Title: EarthCARE Products Definitions
Volume 1 - Common Products Definitions

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	Name	Date	Signature
Prepared by:	Th. Jäger/M. Eisinger	20.08.2014	
Checked by:	K.-W. Kruse	21.08.2014	
Product Assurance:	L. Gessler	30.09.2014	
Configuration Mgmt:	for W. Mrohs	09.12.14	
Project Management:	M. Huchler	30.09.14	

Change Record

Issue	Date	Sheet	Description of Change
Draft-1	17.06.2008	all	first draft issue
Draft-2	30.07.2008	all	Comments from ESA and from the Subcontractors implemented
Draft-3	11.09.2008	all	Further work performed
1	17.10.2008	All	first issue
2	10.07.2009	All	Update to reflect evolutions implemented during the ESSS and ECGP development
3	04.12.2009	All	Update to reflect evolutions implemented during the ESSS and ECGP development
4	27.04.2010	All	Implemented comments from EC-EM-ESA-0390/2010
5	10.06.2010	All	Modified after ECGP Pre-TEB
6	21.10.2010	All	Updated for ECGP KO
7	07.03.2012	All	Implemented changes requested in ESA CR-0005
		42	OCIDR-PROJ-1
8 Draft 1	14.02.2013	24-30	Updated Main Product Header, following agreements with JAXA (GS meeting #53, 7 Nov 2012) and PDGS (6 Feb 2013), renaming time fields to explicitly mention time, and clarifying that UTC time is used.
8 Draft 2	23.09.2013	16	Changed file extensions from .HDR and .DBL to .xml and .h5
		25	Clarified usage of header field originalProductName
8 Draft 3	24.09.2013	12, 20	Added 4 more measurement units for ATLID
		16	Removed obsolete paragraph on measurement data records (not applicable to NetCDF/HDF format)
		18	GeographicCoordinates: Corrected units for latitude/longitude, and simplified structure
		25	Corrected units for [xyz]Velocity
		36	Clarified contents of parameter calibrationParametersQuality
8 Draft 4	25.04.2014	11	Product file name: Changed first time stamp from sensing start to frame start

		25	GSPDR-ALL-DAT-60: Clarified validity period is frame start to frame stop for products. This is different from the agreed RID disposition in order to ensure compatibility with the PDGS.
		25	Fixed Product Header, field File_Version: changed from 1 to 4 digits for compliance to File Format Standard. Changed from product baseline to fixed value of “0001”.
		25	Fixed Product Header, field Source.System: Indicated that actual processing centres will be added at a later stage
		27/31	Main Product Header, field processingCentre: Changed from 4 to 10 characters and indicated identity with field Source.System in Fixed Product Header
		29	GSPDR-ALL-DAT-31: Updated description for level 1d
		32/33	Clarified state vector source is different for level 0 (predicted orbits) and higher level (reconstructed orbits) products. Clarified state vector time (epoch) applies to Kepler elements as well, and state vector is given close to frame start or ANX at orbit start, depending on granularity of orbit file used on input.
		43/44	GSPDR-ALL-DAT-16: Clarified use of annotation header fields in level 1 processing
		43	Clarified sort order of annotated ISPs in level 0 product
8	20.08.2014	24	Validity_Period tag modified for compliance to File Format Standard.
			Formal release from ASD including the ESA draft versions above

Table of Contents

1. COMMON PRODUCTS DEFINITIONS

1.1 Introduction

1.1.1 Scope of the Document

This specification arises in the frame of the ESSS and ECGP. The purpose of this document is to specify the format and content of:

- the Instrument Source Packets for the EarthCARE Instruments;
- the L0/L1 products for the EarthCARE Instruments;
- the Auxiliary Data Files needed in the L0/L1 Processing as long as they are not specified in other ICDs.

The Instrument Source Packets are actually specified in [AD-110] and [RD-04]. For the sake of the readability of this document their specification is repeated here.

This is a living document. The specification of the formats and contents of the ISPs, of the L0/L1 Products and of the Auxiliary Data is based on information available at the time of writing. Parameters' formats and values will change as the ESSS and ECGP processing becomes better defined.

TBDs/TBCs/TBWs mark specifications that are yet to be completed. Currently there are no TBCs/TBDs/TBWs.

1.1.2 References

1.1.2.1 Applicable Documents

[AD-01]	Earth Explorer Ground Segment - File Format Standard	PE-TN-ESA-GS-0001
[AD-02]	Tailoring of the Earth Explorer File Format Standard for the EarthCARE Ground Segment	EC-TN-ESA-GS-0218
[AD-110]	EC Packet Utilisation Standard	EC.STD.ASD.SY.00001

1.1.2.2 Reference Documents

[RD-01]	Abbreviation List	EC.LI.ASD.SY.00001
[RD-02]	NetCDF	See 4.1.1 http://www.unidata.ucar.edu/software/netcdf/
[RD-03]	Earth Observation Mission CFI Software Conventions Document	EO-MA-DMS-GS-0001
[RD-04]	EarthCARE Space to Ground ICD	EC.ICD.ASD.SY.00010

1.1.2.3 Normative Documents

[ND 229]	World Geodetic System 84

1.1.3 Definitions

General EarthCARE Definitions are listed in [RD-01].

1.1.4 Abbreviations

General EarthCARE Abbreviations are listed in [RD-01].

Further abbreviations used in this and in the following volumes are given in Volume 0 - Introduction.

1.1.5 Document Structure

This Document provides the detailed description of:

- The Earthcare Conventions applicable to all EarthCARE Products - Chapter 1.2
- The Generic EarthCARE Product Structure - Chapter 1.3
- Common Data Structures - Chapter 1.4
- The Fixed Product Header - Chapter 1.5
- The Main Product Header - Chapter 1.6
- The L0 Specific Product Header - Chapter 1.7
- The L1 Specific Product Header - Chapter 1.8
- The Measurement Data Set Records for the L0 products - Chapter 1.9
- The structure of the ISP headers - Chapter 1.10

1.1.6 Multiplicity

This document includes tables representing the structures of the Products Headers. Fields in a header may have a size (in bytes) or a multiplicity (for substructures that repeat themselves).

The symbols used to indicate multiplicity are:

0..1	zero or one
0..*	zero or more
1	exactly one
1..*	one or more
*	several

When a substructure repeats itself, there is always first a field defining how many instances of the substructure are present, then the substructure itself. For example:

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
…							
8	MDSCount		NC_UINT64	8	1	8	
9	MDSDescription		MDSDescription	8	*	variable	

In this example, there are *MDSCount* substructures of type *MDSDescription*. If *MDSCount* is 0 (zero), no *MDSDescription* substructure is included at all. The size depends on the number of *MDSDescription* included.

1.2 Earthcare Conventions

1.2.1 Product File Naming

The first field of the Main Product Header contains the product name. The naming conventions for products are specified in [AD-01] and [AD-02]. For the sake of readability an example is provided hereafter:

product name = <Mission_Id>_<File_Class>_<File_Type>_<File_Instance_Id>

whereby:

- *Mission_Id* (3 characters) is always equal to ECA (EarthCARE)
- *File_Class* (4 characters) specifies the agency generating the file, latency, environment and product baseline, with one letter each
- *File_Type* (10 characters) is one of the authorised File Types for the EarthCARE Mission. For products, this includes in the following order the instrument acronym (e.g. ATL_, BBR_, CPR_ or MSI_), the Product Type (e.g. NOM_) and the Product Level (e.g. 0_, 1A, 1B, 1C, 2A or 2B)
- *File_Instance_Id* (40 characters for products) includes the frame start time, processing start time or file creation date (to make the product filenames unique), orbit number and frame ID

Details on the precise format of these building blocks for a product's name are specified in [AD-01] and [AD-02] and reflected in the specification of the Fixed Product Header in this document, which also sets forth the allowed values for these fields.

As an example, an offline BBR level 1B product in nominal BBR mode generated by the operational processor in the ESA PDGS which contains data of the second frame of orbit 10398, the frame starting on26 Oct 2017 14:32:55 UTC, with processing starting the same day at 21:02:18 UTC would have the logical file name:

ECA_EOOA_BBR_NOM_1B_20171026T143255Z_20171026T210218Z_10398B

Remark: This file naming convention assumes the use of an operating system that allows long filenames.

1.2.2 Data Representation

The eligible data types for product structures are listed in Table 1.2-1. Note that C/C++ native types are redefined and replaced with EarthCARE and NetCDF C types. Throughout this document as well as in the other volumes, the corresponding NetCDF C type definitions are used.

Table 1.2-1: Data Types

Variable Type	C/C++ Type	EarthCARE Type	NetCDF C-Type	Range
Character	char	ECchar	NC_BYTE	{-128, +127]
	unsigned char	ECuChar	NC_CHAR	[0 , +255]
1-byte integer	char	ECchar	NC_BYTE	{-128, +127]
	unsigned char	ECuChar	NC_CHAR	[0 , +255]
2-byte integer	short	ECshortInt	NC_SHORT	{-32 768, +32 767]
	unsigned short	ECuShortInt	NC_USHORT	[0, +65 535]
4-byte integer	long	EClongInt	NC_INT	[-2 147 483 648, +2 147 483 647]
	unsigned long	ECuLongInt	NC_UINT	[0, +4 294 967 295]
8-byte integer	long long	EClongLongInt	NC_INT64	[-9 223 372 0368 54 775 808, +9 223 372 036 854 775 807]
	unsigned long long	ECuLongLongInt	NC_UINT64	[0, +18 446 744 073 709 551 615]
4-byte single-precision floating-point number	float	ECfloat	NC_FLOAT	[-3.40282347e+38, 3.40282347e+38] [-1.17549435e-38, 1.17549435e-38]
8-byte double-precision floating-point number	double	ECdouble	NC_DOUBLE	[-1.79e+308, 1.79e+308] [-2.22e-308, 2.22e-308]
Boolean	enum	ECBool	NC_BYTE	ECFALSE = 0 ECTRUE = 1

The IEEE 754-1985 is the standard for storing real numbers in single as well as in double precision. [AD-01] provides further details.

