SCIAMACHY

Level 0 to 1b Processing

Input / Output Data Definition

ENV-TN-DLR-SCIA-0005
Issue 8
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approved	G. Lichtenberg	MF-ATP	ENVISAT Project Manager	30.10.2014

Change Record

Issue	*Rev.*	*Date*	*Page*	*Description of Change*
Draft	-	12.8.96	all	completely new, only the general chapters, the structure of the document and a preliminary description of the level 1b product were given
Draft	A	23.09.96	all	various changes in many section
1	-	19.11.96	all	various changes in many section according to comments by ESTEC
2	-	29.07.96	all	many changes according to: - better understanding of the algorithm (during preparation of the DPM and prototype implementation) and - due to changes in reference documentation
				General changes are given here:
				- description of orbit file was omitted
				- monitoring product was omitted
				- application data format description (extracted 1b data before) was introduced as own section
				- size of MPH was changed due to [R11]
				- notation of field names and contents in SPHs due to [R11]
				- SPH of auxiliary files was changed due to [R11]
				- product component overview tables were introduced
				- definition of DS_NAME in the DSDs was introduced
			29 ff.	Level 1b Product
				- leakage current parameter were provided with error values
				- SZA field in the variable leakage current and spectral calibration parameters was replaced by orbit phase
				- sun reference spectrum was provided with PMD information
				- polarisation sensitivity parameters were changed to different variable names from DPM
				- Errors on Key Data GADS was introduced
				- BSDF GADS was omitted
				- more detail information for the SQADS was provided
				- States ADS was provided with MDS structural information
				- length of PMD data packets was fixed
				- description of MDS construction rules was completely reworked
			64 ff.	Processed Calibration Products
				- same changes to GADS of calibration products as for level 1b product
				- radiance sensitivity GADS of the sun reference spectrum product was omitted
			76 ff.	Auxiliary Files
				- description of an initialisation files was introduced
				- 5 new Key Data types were introduced in the Key Data file
				- spare m-factor types were introduced for future use
			105 ff.	Compound Data Types
				- End pixel number was changed to cluster length in the cluster configuration type

Issue	*Rev.*	*Date*	*Page*	*Description of Change*
				- description of signal values was completely changed (no S1024 or similar type anymore)
				- fractional polarisation values were changed to variables in DPM and error values were introduced
				- Co-ordinate type was changed to MDA style
				- sub-satellite point was introduced in geolocation types
				- special calibration geolocation was omitted, there is now one geolocation record for all no-observational measurements
			112	- fully calculated example for a MDS construction was given
3	-	17.10.97	29 ff.	Change of the level 1b product format according to comments made by Thompson (less and fixed number of MDSs)
			before 64	Exclusion of the application data format from the present I/O DD
			29 ff.	Inclusion of additional GADS for the newly calculated in-flight calibration parameters and definition of the auxiliary calibration products only for input
			all	other minor changes according to internal and external comments (all of which are marked by a revision bar)
4	-	18.02.98	Changes according to comments made by Thomson/MDA to get in agreement with the ENVISAT-1 Product Specification [R11] and to include product elements for parallel processing.	
			10	- Update of ENVISAT Product Specification reference
			16	- Change of Figure 1 to include Attitude File
			17	- Inclusion of Attitude File
			20	- Update of I/O file summary list: change of identifiers according to Prod. Spec. (also changed in the various file descriptions) and inclusion of orbit and attitude file
			29	- Level 1b Product figure was changed
			31	- Level 1b Product component table was changed
			22	- Notation of blank-space characters was defined
			22	- Notation of units in the product headers was defined
			32 ff.	- SHP of the Level 1b Product was updated
			46	- Newly calculated leakage current parameters record was changed from GADS to ADS and moved behind the Level 0 header ADSs
			37 ff.	- Geolocation and Summary of Quality ADS moved directly after the DSD records
			38	- Wavelength differences in SQADS changed from 20 singel values to mean value and standard deviation
			34	- Additional 5 fields added in the SPH to described the number of Nadir, Limb, Occultation, Monitoring states in the level 1b product and those measurement states which have not processed and written into the product
			44	- Reason code for the attachment flag was added in the States ADS
			44	- Relative offset field in the States ADS was omitted
			51, 53	- Type of the Quality indicator in the MDSR was changed from 'sl' to 'sc'

Issue	*Rev.*	*Date*	*Page*	*Description of Change*
			71	- Initialisation File, External State Parameters, State number, number of elements was corrected from 2 to 1
			84, 85	- Dimension KeyData parameter 25. and 26. have been reduced from '2' to '1'
			22, 95	- Notation of geographical co-ordinates was changed from ISO 6703 to ISO 6709
			52	- Monitoring example added for the MDSR construction, including fully calculated table
			17	- Comment about in-flight calibration parameter files in the 'Processing Overview' section was updated
			46, 47	- New ADSs for PPG/Etalon parameters, spectral calibration parameters and the sun reference spectrum have been added
			Additional changes:	
			38	- In SQADS the rainbow flag was added and the number of spare flags was reduced to 10
			41, 47, 67	- The average mirror positions were added to the sun reference GADSs (level 1b product and auxiliary file) and ADS (level 1b product)
			18, 42, 68, 71	- Fixed grid for the polarisation and radiance sensitivity GADSs were introduced
			48, 51	- The quality flags in the level 1b product MDSR were changed to saturation and sun glint / rainbow flags and reduced in size
			48, 49, 51	- The frequency of the integrated PMDs was increased to 32 Hz due to H/W change
			49, 51, 94	- The fractional polarisation values were changed to include also the U parameter for the overlapping regions
			71	- A processing category indicator was introduced the external parameter component of the initialisation file
			82	- The straylight parameter of the Key Data file was changed to have 4 dimensions
			83, 86	- A remark about unused Key Data parameters was added
			89 - 91	- The m-factor parameters were put on a wavelength grid
4	A	18.03.98	46	- Mean noise record was added to the newly calculated leakage current parameter ADS
			38	- Mean difference of leakage current per channel was also given for the PMDs
			40, 46, 60	- Bad pixel mask was added to the PPG/Etalon parameters
			61	- Data volume of PPG/Etalon auxiliary file was changed
			47	- Comment about wavelength error was added to the newly calculated spectral calibration parameters
			71	- A state set-up integration time was added to the external state parameters (spare was reduced)
			86	- Data volume of Key Data file was changed
			91	- Data volume of m-factor file was changed
			10	- Update of reference documents (CFI and PGICD)
			35 - 37	- Clear ordering of the level 1b product DS_NAMES was added

Issue	*Rev.*	*Date*	*Page*	*Description of Change*
			70	- DS_NAMES for the initialisation file was added
			88 ff.	- Clear ordering of the m-factor DS_NAMES was added
			83	- Blocking shift parameter for the SLS spectral lines added in the Key Data file
			85	- Contamination shift parameter for the Fraunhofer lines added in the Key Data file
			44	- Indices to the variable fraction of the leakage current and the spectral calibration parameters were replaced by an orbit phase of the state
4	B	27.03.98	17	- Attitude file format is now available
			20	- Identifier of initialisation file fixed
			23	- ISO identifier for geographical co-ordinates fixed
			42	- Missing remark about radiance sensitivity added
4	C	27.08.98	22	- The unit BU· s was added
			23	- Combined data structure concerning GeoCal was fixed
			37	- The name of the spare DSD record was deleted
			37	- The SQADS component was corrected (field 6); comment about the meaning of the flags was added
			38	- The meaning of the LADS component was explained for measurement states other than nadir
			44	- The States ADS was updated
			49	- Formulae for product size calculation were updated for other measurements than nadir, L_{head} value was fixed
			69	- Identifier for initialisation file was fixed
			72	- Update for variable nature of the grids
			85	- Memory effect is different for the channels, was fixed
			94	- Cluster data type field added
			97	- Combined data structure L0Hdr described
5		21.07.00	*page*	*page numbers refer to issue 4/C*
			40	- Addition of a precise wavelength array as a spectral GADS
			40	- Modification of PPG/Etalon GADS
			46	- Modification of PPG/Etalon ADS
			41	- Modification of Sun Mean Reference GADS
			47	- Modification of Sun Mean Reference ADS
			38	- Addition of the Static Instrument Parameter GADS
			95	- Modification of PolV compound data type (addition of GDF parameters
			37	- Modification of SQADS (addition of SAA region and hot pixel flag)
			96	- Addition of Doppler shift in Limb geolocation compound data type
			44	- Moving of straylight scaling factor from State ADS to MDS
			71	- Spectral template WLS now on keydata file, new PPG_0 template added
			72	- Measurement category added to the division of states into the various MDSs, please note moon scanning has been moved to the monitoring MDS
			46	- Addition of the Average Dark Measurement ADS

Issue	*Rev.*	*Date*	*Page*	*Description of Change*
			46	- Moved solar straylight quantities from Leakage ADS to Average Dark Measurement ADS
			52,54	- Inserted Red Grass flag in MDS records
			41,42	- Modified/new Polarisation Sensitivity and Radiance Sensitivity GADS
			43	- New Slit Function and Small Aperture Slit Function GADS
			94	- Compound data types ESig and ESigc for Epitaxx detector signals now equal to Reticon detector types RSig, RSigc.
			56ff	- Modified Calibration files according to new GADS's
			69ff	- Added Processing Categories GADS, new content of field 4 in Spectrum Templates GADS
			74ff	- Updated Parameters on Keydata file
			88ff	- Addition of new monitoring factor for ND filter
6		06.09.05	*page*	*page numbers refer to issue 5*
			11, 18, 21	- Reference to attitude (AOCS) file
			34	- SPH field 11: init file version & decontamination flag
			43	- More precise definition of orbit phase
			45,55	- Units on the SMR (G)ADS
			45,55	- New Identifiers on the SMR (G)ADS
			55	- Uncalibrated solar ADS
			73	- Sun reference file has one GADS (corrected description)
			78	- Size of Static Parameter GADS increased to 20 kB
			82ff	- Key data parameters updated
			106	- Non-linearity in EPITAXX detector signal
6/A		04.04.06	*page*	*page numbers refer to issue 5*
			11	- Reference to DPM
			47	- Radiance sensitiv. GADS Nadir (corrected cut/paste error)
			73	- Sun reference file: replaced figure
7		03.08.09	*page*	*Page numbers refer to issue 6*
			10	- Introduction updated
			11, 38	- New reference to OCRs
			38	- Include LIMB_MESOSPHERE in Limb MDS
8		14.05.14	*Page*	*Page numbers refer to this issue*
			39	Added DSDs for the new database approach. Added DSD for CAL_INIT_FILE (SCI_LIC_AX).
8		25.09.14	39	Missing database DSD for ppgetalon added
8		25.09.14	105	Format of M-Factor Version 8.31 added
8		13.10.14	2,7,10ff,18,19,21,33ff,46ff,53,57,99	Revision of outdated parts

Issue	***Rev.***	***Date***	***Page***	***Description of Change***
8		30.10.14	10, 14, 18, 19, 21, 33ff, 37,39, 46, 53, 57, 98	Revision of outdated parts and format errors

Table of Content

List of Figures

1 Introduction

1.1 Purpose and Scope

SCIAMACHY is a joint project of Germany, The Netherlands and Belgium for atmospheric measurements. SCIAMACHY has been selected by the European Space Agency (ESA) for inclusion in the list of instruments for Earth observation research for the ENVISAT polar platform, which has been launched in 2002. The SCIAMACHY programme is currently in mission under the supervision of the SCIAMACHY science team (SSAG), headed by the Principal Investigators Professor J. P. Burrows (University of Bremen, Germany), Professor I.A.A. Aben (SRON, The Netherlands) and Dr. C. Muller (BIRA, Belgium).

The Quality Working Group has been installed in 2007 to intensify the development and implementation of the Algorithm Baseline for the operational data processing system of SCIAMACHY. Current members of the QWG are the University of Bremen (IFE) (Lead), BIRA, DLR, and SRON. The expertise of KNMI is brought in via an association with SRON.

The Remote Sensing Technology Institute (IMF) which has been founded in 1999 as split of German Remote Sensing Data Centre (DFD) and other DLR institutes, plays a major role in the design, implementation and operation of the SCIAMACHY ground processors (SGPs) which are part of the ENVISAT payload data segment (PDS). The present document is part of the technical documentation provided by DLR for the design and implementation of the SCIAMACHY level 1 processing software. The funding for these tasks had been available through the Deutsche Agentur für Raumfahrtangelegenheiten (DARA) in Bonn, now DLR, as part of the ENVISAT phase C/D grant. Through Phase E/F the funding is provided by the internal Programme Board of DLR.The present document provides a complete list of input/output data as required or generated by the processor. In particular detailed formats for the ancillary input data (especially instrument characterisation data), all types of calibration data and possible external data are provided.For version 8 of the operational processor the processing approach was changed: instead of using SciCal to generate ADFs, the processor stores and extracts data directly from a database that is internal to the processor. This approach enables us to track the measurements used for each calibration parameter, which was not possible with the old approach (for a deeper explanation see [R7]). The database approach is described in more detail in [R8]. The usage of auxiliary data files (ADFs) for inflight calibration was discontinued. Since the processor now directly generates the dynamic auxiliary data, the initialisation file used for SciCal (SCI_LIC_AX) became an input file for the processor.]). The database approach is described in more detail in [R8].

The M-factor files used for degradation correction are in a new binary format for version 8 and higher.

1.2 Documents

Following documents are applicable for this technical note:

[A1] ENVISAT-1 Ground Segment Concept, ESA/PB-EO(94)75, Issue 5, 20 September 1994

[A2] Algorithm Definition and Software Prototyping for SCIAMACHY Ground Processing up to Level 2, PO-SW-ESA-GS-0294, Issue 2, 8.9.95

[A3] ESA Software Engineering Standards, ESA PSS-05-0, Issue 2, Feb. 1991
The standards defined in this document are tailored by Appendix 3 of [A2]

The following documents are referenced:

[R1] SCIAMACHY Instrument Requirements Document, PO-RS-DAR-EP-0001, Issue 3 Rev. 1, 12.12.95

[R2] SCIAMACHY Operations Concept: I. Mission Scenarios, PO-TN-DLR-SH-0001/1, Issue 2, Rev. 0, 31.5.96

[R3] SCIAMACHY Operations Concept: II. Timeline Generation Rules and Reference Timelines, PO-TN-DLR-SH-0001/2, Issue 1, Rev. 0, 31.10.95

[R4] SCIAMACHY Operations Concept: III. Instrument States, PO-TN-DLR-SH-0001/3, Issue 2, Rev. 0, 25.7.96 (plus Annex from 29.10.96)

[R5] Guidelines for the Specification of Ground Processing Algorithms, PO-RS-ESA-GS-0252, Issue 1, 23.3.95

[R6] ENVISAT-1 Product Format Guidelines, PO-TN-ESA-GS-0242, Issue 5.0, 10.11.95

[R7] ENVISAT-1 Product Definition Guidelines, PO-TN-ESA-GS-0231

[R8] ENVISAT-1 Product Processing Guidelines, PO-TN-ESA-GS-0347, Issue 1.2, 8.5.96

[R9] Definition of Instrument Characterisation Data Base, PO-ID-DOR-SY-0037, Issue 1, 11.5.94

[R10] SCIAMACHY Calibration Plan, PL-SCIA-1000TP/022, Issue 2, 22.1.96

[R11] ENVISAT-1 Products Specification, PO-RS-MDA-GS-2009, Issue 3 Rev. C, 19.6.97

[R12] Payload to Ground Segment Interface Control Document, Volume 14: Measurement Data Definition and Format Description for SCIAMACHY, PO-ID-DOR-SY-0032, Issue 3, 14.1.97

[R13] SCIAMACHY Calibration Key Data, TN-SCIA-0000TP/128, Issue 0.6, 1.11.96

[R14] SCIAMACHY Product Definition, ENV-PD-DLR-SCIA-0001, Issue 1, 15.3.95

[R15] SCIAMACHY Level 0 to 1b Processing, Detailed Processing Model / Parameter Data List, ENV-TN-DLR-SCIA-0006, Issue 6, 20.12.2012

[R16] Re-engineering of Mission Analysis software for ENVISAT-1, PPF_POINTING software User Manual, PO-IS-DMS-GS-0559, Issue 5.4, 17.05.05

[R17] SCIAMACHY OCR Implementation, http://atmos.caf.dlr.de/projects/scops/

1.3 Abbreviations and Acronyms

A list of abbreviations and acronyms which are used throughout this document is given below:

ADS	Annotation Data Set
ADSR	Annotation Data Set Record
AO	Announcement of Opportunity
ASCII	American Standard Code for Information Interchange
ASM	Azimuth Scan Mirror
BCPS	Broadcast Pulse Signal
BSDF	Bi-directional Scattering Distribution Function
BU	Binary Unit
CFI	Customer Furnished Items
DARA	Deutsche Agentur für Raumfahrtangelegenheiten
DFD	Deutsches Fernerkundungsdatenzentrum
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
DOAS	Differential Optical Absorption Spectroscopy
D-PAC	German Processing and Archiving Centre
DS	Data Set
DSD	Data Set Description
DSR	Data Set Record
ENVISAT	Environmental Satellite
ESA	European Space Agency
ESM	Elevation Scan Mirror
ESTEC	European Space Centre of Technology
FOS	Flight Operation Segment
FPN	Fixed Pattern Noise
GADS	Global Annotation Data Set
GOME	Global Ozone Monitoring Experiment
HK	House Keeping
IECF	Instrument Engineering Calibration Facility
IFE	Institut für Fernerkundung der Universität Bremen
IFOV	Instantaneous Field of View
I/O DD	Input/Output Data Definition
ISP	Instrument Science Packet
IUP	Institut für Umweltphysik der Universität Bremen
LBR	Low Bit Rate
LC	Leakage Current
MB	Megabyte
MDS	Measurement Data Set
MDSR	Measurement Data Set Record
MPH	Main Product Header
N/A	not applicable
ND	Neutral Density
NRT	Near Real Time
PAC	Processing and Archiving Centre
PCA	Polarisation Correction Algorithm
PCD	Product Confidence Data
PDHS	Payload Data Handling Segment
PDS	Payload Data Segment
PET	Pixel Exposure Time

PMD	Polarisation Measurement Device
PMTC	Power, Mechanics and Thermal Control Unit
PPG	Pixel-to-Pixel Gain
PQF	Product Quality Facility
SBT	Satellite Binary Time
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SDPU	Signal Data Processing Unit
SLS	Spectral Light Source
SGP	SCIAMACHY Ground Processor
SGP_01	SCIAMACHY Ground Processor for Level 0 to 1b Processing
SOS	SCIAMACHY Operations Support
SoW	Statement of Work
SPH	Specific Product Header
SRON	Space Research Organisation of The Netherlands
SSAG	SCIAMACHY Scientific Advisory Group
SZA	Solar Zenith Angle
TPD	Technisch Physische Dienst
UTC	Universal Time Co-ordinate
WLS	White Light Source

1.4 Document Overview

The present document is divided into the following sections:

- General Assumptions
    - Measurement Scenarios, Timelines and Instrument States
    - Philosophy of Level 1b Product Definition
    - Processing Overview
    - Summary of I/O Files
- Detailed I/O Data Formats
    - Approach for file definition
    - Products
        - Level 0 Product
        - Level 1b Product
        - Leakage Current Parameters
        - PPG/Etalon Parameters
        - Spectral Calibration Parameters
        - Sun Reference Spectrum
    - Auxiliary Data Files
        - Key Data Files
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        - M-Factor Files
- Generic Data Representations
    - Basic Data Types
    - Compound Data Types
- Reference Timeline and State Examples

2 General Assumptions

2.1 Mission Scenarios, Timelines and Instrument States

The operation concept of SCIAMACHY is based on a hierarchy of Mission Scenarios, Timelines and States. A detailed description of the SCIAMACHY operations concept is given in [R2], [R3] and [R4].

The *mission scenarios* describe categories of measurements to be performed and how the various categories are related to each other. The *timelines* represent the implementation of the mission scenarios in the sense that they give a detailed outline of the sequence of individual measurements. Timelines can be generated once scientific and technical mission planning rules have been established. The *states* are the lowest level in the hierarchy; each state represents a single measurement type with a specific set of parameters.

The mission scenarios of SCIAMACHY depend on the time frame of the mission. The target lifetime of ENVISAT and its payload was initially set to 5 years. The final lifetime reached 11 years in the end when contact to the satellite was suddenly lost. The mission scenarios changed several times. During the commissioning phase in the first 6 months of operation after launch, the sequence of measurements differs from that in the routine operations phase. Tasks such as instrument validation and in-flight testing had to be accomplished in the commissioning phase, while in the routine phase a more regular continuous operation pattern was implemented. A high-level SCIAMACHY operations plan was formulated to outline the overall mission goals over the complete lifetime. Since seasonal variations of atmospheric parameters dictate modifications to some of the observation settings, the scenarios followed also a yearly pattern. Finally, with the moon being visible to SCIAMACHY for only a small fraction of its orbit around the Earth, the mission scenarios had be synchronised with the lunar cycle.

