esrin

Via Galileo Galilei
Casella Postale 64
00044 Frascati
Italy
T +39 06 9418 01
F +39 06 9418 0280
www.esa.int

DOCUMENT

Sentinels POD Service File Format Specifications

GMES-GSEG-EOPG-FS-10-0075_v1.24_Sentinels POD Service File Format Specification

Prepared by	**Sentinels POD team**
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7 QUATERNIONS FILES

7.1 Processed Quaternions Files for POD Data Hub (AUX_PROQUA)

7.1.1 Mission applicability

S-1, S-2, S-3

7.1.2 Description

Every Sentinel provides its attitude in the RAW data packages (L0 binary data). This information is decoded into a time tagged quaternions file (ASCII), containing the attitude of the satellites.
The quaternions can be raw (untouched), or processed. Processed quaternions can be interpolated, to align the quaternion to the closer integer epoch, or simulated, in case of data gaps. Each quaternion is flagged to indicate whether is raw, interpolated or simulated.
The data gaps within the real quaternions are filled with simulated attitude using the nominal attitude of each satellite. Available attitude modes are summarized in Table 7-1, relating them to their corresponding mission and indentifier (mode ID).

Table 7-1: Attitude modes

Mission	Mode	Mode ID
Sentinel-1	No mode	10
	Normal Pointing Mode (NPM)	15
	Orbit Control Mode (OCM)	16
Sentinel-2	Initial Acquisition Mode (IAM)	21
	Normal Mode (NOM)	22
	Orbit Control Mode (OCM)	23
	Safe Mode (SFM)	24
Sentinel-3	Flight path pointing guidance (GDC_FLP)	0
	Geocentric pointing guidance (GDC_GEO)	1
	Geodetic pointing guidance (GDC_GED)	2
	Geocentric pointing with yaw-steering guidance (GDC_YEO)	3
	Geodetic pointing with yaw-steering guidance (GDC_YED)	4
	Heliocentric pointing guidance (GDC_SUN)	5

The 123 Euler Angles rotation (pitch (Φ) – roll (θ) – yaw (φ)) of a particular epoch is related to a quaternion of scalar part Q0 and vectorial part (Q1, Q2, Q3) as follows:

$\theta = \text{atan2}(2 * (Q2 * Q3 + Q0 * Q1), (1 - 2 * (Q1 * Q1 + Q2 * Q2)))$
$\Phi = \text{asin}(-2 * (Q1 * Q3 - Q0 * Q2))$
$\varphi = \text{atan2}(2 * (Q1 * Q2 + Q0 * Q3), (1 - 2 * (Q2 * Q2 + Q3 * Q3)))$

7.1.3 Dissemination

The processed platform files are made available to Copernicus Data Hub by the Copernicus POD Service at the Data Hub FTP server.

7.1.4 Data Latency/Coverage

The processed quaternions files are generated by the CPOD Service with a timeliness of 21 days for S-1 and S-2, and 25 days for S-3 (they are aligned to the generation of NTC products). Each one covers 24 hours of data, starting from the beginning of the day (00:00:00 GPST), with a temporal rate aligned to the RAW data (typically, 1 second).

7.1.5 Accuracy

The accuracy of these produts is in accordance with the operational attitude products, already addressed in sections 5.1.5 and 5.2.5 for Sentinel-1 and Sentinel-3, respectively. In the case of the Sentinel-2 mission, as there are not official attitude products, there is no an established requirement in this document. However, comparisons between the real attitude and the simulated attitude yield an agreement better than 20 mdeg, 40 mdeg and 20 mdeg in roll, pitch and yaw, respectively.

7.1.6 Data Volume

Around 1.5 Mbyte when compressed.

7.1.7 Naming Convention

The applicable file naming convention is defined in [AD-2] and detailed in Section 2.

Example of quaternions file name:
S1A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.TGZ
S2A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.TGZ
S3A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.TGZ

7.1.8 Data Structure and Definition

The data structure is described in section 3.1 except that the XML Header and the Data Block are separated in two independent files, which the same filename but different extension:

- XML Header File having extension .HDR
- Data Block File having extension .DBL

Each quaternions product is composed by these two files packaged in a TGZ file. The filename of the HDR and DBL is equal to the TGZ, except the extension.

Example:

S3A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.TGZ

S3A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.HDR

S3A_OPER_AUX_PROQUA_POD__20100101T000000_V20100101T010000_20100101T020000.DBL

The XML Header File is an ASCII file containing data information that users can easily access for identifying the product without need to look inside the Data Block File.

The Data Block File is the quaternions file, whose format is described in section 7.1.8.2.

