CRYOSAT Ground Segment

Instrument Processing Facility L2

L2 Products Format Specification

[L2-FMT]

CS-RS-ACS-GS-5123

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Document Change Record

Issue/Rev.	Class (R=Review /A=Approval)	Date	Reason for Change	Changed Pages/Paragraphs
Cryosat 1				
1.0	R	31/01/2004	Initial Issue for IPF2 Vb	all
1.1	R	26/11/2004	Updated Issue for IPF2 Vd	See sidebars
1.2 Draft	A	16/05/2005	XML and ASCII SPH updated: Surface Id statistics fields introduced List of DS_NAME for Measurement DSD updated to account for Fast Delivery Ocean Processing Chain and the introduction of the old-fashioned products (intermediate).	
1.3	A	16/06/2005	Final Issue for Ve release (excluding FDM chain)	Section 2.3.3 Completely updated
1.4	A	02/08/2005	Inclusion of Fields descriptions + typo Corrections + inclusion of FDO format	
1.5	A	05/09/2005	L2 Product fields 22 and 23 changed from us to ss format	Section 2.3.3.1
1.6	A	09/09/2005	Typographycal Corrections	See Sidebars
1.7	A	24/06/2006	Inclusion of new DS Name for new geocorrections files	See Sidebars
Cryosat 2				
2.0	R	28/01/2008	Vh 1.0 delivery (SIRAL redundancy)	The following sections have been changed: 2.2.2.2 / 2.3.2 / 2.3.3.1 / 2.3.3.2 / 4
2.1	R	18/02/2008	Inserted Comments received during Vh1.0 QR	The following sections have been changed: = Approval Table = Section 1.3.2 (Reference Documents) = Section 2.3.1 (Table 2.3.1-1, reference to LTA added) = Section 2.3.2 (Table 2.3.2-5 reference to CAL3 removed) = Section 2.3.3.2 (Table

				2.3.3.2-4 (MCD Falgs updated) = Section 2.3.3.2 (Table 2.3.3.2-2 Reference to CAL3 removed)
2.2	R	25/03/2009	Vh 1.2 delivery (Data-driven Siral redundancy and integration of geocorrection and retracker CDI)	The following sections have been changed: 1.3: updated referece document 2.3: updated list of MDS and RDS descriptor names 2.2.2.1: XML header updated 2.3.3.1: L2 MDS format updated 2.3.3.2: Intermediate L2 MDS format updated3: L2 FDM format updated 4: Naming convention updated
2.3	R	02/04/2009	After Vh1.2 QR. To include RID and modification agreed at QR meeting	The following sections have been changed: Sec. 2.3.3.1: reported spares (field 44) missing in the previuos issue Sec. 3: SIRAL side parameter moved to bit#30, as agreed at Vh1.2 QR meeting
2.4	R	15/04/2009	Revision to include RID	The following sections have been changed: Sec. 2.3.3.1: Table of L2 MDS records. Field 43 and 44 exchanged for a typo
2.5	R	09/06/2009	Revision to include RID	Sec. 3: total byte size of the FDM L2 MDS corrected
				Sec. 2.3.3.2: reference to DORIS ionospheric correction replaced with GIM
2.6	R	03/10/2011	Issued for Vj1.0	L2 Intermediate format updated with the following changes: – 2 new bits used for the SARin ambiguity flag (Field#73 - Table 2.3.3.2-12); – 1 new bit for the retracker flag (Field#48 – table 2.3.3.2-7); – SARin parameters related to power are now scaled as 1x10-18 W rather than 1x10-15W (field#21, #24, #58, #59, #60).
2.7	R	20/10/2011	Re-issued after ESA comments from ESL Acceptance Review	Description of Field#66 (ocean retracking quality flag) added in the FDM L2 Format description (par. 3)
2.8	R	14/11/2011	New Release to take into account ESA's comments after delivery of IPF2 Vj1.0	Diffuse changes (typo and minor fixing). See side bars. All TBC/TBDs have been solved.
2.9	R	14/12/2012	Update units of SWH SD in FDM	Section 3

			Witter and Chelton turned into Abdalla2007	Section 2.3.2
3.0	R	14/01/2014	New format for release BC/release C: L2I product format is updated with new fields and is supposed to be distributed as the main Cryosat L2 product. The old L2 products will be kept being distributed but to interested users only.	Section 2 : Introduction changed to describe the new format Section 2.3.1 Section 2.3.3.2 updated with new fields added to the MDS Section 2.2.2.1 and section 2.3.1: description of Delta_UT1 filed improved. Section 2.2.2.2: Definition of field #7 has been improved. Section 2.3: added clarification about number of DS. Section 2.2.2.2, section 2.3.1 and section 2.3.2: pointer to the correct set of Product IDs added. Section 2, section 2.3.3, section 2.3.3.2 and section 4: Intermediate turned into In-depth
4.0	R	01/09/2014	Update for baseline C	Section 2: figure 2-1 has been updated Section 2.3.2: DS names of Reference DSD have been updated. Section 2.3.3: MDS structure and Field description have been updated. Section 3 Description of FDM product structure has been improved (not changed)
4.1	R	07/10/2014	Implementation of comments to version 4.0	Same changes as version 4.0 are shown in track change mode Section 1.4: List of acronyms updated. Section 2.3.2: description and list of MDS reviewed to take into account the change to the file types (SIR_SAR_2_ and SIR_GDR_2_) Section 2.3.3.1, 2.3.3.2 and

				section 4: reference to SIR_SAR_2a, SIR_SAR_2B, GDR_2A and GDR_2B either removed or replaced by SIR_SAR_2_ and SIR_GDR_2_ respectively Section 2.3.3: definition of several fields refined to implement ESA's comments. Section 2.3.2, 2.3.3.1 and 2.3.3.2: Start Tracker usage better defined.
4.2	A	14/10/2014	Implementation of comments to version 4.1	Section 2.3.2. List of DS_NAME corrected Section 2.3.3.1. Definition of the fields 18,19,20 and 43 revised Section 2.3.3.2. Definition of the fields 14, 114, 115 and 116 revised. Section 3. Definition of fields 57, 58 and 59 revised Section 4. List of file types revised
4.3	A	01/12/2014	Correction of the L2 MDS record layout	Section 2.3.3.1 : definition of field 51 (Correction Application Flag) has been corrected.
4.4	A	10/02/2015	Correction of the definition of some MDS fields	Section 2.3.3.1. Definition of the fields 17,18 and 19 corrected Section 2.3.3.2. Definition of the fields 114, 115 and 116 corrected. Section 3. Definition of fields 57, 58 and 59 corrected
4.5	A	12/06/2015	The usage of Star Tracker Level 0 aux data for FDM processing has been documented..	Section 2.3.2: Added DS Name : STAR_TRACKER_LEVEL_0_FILE

TABLE OF CONTENTS

1 INTRODUCTION

This document contains the description of the format of the Level-2 products generated inside the PDS for the Cryosat mission.

1.1 PURPOSE AND SCOPE

The purpose of the document is to define the product structure and the content of the Level-2 file generated in the PDS identifying for each data section and field the meaning and the format to be used for its representation.

1.2 DOCUMENT STRUCTURE

The document includes the following sections:

Section 1 - Introduction	The present section.
Section 2 - Level-2 General Format Description	This section gives the general description of the Level-2 products in terms of common organisation and format and the detailed description of the format for each file type.
Section 3 - FDM Products	This section contains the description of the format of the Fast Delivery Marine L2 products.
Section 4 - Cryosat Level-2 Products	This section contains the product file names and the composition rules of the file name.

1.3 APPLICABLE & REFERENCE DOCUMENTS

1.3.1 Applicable Documents

Document Title	Identifier	Reference
Earth Explorer Ground Segment File Format Standard Issue 1.4, 13 June 2003	PE-TN-ESA-GS-0001	[FMT-GUIDE]
Cryosat Ground Segment Master ICD Issue 4.2, 18 October 2007	CS-ID-ESA-GS-0147	[MASTER-ICD]
CRYOSAT Level-2 Products Naming Time Information	CRYOS_CR-3	[CRYOS_CR-3]
Explorer Orbit SW User Manual	CS-MA-DMS-GS-0004 Issue 3.7.5	[EXPL_ORB-SUM]

1.3.2 Reference Documents

Document Title	Identifier	Reference
IPF2 Processors Architecture Description Issue 1.0, 20 November 2003	CS-TN-ACS-GS-5120	[IPF2-TN]
IPF1 Product Formats Specification Issue 6.1, 10 September 2014	CS-RS-ACS-GS-5106	[L1-FMT]
Level 0 Products Specification Format Issue 3.1, 06 November 2007	CS-ID-ACS-GS-0119	[L0-FMT]
IEEE Standard for Binary Floating-Point Arithmetic. ANSI/IEEE Std 754-1985 Institute of Electrical and Electronics Engineers Issue 1985	IEEE-754	[IEEE]
Extensible Markup Language (XML) 1.0 (Second Edition) W3C Recommendation 6 October 2000	http://www.w3.org/TR/2000/REC-xml-20001006	[XML-GUIDE]
XML Schema Definition Language: W3C XML Schema Working Group and Schema Specifications	http://www.oasis-open.org/cover/schemas.html#W3CWorkingGroup	[XML-SCHEMA]

1.4 ACRONYMS AND ABBREVIATIONS

ACS	Advanced Computer Systems S.p.A.
AGC	Automatic Gain Control
AIR	Azimuth Impulse Response
AISP	Annotated Instrument Source Packet
APID	Application Process Identifier
BER	Bit Error Rate
BLOB	Binary Large Object
CADU	Channel Access Data Unit
CAL	Calibration
CCSDS	Consultative Committee for Space Data Systems
COG	Centre Of Gravity
CVCDU	Coded Virtual Channel Data Unit
DEM	Digital Elevation Model
DSR	Data Set Record
EO	Earth Observation
ESA	European Space Agency
FOS	Flight Operations Segment
FBR	Full Bit Rate
FDO	Fast delivery Ocean
G/S	Ground Segment
HK/TM	Housekeeping/Telemetry data
ID	Identifier Digits or Document
I/O	Input/Output
IPF	Instrument Processing Facility
ISP	Instrument Source Packet
L1B	Level 1B
LRM	Low Rate Mode
MDS	Measurement Data Set
MJD	Modified Julian Day
MON	Monitoring
MPH	Main Product Header
MQE	Mean Quadratic Error
PDS	Payload Data System
PSLR	Peak to Side Lobe Ratio
PSS-05	ESA Software Engineering Standard
RC	Radar Cycle
RIR	Range Impulse Response
SAR	Synthetic Aperture Radar mode
SHA	Surfae Height Anomaly
SIN	Synthetic Interferometric mode
SIRAL	Synthetic Interferometric Radar Altimeter
SOW	Statement Of Work
SPH	Specific Product Header
SSHA	Sea-surface Height Anomaly
TAI	International Atomic Time Reference
TBC	To Be Confirmed
TBD	To Be Defined
TT&C	Tracking, Telemetry and Command
U10	Windspeed at 10m altitude, as calculated by the altimeter
UTC	Universal Time Co-ordinates
VCDU	Virtual Channel Data Unit
WGS84	World Geodetic System 1984
XML	eXtensible Markup Language

2 LEVEL-2 GENERAL FORMAT DESCRIPTION

The Level-2 products are derived from the Cryosat L1B products generated by the IPF1 and relevant to the science modes, that is LRM – SAR – SIN (nominal and degraded).

Differently from the L1B products, a common layout (i.e. independent from the SIRAL operative mode) is defined for the Level-2 products.

A L2 product is generated soon after a L1B product is available thus resembling still a data driven approach. This implies that following this first generation step there will be L2 products still separated by modes (specifically LRM – SAR – SIN) defined over the same time window of the input L1B.

The L2 data is the main output from the L2 processors. This is a compact Geophysical Data Record designed to minimise the data volume distributed to users. However, another L2 data set is available and called 'In-depth L2' and is identified with an 'I' in the filetype: SIR_xxxI2x. This dataset contains many more parameters and flags and is therefore much larger. This detailed product is also required as the input to the second pass of the L2 SAR processing chain where the sea-surface height anomaly is interpolated to the location of all measurements identified as sea ice, to allow the computation of freeboard.

The In-depth products are sometimes referred to as the Intermediate products. This is an old terminology coming from the early phases of the Cryosat project and shouldn't be used anymore.

In the second step of the processing, a global L2 product is generated from the L2 mode dependent products collected over an entire orbit, specifically from ANX to ANX. This second step most likely does not imply any specific processing, but simply a concatenation of files in chronological order. L2 products from the first step, in fact, regardless of their SIRAL mode dependence, have binary records with the same layout.

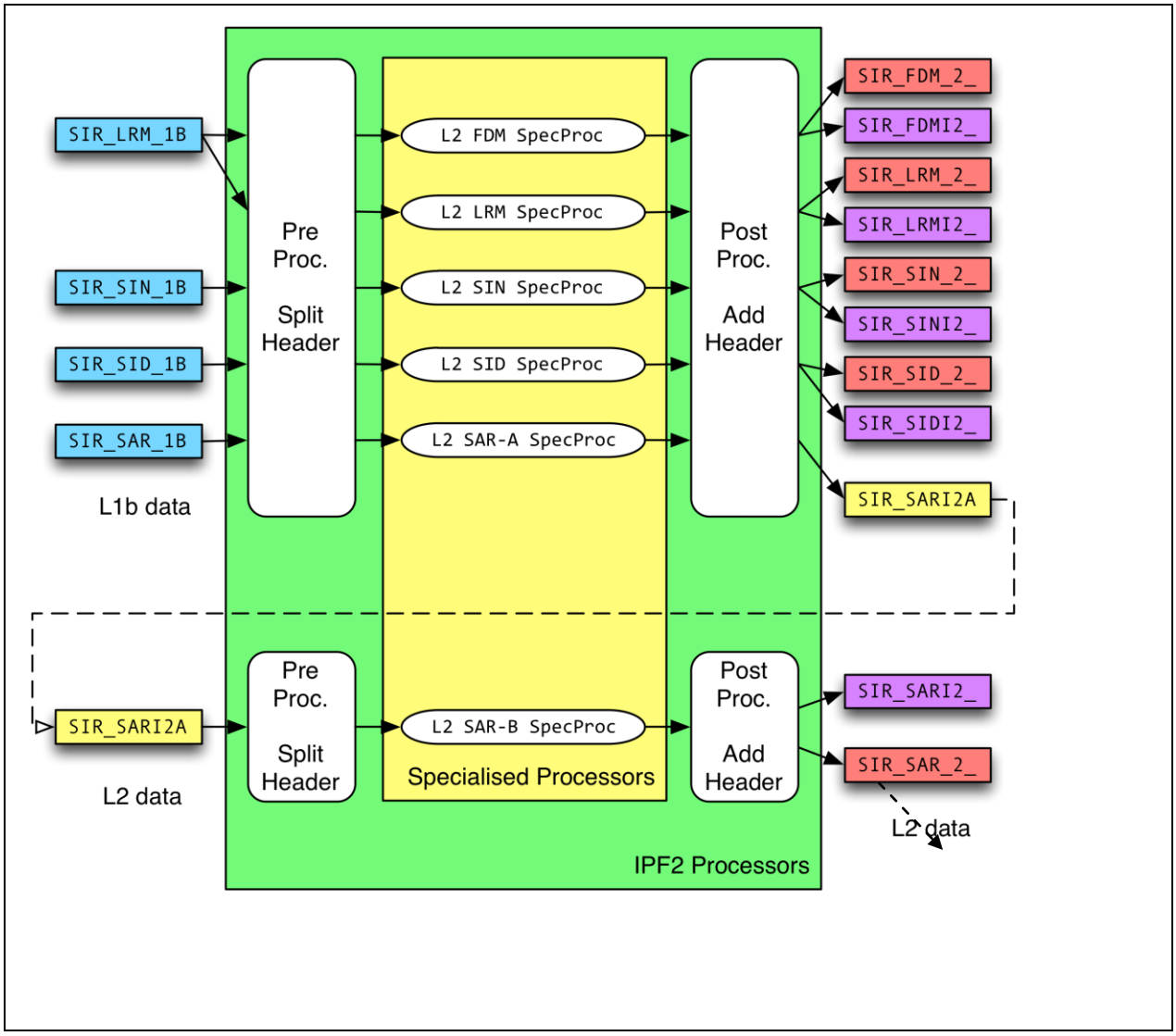

Figure 2-1 Level-2 (Step 1) Product Generation

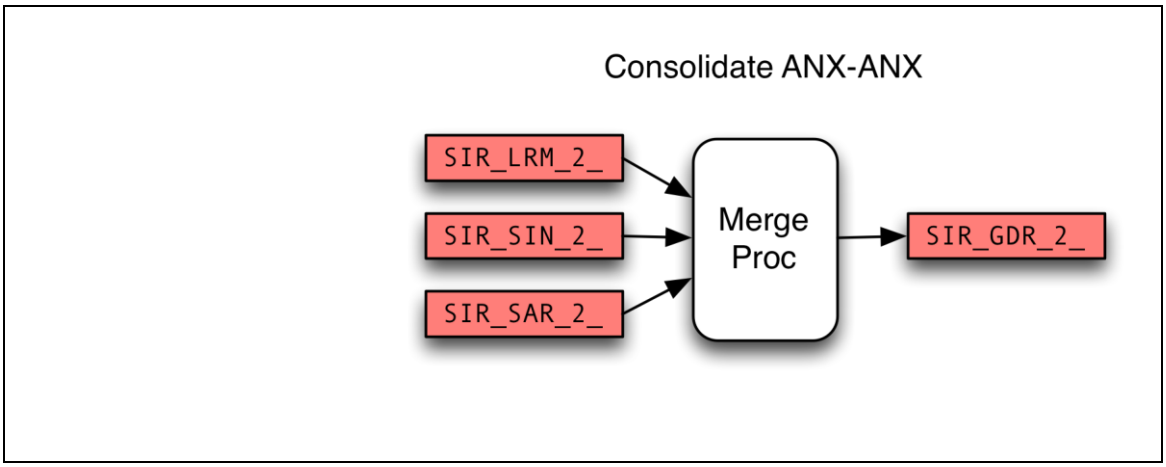

Figure 2-2 Level-2 (Step 2) ANX to ANX Consolidation

2.1 FILE STRUCTURE

The file structure of any file produced by the IPF2 system must follow the requirements of the [FMT-GUIDE] .

Each level-2 product is composed by two files:

- XML Header File
- Product File

The XML Header file is an auxiliary ASCII file that users can easily access for identifying the product without needs to look inside the Product File.

The Product File is the real product containing meaningful instrument data and ASCII header used by ad-hoc developed standard tools for inspecting the product content. In order to use tools already developed for the ENVISAT mission, the product structure for Cryosat will follow the structure of the ENVISAT products as far as possible.

