



*Tailoring of the Earth Explorer File Format  
Standard for the Swarm Ground Segment*

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# SWARM

## **TAILORING OF THE EARTH EXPLORER FILE FORMAT STANDARD FOR THE SWARM GROUND SEGMENT**

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## Change Record

Issue	Date	Page	Section	Req't	Description of Change
1.0	May 2007				First issue
1.1	June 2007				Including comments from ESOC and ESRIN
1.2	August 2008		4.1.2 4.1.3 4.1.5 4.2.3		Revised the allowable file class values (as agreed in the ground segment progress meeting #1) Updated according to agreements reached in ground segment progress meeting #2: - ST1x, ST2x, ST3x changes to STRx. - TLMx changes to HK_x - Editorial: Change references to MPx_ and RPx_ in section 4.2.3
1.3	December 2008		All 4.1.4 4.1.5 4.1.3 4.1.5.4		Editorial: SWARM -> Swarm Agreed GS-PDR updates: RID-45: File instance shapes  RID-43: Missing filetype and RID-82: Deviation from ff standard tailoring.
1.4	February 2009		All 4.1.3  6-9  2.2 7  4.1.3 4.1.4 4.1.5		Removed block capitalisation of section titles  Product file type examples updated to correspond to agreed names (MAGALOW_1b to MAGA_LR_1B).  Added missing [F-STD] sections to make this tailoring document complete with respect to the standard.  Swarm GS PM #4 Action 4.2-ESTEC: File tailoring document to be updated to clarify values to be assigned to the fixed header.  File Type: Semantic Descriptor and File Instance ID expanded to address the agreed new syntax for the REPx File Category (e-mail: K.Galloway, 13/02/09).
1.5	August 2009		4.1.4 4.1.4.3  4.1.4.1 4.1.4.2 4.1.4.3 4.1.5.1 4.1.5.2 4.1.5.3 4.1.5.4 4.1.6		New section: Introduced new shape for immediate request files (IRF)  File version number. Updated definition to include the concept of baseline for Level-1b product files.

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# 1 Introduction

## 1.1 Background

Earth Explorer Missions are part of the Earth Observation Envelope Programme (EOEP). They are small missions led by the European Space Agency (“ESA” or the “Agency”) to cover primary research objectives. The Swarm Mission, (hereinafter also referred to as “Swarm”) has been approved for implementation as the fifth Earth Explorer Mission.

The objectives of the Swarm mission are to provide the best survey ever of the geomagnetic field and the first detailed description of the way this field changes on time scales from a day to several years. After release from the launcher, a side-by-side flying lower pair of satellites at an initial altitude of about 450 km and a single higher satellite at about 530 km will form the Swarm constellation. The constellation configuration will make it possible to produce the first detailed space-time description of ionospheric currents and an improved description of the magnetic field originating within the solid Earth and oceans. The timing of the mission will also make it possible to take advantage of data recovered from previous missions to investigate changes, which occurred in the magnetic field over a full decade time scale. The Swarm nominal mission lifetime will be 4 years and ESA will be in charge for the development and procurement of the Swarm ground segment components.

## 1.2 Purpose and scope

This document is intended to build on the Earth Explorer Ground Segment File Format Standard, [F-STD], by providing the Swarm specific details. Basically this document answers to the points in [F-STD] where it is stated “each mission shall define...”.

The exception to this is the chapter 9 of [F-STD] concerning the “Availability of Tools” which has been ignored as ESA is not providing such tools (e.g. file validation, file display, file conversion,...etc) as a CFI for the Swarm ground segment.

This document should be made applicable to any part of the Swarm ground segment development where there is a file based interface and the file formats are required to follow the [F-STD] standard.

