

EPS-SG Level 0 Product Format Specification

Doc.No. : EUM/LEO-EPSSG/SPE/13/703928
Issue : v4B
Date : 11 November 2024
Division : LEO
Programme : EPS-SG; EPS; PEPS [Inactive]

EUMETSAT
Eumetsat-Allee 1, D-64295 Darmstadt, Germany
Tel: +49 6151 807-7
Fax: +49 6151 807 555
<http://www.eumetsat.int>

Signature Table

	<i>Name</i>	<i>Function</i>	<i>Signature</i>	<i>Date</i>
Book Captain:	Carlos Mas	EPS-SG Instrument Chain System Engineer		
Reviewed by:	Michela Sunda	EPS-SG Instrument Chain System Team Leader		
Reviewed by:	Julian Gude	PDAP System Manager		
Reviewed by:	Yago Andres	EPS-SG GS Technical Manager		
Reviewed by:	Georg Riker	EPS-SG Configuration Management Manager		
Reviewed by:	Esteban Tomas	Quality & Product Assurance Manager for LEO		
Approved by:	Davide Castellazzi	EPS-SG System Manager		

Distribution List

<i>Name</i>	<i>Organisation</i>
EPS-SG Team (mailing list)	EUMETSAT

Change Record

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
V1B	01/12/2014	N/A	Initial Draft version
V1E	23/03/2015	N/A	First Version – Update following internal review
V1F	29/04/2015	EUM-EPS-SG-DCR-214	Updates following System PDR: Section 2.1: added/removed references Section 3.1: Introduction of IAS VER L0 product and updates to list of applicable documents, changed HTM to HKT Section 3.2: replaced figures 1 and 2 by tables and changed HTM to HKT, changed product type for RO to RO_ Section 3.3: updated filename example following GPFS update Section 3.4: clarification that the TM packets are contained as raw binary data without interleaved annotations. Section 3.4.2.1: clarification that the applicable documents listed in section 2.1 are the source of packet details and that they prevail over this document. Removed reference to Sentinel-5 regional L0 products since there is no regional mission for this instrument. Updated figures 1 and 2. Section 4.1: added global attributes Section 4.3.2: Removed column “Allowed Values”, added note on structure for satellite packets, Section 4.3.2.1: Removed figure 4 (TM packet structure) Corrected RO product ID in table 1 and 2, updated table 2. Appendix A: reference to EPS-SG Data Rates document to describe product size
V1G	09/10/2015	EUM-EPSSG-DCR-185	Updates following internal review: Section 2: updated document references Section 3.1: update of Product IDs Section 4.1: typo correction (HTK) Section 4.3.2: introduced variable length data type Section 4.3.2.1: corrections in table 4

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
			Section 1.4: added O-4 Added section 5 on Product Format Version Control Appendix A: updated XML and schema files Section 6: Level 0 Product Size
V1H	01/02/2016	EUM-EPSSG-DCR-195	Updated section 5 on Product Format Version Control Updated DMT template to include revision control
V1I	17/02/2016	EUM-EPSSG-DCR-215	Section 2.3: updated definition of LOBT DCR: DCR numbers entered Updated section 5 on Product Format Version Control
V2	18/07/2016	EUM-EPSSG-DCR-366	General: modified acronym for document [MOS-IRD] in [PUS-IRD], general / minor formatting and text improvements. Section 1.2: added sections 5 and 6. Section 1.5: updated due date for A-1. Section 4.1: text updated to clarify population of global attribute times. Section 4.2: added generic text to the Satellite status sub-group. Section 1.4: - Updated due date for O-2. - Resolved & removed O-7: the UTC time stamp for packet generation time is kept in and its format is defined in Table 13. Section 2.3: updated acronyms table. Section 3.1: updated product type for S5 Section 3.3: - Changed disposition mode example from OPE to O. - Added one underscore in free_text, as per GPFS. Section 3.4: added Error! Reference source not found. 4 and updated Figure 1. Section 4: Introductory text updated and to clarify mapping between tables usage and NetCDF definition. Section 4.1: modified Global parameters in Table 5 according to GPFS V1I: - Capital "C" in Conventions; - Organisation changed to institution;

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
			▪ Baseline moved to processing status group; ▪ Added text to clarify meaning of sensing start / end times in global attributes and updated definitions. ▪ Text updated to clarify population of global attribute times. Section 4.2: added generic text and tables with definition of dimensions and variables for Instrument and Processing status groups. Section 4.3: ▪ Added figure with structure of Data group and improved descriptive text; ▪ Added tables to describe the data group content. Section 4.3.1: ▪ Updated text to align quality group content. ▪ Updated table defining APIDs, instrument modes and applicable ICDs. Section 4.4: ▪ Removed from quality group the following variables: number_idle_packets, number_corrected_packets, number_corrected_characters, number_unsynchronised_packets ▪ Updated definition of variables overall_quality_flag and degraded_gap. ▪ Added Table 16 ▪ Section 6: updated size of EPS-SG L0 products according to latest instrument data rates. Appendix A: ▪ Updated XSD and XML files; ▪ Removed XML file dump.
V2A	21/11/2016	EUM-EPSSG-DCR-450	General: formatting and text improvements Section 2.3: added SN5 to acronyms Section 4.3: updated dimension length in Table 12 and affected variables accordingly in Table 13. Section 4.3.1: updated APID values of Table 14 (ICI and 3MI) Section 4.4: updated description of L0 applicability in specific L0 degraded conditions: ▪ number_missing_packets ▪ number_duplicated_packets ▪ number_corrupted_packets

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
			Section 5: updated Product Format Version in table Appendix A: updated XML description of L0 products format in new attached files
V3	28/08/2017	EUM-EPSSG-DCR-698	Section 2.1: Update ADs titles and references for documents with the information about the TM packet and content Section 4.2.3: removed processor_full_name from source attribute, added value for "processor_name" Section 4.3.1: Table 14: APIDs and Modes updated for IASI-NG, UVNS, MWI, RO, ICI and ADCS Section 4.4, Table 15: changed type and setting of overall_quality_flag, removed the degraded_gap flag. Changed upper-case to lower-case for the first character of some variables. Section 6: Size of IASING L0 VER updated. To be noted that the size does not actually change. The change is because the former number considered a daily average of 7 orbits over 14 where these data are generated, and the new figure is the data generated in one of those 7 orbits, without average. Appendix B: Open Points TBD-01, TBD-03 and TBC-01 have been CLOSED. Files in Appendix A updated according to product description updates described in points above.
V3A	16/10/2017	EUM-EPSSG-DCR-736	Section 2.1: RO TMTC ICD Overview (different name for TMTC Cartography) added as AD. Reference added in Table 14. Table 7: Introduced clarification so it's clear that epoch_time_utc and state_vector_time_utc refers to the sensing start time of the product. Table 14: Fixed name of MWI nominal mode: SCAN instead of SCIENCE. Table 14: New type of RO packets added for APIDs 0x372 and 0x373: ME_Observables. Section 6: Added fragment to refer to Open Point TBD-02, which was previously unreferenced. Appendix A: Embedded xml files updated; general errors clean up and harmonised with files in other processing specifications.

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
V3B	22/01/2018	EUM-EPSSG-DCR-780 EUM-EPSSG-DCR-892	Section 4.3.1: Removed notion of quality statistics on duplicated and corrupted packets. Section 4.4: Removed information on duplicated and corrupted packets. Section 5: updated format versions. Appendix A: embedded files updated. Section 2.2: “IASI-NG science telemetry ICD” added as AD. IASI-NG PUS TAILORING removed as superseded by this ICD. VII TM TC ICD added. VII-PUS-ICD removed as superseded by this ICD. Reference for 3MI TM Cartography provided in AD table. ICI TM Cartography added. Section 4.3.1: Table 14 updated for IASI-NG, according to the changes in the relevant ADs. References to ADs updated in line with Section 2.2 modifications. METimage DIANOSTIC and CALIBRATION Modes merged into a single one. Low frequency ancillary data packet type with APID 0x5A5 added. Product format version corrected wrt to the update in DCR-780: Right one is 4.0. GPFS version updated to 3B. Appendix B: Removed the “To be closed by” column in the open Points table.
V3C	30/04/2018	EUM-EPSSG-DCR-892	Section 4.4 Introduced notes in the descriptions of the fields “gap_item” and “duration_of_data_missing”. _ Section 6 Size of Level 0 products updated according to SGICD issue 5.

