	4	Immed	Unsigned Binary	The total number of packets transmitted for a complete Framing Sensor Frame or Linescan Sensor Swath. This will be a multiple of the number of tiles per line, i.e. the total number of tiles in a frame or swath.
5	Size of tile in the high frequency scanning direction	Mand	4	Immed	Unsigned Binary	The tile size in the high frequency scanning direction. If no tile exists the size is taken

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						as the line size in Field 3. Any padding of zeros is always in the maximum scan direction.
6	Size of tile in the low frequency scanning direction	Mand	4	Immed	Unsigned Binary	The tile size in the low frequency scanning direction. If no tiles exist the size is taken as the frame or swath size in Field 1. Any padding of zeros is always in the maximum scan direction.
7	Number of tiles across a line	Mand	4	Immed	Unsigned Binary	If no tile exists the value is taken as $0000 0001.
8	Number of swaths per frame	Mand	4	Immed	Unsigned Binary	The number of swaths that make up a complete frame. It indicates how many groups of lines the frame has been divided into. For a linescan sensor this value will be $0000 0001.
9	Sensor mode	Mand	1	Encode	Unsigned Binary	$00 OFF $01 ON $02 STANDBY $04 TEST $05 FAIL
10	Pixel size	Mand	2	Immed	Unsigned Binary	The number of bits per pixel.
11	Elements per pixel	Mand	2	Immed	Unsigned Binary	The number of elements per pixel.

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
12	Data Ordering	Mand	1	Encode	Unsigned Binary	Type of multispectral data ordering. $00 INACTIVE (Unispectral data) $01 BAND INTERLEAVED BY PIXEL $02 BAND SEQUENTIAL $03 BAND INTERLEAVED BY LINE See the examples following the Passive Sensor Element Data Table.
13	Line FOV	Mand	8	Immed	RN	The field of view across a line. The FOV angle in radians.
14	Frame or Swath FOV	Mand	8	Immed	RN	The field of view of a frame or swath orthogonal to the line FOV. The FOV angle in radians.
15	Number of Fields	Mand	1	Immed	Unsigned Binary	The number of fields which make up one frame of an interlaced framing sensor. $00 INVALID e.g. linescan sensor $01 NON-INTERLACED FRAMING SENSOR $02 Two fields $03 Three fields etc
16	High frequency scanning direction	Mand	1	Encode	Unsigned Binary	The line scanning direction. $00: Scan in the -y direction. $01: Scan in the +y direction.
17	Low frequency scanning direction	Mand	1	Encode	Unsigned Binary	The frame scanning direction. $00: Scan in the -z direction. S01: Scan in the +z direction.

For n elements the pixel size is:

Pixel size = Element size (ID = 0) + Element size (ID = 1) + … + Element size (ID = n-1)

In analogy to Table A-12.1 "RADAR Sensor Description Data Table", Fields 6 and 7, the physical coordinate system and coordinate system orientation are defined as follows:

The physical coordinate system associated with the image of a passive sensor is the hfsd / lfsd coordinate system (hfsd: high frequency scanning direction; lfsd: low frequency scanning direction) of the sensor, with orientation as given by Fields 16 and 17 of Table A-11.1.

The orientation of the hfsd / lfsd coordinate system relative to the X and Y axes of the image coordinate system shall be by default: hfsd is X positive, lfsd is Y positive.

If Table A-9.3 "Sync Hierarchy and Image Data Structure Data Table" is not used, the build direction of frame and tile image components, and of samples shall be by default "PDA is X positive, SDA is Y positive".

The build direction of field, swath and line image components shall be chosen in a way, so that they coincide with the low frequency scanning direction (lfsd).

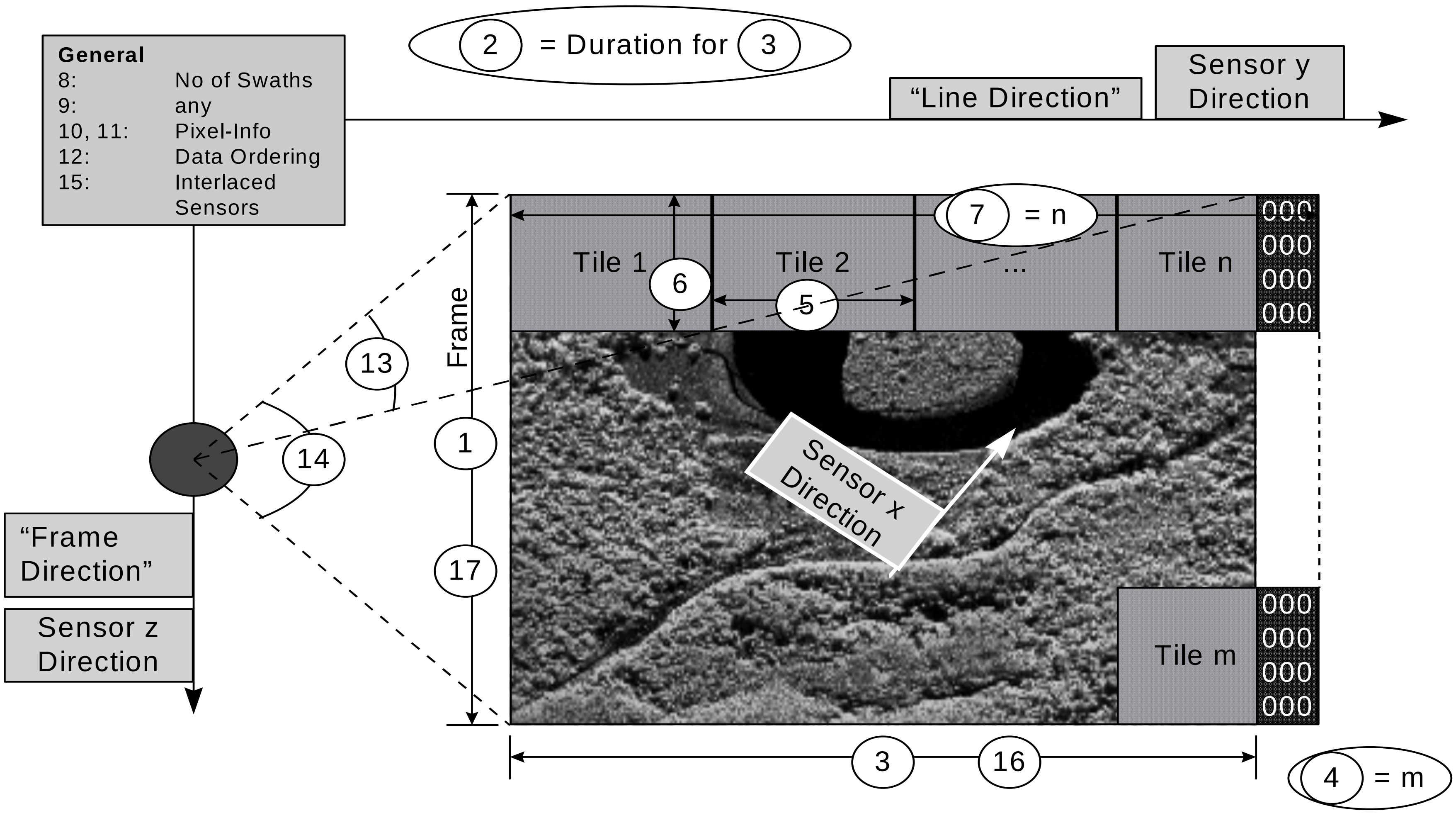


Figure A-4 - Interpretation Diagram for the Sensor Description Data Table.

Additional information concerning the above diagram.

- The 000 on the right represent the padding of pixels up to the edge of the frame in the high frequency direction (field 5).
- Padding of zeros is also allowed in the low frequency direction (field 6, not shown in diagram above).

The numbers in circles refer to the fields in the table.

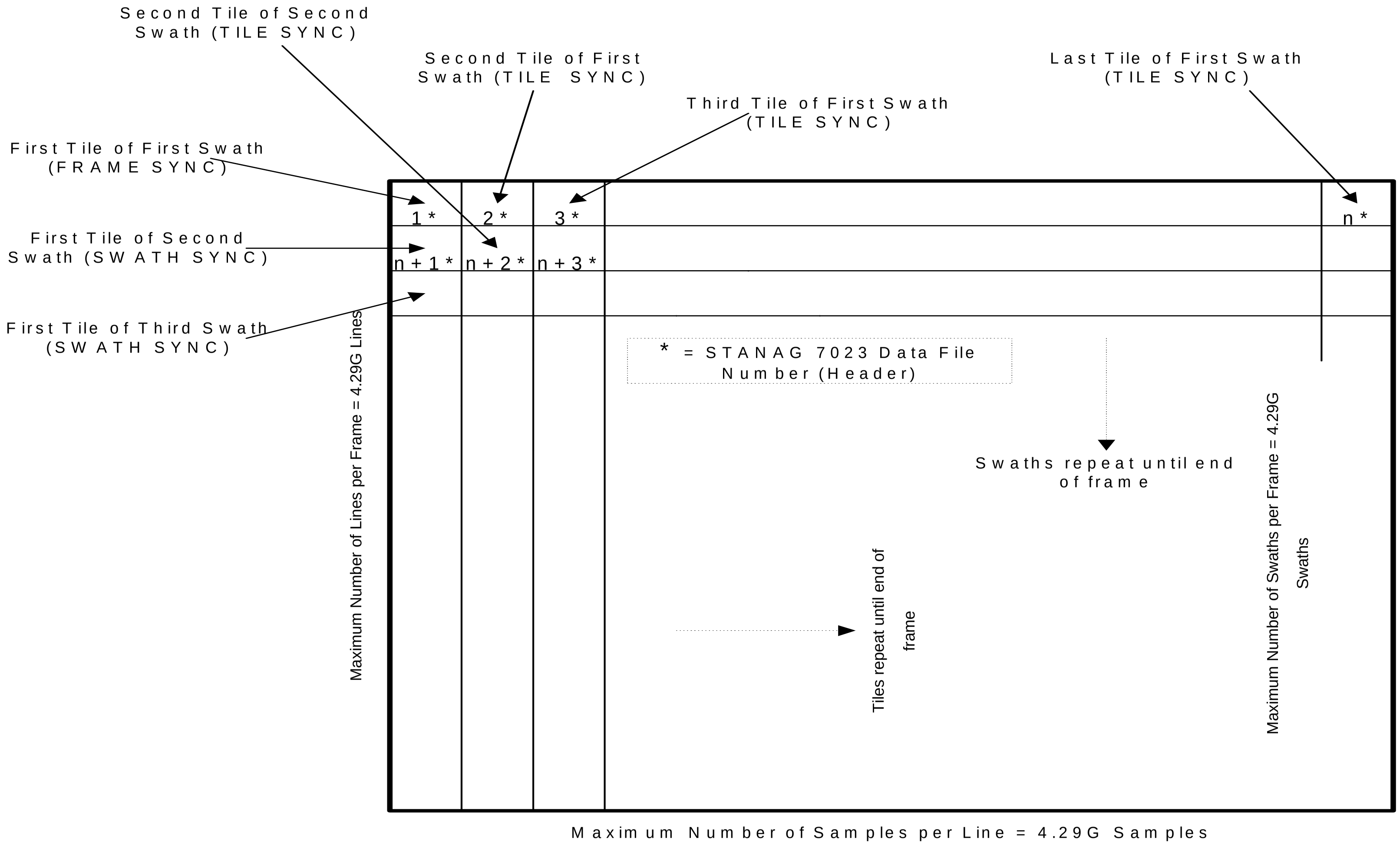


Figure A-5 - The STANAG 7023 Sensor Frame Description to Accommodate Tiles (e.g. JPEG Files)