A fixed number of SCIAMACHY timelines were stored on-board; the opportunity for updating timelines according to established and configuration-controlled procedures was given. Consequently, in order to facilitate daily operations, it was required to develop timeline schemes, which cover most of the envisaged instrument activities (mission scenarios). Initial ideas of mission scenarios included the scientific and technical principles to be followed when generating timelines. Thus reference timelines, which can be considered as examples for the sequence of SCIAMACHY activities, were generated very early; the final timelines for on-board storage evolved from these reference timelines. One of these reference timelines is described in section 5, where it was used to calculate the parameters and sizes of the level 1b product, described in section 3.2.2.

The states are classified according to measurement categories depending on the type of observation e.g. nadir, limb, sun occultation, spectral lamp source, etc. Level 0 to 1b processing picks up the measurements of a complete state of a certain measurement category and routes them through the various processing elements of the level 0 to 1b processor to fill a number of Measurement Data Sets (MDS) and Annotation Data Sets (ADS) for the different groups of measurement categories. The hierarchy of the SCIAMACHY operational concept above the level of these instrument states is (in principle) invisible to a level 1b data user.

2.2 Philosophy of Level 1b Product Definition

The following requirements are driving factors for the design of the level 1b product format, as they have been for the design of the GOME level 1 product:

- Storage space should be saved in the archive and on distribution media
- Most of the information included in the level 0 data should be retained in the level 1b product
- Error values should be given for the earth-shine spectrum and the sun reference spectrum in terms of a relative pixel-to-pixel or noise error and an absolute error on the calibrated radiance

There are basically two options available to fulfil these requirements: full application of all calibration parameters or no application of any parameters. The first option requires the following record for each detector pixel read-out: the radiance, the noise error and the absolute error on the radiance given as floats and a flag given as unsigned character. This yields a size of 13 Bytes per detector pixel and measurement. This approach still requires an application programme, because the wavelength has to be calculated from the corresponding coefficients. Otherwise the size of the record including wavelength would be 17 Bytes. The second option just requires the binary signal read-out (24 bit as a maximum, 16 bits for clusters which are not co-added), an unsigned character (8 bit) for the correction of the memory effect (RETICON arrays only) and an unsigned character for the straylight (8 bit). This yields 3, 4 or 5 Bytes depending on detector material and co-adding. This means that level 1b products using the full application of all calibration parameters require between 3 or 4 times more space on storage and distribution media than products which require the use of an application programme.

It may also be noted that most of the potential users of level 1b data are developers of new retrieval algorithms. These type of users are very interested in the details of the actual level 0 to 1b processing and even want to test various approaches which require the knowledge of level 0 data (e.g. DOAS processing without application of the polarisation correction and to do the retrieval of the polarisation during level 1b to 2 processing), but this data is not available to the general SCIAMACHY data user.

These requirements imply a format where no calibration data is actually applied to the spectrum data. To get level 1b data which might be used for further (e.g. level 1b to 2) processing an additional processing step must be performed to do the application of the calibration data to the signal data and to calculate the associated errors.

2.3 Processing Overview

SCIAMACHY level 0 data is converted into ‘calibrated radiance’ (level 1b) by applying calibration algorithms and calibration parameters. Part of these calibration parameters are determined regularly using in-flight measurement data when SCIAMACHY looks into deep space or takes white light or spectral lamp, or sun diffuser calibration measurements. In addition, data from pre-flight instrument calibration, the so-called Key Data are required. The in-flight calibration parameters will be collected to a complete ‘calibration data base’ over the whole lifetime of SCIAMACHY to be applied to the science observations of the Earth's atmosphere as well as to those of the sun and the moon. The major results of SGP_01 are the level 1b products which include also the geolocation calculated from the appropriate orbit and time correlation information.

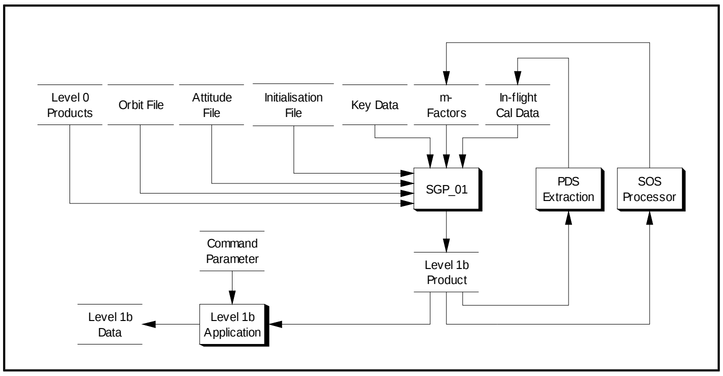

Figure 1: SCIAMACHY Level 0 to 1b Processing Overview

There are a large number of measurements which are not counted to be science observations or in-flight calibration measurements. These measurements are intended to monitor the health and degradation of the instrument which will be used to calculate correction factors (m-factors) for the pre-flight calibration parameters to correct for any type of degradation. This monitoring and correction factor evaluation activity is not part of the operational processors, but will be done by the SCIAMACHY Operations Support (SOS) team which has been installed by DARA, the German member of the AO instrument provider, and is a co-operate project between IFE and DFD. The operational processor will extract the corresponding monitoring measurements form the complete data stream (by generating special MDSs in the level 1b product) to be picked up primarily by the SOS team and some means to use the determined correction factors in the processor which are set to '1' just after launch.

Based on the description above SCIAMACHY level 0 to 1b processing consists of four individual main functions, as depicted in :

- SCIAMACHY ground processor for level 0 to 1b

  The ground processor itself receives the following input data:

– SCIAMACHY level 0 products
  There is just one level 0 product on input. Depending on the consolidation status of this level 0 product the consolidation status of the resulting level 1b product will be accordingly.

– Orbit files
  For NRT processing the predicted state vector in the MPH of the level 0 product has to be applied for the geolocation of the measurements, because no better orbital information is available by that time. During off-line processing the different orbit products are available and will be provided by the processing environment. Whenever orbit files are available, they shall be used instead of the predicted state vector in the level 0 product.

  It is not required to describe the format of orbit files in the present I/O DD. On one hand these files are described somewhere else in the PDS documentation and on the other hand they are not explicitly read by SGP_01, but the CFI orbit propagation routines which require just the filename of these files.

– Attitude File
  This file is assumed to be available for each orbit and contains the AOCS parameters and information about the attitude of the ENVISAT-1 spacecraft (roll, pitch and yaw). If this file is available to SGP_01 the information therein shall be extracted and provided as AOCS parameters, mis-pointing angles and rate to the target calculation of the geolocation module. If the file is not available, the AOCS parameters need to be calculated and the mis-pointing information has to be set to zero.

  It is not required to describe the format of attitude file in the present I/O DD, because it is handled automatically by the orbit propagation CFI [R16].

– A Key Data file
  The Key Data comprises the complete set of pre-flight calibration data which is provided by the instrument provider (TPD), in particular the following information is included:

  - Bi-directional scattering distribution function of the sun diffuser
  - Straylight characteristics
  - Polarisation sensitivity parameters
  - Radiance sensitivity parameters
  - Errors on all Key Data

– An m-factor file
  Due to the degradation of the instrument during its stay in orbit the pre-flight calibration data would have to be changed. Instead of actually changing the pre-flight data the calibration plan [R10] foresees the usage of correction factors, the so-called m-factors, which are collected in this file. See the description of the SOS processor below.

– In-flight Calibration Data files
  For the operation of SGP_01 this type of auxiliary products is essential. In general the in-flight calibration data is *determined* during operation of the processor, but only if the corresponding calibration measurements are included in the set of level 0 data to be processed. These newly calculated in-flight calibration parameters are stored in a special set of ADSs.

  In previous versions (pre version 8) of the processor, the in-flight calibration parameters were picked up from these ADSs by IECF (subsystem SciCal) and used for the generation of new auxiliary products, as described in chapters 3.2.363. to 3.2.6.

  The following parameters are included in these files (one file for each parameter type):

  - Leakage Current Parameters
  - Pixel-to-pixel gain and Etalon Parameters

    - Spectral Calibration Parameters
    - Sun Reference Spectrum
- In-flight Calibration database

  Since processor version 8 we use a PostgreSQL database for storing in-flight calibration data. It basically contains the same data as the in-flight calibration data files and replaces them. Just one set of in-flight calibration data files (four files) are still used for an initial start or reprocessing when the database is still empty.
- Initialisation file

  This file includes a large number of parameters which control nearly every module of SGP_01. Usage of such an initialisation file increases the maintainability of the processor, as these parameters may also be included as constants directly into the code. Some very important elements of this files are the following:
    - Templates of solar and/or earth-shine spectra used for providing spectral calibration offsets
    - Table of set-up time and configuration per state
    - Polarisation and Radiance Sensitivity Grids
- Calibration Initialisation file

  This file defines settings for the inflight calibration part of the processor for example limits for bad and dead pixel detection, time periods for averaging inflight calibration data, etc.

The SGP_01 processor generates the following output:

- Level 1b product

  Each run of SGP_01 generates just one level 1b product. Depending on the consolidation status of the level 0 product on input (consolidated or unconsolidated) the generated product has the corresponding type. Whenever in-flight calibration measurements were present in the level 0 data new in-flight calibration parameters will have been processed. This new calibration data has to be inserted into the level 1b product to be extracted by PDS for subsequent runs of SGP_01.

• Level 1b application programme (scial1c)

The level 1b application programme requires the following input data:

- Level 1b product; the level 1b data product is in principle the only source of data to generate level 1b data. All pieces of information which are required to do the application of calibration parameters and the calculation of the associated errors is available in this product.
- Command parameters; the application programme is able to extract the complete set of information which is included in the level 1b product, if no command parameters are given a default application is done. The command parameters may be used to tailor the application as follows:
    - display general product information (no data extracted)
    - display state information only (no data extracted)
    - display geolocation information only (no data extracted)
    - extract calibration data only (no data extracted)
    - extract a certain type of states only (e.g. only nadir states for NRT processing)
    - extract selected clusters or wavelength regions only
    - extract ground scenes of a certain period (in terms number of scene or time frame)
    - apply only selected calibration parameters only

The level 1b application programme generates the following output:

- Level 1b application data

  depending on the command parameters, as described before, the level 1b application data may have a lot of various appearances useful for specific purposes.

- SOS processor

  As explained before, there are some measurements which will monitor the health and degradation of the instrument and eventually will be used to calculate correction factors (m-factors) for the pre-flight calibration parameters to correct for any type of degradation. This monitoring and correction factor evaluation activity is not part of the operational processors, but will be done by the SCIAMACHY Operations Support (SOS) team. The operational processor will produce special MDSs in the level 1b products which contain the corresponding monitoring measurements. These special MDSs may be used by the SOS team for the generation of the correction factors.

2.4 Summary of I/O Files

A list a all data sets which are interfaced with SGP_01 is given in the following table:

Id	***Type***	***Identifier***	***Name***
1	Product	SCI_NL__0P	SCIAMACHY level 0 product
2	Product	SCI_NL__1P	SCIAMACHY level 1b product
3	Auxiliary	 AUX_FRO_AX DOR_POR_AX DOR_VOR_AX	Various Orbit Files: FOS Restitued Orbit File DORIS Preliminary Orbit State Vector Product DORIS Precise Orbit State Vector Product (not described in this I/O DD)
4	Auxiliary	AUX_FRA_AX	ENVISAT-1 Attitude Data File (not described in this I/O DD)
5	Auxiliary	SCI_LK1_AX	Default leakage current correction parameters for SCIAMACHY level 0 to 1b processing
6	Auxiliary	SCI_PE1_AX	Default PPG/Etalon correction parameters for SCIAMACHY level 0 to 1b processing
7	Auxiliary	SCI_SP1_AX	Default spectral calibration parameters for SCIAMACHY level 0 to 1b processing
8	Auxiliary	SCI_SU1_AX	Default sun reference spectrum of the SCIAMACHY level 0 to 1b processing
9	Auxiliary	SCI_LI1_AX	Initialisation file for the SCIAMACHY level 0 to 1b processor
10	Auxiliary	SCI_LIC_AX	Initialisation file for the inflight calibration part of the SCIAMACHY level 0 to 1b processor
11	Auxiliary	SCI_KD1_AX	Key Data file for SCIAMACHY level 0 to 1b processing
12	Auxiliary	SCI_MF1_AX	Key Data correction factors for SCIAMACHY level 0 to 1b processing (m-Factor file)

The present I/O DD employs a field identification scheme (FIS). Each field has an unambiguous identification as follows (e.g. in the DPM document):

x1.x2.x3

- **x1** is the identification number of the product type, as given in the table above,
- **x2** is the identification number of the individual component of each file. At the beginning of each format description the first table identifies these components which are described in the following tables,
- **x3** is the field number, as given in the format description tables of each file component.

E.g. the coefficients of the spectral calibration parameters may be given as:

2.5.2

„2“ for the level 1b product, „5“ for the Spectral Calibration Parameters GADS and „2“ for the coefficients field.

3 Detailed I/O Data Formats

3.1 Approach for file definition

For each file described in this document, the information is provided following a standardised template. The file description is broken down into the following categories: identifier, name, type, description, format, sizing, data volume, throughput and remarks. In this section each category is defined and the different descriptors used within the categories are presented.

Identifier

An identifier has been defined for each kind of file used and/or generated at the ground segment. This identifier will be used for referring to specific kind of files and for referring to the associated file format. The identifiers are listed in the summary table of the previous section.

Name

This section contains a short descriptive name of the file.

Type

The file type defines the general relation of the file with the ground processor. The following types are defined:

Input: The file contains additional data coming from the FOS or other ESA entities. This type is not present in the present specification.

Product: The file is either the primary data coming from the Space Segment or an *output* of a ground processor, to be delivered to the end users.

Auxiliary: The file is an *input* to the ground processor containing data coming neither from the space segment nor from the ground processor. Data of this type may originate from on-ground characterisation or may be determined analytically. For the generic environment these type of files are handled also like products.

There is a special type of auxiliary file which is an intermediate *input/output* of the ground processor. It is the result of the processing of special calibration measurements. This file is used by the ground processor for further processing towards the generation of user products. For the generic environment these type of files are handled like products.

Besides this general classification it is noted in *Italic* whether the file is used as input, output or both at the interface of the processor.

Description

This section provides details about the contents and purpose of the file.

Format

The level 0 product file is composed of source packets. The format of source packets was defined by the instrument provider. The format of the level 1b product and all other files in this specification have been defined according to the guidelines of [R6] and the approach described in the following paragraphs:

- A file is divided into four main parts: a general header (MPH), a specific header (SPH), data set descriptors (DSD) followed by specific data sets (DS) of the corresponding input/output file. Each of these parts has a specific structure defined in the following sections.
- The detailed format is given in form of tables containing a field number, comment, unit, data type, number of elements (#) and size column.
- Note that in the data definitions in the present document, the notation '∅' is used to indicate the inclusion of an ASCII blank-space character.
- The 'Unit' column gives the physical unit or the kind of interpretation of the field. A dash (-) is given for a field corresponding to a flag, a cardinal number or any other unit-less type of information.

Notation	***Description***
%	Percent
(BU/s)· sr	Binary units per second of a solid angle
(BU/s)/ (photons/m^2· nm· sr· s)	Binary units per second per radiance
-	No unit
$^1/_{16}$ s	Time of BCPS (62.5 ms)
10^{-6} deg	(General angle)· 10^{-6}
BU	Binary units of signal read-outs
BU/s	Binary units per second
BU· s	Binary units multiplied with second
Day	Day
Degree	General angle, 360 per cycle
Keyword	An ASCII keyword in format definition of the SPHs
Km	Kilometre
Lat/Long	Geographical Co-ordinate following ISO 6709
10^{-2} m	10^{-2} metre
10^{-5} (m/s)	10^{-5} metre per second
mbar	Pressure
mol/cm^2	Column density
ms	Millisecond
nm	Nanometre (Wavelength)
photons/m^2· nm· sr· s	Radiance
photons/m^2· nm· s	Irradiance
s	Second
sr^{-1}	1 by Steradian
terminator	Terminator of fields
units	An ASCII representation of a unit in the product headers
us	Microsecond
variable	An ASCII variable after a keyword in format definition of the SPHs; a variable is always surrounded by a set of quotation marks ("variable")

- The 'Type' column in these tables will refer to the following notation:

Notation	*Description*
sc	signed character: -128 to 127
uc	unsigned character: 0 to 255
ss	signed short (2-byte integer): -32768 to 32767
us	unsigned short (2-byte integer): 0 to 65535
sl	signed long (4-byte integer): -2.147.483.648 to 2.147.483.647
ul	unsigned long (4-byte integer): 0 to 4.294.967.295
sd	signed long (8-byte integer): -9.223.372.036.854.775.808 to 9.223.372.036.854.775.807
du	unsigned long (8-byte integer): 0 to 18.446.744.073.709.551.615
fl	float (4-byte real number): 3.40282347e+38 maximum absolute value to 1.17549435e-38 minimum absolute value
do	double (8-byte real number): 1.79e+308 maximum absolute value to 2.22e-308 minimum absolute value
tx	Text field
b	binary field (e.g. flags, detailed description in the remarks column)
<acronym>	two or more of the above (e.g. combined in structures)

The acronyms of the combined data structures are given in the following table. A detailed description of the structure of these combined fields is given in section 4.2 on page 106.

Notation	*Description*
Clcon	Cluster configuration
Coord	Geographical co-ordinate (ISO 6709)
Flags	Quality Flags
GeoL	Geolocation for limb measurements
GeoN	Geolocation for nadir measurements
GeoCal	Geolocation for calibration and monitoring measurements
L0Hdr	Level 0 Header; this is the data packet header and data field header of the detector module ISPs (length 72 Bytes), as described on page 28, therefore, this compound type is not described in section 4.2
MJD	Modified Julian Date for the year 2000
PolV	Fractional polarisation values
Rsig	RETICON detector signal, memory effect correction and straylight record not co-added
Rsigc	RETICON detector signal, memory effect correction and straylight record co-added
Esig	EPITAXX detector signal and straylight record not co-added
ESigc	EPITAXX detector signal and straylight record co-added

- Values in the '#' columns of the format tables are the number of elements of the corresponding data type.
- Values in the 'Size' columns are given in bytes.

Each component of the format description is followed by the size of it taking the number of records in this component into account.

Sizing

The granule which makes up a certain interface file is defined.

Data Volume

The size for a typical reference data set as a whole is given.

Throughput

The number of data sets per time frame is given.

Remarks

Any remarks which are not obvious from the descriptions above are given here.

3.2 Products

3.2.1 Level 0 Product

Identifier

SCI_NL__0P

Name

SCIAMACHY level 0 product

Type

Product *(Input)*

Description

There is one level 0 product corresponding to the main SCIAMACHY observational mode. This level 0 data is composed of time ordered and annotated Instrument Source Packets (ISPs) with a main and specific product header. The SCIAMACHY level 0 product is the basis of all data processing to create higher level SCIAMACHY products. The level 0 product is produced systematically. The NRT version of the product is available from the PDHS 3 hours after data acquisition.

Each ISP consists of a fixed and a variable part:

- the fixed part is called *Packet Header* and has a length of 6 bytes
- the variable part is called *Packet Data Field* and has a variable length.

The Data Field itself is divided into:

- Data Field Header
- Source Data

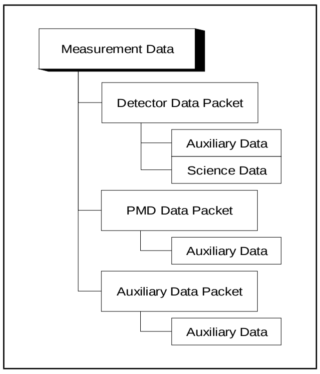

Figure 2: Level 0 Data Source Packet Types

The first 16 bits of the data field header contain the data field header length to identify the begin of the source data.

The SCIAMACHY instrument generates three different types of ISPs:

The packets can be distinguished by the PACKET parameter in Data Field Header.

- A Detector Data Packet consists of:
  - a packet header (6 Bytes)
  - a *data field header* of fixed length; this data field header has a length of 66 Bytes and will be copied together with the packet to the MDSRs of the level 1b product
  - a variable number of detector channel data blocks
    A *channel data block* consists of:
    - a channel identification
    - a channel data header of fixed length
    - a variable number of pixel data blocks

    A *pixel data block* consists of:
    - a *cluster identification*
    - a *counter* of pixel data blocks
    - *cluster definition* (start pixel, length, co-adding factor)
    - *pixel data* of the pixels belonging to the cluster
- A PMD Data Packet consists of:
  - a packet header
  - a *data field header* of fixed length
  - 200 PMD data blocks (40 Hz readouts collected in 5 seconds)
    A *PMD data block* consists of:
    - measurement data from 7 PMDs; two values with different gain for each PMD
- An Auxiliary Data Packet consists of:
  - a packet header
  - a *data field header* of fixed length
  - 5 PMTC auxiliary data frames (collected in 5 seconds)
    A *PMTC auxiliary data frame* consists of:
    - 16 *scanner position data blocks* (16 Hz readouts collected in 1 second)
    - a temperature control HK data block

Format

The detailed format of the ISPs is given in [R12]. The MPH, SPH and DSD is described in [R11].