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
V3D	11/03/2019	EUM-EPSSG-DCR-1129	Section 2.2: Update of Applicable documents: - 3MI TMTC ICD reference added - MWS TMTC IRD replaced by ICD - MWD TM Cartography reference provided (formerly TBD) - Update of reference for ICI TMTC ICD - [S-5 IRDB ICD], [S-5 Pixel Naming] added to the table to make completely explicit the list of S-5 documents, even if they are subsidiary of the TM Cartography. Section 4.3.1: Table 14: - Fix of error. Leftover cell from the merging of METimage DIAGNOSTIC and CALIBRATION modes removed. - Update of relevant AD for MWS. - Completed the list of APIDs for IASI-NG CHECK mode. - [S-5 IRDB ICD], [S-5 Pixel Naming] added to the table to make completely explicit the list of S-5 documents, even if they are subsidiary of the TM Cartography.

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
V3E	30/03/2020	EUM-EPSSG-DCR-1553	[S-5 IRDB ICD] removed from AD list and Table 14. Section 3.3: Naming convention example updated in line with convention update in GPFS V3D. Table 5: Acronym for Sentinel-5 file “instrument” attribute corrected and for ADCS-4 included. Table 14: - POINTING mode removed for MWI and ICI. As they will not be used in flight. Chapter 5: - Product format version control updated Chapter 6: - TBD-02 removed as data rates consolidated at Space Segment CDRs. - IASI-NG L0 product size updated according to [SGICD] evolution - NAVATT product size updated according to [NAV] evolution. Appendix A: - L0_INST xml file updated to align with document content (errors fixed) Appendix B: Removed as TBC/TBD are now closed.
4		EUM-EPSSG-DCR-1554	New products created for IASI-NG L0, and packets re-arranged accordingly. Also, Science IASI-NG TM ICD V5 taken into account: - Table 1 updated - Table 2 updated - Table 6 updated - Table 14 updated - Table 19 updated Typo fixed in filename example.

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
V4A	23/09/2021	EUM-EPSSG-DCR-2049	AD Table: Title fix for [S-5-ICD] document; [RO-ICD] and [RO-Carto] codes updated to use the ones used in Configuration Management; Tables 1 2 and 6: New product for Sentinel 5 Small Pixel packets added Section 4.3: Clarification added about the use of VLEN arrays and tm_packet_length dimension. Tables 7 and 17: Editorial; literal alignment of long names with GPFS Section 2.1: Applicable documents for 3MI TM updated: TMTC ICD mapped to the ASW TMTC ICD and Pixel Position/Packet Definition TN added. Section 4.3.1: Modified to capture that for Sentinel 5 new product, discrimination by SID is necessary Table 14: - 3MI Test Mode added. - S-5 APID list updated as per update of applicable document. Test Mode added. - S-5: Creation of separate product for Small Pixel packets in order to deal with packet delay issue. Section 6: Total Sentinel 5 L0 product size split between the two resulting products. Appendix A: xml attachments updated to re-introduce the “doi” attribute for the L0 products. Alignment of some long names and units (“s” instead of “seconds”) with document. Eccentricity, inclination and semi-major axis ranges updated as per GPFS upate Valid_min for mode_start/stop_time_utc fixed to allow values prior to 2020

Version	Date of Version <i>as on profile</i>	Document Change Request (DCR) Number <i>if applicable</i>	Description of changes
			V2 of the DCR: - S5-SMP product added to Table 6 - “Service” field filled in Table 14 for S5 CALIBRATION mode - In Table 14, Small Pixel packets have been segregated by SID and assigned to SMP product for TEST mode. - APIDs and SIDs in Table 14 for S5 now provided in Hexadecimal - Some S5 packet names in Table 14 aligned with general convention (editorial fix) - Additional alignment in Appendix A xml files of units (“degrees”) with document.
V4B	11/11/24	EPSSG DCR 2908	Attached xmls modified to align type of tm_packets variable to the one in the document body, i.e. NC_UBYTE

Table of Contents

1	Introduction	13
1.1	Purpose and Scope	13
1.2	Document structure	13
1.3	Relation to other documents.....	13
2	Documents	14
2.1	Applicable Documents.....	14
2.2	Reference Documents.....	15
2.3	Acronyms.....	15
2.4	Conventions and Terminology.....	16
3	EPS-SG L0 Products Overview	17
3.1	L0 Product Types.....	17
3.2	List of L0 Products.....	18
3.3	Naming Convention	19
3.4	High-level Product Structure.....	20
4	Detailed Format of EPS-SG L0 Products.....	22
4.1	Global Attributes	22
4.2	Status Group.....	24
4.2.1	Satellite Status	24
4.2.2	Instrument Status.....	25
4.2.3	Processing Status	26
4.3	Data Group	27
4.3.1	TM CCSDS packets.....	28
4.4	Quality Group.....	40
5	Product Format Version Control	42
6	Size of EPS-SG L0 products	43

1 INTRODUCTION

1.1 Purpose and Scope

This document is the Format Specification for EPS-SG Level 0 (L0) products generated centrally by the EPS-SG Ground Segment at the EUMETSAT Headquarters. It specifies the format, detailed content and naming convention of L0 products in agreement with the generic product format conventions set out in the Generic Product Format Specification [GPFS] applicable to all EPS-SG products.

EPS-SG L0 products are NetCDF-4 (Network Common Data Form Version 4) files. L0 products consist of CCSDS (Consultative Committee for Space Data Systems) telemetry (TM) packets generated on-board by the Metop-SG instruments/platform and accompanying metadata necessary for their archiving and processing in the EPS-SG Ground Segment.

1.2 Document structure

The document is structured as follows:

- *Section 1*: Scope and purpose of the document;
- *Section 2*: Applicable and reference documents, acronyms and conventions;
- *Section 3*: Overview of L0 product types generated in the EPS-SG Ground Segment, their high-level format, structure and naming convention;
- *Section 4*: Detailed description of the L0 products content;
- *Section 5*: Product format Version Control;
- *Section 6*: Size of EPS-SG L0 products.

1.3 Relation to other documents

The EPS-SG Level 0 Product Format Specification (L0 PFS) is a System document in the System Specification Tree. It is applicable to the System Requirements Document [SRD], Overall Ground Segment Requirements Document [OGSRD], PDAP Requirements Document [PDAPRD], L1 Product Generation Specifications (Level 1 PGSS) and EPS-SG System and Ground Segment documents including Interface Control Documents (ICDs) wishing to convey information about the L0 products format and content.

This document is derived from and compliant to [GPFS] for generic product format and naming conventions applicable to all EPS-SG products. Eventual inconsistencies between this document and [GPFS] shall be notified to the authors for resolution.

2 DOCUMENTS

2.1 Applicable Documents

<i>Acronym</i>	<i>Title</i>	<i>Reference</i>
[GPFS]	EPS-SG Generic Product Format Specification	EUM/LEO-EPSSG/SPE/13/702108
[PUS-IRD]	Metop-SG PUS Interface Requirement Document [SAC-SY-07]	MOS.IRD.ASF.SYS.00835
[NAV]	Metop-SG Satellite Ancillary Data Protocol and Interface Definition [SAC-IF-05]	MOS-ICD-ADST-SYS-1000116838
[IAS-ICD]	IASI-NG science telemetry ICD	IAS-ICD-ADST-1000258068
[VII-ICD]	METimage TM/TC ICD	METI-ICD-ADSF-1000302031
[VII-Carto]	METimage TMTC Cartography	METI-TN-ADSF-1000127977
[MWS-ICD]	MWS TM and TC ICD	OS-ICD-ADSP-MWS-1000284292
[MWS-Carto]	MWS TMTC Cartography	MOS-ICD-ADSP-MWS-1000343996
[3MI-ICD]	3MI ASW TM/TC ICD	MOS-SP-ADST-3MI ICU-1000384427
[3MI-Carto]	3MI TMTC Cartography	MOS-TN-SES-3MI-0032
[3MI-Pixel Position]	3MI Detectors' position and Pixel packet definition	MOS-TN-SES-3MI-0033
[S-5-ICD]	S5/UVNS - TM/TC ICD	GS5-ICD-ADSO-UVNS-1000157419
[S-5-Carto]	S-5 TMTC Cartography	GS5-TN-ADSO-UVNS-1000132671
[S-5-Meas_Control]	S-5 On-Board Measurement Processing Control	GS5.TN.ASG.UVNS.00003
[S-5 Pixel Naming]	S-5 Pixel Naming Convention	GS5.TN.ASG.UVNS.00019
[SCA-ICD]	SCA TMTC Interface Control Document	MOS-ICD-ADSF-SCA-1000116120
[SCA-Carto]	SCA TMTC Cartography	MOS-DD-ADSF-SCA-1000228695
[MWI-ICD]	MWI ASW Interface Control Document - TM/TC Definition	MOS-ICD-CGS-MWI-0005
[MWI-Carto]	MWI TM Cartography Definition	MOS-TN-CGS-MWI-0044
[ICI-ICD]	MetOp-SG ICI TM/TC Interface Control Document	MOS-ICD-ASE-ICI-0502
[ICI-Carto]	MetOp-SG ICI TM Cartography - Content Definition	MOS-TN-ASE-ICI-0412