1.2.3 Logical Values

Logical values are values which may be either true or false. The following convention is followed:

Table 1.2-2: Logical Values

Logical	Value
True	1
False	0

As an array of characters, the arrays “TRUE” or “FALSE” must be used.

1.2.4 Bit / Byte Numbering

For the purpose of identifying bits within a multi-byte structure, the numbering convention shown below is used (big-endian convention).

Byte 0 is always the most significant byte and is transmitted before Byte 1, which in turn is more significant than and is transmitted before Byte 2 and so on.
Within a byte, bit 0 is the most significant bit, following [AD-110].

The following examples show a 1-byte, a 2-byte and a 3-byte structure respectively.

Table 1.2-3: 1-byte structure

Bytes	**BYTE 0**							
Bits	0	1	2	3	4	5	6	7

Table 1.2-4: 2 byte structure

Bytes	**BYTE 0**								**BYTE 1**							
Bits	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Table 1.2-5: 3 byte structure

Bytes	**BYTE 0**								**BYTE 1**								**BYTE 2**							
Bits	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

1.2.5 Measurement Units

The following Measurement Units are supported in EarthCARE (extending the list in [AD-02]):

Name	**Description**
unitless	Default undefined value: should be used only to indicate that information is missing or when there is no relation to any Measurement Unit
Variable, see Description.	The attribute can hold values with different measurement units. The poissible units will be listed in the attribute description.
m/s^2	Acceleration in m/s^2
A	Ampere
deg	Angle in decimal degrees
rad	Angle in radians
deg/s^2	Angular acceleration in deg/s^2
deg/s	Angular velocity in deg/s
BU	Binary Unit shall be used for uncalibrated sensor values.
BU sr m^3	Binary Unit times Steradiant times cubic metre
day	Day
g	Gram
Hz	Hertz
J	Joule
J/K	Joule per Kelvin
Js	Joule times second
K	Kelvin
K/s	Kelvin per second
kg	Kilogram

MHz	Megahertz
Mhz/s	Megahertz per second
MHz/rad	Megahertz per radians
MHz/rad^2	Megahertz per radians^2
MHz/BU	Megahertz per Binary Unit
m	Meter
us	Microsecond
mJ	Millijoule
uJ/bit	Microjoule per bit
mol	Mole
Ohm	Ohm
Pa	Pascal
1/(sr m)	1 / (Steradiant * Meter)
%	Percent
rpm	Revolutions per minute
s	Second
sr	Solid Angle in Steradians
m/s	Velocity in m/s
V	Volt
V/s	Volt per second
W	Watt
W/m^2	Watt per square meter
W/(m^2 sr)	Watt per square meter per steradian
W/(m^2 um)	Watt per square meter per micrometer

Remark: Within a Data Set Record (see Chapter 1.3) a given data field is always expressed in the same unit.

1.2.6 Angles

As far as geographic coordinates are concerned, angles shall be expressed in decimal degrees and shall be represented using number between -180 deg and +180 deg.

1.2.7 Time

Time is used with an accuracy of up to 1 microsecond. It can be expressed as:

1) **UTC** (Coordinated Universal Time) almost equivalent to GMT (Greenwich Meridian Time) presented as an array of 16, 23 or 26 significant characters in one of the following formats:

   a) YYYYMMDDThhmmssZ
   This format is used for example in the name of the EarthCARE Products. Time is approximated to the closest second.

   b) YYYY-MM-DDThh:mm:ss.sss
   This format is used for example in the Fixed Header of the EarthCARE Products. Time is approximated to the closest known millisecond. If such precision is not available, milliseconds are set to 0.

   c) YYYY-MM-DDThh:mm:ss.ssssss
   This format is used for example in the Specific Product Header of the EarthCARE Products. Time is approximated to the closest known microsecond. If such precision is not available, microseconds are set to 0.

where:

- YYYY year [1950..2050]
- DD day [1..31]
- MM month [01, 02,...11, 12]
- T ASCII character 84 (0x54)
- hh hour [00..23]
- mm minutes [00..59]
- ss second [00..59]
- sss [000…999] set to “000” if irrelevant
- ssssss μs [000000…999999] set to “000000” if irrelevant
- Z ASCII character 90 (0x5A)

e.g., December 29, 2015 at 10:00 is coded as

- 20151229T100000Z
- 2015-12-29T10:00:00.000
- 2015-12-29T10:00:00.000000

Note: In the filenames (case a) time specifications end with a 'Z'. In contrast, file specifications in the headers (cases b and c) do not end with a 'Z', following [AD-01] and [RD-03].

2) **MJD** 2000 (Modified Julian Day 2000) as used in [RD-03] is the decimal number of day since January 1, 2000 at 00:00 hours UTC. Modified Julian Days can be represented:

   a) Either as 3 long integers (4 bytes each, 12 bytes total) as elapsed days, elapsed seconds and elapsed microseconds. E.g., January 3, 2000 at 09:00 is coded as {2, 32400, 0}

   b) Or as a double-precision floating-point number (8 bytes). E.g., January 3, 2000 at 09:00 is coded as {2.375}

As a general rule, UTC time format is used in the MPH and SPH, while MJD format will be used when time stamps are required in Data Set Records.

UTC times in the EarthCARE Product and File Headers are always ‘true’ UTC, i.e. there is no need to apply time corrections in order to take the occurrence of leap seconds into account. Processors shall always use the Mission CFI Software ([RD-03]) to perform time conversions e.g. from UTC to MJD 2000.

1.2.8 Geolocation Information

The WGS84 co-ordinate system is used for all latitude/longitude geolocation. The system is described in [ND 229]. Geolocation information is expressed within EarthCARE products using the following convention:

Geodetic Latitude

Data representation	double-precision floating-point number (8 bytes)
Units	decimal degrees
Sign Convention	positive north (-90 = south pole, +90 = north pole)

Geocentric Longitude

Data representation	double-precision floating-point number (8 bytes)
Units	decimal degrees
Sign Convention	positive east, 0 = Greenwich meridian, range: [-180, 180) i.e., west direction includes -180, east does not include +180

Latitude is always listed prior to longitude

1.2.9 Sizes

All sizes provided for the EarthCARE Products shall follow the following convention:

kilobyte	10E+3 bytes	1 kB or 1 kByte
megabyte	10E+6 bytes	1 MB or 1 MByte
gigabyte	10E+9 bytes	1 GB or 1 GByte
terabyte	10E+12 bytes	1 TB or 1 TByte

EarthCARE Products shall have the minimum possible size in order to spare disk space and to enhance the performance of data transfers.

1.2.10 Byte Alignment and Product Sizes

All sizes listed in the EarthCARE Product Definitions assume products are written to disk in such a way that the minimum disk space is used. For instance, if a field's type is ECchar and its size is three bytes then exactly three bytes should be written to disk.

Depending on the H/W and S/W platform this may or may not be the default behaviour. For example, some compilers perform automatic word-alignment to increase performance. When writing *structures* to disk, one or more bytes of padding may be added to achieve word-alignment.

Obviously, this padding is not desirable as it tends to bloat the size of products. *Output products must have the same size as specified in the EarthCARE Products Definitions.*

This means all Data Structures in the EarthCARE Products Definitions are to be understood as byte-aligned.

Care should be taken depending on the H/W and S/W platform to set compiler flags appropriately to achieve this. Alternatively, fields of a structure may be copied individually to ensure proper alignment and size of data members.

Remark: Note that this effectively waives Requirement binary-20 of [AD-01].

Remark: Since Data blocks are written in HDF/NetCDF format, deviations from this specification may occur when using the HDF/NetCDF libraries.

1.2.11 Header File Format

Headers shall be written to file in XML format and are repeated as groups in the NetCDF/HDF file.

1.2.12 Reference Frames

The reference frames defined in [RD-03] shall be used for all systems.

1.3 Generic EarthCARE Product Structure

1.3.1 Guidelines

In compliance with [AD-01], EarthCARE Products are composed of Headers and Data Blocks.

Headers have a fixed structure - possibly specialised for a particular product - whereas Data Blocks may have different sizes and structures even within a product.

Data Blocks and Data Sets are specialised per instrument and product as specified in the following volumes.

1.3.2 Components

An EarthCARE Product consists of one Product Header and one Data Block (See instrument specific Volumes for details). This generic structure applies to both L0 as well as to L1 Products.

The Fixed Product Header is common to all EarthCARE Products. Its structure is specified in [AD-01] and is provided in Chapter 1.5.

The Main Product Header is also common to all EarthCARE Products. Its structure is specified in Chapter 1.6.

The Specific Product Header is specialised per instrument and product as specified in the following volumes. It includes the description of the Measurement Data Sets contained in the product.

The **L0 Specific Product Header** is common to all L0 EarthCARE Products

The **L1 Specific Product Header** is composed of

(1) attributes common to all L1 EarthCARE products;
(2) Annotation Data Sets (ADS): this Data Set is instrument-specific in that it contains data - e.g. generated during the measurements - that are relevant to the product's further processing;
(3) Quality Data Sets (QDS): each defines a piece of Product Confidence Data;
(4) Reference Data Sets (RDS): each provides a reference to a document relevant to the generation of the product. For example, this can be the name of the parent product, i.e. a product used for generating the current product; for instance, a L0 product is the parent product of an L1 product. Also it could be the name of an auxiliary file used for generating the product.
(5) Measurements Data Set Descriptions specialised for each instrument (these are documented in the instrument-specific volumes)

A Product Data Block consists of one or more Measurement Data Sets, which in turn consist of one or more Measurement Data Set Records.