Sizing

The sizing of a unconsolidated level 0 product is determined by the down link acquisition times which cover approximately one orbit. After level 0 consolidation processing the boundaries of a level 0 product are determined by the satellite crossing times of the ascending node. One consolidated level 0 product covers exactly one orbit.

Data Volume

Approximately 320 MB per orbit

Throughput

SCIAMACHY is intended for continuous measuring. This implies approximately 14.3 orbits and level 0 products per day.

Remarks

N/A

3.2.2 Level 1b Product

Identifier

SCI_NL__1P

Name

SCIAMACHY level 1b product

Type

Product *(Output)*

Description

The level 1b product will include headers (MPH, SPH), calibration data sets which are constant for the entire product, the so-called global annotation data sets (GADS), annotation data sets varying over time (ADS) and several measurement data sets (MDS) depending on the viewing modes which are given by the definition of the corresponding instrument state, as depicted in . The level 1b data product will consist of just one file including all sensor modes excepting dark measurements.

The *main product header* (MPH) has a fixed format, as described in [R11] and includes information about product identification, data acquisition and processing, time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion, product confidence data and sizes of the following data.

A *specific product header* (SPH) will include slicing information, start and stop times and location, references to pre-flight calibration data versions (including m-factor file), product confidence data, summary of the number of states and the data set description records (DSD).

Directly after the DSD records two general PDS-defined *annotation data sets* (ADSs) follow containing condensed quality information (SQADS) and a rough geolocation (LADS).

The different *global annotation data sets* (GADS) will include leakage current and noise characteristics, pixel-to-pixel gain and Etalon parameters, spectral and radiometric calibration parameters, sun reference spectra and the polarisation sensitivity parameters and errors on the Key Data are given in those GADSs.

The time dependent *annotation data sets* (ADS) include information about the sequence of states, the PMD and auxiliary data packets of the level 0 data and optionally a set of newly calculated in-flight calibration parameters if the corresponding measurements are present in the level 0 data.

The *measurement data sets* (MDS) may be divided into three observational MDSs and one monitoring MDS. The observational MDSs include the raw signal values of the array detectors, the memory effect correction (RETICONs only), the calculated straylight, geolocation information, the fractional polarisation values, derived quality flags and header information retained from the detector module data packets. There are two different geolocation information types one for nadir and the other for limb and occultation measurements. The monitoring MDS includes the raw signal values of the array detectors, a reduced set of geolocation information and header information retained from the detector module data packets.

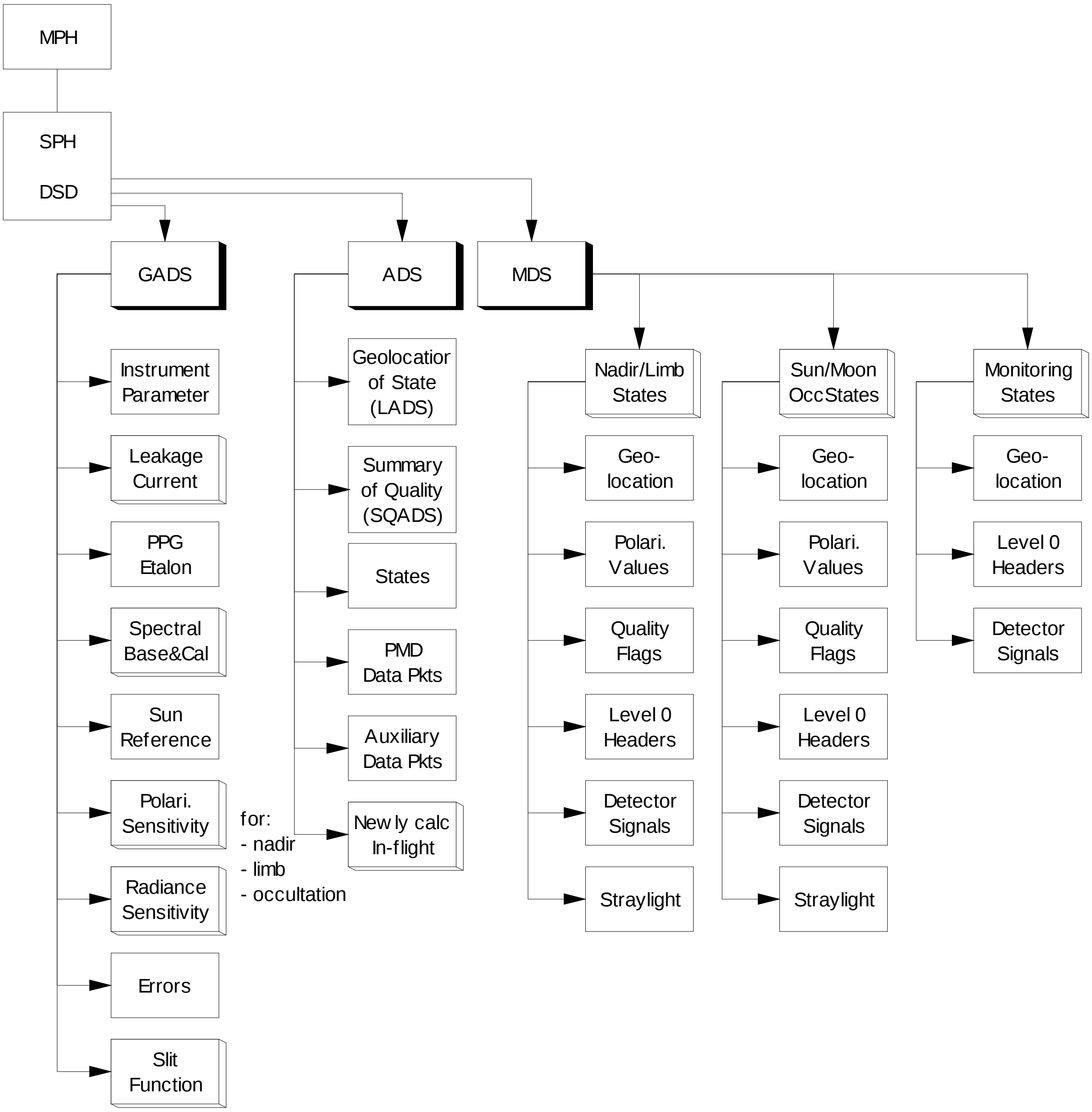

Figure 3: Schematic Structure of the Level 1b Product

Using the included calibration data, the raw signal values of the detector arrays may be converted to geo-located, spectrally and radiometrically calibrated radiance/irradiance. This conversion may be accomplished with an application programme (CFI) which needs to be available to level 1b product users.

Geographical Coverage

Nominal: global

The measured ground or atmospheric pattern depends on the scanning mode used. Only the largest footprint (± 500 km) results in global coverage at the equator after three days.

Radiometric Resolution

16 bit is the resolution of the read-outs of the detector arrays. Due to the co-adding scheme implemented in the SDPU of the instrument the sum of several read-outs of the co-added clusters is given in 24 bits.

Spectral Resolution

240 – 400 nm:	~0.25 nm (channel 1 and 2)
400 – 1000 nm:	~0.5 nm (channel 3 to 5)
1000 – 1700 nm:	~1.5 nm (channel 6)
1940 – 2040 nm:	~0.22 nm (channel 7)
2265 – 2380 nm:	~0.22 nm (channel 8)

Spatial Resolution

SCIAMACHY has a number of possible scanning modes both for nadir and limb viewing, as described in [R1]; spatial resolutions may be very different. For nadir, the along-track length of the ground pixels is given by the fixed Instantaneous Field Of View (IFOV) of 1.8°, which yields approximately 25 km on the Earth's surface. For limb scanning, it seems to be reasonable to measure the same volume of the atmosphere as that for subsequent nadir measurements by selecting an appropriate azimuth position and swath width of the limb scanning mirror.

Absolute Radiometric Accuracy

approximately 3% (depending on the accuracy of the pre-flight instrument response function)

Relative Radiometric Accuracy

<1%

Spectral Accuracy

10.6 0.01 – 0.04 detector elements, corresponding to 0.002 – 0.06 nm

Spatial Accuracy

The spatial accuracy depends on the accuracy of the ENVISAT orbit restitution. The following figures are stated in the general parts of [R12] for nadir measurements:

Restituted Orbit: 60 m along-track, 15 m across-track

Predicted Orbit: 920 m along-track, 15 m across-track (whenever the restituted orbit or even better orbit files are not available)

For limb measurements the attitude control system of the satellite is more important for the spatial accuracy of the measurement. Due to this control system the tangent height may not be calculated better than ± 6 km according to a viewing stability of ± 0.1° into limb direction.

Format

The detailed format description is divided into several tables representing the hierarchy of product content, as depicted in . Some of the sizes in these tables are based on assumptions concerning a specific measurement scenario, including its timelines and states, as described in [R3]. One of these reference timelines is given in section 5. The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Summary of Quality Flags	SQADS
5	Geolocation of the State	LADS
6	Static Instrument Parameters	GADS
7	Leakage Current Parameters (constant fraction)	GADS
8	Leakage Current Parameters (variable fraction)	GADS
9	PPG/Etalon Parameters	GADS
10	Precise Basis Array of Spectral Calibration	GADS
11	Spectral Calibration Parameters	GADS
12	Sun Reference Spectrum	GADS
13	Polarisation Sensitivity Parameters Nadir	GADS
14	Polarisation Sensitivity Parameters Limb/Occultation without ND	GADS
15	Polarisation Sensitivity Parameters Limb/Occultation with ND	GADS
16	Radiance Sensitivity Parameters Nadir	GADS
17	Radiance Sensitivity Parameters Limb/Occultation without ND	GADS
18	Radiance Sensitivity Parameters Limb/Occultation with ND	GADS
19	Errors on Key Data	GADS
20	Slit Function Parameters	GADS
21	Small Aperture Slit Function Parameters	GADS
22	States of the Product	ADS
23	PMD Data Packets	ADS
24	Auxiliary Data Packets	ADS
25	Leakage Current Parameters (newly calculated parts)	ADS
26	Average of the Dark Measurements per State	ADS
27	PPG/Etalon Parameters, newly calculated	ADS
28	Spectral Calibration Parameters, newly calculated	ADS
29	Sun Reference Spectrum, newly calculated	ADS

Id	Product Components	Component Type
30	Nadir Measurement Data Set	MDS
31	Limb Measurement Data Set	MDS
32	Occultation Measurement Data Set	MDS
33	Monitoring Measurement Data Set	MDS

The following paragraphs present the detailed definition of the components listed above:

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	Comments	Unit	Type	#	Size
1	The Main Product Header is described in [R11]	-	m	1247	1247
				Size of Component:	*1247*

Component: Specific Product Header of Level 1b Product
Component Type: SPH No of Records: 1 Record Size: 697

Field	Comments	Unit	Type	#	Size
1	SPH_DESCRIPTOR=	keyword	tx	15	15
	"SCI_NL__1P SPECIFIC HEADER∅∅"	variable	tx	30	30
	New-line character	terminator	tx	1	1
2	STRIPLINE_CONTINUITY_INDICAT-OR=	keyword	tx	31	31
	Strip-line Counter or +000, if the product is a complete segment	-	tx	4	4
	New-line character	terminator	tx	1	1
3	SLICE_POSITION=	keyword	tx	15	15
	Value: +001 to NUM_SLICES or +001 if no strip-line continuity	-	tx	4	4
	New-line character	terminator	tx	1	1
4	NUM_SLICES	keyword	tx	11	11
	Number of slices in this strip-line or +001 if no strip-line continuity	-	tx	4	4
	New-line character	terminator	tx	1	1
5	START_TIME=	keyword	tx	11	11
	Time of the first MDSR in the product, UTC format, example: "10-FEB-1999∅13:32:54.000000"	variable	tx	29	29
	New-line character	terminator	tx	1	1
6	STOP_TIME=	keyword	tx	10	10
	Time of the end of the measurement data in this product, UTC format	variable	tx	29	29
	New-line character	terminator	tx	1	1
7	START_LAT=	keyword	tx	10	10

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
	Latitude of the satellite nadir at the START_TIME, example: +0048000000 for 48° North	variable	tx	11	11
	<10-6degN>	units	tx	10	10
	New-line character	terminator	tx	1	1
8	START_LONG=	keyword	tx	11	11
	Longitude of the satellite nadir at the START_TIME, example: -0120000000 for 120° West	10^{-6} deg	tx	11	11
	<10-6degE>	units	tx	10	10
	New-line character	terminator	tx	1	1
9	STOP_LAT=	keyword	tx	9	9
	Latitude of the satellite nadir at the STOP_TIME	variable	tx	11	11
	<10-6degN>	units	tx	10	10
	New-line character	terminator	tx	1	1
10	STOP_LONG=	keyword	tx	10	10
	Longitude of the satellite nadir at the STOP_TIME	variable	tx	11	11
	<10-6degE>	units	tx	10	10
	New-line character	terminator	tx	1	1
11	Spare (blank characters ∅) For initialisation file version starting at 4.0 the first 33 characters provide init file version and decontamination flag: INIT_VERSION=xxxx DECONT=dddddddd with for each channel d='n'or 'y', example: INIT_VERSION= 401 DECONT=nnnnnnyyy	-	tx	50	50
	New-line character	terminator	tx	1	1
12	KEY_DATA_VERSION=	keyword	tx	17	17
	Key Data Version, pattern: "XX.XX", example: "02.15"	variable	tx	7	7
	New-line character	terminator	tx	1	1
13	M_FACTOR_VERSION=	keyword	tx	17	17
	Version of m-factor file (pattern like field 12)	variable	tx	7	7
	New-line character	terminator	tx	1	1
14	SPECTRAL_CAL_CHECK_SUM=	keyword	tx	23	23
	Range of spectral calibration error ε (summary): "GOOD" if ε ≤ 0.02 "FAIR" if 0.02 < ε ≤ 0.05 "BAD∅" if ε > 0.05	keyword	tx	6	6
	New-line character	terminator	tx	1	1
15	SATURATED_PIXEL=	keyword	tx	16	16

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
	Number of saturated detector pixels n (summary): “GOOD“ if n = 0 “FAIR“ if 0 < n ≤ 100 “BAD∅“ if n > 100	keyword	tx	6	6
	New-line character	terminator	tx	1	1
16	DEAD_PIXEL=	keyword	tx	11	11
	Number of dead detector pixels n (summary): “GOOD“ if n = 0 “FAIR“ if 0 < n ≤ 10 “BAD∅“ if n > 10	keyword	tx	6	6
	New-line character	terminator	tx	1	1
17	DARK_CHECK_SUM=	keyword	tx	15	15
	Difference between measurement and calibrated dark signal (summary): “GOOD“ “FAIR“ “BAD∅“	keyword	tx	6	6
	New-line character	terminator	tx	1	1
18	NO_OF_NADIR_STATES=	keyword	tx	19	19
	Number of Nadir measurement states in this product, example: +025	-	tx	4	4
	New-line character	terminator	tx	1	1
19	NO_OF_LIMB_STATES=	keyword	tx	18	18
	Number of Limb measurement states in this product	-	tx	4	4
	New-line character	terminator	tx	1	1
20	NO_OF_OCCULTATION_STATES=	keyword	tx	25	25
	Number of Occultation measurement states in this product	-	tx	4	4
	New-line character	terminator	tx	1	1
21	NO_OF_MONI_STATES=	keyword	tx	18	18
	Number of Monitoring measurement states in this product	-	tx	4	4
	New-line character	terminator	tx	1	1
22	NO_OF_NOPROC_STATES=	keyword	tx	20	20
	Number of measurement states which are present in the level 0 product, but not the level 1b product	-	tx	4	4
	New-line character	terminator	tx	1	1
22.3	COMP_DARK_STATES=	keyword	tx	17	17
	Number of processed complete dark states	-	tx	4	4
	New-line character	terminator	tx	1	1
22.6	INCOMP_DARK_STATES=	keyword	tx	19	19
	Number of incomplete dark states	-	tx	4	4
	New-line character	terminator	tx	1	1
23	Spare (blank characters ∅)	-	tx	4	4

Field	Comments	Unit	Type	#	Size
	New-line character	terminator	tx	1	1
				Size of Component	*697*

The version information on the Key Data and the m-factor files (field 12 and 13) is actually redundant. The version numbers are originally given in the respective external product files (in the SOFTWARE_VER field of their MPH), which are referenced by the DSDs, and just repeated here for a faster and more convenient control overview.

Component: **Data Set Descriptor Record**
Component Type: DSD No of Records: 49 Record Size: 280

Field	Comments	Unit	Type	#	Size
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*13720*

The first field in these DSDs is the DS_NAME. This field gives the possibility to attach a type to each DS in the product which may be used by extraction programmes to identify a specific content of the product very fast and skip to it immediately. A good example for the usage of this field is the extraction of nadir states only or the extraction of a certain type of calibration parameters. The field allows a maximum length of 28 characters.

The following definitions shall be applied to the DSDs of the 2 general ADSs, 11 GADSs and 8 ADSs of the level 1b product (product components 4 to 24, sequence given by list number):

1. SUMMARY_QUALITY
2. GEOLOCATION
3. INSTRUMENT_PARAMS
4. LEAKAGE_CONSTANT
5. LEAKAGE_VARIABLE
6. PPG_ETALON
7. SPECTRAL_BASE
8. SPECTRAL_CALIBRATION
9. SUN_REFERENCE
10. POL_SENS_NADIR
11. POL_SENS_LIMB
12. POL_SENS_OCC
13. RAD_SENS_NADIR
14. RAD_SENS_LIMB
15. RAD_SENS_OCC
16. ERRORS_ON_KEY_DATA
17. SLIT_FUNCTION
18. SMALL_AP_SLIT_FUNCTION

19. STATES
20. PMD_PACKETS
21. AUXILIARY_PACKETS
22. NEW_LEAKAGE
23. DARK_AVERAGE
24. NEW_PPG_ETALON
25. NEW_SPECTRAL_CALIBRATION
26. NEW_SUN_REFERENCE

The annotation data sets whose names are starting with "NEW_" are not necessarily part of the product, because they are only present when the corresponding in-flight calibration measurements have been processed. In case they are not present the FILENAME field of the DSD record shall be filled with "NOT USED".

The following data set names shall be used for the 4 MDSs:

27. NADIR
28. LIMB
29. OCCULTATION
30. MONITORING

According to the current definition (in [R2], with amendments in [R17]) the following states are defined and it is shown how they are distributed onto the four MDSs listed above including their measurement category (MC) which is already fixed (the numbering of states is still subject to change):

- Nadir MDS
  - NADIR (normal) state id 1 to 22 (MC 1)
  - NADIR_POINTING state id 23 to 25, 42 to 45 and 48 (MC 3)
  - NADIR_ECLIPSE_NOSCAN state id 26 (MC 17)
  - NADIR_ECLIPSE_SCAN state id 27 (MC 18)
- Limb MDS
  - LIMB state id 28 to 41 (MC 2)
  - LIMB_MESOSPHERE state id 27 (MC 26)
- Occultation MDS
  - SO&C_SCANNING state id 47, 49 and 50 (MC 4)
  - SO&C_POINTING state id 51 (MC 5)
  - MO&C_POINTING state id 56 and 57 (MC 6)
- Monitoring MDS

– MOON_SCANNING state id 54 (MC 7)
– SUN_DIFF_CAL_NDOUT state id 52 (MC 8)
– SUN_DIFF_CAL_NDIN state id 62 (MC 16)
– SUB_SOL_CAL state id 53, 58 and 60 (MC 9)
– SPEC_LAMP_CAL state id 59 and 69 (MC 10)
– WHITE_LAMP_CAL state id 61 and 70 (MC 11)
– ELEV_MIRROR_SUN_CAL state id 64, 66 and 68 (MC 13)
– ELEV_MIRROR_MOON_CAL state id 55 (MC 14)
– ADC_CALIBRATION state id 65 (MC 15)

The list above comprises the complete range of measurement states currently defined in [R4] excepting the three special dark measurement states (MC 12), because they are not envisaged to provide more information for any type of scientific or monitoring application on top of the existing leakage current GADSs in the product.

For reference of external in-flight calibration data files and other auxiliary files the following 10 data set names are used for the corresponding DSD records:

31. LEVEL_0_PRODUCT
32. KEY_DATA_FILE
33. M_FACTOR_FILE
34. INIT_FILE
35. CAL_INIT_FILE
36. ORBIT_FILE
37. ATTITUDE_FILE

For referenced files the FILENAME field is filled with the corresponding filename of the external file, in all other cases the FILENAME field is left blank.