[RO-ICD]	Instrument Software TM/TC ICD	P-GRM2-ICD-00696-RSE
[RO-Carto]	RO TMTC ICD Overview	P-GRM2-NOT-01673-RSE
[ADCS-ICD]	ADCS-4 - PUS Implementation for METOP-SG Satellite	A4-INS-ICD-0802-CNES
[MCSD]	EPS-SG Mission Conventions and Standards Document	EUM/LEO- EPSSG/STD/14/745221

2.2 Reference Documents

Acronym	Title	Reference
[SRD]	EPS-SG System Requirements Document	EUM/LEO- EPSSG/SPE/13/735903
[OGSRD]	EPS-SG Overall Ground Segment Requirements Document	EUM/LEO- EPSSG/REQ/13/725156
[PDAPRD]	EPS-SG Payload Data Acquisition and Processing (PDAP) Sub-segment Requirements Document	EUM/LEO-EPSSG/ REQ/15/786996
[SGICD]	Metop-SG Space to Ground Interface Control Document	MOS.ICD.ASD.SYS.00796
[NC-CIC]	NetCDF C Interface Guide	https://www.unidata.ucar.edu/software/netcdf/docs/netcdf-c.pdf

2.3 Acronyms

Acronym	Definition
A-DCS	Advanced Data Collection System
AOI	Area Of Interest
APID	Application Process Identifier
CCSDS	Consultative Committee for Space Data Systems
CDS	CCSDS Day Segmented time code
COBT	Central On-board Time
CUC	CCSDS Unsegmented time Code
ECSS	European Cooperation for Space Standardization
GNSS	Global Navigation Satellite System
GPFS	Generic Product Format Specification
HKTM	House-Keeping Telemetry
HQ	Headquarters
IAS	Infra-red Atmospheric Sounder
ICD	Interface Control Document
ICI	Ice Cloud Imager
IRD	Interface Requirements Document
ISP	Instrument Source Packet
LOBT	Local On-Board Time
L0	Level 0

Acronym	Definition
LSB	Least Significant Bit
MCC	Mission Control Centre
MMAM	Multi-Mission Administrative Messages
MSB	Most Significant Bit
MWI	Micro-Wave Imager
MWS	Micro-Wave Sounder
NAVATT	Navigation and Attitude data
NetCDF	Network Common Data Form
NRT	Near Real Time
OBT	On-board Time
PEC	Packet Error Control
PID	Process ID
PCAT	Packet Category
PFS	Product Format Specification
RO	Radio Occultation
SCA	Scatterometer
SN5	Sentinel-5
SRC	Source (Level 0)
UTC	Universal Time Coordinated
TM	Telemetry
TOD	True Of Date
UVNS	Nadir-viewing Ultra-violet Visible Near-infra-red Short-wave infra-red sounder
VII	Visible Infra-red Imager
3MI	Multi-viewing Multi-channel Multi-polarisation Imager

2.4 Conventions and Terminology

Generic conventions and terminology used in this document for EPS-SG products are those described in the [GPFS]. Generic terms and definitions applicable to the EPS-SG Programme can be found in [MCSD].

3 EPS-SG L0 PRODUCTS OVERVIEW

3.1 L0 Product Types

This section provides an overview of the L0 product types generated by the EPS-SG Ground Segment at the EUMETSAT Headquarters (also referred to as Mission Control Centre). Different L0 product *types* are defined to store different types of TM packets generated on-board by the Metop-SG satellites and instruments as follows:

- One or more L0 product type is defined for each Metop-SG observation instrument. It includes all instrument source packets (ISPs) generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
No different L0 product types are defined at this stage for different types of instrument data (e.g. instrument modes, channels, polarisations, etc.) for the same instrument, except for IASI-NG and Sentinel -5, for which different L0 product types have been defined (see Table 1).
- One L0 product type is defined for NAVATT packets;
- One L0 product type is defined for Payload and Platform HKTM packets;
- One L0 product type is defined for A-DCS packets (only applicable to Metop-SG/B satellites).

Different L0 product *types* are characterised by a different *Product ID* in the product name as defined in [GPFS] and they are listed in the following table. The description in the following table will be expanded in future issues of the document when additional details on the instrument modes and type of packets for each instrument will become available.

Table 1: EPS-SG Level 0 Product Types

L0 Product Type	Product ID	Product content description
HKTM Level 0	HKT-00-SRC	Metop-SG Satellite and Payload HKTM packets providing information on the satellite status, health, operations, etc. This product does not include NAVATT packets that are stored in a separate L0 product
NAVATT Level 0	NAV-00-SRC	NAVATT packets, including orbit state vectors (satellite position and velocity), attitude quaternions, satellite pointing guidance modes, platform status flags such as manoeuvre flags, GPS to COBT time synchronisation flags, etc.
A-DCS Level 0	DCS-00-SRC	ARGOS-4 TM science packets
IAS Level 0 Science	IAS-00-SRC	IASI-NG instrument source packets for science data
IAS Level 0 Verification	IAS-00-VER	IASI-NG instrument source packets for verification data
IAS Level 0 Science	IAS-00-REP	IASI-NG instrument source packets: repeated calibration packets
IAS Level 0 Verification	IAS-00-CHK	IASI-NG instrument source packets: generated in Check mode.
MWS Level 0	MWS-00-SRC	MWS instrument source packets for all instrument modes generating science data

L0 Product Type	Product ID	Product content description
VII Level 0	VII-00-SRC	METImage instrument source packets for all instrument modes generating science data
3MI Level 0	3MI-00-SRC	3MI instrument source packets for all instrument modes generating science data
Sentinel-5 Level 0	SN5-00-SRC	UVNS instrument source packets excluding “Small Pixel packets” for all instrument modes generating science data
Sentinel-5 Level 0	SN5-00-SMP	UVNS “Small Pixel” instrument source packets for all instrument modes generating science data
SCA Level 0	SCA-00-SRC	SCA instrument source packets for all instrument modes generating science data
MWI Level 0	MWI-00-SRC	MWI instrument source packets for all instrument modes generating science data
ICI Level 0	ICI-00-SRC	ICI instrument source packets for all instrument modes generating science data
RO Level 0	RO_-00-SRC	RO instrument source packets for all instrument modes generating science data

L0 products generated for recurrent instrument models are of the same *type* – i.e. they include the same set of Application Process Identifiers (APID). L0 products for recurrent instrument models can be discriminated by the *Spacecraft ID* flag in the product name and by the Global attributes reporting the instrument model as specified in [GPFS].

A-DCS L0 products are only generated for Metop-SG/B satellites.

3.2 List of L0 Products

The following Tables 2 and 3 present an overview of the set of L0 product *types* generated centrally by the EPS-SG Ground Segment at the EUMETSAT Headquarters for each Metop-SG satellite type (A/B). For clarity, the tables also show that both global and regional products are generated for each product *type* in the context respectively of the EPS-SG global and regional missions. There is no regional mission for Sentinel-5, hence no regional L0 products are generated. IAS VER L0 products are only generated in global mission context, since this data is only dumped in Ka-band.