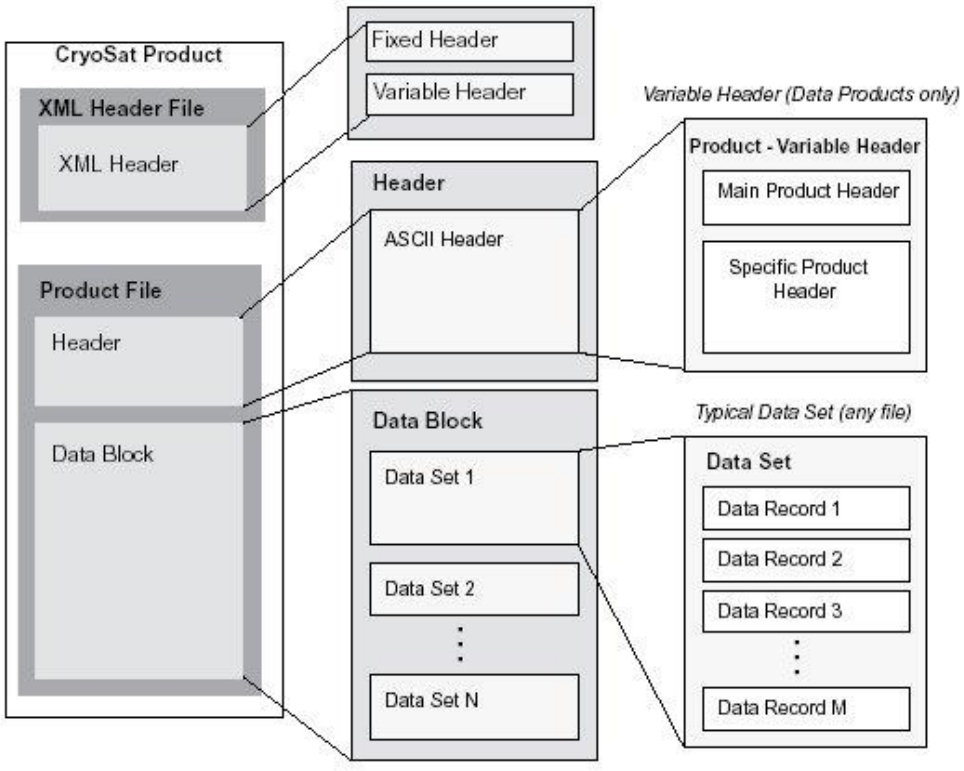

Figure 2-1-1 Structure of the Level-2 Product

2.2 XML HEADER FILE

The XML Header file contains information identifying the product and easy to read as based on a standard syntax accessed by common tools available for visualising its content. The XML syntax has been chosen for the scope of the PDS.

The XML Header file is composed by:

- a Fixed Header
- a Variable Header

The Fixed Header (hereafter called Standard Cryosat Header) is the common header for all files managed into the PDS. That means it is applied to all files flowing amongst the sub-systems composing the PDS.

The Variable Header (hereafter called Product Header) is the header with format and content depending on the file type and kind of product.

2.2.1 Fixed Header (Cryosat Header)

The Standard Cryosat Header is completely ASCII and based on XML syntax and conventions proposed in [FMT-GUIDE].

The format and content of the Standard Cryosat Header is under ESA responsibility and it is specified in [FMT-GUIDE].

2.2.2 Variable Header (Product Header)

The Variable Header (hereafter called Product Header) for the Level-2 product is composed by:

- a XML Main Product Header (XML MPH)
- a XML Specific Product Header (XML SPH) which includes Reference Data Set Descriptors for external input files and one or more XML Specific Measurement Data Headers (XML MDH) for the Data Sets of the Product

The XML MPH and XML SPH are derived from the correspondent headers (MPH and SPH) of the Product File, removing the unused fields and fields already reported in the Standard Cryosat Header.

Each header is completely ASCII and based on XML syntax and conventions proposed in the [FMT-GUIDE].

The following paragraphs describe the format and content of the XML MPH and XML SPH without overload of the XML format description.

2.2.2.1 XML Main Product Header (XML MPH)

Field #	Description	Units	Bytes	Format
	MPH	Tag		
	Product Identification Info			
#01	Product	Tag		
	Product File Name Note: the file name is without extension		62	See Section 4 for legal filenames
#02	Proc_Stage_Code	Tag		
	Processing stage code identifier: RPRO = Reprocessing OFFL = Routine Operations NRT_ = Near Real Time TEST = Test LTA_ = Long Term Archive		4	4*uc
#03	Ref_Doc	Tag		
	Reference Document describing the product		23	CS-RS-ACS-GS-5123
	Data Processing Information			
#04	Proc_Time	Tag		

Field #	Description	Units	Bytes	Format
	Processing Time (Product Generation Time)		30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu
#05	Software_Version	Tag		
	Processor Name and software version number		14	ProcessorName/VV.rr
	Orbit Information			
#06	Phase	Tag		
	Phase Code If not used set to X		1	uc
#07	Cycle	Tag		
	Cycle Number If not used set to +000		4	%+04d
#08	Rel_Orbit	Tag		
	Relative Orbit Number at sensing start time. If not used set to +00000		6	%+06d
#09	Abs_Orbit	Tag		
	Absolute Orbit Number at sensing start time. If not used set to +00000		6	%+06d
#10	State_Vector_Time	Tag		
	UTC state vector time		30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu
#11	Delta_UT1	Tag		
	DELTA_UT1 Universal Time Correction: DUT1 = UT1 – UTC If not used set to +.000000	S	8	%+08.6f
#12	X_Position	Tag		
	X position in Earth Fixed Reference If not used set to +0000000.000	M	12	%+012.3f
#13	Y_Position	Tag		
	Y position in Earth Fixed Reference If not used set to +0000000.000	M	12	%+012.3f
#14	Z_Position	Tag		
	Z position in Earth Fixed Reference If not used set to +0000000.000	M	12	%+012.3f
#15	X_Velocity	Tag		
	X velocity in Earth Fixed Reference If not used set to +0000.000000	m/s	12	%+012.6f
#16	Y_Velocity	Tag		

Field #	Description	Units	Bytes	Format
	Y velocity in Earth Fixed Reference If not used set to +0000.000000	m/s	12	%+012.6f
#17	Z_Velocity	Tag		
	Z velocity in Earth Fixed Reference If not used set to +0000.000000	m/s	12	%+012.6f
#18	State_Vector_Source	Tag		
	Source of Orbit State Vector Record FP = FOS predicted DN = DORIS Level 0 navigator DP = DORIS precise orbit FR= FOS Restituted DI = DORIS Preliminary		2	2*uc
	Product Confidence Data Information			
#19	Product_Err	Tag		
	Product Error Flag 1 errors have been reported in the Product 0 no errors		1	uc
	Product Size Information			
#20	Tot_Size	Tag		
	Total Size of the Data Product	bytes	21	%021d

Table 2.2.2.1-1: XML Main Product Header Description

2.2.2.2 XML Specific Product Header (XML SPH)

Field #	Description	Units	Bytes	FORMAT
	SPH	tag		
Product description and identification				
#1	SPH_Descriptor	tag		
	Name describing the Specific Product Header		28	*ProductID SPECIFIC HEADER* *ProductID* is the file type as specified in *Table 4-1*
Product Time information				
	Time_Information	tag		
#2	Start_Record_Time	tag		
	TAI of the first record in the main MDS of this product		30	TAI=yyyy-mm-ddThh:mm:ss.uuuuuu
#3	Stop_Record_Time	tag		
	TAI of the last record in the main MDS of this product		30	TAI=yyyy-mm-ddThh:mm:ss.uuuuuu
Product Orbit information				
	Orbit_Information	tag		
#4	ABS_Orbit_Start	tag		
	Absolute Orbit Number at sensing start time.		6	%06d
#5	Rel_Time_ASC_Node_Start	tag		
	Relative time since crossing ascending node time relative to start time of data sensing.	s	11	%011.6f
#6	ABS_Orbit_Stop	tag		
	Absolute Orbit Number at sensing stop time.		6	%06d

Field #	Description	Units	Bytes	FORMAT
#7	Rel_Time_ASC_Node_Stop	tag		
	Relative time since crossing ascending node time relative to stop time of data sensing.	s	11	%011.6f
#8	Equator_Cross_Time	tag		
	Time of equator crossing at the ascending node relative to the sensing start time.		30	UTC=yyyy-mm-ddThh:mm:ss.uuuuuu
#9	Equator_Cross_Long	tag		
	Longitude of equator crossing at the ascending node relative to the sensing start time (positive East, 0 = Greenwich) referred to WGS84.	10-6 deg	11	%+011d
#10	Ascending_Flag	tag		
	Orbit Orientation at the sensing start time A=Ascending D=Descending		1	uc
Product Location Information				
	Product_Location	tag		
#11	Start_Lat	tag		
	WGS84 latitude of the first record in the Main MDS (positive north)	10-6 deg	11	%+011d
#12	Start_Long	tag		
	WGS84 longitude of the first record in the Main MDS (positive East, 0 = Greenwich)	10-6 deg	11	%+011d
#13	Stop_Lat	tag		
	WGS84 latitude of the last record in the Main MDS (positive north)	10-6 deg	11	%+011d

Field #	Description	Units	Bytes	FORMAT
#14	Stop_Long	tag		
	WGS84 longitude of the last record in the Main MDS (positive East, 0 = Greenwich)	10-6 deg	11	%+011d
SIRAL Level 1B Quality information				
	Level_1_Confidence_Data	tag		
#15	L1_Proc_Flag	tag		
	Processing errors significance flag 1 errors (percentage of errors greater than threshold) 0 no errors		1	uc
#16	L1_Processing_Quality	tag		
	Percentage of quality checks successfully passed during the ISP processing (max allowed +10000)	10-2 %	6	%+06d
#17	L1_Proc_Thresh	tag		
	Minimum acceptable percentage of quality threshold that must be passed during ISP processing (max allowed +10000)	10-2 %	6	%+06d
#18	Num_L1_DSR_Processed	tag		
	Number of L1 Data Set Records analysed		11	%+011d
SIRAL Instrument Configuration				
	SIR_Instrument_Configuration	tag		
#19	Instrument_Identifier	tag	1	1*uc A (SIRAL Nominal) B (SIRAL Redundant)
SIRAL Mode Statistics				
	SIR_Mode_Statistics	tag		
#20	LRM_Mode_Percent	tag		
	Percentage of input Level-1B records detected in LRM mode	10-2 %	6	%+06d
#21	SAR_Mode_Percent	tag		
	Percentage of input Level-1B records detected in SAR mode	10-2 %	6	%+06d
#22	SARIN_Mode_Percent	tag		

Field #	Description	Units	Bytes	FORMAT
	Percentage of input Level-1B records detected in SIN mode	10-2 %	6	%+06d
#23	Other_Modes_Percent	tag		
	Percentage of input Level-1B records detected in other modes	10-2 %	6	%+06d
SIRAL L1B Surface Statistics				
	Surface_Statistics	tag		
#24	Open_Ocean_Percent	tag		
	Percentage of records detected on open ocean or semi-enclosed seas	10-2 %	6	%+06d
#25	Close_Sea_Percent	tag		
	Percentage of records detected on close seas or lakes	10-2 %	6	%+06d
#26	Continent_Ice_Percent	tag		
	Percentage of records detected on continental ice	10-2 %	6	%+06d
#27	Land_Percent	tag		
	Percentage of records detected on land	10-2 %	6	%+06d
SIRAL Level 2 Processing information				
	Level_2_Confidence_Data	tag		
#28	L2_Prod_Status	tag		
	Complete/Incomplete Product Completion Flag (0 or 1). 1 if the Product has a duration shorter than the input Level-0 input		1	uc
#29	L2_Proc_Flag	tag		
	Processing errors significance flag 1 errors (percentage of errors greater than threshold) 0 no errors		1	uc
#30	L2_Processing_Quality	tag		
	Percentage of quality checks successfully passed during Level-2 processing (max allowed +10000)	10-2 %	6	%+06d
#31	L2_Proc_Thresh	tag		

Field #	Description	Units	Bytes	FORMAT
	Minimum acceptable percentage of quality threshold that must be passed during Level-2 processing (max allowed +10000)	10-2 %	6	%+06d
Data Set Descriptors				
	DSDs	tag		
	List_of_DSDs	tag		
	Data_Set_Descriptor	tag		
#32	Data_Set_Name	tag		
	Name of the Data Set		28	uc
#33	Data_Set_Type	tag		
	M for Measurement – R for Reference		1	uc
#34	File_Name	tag		
	Name of the reference file. Field is left empty for Measurement DSD		62	uc
#35	Data_Set_Offset	tag		
	Offset in bytes from the beginning of the DBL file. For reference DSDs the field is set to 0.	bytes	21	%+021d
#36	Data_Set_Size	tag		
	Size in bytes of the Measurement Data Set Record. For reference DSDs the field is set to 0.	bytes	21	%+021d
#37	Num_of_Records	tag		
	Number of Data Set Records. For reference DSDs the field is set to 0.		11	%+011d
#38	Record_Size	tag		
	Record size in bytes. For reference DSDs the field is set to 0.	bytes	11	%+011d
#39	Byte_Order	tag		
	It describes the endianess of the data set 3210 → Big-endian 0123 → Little-endian For Reference DSDs the field is left empty		4	%4c 3210 for Cryosat

Table 2.2.2.2-1: XML Specific Product Header description

2.3 PRODUCT FILES

The Product File structure follows the one defined for the ENVISAT level-0 products as much as possible. As shown in figure 2.3-1, each product file is composed of:

- Main Product Header (MPH)
- Specific Product Header (SPH)
- Data Sets

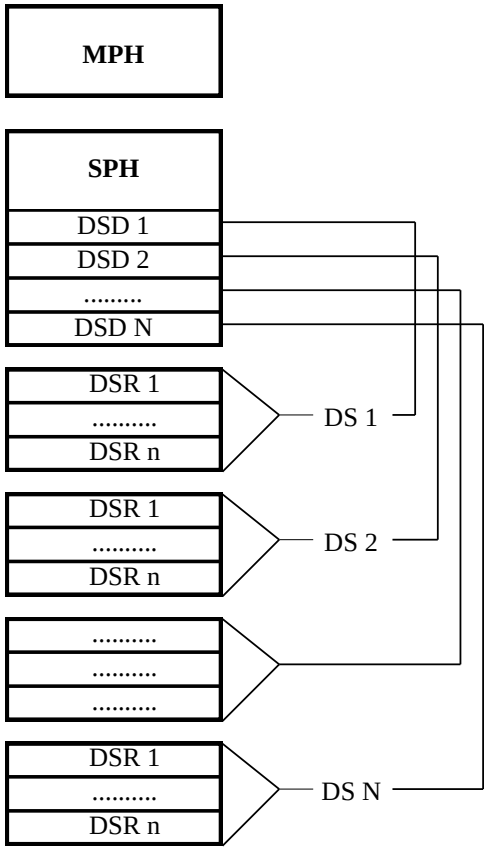

Figure 2.3-1: Generalised Product Structure

The MPH and SPH blocks are ASCII and follow the current syntax for any composing field:

FieldName=*value***<units>**

The Data Sets are completely binary and each of them contains one or more Data Set Records each. Cryosat L2 products contain only one Data Set and the Data Set Records format depends on the file type as specified in this document.

2.3.1 Main Product Header (MPH)

Field #	Description	Units	Bytes	Format
	Product Identification Info			
#01	**PRODUCT**=	keyword	8	
	quotation mark (")		1	uc
	Product File Name It is left justified with trailer blanks		62	See section 4 for legal file names
	quotation mark (")		1	uc
	newline character	terminator	1	
#02	**PROC_STAGE**=	keyword	11	11*uc
	Processing stage code: N = Near-Real Time T = Test O = Off Line (Systematic) R = Reprocessing L = Long-Term Archive		1	
	newline character	terminator	1	
#03	**REF_DOC**=	keyword	8	8*uc
	quotation mark (")		1	uc
	Reference Document describing the product		23	23*uc
	quotation mark (")		1	uc
	newline character	terminator	1	
#04	**Spare** (blank characters)		40	40*uc
	newline character	terminator	1	uc
	Data Processing Information			
#05	**ACQUISITION_STATION**=	keyword	20	20*uc
	quotation mark (")		1	uc
	Acquisition Station ID Filled by blanks		20	Kiruna
	quotation mark (")		1	uc
	newline character	terminator	1	
#06	**PROC_CENTER**=	keyword	12	12*uc
	quotation mark (")		1	uc
	Processing Center ID code		6	Either PDS or LTA
	quotation mark (")		1	uc

Field #	Description	Units	Bytes	Format
	newline character	terminator	1	
#07	**PROC_TIME**=	keyword	10	10*uc
	quotation mark (")		1	uc
	Processing Time (Product Generation Time)	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	
#08	**SOFTWARE_VER**=	keyword	13	13*uc
	quotation mark (")		1	uc
	Processor name, up to 8 characters, and software version number followed by trailer blanks if any. If not used set to blanks		14	14*uc ProcessorName/VV.rr
	quotation mark (")		1	uc
	newline character	terminator	1	
#09	**Spare** (blank characters)		40	40*uc
	newline character	terminator	1	uc
Information on Time of Data				
#10	**SENSING_START**=	keyword	14	14*uc
	quotation mark (")		1	uc
	UTC start time of data sensing. This is the UTC start time of the Input product. If not used set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	
#11	**SENSING_STOP**=	keyword	13	13*uc
	quotation mark (")		1	uc
	UTC stop time of data sensing. This is the UTC stop time of the Input product. If not used set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	
#12	**Spare** (blank characters)		40	40*uc
	newline character	terminator	1	uc
Orbit Information				
#13	**PHASE**=	keyword	6	6*uc
	Phase Code:		1	

Field #	Description	Units	Bytes	Format
	phase letter (A, B, …) If not used set to X			
	newline character	terminator	1	uc
#14	**CYCLE**=	keyword	6	6*uc
	Cycle Number. If not used set to +000		4	%+04d
	newline character	terminator	1	uc
#15	**REL_ORBIT**=	keyword	10	10*uc
	Relative Orbit Number at sensing start time. If not used set to +00000		6	%+06d
	newline character	terminator	1	uc
#16	**ABS_ORBIT**=	keyword	10	10*uc
	Absolute Orbit Number at sensing start time. If not used set to +00000		6	%+06d
	newline character	terminator	1	uc
#17	**STATE_VECTOR_TIME**=	keyword	18	18*uc
	quotation mark (")		1	uc
	UTC state vector time It is filled properly in case of usage of FOS Predicted Orbit information otherwise it shall be set to 27 blanks	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	
#18	**DELTA_UT1**=	keyword	10	10*uc
	DELTA-UT1 Universal Time Correction: DUT1 = UT1 – UTC If not used it shall be set to +.000000	S	8	%+08.6f
	<s>	units	3	3*uc
	newline character	terminator	1	
#19	**X_POSITION**=	keyword	11	11*uc
	X position in Earth Fixed Reference. If not used set to +0000000.000	M	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	