A-11.2 Passive Sensor Element Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0000 1000

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Element size	Mand	1	Immed	Unsigned Binary	The number of bits in the element.
2	Element Bit offset	Mand	2	Immed	Unsigned Binary	The start bit offset of this element within a composite sample.
3	Sensor Element ID	Mand	2	Immed	Unsigned Binary	The sensor element ID. Unique for each element.
4	Minimum wavelength	Mand	8	Immed	RN	Wavelength in metres.
5	Maximum wavelength	Mand	8	Immed	RN	Wavelength in metres.
6	(*)					Repeat Fields 1-5 for each element.

The STANAG allows up to 64K elements per sensor.
The elements are used to indicate different receptor bands of the sensor. E.g. a colour camera might have 3 elements: 1 for red, 1 for green, and 1 for blue. Starting from 0, the elements shall be identified by an incremental Sensor Element ID number.

The above table allows for arbitrary length Element sizes.
By specifying the size and bit offset we assume contiguous bits for an element.

The examples below show three possible representations (band interleaved by pixel (BIP), band sequential (BSQ), band interleaved by line (BIL)) for an RGB image.

```
Case 1 (BIP):  R G B R G B R G B R G B R G B R G B ...     (Line 1)
               R G B R G B R G B R G B R G B R ...         (Line 2)
               R G B R G B R G B R G B R G ...             (Line 3)
               R G B R G B R G B R G B ...                 (Line 4)
               R G B R G B R G B R B ...                   (Line 5)
               ....

Case 2 (BSQ):  R R R R R R R R R R R R R R R R R R ...     (ID = 0, Line 1)
               R R R R R R R R R R R R R R R R ...         (ID = 0, Line 2)
               R R R R R R R R R R R R R R ...             (ID = 0, Line 3)
               R R R R R R R R R R R R ...                 (ID = 0, Line 4)
               ....

               G G G G G G G G G G G G G G G G G G ...     (ID = 1, Line 1)
               G G G G G G G G G G G G G G G G ...         (ID = 1, Line 2)
               G G G G G G G G G G G G G G ...             (ID = 1, Line 3)
               G G G G G G G G G G G G ...                 (ID = 1, Line 4)
               ....

               B B B B B B B B B B B B B B B B B B ...     (ID = 2, Line 1)
               B B B B B B B B B B B B B B B B ...         (ID = 2, Line 2)
               B B B B B B B B B B B B B B ...             (ID = 2, Line 3)
               B B B B B B B B B B B B ...                 (ID = 2, Line 4)
               ....
```

```
Case 3 (BIL):  R R R R R R R R R R R R R R R R R R ...     (ID = 0, Line 1)
               G G G G G G G G G G G G G G G G G G ...     (ID = 1, Line 1)
               B B B B B B B B B B B B B B B B B B ...     (ID = 2, Line 1)
               R R R R R R R R R R R R R R R R ...         (ID = 0, Line 2)
               G G G G G G G G G G G G G G G G ...         (ID = 1, Line 2)
               B B B B B B B B B B B B B B B B ...         (ID = 2, Line 2)
               R R R R R R R R R R R R R R ...             (ID = 0, Line 3)
               G G G G G G G G G G G G G G ...             (ID = 1, Line 3)
               B B B B B B B B B B B B B B ...             (ID = 2, Line 3)
               R R R R R R R R R R R R ...                 (ID = 0, Line 4)
               ....
```

The size of a frame, swath or tile shall be given by the number of lines and the number of samples per line. For example, this means that for tiles that are different in their data ordering only (BIP, BIL or BSQ ordered sensor data) the tile sizes have to be the same.

For multiple element data ordered according to BSQ or BIL, lines or bands of elements shall be ordered according to Sensor Element ID, with Sensor Element ID = 0 occurring first.

For multiple element data ordered according to BIP, the elements shall be ordered according to Sensor Element ID from the most significant to the less significant bit of the composite sample, i.e. Element ID =0 contains the most significant bit. An element bit offset of zero designates the most significant bit.

Sample size

It should be noted that in BIP the three sensor elements (R, G, B) are combined into one composite sample, leading to a sample size of 3 x 8 = 24 bits. In the BSQ and BIL cases the samples of the sensor elements are not combined into a composite one, but remain individually ordered by line or band. Therefore, in these cases one sample contains only the information from a single sensor element, leading to a sample size of 8 bits, which is equal to the corresponding element size.

Example RGB-Sensor:

(For Elements per pixel and Data Ordering see Passive Sensor Description Data Table)

	BIP Case 1	**BSQ Case 2**	**BIL Case 3**
Sample size	24	8	8
Elements per pixel	3	3	3
Data Ordering	$01	$02	$03
Element Size, ID = 0 (R)	8	8	8
Element Size, ID = 1 (G)	8	8	8
Element Size, ID = 2 (B)	8	8	8
Element Bit Offset ID = 0 (R)	0	0	0
Element Bit Offset ID = 1 (G)	8	0	0
Element Bit Offset ID = 2 (B)	16	0	0

In the case of unispectral data (e.g. B/W-Sensor), the field Data Ordering shall be set equal to $00, Elements per pixel equal = 1, and Element size = Sample size.

A-12 RADAR Data Tables

A-12.1 RADAR Sensor Description Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0001

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Image length	Mand	4	Immed	Unsigned Binary	The number of valid pixels in the second dimension of the image coordinate system (Y, see also A-9.3).
2	Image width	Mand	4	Immed	Unsigned Binary	The number of valid pixels in the first dimension of the image coordinate system (X, see also A-9.3).
3	Packets per image	Mand	4	Immed	Unsigned Binary	The total number of packets transmitted for a complete image. This will equal the total number of tiles in an image.
4	Tile length	Mand	4	Immed	Unsigned Binary	The number of pixels in a tile in the second dimension of the image coordinate system (Y, see also A-9.3). This value must be greater

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						than or equal to 1, and less than or equal to the image length. If the image is not split into tiles, tile length equals image length. Any padding of zeros is restricted to pixel coordinates (i ≥ Image width, j ≥ Image length).
5	Tile width	Mand	4	Immed	Unsigned Binary	The number of pixels in a tile in the first dimension of the image coordinate system (X, see also A-9.3). This value must be greater than or equal to 1, and less than or equal to the image width. If the image is not split into tiles, tile width equals image width. Any padding of zeros is restricted to pixel coordinates (i ≥ Image width, j ≥ Image length).
6	Physical coordinate system	Mand	1	Encode	Unsigned Binary	The physical coordinate system associated with the vld/cvld coordinate system of the image. $00 = Range, Cross Range $01 = Across Track, Along Track $02 = Range, Azimuth $03 = X, Y (Rectified imagery)
7	Coordinate System Orientation	Mand	1	Encode	Unsigned Binary	Orientation of vld/cvld coordinate system relative to the X and Y axes

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						of the image coordinate system (see also A-9.3): $00 = vld is X positive, cvld is Y positive. $01 = vld is X positive, cvld is Y negative. $02 = vld is X negative, cvld is Y positive. $03 = vld is X negative, cvld is Y negative. $04 = vld is Y positive, cvld is X positive $05 = vld is Y positive, cvld is X negative. $06 = vld is Y negative, cvld is X positive. $07 = vld is Y negative cvld is X negative. $08 = Rectified imagery. (Positive means aligned in same direction, negative means aligned in opposite direction).
8	Sensor mode	Mand	1	Encode	Unsigned Binary	$00 = OFF $01 = ON $02 = STANDBY $04 = TEST $05 = FAIL
9	Pixel size	Mand	2	Immed	Unsigned Binary	The number of bits per pixel. For n elements the pixel size is Element

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
						size (ID=0) + Element size (ID=1) + ... + Element size (ID=n-1).
10	Elements per pixel	Mand	2	Immed	Unsigned Binary	The number of elements per pixel.
11	Data ordering	Mand	1	Encode	Unsigned Binary	$00 = Inactive (Single element data) $01 = Element interleaved by pixel $02 = Element sequential $03 = Element interleaved by line
12	vld orientation	Cond	1	Encode	Unsigned Binary	Mandatory if image is not Rectified type. $00 = Unused $01 = Starboard, i.e. value of alpha is positive $02 = Port, i.e. value of alpha is negative

If Table A-9.3 “Sync Hierarchy and Image Data Structure Data Table” is not used, the build direction of FRAME and TILE image components, and of samples shall be by default “$01 = PDA is X positive, SDA is Y positive”.