Table 2: L0 Products generated at EUM HQ for Metop-SG A-type satellites

Satellite Type	Instrument / Data Type	Product ID	Mission	Products
Metop-SG-A	IASI-NG	IAS-00-SRC	Global	Global IAS L0
			Regional	Regional IAS L0
		IAS-00-VER	Global	Global IAS VER L0
		IAS-00-REP	Global	Global IAS L0 Repeated packets
			Regional	Regional IAS L0 Repeated packets
		IAS-00-CHK	Global	Global IAS L0 Check Mode

Satellite Type	Instrument / Data Type	Product ID	Mission	Products
			Regional	Regional IAS L0 Check Mode
	METimage	VII-00-SRC	Global	Global VII L0
			Regional	Regional VII L0
	MWS	MWS-00-SRC	Global	Global MWS L0
			Regional	Regional MWS L0
	3MI	3MI-00-SRC	Global	Global 3MI L0
			Regional	Regional 3MI L0
	Sentinel-5	SN5-00-SRC	Global	Global SN5 L0
		SN5-00-SMP	Global	Global SN5 L0 Small Pixel
	RO	RO_-00-SRC	Global	Global RO L0
			Regional	Regional RO L0
	NAVATT	NAV-00-SRC	Global	Global NAVATT L0
			Regional	Regional NAVATT L0
	HKTm	HKT-00-SRC	Global	Global HKTm L0
			Regional	Regional HKTm L0

Table 3: L0 Products generated at EUM HQ for Metop-SG B-type satellites

Satellite Type	Instrument / Data Type	Product ID	Mission	Products
Metop-SG-B	SCA	SCA-00-SRC	Global	Global SCA L0
			Regional	Regional SCA L0
	MWI	MWI-00-SRC	Global	Global MWI L0
			Regional	Regional MWI L0
	ICI	ICI-00-SRC	Global	Global ICI L0
			Regional	Regional ICI L0
	RO	RO_-00-SRC	Global	Global RO L0
			Regional	Regional RO L0
	A-DCS	DCS-00-SRC	Global	Global DCS L0
			Regional	Regional DCS L0
	NAVATT	NAV-00-SRC	Global	Global NAVATT L0
			Regional	Regional NAVATT L0
	HKTm	HKT-00-SRC	Global	Global HKTm L0
			Regional	Regional HKTm L0

3.3 Naming Convention

The naming convention of EPS-SG Level 0 products complies with the naming convention specified in [GPFS] for all EPS-SG products generated in native format.

Example product name (for illustrative purpose only):

W_XX-EUMETSAT-Darmstadt,SAT,SGA1-VII-00-SRC_C_EUMT_20220101121212_G_O_20220101103000_20220101104000_C_N____

This is a global L0 product, generated as EPS-SG global mission type, for the METimage instrument (VII mission) embarked on the Metop-SG/A1 satellite (SGA1). The product was created on the 01 January 2022 at 12:12:12 hours, with a sensing start date of 01 January 2022

at 10:30:00 hours and a sensing end date of 01 January 2022 at 10:40:00 hours. The file was generated in the Ground Segment operational (O) environment during commissioning (C) in near real time (N) mode. The corresponding filename will carry an extension “.nc”.

3.4 High-level Product Structure

All EPS-SG L0 products have the same structure and only differ for the type, format and content of the CCSDS TM packets stored in the *Data* group. Each L0 product type includes a different set of CCSDS TM packets as described in the next sections. The TM packets are contained as raw binary data without any reformatting or interleaved annotations applied.

All EPS-SG Level 0 product types generated by the EPS-SG Ground Segment are NetCDF-4 files complying with the generic structure and data model set out in the [GPFS].

Their high-level structure is presented in Figure 1 and consists of a *Root* group, holding global attributes defined in the [GPFS] and the following sub-groups:

- *Status*
- *Data*
- *Quality*

No additional NetCDF-4 groups or sub-groups are foreseen for L0 products. The *Instrument Status* group is only applicable to Level 0 products for Metop-SG instruments (including A-DCS) and it is not used for NAVATT and HKTM L0 products.

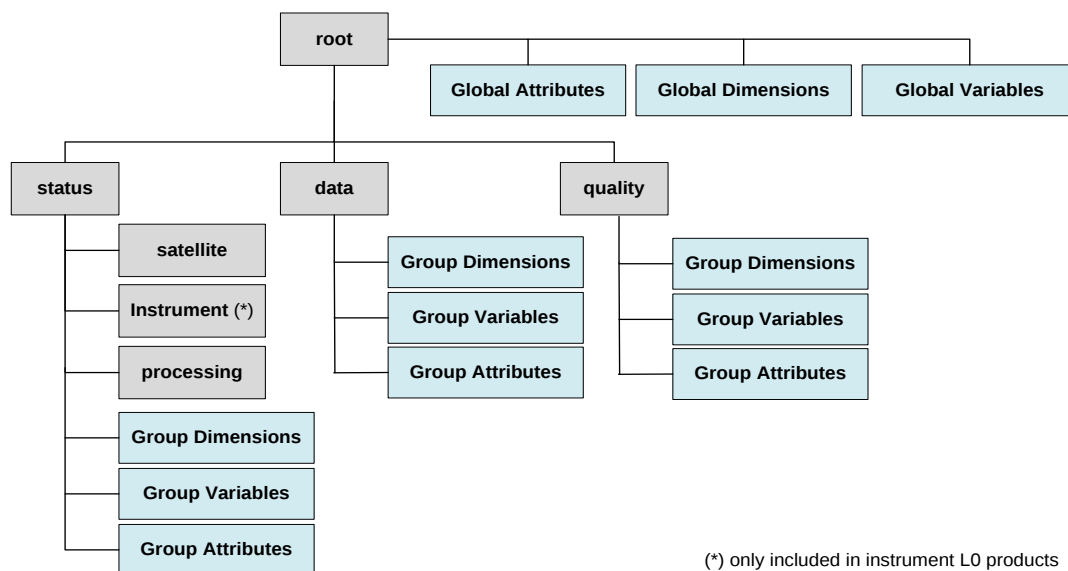


Figure 1: Generic structure of EPS-SG L0 Products (grey: specific contents, blue: generic data types in each group)

The EPS-SG L0 products therefore contain:

- Global attributes including keywords;
- Satellite status information, including navigation data;
- Instrument status information (only applicable to instrument L0 products);

- Data containing the measurement data, i.e. raw TM packets;
- Product quality information.

The following table summarises the NetCDF groups applicable to different L0 products.

Table 4: NetCDF groups used in different L0 products

NetCDF Group	L0 products		
	Instrument L0	NAVATT L0	HKTM L0
Status	√	√	√
Satellite	√	√	√
Instrument	√		
Processing	√	√	√
Data	√	√	√
Quality	√	√	√

4 DETAILED FORMAT OF EPS-SG L0 PRODUCTS

This section provides the description of the detailed format and content of each NetCDF group included in EPS-SG L0 products.

Tables are used to provide the definition of NetCDF groups, dimensions, variables and attributes stored in L0 product files.

4.1 Global Attributes

The set of product global attributes defined in [GPFS] are populated for L0 products as indicated in Table 5 below.

The attributes *sensing_start_time_utc* and *sensing_end_time_utc* contain the start and end time, respectively, associated with each instance of a Level 0 product file. These times are derived from the generation time of the first and last CCSDS packets stored in the L0 product file.

The packet generation time does not correlate precisely with the generation time of the data in the packet. The approach for populating time fields in CCSDS packets varies across the different instruments and it depends on how the instrument packetizes the data, if buffering is implemented, etc. Rather than incorporate sophisticated rules for populating the *sensing_start_time_utc* and *sensing_end_time_utc* global attributes, the packet generation time fields from the first and last packets' CCSDS secondary headers in a Level 0 product file are used.

A resolution of milliseconds is provided for these attributes because it is satisfactory from a cataloguing standpoint and it is consistent with the same global attributes in L1/L2 products.