For data read from the calibration data-base, the data set name is composed from the data-base name and one of the following names:

- leakageconstant
- leakagevariable
- sunreference_D0
- sunreference_E0
- sunreference_D1
- sunreference_E1
- sunreference_D2
- sunreference_A0
- spectralaverages
- ppgetalon
- badpixelmask

For example the DSD for the bad pixel mask has the data set name:

gencal_2011_badpixelmask

where “gencal_2011” is the name of the data base.

The FILENAME field contains the measurement start time, if needed an additional identifier and the processing time of the data-base entry separated by underscore:

<msmstarttime>_<optional ID>_<processing time>.

For example for a not radiometrically calibrated

ASM diffuser measurement:

2011-01-02 19:46:01_A0_2014-01-22 07:17:59

A spare DSD is added after the DSDs pointing to the reference files having no name, but is filled with 279 blank characters (∅) and one new-line character.

The DSD records are logically part of the SPH and according to [R6] the size of SPH has to be constant for a specific product type. Therefore, the number of DSD records is fixed to 49. This number is resulting from the 4 different types of measurement states, plus 26 records which are given by the maximum number of ADSs (GADS, SQADS, LADS and others), 7 records for the description of the external reference files, 11 records for database references plus 1 spare record.

Component: **Summary of Quality Flags per State**
Component Type: SQADS No of Records: 60 Record Size: 182

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the scan phase of the state	-	MJD	1	12
2	Flag indicating if MDS DSRs are attached to the current ADS DSR	-	uc	1	1
3	Mean value of the wavelength differences of Fraunhofer lines compared to the wavelength calibration parameters (per channel)	nm	fl	8	32
4	Standard deviation of the wavelength differences from field 3	nm	fl	8	32
5	Spare (Number of missing readouts in state)	-	us	1	2
6	Mean difference of leakage current or offset per channel and PMD (this field is only valid for limb states; channel 1 to 8, general PMD A to F and the 45° PMD)	%	fl	15	60
7	Sun glint region flag	-	uc	1	1
8	Rainbow region flag	-	uc	1	1
9	SAA region flag	-	uc	1	1
10	Number of hot pixel per channel and PMD (order: 1 to 8 and A to F and 45°)	-	us	30	30
11	Spare for additional flags	-	uc	10	10
Size of Component:					*10920*

To support the Product Quality Facility (PQF) a summary of all quality flags for each state is given in this ADS (see the remark on the ‘States of the Product’ component below). The number of 60 DSRs is resulting form the example in section 5.

For the flags in field 7, 8 and 9 '0' ≡ 'no' and '1' ≡ 'yes'.

Component: **Geolocation of the States**
Component Type: LADS No of Records: 60 Record Size: 45

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the scan phase of the state	-	MJD	1	12
2	Flag indicating if MDS DSRs are attached to the current ADS DSR	-	uc	1	1
3	4 corner co-ordinates of the ground scene which is covered by the state (the first co-ordinate is the one which is the first in time and flight direction, the second the first in time and last in flight direction, the third the last in time and first in flight direction and the fourth the last in time and flight direction)	-	Coord	4	32
Size of Component:					*2700*

To support the extraction of SCIAMACHY data according to a given geolocation this ADS gives the geolocation (4 corner co-ordinates) of the scene on ground which is covered by each states (see the remark on the 'States of the Product' component below). The number of 60 DSRs is resulting form the example in section 5.

For Limb and occultation measurements the co-ordinates are representing the tangent ground points of the beginning and the end of the state and for all other measurements (calibration and monitoring) these co-ordinates shall be filled with the sub-satellite point at the beginning and the end of the state. In theses cases the first and the second as well as the third and fourth co-ordinates have the same values.

Component: **Static Instrument Parameters**
Component Type: GADS No of Records: 1 Record Size: 382

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	n_lc_min	-	uc	1	1
2	ds_n_phases (~12)	-	uc	1	1
3	ds_phase_boundaries (# = ds_n_phase + 1)	-	fl	13	52
4	lc_stray_index	-	fl	2	8
5	lc_harm_order	-	uc	1	1
6	ds_poly_order	-	uc	1	1
7	do_var_lc_cha (3 times 4 characters per EPI-TAXX channel)	-	tx	12	12
8	do_stray_lc_cha (8 times 4 characters per channel)	-	tx	32	32
9	do_var_lc_pmd (2 times 4 characters per IR PMDs)	-	tx	8	8
10	do_stray_lc_pmd (7 times 4 characters per PMD)	-	tx	28	28
11	electrons_bu (per channel)	1/BU	fl	8	32
12	ppg_error	-	fl	1	4
13	stray_error	-	fl	1	4
14	sp_n_phases (~12)	-	uc	1	1
15	sp_phase_boundaries (# = sp_n_phase + 1)	-	fl	13	52
16	startpix_6+	-	us	1	2
17	startpix_8+	-	us	1	2
18	h_toa	m	fl	1	4
19	lambda_end_gdf	nm	fl	1	4
20	do_pol_point ("t" for true and "f" for false)	-	tx	12	12
21	sat_level	BU	us	8	16
22	pmd_saturation_limit	BU	us	1	2
23	do_use_limb_dark ("t" for true and "f" for false)	-	tx	1	1
24	do_pixelwise ("t" for true and "f" for false)	-	tx	8	8
25	alpha0_asm	degree	fl	1	4
26	alpha0_esm	degree	fl	1	4
27	do_fraunhofer (8 times 5 characters per channel)	-	tx	40	40
28	do_etalon (8 times 3 characters per channel)	-	tx	24	24
29	do_IB_SD_ETN ("t" for true and "f" for false)	-	tx	7	7
30	do_IB_OC_ETN ("t" for true and "f" for false)	-	tx	7	7
31	level_2_SMR	-	uc	8	8
Size of Component:					*382*

This GADS contains some instrument specific parameters from the initialisation file which shall be available to the level 1b application programme and level 2 retrieval processing chains.

Component: Leakage Current Parameters (constant fraction)
Component Type: GADS No of Records: 1 Record Size: 163952

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Constant fraction of the fixed pattern noise (FPN) for each detector element of all eight channels (intersect of leakage current straight line)	BU	fl	8192	32768
2	Error on constant fraction of FPN	BU	fl	8192	32768
3	Constant fraction of the leakage current for each detector element of all eight channels (slope of leakage current straight line)	BU/s	fl	8192	32768
4	Error on constant fraction of LC	BU/s	fl	8192	32768
5	Constant fraction of the PMD dark offset of all 7 PMDs, for amplifier A and B (given as 1A, 1B, 2A, etc.)	BU	fl	14	56
6	Error on constant fraction of PMD offset	BU	fl	14	56
7	Mean noise (mean value of standard deviations per detector element)	BU	fl	8192	32768
Size of Component:					*163952*

Component: Leakage Current Parameters (variable fraction)
Component Type: GADS No of Records: 12 Record Size: 90228

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Orbit phase after eclipse (range: 0-1)	-	fl	1	4
2	OBM (near radiator), detector (channels 6-8) and PMD temperatures	K	fl	10	40
3	Variable fraction of the leakage current on top of the constant fraction (field 1 and 3) for channels 6 to 8	BU/s	fl	3072	12288
4	Error of variable fraction of LC	BU/s	fl	3072	12288
5	Solar straylight scattered from the azimuth mirror	BU/s	fl	8192	32768
6	Error on the solar straylight	BU/s	fl	8192	32768
7	Straylight offset for PMDs	BU	fl	7	28
8	Error on straylight offset for PMDs	BU	fl	7	28
9	Variable fraction of the PMD dark offset on top of the constant fraction (field 5) for PMD 5 and 6	BU	fl	2	8
10	Error on the variable fraction of PMD offset	BU	fl	2	8
Size of Component:					*1082736*

Both types of detectors used for the 8 channels of SCIAMACHY are affected by the existence of leakage current. The detectors used for channel 1 to 5 are random access linear photo-diode arrays being not sensitive to temperature fluctuations foreseen in SCIAMACHY and it is expected that a monthly update of the leakage current parameters is sufficient to do an appropriate leakage current correction. Channel 6 to 8 are measuring in the near infra-red which requires a different type of detector material. These detectors are very sensitive to temperature fluctuations of the surrounding material (mainly the optical bench) and themselves. Therefore, two types of leakage current parameters are required:

- The default leakage current pattern is always (for all orbital positions and all integration or exposure times) valid for the channels 1 to 5 and the PMDs 1 to 4 and 7 (45° sensor) and serves as a basis for the other detectors.
- A set of differences in leakage current corresponding to the orbital position (eclipse phase) which may be interpolated for a certain orbital position before applying it to the default leakage current pattern of channel 6 to 8 and PMDs 5 and 6.

There is one additional parameter variable over orbit position which is the solar straylight scattered from the azimuth mirror. This parameter is valid for all 8 detector arrays, but only for limb measurements. This parameter has obviously nothing to do with leakage current, but it is determined during the calculation of the leakage current parameters and therefore placed into the variable fraction of the leakage current parameters.

The ‘Orbit phase after eclipse’ field in the component record of the variable fraction of the leakage current parameters may have a range between ‘0’ and ‘1’. ‘0’ is given by the time when the sub-satellite point on the ground is entering eclipse in the southern hemisphere (SZA = -90 degree) and then it is running proportionally with time until it reaches ‘1’ after one orbit (≈ 100 minutes). It is given for the start of a region in which the calibration parameters are valid. The number of regions which are required for an appropriate determination of the leakage current parameters has to be determined during commissioning phase. The number of 12 records in the format description above is just an example, but it is assumed that this number will be fixed after its determination.

The sequence of PMD dark and straylight offsets is given for the regular PMDs from 1 to 6 with the last value being the one for the 45° PMD detector.

Component: PPG/Etalon Parameters
Component Type: GADS No of Records: 1 Record Size: 139264

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Pixel-to-pixel gain factor	-	fl	8192	32768
2	Etalon Correction Factor	-	fl	8192	32768
3	Etalon Residual	-	fl	8192	32768
4	WLS degradation factor	-	fl	8192	32768
5	Bad pixel mask	-	uc	8192	8192
Size of Component:					*139264*

The bad pixel mask will give the existence of dead or otherwise harmed pixels which may not be used for further processing. The following values are possible: 0 = pixel is ok, 1 = pixel is bad.

Component: Precise Basis of the Spectral Calibration Parameters
Component Type: GADS No of Records: 1 Record Size: 32768

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Wavelength of detector pixel	-	fl	8192	32768
Size of Component:					*32768*

Component: Spectral Calibration Parameters
Component Type: GADS No of Records: 12 Record Size: 372

Field	*Comments*	*Unit*	*Type*	*#*	*Size*

1	Orbit phase after eclipse (range: 0-1)	-	fl	1	4
2	Coefficients of the 4th order polynomial for each detector array (channel)	-	do	40	320
3	Number of used lines per channel	-	us	8	16
4	Wavelength calibration error per channel	-	fl	8	32
Size of Component:					*4464*

SCIAMACHY is equipped with a passive thermal control loop which keeps the optical bench temperature stable within 600 mK. Depending on the temperature of the optical bench, the dispersion of the pre-disperse prism produces different spectral properties on the detector arrays. From measurements of the spectral calibration lamp, a set of spectral calibration parameters will be calculated for each position in orbit relative to the sun (see description of 'orbit phase after eclipse' field under leakage current component). To fulfil the ultimate scientific requirement for a spectral accuracy of $^{1}/_{100}$th of a detector pixel, it is sufficient to define certain orbit phase regions in which the spectral calibration parameters are expected to be fairly constant. These regions will be used as key into the spectral calibration parameters. The number of 12 records in the format description above is just an example, but it is assumed that this number will be fixed after its determination during commissioning phase.

The spectral calibration parameters are a precise basis array of wavelength value for each detector pixel and a sequence of five coefficients of a 4^{th} order polynomial from a_4 to a_0 for each detector array and the eight detector arrays are given from 1 to 8 which gives a total of 40 coefficients.

One set of spectral calibration parameters will be valid for the sun reference measurement. The radiance and the polarisation sensitivity values in the ADSs below will be interpolated to this wavelength grid.

Component: **Sun Reference Spectrum**
Component Type: GADS No of Records: 3 Record Size: 163942

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Sun spectrum identifier "Xn" which may indicate various types of solar measurement; according to the table below	-	tx	2	2
2	Wavelength of the sun measurement	nm	fl	8192	32768
3	Mean sun reference spectrum (uncalibrated has as unit BU)	photons/ cm^2· nm· s	fl	8192	32768
4	Radiometric precision of the mean sun reference spectrum	-	fl	8192	32768
5	Radiometric accuracy of the mean sun reference spectrum	-	fl	8192	32768
6	Diffuser/Small Aperture Etalon	-	fl	8192	32768
7	Average azimuth mirror position	degree	fl	1	4
8	Average elevation mirror position (diffuser)	degree	fl	1	4
9	Average solar elevation angle	degree	fl	1	4
10	Mean value of the corresponding PMD measurements	BU	fl	7	28
11	PMD out-of-band signal with ND out	BU	fl	7	28
12	PMD out-of-band signal with ND in	BU	fl	7	28
13	Doppler shift at 500 nm	nm	fl	1	4
Size of Component:					*491826*

The sun reference spectrum is given in the form of a mean value of different sun diffuser measurements using the bi-directional scattering distribution function (BSDF) of the diffuser to convert the measured radiance into irradiance and the mean values of the corresponding PMD measurements. There may be sun reference spectra obtained from different measurement modes. The reason for this is that during instrument calibration several anomalies were found for different modes. The optimum Sun reference to use in Level 2 processing may depend on the kind of retrieval used there. The various modes are specified by the following identifier:

	Calibrated	**Uncalibrated**
Diffuser (ESM ND in)	D0	E0
Diffuser (ESM ND out)	D1	E1
Diffuser (ASM)	D2	A0

Component: **Polarisation Sensitivity Parameters Nadir**
Component Type: GADS No of Records: 10 Record Size: 65540

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Elevation mirror position	degree	fl	1	4
2	μ_2 nadir for the elevation mirror position of field 1	-	fl	8192	32768
3	μ_3 nadir for the elevation mirror position of field 1	-	fl	8192	32768
Size of Component:					*655400*

Component: **Polarisation Sensitivity Parameters Limb/Occultation without ND**
Component Type: GADS No of Records: 100 Record Size: 65544

The structure of this component is identical to that of 'Polarisation Sensitivity Parameters Limb/Occultation with ND' (see below), but it will contain different mirror positions.

Component: **Polarisation Sensitivity Parameters Limb/Occultation with ND**
Component Type: GADS No of Records: 100 Record Size: 65544

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Elevation mirror position	degree	fl	1	4
2	Azimuth mirror position	degree	fl	1	4
3	μ_2 limb for the elevation and azimuth mirror position of field 1 and 2	-	fl	8192	32768
4	μ_3 limb for the elevation and azimuth mirror position of field 1 and 2	-	fl	8192	32768
Size of Component:					*6554400*

The polarisation sensitivity is expressed as a large number of different parameters which are too dependent on the two positions (azimuth and elevation) of the scanner, so an array of various polarisation sensitivity values for a list of scanner position is required. For nadir a one-dimensional array of two parameters (μ_2, μ_3) is sufficient, because only the position of the elevation mirror is relevant. For limb a two-dimensional array of two parameters (μ_2, μ_3) is required, because the positions of both scanner mirrors are arguments to the two parameters which are necessary for the calculation of the polarisation correction factor.

The number of records given in the nadir and limb related polarisation sensitivity component are examples for the calculation of the product size. The actual number of records depends on the result of the final pre-flight calibration activity. Then ESM and ASM position values will be selected so that linear interpolation between these values yields an error which is well below the systematic error of the corresponding parameter. These values will be placed into the initialisation file and used from there to calculate the present product component. During application of the polarisation sensitivity parameters the scan mirror positions in the geolocation record of the MDS are used to select the correct interval and calculate an appropriate set of polarisation sensitivity parameters using linear interpolation.

Component: Radiance Sensitivity Parameters Nadir with ND
Component Type: GADS No of Records: 10 Record Size: 32772

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Elevation mirror position	degree	fl	1	4
2	Radiance sensitivity for the mirror position of field 1	(BU/s)/ (photons/ $cm^2\cdot$ nm$\cdot$ sr$\cdot$ s)	fl	8192	32768
Size of Component:					*327720*

Component: Radiance Sensitivity Parameters Limb/Occultation without ND
Component Type: GADS No of Records: 100 Record Size: 32776

The structure of this component is identical to that of 'Radiance Sensitivity Parameters Limb/Occultation with ND' (see below), but it will contain different mirror positions.

Component: Radiance Sensitivity Parameters Limb/Occultation with ND
Component Type: GADS No of Records: 100 Record Size: 32776

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Elevation mirror position	degree	fl	1	4
2	Azimuth mirror position	degree	fl	1	4
3	Radiance sensitivity for the elevation and azimuth mirror position of field 1 and 2	(BU/s)/ (photons/ $cm^2\cdot$ nm$\cdot$ sr$\cdot$ s)	fl	8192	32768
Size of Component:					*3277600*

The radiance sensitivity parameters will be an interpolated set of the pre-characterised radiance sensitivity function for the eight detector arrays. The radiance sensitivity is dependent on the scanner position, it is therefore necessary to include an array of radiance sensitivity values for each two-dimensional ($10 \cdot 10 = 100$) scanner position.

The number of records given in the radiance sensitivity component is an example for the calculation of the product size. The actual number of records depends on result of the final pre-flight calibration activity. Then ESM and ASM position values will be selected so that linear interpolation between these values yields an error which is well below the systematic error of the corresponding parameter. These values will be placed into the initialisation file and used from there to calculate the present product component. During application of the radiance sensitivity parameters the scan mirror positions in the geolocation record of the MDS are used to select the correct interval and calculate an appropriate set of radiance sensitivity parameters using linear interpolation.

The radiance sensitivity parameters for the nadir measurements are identified by a fixed value of 360° for the ASM position. ESM and ASM position values in the geolocation records of the MDSs are used to select the correct set of radiance sensitivity parameters from this GADS.

Component: Errors on Key Data
Component Type: GADS No of Records: 1 Record Size: 294912

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Error on μ_2 nadir	-	fl	8192	32768
2	Error on μ_3 nadir	-	fl	8192	32768
3	Error on μ_2 limb	-	fl	8192	32768
4	Error on μ_3 limb	-	fl	8192	32768
5	Error on the radiance sensitivity for the optical bench only	(BU/s)/ (photons/ $cm^2 \cdot nm \cdot sr \cdot s$)	fl	8192	32768
6	Error on radiance sensitivity for elevation mirror only (nadir viewing)	-	fl	8192	32768
7	Error on radiance sensitivity for elevation and azimuth mirror (limb viewing)	-	fl	8192	32768
8	Error on radiance sensitivity for diffuser and azimuth mirror (sun diffuser measurement)	-	fl	8192	32768
9	Error on BSDF	-	fl	8192	32768
Size of Component:					*294912*

To calculate the errors on the final level 1b data the errors on those part of the Key Data which are required during the processing of the application programme have to be included in the level 1b product besides the Key Data itself, as described in the ADSs before. The parameters for which errors are attached are the following:

- polarisation sensitivity parameters for nadir and limb (μ_2 and μ_3),
- radiance sensitivity parameters, and
- the BSDF function.

Component: Slit Function Parameters
Component Type: GADS No of Records: 40 Record Size: 11

Field	***Comments***	***Unit***	***Type***	***#***	***Size***
1	Pixel position for which the slit function is given (0-8191)	-	us	1	2
2	Type of slit function (1 = gauss, 2 = single hyperbolic, 3 = voigt)	-	uc	1	1
3	FWHM of slit function [pixel]	-	fl	1	4
4	For voigt: FWHM of Lorenzian part [pixel]	-	fl	1	4
Size of Component:					*440*

Component: Small Aperture Slit Function Parameters
Component Type: GADS No of Records: 40 Record Size: 11

Field	***Comments***	***Unit***	***Type***	***#***	***Size***
1	Pixel position for which the slit function is given (0-8191)	-	us	1	2
2	Type of slit function (1 = gauss, 2 = single hyperbolic, 3 = voigt)	-	uc	1	1
3	FWHM of slit function [pixel], for voigt: Lorenzian part	-	fl	1	4
4	For voigt only: FWHM of Gaussian part [pixel]	-	fl	1	4
Size of Component:					*440*

The slit function parameters and the small aperture slit function parameters are a copy of the Key Data '_SLIT_F' and '_SMALL_AP_SLIT_F' , respectively. They are included as GADS because they are needed in the level 1 to 2 processing. The number of 40 records is an example, the actual number will be equal to the first dimension of the corresponding parameters on the Key Data file.