The Measurement Data Set Records are instrument- and product-specific, thus they are specified in the following volumes. However, all EarthCARE L0 Products share the same tailoring of the Instrument source Packets included in the Measurement Data Set Records of the L0 Products. While the instrument-specific details are provided in the following volumes, the tailoring is specified in Chapter 1.9.

1.3.3 Fixed vs. Main vs. Specific Product Header

The following guidelines were followed in the allocation of the attributes among the Fixed Product Header, the Main Product Header and the Specific Product Header.

(1) The format and content of the Fixed Product Header is fully specified in [AD-01] and may not be modified.

(2) The format of the Main Product Header is specified in [AD-01]. As to the content, the Main Product Header
- repeats information already included in the Fixed Product Header;
- includes further information on the product as a whole as long as it is neither instrument- nor product-level-specific.

Basically, the Main Product Header provides information that supports browsing an archive to extract potential products of interest using generic search criteria.

(3) The format of the Specific Product Header is specified in [AD-01]. As to the content, the Specific Product Header provides further information on the product as a whole which is instrument- and/or product-level-specific.
Basically, the Specific Product Header provides information that supports browsing an archive to extract potential products of interest using specific search criteria that presuppose a more detailed knowledge of the instrument or processing.

1.3.4 Physical Format

Product Headers shall be included in XML-format, whereas Product Data Blocks shall be in binary format for L0 Products and HDF/NetCDF format for L1 Products ([RD-02]).

The Product Header shall be included in a file named as the product itself with the extension `.xml`.
This file first includes the Fixed Product Header, then the Main Product Header and finally the Specific Product Header in this sequence. The Specific Product Header shall provide first the parameters common to all EarthCARE products, then either the L0- or the L1-specific parameters.

The Product Data Block shall be included in a file named after the product itself with the extension `.h5`. A Product Data Block File shall include the Measurement Data Set Records, which shall be time-ordered (The most efficient solution for time-ordering in terms of I/O shall be selected). It shall also contain the product headers as specified in [AD-02].

1.4 Common Data Structures

The following data structures are used in this volume and in the volumes 2 to 4.

Section 1.4.5 is relevant for internal data representation only and can safely be ignored by data product users.

1.4.1 AppendedCRC

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	CRC	CRC value computed with the polynom x^16 + x^12 + x^5 + 1 with the initial value of 0xFFFF.	unitless	NC_USHORT	2	1	2	
TOTAL:							2	

1.4.2 GeographicCoordinates

Geographic coordinates are expressed according to the Project Conventions.

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	geographicLatitude	Geodetic latitude.	deg	NC_FLOAT	4	1	4	
2	geographicLongitude	Geocentric longitude.	deg	NC_FLOAT	4	1	4	

TOTAL:							Size depends on XML format	

1.4.3 ISPTime

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	coarseTime	Time over 4 bytes.	s	NC_UINT	4	1	4	
2	fineTime	Time Counter with high resolution over 3 bytes.	BU	NC_BYTE	1	3	3	
TOTAL:							7	

1.4.4 LatLongCoordinates

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	latitude	Geodetic Latitude	deg	NC_DOUBLE	8	1	8	
2	longitude	Geocentric Longitude	deg	NC_DOUBLE	8	1	8	
TOTAL:							Size depends on NetCDF format	

1.4.5 ECType

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	ECundefinedTypeEnum		unitless	NC_BYTE	1	1	1	ECundefinedType
2	ECcharEnum	char (1 Byte)	unitless	NC_BYTE	1	1	1	ECchar
3	ECpCharEnum	Pointer to char	unitless	NC_BYTE	1	1	1	ECpChar
4	ECuCharEnum	unsigned char (1 Byte)	unitless	NC_BYTE	1	1	1	ECuChar
5	ECpUCharEnum	Pointer to unsigned char	unitless	NC_BYTE	1	1	1	ECpUChar
6	ECshortIntEnum	short int (2 Bytes)	unitless	NC_BYTE	1	1	1	ECshortInt
7	ECpShortIntEnum	Pointer to short int	unitless	NC_BYTE	1	1	1	ECpShortInt
8	ECuShortIntEnum	unsigned short int (2 Bytes)	unitless	NC_BYTE	1	1	1	ECuShortInt
9	ECpUShortIntEnum	Pointer to unsigned short int	unitless	NC_BYTE	1	1	1	ECpUShortInt
10	EClongIntEnum	long int (4 Bytes)	unitless	NC_BYTE	1	1	1	EClongInt
11	ECpLongIntEnum	Pointer to long int	unitless	NC_BYTE	1	1	1	ECpLongInt

12	ECuLongIntEnum	unsigned long int (4 Bytes)	unitless	NC_BYTE	1	1	1	ECuLongInt
13	ECpULongIntEnum	Pointer to unsigned long int	unitless	NC_BYTE	1	1	1	ECpULongInt
14	EClongLongIntEnum	long long int (8 Bytes)	unitless	NC_BYTE	1	1	1	EClongLongInt
15	ECpLongLongIntEnum	Pointer to long long int	unitless	NC_BYTE	1	1	1	ECpLongLongInt
16	ECuLongLongIntEnum	unsigned long long int (8 Bytes)	unitless	NC_BYTE	1	1	1	ECuLongLongInt
17	ECpULongLongIntEnum	Pointer to unsigned long long int	unitless	NC_BYTE	1	1	1	ECpULongLongInt
18	ECfloatEnum	float (4 Bytes)	unitless	NC_BYTE	1	1	1	ECfloat
19	ECpFloatEnum	Pointer to float	unitless	NC_BYTE	1	1	1	ECpFloat
20	ECdoubleEnum	double (8 Bytes)	unitless	NC_BYTE	1	1	1	ECdouble
21	ECpDoubleEnum	Pointer to double	unitless	NC_BYTE	1	1	1	ECpDouble
22	ECstringEnum	string (only for XML files, variable length)	unitless	NC_BYTE	1	1	1	ECstring
23	ECpStringEnum	Pointer to string	unitless	NC_BYTE	1	1	1	ECpString
24	ECvoidEnum	void - machine-dependent	unitless	NC_BYTE	1	1	1	ECvoid
25	ECpVoidEnum	Pointer to void - machine-dependent	unitless	NC_BYTE	1	1	1	ECpVoid

1.4.6 MeasurementUnit

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	DEFAULT_MEASUREMENT_UNIT	Default undefined value: should be used only to indicate that information is missing or when there is no relation to any Measurement Unit	unitless	NC_BYTE	1	1	1	unitless
2	VARIABLE_MEASUREMENT_UNIT	The attribute can hold values with different measurement units. The possible units will be listed in the attribute description.	unitless	NC_BYTE	1	1	1	variable, see description
3	ACCELERATION	Acceleration in m/s^2	unitless	NC_BYTE	1	1	1	m/s^2
4	AMPERE	Ampere	unitless	NC_BYTE	1	1	1	A
5	ANGLE_DECIMAL_DEGREE	Angle in decimal degrees	unitless	NC_BYTE	1	1	1	deg
6	ANGLE_RADIANS	Angle in radians	unitless	NC_BYTE	1	1	1	rad
7	ANGULAR_ACCELERATION	Angular acceleration in deg/s^2	unitless	NC_BYTE	1	1	1	deg/s^2
8	ANGULAR_VELOCITY	Angular velocity in deg/s	unitless	NC_BYTE	1	1	1	deg/s

9	BINARY_UNIT	Binary Unit shall be used for uncalibrated sensor values.	unitless	NC_BYTE	1	1	1	BU
10	BINARY_UNIT_TIMES_STERADIAN_TIMES_CUBE_METER	Binary Unit times Steradiant times cubic meter	unitless	NC_BYTE	1	1	1	BU sr m^3
11	DAY	Day	unitless	NC_BYTE	1	1	1	day
12	GRAM	Gram	unitless	NC_BYTE	1	1	1	g
13	HERTZ	Hertz	unitless	NC_BYTE	1	1	1	Hz
14	JOULE	Joule	unitless	NC_BYTE	1	1	1	J
15	JOULE_PER_KELVIN	Joule per Kelvin	unitless	NC_BYTE	1	1	1	J/K
16	JOULE_TIMES_SECONDS	Joule times second	unitless	NC_BYTE	1	1	1	Js
17	KELVIN	Kelvin	unitless	NC_BYTE	1	1	1	K
18	KELVIN_PER_SECOND	Kelvin per second	unitless	NC_BYTE	1	1	1	K/s
19	KILOGRAM	Kilogram	unitless	NC_BYTE	1	1	1	kg
20	MEGAHERTZ	Megahertz	unitless	NC_BYTE	1	1	1	MHz
21	MEGAHERTZ_PER_SECOND	Megahertz per second	unitless	NC_BYTE	1	1	1	Mhz/s
22	MEGAHERTZ_PER_RADIANS	Megahertz per radians	unitless	NC_BYTE	1	1	1	MHz/ rad
23	MEGAHERTZ_PER_RADIANS2	Megahertz per $radians^2$	unitless	NC_BYTE	1	1	1	MHz/ rad^2
24	MEGAHERTZ_PER_BINARY_UNIT	Megahertz per Binary Unit	unitless	NC_BYTE	1	1	1	MHz/BU
25	METER	Meter	unitless	NC_BYTE	1	1	1	m
26	MICROSECOND	Microsecond	unitless	NC_BYTE	1	1	1	us
27	MILLIJOULE	Millijoule	unitless	NC_BYTE	1	1	1	mJ
28	MICROJOULE_PER_BIT	Microjoule per bit	unitless	NC_BYTE	1	1	1	uJ/bit
29	MOLE	Mole	unitless	NC_BYTE	1	1	1	mol
30	OHM	Ohm	unitless	NC_BYTE	1	1	1	Ohm
31	PASCAL	Pascal	unitless	NC_BYTE	1	1	1	Pa
32	PER_STERADIAN_PER_METER	1 / (Steradiant * Meter)	unitless	NC_BYTE	1	1	1	1/(sr m)
33	PERCENT	Percent	unitless	NC_BYTE	1	1	1	%
34	REVOLUTIONS_PER_MINUTE	Revolutions per minute	unitless	NC_BYTE	1	1	1	rpm
35	SECOND	Second	unitless	NC_BYTE	1	1	1	s
36	STERADIAN	Solid Angle in Steradians	unitless	NC_BYTE	1	1	1	sr
37	VELOCITY	Velocity in m/s	unitless	NC_BYTE	1	1	1	m/s
38	VOLT	Volt	unitless	NC_BYTE	1	1	1	V
39	VOLT_PER_SECOND	Volt per second	unitless	NC_BYTE	1	1	1	V/s
40	WATT	Watt	unitless	NC_BYTE	1	1	1	W
41	WATT_PER_SQUARE_METER	Watt per square meter	unitless	NC_BYTE	1	1	1	W/m^2
42	WATT_PER_SQUARE_METER_PER_STERADIAN	Watt per square meter per steradian	unitless	NC_BYTE	1	1	1	$W/(m^2$ sr)
43	WATT_PER_SQUARE_METER_PER_MICROMETER	Watt per square meter per micrometer	unitless	NC_BYTE	1	1	1	$W/(m^2$ um)