Field #	Description	Units	Bytes	Format
#20	**Y_POSITION**=	keyword	11	11*uc
	Y position in Earth Fixed Reference. If not used set to +0000000.000	M	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	
#21	**Z_POSITION**=	keyword	11	11*uc
	Z position in Earth Fixed Reference. If not used set to +0000000.000	M	12	%+012.3f
	<m>	units	3	3*uc
	newline character	terminator	1	
#22	**X_VELOCITY**=	keyword	11	11*uc
	X velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	
#23	**Y_VELOCITY**=	keyword	11	11*uc
	Y velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	
#24	**Z_VELOCITY**=	keyword	11	11*uc
	Z velocity in Earth Fixed Reference. If not used set to +0000.000000	m/s	12	%+012.6f
	<m/s>	units	5	5*uc
	newline character	terminator	1	
#25	**VECTOR_SOURCE**=	keyword	14	14*uc
	quotation mark (")		1	uc
	Source of Orbit State Vector Record FP = FOS Predicted DN = DORIS Level 0 navigator DP = DORIS precise orbit FR = FOS Restituted DI = DORIS Preliminary		2	2*uc
	quotation mark (")		1	uc
	newline character	terminator	1	
#26	**Spare** (blank characters)		40	40*uc

Field #	Description	Units	Bytes	Format
	newline character	terminator	1	uc
SBT to UTC conversion Information				
#27	**UTC_SBT_TIME**=	keyword	13	13*uc
	quotation mark (")		1	uc
	Not used and set to 27 blanks		27	$$$$$$$$$$$$$$$$$$$$$$$$$$
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#28	**SAT_BINARY_TIME**=	keyword	16	16*uc
	Satellite Binary Time Not used for Cryosat and set to zeros		11	+0000000000
	newline character	terminator	1	uc
#29	**CLOCK_STEP** =	keyword	11	11*uc
	Clock Step Not used for Cryosat and set to zeros		11	+0000000000
	<ps>	units	4	4*uc
	newline character	terminator	1	uc
#30	**Spare** (blank characters)		32	32*uc
	newline character	terminator	1	uc
Leap Second Information				
#31	**LEAP_UTC**=	keyword	9	9*uc
	quotation mark (")		1	uc
	UTC Time of the occurrence of the leap second. If a leap second occurred in the product window the field is set by a devoted function in the CFI EXPLORER_ORBIT library (see [EXPL_ORB-SUM] for details), otherwise it is set to 27 blanks. It corresponds to the time after the Leap Second occurrence (i.e. midnight of the day after the leap second)		27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#32	**LEAP_SIGN**=	keyword	10	10*uc
	Leap second sign If a leap second occurred in the product window the field is set to	S	4	%+04d

Field #	Description	Units	Bytes	Format
	the expected value by a devoted function in the CFI EXPLORER_ORBIT library (see [EXPL_ORB-SUM] for details), otherwise it is set to +000.			
	newline character	terminator	1	uc
#33	**LEAP_ERR**=	keyword	9	9*uc
	Leap second error flag. This field is always set to 0 considering that CRYOSAT products have true UTC times		1	uc
	newline character	terminator	1	uc
#34	**Spare** (blank characters)		40	40*uc
	newline character	terminator	1	uc
Product Confidence Data Information				
#35	**PRODUCT_ERR**=	keyword	12	12*uc
	Product Error Flag set to 1 if errors have been reported in the product		1	uc
	newline character	terminator	1	uc
Product Size Information				
#36	**TOT_SIZE**=	keyword	9	9*uc
	Total size of the product	bytes	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	Uc
#37	**SPH_SIZE**=	keyword	9	9*uc
	Length of the SPH	bytes	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	Uc
#38	**NUM_DSD**=	keyword	8	8*uc
	Number of Data Set Descriptors, including spares and all other types of DSDs		11	%+011d
	newline character	terminator	1	Uc
#39	**DSD_SIZE**=	keyword	9	9*uc
	Length of each DSD	bytes	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	Uc
#40	**NUM_DATA_SETS**=	keyword	14	14*uc
	Number of attached Data Sets (note that not all the DSDs have a DS attached)		11	%+011d

Field #	Description	Units	Bytes	Format
	newline character	terminator	1	Uc
#41	**CRC**=	keyword	4	4*uc
	Cyclic Redundancy Code computed as overall value of all records of the Measurement Data Set. If not computed it shall be set to -00001		6	%+06d
	newline character	terminator	1	Uc
#42	**Spare** (blank characters)		29	29*uc
	newline character	terminator	1	uc
	TOTAL		**1247**	

Table 2.3.1-1 Product MPH Description

2.3.2 Specific Product Header (SPH)

The Specific Product Header is an ASCII header common to all Level-2 products.

Field #	Description	Units	Bytes	Data Type
Product description and identification				
#1	**SPH_DESCRIPTOR=**	keyword	15	15*uc
	quotation mark (")		1	uc
	ASCII string describing the product		28	28*uc Product ID SPECIFIC HEADER ProductID is the file type as specified in Table 4-1
	quotation mark (")		1	uc
	newline character	terminator	1	uc
Product Time information				
#2	**START_RECORD_TAI_TIME=**	keyword	22	22*uc
	quotation mark (")		1	uc
	TAI of the first record in the Main MDS of this product	TAI	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
#3	**STOP_RECORD_TAI_TIME=**	keyword	21	21*uc
	quotation mark (")		1	uc
	TAI of the last record in in the Main MDS of this product	TAI	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	quotation mark (")		1	uc
	newline character	terminator	1	uc
Product Orbit Information				
#4	**ABS_ORBIT_START**=	Keyword	16	16*uc
	Absolute Orbit Number at Product Start Time		6	%06d
	Newline character	terminator	1	uc

Field #	Description	Units	Bytes	Data Type
#5	**REL_TIME_ASC_NODE_START**=	Keyword	24	24*uc
	Relative time since crossing ascending node time relative to start time of data sensing	s	11	%011.6f
	<s>	units	3	3*uc
	Newline character	terminator	1	Uc
#6	**ABS_ORBIT_STOP**=	Keyword	15	15*uc
	Absolute Orbit Number at Product Stop Time		6	%06d
	Newline character	terminator	1	uc
#7	**REL_TIME_ASC_NODE_STOP**=	Keyword	23	23*uc
	Relative time since crossing ascending node time relative to stop time of data sensing	s	11	%011.6f
	<s>	units	3	3*uc
	Newline character	terminator	1	uc
#8	**EQUATOR_CROSS_TIME_UTC**=	Keyword	23	23*uc
	Quotation mark(")		1	uc
	Time of Equator crossing at the ascending node of the sensing start time	UTC	27	dd-MMM-yyyy hh:mm:ss.uuuuuu
	Quotation mark (")		1	uc
	Newline character	terminator	1	uc
#9	**EQUATOR_CROSS_LONG**=	Keyword	19	19*uc
	Longitude of Equator Crossing at the ascending node of the sensing start time (positive East, 0 = Greenwich) referred to WGS84	s	11	%+011d
	<10-6degE>	units	10	10*uc
	Newline character	terminator	1	uc
#10	**ASCENDING_FLAG**=	Keyword	15	15*uc
	Orbit Orientation at the sensing start time A= Ascending D= Descending		1	uc
	Newline character	terminator	1	uc
Product Location Information				
#11	**START_LAT=**	keyword	10	10*uc

Field #	Description	Units	Bytes	Data Type
	WGS84 latitude of the first record in the Main MDS (positive north)	[10-6 deg]	11	%+011d
	<10-6degN>	units	10	10*uc
	newline character	terminator	1	uc
#12	**START_LONG=**	keyword	11	11*uc
	WGS84 longitude of the first record in the Main MDS (positive East, 0 = Greenwich)	[10-6 deg]	11	%+011d
	<10-6degE>	units	10	10*uc
	newline character	terminator	1	uc
#13	**STOP_LAT=**	keyword	9	9*uc
	WGS84 latitude of the last record in the Main MDS (positive north)	[10-6 deg]	11	%+011d
	<10-6degN>	units	10	10*uc
	newline character	terminator	1	uc
#14	**STOP_LONG=**	keyword	10	10*uc
	WGS84 longitude of the last record in the Main MDS (positive East, 0 = Greenwich)	[10-6 deg]	11	%+011d
	<10-6degE>	units	10	10*uc
	newline character	terminator	1	uc
#15	**Spare (blank characters)**	ascii	50	50*uc
	newline character	terminator	1	uc
Level 1B Quality information				
#16	**L1_PROC_FLAG=**	keyword	13	13*uc
	Processing errors significance flag (1 or 0). 1 if the percentage of L1B records free of processing errors is less than the acceptable threshold		1	uc
	newline character	terminator	1	uc
#17	**L1_PROCESSING_QUALITY=**	keyword	22	22*uc
	Percentage of quality checks successfully passed during the L1B processing (max allowed +10000)	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#18	**L1_PROC_THRESH=**	keyword	15	15*uc

Field #	Description	Units	Bytes	Data Type
	Minimum acceptable percentage of quality threshold that must be passed during L1B processing (max allowed +10000)	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#19	**NUM_L1_DSR_PROC=**		16	16*uc
	Number of L1B Data Set Records analysed		11	%+011d
	newline character	terminator	1	uc
#20	**Spare (blank characters)**	ascii	37	37*uc
	newline character	terminator	1	uc
SIRAL Instrument Configuration				
#21	**INSTR_ID=**	keyword	9	9*uc
	quotation mark (")		1	uc
	Instrument identifier		1	1*uc A = SIRAL Nominal B = SIRAL Redundant
	quotation mark (")		1	uc
	newline character	terminator	1	uc
SIRAL Mode Statistics				
#22	**LRM_MODE_PERCENT=**	keyword	17	17*uc
	Percentage of input L1B records detected in LRM mode	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	uc
#23	**SAR_MODE_PERCENT=**	keyword	17	17*uc
	Percentage of input L1B records detected in SAR mode	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	uc
#24	**SARIN_MODE_PERCENT=**	keyword	19	19*uc
	Percentage of input L1B records detected in SIN mode	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc

Field #	Description	Units	Bytes	Data Type
	Newline character	terminator	1	uc
#25	**OTHER_MODES_PERCENT=**	keyword	20	20*uc
	Percentage of input L1B records detected in any other mode	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	uc
#26	**Spare (blank characters)**	ascii	50	50*uc
	newline character	terminator	1	uc
SIRAL Surface Statistics				
#27	**OPEN_OCEAN_PERCENT=**	keyword	19	19*uc
	Percentage of records detected on open ocean or semi-enclosed seas	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	uc
#28	**CLOSE_SEA_PERCENT=**	keyword	18	18*uc
	Percentage of records detected on close seas or lakes	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	Uc
#29	**CONTINENT_ICE_PERCENT=**	keyword	22	22*uc
	Percentage of records detected on continental ice	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	Uc
#30	**LAND_PERCENT=**	keyword	13	13*uc
	Percentage of records detected on land	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	Newline character	terminator	1	Uc
#31	**Spare (blank characters)**	ascii	50	50*uc
	newline character	terminator	1	uc
Level 2 Processing information				
#32	**L2_PROD_STATUS=**	keyword	15	15*uc
	Complete/Incomplete Product Completion Flag (0 or 1). 1 if the Product as a duration shorter than the input product.		1	uc
	newline character	terminator	1	uc

Field #	Description	Units	Bytes	Data Type
#33	**L2_PROC_FLAG=**	keyword	13	13*uc
	Processing errors significance flag (1 or 0). 1 if the percentage of DSR free of processing errors is less than the acceptable threshold		1	uc
	newline character	terminator	1	uc
#34	**L2_PROCESSING_QUALITY=**	keyword	22	22*uc
	Percentage of quality checks successfully passed during Level-2 processing (max allowed +10000)	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	uc
#35	**L2_PROC_THRESH=**	keyword	15	15*uc
	Minimum acceptable percentage of quality threshold that must be passed during Level-2 processing (max allowed +10000)	[10-2 %]	6	%+06d
	<10-2%>	units	7	7*uc
	newline character	terminator	1	Uc
#36	**Spare (blank characters)**	ascii	50	50*uc
	newline character	terminator	1	Uc
	TOTAL			
DSD Section				

Table 2.3.2-1 Product SPH Description

Notes:

- Fields 16 – 17 – 18 – 19 provide summary quality information of the input L1B that was the source for the higher L2 processing. These fields are derived from the input L1B and transferred in the output L2 SIR_LRM_2_ – SIR_SAR_2_ – SIR_SIN_2_ - SIR_SID_2_ and SIR_LRMI2_ - SIR_SARI2_ – SIR_SINI2_ - SIR_SIDI2_.

  For the Level-2 GDR, field 17 is computed from the corresponding fields of the input products taking into account the number of the DSR records in the input file which is available in field 19 of the input L2 products and recomputing the percentage as a weighted sum over the input

products. Field 18 matches the threshold specified in the processor configuration file for the L2 GDR processing and field 16 is then computed accordingly from fields 17 and 19 using the threshold level in field 18.

- Fields 22 – 23 – 24 - 25 are mainly aimed for the GDR products (which are merged products) providing statistical information on the amount of data in the product belonging to the LRM – SAR – SIN or other modes. These fields are computed from the Mode information that is available in both L1B and L2 records.

- Fields 32 – 33 – 34 – 35 provide summary quality information of the Level-2 product. The calculation of the quality parameters is based on the analysis of the MCD field available in the records.

The DSD Section shall actually be divided in two principal sections, Measurement DSD, indicated as DSD (M) and Reference DSD, indicated as DSD (R). The general structure of a DSD is shown in table 2.3.2-2. The size of a DSD is 280 bytes.

#N	*DSD*			
#N.1	**DS_NAME=**	keyword	8	8*uc
	quotation mark		1	uc
	Name describing the Data Set		28	28*uc
	quotation mark		1	uc
	newline character	terminator	1	uc
#N.2	**DS_TYPE=**	keyword	8	8*uc
	Type of Data Set. It can be: M = Measurement R = Reference		1	uc
	newline character	terminator	1	uc
External product reference				
#N.3	**FILENAME=**	keyword	9	9*uc
	quotation mark		1	uc

	Name of the Reference File. Used if DS_TYPE is set to R. It is left justified with trailer blanks. The file name includes the extension. If not used it is set to 62 blanks.		62	62*uc
	quotation mark		1	uc
	newline character	terminator	1	uc
	Position and size of DS			
#N.4	**DS_OFFSET=**	keyword	10	10*uc
	Length in bytes of MPH + SPH (including DSDs) + DS size of previous Data Set (if any).	byte	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#N.5	**DS_SIZE=**	keyword	8	8*uc
	Length in bytes of the attached Data Set Used if DS_TYPE is set to M If not used set to 0	byte	21	%+021d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
	Number and length of DSRs			
#N.6	**NUM_DSR=**	keyword	8	8*uc
	Number of Data Set Records		11	%+011d
	newline character	terminator	1	uc
#N.7	**DSR_SIZE=**	keyword	9	9*uc
	Length in bytes of the Data Set Record If not used set to +0 If variable set to -1	byte	11	%+011d
	<bytes>	units	7	7*uc
	newline character	terminator	1	uc
#N.8	**Spare**	ascii	32	32*uc
	newline character	terminator	1	uc

Table 2.3.2-2 Generic DSD Description

For convenience the Measurement DSD should appear first in the list, followed by all the needed Reference DSDs.

The effective size of the SPH in number of bytes is defined in field #37 SPH_SIZE of the MPH.

The total number of DSD Descriptors is defined in field #38 of the MPH.

The number of Measurement DSDs is defined in field #40 of the MPH.

For the Measurement Data Sets, the DSD (M) may have the following options for the DS_NAME:

DS_NAME for Measurement DSD
SIR_LRM_L2
SIR_FDM_L2
SIR_SAR_L2
SIR_SIN_L2
SIR_SID_L2
SIR_GDR_2
SIR_LRM_L2_I
SIR_SAR_L2_I
SIR_SIN_L2_I
SIR_SID_L2_I

Table 2.3.2-3 DS Names for Measurement Data Sets DSD

For the Reference DSDs, it is proposed to include all the reference DSDs of the source L1B file, in order to provide a Level-2 product which contains all the references to the files that were used along the IPF1 / IPF2 processing chain to generate the product. In addition, some new DSDs have to be introduced and the complete list is supplied here after:

CONSTANTS_FILE	Constants File
PROC_CONFIG_PARAMS_FILE	Processor Configuration Parameters File
SIRAL_LEVEL_0_FILE	SIRAL Level 0 File from which the L1B product was created
SIRAL_LEVEL_1B_FILE	SIRAL Level 1B File from which the product was created
SIRAL_LEVEL_2_FILE	SIRAL Level 2 File from which the GDR product was created
SCENARIO_FILE	Orbit Scenario File
ORBIT_FILE	Orbit Data File
STAR_TRACKER_LEVEL_0_FILE	Star Tracker Level 0 File
STAR_TRACKER_ATTREF_FILE	Star Tracker Level 1b File
DORIS_USO_DRIFT_FILE	DORIS USO Drift File
FOS_PLATFORM_DATA_FILE	FOS Platform Data File
FOS_HK_TM_FILE	FOS Sorted HouseKeeping Telemetries File
IPF_RA_DATABASE_FILE	Instrument Characterization Data File
CALIBRATION_TYPE_1_FILE	File Product containing CAL_1 corrections
CALIBRATION_TYPE_2_FILE	File Product containing CAL_2 corrections
CALIBRATION_TYPE_EXOTIC	File Product containing Exotic CAL1 SIN corrections
OCEAN_TIDE_FILE	File for Ocean Tide
TIDAL_LOADING_FILE	File for Tidal Loading
EARTH_TIDE_FILE	CartWright File
POLE_TIDE_FILE	Pole Location Data File
SURFACE_TYPE_FILE	Surface Type Map File
S1S2_PRESSURE_00H_MAP	Climatology Pressure Grids for each month at 00 h.
S1S2_PRESSURE_06H_MAP	Climatology Pressure Grids for each month at 06 h.
S1S2_PRESSURE_12H_MAP	Climatology Pressure Grids for each month at 12 h.
S1S2_PRESSURE_18H_MAP	Climatology Pressure Grids for each month at 18 h.