Component: **States of the Product**
Component Type: ADS No of Records: 60 Record Size: 1387

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of scan phase of the state	-	MJD	1	12
2	Flag indicating if MDS DSRs are attached to the current ADS DSR (1: no, 0: yes)	-	uc	1	1
3	Reason code if the attachment flag is set to '1' 0: MDS DSRs are not attached, because this type measurement is not intended to be in the level 1b product (dark measurements) 1: the measurement state was corrupted	-	uc	1	1
4	Orbit phase after eclipse of the state (range: 0-1)	-	fl	1	4
5	Measurement Category	-	us	1	2
6	State ID	-	us	1	2
7	Duration of scan phase of the state	$^1/_{16}$ s	us	1	2
8	Longest integration time	$^1/_{16}$ s	us	1	2
9	Number of clusters	-	us	1	2
10	Cluster Configuration	-	Clcon	64	1088
11	MDS for this state (1 = nadir, 2 = limb, 3 = occultation, 4 = monitoring)	-	uc	1	1
12	Number of repeated geolocation and level 0 headers	-	us	1	2
13	Number of integrated PMD values	-	us	1	2
14	Number of different integration times in all clusters	-	us	1	2
15	Various integration times in this state	$^1/_{16}$ s	us	64	128
16	Number of fractional polarisation values per different integration time	-	us	64	128
17	Total number of fractional polarisation values	-	us	1	2
18	Number of DSRs	-	us	1	2
19	Length of DSR	-	ul	1	4
Size of Component:					*83220*

Each DSR of this ADS corresponds to a certain segment in one of the following MDSs. It describes the parameters of the corresponding state, as far as they are of interest for the data product, which is covered by the related MDS. The DSRs of this ADS are sorted in chronological order as well as the DSRs of all the other time dependent ADSs (SQADS, LADS and the two data packet ADSs). The number of 60 DSRs is resulting form the example in section 5.

The number of 64 elements for the cluster configuration field is due to the maximum number of 64 clusters of the instrument measurement configuration.

Component: PMD Data Packets
Component Type: ADS No of Records: 780 Record Size: 6833

Field	***Comments***	***Unit***	***Type***	***#***	***Size***
1	Start time of the PMD data packet	-	MJD	1	12
2	Flag indicating if MDS DSRs are attached to the current ADS DSR	-	uc	1	1
3	PMD data packet of the level 0 data	-	b	6820	6820
Size of Component:					*5329740*

Component: Auxiliary Data Packets
Component Type: ADS No of Records: 780 Record Size: 1679

Field	***Comments***	***Unit***	***Type***	***#***	***Size***
1	Start time of the auxiliary data packet	-	MJD	1	12
2	Flag indicating if MDS DSRs are attachedto the current ADS DSR	-	uc	1	1
3	Auxiliary data packet of the level 0 data	-	b	1666	1666
Size of Component:					*1309620*

The level 1b product will be the lowest level of SCIAMACHY data delivered to the general user. Therefore, it is a good idea to retain as much of the level 0 data information as possible. The following information in the level 0 data headers will be copied into the level 1b product:

- all PMD data packets, as a single ADS (approx. 5.2 MB)
- all auxiliary data packets, as a single ADS (approx. 1.25 MB)
- all headers of the detector module data packets, as part of each MDS in the product (approx. 0.3 to 3.0 MB depending on the shortest integration time in the states)

The number of 780 records for the PMD and auxiliary data packets ADS results from the generation time of the corresponding data packets. Each of this ISPs is generated by the instrument every five seconds. According to the reference timeline in section 5 the maximum time during one orbit in which observational and most of the monitoring measurement (excepting dark measurements) may be made is about 3900 seconds. This leads to the above mentioned number of PMD and auxiliary ISPs which corresponds to the DSRs in these ADSs.

Newly calculated in-flight calibration ADS components

As explained in the 'Processing Overview' section, in-flight calibration parameters may exist twice in the level 1b product:

1. a first and always existing set of GADSs, as described before, which is valid for the observational measurements of the present product and
2. a second and optional set of ADSs which contains newly calculated in-flight calibration parameters from measurements which were present in the level 0 product on input (denoted by the 'NEW_' prefix in the DS_NAME field of the corresponding DSD).

The first will be used by the application programme for the application of the calibration parameters to the signal values and the second set will be extracted by PDS to auxiliary products to be available for subsequent runs of SGP_01 on input. The latter set of ADSs is described hereafter.

Component: **Leakage Current Parameters (newly calculated partial set)**
Component Type: ADS No of Records: ~12 Record Size: 164021

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the first dark measurement state which was used to calculate this ADSR	-	MJD	1	12
2	Flag indicating if MDSRs are attached to the current ADSR (always set to 1, because these parameters are not directly related to a MDS)	-	uc	1	1
3	Start time of the last dark measurement state which was used to calculate this ADSR	-	MJD	1	12
4	Orbit phase after eclipse (range: 0-1)	-	fl	1	4
5	OBM (near radiator), detector (8x) and PMD temperatures	BU	fl	10	40
6	Fixed pattern noise for channels 1 to 8	BU	fl	8192	32768
7	Error on the FPN	BU	fl	8192	32768
8	Leakage current for channels 1 to 8	BU/s	fl	8192	32768
9	Error on the LC	BU/s	fl	8192	32768
10	Mean noise (mean value of standard deviations per detector element)	BU	fl	8192	32768
11	PMD dark offset for all PMDs for the amplifier A and B (1A, 1B, 2A, etc.)	BU	fl	14	56
12	Error on the PMD offset	BU	fl	14	56
Size of Component:					*1968252*

A new set of leakage current parameters, as described in the constant and variable fraction GADSs before, may be constructed out of several newly calculated partial leakage current set3.2.364s.

Component: **Average of the Dark Measurements per State**
Component Type: ADS No of Records: 30 Record Size: 131253

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the dark measurement state which was used to calculate this ADSR	-	MJD	1	12
2	Flag indicating if MDSRs are attached to the current ADSR (always set to 1, because these parameters are not directly related to a MDS)	-	uc	1	1
3	Average dark measurement spectrum	BU	fl	8192	32768
4	Standard deviation of the dark measurement spectrum	BU	fl	8192	32768
5	PMD dark offset for all PMDs for the amplifier A and B (1A, 1B, 2A, etc.)	BU	fl	14	56
6	Error on the PMD offset	BU	fl	14	56
7	Solar straylight scattered from the azimuth mirror	BU/s	fl	8192	32768
8	Error on the solar straylight	BU/s	fl	8192	32768
9	Straylight offset for PMDs	BU	fl	7	28
10	Error on the PMD straylight offset	BU	fl	7	28
Size of Component:					*3937590*

As already explained above, dark measurements are not included in one of the MDSs. Therefore, this ADS contains the averages and standard deviations of these dark measurement states. The number records is determined by the duration of the eclipse of approx. 40 minutes having 3 consecutive dark measurements per 4 minutes.

Component: PPG/Etalon Parameters
Component Type: ADS No of Records: 1 Record Size: 172045

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the WLS measurement state which was used to calculate this ADSR	-	MJD	1	12
2	Flag indicating if MDSRs are attached to the current ADSR (yes, in the Monitoring MDS)	-	uc	1	1
3	Pixel-to-pixel gain factor	-	fl	8192	32768
4	Etalon Correction Factor	-	fl	8192	32768
5	Etalon Residual	-	fl	8192	32768
6	Average WLS spectrum which has been used for the determination of PPG and Etalon	BU	fl	8192	32768
7	Standard deviation of the WLS spectrum	BU	fl	8192	32768
8	Bad pixel mask	-	uc	8192	8192
Size of Component:					*172045*

Component: Spectral Calibration Parameters
Component Type: ADS No of Records: ~8 Record Size: 33257

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the SLS or sun measurement state which was used to calculate this ADSR	-	MJD	1	12
2	Flag indicating if MDSRs are attached to the current ADSR (yes, in the Monitoring MDS)	-	uc	1	1
3	Orbit phase after eclipse (range: the absolute value is between '0' and '1')	-	fl	1	4
4	Coefficients of the 4th order polynomial for each detector array (channel)	-	do	40	320
5	Source of spectral calibration parameters (0=SLS, 1=sun)	-	uc	8	8
6	Number of used lines per channel	-	us	8	16
7	Wavelength calibration error per channel	-	fl	8	32
8	Average SLS or solar spectrum which has been used for the determination of spectral calibration parameters	BU	fl	8192	32768
9	Selected line positions for 3 lines per channel	nm	fl	24	96
Size of Component:					*300640*

If the spectral calibration algorithm was not able to determine a set of coefficients for a certain detector array the corresponding wavelength calibration error shall be set to -1.

Component: **Sun Reference Spectrum**
Component Type: ADS No of Records: 6 Record Size: 163928

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of the sun diffuser measurement state which was used to calculate this ADSR	-	MJD	1	12
2	Flag indicating if MDSRs are attached to the current ADSR (yes, in the Monitoring MDS)	-	uc	1	1
3	Sun spectrum identifier "X∅" where "X" may indicate various types of solar measurement	-	tx	2	2
4	Neutral density filter flag	-	uc	1	1
5	Wavelength of the sun spectrum	nm	fl	8192	32768
6	Mean sun reference spectrum	photons/ cm^2· nm· s	fl	8192	32768
7	Relative radiometric precision of the mean sun reference spectrum	-	fl	8192	32768
8	Relative radiometric accuracy of the mean sun reference spectrum	-	fl	8192	32768
9	Diffuser/Small Aperture Etalon	-	fl	8192	32768
10	Average azimuth mirror position	degree	fl	1	4
11	Average elevation mirror position (diffuser)	degree	fl	1	4
12	Average solar elevation angle	degree	fl	1	4
13	Mean value of the corresponding PMD measurements	BU	fl	7	28
14	PMD out-of-band signal	BU	fl	7	28
15	Doppler shift at 500 nm	nm	fl	1	4
Size of Component:					*983568*

For each solar measurement, the Sun Reference ADS has two records: the first record is the calibrated spectrum (NB only the ESM Diffuser mode is absolutely calibrated, the other modes carry rough approximations of the intensity), the second record is not calibrated for intensity (units are in BU).

The sun-spectrum identifiers "X∅" (field 3) may have following values:

	Calibrated	**Uncalibrated**
Diffuser (ESM)	D	E
Diffuser (ASM)	D	A
Occultation	O	U
Sub-solar	S	V

PPG/Etalon parameters, spectral calibration parameters and the sun reference spectrum have in principle the same format as the corresponding GADSs described earlier in this format specification. The newly calculated in-flight calibration parameters are only preceded with the first two mandatory fields for ADSs.

MDS Components

After the sequence of annotation data sets (global, location, summary of quality and other ADSs) the four measurement data sets (MDSs) follow. Within each of the following MDSs the states of the corresponding types are sorted in chronological order. Whenever a new state is started by the instrument, it has to be decided to which MDS this state has to be appended. The current MDSR structure will no longer be valid for the arbitrary case and a new MDSR structure has to be determined. This is necessary, because the different instrument settings of the states (viewing mode, integration time, pixel exposure time, co-adding factor, etc.), require a different type of MDSR, as explained below.

The general structure of a MDSR is defined as follows:

- Start time of the DSR, existence and format according to [R6]
- Data set record length according to [R11], this is required for MDSs with a variable record length
- Quality indicator (-1 if empty DSR), existence and format according to [R6]
- Straylight scaling factor (given for the longest integration time per channel)
- Saturation flags

  The saturation flags will be given for each observation and give the number of saturated pixel elements for this observation. If the number is set to 255 then the number of saturated pixel elements is ≥ 255.
- Red Grass flag

  The Red Grass (RG) flags will be given for each observation and for each cluster; for clusters which are missing in the observation the flag is set to 0. The flag is set to 1 if RG is detected in a cluster
- Sun glint / Rainbow flags (observational Nadir MDSs only)

  The sun glint / rainbow flags will be given for each observation and are a binary coded value, as explained in the corresponding DPM [R15]. For limb and occultation measurements this flag field will also be given, but set to '0' and is available for future use.
- Geolocation, depending on the viewing mode their is a different type of geolocation record required (nadir, limb or others; occultation has the same geolocation parameters as limb).
- Integrated PMD values given with 32 Hz (observational MDSs only)

  The PMD read-outs are given at 40 Hz, but they are filtered using a 3rd order Butterworth filter having a filter frequency of 20 Hz. To avoid under-sampling the integrated and synchronised PMD values are therefore given at 32 Hz.
- Level 0 detector module data packet header and data field header according to [R12], as mentioned in section 3.2.1 on page 28
- Fractional polarisation values given for each integration time occurring in this state (observational MDSs only)
- List of specific cluster data records depending on the number of clusters and their detector pixel length.

The following state parameters define the structure of an individual MDSR and the number of MDSRs for the corresponding MDS:

- the measurement duration of a state (t_{dur})
- the number of clusters *for* a given state (c)
- the number of different integration times of these clusters (k)
- integration times of a specific cluster (Δt_{cl})
- the largest common multiple of the cluster's integration time (Δt_{max})
- the shortest integration time of a cluster (Δt_{min})

  for all clusters: $\Delta t_{max} \geq \Delta t_{cl} \geq \Delta t_{min}$
- the number of detector pixels per cluster (n_{cl})

To calculate the structural parameters of a certain MDS, the following formulas have to applied:

- number of MDSRs (N_{rec})

  $$N_{rec} = \frac{t_{dur}}{\Delta t_{max}}$$

  For Limb measurements there is a special situation due to the measurement gap of 3 BCPSs between each azimuth scan. Therefore, the division of the measurement duration by the longest integration time makes no sense and the number of MDSRs for Limb is fixed to 35 consisting of 34 azimuth scan having an integration time of 1.5 seconds and an attached dark measurement by looking into deep space for the last MDSR.[1]
- number of repetitions for the auxiliary information (saturation flags, geolocation, and level 0 detector data packet header, N_{aux}; the integrated PMD values are given always for half of the smallest possible integration time of 31.25 ms, N_{IntPMD})

  $$N_{aux} = \frac{\Delta t_{max}}{\Delta t_{min}} \quad N_{IntPMD} = \frac{\Delta t_{max}}{31.25\ \mathrm{ms}}$$
- number of repetitions for cluster record of cluster i ($N_{cl,i}$)

  $$N_{cl,i} = \frac{\Delta t_{max}}{\Delta t_{cl,i}}$$

  The fractional polarisation values will be given for each integration time which occurs (k times)
- length of a MDSR
  - for observational measurements

    $$L_{rec} = L_{head} + (N_{aux} \cdot L_{aux}) + (N_{IntPMD} \cdot n_{PMD} \cdot 4) + \sum_{j=1}^{k} (N_{cl,j} \cdot L_{pol}) + \sum_{i=1}^{c} (N_{cl,i} \cdot n_{cl,i})$$
  - for monitoring measurements

    $$L_{rec} = L_{head} + (N_{aux} \cdot L_{aux}) + \sum_{i=1}^{c} (N_{cl,i} \cdot n_{cl,i})$$

[1] The measurement duration of a Limb state is 59.0625 seconds. This may be calculated as follows: one azimuth scan has a net integration time of 1.5 seconds and the adjustment of the elevation mirror for the next azimuth scan takes 3 BCPSs corresponding to 0.1875 seconds giving a total of 1.6875 seconds for one azimuth scan. 34 azimuth scan plus one dark measurement into deep space (which takes the same time as one azimuth scan) gives a state duration of: 35 · 1.6875 s = 59.0625 s.

where:

- L_{head} is the length of the constant header information of a MDSR including the quality flags (size = 120 for observational measurements; size = 17 for monitoring measurements)
- L_{aux} is the length of the auxiliary information (size = 182 for observational measurements; size = 92 for monitoring measurements)
- n_{PMD} is the number of PMDs (=7)
- L_{pol} is the length of the fractional polarisation values compound data type (PolV; size = 256)

- length of a MDS

$$L_{MDS} = N_{rec} \cdot L_{rec}$$

Note
The examples and the tables for MDS construction in this I/O DD are only given for illustration purpose. They are based on the present operational definitions given in [R4], but they are by no means fixed for the future. Therefore, software for reading of level 0 and writing of level 1b data have to be designed and implemented in a highly flexible way to identify the structure of states and construct the appropriate MDSR accordingly

Example for an Observational MDSR

According to the present status of parameters, as described in [R4], a particular observational state (State 3) has the following parameters and requires the following MDS construction:

- Scan pattern duration is 5 seconds, 4 seconds forward scan, 1 second backward 4 times faster
- Nadir measurement, measurement category 1, ESM scanning, ≈ 960 km swath width, because scan speed is 16°/second
- Measurement duration: 80 seconds
- Data Rate: Low

This information is required to select the correct co-adding table. Unfortunately, the data rate is a global setting granted by the ENVISAT platform which may not be actively influenced by the SCIAMACHY instrument. E.g. if SCIAMACHY is commanded for high data rate and ENVISAT is accepting low data rate only, additional data beyond the maximum allowed data rate is truncated.

In general SCIAMACHY is operated in low data rate except for sun occultation measurements where the nadir view is still in eclipse, MERIS is not operated in high rate mode and ENVISAT is therefore accepting high data rate from SCIAMACHY.

- Pixel exposure times

The detector array readout electronics allows only one readout time per channel except channel 1 and 2 which have two electronically separated regions (virtual channels a and b) on the detector array.

Channel	1a	1b	2a	2b	3	4	5	6	7	8
PET (s)	20	5	5	1	0.5	0.5	1	1	1	1

- Cluster table index: 3

This table contains 62 definitions with channel id, cluster index, cluster id, start pixel and cluster length (details my be found in [R4]). There are the following number of clusters in each individual channel:

Channel	1a	1b	2a	2b	3	4	5	6	7	8
# of clusters	2	3	3	3	12	11	11	11	3	3

Other cluster tables may contain a different number of clusters per channel and a different total number of clusters.

- Co-adding Index: 23 (thick lines show the 10 channel boundaries)

Cluster Index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Co-adding Factor	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1	1
Cluster Index	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Co-adding Factor	2	2	1	2	2	1	2	2	1	2	2	1	2	2	1	2
Cluster Index	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Co-adding Factor	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cluster Index	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Co-adding Factor	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0

The information above allows to identify the various pieces of information about this state:

- number MDSRs: 4
- number of repetitions of auxiliary data (saturation flags, geolocation, level 0 header): 40
- number of repetitions of integrated PMD values: 640 ($\Rightarrow 640 \cdot 7 = 4480$, the integrated PMD values are given as group of 7 float values for the PMDs A to F and the 45° PMD being the last value)
- number of repetitions of the various clusters: 1, 4, 20 or 40 times depending on the
- different integration times: 20, 5, 1 and 0.5 seconds
- the fractional polarisation values are given for all 4 integration times in the appropriate timely resolution: 1+4+20+40 = 65 times, the longest integration time with just one value comes first and then in the order of integration time to the shortest

A data set component table for this example state would look as follows (extensive cluster data fields are omitted, find the fully calculated example in section 5 on page Error: Reference source not found):

Component: **Example MDS segment for State 3**
Component Type: MDS No of Records: 4 Record Size: 541045

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of DSR	-	MJD	1	12
2	DSR length	-	ul	1	4
3	Quality indicator (-1 if empty DSR)	-	sc	1	1
4	Scale factor for the straylight values in the signal compound type per channel	-	uc	8	8
5	Saturation flags	-	uc	40	40
6	Red Grass flag	-	uc	40*62	40*62
7	Sun glint / Rainbow flags	-	uc	40	40
8	Geolocation	-	GeoN	40	4320
9	Level 0 detector module data packet headers	-	L0Hdr	40	2880
10	Integrated PMD values	BU· s	fl	4480	17920
11	Fractional polarisation values	-	PolV	65	16640
12	Cluster 1 data (1*5 pixel)	-	Rsig	5	20
13	Cluster 2 data (1*528 pixel)	-	Rsig	528	2112
...	...	...	...	...	...
19	Cluster 8 data (4*643 pixel)	-	Rsig	2572	10288
...	...	...	...	...	...
27	Cluster 16 data (40*205 pixel)	-	RSig	8200	32800
28	Cluster 17 data (20*185 pixel)	-	Rsigc	3700	18500
...	...	...	...	...	...
72	Cluster 61 data (20*878 pixel)	-	ESig	17560	52680
73	Cluster 62 data (20*10 pixel)	-	ESig	200	600
Size of Component:					*2164180*

Example for a Monitoring MDSR

According to the present status of parameters, as described in [R4], a particular monitoring state (State 53) has the following parameters and requires the following MDS construction:

- No scanning for this state
- Sub-solar calibration pointing measurement, measurement category 9
- Measurement duration: 21 seconds
- Data Rate: Low
- Pixel exposure times

The detector array readout electronics allows only one readout time per channel except channel 1 and 2 which have two electronically separated regions (virtual channels a and b) on the detector array. Channel 6 and 7 are readout using the 'hot' mode, this means that

Channel	1a	1b	2a	2b	3	4	5	6	7	8
PET (s)	$^1/_8$	$^1/_8$	$^1/_{16}$	$^1/_{16}$	$^1/_{16}$	$^1/_{16}$	$^1/_{16}$	$^1/_{32}$	$^1/_{32}$	$^1/_{16}$

- Cluster table index: 1

This table contains 26 definitions with channel id, cluster index, cluster id, start pixel and cluster length (details my be found in [R4]). There are the following number of clusters in each individual channel:

Channel	1a	1b	2a	2b	3	4	5	6	7	8
# of clusters	2	2	2	2	3	3	3	3	3	3

Other cluster tables may contain a different number of clusters per channel and a different total number of clusters.