## 1.3 Acronyms and Terminology

### 1.3.1 Acronyms

ACC	Accelerometer
ASCII	American Standard Code for Information Interchange
ASM	Absolute Scalar Magnetometer
BinX	Binary XML Description Language
CCC	Satellite Command and Control Centre
CD	Compact Disk
CFI	Customer Furnished Item

CPU	Computer Processing Unit
DCN	Document Change Notice
ECSS	European Cooperation for Space Standardisation
EFI	Electric Field Instrument
ESA	European Space Agency
ESL	Expert Support Laboratory
FTP	File Transfer Protocol
GIF	Graphics Interchange Format
GPS	Global Positioning System
GPSR	GPS Receiver
GS	Ground Segment
GSV	Ground Segment Validation
GUI	Graphical User Interface
HEX	Hexadecimal
HKTM	Housekeeping Telemetry
HMI	Human Machine Interface
ICD	Interface Control Document
IDL	Interactive Data Language
IP	Internet Protocol
ISP	Instrument Source Packet
JPEG	Joint Photographic Experts Group
LEOP	Launch and Early Orbit Phase
LTA	Long Term Archive
NA	Not Applicable
PCD	Product Confidence Data
PDF	Adobe Portable Document Format
PLM	Payload Module
SFTP	Secure File Transfer Protocol
SSH	Secure Shell
STR	Star Tracker
TBC	To Be Confirmed by the Agency
TBD	To Be Defined by the Agency
TDS	Test Data Set
TF	Transfer Frame
TIFF	Tagged Image File Format
TT&C	Telemetry and Telecommand
VCDU	Virtual Channel Data Unit
VFM	Vector Field Magnetometer
W3C	World Wide Web
XML	Extensible Mark-up Language

### **1.3.2 Terminology**

This document and its appendixes use the terms:

- the Agency to indicate the European Space Agency (ESA)
- the Project to indicate the Swarm project team
- TBC To Be Confirmed by the Agency, or in agreement with the Agency
- TBD To Be Defined by the Agency, or in agreement with the Agency

For schedule dates indicated as month/year, end of the month is the exact date assumed.

Note that “e.g.” is used to indicate examples. These represent possibilities and not a definitive list. To illustrate: The dog shall have a name (e.g. Spot, Fluffy,..etc.). On the other hand “ie.” is used to precise wording. To illustrate: The dog shall sleep during normal working hours (ie. Monday to Friday from 09:00 to 18:00).

## **2 Documents**

### **2.1 Applicable Documents**

[F-STD] Earth Explorer File Format Standards, PE-TN-ESA-GS-0001, issue 1.4, 13-06-03.

### **2.2 Reference Documents**

[MRD] Swarm Mission Requirements Document, SW-MD-ESA-SY-001

[Master-ICD] Swarm Master ICD, SW-IC-ESA-IC-0117

## **3 File Structure**

### **3.1 Logical vs Physical Files**

The content of [F-STD] fully applies to Swarm.

### **3.2 Header**

The content of [F-STD] fully applies to Swarm.

### **3.3 Data Block**

The content of [F-STD] fully applies to Swarm.

### **3.4 Packaging and Distribution of Files**

One file compression standard will be used in Swarm ground segment files. This is detailed in 4.2.3.

## 4 File Naming

### 4.1 Logical File Name

The content of [F-STD] fully applies to Swarm. The Earth Explorer logical file name is given by:

MM\_CCCC\_TTTTTTTTTT\_<instance\_id>

where:

MM = Mission ID

CCCC = File Class

TTTTTTTTTT = File Type

<instance\_id> = File Instance ID

#### 4.1.1 Mission ID

For Swarm:

MM = SW

#### 4.1.2 File Class

For Swarm the following are the allowable File Class values:

**TEST:** for internal testing purposes only (e.g. files generated as input to or output from acceptance testing, GSV,..etc.)