1.5 FixedProductHeader

The Fixed Product Header is identical for all products. Some information in this header is redundant with information in the Main Product Header.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	File_Name	unitless	NC_BYTE	60	1	60	
2	File_Description	unitless	NC_BYTE	2000	1	2000	
3	Notes	unitless	NC_BYTE	2000	1	2000	
4	Mission	unitless	NC_BYTE	9	1	9	EarthCARE
5	File_Class	unitless	NC_BYTE	4	1	4	
6	File_Type	unitless	NC_BYTE	10	1	10	
7	Validity_Period	unitless	Validity_Period				
8	File_Version	unitless	NC_BYTE	4	1	4	0001
9	Source	unitless	Source				
TOTAL:						Size depends on XML format	

1.5.1 File_Name

This is the logical file name of the product. The format must follow the rules set forth in [AD-01] and [AD-02].

1.5.2 File_Description

This is a one-line description of the File Type. Allowed descriptions are pre-defined for each project for each File Type defined. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

1.5.3 Notes

This is a textual description of the product/file. There are no prescriptions on its format provided it fits into the maximum allowed size. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

1.5.4 Mission

The Mission field must be set to the applicable value for the project. For EarthCARE the value is shown in the table.

1.5.5 File_Class

This describes the agency generating the product (ESA/JAXA), its latency (NRT/offline/not applicable), the environment (operational, test, simulator, system verification), and the product baseline. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

For EarthCARE each letter of the File Class has a specific meaning as follows: CCCC = ABCD where: A = Agency generating the file E ESA J JAXA B = Latency N Near-real time (placeholder only, currently not used) O Offline X Not applicable C = Environment O Operational (Only these files will be distributed to users) T Test S Simulator (formerly SIMU) V System Verification Test (formerly SVTx) D = Product baseline

1.5.6 File_Type

This defines the file/product structure. All file/products of the same File Type share same structure. See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

The 10 character File Type can be subdivided into two sub-fields as follows: TTTTTTTTTT = FFFFDDDDDD where: FFFF = File Category DDDDDD = Semantic Descriptor

1.5.7 Validity_Period

For products, the Validity Period equals the time span between the time stamps of the frame start and frame stop, with frameStartTime and frameStopTime as defined below (sections 1.6.45 and 1.6.46).

For files, the Validity Period defines the time span during which the content of the file should be used in the processing.

For the purposes of the Fixed Product Header times are in CCSDS time format: "UTC=YYYY-MM-DDThh:mm:ss", e.g. "UTC=2014-08-20T12:00:00". See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. The default value for the start of a Validity Period is 0000-00-00T00:00:00, for the end of a Validity Period is 9999-99-99T99:99:99.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	Validity_Start	unitless	NC_BYTE	23	1	23	
2	Validity_Stop	unitless	NC_BYTE	23	1	23	
TOTAL:						Size depends on XML format	

1.5.7.1 Validity_Start

Validity_Start is the UTC time of the frame start.

1.5.7.2 Validity_Stop

Validity_Stop is the UTC time of the frame stop.

1.5.8 File_Version

This field is retained for compatibility with "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001. It was used to distinguish between different instances of files with the same validity. For EarthCARE products it has no meaning as the processing time is used to distinguish between product instances. It is therefore always set to “0001”..

1.5.9 Source

This describes the (sub)system that generated the product/file.

See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. A Source consists of:

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	System	unitless	NC_BYTE	10	1	10	
2	Creator	unitless	NC_BYTE	10	1	10	
3	Creator_Version	unitless	NC_BYTE	4	1	4	
4	Creation_Date	unitless	NC_BYTE	23	1	23	
TOTAL:						Size depends on XML format	

1.5.9.1 System

See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

Supported values are (this is a preliminary list, the PDGS will add actual processing centres later):

Value	Description
UndefGrSys	Default undefined value: should be used only to indicate that information is missing
ECSIMxxxxx	Must be used when the product/file was generated within the ECSIM
PDGSxxxxxx	Must be used when the product/file was generated within the PDGS
JAXAxxxxxx	Must be used when the product/file was generated by JAXA
MLSEABBR10	Used by SEA CCDB generation processor

1.5.9.2 Creator

See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details.

Supported values are:

Value	Description
UndefCreat	Default undefined value: should be used only to indicate that information is missing
ESSSxxxxxx	Must be used when the product/file was generated within the ESSS
ECGPxxxxxx	Must be used when the product/file was generated within the ECGP
PDGSxxxxxx	Must be used when the product/file was generated within the PDGS
JAXAxxxxxx	Must be used when the product/file was generated by JAXA
MLSEABBR10	Used by SEA CCDB generation processor

1.5.9.3 Creator_Version

This is the version of the system that generated the product/file. As an example, version 23 must be written as "0023".

1.5.9.4 Creation_Date

This is the creation date of the product/file. Creation dates are in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss.

1.6 MainProductHeader

The Main Product Header is identical for all Products. Some information in this header is redundant with information in the Fixed Product Header. It provides general information applicable to all products independently of level, processing mode, etc.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	productName	unitless	NC_BYTE	60	1	60	
2	originalProductName	unitless	NC_BYTE	60	1	60	
3	missionID	unitless	NC_BYTE	3	1	3	ECA
4	fileClass	unitless	NC_BYTE	4	1	4	
5	fileCategory	unitless	NC_BYTE	4	1	4	
6	productType	unitless	NC_BYTE	3	1	3	
7	productLevel	unitless	NC_BYTE	2	1	2	
8	sensingStartTime	unitless	NC_BYTE	23	1	23	
9	sensingStopTime	unitless	NC_BYTE	23	1	23	
10	degradedProductQualityFlag	unitless	ECBool	1	1	1	
11	description	unitless	NC_BYTE	2000	1	2000	
12	processorName	unitless	NC_BYTE	2000	1	2000	
13	processorMajorVersion	unitless	NC_SHORT	2	1	2	
14	processorMinorVersion	unitless	NC_SHORT	2	1	2	
15	executableMajorVersion	unitless	NC_SHORT	2	1	2	
16	executableMinorVersion	unitless	NC_SHORT	2	1	2	
17	formatMajorVersion	unitless	NC_SHORT	2	1	2	
18	formatMinorVersion	unitless	NC_SHORT	2	1	2	
19	subsettedProduct	unitless	ECBool	1	1	1	
20	dataBlockSize	unitless	NC_UINT64	8	1	8	
21	acquisitionStation	unitless	NC_BYTE	10	1	10	
22	processingCentre	unitless	NC_BYTE	10	1	10	
23	processingStartTime	unitless	NC_BYTE	23	1	23	
24	processingStopTime	unitless	NC_BYTE	23	1	23	
25	orbitNumber	unitless	NC_USHORT	2	1	2	
26	frameID	unitless	NC_BYTE	1	1	1	
27	ANXTime	unitless	NC_BYTE	26	1	26	
28	ANXLongitude	deg	NC_DOUBLE	8	1	8	
29	stateVectorSource	unitless	NC_BYTE	15	1	15	
30	stateVectorTime	unitless	NC_BYTE	26	1	26	
31	xPosition	m	NC_DOUBLE	8	1	8	
32	yPosition	m	NC_DOUBLE	8	1	8	
33	zPosition	m	NC_DOUBLE	8	1	8	
34	xVelocity	m/s	NC_DOUBLE	8	1	8	
35	yVelocity	m/s	NC_DOUBLE	8	1	8	
36	zVelocity	m/s	NC_DOUBLE	8	1	8	
37	orbitSemiMajorAxis	m	NC_DOUBLE	8	1	8	
38	orbitEccentricity	unitless	NC_DOUBLE	8	1	8	
39	orbitInclination	deg	NC_DOUBLE	8	1	8	
40	perigeeArgument	deg	NC_DOUBLE	8	1	8	
41	rightAscension	deg	NC_DOUBLE	8	1	8	
42	meanAnomaly	deg	NC_DOUBLE	8	1	8	
43	frameStartCoordinates	unitless	GeographicCoordinates	45	1	45	

44	frameStopCoordinates	unitless	GeographicCoordinates	45	1	45	
45	frameStartTime	unitless	NC_BYTE	23	1	23	
46	frameStopTime	unitless	NC_BYTE	23	1	23	
47	frameStartMargin	km	NC_DOUBLE	8	1	8	
48	frameStopMargin	km	NC_DOUBLE	8	1	8	
TOTAL:						Size depends on XML format	

1.6.1 productName

The productName field in the Main Product Header is identical to the File_Name field in the Fixed Product Header.