- Co-adding Index: 31 (thick lines show the 10 channel boundaries)

Cluster Index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Co-adding Factor	4	4	4	4	8	8	8	8	8	8	8	8	8	8	8	8
Cluster Index	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Co-adding Factor	8	8	8	8	8	8	8	8	8	8	0	0	0	0	0	0
Cluster Index	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Co-adding Factor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cluster Index	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Co-adding Factor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The information above allows to identify the various pieces of information about this state:

- number MDSRs: 42
- number of repetitions of auxiliary data (geolocation, level 0 header): 1
- number of repetitions of the various clusters: 1
- because there is only one integration time of 0.5 seconds

A data set component table for this example state would look as follows (extensive cluster data fields are omitted, find the fully calculated example in section 5 on page Error: Reference source not found):

Component: **Example MDS segment for State 53**
Component Type: MDS No of Records: 42 Record Size: 33401

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Start time of DSR	-	MJD	1	12
2	DSR length	-	ul	1	4
3	Quality indicator (-1 if empty DSR)	-	sc	1	1
4	Scale factor for the straylight values in the signal compound type per channel	-	uc	8	8
5	Saturation flags	-	uc	40	40
6	Red Grass flag	-	uc	40*26	40*26
7	Geolocation	-	GeoCal	1	20
8	Level 0 detector module data packet headers	-	L0Hdr	1	72
9	Cluster 1 data (1*5 pixel)	-	Rsigc	5	25
10	Cluster 2 data (1*528 pixel)	-	Rsigc	528	2640
...	...	...	...	...	...
18	Cluster 10 data (1*930 pixel)	-	Rsigc	930	4650
...	...	...	...	...	...
33	Cluster 25 data (1*878 pixel)	-	Esigc	878	3512
34	Cluster 26 data (1*10 pixel)	-	Esigc	10	40
Size of Component:					*1402842*

Sizing

The granule of a level 1b product is determined by the consolidation status and size of the level 0 product on input.

Only complete states will be processed. This means that ISPs which are not belonging to a complete state at the beginning or the end of a level 0 product will be skipped. Consolidation processing has to take care of the state boundaries to ensure that no data is lost.

Data Volume

According to the example in section 5 on page 110 approx. 186 MB/orbit are expected. If the sun diffuser measurement in this example is replaced by a sun occultation measurement operated in high data rate the data volume of a level 1b product is expected to be extended to approx. 205 MB/orbit.

Throughput

SCIAMACHY is intended for continuous measuring. This implies approximately 14 orbits and the same number of level 1b products per day.

Remarks

General Structure of Calibration Parameters

Calibration parameters are in general given for all eight detector arrays, if not otherwise noted. Each detector array has 1024 detector elements which are kept together and are recorded from 0 to 1023 (0 corresponds to the lowest and 1023 to the highest wavelength in the corresponding channel) and the arrays are recorded from 1 to 8 which gives a total of 8192 consecutive values.

Reversed read-out order of channel 2[2]

The reversed read-out order of channel 2 is not affecting the data format of the level 1b product. Similar to all other channels the detector pixel readouts are given in ascending wavelength order. It is just a timing issue at which precise time the individual pixels of channel 2 have been read out. This means that the last pixel of channel 1 is read out at the same time as the first pixel of channel 2 and the last pixel of channel 2 is read out at the same time as the first pixel of channel 3. This may be used to gain the over-lapping regions between channel 1 and 2 and between channel 2 and 3 to retrieve a fractional polarisation value for these wavelength ranges which in general would suffer from an spatial aliasing effect due to the finite read-out time of all detector pixel of an array. Default Calibration Files

The following calibration files are presented to the processor on input. For the very first orbits, the calibration database cannot provide calibration data because the processor searches the most recent calibration data in the past and they do not exist for the very first orbits. Then calibration data from the default calibration files will be applied.

[2] This note is only interesting for those who know about this reversed read-out order and are wondering whether it is influencing the level 1b data format. In level 0 data the cluster configuration information and cluster data itself from channel 2 are given in reversed order. SGP_01 takes care of re-ordering to provide all clusters in ascending wavelength order.

3.2.3 Leakage Current Parameters

Identifier

SCI_LK1_AX

Name

Leakage current correction parameters for SCIAMACHY level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The leakage current correction parameter file will include headers and two global annotation data sets (GADS), as depicted in . The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification, data acquisition and processing, time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion, product confidence data and sizes of the following data. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following global annotation data sets which include the leakage current and noise characteristics.

The leakage current parameters are expected to be dependent on the position in orbit. Therefore, the calculation of these parameters require an orbit phase field for annotation and the application needs them for selection of appropriate parameters. The parameters are divided into a constant fraction of the leakage current and a fraction being variable with orbit phase which is realised by two GADSs. The calculation of leakage current parameters requires a certain set of dark calibration measurement states as well as the last measurements of the limb states and the orbit phase of the corresponding measurements.

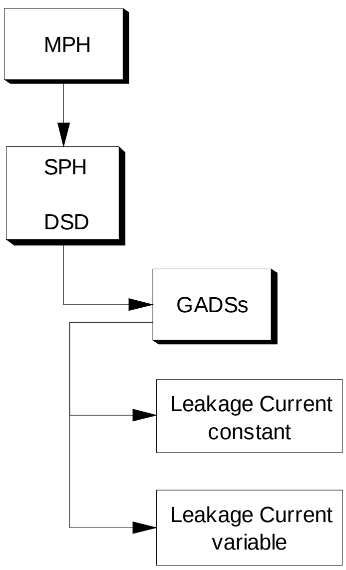

Figure 4: Schematic Structure of the Leakage Current Parameters

Format

The detailed format description is divided into several tables representing the hierarchy of the files content, as depicted in . The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Leakage Current Parameters (constant fraction)	GADS
5	Leakage Current Parameters (variable fraction)	GADS

Component: **Main Product Header**
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: **Specific Product Header of Auxiliary Data**
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"LEAKAGE_CURRENT_PARAMETER∅∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: **Data Set Descriptor Record**
Component Type: DSD No of Records: 2 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*560*

For the data set name definitions please refer to the corresponding GADSs in the level 1b product.

Component: **Leakage Current Parameters (constant fraction)**
Component Type: GADS No of Records: 1

This is a copy of the corresponding GADS on the Level 1b product

Component: **Leakage Current Parameters (variable fraction)**
Component Type: GADS No of Records: 12

This is a copy of the corresponding GADS on the Level 1b product

Sizing

One complete set of leakage current parameters are covered by this file.

Data Volume

The leakage current parameter file requires approximately 1.2 MB.

Throughput

The eclipse side of the orbit will most of the time be used for dark measurements and the optimised nadir/limb scanning strategy on the illuminated side of the Earth provides enough additional limb data measurements into deep space to calculate a complete set of leakage current parameters every orbit. Nevertheless, this is much to often and most of this data will be discarded. Approximately one leakage current parameter set per week is envisaged.

Remarks

See the corresponding remark concerning the leakage current components of this product in the description of the level 1b product (section 3.2.2).

3.2.4 PPG/Etalon Parameters

Identifier

SCI_PE1_AX

Name

PPG/Etalon correction parameters for SCIAMACHY level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The PPG/Etalon correction parameter file will include headers and just one global annotation data sets (GADS), as depicted in . The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification, data acquisition and processing, time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion, product confidence data and sizes of the following data. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following global annotation data set which includes the PPG/Etalon characteristics.

The PPG/Etalon parameters are not expected to be depended on the position in orbit. Therefore, the data set consists of just one set of parameters. The calculation of the PPG/Etalon parameters requires one WLS measurement states.

Format

The detailed format description is divided into several tables representing the hierarchy of the files content, as depicted in . The product consists of the following components:

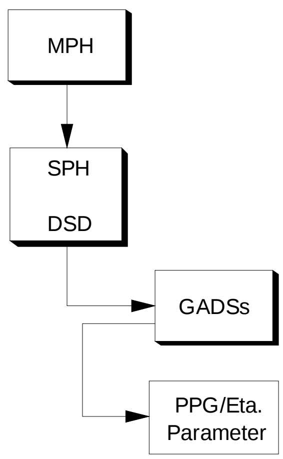

Figure 5: Schematic Structure of the PPG/Etalon Parameters

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	PPG/Etalon Parameters	GADS

Component: **Main Product Header**
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: **Specific Product Header of Auxiliary Data**
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"PPG_ETALON_CORRECTION_PARAM∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank character ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: **Data Set Descriptor Record**
Component Type: DSD No of Records: 1 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*280*

For the data set name definition please refer to the corresponding GADS in the level 1b product.

Component: **PPG/Etalon Parameters**
Component Type: GADS No of Records: 1

This is a copy of the corresponding GADS on the Level 1b product

Sizing

One complete set of PPG/Etalon parameters is covered by this file.

Data Volume

The PPG/Etalon parameter file requires approximately 1.4 MB.

Throughput

WLS measurements are planned for the weekly calibration timeline. Therefore, a PPG/Etalon file is expected once per week.

Remarks

N/A

3.2.5 Spectral Calibration Parameters

Identifier

SCI_SP1_AX

Name

Spectral calibration parameters for SCIAMACHY level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The spectral calibration parameter file will include headers and just one global annotation data sets (GADS), as depicted in . The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification, data acquisition and processing, time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion, product confidence data and sizes of the following data. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following global annotation data set which includes the spectral calibration parameters.

The spectral calibration parameters are expected to be depended on the position in orbit. Therefore, the calculation of these parameters require an orbit phase field for annotation and the application needs them for selection of appropriate parameters. The calculation of spectral calibration parameters requires one SLS measurement state.

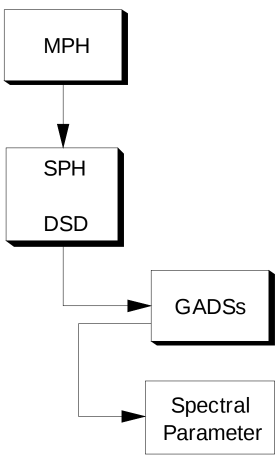

Figure 6: Schematic Structure of the Spectral Calibration Parameters

Format

The detailed format description is divided into several tables representing the hierarchy of the files content, as depicted in . The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Precise Basis of the Spectral Calibration Parameters	GADS
5	Spectral Calibration Parameters	GADS

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: Specific Product Header of Auxiliary Data
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"SPECTRAL_CALIBRATION_PARAM∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank character ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: Data Set Descriptor Record
Component Type: DSD No of Records: 2 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*560*

For the data set name definition please refer to the corresponding GADS in the level 1b product.

Component: **Precise Basis of the Spectral Calibration Parameters**
Component Type: GADS No of Records: 1

This is a copy of the corresponding GADS on the Level 1b product

Component: **Spectral Calibration Parameters**
Component Type: GADS No of Records: 12

This is a copy of the corresponding GADS on the Level 1b product

Sizing

One complete set of spectral calibration parameters are covered by this file.

Data Volume

The spectral calibration parameter file requires approximately 38 kB.

Throughput

SLS measurements are planned for the weekly calibration timeline. Therefore, a spectral calibration file is expected once per week.

Remarks

N/A

3.2.6 Sun Reference Spectrum

Identifier

SCI_SU1_AX

Name

Sun reference spectrum of the SCIAMACHY level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The sun reference spectrum file will include headers and one global annotation data set (GADS), as depicted in . The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification, data acquisition and processing, time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion, product confidence data and sizes of the following data. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following global annotation data set containing the sun reference spectrum.

The sun reference spectrum will be measured once per day and is valid for this period. The corresponding spectral calibration parameters included in this file allow the calculation of a complete solar irradiance spectrum for this day. The sun reference spectrum requires one sun diffuser measurement state.

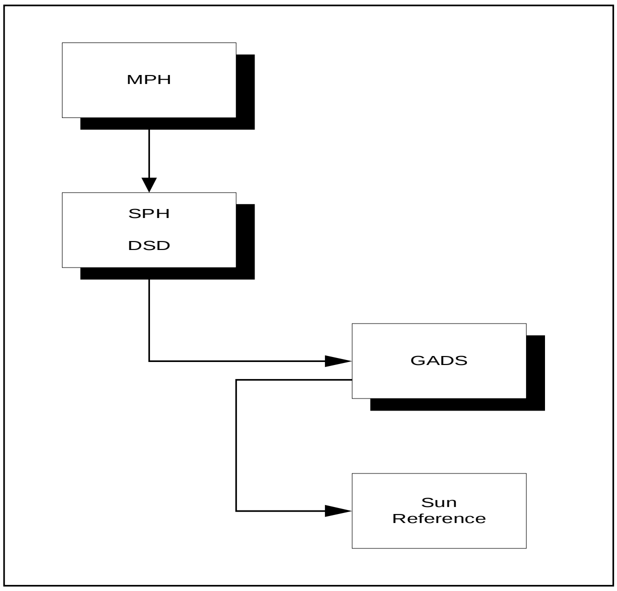

Figure 7: Schematic Structure of the Sun Reference Spectrum File

Format

The detailed format description is divided into several tables representing the hierarchy of the files content, as depicted in . The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Sun Reference Spectrum	GADS

Component: **Main Product Header**
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: **Specific Product Header of Auxiliary Data**
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"SUN_REFERENCE_PARAMETER∅∅∅∅∅“	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: **Data Set Descriptor Record**
Component Type: DSD No of Records: 1 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*280*

For the data set name definitions please refer to the corresponding GADSs in the level 1b product.

Component: **Sun Reference Spectrum**
Component Type: GADS No of Records: 1

This is a copy of the corresponding GADS on the Level 1b product

Sizing

One complete sun reference spectrum is covered by this file.

Data Volume

The sun reference spectrum parameter file requires approximately 165 kB.

Throughput

As explained before, it is expected to do one sun diffuser calibration per day which yields one sun reference spectrum file per day.

Remarks

See the corresponding remarks concerning the various components of this product in the description of the level 1b product (section 3.2.2).

3.3 Auxiliary Data Files

3.3.1 Initialisation File

Identifier

SCI_LI1_AX

Name

Initialisation file for a SCIAMACHY level 0 to 1b processor

Type

Auxiliary *(Input)*

Description

In principle static parameters may be inserted as constants directly into the processor’s code, but the use of an initialisation file improves the maintainability of SGP_01. The GADS of the initialisation file for the static parameters is a simple ASCII list consisting of a number of keywords representing the static parameters of the level 0 to 1b processing followed by the values of these parameters. The position of the parameters in this list is arbitrary, but the structure of the parameter values following a certain parameter's name has to be known by the code reading the static parameters.

Besides the static parameters the initialisation file includes also a set of three spectrum templates (gathered in a second GADS), a list of external instrument state parameters (the third GADS) which are not available through the ISPs of the instrument and the polarisation and radiance sensitivity grids (fourth GADS).

The initialisation file will include headers and three GADS. The main product header (MPH) has a fixed format, as described in [R11], and includes information about product identification and sizes of the following data. Other fields in the general MPH (such as data acquisition and processing time, position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion and product confidence data) have no real meaning for this product type and will be left blank. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following GADSs. The GADSs of this initialisation file will have a single DSR described below.

Format

The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Static Parameters	GADS
5	Spectrum Templates	GADS
6	External State Parameters	GADS
7	Processing Categories	GADS
8	Polarisation and Radiance Sensitivity Grids	GADS

The following paragraphs describe the detailed definition of the components listed above:

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: Specific Product Header of Auxiliary Data
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"INITIALISATION_FILE∅∅∅∅∅∅∅∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: Data Set Descriptor Record
Component Type: DSD No of Records: 5 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*1400*

The DS_NAME field of the DSDs will be set according to the content of the corresponding GADS. The following keywords are used:

1. Static Parameters
2. Spectrum Templates
3. External State Parameters
4. Processing Categories
5. Pol. and Rad. Sens. Grids

Component: Static Parameter
Component Type: GADS No of Records: 1

The following GADS record is an ASCII list of parameters not defined by their precise position in the file, but by keywords for each parameter. Initialisation parameter inputs are either logical control flags, real or integer numbers, or names (key-word or key-words). Each 'name' input is one of a small group of possible name options.

```
...
Parameter-Keyword
Parameter-Value(s)
...
```

Lines preceded by an exclamation mark '!' or not starting in the first column are handled as comments. The following conventions shall be adopted for parameter input:

- logical parameters values shall be given as '`t`' or '`f`';
- numerical parameter values shall follow the syntax for numerical constants in the C programming language;
- all possible choices of name parameter values shall be described.

The detailed list of parameters is given in the corresponding DPM [R15].

The size of this component was fixed to a new size of 20 kB. This is approximately 25% more than the actually size of this component today (15060 Bytes on 2.9.2005) leaving enough space for future changes. The empty space at the end of the static parameters is filled with blanks until the end of the component.

Component: Spectrum Templates
Component Type: GADS No of Records: 1 Record Size: 131072

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Wavelength	nm	fl	8192	32768
2	External sun reference spectrum	-	fl	8192	32768
3	Template earth-shine spectrum	-	fl	8192	32768
4	External PPG reference spectrum (for Key-Data)	-	fl	8192	32768
Size of Component:					*131072*

This spectrum data will be used for the retrieval of relative Etalon information. The spectra are given as unit-less quantities.

Component: **External State Parameters**
Component Type: GADS No of Records: 70 Record Size: 13

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	State number	-	us	1	2
2	Delay time of measurement after BCPS start	ms	fl	1	4
3	State set-up integration time	ms	fl	1	4
4	Spare	-	b	3	3
Size of Component:					*910*

Most of the information about the state definitions which is required for processing is included in the ISPs. The quantity above needs to be provided externally.

Component: **Processing Categories**
Component Type: GADS No of Records: 20 Record Size: 3

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Measurement category	-	us	1	2
2	Processing category (0=other, 1=nadir, 2=limb, 3=occultation, 4=sub-solar, 5=sun diffuser, 6=SLS, 7=WLS, 8=dark, 9=ignore)	-	uc	1	1
Size of Component:					*60*

This provides the mapping between the various processing branches (decision which calibration/processing has to be applied for which measurement) and the Measurement Category of the ISP.

Component: **Polarisation and Radiance Sensitivity Grids**
Component Type: GADS No of Records: 1 Record Size: -

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Number of ESM positions for the polarisation sensitivity parameters Nadir, $n_{pol,EN}$	-	us	1	2
2	ESM positions for the polarisation sensitivity parameters Nadir	-	fl	$n_{pol,EN}$	4* $n_{pol,EN}$
3	Number of ESM positions for the polarisation sensitivity parameters Limb, $n_{pol,EL}$	-	us	1	2
4	ESM positions for the polarisation sensitivity parameters Limb	-	fl	$n_{pol,EL}$	4* $n_{pol,EL}$
5	Number of ASM positions for the polarisa-tion sensitivity parameters Limb, $n_{pol,AL}$	-	us	1	2
6	ASM positions for the polarisation sensitivity parameters Limb	-	fl	$n_{pol,AL}$	4* $n_{pol,AL}$
7	Number of ESM positions for the radiance sensitivity parameters, $n_{rad,E}$	-	us	1	2
8	ESM positions for the radiance sensitivity parameters	-	fl	$n_{rad,E}$	4* $n_{rad,E}$
9	Number of ASM positions for the radiance sensitivity parameters, $n_{rad,A}$	-	us	1	2
10	ASM positions for the radiance sensitivity parameters	-	fl	$n_{rad,A}$	4* $n_{rad,A}$

Size of Component:	-

The number of scan mirror positions used for the polarisation and radiance sensitivity component of the level 1b product are defined by this GADS of the initialisation file. The actual number for each individual category of parameter depends on the result of the final pre-flight calibration activity. Then ESM and ASM position values will be selected so that linear interpolation between these values yields an error which is well below the systematic error of the corresponding parameter. During application of these parameters the scan mirror positions in the geolocation record of the MDS are used to select the correct interval and calculate an appropriate set of parameters using linear interpolation.

Sizing

N/A

Data Volume

approx. 146 kB

Throughput

In principle there is just one initialisation file for each sofware version. In the commissioning phase, regular updates (maximum once per week) are not unlikely.

Remarks

3.3.2 Calibration initialisation File

Identifier

SCI_LIC_AX

Name

Initialisation file for the inflight calibration part of the SCIAMACHY level 0 to 1b processor

Type

Auxiliary *(Input)*

Description

This file defines settings for the inflight calibration part of the processor for example limit for bad and dead pixel detection, time periods for averaging inflight calibration data, etc.

The GADS of the calibration initialisation file looks similar to the static parameter initialisation file (SCI_LI1_AX): it is a simple ASCII list consisting of a number of keywords representing the static parameters of the level 0 to 1b processing followed by the values of these parameters. The position of the parameters in this list is arbitrary, but the structure of the parameter values following a certain parameter's name has to be known by the code reading the static parameters.