**OPER:** for Routine Operations files

**RPRO:** for Re-Processing Files

#### 4.1.3 File Type

The 10 character File Type can be subdivided into two sub-fields as follows:

TTTTTTTTTT = FFFFDDDDDD

where:

FFFF = File Category

DDDDDD = Semantic Descriptor

#### 4.1.3.1 File Category

For Swarm the following are the allowable File Category values<sup>1</sup>:

- AUX\_**: for auxiliary data files to be used independently for all 3 spacecrafts.
- AUXx**: for auxiliary data files spacecraft dependant.
- LOG\_**: for logging files spacecraft independent (e.g. error logs, breakpoint output,...etc).
- LOGx**: for logging files spacecraft dependant.
- MPLx**: for mission planning files.
- REP\_**: for reporting files which are independent of the spacecraft.
- REPx**: for reporting files (e.g. acquisition reports, production reports, archiving).
- HK\_x**: for telemetry retrieval files.
- CMDx**: for Command Sequences to be uplinked to the satellites.
- OBSx**: for files used for on-board software maintenance.
- TMx\_**: for the VC-4 telemetry files provided by FOS to the PDGS.

For Data Product files, the File Category shall look like IIIx, where III is instrument specific:

- ACCx**: for files containing products derived from Accelerometer data.
- ASMx**: for files containing products derived from ASM data.
- MAGx**: for Magnetic products, derived from both ASM and VFM data (high sampling, low sampling, temporal calibration coefficients).
- GPSx**: for files containing products derived from GPSR data.
- MODx**: for Medium Orbit Determination files (Level1B).
- EFIx**: for files containing products derived from EFI data (Level0 or Plasma L1B ).
- STRx**: for files containing products derived from star tracker data.
- VFMx**: for files containing products derived from VFM data reports,...etc).

With x being “A”, “B” or “C”, respectively for Swarm A, Swarm B or Swarm C.

#### 4.1.3.2 Semantic Descriptor

The Semantic Descriptor must be unique for a File Type and be as descriptive as possible given the 6 character limitation. The Semantic Descriptor can be composed of only upper case letters, numbers, and the underscore character (“\_”). The document defining the file format details of each File Type shall also define the Semantic Descriptor with the following 2 exceptions where the Semantic Descriptors are pre-defined:

##### **(a) Data Product Files:**

For the data product files (see section 4.1.3.1) the semantic descriptor shall be defined as follows:

XXXXLL

where XXXX provides a description of the product and LL describes the product level, i.e.:

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1. File Categories allowed for Level2 products will be detailed at a later stage, when the study on the Level2 architecture is completed.

- 0\_ for Level-0
- 1B for Level-1b
- 2\_ for Level-2

With the above definition, examples of data product files would be:

MAGA\_LR\_1B: for magnetic Level-1b product sampled at low frequency for Swarm A.

GPSBNAV\_0\_: for the Level-0 navigational solution from the GPS for Swarm B.

#### **(b) The REPx File Category:**

For the REPx reporting files (see section 4.1.3.1) the source of the report will be identified in the 6 characters allocated to the Semantic Descriptor. For example:

REPA\_DQC\_: A report relating to Swarm A generated by the PDGS data quality control component.

REPB\_L1BOP: A report relating to Swarm B generated by the PDGS Level-1b operational processor.

### **4.1.4 File Instance ID**

The File Instance ID is limited to no more than 41 characters and can be composed of only upper case letters, numbers, and the underscore character (“\_”). There are three File Instance ID shapes identified for Swarm.

#### **4.1.4.1 Shape 1: Standard Swarm File Instance ID**

This File Instance ID shape applies to every Swarm File Category with the exception of REPx (see section 4.1.4.2). The standard Swarm File Instance ID shape has the syntax:

<instance\_id> = yyyyymmddThhmmss\_YYYYMMDDTHHMMSS\_vvvv

This shape has 4 different contexts which are described in section 4.1.5 below. Any document defining the file format details of each File Type shall make clear which context is applicable.

#### **4.1.4.2 Shape 2: REPx File Instance ID**

This is the File Instance ID shape which applies to the REPx File Category (section 4.1.3.1). The REPx File Instance ID shape has the syntax:

<instance\_id> = yyyyymmddThhmmss\_XXXXXXXXXXYYYYMMDDTHHMMSS\_vvvv

where:

- yyyyymmddThhmmss is the creation time of the report file.
- XXXXXXXXXXXX is the 10 character File Type (section 4.1.3) of the product file for which the report was generated.
- YYYYMMDDTHHMMSS is the validity or sensing start time of the product file for which the report was generated (see section 4.1.5.1).
- vvvv is the file version number (see section 4.1.6).