1.6.2 originalProductName

This field should be left empty when the product is created. When renaming the product (which is necessary, e.g., for JAXA products received at the ESA PDGS) the (logical) file name before renaming should be reported here, but only in the XML header file. In the datablock file, this field shall remain empty. This way the datablock file does not have to be modified when the file is renamed.

1.6.3 missionID

This is a project-specific field which is always set to 'ECA'.

For EarthCARE: MMM = ECA Note: This is preferred to EC_ in order to avoid double underscores __ in file names (they may look like a single one depending on the font used).

1.6.4 fileClass

This is a repetition of the file class element of the product file name. See [AD-02] for details.

For EarthCARE each letter of the File Class has a specific meaning as follows: CCCC = ABCD where: A = Agency generating the file E ESA J JAXA B = Latency N Near-real time (placeholder only, currently not used) O Offline X Not applicable C = Environment O Operational (Only these files will be distributed to users) T Test S Simulator (formerly SIMU) V System Verification Test (formerly SVTx) D = Product baseline

1.6.5 fileCategory

This is a repetition of the file category element of the product file name. See [AD-02] for details.

This is a project-specific field. Supported values are:

Value	Description
XXX_	Default undefined value: should be used only to indicate that information is missing
MPL_	for mission planning files
TLM_	for telemetry retrieval files
GEO_	for orbit and attitude files created from satellite telemetry (these files can be associated with a downlink frame which means they will use shape 1 of the file instance ID, see section 4.1.4.1. Therefore it is useful to have a separate file category for these files.)
AUX_	for all other auxiliary data files used in instrument data processing
REP_	for reports
LOG_	for log files
MTD_	for metadata files

ATL_	for ATLID data product files
BBR_	for BBR data product files
CPR_	for CPR data products files
MSI_	for MSI data product files
AC__	for ATLID+CPR synergistic product files
AM__	for ATLID+MSI synergistic product files
BM__	for BBR+MSI synergistic product files
ACM_	for ATLID+CPR+MSI synergistic product files
ALL_	for ATLID+CPR+MSI+BBR synergistic product files

1.6.6 productType

This is a repetition of the product type element of the product file name. See [AD-02] for details.

1.6.7 productLevel

This is a repetition of the product level element of the product file name. See [AD-02] for details.

See "Earth Explorer Ground Segment - File Format Standard" - PE-TN-ESA-GS-0001 for details. Supported values are:

Value	Description
XX	Default undefined value: should be used only to indicate that information is missing or when there is no relation to any Product Level
0_	for Level 0
1A	for Level 1a (placeholder only, not used)
1B	for Level 1b
1C	for Level 1c (MSI only)
1D	for Level 1d (support products, e.g., joint standard grid)
2A	for Level 2a (single-instrument products)
2B	for Level 2b (synergistic products)

1.6.8 sensingStartTime

The sensing start time is the UTC time stamp of the least recent sample in the product, in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss. This is the actual sensing time, so it is affected by data gaps, instrument sampling, and frame margins applied, and it will be different between product levels. For synergistic products, the least recent (i.e., earliest) start sensing time (from the set of start sensing times for the various instruments) has to be used.

1.6.9 sensingStopTime

The sensing stop time is the UTC time stamp of the most recent sample in the product, in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss. This is the actual sensing time, so it is affected by data gaps, instrument sampling, and frame margins applied, and it will be different between product levels. For synergistic products, the most recent (i.e., latest) start sensing time (from the set of stop sensing times for the various instruments) has to be used.

1.6.10 degradedProductQualityFlag

Boolean flag to assess the overall product quality identifying the presence of significant errors within the product. Set to TRUE (1) if significant errors are present in the product.

Value	Description

0	Indicates a false condition.
1	Indicates a true condition.

1.6.11 description

A comment relevant to the product/file can be written here. There are no format constraints as long as the text fits into the maximum allowed size.

1.6.12 processorName

The name of the processor that generated the product, used the file etc. is provided here. For instance, this field could be set to "BBR PDGS L0 Processor". There are no format constraints as long as the text fits into the maximum allowed size.

1.6.13 processorMajorVersion

This is the major version of the overall processor that generates the product/file, comprising not only the executable(s) but also its configuration (e.g., selection of algorithm options, thresholds, static auxiliary inputs etc.). It is assumed that this overall processor configuration be uniquely identified through a "Major Version.Minor Version" for Configuration Control. At least a major version must be defined and be stored in this field. This version will be controlled by the host infrastructure, i.e., it shall neither be hardcoded in the processor nor be read from its configuration file.

1.6.14 processorMinorVersion

This is the minor version of the overall processor that generates the product/file, comprising not only the executable(s) but also its configuration (e.g., selection of algorithm options, thresholds, static auxiliary inputs etc.). It is assumed that this overall processor configuration be uniquely identified through a "Major Version.Minor Version" for Configuration Control. If a Minor Version is not used, this field must be set to 0. This version will be controlled by the host infrastructure, i.e., it shall neither be hardcoded in the processor nor be read from its configuration file.

1.6.15 executableMajorVersion

This is the major version of the executable (or combination of executables) that generates the product/file. It is assumed that any software generating files/products be uniquely identified through a "Major Version.Minor Version" for Configuration Control. At least a major version must be defined and be stored in this field. This version is determined by the executable itself, so it should not be read from the configuration file, but be coded in source code header files or other files used in building the executable in order not to be modifiable after the executable has been built.

1.6.16 executableMinorVersion

This is the minor version of the executable (or combination of executables) that generates the product/file. It is assumed that any software generating files/products be uniquely identified through a "Major Version.Minor Version" for Configuration Control. If a Minor Version is not used, this field must be set to 0. This version is determined by the executable itself, so it should not be read from the configuration file, but be coded in source code header files or other files used in building the executable in order not to be modifiable after the executable has been built.

1.6.17 formatMajorVersion

This is the major version of the format of the product/file. At least a major version must be defined and be stored in this field. Product definition documents must specify this format version for each product/file they are defining. The format version changes for any product format change, e.g., addition or removal of groups or datasets. The format version is updated only when the format actually changes, not when the Product definition document is updated for another reason. This version is determined by the executable itself (even in case a given executable supports more than one format version), so it should not be read from the configuration file, but be coded in source code header files or other files used in building the executable in order not to be modifiable after the executable has been built.

1.6.18 formatMinorVersion

This is the minor version of the format of the product/file. If a Minor Version is not used, this field must be set to 0. Product definition documents must specify this format version for each product/file they are defining. The format version changes for any product format change, e.g., addition or removal of groups or datasets. The format version is updated only when the format actually changes, not when the Product definition document is updated for another reason. This version is determined by the executable itself (even in case a given executable supports more than one format version), so it should not be read from the configuration file, but be coded in source code header files or other files used in building the executable in order not to be modifiable after the executable has been built.

1.6.19 subsettedProduct

This is used to mark products extracted from a base product without further processing, i.e. just as an extraction of data. In this case the field "parent product 1" shall be the name of the base product. If used set to true, else to false.

Value	Description
0	Indicates a false condition.
1	Indicates a true condition.

1.6.20 dataBlockSize

This is the size of the data block file in bytes.

1.6.21 acquisitionStation

This is the Acquisition Station (e.g., Kiruna) where the downlink occurred. Supported values are:

The Acquisition Station is project-specific, i.e. not mandated in the Earth Explorer File Format Standard. Supported values are:

Value	Description
XXXXXXXXXX	Default undefined value: should be used only to indicate that information is missing
Kiruna____	

1.6.22 processingCentre

This is the Processing Centre where the product was generated. This is identical to the field Source.System in the fixed product header, see section 1.5.9.1.

1.6.23 processingStartTime

This is the processing start time (UTC) of the product, i.e. when the first product sample was processed on ground. Processing dates are in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss.

1.6.24 processingStopTime

This is the processing stop time (UTC) of the product, i.e. when the last product sample was processed on ground. Processing dates are in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss.

1.6.25 orbitNumber

This is the orbit number for the current product (excluding margins added for overlap between products). It is the same number as used in the file instance ID of the file name, see [AD-02]. The orbit number is increased by one at each ascending node crossing (ANX). orbitNumber refers to the orbit number at the end of a frame (frame stop). This is relevant for frames crossing the ascending node, typically the first frame (frame A).

1.6.26 frameID

This is the frame identifier for the current product (A, B, C, D, …). It is the same letter as used in the file instance ID of the file name, see [AD-02]. The first frame (frame A) is the one crossing the ascending node or starting at the ascending node.

1.6.27 ANXTime

This is the UTC date/time of the ANX at the start of the current orbit (given by orbitNumber), in CCSDS time format: YYYY-MM-DDThh:mm:ss.ssssss. This means, all frames within the given orbit will have the same ANXTime, i.e. the ones at the start of the first frame (frame A).

1.6.28 ANXLongitude

This is the longitude of the ANX at the start of the current orbit (given by orbitNumber), i.e., the longitude at ANXTime. This means, all frames within the given orbit will have the same ANXLongitude, i.e. the ones at the start of the first frame (frame A).