Table 5: Global Attributes

Attribute name=	Data Type type=	Meaning and/or Value
Conventions	NC_STRING	e.g. "CF-1.6"
metadata_conventions	NC_STRING	e.g. "Unidata Dataset Discovery v1.0"
product_name	NC_STRING	Product name as defined in [GPFS] Section 3.2
title	NC_STRING	"EPS-SG Level 0 Product"
summary	NC_STRING	See Table 6
keywords	NC_STRING	"source packets, level 0, raw data, EPS-SG, polar meteorological satellite, Metop-SG"
history	NC_STRING	("original generated product" "aggregated product" "sub-setted product")
institution	NC_STRING	"EUMETSAT"
spacecraft	NC_STRING	Metop-SG A satellites: ("SGA"[1-3]) Metop-SG B satellites: ("SGB"[1-3])
instrument	NC_STRING	("IAS" "MWS" "VII" "RO_" "3MI" "MWI" "ICI" "SN5" "SCA" "MSP" "NAV" "HKT" "DCS")
product_level	NC_STRING	"0"
type	NC_STRING	("SRC" "VER") SRC = source data VER = verification data (IASI-NG)
mission_type	NC_STRING	("Global" "Regional" "Local")

disposition_mode	NC_STRING	("Test" "Commissioning" "Operational" "Validation")
sensing_start_time_utc	NC_STRING	UTC time of start of sensing data formatted in CF date and time format [GPFS] with ms precision. It corresponds to the generation time of the first packet stored in the L0 product.
sensing_end_time_utc	NC_STRING	UTC time of end of sensing data formatted in CF date and time format [GPFS] with ms precision. It corresponds to the generation time of the last packet stored in the L0 product.
environment	NC_STRING	("Operational" "Validation" "Integration & Verification" "Development" "Engineering")
references	NC_STRING	"www.eumetsat.int"
orbit_start	NC_UINT	Absolute orbit number at sensing_start_time_utc
orbit_end	NC_UINT	Absolute orbit number at sensing_end_time_utc

Table 6: Global Attributes – Summary Field

Product type	Value
IAS-00-SRC	IASI-NG Level 0 Product including instrument source packets (ISPs) for science data (observational OBS, auxiliary ADA) generated by the instrument in OPER and CHECK mode.
IAS-00-VER	IASI-NG Level 0 Product including instrument source packets (ISPs) for verification data (ADV) generated by the instrument in OPER mode.
IAS-00-REP	IASI-NG instrument source packets: repeated calibration packets
IAS-00-CHK	IASI-NG instrument source packets: generated in CHECK mode.
VII-00-SRC	VII Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
MWS-00-SRC	MWS Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
3MI-00-SRC	3MI Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
SN5-00-SRC	S-5 Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable), excluding the "Small Pixel" type of packets.
S5-00-SMP	S-5 Level 0 Product including instrument the specific type "Small Pixel" of source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
RO_-00-SRC	RO Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
SCA-00-SRC	SCA Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
ICI-00-SRC	ICI Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).

MWI-00-SRC	MWI Level 0 Product including instrument source packets generated by the instrument in any instrument mode generating science data such as measurement modes, calibration modes and special modes only used during commissioning (where applicable).
DCS-00-SRC	A-DCS Level 0 Product including TM science data packets generated by the instrument.
NAV-00-SRC	NAVATT Level 0 Product including NAVATT packets.
HKT-00-SRC	HKTM Level 0 Product including Payload and Platform HKTM packets.

4.2 Status Group

4.2.1 Satellite Status

The following table lists the variables included in the Satellite status group of all EPS-SG L0 products.

Note that some variables defined in Satellite status in [GPFS] only apply to L1/L2 products and hence they are not provided in L0 products. They are: earth_sun_distance_ratio, location tolerances, yaw/pitch/roll biases and manoeuvres information.

Table 7: Satellite Status Variables

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=
Orbit Parameters shape=1			
epoch_time_utc	NC_DOUBLE	"Epoch time in UTC of the orbital elements". Note: CF date and time format as per GPFS. It corresponds to sensing_start_time_utc (in Global attributes, Table 5)	seconds since 2020-01-01 00:00:00.000
semi_major_axis	NC_DOUBLE	"Semi major axis of the orbit at epoch time [TOD]"	"m"
eccentricity	NC_DOUBLE	"Eccentricity of the orbit at epoch time [TOD]"	-
inclination	NC_DOUBLE	"Inclination of the orbit at epoch time [TOD]"	"degrees"
perigee_argument	NC_DOUBLE	"Argument of perigee of the orbit at epoch time [TOD]"	"degrees"
right_ascension	NC_DOUBLE	"Right ascension of the orbit at epoch time [TOD]"	"degrees"
mean_anomaly	NC_DOUBLE	"Mean anomaly of the orbit at epoch time [TOD]"	"degrees"
Location Summary shape=1			
subsat_latitude_start	NC_DOUBLE	"Latitude of sub-satellite point at start of the product"	"degrees_north"
subsat_longitude_start	NC_DOUBLE	"Longitude of sub-satellite point at start of the product"	"degrees_east"
subsat_latitude_end	NC_DOUBLE	"Latitude of sub-satellite point at end of the product"	"degrees_north"
subsat_longitude_end	NC_DOUBLE	"Longitude of sub-satellite point at end of the product"	"degrees_east"
State Vector Parameters shape=1			

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=
state_vector_time_utc	NC_DOUBLE	"Time of the state vector in UTC" Note: CF date and time format as per GPFS. It corresponds to sensing_start_time_utc (in Global attributes, Table 5)	seconds since 2020-01-01 00:00:00.000
x_position	NC_DOUBLE	"X position of the orbital state vector [EARTH+FIXED]"	"m"
y_position	NC_DOUBLE	"Y position of the orbital state vector [EARTH+FIXED]"	"m"
z_position	NC_DOUBLE	"Z position of the orbital state vector [EARTH+FIXED]"	"m"
x_velocity	NC_DOUBLE	"X velocity of the orbital state vector [EARTH+FIXED]"	"m/s"
y_velocity	NC_DOUBLE	"Y velocity of the orbital state vector [EARTH+FIXED]"	"m/s"
z_velocity	NC_DOUBLE	"Z velocity of the orbital state vector [EARTH+FIXED]"	"m/s"
Leap Second Information shape=1			
leap_second_time_utc	NC_DOUBLE	"UTC time of a leap second occurrence in the product" Note: CF date and time format as per GPFS, represents the time after the leap second occurrence (i.e. midnight of day after the leap second; no leap second results in 0).	seconds since 2020-01-01 00:00:00
leap_second_value	NC_SHORT	"Value of leap second in product (1, 0, or -1)" Note: 1 = increment -1 = decrement	"s"

4.2.2 Instrument Status

This group is only present in Instrument L0 products (i.e. not included in NAVATT and HKTM L0 products).

Table 8: Instrument Status Dimensions

Dimension name=	Comment	Dimension length=
mode_items	Number of modes the instrument assumed during product duration	"" 1 ≤ N

Table 9: Instrument Status Variables

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=
Instrument Modes shape=mode_items			

mode_start_time_utc	NC_DOUBLE	“Mode start time in UTC” Note: If data in the product is from a single mode, it corresponds to sensing_start_time_utc in global attributes. CF date and time format.	seconds since 2020-01-01 00:00:00.000
mode_end_time_utc	NC_DOUBLE	“Mode end time in UTC” Note: If data in the product is from a single mode, it corresponds to sensing_end_time_utc in global attributes. CF date and time format.	seconds since 2020-01-01 00:00:00.000
instrument_mode	NC_STRING	“Name of the instrument mode” Note: valid modes in Table 14	-

Note: The start / end times of a given instrument mode are derived from the CCSDS packets generation times and they may not precisely indicate the actual start / end times of the mode, depending on how the instrument packetizes the data and if buffering is implemented.

4.2.3 Processing Status

Table 10: Processing Status Attributes

Attribute name=	Data Type type=	Meaning and/or Value
processor_name	NC_STRING	Name of the product processor: “L0”
processor_version	NC_STRING	Version number of the processor.
format_version	NC_STRING	Product format version control number.
processing_mode	NC_STRING	Processing mode in which the product was generated (“NRT” “Backlog”).
pgs_reference_and_version	NC_STRING	Reference and version of the PGS.
pfs_reference_and_version	NC_STRING	Reference and version of the PFS.
source	NC_STRING	As particularised in the relevant product format specification, an array of strings of the form specified in as follows: (AUXILIARY_DATA_NAME)* (INPUT_PRODUCT_NAME)* where the asterisks indicate zero or more instances Note: it is intended that users of the product can determine from the source attribute the version of the processing software and algorithm and the configuration data used to create the product, as well as the products that were inputs to its creation.

Table 11: Processing Status Variables

Variable name=	Data Type type=	Attribute name=“long_name” value=	Attribute name=“units” value=
Creation Time Information shape=1			
creation_time_utc	NC_DOUBLE	“UTC time of the product creation” Note: CF date and time format.”	seconds since 2020-01-01 00:00:00

4.3 Data Group

The *Data* group includes two arrays:

- *tm_packets*: variable length array of unsigned bytes (refer to [NC-CIC]) including a sequence of raw telemetry (TM) CCSDS packets. The type, content, format and sequence of TM packets stored in the array depend on the packet type included in the L0 product as explained in section 0. CCSDS packets are stored without interleaved annotation. Each array entry is a packet;
- *tm_packet_time_utc*: array of doubles including the UTC generation time of each CCSDS packet stored in the product. This array has the same dimension of the other array, with one entry for each CCSDS packet.