#### **4.1.4.3 Shape 3: Immediate response files**

Immediate response files are a sub-category of the MPLx file category (section 4.1.3.1) and have the file type MPLx\_IRF\_. The instance ID shape corresponding to this file type has the syntax:

<instance\_id> = RRRRRRRR\_YYYYMMDDTHHMMSS\_vvvv

where:

- RRRRRRRR is the request name completed with underscores as necessary.
- YYYYMMDDTHHMMSS is the execution time of the immediate response request.
- vvvv is the file version number (see section 4.1.6).

## 4.1.5 Possible File Instance ID Sub-Elements

### 4.1.5.1 Shape 1, Context 1: Sensing Period

In the sensing period context the <instance\_id> components have the following meaning:

- yyyymmddThhmmss is the Swarm sensing start time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- YYYYMMDDTHHMMSS is the Swarm sensing stop time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- vvvv is the file version number (see section 4.1.6).

This File Instance ID context is intended in particular for files of File Category ASM<sub>x</sub>, EFi<sub>x</sub>, MAG<sub>x</sub>, MOD<sub>x</sub>, STR<sub>x</sub>, GPS<sub>x</sub>, ACC<sub>x</sub>, VFM<sub>x</sub> and HK<sub>x</sub>.

As Swarm sensing time values will typically have greater precision than a second, all sensing start times shall be rounded down and all sensing stop times shall be rounded up. If only a single sensing time value is contained in the file (i.e. a point value) then the time shall be rounded down and used as both the sensing start time and the sensing stop time.

Examples:

Sensing Start Time	Sensing Start Time	Time part of File Instance ID
08-JUN-2005 12:15:00.300000	08-JUN-2005 13:04:59.999999	20050608T121500_20050608T130500
08-JUN-2005 12:15:00.300000	08-JUN-2005 12:15:00.400000	20050608T121500_20050608T121501
08-JUN-2005 12:15:00.000000	08-JUN-2005 12:15:00.900000	20050608T121500_20050608T121501
08-JUN-2005 12:15:00.300000	None	20050608T121500_20050608T121500

### 4.1.5.2 Shape 1, Context 2: Validity Period with respect to Swarm Sensing Time

In the validity period with respect to Swarm sensing time context the <instance\_id> components have the following meaning:

- yyyymmddThhmmss is the validity start time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- YYYYMMDDTHHMMSS is the validity stop time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- vvvv is the file version number (see section 4.1.6).

The validity time refers to the Swarm sensing time to which the data is to be applied. This File Instance ID is intended in particular for files of File Category AUX<sub>x</sub>, AUX<sub>x</sub>.

As validity time values may have greater precision than a second, all validity start times shall be round down and all validity stop times shall be rounded up. If only a single validity time value is contained in the file (i.e. a point value) then the time shall be rounded down and used as both the validity start time and the validity stop time.

As per [F-STD], if a file is intended to be valid regardless of Swarm sensing start time then the validity start time shall be given as 00000000T00000000, and if a file is intended to be valid regardless of Swarm sensing stop time then the validity stop time shall be given as 99999999T99999999.

Therefore a file that is intended to always be valid for Swarm data would contain 00000000T00000000\_99999999T99999999.

#### 4.1.5.3 *Shape 1, Context 3: Validity Period with respect to Time of Contents Relevance*

In the validity period with respect to time of contents relevance context the <instance\_id> components have the following meaning:

- `yyyymmddThhmmss` is the validity start time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000)
- `YYYYMMDDTHHMMSS` is the validity stop time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000)
- `vvvv` is the file version number (see section 4.1.6).

The validity time refers to the relevance of the information content of the file in terms of local time. This File Instance ID is intended in particular for files of File Category MPLx, LOGx and LOG\_.

As validity time values may have greater precision than a second, all validity start times shall be round down and all validity stop times shall be rounded up. If only a single validity time value is contained in the file (ie. a point value) then the time shall be rounded down and used as both the validity start time and the validity stop time.