1.6.29 stateVectorSource

This field describes where the State Vector used for generating the product comes from (e.g. Flight Operating Segment). Supported values are:

Supported values are:

Value	Description
UndefinedSource	Default undefined value: should be used only to indicate that information is missing
GENERATEDxxxxxx	Generated State Vectors have the lowest accuracy
FOS_PREDICTEDxx	The FOS can predict State Vectors for instance on the basis of nominal orbit conditions. This is the default value for level 0 products.
FOS_RESTITUTEDx	The FOS can compute State Vectors on the basis of information received after the orbit completed, for instance using data downlinked from the satellite
ONBOARD_GPSxxxx	Onboard Solution State Vector from PDGS reconstructed orbit files. This is the default value for level 1 and level 2 products.

1.6.30 stateVectorTime

UTC Time, in CCSDS time format: YYYY-MM-DDThh:mm:ss.ssssss, associated to the satellite state vector given in Cartesian form in the following six fields position ([xyz]Position) and velocity ([xyz]Velocity), and as Kepler elements in the six fields after that (orbitSemiMajorAxis to meanAnomaly).

The orbit position for which the state vector is given depends on the granularity of the orbit file used on input. In the default case (PDGS reconstructed orbit files, stateVectorSource = ONBOARD_GPS) state vectors are available every second, and the orbit state vector closest to the frame start will be reported, independently whether it is slightly before or slightly after frame start. In the backup cases state vectors in the orbit files are provided less frequently, e.g., twice per orbit (ascending and descending node crossing). In these cases the state vector given is close to ANX at the start of the orbit indicated by orbitNumber (section 1.6.25). It is the state vector closest to ANX from the orbit file used on input, independently whether it is slightly before are slightly after ANX.

1.6.31 xPosition

This is the position (in meters) on ground along the x-axis in the WGS84 Reference System. If not used set to 0.

1.6.32 yPosition

This is the position (in meters) on ground along the y-axis in the WGS84 Reference System. If not used set to 0.

1.6.33 zPosition

This is the position (in meters) on ground along the z-axis in the WGS84 Reference System. If not used set to 0.

1.6.34 xVelocity

This is the velocity (in meters/second) on ground along the x-axis in the WGS84 Reference System. If not used set to 0.

1.6.35 yVelocity

This is the velocity (in meters/second) on ground along the y-axis in the WGS84 Reference System. If not used set to 0.

1.6.36 zVelocity

This is the velocity (in meters/second) on ground along the z-axis in the WGS84 Reference System. If not used set to 0.

1.6.37 orbitSemiMajorAxis

This is the semi major axis (in meters) of the first orbit covered in the product (field orbitStart).

1.6.38 orbitEccentricity

This is the eccentricity of the first orbit covered in the product (field orbitStart).

1.6.39 orbitInclination

This is the inclination (in 10-3 decimal degrees, i.e. decimal millidegrees) of the first orbit covered in the product (field orbitStart).

1.6.40 perigeeArgument

This is the argument of perigee (in 10-3 decimal degrees, i.e. decimal millidegrees) for the first orbit covered in the product (field orbitStart).

1.6.41 rightAscension

This is the right ascension (in 10-3 decimal degrees, i.e. decimal millidegrees) for the first orbit covered in the product (field orbitStart).

1.6.42 meanAnomaly

This is the mean anomaly (in 10-3 decimal degrees, i.e. decimal millidegrees) of the satellite at the acquisition of the first sample contained in the product.

1.6.43 frameStartCoordinates

These are the geographic coordinates (latitude and longitude) of the subsatellite point at the frame start. The frame start latitude is determined by the number of frames per orbit and the latitude offset of the start of the first frame in an orbit (frame A). This theoretical frame start latitude (e.g., +22.5 deg for frame B, for the case of 8 frames per orbit and a latitude offset of −22.5 deg for frame A start) is used here, independent of data gaps or instrument sampling. The frame start longitude is the longitude of the point where the subsatellite track crosses the frame start latitude. Frame boundary coordinates are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field. This will be the same value for all product levels.

See chapter 1.4.

1.6.44 frameStopCoordinates

These are the geographic coordinates (latitude and longitude) of the subsatellite point at the frame end. The frame stop latitude is determined by the number of frames per orbit and the latitude offset of the start of the first frame in an orbit (frame A). This theoretical frame stop latitude (e.g., +67.5 deg for frame B, for the case of 8 frames per orbit and a latitude offset of −22.5 deg for frame A start) is used here, independent of data gaps or instrument sampling. The frame stop longitude is the longitude of the point where the subsatellite track crosses the frame stop latitude. Frame boundary coordinates are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field. This will be the same value for all product levels.

See chapter 1.4.

1.6.45 frameStartTime

This is the UTC time when the subsatellite track crosses the frame start latitude, in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss. Frame boundary times are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field. This will be the same value for all product levels.

1.6.46 frameStopTime

This is the UTC time when the subsatellite track crosses the frame stop latitude, in CCSDS time format: UTC=YYYY-MM-DDThh:mm:ss. Frame boundary times are solely determined by the satellite orbit, i.e. instrument viewing directions or instrument sampling do not affect this field. This will be the same value for all product levels.

1.6.47 frameStartMargin

This is the length along-track of the data which have been added to the product before the frame start, in km. This is an approximate value only, so it should be given in full km (no fractional part). This is because the actual margin is derived using a fixed time offset from frame start while the satellite ground speed varies slightly along the orbit, and because of the finite instrument sampling. Set to zero (0.0) if no margin is added.

1.6.48 frameStopMargin

This is the length along-track of the data which have been added to the product after the frame end, in km. This is an approximate value only, so it should be given in full km (no fractional part). This is because the actual margin is derived using a fixed time offset from frame start while the satellite ground speed varies slightly along the orbit, and because of the finite instrument sampling. Set to zero (0.0) if no margin is added.

1.7 L0SpecificProductHeader

The L0 Specific Product Header provides instrument-independent information common to L0 products.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	countISPs	unitless	NC_UINT	4	1	4	
2	countCRCErrorISPs	unitless	NC_UINT	4	1	4	
3	countMissingISPs	unitless	NC_UINT	4	1	4	
4	countDiscardedISPs	unitless	NC_UINT	4	1	4	
5	countRSCorrectedISPs	unitless	NC_UINT	4	1	4	
6	countRSCorrections	unitless	NC_UINT	4	1	4	
TOTAL:						Size depends on XML format	

1.7.1 countISPs

This is the total number of ISPs in the L0 product.

1.7.2 countCRCErrorISPs

This is the number of ISPs containing CRC errors (e.g., corrupt, incomplete, etc.) in the L0 product.

1.7.3 countMissingISPs

This is the number of missing ISPs in the L0 product.

1.7.4 countDiscardedISPs

This is the number of discarded (e.g., unreadable, out-of-range, etc.) ISPs in the L0 product.

1.7.5 countRSCorrectedISPs

This is the number of Reed-Salomon corrected ISPs in the L0 product.

1.7.6 countRSCorrections

Number of symbols corrected with Reed-Solomon.

1.8 L1SpecificProductHeader

The L1 Specific Product Header provides instrument-dependent information specific to the L1 products of a given instrument. It is composed of its own instrument-independent attributes as well as one or more instrument-specific Measurement Data Set Descriptions; also it may contain Annotation Data Sets, Quality Data Sets and Reference Data Sets. This section describes the general part of the L1 Specific Product Header. This general part is never used in any product but is always specialised per instrument. For the instrument specific specialisations see the corresponding volumes 2 to 4.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	calibrationParametersQuality	unitless	CalibrationParameterQuality	4	1	4	0:UNDEFINED_QUALITY 1:NOT_APPLICABLE 2:RECENT 3:STALE (see below)
2	firstLineFirstSampleCoord	unitless	GeographicCoordinates	45	1	45	
3	firstLineMiddleSampleCoord	unitless	GeographicCoordinates	45	1	45	
4	firstLineLastSampleCoord	unitless	GeographicCoordinates	45	1	45	
5	lastLineFirstSampleCoord	unitless	GeographicCoordinates	45	1	45	
6	lastLineMiddleSampleCoord	unitless	GeographicCoordinates	45	1	45	
7	lastLineLastSampleCoord	unitless	GeographicCoordinates	45	1	45	
8	RDSCount	unitless	NC_UINT64	8	1	8	0
9	referenceDataSetVector	unitless	ReferenceDataSet	2127	0 - *	variable	
10	QDSCount	unitless	NC_UINT64	8	1	8	0
11	qualityDataSetVector	unitless	QualityDataSet	2151	0 - *	variable	
12	ADSCount	unitless	NC_UINT64	8	1	8	0
13	annotationDataSetVector	unitless	AnnotationDataSet	2175	0 - *	variable	
14	MDSCount	unitless	NC_UINT64	8	1	8	0
15	mdsDescriptionVector	unitless	MDSDescription	8	0 - *	variable	
TOTAL:						Size depends on XML format	

1.8.1 calibrationParametersQuality

Should the L1 product contain calibration parameters, this field provides their quality status. Indeed a L1 product may be used in closed loop to process the next L1 product, if the former includes updated calibration information.

Supported values are:

Value	Description
UNDEFINED_QUALITY	Default undefined value: should be used only to indicate that information is missing

NOT_APPLICABLE	This should be used when no value is applicable
RECENT	This is to be used when the value of the calibration parameter is recent, i.e. can be used for processing. That is, the calibration parameter is still within its validity period
STALE	This is to be used when the value of the calibration parameter is stale, i.e. should not be used for processing. That is, the calibration parameter is no longer within its validity period. Note that this does not necessarily mean that the parameter cannot be used for processing: however, using it may lead to unexpected or (partially) wrong results

1.8.2 firstLineFirstSampleCoord

These are the geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the least recent sample of the least recent acquisition line in the product.

See chapter 1.4.

1.8.3 firstLineMiddleSampleCoord

These are the geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the middle sample of the least recent acquisition line in the product. If meaningless longitude and latitude are to be set to 0.

See chapter 1.4.