Two illustrative examples concerning Field 7, Image Coordinate System Orientation, are given below:

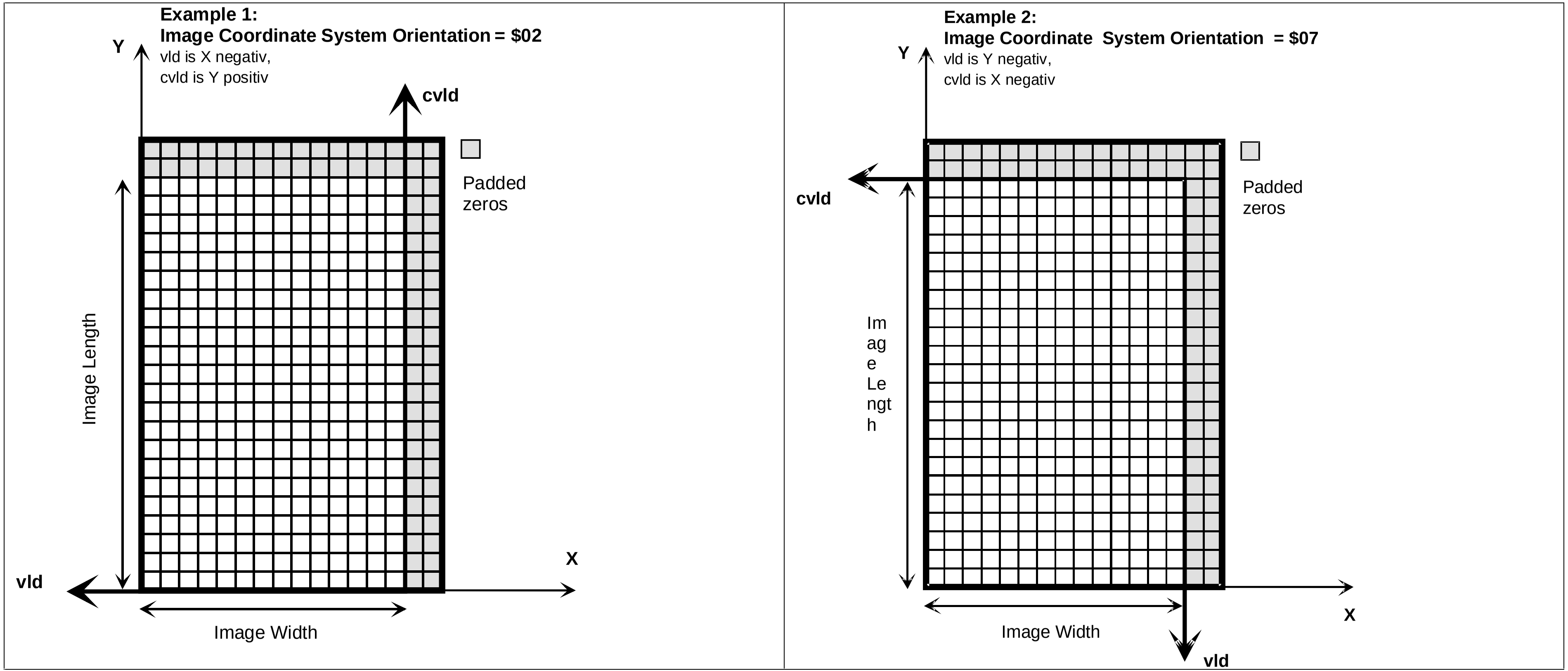


Figure A-6 – Illustrative Examples of Image Coordinate System Orientation.

A-12.2 RADAR Collection Plane Image Geometry Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0300

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Alpha	Mand	8	Immed	RN	Angular offset of the Virtual Look Direction from the Reference Track. Positive alpha = Starboard Negative alpha = Port
2	Virtual distance to the first pixel in the image.	Mand	8	Immed	RN	Distance from sensor virtual position to first pixel in the image, in metres.
3	Pixel interval in the Virtual Look Direction	Mand	8	Immed	RN	Pixel interval in the Virtual Look Direction, dvld, in metres
4	Pixel interval in the Cross Virtual Look Direction	Mand	8	Immed	RN	Pixel interval in the Cross Virtual Look Direction, dcvld. Units defined in field 5.
5	Units of measurement for CrossVirtual Look Direction	Mand	1	Encode	Unsigned Binary	$00 = angular (radians) $01 = distance (metres)

Figure A-7 describes the general geometry. Figures A-8 and A-9 give examples for squinted Swath SAR and Spot SAR, respectively; Virtual Distance to the first pixel is indicated by R.

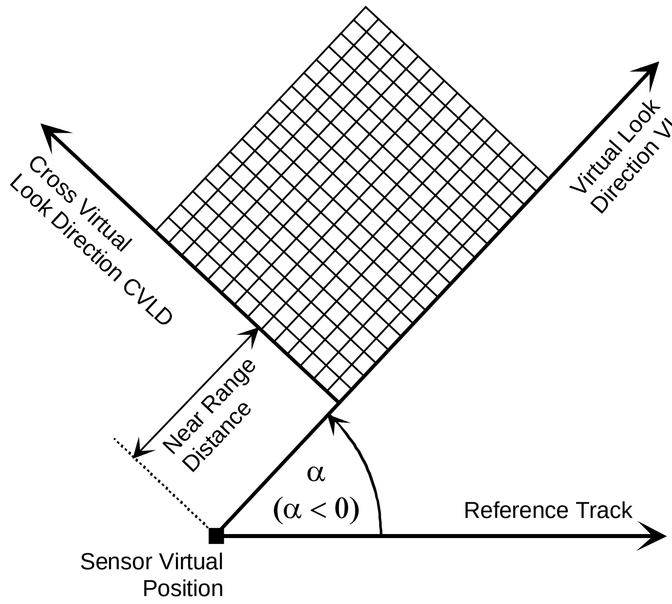


Figure A-7 - General Geometry

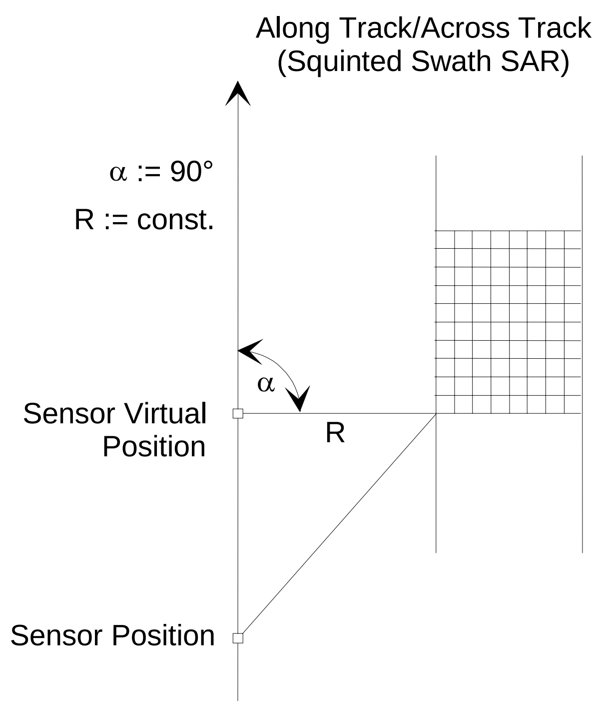


Figure A-8 Example for Swath SAR

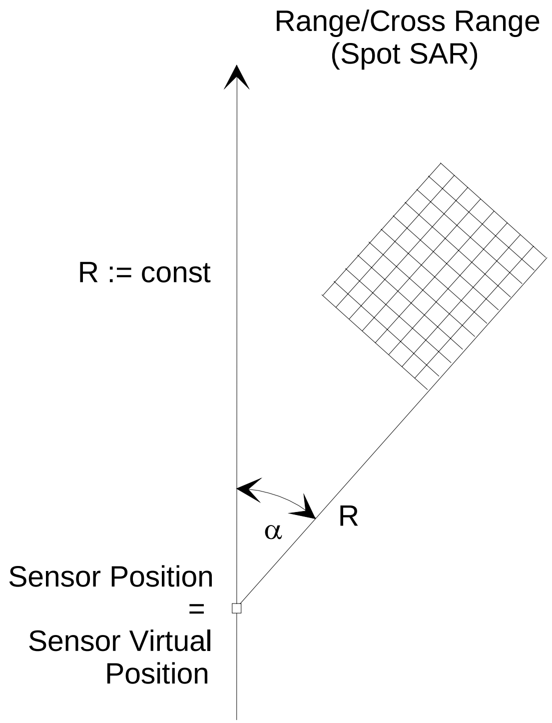


Figure A-9 - Example for Spot SAR

A-12.3 Reference Track Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0301

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Sensor Virtual Position geo-location	Mand	8 + 8	Immed	RN + RN	WGS84
2	Sensor Virtual Position MSL altitude	Cond	8	Immed	RN	At least one altitude field (2, 3, or 4) shall be used.
3	Sensor Virtual Position AGL altitude	Cond	8	Immed	RN	At least one altitude field (2, 3, or 4) shall be used.
4	Sensor Virtual Position GPS altitude	Cond	8	Immed	RN	At least one altitude field (2, 3, or 4) shall be used. WGS84
5	Reference Track north	Mand	8	Immed	RN	The component of Reference Track in the northerly direction
6	Reference Track east	Mand	8	Immed	RN	The component of Reference Track in the easterly direction
7	Reference Track	Mand	8	Immed	RN	The component of Reference Track in

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
	down					the downward direction
8	Reference Track Speed	Opt	8	Immed	RN	The speed of the virtual or real sensor along the Reference Track

The Reference Track shall be built up by a series of straight line segments.

A-12.4 Rectified Image Geometry Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0302

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Axx	Mand	8	Immed	RN	Image to Cartographic coefficient
2	Axy	Mand	8	Immed	RN	Image to Cartographic coefficient
3	Ayx	Mand	8	Immed	RN	Image to Cartographic coefficient
4	Ayy	Mand	8	Immed	RN	Image to Cartographic coefficient
5	Cx	Mand	8	Immed	RN	Image to Cartographic coefficient
6	Cy	Mand	8	Immed	RN	Image to Cartographic coefficient
7	Data 1	Cond	8	Immed	RN	1st parameter of the projection datum
8-25	Data 2 to Data 19	Cond	8	Immed	RN	The number of parameters used is conditional on the projection type.
26	Data 20	Cond	8	Immed	RN	20th parameter of the projection datum
27	Near Range Point Depression angle	Mand	8	Immed	RN	The downward angle from an xy plane associated with the real sensor. The sensor xy plane is parallel with the xy Flat plane. See diagram.
28	Far Range Point Depression angle	Mand	8	Immed	RN	The downward angle from an xy plane associated with the real sensor. The

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						sensor xy plane is parallel with the xy Flat plane. See diagram.
29	Projection type	Mand	1	Encode	Unsigned Binary	$00 = Unused $01 = Cartesian plane projection $02 = Stereographic $03 = Transverse Mercator £04 = Mercator
30	Terrain model	Mand	1	Encode	Unsigned Binary	$00 = no DTM used $01 = DTED $FF = other DTM used

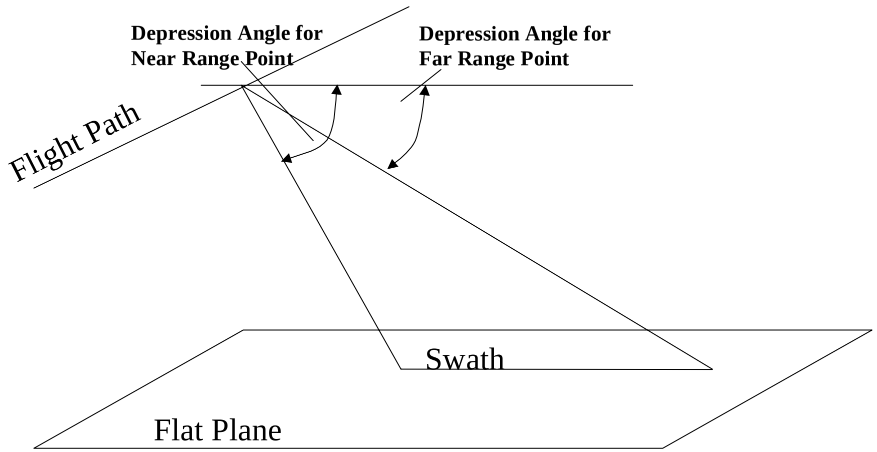


Figure A-10 - Diagram of Depression Angle.