S1_TIDE_AMPLITUDE_MAP	S1 tide grid of monthly mean of global amplitude
S2_TIDE_AMPLITUDE_MAP	S2 tide grid of monthly mean of global amplitude
S1_TIDE_PHASE_MAP	S1 tide grid of monthly mean of global phase
S2_TIDE_PHASE_MAP	S2 tide grid of monthly mean of global phase
MODIFIED_DIP_MAP_FILE	Modified Dip Map File used for Bent Ionospheric Correction
IONO_COEFFICENTS_FILE	Ionospheric Coefficients file used for Bent Ionospheric Correction
SAI_FILE	Solar Activity Index File used for Bent Ionospheric Correction
GPS_IONO_MAP	GPS Ionospheric Map Data generated by using analysis data
GPS_IONO_MAP_FORECAST	GPS Ionospheric Map Data generated by using forecast data
SURFACE_PRESSURE_FILE	Surface Pressure File for Meteo Correction generated by using analysis data
SURFACE_PRESSURE_FORECAST	Surface Pressure File for Meteo Correction generated by using forecast data
MEAN_PRESSURE_FILE	Mean Pressure File for Meteo Correction generated by using analysis data
MEAN_PRESSURE_FORECAST	Mean Pressure File for Meteo Correction generated by using forecast data
WET_TROPOSHERE_FILE	Wet Troposphere File for Meteo Correction generated by using analysis data
WET_TROPOSHERE_FORECAST	Wet Troposphere File for Meteo Correction generated by using forecast data
MOG_2D_FILE	2D Gravity Wave model for Dynamic Atmospheric Correction (DAC) generated by using analysis data
MOG_2D PRELIMINARY	2D Gravity Wave model for Dynamic Atmospheric Correction (DAC) generated by using forecast data
U_WIND_FILE	U Wind component File for Meteo Correction generated by using analysis data
U_WIND_FORECAST	U Wind component File for Meteo Correction generated by using forecast data
V_WIND_FILE	V Wind component File for Meteo Correction generated by using analysis data
V_WIND_FORECAST	V Wind component File for Meteo Correction generated by using forecast data
METEO_GRID_DEF_FILE	Meteo Grid Definition File
DEM_MODEL_FILE	DEM File
SLOPE_MODEL_FILE	Surface Slope File
MEAN_SEA_SURFACE_FILE	Mean Sea Surface File
SNOW_DEPTH_CLIMATE_FILE	Snow depth Climatology File
SEA_ICE_CONCENTRATION_FILE	Sea Ice Concentration File
GEOID_FILE	Geoid File
ODLE_FILE	Ocean Depth/Land Elevation File
SEA_STATE_BIAS_FILE	Sea State Bias File
WIND_MODEL_FILE	Abdalla2007 Windspeed table

Table 2.3.2-5 DS Names for Reference DSDs

2.3.3 Measurement Data Set Record (MDS)

2.3.3.1 L2 MDS Records Layout

The L2 Measurement Dataset has a single format which is independent of mode and thus applies to products SIR_LRM_2_ , SIR_SAR_2_ , SIR_SIN_2_ , SIR_SID_2_ , SIR_GDR_2_. However the meaning of some fields is mode dependent.

The L2 format has been designed with the goal of minimising data volume. There is a 'Blocking' of high-rate data in each record (as in L1b). This allows measurements to be available at the highest rate (about 21Hz) without repetition of slowly varying corrections factors (at 1Hz) such as the Dry Tropospheric Range Correction.

Product parameters are grouped according to function into 3 sub-structures as follows:

- Location Group — time and orbit location plus the measurement mode
- External Corrections Group — geophysical corrections
- Measurements Group — derived from instrument measurement parameters (this structure is repeated 20 times per record).

Note that instrument mode switching and data partitioning can occur at the highest rate. Sometimes a record will contain less than 20 measurements. In this case, the remaining unused blocks in the measurement group are flagged and filled with zeros.

The record structure is illustrated in the following diagram. The repetition frequency of the first two sub-structures is 1Hz but the Measurements Group sub-structure is repeated 20 times in each MDS record.

Repetition of sub-structure		
x1	x1	x20
Time & Orbit Group	External Corrections	Measurement Group

Figure 2.3.3.1-1 Level-2 MDS Layout

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
Time and Orbit group					
1	Data Record Time (MDSR Time Stamp)	TAI	sl+2*ul	12	12
2	Measurement mode (LRM/ SAR/ SIN/ SID)	-	ull	8	8
3	Latitude of Orbit in WGS84	10-7 degrees	sl	4	4
4	Longitude of Orbit in WGS84	10-7 degrees	sl	4	4
5	Altitude of COG above reference ellipsoid (interpolated value)	mm	sl	4	4
6	Spacecraft Roll Angle	10-7 degrees	sl	4	4
7	Spacecraft Pitch Angle	10-7 degrees	sl	4	4
8	Spacecraft Yaw Angle	10-7 degrees	sl	4	4
9	Spare	-	ss	2	2
10	Number of valid Measurements in this record	-	us	2	2
	Sub-total size				**48**
External Corrections group (see note (a))					
11	Dry Tropospheric Correction	mm	ss	2	2
12	Wet Tropospheric Correction	mm	ss	2	2
13	Inverse Barometric Correction	mm	ss	2	2
14	Dynamic Atmospheric Correction (DAC, from Mog2d)	mm	ss	2	2
15	Ionospheric Correction	mm	ss	2	2
16	Sea State Bias (EM Bias)	mm	ss	2	2
17	Elastic Ocean Tide	mm	ss	2	2
18	Long Period Ocean Tide	mm	ss	2	2
19	Ocean Loading Tide	mm	ss	2	2
20	Solid Earth Tide	mm	ss	2	2
21	Geocentric Polar Tide	mm	ss	2	2
22	Spare (for longword alignment)	-	ss	2	2
23	Surface type flag	-	ull	8	8
24	MSS / Geoid from model	mm	sl	4	4
25	Ocean Depth / Land Elevation from model	mm	sl	4	4

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
26	Ice Concentration (see note (b))	%/100	ss	2	2
27	Snow Depth	mm	ss	2	2
28	Snow Density	kg/m^3	ss	2	2
29	Spare (for longword alignment)	-	us	2	2
30	Corrections status flags	-	ul	4	4
31	Significant Wave Height	mm	ss	2	2
32	Wind speed	mm/s	us	2	2
33	Array of spares	-	ul	2*4	8
	Sub-total size				**64**
Measurements group - Repeated 20 times					
34	delta time (to give 20Hz time)	μ sec	sl	4	4
35	Latitude of measurement	10-7 degrees	sl	4	4
36	Longitude of measurement	10-7 degrees	sl	4	4
37	Height of surface w.r.t. reference ellipsoid (retracker 1)	mm	sl	4	4
38	Height of surface w.r.t. reference ellipsoid (retracker 2)	mm	sl	4	4
39	Height of surface w.r.t. reference ellipsoid (retracker 3)	mm	sl	4	4
40	Backscatter (sigma-zero) (retracker1)	dB/100	ss	2	2
41	Backscatter (sigma-zero) (retracker2)	dB/100	ss	2	2
42	Backscatter (sigma-zero) (retracker3)	dB/100	ss	2	2
43	Freeboard	mm	ss	2	2
44	Interpolated Sea Surface Height Anomaly	mm	ss	2	2
45	Number of interpolated records for SSHA	-	ss	2	2
46	SSHA Interpolation Quality	mm	ss	2	2
47	Peakiness	1/100	us	2	2
48	Number of Echoes or Beams averaged	-	us	2	2
49	Spare (for longword alignment)	-	us	2	2
50	Quality flags	-	ul	4	4
51	Correction Application Flag	-	ul	4	4
52	Retracker 1 Quality Value	-	ul	4	4
53	Retracker 2 Quality Value	-	ul	4	4
54	Retracker 3 Quality Value	-	ul	4	4
	Sub-total size				**64x20**
	Total Record Size				**1392**

Table 2.3.3.1-1 L2 MDS

(a) Geophysical corrections will be zero in the product if they have not been applied to the L2 corrected height due to surface type or other processing considerations.
(b) The unit of ice concentration in this product is different to that in the L2I product because of the range limitation of a signed short variable.

Fields Descriptions

Field 1) MDSR Time Stamp - for the first measurement of the 20 in each L2 record. Corresponding to time when the satellite is passing overhead of the centre of the altimeters' footprint, as defined by Latitude and Longitude in field 3 & field 4. To get the times for the remaining 19 measurements the delta time in field 34 must be added.

Field 2) Measurement Mode - Identifies the SIRAL instrument measurement mode. Each of the 20 measurements is flagged using 3 bits. Altogether this uses 63 out of 64 bits. see Table 2.3.3.1-2

Definition	PDS Bit	SS Bit	Setting
Measurement mode - for the first record, of 20 in the measurement group	63-61	0-2	000 = 0 = Other mode (calibration, acquisition, etc...) or unknown 001 = 1 = LRM 010 = 2 = SAR 011 = 3 = SIN 100 = 4 = SID (SIN degraded case)
Measurement mode - for the second record, of 20 in the measurement group	60-58	3-5	as above
Measurement mode – for the third record, of 20 in the measurement group	57-55	6-8	as above
etc for records 4…19	etc	etc	as above
Measurement mode - for the 20th record, of 20 in the measurement group	6-4	57-59	as above
Star Tracker Usage	3-1	60-62	000 = 0 No Star Tracker data used for product generation 100 = 4 = Star Tracker data used for product generation and it is the same used by the satellite through its AOCS (Attitude Orbit Control System)
unused	0	63	set to 0

Table 2.3.3.1-2 Mode ID

Field 3) Latitude of Orbit - Corresponding to the nadir position at the time of the 1Hz time stamp. Units are 10^{-1} μdegrees.

Field 4) Longitude of Orbit - Corresponding to the nadir position at the time of the 1Hz time stamp. Units are 10^{-1} μdegrees.

Field 5) Altitude - the Altitude of the Satellite CoG above reference ellipsoid at Nadir.

Field 6) Antenna Bench Roll Angle – corresponding to the MDSR Time Stamp in field 1.

Field 7) Antenna Bench Pitch Angle – corresponding to the MDSR Time Stamp in field 1.

Field 8) Antenna Bench Yaw Angle – corresponding to the MDSR Time Stamp in field 1.

Field 9) Spare

Field 10) Number of valid Measurements in this record, i.e. number of measurement records not flagged as "Block Degraded" (see field 19 of "in-depth" product) – this shows the number of high-rate measurements in this record. Normally this will be 20 but at the end of an orbit segment, this may be fewer. In a consolidated GDR this may occur in the body of the file where a mode switch occurs.

Note: Below, where the text refers to corrections being added to range, be aware that the set of corrections actually used for a record depends on surface type and mode. The set of corrections actually applied during the computation of height is defined by field 51.

Field 11) Dry Tropospheric Correction - added (if required, see field 51) to the range measurement that was used to compute height, to correct for the propagation delay to the radar pulse, caused by the dry-gas component of the Earth atmosphere.

Field 12) Wet Tropospheric Correction - added (if required, see field 51) to the range measurement that was used to compute height, to correct for the propagation delay to the radar pulse, caused by the H2O component of the Earth atmosphere.

Field 13) Inverse Barometric Correction - added (if required, see field 51) to the range measurement that was used to compute height, to correct for the depression of the ocean surface caused by the local barometric pressure. Only one of inverse barometric correction and dynamic atmospheric correction are used, as they are alternatives.

Field 14) Dynamic Atmospheric Correction (DAC, from MOG2D model) - added (if required, see field 51) to the range measurement that was used to compute height, to correct both the Inverse Barometric effect and the high-frequency ocean response to wind forcing. Only one of inverse barometric correction and dynamic atmospheric correction are used, as they are alternatives.

Field 15) Ionospheric Correction - added (if required, see field 51) to the range measurement that was used to compute height, to correct for the delay to the radar pulse caused by free electrons in the ionosphere. Computed from a simple model in NRT data or from GPS satellite derived (GIM) map in normal processing.

Field 16) Sea State Bias correction (a.k.a. EM bias correction) An empirical correction proportional to the

significant wave height which compensates for the asymmetric shape of ocean waves . Added (if required, see field 51) to the range measurement that was used to compute height.This is computed by the geophysical CFI library.

Field 17) Total Geocentric Ocean Tide added (if required see field 51) to the range measurement used to compute height, to remove the total effect of ocean tides. Set to 32767 in case of error.

Field 18) Long-Period Equilibrium Ocean Tide (component of total ocean tide) added (if required, see field 51) to the range measurement that was used to compute height, to remove the effect of the oceanic response to the single tidal forcing. Set to 32767 in case of error.

Field 19) Ocean Loading Tide - added (if required, see field 51) to the range measurement that was used to compute height, to remove the effect of local distortion to the Earth crust caused by increasing weight of ocean as local water tide rises. Set to 32767 in case of error."

Field 20) Solid Earth Tide - added (if required, see field 51) to the range measurement that was used to compute height, to remove the effect of local tidal distortion in the Earth crust.

Field 21) Geocentric Polar Tide - added (if required, see field 51)to the range measurement that was used to compute height, to remove a long-period distortion of the Earth's crust. Although called a 'tide', this is in fact caused by variations in centrifugal force as the Earth's rotational axis moves its geographic location.

Field 22) Spare

Field 23) Surface type flag - enumerated key to classify surface at nadir provided by a model in the Geographycal CFI library. The information is packed into 3 bits allowing a number range of 0-7. To flag all 20 measurements in a record, 60 bits are needed hence this field is 8-byte, or long-long integer. Note this flag is distinct from the surface discrimination in the SAR processing (part of field 50). The 4 unused bits are set to zero. See Table 2.3.3.1-3

Value	Definition
0	Open Ocean
1	Closed Sea
2	Continental Ice
3	Land
4-7	currently unused

Table 2.3.3.1-3 Surface Type Flag

Field 24) MSS/Geoid from model : Over Ocean (field Surface Type = 0 or 1) this is the surface height

from the MSS supplied in the Geophysical Correction CFI library. Over Land (field Surface Type = 2 or 3) this is the Geoid height from the CFI library.

Field 25) ODLE from model : Height or depth (negative) value interpolated from the Ocean Depth / Land Elevation model supplied in the Geophysical Corrections CFI library.

Field 26) Ice Concentration : in 1/100 of a percent. This is merged from a dynamic auxiliary file if data is available for the current time period. If data is not available, a climatology model is used instead.

Field 27) Snow Depth : in mm merged from a climatology model. This can be used (by the L2 product user) to adjust the freeboard estimate to account for snow-loading.

Field 28) Snow Density : in kg/m^3 merged from a climatology model (currently a constant value). This can be used (by the L2 product user) to adjust the freeboard estimate to account for snow-loading.

Field 29) Spare

Field 30) Corrections status flag - used to show validity of 1Hz corrections. This flag is at 1Hz and so can only indicate the validity of 1Hz parameters. The corrections have been used to derive the surface height (field 37, 38 and 39) in the L2 products. See table 2.3.3.1-4.

Definition	PDS Bit	SS Bit	Setting
Dry Tropospheric delay correction	31	0	0 = OK, 1 = invalid
Wet Tropospheric delay correction	30	1	0 = OK, 1 = invalid
Inverse Barometer correction	29	2	0 = OK, 1 = invalid
Dynamic Atmospheric correction (DAC)	28	3	0 = OK, 1 = invalid
GIM Ionospheric correction	27	4	0 = OK, 1 = invalid
Model Ionosphere correction	26	5	0 = OK, 1 = invalid
Ocean tide	25	6	0 = OK, 1 = invalid
Long Period Equilibrium Ocean tide	24	7	0 = OK, 1 = invalid
Ocean loading tide	23	8	0 = OK, 1 = invalid
Solid Earth tide	22	9	0 = OK, 1 = invalid
Geocentric Polar tide	21	10	0 = OK, 1 = invalid
Surface Type Flag	20	11	0 = OK, 1 = invalid
Ice concentration model	19	12	0 = OK, 1 = invalid
Snow depth model	18	13	0 = OK, 1 = invalid
Snow density model	17	14	0 = OK, 1 = invalid
Mean Sea Surface model	16	15	0 = OK, 1 = invalid
Geoid modes	15	16	0 = OK, 1 = invalid
ODLE from model	14	17	0 = OK, 1 = invalid
DEM model	13	18	0 = OK, 1 = invalid
Slope model	12	19	0 = OK, 1 = invalid
Sea-state bias model	11	20	0 = OK, 1 = invalid
Significant Wave Height	10	21	0 = OK, 1 = invalid
Altimeter Wind Speed	9	22	0 = OK, 1 = invalid
Unused	8-0	23-31	N/A

Table 2.3.3.1-4 Corrections Status Flag

Field 31) reserved for Significant Wave Height . The Significant Wave Height in mm and preserving negative values rather than clipping at zero. Currently un-calibrated.

Field 32) reserved for Altimetric wind speed. The wind speed is calculated from a model by the geocorrections CFI. Currently un-calibrated.

For the 20Hz measurements note that sometimes this will be empty (zero-filled) when measurements finish before the end of a block of 20. This condition is indicated by the Quality flags in field 43.

Field 33) Spares.

Field 34) Delta Time – Delta time is to be added to the 1 Hz time stamp (in field 1) to give the correct time for each of the 20Hz measurement. Set to zero if block is partially empty.

Field 35) Measurement Latitude – The latitude of the echoing point position - this includes the x-track offset for SIN mode measurements and the slope-corrected position for LRM mode measurements. Units are 10^{-1} μdegrees. Note that Latitude at Nadir is preserved in field 3.

Field 36) Measurement Longitude – The longitude of the echoing point position - this includes the x-track offset for SIN mode measurements and the slope-corrected position for LRM mode measurements. Units are 10^{-1} μdegrees. Note that Longitude at Nadir is preserved in field 4.

Retracker ID	Mode LRM	Mode SAR	Mode SARin
1	Ocean CFI model fit	Laxon/Ridout sea-ice model fit	Wingham/Wallis model fit
2	UCL land-ice	TBD	TBD
3	OCOG	TBD	TBD

Table 2.3.3.1-5 Retrackers Executed by Mode

Field 37) Height of surface. The height of the surface at the measurement point w.r.t. the reference ellipsoid. Computed by retracker 1 (see Table 2.3.3.1-5).

Field 38) Height of surface. The height of the surface at the measurement point w.r.t. the reference ellipsoid. Computed by retracker 2 (see Table 2.3.3.1-5).

Field 39) Height of surface. The height of the surface at the measurement point w.r.t. the reference ellipsoid. Computed by retracker 3 (see Table 2.3.3.1-5).

Field 40) Sigma 0. The fully corrected backscatter including instrument gain correction and bias, Computed. Computed by retracker 1 (see Table 2.3.3.1-5).

Field 41) Sigma 0. The fully corrected backscatter including instrument gain correction and bias, Computed. Computed by retracker 2 (see Table 2.3.3.1-5).

Field 42) Sigma 0. The fully corrected backscatter including instrument gain correction and bias, Computed. Computed by retracker 3 (see Table 2.3.3.1-5).

Field 43) Freeboard. The SAR mode computed freeboard of the sea ice. Initially (e.g. for launch plus 1 year) this was set to '-9999' for all records. With Baseline C, the freeboard is computed and this field is filled in the L2 product. Note that Freeboard can be a small negative value when there is sufficient snow-loading on thin ice. Set to 0 in SARin and LRM modes.

Field 44) Interpolated Sea Surface Height Anomaly – The ocean height anomaly, computed by comparing the interpolated ocean height from the SAR processing with the MSS from the model. Note that the interpolated ocean height is different from the surface height in field 37-38-39.

Field 45) Number of interpolated records for SSHA is the number of records that were used to create the fit to calculate the SSHA.

Field 46) SSHA Interpolation Quality is the root mean square (RMS) of the residuals of the SSHA fit.

Field 47) Peakiness of the echo in the L1b product. Note that this requires different interpretation for SAR and SIN echoes which do not have the 'usual' pulse-limited echo shape.

Field 48) Number of Echoes/Beams averaged. In LRM mode this is the number of echoes that have been averaged to make one measurement (normally). In SAR and SIN modes, it is the number of Doppler beams which have been stacked to derive each measurement. Near the begining and end of each section of SAR or SIN mode operation, this number reduces below the nominal value and there is a corresponding decrease in the signal to noise ratio of the waveform.

Field 49) Spare

Field 50) Measurement Quality Flags indicating the quality of the 20Hz measurement parameters. See table 2.3.3.1-6.