1.8.4 firstLineLastSampleCoord

These are the geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the most recent sample of the least recent acquisition line in the product. If meaningless longitude and latitude are to be set to 0.

See chapter 1.4.

1.8.5 lastLineFirstSampleCoord

These are the geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the least recent sample of the most recent acquisition line in the product. If meaningless longitude and latitude are to be set to 0.

See chapter 1.4.

1.8.6 lastLineMiddleSampleCoord

These are the geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the middle sample of the most recent acquisition line in the product. If meaningless longitude and latitude are to be set to 0.

See chapter 1.4.

1.8.7 lastLineLastSampleCoord

Geographic coordinates (in 10-3 decimal degrees, i.e. decimal millidegrees) of the most recent sample of the most recent acquisition line in the product.

See chapter 1.4.

1.8.8 RDSCount

This is the number of Reference Data Sets included in the product.

1.8.9 referenceDataSetVector

This Data Set provides a reference to a document relevant to the generation of the product. For example, this can be the name of the parent product, i.e. a product used for generating the current product; for instance, a L0 product is the parent product of an L1 product. Also it could be the name of an auxiliary file (even external to the Ground Segment) used for generating the product.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	name	unitless	NC_BYTE	40	1	40	
2	note	unitless	NC_BYTE	2000	1	2000	
3	reference	unitless	NC_BYTE	40	1	40	
4	type	unitless	NC_BYTE	15	1	15	
5	measurementUnit	unitless	NC_BYTE	32	1	32	
TOTAL:						Size depends on XML format	

1.8.9.1 name

This name identifies the parameter. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.9.2 note

This is a free text field that can be used e.g. during tests to provide additional information. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.9.3 reference

This is a reference to further documentation, information, etc. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.9.4 type

This is the type of the scalar parameter. It can be any of the Mapping Types supported.

See chapter 1.4.

1.8.9.5 measurementUnit

This is the measurement unit of the field. Supported values are:

See chapter 1.4.

1.8.10 QDSCount

This is the number of Quality Data Sets included in the product.

1.8.11 qualityDataSetVector

This Data Set defines a piece of Product Confidence Data. A PCD is always a Scalar whose type can be chosen among those supported in the Project.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	name	unitless	NC_BYTE	40	1	40	
2	note	unitless	NC_BYTE	2000	1	2000	
3	reference	unitless	NC_BYTE	40	1	40	
4	type	unitless	NC_BYTE	15	1	15	
5	measurementUnit	unitless	NC_BYTE	32	1	32	
6	Scalar		Scalar	24	1	24	
TOTAL:						Size depends on XML format	

1.8.11.1 name

This name identifies the parameter. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.11.2 note

This is a free text field that can be used e.g. during tests to provide additional information. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.11.3 reference

This is a reference to further documentation, information, etc. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.11.4 type

This is the type of the scalar parameter. It can be any of the Mapping Types supported.

See chapter 1.4.

1.8.11.5 measurementUnit

This is the measurement unit of the field. Supported values are:

See chapter 1.4.

1.8.11.6 Scalar

This is used to store a scalar parameter.

1.8.12 ADSCount

This is the number of Annotation Data Sets included in the product.

1.8.13 annotationDataSetVector

This Data Set is instrument-specific in that it contains data - e.g. generated during the measurements - that are relevant to the product's further processing.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	name	unitless	NC_BYTE	40	1	40	
2	note	unitless	NC_BYTE	2000	1	2000	
3	reference	unitless	NC_BYTE	40	1	40	
4	type	unitless	NC_BYTE	15	1	15	
5	measurementUnit	unitless	NC_BYTE	32	1	32	
6	Scalar		Scalar	24	1	24	
7	Vector		Vector	24	1	24	
TOTAL:						Size depends on XML format	

1.8.13.1 name

This name identifies the parameter. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.13.2 note

This is a free text field that can be used e.g. during tests to provide additional information. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.13.3 reference

This is a reference to further documentation, information, etc. There are no prescriptions on its format provided it fits into the maximum allowed size.

1.8.13.4 type

This is the type of the scalar parameter. It can be any of the Mapping Types supported.

See chapter 1.4.

1.8.13.5 measurementUnit

This is the measurement unit of the field. Supported values are:

See chapter 1.4.

1.8.13.6 Scalar

This is used to store a scalar parameter.

1.8.13.7 Vector

This is used to store a Vector. Note that matrices will have to be stored as vectors: i.e., each line of a matrix is to be stored as an independent vector. A vector has no parameters since it is composed of Scalars.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	Scalar		Scalar	24	*	variable	
TOTAL:						Size depends on XML format	

1.8.13.7.1 Scalar

This is used to store a scalar parameter.

1.8.14 MDSCount

This is the number of Measurement Data Sets included in the product.

1.8.15 mdsDescriptionVector

The Measurement Data Set Description is common to each instrument in the L0 product and specialised for each instrument in the L1 product. Further details are provided in the instrument-specific volumes.

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	MDSRecordsCount	unitless	NC_UINT64	8	1	8	
TOTAL:						Size depends on XML format	

1.8.15.1 MDSRecordsCount

This is the number of Measurement Data Set Records contained in the Measurement Data Set. For L0 Products, this corresponds to the number of ISPs in the product.

1.9 L0MDSRecord

The Level 0 Data Block File is composed by N binary records of annotated instrument source packets (AISP). Each AISP record contains information relative to an Instrument Source Packet, as extracted from the CCSDS multiplexed stream and according to the VCID and APID marking the instrument data, annotated by time and quality information. Summarizing the AISP record is composed by: - Annotation Header - Instrument Source Packet (i.e., the Annotation Header precedes the Instrument Source Packet).

Instrument Source Packets are sorted by sensing time (field #1 of the Annotation Header). In case there is more than one source packet with the same sensing time, secondary sorting will be by sequence count (from Source Packet Header, see Table 1.10-1 below).

#	Field name	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	ISPAnnotationHeader		ISPAnnotationHeader	40	1	40	
2	ISP		ISP	variable	1	variable	
TOTAL:						variable	

1.9.1 ISPAnnotationHeader

The Annotation Header of the AISP record contains time and quality information. This information is organized as: - ISP Sensing Time - ISP Downlink Time - ISP Product Confidence Data.

Some annotation header fields need to be checked by the level 1 processors. This is indicated in the table below. The remaining fields are for internal use in the ground segment.

In case of a duplicated packet, the second packet is already removed in L0 processing. There is no flag recording duplicated packets.

#	Field name	Description	Units	NetCDF C-Types	Size of each element	Number of elements	Total size	Value
1	SensingTime	It is the time of the actual acquisition of the source packet. It is a UTC time based on the on-board time contained within the packet, possibly applying on-ground FOS time correlation in case of satellite GPS time unavailability. The level 1 processor shall base geolocation calculations on this timestamp.	unitless	ModifiedJulianDays2000	12	1	12	
2	DownlinkTime	It is the time of the downlink on ground of the source packet (G/S time).	unitless	ModifiedJulianDays2000	12	1	12	
3	PacketLength	ISP Length = (length of source packet data field) – 1. This field uses the same definition as the Packet Length field of the Packet Header as specified in CCSDS definitions. This field indicates the actual length	unitless	NC_USHORT	2	1	2	

		of the science packet; it does not rely on the packet length indicated in the packet header. The level 1 processor should discard the packet if this field is different from the expected packet length.						
4	NumberOfVCDUs	Number of VCDUs containing the current ISP.	unitless	NC_USHORT	2	1	2	
5	NumberOfReedSolomonCorrectedVCDUs	Number of VCDUs containing the current ISP that were corrected with Reed-Solomon.	unitless	NC_USHORT	2	1	2	
6	NumberOfReedSolomonIncorrigibleVCDUs	Number of VCDUs containing the current ISP that were incorrigible with Reed-Solomon. The level 1 processor should discard the packet if this flag is greater than zero.	unitless	NC_USHORT	2	1	2	
7	NumberOfMissingVCDUs	Number of missing VCDUs containing the current ISP. The level 1 processor should discard the packet if this flag is greater than zero.	unitless	NC_USHORT	2	1	2	
8	NumberOfReedSolomonCorrectedSymbolsCADU	Number of symbols corrected by Reed-Solomon in CADUs containing the current ISP.	unitless	NC_USHORT	2	1	2	
9	CRCErrorFlag	CRC Error Flag, identifying the detection of CRC error in the packet (set to FF in case of error otherwise set to 00). The level 1 processor should discard the packet if this flag indicates an error.	unitless	NC_CHAR	1	1	1	
10	Spare1	Spare field.	unitless	NC_CHAR	1	1	1	
11	Spare2	Spare field.	unitless	NC_CHAR	1	1	1	
12	Spare3	Spare field.	unitless	NC_CHAR	1	1	1	
TOTAL:							40	

1.9.2 ISP

This is the basic ISP structure. For details see the information in the chapters below as well as the instrument dependent specialisations in the corresponding product definition volumes.

1.10 Instrument Source Packets

1.10.1 Packet Header

The ISP Fixed Header complies with the General High Data Rate Source Packet Structure* set forth in [AD-110] and [RD-04]. In the EarthCARE case, a tailoring applies as described hereafter.

The data representation of a Packet Header in the EarthCARE L0 Products is as follows:

Name	Type	Size
packetIdentification	ECuShortInt	2
packetSequenceControl	ECuShortInt	2
packetLength	ECuShortInt	2

The following table shows how the Packet Header is to be interpreted. The Packet Data Field is specified in Chapter 1.10.2.