#### 4.1.5.4 *Shape 1, Context 4: Downlink Period*

In the downlink period context the <instance\_id> components have the following meaning:

- `yyyymmddThhmmss` is the downlink (earth reception) start time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- `YYYYMMDDTHHMMSS` is the downlink (earth reception) stop time of the data contained in the file in CCSDS compact format (e.g. 20050608T121500 represents 08-JUN-2005 12:15:00.000000).
- `vvvv` is the file version number (see section 4.1.6).

This File Instance ID context is intended in particular for files of File Category TMx\_.

As Swarm downlink time values will typically have greater precision than a second, all downlink start times shall be rounded down and all downlink stop times shall be rounded up. If only a single downlink time value is contained in the file (i.e. a point value) then the time shall be rounded down and used as both the downlink start time and the downlink stop time.

#### 4.1.6 File version number

In sections 4.1.4 and 4.1.5 above a version number vvvv is defined. This section explains this component of the file instance identifiers.

In general it is a simple 4 digit, monotonically increasing by 1 version number beginning at 0001 (not 0000) and is intended to distinguish between files having all other file name attributes the same. For example, if a processor were to generate a product using the same inputs twice, the resulting output file names would be identical except that the version number advances by one for the second product.

The exception to the above rule is the version number applicable to Level-1b product files (see section 4.1.3.2). For these files the version number vvvv is further decomposed to:

bbvv

where:

- bb is the Level-1b operational processor baseline identifier, a simple 2 digit number uniquely identifying a version of the Level-1b processor.
- vv is a simple 2 digit, monotonically increasing by 1 version number beginning at 01 (not 00) and is intended to distinguish between Level-1b product files having all other file name attributes the same.

#### 4.1.7 File Name Size

The content of [F-STD] fully applies to Swarm.

### 4.2 Physical File Names

#### 4.2.1 File Names and Extensions

The content of [F-STD] fully applies to Swarm.

#### 4.2.2 Single File vs Header and Data Block Files

The content of [F-STD] fully applies to Swarm.

#### 4.2.3 Packaging and Distribution Files

Each Swarm File Type shall have only one packaging and distribution mechanism. There are four packaging mechanisms that will be supported:

MM\_CCCC\_TTTTTTTTTT\_<instance\_id>.EEF

This packaging is to be used for pure XML files and will contain both header and data block. It is expected that most files of File Category LOG\_, MPLx, and REPx will use this packaging.

MM\_CCCC\_TTTTTTTTTT\_<instance\_id>.HDR

This packaging is to be used for an XML header file in the case that the data block is non-XML. It is expected that most files of File Category ASMx, EFIx, MAGx, MODx, STRx, GPSx, ACCx, VFMx and HK\_x. will use this packaging.

MM\_CCCC\_TTTTTTTTTT\_<instance\_id>.DBL

This packaging is to be used for a non-XML data block. The .HDR and .DBL will have the same file name save for the extension. It is expected that most files of File Category ASMx, EFIx, MAGx, MODx, STRx, GPSx, ACCx, VFMx and HK\_x. will use this packaging.

MM\_CCCC\_TTTTTTTTTT\_<instance\_id>.ZIP

This packaging is the result of performing a “zip” command on a pair of .HDR and .DBL files. The resulting .ZIP file will have the same file name save for the extension as the .HDR and .DBL.

The .ZIP packaging for the File Types with a non-XML data block shall be used systematically for distribution. The entity receiving these files is thus responsible for the unpackaging of the .ZIP in order to access the .HDR and/or .DBL as needed.

The document defining the file format details of each File Type shall make clear which packaging is applicable.

## **5 File Syntax**

### **5.1 General Considerations**

#### **5.1.1 Standard File Syntax - XML**

The content of [F-STD] fully applies to Swarm.

#### **5.1.2 Exceptions**

The content of [F-STD] fully applies to Swarm.

#### **5.1.3 Earth Explorer XML Conventions**

The content of [F-STD] fully applies to Swarm.