Definition	PDS Bit	SS Bit	Setting
Record degraded	31	0	0= OK, 1= degraded or zero-filled for padding. Indicates that the degradation of the record is serious so that it should not be

Definition	PDS Bit	SS Bit	Setting
			processed.
Orbit error	30	1	0 = OK, 1 = error detected
Orbit discontinuity	29	2	0= OK, 1= orbit discontinuity occured (e.g. gap)
Height error 1	28	3	0 = OK, 1 = error in the height derivation for retracker 1.
Height error 2	27	4	0 = OK, 1 = error in the height derivation for retracker 2.
Height error 3	26	5	0 = OK, 1 = error in the height derivation for retracker 3.
Backscatter error 1	25	6	0 = OK, 1 = error in the backscatter derivation for retracker 1.
Backscatter error 2	24	7	0 = OK, 1 = error in the backscatter derivation for retracker 2.
Backscatter error 3	23	8	0 = OK, 1 = error in the backscatter derivation for retracker 3.
SSHA interpolation error	22	9	0 = no warning, 1 = SSHA degraded
Peakiness error	21	10	0 = no, 1 = error
Freeboard error	20	11	0 = OK, 1 = error
SAR discriminator = Ocean	19	12	0 = no, 1 = yes
SAR discriminator = Lead	18	13	0 = no, 1 = yes
SAR discriminator = Sea-Ice	17	14	0 = no, 1 = yes
SAR discriminator = Unknown	16	15	0 = no, 1 = yes
SIN x-track angle error	15	16	0 = no, 1 = ambiguous angle
Receive Ch1 error for SIN	14	17	0= OK, 1= degraded or missing
Receive Ch2 error for SIN	13	18	0= OK, 1= degraded or missing
SIRAL_Identifier	12	19	0= Nominal, 1= Redundant
Surface Model Unavailable	11	20	0 = OK, 1 = no DEM/Slope model for location
Mispointing Error	10	21	0 = OK, 1= error during calculation
Delta Time Error	9	22	0 = OK, 1= error during calculation
LRM Slope Model Data Valid	8	23	0 = Slope Model Valid and Applied, 1 = no Valid Model Available

Definition	PDS Bit	SS Bit	Setting
SARin BaselineBad Flag	7	24	0 = Baseline OK 1 = Baseline Error
SARin Out of Range Flag	6	25	0 = Computed Range OK 1 = Computed Range outside of Threshold
SARin Bad Velocity Flag	5	26	0 = Velocity OK, 1 = Velocity Out of Range
Calibration Warning	4	27	0 = no warning 1 = non-nominal calibration applied
Unused	3-0	28-31	N/A

Table 2.3.3.1-6 Measurement Quality Flags

Field 51) Correction Application Flags indicating which corrections were applied in the computation of the height values in this record. The intent is to allow the user to remove applied corrections and substitute their own. See table 2.3.3.1-7.

Definition	PDS Bit	SS Bit	Setting
Corrected for internal calibration	31	0	0= no, 1= corrected
Corrected for radial Doppler	30	1	0= no, 1= corrected
Corrected for Dry Tropospheric	29	2	0= no, 1= corrected
Corrected for Wet Tropospheric	28	3	0= no, 1= corrected
Corrected for Inverse Barometer	27	4	0= no, 1= corrected
Corrected for High Frequency Ocean Barotropic response to atmospheric forcing.	26	5	0= no, 1= corrected
Corrected for Ionosphere (GIM model)	25	6	0= no, 1= corrected
Corrected for Ionosphere (Model)	24	7	0= no, 1= corrected
Corrected for Ocean tide	23	8	0= no, 1= corrected
Corrected for Long period equilibrium ocean tide	22	9	0= no, 1= corrected
Corrected for Ocean loading tide	21	10	0= no, 1= corrected
Corrected for Solid Earth tide	20	11	0= no, 1= corrected

Definition	PDS Bit	SS Bit	Setting
Corrected for Geocentric Polar tide	19	12	0= no, 1= corrected
Corrected for Slope Doppler correction	18	13	0= no, 1= corrected
Mode specific window offset applied	17	14	0= no, 1= offset applied
SAR retracker applied	16	15	0= no, 1= retracker applied
SARin retracker applied	15	16	0 = no, 1 = retracker applied
LRM retracker applied	14	17	0 = no, 1 = retracker applied
LRM ocean bias applied	13	18	0 = no bias applied, 1 = bias applied
LRM ice bias applied	12	19	0 = no bias applied, 1 = bias applied
SAR ocean bias applied	11	20	0 = no bias applied, 1 = bias applied
SAR ice bias applied	10	21	0 = no bias applied, 1 = bias applied
SARin ocean bias applied	9	22	0 = no bias applied, 1 = bias applied
SARin ice bias applied	8	23	0 = no bias applied, 1 = bias applied
LRM slope model data valid	7	24	0 = slope model valid, 1 = no valid model available
SARin baseline bad flag	6	25	0 = baseline is correct 1 = baseline error
SARin out of range flag	5	26	0 = computed range is correct 1 = computed range outside of thresholds
SARin bad velocity flag	4	27	0 = velocity is correct 1 = velocity is out of range
Sea-state bias used	3	28	0 = sea state bias not applied 1 = sea state bias applied
Unused	2-1	29-30	-
Master Failure flag	0	31	0 = OK 1 = Height not fully corrected

Field 52) Retracker 1 Quality Value – chi^2 value from fit of waveform amplitude.

Field 53) Reserved for retracker 2 Quality Value

Field 54) Reserved for retracker 3 Quality Value

2.3.3.2 In-depth L2 MDS Records Layout

In addition to the main L2 GDR output, a second L2 data set can be output which is called 'In-depth L2' and is identified with an 'I' in the filetype: SIR_xxxI2x. It applies to products SIR_LRMI2_ , SIR_SARI2_ , SIR_SINI2_ , SIR_SIDI2_ , SIR_FDMI2_ . This dataset contains many more parameters and flags and is therefore much larger. The in-depth format is required as the input to the second pass of the L2 SAR processing chain for Sea Ice areas, and it is also useful for detailed analysis.

The L2I Measurement Dataset has a single format which is independent of mode . However the meaning of some fields is mode dependent – some fields are entirely unused in some modes.

The L2I format has been designed with the goal of ease of use rather than reduction of data volume.

This means that there is repetition of some information that varies slowly.
Geophysical corrections are interpolated at 1 Hz and will therefore nominally be the same for 20 consecutive records.
The corrections are interpolated at the lat/lon position given in the first of those 20 records.

Product parameters are grouped according to function into 5 sub-structures as follows:

- Location Group — time and orbit location
- Measurements Group — derived from instrument measurement parameters
- Auxiliary Measurements Group — from auxiliary data or models
- External Corrections Group — geophysical corrections
- Internal Corrections Group — calibration corrections etc

The record structure is illustrated in the following diagram. The repetition frequency of each sub-structure is 1Hz.

Repetition of sub-structure				
x1	x1	x1	x1	x1
Time & Orbit Group	Measurement Group	Aux Measurements	External Corrections	Internal Corrections

Figure 2.3.3.2-1 In-depth Level2 MDS Layout

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
Time and Orbit group					
1.	Data Record Time (MDSR Time Stamp)	TAI	sl+2*ul	12	12
2.	USO correction	10^{-15}	sl	4	4
3.	Mode ID (instrument mode information)	-	us	2	2
4.	Source Sequence Counter (from telemetry)	-	us	2	2
5.	Instrument Config (including loop status)	-	ul	4	4
6.	Surface Sample Counter (Record Counter)	-	ul	4	4
7.	Latitude of measurement in WGS84	10^{-1} μ-degree (see note 1)	sl	4	4
8.	Longitude of measurement in WGS84	10^{-1} μ-degree (see note 1)	sl	4	4
9.	Altitude of COG above reference ellipsoid (interpolated value)	mm	sl	4	4
10.	Instantaneous altitude rate derived from orbit	mm/s	sl	4	4
11.	Satellite velocity vector[3] (in IERF)	mm/s	sl	3*4	12
12.	Real beam direction vector[3] (in CRF)	μm	sl	3*4	12
13.	Interferometer baseline vector[3] (in CRF)	μm	sl	3*4	12
14.	Star Tracker ID	-	us	2	2
15.	Spare	-	us	2	2
16.	Spacecraft Roll	10^{-7} degrees	sl	4	4
17.	Spacecraft Pitch	10^{-7} degrees	sl	4	4
18.	Spacecraft Yaw	10^{-7} degrees	sl	4	4
19.	Level-2 Measurement Confidence Data (flag word)	-	ul	4	4
Sub-total size					**100**
Measurements group					
20.	Height of surface w.r.t. ellipsoid (retracker1)	mm	sl	4	4
21.	Height of surface w.r.t. ellipsoid (retracker2)	mm	sl	4	4
22.	Height of surface w.r.t. ellipsoid (retracker3)	mm	sl	4	4
23.	Sigma-0 (retracker1)	dB/100	sl	4	4

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
		(see note 2)			
24.	Sigma-0 (retracker2)	dB/100 (see note 2)	sl	4	4
25.	Sigma-0 (retracker3)	dB/100 (see note 2)	sl	4	4
26.	Significant Wave Height	mm	sl	4	4
27.	Peakiness	1/100	sl	4	4
28.	Retracked range correction (retracker1)	mm	sl	4	4
29.	Retracked range correction (retracker2)	mm	sl	4	4
30.	Retracked range correction (retracker3)	mm	sl	4	4
31.	Spare	-	-	4	4
32.	Spare	-	-	4	4
33.	Spare	-	-	4	4
34.	Retracker 1 Quality Metric	-	sl	4	4
35.	Retracker 2 Quality Metric	-	sl	4	4
36.	Retracker 3 Quality Metric	-	sl	4	4
37.	Retracker output 3	see definition	sl	4	4
38.	Retracker output 4	see definition	sl	4	4
39.	Retracker output 5	see definition	sl	4	4
40.	Retracker output 6	see definition	sl	4	4
41.	Retracker output 7	see definition	sl	4	4
42.	Retracker output 8	see definition	sl	4	4
43.	Retracker output 9	see definition	sl	4	4
44.	Retracker output 10	see definition	sl	4	4
45.	Retracker output 11	see definition	sl	4	4
46.	Retracker output 12	see definition	sl	4	4
47.	Retracker output 13	see definition	sl	4	4
48.	Retracker output 14	see definition	sl	4	4
49.	Retracker output 15	see definition	sl	4	4
50.	Retracker output 16	see definition	sl	4	4
51.	Retracker output 17	see definition	sl	4	4
52.	Retracker output 18	see definition	sl	4	4
53.	Retracker output 19	see definition	sl	4	4
54.	Retracker output 20	see definition	sl	4	4
55.	Retracker output 21	see definition	sl	4	4
56.	Retracker output 22	see definition	sl	4	4
57.	Retracker output 23	see definition	sl	4	4

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
58.	Reserved for power echo shape parameter	-	sl	4	4
59.	Beam behaviour parameter [50]	-	-	100	100
60.	X-Track Angle (interferometric angle computed at Retrack point)	μ radians	sl	4	4
61.	X-Track Angle Correction	μ radians	sl	4	4
62.	Coherence (at Retrack point)	1/1000	sl	4	4
63.	Interpolated Ocean Height	mm	sl	4	4
64.	Freeboard	mm	sl	4	4
65.	Surface Height Anomaly	mm	sl	4	4
66.	Interpolated Sea Surface Height Anomaly	mm	sl	4	4
67.	Interpolation error for Ocean Height	mm	us	2	2
68.	Number of interpolation points used forward	-	us	2	2
69.	Number of interpolation points used backward	-	us	2	2
70.	Radius of interpolation -forward (in time)	ms	us	2	2
71.	Radius of interpolation -backward (in time)	ms	us	2	2
72.	Interpolation error flag	-	us	2	2
73.	Measurement mode (SAR / SIN / LRM)	-	ul	4	4
74.	Measurement Quality Flags	-	ul	4	4
75.	Retracker Flags	-	ul	4	4
76.	Height Status Flags	-	ul	4	4
77.	SAR Freeboard Status Flags	-	ul	4	4
78.	Number of Echoes or Beams averaged	-	us	2	2
79.	Spare (reserved for wind speed)	-	us	2	2
80.	Measurement Spares	-	uc	12x1	12
Sub-total size					**332**
Auxiliary Measurements group					
81.	Ice concentration parameter	%/1000	sl	4	4
82.	Snow Depth	mm	sl	4	4
83.	Snow Density	kg/m^3	sl	4	4
84.	Discriminator result (enumerated type)	-	sl	4	4
85.	SIN Discriminator Parameter 1=total power	-	sl	4	4
86.	SIN Discriminator Parameter 2=max power	-	sl	4	4
87.	SIN Discriminator Parameter 3=mean power	-	sl	4	4

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
88.	SIN Discriminator 4=bin of max power	-	sl	4	4
89.	SIN Discriminator 5=bin of half max power	-	sl	4	4
90.	SIN Discriminator 6=max Coherence	-	sl	4	4
91.	SIN Discriminator 7=bin of max Coherence	-	sl	4	4
92.	SIN Discriminator 8=first power bin	-	sl	4	4
93.	SIN Discriminator 9=last power bin	-	sl	4	4
94.	SIN Discriminator 10 - reserved	-	sl	4	4
95.	Discriminator status flag	-	ul	4	4
96.	Slope model correction attitude	μdeg	sl	4	4
97.	Slope model correction azimuth	μdeg	sl	4	4
98.	Slope Doppler Correction	mm	sl	4	4
99.	Uncorrected Latitude	10^{-1} μ-degree (see note 1)	sl	4	4
100.	Uncorrected Longitude	10^{-1} μ-degree (see note 1)	sl	4	4
101.	Ambiguity indicator	-	ul	4	4
102.	MSS from model	mm	sl	4	4
103.	Geoid from model	mm	sl	4	4
104	Ocean Depth / Land Elevation from model	mm	sl	4	4
105.	DEM elevation (interpolated)	mm	sl	4	4
106.	DEM identifier (used in SIN mode)	-	ul	4	4
107.	Auxiliary Spares	-	uc	16x1	16
Sub-total size					**120**
External Corrections group					
108.	Dry Tropospheric Correction	mm	sl	4	4
109.	Wet Tropospheric Correction	mm	sl	4	4
110.	Inverse Barometric Correction	mm	sl	4	4
111.	Dynamic Atmospheric Correction (DAC from Mog2D)	mm	sl	4	4
112.	GIM Ionospheric Correction	mm	sl	4	4
113.	Model Ionospheric Correction	mm	sl	4	4
114.	Elastic Ocean Tide	mm	sl	4	4
115.	Long Period Ocean Tide	mm	sl	4	4
116.	Ocean Loading Tide	mm	sl	4	4

ID	Descriptor	Unit	Type	Size (bytes)	Tot. Size (bytes)
117.	Solid Earth Tide	mm	sl	4	4
118.	Geocentric Polar Tide	mm	sl	4	4
119.	Surface type flag	-	ul	4	4
120.	Correction status flags	-	ul	4	4
121.	Correction error flags	-	ul	4	4
122.	Sea State Bias (EM Bias)	mm	sl	4	4
123.	Spare		uc	8x1	8
Sub-total size					**68**
Internal Corrections group					
124.	Doppler range correction (inc slope)	mm	sl	4	4
125.	Instrument Range Correction, t-r antenna	mm	sl	4	4
126.	Instrument Range Correction, r only antenna	mm	sl	4	4
127.	Instrument Sigma-0 correction, t-r antenna	dB/100 (see note 2)	sl	4	4
128.	Instrument Sigma-0 correction, r only antenna	dB/100 (see note 2)	sl	4	4
129.	Internal Phase Correction	milli-radians	sl	4	4
130.	External Phase Correction	milli-radians	sl	4	4
131.	Noise power measurement	dB/100 (see note 2)	sl	4	4
132	Phase Slope Correction	m-rad	sl	4	4
133.	Spare		uc	8x1	8
Sub-total Size					**44**
Total Record Size					**664**

1) 10^{-1} μdegree is an exotic unit exclusively used at binary record level to improve resolution of the lat and long fields

2) 10^{-2} dB is an exotic unit used for db-units related fields.

Table 2.3.3.2-1 Interim L2 MDS

Field 1) MDSR Time Stamp - corresponding to the time the satellite is overhead of the centre of the measurement footprint, which is at the location given by Latitude and Longitude in field 99 & field 100.

Field 2) USO Correction - this field is copied in from the input Level 1b product where it is defined as: (*x*

-1)*10^15 where *x* is the ratio between the nominal and modelled frequencies. (TBC)

Field 3) Mode ID - Identifies the SIRAL instrument measurement mode. see table 2.3.3.2-2. This field is copied from ModeID field stored in input L1b.

Definition	PDS Bit	SS Bit	Setting
Instrument mode - derived from configuration bits in the L0	15-10	0-5	000001 = 1 = LRM 000010 = 2 = SAR 000011 = 3 = SIN 001011 = 11 = CAL1-LRM 001100 = 12 = CAL1-SAR 001101 = 13 = CAL1-SIN 010110 = 22 = CAL2-SAR 010111 = 23 = CAL2-SIN 100001 = 33 = CAL3
SIN degraded case	9	6	set to 1 if one receive chain is missing
Reserved	8	7	set to 0
CAL4 Mode	7	8	set to 1 for CAL4 packets
Platform attitude control	6-5	9-10	00 = unknown 01 = Local Normal Pointing mode (affirmed) 10 = Yaw Steering mode (affirmed)
Reserved	4-0	11-15	set to 0

Table 2.3.3.2-2 Mode ID

Field 4) Source Sequence Counter - passed through from the L1b record. Originally read from the L0 echo telemetry packet (of the master channel in the case of SIN). This is a 16384 cyclic modulo counter, starting from 0, incrementing by 1. A separate counter is maintained for each instrument mode.

Field 5) Instrument Configuration flag - (ul giving 32 bits) This is derived from flags in the L0 packets for tracking and echo. See table 2.3.3.2-3. This field is copied from the Instrument Configuration flag stored in input L1b, but for the SIRAL_Identifier bitfield, set by the L2 specialized processors.

Definition	PDS Bit	SS Bit	Setting
Reception_chain_to_use	31-30	0-1	00 = 0 = unknown 01 = 1 = chain 1

Definition	PDS Bit	SS Bit	Setting
			10 = 2 = chain 2 11 = 3 = both
SIRAL_Identifier	29	2	0 = Nominal 1 = Redundant
Reserved	28	3	set to 0
Bandwidth	27-26	4-5	00 = unknown 01 = 320 MHz 10 = 40 MHz
Reserved	25	6	set to 0
Reserved	24	7	set to 0
Tracking mode	23-22	8-9	00 = 0 = unknown 01 = 1 = LRM 10 = 2 = SAR 11 = 3 = SIN
External Calibration	21	10	0 = no, 1 = external calibration
Reserved	20	11	set to 0
Loop status	19	12	0 = closed loop 1 = open loop
Loss of echo (from cycle report)	18	13	0= OK, 1 = loss of echo
Real-time error (from cycle report)	17	14	0= OK, 1 = real time computation error (computing cycle too long)
Echo saturation error (from cycle report)	16	15	0= OK, 1 = echo saturation detected
Reception_Band_Attenuation	15	16	0 = not attenuated 1 = attenuated
Cycle Report General Error	14	17	0 = cycle report is 0 1 = cycle report is not 0
Reserved	13	18	Set to 0
Reserved	12	19	Set to 0
Reserved	11	20	Set to 0
STR_ATTREF Star Tracker data used	10	21	Set to 1 if STR_ATTREF is used
Reserved	9-0	22-31	set to 0

Table 2.3.3.2-3 Instrument Configuration Flag

Field 6) Record counter - increment by 1 for each record in the L2 product.