The initialisation file will include headers and one GADS. The main product header (MPH) has a fixed format, as described in [R11], and includes information about product identification and sizes of the following data. Other fields in the general MPH (such as data acquisition and processing time, position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion and product confidence data) have no real meaning for this product type and will be left blank. A specific product header (SPH) will include a SPH descriptor and the data set description record (DSD) for the following GADS. The GADS of this initialisation file will have a single DSR described below.

Format

The product consists of the following components:

Id	*Product Components*	*Component Type*
1	Main Product Header	MPH
2	Specific Product Header	SPH
3	Data Set Descriptor	DSD
4	Static Parameters	GADS

The following paragraphs describe the detailed definition of the components listed above:

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: Specific Product Header of Auxiliary Data
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"INITIALISATION_FILE∅∅∅∅∅∅∅∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: Data Set Descriptor Record
Component Type: DSD No of Records: 5 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*1400*

The DS_NAME field of the DSDs will be set according to the content of the corresponding GADS. The following keywords are used:

1. Static Parameters

Component: **Static Parameter**
Component Type: GADS No of Records: 1

The following GADS record is an ASCII list of parameters not defined by their precise position in the file, but by keywords for each parameter. Initialisation parameter inputs are either logical control flags, real or integer numbers, or names (key-word or key-words). Each 'name' input is one of a small group of possible name options.

```
...
Parameter-Keyword
Parameter-Value(s)
...
```

Lines preceded by an exclamation mark '!' or not starting in the first column are handled as comments. The following conventions shall be adopted for parameter input:

- logical parameters values shall be given as '`t`' or '`f`';
- numerical parameter values shall follow the syntax for numerical constants in the C programming language;
- all possible choices of name parameter values shall be described.

The detailed list of parameters is given in the corresponding DPM [R15].

The size of this component was fixed to a new size of 20 kB. This is approximately 25% more than the actually size of this component today (15060 Bytes on 2.9.2005) leaving enough space for future changes. The empty space at the end of the static parameters is filled with blanks until the end of the component.

3.3.3 Key Data Files

Identifier

SCI_KD1_AX

Name

Key Data files for SCIAMACHY level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The so-called Key Data files are one part of the characterisation data base of SCIAMACHY which will be used for the operational processing. The Key Data files will be provided by the calibration and characterisation team according to [R9]. The following parameters are envisaged:

- Radiance Sensitivity
  - absolute radiance calibration
  - scanner dependency
    - for nadir
    - for limb
- Polarisation Sensitivity

– polarisation properties for nadir mode
  - s/p for instrument without elevation mirror
  - elevation mirror dependency
  - ratio PMD signal to detector pixel signal
– polarisation properties for limb mode
  - s/p for instrument without scanner
  - scanner dependency
  - several parameters which are expressing the ratios PMD signal to detector signal and general PMD signal to 45° PMD signal

- Bi-directional Scattering Distribution Function
  – parallel polarised
  – perpendicular polarised
- Straylight Characteristics (tbd.)
- List of spectral lines to be used for spectral calibration
- Errors on all Key Data as listed above

Format

The Key Data file will include headers and a set of MDSs. The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification and sizes of the following data. Other fields in the general MPH like data acquisition and processing time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion and product confidence data have no real meaning for this product type and will be left blank. A specific product header (SPH) will include the identification of the version of this Key Data file and the data set description records (DSD) for the following MDSs. The MDSs of this Key Data file will have just one DSR which consist of one complete file out of the characterisation data base as delivered by the calibration and characterisation team. The header layout may be described as follows:

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: Specific Product Header of Auxiliary Data
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"KEY_DATA_FILE∅∅∅∅∅∅∅∅∅∅∅∅∅∅∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: **Data Set Descriptor Record**
Component Type: DSD No of Records: 30 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*8400*

For the time being 39 key data parameters in the same number of “adt” files are delivered by the calibration and characterisation team [R13], with some updates from SSAG scientists. These are assembled by DLR into one Keydata file. The DS_NAME field of the DSDs will be set according to the content of the corresponding MDS or “adt” file. The following keywords are present (not necessarily in this order):

1. BRDF_s
2. BRDF_p
3. ELEV_s
4. ELEV_p
5. ETA_NAD
6. XI_NAD
7. OBM_s_p
8. ETA_LIMB
9. ZETA_LIMB
10. EL_AZ_p
11. EL_AZ_s
12. OMEGA_LIMB
13. KAPPA_LIMB
14. XI_LIMB
15. SIGMA_LIMB
16. PSI_LIMB
17. TAU_LIMB
18. SIGMA_NAD
19. PSI_NAD
20. TAU_NAD
21. OMEGA_NAD
22. KAPPA_NAD
23. ZETA_NAD
24. STRAY_UNIFORM
25. STRAY_GHOST
26. STRAY_CH1
27. SPEC_LINE

28. SLIT_F
29. SMALL_AP_SLIT_F
30. ABS_RAD
31. ABS_IRR
32. NDF
33. NDF_s_p
34. MEM_EFFECT_COEF
35. PMD_CROSS_COEF
36. BAD_PIXEL_MASK
37. REF_WLS
38. FRAUNH_LINE
39. NON_LIN

The general format description of the key data files is defined in [R9]. For a format description of a specific characterisation data base this general definition has to be extended by a set of acronyms, parameter name definitions and dimensions of the different parameters in the data base. A preliminary version of this information is given here.

Note
The dimensions given here are for illustration purpose only! *The true dimensions must be read from the calibration files*

The following list defines the acronyms specific of the individual parameters in the files mentioned above including:

1. Parameter name: _BRDF_s
   Comment = Bi-directional reflection distribution function measured with s-polarisation detector (ac_ucs / FOV)
   Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
   Unit = sr-1
   Dimensions = 3
   Dim_1 = 21
   Dim_1_Argument = Wavelength
   Dim_1_Unit = nm
   Dim_1_List = 240, 270, 300, 330, 360, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400
   Dim_1_Vacuum = .TRUE.
   Dim_2 = 5
   Dim_2_Argument = Elevation mirror position
   Dim_2_Unit = degree
   Dim_2_List = 19.5, 21.625, 23.75, 25.875, 28
   Dim_3 = 4
   Dim_3_Argument = Azimuth mirror position

Dim_3_Unit = degree
Dim_3_List = -45, -35, -28.875, -22.75
Data_Type = _R4

2. Parameter name: _BRDF_p
Comment = Bi-directional reflection distribution function measured with p-polarisation detector (ac_ucp / FOV)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = sr-1
Dimensions = 3
Dim_1 = 21
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240, 270, 300, 330, 360, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = 19.5, 21.625, 23.75, 25.875, 28
Dim_3 = 4
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -45, -35, -28.875, -22.75
Data_Type = _R4

3. Parameter name: _ELEV_s
Comment = Reflection of ESM measured with s-polarisation detector (anauns)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 18
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240, 300, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -61, -53, -45, -37, -29
Data_Type = _R4

4. Parameter name: _ELEV_p
Comment = Reflection of ESM measured with p-polarisation detector (anaunp)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 18
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240, 300, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400

Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -61, -53, -45, -37, -29
Data_Type = _R4

5. Parameter name: _ETA_NAD
Comment = Polarisation properties in NADIR mode (OBMs_p*(anauns/anaunp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -61, -53, -45, -37, -29
Data_Type = _R4

6. Parameter name: _XI_NAD
Comment = Ratio PMD signal / detector pixel signal (on0pnq / on0pnd)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

7. Parameter name: _OBM_s_p
Comment = s- over p sensitivity of the instrument without scanner
((on0snd/on0pnd)*(an0unp/an0uns) = 'tmp')
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

8. Parameter name: _ETA_LIMB
Comment = Polarisation properties in LIMB mode
(OBMs_p*alasls+alaslp)/(OBMs_p*alapls+alaplp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3

Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

9. Parameter name: _ZETA_LIMB
Comment = Polarisation properties –45/45 in LIMB mode
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

10. Parameter name: _EL_AZ_p
Comment = Elevation and Azimuth scanner calibration with p-polarisation detector (alaulp)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 18
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240, 300, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree

Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

11. Parameter name: _EL_AZ_s
Comment = Elevation and Azimuth scanner calibration with s-polarisation detector (alauls)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 18
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240, 300, 400, 500, 600, 700, 750, 790, 820, 850, 900, 950, 1000, 1100, 1300, 1500, 1900, 2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

12. Parameter name: _OMEGA_LIMB
Comment = ((TMP2*ala4lp)/(OBMs_p*ala4ls+ala4lp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

13. Parameter name: _KAPPA_LIMB
Comment = ((TMP2*alaslp)/(OBMs_p*alasls+alaslp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400

Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

14. Parameter name: _XI_LIMB
Comment = ((TMP2*alaplp)/(OBMs_p*alapls+alaplp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

15. Parameter name: _SIGMA_LIMB
Comment = ((TMP3*ala4lx)/(OBMs_p*ala4ls+ala4lp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

16. Parameter name: _PSI_LIMB
Comment = ((TMP3*alaslx)/(OBMs_p*alasls+alaslp))

Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

17. Parameter name: _TAU_LIMB
Comment = ((TMP3*alaplx)/(OBMs_p*alapls+alaplp))
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 3
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -11.4, -12.7, -14.0, -9.75, -11.875,
Dim_3 = 6
Dim_3_Argument = Azimuth mirror position
Dim_3_Unit = degree
Dim_3_List = -50.4, -39.6, -45.0, -35.0, -22.75, -28.875
Data_Type = _R4

18. Parameter name: _SIGMA_NAD
Comment = tbd.
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -61, -53, -45, -37, -29
Data_Type = _R4

19. Parameter name: _PSI_NAD
    Comment = tbd.
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 1
    Dim_1 = 8192
    Dim_1_Argument = Wavelength
    Dim_1_Unit = nm
    Dim_1_List = 240-2400
    Data_Type = _R4
20. Parameter name: _TAU_NAD
    Comment = tbd.
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 1
    Dim_1 = 8192
    Dim_1_Argument = Wavelength
    Dim_1_Unit = nm
    Dim_1_List = 240-2400
    Data_Type = _R4
21. Parameter name: _OMEGA_NAD
    Comment = tbd.
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 2
    Dim_1 = 8192
    Dim_1_Argument = Wavelength
    Dim_1_Unit = nm
    Dim_1_List = 240-2400
    Dim_1_Vacuum = .TRUE.
    Dim_2 = 5
    Dim_2_Argument = Elevation mirror position
    Dim_2_Unit = degree
    Dim_2_List = -61, -53, -45, -37, -29
    Data_Type = _R4
22. Parameter name: _KAPPA_NAD
    Comment = tbd.
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 1
    Dim_1 = 8192
    Dim_1_Argument = Wavelength
    Dim_1_Unit = nm
    Dim_1_List = 240-2400
    Data_Type = _R4
23. Parameter name: _ZETA_NAD
    Comment = tbd.
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 2

Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Dim_1_Vacuum = .TRUE.
Dim_2 = 5
Dim_2_Argument = Elevation mirror position
Dim_2_Unit = degree
Dim_2_List = -61, -53, -45, -37, -29
Data_Type = _R4

24. Parameter name: _STRAY_UNIFORM
Comment = tbd.
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 8
Dim_1_Argument = Channel nr.
Dim_1_Unit = -
Data_Type = _R4

25. Parameter name: _STRAY_GHOST
Comment = tbd.
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 12
Dim_1_Argument = 3 positions , 2 start pixels, 2 end pixels, 4 intensities, 1 pixel range
Dim_1_Unit = -
Dim_1_List = P1, P2, P3,
min_parent, min_ghost,
max_parent, max_ghost,
I1, I2, I3, I4
smoothing_width
Dim_2 = 17
Dim_2_Argument = Ghost nr. (x.1 = p-polarised, x.2 = s-polarised)
Dim_2_List = 1, 3, 4, 5, 6, 7, 8.1, 8.2, 9, 10, 11, 12, 13.1, 13.2, 16, 18, 19
Dim_2_Unit = -
Data_Type = _R8*3_I2*4_R8*4_I2

26. Parameter name: _STRAY_CH1
Comment = tbd.
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 1026 (=1024+2)
Dim_1_Argument = Target pixel, Source start pixel, Source end pixel
(NB start and end pixel refer to filter boundaries)
Dim_1_Unit =
Dim_1_List = 1 – 1024, startpix (range: 1-5120), endpix (range: 1-5120)
Dim_2 = tbd (n_filter *2 for s,p-pol)
Dim_2_Argument = Filter nr s/p (sequence: 1p, 1s, 2p, 2s, ...)
Dim_2_Unit = -

Dim_2_List = Filter coefficient for each pixel and start/end pixel values
Data_Type = _R4*1024_I2*2

27. Parameter name: _SPEC_LINE
Comment = Spectral calibration - list of used SLS spectral lines
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = nm
Dimensions = 2
Dim_1 ≈ 80
Dim_1_Argument = first guess pixel position
Dim_1_Unit = -
Dim_1_List = pos_1, pos_2, ..., pos_n (range of pos_i: 1 - 8192)
Dim_1_Vacuum = .TRUE.
Dim_2 = 2
Dim_2_Argument = Reference wavelength and SLS blocking shift
Dim_2_Unit = nm
Dim_2_List = External SLS wavelength, (Internal – External) wavelength
Data_Type = _R4

28. Parameter name: _SLIT_F
Comment = Slit function
Dimensions = 2
Dim_1 = 3
Dim_1_Argument = 3 params
Dim_1_Unit = -
Dim_1_List = type ,FWHM_1,FWHM_2
Dim_2 = 16
Dim_2_Argument = pixel positions
Dim_2_Unit = -
Dim_2_List = 1 1024 1025 2048 2049 3072 3073 4096 4097 5120 5121 6144 6145 7168 7169 8192
Data_Type = _R4

29. Parameter name: _SMALL_AP_SLIT_F
Comment = Slit function with small aperture in beam
Dimensions = 2
Dim_1 = 3
Dim_1_Argument = 3 params
Dim_1_Unit = -
Dim_1_List = type ,FWHM_1,FWHM_2
Dim_2 = 2
Dim_2_Argument = pixel positions
Dim_2_Unit = -
Dim_2_List = 1 1024 1025 2048 2049 3072 3073 4096 4097 5120 5121 6144 6145 7168 7169 8192
Data_Type = _ R4

30. Parameter name: _ABS_RAD
Comment = Absolute radiance calibration
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = (BU/s) / (W/sr.cm3)
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength

Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

31. Parameter name: _ABS_IRR
Comment = Absolute irradiance calibration (redundant)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = (BU/s) / (W/cm3)
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

32. Parameter name: _NDF
Comment = tbd (Transmission function of the neutral density filter)
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

33. Parameter name: _NDF_s_p
Comment = s- over p sensitivity of the neutral density filter
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

34. Parameter name: MEM_EFFECT_COEF
Comment = Correction factor for the memory effect of the RETICON detector arrays
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = -
Dimensions = 2
Dim_1 = 128
Dim_1_Argument = Raw Signal Values
Dim_1_Unit = -
Dim_1_List = 0, 512, 1024, ... , 65024
Dim_2 = 5
Dim_2_Argument = Channel number
Dim_2_Unit = -

Dim_2_List = 1, 2, 3, 4, 5
Data_Type = _R4

35. Parameter name: PMD_CROSS_COEF
Comment = tbd (Parameters for PMD crosstalk)
Accuracy = acc_pmd1, acc_pmd2, ... , acc_pmd45, 0 (8 numbers, 1 value per pmd, range 0-1)
Unit = -
Dimensions = 1
Dim_1 = 6
Dim_1_Argument = Several parameters of the crosstalk effect correction
Dim_1_Unit = -
Dim_1_List = f1 f2 a1 b0 c0 c1
Data_Type = _I2*3_R8*4

36. Parameter name: BAD_PIXEL_MASK
Comment =
Accuracy = 0,0,0,0,0,0,0,0
Unit = -
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Pixel number
Dim_1_Unit = -
Dim_1_Start = 1
Dim_1_Step = 1
Data_Type = _I2

37. Parameter name: _REF_WLS
Comment = tbd (WLS spectrum minus first 8 seconds from ABS_RAD calibration period, corrected for dark signal and (if necessary) straylight)
Accuracy = 0,0,0,0,0,0,0,0 (1 value per channel, range 0-1)
Unit = - (BU/s)
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240 - 2400
Dim_1_Vacuum = .TRUE.
Data_Type = _R4

38. Parameter name: _FRAUNH_LINE
Comment = Spectral calibration - list of used Fraunhofer lines
Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
Unit = nm
Dimensions = 2
Dim_1 ≈ 50
Dim_1_Argument = first guess pixel position
Dim_1_Unit = -
Dim_1_List = pos_1, pos_2, ..., pos_n (range of pos_i: 1 - 8192)
Dim_1_Vacuum = .TRUE.
Dim_2 = 2
Dim_2_Argument = Reference wavelength and blending shift
Dim_2_Unit = nm
Dim_2_List = Reference wavelength, blending shift
Data_Type = _R4

39. Parameter name: NON_LIN
    Comment = Created by SRON 7.11.2003
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = -
    Dimensions = 2
    Dim_1 = 256
    Dim_1_Argument = Raw Signal Values
    Dim_1_Unit = -
    Dim_1_List = 0, 256, 512, ... , 65280
    Dim_2 = 14
    Dim_2_Argument = Start pixel number
    Dim_2_Unit = -
    Dim_2_List = 5121, 5120, 5633, ... , 7680
    Data_Type = _R4
40. (currently not implemented)
    SMALL_AP_DIFFRAC
    Comment = tbd (diffraction pattern from small aperture)
    Accuracy = acc_ch1, acc_ch2, ... , acc_ch8 (1 value per channel, range 0-1)
    Unit = tbd
    Dimensions = tbd
    Data_Type = _R4

Sizing

Each set of parameters of the characterisation data base will be put into a different file by the calibration and characterisation team. These files are put together as the „one and only“ Key Data file using the general MPH/SPH approach defining each of these Key Data files (completely unmodified) to be a GADS of this new Key Data file.

Data Volume

approx. 12 MB

Throughput

There is just one Key Data file for the entire mission; updates to incorporate new or modified calibration algorithms are possible.

Remarks

Parameters 28 and 29 may not be used by level 0 to 1b processing, but they are copied to GADS on the Level 1b product for use in level 1b to 2 processing.

3.3.4 m-Factor File

Identifier

SCI_MF1_AX

Name

SCIAMACHY m-factor file for the level 0 to 1b processing

Type

Auxiliary *(Input)*

Description

The so-called m-factor files are an extension to the characterisation data base of SCIAMACHY to describe the degradation of the instrument during flight. The following parameters are envisaged by the calibration plan [R10]:

- Ratio of sun diffuser measurements
  - ratio of the detector array signals
- Ratios of sun occultation measurements
  - ratio of the detector array signals
  - ratio of the regular PMD signals
  - ratio of the 45° PMD signal
- Ratios of sub-solar calibration measurements
  - ratio of the detector array signals
  - ratio of the regular PMD signals
  - ratio of the 45° PMD signal (additional compared to Calibration Plan)
- Ratio of WLS measurements with and without ND filter
  - ratio of the detector array signals
- Spare ratios of an arbitrary calibration measurements (additional compared to Calibration Plan)
  - ratio of the detector array signals
  - ratio of the regular PMD signals
  - ration of the 45° PMD signal

Format

The m-factor file will include headers and a set of MDSs. The main product header (MPH) has a fixed format, as described in [R6] and includes information about product identification and sizes of the following data. Other fields in the general MPH like data acquisition and processing time and position of the measurement data, ENVISAT orbit and position, SBT to UTC conversion and product confidence data have no real meaning for this product type and will be left blank. A specific product header (SPH) will include a SPH descriptor and the data set description records (DSD) for the following MDSs. The MDSs of this m-factor file will have just one DSR which consist of one complete file out of the list of different m-factor files as delivered by the SOS team. The header layout may be described as follows:

Component: Main Product Header
Component Type: MPH No of Records: 1 Record Size: 1247

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	The Main Product Header is described in [R11]	-	m	1247	1247
Size of Component:					*1247*

Component: Specific Product Header of Auxiliary Data
Component Type: SPH No of Records: 1 Record Size: 98

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	SPH_DESCRIPTOR=	keyword	tx	15	15
2	"M_FACTOR_FILE∅∅∅∅∅∅∅∅∅∅∅∅∅∅∅"	variable	tx	30	30
3	New-line character	terminator	tx	1	1
4	Spare (blank characters ∅)	-	tx	51	51
5	New-line character	terminator	tx	1	1
Size of Component:					*98*

Component: Data Set Descriptor Record
Component Type: DSD No of Records: 11 Record Size: 280

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Data Set Descriptor Record, as described in [R11]	-	m	280	280
Size of Component:					*3080*

For the time being 11 m-factor parameters in the same number of m-factor files are expected by the SOS team [R10]. The DS_NAME field of the DSDs will be set according to the content of the corresponding MDS or m-factor file. The following keywords are envisaged:

- from sun diffuser measurements
  1. M_CAL
- from sun occultation
  2. M_DL
  3. M_PL
  4. M_QL
- from sub-solar calibration
  5. M_DN
  6. M_PN
  7. M_QN
- from WLS measurements
  8. M_NDF
- spare m-factor set (e.g. from moon occultation)
  9. M_DS
  10. M_PS
  11. M_QS

The general format description of these files is defined in [R9]. For a format description of a specific characterisation data base this general definition has to be extended by a set of acronyms, parameter name definitions and dimensions of the different correction factors. A first version of this information will be given here, because the characterisation activity was even not yet started and it is very likely that also this information (like the characterisation data base) is subject to change.