7.1.8.1 XML Header File

The XML Header file contains general information identifying the product. It is composed by:

- a Fixed Header section
- a Variable Header section

7.1.8.1.1 Fixed Header

Table 7-2: Fixed Header of Quaternions Files

XML Tag Name Level 1	XML Tag Name Level 2	Value	Description
File_Name			Product File Name as defined in section 7.1.7 without extension
File_Description		Quaternions File	Description of the file
Notes		Variable	Free Text
Mission		Sentinel-N#	N indicates the spacecraft family; 1,2,3 # indicates the spacecraft model; A,B
File_Class		OPER	This field is part of the File Name and indicates the type of processing (section 7.1.7)
File_Type		AUX_PROQUA	This field is part of the file name (section 7.1.7)
Validity_Period			
	Validity_Start	Variable	UTC Validity Start Date UTC=yyyy-mm-ddThh:mm:ss
	Validity_Stop	Variable	UTC Validity Stop Date UTC=yyyy-mm-ddThh:mm:ss
File_Version		XXXX	The value of the File_Version field starts from 0001 and increases by 1 every time a new version of the same file is generated.
Source			
	System	POD_	Name of the Ground Segment component creating the product
	Creator	POD_	Name of the tool creating the product

XML Tag Name Level 1	XML Tag Name Level 2	Value	Description
	Creator_Version	Variable	Version of the service software generating the product
	Creation_Date	Variable	This field gives the UTC date of the generation of the file UTC=yyyy-mm-ddThh:mm:ss

7.1.8.1.2 XML Specific product header

Table 7-3: Specific Header of Quaternions Files

XML Tag Name Level 1	Value	Description
SPH_Descriptor	Quaternions File	Name describing the Specific Product Header
Validity_Start	Variable	GPS=yyyy-mm-ddThh:mm:ss.uuuuuu GPS of the first record of the original file
Validity_Stop	Variable	GPS=yyyy-mm-ddThh:mm:ss.uuuuuu GPS of the last record of the original file
Attitude_Mode	Variable	Attitude mode as defined in Table 7-1
Attitude_ID	Variable	Attitude identifier as defined in Table 7-1

7.1.8.2 Quaternions Data Block File

The Data Block File contains firstly five lines that represent a header. The entries of this header are discribed in Table 7-4 below.

Table 7-4: Header structure in Data Block of Quaternions File

Header Entry	Description

Parameter list	List of elements correlated to the body columns:
	• Q_COMPR: real part of the quaternion
	• Q_COMP1: first component of the vectorial part of the quaternion
	• Q_COMP2: second component of the vectorial part of the quaternion
	• Q_COMP3: third component of the vectorial part of the quaternion
	• ATT_MODE: attitude mode ID as defined in Table 7-1 represented by the quaternion
	• SOURCE: source of the data.
	  ○ r = real data
	  ○ i = interpolated data
	  ○ s = simulated data

Satellite	Sentinel-N#; N: indicates the spacecraft family; 1, 2, 3 #: indicates the spacecraft model; A,B

Header Entry	Description
Start date (GPS)	GPS time of the first record of the body (format: yyyy/mm/dd hh:mm:ss)
End date (GPS)	GPS time of the last record of the body (format: yyyy/mm/dd hh:mm:ss)
Step (sec)	Temporal step between consecutive records of the body. This field is null if the step is variable
Nr. records	Number of records in the body

Then, the body is represented by a list of time tagged quaternions. The first column of the body is the GPS time of the corresponding quaternion, while the others map one-by-one and in the same order the Parameter List. An example of the quaternions data block is:

```
# Parameter list  : Q_COMPR   Q_COMP1   Q_COMP2   Q_COMP3   ATT_MODE  SOURCE
# Satellite       : Sentinel-3A
# Start date (GPS): 2017/02/19 00:00:00
# End date   (GPS): 2017/02/19 23:59:59
# Step (sec)      :
# Nr. records     : 86400
2017/02/19 00:00:00.000     0.255594     0.434377     0.829076    -0.242120  4 r
2017/02/19 00:00:01.000     0.255180     0.434519     0.829202    -0.241868  4 r
2017/02/19 00:00:02.000     0.254767     0.434661     0.829328    -0.241617  4 r
2017/02/19 00:00:03.000     0.254354     0.434802     0.829454    -0.241365  4 r
2017/02/19 00:00:04.000     0.253941     0.434944     0.829580    -0.241114  4 r
2017/02/19 00:00:05.000     0.253527     0.435085     0.829705    -0.240863  4 r
2017/02/19 00:00:06.000     0.253114     0.435227     0.829830    -0.240611  4 r
```