Field 7) Latitude of measurement - Corrected for off-nadir position of the retracked point; in SIN by using the inferred x-track angle and in LRM using slope model. The L1b Latitude (at Nadir) is

preserved in field 99. Units are 10^{-1} µdegrees.

Field 8) Longitude of measurement - Corrected for off-nadir position of the retracked point; in SIN by using the inferred x-track angle and in LRM using slope model. The L1b Longitude (at Nadir) is preserved in field 100. Units are 10^{-1} µdegrees.

Field 9) Altitude - Altitude of the Satellite CoG above reference ellipsoid at Nadir. This is not modified by SIN or LRM processing.

Field 10) Altitude rate - instantaneous rate of change of Altitude with time (from L1b)

Field 11) Satellite velocity vector - described in the International Terrestrial Reference Frame in the International Earth Fixed System. This is not a unit vector as the velocity magnitude is also required.

Field 12) Real beam direction vector - described in the CryoSat Reference Frame. This is a unit vector and the units are micro-metres.

Field 13) Interferometric baseline vector - described in the Cryosat Reference Frame. This is a unit vector and the units are micro-metres.

Field 14) Start Tracker ID. The following values are valid Star Tracker Identifications:

0	No Star Tracker data used for product generation and attitude initialisation done by using default values from the IPFDB
4	Data of STR_ATTREF used for product generation

Field 15) Spare

Field 16) Antenna Bench Roll Angle corresponding to the MDSR Time Stamp

Field 17) Antenna Bench Pitch Angle corresponding to the MDSR Time Stamp

Field 18) Antenna Bench Yaw Angle corresponding to the MDSR Time Stamp

Field 19) L2 MCD - Measurement Confidence flags. See table 2.3.3.2-4. Generally the MCD flags indicate problems when set. If the whole MCD is 0 then no problem and nominal conditions were detected. Serious errors (**bold** in the table) are indicated by setting bit 31 (SS bit 0). In which

case the block must not be processed. Other error settings can be regarded as warnings.

Definition	PDS Bit	SS Bit	Setting
Block degraded	31	0	0= OK, 1= Degraded (set if the block should not be processed – indicated by **bold** typeface)
Blank Block	30	1	0 = OK 1 = Blank Block inserted for record padding
Datation Degraded	29	2	0 = OK 1 = Datation is bad or not set
Orbit propagation error	28	3	0= OK, 1= error (returned by CFI or by independent check)
Orbit file change	27	4	0= OK, 1= Orbit file has changed w.r.t. previous record
Orbit discontinuity	26	5	0= OK, 1= discontinuity (eg gap)
Echo Saturation -from L0	25	6	0= OK, 1= saturated (from echo saturation flag in the telemetry)
Other Echo error (e.g. empty waveform)	24	7	0= OK, 1= echo error
Receive Ch1 error for SIN	23	8	0= OK, 1= degraded or missing
Receive Ch2 error for SIN	22	9	0= OK, 1= degraded or missing
Window Delay Inconsistency	21	10	0 = OK (value is in range) 1 = value out of range or computation error
AGC Inconsistency	20	11	0 = OK (value is in range) 1 = value out of range or computation error
CAL 1 Correction Missing	19	12	0= OK, 1= missing - not applied
CAL1 from IPF DataBase used	18	13	0= default not used 1= default from IPF DB used
DORIS USO correction missing	17	14	0= OK, correction available 1= correction factor not available
Complex Cal1 from IPF DataBase used	16	15	0= default not used 1= default from IPF DB used

Definition	PDS Bit	SS Bit	Setting
TRK Echo Error	15	16	0= OK, 1= degraded tracking echo
Echo Rx1 Error	14	17	0= OK, 1= bad raw echo
Echo Rx2 Error	13	18	0= OK, 1= bad raw echo
Noise Power Measurement Inconsistency	12	19	0= OK, 1= degraded, Value out of range or computation error
Azimuth Calibration Missing	11	20	0= OK, Azimuth calibration applied 1= No azimuth calibration
Antenna Bending Correction	10	21	0= applied 1= not applied
Reserved	9	22	Set to 0
Reserved	8	23	Set to 0
Phase Perturbation Correction application	7	24	0 = applied , 1 = not applied
CAL 2 Correction Missing	6	25	0= OK, 1= missing - not applied
CAL 2 from IPF DB used	5	26	0= default not used 1= default from IPF DB used
Power scaling error (LRM/FDM only)	4	27	0= OK, 1= Error in power scaling
Attitude Correction Missing	3	28	0= OK, Attitude correction applied 1= Not corrected
Reserved	2	29	set to 0
Reserved	1	30	set to 0
Phase Perturbation Correction Mode	0	31	0 = computed by CCAL1 1 = default from IPFDB used (applicable only to SARin data)

Table 2.3.3.2-4c MCD Flag

Field 20) Height of surface computed by retracker 1. Computed at measurement point w.r.t. the reference ellipsoid. See Table 2.3.3.2-4a for the details of the retracker by mode.

Field 21) Height of surface computed by retracker 2. Computed at measurement point w.r.t. the reference ellipsoid. See Table 2.3.3.2-4a for the details of the retracker by mode.

Field 22) Height of surface computed by retracker 3. Computed at measurement point w.r.t. the reference ellipsoid. See Table 2.3.3.2-4a for the details of the retracker by mode.

Retracker ID	Mode LRM	Mode SAR	Mode SARin
1	Ocean CFI model fit	Laxon/Ridout sea-ice model fit	Wingham/Wallis model fit
2	UCL Land Ice	TBD	TBD

Retracker ID	Mode LRM	Mode SAR	Mode SARin
3	OCOG	TBD	TBD

Table 2.3.3.2-4a Retrackers executed by mode

Field 23) Sigma 0 from retracker 1. Fully corrected including instrument gain corrections and retracker correction.

Field 24) Sigma 0 from retracker 2. Fully corrected including instrument gain corrections and retracker correction.

Field 25) Sigma 0 from retracker 3. Fully corrected including instrument gain corrections and retracker correction.

Field 26) Significant Wave Height (SWH) calculated from an internal SWH squared value but sign is preserved

Field 27) Peakiness of the echo in the L1b product. This requires different interpretation for SAR and SIN echoes which have a different shape than the 'usual' pulse-limited echo shape.

Field 28) Retracked range correction for retracker 1. The offset of the retracked point on the echo from the reference point of the range window. This is a 1-way correction in mm. It has been applied in the computation of height.

Field 29) Retracked range correction for retracker 2. The offset of the retracked point on the echo from the reference point of the range window. This is a 1-way correction in mm. It has been applied in the computation of height.

Field 30) Retracked range correction for retracker 3. The offset of the retracked point on the echo from the reference point of the range window. This is a 1-way correction in mm. It has been applied in the computation of height.

Field 31) Spare.

Field 32) Spare

Field 33) Spare.

Field 34) Retracker 1 quality metric. This field differs by mode (see Table 2.3.3.2-4b) .

Field 35) Retracker 2 quality metric. This field differs by mode (see Table 2.3.3.2-4b) .

Field 36) Retracker 3 quality metric. This field differs by mode (see Table 2.3.3.2-4b).

Field 37) Retracker output 3. The amplitude of the waveform derived by retracker 1, in scaled Watts (see Table 2.3.3.2-4b)

Field 38) Retracker output 4. This field differs by mode (see Table 2.3.3.2-4b)

Field 39) Retracker output 5. Currently spare (see Table 2.3.3.2-4b)

Field 40) Retracker output 6. This field differs by mode (see Table 2.3.3.2-4b)

Field 41) Retracker output 7. This field differs by mode (see Table 2.3.3.2-4b)

Field 42) Retracker output 8. This field differs by mode (see Table 2.3.3.2-4b)

Field 43) Retracker output 9. This field differs by mode (see Table 2.3.3.2-4b)

In LRM mode, the OCOG parameters presented in the next three fields are the output of the OCOG retrack performed on the power waveform read from the L1b product. In SAR and SARin mode, the L1b power waveform is first convolved with a function to produce an LRM-like waveform before the OCOG retrack is performed. This is part of the algorithm used to derive backscatter values from the SAR processed waveform shapes.

Field 44) Retracker output 10. OCOG position in milli-bins (see Table 2.3.3.2-4b)

Field 45) Retracker output 11. OCOG amplitude in scaled Watts (see Table 2.3.3.2-4b)

Field 46) Retracker output 12. OCOG width in milli-bins (see Table 2.3.3.2-4b)

Field 47) Retracker output 13. Tracker range in milli-meters. This value represents the window delay from the L1b product, converted from a time into a range (see Table 2.3.3.2-4b)

Field 48) Retracker output 14. This field differs by mode (see Table 2.3.3.2-4b)

Field 49) Retracker output 15. This field differs by mode (see Table 2.3.3.2-4b)

Field 50) Retracker output 16. This field differs by mode (see Table 2.3.3.2-4b)

Field 51) Retracker output 17. This field differs by mode (see Table 2.3.3.2-4b)

Field 52) Retracker output 18. This field differs by mode (see Table 2.3.3.2-4b)

Field 53) Retracker output 19. This field differs by mode (see Table 2.3.3.2-4b)

Field 54) Retracker output 20. This field differs by mode (see Table 2.3.3.2-4b)

Field 55) Retracker output 21. This field differs by mode (see Table 2.3.3.2-4b)

Field 56) Retracker output 22. This field differs by mode (see Table 2.3.3.2-4b)

Field 57) Retracker output 23. This field differs by mode (see Table 2.3.3.2-4b)

Field	ID	LRM	SAR	SARin
Field 34	1	MQE of retracker 1 fit [scaled 1e6]	chi^2 of retracker 1 fit [scaled 1e6]	chi^2 of retracker 1 fit [scaled 1e6]
Field 35	2	MQE of retracker 1 fit [scaled 1e6]	Reserved for retracker 2	Reserved for retracker 2
Field 36	3	Reserved for retracker 3	Reserved for retracker 3	Reserved for retracker 3
Field 37	4	Retracker 1 fitted amplitude [scaled Watts]	Retracker 1 fitted amplitude [scaled Watts]	Retracker 1 fitted amplitude [scaled Watts]
Field 38	5	Retracker 1 leading Edge width [milli-bins]	Spare	Retracker 1 waveform width [milli-bins]
Field 39	6	Spare	Spare	Spare
Field 40	7	Retracker 1 noise est [scaled Watts]	Spare	chi^2 of retracker 1 phase fit [scaled 1e6]
Field 41	8	Spare	Retracker 1 fit sigma [scaled 1e6]	Phase from retracker 1 [micro-radians]
Field 42	9	Spare	Retracker 1 fit exponential [scaled 1e6]	Phase Slope from retracker 1 [micro-radians/bin]
Field 43	10	Spare	Spare	Leading edge slope from retracker 1

Field	ID	LRM	SAR	SARin
				[scaled 1e3]
Field 44	11	OCOG position [milli-bins]	OCOG position [milli-bins]	OCOG position [milli-bins]
Field 45	12	OCOG amplitude [scaled Watts]	OCOG amplitude [scaled Watts]	OCOG amplitude [scaled Watts]
Field 46	13	OCOG width [milli-bins]	OCOG width [milli-bins]	OCOG width [milli-bins]
Field 47	14	Window delay [milli-meters]	Window delay [milli-meters]	Window delay [milli-meters]
Field 48	15	Spare	Spare	Tail Slope from retracker 1 [1e18W/bin^0.5]
Field 49	16	Spare	Spare	Tail Decay from retracker 1 [1e6/bin]
Field 50	17	Reserved for retracker 2	Reserved for retracker 2	Reserved for retracker 2
Field 51	18	Reserved for retracker 2	Reserved for retracker 2	Reserved for retracker 2
Field 52	19	Reserved for retracker 2	Reserved for retracker 2	Reserved for retracker 2
Field 53	20	Reserved for retracker 2	Reserved for retracker 2	Reserved for retracker 2
Field 54	21	OCOG Amplitude [counts]	Reserved for retracker 3	Reserved for retracker 3
Field 55	22	25% OCOG range correction [mm]	Reserved for retracker 3	Reserved for retracker 3
Field 56	23	Reserved for retracker 3	Reserved for retracker 3	Reserved for retracker 3
Field 57	24	Reserved for retracker 3	Reserved for retracker 3	Reserved for retracker 3

Note The retracker parameters listed in the following fields are intended mainly for internal used, for monitoring and tuning the performance of the retrackers. As such, they are subject to change between releases of the IPF2 Specialised Processors. Where [scaled Watts] are given as a unit, the scaling is done via a runtime parameter from the PCONF, set to 1e18 at the time of writing. The meaning of 'Retracker

1,2,3' by mode is given in Table 2.3.3.2-4a

Table 2.3.3.2-4b Retrackers auxiliary output parameters

Field 58) Reserved for power echo shape parameter

Field 59) Beam Behaviour parameter - array of 50 integers to characterise the shape of the set of Doppler echoes from a common surface location prior to stacking (averaging). Currently the first 5 numbers are defined as follows, while the remainder are reserved for future use. See table 2.3.3.2-5.

Index	Definition	Type	Setting
[0]	Standard Deviation	us	Unitless Stack beam/100
[1]	Stack Centre (Beam in stack at maximum of the fitted gaussian)	us	Unitless Stack beam/100
[2]	Stack Scaled Amplitude	us	Normalised value with 65535
[3]	Stack Skewness	ss	Unitless Value/100 or -99900 if cannot be computed
[4]	Stack Kurtosis	ss	Unitless Value/100 or -99900 if cannot be computed

Table 2.3.3.2-5 Beam Behaviour

Field 60) X-Track Angle from the interferometric processing in SIN mode. This is the inferred across-track angle corresponding to the retrack point of the SIN echo. This can be used in combination with the altitude to derive a horizontal offset from Nadir. The Latitude and Longitude in field 7 and field 8 include this offset. Set to zero for SAR and LRM. The definition of this field preserves the sign of the phase difference and therefore switches sign in Redundant mode.

Field 61) X-Track Angle Correction. An empirically derived correction to the cross-angle angle is included in field 60. The value of the correction applied is given in this field. Subtract this value from field 60 to remove the correction.

Field 62) Coherence of the SIN echoes at the retracking point, this provides a measure of confidence in the interferometric result. Set to 0 for SAR and LRM modes.

Field 63) Along-track interpolated Mean Sea Surface Ocean Height (or MSS) : the ocean height spatially interpolated from the MSS model, which is used in conjunction with ocean surface height (derived from retracker 1 in field 20) to compute a sea surface height anomaly.

Field 64) Freeboard : SAR mode computed freeboard of the Sea Ice. Set to 0 in SIN and LRM modes.

Field 65) Corrected Surface Height Anomaly : difference between the measured sea surface height (corrected for geophysical and atmospheric effects) and the MSS from the model.

Field 66) Interpolated Sea Surface Height Anomaly : difference between the interpolated and corrected sea surface height and the MSS from the model.

Field 67) Interpolation error for Ocean Height : height error (RMS residual) in mm associated with the interpolated Ocean Height.

Field 68) Number of interpolation points used forward : the number of measurement points in front of current record that were used to interpolate the Ocean Height of this record.

Field 69) Number of interpolation points used backward : the number of measurement points behind current record that were used to interpolate the Ocean Height of this record.

Field 70) Radius of interpolation -forward (in time) : maximum distance, in front of current location, of points used to interpolate the Ocean Height of this record. Units are in time (ms) which can be converted to km by multiplying by the satellite ground-speed.

Field 71) Radius of interpolation -backward (in time) : maximum distance, behind current location, of points used to interpolate the Ocean Height of this record. Units are in time (ms) which can be converted to km by multiplying by the satellite ground-speed.

Field 72) Interpolation error flag : indicates errors in ocean height interpolation.

Definition	**PDS Bit**	**SS Bit**	**Setting**
Result Unreliable	31	0	0 = ok 1 = error
Interpolation one-sided (extrapolation)	30	1	0 = ok 1 = warning
No values available for interpolation	29	2	0 = ok 1 = error
Spare	28-0	3-31	-

Table 2.3.3.2-5a Interpolation Error Flags

Field 73) Measurement mode (LRM / SAR / SIN) : LRM=1, SAR=2, SIN=3

Field 74) Measurement Quality Flags : indicate errors with any component parameters in this group. See table 2.3.3.2-6.

Definition	PDS Bit	SS Bit	Setting
Height error retracker 1	31	0	0 = OK, 1 = Error
Height error retracker 2	30	1	0 = OK, 1 = Error
Height error retracker 3	29	2	0 = OK, 1 = Error
Sigma0 error retracker 1	28	3	0 = OK, 1 = Error
Sigma0 error retracker 2	27	4	0 = OK, 1 = Error
Sigma0 error retracker 3	26	5	0 = OK, 1 = Error
Peakiness error	25	6	0 = OK, 1 = Error
Echo shape error	24	7	0 = OK, 1 = Error
x-track angle error	23	8	0 = OK, 1 = Error
Coherence error	22	9	0 = OK, 1 = Error
Arithmetic error	21	10	0 = OK, 1 = Error
Altimeter wind calculation error	20	11	0 = OK, 1 = Error
Significant wave height calculation error	19	12	0 = OK, 1 = Error
Unused	18-0	13-31	set to 0

Table 2.3.3.2-6 Measurement Quality Flag

Field 75) Retracker Flags : indicate errors from the retracker algorithms, and waveform QA results, in each mode. See table 2.3.3.2-7.

Definition	PDS Bit	SS Bit	Setting
Spare	31	0	Set to 0
Low or zero power in waveform flag	30	1	0 = OK, 1 = Error
Low peakiness flag	29	2	0 =OK, 1 = Peakiness below threshold
High peakiness flag	28	3	0 =OK, 1 = Peakiness above threshold
High noise flag	27	4	0 =OK, 1 = Noise above threshold
Low variance flag	26	5	0 =OK, 1 = Variance below threshold
Bad leading edge flag	25	6	0 =OK, 1 = Error
Spare	24	7	-
Abnormal beam behaviour parameters	23	8	0 =OK, 1 = Error
Spare	22	9	-
Spare	21	10	-
Reserved for future use for U10 parameter	20	11	-
Spare	19	12	-
Spare	18	13	-
SIN retrack interpolation failure flag	17	14	0 =OK, 1 = Error
SIN low coherence flag	16	15	0 = OK, 1 = Coherence below threshold
Fit Failed	15	16	0 =OK, 1 = Error
FDM OCOG failed	14	17	0 =OK, 1 = Error
Poor Power fit	13	18	0 =OK, 1 = chi squared above threshold
Poor Phase fit (SIN mode only)	12	19	0 = OK, 1 = chi squared above threshold
Retracker 1 failure	11	20	0 =OK, 1 = Error
Retracker 2 failure	10	21	0 =OK, 1 = Error
Retracker 3 failure	9	22	0 =OK, 1 = Error
Spare	8-0	23-31	-

Table 2.3.3.2-7 Retracker Flag

Field 76) Height Status Flags : show which corrections have been applied to the height fields. See table 2.3.3.2-8.