Projection datum
All projections are done relative to the WGS84.

Each kind of projection has its own set of parameters. The STANAG uses projection types and datum commonly used in geography, except for the Cartesian plane projection designed for basic corrections of raw images.

$01 = Cartesian plane projection
This is not a standard projection used for cartography. The plane is described by a point, centre of the cartographic referential, and its normal vector.

- Data 1 : Latitude of a point of the projection plane (radian)
- Data 2 : Longitude of a point of the projection plane (radian)
- Data 3 : Elevation of a point of the projection plane (usually zero metre)
- Data 4 : the geodesic azimuth (radian, usually zero so that Yc is North and Xc is East, π/2 means Yc is East and Xc South)
- Data 5 : angle of sight (usually π/2, so that the plane is tangent to the ellipsoid)
- Data 6 : azimuth of the normal vector of the projection plane (not of use if Data 5 = π/2)

Origin of the resulting cartographic referential is the point used to define the plane.

$02 = Stereographic (oblique on a sphere)
The plane is described by the point of tangency. It shall be assumed that the tangent plane lies at zero elevation.

- Data 1 : Latitude of the point of tangency of the tangent projection plane (radian)
- Data 2 : Longitude of the point of tangency of the tangent projection plane (radian)
- Data 3 : sphere radius (metre)
- Data 4 : Xc origin (metre, usually zero)
- Data 5 : Yc origin (metre, usually zero)

Origin of the resulting cartographic referential is the point of tangency, with the specified offsets.

$03 = Transverse Mercator

Projection onto a cylinder whose axis is in the equatorial plane. General description is preferred, even if the only true parameter is the meridian of tangency, all other parameters being conventionally set :

- Data 1 : the meridian (longitude) of tangency (radian)
- Data 2 : the latitude of tangency (radian; it is usually the equator, zero)
- Data 3 : Xc origin (it is usually an offset of 500,000 metre from the meridian of tangency)
- Data 4 : Yc origin (it is usually on the equator, i. e. zero metre, but often fits the latitude, like 4,500,000 in Europe)
- Data 5 : scale (usually 1 or 0.9996)

Origin of the resulting cartographic referential is described with an offset in metre from the crossing of this meridian and the equator.

UTM projections are Transverse Mercator projections, numbered UTM 1 to UTM 60, used to that cover 6 degree lunes. If F refers to the UTM number, then UTM F is typically used to cover longitude [6(F-31), 6(F-30)] and Data 1 is 6(F-31)+ 3 (to convert in radian).

$04 = Mercator

Projection onto a cylinder whose axis is in the equatorial plane. General description is preferred, even if the only true parameter is the meridian of tangency, all other parameters being conventionally set :

- Data 1 : the meridian (longitude) of tangency (radian)
- Data 2 : the latitude of tangency (radian)
- Data 3 : the geodesic azimuth (radian)
- Data 4 : angle of rotation of the Xc, Yc axes (radian, usually zero)
- Data 5 : sphere radius (metre)

- Data 6 : Xc origin (metre)
- Data 7 : Yc origin (metre)

Image referential

The rectified image does not need to be rotated to fit the cartographic axes defined by the projection. The coordinates of any pixel of the rectified image into the cartographic referential (defined by the projection) is described by the function :

$$\begin{bmatrix} Xc \\ Yc \end{bmatrix} = \begin{bmatrix} Axx & Axy \\ Ayx & Ayy \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} + \begin{bmatrix} Cx \\ Cy \end{bmatrix}$$

where :

- (X, Y) are the coordinates of the pixel in the rectified image referential,
- (Xc, Yc) are the coordinates in the cartographic referential (usually Xc axis is heading East and Yc axis is heading North),
- [C] holds the translation (such that (- Cx,- Cy) are the cartographic coordinates in metres of the pixel (0,0))
- [A] matrix holds the rotation of the image in the cartographic referential, it scales and when necessary flips coefficients.

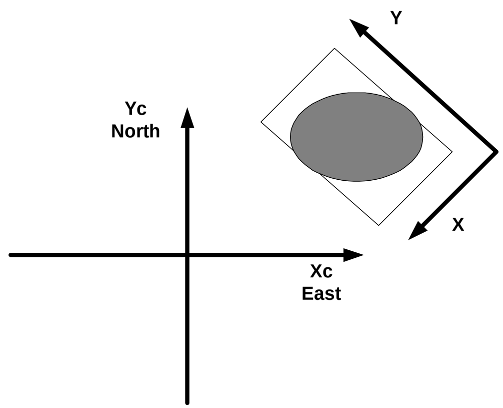


Figure A-11 – Coordinates.

Image bounding box
Even in a non-rotated rectified image referential, there may be some undefined pixels. It is up to the producing system to define invalid data pixels (defined in the RADAR Element Data Table) to determine the exact boundary of the valid pixels.

A-12.5 Virtual Sensor Definition Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0303

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Transmit phase difference	Mand	8	Immed	RN	The phase difference between the transmitted pulses
2	Receive phase difference	Opt	8	Immed	RN	The phase shift applied to the pulse from the second receiving antenna before the pulses were combined
3	Transmit antenna 1 Sensor number	Mand	2	Immed	Unsigned Binary	The Sensor number of the first transmitting antenna $FFFF = antenna not in use
4	Transmit antenna 2 Sensor number	Mand	2	Immed	Unsigned Binary	The Sensor number of the second transmitting antenna $FFFF = antenna not in use
5	Receive antenna 1 Sensor number	Mand	2	Immed	Unsigned Binary	The Sensor number of the first receiving antenna $FFFF = antenna not in use
6	Receive antenna 2 Sensor number	Mand	2	Immed	Unsigned Binary	The Sensor number of the second receiving antenna $FFFF = antenna not in use

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
7	Combination operation	Mand	1	Immed	Encode	The combination operation applied to the pulses $00 = Addition $01 = Subtraction

Virtual Sensor Definition Example

Suppose there is a system with 1 transmit antenna, and 2 receive antennas. These are real, physical things, and therefore their positions, attitudes etc. are described as usual. Let the transmit antenna have sensor number #1, the first receive antenna have sensor number #2, and the second receive antenna have sensor number #3.

The system takes the data from the first receive antenna, and uses this to produce an image stream. The system takes data from the first and second receivers, subtracts the second signal from the first, and uses the resultant data to produce an image stream.

The first image stream comes from a virtual sensor. It needs to be given a sensor number – let it be called sensor number #4.

Let the second image stream be virtual sensor #33.

There will be two virtual sensor definition tables:

Source Type : Sensor Parametric Data
Source Address : 01000100 (i.e. sensor number #4)
File Address : $0001 0303

Field	Field name	Value
1	Transmit phase difference	0
2	Receive phase difference	0
3	Transmit antenna 1 Sensor number	1
4	Transmit antenna 2 Sensor number	FFFF
5	Receive antenna 1 Sensor number	2
6	Receive antenna 2 Sensor number	FFFF
7	Combination operation	00

Source Type : Sensor Parametric Data
Source Address : 01100001 (i.e. sensor number #33)
File Address : $0001 0303

Field	Field name	Value
1	Transmit phase difference	0
2	Receive phase difference	0
3	Transmit antenna 1 Sensor number	1
4	Transmit antenna 2 Sensor number	FFFF
5	Receive antenna 1 Sensor number	2
6	Receive antenna 2 Sensor number	3
7	Combination operation	01

Suppose, now, that the data used to form image streams 1 and 2 is added together, with the data from image stream 2 having a $\pi/2$ phase shift applied before the addition.

Let this be virtual sensor number #34. Then the virtual sensor definition table would be:

Source Type : Sensor Parametric Data
Source Address : 01100010 (i.e. sensor number #34)
File Address : $0001 0303

Field	Field name	Value
1	Transmit phase difference	0
2	Receive phase difference	$\pi/2$
3	Transmit antenna 1 Sensor number	FFFF
4	Transmit antenna 2 Sensor number	FFFF
5	Receive antenna 1 Sensor number	4
6	Receive antenna 2 Sensor number	33
7	Combination operation	00

The fact that fields 5 and 6 correspond to virtual sensor numbers means that the virtual sensor definition tables need to be interrogated further to find the definitions of the these virtual sensors, to trace back to real antennas.

A-12.6 RADAR Parameters Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0304

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Processed resolution in vld	Opt	8	Immed	RN	Resolution in metres
2	Processed resolution in cvld	Opt	8	Immed	RN	Resolution in metres
3	Wavelength	Opt	8	Immed	RN	Wavelength in metres
4	Average power	Opt	8	Immed	RN	The average power is defined as the peak power divided by the duty cycle. (Watts)
5	Antenna Gain	Opt	8	Immed	RN	Antenna gain. (dB)
6	PRF	Opt	8	Immed	RN	Pulse repetition spatial frequency - units of “per metre”, for the un pre-summed data.
7	Radiometric scale factor	Opt	8	Immed	RN	A scale rating relating image pixel values to radar power levels. (dBW)
8	Aperture Time	Opt	8	Immed	RN	The length of time (Seconds) for which data was collected to form one image sample (the time taken to form