### **5.2 File Syntax – Hierarchical Decomposition**

#### **5.2.1 Top-Level File Syntax**

The content of [F-STD] fully applies to Swarm.

#### **5.2.2 Header Syntax**

The content of [F-STD] fully applies to Swarm.

#### **5.2.3 Data Block Syntax**

The content of [F-STD] fully applies to Swarm.

#### **5.2.4 XML ASCII Data Set Syntax**

The content of [F-STD] fully applies to Swarm.

### **5.3 File Syntax – Summary**

#### **5.3.1 XML ASCII File Syntax**

The example 5.3.1-1 in [F-STD] is relevant to Swarm while 5.3.1-2 is not. A file with a pure XML structure shall be packaged as file\_name.EEF and not as two separate files (ie. file\_name.HDR + file\_name.DBL).

### **5.3.2 Non-XML ASCII File Syntax**

The example 5.3.2-4 in [F-STD] is relevant to Swarm while 5.3.2-3 is not. A file with a non-XML data block shall be packaged as two separate files (ie. file\_name.HDR + file\_name.DBL). Note that in this case no file\_name.EEF is to be generated.

### **5.3.3 Binary File Syntax**

The content of [F-STD] fully applies to Swarm.

## **6 Data Representation**

### **6.1 General Considerations**

The content of [F-STD] fully applies to Swarm.

### **6.2 ASCII Data Representation**

The content of [F-STD] fully applies to Swarm.

### **6.3 Binary Data Representation**

The content of [F-STD] fully applies to Swarm.

## 7 Headers Content

### 7.1 Fixed Header

The following table shows the allowed values for the tags which appear in the fixed header of the Swarm files.

Tag Name	Type	Allowed Values
File_Name	string	Repetition of the Logical File Name (section 4.1)
File_Description	string	A one-line description of the File Type. For Swarm these are defined in [Master-ICD].
Notes	string	Multi-lines of free text added by the creating system. There are no restriction on the allowed values.
Mission	string	Swarm
File_Class	string	Repetition of the File Class (section 4.1.2).
File_Type	string	Repetition of File Type (section 4.1.3).
<b>Validity_Period</b>	<b>structure</b>	<b>The 2 subsequent tags relate to this structure</b>
Validity_Start	string	The start time of the validity period for the file in CCSDS ASCII format with time reference. For shape 1 files this corresponds to the Instance ID start time (sections 4.1.4.1 and 4.1.5). For shape 2 files this corresponds to the report file creation time (section 4.1.4.2).
Validity_Stop	string	The stop time of the validity period for the file in CCSDS ASCII format with time reference. For shape 1 files this corresponds to the Instance ID stop time (sections 4.1.4.1 and 4.1.5). For shape 2 files this corresponds to the creation time of the report file (section 4.1.4.2) and is therefore the same as the Validity_Start value.
File_Version	string	Repetition of the file version element in the File Instance ID (see section 4.1.4).
<b>Source</b>	<b>structure</b>	<b>The 4 subsequent tags relate to this structure</b>
System	string	Name of the ground segment element creating the file. The allowed values are: FOS or PDGS.
Creator	string	The name of the subsystem/ tool creating the file. The allowed values will be defined by those responsible for the FOS and PDGS development as necessary.
Creator_Version	string	Version of the subsystem/ tool creating the file.
Creator_Date	string	UTC creation date, in CCSDS ASCII format with time reference.

## **7.2 Variable Header**

### **7.2.1 General Considerations**

The content of [F-STD] fully applies to Swarm.

### **7.2.2 Variable Header Content for Binary Data Blocks**

The content of [F-STD] fully applies to Swarm.

### **7.2.3 Variable Header Content for Binary Data Products**

The content of [F-STD] fully applies to Swarm.



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## **8 Data Block Contents**

The content of [F-STD] fully applies to Swarm.

## **9 Availability of Tools**

Not applicable (see section 1.2).



*Tailoring of the Earth Explorer File Format  
Standard for the Swarm Ground Segment*

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