Definition	PDS Bit	SS Bit	Setting
Corrected for internal calibration	31	0	0 = no, 1 = corrected
Corrected for Radial Doppler	30	1	0 = no, 1 = corrected
Corrected for Dry Troposphere	29	2	0 = no, 1 = corrected
Corrected for Wet Troposphere	28	3	0 = no, 1 = corrected
Corrected for Inverse Barometer	27	4	0 = no, 1 = corrected
Corrected for High Frequency Variability from DAC	26	5	0 = no, 1 = corrected
Corrected for Ionosphere - GIM	25	6	0 = no, 1 = corrected
Corrected for Ionosphere - Model	24	7	0 = no, 1 = corrected
Corrected for Ocean Tide	23	8	0 = no, 1 = corrected
Corrected for Long period equilibrium Ocean Tide	22	9	0 = no, 1 = corrected
Corrected for Ocean loading tide	21	10	0 = no, 1 = corrected
Corrected for Solid earth tide	20	11	0 = no, 1 = corrected
Corrected for Geocentric Polar tide	19	12	0 = no, 1 = corrected
Corrected for Slope Doppler correction	18	13	0 = no, 1 = corrected
Mode specific window offset applied	17	14	0 = no, 1 = offset applied
SAR retracker applied	16	15	0 = no, 1 = retracker applied
SIN retracker applied	15	16	0 = no, 1 = retracker applied
LRM retracker applied	14	17	0 = no, 1 = retracker applied
LRM Ocean bias applied	13	18	0 = no bias applied, 1 = bias applied
LRM Ice bias applied	12	19	0 = no bias applied, 1 = bias applied
SAR Ocean bias applied	11	20	0 = no bias applied, 1 = bias applied
SAR Ice bias applied	10	21	0 = no bias applied, 1 = bias applied
SIN Ocean bias applied	9	22	0 = no bias applied, 1 = bias applied
SIN Ice bias applied	8	23	0 = no bias applied, 1 = bias applied

Definition	PDS Bit	SS Bit	Setting
LRM Slope model data valid	7	24	0 = slope model valid, 1 = no valid model available NOTE: This flag inidicates whether the slope model data is valid for this location, i.e. this flag is set if and only if the current location is both over a slope model and the data at the current location in the slope model is not flagged as bad.
SIN baseline bad flag	6	25	0 = baseline OK, 1 = baseline error
SIN out of range flag	5	26	0 = computed range OK, 1 = computed range outside of threshold
SIN bad velocity flag	4	27	0 = velocity OK, 1 = velocity out of range
Sea-state bias used	3	28	0 = sea state bias not applied, 1 = sea state bias applied
Unused	2 - 1	29-30	set to 0
Master Failure flag	0	31	0 = OK, 1 = Height not fully corrected

Table 2.3.3.2-8 Height Status Flag

Field 77) SAR Freeboard Status Flags : indicate availability and reliability of the freeboard measurement. See table 2.3.3.2-9.

Definition	PDS Bit	SS Bit	Setting
Freeboard measurement unavailable	31	0	0 = OK, 1 = unavailable
Freeboard measurement unreliable	30	1	0 = OK, 1 = unreliable
Freeboard measurement is within northern geographical boundary	29	2	0 = outside, 1 = inside NOTE: This flag is set if a sea-ice measurement is located in a geographical region where this kind of measurements is very unlikely to be made and therefore they should be rejected. The off-limits geographical regions are boxes which are

Definition	PDS Bit	SS Bit	Setting
			defined into the PCONF by means of a set of lat/lon pairs.
Freeboard measurement is within southern geographical boundary	28	3	0 = outside, 1 = inside NOTE: This flag is set if a sea-ice measurement is located in a geographical region where this kind of measurements is very unlikely to be made and therefore they should be rejected. The off-limits geographical regions are boxes which are defined into the PCONF by means of a set of lat/lon pairs.
spare	27 - 0	4 - 31	set to 0

Table 2.3.3.2-9 SAR Freeboard Status Flag

Field 78) Number of echoes/beams averaged : In LRM mode this is the number of echoes which have been averaged to make one measurement (normally). In SAR and SIN modes it is the number of Doppler beams which have been stacked to derive each measurement. Near the beginning and end of each section of SAR or SIN mode operation this number will reduce below the nominal value and there is a corresponding decrease in the signal to noise ratio of the waveform.

Field 79) Spare : reserved for wind speed.

Field 80) Measurement Spares : reserved for possible future use

Field 81) Ice concentration parameter : an estimate of Sea Ice concentration percentage merged from dynamic model data.

Field 82) Snow Depth in mm merged from a climatology model data. This can be used (by L2 product user) to adjust the freeboard estimate.

Field 83) Snow Density in kg/m^3. This can be used (by L2 product user) to adjust the freeboard estimate.

Field 84) Discriminator result : enumerated type code showing the result of the discriminator algorithm in each chain. See table 2.3.3.2-10.

Value	Definition
1	Result of LRM discrimination is undefined
2	Result of LRM discrimination is ocean
3	Result of LRM discrimination is land ice plateau
101	Result of SIN discrimination is undefined
102	Result of SIN discrimination is altimeter mode
201	Result of SAR discrimination is undefined.
202	Result of SAR discrimination is ocean.
203	Result of SAR discrimination is Sea Ice.
204	Result of SAR discrimination is Leads.

Table 2.3.3.2-10 Discriminator Results

Field 85)SIN Discriminator Parameter 1 – Total Power in Waveform

Field 86)SIN Discriminator Parameter 2 – Maximum Power in Waveform

Field 87)SIN Discriminator Parameter 3 – Mean Power in Waveform

Field 88)SIN Discriminator Parameter 4 – Bin of Maximum Power

Field 89)SIN Discriminator Parameter 5 – Bin of Half Maximum Power

Field 90)SIN Discriminator Parameter 6 – Maximum Coherence

Field 91)SIN Discriminator Parameter 7 – Bin of Maximum Coherence

Field 92)SIN Discriminator Parameter 8 – First Power Bin

Field 93)SIN Discriminator Parameter 9 – Last Power Bin

Field 94)SIN Discriminator Parameter 10 – Reserved for Future Use

Field 95) Discriminator status flag : shows quality of the discriminator result for each mode. See table 2.3.3.2-11.

Definition	PDS Bit	SS Bit	Setting
Overall discriminator failure flag	31	0	0 = OK, 1 = Failure
Reserved for LRM	30-22	1-9	set to 0
SIN Low Variance flag	21	10	0 = OK, 1 = Low Variance
SIN Bad Leading Edge flag	20	11	0 = OK, 1 = Bad Leading edge
SIN High Noise flag	19	12	0 =OK, 1 = Noisy Waveform
SIN Low Peakiness flag	18	13	0 = OK, 1 = Low Peakiness
SIN Low Power flag	17	14	0 = OK, 1 = Low Power
SIN High Peakiness flag	16	15	0 = OK, 1 = High Peakiness
Reserved for SIN	15-12	16-19	set to 0
SAR high peakiness flag	11	20	0 =OK, 1 = yes
SAR low peakiness flag	10	21	0 =OK, 1 = yes
SAR low or zero power flag	9	22	0 = OK, 1 = low/zero power
SAR abnormal beam behaviour parameters	8	23	0 = OK, 1 = bad
SAR ice concentration unavailable	7	24	0 = OK, 1 = unavailable
SAR ice concentration unreliable	6	25	0 = OK, 1 = unreliable
SAR signal to noise ratio too low	5	26	0 = OK, 1 = Noisy Waveform
SAR Waveform is too wide	4	27	0 = OK, 1 = Wide Waveform
Unused	3 - 0	28 - 31	-

Table 2.3.3.2-11 Discriminator Status Flag

Field 96) Slope model correction attitude : attitude angle of the nearest echoing point on surface as determined from slope model in LRM processing. 0 if slope model not available or invalid. Set to 0 for SAR and SIN but may be used in the event of SIN mode with only one operating receive chain (SIN degraded mode = SID).

Field 97) Slope model correction azimuth : azimuth angle of nearest echoing point on surface as determined from slope models in LRM processing. 0 if model not present or invalid. Set to 0 for SAR and SARin but may be used in the event of SARin mode with only one operating

receive chain (SID mode)

Field 98) Slope Doppler correction:The full Doppler correction including slope effects..

Field 99) Uncorrected Latitude of the Nadir position - this allows for removal of the slope corrected position if desired.

Field 100) Uncorrected Longitude of the Nadir position - this allows for removal of the slope corrected position if desired.

Field 101) Ambiguity indicator : to flag the case where the interferometric angle may be ambiguous due to phase wrapping. See table 2.3.3.2-12.

Definition	PDS Bit	SS Bit	Setting
Overall Ambiguity	31	0	0 = OK, 1 = ambiguous, height may be incorrect
Unused	30-22	1-9	set to 0
DEM not available	21	10	0 = DEM available, 1 = no DEM for location, no check on height possible
Different elevations	20	11	0 = Height matches DEM to within threshold 1 = Difference between height and DEM out of range
Retracker failed	19	12	0 = Retracking OK 1 = Retracking failed
Maths error	18	11	0 = Computation OK 1 = Mathematical eror during ambiguity check
Unused	17-0	10-31	set to 0

Table 2.3.3.2-12 SIN Ambiguity Indicator Flags

Field 102) MSS from the CFI library.

Field 103) Geoid from the CFI library.

Field 104) Ocean Depth / Land Elevation from the ODLE model supplied in the CFI library.

Field 105) DEM Elevation : interpolated from a DEM to act as a check against the SIN derived elevation. For SIN mode only, =0 for LRM & SAR.

Field 106) DEM identifier : to identify the DEM used in SIN or the slope model used in LRM

Field 107) Auxiliary Spares : reserved for possible future use

Field 108) Dry Tropospheric Correction - added to range measurement used to compute height to correct for the propagation delay to the radar pulse, caused by the dry-gas component of the Earth atmosphere.

Field 109) Wet Tropospheric Correction - added (if required, see field 76) to range measurement that was used to compute height to correct for the propagation delay to the radar pulse, caused by the H_2O component of the Earth atmosphere.

Field 110) Inverse Barometric Correction - added (if required, see field 76)to range measurement that was used to compute height to correct for the depression of the ocean surface caused by the local barometric pressure.

Field 111) Dynamic Atmospheric Correction (DAC from Mog2D) - added (if required, see field 76) to range measurement that was used to compute height, to correct for both the Inverse Barometric effect and the high-frequency ocean response to wind forcing.

Field 112)GIM Ionospheric Correction - added (if required, see field 76) to range measurement that was used to compute height to correct for the delay to the radar pulse caused by free electrons in the ionosphere. Computed from the concurrent GIM data.

Field 113) Model Ionospheric Correction - added (if required, see field 76) to range measurement that was used to compute height, to correct for the delay to the radar pulse caused by free electrons in the ionosphere. Computed from a ionospheric model.

Field 114) Total Geocentric Ocean Tide added (if required, see field 76) to the range used to compute the height, to remove the total effects of ocean tides. Set to 32767 in case of error.

Field 115) Long-Period Equilibrium Ocean Tide (component of total ocean tide) added (if required, see field 76) to the range measurement that was used to compute height to remove the effect of the oceanic response to the single tidal forcing. Set to 32767 in case of error.

Field 116) Ocean Loading Tide added (if required, see field 76) to the range measurement that was used to compute height to remove the effect of local distortion to the Earth crust caused by increasing weight of ocean as local water tide rises. Set to 32767 in case of error."

Field 117) Solid Earth Tide added (if required, see field 76) to the range measurement that was used to compute height to remove the effect of local tidal distortion in the Earth's crust.

Field 118) Geocentric Polar Tide added (if required, see field 76) to the range measurement that was used to compute height to remove a long-period distortion of the Earth's crust. Although called a 'tide' this is in fact caused by variations in centrifugal force as the Earth's rotational axis moves its geographic location.

Field 119) Surface type flag - enumerated key to classify surface at nadir provided by a CFI map. This flag is distinct from the surface discrimination in the SAR processing. See Table 2.3.3.3-12a

Value	Definition
0	Open Ocean
1	Closed Sea
2	Continental Ice
3	Land
4-7	Currently unused

Field 120) Correction status flag - used to show which correction algorithms have been called. See table 2.3.3.2-13. This field contains a bit that indicates if there corrections that are interpolated at 1Hz were interpolated at the location given in this record (field 99 and field 100). If they were not, they were interpolated at the location of the previous record where that bit was set.

Definition	PDS Bit	SS Bit	Setting
Dry Tropospheric Correction Called	31	0	0 = no, 1 = yes
Wet Tropospheric Correction Called	30	1	0 = no, 1 = yes
Inverse Barometric Correction Called	29	2	0 = no, 1 = yes
High Frequency Variability from Dynamic Atmospheric Correction Called	28	3	0 = no, 1 = yes
GIM Ionospheric Correction Called	27	4	0 = no, 1 = yes
Model Ionospheric Correction Called	26	5	0 = no, 1 = yes
Ocean Tide Called	25	6	0 = no, 1 = yes
Long-period equilibrium Ocean Tide Called	24	7	0 = no, 1 = yes

Definition	PDS Bit	SS Bit	Setting
Ocean Loading Tide Called	23	8	0 = no, 1 = yes
Solid Earth Tide Called	22	9	0 = no, 1 = yes
Geocentric Polar Tide Called	21	10	0 = no, 1 =yes
Surface type flag Called	20	11	0 = no, 1 = yes
Ice concentration model Called	19	12	0 = no, 1 = yes
Snow depth model Called	18	13	0 = no, 1 = yes
Snow density model Called	17	14	0 = no, 1 = yes
MSS model Called	16	15	0 = no, 1 = yes
Geoid model Called	15	16	0 = no, 1 = yes
ODLE model Called	14	17	0 = no, 1 = yes
DEM model Called	13	18	0 = no, 1 = yes
Slope model Called	12	19	0 = no, 1 = yes
Sea-State Bias model Called	11	20	0 = no, 1 =yes
Reserved	10-1	21-30	set to 0
1 Hz Interpolated Location Indicator	0	31	0 = Corrections interpolated elsewhere 1 = Corrections interpolated at the lat/lon position of this record

Table 2.3.3.2-13 Corrections Status Flags

Field 121) Correction error flag - used to show if a correction algorithms returned an error when called see table 2.3.3.2-14. .

Definition	PDS Bit	SS Bit	Setting
Dry Tropospheric Correction Error	31	0	0 = OK, 1 = error
Wet Tropospheric Correction Error	30	1	0 = OK, 1 = error
Inverse Barometric Correction Error	29	2	0 = OK, 1 = error
High Frequency Variability DAC Correction	28	3	0 = OK, 1 = error

Definition	PDS Bit	SS Bit	Setting
Error			
GIM Ionospheric Correction Error	27	4	0 = OK, 1 = error
Model Ionospheric Correction Error	26	5	0 = OK, 1 = error
Ocean Tide Error	25	6	0 = OK, 1 = error
Long-period equilibrium Ocean Tide Error	24	7	0 = OK, 1 = error
Ocean Loading Tide Error	23	8	0 = OK, 1 = error
Solid Earth Tide Error	22	9	0 = OK, 1 = error
Geocentric Polar Tide Error	21	10	0 = OK, 1 = error
Surface type flag Error	20	11	0 = OK, 1 = error
Ice concentration Error	19	12	0 = OK, 1 = error
Snow depth Error	18	13	0 = OK, 1 = error
Snow density Error	17	14	0 = OK, 1 = error
MSS model Error	16	15	0 = OK, 1 = error
Geoid model Error	15	16	0 = OK, 1 = error
ODLE model Error	14	17	0 = OK, 1 = error
DEM model Error	13	18	0 = OK, 1 = error
Slope model Error	12	19	0 = OK, 1 = error
Sea-State Bias model Error	11	20	0 = OK, 1 = error
Reserved	10-0	21-31	set to 0

Table 2.3.3.2-14 Corrections Error Flags

Field 122) Sea State Bias correction (a.k.a. EM bias correction) An empirical correction proportional to the significant wave height which was added (if required, see field 76) to the range used to compute the height to compensate for the asymmetric shape of ocean waves . This is computed by the geophysical CFI

Field 123) Correction spares - reserved for future use.

Field 124) Doppler range correction - computed for the component of satellite velocity in the nadir

direction. The window delay used to compute height already contains this correction.

Field 125) Instrument Range Correction (Tx-Rx chain) - Calibration correction to range on channel 1 copied through from L1b, where it was applied

Field 126) Instrument Range Correction (Rx only chain) - Calibration correction to range on channel 2 copied through from L1b, where it was applied

Field 127) Instrument Gain Correction (Tx-Rx chain) - Calibration correction to gain on channel 1 copied through from L1b, where it was applied

Field 128) Instrument Gain Correction (Rx only chain) - Calibration correction to gain on channel 2 copied through from L1b, where it was applied

Field 129) Internal phase correction. - copied through from L1b, where it was applied

Field 130) External phase correction. - copied through from L1b, where it was applied

Field 131) Noise power measurement converted from telemetry units to be the noise floor of FBR measurement echoes, copied through from L1b

Field 132) Phase Slope Correction, copied through from the L1b, where it was applied

Field 133) reserved spares

3 FAST DELIVERY MARINE MODE L2 DATA PRODUCTS

A special Level-2 chain has been designed to produce a Fast Delivery Marine Mode (FDM) product for the benefit of meteorology and oceanography. This product is produced from LRM mode data only and is run as soon as possibly after acquisition using the DORIS Navigator orbit. The frequency of FDM data records is approximately one per second.

The FDM Measurement Dataset has a single format as it is only ever produced from SIRAL LRM data.

Product parameters are grouped according to function into 5 logical sub-structures as follows:

Location Group	time and orbit location
Range Group	range and retracker results
Range Corrections Group	derived from auxiliary data or models
SWH and Backscatter Group	parameters relating to SWH and sigma0
Geophysical Group	MSS, Geoid, Tides etc from external data

The record structure is illustrated in the following diagram and exclusively applies to SIR_FDM_2_ product type. The repetition frequency of each sub-structure is 1Hz, therefore the groups are conceptual rather than physical.

Repetition of sub-structure				
x1	x1	x1	x1	x1
Time & Orbit Group	Range Group	Corrections Group	SWH & Backscatter	Geophysical Group

Where 1Hz 'averaged' values are listed below, they are created from the 20Hz measurements at the 1Hz location given in the L1b product. This is nominally the centre of the 1-20 valid measurements in the 20Hz block. The average is created by linear regression to the 1Hz location with rejection of outliers.