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
						a synthetic aperture for SAR).
9	Pulse Compression Ratio	Opt	8	Immed	RN	Pulse Compression Ratio
10	Azimuth Beamwidth	Opt	8	Immed	RN	The azimuth beamwidth: one-way - 3dB points (radians)
11	Interpulse Transmit Beamwidth	Opt	8	Immed	RN	Bandwidth of the transmitted pulse. (Hertz)
12	Instantaneous Receiver Beamwidth	Opt	8	Immed	RN	Bandwidth of the receiver IF stage. (Hertz)
13	A/D converter sample rate	Opt	8	Immed	RN	Sample rate for A/D converter. (Hertz)
14	RADAR mode	Mand	2	Encode	Unsigned Binary	$00 = Swath $01 = Spotlight $02 = Real beam ground map $03 = Enhanced real beam ground map $04 = Doppler beam sharpened map $05 = SAR overlaid with MTI $06 = Interferometric SAR $07 = Polarimetric SAR $08 = Inverse SAR $09 = Side-looking Array SAR (SLAR)
15	Processed number of looks	Opt	2	Immed	Unsigned Binary	Processed number of looks that were [incoherently] summed to produce the image
16	Pre-summing in range	Opt	2	Immed	Unsigned Binary	The number of samples that were pre-summed in range in the raw data before processing.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
17	Pre-summing in azimuth	Opt	2	Immed	Unsigned Binary	The number of samples that were pre-summed in azimuth in the raw data before processing.
18	Number of A/D converter bits	Opt	1	Immed	Unsigned Binary	Total number of bits in the A/D converter.
19	Interpulse modulation type	Opt	1	Encode	Unsigned Binary	$00 = None $01 = Chirp $02 = Binary phase code - Barker $03 = Binary phase code - Galois $04 = Quadrature phase code
20	Pulse-to-pulse modulation type	Opt	1	Encode	Unsigned Binary	$00 = None $01 = Linear step $02 = Pseudo-random step $03 = Pseudo-random $04 = Step plus pseudo-random
21	Range compression processing algorithm	Opt	1	Encode	Unsigned Binary	$00 = None $01 = Stretch compression $02 = Analogue matched filter $03 = Digital matched filter $04 = Stretch plus matched filter $05 = Step plus matched filter
22	Azimuth compression processing algorithm	Opt	1	Encode	Unsigned Binary	$00 = None $01 = Enhanced real beam $02 = Real beam $03 = Doppler $04 = Polar format $05 = Range migration

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						$06 = Chirp scaling
23	Autofocus processing algorithms	Opt	1	Encode	Unsigned Binary	$00 = None $01 = Motion compensation (MOCO) only $02 = Phase gradient plus MOCO $03 = Phase difference plus MOCO $04 = Multilook registration plus MOCO $05 = Contrast optimisation plus MOCO $06 = Prominent point processing plus MOCO $07 = Mapdrift plus MOCO $08 = Multiple Aperture Mapdrift plus MOCO
24	Range processing weighting	Opt	1	Encode	Unsigned Binary	$00 = Uniform $01 = -20dB m = 6 Taylor $02 = -25dB m = 12 Taylor $03 = -30dB m = 23 Taylor $04 = -35dB m = 44 Taylor $05 = -40dB m = 81 Taylor $06 = -40dB m = 6 Dolph-Chebyshev $07 = -50dB m = 6 Dolph-Chebyshev $08 = -60dB m = 6 Dolph-Chebyshev $09 = Spatially varying apodisation
25	Azimuth processing weighting	Opt	1	Encode	Unsigned Binary	$00 = Uniform $01 = -20dB m = 6 Taylor $02 = -25dB m = 12 Taylor

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						$03 = -30dB m = 23 Taylor $04 = -35dB m = 44 Taylor $05 = -40dB m = 81 Taylor $06 = -40dB m = 6 Dolph-Chebyshev $07 = -50dB m = 6 Dolph-Chebyshev $08 = -60dB m = 6 Dolph-Chebyshev $09 = Spatially varying apodisation
26	Antenna azimuth weighting	Opt	1	Encode	Unsigned Binary	$00 = Uniform $01 = -20dB m = 6 Taylor $02 = -25dB m = 12 Taylor $03 = -30dB m = 23 Taylor $04 = -35dB m = 44 Taylor $05 = -40dB m = 81 Taylor $06 = -40dB m = 6 Dolph-Chebyshev $07 = -50dB m = 6 Dolph-Chebyshev $08 = -60dB m = 6 Dolph-Chebyshev
27	Antenna elevation weighting	Opt	1	Encode	Unsigned Binary	$00 = Uniform $01 = -20dB m = 6 Taylor $02 = -25dB m = 12 Taylor $03 = -30dB m = 23 Taylor $04 = -35dB m = 44 Taylor $05 = -40dB m = 81 Taylor $06 = -40dB m = 6 Dolph-Chebyshev $07 = -50dB m = 6 Dolph-Chebyshev $08 = -60dB m = 6 Dolph-Chebyshev

If a single sensor is used in different modes and the modes are simultaneous then each mode must have its own sensor number and this table is sent for each sensor number.

If a single sensor is used in different modes and the modes are serial then only one sensor number is required but this table must be sent each time the mode changes.

A-12.7 ISAR Track Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 0305

Field	**Field name**	**Req.**	**No. Bytes**	**Field Type**	**Encoding Scheme**	**Description/Encoding units**
1	Road curvature	Mand	8	Immed	RN	Radius of curvature of the road which the target is moving. (metres) See Field 5.
2	Radial speed of vehicle	Mand	8	Immed	RN	Metres per second. See Field 6.
3	Track ID	Opt	4	Immed	Unsigned Binary	Track identification
4	Track type	Cond	1	Encode	Unsigned Binary	$00 = Unused If Track ID is specified, then: $01 = Link 16 $02 = NATO Track number (NTN)
5	Direction of road curvature	Mand	1	Encode	Unsigned Binary	$00 = Unused $01 = Clockwise $02 = Anti-clockwise
6	Direction of vehicle radial velocity	Mand	1	Encode	Unsigned Binary	$00 = Unused $01 = Away from the sensor $02 = Towards the sensor

A-12.8 RADAR Element Data Table

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 01xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Parametric Data
Source Address : $40 to $7F
File Address : $0001 1000

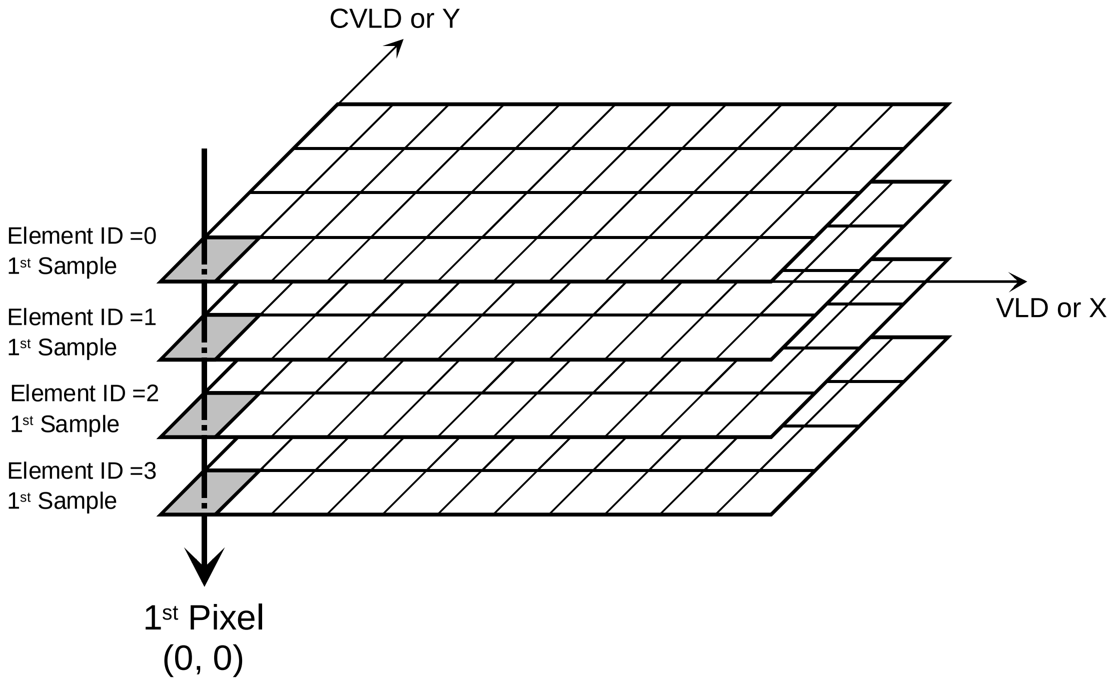
Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Element size	Mand	1	Immed	Unsigned Binary	The number of bits in one sample from this element.
2	Element Bit offset	Mand	2	Immed	Unsigned Binary	The start bit offset of this element within a composite sample.
3	Sensor Element ID	Mand	2	Immed	Unsigned Binary	The sensor element ID. Unique for each element. Any ordering of elements is sequential with respect to Element ID, starting from 0.
4	Type of Element	Mand	1	Encode	Unsigned Binary	$00 = Unsigned Binary $01 = Signed Binary $02 = Real Number $03 = Short Float (IEEE 32-bit definition)
5	Physical characteristic	Mand	2	Encode	Unsigned Binary	MTI velocity should be given relative to the antenna position (radial velocity), or relative to the image (x, y) or the ground (N, E) coordinate system. MTI velocity

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						component is positive from antenna to pixel. $00 = Radar measurement $01 = Height $02 = Velocity (image referenced (x, y)) $03 = Velocity (ground referenced (N, E)) $04 = Radial velocity component from antenna to pixel $05 = MTI indication $06 = Radar measurement MTI $07 = Pixel validity If an element is used for pixel validation, an element sample value of zero indicates valid imagery. Any non-zero value is used for invalid data.
6	RF Centre frequency	Opt	8	Immed	RN	The RF centre frequency of the radar. (Hertz)
7	RF Bandwidth	Opt	8	Immed	RN	The RF bandwidth of the radar. (Hertz) (e.g. the RF bandwidth of the Range Chirp).Normally the RF bandwidth is symmetrically around the RF centre frequency.

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
8	Mean Doppler Frequency	Opt	8	Immed	RN	The mean doppler frequency used for processing. (Hertz)
9	Look Centre Frequency	Opt	8	Immed	RN	The base (centre) doppler frequency used for processing this look.
10	Look Bandwidth	Opt	8	Immed	RN	The doppler bandwidth used for processing this look. (Hertz) Normally for Radar measurement but also used for forming MTI overlay (Radar Measurement MTI). Normally the RF bandwidth is symmetrically around the base (centre) doppler frequency.
11	Minimum Element Value	Mand	8	Immed	RN	Used with the Transfer Function Type to scale the element value from the physical value.
12	Maximum Element Value	Mand	8	Immed	RN	Used with the Transfer Function Type to scale the element value from the physical value.
13	Minimum Physical Value	Mand	8	Immed	RN	Used with the Transfer Function Type to scale the element value from the physical value.
14	Maximum Physical Value	Mand	8	Immed	RN	Used with the Transfer Function Type to scale the element value from the physical value.
15	Polarisation	Opt	1	Encode	Unsigned Binary	$00 = HH $01 = VV $02 = HV

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
						\$03 = VH
16	Use of element	Mand	1	Encode	Unsigned Binary	\$00 = Magnitude Radar Measurement \$01 = Phase \$02 = In phase (I) \$03 = Quadrature (Q) \$04 = Velocity Magnitude \$05 = Velocity Direction Angle \$06 = Radial Velocity (negative if approaching) \$07 = v_x or v_N \$08 = v_y or v_E \$09 = Value \$10 = $(\text{Magnitude})^2$
17	Transfer Function Type	Mand	1	Encode	Unsigned Binary	\$00 = Linear \$01 = Logarithmic (natural) \$02 = Exponential
*	Repeat fields 1 to 17 for each element					

It should be noted, that the term element is expanded beyond the scope of Editon 2. The term element shall be associated with one layer of information for a certain sensor image, which fits well to passive sensors as well. The following sketch may support clarification of terms.