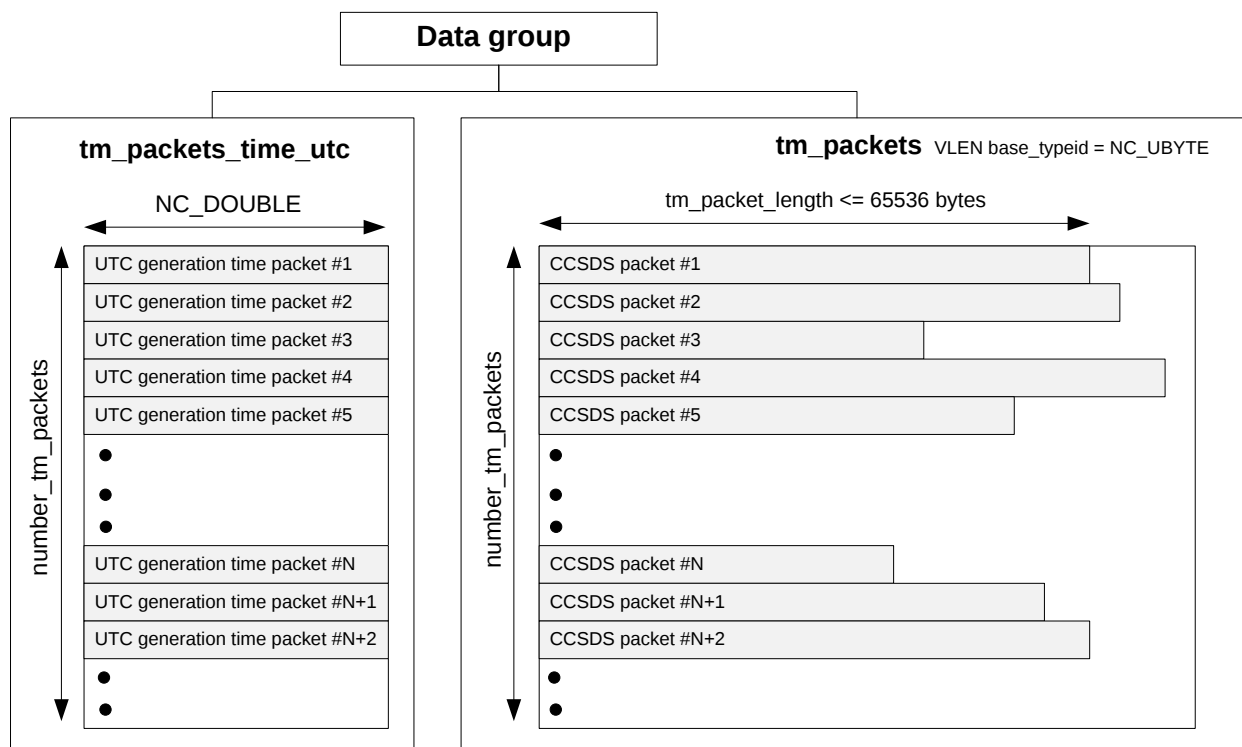


Figure 2: Content of L0 Products Data Group

The following tables define the dimensions and variables of the *Data* group.

Table 12: Data Dimensions

Dimension name=	Comment	Dimension length=
number_tm_packets	Number of TM packets in the L0 product. Depends on the duration of the L0 product.	“”
tm_packet_length	Length of the TM packet, ≤65536 (bytes). This dimension is variable and depends on the TM packet type. It may be variable for the same packet type.	“*”

Table 13: Data Variables

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=	Content description
TM Packets shape=number_tm_packets tm_packet_length (1)				
tm_packets	VLEN base_typeid = NC_UBYTE	"Array of TM packets"	-	This variable is a 2D array including a sequence of CCSDS TM packets of one or more types. No interleaved annotation is included.
TM Packets Information shape=number_tm_packets				
tm_packet_time_utc	NC_DOUBLE	"Array of UTC generation times of TM packets"	seconds since 2020-01-01 00:00:00.000000	Array of UTC times in CF date and time format with one entry for each packet included in the tm_packets array. The UTC time reported for each packet is the packet generation time in UTC time scale computed by converting the OBT time included in the packet secondary header to UTC. The OBT is either LOBT or COBT depending on packet type."

(1): The dimension tm_packet_length is variable and for this reason is not explicit in the product, instead the variable **tm_packets** is supported by a VLEN type. The base-type used with VLEN array tm_packets is NC_UBYTE.

4.3.1 TM CCSDS packets

The Space to Ground Interface Control Document [SGICD] and the Instrument Interface Control Documents applicable to this document and listed in section 2.1, are the source of TM CCSDS packet details. These are not repeated here. The structure of all EPS-SG packets conforms to [PUS-IRD].

The *tm_packets* variable included in the *Data* group of a L0 product is an array including a sequence of CCSDS TM packets.

Each EPS-SG L0 product type includes different types of TM packets.

- TM packets are stored in the *tm_packets* variable in the same sequence in which they are generated on-board and their order depends on the TM packet type. If the L0 product includes TM packets of different types (multiple APIDs) e.g. referring to different channels or modes of the same instrument, the order in which TM packets are stored is the same in which they are generated on-board, and packets for different APIDs may be interleaved. For instance:

- The *tm_packets* variable of a NAVATT L0 product includes a time-ordered sequence of NAVATT packets of the same type (a single APID);
 - In a VII L0 product, the *tm_packets* variable includes TM packets of different types (multiple APIDs), for different channels and modes of the METImage instrument. Different packet types may be interleaved by channel or time depending on the order in which they are generated by the instrument and specified in the corresponding instrument ICD.
- Duplicated packets are identified and discarded during L0 processing. They are not included in the *tm_packets* variable.
 - Corrupted packets that failed the Packet Error Control (PEC) field check are discarded during the level 0 processing and not reported in the *tm_packets* variable. The PEC field includes a cyclic redundancy code (CRC) whose definition is given in [PUS-IRD] Annex B.4.4.
 - Missing packets are identified during L0 processing and they are not replaced with dummy or synthetic data. Statistics on the number of missing packets are reported in the *Quality* group (see section 0). Eventual corrupted packets removed during L0 processing are also accounted for in the statistics of missing packets.

The set of TM packets included in each EPS-SG L0 product type are reported in the following table, along with the Satellite or instrument ICD defining their detailed content, format and order. TM packets are identified by the on-board service (type, subtype) specified in [PUS-IRD] and by their APID. For completeness, Process Identifiers (PID, first seven bits of APID) and Packet CATegories (PCAT, last four bits of APID) values composing the APID (11 bits) are also reported.

In the particular case of Sentinel-5, packets need to be further identified by its Structure Identifier (SID) in order to discriminate, within the same APID, two different types of packets (Science and Small Pixel).

This table is to be populated and expanded during the design phase of the Ground Segment.