ID	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
Time and orbit Group					
1.	Data Record Time (MDSR Time Stamp)	TAI	sl+2*ul	12	12
2.	20 Hz Time differences [0..19]	μ-s	sl	20*4	80
3.	Latitude of measurement	10^{-1} μ-degree	sl	4	4
4.	20 Hz Latitude of measurement [0..19]	10^{-1} μ-degree	sl	20*4	80
5.	Longitude of measurement	10^{-1} μ-degree	sl	4	4
6.	20 Hz Longitude of measurement [0..19]	10^{-1} μ-degree	sl	20*4	80
7.	Record Counter	-	ul	4	4
8.	MCD	-	ul	4	4
9.	Altitude of COG above reference ellipsoid	mm	sl	4	4
10.	20 Hz Altitude of COG above reference ellipsoid [0..19]	mm	sl	20*4	80
11.	Instantaneous altitude rate derived from orbit	mm/s	ss	2	2
12.	Spares	-	uc	2*1	2
	Sub-total size				**356**
Range Measurements Group					
13	CFI retracker range to ocean surface	mm	ul	4	4
14	20 Hz CFI range [0..19]	mm	ul	20*4	80
15	Standard deviation of 20 Hz CFI range	mm	us	2	2
16	Number of 20 Hz valid points for CFI range		us	2	2
17	Ocean range averaging status flags		ul	4	4
18	Averaged OCOG range	mm	ul	4	4
19	20 Hz OCOG range [0..19]	mm	ul	20*4	80
20	Standard deviation of 20 Hz OCOG range	mm	us	2	2
21	Number of 20 Hz valid points for OCOG range		us	2	2
22	OCOG range averaging status flags		ul	4	4
	Sub-total size				**184**
Corrections Group					
23	Doppler correction	mm	ss	2	2
24	Dry Tropospheric correction	mm	ss	2	2
25	Model Wet Tropospheric correction	mm	ss	2	2
26	Inverse Barometer correction	mm	ss	2	2
27	High Frequency Variability DAC correction	mm	ss	2	2
28	Ionospheric correction	mm	ss	2	2
29	Sea State Bias correction (EM Bias)	mm	ss	2	2
30	Spare (reserved for future use)	-	ss	2	2
31	Spare (reserved for future use)	-	ss	2	2

ID	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
32	Spare (reserved for future use)	-	ss	2	2
	Sub-total size				**20**
	SWH & Backscatter Group				
33	Averaged Square of Significant Wave Height	mm^2	sl	4	4
34	Averaged Significant Wave Height	mm	ss	2	2
35	Spare		ss	2	2
36	20 Hz SWH-squared [0..19]	mm^2	sl	20*4	80
37	Standard deviation of 20 Hz SWH-squared	$1.0x10^{-3}$ m^2	ss	2	2
38	Number of 20 Hz valid points for SWH-sq	-	us	2	2
39	SWH-squared averaging status flags	-	ul	4	4
40	Spare	-	ss	2	2
41	Corrected averaged ocean backscatter coefficient	dB/100	ss	2	2
42	20 Hz ocean backscatter coefficient [0..19]	dB/100	Ss	20*2	40
43	Standard deviation of 20 Hz CFI backscatter coefficient	dB/100	Us	2	2
44	Number of 20 Hz valid points for CFI backscatter coefficient	-	us	2	2
45	Ocean backscatter averaging status flags	-	ul	4	4
46	Spare	-	ss	2	2
47	Corrected averaged OCOG backscatter coefficient	dB/100	ss	2	2
48	20 Hz OCOG backscatter coefficient [0..19]	dB/100	ss	20*2	40
49	Standard deviation of 20 Hz OCOG backscatter coefficient	dB/100	us	2	2
50	Number of 20 Hz valid points for OCOG backscatter coefficient	-	us	2	2
51	OCOG backscatter averaging status flags	-	ul	4	4
52	off nadir angle of the satellite from platform data	$deg/10^4$	sl	4	4
53	Spare - reserved for future use	-	sl	4	4
	Sub-total size				**208**
Geophysical Group					
54	Mean Sea Surface height (MSS)	mm	sl	4	4
55	Geoid from standard model	mm	sl	4	4
56	Ocean Depth / Land Elevation (ODLE)	mm	sl	4	4

ID	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
57	Total ocean tide (solution 2)	mm	ss	2	2
58	Long period ocean tide	mm	ss	2	2
59	Ocean loading tide (solution 2)	mm	ss	2	2
60	Solid earth tide height	mm	ss	2	2
61	Geocentric pole tide height	mm	ss	2	2
62	Altimeter wind speed	mm/s	ss	2	2
63	U-component of the model wind vector	mm/s	ss	2	2
64	V-component of the model wind vector	mm/s	ss	2	2
65	20 Hz ku-band peakiness [0..19]	-	us	20*2	40
66	Ocean retracking quality [20bits]	flags	ul	4	4
67	Altimeter surface type flag	flags	us	2	2
68	Spare (reserved for sea ice flag)	flags	us	2	2
	Sub-total size				**76**
				Total Size	844 Bytes

Table 3-1 FDM L2 MDS

Field 1) MDSR Time Stamp corresponding to satellite overhead location for the 1Hz measurement at position given by 1Hz Latitude and Longitude field 3 & field 5

Field 2) 20 Hz time - to be added to Time Stamp to give time of each high-rate measurement. It may be negative

Field 3) Latitude at 1Hz - Corresponding to Nadir. Units are 10^{-1} μdegrees.

Field 4) Latitude at 20Hz - Corresponding to Nadir. Units are 10^{-1} μdegrees.

Field 5) Longitude at 1Hz - Corresponding to Nadir. Units are 10^{-1} μdegrees.

Field 6) Longitude at 20Hz - Corresponding to Nadir. Units are 10^{-1} μdegrees.

Field 7) Record counter increment by 1 for each record in the L2 product.

Field 8) L2 MCD - Measurement confidence flags. Generally the MCD flags indicate problems when set. If the whole MCD is 0 then no problem and nominal conditions were detected. Serious errors (bold style in the table) are indicated by setting bit 31 (SS bit 0). In which case the block must not be processed. Other error settings can be regarded as warnings. This field is copied from the MCD stored in input L1b, except for the 31 in which the SIRAL Identifier is stored by the Specialized FDM Processor.

Definition	PDS Bit	SS Bit	Setting
Block degraded	31	0	0= OK, 1= degraded **(set if the block should not be processed -** conditions are indicated in **bold** in this table**)**
Blank Block	30	1	0= OK, 1= Blank block inserted for record padding
Datation degraded	29	2	0= OK, 1= datation is bad or not set
Orbit propagation error	28	3	0= OK, 1= error (returned by CFI or by independent check)
Orbit file change	27	4	0= OK, 1= Orbit file has changed w.r.t. previous record
Orbit discontinuity	26	5	0= OK, 1= discontinuity (e.g. gap)
Echo Saturation from L0	25	6	0= OK, 1= saturated (from echo saturation flag in the telemetry)
Other Echo error (e.g. empty waveform)	24	7	0= OK, 1= echo error (set if either Echo Rx1 or Rx2 Error bit is set)
Receive Ch1 error for SIN	23	8	0= OK, 1= degraded or missing
Receive Ch2 error for SIN	22	9	0= OK, 1= degraded or missing
Window Delay Inconsistency	21	10	0= OK, 1= degraded, value out of range or computation error
AGC Inconsistency	20	11	0= OK, 1= degraded, value out of range or computation error
CAL 1 Correction Missing	19	12	0= OK, 1= missing or not applied
CAL1 from IPF DB used	18	13	0= default not used 1= default from IPF DB used
DORIS USO correction missing	17	14	0= OK, correction available 1= correction factor not available
Complex Cal1 from IPF DB used	16	15	0= default not used 1= default from IPF DB used
TRK Echo Error	15	16	0= OK, 1= degraded tracking echo
Echo Rx1 Error	14	17	0= OK, 1= bad raw echo
Echo Rx2 Error	13	18	0= OK, 1= bad raw echo
Noise Power Measurement Inconsistency	12	19	0= OK, 1= degraded, value out of range or computation error
Azimuth Calibration Missing	11	20	0= OK, Azimuth calibration applied 1= No Azimuth calibration
Azimuth Calibration from IPF DB	10	21	0= default not used 1= default from IPF DB used

Definition	PDS Bit	SS Bit	Setting
Range window calibration function missing	9	22	0= OK, calibrated 1= No calibration applied.
Range window calibration function from IPF DB	8	23	0= default not used 1= default from IPF DB used
Phase Perturbation Correction application	7	24	0 = applied , 1 = not applied
CAL 2 Correction Missing	6	25	0= OK, 1= missing or not applied
CAL 2 from IPF DB used	5	26	0= default not used 1= default from IPF DB used
Power scaling error	4	27	0= OK, 1= Error in power scaling
Attitude Correction Missing	3	28	0= OK, Attitude correction applied 1= Not corrected
Attitude Interpolation Error	2	29	0 = OK 1 = Interpolation Error, attitude is wrong
SIRAL Side	1	30	0 = Nominal, 1 = Redundant
Phase Perturbation Correction mode	0	31	0 = computed by CCAL1 1 = default from IPF DB used (applicable only to SIN data)

Field 9) Altitude at 1 Hz- Altitude of the Satellite CoG above reference ellipsoid at Nadir.

Field 10) Altitude at 20 Hz- Altitude of the Satellite CoG above reference ellipsoid at Nadir.

Field 11) Altitude rate - instantaneous rate of change of Altitude with time (from L1b)

Field 12) Spares

Field 13) Ocean Range retracked by the CFI ocean retracker. Set to 65535 in case of error.

Field 14) Ocean Range at 20 Hz retracked by the CFI retracker. Set to 4294967295 in case of error.

Field 15) Standard deviation of 20 Hz CFI retracked range. Set to 65535 in case of error.

Field 16) Number of 20 Hz valid points for CFI retracked range measurement. Set to 65535 in case of error.

Field 17) CFI retracked range averaging status bitmask. PDS bit 0 indicates if the first of the 20Hz values was used in the averaging and PDS bit 19 if the last was used. PDS bits 20-30 are unused and PDS bit 1 is set if the master fail flag was set by the CFI call. Bits are set if the value was used and are clear otherwise. if the master fail bit is set then the values stored in

the fields 13, 14, 15, 16 should be ignored.

Field 18) Ocean Range retracked by the OCOG algorithm retracker. Set to 65535 in case of error.

Field 19) Ocean Range at 20 Hz retracked by the OCOG retracker. Set to 4294967295 in case of error.

Field 20) Standard deviation of 20 Hz OCOG range measurement. Set to 65535 in case of error.

Field 21) Number of 20 Hz valid points for OCOG retracked range measurement. Set to 65535 in case of error.

Field 22) OCOG retracked range averaging status bitmask. PDS bit 0 indicates if the first of the 20Hz values was used in the averaging and PDS bit 19 if the last was used. PDS bits 20-30 are unused and PDS bit 1 is set if the master fail flag was set by the OCOG call. Bits are set if the value was used and are clear otherwise. if the master fail bit is set then the values stored in the fields 18, 19, 20, 21 should be ignored.

Field 23) Doppler Correction to Range - caused by the Doppler shift in the line of sight to the Nadir direction. The correction is applied in the range measurement. Set to 32767 in case of error.

Field 24) Dry Tropospheric Correction to be added (if required by the user) to range measurement to correct for the propagation delay of the radar pulse, caused by the dry-gas component of the Earth atmosphere. Set to 32767 in case of error.

Field 25) Wet Tropospheric Correction to be added (if required by the user) to range measurement to correct for the propagation delay of the radar pulse, caused by the H_2O component of the Earth atmosphere. Set to 32767 in case of error.

Field 26) Inverse Barometric Correction to be added (if required by the user) to range measurement to correct for the depression of the ocean surface caused by the local barometric pressure. Set to 32767 in case of error.

Field 27) High Frequency Variability to be added (if required by the user) to range measurement to correct for both the Inverse Barometric effect and the high-frequency ocean response to wind forcing. Set to 32767 in case of error.

Field 28) Ionospheric Correction to be added (if required by the user) to range measurement to correct for the delay of the radar pulse caused by free electrons in the ionosphere. Computed from the GIM or Bent ionospheric model as requested by the Processor Configuration file. Set to 32767 in case of error.

Field 29) Sea State Bias correction (a.k.a. EM bias correction) empirical correction proportional to the

significant wave height which compensates for the asymmetric shape of ocean waves- to be added to range (if required by the user). This is computed by the geophysical CFI library. Set to 32767 in case of error.

Field 30) spare

Field 31) spare

Field 32) spare

Field 33) square of the 1Hz SWH - in mm^2, NOTE that this can be a negative value so the user must take care if taking a square root (negative values are possible because SWH^2 is derived from (SigmaC^2 - PTR_width^2), the difference between the expected and observed width of the leading edge of the waveform, which can be <0). Returned by CFI. Set to 2147483647 in case of error.

Field 34) SWH at 1Hz returned by CFI. Set to 32767 in case of error.

Field 35) spare - (for byte alignment)

Field 36) SWH squared at 20Hz (see note for field 33), returned by CFI. Set to 2147483647 in case of error.

Field 37) Standard deviation of SWH squared at 20Hz, returned by CFI. Set to 65535 in case of error.

Field 38) Number of 20Hz valid points for SWH squared, returned by CFI. Set to 65535 in case of error.

Field 39) SWH squared averaging status bitmask. PDS bit 0 indicates if the first of the 20Hz values was used in the averaging and PDS bit 19 if the last was used. PDS bits 20-30 are unused and PDS bit 1 is set if the master fail flag was set by the CFI call. Bits are set if the value was used and are clear otherwise. if the master fail bit is set then the values stored in the fields 34, 36, 37, 38 should be ignored.

Field 40) spare - (for byte alignment)

Field 41) Corrected ocean backscatter coefficient (Sigma0) corrected for calibrations and CFI retracker. Set to 32767 in case of error.

Field 42) 20 Hz Corrected ocean CFI backscatter coefficient (Sigma0) Set to 32767 in case of error.

Field 43) Standard Deviation of 20Hz corrected ocean CFI backscatter coefficient. Set to 65535 in case of error.

Field 44) Number of valid points of 20Hz corrected ocean CFI backscatter coefficient. Set to 65535 in case of error.

Field 45) Ocean CFI backscatter averaging status bitmask. PDS bit 0 indicates if the first of the 20Hz values was used in the averaging and PDS bit 19 if the last was used. PDS bits 20-30 are unused and PDS bit 1 is set if the master fail flag was set by the CFI call. Bits are set if the value was used and are clear otherwise. if the master fail bit is set then the values stored in the fields 41, 42, 43, 44 should be ignored.

Field 46) spare - (for byte alignment)

Field 47) Corrected OCOG backscatter coefficient (Sigma0) corrected for calibrations and OCOG retracker. Set to 32767 in case of error.

Field 48) 20 Hz Corrected OCOG backscatter coefficient (Sigma0). Set to 32767 in case of error.

Field 49) Standard Deviation of 20Hz corrected OCOG backscatter coefficient. Set to 65535 in case of error.

Field 50) Number of valid points of 20Hz corrected OCOG backscatter coefficient. Set to 65535 in case of error.

Field 51) OCOG backscatter averaging status bitmask. PDS bit 0 indicates if the first of the 20Hz values was used in the averaging and PDS bit 19 if the last was used. PDS bits 20-30 are unused and PDS bit 1 is set if the master fail flag was set by the CFI call. Bits are set if the value was used and are clear otherwise. if the master fail bit is set then the values stored in the fields 47, 48, 49, 50 should be ignored.

Field 52) Off Nadir angle from satellite data. This is the platform mispointing angle derived from the Star Trackers.

Field 53) Spare - reserved for possible future use as Off Nadir angle from waveform data.

Field 54) Mean Sea Surface from CryoSat UCL04 model. Set to 2147483647 in case of error.

Field 55) Geoid from CFI library. Set to 2147483647 in case of error.

Field 56) ODLE - Ocean Depth / Land Elevation. Set to 2147483647 in case of error.

Field 57) Total Geocentric Ocean Tide to be added to the range measurement used to compute height to remove the effect of ocean tides. This field includes both field 58 and field 59. Set to 32767 in case of error.

Field 58) Long-Period Equilibrium Ocean Tide to be added to the range measurement in order to remove the effect of the oceanic response to the single tidal forcing. This component is already included in the total geocentric ocean tide value of field 57. Set to 32767 in case of error.

Field 59) Ocean Loading Tide to be added to the range measurement to remove the effect of local distortion to the Earth crust caused by increasing weight of ocean as local water tide rises. This component is already included in the total geocentric ocean tide value of field 57. Set to 32767 in case of error."

Field 60) Solid Earth Tide to be added to the range to remove the effect of local tidal distortion in the Earth crust. Set to 32767 in case of error.

Field 61) Geocentric Polar Tide to be added to the range to remove a long-period distortion of the Earth' crust. Although called a 'tide' this is in fact caused by variations in centrifugal force as the Earth rotational axis moves its geographic location. Set to 32767 in case of error.

Field 62) Altimetric Wind Speed computed from backscatter coefficient. Set to 32767 in case of error.

Field 63) U-component of the ECMWF model wind vector. Set to 32767 in case of error.

Field 64) V-component of the ECMWF model wind vector. Set to 32767 in case of error.

Field 65) Peakiness of the echo in the L1b product. Units are 1/1000. Set to 65535 in case of error.

Field 66) Ocean retracking quality flag using 20 bits to indicate OK/error.
This 1Hz flag contains information about the retracking of the 20Hz records that were used to create the 1Hz record.
PDS Bits 0-19 (SS Bits 31-12) correspond to the 20Hz records. The other bits are unused.
The bit corresponding to a 20Hz record is set to 1 if the CFI ocean retracker executed successfully for that record and is set to 0 otherwise.

Field 67) Surface type flag - enumerated key to classify surface at nadir provided by a model. This flag is provided at 1 Hz. See definitions in table 2.3.3.1-3.

Field 68) Spare

4 CRYOSAT LEVEL-2 PRODUCTS NAMING RULES

The file names follow the official conventions as for [MASTER-ICD].

MM_CCCC_XXXXXXXXXX_yyyymmdd_hhmmss_YYYYMMDD_HHMMSS__***bvvv***.ttt

MM = CS (Mission Identifier)

CCCC = file class which can be: OFFL (Off Line Processing/Systematic)
NRT_ (Near Real Time)
RPRO (ReProcessing)
TEST (Testing)
LTA_ (Long Term Archive)

yyyymmdd_hhmmss = validity start time corresponds to the input Level 1 UTC start time (according to the change request [CRYOS_CR-3])

YYYYMMDD_HHMMSS = validity stop time corresponds to the input Level 1 UTC stop time (according to the change request [CRYOS_CR-3])

b is the baseline identifier as read-in from the PCONF

vvv is the version number of the file

ttt is the extension: HDR for Header and DBL for binary data

XXXXXXXXXX is the file type. For the Level-2 products, this is defined in the following table:

File Type	**Description**
SIR_LRM_2_	L2 Product from Low Resolution Mode Processing
SIR_FDM_2_	L2 Product from Fast Delivery Marine Mode Processing
SIR_SIN_2_	L2 Product from SAR Interferometric Processing
SIR_SID_2_	L2 Product from SIN Degraded Processing
SIR_SAR_2_	L2 Product from SAR Processing
SIR_GDR_2_	L2 Consolidated Product
SIR_LRMI2_	In-depth L2 Product from LRM Processing
SIR_SINI2_	In-depth L2 Product from SIN Processing
SIR_SIDI2_	In-depth L2 Product from SIN Degraded Process.
SIR_SARI2_	In-depth L2 Product from SAR Processing

END OF DOCUMENT