CVLD or Y
VLD or X
Element ID =0
1st Sample
Element ID =1
1st Sample
Element ID =2
1st Sample
Element ID =3
1st Sample
1st Pixel
(0, 0)

A-13 Sensor Data Tables

The Sensor Data Tables are five tables with their own Data File Address. These tables are used to describe the sensor data and its pixel registration (x, y, z) within the image. The sensor sample timing describes the time relationship between adjacent pixels.

The Data File Addresses of the Sensor Data Tables are as follows.

Data File	**Data File Address**
Sensor Data Table	$0000 0000
Sensor Sample "x" Coordinate Table	$0000 0010
Sensor Sample "y" Coordinate Table	$0000 0020
Sensor Sample "z" Coordinate Table	$0000 0030
Sensor Sample Timing Table	$0000 0050

A-13.1 Sensor Data Table

This table is used to transmit the sensor data.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 10xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Data
Source Address : $80 to $BF
File Address : $0000 0000

Field	Field name	Req.	No. Bits	Field Type	Encoding Scheme	Description/Encoding units
1	Sensor data	Mand	Sample size	Immed	See next column	The encoding scheme is described by the following 4 tables as used: 1. Sensor Description Data Table 2. Sync Hierarchy and Image Build Data Table 3. Sensor Element Data Table 4. Sensor Compression Data Table
2	(*)					Repeat for each sample.

The data file size must be a multiple of whole bytes. Any padding will be in the last byte and from the LSB towards the MSB. Examples 1 and 2 show how the bits are packed into the data file for a RGB band interleaved by pixel (BIP) representation for a 3 byte data file containing 3 elements, i.e. one sample. (In reality the data file size would be much bigger containing many samples).

Example 1
3 8-bit RGB elements making a single BIP sample.

Red = 112_{10}								Green = 86_{10}								Blue = 50_{10}							
0	1	1	1	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	1	0	0	1	0
Byte 1								Byte 2								Byte 3							

MSB → LSB

Example 2
3 6-bit RGB elements making a single BIP sample. The least significant bits are padded with xxxxxx.

Red = 45_{10}						Green = 37_{10}						Blue = 18_{10}											
1	0	1	1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	X	X	X	X	X	X
Byte 1								Byte 2								Byte 3							

MSB → LSB

If in example 2 there were 750 6-bit RGB elements (250 BIP samples) to make 250 pixels, then:

Total no. of bits in table = 750 x 6 = 4500 bits, and 4500 bits = 562 bytes and 4 bits, the padding is xxxx. The data file size for the 750 6-bit elements would be 563 bytes.

A-13.2 Sensor Sample "x" Coordinate Data Table

This table is used to describe the pixel registration of the sensor data.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 10xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Data
Source Address : $80 to $BF
File Address : $0000 0010

Field	Field name	Req.	No. Bits	Field Type	Encoding Scheme	Description/Encoding units
1	Sample "x" coordinate	Mand	Size of "x" vector component	Immed	See next column	The encoding scheme is described by the Sensor Sample Coordinate Description Data Table.
2	(*)					Repeat for each sample, if Vector model is equal to $00=Sample by sample in the Sensor Sample Coordinate Description Data Table, else, repeat for each pixel.

This table is used for the sensor modelling method VECTOR MODELLING. It is used in conjunction with the Sensor Sample Coordinate Description Data Table.

The data file size must be a multiple of whole bytes. Any padding will be in the last byte and from the LSB towards the MSB.

A-13.3 Sensor Sample “y” Coordinate Data Table

This table is used to describe the pixel registration of the sensor data.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 10xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Data
Source Address : $80 to $BF
File Address : $0000 0020

Field	Field name	Req.	No. Bits	Field Type	Encoding Scheme	Description/Encoding units
1	Sample “y” coordinate	Mand	Size of “y” vector component	Immed	See next column	The encoding scheme is described by the Sensor Sample Coordinate Description Data Table.
2	(*)					Repeat for each sample, if Vector model is equal to $00=Sample by sample in the Sensor Sample Coordinate Description Data Table, else, repeat for each pixel.

This table is used for the sensor modelling method VECTOR MODELLING. It is used in conjunction with the Sensor Sample Coordinate Description Data Table.

The data file size must be a multiple of whole bytes. Any padding will be in the last byte and from the LSB towards the MSB.

A-13.4 Sensor Sample "z" Coordinate Data Table

This table is used to describe the pixel registration of the sensor data.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 10xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Data
Source Address : $80 to $BF
File Address : $0000 0030

Field	Field name	Req.	No. Bits	Field Type	Encoding Scheme	Description/Encoding units
1	Sample "z" coordinate	Mand	Size of "z" vector component	Immed	See next column	The encoding scheme is described by the Sensor Sample Coordinate Description Data Table.
2	(*)					Repeat for each sample, if Vector model is equal to $00=Sample by sample in the Sensor Sample Coordinate Description Data Table, else, repeat for each pixel.

This table is used for the sensor modelling method VECTOR MODELLING. It is used in conjunction with the Sensor Sample Coordinate Description Data Table.

The data file size must be a multiple of whole bytes. Any padding will be in the last byte and from the LSB towards the MSB.

A-13.5 Sensor Sample Timing Data Table

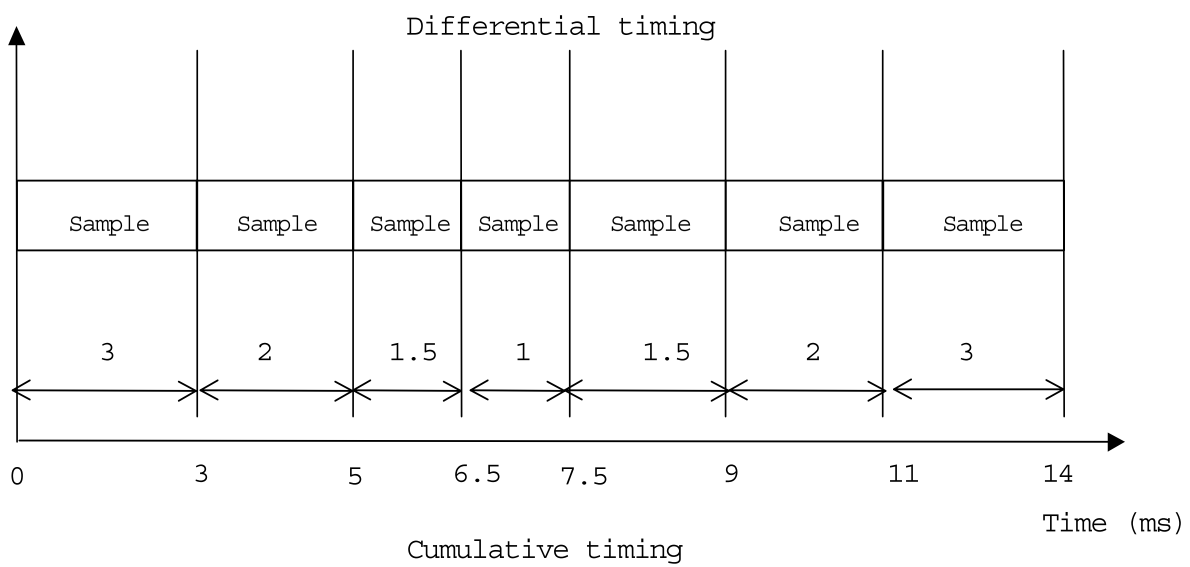
This table is used to describe the timing of the sensor data samples.

The sensor number is encoded into the Source Address. The binary form of the Source Address is: 10xxxxxx, where xxxxxx is the sensor number.

Source Type : Sensor Data
Source Address : $80 to $BF
File Address : $0000 0050

Field	Field name	Req.	No. Bytes	Field Type	Encoding Scheme	Description/Encoding units
1	Sample Timing	Mand	8 or 4	Immed	See next column	Timing value in seconds. The encoding scheme is described by the Sensor Sample Timing Description Data Table.
2	(*)					Repeat for each sample, if Timing model is equal to $00=Sample by sample in the Sensor Sample Timing Description Data Table, else, repeat for each pixel.

This table is used in conjunction with the Sensor Sample Timing Description Data Table.



Example of Sample Timing methods

Regardless of data ordering (BIP, BSQ, BIL) sample timing shall express the timing relationship of adjacent samples of the same element.

Annex B – Data Definitions

B-1 Real Numbers (RN)

Definition of a Real Number (RN) - IEEE Standard 754.

Real numbers in STANAG 7023 are represented in the IEEE double format.

B-1.1 64-bit Double Format

The IEEE double format consists of three fields: a 52-bit fraction, f; an 11-bit biased exponent, e; and a 1-bit sign, S. These fields are stored contiguously in two successively addressed 32-bit words, as shown in Figure B-1.

Real Number Big Endian Byte Ordering:

[byte 8 **MSB**][byte 7][byte 6][byte 5][byte 4][byte 3]byte 2][byte 1][byte 0 **LSB**]
Increasing byte ordering in the record→

If f [31:0] denotes the least significant 32 bits of the fraction, then bit 0 is the least significant bit of the entire fraction and bit 31 is the most significant of the 32 least significant fraction bits.

In the other 32-bit word, bits 0-19 contain the 20 most significant bits of the fraction, f [51:32], with bit 0 being the least significant of these 20 most significant fraction bits, and bit 19 being the most significant bit of the entire fraction; bits 20-30 contain the 11-bit biased exponent, e, with bit 20 being the least significant bit of the biased exponent and bit 30 being the most significant; and the highest-order bit 31 contains the sign bit, S.

Figure B-1 numbers the bits as though the two contiguous 32-bit words were one 64-bit word in which bits 0-51 store the 52-bit fraction, f; bits 52-62 store the 11-bit biased exponent, e; and bit 63 stores the sign bit, S.

S	**e [62:52]**	**f [51:32]**

f [31:0]

Figure B-1 - Double Storage Format

The values of the bit patterns in these three fields determine the value represented by the overall bit pattern.