Table 14: TM packets included in each EPS-SG Level 0 Product Type

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
HKTM Level 0	HKT-00-SRC	Satellite and Payload HKTM packets	NA	All but (200,x) and (145,x)	All but the PIDs allocated for science and calibration		[PUS-IRD]
NAVAT T Level 0	NAV-00-SRC	NAVATT TM packets	NA	(145,200)	24	- 0	[PUS-IRD], [NAV]
A-DCS Level 0	DCS-00-SRC	ARGOS-4 TM packets	OPER	(200,3)	4C	- C Science - 7 Science Report - 3 Science Table - 9 Science Memory - 2 Science Diagnostic	[ADCS-ICD]
IAS Level 0	IAS-00-SRC	IASI-NG Operational Mode science data	OPER	(200,3)	3E	- 1 (ODS) - 2 (ODI) - 4 (ADA_MET_OPD) - 6 (ADA_MET_raW) - D (ADA_PROCESSING) -	[IAS-ICD]
	IAS-00-REP	IASI-NG Repeated packets in OPER Mode	OPER		3E	- 7 (ODS_repeat) - 8 (ADA_MET_Raw_repeat) - B (ODI_repeat) - C (ADA_PROCESSING_repeat) - F (ADA_MET_OPD_repeat)	
	IAS-00-CHK	IASI-NG Check Mode science data	CHECK		3F	- 0 (ADV_PMD) - 1 (ODS) - 2 (ODI) - 3 (ADV_IFG_1_6) - 4 (ADA_MET_OPD) - 5 (ADV_MET_SPL) - 6 (ADV_MET_Raw) - 7 (ADV_MEC_DIAG)	

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
						- 8 (ADV_MET_DIAG1) - 9 (ADV_IMA) - A (ADV_MEC_SVC - B (ADV_US_1_9) - C (ADV_MET_DIAG2) - D (ADA_PROCESSING) - E (ADV_MEC_OTS) - F (ADV_MEC_IFM)	
	IAS-00-VER	IASI-NG verification data (ADV) generated in OPER mode	OPER	(200,3)	3E	- 3 (ADV_IFG_1_6) - 5 (ADV_MET_SPL) - 9 (ADV_IMA) - A (ADV_MEC_xyz; xyz € {"IFM,OTS",SVC"})	
MWS Level 0	MWS-00-SRC	MWS Scan Mode ISPs	SCAN	(200,3)	45	- 0 Ancillary Data - 1 MWS-1 - 2 MWS-2 - 3 MWS-3-16 - 4 MWS-17 - 5 MWS-18 - 6 MWS-19-23 - 7 MWS-24	[MWS-Carto], [MWS-ICD]
		MWS Pointing Mode ISPs	POINTING	(200,3)	45	- 8 Ancillary Data - 9 MWS-1 - A MWS-2 - B MWS-3-16 - C MWS-17 - D MWS-18 - E MWS-19-23 - F MWS-24	

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
VII Level 0	VII-00-SRC	METimage Science Mode ISPs	OPER Note: “Science” in [VII-Carto]	(200,3)	5A	- 0 High Frequency Ancillary Data - 5 Low frequency Ancillary Data - 3 High priority channels, Post-scan pixels, GAP channel pixels - 4 Low priority channels	[VII-Carto], [VII-ICD]
		METimage Calibration-Diagnostic Mode ISPs	CALIBRATION/DIAGNOSTIC		5B	- 0 High Frequency Ancillary Data - 5 Low frequency Ancillary Data 3 all channels: Post-scan pixels. Readout pixels	
3MI Level 0	3MI-00-SRC	3MI Operational Mode ISPs	OPER Note: “Operational” in the 3MI TMTC ICD	(200,3)	4C	- 1 VNIR detector - 2 SWIR detector	[3MI-Carto], [3MI ICD], [3MI-Pixel Position]
		3MI Operational Calibration (Dark) Mode ISPs	CALIBRATION Note: “Calibration” in the 3MI TMTC ICD		4D	- 1 VNIR detector - 2 SWIR detector	

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product				Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)		
		3MI Test Mode ISPs	TEST		4D	- 3 VNIR detector - 4 SWIR detector		
UVNS Level 0	SN5-00-SRC	UVNS Operational Mode ISPs	OPER Note: “OPE” in the UVNS TMTC ICD	(200,3)	53	PCAT (hex)	SID (dec)	[S-5-Carto], [S-5-ICD], [S-5-Meas_Control], [S-5 Pixel Naming]
				- 0 Ancillary Data - 1 UV1 Science Data; - 2 UV2a Science Data; - 3 UV2 Science Data; - 4 VIS Science Data; - 5 NIR-1 Science Data; - 6 NIR-2 Science Data; - 7 SWIR1 Science Data; - 8 SWIR3 Science Data;		- (All) Ancillary Data - 140 UV1 Science Data; - 145 UV2a Science Data; - 150 UV2 Science Data; - 155 VIS Science Data; - 160 NIR-1 Science Data; - 165 NIR-2 Science Data; - 170 SWIR1 Science Data; - 180 SWIR3 Science Data;		
		UVNS Calibration Mode ISPs	CALIBRATION Note: “CAL” in the UVNS TMTC ICD	(200,3)	54	- 0 Ancillary Data - 1 UV1 Science Data; - 2 UV2a Science Data; - 3 UV2 Science Data;	- (All) Ancillary Data - 140 UV1 Science Data; - 145 UV2a Science Data; - 150 UV2 Science Data;	

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product				Applicable ICD for TM packet format and content	
				Service (Type, Subtype)	PID (hex)	PCAT (hex)			
						- 4 VIS Science Data; - 5 NIR-1 Science Data; - 6 NIR-2 Science Data; - 7 SWIR1 Science Data; - 8 SWIR3 Science Data;	- 155 VIS Science Data; - 160 NIR-1 Science Data; - 165 NIR-2 Science Data; - 170 SWIR1 Science Data; - 180 SWIR3 Science;		
		UVNS Test Mode ISPs	TEST	(200,3)	53	- 9 UV1 Science Data TM; - A UV2a Science Data - B UV2 Science Data; - C VIS Science Data; - D NIR-1 Science Data; - E NIR-2 Science Data; - F SWIR1 Science Data;	- 140 UV1 Science Data; - 145 UV2a Science Data; - 150 UV2 Science Data; - 155 VIS Science Data; - 160 NIR-1 Science Data; - 165 NIR-2 Science Data; - 170 SWIR1 Science Data;		
						54	- 9 SWIR3 Science Data;		
					SN5-00-SMP	UVNS Operational Mode ISPs – Small Pixels Product	OPER Note: “OPE” in the UVNS TMTC ICD		(200,3)

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product				Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)		
						- 1 UV1 Small Pixel TM; - 2 UV2a Small Pixel; - 3 UV2 Small Pixel; - 4 VIS Small Pixel - 5 NIR-1 Small Pixel; - 6 NIR-2 Small Pixel; - 7 SWIR1 Small Pixel; - 8 SWIR 3 Small Pixel	- 141 UV1 Small Pixel TM; - 146 UV2a Small Pixel; - 151 UV2 Small Pixel; - 156 VIS Small Pixel - 161 NIR-1 Small Pixel; - 166 NIR-2 Small Pixel; - 171 SWIR1 Small Pixel; - 181 SWIR3 Small Pixel	
		UVNS Calibration Mode ISPs – Small Pixels Product	CALIBRATION Note: “CAL” in the UVNS TMTC ICD	(200,3)	54	PCAT (hex)	SID (dec)	
						- 1 UV1 Small Pixel TM; - 2 UV2a Small Pixel; - 3 UV2 Small Pixel; - 4 VIS Small Pixel - 5 NIR-1 Small Pixel; - 6 NIR-2 Small Pixel;	- 141 UV1 Small Pixel TM; - 146 UV2a Small Pixel; - 151 UV2 Small Pixel; - 156 VIS Small Pixel - 161 NIR-1 Small Pixel; - 166 NIR-2 Small Pixel;	

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product				Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)		
						- 7 SWIR1 Small Pixel; - 8 SWIR 3 Small Pixel	- 171 SWIR1 Small Pixel; - 181 SWIR3 Small Pixel	
		UVNS Test Mode ISPs – Small Pixels Product	TEST	(200,3)	53	- 9 UV1 Small Pixel TM; - A UV2a Small Pixel; - B UV2 Small Pixel; - C VIS Small Pixel - D NIR-1 Small Pixel; - E NIR-2 Small Pixel; - F SWIR1 Small Pixel	- 141 UV1 Small Pixel TM; - 146 UV2a Small Pixel; - 151 UV2 Small Pixel; - 156 VIS Small Pixel - 161 NIR-1 Small Pixel; - 166 NIR-2 Small Pixel; - 171 SWIR1 Small Pixel;	
						54	- 9 SWIR 3 Small Pixel	
SCA Level 0	SCA-00-SRC	SCA measurement mode ISPs	OPER Note: “Nominal” in the SCA TMTC ICD	(200,3)	53	- 0 Ancillary Data - C Science Data		[SCA-ICD] [SCA-Carto]