Table 1.10-1: Instrument Data Source Packet Structure

Source Packet											
Packet Header								Packet Data Field			
Packet Identification					Packet Sequence Control		Packet Length	PUS Data Field Header	Instrument Data Field		
Version Number	Type	Data Field Header Flag	Application Process Identifier		Segmen-tation Flags	Source Sequence Count			Ins. Data Field Header	Data	CRC
			PID	PCAT							
3 bits	1 bit	1 bit	7bits	4bits	2 bits	14 bits	16 bits	96 bits	48 +TBD bits	≤ 524128 bits	16 bits
2 bytes					2 bytes		2 bytes	12 bytes	6 + TBD bytes	≤ 65516 bytes	2 bytes

The following specific properties apply for the data source packets

- The source packet size may be variable within one data take;
- The maximum size of the packet data field is 2^{16}= 65536 bytes
- The overall source packet maximum size is 65542 bytes.

Note that the TBDs in Table 1.10-1 actually mean that each EarthCARE Instrument is free to specify its own Instrument Data Field Header. Thus, these TBDs are in fact solved in the following instrument-specific volumes.
Table 1.10-2 specifies how the fields in the Packet Header are to be filled in the EarthCARE case.

Remark: Note that the values in Table 1.10-2 are either binary or decimal values. To highlight this, the suffixes “b” and “dec” are used. For instance, 11b means both bits “up” in a two-bit field; 13dec means decimal 13 (thirteen).

Remark: Due to the nature of ISPs and to the applicable documents ([AD-110] and [RD-04]) Requirement

* For Instrument Data Source Packets specified in this document the User Data Field is called Instrument Data Field.

binary-3 of [AD-01] must be waived for ISPs.

Remark: Note that the Most Significant Bit in the following table is always b_0. This contrasts with the convention defined in 1.2.4 but must be so defined in compliance with the applicable documents as far as the Measurement Data Stream is concerned ([AD-110] and [RD-04]).

Table 1.10-2: Instrument Data Source Packet Structure

Parameter		MSB	Value
Version Number:		b_0-b_2	000b
Type:		b_3	0b
Data Field Header Flag:		b_4	1b in case of user source packets 0b in case of Idle Source Packet
Application Process ID (APID):	PID	b_5-b_{11}	• PID=0, PCAT=0 => APID = 0 (n/a for EarthCare on X-band) • APID = “11111111111” (eleven ones) is reserved for idle packets. • for Instrument data source packets the PCAT as set forth in Table 1.10-4 are reserved The PID's shall be used as defined in [AD-110] and [RD-04] and are listed below.
	PCAT	b_{12}-b_{15}	
Segmentation Flags		b_{16}-b_{17}	11b
Source Sequence Count		b_{18}-b_{31}	source packet count value 0 - 2^14-1
Packet Length (16 bits)		b_{32}-b_{47}	number of octets in packet data field -1

The APID field is to be filled as follows:

Table 1.10-3: PID Values

PID(hex)	Unit	MN	Application	Functions
40	ATLID		ATLID ICU Application	
41 - 43				Spare
44	MSI		MSI ICU Application	
45 - 47				Spare
48	BBR		BBR ICU Application	
49 - 4B				Spare
4C	CPR		CPR ICU Application	
4D - 4F				Spare

Table 1.10-4: PCAT Values

Telemetry		
Packet Category (DEC)	**Description**	**TM Packets**
12	Science 0	Nominal
13	Science 1	Raw
14	Reserved	Reserved

1.10.2 Packet Data Field

A Packet Data Field consists of a fixed length PUS Data Field Header and variable length measurement or calibration data record (see Table 1.10-1).

1.10.2.1 PUS Data Field Header

The PUS data field header is part of every source packet data field header in the X-Band downlink with the exception of idle source packets.

Table 1.10-5 specifies how the fields in the PUS Data Field header are to be interpreted in the EarthCARE case.

Table 1.10-5: PUS Data Field Header

Spare 1	TM Source Packet PUS Version Number	Spare 2	Service Type	Service Subtype	Destination ID	Time	Time Quality
1 bit	3 bit	4 bit	8 bit	8bit	8 bit	56	8 bit
1 byte			1 byte	1 byte	1 byte	7 bytes	1 byte

whereby Time is split into coarse time (4 bytes) and fine time (3 bytes).

Table 1.10-6 specifies how the fields in the PUS Data Field Header are to be interpreted in the EarthCARE case.

Table 1.10-6: PUS Data Field Header

Parameter	MSB	Description	Range or value
Spare 1	b_0	Not used	Must be set to 0 for all TM source packets
TM Source Packet PUS Version Number	b_1 - b_3		(0 was used for ESA PUS version) 1 for ECSS PUS
Spare 2	b_4 - b_7	Filler to complete the byte	Must be set to 0 for all TM source packets
Service Type	b_8 - b_{15}	Indicates the service to which the packet relates	See [AD-110] and [RD-04]
Service Subtype	b_{16} - b_{23}	Indicates the service subtype to which the packet relates	See [AD-110] and [RD-04]
Destination ID	b_{24} - b_{31}	Indicates the destination of the packet (May be omitted if only one destination exists)	See [AD-110] and [RD-04]
Time	b_{32} - b_{87}	Onboard time (OBT)	Coarse time: LSB = 1 sec Fine Time: LSB = 1/16777215 sec
Time Quality	b_{88} - b_{95}	This shall give the status of the time reporting sub-service, i.e. current PPS source and whether synchronization is enabled	**Bit 3:** Time Type 0 = Elapsed Time (ET); 1 = OBT **Bit 4:** Sync. Source 0 = internal; 1 = external **Bit 5:** Ext. Sync. Source Detail 0 = MIL-Bus Major Frame; 1 = 1Hz Pulse **Bit 6:** Sync. Status 0 = NoSync; 1 = InSync **Bit 7:** …Synchronization Enabled/Disabled 0 = Disabled; 1 = Enabled

The Service Type and Service Subtype fields are to be filled as in Table 1.10-7.

Each instrument shall select one service type (e.g. the smallest number) as science data service from the service type range allocated to the instrument.
For different measurement data formats of one instrument dedicated service sub-types starting from 1, 2 … shall be defined.

Table 1.10-7: Service Type and Service Subtype - Values

Service type (dec.)	Application
225	ATLID Science
226 - 229	Other ATLID application services
235	MSI Science
236 - 239	Other MSI application services
230	BBR Science
231 - 234	Other BBR application services
240	CPR Science
241 - 244	Other CPR application services

The Destination field is to be filled as follows:

Table 1.10-8: Destination - Values

Destination ID (DEC)	Destination ID (Hex)	Application
00	00	Ground / FOS / PDGS
		Further TBD

1.10.2.2 ISP Packet Data Field Header

This ISP Packet Data Field Header is instrument-specific. However, a basic structure is prescribed below.

Table 1.10-9: ISP Packet Data Field Header - Values

S/C State Vector Quality	ISP Version Format	Instrument Ancillary Data
4 bytes	2 bytes	n bytes - instrument-specific

Table 1.10-10: ISP Packet Data Field Header - Values

Parameter	MSB	Description	Range or value
S/C State Vector Quality	b0 - b31	Contains details about the S/C state vector quality information	As received from the S/C
ISP Format Version	b32 - b47	Stores the version number of the ICD where the ISP format definition is specified.	The most significant byte shall store the major version and the least significant byte shall store the minor version.
Instrument Ancillary Data	b48 - bxx	Any instrument data which may be used for processing of instrument measurement data	-

Instrument Ancillary Data are the “scientific payload” of an ISP. Their structure and format must be specified for each EarthCARE Instrument in the corresponding Vol. 2 through 5 of the EarthCARE Products

Definitions.

1.10.3 Measurement Data Type

In EarthCARE there is a one-to-one correspondence between the triple “APID (Table 1.10-2) + Service Type (Table 1.10-7) - Service Subtype” and the structure and format of the Instrument Ancillary Data.

In the specification of the L0 and L1 products the term “Measurement Data Type” is used. A Measurement Data Type corresponds to exactly one triple “APID + Service Type + Service Subtype”. Hence Measurement Data Type unambiguously identifies the structure and format of an ISP.

AIRBUS DEFENCE & SPACE

EarthCARE Routing Sheet

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Schneider, Matthias		
Schneider, Reinhard		
Weigl, Andreas		
Wiehe, Birgit		
Gotsmann, Michael		
Hoffmann, Thomas		
Jentsch , Christian		

ASF	Copy
Toulemont, Yves	
Gaizin, Josette	
Bonnes, Evelyne	
Antoine, Pierre-Oliver	
Archer, Julien	
Coiffin, Jean-François	
Corselle, Bertrand	x
Delettrez, Christophe	
Evin, Ronan	
Le Hors, Lenaic	x
Levillain, Yves	
Mazuray, Laurent	
Nonnet, Jean-Christoph	
Olivier, Frederic	
Pibrac, Dominque	
Thoral, Pierre	

ASU	Copy
Wood, Hazel	
Ecclestone, Tim	
Sheahan, Mick	
Fernando, Priya	
Pujol, Bruno	
Kightley, Glenn	
Tomkins, Kevin	
Rodier, Caroline	
Loakes, David	
Magowan, Norman	
Pearson, Mick	
Robson, Phil	

Ext. Companies	
ESA	x
SEA	x
SSTL	x
ASE - PCDU	
CASA - HAR	
CST - ISVV	
DS - SA	
ETS	
GMV - ECGP	x
HEMA	
RSA-MLI	
RUAG-A (MGSE)	
RUAG-CH (SADM)	
RUAG - SBA; XBA	
SG - DSS	
SSBV	
SYD - MMFU	
TES - XBS	
TAS-E - SBS	
S-2	
Bursch, Stefan	
Sontag, Heinz	
Steiter, Christian	
Welsch, Mario	
Selegrad, Markus	
Konrad, Thomas	
Brockhaus, Markus	
Schweickert, Gunn	
Nacke, Thilo	