Table B-1 shows the correspondence between the values of the bits in the three constituent fields, on the one hand, and the value represented by the double-format bit pattern on the other; u means don't care, because the value of the indicated field is irrelevant to the determination of value for the particular bit pattern in double format.

Double-Format Bit Pattern	**Value**
0< e <2047	$(-1)^s$ x 2^{e-1023} x 1.f (normal numbers)
e=O; f≠0 (at least one bit in f is nonzero)	$(-1)^s$ x 2^{-1022} x O.f (subnormal numbers)
e=O; f=0 (all bits in f are zero)	$(-1)^s$ x 0.0 (signed zero)
s=0; e=2047; f=.000—00 (all bits in f are zero)	+INF (positive infinity)
s=1; e=2047; f =.000—00 (all bits in f are zero)	-INF (negative infinity)
s=u; e=2047; f≠0 (at least one bit in f is nonzero)	NaN (Not-a-Number)

Table B-1 - Values Represented by Bit Patterns in IEEE Double Format.

Notice that when e<2047, the value assigned to the double-format bit pattern is formed by inserting the binary radix point immediately to the left of the fraction's most significant bit, and inserting an implicit bit immediately to the left of the binary point. The number thus formed is called the significant. The implicit bit is so named because its value is not explicitly given in the double-format bit pattern, but is implied by the value of the biased exponent field.

For the double-format, the difference between a normal number and a subnormal number is that the leading bit of the significand (the bit to the left of the binary point) of a normal number is 1, whereas the leading bit of the significand of a subnormal number is 0. Double-format subnormal numbers were called double-format denormalized numbers in IEEE Standard 754.

The 52-bit fraction combined with the implicit leading significand bit provides 53 bits of precision in double-format normal numbers.

Examples of important bit patterns in the double-storage format are shown in Table B-2. The bit patterns in the second column appear as two 8-digit hexadecimal numbers. For the SPARC and HP 700 architectures, the left one is the value of the lower addressed 32-bit word, and the right one is the value of the higher addressed 32-bit word, while for the x86 and PowerPC architectures, the left one is the higher addressed word, and the right one is the lower addressed word.

Common Name	**Bit Pattern (Hex)**	**Equivalent Value**
+0	00000000 00000000	0.0
-0	80000000 00000000	-0.0
1	3FF00000 00000000	1.0
2	40000000 00000000	2.0
max normal number	7FEFFFFF FFFFFFFF	1.7976931348623157e+308
min. positive normal number	00100000 00000000	2.2250738585072014e-308
max subnormal number	000FFFFF FFFFFFFF	2.2250738585072009e-308
min. positive subnormal number	00000000 00000001	4.9406564584124654e-324
+ ∞	7FF00000 00000000	Infinity
- ∞	FFF00000 00000000	-Infinity
Not-a-Number	FFFFFFFF FFFFFFFF	NaN

Table B-2 - Bit Patterns in Double-Storage Format and their IEEE Values

The STANAG 7023 chosen hex value of a NaN as shown in Table B-2.

B-1.2 32-bit Single Precision Floating-Point Format

This data format is referred to as Short Float (IEEE 32-bit definition) in the text.

In the IEEE 754 standard the Short float representation is laid out as:

S	eeeeeeee	fffffffffffffffffffffff
31	30 23	22 bits 0

Where,
The sign field “S” is 1-bit.
The exponent field “e” is 8-bits.
The fractional field of the mantissa is 23-bits.

To allow the representation of special values (0, Infinity, NaN) two bit patterns are reserved thus limiting the power (p) of the exponent range to [-126, 127].

Since the mantissa has a total of 24-bits (23-bits plus the hidden bit) and is rounded, the magnitude of the relative error in a number is bounded by $2^{-24} = 5.96\ldots \times 10^{-8}$. This means that greater than 7 decimal digit precision is available. (The largest possible mantissa is $M = 2^{24} = 16777216$, which has greater than 7 digits of precision).

The largest positive number that can be stored is:

1.11111111111111111111111 (binary) x 2^{127}
= $3.403\ldots \times 10^{38}$

The smallest positive number is:

1.00000000000000000000000(binary) x 2^{-126}
= $1.175\ldots \times 10^{-38}$

The special values for the 32-bit format follow the same rules as for the 64-bit format above. The 64-bit format is exactly the same except that the pattern is simply extended to fill out the longer exponent and fraction fields.

In the exponent field the bit patterns 00000000 and 11111111 are reserved so that they can be used to denote special values. The zero pattern is used for zero:

0 00000000 00000000000000000000000 = 0.0 (zero decimal)

This is necessary since the hidden bit in the mantissa implies that a number is non-zero even when the fractional part is zero. The ones pattern is used for error conditions:

The representations for infinity are:

0 11111111 00000000000000000000000 = positive infinity

1 11111111 00000000000000000000000 = negative infinity

These values appear if a number is divided by zero or if a calculation causes an overflow condition. Comparison tests ensure that infinity is bigger than any number.

The representation for Not-a-Number (NaN) is:

0 11111111 01111111111111111111111 = NaNS

0 11111111 10000000000000000000000 = NaNQ

NaNS means "signalling", it generates a trap, while NaNQ means "quiet", the calculation continues. Which of these is generated is usually a compiler option.

B-2 Units

B-2.1 Definition

SI Units (plus derived units). See ISO 1000.

The range of radians will be: $-\pi \leq$ radians $< +\pi$

Time	= seconds
Length	= metres
Area	= metres^2
Height	= metres
Velocity	= metres/sec
Acceleration	= metres/sec^2
Angle	= radians
Angular Velocity	= radians/sec
Angular Acceleration	= radians/sec^2

B-2.2 World Geodetic System (WGS-84 - see ISO 6709/1983)

Latitude and Longitude will be represented as a Real Number + Real Number (RN+RN). The format will be Latitude followed by Longitude. The Real Numbers will be in double format.

The form will be:

RADIANS, rads(.)decimal rads of the earth's curvature.
(+ve East of the meridian, and +ve North of the equator).

Angular Measurements for Lat/Long

	Range
Latitude	North $\leq +\pi/2$ rads (+90 degrees) Zero latitude = 0 rads South $\geq -\pi/2$ rads (-90 degrees)

Longitude	West ≥ -π rads (-180 degrees) Zero longitude = 0 rads East < +π rads (+180 degrees)

B-2.3 Angular Measurements for Heading

The diagram below also shows the relationship between Heading and the X, Y coordinate system.

The range of radians will be: $-\pi \leq$ radians $< +\pi$

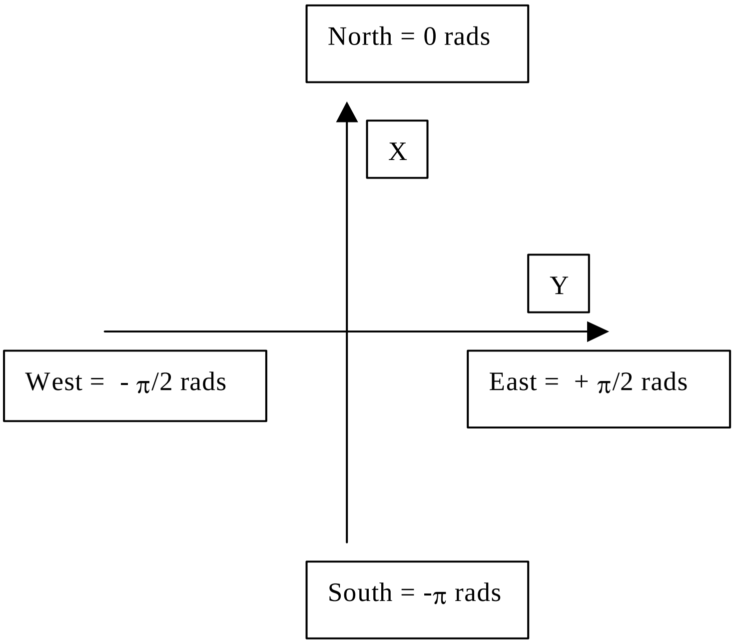


Figure B-2 – Relationship Between Heading and X, Y Coordinate System.

B-2.4 Date Time Group

B-2.4.1 Definition

Total Bytes = 8, Unsigned Binary
byte 7 transmitted first ... byte 0.

BYTES							
7 & 6		5	4	3	2	1 & 0	
YEAR		MONTH (1-12)	DAY (1-31)	HOUR (0-23)	MINUTE (0-59)	MILLISECOND (0-59999)	
1997		12	01	07	59	1500	
8	7	6	5	4	3	2	1
0000 0111	1100 1101	0000 1100	0000 0001	0000 0111	0011 1011	0000 0101	1101 1100
07, CD		0C	01	07	3B	05, DC	

Example - 1st December 1997, 07:59. 1.5 seconds
1500 ms = 1.5 seconds.

B-2.5 Order of Data

B-2.5.1 Big Endian Byte Order

Data within STANAG 7023 tables is written using the Big Endian Byte Order Format where the Most Significant Bit of a byte is bit 7, the Least Significant Bit of a byte is bit 0.

MSB							LSB
1	0	0	1	1	1	0	1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Binary Number represents $9D_{(16)}$ or $157_{(10)}$

Bytes are ordered Most Significant Byte first, Least Significant Byte last. E.g. for an 8 byte Field the ordering would be.

[byte 8 MSB][byte 7][byte 6][byte 5][byte 4][byte 3]
[byte 2][byte 1][byte 0 LSB]
Increasing byte ordering in the record →

B-2.6 ASCII (ISO/IEC 10646-1)

8-bit ASCII characters are LEFT justified. ASCII fields are to be used as free text for transmission of non-encoded immediate information.

The subset of ASCII characters to be used are the printable characters plus the NULL, i.e.:

NULL ($00)
space ($20) to tilde ($7E)

The following string "Hello" encoded into an 8 byte wide ASCII field, is represented as follows:

H	e	l	l	o	NULL	NULL	NULL
$48_{(16)}$	$65_{(16)}$	$6C_{(16)}$	$6C_{(16)}$	$6F_{(16)}$	$00_{(16)}$	$00_{(16)}$	$00_{(16)}$
$72_{(10)}$	$101_{(10)}$	$108_{(10)}$	$108_{(10)}$	$111_{(10)}$	$0_{(10)}$	$0_{(10)}$	$0_{(10)}$
BYTE 7	BYTE 6	BYTE 5	BYTE 4	BYTE 3	BYTE 2	BYTE 1	BYTE 0
WRITTEN FIRST							WRITTEN LAST

B-3 Cyclic Redundancy Check (CRC)

Details and examples of CRC are widely available in open literature. CRC algorithms treat any bit sequence to be checked as a binary polynomial. Given the original bit sequence, the CRC generates a check sequence and appends it to the original. The check sequence is generated so that the resulting bit sequence is exactly devisable by some pre-defined binary polynomial. This pre-defined binary polynomial is called the devisor or CRC polynomial.