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
MWI Level 0	MWI-00-SRC	MWI Operational Scan mode ISPs	SCAN Note: “OP_SCAN” in the MWI TMTC ICD SCIENCE	(200,3)	45	- 0 Ancillary Data - 1 Earth View Window - 2 Hot Window - 3 Cold Window - 4 RFI data	[MWI-ICD] [MWI-Carto]
ICI Level 0	ICI-00-SRC	ICI Operational Scan mode ISPs	SCAN Note: “OP_SCAN” in the ICI TMTC ICD	(200,3)	5A	- 1 EO, all channels	[ICI-ICD] [ICI-Carto]
					5B	- 1 Cold sky calibration, all channels - 2 OBCT calibration, all channels	
RO Level 0	RO_-00-SRC	RO Occultation Mode ISPs	OCCULTATION Note: “Occultation” in the RO TMTC ICD	(200,3)	37	- 0 IC function Engineering Data - 1 NAV_SCIENCE: POD_EXT_Nav_Sol, POD_Tracking State, Sup_ChannelStatus, Sup_Noise_Hist, Sup_SatInView, Evt_GnssAlm, Evt_GnssEph, Evt_GnssClkCorr, Evt_GnssGroupDelay Evt_GnssDiffCorr, Evt_GnssUTC, Evt_GnssTimeOffset, Evt_GnssEOP, Evt_AGC_Status	[RO-ICD]

EPS-SG Level 0 Product Format Specification

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
						- 2 ROr_SCIENCE_DATA: PVT_Time_Base, Satellites_In_View, Noise Histogram_and_Gain, Tracking_State_Change, GNSS_SV_Ephemeris, Frodo_Status, ME_Observables - 3 ROs_SCIENCE_DATA: PVT_Time_Base, Satellites_In_View, Noise Histogram_and_Gain, Tracking_State_Change, GNSS_SV_Ephemeris, Frodo_Status, ME_Observables - 6 NAV_POD_DATA: CarrierAmp, CarrierPhase, PseudoRange - 8 ROr: Signal Data Packet - 9 ROr: Diagnostic Tracking Aid Packets - C ROs: Signal Data Packet - D ROs: Diagnostic Tracking Aid Packets	
		RO Navigation Mode ISPs	NAVIGATION Note: "Navigation" in the RO TMTC ICD		37	- 0 IC function Engineering Data - 1 NAV_SCIENCE: POD_EXT_Nav_Sol, POD_Tracking State, Sup_ChannelStatus, Sup_Noise_Hist, Sup_SatInView, Evt_GnssAlm, Evt_GnssEph, Evt_GnssClkCorr, Evt_GnssGroupDelay Evt_GnssDiffCorr, Evt_GnssUTC, Evt_GnssTimeOffset, Evt_GnssEOP, Evt_AGC_Status	

Product Type	Product ID	Description / Mode	Instrument Mode ID	TM Packets in the product			Applicable ICD for TM packet format and content
				Service (Type, Subtype)	PID (hex)	PCAT (hex)	
						- 6 NAV_POD_DATA: CarrierAmp, CarrierPhase, PseudoRange	

4.4 Quality Group

The Quality Group is common to all Level 0 products. It contains common attributes applicable from [GPFS] and additional attributes specific for L0 products as defined in the following table.

Table 15: Quality Group Attributes

Attribute name=	Data Type type=	Meaning and/or Value
overall_quality_flag	NC_USHORT	Flag indicating the overall quality of the L0 product. 0 (nominal quality) = no missing packets in L0 product and no corrupted packets discarded during L0 processing. Setting of individual bits indicate degraded conditions: Bit 0: always set to 0 (not used in L0) Bit 1: Data gap(s) Bit 2: always set to 0 (not used in L0) Bit 3: always set to 0 (not used in L0) Bit 4: missing auxiliary data Bits 5 to 15: always set to 0 (not used in L0)
number_missing_packets	NC_UINT	Overall number of missing TM packets in the L0 product. This includes TM packets originally missing in the input data stream and corrupted packets removed during L0 processing. Note: Only applicable to L0 products.

Table 16: Quality Group Dimensions

Dimension name=	Comment	Dimension length=
gap_items	Number of data gaps identified. Note 1: based on expected nominal product duration Note 2: it will not appear in the Product if overall_quality_flag bit 1 equals 0.	"" $1 \leq N$

Table 17: Quality Group Variables

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=
Product Duration shape=1			
duration_of_product	NC_DOUBLE	"Entire duration of the product"	"s"
duration_of_data_present	NC_DOUBLE	"Amount of data present in the product"	"s"
duration_of_data_missing	NC_DOUBLE	"Amount of data missing in the product" Note: based on expected nominal product duration	"s"
Gaps Information shape=gap_items			
gap_start_time_utc	NC_DOUBLE	"Gap start time in UTC" Note: will not appear in the L0 Product if overall_quality_flag bit 1 equals to 0. CF date and time format.	Seconds since 2020-01-01 00:00:00.000
gap_end_time_utc	NC_DOUBLE	"Gap end time in UTC"	Seconds since 2020-01-01 00:00:00.000

EPS-SG Level 0 Product Format Specification

Variable name=	Data Type type=	Attribute name="long_name" value=	Attribute name="units" value=
		Note: will not appear in the L0 Product if overall_quality_flag bit 1 equals to 0. CF date and time format.	

5 PRODUCT FORMAT VERSION CONTROL

Table 18 provides the *Product Format Version Control Numbers* of the L0 Product defined within this document, as described in the [GPFS]. The Product Format Version Control Number is updated according the guidelines described in the [GPFS].

Table 18: Record Format Version Numbers

Product ID	Product Format Version Control Number (format_version)	Product Format Specification Issue (pfs_reference_and_version)	Generic Product Format Specification Issue (gpfs_reference_and_version)
L0*	0.0	1E	1E
L0*	1.0	1H	1H
L0*	1.1	1I	1H
L0*	2.0	2	2.0
L0*	2.0	2A	2A
L0*	3.0	3	3
L0*	3.0	3A	3
L0*	4.0	3B	3B
L0*	4.0	3C	3B
L0*	4.0	3D	3C
L0*	5.1	3E	3D
L0*	5.2	4	4
L0*	5.3	4A	4

(*)All L0 product types as defined in Table 1.

6 SIZE OF EPS-SG L0 PRODUCTS

The size of EPS-SG Level 0 products is close to the raw data size that comes from the instruments/spacecraft and it is marginally amended to take into account product metadata. The table below reports the current estimate based on the latest instrument data rates and considering 1 orbit of data as a reference. The Level 0 product size is based on the corresponding instrument data rates as presented in [SGICD]. The size of individual L0 product files depends on the products granularity which will be defined by the PDAP contractor in Phase C.

Table 19: EPS-SG Level 0 Product Size

Product Type	Product ID	Size (1 orbit as reference)
Metop-SG A satellite		
IAS Level 0 Science	IAS-00-SRC	4 554.800MB
IAS Level 0 Verification	IAS-00-VER	1 333.200MB
IAS Level 0 Repeat	IAS-00-REP	517.4 MB
IAS Level 0 Check	IAS-00-CHK	5 124 MB (1)
VII Level 0	VII-00-SRC	10 212.449 MB
MWS Level 0	MWS-00-SRC	38.010 MB
3MI Level 0	3MI-00-SRC	3 063.126 MB
Sentinel-5 Level 0	SN5-00-SRC	8 910.16MB
Sentinel-5 Level 0 Small Pixel	SN5-00-SMP	1 127.341 MB (2)
RO Level 0	RO_-00-SRC	1 216.311 MB
NAVATT Level 0	NAV-00-SRC	17.560 MB
HKTM Level 0	HKT-00-SRC	28.212 MB
Metop-SG B satellite		
SCA Level 0	SCA-00-SRC	9 122.330 MB
MWI Level 0	MWI-00-SRC	1 520.388 MB
ICI Level 0	ICI-00-SRC	380.097 MB
RO Level 0	RO_-00-SRC	1 216.311 MB
A-DCS Level 0	DCS-00-SRC	60.816 MB
NAVATT Level 0	NAV-00-SRC	17.560 MB
HKTM Level 0	HKT-00-SRC	28.212 MB

(1): Worst case: CHK mode volume depends on the configuration of the mode. Additionally, it does not have to be added to the Science/Repeat/Verification data volume for a per-orbit volume calculation, as it is mutually exclusive with them.

(2): Case for an orbit with Solar Calibration. Orbits with other types of calibration may be slightly different.

Appendix A XML DESCRIPTION OF EPS-SG L0 PRODUCTS FORMAT

This appendix provides the XML files for the NetCDF-4 EPS-SG L0 products (EPS-SG-L0-INST-PFS.xml, EPS-SG-L0-NAVATT-PFS.xml and EPS-SG-L0-HKTM-PFS.xml).



L0_HKTM 4B.xml



L0_NAVATT 4B.xml



L0_INST 4B.xml