The following list defines the acronyms specific of the individual m-factors in the files mentioned above:

- Sun viewing via diffuser with ND filter ratio

1. Parameter name: _M_FACTOR_CAL
   Comment = Ratio of the array detector signals between a reference sun diffuser measurement with the neutral density filter inserted and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 8192
   Dim_1_Argument = Wavelength
   Dim_1_Unit = nm
   Dim_1_List = 240-2400
   Data_Type = _R4

- Sun occultation measurement ratio

2. Parameter name: _M_FACTOR_DL
   Comment = Ratio of the array detector signals between a reference sun occultation measurement and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 8192
   Dim_1_Argument = Wavelength
   Dim_1_Unit = nm
   Dim_1_List = 240-2400
   Data_Type = _R4
3. Parameter name: _M_FACTOR_PL
   Comment = Ratio of the regular PMD signals between a reference sun occultation measurement and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 6
   Dim_1_Argument = PMD number
   Dim_1_Unit = <none>
   Dim_1_Start = 1
   Dim_1_Step = 1
   Data_Type = _R4
4. Parameter name: _M_FACTOR_QL
   Comment = Ratio of the 45° PMD signal between a reference sun occultation measurement and a corresponding measurement at a certain time
   Accuracy = tbd.

Unit = <none>
Dimensions = 1
Dim_1 = 1
Dim_1_Unit = <none>
Data_Type = _R4

- Sub-solar calibration measurement ratio

5. Parameter name: _M_FACTOR_DN
Comment = Ratio of the array detector signals between a reference sub-solar calibration measurement and a corresponding measurement at a certain time
Accuracy = tbd.
Unit = <none>
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Data_Type = _R4
6. Parameter name: _M_FACTOR_PN
Comment = Ratio of the regular PMD signals between a reference sub-solar calibration measurement and a corresponding measurement at a certain time
Accuracy = tbd.
Unit = <none>
Dimensions = 1
Dim_1 = 6
Dim_1_Argument = PMD number
Dim_1_Unit = <none>
Dim_1_Start = 1
Dim_1_Step = 1
Data_Type = _R4
7. Parameter name: _M_FACTOR_QN
Comment = Ratio of the 45° PMD signal between a reference sub-solar calibration measurement and a corresponding measurement at a certain time
Accuracy = tbd.
Unit = <none>
Dimensions = 1
Dim_1 = 1
Dim_1_Unit = <none>
Data_Type = _R4

- WLS with / without ND filter ratio

8. Parameter name: _M_FACTOR_NDF
Comment = (tbd)
Accuracy = tbd.
Unit = <none>
Dimensions = 1
Dim_1 = 8192
Dim_1_Argument = Wavelength
Dim_1_Unit = nm
Dim_1_List = 240-2400
Data_Type = _R4

- Spare ratio

9. Parameter name: _M_FACTOR_DS
   Comment = Ratio of the array detector signals between a reference spare calibration measurement and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 8192
   Dim_1_Argument = Wavelength
   Dim_1_Unit = nm
   Dim_1_List = 240-2400
   Data_Type = _R4
10. Parameter name: _M_FACTOR_PS
   Comment = Ratio of the regular PMD signals between a reference spare calibration measurement and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 6
   Dim_1_Argument = PMD number
   Dim_1_Unit = <none>
   Dim_1_Start = 1
   Dim_1_Step = 1
   Data_Type = _R4
11. Parameter name: _M_FACTOR_QS
   Comment = Ratio of the 45° PMD signal between a reference spare calibration measurement and a corresponding measurement at a certain time
   Accuracy = tbd.
   Unit = <none>
   Dimensions = 1
   Dim_1 = 1
   Dim_1_Unit = <none>
   Data_Type = _R4

Sizing

All m-factors will be put into one file.

Data Volume

approx. 1.0 MB

Throughput

Major calibration measurements are planned every month during normal operation of SCIAMACHY. Therefore, it is expected that a new set of m-factors may be generated once per month.

Remarks

3.3.5 M-Factor File Version 8

The new M-Factor file for processor version 8 and above has now a binary data set with the following format:

Field	***Comments***	***Unit***	***Type***	***#***	***Size***
1	number of (complex) refractiv indexes	-	sl	1	4
2	number of contamination layers	-	sl	1	4
3	number of surfaces with contamination	-	sl	1	4
4	number of retarder parameters	-	sl	1	4
5	number of OBM M1 mfactor for science detector	-	sl	1	4
6	number of OBM M1 mfactor for PMD	-	sl	1	4
7	number of add parameters	-	sl	1	4
8	wavelength grid of the science channel detector	nm	fl	8192	32768
9	refractive index	-	fl	16384	65536
10	contamination layer thickness (layers * n_surfaces)	-	fl	F2*F3 (6)	24
11	retarder parameter	-	fl	F4 (1)	4
12	M1 science channel	-	fl	F5 * 8192	32768
13	M1 PMD channel	-	fl	F6*7	28
14	add_parameter	-	fl	F7	4
Size of compound Type:					*131160*

4 Generic Data Representations

The data representations used throughout this data definition document follow a number of conventions which are stated as guidelines in [R6]. No other data types were used. The basic data types are listed in section 4.1 and are defined in more detail in section 3.1 on page 23. All data types which are indicated by ‘m’ (mixed data type) are composed of a combination of these generic data types and are described in the documents mentioned in the ‘Comments’ section of the format tables. Mixed or compound data types which are specific to the present document are defined in section 4.2.

4.1 Basic Data Types

Basic data types are the following:

- signed or unsigned character (1 byte)
- signed or unsigned short integer (2 byte)
- signed or unsigned long integer (4 byte)
- signed or unsigned long integer (8 byte)
- single precision floating-point number (4 byte)
- double precision floating-point number (8 byte)
- bit fields (any number of bytes up to 8)
- time formats
  - UTC
  - MJD 2000
- geographical location
- orbit state vectors

Details may be found in the above mentioned document.

4.2 Compound Data Types

The following compound data types are used throughout this data definition:

Cluster configuration
Notation: Clcon

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Cluster ID (1-64 are valid entries for an existing cluster, the first cluster ID being '0' notifies the end of the cluster ID list)	-	uc	1	1
2	Channel Number (1-8)	-	uc	1	1
3	Start pixel number (inclusive, 0-1023)	-	us	1	2
4	Cluster length (1-1024)	-	us	1	2
5	Pixel Exposure Time (PET)	s	fl	1	4
6	Integration Time	$^1/_{16}$ s	us	1	2
7	Co-adding factor	-	us	1	2
8	Number of cluster readouts per DSR	-	us	1	2
9	Cluster data type (Rsig = 1, Rsigc = 2, ESig = 3, ESigc = 4)	-	uc	1	1
Size of compound Type:					*17*

RETICON detector signal with memory effect correction and straylight not co-added
Notation: RSig

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Memory effect correction	BU	sc	1	1
2	Signal value of one detector element	BU	us	1	2
3	Straylight[3]	$^1/_{10}$ BU	uc	1	1
Size of compound Type:					*4*

RETICON detector signal with memory effect correction and straylight co-added
Notation: RSigc

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Signal value of one detector element and memory effect correction coded into one unsigned long value(the signal value is given in the lower 24 bits in BU, the memory effect correction is given in the upper 8 bits as signed character in BU)	BU	ul	1	4
2	Straylight	$^1/_{10}$ BU	uc	1	1
Size of compound Type:					*5*

[3] To yield the actual straylight the value for straylight given here and in the following data types has to be multiplied with the scale factor given in the States ADS for each state and channel.

Structure of field 1:

Rsigc

MSB			*LSB*
8 bit (sc)	*24 bit*		
Mem effect corr		Signal value	

EPITAXX detector signal with straylight not co-added
Notation: ESig

Now equal to data type RSig. The location for memory effect is used for non-linearity correction

EPITAXX detector signal with straylight co-added
Notation: ESigc

Now equal to data type RSigc. The location for memory effect is used for non-linearity correction

Fractional polarisation values
Notation: PolV

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Fractional polarisation values Q (6 values derived from the PMDs, 5 values derived from the over-lapping regions and one model value below 300 nm)	-	fl	12	48
2	Errors on Q values	-	fl	12	48
3	Fractional polarisation values U (6 values derived from the PMDs and one model value below 300 nm)	-	fl	12	48
4	Errors on the U values	-	fl	12	48
5	Representing wavelength for the fractional polarisation values and the 45° PMD	nm	fl	13	52
6	GDF parameters	-	fl	3	12
Size of compound Type:					*256*

Geographical co-ordinate (ISO 6709)
Notation: Coord

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Latitude (-90 to 90, -90 is the south pole, 90 the north pole, 0 the equator)	10^{-6} deg	sl	1	4
2	Longitude (-180 to 180, meridian is '0' and minus is going to West)	10^{-6} deg	sl	1	4
Size of compound Type:					*8*

Geolocation for limb measurements
Notation: GeoL

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Position of ESM compared to zero position	degree	fl	1	4
2	Position of ASM compared to zero position	degree	fl	1	4
3	Solar zenith angles of the start, middle and end of the integration time at TOA	degree	fl	3	12
4	Solar azimuth angles of the start, middle and end of the integration time at TOA	degree	fl	3	12
5	Line-of-sight zenith angles of start, middle and end of the integration time at TOA	degree	fl	3	12
6	Line-of-sight azimuth angles of start, middle and end of the integration time at TOA	degree	fl	3	12
7	Satellite Height at the middle of the integration time	km	fl	1	4
8	Earth radius at the middle of the integration time	km	fl	1	4
9	Sub-satellite point at the middle of the integration time	-	Coord	1	8
10	Co-ordinates of tangent ground point of the start, middle and end of the integration time	-	Coord	3	24
11	Tangent height of the start, middle and end of the integration time	km	fl	3	12
12	Doppler shift at 500 nm at the middle of the integration time	nm	fl	1	4
Size of compound Type:					*112*

Geolocation for nadir measurements
Notation: GeoN

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Position of ESM compared to zero position	degree	fl	1	4
2	Solar zenith angles of the start, middle and end of the integration time at TOA	degree	fl	3	12
3	Solar azimuth angles of the start, middle and end of the integration time at TOA	degree	fl	3	12
4	Line-of-sight zenith angles of start, middle and end of the integration time at TOA	degree	fl	3	12
5	Line-of-sight azimuth angles of start, middle and end of the integration time at TOA	degree	fl	3	12
6	Satellite Height at the middle of the integration time	km	fl	1	4
7	Earth radius at the middle of the integration time	km	fl	1	4
8	Sub-satellite point at the middle of the integration time	-	Coord	1	8
9	4 corner co-ordinates of the nadir ground pixel(the first co-ordinate is the one which is the first in time and flight direction, the second the first in time and last in flight direction, the third the last in time and first in flight direction and the fourth the last in time and flight direction)	-	Coord	4	32
10	Centre co-ordinate of the nadir ground pixel	-	Coord	1	8
Size of compound Type:					*108*

Geolocation for calibration and monitoring measurements
Notation: GeoCal

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Position of ESM compared to zero position	degree	fl	1	4
2	Position of ASM compared to zero position	degree	fl	1	4
3	Solar zenith angle at the middle of the integration time	degree	fl	1	4
4	Sub-satellite point at the middle of the integration time	-	Coord	1	8
Size of compound Type:					*20*

Modified Julian Date for the year 2000

Notation: MJD

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	Number of days elapsed since the 1.1.2000 at 00:00 hour (this may be negative before that date)	day	sl	1	4
2	Seconds elapsed since the beginning of the day	s	ul	1	4
3	Number of microseconds elapsed since the last second	us	ul	1	4
Size of compound Type:					*12*

Level 0 Data Header of the Detector Module ISPs

Notation: L0Hdr

The 'L0Hdr' compound data type consists of a one-by-one copy of two data structures from the detector module ISPs, as described in [R12]:

Field	*Comments*	*Unit*	*Type*	*#*	*Size*
1	PACKET HEADER	-	b	6	6
2	DATA FIELD HEADER	-	b	66	66
Size of compound Type:					*72*

5 Reference Timeline and State Example

To do some appropriate calculations for the size of a level 1b product it is necessary to consider a reference timeline representing one typical measurement scenario. The timeline described in the following table is a nominal „No Moon / Sun Diffuser / Sub-solar Calibration“ orbit mission scenario. Its characteristics are as follows:

- start with limb measurements prior to sun diffuser observations
- perform sun diffuser measurement
- append optimised limb/nadir sequence after the sun diffuser state until the start of the sub-solar window
- perform sub-solar measurement
- append optimised limb/nadir sequence until start of eclipse phase
- perform nadir eclipse, dark current or other calibration measurements for the rest of the orbit

This reference orbit, as described in very much detail in [R3], is listed in the following table. Duration figures are given in seconds. Each state has a set-up and cleanup phase which takes a certain amount of time. Therefore, the addition of execution times of the measurement phases does not correspond exactly with the absolute time in orbit.

Index	StateID	Description	Duration	End Time in Orbit
1	28	Limb, ESM & ASM scanning, swath width 960 km	59	T_1+59.95
2	28	see above	59	
3	28	see above	59	
4	28	see above	59	
5	52	Sun Diffuser Calibration, ND filter out	30	
6	28	see above	59	
7	29	Limb, ESM & ASM scanning, swath width 960 km	59	
8	29	see above	59	
9	30	Limb, ESM & ASM scanning, swath width 960 km	59	
10	1	Nadir, ESM scanning, swath width 960 km	80	
11	30	see above	59	
12	2	Nadir, ESM scanning, swath width 960 km	80	
13	30	see above	59	
14	3	Nadir, ESM scanning, swath width 960 km	80	
15	31	Limb, ESM & ASM scanning, swath width 960 km	59	
16	4	Nadir, ESM scanning, swath width 960 km	65	
17	32	Limb, ESM & ASM scanning, swath width 960 km	59	
18	4	see above	65	
19	32	see above	59	
20	5	Nadir, ESM scanning, swath width 960 km	65	
21	32	see above	59	
22	6	Nadir, ESM scanning, swath width 960 km	65	
23	32	see above	59	
24	6	see above	65	
25	32	see above	59	
26	6	see above	65	

Index	StateID	Description	Duration	End Time in Orbit
27	32	see above	59	
28	7	Nadir, ESM scanning, swath width 960 km	65	
29	32	see above	59	
30	7	see above	65	
31	32	see above	59	
32	7	see above	65	
33	32	see above	59	
34	58 or 60	Sub-solar Calibration	22	
35	8	Nadir, ESM scanning, swath width 960 km	65	
36	32	see above	59	
37	7	see above	65	
38	32	see above	59	
39	7	see above	65	
40	32	see above	59	
41	7	see above	65	
42	32	see above	59	
43	6	see above	65	
44	33	Limb, ESM & ASM scanning, swath width 960 km	59	
45	6	see above	65	
46	34	Limb, ESM & ASM scanning, swath width 960 km	59	
47	6	see above	65	
48	34	see above	59	
49	5	see above	65	
50	35	Limb, ESM & ASM scanning, swath width 120 km	59	
51	4	see above	65	
52	36	Limb, ESM & ASM scanning, swath width 120 km	59	
53	4	see above	65	
54	3	see above	80	
55	3	see above	80	
56	2	see above	80	
57	2	see above	80	
58	1	see above	80	T_1+3905.6
59 ff.	26			
	63			T_1+6036.0

The following tables are the fully calculated examples from section 3.2.2 on page 59.

State 3:

No	***Description***	***Type length***	***Cluster per pixel***	***Elements***	***Size***
1	Start time	12		1	12
2	DSR length	4		1	4
3	Quality indicator	1		1	1
4	Saturation flags	1		40	40
5	Sun glint / Rainbow flags	1		40	40
6	Geolocation	108		40	4320
7	Level 0 data packest	72		40	2880
8	Integrated PMD values	4		4480	17920
9	Fractional polarisation values	244		65	15860
10	Cluster Data 1	4	5	1	20
11	Cluster Data 2	4	528	1	2112
12	Cluster Data 3	4	24	4	384
13	Cluster Data 4	4	40	4	640
14	Cluster Data 5	4	5	4	80
15	Cluster Data 6	4	5	4	80
16	Cluster Data 7	4	96	4	1536
17	Cluster Data 8	4	643	4	10288
18	Cluster Data 9	4	52	20	4160
19	Cluster Data 10	4	44	20	3520
20	Cluster Data 11	4	5	20	400
21	Cluster Data 12	5	5	20	500
22	Cluster Data 13	4	46	40	7360
23	Cluster Data 14	5	82	20	8200
24	Cluster Data 15	4	103	40	16480
25	Cluster Data 16	4	205	40	32800
26	Cluster Data 17	5	185	20	18500
27	Cluster Data 18	5	21	20	2100
28	Cluster Data 19	4	41	40	6560
29	Cluster Data 20	5	20	20	2000
30	Cluster Data 21	5	161	20	16100
31	Cluster Data 22	4	66	40	10560
32	Cluster Data 23	5	5	20	500
33	Cluster Data 24	5	5	20	500
34	Cluster Data 25	4	75	40	12000
35	Cluster Data 26	5	134	20	13400
36	Cluster Data 27	5	23	20	2300
37	Cluster Data 28	4	46	40	7360
38	Cluster Data 29	5	23	20	2300
39	Cluster Data 30	5	398	20	39800
40	Cluster Data 31	4	116	40	18560
41	Cluster Data 32	5	23	20	2300
42	Cluster Data 33	4	92	40	14720
43	Cluster Data 34	5	5	20	500
44	Cluster Data 35	4	5	20	400
45	Cluster Data 36	4	69	20	5520
46	Cluster Data 37	4	173	20	13840
47	Cluster Data 38	4	18	20	1440
48	Cluster Data 39	4	33	20	2640

No	Description	Type length	Cluster per pixel	Elements	Size
49	Cluster Data 40	4	18	20	1440
50	Cluster Data 41	4	396	20	31680
51	Cluster Data 42	4	34	20	2720
52	Cluster Data 43	4	35	20	2800
53	Cluster Data 44	4	138	20	11040
54	Cluster Data 45	4	5	20	400
55	Cluster Data 46	3	10	20	600
56	Cluster Data 47	3	51	20	3060
57	Cluster Data 48	3	230	20	13800
58	Cluster Data 49	3	24	20	1440
59	Cluster Data 50	3	168	20	10080
60	Cluster Data 51	3	25	20	1500
61	Cluster Data 52	3	174	20	10440
62	Cluster Data 53	3	62	20	3720
63	Cluster Data 54	3	124	20	7440
64	Cluster Data 55	3	63	20	3780
65	Cluster Data 56	3	10	20	600
66	Cluster Data 57	3	10	20	600
67	Cluster Data 58	3	877	20	52620
68	Cluster Data 59	3	10	20	600
69	Cluster Data 60	3	10	20	600
70	Cluster Data 61	3	878	20	52680
71	Cluster Data 62	3	10	20	600
					537777

State 53:

No	Description	Type length	Cluster per pixel	Elements	Size
1	start time	12		1	12
2	DSR length	4		1	4
3	quality indicator	1		1	1
4	geolocation	20		1	20
5	Level 0 data packest	72		1	72
6	Cluster Data 1	5	5	1	25
7	Cluster Data 2	5	528	1	2640
8	Cluster Data 3	5	64	1	320
9	Cluster Data 4	5	5	1	25
10	Cluster Data 5	5	5	1	25
11	Cluster Data 6	5	739	1	3695
12	Cluster Data 7	5	96	1	480
13	Cluster Data 8	5	5	1	25
14	Cluster Data 9	5	5	1	25
15	Cluster Data 10	5	930	1	4650
16	Cluster Data 11	5	5	1	25
17	Cluster Data 12	5	5	1	25
18	Cluster Data 13	5	931	1	4655
19	Cluster Data 14	5	5	1	25
20	Cluster Data 15	5	5	1	25
21	Cluster Data 16	5	914	1	4570
22	Cluster Data 17	5	5	1	25
23	Cluster Data 18	4	10	1	40
24	Cluster Data 19	4	933	1	3732
25	Cluster Data 20	4	10	1	40
26	Cluster Data 21	4	10	1	40
27	Cluster Data 22	4	877	1	3508
28	Cluster Data 23	4	10	1	40
29	Cluster Data 24	4	10	1	40
30	Cluster Data 25	4	878	1	3512
31	Cluster Data 26	4	10	1	40
					32361