Using CRC-16 for 8-bit transmission streams, an extra 2-Byte (16-bit) check sequence, that helps detect bit errors, is appended to the bit sequence to be checked. For the bit sequence represented by the hexadecimal number $(\text{FFFF FFFF FFFF FF01})_{hex}$, CRC-16 shall calculate a check sequence of 0026_{hex}.

B-3.1 Example Code for bitwise CRC-16 calculation

The C-language example code for CRC-16 calculation is provided to enable implementing nations to prove the outcome of other possible CRC-16 algorithms.

The bit shuffling algorithm used is easily implemented and consumes very little memory. However, its time performance is rather poor. The code calculates the CRC-16 check sequence in hexadecimal representation for an arbitrary bit sequence stored in a file, the name of which may be provided as a command line parameter. Other implementations than bitwise CRC calculation are possible. These table-driven algorithms process one byte at a time and are faster than a bitwise implementation. At the same time they consume more memory, as they have to keep tables in memory during runtime.

```
/* Begin of CRC-16 generation code */
/* ------------------------------------------------------- */

#include        <stdio.h>
#include        <stdlib.h>
#include        <string.h>

#define         M16     0x8005  /* crc-16 mask */

unsigned short updcrc(unsigned short, short, unsigned short);
void perr(char *);

char            filename[100]; /* test data file name */
unsigned short          crc16; /* calculated crc-16 check sequence */
short                   ch; /* container for one byte of test data */
```

```
unsigned int        num; /* number of bytes in the checked test data file */
FILE                *fp; /* test data file */

main(int argc, char *argv[])
{
        if(argc>2)      perr("Usage:   crc16exe [filename]");
        /* crc16exe represents the name of this executable program file */
        if(argc==2)     strcpy(filename, argv[1]);
        else
        {
                printf("\nEnter filename:  "); gets(filename);
        }

        if((fp=fopen(filename,"rb"))==NULL) perr("Can't open the file");
        num = 0;
        crc16 = 0;

        while((ch=(short)fgetc(fp))!=EOF) /* explicit cast to short */
        {
                num ++;
                crc16=updcrc(crc16,ch,M16); /* Insert the CRC-16 bit mask */
        }

        fclose(fp);
        printf("\nNumber of bytes = %lu\nCRC16 = %04X\n\n",num,crc16);
}

unsigned short updcrc(unsigned short crc, short c, unsigned short mask)
{
        int i;
        c<<=8;
        for(i=0;i<8;i++)
        {
                if((crc ^c) & 0x8000) crc=(crc<<1) ^mask;
                else crc<<=1;
                c<<=1;
        }
        return crc;
}

void perr(char *s)
{
        printf("\n%s",s); exit(1);
}
/* End of CRC-16 generation code */
```

Annex C – Abbreviations and Glossary

C-1 Abbreviations

ASCII	American Standard Code for Information Interchange
ATO	Air tasking Order
BE	Basic Encyclopaedia
Cond	Conditional Requirement
CRC	Cyclic Redundancy Check
CVLD	Cross Virtual Look Direction
DHT	Define Huffman Tables
DIAM	Defense Intelligence Agency
DQT	Define Quantisation Tables
DRI	Define Restart Interval
DTG	Date Time Group
EEI	Essential Elements of Information
Encode	Encoded Value
EO	Electro-Optical
EOI	End Of Image
FOV	Field of View
FRAG	Fragmentary Order
GPS	Global Positioning System
Hex	Hexadecimal
Immed	Immediate Value
INS	Inertial Navigation System
IR	Infra Red
ISO/IEC	International Standards Organisation / International Electrotechnical Commission
JPEG	Joint Photographic Experts Group
LSB	Least Significant Byte
LTOIV	Latest Time of Intelligence Value
Mand	Mandatory Requirement
mm	Millimetre
MSB	Most Significant Byte
MTI	Moving Target Indicator
NaN	Not a Number
NATO	North Atlantic Treaty Organisation
Opt	Optional Requirement
RGB	Red, Green, Blue
RMS	Reconnaissance Management System
RN	Real Number

RST	Restart
SAR	Synthetic Aperture Radar
SOF	Start Of Frame
SOF_0	Start Of Frame for 8-bit Baseline JPEG
SOF_1	Start Of Frame for 12-bit Extended Sequential JPEG
SOI	Start Of Image
SOS	Start Of Scan
UTC	Universal Time Coordinated
V/H	The ratio of velocity to height. Used to correct sensor geometry.
VLD	Virtual Look Direction
YCbCr601	Luminance Chrominance Colour Space in accordance with CCIR601

C-2 Glossary

Auxiliary data	Information generated by the collection system to describe all aspects of the mission as required except for the sensor data.
Auxiliary data file	A logical grouping of auxiliary data.
Byte	Eight binary digits (bits)
CRC-16	An error checking algorithm for use on data.
Data file	The realisation of a Table as a data stream.
Data file address	Allows each Table to have a unique address. Used to relate the data file to a specific Table for decoding purposes.
Data file number	A generation sequence number (not necessarily a transmission sequence number) and acts as a counter per source address.
Data file size	The number of bytes in a data file.
Data Segment	A segment that is primarily used for sensor data files but could also have interleaved auxiliary data files.
Element	The smallest definable sensitive area of the detector array of a sensor. A sensor element produces an output representing the detected energy from a scene element within one single wavelength band to which the sensor is sensitive.

	The term element shall be associated with one layer of information for a certain sensor image Pixels are made from samples; Samples are made from elements. Pixel size ≥ Sample size Sample size ≥ Element size
Field (picture)	An interleaved part of a frame, e.g. a standard TV frame is made up of two fields. Not all frames use fields.
Field of view (FOV)	The area of coverage of a specific sensor. Usually stated in angular dimensions.
Fragmentary order (FRAG)	An abbreviated form of an "Operations (OPS) Order", generally more specific and time sensitive.
Frame	An image component. Its structure is defined in the Sync Hierarchy and Image Build Data Table.
Gimbals	A mechanical structure that enables a sensor to reposition itself relative to the platform.
Header	A 32 byte table preceding a data file. Its contents define the structure of the associated data file.
Information Requester	A person who requests information from the mission but who was not responsible for requesting or planning the mission.
Line	An image component. Its structure is defined in the Sync Hierarchy and Image Build Data Table.
Mission Requester	A person who requests a mission to be flown or planned to obtain information.
Packet	A data structure consisting of a sync, a header, and a data file.
Pan framing sensor	A pan framing sensor collects data samples while the sensor is in continuous motion.
Pixel	A picture element. The smallest resolvable area of an image, either on screen or stored in memory. Samples relating to the same pixel shall be contained within a single packet of sensor data.

	Pixels are made from samples; Samples are made from elements. Pixel size ≥ Sample size Sample size ≥ Element size
Postamble	A collection of auxiliary data files to enable efficient analysis of the record. Postamble data files are optional and may be appended to the preamble (if possible) or appended to the data segments.
Preamble	The first segment in a record. The contents of a preamble shall enable an exploitation system to interpret and act upon subsequent segments.
RADALT	Radar Altimeter. A radio ranging instrument which measures the distance between the instrument and the ground or surface level. Typically in the context of aircraft the RADALT is the "radar altitude" above ground level, i.e. the actual height of the aircraft above the nearest surface vertically below the aircraft.
Record	The top level data structure consisting of all of the segments. A record may contain all or a portion of the data collected during a mission.
Sample	A digital value representing the output of one or more sensor elements. The ordering of the samples can differ from sensor to sensor. Pixels are made from samples; Samples are made from elements. Pixel size ≥ Sample size Sample size ≥ Element size
Scene element	An area on the ground that is projected onto a single sensor element of the sensor at a given instant in time.
Segment	A segment consists of a set of interleaved packets of data without any time discontinuities. Segments are defined for the purpose of transmitting related sensor data and

	auxiliary data.
Sensor data	Image data collected by a sensor.
Sensor data file	A logical grouping of data for a specific sensor.
Source address	Related tables have the same source address for “high level” addressing.
Step framing sensor	A step framing sensor collects data samples while the sensor is moved in a step-stop motion.
Super frame	The highest order of image component. Its structure is defined in the Sync Hierarchy and Image Build Data Table.
Swath	An image component. Its structure is defined in the Sync Hierarchy and Image Build Data Table.
Sync	A prescribed bit pattern used as a marker to enable systems to recognise the start of system specific data streams.
Table	The STANAG 7023 documented representation of a data file.
Target index number	A unique number assigned to each target to associate it with related target information tables.
Tick	The user defined unit of time for the system.
Tile	A rectangular area of a frame described by the number of lines and the number of samples per line.
Time tag	A counter used by the system. The Tick sets the incremental rate. Used for time sequencing data.

RATIFICATION AND IPLEMENTATION DETAILS

STADE DE RATIFICATION ET DE MISE EN APPLICATION

Nation	NATIONAL RATIFICATION/REFERENCE DE LA RATIFICATION NATIONALE	National Implementing Document/ Document national de mise en application	Implementation/Mise en application					
			Intended date of implementation/Date prevue de mise en application			Date implementation was achieved/ Date réele de mise en application		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE								
CA	2441-7023(Dar 4), dated 3 July 2002	Ratifing but not implemented			N/A			N/A
CZ								
DA								
FR	020236/DEF/EMA/OL.4/NP, dated 5 Feb. 03		DOP	DOP	DOP			
GE	BMVg-FüSI6-Az03-51-60, dtd 30 Dec. 02		+4	+4	+4			
GR	F.060/AD/8/678, dated 9 Jan 03				DOP			
HU								
IT	ARM/NATO/NU/541, dated 6 June 2003	STANAG			TBD			TBD
LU								
NL								
NO								
PL	157/ROK/P, dated 17 Oct. 2002	Ratifing but not implemented			N/A			N/A
PO								
SP								
TU	HAVSTANEM-289				Jul 04			
UK	D/DStan/12/15/7023, dated 13 May 02		TBN	TBN	TBN			
US								

* See overleaf reservations/Voir reserves au verso
\+ See comments overleaf/Voir commentaires au verso
x Service(s) implementing/Armee(s) mettant en application

i

Reservations
None

Comments:

CA: CA is monitoring Air Reconnaissance Primary Imagery Data Standards, but not taking national actions.

PL: Implementation will be possible when the Air Reconnaissance System will be created in the Polish Armed Forces (Consistent with NATO requirements, what means appropriate equipment, software and procedures).